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FAA AIP No. - 3-27-0024-50-11
RS&H PROJ. No. – 214.1882.091
CITY OF DULUTH BID No. 11-4401

PROJECT MANUAL

VOLUME 4 OF 4

Date: FEBRUARY 3, 2011

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SECTION 16050 - BASIC ELECTRICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this and the other sections of Division 16.

1.2 SUMMARY

A. This Section includes general requirements for electrical installations. These requirements are applicable to all Division 16 work. The following requirements are included in this Section to expand the requirements specified in Division 1:

1. Submittals.
2. Coordination drawings.
3. Record documents.
4. Maintenance manuals.
5. Rough-ins.
6. Electrical installations.
7. Cutting and patching.
8. Codes, Permits and Inspections.
9. Separation of Work Between Trades.
10. Definitions and Interpretations.
11. Energy Conservation Rebate Programs.

1.3 SUSTAINABLE DESIGN

A. Sustainable Design Intent: Comply with project requirements intended to achieve a Certified Rating, measured and documented according to the LEED Green Building Rating System, of the US Green Building Council.

B. LEED Certification Documentation: Submit documentation from the manufacturer highlighting LEED requirements for materials and products of this Section.

C. Comply with the requirements of Division 1 Section “LEED REQUIREMENTS”.

D. Construction Waste Management: Comply with the requirements of Division 1, Section “Construction Waste Management”, for removal and disposal of construction debris and waste.

1.4 SUBMITTALS

A. General: Follow the procedures specified in Division 1 Section "SUBMITTALS."

B. Additional copies may be required by individual sections of these Specifications.

1.5 COORDINATION DRAWINGS

A. Prepare coordination drawings in accordance with Division 1 to a scale of 1/4"=1'-0" (1:50) or larger; detailing major elements, components, and systems of electrical equipment and materials in relationship with other systems, installations, and building components in all electric rooms including 1st floor main electrical room, 2nd floor electrical room and 3rd floor electrical room. Indicate locations where space is limited for installation and access and where sequencing and coordination of installations are of importance to the efficient flow of the Work, including (but not necessarily limited to) the following:

1. Indicate the proposed locations of major raceway systems, equipment, and materials. Include the following:

(a) Clearances for servicing equipment, including space for equipment disassembly required for periodic maintenance.

(b) Exterior wall and foundation penetrations.

(c) Fire-rated wall and floor penetrations.

(d) Equipment connections and support details.

(e) Sizes and location of required concrete pads and bases.

2. Indicate scheduling, sequencing, movement, and positioning of large equipment into the building during construction.

3. Prepare floor plans, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.

B. Project Coordination Drawings

1. This Trade shall add to Coordination Drawings prepared by the HVAC Contractor showing all of the electrical work (equipment, conduit, etc.) to be installed as part of the work of this section of the specifications.

2. Requirements for vibration isolation and seismic restraints shall be shown on the coordination drawings by each trade.

3. This Trade after showing all of the electrical work shall forward the completed electronic AutoCAD files to the General Contractor/Construction Manager.

4. The Electrical Contractor shall attend a series of meetings arranged by the General Contractor/Construction Manager to resolve any real or apparent interferences or conflicts with the work of the other Contractors.

5. The Electrical Contractor shall then make adjustments to his work on the Coordination Drawings to resolve any real or apparent interferences or conflicts.

6. After any real or apparent interferences and conflicts have been incorporated into the Coordination Drawings, the Electrical Contractor shall “sign-off” the final Coordination Drawings.

7. The Electrical Contractor shall not install any of this work prior to “sign-off” of final Coordination Drawings. If the electrical work proceeds prior to sign-off of Coordination Drawings, any change to the electrical work to correct the interferences and conflicts which result will be made by the Electrical Contractor at <u>no additional cost to the project.</u>]

1.6 RECORD DOCUMENTS

A. Prepare record documents in accordance with the requirements in Division 1. In addition to the requirements specified in Division 1, comply with the following:

1. A complete set of "as-built" or record electric drawings shall be made up and delivered to the Architect.

2. The drawings shall show:-

(a) All electric work installed exactly in accordance with the original design.

(b) All electric work installed as a modification or addition to the original design.

(c) The dimensional information necessary to delineate the exact location of all circuitry and wiring runs (other than lighting and appliance branch circuitry and small control, signal and communications runs) which are so buried or concealed as to be untraceable by inspection through the regular means of access established for inspection and maintenance.

(d) The numbering information necessary to correlate all electrical energy consuming items (or outlets for same) to the panel or switchboard circuits from which they are supplied.

3. The drawings shall be produced using AutoCAD software. The design drawing files will be made available should it be determined that such files would serve as suitable backgrounds for the "as-built" drawings. These documents remain the property of Cosentini Associates and may be used for no other purpose without expressed, written consent. The contractor shall assume all liabilities resulting from unauthorized use or modifications to the drawings.

4. "As-built" information shall be submitted as follows:
   (a) CADD drawing files on CD-R in AutoCAD format.
   (b) One (1) set of reproducible drawings.
   (c) Two (2) sets of blueprints.

5. The quantity of design drawings which are made available shall in no way be interpreted as setting a limit to the number of drawings necessary to show the required "as-built" information.

6. Progress prints of record drawings shall be submitted monthly during the construction period for Architect's approval.

1.7 MAINTENANCE MANUALS

A. Prepare maintenance manuals in accordance with Division 1. In addition to the requirements specified in Division 1, include the following information for major equipment items such as engine generator set(s), UPS equipment, alarm system(s), communications systems, transformers, busways, switchgear, switchboards, panelboards, automatic transfer switches, lighting fixtures, and other items as specified elsewhere.

1. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of replacement parts.

2. Manufacturer's printed operating procedures include start-up, break-in, and routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions.

3. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.

4. Servicing instructions.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to the project properly identified with names, model numbers, types, grades, compliance labels, and other information needed for identification.

1.9 CODES, PERMITS AND INSPECTIONS

A. All work shall meet or exceed the latest requirements of all national, state, county, municipal, and other authorities exercising jurisdiction over electrical construction work and the project.

B. All required permits and inspection certificates shall be obtained, paid for, and made available at the completion of the work.

C. Any portion of the work which is not subject to the requirements of an electric code published by a specific authority having jurisdiction shall be governed by the National Electrical Code and other applicable sections of the National Fire Code, as published by the National Fire Protection Association.

D. Equipment, material, layout and installation provided as part of the electrical work shall conform to the requirements of all agencies having jurisdiction. Include as part of the electrical work all required filings and submissions for approval. Equipment furnished separate from - but installed as part of - the electrical work, which does not have all necessary approvals, shall not be installed until approvals are obtained by the parties furnishing the equipment.

E. Installation procedures, methods and conditions shall comply with the latest requirements of the Federal Occupational Safety and Health Administration (OSHA).

F. All equipment furnished as part of the electrical work shall comply with the latest editions of all applicable state and municipal “energy codes.” Provide certification from the equipment suppliers for all energy-consuming equipment that the equipment fully complies with these codes. Equipment submissions will not be accepted for review unless accompanied by such certification in writing.

1.10 GUARANTEES AND CERTIFICATIONS

A. All work shall be guaranteed to be free from defects. Any defective materials or workmanship as well as damage to the work of all trades resulting from same shall be replaced or repaired as directed for the duration of stipulated guaranteed periods.

B. The duration of guarantee periods following the date of beneficial use of the system shall be one year. Beneficial use is defined as operation of the system to obtain its intended use.

C. The date of acceptance shall be the date of the final payment for the work or the date of a formal notice of acceptance, whichever is earlier.

D. Non-durable items such as electric lamps, shall be replaced up to the date of acceptance, such that they shall have had no more than 100 hours use prior to this date.

E. Certification shall be submitted attesting to the fact that specified performance criteria are met by all items of electrical equipment for which such certifications is required.

1.11 SEPARATION OF WORK BETWEEN TRADES

A. The specifications for the overall construction delineate various items of work under separate trade headings. The list below sets forth this delineation to the extent that it affects the electric work.

B. In the absence of more detailed information, the list shall be taken as a specific instruction to the electrical trade to include the work assigned to it.

C. Indications that any trade is to perform an item of work means that it is to perform the work for its own accommodation only, except as specifically noted otherwise.

Oth	=	Other than electrical or mechanical.
Plb	=	Plumbing
FP	=	Fire Protection

Htg	=	Heating, Ventilating & Air Conditioning
Elec	=	Electrical.
f	=	Furnished.
i	=	Installed.
p	=	Provided (furnished and installed).

Item	Oth	Plb	FP	Htg	Elec	Note
Motors for mechanical equipment.		p	p	p		
Motor controllers for:						Specifications and drawings delineate exceptions.
Htg				f	i	
Plb		f			i	Includes motor control centers if applicable.
FP			f			
Motor control devices for:						Specifications and drawings delineate exceptions.
Htg				p		
Plb		p				Control devices for mounting within controller are provided integral with controller.
FP			p			
Power wiring for motors:						
Htg					p	
Plb					p	
FP						
Control wiring for motor controllers:						Specifications and drawings delineate exceptions.
Htg				p		
Plb					p	
FP					p	

Item	Oth	Plb	FP	Htg	Elec	Note
Temporary light and power.	p					See General conditions specifications. To accommodate all trades.
Temporary water.	p					
Temporary heat.	p					
Temporary toilets.	p					
Hoisting.					p	
Rigging.					p	
Bracing and dunnage for safe rigging.					p	
Cutting, chasing and patching.	p					Cost where due to late installation or improper coordination of work is the responsibility of the electric.
Framed slots and openings in walls, decks and slabs.	p					Coordination drawings are required from the electric.
Sleeves through non-waterproof slabs, decks and walls.					p	Includes drilling of holes when required.
Sleeves through waterproof slabs, decks and walls.					p	Includes drilling of holes for other than field poured concrete.
Waterproof sealing of sleeves through waterproof slabs, decks and walls.					p	
Fireproof sealing (fire-stopping) excess opening spaces in slabs, decks and fire-rated walls.					p	

Item	Oth	Plb	FP	Htg	Elec	Note
Excavation and backfill inside buildings.	p					
Excavation and backfill outside buildings.					p	
Concrete encasement of conduits.					p	Red coloring for concrete encasing primary voltage runs included in electric.
Electric manholes and handholes.					p	Furnishing of covers, associated frames and other hardware included in electric.
Fastenings.					p	
Supports.					p	
Flashing of electric conduits through roof (pitch pockets).	p					
Concrete foundations, pads and bases inside buildings.	p					Furnishing of anchors and vibration mounts included in the electric.
Concrete foundations, pads and bases outside buildings.					p	Furnishing of anchors and vibration mounts included in the electric.
Concrete lined trenches in building foundation.	p					
Field touch-up painting of damaged shop coats.					p	
Field rustproof painting of supporting steel members, frames and racks.					p	

Item	Oth	Plb	FP	Htg	Elec	Note
Finish painting of exposed work.	p					Red coloring of exposed fire protection alarm systems circuitry included in electric. Red and white striping of exposed primary voltage runs included in electric.
Finished wall and ceiling access doors, panels and supporting frames.	i				f	Supplying list of locations where required included in electric.
Permanent catwalks to equipment.	p					Supplying list of locations where required included in electric.
Permanent ladders to equipment.	p					Supplying list of locations where required included in electric.
Opening frames for ceiling recessed lighting fixtures and other electrical items.					p	
Luminous ceilings.	p					Lamp strips and lamps included in electric.
Electric duct heaters (heaters installed in air ducts).				p		Line and control connections included in electric.
Electric heaters with integral fans, (unit heaters, cabinet heaters, fan coil units and the like.)				p		Line and control connections included in electric.
Electric radiators (baseboard, sill line and convector type heaters).					p	
Electric water heaters.		p				Line and control connections included in electric.

Item	Oth	Plb	FP	Htg	Elec	Note
Electric boilers.				p		Line and control connections included in electric.
Through wall sleeve type air conditioning and electric heating units.					p	
Electric heater cables for radiant space heating.					p	
Electric heater cables for snow melting.					p	
Electric heater cables for mechanical system pipe tracing.					p	
Electric power consuming items and controls for same not referred to above.	p	p	p	p		Line and control connections to equipment included in electric.
Rubbish removal.					p	Removal of the shipping and packing materials of electrical items is included in the electric regardless by whom the items are furnished.
Special tools for maintenance of equipment furnished as part of electric work.					f	

D. Include in the electrical work all necessary supervision and the issuing of all coordination information to any other trades who are supplying work to accommodate the electrical installations.

E. For items of equipment which are to be installed but not purchased as part of the electrical work, the electrical work shall include:
1. The coordination of their delivery.

2. Their unloading from delivery trucks driven in to any point on the property line at grade level.

3. Their safe handling and field storage up to the time of permanent placement in the project.

4. The correction of any damage, defacement or corrosion to which they may have been subjected.

5. Their field make-up and internal wiring as may be necessary for their proper operation.

6. Their mounting in place including the purchase and installation of all dunnage, supporting members, and fastenings necessary to adapt them to architectural and structural conditions.

7. Their connection to building wiring including the purchase and installation of all "crown boxes" or other type of termination junction boxes necessary to adapt and connect them to this wiring. Included also shall be the purchase and installation of any substitute lugs or other wiring terminations as may be necessary to adapt their terminals to the building wiring as called for and to the connection methods set forth in these specifications.

F. Items of equipment which are installed but not purchased as part of the electrical work shall be carefully examined upon delivery to the project. Claims that any of these items have been received in such condition that their installation will require procedures beyond the reasonable scope of the electric work will be considered only if presented in writing within one week of the date of delivery to the project of the items in question. The electric work includes all procedures, regardless of how extensive, necessary to put into satisfactory operation, all items for which no claims have been submitted as outlined above.

1.12 DEFINITIONS AND INTERPRETATIONS

A. As used in the drawings and specifications for electrical work, certain non-technical words shall be understood to have specific meanings as follows regardless of indications to the contrary in the General Conditions or other documents governing the electric work.

"Furnish" -- Purchase and deliver to the project site complete with every necessary appurtenance and support, all as part of the electrical work. Purchasing shall include payment of all sales taxes and other surcharges as may be required to assure that purchased items are free of all liens, claims or encumbrances. Payment of sales taxes is, however, specifically excluded.

"Install" -- Unload at the delivery point at the site and perform every operation necessary to establish secure mounting and correct operation at the proper location in the project, all as part of the electrical work.

"Provide" -- "Furnish" and "install."

"New" -- Manufactured within the past two years and never before used.

Regardless of their usage in codes or other industry standards, certain words as used in the drawings or specifications for the electrical work, shall be understood to have the specific meanings ascribed to them in the following list:-

"Circuitry" -- Any electric work (not limited to light and power distribution) which consists of wires, cables, raceways, and/or specialty wiring method assemblies taken all together complete with associated junction boxes, pull boxes, outlet boxes, joints, couplings, splices and connections except where limited to a lesser meaning by specific description.

"Wiring" -- Same as Circuitry.

"Circuit" -- Any specific run of circuitry.

"Branch Circuit" -- Any light and power distribution system circuit which, at its load end, is directly connected to one or more electrical energy consuming items with no overcurrent protection devices interposed, other than (where required) those protecting the energy consuming items from overloading or overheating.

"Appliance Panel" -- Any panel, used in a light and power distribution system, containing single pole and/or multipole branches rated in various sizes.

"Lighting Panel" -- Any panel used in a light and power distribution system, having all (or the majority) of its branches single pole and rated the same.

"Lighting and Appliance Branch Circuitry" -- All or any portion of branch circuits outgoing from a lighting or appliance panel.

"Feeder" -- Any item of light and power circuitry used in a distribution system which is not lighting and appliance branch circuitry.

"Main Feeder" -- Any feeder which, at its supply end, is connected through its own overcurrent protection (and switching) device, and none other, directly to a main service or a main service overcurrent protection (and switching) device.

"Branch Feeder" -- A feeder, other than a main feeder, which complies with the definition of a branch circuit.

"Submain Feeder" -- Any feeder which is neither a main feeder nor a branch feeder.

"Distribution Panel" -- Any panel, used in a light and power distribution system, containing only multi-pole branches and with all (or the majority) of its branches used for feeders supplying other panels.

"Power Panel" -- Same as distribution panel, except with all (or the majority) of its branches used for feeders which do not supply other panels.

"Motor Power Circuit" -- Any circuit which operates nominally at 100 volts or more, and which carries electrical input energy to a motor.

"Motor Control Circuit" (used in conjunction with a motor for which a magnetic starter is supplied) -- Any circuit (other than a motor power circuit), which operates nominally at 100 volts or more, and which carries current intended for directing or indicating the performance of a motor starter.

"Motor Control Circuit" (used in conjunction with a motor for which a manual starter is supplied) -- Any circuit containing an extension of power circuit wires, other than those constituting the direct connection between source of supply, starter and motor.

"Motor Control Actuating Device" -- Any device which performs a switching function in a motor control circuit (pushbuttons, automatic contacting devices, etc.).

"Motor Control Actuated Device" -- Any device which functions in response to voltage received from a motor control circuit (pilot lights, solenoids, etc.)

"Package Unit" -- An item of equipment having one or more motors or other electric energy consuming elements integrally factory mounted on a single base, complete with all associated control devices and interconnecting wiring.

"Low Voltage" -- Below 50 volts.

"Process Control System" -- An overall control and/or logging system of a low voltage, electronic or pneumatic type available as a fully installed "package" from specialty manufacturers (commonly referred to as a "Temperature Control System" or an "Automatic Control System" or a "Building Management System" where used in conjunction with air conditioning).

"Grade Slab" -- A building floor slab which is in contact with or directly over grade (earth).

"Building Confines" -- The extent of a building, as defined by the outside surfaces of its peripheral walls, the top surface of its roof, and the underside surface of its grade slab.

"Distribution Switch" -- Any switch used in a light and power system other than a tumbler, toggle or specialty switch in the "wiring device" category.

"Normal Electric Work Conditions" -- Locations within building confines which are neither damp, wet nor hazardous and which are not used for air handling.

"Underground" -- Subsurface and exterior to building foundations.

"At Underside of Grade Slab" -- Under a grade slab and integrated into it.

"Below Grade Slab" -- Under a grade slab but not integrated into it.

"Standard" (as applied to wiring devices) -- Not of a separately designated individual type.

"Raceway" -- Any pipe, duct, extended enclosure, or conduit (as specified for a particular system) which is used to contain wires, and which is of such nature as to require that the wires be installed by a "pulling in" procedure.

"Specialty Cast-in-Floor Raceway" -- Underfloor duct, cellular deck and the like.

"Concealed" (as applied to circuitry) -- Covered completely by building materials, except for penetrations (by boxes and fittings) to a level flush with the surface as necessitated by functional or specified accessibility requirements.

"Exposed" (as applied to circuitry) -- Not covered in any way by building materials.

"Subject to Mechanical Damage" -- Exposed within seven feet of the floor in mechanical rooms, vehicular spaces, or other spaces where heavy items (over 100 pounds) are moved around or rigged as a common practice or as required for replacement purposes.

"Primary" (as applied to light and power distribution) -- Over 600 volts.

"Secondary" (as applied to light and power distribution) -- Under 600 volts.

"Assembly" -- A defined set of elements of electric work.

B. The following shall be treated as damp or wet locations within building confines, regardless of whether or not a high ambient moisture level is found to exist:-

1. Spaces where any designations indicating weatherproof (WP) or vapor-proof (VP) appear on the drawings.

2. Cooling tower areas.

3. Below waterproofing in slabs applied directly on grade.

4. Kitchens up to a height of 18" above finished floor.

5. Outside of waterproofing in foundation walls in contact with grade.

6. Above waterproofing in slabs having no building above.

7. Above waterproofing in fill on slabs having no building above.

8. Spaces containing equipment owned and/or maintained by the electric utility company.

C. Electric work in slabs, walls or suspended ceilings which bound on a space defined as a damp or wet location shall meet the damp or wet location requirements if it enters into, or opens into the damp or wet location in any way.

D. Where the word "conduit" is used without specific reference to type, it shall be understood to mean "raceway".

E. Except where modified by a specific notation to the contrary, it shall be understood that the indication and/or description of any electrical item in the drawings and specifications for electrical work carries with it the instruction to furnish, install and connect the item as part of the electrical work regardless of whether or not this instruction is explicitly stated.

F. It shall be understood that the specifications and drawings are complementary and are to be taken together for a complete interpretation of the work. Where there are conflicts between the drawings and specifications or within the specifications or drawings themselves, the items of higher standard shall govern.

G. To the extent that they govern the basic work, the specifications also govern change order work if any.

H. No exclusion from or limitation in, the symbolism used on the drawings for electrical work or the language used in the specifications for electrical work shall be interpreted as a reason for omitting the appurtenances or accessories necessary to complete any required system or item of equipment.

I. The drawings for electrical work utilize symbols and schematic diagrams which have no dimensional significance. The work shall, therefore, be installed to fulfill the diagrammatic intent expressed on the electrical drawings, but in conformity with the dimensions indicated on the final working drawings, field layouts and shop drawings of all trades. In particular, information as to the exact size, location and electrical connection points for mechanical equipment shall be derived by reference to HVAC and Plumbing documents.

J. Certain details appear on the drawings for electrical work which are specific with regard to the dimensioning and positioning of the work. These are intended only for general information purposes. They do not obviate field coordination for individual items of the indicated work.

K. Information as to general construction and architectural general construction and architectural features and finishes shall be derived from structural and architectural drawings and specifications only.

L. The use of words in the singular shall not be considered as limiting where other indications denote that more than one item is referred to.

M. Ratings of devices, materials and equipment specified without reference to specific performance criteria shall be understood to be nominal or nameplate ratings established by means of industry standard procedures.

N. The restriction of conductors in wires to copper, as specified elsewhere, shall be understood to also apply to all conductors (wire, cable or bus as applicable), including those provided as part of factory assembled components such as transformers, switchboards, panelboards, switchgear, overcurrent protection and switching devices. This restriction shall apply equally to all such equipment regardless of indications (or lack thereof) elsewhere to the contrary. Aluminum will not be acceptable.

PART 2 - PRODUCTS

2.1 TOUCH UP PAINT

A. For Equipment: Equipment manufacturer's paint selected to match installed equipment finish.

B. Galvanized Surfaces: Zinc-rich paint recommended by item manufacturer.

2.2 ACCESS DOORS IN FINISHED CONSTRUCTION

A. Access doors as required for operation and maintenance of concealed equipment, valves, controls, etc. will be coordinated by general contractor.

1. Access doors shall be of ample size, minimum of 16 inches x 16 inches (40 cm. x 40 cm.).

B. Furnish (confirm with GC) access doors as required for operation and maintenance of concealed equipment, valves, controls, etc., and coordinate their delivery with the installing Trade.

1. Coordinate and prepare a location, size, and function schedule of access required and deliver to a representative of the installing Trade.

2. Doors shall be minimum size 16 inches x 16 inches (40 cm. x 40 cm.) as manufactured by Karp Associates, Inland Steel Products "Milcor", “MIFAB” or other approved in accordance with the following schedule:

Location	Type	Catalog Number
Plaster Ceiling	Recessed Door Panel	Karp DSC-210-PL Milcor Style AP MIFAB-CAD-PL
Acoustic Tile Ceiling	Recessed Door Panel for Tile	Karp DSC-210 Milcor Style AT MIFAB-CAD
Plaster Wall	Flush Door Panel	Karp DSC-214-PL Milcor Style K MIFAB-CAD-PL-PL
Drywall	Flush Door Panel	Karp DSC-214-M Milcor Style DW MIFAB-MDW
Drywall	Recessed Door Panel	Karp-RDW-210 MIFAB-CAD-FL
Ceramic Tile Walls	Flush Door Panel	Karp DSC-214-M Milcor Style M MIFAB-UA
Masonry Wall	Flush Door Panel	Karp DSC-214-M Milcor Style M MIFAB-UA
3-Hour Rated Masonry Shaft	Flush Door Panel	Karp DSC-211-FRT MIFAB-MPFR-SD
1-1/2 Hour Rated Shaft	Flush Door Panel	Karp KRP-150-FR Milcor Fire Door Rated Access Door Panel MIFAB-MPFR

3. Doors and frames shall be given a factory prime coat of corrosion resistant paint.

4. Type shall be as approved by Architect.

5. Frames shall be welded minimum l4 gauge steel, mitered corners ground smooth with anchors.

6. Finish shall be as selected and approved by Architect.

7. Doors shall be minimum 14 gauge steel, heavy hinges flush with frame, invisible when closed.

PART 3 - EXECUTION

3.1 ROUGH-IN

A. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.

B. Refer to equipment specifications in Divisions 2 through 16 for rough-in requirements.

3.2 ELECTRICAL INSTALLATIONS

A. General: Sequence, coordinate, and integrate the various elements of electrical systems, materials, and equipment. Comply with the following requirements:

1. Coordinate electrical systems, equipment, and materials installation with other building components.

2. Verify all dimensions by field measurements.

3. Arrange for chases, slots, and openings in other building components during progress of construction, to allow for electrical installations.

4. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed.

5. Sequence, coordinate, and integrate installations of electrical materials and equipment for efficient flow of the Work. Give particular attention to large equipment requiring positioning prior to closing in the building.

6. Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide the maximum headroom possible.

7. Install systems, materials, and equipment to conform with approved submittal data, including coordination drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the Work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer conflict to the Architect.

8. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components, where installed exposed in finished spaces.

9. Install electrical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations.

10. Coordinate location of access panels or doors where outlet boxes, junction boxes, or equipment are concealed behind finished surfaces.

11. Install systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope.

B. Coordinate electrical service connections to components furnished by utility companies.

1. Coordinate installation and connection of exterior underground and overhead utilities and services.
2. Comply with requirements of authorities having jurisdiction and of utility company providing electrical power and other services.

C. Locations of all devices, fixtures, and other visible components shall be as indicated on the architectural drawings. Mounting heights shall be as specified in Division 16 Section “Raceways and Boxes”.

D. Each piece of mechanical equipment located outside the building or on the roof shall be within 25 feet (7 m) of a duplex outlet. Where necessary to meet this criteria, provide duplex outlets in addition to those devices shown on the drawings. Each shall be complete with waterproof cover and integral GFI protection, and 20 ampere circuitry to the nearest 120 volt panel on the proper electric meter.

3.3 FIRESTOPPING

A. Apply firestopping to cable and raceway penetrations of fire-rated floor and wall assemblies to achieve fire-resistance rating of the assembly. Firestopping materials and installation requirements are specified in Division 7 Section "Firestopping."

3.4 FOUNDATIONS

A. General

1. All equipment, including but not limited to Switchgear, Switchboards, Motor control centers, Generators, Uninterruptible power supplies and battery racks, Automatic transfer switches, transformers shall be provided with foundations.

2. Furnish shop drawings showing adequate concrete reinforcing steel details and templates for all concrete foundations and supports, and all required anchor bolts and other appurtenances necessary for the proper installation of this equipment. All concrete work shall be shown in detail on the shop drawings, prepared by this trade.

3. Each piece of equipment shall be set on a concrete base minimum 4 inches (10 cm.) high and extending 3 inches (8 cm.) beyond the equipment in all directions. Bases shall be integrally keyed to structural slab.

3.5 CUTTING AND PATCHING

A. General: Perform cutting and patching in accordance with Division 1 Section "Cutting and Patching." In addition to the requirements specified in Division 1, the following requirements apply:

1. Perform cutting, fitting, and patching of electrical equipment and materials required to:

(a) Uncover Work to provide for installation of ill-timed Work.

(b) Remove and replace defective Work.

(c) Remove and replace Work not conforming to requirements of the Contract Documents.

(d) Upon written instructions from the Architect, uncover and restore Work to provide for Architect observation of concealed Work.

2. Protection of Installed Work: During cutting and patching operations, protect adjacent installations.

3. Patch finished surfaces and building components using new materials specified for the original installation and experienced Installers.

B. Identify for future use with a tag at each unterminated end all low voltage (audio, data, Class 2, Class 3, PLTC, fire alarm, optical fiber, communications, coaxial, and network) cables.

3.6 REFINISHING AND TOUCH UP PAINTING

A. Clean damaged and disturbed areas and apply primer, intermediate, and finish coats to suit the degree of damage at each location.

B. Follow paint manufacturer's written instructions for surface preparation and for timing and application of successive coats.

C. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.

D. Repair damage to PVC or paint finishes with matching touch up coating recommended by manufacturer.

3.7 FIELD QUALITY CONTROL

A. Inspect installed components for damage and faulty work, including the following:

1. Cutting and patching for electrical construction.

2. Touch up painting.

3.8 CLEANING AND PROTECTION

A. On completion of installation, including outlets, fittings, and devices, inspect exposed finish. Remove burrs, dirt, paint spots, and construction debris.

B. Protect equipment and installations and maintain conditions to ensure that coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.

END OF SECTION 16050

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes computer-based, fault-current and overcurrent protective device coordination studies, and the setting of these devices. Protective devices shall be set based on results of the protective device coordination study.

1. Fully rated systems are required.

1.3 SUBMITTALS

A. Product Data: For computer software program to be used for studies.

B. Product Certificates: For coordination-study and fault-current-study computer software programs, certifying compliance with IEEE 399.

C. Qualification Data: For coordination-study specialist.

D. Other Action Submittals:
The following submittals shall be made after the approval process for system protective devices has been completed. Submittals shall be in print and electronic form. Provide 2 copies of the studies on separate CD's so that it can be reviewed using the same software that was used to perform the study.

1. Coordination-study input data, including completed computer program input data sheets.

2. Coordination-study report.

3. Equipment evaluation report.

4. Setting report.

5. Flash hazard analysis.

1.4 QUALITY ASSURANCE

A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are not acceptable.

B. Coordination-Study Specialist Qualifications: An entity in the application of computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.

1. Professional engineer, licensed in the state where the Project is located, shall be responsible for the study. All elements of the study shall be performed under the direct supervision and control of engineer.

C. Comply with IEEE 399 for general study procedures.

D. Comply with IEEE 242 for short-circuit currents and coordination time intervals.

E. Comply with NFPA 70 as amended by state and local codes.

F. Comply with NFPA 70E for flash hazard analysis.

PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE DEVELOPERS

A. Available Computer Software Developers: Subject to compliance with requirements, companies offering computer software programs that may be used in the Work include, but are not limited to, the following:

1. CYME International, Inc.

2. EDSA Micro Corporation.

3. Electrical Systems Analysis, Inc.

4. SKM Systems Analysis, Inc.

2.2 COMPUTER SOFTWARE PROGRAM REQUIREMENTS

A. Comply with IEEE 399.

B. Analytical features of fault-current-study computer software program shall include "mandatory," "very desirable," and "desirable" features as listed in IEEE 399, Table 7-4.

C. Computer software program shall be capable of plotting and diagraming time-current-characteristic curves as part of its output. Computer software program shall report device settings and ratings of all overcurrent protective devices.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine Project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance.

B. Proceed with coordination study only after relevant equipment submittals have been assembled. Overcurrent protective devices not submitted for approval with coordination study may not be used in study.

3.2 FAULT-CURRENT STUDY

A. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project and use approved computer software program to calculate values.

B. Calculate momentary and interrupting duties on the basis of maximum available fault current.

C. Calculations to verify interrupting ratings of overcurrent protective devices shall comply with the following:

1. Low-Voltage Circuit Breakers: IEEE 1015 and IEEE C37.50.

2. Low-Voltage Fuses: IEEE C37.46.

3. Circuit Breakers: IEEE C37.13.

D. Study Report: Enter calculated X/R ratios and interrupting (5-cycle) fault currents on electrical distribution system diagram of the report. List other output values from computer analysis, including momentary (1/2-cycle), interrupting (5-cycle), and 30-cycle fault-current values for 3-phase, 2-phase, and phase-to-ground faults.

E. Equipment Evaluation Report: Prepare a report on the adequacy of overcurrent protective devices by comparing fault-current ratings of these devices with calculated fault-current momentary and interrupting duties. Adjust device settings as required.

F. Flash Hazard Analysis: Determine the Flash Protection Boundary and the personal protective equipment that people within the Flash Protection Boundary shall use. Provide information required to properly label each piece of equipment to conform to the requirements of the applicable codes and standards.

3.3 COORDINATION STUDY

A. Gather and tabulate the following input data to support coordination study:

1. Product Data for overcurrent protective devices specified in other Division 16 Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.

2. Impedance of utility service entrance.

3. Electrical distribution system diagram showing the following:

   (a) Load current that is the basis for sizing continuous ratings of circuits for cables and equipment.

   (b) Circuit-breaker and fuse-current ratings and types.

   (c) Relays and associated power and current transformer ratings and ratios.

   (d) Transformer kilovolt amperes, primary and secondary voltages, connection type, impedance, and X/R ratios.

   (e) Generator kilovolt amperes, size, voltage, and source impedance.

   (f) Cables. Indicate conduit material, sizes of conductors, conductor material, conductor insulation, and length.

   (g) Busway ampacity and impedance.

   (h) Motor horsepower and code letter designation according to NEMA MG 1.

4. Data sheets to supplement electrical distribution system diagram, cross-referenced with tag numbers on diagram:

   (a) Special load considerations, including starting inrush currents and frequent starting and stopping.

   (b) Magnetic inrush current overload capabilities of transformers.

   (c) Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.

   (d) Ratings, types, and settings of utility company's overcurrent protective devices.

   (e) Special overcurrent protective device settings or types stipulated by utility company.

   (f) Time-current-characteristic curves of devices indicated to be coordinated.

(g) Manufacturer, frame size, interrupting rating in amperes RMS symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers.

(h) Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.

(i) Panelboards, switchboards, motor-control center ampacity, and interrupting rating in amperes RMS symmetrical.

B. Perform coordination study and prepare a written report using the results of fault-current study and approved computer software program. Comply with IEEE 399.

C. Comply with NFPA 70, as amended by state and local codes for coordination of devices, and for overcurrent protection of circuit elements and devices.

1. Emergency Systems and Legally Required Standby Systems: Distribution system shall be selectively coordinated. Series rated devices shall not be used for distribution, regardless of any indication to the contrary.

D. Comply with IEEE recommendations for fault currents and time intervals.

E. Transformer Primary Overcurrent Protective Devices:

1. Device shall not operate in response to the following:

(a) Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.

(b) Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.

2. Device shall protect transformer according to IEEE C57.12.00, for fault currents.

F. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and conductor melting curves in IEEE 242. Verify adequacy of phase conductors at maximum three-phase bolted fault currents, equipment grounding conductors, and grounding electrode conductors at maximum ground-fault currents.

G. Coordination-Study Report: Prepare a written report indicating the following results of coordination study:

1. Tabular Format of Settings Selected for Overcurrent Protective Devices:

(a) Device tag.
(b) Relay-current transformer ratios; and tap, time-dial, and instantaneous-pickup values.
(c) Circuit-breaker sensor rating; and long-time, short-time, and instantaneous settings.
(d) Fuse-current rating and type.
(e) Ground-fault relay-pickup and time-delay settings.

2. Coordination Curves: Prepared to determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between series devices, including power utility company's upstream devices. Show the following specific information:

(a) Device tag.
(b) Voltage and current ratio for curves.
(c) Three-phase and single-phase damage points for each transformer.
(d) No damage, melting, and clearing curves for fuses.
(e) Cable damage curves.
(f) Transformer inrush points.
(g) Maximum fault-current cutoff point.

3. Completed data sheets for setting of overcurrent protective devices.

3.4 OVERCURRENT PROTECTIVE DEVICE SETTING

A. Manufacturer's Field Service: Engage a factory-authorized service representative, of electrical distribution equipment being set and adjusted, to assist in setting of overcurrent protective devices within equipment.

B. Testing: Perform the following device setting and prepare reports:

1. After installing overcurrent protective devices and during energizing process of electrical distribution system, perform the following:

(a) Verify that overcurrent protective devices meet parameters used in studies.
(b) Adjust devices to values listed in study results.

2. Adjust devices according to recommendations in Chapter 7, "Inspection and Test Procedures," and Tables 10.7 and 10.8 in NETA ATS.

END OF SECTION 16055

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes grounding of electrical systems and equipment. Grounding requirements specified in this Section may be supplemented in other sections of these Specifications.

B. Related sections include the following:

1. Division 16 Section "Conductors and Cables."

2. Division 16 Section "Raceways and Boxes."

3. Division 16, Section "Underground Ducts and Utility Structures."

4. Division 16, Section "Lightning Protection."

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

1. Ground rods, connectors, exothermic welds, ground bars, grounding conductors and other components of system.

B. Field Test Reports: Written reports specified in Part 3.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by Underwriters Laboratories, Inc.

B. Comply with UL 467.

C. Comply with NFPA 70, as amended by state and local codes.

D. Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system.

E. Comply with applicable BICSI standards.

F. Comply with ANSI/IEEE 142

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the Work include, but are not limited to, the following:

1. Erico Products, Inc.

2. Ideal Industries, Inc.

3. Kearney.

4. O-Z/Gedney Co.

5. Raco, Inc.

6. Thomas & Betts, Electrical

2.2 GROUNDING CONDUCTORS

A. For insulated conductors, comply with Division 16 Section "Conductors and Cables."

B. Material: Copper

C. Equipment Grounding Conductors: Insulated with green-colored insulation.

D. Isolated Ground Conductors: Insulated with green-colored insulation with yellow stripe. On feeders with isolated ground, use colored tape - alternating bands of green and yellow tape to provide a minimum of three bands of green and two bands of yellow.

E. Grounding Electrode Conductors: Stranded cable.

F. Underground Conductors: Bare, tinned, stranded, unless otherwise indicated.

G. Bare Copper Conductors: Comply with the following:

1. Solid Conductors: ASTM B 3.

2. Assembly of Stranded Conductors: ASTM B 8.

3. Tinned Conductors: ASTM B 33.

H. Copper Bonding Conductors: As follows (except where otherwise indicated):

1. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG copper conductor, 0.25-inch (6.4 mm) in diameter.

2. Bonding Conductor: No. 4 or No. 6 AWG, stranded copper conductor.

3. Bonding Jumper: Bare copper tape, braided bare copper No. 30 AWG conductors, terminated with copper ferrules; 1.625 inch (42 mm) wide and 1/16 inch (1.5 mm) thick.

4. Tinned Bonding Jumper: Tinned-copper tape, braided copper No. 30 AWG conductors, terminated with copper ferrules; 1-5/8 inches (42 mm) wide and 1/16 inch (1.5 mm) thick.

I. Grounding Bus: Bare, annealed copper bars of rectangular cross section, 1/4 by 2 inches (6 by 50 mm) in cross section, unless otherwise indicated; with mounting insulators.

2.3 CONNECTOR PRODUCTS

A. Comply with IEEE 837 and UL 467; listed for use for specific types, sizes, and combinations of conductors and connected items.

B. Connectors: Bolted-pressure-type connectors, or compression type.

C. Bolted Clamps: Heavy-duty type.

D. Pressure Connectors: High-conductivity-plated units.

E. Main Grounding System - Welded Connections: Exothermic-welded type, in kit form, and selected per manufacturer's written instructions for the specific types, sizes, and combinations of conductors and other items to be connected.

1. Manufacturer: Erico “Cadweld” system.

2.4 GROUNDING ELECTRODES

A. Ground Rods: Copper-clad steel with high-strength steel core and electrolytic-grade copper outer sheath, molten welded to core.

1. Size: 3/4 inch by 10 feet (19 by 3000 mm).

PART 3 - EXECUTION

3.1 APPLICATION

A. Equipment Grounding Conductor Application: Comply with NFPA 70, as amended by state and local codes, for sizes and quantities of equipment grounding conductors except where specific types, larger sizes or more conductors are indicated.

1. Provide equipment grounding conductors with circuit conductors for all feeders and branch circuits.

B. Signal and Communications: For telephone, alarm, voice and data and other communication systems, provide a #4 AWG minimum green insulated copper conductor in raceway from the grounding electrode system to each service location, antenna, terminal cabinet, wiring closet and central equipment location.

C. The ground bus of switchboards and switchgear shall be connected to the main grounding electrode by means of insulated grounding electrode conductors run in intermediate metallic conduit and sized as per Code.

D. The neutral bar of each individually enclosed service switch shall be bonded to its enclosure on the line side of a removable link (included therein), and connected to the main grounding electrode by means of insulated grounding electrode conductors run in intermediate metallic conduit and sized as per Code.

E. The emergency generator system neutral shall be grounded by means of a connection from the [neutral bar in the generator main circuit breaker enclosure to the main grounding electrode by means of an insulated grounding electrode conductor run in intermediate conduit and sized as per Code. Include a bonding connection from the neutral to the equipment enclosure.

F. The Uninterruptible Power Source (UPS) system neutral shall be grounded by means of a connection from the neutral bar in the UPS main circuit breaker enclosure to the main grounding electrode by means of an insulated grounding electrode conductor run in intermediate conduit and sized as per Code. Include a bonding connection from the neutral to the equipment enclosure.

G. The main grounding electrode shall be an accessible point on the nearest metallic main water service pipe. Connection shall be made on the street side of the main valve utilizing a ground clamp of a type specifically manufactured for the purpose. Bonding jumpers shall be provided around the water meters (if provided) and around insulating joints and/or sections, utilizing conductors sized as per Code and run in IMC. Bond the structural steel to the grounding electrode system.

H. The water pipe ground shall be supplemented by an additional "made" electrode consisting of buried ground rods, and provided in sufficient quantity so as to have a measured resistance to ground of not more than 5 ohms. Establish a bonding connection from the "made" electrode consisting of green insulated conductors run in IMC and sized as per Code.

I. Bond the reinforcing bars in concrete to the nearest grounding electrode. Where reinforcing bars are installed in building foundations and footings protect the bonding conductor during construction. Arrange for inspection by the authority having jurisdiction prior to placement of concrete.

J. The neutral of secondary winding of each low voltage (i.e., less than 600 volts) transformer shall be grounded to the grounding electrode as specified hereinafter by means of an insulated grounding conductor sized as per Code and run in IMC. The neutral of each transformer shall be bonded to the transformer enclosure by means of an insulated conductor sized as per code. If not factory installed the jumper shall be field installed within the transformer enclosure.

K. At each secondary voltage to secondary voltage transformer, bond the metallic water piping system to the transformer neutral at the nearest available location utilizing conductors sized equal to the grounding electrode conductor and run in conduit.

L. The grounding electrode for each low voltage (both windings 600 volts or less) transformer shall be the main water service pipe entering the building taken at a point on the street side of its main valve. Utilize a common ground clamp on the main water pipe, with means for connecting the multiple separate grounding conductors from the various transformers. In lieu of multiple separate grounding conductors, multiple connection to a "ground bus cable" may be utilized. The ground bus cable shall consist of a 500 MCM green coded insulated copper conductor run in 1-1/2 inch (DN 41) threaded steel conduit from the street side of the main water service valve, throughout the building to all dry type transformer locations requiring grounding. The ground bus cable shall be connected to the main water pipe by means of a ground clamp of a type specifically manufactured for the purpose. At each transformer location, establish a "grounding electrode" connection point by arranging a break in the "ground bus cable" conduit exposing the cable for not more than a twelve inch length. Ends of conduit at the break shall be equipped with bushings. The connection shall be made by means of an irreversible compression connector listed for the purpose or an exothermic weld.

M. Include a properly sized green insulated grounding conductor within the conduit for each feeder supplying a panel containing an isolated ground bus (i.e., insulated from ground). Increase indicated conduit size if necessary to accommodate this conductor. Connect to the neutral grounding facility for feeders originating at the service entry point or at 480-120/208 volt stepdown transformers as applicable.

N. Bond metallic conduits containing grounding electrode conductors and main bonding conductors to the ground bus service enclosure and/or grounding electrode at both ends of each run utilizing grounding bushings and jumpers. Bonding jumpers shall be sized equal to the grounding electrode conductors.

O. Provide grounding bonds for all metallic conduits of the light and power system which terminate at (or in pits below) distribution equipment for which a ground bus is specified. Accomplish this by equipping the conduits with bushings of the grounding type connected individually to the ground bus.

P. Provide supplementary ground bonding to maintain continuity of the equipment and raceway grounding system as follows:

1. Bonding jumpers shall be applied where wiring devices (receptacles and switches) are not equipped with approved self-grounding features. Include any necessary field modifications for termination of the bonding jumpers so as to insure grounding continuity.

2. Bonding jumpers shall be applied to insure that grounding continuity does not depend solely on the supporting screws fastening metallic enclosures together.

3. Include any necessary field modifications for termination of the bonding jumpers so as to insure grounding continuity.

Q. Provide grounding of raised metallic floors used to contain wiring to computers and/or other equipment. Where the floor system is of a type that is specifically designed by the manufacturer to maintain ground continuity through its metallic structural support system, the grounding may be accomplished by means of no fewer than (8) bonding connections spaced equally about the perimeter but in no case more than 100 feet (30 m) apart. Utilize #8 AWG green insulated copper conductors for the connection of the bonding locations to the ground bus in the panel serving the equipment and the service ground point. If the raised floor is to be used as an air handling plenum, the insulation shall be of a fluoropolymer type suitable for use in plenums without raceway. If the floor system is not designed to maintain ground continuity through the metallic structural support system, alternating support pedestals in each direction must be connected to the bonding conductors.

R. Provide a ground connection for each 100 feet (30 m) of run of cable tray, and for each isolated run of less than 100 feet (30 m), by means of a #6 AWG green coded insulated copper conductor run in 3/4 inch (DN 21) conduit. The grounding electrode for each run of cable tray requiring same shall consist of a cadweld connection to adjacent structural steel at a point where only fireproofing and not structural concrete is applied to it or the nearest cold water pipe if steel is not available. Utilize ground clamps of a type specifically manufactured for the purpose.

S. Provide supplementary ground bonding for each motor control center (MCC) as follows:

1. Provide equipment grounding conductors as required to insure that all sections (including attached integral or field installed pullboxes) are bonded together by means of these conductors and by means of the MCC ground bus (if a ground bus is included in the MCC).

2. Provide grounding bushings and jumpers as required to insure that all conduits and any contained equipment grounding conductors are bonded to the enclosure grounding conductors (or ground bus).

T. Where specifically noted on the drawings, or described hereinbefore in this Section, include insulated equipment and raceway grounding conductors run within the raceways. Where insulated equipment grounding conductors required for feeders have not been included in the quantities of conductors indicated on the drawings, incorporate such conductors in accordance with the electrical code. Adjust conduit sizing if required.

U. Common Ground Bonding With Lightning Protection System: Bond electric power system ground directly to lightning protection system grounding conductor at closest point to electric service grounding electrode. Use bonding conductor sized same as system ground conductor and installed in conduit.

V. Grounding Underground Distribution System Components complies with IEEE C2 grounding requirements and the following. Provide additional grounding if required to comply with Utility Company standards.

1. Grounding Manholes and Handholes: Install a driven ground rod through manhole or handhole floor, close to wall, and set rod depth so 4 inches (100 mm) will extend above finished floor. If necessary, install ground rod before manhole is placed and provide No. 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2 inches (50 mm) above to 6 inches (150 mm) below concrete. Seal floor opening with waterproof, non-shrink grout.

2. Grounding Connections to Manhole Components: Bond exposed-metal parts such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with No. 4 AWG minimum, stranded, hard-drawn copper bonding conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields as recommended by manufacturer of splicing and termination kits.

3. Pad-Mounted Transformers and Switches: Install two ground rods and ground ring around the pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with pad mounted equipment by connecting them to underground cable and grounding electrodes. Install tinned-copper conductor not less than No. 2 AWG for ground ring and for taps to equipment grounding terminals. Bury ground ring not less than 6 inches (150 mm) from the foundation.

3.2 INSTALLATION

A. General: Ground electrical systems and equipment according to NFPA 70, as amended by state and local codes, except where Drawings or Specifications exceed such requirements.

B. Grounding Rods: Locate a minimum of 1-rod length from each other and at least the same distance from any other grounding electrode.

1. Drive until tops are 2 inches (50 mm) below finished floor or final grade, except as otherwise indicated.
2. Interconnect with grounding-electrode conductors. Use exothermic welds, except at test wells and as otherwise indicated. Make these connections without damaging copper coating or exposing steel.

C. Grounding Conductors: Route along the shortest and straightest paths possible, except as otherwise indicated. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

D. Underground Grounding Conductors: Use bare copper wire. Bury at least 24 inches (600 mm) below grade.

E. Metal Water Service Pipe: Provide insulated copper grounding conductors, sized as indicated, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes by grounding-clamp connectors. Where a dielectric main water fitting is installed, connect grounding conductor to street side of fitting. Provide a grounding jumper with the same size conductor across dielectric fittings. Bond grounding-conductor conduit to conductor at each end.

F. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with grounding-clamp connectors.

G. Bond interior metal piping systems and metal air ducts to equipment grounding conductors of associated pumps, fans, blowers, electric heaters, and air cleaners. Use braided-type bonding straps.

3.3 CONNECTIONS

A. General: Make connections so possibility of galvanic action or electrolysis is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.
1. Use electroplated or hot-tin-coated materials to assure high conductivity and to make contact points closer in order of galvanic series.
2. Make connections with clean, bare metal at points of contact.
3. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

B. Exothermic-Welded Connections: Use for connections to structural steel and for underground connections, except those at test wells. Comply with manufacturer's written instructions. Welds that are puffed up or that show convex surfaces indicating improper cleaning are not acceptable.

C. Equipment Grounding-Wire Terminations: For No. 8 AWG and larger, use pressure-type grounding lugs. No. 10 AWG and smaller grounding conductors may be terminated with winged pressure-type connectors.

D. Noncontact Metal Raceway Terminations: Where metallic raceways terminate at metal housings without mechanical and electrical connection to housing, terminate each conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor to grounding bus or terminal in housing. Bond electrically noncontinuous conduits at both entrances and exits with grounding bushings and bare grounding conductors, except as otherwise indicated.

E. Tighten screws and bolts for grounding and bonding connectors and terminals according to manufacturer's published torque-tightening values. Where these requirements are not available, use those specified in UL 486A and UL 486B.

F. Compression-Type Connections: Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Use tools and dies recommended by manufacturer of connectors. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on grounding conductor.

G. Moisture Protection: Where insulated grounding conductors are connected to grounding rods or grounding buses, insulate entire area of connection and seal against moisture penetration of insulation and cable.

3.4 FIELD QUALITY CONTROL

A. Testing Agency: Engage an independent electrical testing organization to perform tests described below.

B. Tests: Subject the completed grounding system to a megger test at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal.. Measure ground resistance not less than 2 full days after the last trace of precipitation, and without the soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance. Perform tests by the fall-of-potential method according to IEEE 81.

C. Maximum grounding resistance shall be less than or equal to 5 ohms.

D. Excessive Ground Resistance: Where resistance to ground exceeds specified values, provide additional grounding to achieve required results.

E. Report: Prepare test reports, certified by the testing organization, of ground resistance at each test location. Include observations of weather and other phenomena that may affect test results.

F. Field Test Reports: Submit written test reports to include the following:

1. Test procedures used.

2. Test results that comply with requirements.

3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

END OF SECTION 16060

SECTION 16075 - ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes electrical identification materials and devices required to comply with ANSI C2, NFPA 70 - as amended by state and local codes, OSHA standards, and the requirements of the authorities having jurisdiction. All power distribution equipment shall be labeled.

1.3 SUBMITTALS

A. Product Data: For each electrical identification product indicated.

B. Schedule of Nomenclature: An index of electrical equipment and system components used in identification signs and labels.

C. Samples: For each type of label and sign to illustrate size, colors, lettering style, mounting provisions, and graphic features of identification products.

1.4 QUALITY ASSURANCE

A. Comply with NFPA 70, as amended by state and local codes.

B. Comply with ANSI A13.1 and NFPA 70 for color-coding.

C. Comply with ANSI Z535-2, Z535-4, and NFPA 70E.

D. Comply with ANSI C2.

E. Comply with 29 CFR 1910.145

1.5 COORDINATION

A. Coordinate identification names, abbreviations, colors, and other features with requirements in the Contract Documents, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual, and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.

B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

C. Coordinate installation of identifying devices with location of access panels and doors.

D. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 RACEWAY AND CABLE LABELS

A. Comply with ANSI A13.1, Table 3, for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.

1. Color: Black letters on orange field.

2. Legend: Indicates voltage and service.

B. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

C. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeves, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

D. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeves, 2 inches (50 mm) long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

E. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; 2 inches (50 mm) wide; compounded for outdoor use.

2.2 CONDUCTOR AND COMMUNICATION- AND CONTROL-CABLE IDENTIFICATION MATERIALS

A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils (0.08 mm) thick by 1 to 2 inches (25 to 50 mm) wide.

B. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

C. Aluminum Wraparound Marker Labels: Cut from 0.014-inch- (0.35-mm-) thick aluminum sheet, with stamped, or embossed legend, and fitted with tabs and matching slots for permanently securing around wire or cable jacket or around groups of conductors.

D. Metal Tags: Brass or aluminum, 2 by 2 by 0.05 inch (50 by 50 by 1.3 mm), with stamped legend, punched for use with self-locking nylon tie fastener.

E. Write-On Tags: Polyester tag, 0.015 inch (0.38 mm) thick, with corrosion-resistant grommet and polyester or nylon tie for attachment to conductor or cable.

1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.

2.3 UNDERGROUND-LINE WARNING TAPE

A. Description: Permanent, bright-colored, continuous-printed, polyethylene tape.

1. Not less than 6 inches (150 mm) wide by 4 mils (0.102 mm) thick.

2. Compounded for permanent direct-burial service.

3. Embedded continuous metallic strip or core.

4. Printed legend shall indicate type of underground line.

2.4 WARNING LABELS, NAMEPLATES AND SIGNS

A. Comply with NFPA 70 and 29 CFR 1910.145.

B. Engraved Plastic Warning Labels, Nameplates and Signs: Engraving stock, melamine plastic laminate, minimum 1/16 inch (1.6 mm) thick for signs up to 20 sq. in. (129 sq. cm) and 1/8 inch (3.2 mm) thick for larger sizes.

1. Engraved legend with black letters on white face.
2. Punched or drilled for mechanical fasteners.

C. Baked-Enamel Warning Signs for Interior Use: Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for the application. 1/4-inch (6.4-mm) grommets in corners for mounting. Nominal size, 7 by 10 inches (180 by 250 mm).

D. Exterior, Metal-Backed, Butyrate Warning Signs: Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch (1-mm) galvanized-steel backing; and with colors, legend, and size required for application. 1/4-inch (6.4-mm) grommets in corners for mounting. Nominal size, 10 by 14 inches (250 by 360 mm).

E. Warning label and sign shall include, but are not limited to, the following legends:

1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."

2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 48 INCHES (1200 MM).". Adjust clearance dimensions as required for system voltage and equipment configuration.

3. Arc Flash Warning: "POTENTIAL ARC FLASH HAZARD - APPROPRIATE PERSONAL PROTECTIVE EQUIPMENT AND TOOLS REQUIRED WHEN WORKING ON THIS EQUIPMENT."

F. Fasteners for Nameplates and Signs: Self-tapping, stainless-steel screws or No. 10/32, stainless-steel machine screws with nuts and flat and lock washers.

2.5 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Cable Ties: Fungus-inert, self-extinguishing, one-piece, self-locking, Type 6/6 nylon cable ties.

1. Minimum Width: 3/16 inch (5 mm).

2. Tensile Strength: 50 lb (22.3 kg) minimum.

3. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).

4. Color: Black, except where used for color-coding.

B. Paint: Formulated for the type of surface and intended use.

1. Primer for Galvanized Metal: Single-component acrylic vehicle formulated for galvanized surfaces.

2. Primer for Concrete Masonry Units: Heavy-duty concrete masonry unit block filler.

3. Primer for Concrete: Exterior concrete and masonry primer.

4. Enamel: Exterior semigloss acrylic enamel.

PART 3 - EXECUTION

3.1 APPLICATION

A. Accessible Raceways and Cables of Auxiliary Systems: Identify the following systems with color-coded, self-adhesive vinyl tape applied in bands or with snap-around, color-coding bands:

1. Fire Alarm System: Red.

2. Telecommunication System: Green and yellow.

3. Control Wiring: Green and red.

B. Power-Circuit Conductor Identification: For primary and secondary conductors No. 1/0 AWG and larger in vaults, pull and junction boxes, manholes, and handholes use aluminum wraparound marker labels or non-ferrous metal tags. Identify source and circuit number of each set of conductors. For single conductor cables, identify phase in addition to the above.

C. Branch-Circuit Conductor Identification: Where there are conductors for more than three branch circuits in same junction or pull box, use aluminum wraparound marker labels. Identify each ungrounded conductor according to source and circuit number.

D. Ground fault interrupter outlets: Identify receptacles supplied by ground fault interrupter circuit breakers or by upstream ground fault interrupter receptacles. Use engraved letters on device plate.

E. Conductors to Be Extended in the Future: Attach write-on tags to conductors and list source and circuit number.

F. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, signal, sound, intercommunications, voice, and data connections.

1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.

2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.

3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and Operation and Maintenance Manual.

G. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable. Install underground-line warning tape for both direct-buried cables and cables in raceway.

H. Warning Labels for Cabinets, Boxes, and Enclosures for Power and Lighting: Comply with 29 CFR 1910.145 and apply warning signs. Identify system voltage with black letters on an orange background. Apply to exterior of door, cover, or other access.

1. Equipment with Multiple Power or Control Sources: Apply to door or cover of equipment including, but not limited to, the following:

(a) Power transfer switches.
(b) Controls with external control power connections.

2. Equipment Requiring Workspace Clearance According to NFPA 70: Unless otherwise indicated, apply to door or cover of equipment but not on flush panelboards and similar equipment in finished spaces.

3. Switchboards, Panelboards, Equipment Control Panels, Meter Socket Enclosures, and Motor Control Centers: Labeled to warn of potential electric arc flash hazards. The label shall be located so as to be clearly visible

before examination, adjustment, servicing, or maintenance of the equipment.

I. Instruction Signs:

1. Operating Instructions: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.

2. Emergency Operating Instructions: Install instruction signs with white legend on a red background with minimum 3/8-inch- (10-mm-) high letters for emergency instructions at equipment used for power transfer or for load shedding.

J. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.

1. Labeling Instructions:

(a) Equipment: Engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with 1/2-inch- (13-mm-) high letters on 1-1/2-inch- (38-mm-) high label; where 2 lines of text are required, use labels 2 inches (50 mm) high.

(b) Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.

2. Equipment to Be Labeled:

(a) Panelboards, electrical cabinets, and enclosures.

(b) Access doors and panels for concealed electrical items.

(c) Electrical switchgear and switchboards.

(d) Transformers.

(e) Emergency system boxes and enclosures.

(f) Motor-control centers.

(g) Disconnect switches.

(h) Enclosed circuit breakers.

(i) Motor starters.

(j) Push-button stations.

(k) Power transfer equipment.

(l) Contactors.

(m) Remote-controlled switches, dimmer modules, and control devices.

(n) Battery racks.

(o) Power-generating units.

(p) Voice and data cable terminal equipment.

(q) Master clock and program equipment.

(r) Intercommunication and call system stations.

(s) Television/audio components, racks, and controls.

(t) Fire-alarm control panel and annunciators.

(u) Monitoring and control equipment.

(v) Uninterruptible power supply equipment.

(w) Terminals, racks, and patch panels for voice and data communication and for signal and control functions.

3.2 INSTALLATION

A. Verify identity of each item before installing identification products.

B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.

C. Apply identification devices to surfaces that require finish after completing finish work.

D. Attach signs and plastic labels with screws and auxiliary hardware appropriate to the location and substrate.

E. System Identification Color Banding for Raceways and Cables: Each color band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 50-foot (15-m) maximum intervals in straight runs, and at 25-foot (7.6-m) maximum intervals in congested areas.

F. Color-Coding for Phase and Voltage Level Identification, 600 V and Less: Use the colors listed below for ungrounded service, feeder, and branch-circuit conductors.

1. Color shall be factory applied the entire length of conductors, except the following field-applied color-coding methods may be used instead of factory-coded wire for sizes larger than No. 10 AWG:

   (a) Colored, pressure-sensitive plastic tape in half-lapped turns for a distance of 6 inches (150 mm) from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Use 1-inch- (25-mm-) wide tape in colors specified. Locate tape bands to avoid obscuring cable identification markings.

   (b) Colored cable ties applied in groups of three ties of specified color to each wire at each terminal or splice point starting 3 inches (76 mm) from the terminal and spaced 3 inches (76 mm) apart. Apply with a special tool or pliers, tighten to a snug fit, and cut off excess length. Locate bands to avoid obscuring cable identification markings.

2. Colors for 208/120-V Circuits:
   (a) Phase A: Black.
   (b) Phase B: Red.
   (c) Phase C: Blue.

3. Colors for 480/277-V Circuits:
   (a) Phase A: Brown.
   (b) Phase B: Orange.
   (c) Phase C: Yellow.

G. Aluminum Wraparound Marker Labels and Metal Tags: Secure tight to surface of conductor or cable at a location with high visibility and accessibility.

H. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 6 to 8 inches (150 to 200 mm) below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches (400 mm) overall.

I. Painted Identification: Install painted identification according to manufacturer's written instructions and as follows:

1. Clean surfaces of dust, loose material, and oily films before painting.

2. Prime surfaces using type of primer specified for surface.

END OF SECTION 16075

P ART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes general requirements for electrical field testing and inspecting. Detailed requirements are specified in each Section containing components that require testing. General requirements include the following:

1. Coordination requirements for testing and inspecting

2. Reporting requirements for testing and inspecting.

1.3 QUALITY ASSURANCE

A. As specified in each Section containing electrical testing requirements.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

3.1 GENERAL TESTS AND INSPECTIONS

A. Where no specific requirements are given, provide testing in accordance with the latest version of the InterNational Testing Association (NETA) Acceptance Testing Specification for Electric Power Distribution Equipment and Systems.

B. Where tests are specified to be performed by an independent testing agency, prepare systems, equipment, and components for tests and inspections, and perform preliminary tests to ensure that systems, equipment, and components are ready for independent agency testing. Include the following minimum preparations as appropriate:

1. Perform insulation-resistance tests.

2. Perform continuity tests.

3. Perform rotation test (for motors to be tested).

4. Provide a stable source of single-phase, 208/120-V electrical power for test instrumentation at each test location.

C. Test and Inspection Reports: In addition to requirements specified elsewhere, report the following:

1. Manufacturer's written testing and inspecting instructions.

2. Calibration and adjustment settings of adjustable and interchangeable devices involved in tests.

3. Tabulation of expected measurement results made before measurements.

4. Tabulation of "as-found" and "as-left" measurement and observation results.

3.2 COMMISSIONING

A. Provide manpower as required to assist the commissioning agent, as required in Division 1 Section “GENERAL COMMISSIONING REQUIREMENTS” and Division 1 Section “HVAC COMMISSIONING REQUIREMENTS”.

END OF SECTION 16080

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes underground conduits and ducts, duct banks, pull boxes and handholes , manholes , and other underground utility structures .

1.3 SYSTEM DESCRIPTION

A. Underground Ducts: Plastic conduit encased in concrete.

B. Manholes: Cast-in-place concrete.

C. Manholes: Underground, precast concrete utility structures.

1.4 SUBMITTALS

A. Product Data: For metal accessories for manholes and handholes, conduit and duct, duct bank materials, and miscellaneous components.

B. Shop Drawings: Show details and design calculations for precast manholes and handholes, including reinforcing steel. Stamp drawings with seal of registered professional structural engineer.

C. Certificate for concrete and steel used in underground precast concrete utility structures, according to ASTM C 858.

D. Product Test Reports: Indicate compliance with ASTM C857 and ASTM C858

E. Record Documents: Show dimensioned locations of underground ducts, handholes, and manholes.

1.5 QUALITY ASSURANCE

A. Listing and Labeling: Provide products specified in this Section that are Underwriters Laboratories listed and labeled.

1. The Terms "Listed" and "Labeled": As defined in the "National Electrical Code," Article 100.

B. Comply with NFPA 70, as amended by state and local codes.

C. Comply with ANSI C2.
D. Comply with Utility requirements.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver ducts to site with ends capped. Store nonmetallic ducts with supports to prevent bending, warping, and deforming.

B. Store precast concrete units at site as recommended by manufacturer to prevent physical damage. Arrange so identification markings are visible.

C. Lift and support precast concrete units only at designated lifting or supporting points.

1.7 PROJECT CONDITIONS

A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated.

1. Notify Architect not less than 2 days in advance of proposed utility interruptions.

2. Do not proceed with utility interruptions without Architect's written permission.

1.8 COORDINATION

A. Coordinate layout and installation of ducts, manholes, and handholes with final arrangement of other utilities as determined in the field.

B. Coordinate elevations of duct and duct-bank entrances into manholes and handholes with final profiles of conduits as determined by coordination with other utilities and underground obstructions. Revise locations and elevations as required to suit field conditions and to ensure duct runs drain to manholes and handholes, and as approved by Architect.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering the specified products that may be incorporated in the Work include, but are not limited to, the following:

1. Underground Precast Concrete Utility Structures:

(a) Precast Division; Carder Concrete Products.

(b) Christy Concrete Products, Inc.

(c) Elmhurst-Chicago Stone Co.

(d) Riverton Concrete Products.

(e) A. Rotondo & Sons, Inc.

(f) Rotondo/Penn-Cast, Inc.

(g) Smith-Midland Corp.

(h) Utility Vault Co.

(i) Wausau Concrete Co.

2. Frames and Covers:

(a) Campbell Foundry Co.

(b) East Jordan Iron Works, Inc.

(c) McKinley Iron Works, Inc.

(d) Neenah Foundry Co.

3. Nonmetallic Ducts:

(a) Arnco Corp.

(b) Breeze-Illinois, Inc.

(c) CANTEX, Inc

(d) Carlon; Lamson & Sessions Company.

(e) Pipe & Plastic Group; Certainteed Products Corp.

2.2 CONDUIT AND DUCT

A. Rigid Plastic Underground Conduit: UL 651A, Type EB PVC.

B. Rigid Plastic Conduit: NEMA TC 2, Schedule 40 or Schedule 80 PVC, rated for use with 90 deg C conductors under all installation conditions.

C. Rigid Steel Conduit: ANSI C80.1, galvanized.

D. Plastic-Coated Rigid Steel Conduit and Fittings: NEMA RN 1.

E. PVC Conduit Fittings: NEMA TC 3.

F. Manufactured Bends: Not less than 36-inch (900 mm.) radius.

2.3 PULL BOXES AND HANDHOLES

A. Cast Metal Boxes: Cast aluminum, sized as indicated, with outside flanges and recessed, gasketed cover for flush mounting. Nonskid finish on cover.

B. Cover Legend: High voltage, electric, signal or other as directed by the Architect.

2.4 UNDERGROUND PRECAST CONCRETE UTILITY STRUCTURES

A. Where field poured manholes or handholes have been indicated on the drawings, precast units of equivalent size may be substituted, subject to compliance with all requirements specified in this Section.

B. Precast Units: Interlocking, mating sections, complete with accessory items, hardware, and features as indicated. Include concrete knockout panels for conduit entrance and sleeve for ground rod.

C. Design structure according to ASTM C 858.

D. Structural Design Loading: ASTM C 857, Class A-16.

E. Fabricate according to ASTM C 858.

F. Joint Sealant: Continuous extrusion of asphaltic butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand the maximum hydrostatic pressures at the installation location with the ground water level at grade.

G. Source Quality Control: Inspect structures according to ASTM C 1037.

2.5 ACCESSORIES

A. Duct Supports: Rigid PVC spacers selected to provide minimum duct spacings and concrete cover depths indicated, while supporting ducts during concreting.

B. Frames and Covers: Cast iron with cast-in legend ELECTRIC or SIGNAL or other as directed. Machine cover-to-frame bearing surfaces.

C. Sump Frame and Grate: Comply with FS RR-F-621, Type VII for frame and Type I for cover.

D. Pulling Eyes in Walls: Eyebolt with reinforcing bar fastening insert. 2-inch (50 mm) diameter eye, 1-inch (25 mm) by 4-inch (100 mm) bolt. Working load embedded in 6-inch (150 mm), 4000 psi (27.6 MPa) concrete: 13,000 pounds (6,000 kg.) minimum tension.

E. Bolting Inserts for Cable Stanchions: Flared, threaded inserts of noncorrosive, chemical resistant, nonconductive thermoplastic material; 1/2-inch (12 mm) internal diameter by 2-3/4 inches (68 mm) deep, flared to 1-1/4 inch (30 mm) minimum at base. Tested ultimate pull-out strength: 12,000 pounds (5,500 kg.) minimum.

F. Expansion Anchors for Installation After Concrete is Cast: Zinc-plated carbon steel wedge type with stainless-steel expander clip 1/2-inch (12 mm) bolt size, 5,300-pound (2,400 kg.) rated pull-out strength, and 6,800-pound (3,100 kg) rated shear strength minimum.

G. Cable Stanchions: Hot-rolled, hot-dipped galvanized "T" section steel, 2-1/4-inch (56 mm) size, punched with 14 holes on 1-1/2-inch (35 mm) centers for cable arm attachment.

H. Cable Arms: 3/16-inch (5 mm) thick hot-rolled, hot-dipped galvanized sheet steel pressed to channel shape, approximately 12 inches (300 mm) wide by 14 inches (350 mm) long and arranged for secure mounting in horizontal position at any position on cable stanchions.

I. Cable Support Insulators: High glaze, wet-process porcelain arranged for mounting on cable arms.

J. Ground Rods: Solid copper clad steel, 3/4-inch (18 mm) diameter by 10-feet (3 m) length.

K. Ground Wire: Stranded bare copper, No. 6 AWG minimum.

L. Ladder: UL-listed, heavy-duty wood, specifically designed for electrical manhole use. Minimum length equal to the distance from the deepest manhole floor to grade plus 3 feet (1 m).

M. Duct Sealing Compound: Nonhardening, safe for human skin contact, not deleterious to cable insulation, workable at temperatures as low as 35 deg F (1 deg C), withstands temperature of 300 deg F (149 deg C) without slump, and adheres to clean surfaces of plastic ducts, metallic conduits, conduit coatings, concrete, masonry, lead, cable sheaths, cable jackets, insulation materials, and the common metals.

2.6 CONSTRUCTION MATERIALS

A. Brick: Conform to ASTM C 55, concrete brick Type I, Grade N.

B. Mortar: Conform to ASTM C 270, Type M, except for quantities less than 2.0 cu. ft. (60 L), where packaged mix complying with ASTM C 387, Type M may be used.

C. Concrete: Conform to Division 16 Section "Basic Electric Materials and Methods" for concrete and reinforcing.

1. Strength: 3,000 psi (20.7 MPa) minimum 28-day compressive strength.

2. Aggregate For Duct Encasement: 3/8-inch (10 mm) maximum size.

PART 3 - EXECUTION

3.1 APPLICATION

A. Underground Duct Banks: Concrete encased rigid plastic underground conduit, except as noted below.

B. Duct Banks Under Paved Areas open to regular vehicular traffic: Reinforced concrete encased rigid plastic underground conduit.

C. Duct Banks Passing Under Buildings: Concrete encased rigid steel conduit.

D. Single Tier Duct Banks: Direct buried Schedule 40 PVC rigid plastic conduit, except utilize plastic coated rigid steel conduits where under buildings.

E. Manholes (and Handholes): Cast-in-place concrete or underground precast concrete utility structures.

3.2 EXAMINATION

A. Examine site to receive ducts and manholes for compliance with installation tolerances and other conditions affecting performance of the underground ducts and manholes. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.3 EARTHWORK

A. Excavation and Backfill: Conform to Division 16, Section "Basic Electrical Materials and Methods."

B. Restore surface features at areas disturbed by excavation, and reestablish original grades except as otherwise indicated. Replace removed sod as soon as possible after backfilling is completed. Restore all areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, or mulching.

C. Restore disturbed paving. Refer to "Cutting and Patching" in Division 1.

D. Comply with Division 2.

3.4 CONDUIT AND DUCT INSTALLATION

A. Install nonmetallic conduit and duct as indicated according to manufacturer's written instructions.

B. Slope: Pitch ducts minimum of 4 inches per 100 feet (1:300) to drain toward manholes and handholes and away from buildings and equipment. Slope ducts from a high point in runs between 2 manholes to drain in both directions.

C. Curves and Bends: Use manufactured elbows for stub-ups at equipment and at building entrances. Use manufactured long sweep bends with a minimum radius of 25 feet (7.5 m) both horizontally and vertically at other locations.

D. Make joints in ducts and fittings watertight according to manufacturer's instructions. Stagger couplings so those of adjacent ducts do not lie in the same plane.

E. Duct Entrances to Manholes and Handholes: Space end bells approximately 10 inches (250 mm) on center for 5-inch (125 mm) ducts and varied proportionately for other duct sizes. Change from regular spacing to end-bell spacing 10 feet (3 m) from the end bell without reducing duct line slope and without forming a trap in the line. Grout end bells into manhole walls from both sides to provide watertight entrances.

F. Building Entrances: Transition from underground duct to conduit 10 feet (3 m) minimum outside the building wall. Use fittings manufactured for the purpose. Follow appropriate installation instructions below.

1. Concrete-Encased Ducts: Install reinforcing in duct banks passing through disturbed earth near buildings and other excavations. Coordinate duct bank with structural design to support duct bank at wall without reducing structural or watertight integrity of building wall.

2. Direct-Buried, Nonencased Duct Entering Nonwaterproofed Walls: Install a Schedule 40 galvanized-steel pipe sleeve for each duct. Caulk space between conduit and sleeve with duct-sealing compound on both sides for moisture-tight seal.

3. Waterproofed Wall and Floor Entrances: Install a watertight entrance-sealing device with the sealing gland assembly on the inside. Anchor device into masonry construction with 1 or more integral flanges. Secure membrane waterproofing to the device to make permanently watertight.

G. Separation Between Direct-Buried, Nonencased Ducts: 3 inches (75 mm) minimum for like services, and 6 inches (150 mm) minimum between power and signal ducts.

H. Concrete-Encased Nonmetallic Ducts: Support on plastic separators coordinated with duct size and required duct spacing, and install according to the following:

1. Separator Installation: Space separators close enough to prevent sagging and deforming of ducts, and secure separators to the earth and to ducts to prevent floating during concreting. Do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.

2. Concreting: Spade concrete carefully during pours to prevent voids under and between conduits and at exterior surface of envelope. Do not use power-driven agitating equipment unless specifically designed for duct bank application. Pour each run of envelope between manholes or other terminations in 1 continuous operation. When more than one pour is necessary, terminate each pour in a vertical plane and install 3/4-inch (18 mm) reinforcing rod dowels extending 18 inches (450 mm) into the concrete on both sides of joint near the corners of the envelope.

3. Reinforcing: Reinforce duct banks where they cross disturbed earth, where they cross over or under underground utilities or other obstructions and where indicated.

4. Forms: Use the walls of the trench to form the side walls of the duct bank where the soil is self-supporting and concrete envelope can be poured without soil inclusions, otherwise, use forms.

5. Minimum Clearances Between Ducts: 3 inches (75 mm) between ducts and exterior envelope wall, 2 inches (50 mm) between ducts for like services, and 4 inches (100 mm) between power and signal ducts.

6. Depth: Except as otherwise indicated, install top of duct bank at least 30 inches (750 mm) below finished grade. Increase cover where required by field conditions. Clearance may be reduced (to a minimum of 18" (450 mm)) where passing over other utilities or obstructions or where necessary to avoid low points. Reinforce the concrete where clearance is so reduced.

I. Stub-Ups: Use rigid steel conduit for stub-ups to equipment. For equipment mounted on outdoor concrete pads, extend steel conduit a minimum of 5 feet (1.5 m) from edge of pad. Install insulated grounding bushings on the terminations. Couple steel conduits to the ducts with adapters designed for the purpose and then encase coupling with 3 inches (75 mm) of concrete.

J. Sealing: Provide temporary closure at terminations of ducts that are wired under this Project. Seal spare ducts at terminations. Use sealing compound and plugs to withstand at least 15 psi (1.03 MPa) hydrostatic pressure.

K. Pulling Cord: Install 100-pound (45 kg) test nylon cord in ducts, including spares.

3.5 UNDERGROUND UTILITY STRUCTURE INSTALLATION

A. Elevation: Install manholes with roof top at least 15 inches (375 mm) below finished grade. Install handholes with depth as indicated. Where indicated, cast handhole cover frame directly into roof of handhole and set roof surface 1 inch (25 mm) above grade.

B. Access: Install cast-iron frame and cover. For manholes, use 30-inch (750 mm) cover except as indicated. Use 30-inch (750 mm) cover for handholes, except use 24-inch (600 mm) covers for 24-inch (600 mm) by 24-inch (600 mm) handholes. Install brick chimney to support frame and cover and to connect cover with roof opening. Provide moisture-tight masonry joints and waterproof grouting for cast-iron frame to chimney. Set frames in paved areas and traffic ways flush with finished grade. Set other frames 1 inch (25 mm) above finished grade.

C. Hardware: Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cable and conductors and as indicated.

D. Field-Installed Bolting Anchors: Do not drill deeper than 3-7/8 inches (96 mm) for anchor bolts installed in the field. Use a minimum of 2 anchors for each cable stanchion.

E. Grounding: Install ground rod through floor in each structure with top protruding 4 inches (100 mm) above floor. Seal the floor opening against water penetration with waterproof nonshrink grout. Ground exposed metal components and hardware with bare copper ground conductor. Train conductors neatly around corners. Install on walls and roof using cable clamps secured with expansion anchors.

F. Cast-In-Place Underground Structure Installation: Conform to applicable requirements of Division 16 Section "Basic Electric Materials and Methods."

1. Finish interior surfaces with a smooth troweled finish.

2. Windows for Future Duct Connections: Form and pour concrete knock-out panels 1-1/2 to 2 inches (37 to 50 mm) thick, arranged as indicated.

G. Precast Concrete Underground Structure Installation: Install as indicated, according to manufacturer's written instructions and ASTM C 891.

1. Install units plumb and level and with orientation and depth coordinated with arrangement of connecting ducts to minimize bends and deflections required for proper entrances.

2. Support units on a level bed of crushed stone or gravel, graded from the 1-inch (25 mm) sieve to the No. 4 sieve and compacted to same density as adjacent undisturbed earth.

3.6 EXCAVATION FOR UNDERGROUND CONDUIT BANKS

A. Slope sides of excavations to comply with local codes and ordinances. Shore and brace as required for stability of excavation.

B. Shoring and Bracing: Establish requirements for trench shoring and bracing to comply with local codes and authorities. Maintain shoring and bracing in excavations regardless of time period excavations will be open.

1. Remove shoring and bracing when no longer required. Where sheeting is allowed to remain, cut top of sheeting at an elevation of 30 inches (750 mm) below finished grade elevation.

C. Install sediment and erosion control measures in accordance with local codes and ordinances.

D. Dewatering: Prevent surface water and subsurface or ground water from flowing into excavations and from flooding project site and surrounding area.

1. Do not allow water to accumulate in excavations. Remove water to prevent softening of bearing materials. Provide and maintain dewatering system components necessary to convey water away from excavations.
2. Establish and maintain temporary drainage ditches and other diversions outside excavation limits to convey surface water to collecting or run-off areas. Do not use trench excavations as temporary drainage ditches.

E. Material Storage: Stockpile satisfactory excavated materials where directed, until required for backfill or fill. Place, grade, and shape stockpiles for proper drainage.

1. Locate and retain soil materials away from edge of excavations. Do not store within drip-line of trees indicated to remain.

2. Remove and legally dispose of excess excavated materials and materials not acceptable for use as backfill or fill.

F. Excavation for Underground Vaults and Electrical Structures: Conform to elevations and dimensions shown within a tolerance of plus or minus 0.25 foot (75 mm); plus a sufficient distance to permit placing and removal of concrete form work, installation of services, other construction, and for inspection.

1. Excavate, by hand, areas within drip-line of large trees. Protect the root system from damage and dry-out. Maintain moist conditions for root system and cover exposed roots with burlap. Paint root cuts of 1 inch (25 mm) in diameter and larger with emulsified asphalt tree paint.

2. Take care not to disturb bottom of excavation. Excavate by hand to final grade just before concrete reinforcement is placed.

G. Trenching: Excavate trenches for electrical installations as follows:

1. Excavate trenches to the uniform width, sufficiently wide to provide ample working room and a minimum of 6 to 9 inches (150 to 225 mm) clearance on both sides of raceways and equipment.

2. Excavate trenches to depth required to accommodate the installation of conduit (duct banks) in compliance with the requirements of Section 16119.

3. Limit the length of open trench to that in which installations can be made and the trench backfilled within the same day.

4. Where rock is encountered, carry excavation below required elevation and backfill with a layer of crushed stone or gravel prior to installation of raceways and equipment. Provide a minimum of 6 inches (150 mm) of stone or gravel cushion between rock bearing surface and electrical installations.

H. Cold Weather Protection: Protect excavation bottoms against freezing when atmospheric temperature is less than 35 deg F (1 deg 2 C).

I. Backfilling and Filling: Place soil materials in layers to required subgrade elevations for each area classification listed below, using materials specified in Part 2 of this Section.

1. Under walks and pavements, use a combination of subbase materials and excavated or borrowed materials.

2. Under building slabs, use drainage fill materials.

3. Under piping and equipment, use subbase materials where required over rock bearing surface and for correction of unauthorized excavation.

4. For raceways less than 30 inches (750 mm) below surface of roadways, provide 4-inch (100mm)thick concrete base slab support. After installation of raceways, provide a 4-inch (100mm)thick concrete encasement (sides and top) prior to backfilling and placement of roadway subbase.

5. Other areas, use excavated or borrowed materials.

J. Backfill excavations as promptly as work permits, but not until completion of the following:

1. Inspection, testing, approval, and locations of underground utilities have been recorded.

2. Removal of concrete formwork.

3. Removal of shoring and bracing, and backfilling of voids.

4. Removal of trash and debris.

K. Placement and Compaction: Place backfill and fill materials in layers of not more than 8 inches (200 mm) in loose depth for material compacted by heavy equipment, and not more than 4 inches (100 mm) in loose depth for material compacted by hand-operated tampers.

L. Before compaction, moisten or aerate each layer as necessary to provide optimum moisture content. Compact each layer to required percentage of maximum dry density or relative dry density for each area classification specified below. Do not place backfill or fill material on surfaces that are muddy, frozen, or contain frost or ice.

M. Place backfill and fill materials evenly adjacent to structures, piping, and equipment to required elevations. Prevent displacement of raceways and equipment by carrying material uniformly around them to approximately same elevation in each lift.

N. Compaction: Control soil compaction during construction, providing minimum percentage of density specified for each area classification indicated below.

1. Percentage of Maximum Density Requirements: Compact soil to not less than the following percentages of maximum density for soils which exhibit a well-defined moisture-density relationship (cohesive soils), determined in accordance with ASTM D 1557 and not less than the following percentages of relative density, determined in accordance with ASTM D 2049, for soils which will not exhibit a well-defined moisture-density relationship (cohesionless soils).

   (a) Areas Under Structures, Building Slabs and Steps, Pavements: Compact top 12 inches (300 mm) of subgrade and each layer of backfill or fill material to 90 percent maximum density for cohesive material, or 95 percent relative density for cohesionless material.

   (b) Areas Under Walkways: Compact top 6 inches of subgrade and each layer of backfill or fill material to 90 percent maximum density for cohesive material, or 95 percent relative density for cohesionless material.

   (c) Other Areas: Compact top 6 inches (150 mm) of subgrade and each layer of backfill or fill material to 85 percent maximum density for cohesive soils, and 90 percent relative density for cohesionless soils.

2. Moisture Control: Where subgrade or layer of soil material must be moisture conditioned before compaction, uniformly apply water. Apply water in minimum quantity necessary to achieve required moisture content and to prevent water appearing on surface during, or subsequent to, compaction operations.

O. Subsidence: Where subsidence occurs at electrical installation excavations during the period 12 months after Substantial Completion, remove surface treatment (i.e., pavement, lawn, or other finish), add backfill material, compact to specified conditions, and replace surface treatment. Restore appearance, quality, and condition of surface or finish to match adjacent areas.

3.7 CONCRETE ENCASEMENT FOR UNDERGROUND CONDUIT BANKS

A. Utilize the sides of the trench in formwork for underground conduit banks to the maximum extent possible. Utilize a splashboard to divert the concrete flow away from the trench sides to avoid dislodging soil and stones.

B. Provide reinforcement where required. Verify that any required reinforcement is installed prior to commencing placement of concrete.

C. Place concrete in accordance with the following:

1. General: Comply with ACI 304, "Guide for Measuring, Mixing, Transporting, and Placing Concrete," and as specified.

2. Deposit concrete continuously or in layers of such thickness that no new concrete will be placed on concrete that has hardened sufficiently to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as specified. Deposit concrete to avoid segregation at its final location.

3. Cold-Weather Placement: Comply with provisions of ACI 306 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions or low temperatures.

4. When air temperature has fallen to or is expected to fall below 40°F (4°C), uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50°F (10°C) and not more than 80°F (27°C) at point of placement.

   (a) Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.

   (b) Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise accepted in mix designs.

D. Installation of Fire-Stopping Sealant: Install sealant, including forming, packing, and other accessory materials, to fill openings around electrical services penetrating floors and walls, to provide fire-stops with fire-resistance ratings indicated for floor or wall assembly in which penetration occurs. Comply with installation requirements established by testing and inspecting agency.

3.8 FIELD QUALITY CONTROL

A. Testing: Demonstrate capability and compliance with requirements upon completion of installation of underground duct and utility structures.

1. Grounding: Test manhole grounding to ensure electrical continuity of bonding and grounding connections. Measure ground resistance at each ground rod and report results. Use an instrument specifically designed for ground-resistance measurements.

2. Duct Integrity: Rod ducts with a mandrel 1/4 inch (6 mm) smaller in diameter than internal diameter of ducts. Where rodding indicates obstructions in ducts, remove the obstructions and retest.

3. Water Tightness: Make internal inspection of manholes 3 months after completion of construction for indications of water ingress. Where leakage is noted, remove water and seal leak sources. Reinspect after 2 months and reseal remaining leak sources. Repeat process at 2 month intervals until leaks are corrected.

B. Inspect installed components for damage and faulty work, including the following:

1. Concrete for underground conduit runs.
2. Excavation for underground conduit runs.

C. Correct installations where possible, and retest to demonstrate compliance. Otherwise, remove and replace defective products and retest.

3.9 CLEANING

A. Pull brush through full length of ducts. Use round bristle brush with a diameter 1/2 inch (12 mm) greater than internal diameter of duct.

B. Clean internal surfaces of manholes including sump. Remove foreign material.

END OF SECTION 16119

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes building wires and cables and associated splices, connectors, and terminations for wiring systems rated 600 volts and less.

1.3 SUBMITTALS

A. Product Data: for each type of product indicated.

B. Field Quality Control Test Reports.

1.4 QUALITY ASSURANCE

A. Listing and Labeling: Provide products specified in this Section that are Underwriters Laboratories listed and labeled.

1. The Terms "Listed and Labeled": As defined in the "National Electrical Code," Article 100.

B. Comply with NFPA 70, as amended by state and local codes.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the manufacturers specified.

2.2 CONDUCTORS AND CABLES

A. Available Manufacturers:

1. American Insulated Wire Corp.; a Leviton Company.

2. General Cable Corporation.

3. Senator Wire & Cable Company.

4. Southwire Company.

5. Belden, Division Cooper Industries.

6. Cable & Wire Division, AT&T.

7. Pyrotenax.

B. Refer to Part 3 "Conductor and Insulation Applications" Article for insulation type, cable construction, and ratings.

1. Conductor Material: Copper, complying with NEMA WC 5 or 7; solid conductor for No. 10 AWG and smaller, stranded for No. 8 AWG and larger.

2. Conductor Insulation Types: Type THHN, THWN, XHHW complying with NEMA WC 5 or 7.

C. Electrical Circuit Protective System Cable: Where required by code, or where indicated on the drawings, feeders and circuitry are a fire rated cable system, except where enclosed within equivalent fire rated construction indicated on the architectural drawings. Mineral-insulated, metal-sheathed cable, Type MI.

2.3 CONNECTORS AND SPLICES

A. Available Manufacturers:

1. AFC Cable Systems, Inc.

2. AMP Incorporated/Tyco International.

3. Hubbell/Anderson.

4. O-Z/Gedney; EGS Electrical Group LLC.

5. 3M Company; Electrical Products Division.

B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

PART 3 - EXECUTION

3.1 WIRE AND INSULATION APPLICATIONS

A. Utilize copper conductors with THWN, THHN or XHHW insulation, except provide THHW-2, THWN-2 or XHHW-2 insulation for conductors 1/0 and larger in "wet" locations. Conductors utilized in underground installations are UL Listed for use in wet locations. Conductors are run in raceways as described in Section 16 “Raceways and Boxes”. Type THHW and THHW-2 are not utilized where excluded by conduit sizing. Type THWN are not utilized for connection to 100 percent rated overcurrent devices.

B. Electrical circuit protective system cable is utilized for feeders and circuitry which is required to be fire rated and which is not enclosed within equivalent fire rated construction indicated on the architectural drawings.

1. A one-hour rating is required for:

(a) Feeders for Emergency Systems except where run within space directly protected by sprinklers.

(b) Normal and emergency feeders to fire pump.

C. In general, cable ampacities are based on a 60 degree C rating for cables #1 AWG and smaller and on a 75 degree C rating for larger cables. In conjunction with this, note the following:

1. 75 degree C ratings may be utilized for cables #1 AWG and smaller where overcurrent protection and switching devices (OCD's), wiring devices and solidly connected equipment connected to such cables are listed and identified for use with 75 degree C rated conductors. (Note that these specifications require all OCD's - regardless of ampere rating to be suitable for use with 75 degree C rated conductors).

2. Increase indicated cable (and raceway) sizing as required for circuitry where conductors #1 AWG and smaller will connect directly to solidly connected utilization equipment whose load current will exceed the 60 degree C rating of the cable, <u>and for which manufacturer's approval for cable terminations is less than 75 degrees C</u>, or to receptacles whose ampere rating exceeds the 60 degree C rating of the connected cables <u>unless such receptacles are listed for use with 75 degree C rated conductors.</u> Note that accessible intermediate tap boxes may be utilized adjacent to 60 degree C rated terminations to allow conductor "upsizing" locally so as to comply with such termination requirements.

D. For low voltage systems where circuits are power limited in accordance with Class 2 or Class 3 requirements (as defined in Article 725 of the National Electrical Code) utilize cables having characteristics as follows:

1. Cables are of a fluoropolymer type having adequate fire-resistant and low-smoke producing characteristics and are U.L. listed for plenum use (Type

CL2P for Class 2 circuits, type CL3P or CMP for Class 3 circuits), except that where run in conduit, they may be U.L. type CL3, or where run in cable trays they are U.L. type CMP.

E. For low voltage systems whose circuits are not power limited Class 2 or Class 3 (in accordance with the requirements of Article 725 of the National Electrical Code), and which are not telecommunications circuitry (in accordance with Article 800 thereof), utilize copper conductors having TFN insulation for sizes #16 AWG and smaller, and type THHN or THWN for sizes #14 AWG and larger. Wires are run in electric metallic tubing.

F. Low voltage circuits intended for the distribution of voice or data utilize communications cables (complying with requirements of Article 800 of the National Electrical Code) having characteristics as follows:

1. Cables are of a fluoropolymer type having adequate fire-resistant and low-smoke producing characteristics and are U.L. listed for plenum use (Type CMP), except that where run in conduit, they may be U.L. type CM.

2. Refer to Division 16, Section "Fire Protective Alarm System" for fire alarm system wiring.

3.2 INSTALLATION

A. Conceal cables in finished walls, ceilings and floors unless otherwise indicated.

B. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

C. Use pulling means including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

D. Install exposed cables, parallel and perpendicular to surfaces of exposed structural members and follow surface contours where possible.

E. Support cables according to Division 16 Section "Basic Electrical Materials and Methods."

F. Seal around cables penetrating fire-rated elements according to Division 7 Section “Through-Penetration Firestop Systems."

G. Identify wires and cables according to Division 16 Section "Electrical Identification" and Division 16 Section “Supporting Devices”.

3.3 CONNECTIONS:

A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

B. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.

C. Maintain all splices and joints in removable cover boxes or cabinets where they may be easily inspected.

D. Locate each completed conductor splice or joint in the outlet box, junction box, or pull box containing it, so that it is accessible from the removal cover side of the box.

E. Join solid conductors #8 AWG and smaller by securely twisting them together and soldering, or by using insulated coiled steel spring "wire nut" type connectors. Exclude "wire nuts" employing non-expandable springs. Terminate conductors #8 AWG and smaller by means of a neat and fast holding application of the conductors directly to the binding screws or terminals of the equipment or devices to be connected. Terminals and connectors are U.L. approved specifically for the application.

F. Join, tap and terminate stranded conductors #6 AWG and larger by means of solder sleeves, taps and lugs with applied solder or by means of pressure indent type connectors, or mechanical connectors utilizing ball tipped set screws. Apply pressure indent type connectors, utilizing tools manufactured specifically for the purpose and having features preventing their release until the full pressure has been exerted on the lug or connector. Factory installed equipment or device terminals are of types UL approved specifically for the application.

G. Except where wire nuts are used, build up insulation over conductor joints to a value equal both in thickness and dielectric strength to that of the factory applied conductor insulation. Insulation of conductor taps and joints are by means of half-lapped layers of rubber tape, with an outer layer of friction tape; by means of half-lapped layers of approved plastic electric insulating tape; or by means of split insulating casings manufactured specifically to insulate the particular connector and conductor, and fastened with stainless steel or non-metallic snaps or clips.

H. Exclude splicing procedures for neutral conductors in lighting and appliance branch circuitry which utilize device terminals as the splicing points.

I. Exclude joints or terminations utilizing solder in any conductors used for grounding or bonding purposes.

J. Exclude all but solder or pressure indent type joints in conductors used for signaling or communications purposes.

3.4 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 7 Section "Through-Penetration Firestop Systems."

B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.

C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

D. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.

E. Cut sleeves to length for mounting flush with both wall surfaces.

F. Extend sleeves installed in floors 2 inches (50 mm) above finished floor level.

G. Size pipe sleeves to provide 1/4-inch (6.4-mm) annular clear space between sleeve and cable unless sleeve seal is to be installed.

H. Seal space outside of sleeves with grout for penetrations of concrete and masonry and with approved joint compound for gypsum board assemblies.

I. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and cable, using joint sealant appropriate for size, depth, and location of joint according to Division 7 Section "Joint Sealants."

J. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at cable penetrations. Install sleeves and seal with firestop materials according to Division 7 Section "Through-Penetration Firestop Systems."

K. Roof-Penetration Sleeves: Seal penetration of individual cables with flexible boot-type flashing units applied in coordination with roofing work.

L. Aboveground Exterior-Wall Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Size sleeves to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.

M. Underground Exterior-Wall Penetrations: Install cast-iron "wall pipes" for sleeves. Size sleeves to allow for 1-inch (25-mm) annular clear space between cable and sleeve for installing mechanical sleeve seals.

3.5 SLEEVE-SEAL INSTALLATION

A. Install to seal underground exterior-wall penetrations.

B. Use type and number of sealing elements recommended by manufacturer for cable material and size. Position cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.6 FIREPROOFING WIRES AND CABLES:

A. Beyond the termination of raceways, apply fireproofing over the unprotected insulation and/or splices of the following:-

1. All service feeder cables ahead of main service overcurrent protection devices within all the pits, cable chambers or pull boxes they pass through and elsewhere where they are not enclosed in raceways.

2. Fire pump feeder cables wherever they extend beyond the termination of raceways.

3. All feeder wires and cables emanating from different secondary service connections or both normal and emergency supplies which, due to indications on the drawings or unavoidable field conditions are forced to enter the same unbarriered compartment of a cable chamber, cable pit, pull box or junction box.

B. Fireproofing of wires and cables is by means of a half-lapped layer of Scotch 77 fire and arc-proofing tape. The wrapped tape is secured by a band consisting of two layers of glass cloth electrical tape. Fireproofing is extended up into raceways. Fireproofing is applied in an overall manner to raceway groupings of conductors.

3.7 INSTALLATION OF CIRCUITRY FOR MISCELLANEOUS LOW VOLTAGE SYSTEMS:

A. Comply with requirements described in applicable subsections of this Section. In particular, note the following circuitry requirements for low voltage systems:

1. Wiring for miscellaneous low voltage systems may be run without conduit - subject to the approval of the local authorities - except where prohibited by other sections of these specifications or by indications on the drawings.

2. Where conduit is required, it is steel electric metallic tubing (EMT), except that it is galvanized intermediate steel conduit where located within 8 feet (2.4 m) of the floor in mechanical spaces (or is otherwise exposed to mechanical damage), or is intended for embedment in concrete.

3. Wires and cables have characteristics - in compliance with Articles 725 and/or 800 (as applicable) of the National Electrical Code - as described elsewhere in the specifications or drawings for this project, and are U.L. listed in accordance therewith.

4. Where wires and cables are permitted to be run without conduit, they are independently supported from the building structure or ceiling suspension systems at intervals not exceeding four feet on center, utilizing cable supports specifically approved for the purpose. Wires and cables do not rest on or depend on support from suspended ceiling media (tiles, lath, plaster, as well as splines, runners or bars in the plane of the ceiling), nor are they supported from pipes, ducts or conduits. Where cables are bundled together, separate bundles are provided separately for each type of cabling and separately for each independent system. Bundling and/or supporting ties are of a type suitable for use in a ceiling air handling plenum regardless of whether or not installed in a plenum.

5. Cables are tagged or labeled at each termination point and in each intermediate junction box, pull box or cabinet through which they pass.

6. Comply with applicable requirements for locating and routing circuitry, for installing circuitry, and for fire-stopping as described in other sub-section of this Section.

3.8 FIELD QUALITY CONTROL

A. Testing: Perform the following field quality-control testing:

1. After installing conductors and cables and before electrical circuitry has been energized, test for compliance with requirements.

2. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.3.1. Certify compliance with test parameters.

B. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each splice in cables and conductors No. 2 AWG and larger. Remove box and equipment covers so splices are accessible to portable scanner.

1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each splice 11 months after date of Substantial Completion.

2. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

3. Record of Infrared Scanning: Prepare a certified report that identifies splices checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

C. Test Reports: Prepare a written report to record the following:

1. Test procedures used.

2. Test results that comply with requirements.

3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

END OF SECTION 16120

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.

B. Related sections include the following:

1. Division 16 Section “Underground Ducts and Utility Structures” for exterior ductbanks, manholes, and underground utility construction.

2. Division 16 Section “Basic Electrical Materials and Methods” for firestopping.

3. Division 16 Section “Supporting Devices” for raceway and box supports.

4. Division 16 Section “Wiring Devices” for devices installed in boxes and for floor-box service fittings.

1.3 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. ENT: Electrical non-metallic tubing.

C. FMC: Flexible metal conduit.

D. IMC: Intermediate metal conduit.

E. LFMC: Liquidtight flexible metallic conduit.

F. RNC: Rigid nonmetallic conduit.

1.4 SUBMITTALS

A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70, as amended by state and local codes.

1.6 COORDINATION

A. Coordinate layout and installation of raceways, boxes, enclosures, cabinets and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system and partition assemblies.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection.

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering Products that may be incorporated in the Work include, but are not limited to, the following:

2.2 METAL CONDUIT AND TUBING:

A. Available Manufacturers

1. Alflex Corp

2. Grinnell Co./Tyco International; Allied Tube and Conduit Div.

3. LTV Steel Tubular Products Company.

4. Wheatland Tube Co.

5. Triangle PWC, Inc.

B. Rigid Steel Conduit: ANSI C80.1

C. IMC: ANSI C80.6.

D. PVC-Coated Steel Conduit: PVC-coated IMC.

1. Comply with NEMA RN 1.
2. Coating Thickness: 0.040 inch (1 mm), minimum.

E. EMT and Fittings: ANSI C80.3.

1. Fittings: Set-screw or compression.

F. FMC: Zinc coated steel.

G. LFMC: Flexible steel conduit with PVC jacket.

H. Fittings: NEMA FB 1; listed for type and size raceway with which used, and for application and environment in which installed.

(a) Fittings for EMT: Die-cast compression type.

(b) Coating for Fittings for PVC-Coated Conduit: Minimum thickness, 0.040 inch (1 mm), with overlapping sleeves protecting threaded joints.

I. RNC: NEMA TC 2, Schedule 40 and Schedule 80 PVC.

2.3 METAL WIREWAYS

A. Available Manufacturers:

1. Hoffman.

2. Square D

3. The Wiremold Company

B. Material and Construction: Sheet metal sized and shaped as indicated.

1. Dry locations: NEMA 250, Type1.

2. Damp or Wet locations: NEMA 250, Type 3R.

C. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for a complete system.

D. Select features, unless otherwise indicated, as required to complete wiring system and to comply with NFPA 70.

E. Wireway Covers: Screw-cover type.

F. Finish: Manufacturer’s standard enamel finish.

2.4 SURFACE RACEWAYS

A. Surface Metal Raceway: Galvanized steel with snap-on covers. Finish with manufacturer's standard prime coating and paint finish as selected by the architect.

1. Available Manufacturers:

(a) Thomas & Betts Corporation.

(b) Walker Systems, Inc; Wiremold Company (The)

(c) The Wiremold Co., Electrical Sales Division.

B. Types, sizes and channels as indicated and required for each application, with fittings that match and mate with raceways.

2.5 BOXES, ENCLOSURES AND CABINETS

A. Available Manufacturers:

1. Cooper Crouse-Hinds; Div. Of Cooper Industries, Inc.
2. Emerson/General Signal; Appleton Electric Company.
3. Erickson Electrical Equipment Co.
4. Hoffman.
5. Hubbell, Inc.; Killark Electric Manufacturing Co.
6. O-Z/Gedney; Unit of General Signal.
7. RACO; Division of Hubbell, Inc.
8. Spring City Electrical Manufacturing Co.
9. Thomas & Betts Corporation.
10. Walker Systems Inc.; Wiremold Company (The).

B. Sheet Metal Outlet and Device Boxes: NEMA OS 1.

C. Cast Metal Outlet and Device Bopxes: NEMA FB 1, Type FD, with gasketed cover.

D. Nonmetallic Outlet and Device Boxes: NEMA OS 2.

E. Floor Boxes: Cast metal, fully adjustable, rectangular.

F. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

G. Cast Metal Pull and Junction Boxes: NEMA FP 1 cast aluminum with gasketed cover.

H. Cabinets: NEMA 250, Type 1, galvanized steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel. Hinged door in front cover with flush latch and associated hinge. Key latch to match panelboards. Include metal barriers to separate wiring of different systems and voltage and include accessory feet where required for freestanding equipment.

I. Pull boxes for Telephone and Signal System Raceways: ANSI/EIA/TIA-569A

2.6 FACTORY FINISHES

A. Finish: For raceway, enclosure, or cabinet components, provide manufacturer's standard prime-coat finish ready for field painting.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

A. Outdoors: Use the following wiring methods, except as specifically noted otherwise.

1. Exposed: Rigid steel or IMC.
2. Concealed: Rigid steel or IMC.
3. Underground, Single Run: RNC.
4. Underground, Grouped: RNC.
5. Connection to Vibrating Equipment (including transformers and hydraulic, pneumatic, electric solenoid, or motor driven equipment): LFMC.
6. Exposed within 30 feet (10 meters) chiller: PVC coated steel conduit.
7. Boxes and Enclosures: NEMA 250, Type 3R or 4.

B. Indoors: Use the following wiring methods:

1. IMC for all purposes and in all applications except where specifically excluded, or where alternate methods are specified below.
2. Normal and emergency feeders to fire pumps: Rigid steel conduit. Feeder conduit encased in 2 inches (5cm) of concrete (or other code approved equivalent) where conduits are not physically routed outside the building. Exclude concrete for jockey pumps and/or auxiliary pumps.
3. Control circuitry to fire pumps: Rigid steel conduit.
4. Utilize EMT for:

(a) Main and submain feeders.

(b) Branch feeders.

(c) Lighting and appliance branch circuitry.

5. Exposed lighting and appliance branch circuitry runs in finished spaces : Surface metal raceway.

6. Refer to appropriate Sections of Division 16 for additional requirements relating to wiring methods for control/signal transmission, fire alarm systems, telecommunications, and other communication and alarm system distribution.

7. Wiring methods listed above shall be restricted as follows:

(a) Exclude EMT from concrete embedment, from locations where subject to mechanical damage and from exposed locations in finished spaces.

(b) Exclude surface metal raceway from concealed installations, from locations where subject to mechanical damage and from wet or damp locations.

(c) Utilize only intermediate or rigid steel conduit from runs in (or opening into) hazardous areas. Comply with electric code requirements regarding sealing fittings, boxes, enclosures as appropriate for the conditions of atmospheric contamination.

8. The following shall be treated as damp or wet locations within building confines, regardless of whether or not a high ambient moisture level is found to exist:

(a) Spaces where any designations indicating weatherproof (WP) or vaporproof (VP) appear on the drawings.

(b) Parking garage areas.

(c) Loading docks.

(d) Chiller areas.

(e) Below waterproofing in slabs applied directly on grade.

(f) Kitchens up to a height of 18inches (45 cm) above finished floor.

(g) Outside of waterproofing in foundation walls in contact with grade.

(h) Above waterproofing in slabs having no building above.

(i) Above waterproofing in fill on slabs having no building above.

(j) Spaces containing equipment owned and/or maintained by the electric utility company.

(k) Electric work in slabs, walls or suspended ceilings which bound on a space defined as a damp or wet location shall meet the damp or wet location requirements if it enters into, or opens into the damp or wet location in any way.

(l) Tug ramps, tug tunnels and other similar areas.

9. The following shall be interpreted as being "hazardous" locations regardless of actual condition of atmospheric contamination.

(a) The entire floor to ceiling volume of space where any designations indicating "explosion proof" (EP) are shown.

(b) Gas meter rooms.

(c) The volume included between the floor and a height of 18inches (45 cm) above the floor throughout all space designated for parking, including all associated above grade vehicular ramps and access ways, and all spaces on the floor not separated from the parking space by partitions.

(d) The entire floor to ceiling volume of all spaces designated for the storage of flammable anesthetics.

(e) The volume included between the floor and a height of 60 inches (150 cm) above the floor throughout all spaces designated for the administration of flammable anesthetics.

(f) The entire interior volume of any paint spray booth and its associated ductwork.

(g) The entire volume of any space falling within 20 feet (6 meters) of the open face of any paint spray booth, and which is not cut off by air tight, unpierced walls, partitions, slabs or other general construction elements.

(h) The entire floor to ceiling volume of any space designated for painting by means of open spraying or tank dipping.

(i) Electric work located in slabs, walls or suspended ceilings which bound on a space defined as a hazardous location shall meet the hazardous location requirements if it enters into, or opens into, the hazardous location in any way.

C. Minimum Raceway Size: 3/4 inch (DN 21) trade size.

D. Indicated Raceway Size: Raceway sizes indicated are based on non-flexible conduit. Where flexible type raceways are specified, increase raceway size as required to maintain code mandated maximum conduit fill.

E. Raceway Fittings: Compatible with raceways and suitable for use and location.

1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings, unless otherwise indicated.

2. EMT: Where embedded in concrete, utilize concrete compression type couplings, connectors and fittings of a type which assures ground continuity.

3. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with that material. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer.

3.2 INSTALLATION

A. Keep raceways at least 6 inches (150 mm) away from parallel runs of flues and steam or hot water pipes. Install horizontal raceway runs above water and steam piping.

B. Complete raceway installation before starting conductor installation.

C. Support raceway as specified in Division 16 Section "Supporting Devices."

D. Install temporary closures to prevent foreign matter from entering raceway.

E. Protect stub-ups from damage where conduits rise through floor slabs. Arrange so curved portion of bends is not visible above the finished slab.

F. Make bends and offsets so the inside diameter is not reduced. Unless otherwise indicated, keep the legs of a bend in the same plane and the straight legs of offsets parallel.

G. Conceal conduit and EMT within finished walls, ceilings, and floors, unless otherwise indicated.

1. Install concealed raceways with a minimum of bends in the shortest practical distance, considering type of building construction and obstructions, unless otherwise indicated.

H. Install exposed raceways parallel to or at right angles to nearby surfaces or structural members, and follow the surface contours as much possible.

1. Run parallel or banked raceways together on common supports.

2. Make parallel bends in parallel or banked runs. Use factory elbows only where elbows can be installed parallel; otherwise, provide field bends for parallel raceways.

I. Join raceways with fittings designed and approved for the purpose and make joints tight.

1. Use insulating bushings to protect conductors.

J. Tighten set screws of threadless fittings with suitable tool.

K. Equip all raceways, including those embedded in concrete which cross building expansion or control joints, with expansion fittings having flexible grounding bonds bypassing sliding parts. Arrange expansion fittings on concrete embedded raceways so that sliding action is not impeded.

L. Terminations:

1. Where raceways are terminated with locknuts and bushings, align the raceway to enter squarely, and install the locknuts with dished part against the box. Use two locknuts, one inside and one outside box.

2. Where terminating in threaded hubs, screw the raceway or fitting tight into the hub so the end bears against the wire protection shoulder. Where chase nipples are used, align the raceway so the coupling is square to the box, and tighten the chase nipple so no threads are exposed.

M. Install pull wires in empty raceways. Use No. 14 AWG zinc-coated steel or monofilament plastic line having not less than 200-lb (90 kg) tensile strength. Leave not less than 12 inches (300 mm) of slack at each end of the pull wire.

N. Telephone and Signal System Raceways 2-Inch Trade Size (DN 53) and Smaller: In addition to the above requirements, install in maximum lengths of 100 feet (30 m) and with a maximum of two 90-degree bends or equivalent. Install pull or junction boxes where necessary to comply with these requirements. Pull or junction boxes shall be sized in accordance with ANSI/EIA/TIA-569A guidelines.

O. Install raceway sealing fittings according to the manufacturer's written instructions. Locate fittings at suitable, approved, accessible locations and fill them with UL-listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points and elsewhere as indicated:

1. Where conduits pass from warm locations to cold locations, such as the boundaries of refrigerated spaces and air-conditioned spaces.

2. Where otherwise required by the NFPA70.

P. Stub-up Connections: Extend conduits through concrete floor for connection to freestanding equipment. Install with an adjustable top or coupling threaded inside for plugs set flush with finished floor. Extend conductors to equipment with rigid steel conduit; FMC may be used 6 inches (150 mm) above the floor. Install screwdriver-operated, threaded plugs flush with floor for future equipment connections.

Q. Flexible Connections: Use maximum of 6 feet (1.8 m) of FMC for recessed and semirecessed lighting fixtures; for equipment subject to vibration, noise transmission, or movement; and for all motors. Use LFMC in wet or damp locations. Install separate ground conductor across flexible connections.

R. Surface Raceways: Install a separate, green, ground conductor in raceways from junction box supplying raceways to receptacle or fixture ground terminals.

S. Set floor boxes level and flush with finished floor surface.

T. Install hinged cover enclosures and cabinets plumb. Support at each corner.

U. Raceways Embedded in Slabs: Embedment of circuitry in field poured concrete slabs and fill will be permitted subject to the approval of the structural engineer, compliance with the "pour schedule" established for the project, and to the following criteria:

1. They shall be routed in such a manner as to coordinate with the structural requirements of the building. Submit proposed routing to structural engineer for approval. Raceways proposed to be embedded in concrete which are not approved by the structural engineer shall be installed in another manner (in accordance with these specifications).

2. Note that embedment of conduit in field poured concrete slabs and/or fill will not be permitted in tenant areas and other spaces where the location of all electrical lighting, power and signal outlets are not shown on the electrical drawings.

3. Maximum outside diameter of raceways shall not exceed one third of concrete thickness. Raceways shall be run in a "single layer" with their outside surface no closer than 1 inch (25mm) to any surface of the concrete.

4. Install in middle 1/3 of slab thickness.

5. Provide support for raceways independent of reinforcing rods.

6. Secure raceways to reinforcing rods to prevent sagging or shifting during concrete placement.

7. Space raceways laterally to prevent voids in the concrete.

8. Run raceway larger than 1 inch (DN 27) trade size parallel to or at right angles to main reinforcement. When at right angles to reinforcement, place raceway close to slab support.

9. They shall not be spaced closer than 3 diameters on center, with a minimum of 3 inches (75mm) between the outside surfaces of the raceways, except at tees, crosses or other single level wide angle junction points.

10. Where crossovers or close groupings are unavoidable, circuitry shall either be dog-legged out of the concrete or be carefully field coordinated so as not to cause structural weakness. Where in metal deck or subfloor type of construction, crossovers shall occur only in valleys.

11. Where turned up or down into a wall or partition they shall, before entering same, be routed parallel for a long enough distance to assure that no relocation of the wall or partition will be necessary to conceal the required bend.

12. They shall be routed in accordance with field instructions issued by the Architect where such instructions differ from specifications set forth herein.

V. To the extent that circuitry cannot be embedded in concrete slabs and fill, floor and wall mounted outlets shall be supplied in conformance with so-called "poke through system" criteria as described below. Outlets supplied from a specialty cast-in-floor raceway system constitute an exception to this criteria.

W. Criteria for the "poke through" system of circuitry are as follows:-

1. Circuitry shall be run in the hung ceiling space of the story which it serves or in the hung ceiling space of the story immediately below, utilizing openings cut through the floor slab when necessary.

2. The running of circuitry, at the story below the one served, shall be held to an absolute minimum, and shall be used only for tying floor outlets to their nearest adjacent outlets or for other such unavoidable purposes.

3. Circuitry serving a given story shall emanate from local supply or central facilities on the same story and none other.

4. Openings through floor slabs shall be cut, patched and "firestopped" as part of the electrical work. "Firestopping" shall include the filling in of excess opening spaces as well as the utilization of approved, fire-rated through-floor fittings for all floor outlets. These fire-rated fittings shall each be of the "dual service" type, complete with integral floor stanchion which can accommodate 120 volt and telephone and/or signal) circuitry and devices.

All "firestopping" shall be performed as directed in the field. General instructions establishing cutting, patching and "firestopping" separate from the electric work are not applicable to the poke through system of circuitry.

5. Openings through floor slabs shall not be spaced closer together than 2 feet (61 cm), and no more than one fire-rated fitting per 65 square feet (6 square meters) of floor area in each span shall be utilized.

3.3 LOCATING AND ROUTING CIRCUITRY:

A. All circuitry shall be run concealed except that it shall be run exposed:-

1. Horizontally at the ceiling of permanently unfinished spaces which are not assigned to mechanical or electrical equipment.

2. Horizontally and vertically in mechanical equipment spaces.

3. Horizontally and vertically in electric equipment rooms.

4. Where specifically noted on the drawings.

B. Concealed circuitry shall be so located that building construction materials can be applied over its thickest elements without being subject to spalling or cracking.

3.4 INSTALLING JUNCTION, PULL AND OUTLET BOXES:

A. Apply junction and pull boxes in accordance with the following:-

1. Include pull boxes in long straight runs of raceway to assure that cables are not damaged when they are pulled in.

2. Include junction and pull boxes to assure a neat and workmanlike installation of raceways.

3. Include junction and pull boxes to fulfill requirements pertaining to the limitations to the number of bends permitted in raceway between cable access points, the accessibility of cable joints and splices, and the application of cable supports.

4. Where the wires and cables following the same routing are indicated as running through separate pull boxes, it shall be understood that a segregation of the wires and cables is required. Separately indicated pull boxes may be incorporated into single boxes on condition that segregation is maintained by barriers of the type hereinafter specified.

5. Include all required junction and pull boxes regardless of indications on the drawings (which, due to symbolic methods of notation, may omit to show some of them).

B. Apply outlet boxes in accordance with the following:-

1. Unless noted below or otherwise specifically indicated, include a separate outlet box for each individual wiring device, lighting fixture and signal or communication system outlet component. Outlet boxes supplied attached to lighting fixtures shall not be used as replacements for the boxes specified herein unless they are specifically rated to accept "through circuit" building wires.

2. A continuous row of fixtures of the end-to-end channel type, designed for "through wiring," and wired in accordance with the specifications hereinafter pertaining to circuitry through a series of lighting fixtures, may be supplied through a single outlet box.

3. A series of separate fixtures, designed for "through wiring," spaced not more than 2 feet (600mm) apart, and interconnected with conduit or raceway and circuitry which is in accordance with the specifications hereinafter pertaining to circuitry through a series of lighting fixtures, may be supplied through a single outlet box.

4. Connection to recessed ceiling fixtures supplied with pigtails may be arranged so that more than one, but not more than four, such fixtures are connected into a single outlet box. When adopting this procedure:-

   (a) Utilize an outlet box no smaller than 4-11/16 inches (119mm) square by 2-1/8 inches (54 mm) deep.

   (b) Allow no fixture to be supplied from an outlet box in another room.

5. Multiple local switches indicated at a single location shall be gang mounted in a single outlet box.

6. Include all required outlet boxes regardless of indications on the drawings (which due to symbolic methods of notation, may omit to show some of them).

7. Regardless of any indications on the drawings, flush wall mounted outlet boxes shall not be set back-to-back in fire rated walls or partitions, even if they are displaced vertically. Such outlets shall be offset horizontally by 24 inches (610mm) or as otherwise required to maintain the fire rating.

8. Exclude "through-the-wall" collar type outlet boxes for flush devices indicated back-to-back in non-fire rated partitions or walls. Where necessary to accommodate box depths, outlets shown back-to-back shall be horizontally offset.

C. Install junction boxes, pull boxes and outlet boxes in accordance with the following:-

1. Exclude surface mounted outlet boxes in conjunction with concealed circuitry.

2. Exclude unused circuitry openings in junction and pull boxes. In larger boxes each such opening shall be closed with a galvanized sheet steel plate fastened with a continuous weld all around. In small outlet type boxes, utilize plugs as specified for such boxes.

3. Close up all unused circuitry openings in outlet boxes. Unused openings in cast boxes shall be closed with approved cast metal threaded plugs. Unused openings in sheet metal boxes shall be closed with sheet metal knock-out plugs.

4. Pack "through the wall" collar type outlet boxes with a sound deadening, non-hardening, non-hygroscopic, non- combustible, high dielectric stuffing material manufactured specifically for the purpose.

5. Outlet boxes for switches shall be located at the strike side of doors. Indicated door swings are subject to field change. Outlet boxes shall be located on the basis of final door swing arrangements.

6. Boxes and plaster covers for duplex receptacles shall be arranged for vertical mounting of the receptacle.

7. Equip outlet boxes used for devices which are connected to wires of systems supplied by more than one set of voltage characteristics with barriers to separate the different systems.

D. Barriers in junction and pull boxes of outlet size shall be of the same metal as the box.

E. Barriers in junction and pull boxes which are larger than outlet size shall be of polyester resin fiberglass of adequate thickness for mechanical strength but in no case less than 1/4 inch (6.5mm). Each barrier shall be mounted, without fastenings, between angle iron guides so that they may be readily removed.

3.5 MOUNTING HEIGHTS

A. Heights of all wall mounted outlets and equipment shall be in accordance with the following list. (Dimensions are above finished floor unless noted.)

1. Receptacle or telephone outlet in field constructed wall, partition or column unless otherwise specified below -- 18 inches (45 cm) to centerline.

2. Receptacle or telephone outlet in factory fabricated wall or partition, unless otherwise specified below -- Dimension determined by wall or partition construction.

3. Receptacle or telephone outlet in mechanical spaces, electric switchboard rooms, electric closets -- 60 inches (150 cm) to centerline.

4. Toggle switch outlet in field constructed wall partition or column -- 46 inches (117 cm) to centerline.

5. Toggle switch outlet in factory fabricated wall or partition -- Dimension determined by wall or partition construction.

6. Bracket lighting outlets, except for "over door" -- 90 inches (228 cm) to centerline.

7. Bracket lighting outlet over door -- as required to center outlet between top surface of door lintel and underside of ceiling.

8. Wall exit sign except for over door -- 90 inches (228 cm) to centerline.

9. Exit sign over door -- As required to center sign between top surface of door lintel and underside of ceiling.

10. Outlet for any signal system device other than fire alarm station requiring manual operation -- 46 inches (117 cm) to centerline.

11. Manual fire alarm station -- 46 inches (117 cm) to centerline.

12. Outlet for any signal system visual or sounding device other than fire alarm visual device or visual/sounding device -- As required for device to clear underside of ceiling by 1 inch (25 mm).

13. Outlet for fire alarm visual device -- Visual device 80 inches (203 cm) AFF, except as otherwise noted.

14. Clock outlet -- As required for clock to clear underside of ceiling by 1 inch (25 mm).

B. Architectural drawings and field instructions issued by the Architect take precedence over the above list and shall be adhered to.

3.6 PROTECTION

A. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, to ensure that coatings, finishes, and cabinets are without damage or deterioration at Substantial Completion.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.

2. Repair damage to PVC or paint finishes with matching touch-up coating recommended by the manufacturer.

3.7 CLEANING

A. After completing installation of exposed, factory-finished raceways and boxes, inspect exposed finishes and repair damaged finishes.

END OF SECTION 16130

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Single and duplex receptacles, ground-fault circuit interrupters, integral surge suppression units, and isolated-ground receptacles.

2. Single- and double-pole snap switches and dimmer switches.

3. Device wall plates.

4. Floor service outlets, poke-through assemblies, and multioutlet assemblies.

1.3 DEFINITIONS

A. GFCI: Ground-fault circuit interrupter.

B. EMI: Electromagnetic interference.

C. RFI: Radio-frequency interference.

D. TVSS: Transient voltage surge suppressor.

E. UTP: Unshielded twisted pair.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of wiring device through one source from a single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with NFPA 70, as amended by state and local codes.

1.6 COORDINATION

A. Receptacles for Owner-Furnished Equipment: Match plug configurations.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Wiring Devices:

    (a) Bryant Electric, Inc./Hubbell Subsidiary.

    (b) Hubbell Incorporated; Wiring Device-Kellems.

    (c) Leviton Mfg. Company Inc.

    (d) Pass & Seymour/Legrand; Wiring Devices Div.

2. Wiring Device type Lighting Dimmers:

    (a) Lutron.

    (b) Lightolier.

3. Wiring Devices for Hazardous (Classified) Locations:

    (a) Crouse-Hinds/Cooper Industries, Inc.; Arrow Hart Wiring Devices.

    (b) EGS/Appleton Electric Company.

    (c) Killark Electric Manufacturing Co./Hubbell Incorporated.

4. Multioutlet Assemblies:

   (a) Hubbell Incorporated; Wiring Device-Kellems.

   (b) Wiremold Company (The).

5. Poke-Through, Floor Service Outlets and Telephone/Power Poles:

   (a) Hubbell Incorporated; Wiring Device-Kellems.

   (b) Pass & Seymour/Legrand; Wiring Devices Div.

   (c) Square D/Groupe Schneider NA.

   (d) Thomas & Betts Corporation.

   (e) Wiremold Company (The).

2.2 RECEPTACLES

A. Receptacles: NEMA WD 6, Comply with NEMA WD 1, Federal Specification WC 596, and UL 498. Rectangular (decorator) style in public spaces.

B. Straight-Blade and Locking Receptacles: Commercial specification grade, configuration 5-20R.

C. GFCI Receptacles: Straight blade type, Commercial specification grade, with integral NEMA WD 6, Configuration 5-20R duplex receptacle; complying with UL 498 and UL 943. Design units for installation in a 2-3/4-inch- (70-mm-) deep outlet box without an adapter. Incorporate "through feed" features permitting the optional protection of downstream receptacles if desired.

D. Isolated-Ground Receptacles: Straight blade, Commercial specification grade, duplex receptacle, with equipment grounding contacts connected only to the green grounding screw terminal of the device and with inherent electrical isolation from mounting strap.

   1. Devices: Listed and labeled as isolated-ground receptacles.

   2. Isolation Method: Integral to receptacle construction and not dependent on removable parts.

E. TVSS Receptacles: Straight blade, NEMA WD 6, Configuration 5-20R, with integral TVSS in line to ground, line to neutral, and neutral to ground.

1. TVSS Components: Multiple metal-oxide varistors; with a nominal clamp level rating of 500 volts and minimum single transient pulse energy dissipation of 140 J line to neutral, and 70 J line to ground and neutral to ground.

2. Active TVSS Indication: Visual only with light visible in face of device to indicate device is "active" or "no longer in service."

2.3 SWITCHES

A. Single- and Double-Pole Switches: Comply with NEMA WD 1 and WD 6, Federal Specification WS-896, and UL 20. Rectangular (decorator) style in public spaces.

1. Snap Switches: Heavy-Duty grade, quiet type.

2. Dimmer Switches: Modular, full-wave, solid-state units with integral, quiet on/off switches and audible frequency and EMI/RFI filters.

    (a) Control: Continuously adjustable; with single-pole or three-way switching to suit connections.

    (b) Incandescent Lamp Dimmers: Modular, 120 V, 60 Hz with continuously adjustable rotary knob, toggle switch, or slider; single pole with soft tap or other quiet switch; EMI/RFI filter to eliminate interference; and 5-inch (130-mm) wire connecting leads. Suitable for use with magnetic or electronic low voltage lamp transformers as required to suit load.

    (c) Fluorescent Lamp Dimmer Switches: Modular; compatible with dimmer ballasts; trim potentiometer to adjust low-end dimming; dimmer-ballast combination capable of consistent dimming with low end not greater than 20 percent of full brightness.

2.4 WALL PLATES

A. Single and combination types with openings to match corresponding wiring devices. Comply with NEMA WD 1 and WD 6.

1. Plate-Securing Screws: Metal with head color to match plate finish.

2. Material for Finished Spaces: as indicated by architect

3. Material for Unfinished Spaces: Galvanized steel Smooth.

4. Material for Wet Locations: Cast aluminum with spring-loaded lift cover, and listed and labeled for use in "wet locations." Enclosures for 120 Volt receptacles rated 20 Amperes or less are weatherproof whether or not the attachment plug cap is inserted.

2.5 FLOOR SERVICE FITTINGS

A. Type: Modular **[flush-type] [flap-type] [above-floor]**, dual-service units suitable for wiring method used.

B. Compartments: Barrier separates power from voice and data communication cabling.

C. Service Plate: **[Rectangular] [Round],** [**die-cast aluminum] [solid brass]** with satin finish.

D. Power Receptacle: NEMA WD 6, Configuration 5-20R, gray finish, unless otherwise indicated.

2.6 POKE-THROUGH ASSEMBLIES

A. Description: Factory-fabricated and -wired assembly of below-floor junction box with multichanneled, through-floor raceway/firestop unit and detachable matching floor service outlet assembly.

1. Service Outlet Assembly

2. Furniture feed type service assembly: connections for power and communications.

3. Size: Selected to fit nominal cored holes in floor and matched to floor thickness.

4. Fire Rating: Unit is listed and labeled for fire rating of floor-ceiling assembly.

5. Closure Plug: Arranged to close unused 3-inch (75-mm) 4-inch (100-mm) cored openings and reestablish fire rating of floor.

6. Wiring Raceways and Compartments: For a minimum of four No. 12 AWG conductors; and a minimum of four, 4-pair, Category 5 voice and data communication cables.

2.7 MULTIOUTLET ASSEMBLIES

A. Components of Assemblies: Products from a single manufacturer designed for use as a complete, matching assembly of raceways and receptacles.

1. Raceway Material: Metal, with manufacturer's standard finish.

2. Wire: No. 12 AWG.

2.8 FINISHES

A. Color:

1. Wiring Devices Connected to Normal Power System: As selected by Architect from manufacturer’s standard colors, unless otherwise indicated or required by NFPA 70.

2. Wiring Devices Connected to Emergency Power System: Red.

3. Isolated-Ground Receptacles: Orange

4. Comply with NEMA WD 1.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install devices and assemblies level, plumb, and square with building lines.

B. Install wall dimmers to achieve indicated rating after derating for ganging according to manufacturer's written instructions.

C. Install unshared neutral conductors on line and load side of dimmers according to manufacturers' written instructions.

D. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical, and with grounding terminal of receptacles on top. Group adjacent devices under single, multigang wall plates.

E. Remove wall plates and protect devices and assemblies during painting.

F. Adjust locations of floor service outlets to suit arrangement of partitions and furnishings.

3.2 IDENTIFICATION

A. Comply with Division 16 Section "Electrical Identification."

1. Receptacles Connected to Emergency Power System: Identify panelboard and circuit number from which served. Use hot stamped or engraved machine printing with red-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.

3.3 CONNECTIONS

A. Ground equipment according to Division 16 Section "Grounding and Bonding."

B. Connect wiring according to Division 16 Section "Conductors and Cables."

C. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.4 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:

1. After installing wiring devices and after electrical circuitry has been energized, test for proper polarity, ground continuity, and compliance with requirements.

2. Test GFCI operation with both local and remote fault simulations according to manufacturer's written instructions.

B. Remove malfunctioning units, replace with new units, and retest as specified above.

END OF SECTION 16140

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following lighting control devices:

1. Time switches.

2. Photoelectric switches.

3. Occupancy sensors.

4. Multipole contactors.

B. Related Sections include the following:

1. Division 16 Section "Wiring Devices" for wall-box dimmers and manual light switches.
2. Division 16 Section 16146 “Lighting Control Panelboards Powerlink G3”.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Field quality-control test reports.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.5 COORDINATION

A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Lighting control devices have been specified on the drawings and in other Division 16 Sections. Where they introduce lists, the following requirements apply to product selection:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
    a. Hubbell Building Automation
    b. Lighting Control and Design
    c. Square D PowerLink
    d. Eaton/Cutler-Hammer
2. All occupancy sensors shall be from same manufacturer.

2.2 GENERAL LIGHTING CONTROL DEVICE REQUIREMENTS

A. Line-Voltage Surge Protection: An integral part of the devices for 120- and 277-V solid-state equipment. For devices without integral line-voltage surge protection, field-mounting surge protection shall comply with IEEE C62.41 and with UL 1449.

2.3 CONDUCTORS AND CABLES

A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG, complying with Division 16 Section "Conductors and Cables."

B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded copper conductors not smaller than No. 18 AWG, complying with Division 16 Section "Conductors and Cables."

C. Class 1 Control Cable: Multiconductor cable with stranded copper conductors not smaller than No. 14 AWG, complying with Division 16 Section "Conductors and Cables."

PART 3 - EXECUTION

3.1 SENSOR INSTALLATION

A. Install and aim sensors in locations to achieve at least 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

3.2 WIRING INSTALLATION

A. Wiring Method: Comply with Division 16 Section "Conductors and Cables." Minimum conduit size shall be 3/4 inch trade size (DN21).

B. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.

C. Install field-mounting transient voltage suppressors for lighting control devices in Category A locations that do not have integral line-voltage surge protection.

D. Size conductors according to lighting control device manufacturer's written instructions, unless otherwise indicated.

E. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

F. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.3 IDENTIFICATION

A. Identify components and power and control wiring according to Division 16 Section Electrical Identification."

B. Label time switches and contactors with a unique designation.

3.4 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:

1. After installing time switches and sensors, and after electrical circuitry has been energized, adjust and test for compliance with requirements.
2. Operational Test: Verify actuation of each sensor and adjust time delays.

B. Remove and replace lighting control devices where test results indicate that they do not comply with specified requirements.

C. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.5 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting sensors to suit actual occupied conditions. Provide up to two visits to site outside normal occupancy hours for this purpose.

END OF SECTION 16145

1.1 INTRODUCTION

A. The work covered in this section is subject to all the requirements in the General Conditions of the Specifications.

B. The contractor shall coordinate all of the work in this section with all of the trades covered in other sections of the specification to provide a complete and operable system.

1.2 DESCRIPTION OF WORK

A. The extent of the lighting control system work is indicated by the drawings and by the requirements of this section. It is defined to include, but not by way of limitation:
   1. Panelboards containing both standard and remotely operable circuit breakers
   2. Control electronics for switching circuit breakers and monitoring the status of the system
   3. Associated low voltage switches, occupancy sensors and external time clocks
   4. Any work stations, software and communications hardware

B. System installation includes the following:
   1. Wiring of main and branch circuit conductors
   2. Installation of external control devices and wiring to the panelboard controller
   3. Installation of communications conductors and associated hardware

1.3 QUALITY ASSURANCE

A. Manufacturers: Firms engaged in the manufacture of lighting control equipment and ancillary equipment, of the types indicated, whose products have been in satisfactory use in similar service for not less than five years.

B. Component Testing: All electronic component board assemblies are to be factory tested and burned in prior to installation.

C. System Support: Factory fax/telephone/email support shall be available free of charge during normal business hours.

D. NEMA Compliance: Comply with applicable portions of NEMA standards pertaining to types of electrical equipment and enclosures.

E. NEC Compliance: Comply with applicable portions of the NEC including Articles 110-10 and 725.

F. UL Compliance: Comply with applicable UL standards for panelboards, circuit breakers and energy management equipment.

G. FCC Emissions: All assemblies are to be in compliance with FCC emissions Standards specified in Part 15, Subpart J for Class A applications.

H. IEC 1000: Electronic panelboard components shall meet or exceed levels specified below:

1. ESD Immunity	IEC 1000, Level 4
2. RF Susceptibility	IEC 1000, Level 3
3. Electrical Fast Transient Susceptibility	IEC 1000, Level 3
4. Electrical Surge Susceptibility—power line	IEC 1000, Level 4
5. Electrical Surge Susceptibility—interconnection lines	IEC 1000, Level 3

I. ISO 9002: Manufacture of hardware and software components shall be registered as ISO 9000 compliant.

1.4 WARRANTY

A. Manufacturer shall warrant specified equipment to be free from defects in materials and workmanship for at least one year from the date of installation or eighteen months from date of purchase.

1.5 EQUIPMENT

A. Equipment shall be Square D POWERLINK G3 system or pre-approved equal.

1.6 SUBMITTALS

A. Product Data Sheets: Submit manufacturer’s data sheet for the lighting control system and specified components

B. Panel Drawings: Submit manufacturer’s dimensional drawings and circuit breaker placement locations for each panelboard.

C. One Line Diagram: Submit a one-line diagram of the system configuration proposed if it differs from that illustrated in the riser diagram included in these specifications.

D. Typical Wiring Diagrams: Submit typical connection diagrams for all components including, but not limited to, panelboards, low voltage switches, occupancy sensors, light level controllers, communications devices, and personal computers.

E. Substitutions: If a system from another manufacturer is submitted for approval, the following submittals are required: Short circuit study demonstrating NEC110-10 compliance for all remotely-operated switching devices. Elevation drawing showing placement of equipment in equipment rooms.

PART 2 - MATERIALS AND COMPONENTS

2.1 LIGHTING CONTROL SYSTEM

A. The lighting control system shall consist of microprocessor-based control electronics with remotely operated circuit breakers mounted to a UL67 listed lighting panelboard interior and enclosed in a UL50 listed panelboard enclosure. The circuit breakers shall provide overcurrent protection, and have an AIR rating or series connected rating that meets or exceeds the fault current of the system to which the panelboard is being applied.

B. Each master control panel shall meet or exceed the following capabilities:

1. Sixteen (16) 2-wire input terminals for connection to external low voltage switch contacts.

2. Time of day scheduling to automatically shut off lighting at specific programmed times
3. Direct control of 168 branch circuits in a master/slave sub-net configuration.
4. Provide true status feedback by monitoring branch circuit breaker status based on actual system voltage at load side terminal.
5. Accept remote commands through the facilities Ethernet infrastructure.

C. All lighting control components shall be installed in a conventional panelboard 20 inches wide or column-width enclosures (as noted on drawings). Suitable barriers shall be installed to separate Class 2 wiring from power conductors.

2.2 HARDWARE

A. To minimize space requirements, the remotely operated circuit breakers and electronics shall be integral to the lighting panelboard.

1. Remotely Operated Circuit Breakers—all remotely operated branch circuit breakers shall provide overload and short circuit protection suitable for the location in the electrical system, as defined in the panelboard schedules. Remotely operated power switching devices shall have the following:
2. Integral branch circuit overcurrent protection as required by the National Electrical Code (NEC). All circuit breakers shall have a UL Listed interrupting rating sufficient for the application or UL Listed series connected ratings for the maximum available fault current at that point in the system. Submittals reflecting the use of relays or contactors to perform remote switching must show evidence in writing that the relays withstand the available fault current.
3. UL Listed SWD ratings for 15A and 20A 1-, 2- and 3-pole branch devices, HID ratings, and HACR ratings.
4. Handle operator that shall mechanically open the power switching device contacts when moved to the OFF position and disable the contacts from being remotely closed.
5. Manual override switch to enable or disable the remote operation of the device and allow breaker handle to fully control the On/Off state of the breaker. Override must fully disengage remote operation of the breaker mechanism. Device utilizing ‘one-shot’ or ‘temporary’ overrides will not be accepted.
6. Visible flag that clearly indicates the status of the circuit breaker contacts with the panel trim installed. Flag shall indicate: ON, OFF, and TRIPPED circuit breaker states. The visible flag shall be mechanical in nature, directly tied to the circuit breaker mechanism, and shall be provided in addition to any status indicator supplied by the system electronics.
7. Switching endurance rating of 200,000 open/close/open remote operations. Switching devices with lower ratings may be judged to be acceptable, but must be provided with [100%] [200%] spare switching devices for each circuit to ensure an equivalent total number of operations.

B. Lighting Control Electronics—Master Panelboards

1. Panels identified on the power riser diagram as master panels shall contain both a power supply module and controller in the indicated spaces. Master panels provide power and control for operating and monitoring remotely operated branch circuit breakers connected to control busses located in master and slave panelboards. One power supply module and controller shall support up to eight (8) control busses.

2. Master panels shall contain a nameplate label, located on the panel trim indicating its designation, automation level network address, and the designations and addresses of all associated slave panels.
3. A power supply module shall be furnished to provide control power for the operation of the remotely operated circuit breakers, controller, bus system and low voltage inputs. Power module(s) shall connect directly to the panel interior and receive line voltage from the panel bus. Power module(s) shall be internally self-protected and operate within a range of –15% to +10% of its nominal line voltage rating.
4. The controller shall operate whenever voltage is within the power supply operating range. In the event of incoming power outage, the controller shall automatically halt execution in a safe manner. Upon return of power, the controller shall automatically reboot and return to normal system operation.
5. The controller shall include the following:
    a. Integral keypad and LCD front panel for local setup. Front panel setup shall permit local input setup and creation of time schedules without requiring separate PC-based software or hand held loader devices.
    b. RS-232 serial communications interface to permit local connection to personal computer without having to remove panel trim.
    c. Non-volatile memory to retain all setup and configurations.
    d. Sixteen terminals configurable for either sixteen (16) two-wire inputs, eight (8) three-wire inputs, or eight (8) two-wire inputs with status feedback for pilot LED's. All configurations shall allow either momentary or maintained control devices to be attached without providing any external control power.
    e. An auxiliary control power source for powering external control devices such as occupancy sensors and low voltage photo sensors, as indicated on drawings.
    f. Programmable input timers to permit timed override periods.
    g. Adjustable blink notice.
    h. Ability to log and display remotely operated breaker On-time.
    i. Ability to log events including changes to breaker state, input state, zone state, schedule periods, and bus operational status.
    j. Capability for accepting downloadable firmware so that the latest production features may be added in the future without replacing the module.
6. Time scheduler shall provide, at minimum, the following:
    a. Sixteen (16) independent schedules, each having twenty-four (24) time periods.
    b. Clock configurable for 12-hour (AM/PM) or 24-hour format.
    c. Schedule periods settable to the minute.
    d. 365-day calendar, with automatic daylight savings and leap year adjustments.
    e. Day-of-week, day-of-month, day-of-year with one-time or repeating capability.
    f. Thirty-two (32) special date periods with ability to nest different periods within other periods.

g. Astronomical tracker to automatically adjust sunrise and sunset times throughout the year.

7. Each panel controller shall have no less than sixteen (16) physical inputs that can be connected to external devices as shown on the drawings. These inputs shall be configured according to the customers requirements and shall be capable of providing the following capabilities:

   a. Configurable for Normally Open, Normally Closed, 2-wire maintained toggle, 2-wire momentary toggle, 2-wire momentary On, 2-wire momentary Off, or 3-wire momentary operation.

   b. Inputs shall also be capable of operating in conjunction with a building automation system to provide blink notice operation.

   c. Capable of assigning timers to inputs for local override operation. Timers type shall include timed On and Off-delay capabilities. Time increments shall be settable between 5 minutes to 18 hours.

   d. An input synchronization service shall be provided to synch inputs with other inputs, zones, time schedules, or remote sources. This synchronization service shall be used to control input state, input inhibit mode (enable/disable), or sync timers (enable/disable).

8. Each panel controller shall be capable of operating in a pass-through mode for Modbus connected devices, such as meters, whereby the information is automatically ported to the Modbus TCP/IP port without separate gateway devices.

9. Each panel controllers shall have the capability of configuring either local or remote sources in an “AND”, “EXOR”, “EOR” or “LAST EVENT” configuration. Sources shall include, but not be limited to, inputs, time schedules, or status. Up to four sources shall be permitted in a custom configurable logic arrangement.

10. Zone priorities shall be assignable to each zone such that the particular zone shall have priority over other zones. Zones priorities shall be capable of forcing all breakers in the zone to an On state or an Off state depending on the particualar configuration.

11. Ethernet Communications: Each panel controller shall be capable of networking with other panel controllers in a peer-to-peer configuration using an Ethernet 10Base-T network.

    a. Each panel controller shall support Ethernet communications using Modbus TCP/IP or BACnet/IP protocols,

    b. Each input connected to the controller shall be capable of controlling any branch circuit connected to any other controller.

    c. A schedule programmed in one controller shall be capable of controlling any branch circuit connected to any other controller.

    d. Means for setting initial Ethernet parameters via a local operator interface without having to employ special software or configuration tools.

12. Time Synchronization Service: Each panel controller shall incoporate a time synchronization service to update controller clock to a network time server. Time serve shall incorporate both a primary and secondary source. Update interval shall be setable from 1 to 24 hours.

13. Embedded Web Server: Each panel controllers shall incorporate a web-enabled server for displaying information over a standard web browser. Web-accessible information shall include:
    a. A secure, password protected login screen for modifying operational parameters to ensure only authorized access. Password administration shall be accessible to authorized users via web page interface.
    b. Separate web pages for each panel with the arrangement of breakers on the page matching the physical appearance of the panel. Panel status pages shall also include breaker nametags, pole configuration, location in panel, and actual contact state (On/Off/Tripped/Manual) for the master panel and each associated slave panel. The web page shall also provide the ability to observe breaker On-time and blink information in real time.
    c. Panel summary showing the master and all slave panels connected to the controller.
    d. Controller summary showing controller diagnostic information.
    e. For a consistent user interface provide remote front panel mimic screens for setting up controller parameters, input types, zones, and operating schedules. Mimic screens shall also allow direct breaker control and zone overrides.
    f. The user interface shall share a common “look and feel” between panels and other web-enabled distribution equipment.
14. Alarm and Email Notification: Each master controller shall incorporate an alarm and automated e-mail notification service. These services shall be capable of automatically initiating alarms based on preconfigured conditions and routing alarm alerts as directed by the customer. Customer shall furnish a list of alarms to be configured and email addresses to receive each alarm.
    a. Alarms shall be configurable for the following parameters:
        1) Global alarms: power loss, non-responding breakers, loss and restoration of sub-net communications, loss and restoration of serial port communications, loss and restoration of Modbus TCP Ethernet commands.
        2) Specific alarms: input status, zone status, breaker status on-time (0 to 99999 hours) and strike counter.
15. Email notification service shall include the ability to automatically route an email message to five individual email addresses. Within the body text of the email, provide a link that will automatically redirect the user to the associated panels’ status web page.
16. BACnet Conformance (Coordinate with BAS contractor for requirements):
    a. Reference BACnet Standard, ANSI/ASHRAE 135
    b. Each panel controller shall, at a minimum, support serial BACnet MS/TP and Ethernet BACnet/IP communications.
    c. Each panel controller shall be able to communicate directly via BACnet RS-485 serial networks and Ethernet 10Base-T networks as a native BACnet device.
    d. Each panel controller shall comply with Annex J of Standard 135 for IP connections.

e. Each panel controller shall function as a BACnet Application Specific Controller in accordance with Annex L of Standard 135, and shall support the following BACnet Interoperability Building Blocks:

1) Data Sharing - Read Property - B
2) Data Sharing - Read Property Multiple - B
3) Data Sharing - Write Property - B
4) Data Sharing - Write Property Multiple - B
5) Device Management - Dynamic Device Binding - B
6) Device Management - Dynamic Object Binding - B
7) Device Management - Device Communication Control - B
8) Device Management - Time Synchronization - B
9) Device Management - UTC Time Synchronization - B
10) Device Management - Reinitialize Device - B

17. Standard BACnet object types supported shall, as a minimum, include Analog Value, Binary Value, Multi-State Value and Multi-State Output.

a. Lighting Control Electronics—Slave panels
b. Panels marked as slave panels shall contain the necessary busses and network hardware to allow connection of the sub-net wiring between panels.
c. Sub-net wiring connections shall allow connection of wiring to a terminal that can be removed from the panel without interrupting the communications to other panels.
d. Slave panels shall contain a nameplate label attached to the deadfront trim indicating the panel designation, network address of the panel, and the panel designation of the associated master panel.

18. Under-Voltage Sensing Relay – Emergency Lighting System Response

a. System shall be provided with an under-voltage sensing relay in each normally powered lighting panel to trigger the emergency response in the associated emergency lighting panel. Relay shall be set to respond whenever a voltage loss of 50% of nominal occurs on any phase for more than 1 second in any normal panel.
b. Panels designated as EM on drawings shall be provided with a UPS sized to provide 90 minutes of backup power at 2A of 120V load. Upon receiving a trigger from any sensing relay, the EM panel will sequence all breakers to the ON position. A delay of 0.1 seconds between breakers will be used to minimize startup demand on the emergency generator.

19. Web Based User Interface

a. A web based user interface to the lighting control system shall be provided to display graphical depictions of the facility and provide control icons to view status, operate overrides, and change global time schedules.
b. The web based control interface shall incorporate a dedicated industrial grade server and operating system designed specifically for providing web based control applications.
c. Standard features of the web based user interface shall include:

1) A three level user log-on identification and password. Level one authorization shall provide viewing of web-pages and initiation of graphical overrides. A level two authorization shall allow changing of time schedules.

2) The ability to operate up to thirty-two global zones. Zone operating provisions shall include:

   a. A status icon for each zone. Status icon shall indicate if the zone is being commanded On, Off, or is in an override state.

   b. An override capability for switching the zone On or Off with a timer capability for maintaining the zone On for a preset period.

   c. The ability to establish a global operating time schedule for each zone. The time schedule shall operate on a repeating 7-day basis and have the ability to create special operating schedules for holidays and special events.

d. Additional capabilities.

1) Provide the ability for [#] individual specific user ID's. These specific ID's shall restrict log-on capability to specific web pages and/or control objects. The NAC shall provide an audit trail for tracking the time and date of when access to the system was granted.

2) Integration with building automation system. Access to global lighting zones shall be available to the building automation system. Coordinate work with BAS supplier and contractor.

20. Light Level Sensor

a. Provide light level sensor as shown on the drawings.

b. Light level sensors shall communicate with all other system units and obtain power via the UTP communication cable.

c. Light level sensors shall capable of measuring ambient light levels in the range of 0 to 300 footcandles.

d. Light levels sensor shall measure the ambient light level and output devices (such as Dimmer Units) shall be controlled to maintain constant illuminance in a given area, under varying conditions.

e. Light level sensors shall incorporate filtering and hysteresis functions to suppress noise and compensate for rapid light intensity fluctuations.

f. If the natural ambient illuminance level is such that extra illumination is not necessary, an Off command shall be transmitted by the Light Level Sensor to the designated output devices.

g. The field of View of the light level sensor shall be 180 degrees.

21. Distributed Relays

a. Provide distributed relay units sized according to the ratings shown on the drawings. All distributed relays shall have a UL listed short circuit current rating and be installed in enclosures suitable for application. Relays without a published UL short circuit current rating will not accepted.

b. Distributed relays shall communicate with all other system units on the same network without the use of central controllers.

c. All relays shall incorporate LED's to indicate network communication and indepentent relay status.

d. All relay channels shall incorporate independent overrides for each channel.

22. 4 Channel 0 – 10V DC Analog Output Unit

a. Provide analog output units as required. All analog output units shall be installed in enclosures suitable for the application.

b. Analog output units shall communicate with all other system units on the same network without the use of central controllers.

c. This unit shall provide the means to control four independent loads on the control system network over a control voltage range of 0-10V DC. The unit shall be capable of controlling OEM products, including dimmable electronic fluorescent ballasts, with a 0-10V control input. The output voltages shall be optically isolated from the control network.

d. The unit output (control) current rating per channel shall be 2.5mA when the unit is sourcing current, 5mA at Vout = 0V and 6mA at Vout = 12V when sinking current.

e. The output rise / fall time (99%) shall be less than 800msec (critically damped).

f. The unit shall provide an electrical isolation rating of 3500VAC RMS.

g. The output module shall be installed in an enclosure suitable for the application.

23. DALI Gateway

a. Provide UL listed DALI gateways as required.

b. All DALI gateways shall be installed in enclosures suitable for application.

c. DALI gateways shall communicate with all other system units on the same network without the use of central controllers. The gateway shall also constantly monitor the DALI network and be able to control up to 64 DALI ballast per channel.

d. Each DALI channel shall be able to control up to sixteen (16) groups and scenes per channel.

24. Distributed Dimmers

a. Provide UL listed distributed dimmer units sized according to the load type and power requirements as shown on the drawings.

b. All distributed dimmers be installed in enclosures suitable for application. Enclosures requiring fans for cooling are not acceptable.

c. Distributed dimmer units shall communicate with all other system units on the same network without the use of central controllers.

d. Each dimmer channel shall incorporate thermal sensors for over-temperature protection.

e. Each dimmer channel shall incorporate circuitry to minimize lamp flicker and provide an effective dimming range from 2 – 98% nominal voltage.

2.3 NETWORKS

A. Sub-net

1. Provide sub-net wiring between master and slave panels as indicated on the drawings. Sub-net wiring shall permit slave panels to receive power and control data from the master panelboard. Each master/slave system may consist of a maximum of 8 panels total.
2. Sub-net communications shall follow Class 1 wiring practices. Communications conductors shall be Belden 27326 or equal having the same voltage rating as the branch circuit conductors. Wiring distances shall not exceed the manufacturer's recommendations.

B. Ethernet Network:

1. Installing contractor shall coordinate work with the network administrator to assure that proper connection points are available. The installing contractor shall also secure one static IP address for each master controller.
2. Network shall support Ethernet 10Base-T communications.
3. Communications wiring to master panels shall be Category 5 cable having 8 position 8 contact (8P8C) modular plugs terminated using the T568A or T568B pin/pair assignments as defined in TIA/EIA-568-B.
4. Future integration and service shall be promoted by using only open communication protocols between lighting control panels. An open protocol is one that has specifications published in the public domain and that is used by more than 10 manufacturers. Modbus, Modbus (TCP/IP), BACnet IP, BACnet MSTP, and DMX, are considered acceptable. Submittals listing any other protocol will not be considered unless they demonstrate that these criteria are met. The same open protocol shall be used over all media that are part of the system, including serial busses, the LAN, or other connections.
5. Installation of additional special purpose networks shall be minimized by using the existing facility Ethernet LAN to connect various lighting panels or groups of lighting panels as shown on the drawings. Equipment shall be compatible with industry standard TCP/IP protocols.
6. Power Monitoring metering devices as shown on the drawings shall connect using the same network as the lighting control panels. The controller shall support a pass-through mode for Modbus connected meters whereby the information is automatically ported to the Modbus TCP/IP port without separate gateway devices.
7. Provide sub-net wiring between master and slave panels as indicated on the drawings. Sub-net wiring shall permit slave panels to receive power and control data from the master panelboard. No more than eight (8) bus rails shall be connected to the sub-net.
8. Sub-net communications shall follow Class 1 wiring practices. Communications conductors shall be Belden 27326 or equal having the same voltage rating as the branch circuit conductors. Wiring distances shall not exceed the manufacturer's recommendations.
9. Communications wiring to master panels shall use Category 5 cabling. Installing contractor shall coordinate work with the network administrator to assure that proper connection points are available. The installing contractor shall also secure one static IP address for each master controller.

2.4 CONFIGURATION SOFTWARE

B. Configuration software shall be designed specifically for the lighting control system and supported by the manufacturer. Software shall support system configuration, printing of configuration records, and monitoring and control functions in a Windows environment.

C. For basic setup and control, the software shall serve as a configuration and diagnostic utility. Basic features shall include support for configuring inputs, zones, circuit breaker actions, and time schedules. Software shall be able to monitor the status of the system and provide visual indication of input status, circuit breaker status, and operational parameters. Software shall be able to establish connections to the system through a controller front port, RS232 port, RS485 port, and Ethernet port. Support for remote system dial-up shall be incorporated into the software package.

PART 3 – SERVICES

3.2 CUSTOMIZATION

A. Manufacturer shall provide any custom hardware or communication devices necessary to make the system perform as specified above.

B. Manufacturer shall provide PC user interface custom screens. Rough layouts of the screens will be provided to the manufacturer no less than 30 days before scheduled system start-up.

3.3 START-UP

A. Manufacturer shall provide on site services to confirm correct communications wiring in the field, initiate communications between panels, and program the lighting control system. The electrical contractor shall provide zone configuration schedules, time-of-day schedules, and input override assignments to be used in programming to the manufacturer no less than 14 days before planned system start-up.

B. Manufacturer shall provide 1 day of on-site training during the start up period.

END OF SECTION 16146

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes secure support from the building structure for electrical items by means of hangers, supports, anchors, sleeves, inserts, seals, and associated fastenings.

B. Related sections include the following:

1. Refer to other Division 16 sections for additional specific support requirements that may be applicable to specific items.

1.3 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.

B. Product data for each type of product specified.

1.4 QUALITY ASSURANCE

A. Electrical Component Standard: Components and installation comply with NFPA 70, as amended by state and local codes.

B. Electrical components are listed and labeled by UL, ETL, CSA, or other approved, nationally recognized testing and listing agency that provides third-party certification follow-up services.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the Work include, but are not limited to, the following:

1. Slotted Metal Angle and U-Channel Systems:

(a) B-Line Systems, Inc.

(b) Haydon Corp.

(c) Kin-Line, Inc.

(d) Unistrut Diversified Products

2. Conduit Sealing Bushings:

(a) Cooper Industries, Inc.

(b) L.E. Mason Co.

(c) O-Z/Gedney

(d) Raco, Inc.

(e) Spring City Electrical Mgf. Co.

(f) Thomas & Betts Corp.

2.2 COATINGS

A. Coating: Supports, support hardware, and fasteners are protected with zinc coating or with treatment of equivalent corrosion resistance using approved alternative treatment, finish, or inherent material characteristic. Products for use outdoors are hot-dip galvanized.

2.3 MANUFACTURED SUPPORTING DEVICES

A. Raceway Supports: Clevis hangers, riser clamps, conduit straps, threaded C-clamps with retainers, ceiling trapeze hangers, wall brackets, and spring steel clamps.

1. Fasteners: Types, materials, and construction features as follows:

2. Expansion Anchors: Carbon steel wedge or sleeve type.

3. Toggle Bolts: All steel springhead type.

B. Powder-Driven Threaded Studs: Heat-treated steel, designed specifically for the intended service.

C. Conduit Sealing Bushings: Factory-fabricated watertight conduit sealing bushing assemblies suitable for sealing around conduit, or tubing passing through concrete floors and walls. Construct seals with steel sleeve, malleable iron body, neoprene sealing grommets or rings, metal pressure rings, pressure clamps, and cap screws.

D. Cable Supports for Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug for nonarmored electrical cables in riser conduits. Provide plugs with number and size of conductor gripping holes as required to suit individual risers. Construct body of malleable-iron casting with hot-dip galvanized finish.

E. U-Channel Systems: 16-gauge steel channels, with 9/16-inch (14 mm) diameter holes, at a minimum of 8 inches (20 cm) on center, in top surface. Provide fittings and accessories that mate and match with U-channel and are of the same manufacture.

2.4 FABRICATED SUPPORTING DEVICES

A. General: Shop- or field-fabricated supports or manufactured supports assembled from U-channel components.

B. Steel Brackets: Fabricated of angles, channels, and other standard structural shapes. Connect with welds and machine bolts to form rigid supports.

C. Pipe Sleeves: Provide pipe sleeves of one of the following:

1. Sheet Metal: Fabricate from galvanized sheet metal; round tube closed with snaplock joint, welded spiral seams, or welded longitudinal joint. Fabricate sleeves from the following gauge metal for sleeve diameter noted:

   (a) 3 inch (8 cm) and smaller: 20-gauge.

   (b) 4 inch (10 cm) to 6-inch (15 cm): 16-gauge.

   (c) over 6-inch (15 cm): 14-gauge.

2. Steel Pipe: Fabricate from Schedule 40 galvanized steel pipe.

3. Plastic Pipe: Fabricate from Schedule 80 PVC plastic pipe.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install supporting devices to fasten electrical components securely and permanently in accordance with Electrical Code requirements.

B. Coordinate with the building structural system and with other electrical installation.

C. Raceway Supports: Comply with NFPA 70, as amended by state and local codes, and the following requirements:

1. Conform to manufacturer's recommendations for selection and installation of supports.

2. Strength of each support is adequate to carry present and future load multiplied by a safety factor of at least four. Where this determination results in a safety allowance of less than 200 lbs (90 kg), provide additional strength until there is a minimum of 200 lbs (90 kg) safety allowance in the strength of each support.

3. Install individual and multiple (trapeze) raceway hangers and riser clamps as necessary to support raceways. Provide U-bolts, clamps, attachments, and other hardware necessary for hanger assembly and for securing hanger rods and conduits.

4. Support parallel runs of horizontal raceways together on trapeze-type hangers.

5. Support individual horizontal raceways by separate pipe hangers. Spring steel fasteners may be used in lieu of hangers only for 1-1/2-inch (DN 41) and smaller raceways serving lighting and receptacle branch circuits above suspended ceilings only. For hanger rods with spring steel fasteners, use 1/4 inch (6 mm) diameter or larger threaded steel. Use spring steel fasteners that are specifically designed for supporting single conduits or tubing.

6. Support exposed and concealed raceway within 1 foot (30 cm) of an unsupported box and access fittings. In horizontal runs, support at the box and access fittings may be omitted where box or access fittings are independently supported and raceway terminals are not made with chase nipples or threadless box connectors.

7. In vertical runs, arrange support so the load produced by the weight of the raceway and the enclosed conductors is carried entirely by the conduit supports with no weight load on conductor terminals.

D. Vertical Conductor Supports: Install simultaneously with installation of conductors.

E. Miscellaneous Supports: Support miscellaneous electrical components as required to produce the same structural safety factors as specified for raceway supports. Install metal channel racks for mounting cabinets, panelboards, disconnects, control enclosures, pull boxes, junction boxes, transformers, and other devices.

F. In open overhead spaces, cast boxes threaded to raceways need not be supported separately except where used for fixture support; support sheet metal boxes directly from the building structure or by bar hangers. Where bar hangers are used, attach the bar to raceways on opposite sides of the box and support the raceway with an approved type of fastener not more than 24 inches (60 cm) from the box.

G. Sleeves: Install in concrete slabs and walls and all other fire- rated floors and walls for raceways and cable installations. For sleeves through fire rated-wall or floor construction, apply UL- listed firestopping sealant in gaps between sleeves and enclosed conduits and cables in accordance with "Firestopping" requirement of Division 16 Section "Basic Electrical Materials and Methods."

H. Conduit Seals: Install seals for conduit penetrations of slabs on grade and exterior walls below grade and where indicated. Tighten sleeve seal screws until sealing grommets have expanded to form watertight seal.

I. Fastening: Unless otherwise indicated, fasten electrical items and their supporting hardware securely to the building structure, including but not limited to conduits, raceways, cables, busways, cabinets, panelboards, transformers, boxes, disconnect switches, and control components in accordance with the following:

1. Fasten by means of wood screws or screw-type nails on wood, toggle bolts on hollow masonry units, concrete inserts or expansion bolts on concrete or solid masonry, and machine screws, welded threaded studs, or spring-tension clamps on steel. Threaded studs driven by a powder charge and provided with lock washers and nuts may be used instead of expansion bolts and machine or wood screws. Do not weld conduit, pipe straps, or items other than threaded studs to steel structures. In partitions of light steel construction, use sheet metal screws.

2. Holes cut to depth of more than 1-1/2 inches (4 cm) in reinforced concrete beams or to depth of more than 3/4 inch (2 cm) in concrete do not cut the main reinforcing bars. Fill holes that are not used.

3. Ensure that the load applied to any fastener does not exceed 25 percent of the proof test load. Use vibration- and shock- resistant fasteners for attachments to concrete slabs.

J. In general, walls and partitions are not suitable for supporting the weight of panelboards, dry type transformers and the like. Include supporting frames or racks extending from floor slab to ceiling slab for all such items unless specifically instructed otherwise by the Architect.

K. Include supporting frames or racks for equipment, intended for vertical surface mounting, which is required in a free standing position.

L. Supporting frames or racks are of standard angle, standard channel or specialty support system steel members. They are rigidly bolted or welded together and adequately braced to form a substantial structure. Racks are of ample size to assure a workmanlike arrangement of all equipment mounted on them.

M. No work intended for exposed installation in damp locations is mounted directly on any building surface. In such locations, flat bar members or spacers are used to create a minimum of 1/4 inch (6 mm) air space between the building surfaces and the work.

N. Support vertical runs of bus duct at intervals no greater than the floor to floor height, or 13 feet (4 m), whichever is smaller. Support horizontal runs of bus duct at intervals no greater than 5 feet (150 cm).

O. Nothing (including outlet, pull and junction boxes and fittings) depends on electric conduits, raceways or cables for support except that threaded hub type fittings having a gross volume not in excess of 100 cubic inches (1600 cc) may be supported from heavy wall conduit, where the conduit in turn is securely supported from the structure within 5 inches (12 cm) of the fitting on two opposite sides.

P. Nothing rests on, or depends for support on, suspended ceiling media (tiles, lath, plaster, as well as splines, runners, bars and the like in the plane of the ceiling). Vertical members which suspend the ceiling (together with their horizontal bracing which occurs above the ceiling), however, may be used for support, subject to the following criteria:

1. Supporting procedures are in accordance with the ceiling system manufacturer's instructions.

2. Supporting members for circuitry are rigid. Wires may not be used for such supports.

3. The ceiling is not fire rated.

Q. In conjunction with lighting fixtures or other items weighing less than 40 pounds (18 kg), the above restriction against supporting from suspended ceiling splines, runners or bars in the plane of the ceiling may be waived for ceilings which have been specifically approved for the weight and arrangement of fixtures being applied. Any support members, mechanical fastening means (i.e., bolts, screws or rivets), or other appurtenances, however, required to tie in or adapt to the fixtures and their ceiling opening frames (if any) to the ceiling in the approved manner are included as part of the electric work.

R. As a minimum procedure, support surface or pendant mounted lighting fixture:-

1. From its outlet box by means of an interposed metal strap, where weight is less than 5 pounds (2 kg).

2. From its outlet box by means of a hickey or other direct threaded connection, where weight is from 5 pounds (2 kg) to 50 pounds (20 kg).

3. Directly from structural slab, deck or framing member, where weight exceeds 50 pounds (20 kg).

S. As a minimum procedure, support recessed lighting fixtures as follows:

1. From ceiling suspension members, as described above, <u>where weight is 80 pounds (35 kg) or less</u>. Fluorescent fixtures are provided with clips to secure the fixtures to the ceiling members at two opposite ends of each fixture.

2. Directly from structural slabs, decks or framing members where weight is more than 80 pounds (35 kg).

T. Include in the electric work channel sills or skids for leveling and support of all floor mounted electrical equipment.

U. Where permitted loading is exceeded by direct application of electrical equipment to a slab or deck, include in the electric work proper dunnage as required to distribute the weight in a safe manner.

END OF SECTION 16190

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes an emergency stand-by packaged engine generator set(s) with the following features and accessories:

1. Engine generator set.
2. Fuel tank
3. Starting battery.
4. Battery charger.
5. Remote stop switch.
6. Muffler.
7. Outdoor enclosure.
8. Remote annunciator.

B. Related Sections include the following:

1. Division 16 Section "Transfer Switches" for transfer switches, including sensors and relays to initiate automatic-starting and -stopping signals for engine generator sets.

1.3 DEFINITIONS

A. Standby Rating: Power output rating equal to the power the generator set delivers continuously under normally varying load factors for the duration of a power outage.

B. Operational Bandwidth: The total variation from the lowest to the highest value of a parameter over the range of conditions indicated, expressed as a percentage of the nominal value of the parameter.

C. Steady-State Voltage Modulation: The uniform cyclical variation of voltage within the operational bandwidth, expressed in Hz or cycles per second.

1.4 SUBMITTALS

A. Product Data: Include data on features, components, ratings, and performance. Include the following:

1. Dimensioned outline plan and elevation drawings of engine generator set and other components specified.

2. Thermal damage curve for generator.

3. Time-current characteristic curves for generator protective device.

4. Fuel specification, engine make, number of cylinders, bore, stroke, compression ratio, displacement cooling system capacity, radiator air flow requirements, make and type of generator, generator bearings and dimensions.

B. Shop Drawings: Indicate fabrication details, dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Design Calculations: Signed and sealed by a qualified professional engineer. Calculate requirements for selecting vibration isolators and for designing vibration isolation bases.

2. Vibration Isolation Base Details: Signed and sealed by a qualified professional engineer. Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include base weights.

3. Wiring Diagrams: Detail wiring for power and control connections and differentiate between factory-installed and field-installed wiring.

4. Generator Enclosure and muffler mounting and dimensions.

5. Generator Warranty.

C. Qualification Data: For firms specified in "Quality Assurance" Article.

D. Field Test and Observation Reports: Indicate and interpret test results and inspection records relative to compliance with performance requirements.

E. Certified Summary of Performance Tests: Demonstrate compliance with specified requirement to meet performance criteria for sensitive loads.

F. Factory Test Reports: For units to be shipped for this Project, showing evidence of compliance with specified requirements.

G. Exhaust Emissions Test Report: To show compliance with applicable regulations.

H. Sound Measurement Test Report: To show compliance with applicable regulations.

I. Certification of Torsional Vibration Compatibility: Comply with NFPA 110.

J. Field test report of tests specified in Part 3.

K. Maintenance Data: For each packaged engine generator and accessories to include in maintenance manuals specified in Division 1. Include the following:

1. Detail operating instructions for both normal and abnormal conditions.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Maintain a service center capable of emergency maintenance and repairs at the Project site with 8 hours maximum response time.

B. Source Limitations: Obtain engine generator set and auxiliary components specified in this Section through one source from a single manufacturer with the responsibility for the entire system.

C. Electrical Components, Devices and Accessories: Underwriters Laboratories listed or labeled.

1. The Terms "Listed" and "Labeled": As defined in the National Electrical Code, Article 100.

D. Comply with NFPA 70, as amended by state and local codes.

E. Comply with NFPA 110 requirements for a Level 1 emergency power supply system.

F. Comply with UL 2200, listed and labeled.

G. Engine Exhaust Emissions: Comply with applicable federal, state and local government requirements, including published requirements which will be in effect at the date of system commissioning.

H. Noise Emission: Comply with applicable federal, state and local government requirements due to sound emitted by generator set including engine, engine exhaust, engine cooling-air intake and discharge, and other components of installation.

I. Comply with UL 142.

J. Comply with EPA emissions Tier 4.

J. DELIVERY, STORAGE, AND HANDLING

J. Deliver engine generator set and system components to their final locations in protective wrappings, containers, and other protection that will exclude dirt and moisture and prevent damage from construction operations. Remove protection only after equipment is safe from such hazards.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Caterpillar, Inc.; Engine Division.

2. Detroit Diesel.

3. Cummins Power Generation.

2.2 ENGINE GENERATOR SET

A. Furnish a coordinated assembly of compatible components.

B. Ratings: Voltage and power output ratings of system shall be as indicated. Frequency shall match utility service frequency unless otherwise indicated. Unit shall supply its indicated KW power load at power factors down to 80 percent.

C. Output Connections: 3 phase, 4 wire.

D. Safety Standard: Comply with ASME B15.1.

E. Nameplates: Each major system component shall be equipped with a conspicuous nameplate of component manufacturer. Nameplate shall identify manufacturer of origin and address, and model and serial number of item.

F. Limiting dimensions indicated for system components shall not be exceeded.

G. Power Output Rating: Nominal ratings shall be as indicated, with capacity as required to operate as a unit as evidenced by records of factory testing.

H. Emissions and Noise: Emissions and Noise shall be in compliance with all applicable criteria regarding environmental pollution of all agencies having jurisdiction

I. Skid: Adequate strength and rigidity to maintain alignment of mounted components without dependence on a concrete foundation. Skid shall be free from sharp edges and corners. Lifting attachments shall be arranged to facilitate lifting with slings without damaging any components.

J. The engine-generator set(s), including radiator, shall be provided with a structural steel base. The base shall have sufficient rigidity for spring type isolators in quantities as required between enclosure floor and generator. Mounting shall incorporate a leveling device, vertical stops and three layers of neoprene acoustical pad, with each layer separated by a steel plate. The mountings shall be installed directly under the structural steel base and positioned to accept the weight and weight distribution for uniform mounting deflection. Spring isolators shall provide a minimum static deflection of 2 inches (5 cm) and shall be similar to Mason Industries, Inc., Type SLR or as approved. Neoprene pads shall be similar to Mason Industries Type W, or as approved.

2.3 GENERATOR-SET PERFORMANCE, NOMINAL

A. The emergency stand-by generator set and associated controls and appurtenances shall be suitable for use where up to 33 percent of the total load to be supplied are non-linear loads .

B. Steady-State Voltage Operational Bandwidth: 4 percent of rated output voltage from no load to full load.

C. Steady-State Voltage Modulation Frequency: Less than one Hz.

D. Transient Voltage Performance: Not more than 10 percent variation for 50 percent step-load increase or decrease. Voltage shall recover to remain within the steady-state operating band within 2 seconds. Unit shall accept a one-step application of 100 percent of specified load rating without causing the engine to stall.

E. Steady-State Frequency Operational Bandwidth: 0.5 percent of rated frequency from no load to full load.

F. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.

G. Transient Frequency Performance: Less than 2-Hz variation for a 50 percent step-load increase or decrease. Frequency shall recover to remain within the steady-state operating band within 3 seconds.

H. Output Waveform: At no load, harmonic content measured line-to-line or line-to-neutral shall not exceed 5 percent total and 3 percent for single harmonics. The telephone influence factor, determined according to NEMA MG 1, shall not exceed 50.

I. Sustained Short-Circuit Current: For a 3-phase, bolted short circuit at the system output terminals, the system shall supply a minimum of 250 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to any generator system component.

J. Temperature Rise of Generator: Not more than 115 deg C over a 40 deg C ambient, as measured by resistance, NEMA MG 1 when operating continuously at full-rated load.

K. Starting Time: Maximum total time period for a cold start, with ambient temperature at the low end of the specified range, shall be 8 seconds. Time period shall include output voltage and frequency settlement within specified steady-state bands.

2.4 SERVICE CONDITIONS

A. Environmental Conditions: Engine generator system shall withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability:

1. Ambient Temperature: Minus 35 deg C to plus 50 deg C

2. Altitude: Sea level to 1485 feet (453 m)

2.5 ENGINE

A. Comply with NFPA 37.

B. Fuel: Diesel fuel oil grade DF-2.

C. Maximum Engine Speed: 1800 rpm.

D. Maximum Piston Speed for 2-Cycle Engines: 1725 fpm (880 cm/s).

E. Maximum Piston Speed for 4-Cycle Engines: 2250 fpm (1140 cm/s).

F. Lubrication System: Pressurized by a positive-displacement pump driven from engine crankshaft. The following items shall be mounted on the engine or skid:

1. Filter and Strainer: Rated to remove 90 percent of particles 5 microns and smaller while passing full flow.

2. Oil Cooler: Maintains lubricating oil at manufacturer's recommended optimum temperature.

3. Thermostatic Control Valve: Controls flow in system to maintain optimum oil temperature. Unit shall be capable of full flow and shall be designed to be fail-safe.

4. Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no disassembly and without the use of pumps or siphons or special tools or appliances.

G. Engine Fuel System: Comply with NFPA 37. System includes the following:

1. Integral Injection Pumps: Driven by engine camshaft. Pumps shall be adjustable for timing and cylinder pressure balancing.

2. Main Fuel Pump: Mounted on engine. Pump shall ensure adequate primary fuel flow under starting and load conditions.

3. Fuel Oil Filters: Primary and secondary. Primary filter shall include water separator.

4. Relief/Bypass Valve: Automatically regulates pressure in fuel line and returns excess fuel to source.

5. Integrally mounted, electric motor driven, air cooled fuel oil cooler, complete with electric supply tapped from generator control panel. Radiator cooled unit will not be acceptable unless manufacturer certifies that radiator has been sized to accommodate this additional load. Cooler shall limit maximum engine fuel inlet temperature with engine running continuously at full load as required by engine manufacturer.

H. Coolant Jacket Heater: Electric-immersion type, factory installed in coolant jacket system. Comply with NFPA 110 requirements for Level 1 equipment for heater capacity.

2.6 GOVERNOR

A. Type: Adjustable electronic isochronous type, with speed droop provisions.

2.7 ENGINE COOLING SYSTEM

A. Description: Closed loop, liquid cooled, with radiator factory mounted on engine generator-set skid and integral engine-driven coolant pumping.

B. Radiator: Rated for specified coolant. Airflow shall be less than 100 CFM (170 cubic meters per hour) per kilowatt of certified load.

1. Radiator Core Tubes: Nonferrous-metal construction other than aluminum.

2. Size of Radiator: Adequate to contain expansion of total system coolant from cold start to 110 percent load condition.

3. Fan: Driven by multiple belts from engine shaft. Unit shall be sized to deliver required air flow with at least 1/2 inch water column (.12 kPa) static pressure plus drop within radiator.

C. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anti-corrosion additives as recommended by engine manufacturer.

D. Temperature Control: Self-contained, thermostatic-control valve shall modulate coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.

E. Coolant Hose: Flexible assembly with nonporous rubber inside surface and aging, ultraviolet, and abrasion-resistant fabric outer covering.

1. Rating: 50-psig (345-kPa) maximum working pressure with 180 deg F (82 deg C) coolant, and noncollapsible under vacuum.

2. End Fittings: Flanges or steel pipe nipples with clamps to suit piping and equipment connections.

2.8 FUEL SUPPLY SYSTEM

A. Comply with NFPA 30 and NFPA 37.

B. Base-Mounted Fuel Oil Tank: Factory-installed and -piped, listed and labeled fuel oil tank. Features shall include the following:

1. Double walled tank with integral leak detection with dry contact closure for connection to BMS.

2. Tank level indicator.

3. Capacity: Fuel for 24 hours of continuous operation at 100 percent rated power output.

4. Vandal-resistant fill cap.

5. Tank shall be vented to the outside of the enclosure with a minimum of a two inch pipe with appropriate ball plunger type apparatus which will only allow fumes to be released to the atmosphere and not liquids.

C. Interior Fuel Oil Piping: Include required field installed piping between the fuel tank and the engine. Refer to Division 15 specifications for materials and installation.

2.9 ENGINE EXHAUST SYSTEM

A. Muffler: Critical type, sized as recommended by engine manufacturer. Measured sound level at a distance of 10 feet (3 m) from the exhaust discharge, shall be 85 dBA or less. Muffler shall be sized so that engine will be capable of delivering its rated output with a friction head back pressure of up to 3/4 inches of mercury (2.5 kPa) in the exhaust pipe extension from the output side of the muffler (i.e., excluding the drop in the muffler).

B. Connections from Engine to Exhaust System: Flexible section of corrugated stainless-steel pipe.

C. Supports of Muffler and Exhaust Piping: Spring hangers and all-thread rods as specified in Division 15 Section “Vibration Control”; attached to generator housing.

D. Exhaust Piping External to Engine: Welded joints and fittings

E. Thimbles for Exhaust Piping: Comply with NFPA 211.

2.10 AIR INTAKE AND EXHAUST SYSTEM

A. All required material and appurtenances

2.11 STARTING SYSTEM

A. Description: 24-V electric, with negative ground and including the following items:

1. Components: Sized so they will not be damaged during a full engine-cranking cycle with ambient temperature at maximum specified in "Environmental Conditions" Paragraph above.

2. Cranking Motor: Heavy-duty unit that automatically engages and releases from engine flywheel without binding.

3. Cranking Cycle: As required by NFPA 110 for Level 1 systems.

4. Battery : Adequate capacity within ambient temperature range specified in "Service Conditions" Paragraph above to provide specified cranking cycle at least twice without recharging.

5. Battery Cable: Size as recommended by generator set manufacturer for cable length. Include required interconnecting conductors and connection accessories.

6. Battery-Charging Alternator: Factory mounted on engine with solid-state voltage-regulation and 35-A minimum continuous rating.

7. Battery Charger: Current-limiting, automatic-equalizing and float-charging type. Unit shall comply with UL 508 and shall include the following features:

   (a) Operation: Equalizing-charging rate of 10 A shall be initiated automatically after battery has lost charge until an adjustable equalizing voltage is achieved at battery terminals. Unit shall then automatically switch to a lower float-charging mode and continue operating in that mode until battery is discharged again.

   (b) Automatic Temperature Compensation: Adjusts float and equalizes voltages for variations in ambient temperature from minus 40 deg C to plus 60 deg C to prevent overcharging at high temperatures and undercharging at low temperatures.

   (c) Automatic Voltage Regulation: Maintains output voltage constant regardless of input voltage variations up to plus or minus 10 percent.

   (d) Ammeter and Voltmeter: Flush mounted in charger enclosure. Meters shall indicate charging rates.

   (e) Safety Functions: Include sensing of abnormally low battery voltage arranged to close contacts providing low battery voltage indication on control and monitoring panel. Also include sensing of high battery voltage and loss of AC input or DC output of battery charger. Either of these conditions shall close a set of dry contacts that provide a battery charger malfunction indication at system control and monitoring panel and a dry contact closure for connection to BMS.

(f) Enclosure and Mounting: NEMA 250, Type 1, wall-mounted cabinet.

2.12 CONTROL AND MONITORING

A. Automatic Starting System Sequence of Operation: When mode-selector switch on the control and monitoring panel is in the automatic position, remote-control contacts in one or more separate automatic transfer switches shall initiate starting and stopping of generator set. When mode-selector switch is switched to the on position, generator set shall start. The off position of same switch shall initiate generator-set shutdown. When generator set is running, specified system or equipment failures or derangements shall automatically shut down generator set and initiate alarms. Operation of a remote emergency-stop switch shall also shut down generator set.

B. Manual Starting System Sequence of Operation: Switching on-off switch on the generator control panel to the on position shall start generator set. The off position of same switch shall initiate generator-set shutdown. When generator set is running, specified system or equipment failures or derangements shall automatically shut down generator set and initiate alarms. Operation of a remote emergency-stop switch shall also shut down generator set.

C. Configuration: Operating and safety indications, protective devices, basic system controls, and engine gages shall be grouped on a common control and monitoring panel mounted on the generator set. Mounting method shall isolate the control panel from generator-set vibration.

(a) Current and potential transformers: Instrument accuracy class.

D. Indicating and Protective Devices, and Controls: Include those required by NFPA 110 for a Level 1 system, plus the following:

1. Ac voltmeter.
2. Ac ammeter.
3. Ac frequency meter.
4. Dc voltmeter (alternator battery charging).
5. Engine-coolant temperature gage.
6. Engine lubricating-oil pressure gage.
7. Running-time meter.

8. Ammeter-voltmeter, phase-selector switch or switches.

9. Generator-voltage adjusting rheostat.

E. Supporting Items: Include sensors, transducers, terminals, relays, and other devices, and wiring required to support specified items. Locate sensors and other supporting items on engine, generator, or elsewhere to suit manufacturer's standard.

F. Connection to Data Link: A Mod-Bus compatible interface for all monitoring and alarm functions. Also provide a separate terminal block, factory wired to Form “C” dry contacts, for each alarm and status indication for connections for data link transmission of indications to remote data terminals.

G. Common Remote Audible Alarm: Comply with NFPA 110 requirements for Level 1 systems. Include necessary contacts and terminals in control and monitoring panel for connection to BMS.

1. Engine high-temperature shutdown.

2. Lube-oil low-pressure shutdown.

3. Overspeed shutdown.

4. Remote emergency-stop shutdown.

5. Engine high-temperature prealarm.

6. Lube-oil low-pressure prealarm.

7. Fuel tank low level.

8. Overcrank shutdown.

9. Coolant low-temperature alarm.

10. Control switch not in auto position.

11. Battery-charger malfunction alarm.

12. Battery low-voltage alarm.

H. Remote Alarm Annunciator / Control: An LED labeled with proper alarm conditions shall identify each alarm event and a common audible signal shall sound for each alarm condition. Silencing switch in face of panel shall silence signal without altering visual indication. Connect so that after an alarm is silenced, clearing initiating condition will reactivate alarm until silencing switch is reset. Include manual Hand-Off-Auto control switch to control operation of generator. Cabinet and faceplate shall be surface- or flush-mounting type to suit mounting conditions indicated. Install at fire command center or location as directed, complete with all required circuitry.

I. Remote Emergency-Stop Switch: Multipole emergency generator break-glass switch, in NEMA 3R enclosure located at the exterior of the generator enclosure at strike side of the main door. Provide nameplate to read "Emergency Generator Emergency Shutdown and Stop of Fuel Oil Flow". Activation of break-glass switch to shut down fuel supply to the engine with spare dry contact for connection to BMS. Install complete with circuitry.

2.13 GENERATOR OVERCURRENT AND FAULT PROTECTION

A. Overcurrent protective devices: Generator overcurrent devices and other indicated components shall be grouped in a separately mounted generator power panel. Devices serving Elevators and “Emergency” System and “Legally Required Standby System” loads other than fire pumps shall be fully coordinated with downstream devices, and shall be switch and fuse type if required in order to achieve this coordination. Other devices shall be circuit breaker type. Panel features shall include:

1. Generator Circuit Breakers: Molded case or insulated case type conforming to Division 16 Section "Selection of Overcurrent Devices" with suitable interrupting capacity.

    (a) Feeder Overcurrent Devices: with ratings as indicated on drawings. Instantaneous trip settings shall be adjustable.

2. Generator Switch and Fuse Devices: Fusible switching devices conforming to Division 16 Section "Selection of Overcurrent Devices" with suitable interrupting capacity.

    (a) Feeder Overcurrent Devices: with ratings as indicated on drawings.

3. Ground Fault: Sensors plus alarm relay. Automatic tripping shall not be provided. Integrate ground-fault alarm indication with other generator-set alarm indications.

2.14 GENERATOR, EXCITER, AND VOLTAGE REGULATOR

A. Comply with NEMA MG 1 and specified performance requirements.

B. Drive: Generator shaft shall be directly connected to engine shaft. Exciter shall be rotated integrally with generator rotor.

C. Electrical Insulation: Class H or Class F.

D. Stator-Winding Leads: Brought out to terminal box to permit future reconnection for other voltages if required.

E. Construction prevents mechanical, electrical, and thermal damage due to vibration, overspeed up to 125 percent of rating, and heat during operation at 100 percent of rated capacity.

F. Excitation shall use no slip or collector rings, or brushes, and shall be arranged to sustain generator output under short-circuit conditions as specified.

G. Enclosure: Dripproof.

H. The generator together with its associated voltage regulator, exciter, instrumentation and controls shall be of a type which shall be suitable for applications where the load to be supplied consists of substantial amounts of non-linear (i.e., harmonic producing) equipment. Isolation transformers, complete with filtering equipment, shall be provided to minimize the effect of distortion on the voltage regulator power supply and sensing circuits, on governor control and supply circuits, on instrumentation and relaying and on other voltage sensing components. Voltage and current sensing devices shall sense true RMS values, and frequence sensing devices shall sense zero crossover.

I. Excitation System: Generator shall be equipped with a permanent magnet generator excitation system. The output of the PMG shall be used to supply power to the voltage regulator and to effectively isolate the regulator power circuits from the distortion that occurs when the generator supplies large non-linear loads. Under short circuit conditions, system shall be capable of sustaining 300 percent of rated current for 10 seconds. Rotating rectifier shall use a three phase full wave rectifier assembly with hermetically sealed silicon diodes protected against abnormal transient conditions by a surge protector.

J. Voltage Regulator: Completely solid state with electronic components encapsulated for protection against vibration and atmospheric deterioration. The regulator includes three phase RMS sensing, true volts per hertz operation with adjustable cut in, and provisions for parallel operation.

1. A voltage adjusting rheostat shall be provided on the control panel to permit a ± 10 percent adjustment in generator voltage.

2. The voltage regulator also includes circuits that provide loss of sensing voltage shutdown and overexcitation shutdown with inverse time characteristic to protect the generator and the connected load from abnormal voltages. Loss of sensing shutdown does not activate if a short circuit condition were to occur.

K. Strip Heater: Thermostatically controlled unit arranged to maintain stator windings above dew point.

L. Windings: Two-thirds pitch stator winding and fully linked amortisseur winding.

2.15 OUTDOOR GENERATOR SET ENCLOSURE (WALK-IN)

A. Weatherproof, walk-in type, sound attenuating enclosure which limits the sound as required to comply with applicable sound restrictions, but in any case to no more than 85 dBA as measured at 3 feet (90 cm) from any side, top or bottom, under all operating conditions. Appropriate sound baffling and insulation shall be applied to achieve this designated sound level. The exterior four sides of the enclosure shall be free of louvers, dampers, sound traps, etc. Air intake shall be from below, air discharge from top.

B. Construction:

1. Exterior shall be 4 inch (10 cm) thick panels of bolted together construction.

2. All panel exterior surfaces shall be of aluminum, finished in a color as selected.

3. All interior perforated surfaces shall be aluminum.

4. Each panel includes aluminum framing with studs no more than 24 inches (60 cm) on center. Stiffened wall panels shall not exceed 24 inches (60 cm) in width.

5. The panel cores shall be 100 percent filled with fireproof mineral fiber sound-absorbing material.

6. The enclosure shall be sized as required with a minimum of 2 feet (60 cm) of working space all around, and with a minimum of 42 inches (100 cm) at electrical connections). The enclosure shall include multiple 36 inch (90 cm) wide by 80 inch (200 cm) high prehung, full 2 inch (50 cm) thick, insulated soundproof doors, fully gasketed all around on all four (4) flanged edges. The doors shall be industrial type for severe service. Doors shall be constructed and detailed to maintain the maximum sound level as specified above outside enclosure.

7. Provide stairs complete with platforms, railings, and handrails for each personnel door. They shall be steel, hot-dipped galvanized after fabrication, and shall comply with the requirements of Division 5, Miscellaneous Metals. They shall comply with the applicable building codes, OSHA standards, State Occupational Safety and Health Plan requirements, and other applicable regulations.

8. The roof shall be of the bolt together panel type, constructed similar to side walls and shall be a weatherproof deck. The roof shall have a full flashed opening for the exhaust pipe and vent. A gasketed engine exhaust outlet shall be provided as a prevention against leakage into the enclosure. The sidewall, roof and/or floor shall have gasketed openings to accommodate the penetration of support elements.

9. All louver openings shall be full framed and flashed with "U" type drip caps, extending to 4 inches (10 cm) on either side of the opening, with external full length rainhoods.

10. The enclosure shall be designed to withstand wind loading of a minimum of 125 mph (200 km per hour) without damage to the enclosure or roof system. In addition to the wind load, the roof shall be designed for loading of 50 lbs./sq.ft. (2.4 kPa) without buckling or deformation.

11. The enclosure shall be a walk-in type designed to remain structurally intact during normal transport and rigging, with no loss of shape or weathertightness. The enclosure base shall be furnished with "I" beams sized and spaced as required.

12. Louvers shall be fail-safe of the "spring open, motor close" type. The automatic louvered dampers (ALD's) at the intake and discharge louvers shall be quick opening upon signal to start generator. ALD's shall be low leakage type (maximum allowable leakage of 20 cfm/sq.ft. (3.16 cubic meters per hour/square meter) at 4 in. water gauge (1 kPa) differential pressure).

13. Enclosure shall include summer ventilation fan (with necessary louvers) and thermostat, two (2) space heaters complete with thermostat, sized as required to maintain a minimum housing interior temperature of 40 deg F (5 deg C) ; two (2) battery two-head lights, ten (10) interior vaporproof incandescent type lights with associated 3-way toggle switches at enclosure doors, two (2) duplex receptacles, four (4) exterior weatherproof incandescent type lights above door with two (2) weatherproof switches mounted on the exterior of the enclosure, all installed and wired to a local 3 phase, 4 wire, 120/208 volt, 100 ampere panel installation enclosure. Panel shall have a 3P-100A main circuit breaker. All wiring devices and fixtures shall be weatherproof. All generator enclosure devices (lights, heaters, receptacles, etc.) shall be completely wired and piped in rigid galvanized steel conduit to panelboard.

14. The engine-generator set, including radiator, shall be provided with a structural steel base. The base shall have sufficient rigidity for spring type isolators in quantities as required between enclosure floor and generators. Mounting shall incorporate a leveling device, vertical stops, and three layers of neoprene acoustical pad, with each layer separated by a steel plate. The mountings shall be installed directly under the structural steel base and shall be positioned to accept the weight and weight distribution for uniform mounting deflection. Spring isolators shall provide a minimum static deflection of 2 inches (5 cm) and shall be similar to Mason Industries, Inc., Type SLR, or as approved. Neoprene pads shall be similar to Mason Industries, Inc., Type W, or as approved.

15. The entire enclosure shall be mounted on 3/4 inch (19 mm) neoprene waffle pads sized and positioned for 0.11 inch (2.8 mm) deflection at installed loaded conditions. Pads shall be similar to Mason Industries, Inc. Type "Super W", or as approved. The entire assembly shall be capable of withstanding an external force up to 1.0 g without malfunction.

16. The muffler shall be contained within the housing. Exhaust pipe shall extend through the housing and shall be fitted with a rain cap. Include supports as required.

C. The generator fuel tank shall be be vented to the outside of the enclosure with a minimum of a 2 inch (5 cm) pipe with appropriate ball plunger type apparatus which will only allow fumes to be released to the atmosphere and not liquids.

2.16 FINISHES

A. Indoor Enclosures and Components: Manufacturer's standard enamel over corrosion-resistant pretreatment and primer.

B. Outdoor Enclosures: Polyurethane enamel over corrosion-resistant pretreatment and manufacturer's compatible standard primer.

2.17 SOURCE QUALITY CONTROL

A. Factory Tests: Include Project-specific equipment testing (testing of equipment manufactured specifically for this Project).

B. Project-Specific Equipment Tests: Factory test engine generator set and other system components and accessories before shipment. Test items individually and assembled and connected as a complete system the same as specified in "Field Quality Control" Article below. Record and report test data. Conform to the following:

1. Test Equipment: Use instruments calibrated within the previous 12 months and with accuracy directly traceable to the National Institute of Standards and Technology.

2. Hydrostatic Test: Perform on radiator, heat exchanger, and engine water jacket.

3. Generator Tests: Comply with IEEE 115.

4. Complete-System, Continuous-Operation Test: Include nonstop operation for a minimum of 8 hours, including at least 2 hours each at one-half, three-fourths, and full load. If unit stops during the 8-hour test, repeat the complete test. Record the following minimum data at start and end of each load run, at 15-minute intervals between those times, and at 15-minute intervals during balance of test:

(a) Fuel consumption.

(b) Exhaust temperature.

(c) Jacket water temperature.

(d) Lubricating oil temperature and pressure.

(e) Generator load current and voltage, each phase.

(f) Generator system gross and net output kW.

5. Complete-System Performance Tests: Include the following to demonstrate conformance to specified performance requirements:

(a) Single-step load pickup.

(b) Transient and steady-state governing.

(c) Transient and steady-state voltage performance.

(d) Safety shutdown devices.

6. Observation of Test: Provide 14 days' advance notice of tests and opportunity for observation of test by Owner's representatives.

7. Report test results within 10 days of completion of test.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, equipment bases, and conditions, with Installer present, for compliance with requirements for installation and other conditions affecting packaged engine-generator performance.

B. Examine roughing-in of piping systems and electrical connections. Verify actual locations of connections before packaged engine-generator installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install generator set(s), and other components as indicated, in accordance with equipment manufacturers written instructions, and with recognized industry practices, to ensure proper performance in accordance with the specifications. Comply with applicable NEMA standards pertaining to installation of engine-generator sets and accessories and with NFPA110.

B. Install packaged engine generator to provide access, without removing connections or accessories, for periodic maintenance.

C. Coordinate with the work of other trades including fuel tanks, pumps, piping, ductwork and accessories as necessary to provide a complete operational system.

D. Include the installation of control and monitoring panels, battery charger(s), remote annunciator panel, batteries and racks and other appurtenances to the extent that such appurtenances are not factory installed and wired. Piping between engine and fuel tank complies with Division 15 section 15591 “Fuel Oil System Piping and Storage Tanks”.

E. Include field interwiring and power supply and control connections for batteries, battery chargers, pumps, heaters, float switches, solenoid valves, damper operators and other miscellaneous items as required in accordance with manufacturers wiring diagrams. Such wiring includes (but is not be limited to):

1. Wiring between battery and engine control panel(s) and battery charger(s).

2. Power supply wiring from an appliance panel to battery charger.

3. Power supply wiring from an appliance panel and control wiring for engine jacket water heater(s).

4. Power supply wiring for fuel pumps and fuel management control panel.

5. Control wiring for fuel pumps, fuel tanks, float switches, valves, leak detection system, and other fuel supply system components.

6. Power supply and control wiring for automatic louver damper operators.

7. Emergency stop break glass switch and control wiring run to engine control panel.

8. "Manual start" switch and control wiring to engine control panel.

9. Remote annunciator panel mounted where indicated or where directed, complete with power supply and alarm interwiring to engine control panel.

F. Ground equipment in accordance with Division 16 Section "Grounding and Bonding." .

G. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.3 IDENTIFICATION

A. Identify system components according to Division 16 Section "Electrical Identification."

3.4 FIELD QUALITY CONTROL

A. Testing: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.

B. Tests: Include the following:

1. Tests recommended by manufacturer.

2. InterNational Electrical Testing Association Tests: Perform each visual and mechanical inspection and electrical and mechanical test stated in InterNational Electrical Testing Association's NETA ATS for emergency engine generator tests. Certify compliance with test parameters.

3. NFPA 110 Acceptance Tests: Perform tests required by NFPA 110 that are additional to these specified herein, including, but not limited to a single step full load pickup test.

4. Testing Load Bank: Building loads may be used for generator testing. Supplement building loads with a resistive load bank as required to load generator to its full rated load for testing. Provide temporary interconnecting cables and connections.

5. Battery Tests: Measure charging voltage and voltages between available battery terminals for full-charging and float-charging conditions. Check electrolyte level and specific gravity under both conditions. Equalize charging of battery cells according to manufacturer's written instructions. Record individual cell voltages. Test for contact integrity of all connectors. Perform an integrity load test and a capacity load test for the battery. Verify acceptance of charge for each element of battery after discharge. Verify measurements are within manufacturer's specifications.

6. Battery-Charger Tests: Verify specified rates of charge for both equalizing and float-charging conditions.

7. System Integrity Tests: Methodically verify proper installation, connection, and integrity of each element of engine generator system before and during system operation. Check for air, exhaust, and fluid leaks.

8. Exhaust System Back-Pressure Test: Use a manometer with a scale exceeding 40 inches water gauge (120 kPa). Connect to exhaust line close to engine exhaust manifold. Verify that back pressure at full-rated load is within manufacturer's written allowable limits for the engine.

9. Exhaust Emissions Test: Conform with applicable government test criteria.

10. Voltage and Frequency Transient Stability Tests: Use recording oscilloscope to measure voltage and frequency transients for 50 and 100 percent step-load increases and decreases and verify that performance is as specified.

11. Harmonic-Content Tests: Measure harmonic content of output voltage under 25 percent and at 100 percent of rated linear load. Verify that harmonic content is within specified limits.

C. Coordinate tests for transfer switches and run them concurrently.

D. Retest: Correct deficiencies identified by tests and observations and retest until specified requirements are met.

E. Report results of tests in writing. Record adjustable settings, time delays and other valves and observations. Attach a label or tag to each tested component indicating satisfactory completion of tests.

F. Test instruments shall be calibrated to National Institute of Standards and Technology (NIST) Standards.

G. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each power wiring termination and each bus connection. Remove all access panels so terminations and connections are accessible to portable scanner.

1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan 11 months after date of Substantial Completion.
2. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
3. Record of Infrared Scanning: Prepare a certified report that identifies terminations and connections checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

H. Provide fuel as required for testing, and as required such that fuel tank is full at completion of testing.

3.5 CLEANING

A. Upon completion of installation, inspect system components. Remove paint splatters and other spots, dirt, and debris. Touch up scratches and mars of finish to match original finish. Clean components internally using methods and materials recommended by manufacturer.

3.6 DEMONSTRATION

A. Training: Engage a factory-authorized service representative to demonstrate adjustment, operation, and maintenance of system and to train Owner's maintenance personnel as specified below.

1. Conduct a minimum of 8 hours of training as specified in Division 1 Section "Contract Closeout."
2. Schedule training with at least 7 days advance notice.

END OF SECTION 16231

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes installation of solid-state, PWM, VFCs for speed control of three-phase, squirrel-cage induction motors. VFC's will be furnished as part of Division 15.

B. Related Sections include the following:

1. Division 16 Section "Basic Electrical Materials and Methods" for general materials and installation methods.

2. Division 16 Section "Enclosed Controllers, (Installation of)" for control wiring.

1.3 DEFINITIONS

A. BMS: Building management system.

B. VFC: Variable frequency controller.

1.4 SUBMITTALS

A. Field Test Reports: Written reports specified in Part 3.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Underwriters Laboratories listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70, as amended by state and local codes.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store VFCs indoors in clean, dry space with uniform temperature to prevent condensation. Protect VFCs from exposure to dirt, fumes, water, corrosive substances, and physical damage.

1.7 COORDINATION

A. Coordinate layout and installation of VFCs with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate features of VFCs, installed units, and accessory devices with pilot devices and control circuits to which they connect.

C. Coordinate features, accessories, and functions of each VFC and each installed unit with ratings and characteristics of supply circuit, motor, required control sequence, and duty cycle of motor and load.

1.8 EXTRA MATERIALS

A. Spare Fuses: Furnish one spare for every five installed, but not less than one set of three of each type and rating.

PART 2 - PRODUCTS

(NOT APPLICABLE)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, surfaces, and substrates to receive VFCs for compliance with requirements, installation tolerances, and other conditions affecting performance.

B. Examine roughing-in for conduit systems to verify actual locations of conduit connections before VFC installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General: Install VFCs in accordance with manufacturer’s written instructions.

B. See Division 16 Section "Basic Electrical Materials and Methods" for additional general installation requirements.

C. Location: Locate controllers as indicated and within site of motors controlled. Where controller is not located within sight of the motor controlled (as defined in the National Electrical Code), provide a nonfusible disconnect switch to serve as the local motor disconnect. Switch includes additional dry contact to lock out operation of VFC when disconnect is open.

D. Mounting: For control equipment at walls, bolt units to wall or mount on light-weight structural steel channels bolted to the wall. For controllers not at walls, provide freestanding racks fabricated of structural steel members and light-weight slotted structural steel channels.

E. Where VFC consists of more than a single cabinet, provide all required interwiring between cabinets.

F. Controller Fuses: Install fuses in each fusible switch. Comply with requirements in Division 16 Section "Fuses."

G. Anchor each VFC assembly to steel-channel sills arranged and sized according to manufacturer's written instructions. Attach by bolting. Level and grout sills flush with mounting surface.

3.3 IDENTIFICATION

A. Identify VFCs, components, and control wiring according to Division 16 Section "Electrical Identification."

B. Operating Instructions: Frame printed operating instructions for VFCs, including control sequences and emergency procedures. Fabricate frame of finished metal, and cover instructions with clear acrylic plastic. Mount on front of VFC units.

3.4 CONTROL WIRING INSTALLATION

A. Install wiring between VFCs and terminal cabinets according to Division 16 Section "Enclosed Controllers (Installation of)."

B. Bundle, train, and support wiring in enclosures.

C. Connect hand-off-automatic switch and other automatic-control devices where available.

1. Connect selector switches to bypass only manual- and automatic-control devices that have no safety functions when switch is in hand position.

2. Connect selector switches with control circuit in both hand and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

D. Install control wiring between VFCs and interlock contact in motor disconnect switch and connect to lock-out VFC until switch has been re-closed to permit restart.

E. For each motor automatically and/or manually controlled or monitored by the fire alarm system, include control wiring extensions as specified as part of the fire alarm system to an adjacent FPA addressable module.

3.5 CONNECTIONS

A. Conduit installation requirements are specified in other Division 16 Sections. Drawings indicate general arrangement of conduit, fittings, and specialties.

B. Ground equipment according to Division 16 "Grounding and Bonding."

3.6 FIELD QUALITY CONTROL

A. Prepare for acceptance tests as follows:

1. Test insulation resistance for each connecting supply, feeder, and control circuit.

2. Test continuity of each circuit.

3. Assist the Division 15 contractor with testing as required.

B. Division 15 trade will engage a factory-authorized service representative to perform startup service.

C. Verify that electrical wiring installation complies with manufacturer's submittal and installation requirements in Division 16 Sections.

3.7 ADJUSTING

A. Set field-adjustable switches and circuit-breaker trip ranges.

3.8 CLEANING

A. Clean VFCs internally, on completion of installation, according to manufacturer's written instructions. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

END OF SECTION 16269

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes transient voltage surge suppressors for low-voltage power, control, and communication equipment.

B. Related Sections include the following:

1. Division 16 Section "Panelboards" for factory-installed transient voltage surge suppressors.

2. Division 16 Section "Switchboards" for factory-installed transient voltage surge suppressors.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities; shipping, installed, and operating weights; furnished specialties; and accessories.

B. Product Certificates: Signed by manufacturers of transient voltage suppression devices, certifying that products furnished comply with the following testing and labeling requirements:

1. UL 1283 certification.

2. UL 1449 listing and classification.

C. Field Test Reports: Written reports of tests specified in Part 3 of this Section. Include the following:

1. Test procedures used.

2. Test results that comply with requirements.

3. Failed test results and corrective action taken to achieve requirements.

D. Maintenance Data: For transient voltage suppression devices to include in maintenance manuals specified in Division 1.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain suppression devices and accessories through one source from a single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. IEEE Compliance: Comply with IEEE C62.41, "IEEE Guide for Surge Voltages in Low Voltage AC Power Circuits," and test devices according to IEEE C62.45, "IEEE Guide for Surge Suppressor Testing."

D. NEMA Compliance: Comply with NEMA LS 1, "Low Voltage Surge Protective Devices."

E. UL Compliance: Comply with UL 1283, "Electromagnetic Interference Filters," and UL 1449, "Transient Voltage Surge Suppressors."

F. Comply with NFPA 70, Article 285.

1.5 PROJECT CONDITIONS

A. Placing into Service: Do not energize or connect service entrance equipment, panelboards and data terminals to their sources until the surge protective devices are installed and connected.

B. Service Conditions: Rate surge protective devices for continuous operation under the following conditions, unless otherwise indicated:

1. Maximum Continuous Operating Voltage: Not less than 115 percent of nominal system operating voltage.

2. Operating Temperature: 30 to 120 deg F (0 to 50 deg C).

3. Humidity: 0 to 85 percent, noncondensing.

4. Altitude: Less than 20,000 feet (6000 m) above sea level.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Cutler-Hammer, Inc.
2. Siemens Energy & Automation.
3. Square D Co.

2.2 SERVICE ENTRANCE SUPPRESSORS

A. Surge Protective Device Description: Non-modular type with the following features and accessories:

1. LED indicator lights for power and protection status.

2. Audible alarm, with silencing switch, to indicate when protection has failed.

3. One set of dry contacts rated at 5 A, 250-V AC, for remote monitoring of protection status.

4. Fuses, rated at 200-kA interrupting capacity.

B. Peak Single-Impulse Surge Current Rating: 240 kA per phase.

C. Connection Means: Permanently wired.

D. Protection modes and UL 1449 clamping voltage for grounded wye circuits with voltages of 480Y/277; 3-phase, 4-wire circuits, are as follows:

1. Line to Neutral: 800 V for 480Y/277.

2. Line to Ground: 800 V for 480Y/277.

3. Neutral to Ground: 800 V for 480Y/277.

2.3 PANELBOARD SUPPRESSORS

A. Surge Protective Device Description: Non-modular type with the following features and accessories:

1. LED indicator lights for power and protection status.

2. Audible alarm, with silencing switch, to indicate when protection has failed.

3. Fuses, rated at 200-kA interrupting capacity.

B. Peak Single-Impulse Surge Current Rating: 120 kA per phase.

C. Protection modes and UL 1449 clamping voltage for grounded wye circuits with voltages of 480Y/277 and 208Y/120; 3-phase, 4-wire circuits, are as follows:

1. Line to Neutral: 800 V for 480Y/277, 400 V for 208Y/120.

2. Line to Ground: 800 V for 480Y/277, 400 V for 208Y/120.

3. Neutral to Ground: 800 V for 480Y/277, 400 V for 208Y/120.

D. Connection Means: Permanently wired.

2.4 PLUG-IN SURGE SUPPRESSORS

A. Description: Non-modular, plug-in suppressors with at least four 15-A, 120-V AC, NEMA WD 6, Configuration 15-15R receptacles, suitable to plug into a NEMA WD 6, Configuration 15-15R receptacle; with the following features and accessories:

1. LED indicator lights for power and protection status.

B. Peak Single-Impulse Surge Current Rating: 13 kA per phase.

C. Protection modes and UL 1449 clamping voltage are as follows:

1. Line to Neutral: 475 V.

2. Line to Ground: 475 V.

3. Neutral to Ground: 475 V.

2.5 CONTROL AND DATA TERMINALS

A. Protectors for copper control, data, antenna, telephone, conductors entering the building from the outside are as recommended by the manufacturer for the type of line being protected.

2.6 ENCLOSURES

A. NEMA 250, with type matching the enclosure of panel or device being protected, unless factory - installed within equipment enclosure.

PART 3 - EXECUTION

3.1 INSTALLATION OF SURGE PROTECTIVE DEVICES

A. Install devices at service entrance on load side of largest service switch, with ground lead bonded to service entrance ground.

B. Surge protection device shall be integral to panelboard or switchgear and manufacturer of the device shall be the same as that of the equipment.

C. Install devices for panelboards with conductors between suppressor and points of attachment as short and straight as possible. Do not exceed manufacturer's recommended lead length. Do not bond neutral and ground.

1. Provide 60-A, 3 pole circuit breaker as a dedicated disconnect for the suppressor, unless otherwise indicated.

3.2 CONNECTIONS

A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A.

3.3 FIELD QUALITY CONTROL

A. Testing: Perform the following field quality-control testing:

1. After installing surge protective devices, but before electrical circuitry has been energized, test for compliance with requirements.

2. Complete startup checks according to manufacturer's written instructions.

3. Perform each visual and mechanical inspection and electrical test stated in NETA ATS, Section 7.19. Certify compliance with test parameters.

B. Repair or replace malfunctioning units. Retest after repairs or replacements are made.

END OF SECTION 16289

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes individually mounted enclosed switches and circuit breakers used for the following:

1. Service disconnecting means.

2. Feeder and branch-circuit protection.

3. Motor and equipment disconnecting means.

B. Related Sections include the following:

1. Division 16 Section "Wiring Devices" for attachment plugs, receptacles, and toggle switches used for disconnecting means.

2. Division 16 Section "Switchboards" for individually enclosed, fusible switches used as feeder protection.

3. Division 16 Section "Fuses" for fusible devices.

4. Division 16 Section “Selection of Overcurrent Devices” for additional information.

5. Division 16 Section "Enclosed Controllers (Installation of)"

6. Division 16 Section "Variable Frequency Controllers (Installation of)"

1.3 SUBMITTALS

A. Product Data: For each type of switch, circuit breaker, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each switch and circuit breaker include the following:

1. Enclosure types and details for types other than NEMA 250, Type 1.
2. Current and voltage ratings.
3. Short-circuit current rating.
4. UL listing for series rating of installed devices.
5. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

C. Field Test Reports: Written reports specified in Part 3.

D. Maintenance Data: Include the following:

1. Routine maintenance requirements for components.
2. Manufacturer's written instructions for testing and adjusting switches and circuit breakers.
3. Time-current curves, including selectable ranges for each type of circuit breaker.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by Underwriters Laboratories.

B. Comply with NEMA AB 1 and NEMA KS 1.

C. Comply with NFPA 70, as amended by state and local codes.

1.5 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation under the following conditions, unless otherwise indicated:

1. Ambient Temperature: Not less than minus 22 deg F (minus 30 deg C) and not exceeding 104 deg F (40 deg C).
2. Altitude: Not exceeding 6600 feet (2000 m).

1.6 COORDINATION

A. Coordinate layout and installation of switches, circuit breakers, and components with other construction, including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Eaton Corp.; Cutler-Hammer Products
2. General Electric Co.; Electrical Distribution & Control Division.
3. Siemens Energy & Automation, Inc.
4. Square D Co.

2.2 ENCLOSED SWITCHES

A. Enclosed, Nonfusible Switch: NEMA KS 1, Type HD, with lockable handle with provisions for two padlocks, and interlocked with cover in closed position. Where used as an in-sight disconnect interposed into the circuit between a Variable Frequency Controller (VFC) and a motor, or used as an in-sight disconnect for a hydraulic elevator, include an auxiliary contact to open the motor control circuit prior to opening of main contacts. Auxiliary contact shall close after the main contacts close. Where used as an in-sight disconnect where six conductors are required between the motor controller and the motor, switch shall be a six pole device regardless of indications on the drawings.

B. Enclosed, Fusible Switch, 800 A and Smaller: NEMA KS 1, Type HD, with clips to accommodate specified fuses, lockable handle with provisions for two padlocks, and interlocked with cover in closed position.

C. Enclosed Fusible Switch, 1200A and Larger: Bolted pressure type, UL 977; operating mechanism shall utilize a rotary-mechanical bolting action to produce and maintain high clamping pressure on the switch blade after it engages the stationary contacts.

D. Service switches on 277/480 volt system shall have shunt trip mechanisms suitable for operation in response to manual activation, or automatic operation in response to ground fault relay.

2.3 ENCLOSED CIRCUIT BREAKERS

A. Refer to Division 16 Section “Selection of Overcurrent Devices” for additional information.

2.4 ENCLOSURES

A. NEMA AB 1 and NEMA KS 1 to meet environmental conditions of installed location.

1. Outdoor Locations: NEMA 250, Type 3R.

2. Kitchen Areas: NEMA 250, Type 4X, stainless steel.

3. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.

4. Hazardous Areas Indicated on Drawings: NEMA 250, Type 7C.

2.5 FACTORY FINISHES

A. Finish: Manufacturer's standard paint applied to factory-assembled and -tested enclosures before shipping.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance.

1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

3.3 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 16 Section.

B. Enclosure Nameplates: Label each enclosure with engraved metal or laminated-plastic nameplate mounted with corrosion-resistant screws.

3.4 CONNECTIONS

A. Install equipment grounding connections for switches and circuit breakers with ground continuity to main electrical ground bus.

B. Install power wiring. Install wiring between switches and circuit breakers, and control and indication devices.

C. Install control circuit lockout wiring between disconnect switches and VFC’s.

D. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.5 FIELD QUALITY CONTROL

A. Testing: After installing enclosed switches and circuit breakers and after electrical circuitry has been energized, demonstrate product capability and compliance with requirements.

1. Procedures: Perform each visual and mechanical inspection and electrical test indicated in NETA ATS, Section 7.5 for switches and Section 7.6 for molded-case circuit breakers. Certify compliance with test parameters.

2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

B. Testing Reports: Prepare a written report to record the following:

1. Test procedures used.

2. Test results that comply with requirements.

3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

3.6 ADJUSTING

A. Set field-adjustable switches and circuit-breaker trip ranges.

3.7 CLEANING

A. On completion of installation, inspect interior and exterior of enclosures. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.

END OF SECTION 16410

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes transfer switches rated 600 V and less and the following items:

1. Automatic transfer switches.

B. Related Sections include the following:

1. Division 15 Section "Electric-Drive, Horizontal Fire Pumps" for automatic transfer switches furnished with fire pumps.

1.3 SUBMITTALS

A. Product Data: Include dimensioned plans, sections, and elevations showing minimum clearances, conductor entry provisions, gutter space, installed features and devices, and materials lists.

B. Wiring Diagrams: Details of wiring for transfer switches and differentiating between manufacturer-installed and field-installed wiring. Show both power and control wiring.

C. Product Certificates: Signed by manufacturer certifying that products furnished comply with requirements and that switches have been tested for short-circuit closing and withstand ratings applicable to units for Project.

D. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

E. Maintenance Data: For each type of product to include in the maintenance manuals specified in Division 1. Include all features and operating sequences, both automatic and manual. List all factory settings of relays and provide relay-setting and calibration instructions.

1.4 QUALITY ASSURANCE

A. Testing Agency Qualifications: Testing agency meets OSHA criteria for accreditation of testing laboratories, Title 29, Part 1907, or is a full member company of the InterNational Electrical Testing Association.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or National Institute for Certification in Engineering Technologies, to supervise on-site testing specified in Part 3.

B. Emergency Service: Manufacturer maintains a service center capable of providing emergency maintenance and repairs at Project site with an 8-hour maximum response time.

C. Source Limitations: Obtain automatic transfer switches from a single manufacturer who assumes responsibility for all components.

D. Listing and Labeling: Provide transfer switches specified in this Section that are listed and labeled for emergency service under UL 1008.

1. The Terms "Listed" and "Labeled": As defined in the National Electrical Code, Article 100.

E. Comply with NFPA 70, as amended by state and local codes.

F. Comply with NFPA 110.

G. Comply with NEMA ICS 1.

H. Compy with IEC 947-6-1, IEEE 446, NEMA ICS 10-1993 and UL 508.

I. UL Compliance: Comply with UL 1008, "Automatic Transfer Switches," unless requirements of these Specifications are stricter.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. ASCO 7000 series
2. GE ZTS
3. Eaton/C-H

2.2 GENERAL TRANSFER-SWITCH PRODUCT REQUIREMENTS

A. Indicated Current Ratings: Apply as defined in UL 1008 for continuous loading and total system transfer, including tungsten filament loads not exceeding 30 percent of switch ampere rating, unless otherwise noted.

1. Tested Fault-Current Closing and Withstand Ratings: Adequate for duty imposed by protective devices at installation locations in Project under the fault conditions indicated based on testing according to UL 1008.

B. Where Transfer Switch Includes Internal Protection: Rating of switch and trip unit combination exceeds indicated fault-current value at installation location.

C. Annunciation and Control Interface Components: Devices at transfer switches for communicating with remote annunciators or annunciator and control panels have communications capability matched with the remote device.

D. Solid-State Controls: Repetitive accuracy of all settings is plus or minus 2 percent or better over an operating temperature range of minus 20 degrees C to 70 degrees C.

E. Resistance to Damage by Voltage Transients: Components meet or exceed voltage-surge withstand capability requirements when tested according to ANSI C37.90.1. Components meet or exceed voltage-impulse withstand test of NEMA ICS 1.

F. Neutral Pole: Switch is of the 3-pole type when interposed in a 3-wire feeder, and of the 4-pole type when interposed in a 4-wire feeder, regardless of any other indication to the contrary. Neutral pole is switched simultaneously with phase poles.

G. Neutral Terminal: Ampacity and switch rating of neutral path is equal to the rating of the switch, unless otherwise indicated.

H. Oversize Neutral: Ampacity and switch rating of neutral path through units indicated for installation in feeder with oversize neutral is double the nominal rating of the circuit in which the switch is installed.

I. Enclosures: General-purpose NEMA 250, Type 1, complying with NEMA ICS 6; UL 508, unless otherwise indicated.

J. Factory Wiring: Train and bundle factory wiring and label consistent with Shop Drawings, either by color code or by numbered or lettered wire and cable tape markers at terminations.

1. Designated Terminals: Pressure type suitable for types and sizes of field wiring indicated.

2. Power-Terminal Arrangement and Field-Wiring Space: Suitable for top, side, or bottom entrance of feeder conductors as indicated.

3. Control Wiring: Equipped with lugs suitable for connection to terminal strips.

K. Electrical Operation: Accomplish by a nonfused, momentarily energized solenoid or electric motor-operated mechanism, mechanically and electrically interlocked in both directions.

L. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.

1. Limitation: Switches using molded-case switch or insulated-case circuit-breaker components and switches using contactors not designed for continuous-duty repetitive switching between active power sources are not acceptable.

2. Switch Action: Double throw; mechanically held in both directions.

3. Switch Contacts: Silver composition for load current switching. Conventional automatic transfer-switch units rated 225 A and greater have separate arcing contacts.

2.3 AUTOMATIC TRANSFER SWITCH

A. Comply with Level 1 equipment according to NFPA 110.

B. Switching Arrangement: Double-throw type, incapable of pauses or intermediate position stops during normal functioning, unless otherwise indicated.

C. Manual Switch Operation: Manually operated under load, with the door closed, and with either or both sources energized. Transfer time is the same as for electrical operation. Control circuit automatically disconnects from electrical operator during manual operation.

D. Signal-before-Transfer and Retransfer Contacts: A set of normally open/normally closed dry contacts operates in advance of retransfer to normal source and a second set which operates in advance of transfer to the emergency source. Interval is adjustable from 1 to 30 seconds.

E. Automatic Transfer Switches for Large-Motor Loads: Where supplying elevators or other individual motors 20 HP and larger, operator has a programmed neutral position arranged to provide a midpoint between the 2 working switch positions, with an intentional, time-controlled pause at the midpoint during transfer. The pause is adjustable from 0.5 to 30 seconds minimum and factory set at 0.5 second, unless otherwise indicated. Time delay occurs for both transfer directions. In lieu thereof include factory-wired, internal, in-phase monitor relay. The relay controls transfer to occur when the 2 sources are synchronized in phase. The relay compares phase relationship and frequency difference between the normal and emergency sources and initiates transfer when both sources are within 15 electrical degrees, and only if transfer can be completed within 60 electrical degrees. In-phase transfer is initiated only if both sources are within 2 Hz of nominal frequency and 70 percent or more of nominal voltage.

2.4 AUTOMATIC TRANSFER-SWITCH FEATURES

A. Voltage sensing for each phase of normal source. Pickup voltage is adjustable from 85 to 100 percent of nominal, and dropout voltage is adjustable from 75 to 98 percent of pickup value. Factory set for pickup at 90 percent and dropout at 85 percent.

B. Time delay for override of normal-source voltage sensing delays transfer and engine start signals. Adjustable 0 to 6 seconds and factory set at 1 second.

C. Voltage/Frequency Lockout Relay: Prevents premature transfer to an emergency generator set. Pickup voltage is adjustable from 85 to 100 percent of nominal. Factory set to pickup at 90 percent. Pickup frequency is adjustable from 90 to 100 percent of nominal. Factory set to pickup at 95 percent.

D. Time Delay for Retransfer to Normal Source: Adjustable from 0 to 30 minutes and factory set at 10 minutes. Provides automatic defeat of the delay on loss of voltage or sustained undervoltage of the emergency source, provided normal supply has been restored.

E. Test Switch: Simulates normal-source failure.

F. Switch-Position Pilot Lights: Indicate source to which load is connected.

G. Source-Available Indicating Lights: Supervise sources via the transfer-switch, normal- and emergency-source sensing circuits.

1. Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."

2. Emergency Power Supervision: Red light with nameplate engraved "Emergency Source Available."

H. Unassigned Auxiliary Contacts: 4 normally open single-pole, double-throw contacts for each switch position, rated 10 A at 240 V, ac.

I. Transfer Override Switch: Overrides automatic retransfer control so automatic transfer switch will remain connected to emergency power source regardless of the condition of the normal source. A pilot light indicates override status.

J. Engine Starting Contacts: 1 isolated, normally closed and 1 isolated, normally open. Contacts are gold flashed or gold plated and rated 10 A at 32 V, dc minimum.

K. Engine Shutdown Contacts: Time delay adjustable from 0 to 25 minutes; factory set at 5 minutes. Initiates shutdown at remote engine-generator controls after retransfer of load to normal source.

L. Digital Communication Interface: Mod-bus system interface for all control and monitoring functions.

2.5 FINISHES

A. Enclosures: Manufacturer's standard enamel over corrosion-resistant pretreatment and primer.

2.6 SOURCE QUALITY CONTROL

A. Factory Test Components, Assembled Switches, and Associated Equipment: Ensure proper operation. Check transfer time and voltage, frequency, and time-delay settings for compliance with specified requirements. Perform dielectric strength test complying with NEMA ICS 1.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Floor Mounting of Switches: Level and anchor unit to floor.

B. Identify components according to Division 16 Section "Electrical Identification."

3.2 WIRING TO REMOTE COMPONENTS

A. For automatic transfer switch(es) include 4 #14 THWN control circuit run in conduit from switch(es) to emergency generator starting and shutdown devices at engine generator control gear. Connect as required.

B. For automatic transfer switch(es) include 2 #14 voltage sensing circuit run in conduit from switch(es) to Building Management System panel to sense "emergency power." Terminate in outlet box with slack conductors (for extension by others) at panel. Connect to voltage sensing contact at ATS.

C. Circuitry extensions from transfer switches as described above include extensions from automatic transfer switches furnished by others as part of fire pump controllers.

D. For automatic transfer switch (es) supplying elevators, include 6 #14 control circuit run in conduit from elevator interface contacts in switch(es) to associated elevator machine room. Terminate in outlet box with slack conductors (for extension by others) adjacent to elevator group controller. Include also 2 #14 run to each hydraulic elevator not supplied through an automatic transfer switch.

3.3 CONNECTIONS

A. Ground equipment as indicated and required by National Electrical Code.

   1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.4 FIELD QUALITY CONTROL

A. Testing: Test transfer-switch products by operating them in all modes. Perform tests recommended by manufacturer under the supervision of manufacturer's factory-authorized service representative. Correct deficiencies and report results in writing. Record adjustable relay settings.

B. Ground-Fault Tests: Coordinate with testing of ground-fault protective devices for power delivery from both sources.

1. Assist in verifying grounding connections and locations and ratings of sensors.

2. Assist in observing reaction of circuit-interrupting devices when simulated fault current is applied at sensors.

C. Coordinate tests with tests of generator plant and run them concurrently.

D. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation and contact resistances and time delays. Attach a label or tag to each tested component indicating satisfactory completion of tests.

3.5 CLEANING

A. After completing equipment installation, inspect unit components. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.

B. Clean equipment internally, on completion of installation, according to manufacturer's written instructions.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's personnel to adjust, operate, and maintain transfer switches and related equipment as specified below:

1. Coordinate this training with that for generator equipment.

2. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining equipment.

3. Schedule training with Owner, through Architect, with at least seven days' advance notice.

4. Provide a minimum of four hours of instruction.

END OF SECTION 16415

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes bolted-pressure contact switches and high-pressure, butt-type contact switches.

1.3 SUBMITTALS

A. Product Data: For each type of switch specified. Include dimensioned outline drawings and complete description of features of switch and accessory components.

B. Shop Drawings: Diagram power, signal, and control wiring and differentiate between manufacturer-installed and field-installed wiring.

C. Maintenance Data: For switches and accessories to include in maintenance manuals specified in Division 1.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by Underwriters Laboratories.

B. Comply with UL 977.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Bolted-Pressure Contact Switches:

(a) Boltswitch, Inc.

(b) Cutler-Hammer Products; Eaton Corporation.

(c) Pringle Electrical Mfg. Co.

(d) Siemens Energy & Automation, Inc.

(e) Square D/Group Schneider.

2. High-Pressure, Butt-Type Contact Switches:

(a) General Electric Co.

2.2 DEVICE TYPE AND DESCRIPTION

A. Bolted-Pressure Contact Switch: Operating mechanism uses a rotary-mechanical-bolting action to produce and maintain high-clamping pressure on the switch blade after it engages the stationary contacts.

B. High-Pressure, Butt-Type Contact Switch: Operating mechanism uses butt-type contacts and a spring-charged mechanism to produce and maintain high-contact pressure when switch is closed.

C. Main Contact Interrupting Capability: Twelve times the switch current rating, minimum.

D. Operating Mechanism: Manual handle operation to close switch stores energy in mechanism for closing and opening.

1. Electrical Trip: Operation of lever or push-button trip switch, or trip signal from ground-fault relay or remote-control device, causes switch to open.

2. Mechanical Trip: Operation of mechanical lever or push-button or another device causes switch to open.

E. Enclosure: NEMA 250, Type 1, unless otherwise indicated.

F. Mounting and Anchorage Devices: Comply with manufacturer-certified device descriptions.

G. Auxiliary Switches: Factory installed, single pole, double throw, with leads connected to terminal block, and including one set more than quantity required for functional performance indicated.

H. Service-Rated Switches: Labeled for use as service equipment.

I. Ground-Fault Relay: Where required (as specified elsewhere) comply with UL 1053. Self-powered type with mechanical ground-fault indicator, test function, tripping relay with internal memory, and three-phase current transformer/sensor.

1. Configuration: Integral with fused power circuit device.

2. Tripping Relay: Adjustable pickup current and delay time with inverse- and constant-current characteristics.

3. Internal Memory: Integrates the cumulative value of intermittent arcing ground-fault currents and uses the effect to initiate tripping.

4. No-Trip Relay Test: Operation of "no-trip" test control permits ground-fault simulation test without tripping switch.

5. Test Control: Simulates ground fault to test relay and switch (or relay only if "no-trip" mode is selected).

6. Trip Indicator: Visually indicates ground-fault trip has occurred.

J. Open-Fuse Trip Device: Arranged to trip switch open if a phase fuse opens. Configuration: Integral with fused power circuit device.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Mount individual wall-mounting switches with tops at uniform height, unless otherwise indicated. Anchor floor-mounting switches to floor or equipment base.

3.2 FIELD QUALITY CONTROL

A. Inspect interior of switch enclosures for the following:

1. Mechanical and electrical connections.

2. Switch and relay type and labeling verification.

3. Rating of installed fuses.

4. Proper installation of type, size, quantity, and arrangement of mounting or anchorage devices complying with manufacturer's certification.

B. Testing: Perform the following field quality-control testing:

1. Test mounting and anchorage devices according to requirements in Division 16 Section "Seismic Controls for Electrical Work."

2. Energize circuits and demonstrate operation. Do not operate switches under load unless approved by Owner and Architect.

   (a) Demonstrate switch operation through six opening/closing cycles with circuit unloaded. Test door interlocking device and interlock defeating device.

(b) Electrical Operating Features: Test according to manufacturers' written instructions.

C. Retesting: Correct deficiencies shown by inspections and tests and completely retest work affected by such deficiencies.

D. Report of Inspections and Tests: Written record of results of inspections, tests, and adjustment settings.

END OF SECTION 16419

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the installation of A.C. individually enclosed motor controllers rated 600 V and below. The motor controllers will be furnished as part of Division 15 and Division 13.

B. Related Sections include the following:

1. Division 16 Section “Basic Electrical Materials and Methods” for general materials and installation methods.

2. Division 16 Section “Selection of Overcurrent Devices” for OCD’s and disconnect switches used with motor controllers.

3. Division 15 Section “Enclosed Controllers (Installation of)”.

4. Division 16 Section “Variable Frequency Controllers, Installation of”

1.3 SUBMITTALS

A. Field Test Reports: Written reports specified in Part 3.

1.4 QUALITY ASSURANCE

A. Comply with NFPA 70, as amended by state and local codes.

B. The terms "listed" and "labeled" are defined as they are in the National Electrical Code, Article 100.

1.5 COORDINATION

A. Coordinate layout and installation of enclosed controllers with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate features of enclosed controllers and accessory devices with pilot devices and control circuits to which they connect.

C. Coordinate features, accessories, and functions of each enclosed controller with ratings and characteristics of supply circuit, motor, required control sequence, and duty cycle of motor and load.

PART 2 - PRODUCTS

(NOT APPLICABLE)

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Install independently mounted motor control devices in accordance with manufacturer's written instructions.

B. Location: Locate controllers as indicated and within sight of motors controlled. Where controller is not located within sight of the motor controlled (as defined in the National Electrical Code), provide a nonfusible disconnect switch to serve as the local motor disconnect.

C. Mounting: For control equipment at walls, bolt units to wall or mount on light-weight structural steel channels bolted to the wall. For controllers not at walls, provide freestanding racks fabricated of structural steel members and light-weight slotted structural steel channels.

D. Motor-Controller Fuses: Install fuses in each fusible switch. Conform to requirements of Division 16 Section "Overcurrent Protection Device Coordination."

E. Modify as required the internal control of motors if necessary to accommodate connection of external control wiring in accordance with applicable wiring diagrams.

F. Relay settings: Modify factory settings of adjustable time delay relays in accordance with an approved schedule.

3.2 IDENTIFICATION

A. Identify motor control components and control wiring in accordance with Division 16 Section "Electrical Identification." Where not cover mounted on motor controller, device identification nameplate identify the associated motors.

3.3 CONTROL WIRING

A. Control wiring for HVAC motors will be provided as part of the Building Management System (central mechanical control system) work of Division 15, except for the following wiring which is provided as part of the electrical work (Division 16):

1. For each motor automatically and/or manually controlled or monitored by the fire alarm system, include control wiring extensions as specified as part of the fire alarm system to an adjacent FPA addressable modules.

2. For each motor supplied by a VFC, run 2 #14 from the disconnect switch at the motor to the VFC, and connect so as to de-energize “start circuit” when switch is open. Run with power circuitry or in separate raceway.

B. Control wiring for plumbing/fire protection motors is provided as part of the electrical work. For each such motor, provide wiring and connect to all outlying control devices as directed. Refer to plumbing and fire protection drawings and specifications for quantities and locations.

C. Damper Control Interface: Start command to open associated dampers before the motor is allowed to operate. Input to accept damper limit switch contact closure to allow the motor to operate in hand and auto or remote mode.

D. Safety Control Interface: Input to accept safety device contact closure to stop motor operation in hand and auto or remote mode.

E. Control wiring is accomplished utilizing #14 AWG copper conductor with THWN insulation run in conduit as specified for feeders in Division 16, Section "Raceways."

F. Include any necessary field installed make-up wiring (within motor controller enclosures) as required to incorporate the contained devices and accessories into the control scheme.

3.4 MOTOR CONTROLLER FUSES

A. Motor-Controller Fuses: Install indicated fuses in each fusible switch.

3.5 CONTROL WIRING INSTALLATION

A. Install required control wiring according to Division 16 Section "Conductors and Cables."

B. Bundle, train, and support wiring in enclosures.

C. Connect hand-off-automatic switches and other automatic control devices and accessories within controllers as required to accommodate the control scheme.

1. Connect selector switches to bypass only the manual and automatic control devices that have no safety functions when switch is in the hand position.

2. Connect selector switches with motor-control circuit in both hand and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.6 CONNECTIONS

A. Tighten connectors, terminals, bus joints, and mountings. Tighten field-connected connectors and terminals, including screws and bolts, according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

B. Ground equipment.

3.7 FIELD QUALITY CONTROL

A. Prepare for acceptance tests as follows:

1. Test insulation resistance for each enclosed controller bus, component, connecting supply, feeder, and control circuit.

2. Test continuity of each circuit.

B. Testing: After installing enclosed switches and circuit breakers and after electrical circuitry has been energized, demonstrate product capability and compliance with requirements.

1. Procedures: Perform each electrical test and visual and mechanical inspection indicated in NETA ATS, Sections 7.5, 7.6, and 7.16. Certify compliance with test parameters.

2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

C. Testing Reports: Prepare a written report to record the following:

1. Test procedures used.

2. Test results that comply with requirements.

3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

3.8 ADJUSTING

A. Set field-adjustable switches and circuit-breaker trip ranges.

3.9 CLEANING

A. Clean enclosed controllers internally, on completion of installation, according to manufacturer’s written instructions. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

END OF SECTION 16420

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification sections apply to this Section.

1.2 SUMMARY

A. This Section includes all overcurrent protective devices (OCPD's) (OCD's) required for the project. It defines the type of OCPD required for each individually mounted device, panelboard, switchboard, switchgear and miscellaneous device required.

B. Related Sections: The following Sections requirements relate to this Section:

1. Division 16, Section "Enclosed Switches and Circuit Breakers."

2. Division 16, Section "Panelboards."

3. Division 16, Section "Switchboards."

4. Division 16, Section "Switchgear."

1.3 SUBMITTALS

A. General: Submit the following according to the Conditions of the Contract and Division 1 Specifications Section.

B. Descriptive data defining how the required short circuit ratings will be met by the equipment furnished under the Related Sections described above. System shall be fully rated.

C. In advance of, or in conjunction with, the submission of shop drawings for approval, provide data defining in detail how the required coordination and short circuit current ratings specified elsewhere in these specifications are achieved with the equipment being furnished under the listed Related Sections. The data shall, in narrative or graphic fashion, fully define how the various devices, individually, or in combination, comply with the "fully rated" short circuit current requirements. Include certifications from the manufacturer as to the UL approvals for these ratings for all proposed equipment. Short circuit and coordination study shall include recommended device settings. In particular, demonstrate selective coordination of overcurrent devices used for Emergency Systems and Legally Required Standby Systems.

D. Arc flash study indicating arc flash hazard at each piece of distribution equipment.

1.4 QUALITY ASSURANCE

A. Comply with NFPA 70 as amended by state and local codes.

B. Listing and Labeling: Products - as described with the Related Sections above - shall be Underwriters Laboratories listed and labeled as defined in NFPA 70 Article 100.

PART 2 - PRODUCTS

2.1 GENERAL

A. Refer to Related Sections listed hereinbefore for general product requirements.

B. Short circuit current ratings, and the manufacturer's labels attesting to these ratings (based on U.L. listings), will be required for overcurrent protection devices, where they are individually mounted and for the equipment assemblies when they are incorporated in panels, switchboards, switchgear, etc. Such ratings shall be in accordance with the following:-

1. In order to insure that they are at least equal to the available fault current, minimum ratings have been specified herein for the individual overcurrent device types, and in the pertinent sections for panelboards, switchboards, switchgear and other assemblies or devices. .

C. All overcurrent protection and switching devices shall be U.L. listed as suitable for the termination of 75 degree C conductors, sized in accordance with their 75 degree C ampacity ratings. Devices shall be specifically identified accordingly and shall bear the designation "60 / 75 degree C" or "75 degree C", regardless of whether incorporated in panelboards, switchboards or other assemblies or whether individually mounted.

2.2 APPLICATION

A. Overcurrent protective devices (OCD'S) shall be provided as described hereinafter.

B. OCD's shall be of the current limiting circuit breaker type (CLCB) except as noted hereinafter.

C. Branch circuit breakers in 277/480 (265/460) volt lighting or appliance panels shall be of the standard molded case type.

D. Main and branch circuit breakers in 120/208 volt panelboards of all types shall be of the standard molded case type.

E. Individually mounted overcurrent protection and switching devices shall be as follows:

1. For use on 277/480 (265/460) volt circuits, they shall be of the CLCB molded case breaker type.

2. For use on 120/208 volt circuits, they shall be of the standard molded case circuit breaker type.

F. Emergency Systems and Legally Required Standby Systems: Overcurrent devices shall be selected such that all overcurrent devices in the distribution system are selectively coordinated.

1. Overcurrent devices for Emergency Systems and Legally Required Standby Systems shall be switch and fuse type. Devices up to and including 800 amperes shall be quick-make, quick-break type switches with cartridge fuses. Devices over 800 amperes shall be bolted pressure type switches with cartridge fuses. This requirement includes all overcurrent devices providing utility service to the transfer switches, providing generator power to the transfer switches, and on the load side of transfer switches - including branch circuit overcurrent protection.

2. Short circuit rating of panelboards and devices shall be as required to provide a fully rated system.

2.3 CURRENT LIMITING CIRCUIT BREAKERS

A. Where intended for mounting in main switchboards, switchgear or as individually mounted service switches they shall be of the 100 percent rated (i.e., capable of carrying 100 percent of their rating continuously), fixed (stationary) mounted and drawout mounted air frame type, with current limiting fuses accessibly mounted in the line side bus connections to each pole of the breakers. They shall be as follows:

1. Their circuit breaker elements shall consist of quick-make quick-break mechanically trip free air immersed circuit breaker mechanisms arranged to operate all poles simultaneously and equipped with an adjustable solid state type overcurrent tripping device, incorporating:-

(a) Short time inverse current characteristic tripping in main breakers.

(b) Instantaneous short circuit tripping except in main breakers.

(c) Long time inverse current characteristic tripping for all breakers.

(d) Ground fault tripping. Refer to Division 16 Section entitled "Main Switchboards "Switchgear" for further information regarding features and functions. Dry contacts which close on ground fault trip shall be provided for monitoring by the BMS.

2. Their breaker contacts shall be complete with arc quenchers in each pole, interpole barriers and latches with mechanical pushbutton trips and position indicators.

3. They shall have shunt trip devices complete with control transformers, "line side" shunt trip control supply connections, and internal factory wiring to accessible terminals as required for the present or future extension of the trip control circuit at a 120 volt control voltage level, to remote normally open external actuating devices.

4. They shall have phase failure protection relay systems arranged to trip them open in response to a sustained voltage in any phase which is lower than 75 percent of the other phase voltages.

5. Sizing of the current limiting fuse for each circuit shall be as selected by the manufacturer as part of the coordination study. Fuses shall be capable of safely interrupting currents of up to 200,000 amperes RMS symmetrical. Fuses shall coordinate with, and back up, the associated circuit breakers so that faults up to the safe capability of the breakers will be interrupted by the breakers, and larger faults will be interrupted by the fuse without damage to the breakers.

B. Current limiting circuit breakers intended for use in power and/or distribution panels, or for use as individually mounted overcurrent protection devices, shall be of the molded case type. In ratings up to the maximum frame size in which they are available from the manufacturer, they shall be of the fuseless type. In larger frame sizes, they shall be of a type which incorporates an integral current limiting fuse in each pole. Current limiting molded case circuit breakers shall be as follows:

1. Their breaker elements shall consist of manually operated, quick-make, quick-break, mechanically trip free operating mechanisms for simultaneous operation of all poles, with contacts, arc interrupters and trip elements for each pole.

2. Their breaker tripping units shall be of the adjustable solid state type incorporating long time delay and instantaneous tripping, or of the "thermal-magnetic" type having bi-metallic elements for time delay overload protection, and magnetic elements for short circuit protection.

3. They shall be of either the fuseless type or of the type which incorporates current limiting fuses.

4. Where of the fuseless type, they shall incorporate high speed blow-apart current limiting contacts, and shall have a short circuit interrupting capacity of at least 150,000 RMS symmetrical amperes at the specified system voltage.

5. Where they are of the type which incorporates fuses (i.e., in frame sizes larger than 400 amps), they shall be as follows:-

   (a) Their fuses shall be equipped with release buttons arranged to trip open the latches of their circuit breaker elements.

(b) Each shall have its fuses and breaker elements integrally mounted in a single overall molded phenolic plastic case.

(c) The fuses shall be capable of safely interrupting fault currents in the order of 200,000 amperes RMS symmetrical. The current limiting fuses shall coordinate with and back up the circuit breakers they are associated with so that all fault overload currents occurring within the safe capability of the breakers shall cause the breakers to open, and all currents occurring beyond the safe capability of the breakers shall cause the fuses to open; the opening of fuses being such as to prevent damage to any circuit breaker components parts.

C. In lieu of the air frame CLCB's specified hereinbefore for mounting in main switchboards or as individually mounted service switches, stationery molded case circuit breaker sizes may be utilized in frame sizes up to 800 amps. They shall be as follows:

1. They shall be 100 percent rated.

2. They shall be provided with solid state tripping devices, incorporating all of the features and characteristics specified hereinbefore for current limiting air frame circuit breakers.

3. They shall in all other respects comply with the requirements specified for current limiting circuit breakers in power and/or distribution panels.

2.4 STANDARD MOLDED CASE CIRCUIT BREAKERS

A. Standard molded case circuit breakers shall comply with the following:-

1. They shall consist of manually operated quick-make, quick-break mechanically trip free operating mechanisms for simultaneous operation of all poles, with contacts, arc interrupters and trip elements for each pole, all enclosed in molded phenolic plastic cases.

2. Their tripping units shall be of the "thermal magnetic" type having bi-metallic elements for time delay overload protection, and magnetic elements for short circuit protection.

3. Where no frame sizes are indicated their interrupting capacity (in RMS symmetrical amperes) shall not be less than 14,000 amperes for use in 277/480 (265/460) volt lighting and appliance panels, nor less than 10,000 amperes for use in 120/208 volt lighting or appliance panels.

4. Where frame sizes are indicated their interrupting capacity (in RMS symmetrical amperes) shall not be less than 22,000 amperes for 100 amperes and 225 amperes frame circuit breakers, nor less than 42,000 amperes for larger frame sizes.

5. The minimum interrupting capacity in symmetrical RMS amperes of the circuit breakers intended for use in panelboards shall be as noted above.

6. They shall be of the "bolted-in" type.

7. Single pole breakers sized 20 amps or less shall be rated for switching duty.

8. Where utilized for circuits supplying HID lighting, they shall be HID rated.

9. They shall be multi-pole circuit breakers, or single-pole circuit breakers with handle ties where serving multi-wire branch circuits in relocatable partitions or systems furniture.

10. They shall be equipped with 5 milliamp sensitivity ground fault interrupting features where so indicated, and/or where they supply 120 volt, 15- and 20-ampere receptacles in bathrooms, kitchens, within 6 feet of sinks, where intended for use by vending machines, and other such code mandated locations and with 30 milliamps sensitivity G.F.I. features where they supply piping tracing cables or snow melting cables or gutter de-icing cables or HWAT cables.

2.5 BOLTED PRESSURE SWITCHES

A. Select bolted pressure type distribution switches in accordance with the following:-

1. They shall have copper current-carrying elements having silver plated contact surfaces.

2. They shall have blade locks to prevent them from opening under short circuit stresses and a mechanism which produces initial contact pressure on the jaws in addition to final bolted pressure when they are closed.

3. They shall be capable of interrupting at least 12 time their rating without damage in accordance with NEMA and UL performance standards.

4. They shall have auxiliary renewable arcing contacts which "make" before and "break" after main current-carrying elements function.

5. They shall be equipped with operating mechanisms which incorporate manual closing and tripping.

6. Where used as service disconnects, they incorporate electrical tripping. Electrical tripping shall incorporate a stored energy mechanism that permits closure only after the opening mechanism has been charged. They shall be complete with control transformers, "line side" trip control supply connections, and internal factory wiring to accessible terminals as required for the present or future extension of the trip control circuit at a 120 volt control voltage level, to remote normally open external actuating devices. The trip circuit shall operate down to 55 percent of nominal voltage.

7. They shall be designed for use with Class "L" fuses.

8. They shall be 100 percent rated when mounted in an enclosure, in accordance with UL test procedures for individual mounting or for incorporation into panelboards or switchboards.

9. They shall be equipped with an Open-Fuse Trip Device arranged to trip switch open if a phase fuse opens.

2.6 QUICK-MAKE, QUICK-BREAK SWITCHES

A. Select quick-make, quick-break type distribution switches in accordance with the following:-

1. They shall equal or exceed the performance required for NEMA type H.D. horsepower rated switches.

2. They shall have arc quenchers and circuit breaker type pressure contacts.

3. Where intended for panelboard or switchboard mounting, they shall be of the "bolted-in" type.

4. They shall be designed for use only with Class "J" fuses up to 600 amps, and "Class L" fuses above 600 amps. Where protecting a branch circuit for emergency systems and legally required standby systems, fuses shall be current limiting type. They shall incorporate factory installed clips designed to insure the use of proper fuses. Coordinate to insure that fuses supplied for the project match these fuse gaps.

5. Switches 400 amperes or larger shall be equipped with an Open-Fuse Trip Device arranged to trip switch open if a phase fuse opens.

2.7 FUSES

A. Select fuses for use in switch and fuse type overcurrent devices in accordance with the following:

1. Regardless of the actual available fault current they shall, at full recovery voltage, be capable of safely interrupting fault currents of 200,000 amperes RMS symmetrical deliverable at the line side of the fuse.

2. They shall be suitable for application to fuse gaps which reject other types of fusing. Coordinate with supplier(s) of all fusible switch units (in panels, switchboards, etc.) for the project to insure that fuse gaps match the specified fuse types.

3. Except as noted hereinafter, in sizes up to 600 amps, they shall be of the Class "J" time delay type, capable of carrying 500 percent of rated current for not less than 10 seconds and UL listed as a "Class J" fuse. Fuses shall be Shawmutt Type "AJT", Bussmann Type "LPJ", or other approved. Approval is contingent on certified test data demonstrating full compliance with the following requirements:-

    (a) Fuse shall carry 500 percent of rating for at least 10 seconds.

    (b) Fuse shall be suitable for motor feeders when applied at 150 percent of motor full load current.

    (c) Fuse selectivity with downstream fuses shall be:-

        (1) 2:1 with "J" time delay

        (2) 3:1 with "RK-5" time delay

        (3) 2:1 with "RK-1" time delay

4. Where intended for use in motor starters (individual, or in motor control centers) they shall be of the dual element time delay type, UL listed as "Class RK-5", and capable of carrying 500 percent of rating for at least 10 seconds. Utilize "Class RK-1" time delay fuses where required to insure coordination with upstream fuses.

5. Where protecting a branch circuit fuses shall be current limiting type.

6. Except as noted hereinafter, in sizes over 600 amps, they shall be of the current limiting type, UL listed as "Class L".

7. Where protecting a feeder or tap supplying a single large motor or transformer, fuses in the range of 800 to 2000 amps shall have special "Class L" time delay characteristics equal to Shawmutt Type "A4BT" or Bussmann Type "KRP-C" fuses.

2.8 GROUND FAULT TRIPPING

A. Provide ground fault tripping for each individually mounted service switch over 800 amps and for each main switchboard device and each switchgear device.

2.9 ELEVATOR POWER/DISTRIBUTION PANELS

A. Branch units in power/distribution panels supplying elevators shall be of the quick-make, quick-break distribution switch type with time delay fuses.

    1. Where serving as the in-sight disconnect for a hydraulic elevator, they shall incorporate an auxiliary dry contact.

PART 3 - EXECUTION

3.1 GENERAL

A. Comply with the requirements of Division 16 Sections "Enclosed Switches and Circuit Breakers," "Fuses," "Panelboards," "Switchboards" and "Switchgear".

B. Submit recommended settings for all adjustable or interchangeable overcurrent and ground fault tripping devices. Include a complete short circuit and coordination study to demonstrate that the recommended device settings will provide a completely coordinated system based on the available fault currents. Full coordination of all devices used for Emergency Systems and Legally Required Standby Systems is required. Include all work required in the field to verify that factory settings are as recommended, and to field set device whose settings are not as recommended.

END OF SECTION 16422

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes basic requirements for the installation of light and power feeders and circuitry run at less than 600 volts.

B. Related Sections: The following sections contain requirements that relate to this Section:

1. Division 16, Section "Raceways and Boxes."

2. Division 16, Section "Conductors and Cables."

3. Division 16, Section "Panelboards."

1.3 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.

B. Circuited up "as-built" drawings and panel directories as called for in the Division 16 related sections.

1.4 QUALITY ASSURANCE

A. Comply with NFPA 70, as amended by state and local codes.

PART 2 - PRODUCTS

2.1 GENERAL

A. Products shall be as specified in the Division 16 related sections.

PART 3 - EXECUTION

3.1 INSTALLATION OF FEEDERS

A. Feeder connections shall be in the phase rotation which establishes proper operation for all equipment supplied.

B. Feeders consisting of multiple cables and raceways shall be arranged such that each raceway of the feeder contains one cable for each phase leg (and one neutral cable if any).

C. Each individual tap off a feeder which consists of multiple cables per phase (and neutral if any) shall be arranged so that all of the cables of a phase leg (and neutral if any) of the feeder are connected to the corresponding phase leg (and neutral if any) of the individual tap.

D. Indications of conductor sizing for three phase and three phase/four wire feeders shall, unless otherwise noted on the drawings, be understood as follows:

1. (3) equally sized conductors represents a three phase feeder.

2. (4) equally sized conductors represents a three phase/4 wire feeder with 100% neutral.

3. (3) equally sized conductors plus (1) smaller conductor represents a three phase/three wire feeder plus ground wire.

4. (4) equally sized conductors plus (1) smaller conductor represents a three phase/four wire feeder plus ground wire).

5. (3) equally sized conductors plus (1) larger conductor or (2) equally sized conductors represents a three phase/4 wire feeder with neutral oversized to accommodate "harmonic-rich loads."

6. (3) equally sized conductors plus (1) larger conductor or (2) equally sized conductors and one smaller conductor represents a three phase/four wire feeder with neutral oversized to accommodate "harmonic-rich" loads plus a ground wire.

3.2 INSTALLATION OF LIGHTING AND APPLIANCE BRANCH CIRCUITRY

A. Circuitry indicated without sizing shall be understood to be lighting and appliance branch circuitry protected at 20 amps or less.

B. Conform all lighting and appliance branch circuitry (regardless of whether protected above or below 20 amps) to the following:-

1. Except as noted below, circuitry shall be multi-wire utilizing common neutrals arranged so that no neutral conductor acts as a common wire for more than one circuit conductor connected to the same phase leg of the supply system.

(a) Common neutrals shall not be utilized for circuitry runs emanating from panel branches having ground fault interrupting features regardless of any indication to the contrary on the floor plans.

(b) Common neutrals shall not be utilized for circuitry runs containing more than (6) 120 volt receptacle circuits within a single raceway (conduit, underfloor duct).

2. Conductors used as common neutrals for multiple (2 or 3) 120 volt branch circuits protected at 20 amps or less shall be #10 AWG where such circuits supply receptacles which are dedicated to - or may be utilized for - "harmonic-rich" loads such as personal computers, computer terminals, word processors, printers and the like. Accordingly, common neutrals supplying receptacles shall be understood to be #10 AWG under the following conditions:

(a) Wherever so indicated (by note or otherwise) on the drawings.

(b) Throughout all office areas, computer rooms or other data processing spaces and laboratories.

3. Branch circuitry supplying relay controlled lighting fixtures shall be understood to include all necessary interconnections between the control panels containing the relays and the associated lighting or appliance panels.

4. Under no condition shall any local switch break a neutral conductor.

5. At any location where lighting and appliance branch circuitry is extended from a flush mounted panelboard to a suspended ceiling immediately above, at least four 1-inch empty conduits shall be included (in addition to those required for active circuitry) to permit future wiring escape from the panelboard. The empty conduits shall extend up from the panel and shall terminate in a threaded conduit cap immediately after turning out into the hung ceiling space.

6. Raceway sizes shall conform to standard maximum permissible occupancy requirements except where these are exceeded by other requirements specified elsewhere.

7. Two and three pole branches in panels shall be used respectively for individual single phase load items connected line to line and individual three phase load items. Where circuitry indications require the use of 2-pole and/or 3-pole branch breakers which have not been scheduled, provide in the panelboards the required multi-pole breakers in lieu of the equivalent number of single pole branch breakers. Required quantities of single, two and three pole branch breakers shall be confirmed prior to ordering panels.

C. Conform lighting and appliance branch circuitry, indicated as being protected at 20 amps or less, to the following:-

1. 120 volt circuitry shall be supplied from 20 amp panel branches except as indicated otherwise.

2. 277 (265) volt circuitry shall be supplied from 20 amp panel branches except as indicated otherwise.

3. Except as specified below, minimum conductor size shall be #12 AWG.

4. Common neutrals shall not be utilized for circuitry runs containing more than (6) 120 volt receptacle circuits within a single raceway (conduit, cellular deck, underfloor duct]) except as noted below.

5. For circuitry run in underfloor raceway systems (cellular deck, underfloor duct), comply with the following:

   (a) Utilize #10 AWG phase leg conductors and #8 AWG neutral conductors for runs contained in branch cells or ducts (i.e., cells or ducts intended for the direct supplying of receptacles or other outlets from after-set inserts or pre-set inserts mounted on them).

   (b) Utilize #8 AWG conductors for home run circuitry contained in main runs (i.e., trench headers, junction headers or header ducts).

   (c) Common neutrals shall be utilized for all circuitry contained in main runs and branch runs. Neutral conductors shall be tapped and reduced in insert outlet boxes to #10 or #12 AWG for direct connection to receptacles.

6. Conductors for 120 volt circuitry extending in excess of 75 feet, from the point of supply, to the first outlet shall be #10 AWG (minimum) copper to the first outlet. Increase beyond #10 AWG if required for compliance with code-mandated voltage drop restrictions.

7. Conductors for 277 (265) volt circuitry extending in excess of 150 feet, from the point of supply, to the first outlet shall be #10 AWG (minimum) copper to the first outlet. Increase beyond #10 AWG if required for compliance with code-mandated voltage drop restrictions.

8. Conductors used in runs consisting of more than six wires (exclusive of grounding conductors) in a single raceway shall be #10 AWG copper minimum. Increase beyond #10 AWG as required to comply with code-mandated derating factors, and as specified hereinbefore.

9. Circuits supplying receptacles which are not of the ground fault circuit interrupting type, and are located as noted below, shall be connected to panel branches that are equipped with ground fault interrupting features:

   (a) Receptacles located in bathrooms. Bathrooms shall be defined as spaces containing a basin plus a toilet, tub or shower.

   (b) Receptacles located within 6 feet of any sink and intended to serve counter top surfaces.

   (c) Receptacles in commercial and institutional kitchens.

(d) All receptacles mounted on building exterior surfaces.

(e) All receptacles mounted in garages.

(f) All receptacles mounted in elevator machine rooms, machinery spaces and pits.

10. Circuits supplying pipe tracing cable, snow melting cable, gutter melting cable and HWAT cable shall be connected to panel branches equipped with 30 ma interrupting features for equipment protection.

D. Where circuitry has not been delineated for lighting fixtures, receptacles, switches and miscellaneous items intended for protection at 20 amps, such items shall be provided with circuitry conforming to the requirements listed below. Prior to installation of circuitry, submit for review floor plans showing circuit numbers, home runs, and interconnecting circuitry for all such items.

1. When circuiting up recessed ceiling lighting fixtures, connect fixtures on the basis of more than one fixture to a single outlet box, in an approved manner, as required to insure that circuits will not be unnecessarily lightly loaded due to mandated, restrictions on the maximum number of outlets per circuit. Except with special permission, unnecessarily light loading shall be understood to mean, less than 1000 volt amps (VA) on a 120 volt circuit and less than 3200 VA on a 277 volt circuit.

2. The total load on a circuit shall be computed by ascribing volt-amps to individual items on the basis of the following:-

ITEM	VOLT-AMPS (VA)
Any lighting fixture.	Input volt-amps as per lighting fixture schedule.
Any outlet with no specific wattage or circuiting instruction indicated.	180 volt amperes
Any outlet (other than for resistance heating) with wattage indicated.	1.15 x Indicated wattage
Any resistance heating outlet with wattage indicated.	1.0 x Indicated wattage
Any fractional HP motor with HP indicated.	2500 x Indicated HP
Any outlet with amps indicated.	120 x Indicated amps

3. Not more than 1300 total VA shall be applied to any 15 amp, 120 volt panel branch circuit nor more than 1450 VA to any 20 amp, 120 volt branch circuit.

Not more than 4000 VA shall be applied to any 277 (265) panel branch circuit.

4. A separate 20 amp panel branch circuit supplying no other outlets shall be used for each outlet indicated as an "individual appliance circuit" or "heavy duty" outlet.

5. Lighting fixture shall be connected to 20 amp panel branch circuits. Solidly connected equipment less than 1300 VA shall be connected to 15 amp panel branch circuits except as indicated or noted herein.

6. Lighting fixtures and receptacles shall not be connected to the same branch circuit.

7. Any installed lighting and appliance branch circuitry, found (as a result of unnecessarily light loading of conductors) to make excessive use of panel branches, shall be rearranged.

8. Circuits shall be balanced on phases at their supply point as evenly as possible.

9. The final arrangement of lighting and appliance branch circuitry shall be fully delineated on the record, or "as-built" drawings called for elsewhere.

END OF SECTION 16424

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes provisions for the accommodation of utility company metering equipment.

B. Related Sections: The following Division 16 Sections contain requirements that relate to this Section:

1. "Raceways and Boxes."
2. "Conductors and Cables."
3. "Submetering" .

1.3 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.

1. Product data for each product and component specified.
2. Shop drawings of utility company metering provisions with indication of approval by utility company.

1.4 QUALITY ASSURANCE

A. Listing and Labeling: Provide components that are Underwriters Laboratories listed and labeled.

1. The terms "listed" and "labeled": As defined in the National Electrical Code, Article 100.

B. Electrical Component Standard: Components and installation shall comply with NFPA 70 .

1.5 GENERAL

A. All electricity delivered to the project will be utility company metered through a main "house" metering installation. Electricity consumed by each tenant will be submetered by the airport. Submetering system shall be E-Mon or approved equal.

B. Provide meter pans and/or backboards and current transformers per utility company requirements.

C. Provide instrument wiring per utility company requirements.

D. Provide "house" meter totalizing impulse wiring systems per utility company requirements.

E. Install current transformers furnished by the utility company.

F. Meters will be furnished and installed by the utility company.

G. All work for the metering installation shall be provided in accordance with instructions issued by the utility company.

PART 2 - PRODUCTS

2.1 GENERAL

A. Furnish in accordance with the applicable requirements of Division 16 Sections "Wires and Cables" and "Raceways, Boxes and Cabinets."

PART 3 - EXECUTION

3.1 GENERAL

A. Install in accordance with the applicable requirements of Division 16 Sections “Conductors and Cables" and "Raceways and Boxes."

END OF SECTION 16427

PART 2 - GENERAL

1.1 RELATED DOCUMENTS

1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

1. This Section includes an electronic submetering system using power line carrier (PLC) signal transmission.

1.3 SUBMITTALS

1. General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections.

2. Product Data for each component specified, including detailed manufacturer's specifications. Include data on features, ratings, and performance. Include dimensioned views of components and enclosures.

3. Wiring diagrams detailing internal and interconnecting wiring.

4. Qualification data for firms and persons specified in the "Quality Assurance" Article. Describe capabilities and experience, and provide references when requested.

5. Field test reports for tests specified in Part 3.

6. Maintenance data for products to include in the operation and maintenance manual specified in Division 1. Include the following:

    1. Detailed operating instructions covering operation under both normal and abnormal conditions.

    2. Routine maintenance requirements for system components.

    3. Lists of spare parts and replacement components recommended to be stored at the site for ready access.

1.4 QUALITY ASSURANCE

1. Installer Qualifications: Engage an experienced Installer who is an authorized representative of the system manufacturer to supervise installation of the system.

2. Manufacturer Qualifications: Engage firms experienced in manufacturing systems and equipment similar to those indicated for this Project and that have a record of successful in-service performance.

3. Service Center: Select a system manufacturer who maintains a service center capable of providing training, parts, and emergency maintenance and repairs at the Project site with a 24-hour maximum response time.

4. Comply with NFPA 70.

5. Listing and Labeling: Provide Underwriters Laboratories listed and labeled items for system components of types covered by listing or labeling services.

    1. The Terms "Listed" and "Labeled": As defined in the National Electrical Code, Article 100.

6. Meter accuracy for billing.

1.5 WARRANTY

1. Special Warranty: Submit a written warranty signed by the manufacturer and Installer agreeing to correct system deficiencies and replace components that fail in materials or workmanship within the specified warranty period when installed and used according to the manufacturer's written instructions. This warranty shall be in addition to, and not limiting, other rights the Owner may have under other provisions of the Contract Documents.

2. Special Warranty Period: 3 years.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the Work include, but are not limited to, the following:
    1. E-Mon

2 Square D Power Logic

1.1 SYSTEM DESCRIPTION

1. The electronic submetering system shall utilize power line carrier (PLC) distribution of signals and shall consist of the following:

    1. Central data collection equipment.
    2. Outlying submetering modules (i.e., "submeters").
    3. Current transformers.
    4. 9600 baud (minimum) Hayes - compatible modem.
    5. On-site billing equipment. (Including any necessary software).
    6. Interwiring as required.

2. The outlying submetering modules shall each consist of a microprocessor based electronic metr, a carrier current communications section for two-way distribution of data over power lines, and a power supply. The modules shall each function in conjunction with current transformers and voltage supply connections as follows:

    1. Meters and associated current transformers shall be provided for individual tenants as indicated on plans.

    2. Each submeter shall monitor current voltage and power so as to enable computing of kilowatt-hours (KWH) consumption and kilowatt (KW) integrated demand (over 15 or 30 minute period to match local utility company practice). Consumption and demand shall be displayed on command (or continuously) at the submeter.

    3. The modules shall have a non-volatile memory so that information will be retained without use of batteries in the event of voltage disturbances or power outages.

    4. The modules shall be capable of measuring 120/208 volt single phase, 3 wire, 120/208 volt 3 phase, 4 wire and 277/480 volt 3 phase, 4 wire electrical services, and shall be accurate within 2 percent.

    5. The modules shall transmit data to the central equipment to enable the storage of KWH consumption and 15 or 30 minute integrated KW demand on a time-of-day basis, with the time frame divided into two to four intervals per day in accordance with local utility practice. It shall be possible to randomly combine the data from multiple outlying meter modules so as to read totalized KWH consumption and coincident integrated demand KW.

    6. Include equipment, wiring and software to permit individual or coincident demands to be reported at the time that the building Utility Company master meter peaks each month. Include wiring to the Utility Company meter, as well as the cost of any charges from the Utility Company for interface equipment necessary to monitor the Utility Company demand meter.

    7. Data transmission shall be over building power supply wires. Dedicated wiring shall not be required between meter modules and the central equipment.

3. The central equipment shall include all items necessary to receive data from outlying submeters to analyze and store data as it is received, to query each outlying submeter to verify proper operation, to transmit data on demand for readout of consumption and demand for any submeter unit. The central equipment shall also include all items as necessary to transmit data via modem, utilizing telephone lines, to an off-site facility for billing and/or diagnostic purposes. It shall also be able to transmit data to on-site billing equipment if provided.

4. Provide on-site billing equipment including but not limited to microcomputer, software, printer and peripheral printer as required to permit the Owner to prepare monthly bills for outlying submeter.

PART 2 - EXECUTION

2.1 GENERAL

1. The system shall generally utilize building power circuitry for the transmission of data to and from the submetering modules. To the extent that wiring is required for data transmission and for power live connections, it shall be included and shall comply with Division 16 Sections "Wires and Cables" and "Raceway, Boxes and Cabinets."

2. The system and all its components must receive the approval of all agencies having jurisdiction, prior to installation of any equipment or wiring.

3. The system supplier must guarantee his ability to provide off-site diagnostic analysis of the system via telephone lines, as well as his ability to provide off-site preparation of bills in the required format required by Owner. Include one year's free diagnostic service (including on-site repairs and adjustments) and preparation of bills.

4. Submit a separate price for service, repairs and off-site billing after the first year.

2.2 IDENTIFICATION

1. Identify system components, wiring, and cabling, according to Division 16 Section "Electrical Identification."

2.3 FIELD QUALITY CONTROL

1. Manufacturer's Field Service: Provide services of a factory-authorized service representative to supervise the field assembly and components connection and the pretesting, testing, and adjusting of the system.

2. Inspection: Verify that components and wiring are properly installed, connected, and labeled and that interconnecting wires and terminals are identified.

3. Pretesting: Pretest all components, wiring, and functions to verify they conform to specified requirements. Replace malfunctioning or damaged items with new items. Retest until satisfactory performance and conditions are achieved.

4. Operational Acceptance Tests: Perform operational system tests to verify system conforms to Specifications. Include all modes of system operation.

2.4 DEMONSTRATION

1. Training: Arrange and pay for the services of a factory-authorized service representative to demonstrate operation, and maintenance of the system and to train Owner's personnel.

    1. Demonstrate programming of the central equipment.

    2. Demonstrate on-site preparation of bills.

2. Conduct a minimum of 6 hours' training.

3. Schedule demonstration, training, and adjustment with Owner with at least 7 days' advance notice.

END OF SECTION 16428

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes metal-enclosed, low-voltage, power circuit-breaker switchgear rated 1000 V and less for use in AC systems.

1.3 REFERENCE

A. The equipment lineup in this specification shall be designed and manufactured according to latest revision of the following standards, unless otherwise noted.

B. ANSI C37.16, Low Voltage Power Circuit Breakers and AC Power Circuit Protectors, Preferred Ratings, Related Requirements and Application Recommendations.

C. ANSI C37.17, Trip Devices for AC and General Purpose DC Low-Voltage Power Circuit Breakers.

D. ANSI C37.50, Switchgear - Low Voltage AC Power Circuit Breakers Used in Enclosures - Test Procedures.

E. ANSI C37.51, Switchgear - Metal-Enclosed Low-Voltage AC Power Circuit Breaker Switchgear Assemblies - Conformance Test Procedures.

F. ANSI C39.1, Electrical Analog Indicating Instruments, Requirements.

G. ANS/IEEE C37.13, In Enclosures, Low-Voltage AC Power Circuit Breakers Used.

H. ANS/IEEE C37.20.1, Metal-Enclosed Low Voltage Power Circuit Breaker Switchgear.

I. ANSI/IEEE C37.27, Low-Voltage AC Non-Integrally Fused power Circuit Breakers (Using Separately Mounted Current Limiting Fuses), Application Guide.

J. ANSI/IEEE C57.13, Instrument Transformers, Requirements.

K. ANSI/NFPA 70, National Electrical Code.

L. IEEE C37.90.2 - 1987, Trial Use Standard Withstand Capability of Relay Systems to Radiated Electromagnetic Interference from Transceivers.

M. UL 10666, Low Voltage AC and DC Power Circuit Breakers Used in Enclosures.

N. UL 1558, Metal-Enclosed Low-Voltage Power Circuit Breaker Switchgear.

1.4 SUBMITTALS

A. Product Data: For each type of switchgear, circuit breaker, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each type of switchgear and related equipment.

1. Dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings. Include the following:

(a) Enclosure types and details.

(b) Nameplate legends.

(c) Bus configuration with size and number of conductors in each bus run, including phase, neutral, and ground conductors of main and branch buses.

(d) Current rating of buses.

(e) Short-time and short-circuit current rating of switchgear assembly.

(f) Utility company's metering provisions with indication of approval by utility company.

(g) UL listing for series rating of installed devices.

(h) Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

2. Wiring Diagrams: Diagram power, signal, and control wiring and differentiate between manufacturer-installed and field-installed wiring.

C. Coordination Drawings: Floor plans showing dimensioned layout, required working clearances, and required area above and around switchgear where pipe and ducts are prohibited. Show support locations, type of support, and weight on each support. Indicate field measurements.

D. Field Test Reports: Submit written test reports and include the following:

1. Test procedures used.

2. Test results that comply with requirements.

3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

E. Manufacturer's field service report.

F. Maintenance Data: For switchgear and components to include in maintenance manuals specified in Division 1. In addition to requirements specified in Division 1 Section "Closeout Procedures," include the following:

1. Routine maintenance requirements for switchgear and all installed components.

2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.

3. Time-current curves, including selectable ranges for each type of overcurrent protective device.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain switchgear through one source from a single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by Underwriters Laboratories.

C. Comply with NFPA 70, as amended by state and local codes.

D. Comply with UL 1558 and UL 1066.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver switchgear in sections of lengths that can be moved past obstructions in delivery path.

B. Store switchgear indoors in clean dry space with uniform temperature to prevent condensation. Protect switchgear from exposure to dirt, fumes, water, corrosive substances, and physical damage.

C. If stored in areas subjected to weather, cover switchgear to provide protection from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside switchgear; install electric heating (250 W per section) to prevent condensation.

1.7 PROJECT CONDITIONS

A. Installation Pathway: Remove and replace building components and structures to provide pathway for moving switchgear into place.

B. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:

1. Notify Architect not less than seven days in advance of proposed utility interruptions. Identify extent and duration of utility interruptions.

2. Indicate method of providing temporary utilities.

3. Do not proceed with utility interruptions without Architect's written permission.

1.8 COORDINATION

A. Coordinate layout and installation of switchgear and components with other construction that penetrates ceilings or is supported by them, including conduit, piping, equipment, and adjacent surfaces. Maintain required clearances for workspace and equipment access doors and panels.

1.9 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fuses: Six of each type and rating used. Include spares for potential transformer fuses and control power fuses.
2. Indicating Lights: Six of each type installed.
3. Touchup Paint: Three containers of paint matching enclosure finish, each 0.5 pint (250 mL).

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. ABB Low Voltage Systems Div.
2. Eaton/Cutler-Hammer
3. GE
4. Schneider Electric/Square D

2.2 EQUIPMENT SUMMARY INFORMATION

A. The low voltage metal enclosed integrated switchgear system lineup shall be engineered and fabricated to meet the specific project electrical distribution, protection and control requirements as detailed in this specification. The specific equipment lineup properties listed below.

B. Equipment construction shall house all live components in a grounded metal enclosure with a code gauge modular designed steel frame with removable plates. The overall lineup enclosure construction type shall be as Indoor type NEMA 1. The enclosure is intended for indoor use primarily to provide a degree of protection against contact with the enclosed equipment.

C. To facilitate the ease of equipment assembly and installation, the MAXIMUM equipment shipping split section width shall be 38 inches to provide individual vertical stacks, which will allow easier egress to the final location.

D. When shipped from the factory the packaging shall be standard domestic factory packaging (poly wrapped, cardboard/styrofoam cushions, etc.),

E. The switchgear lineup shall be rated and labeled to receive a power supply Line-to-of 480/277 volts, 3 phase, 4 wire, 60 hertz. System control power shall be derived from the line side of all sources feeding the switchgear.

F. The main bus in the switchgear lineup shall be made of copper and shall be rated as indicated on the drawings.

G. The overall short circuit value of the switchgear lineup shall be rated as indicated on the drawings. Under normal conditions, the overall short circuit value of the switchgear shall be a 30 cycle short circuit rating and shall not rely on any instantaneous, premature, discriminator, making-current-release function of a protective device to achieve the overall rating.

H. A ground bus shall be secured to each vertical section structure. It shall also extend the entire length of switchgear lineup and shall be equipped with a 4/0 terminal for connection to the building's ground system. The ground bus in the switchgear lineup shall be made of copper and shall be rated appropriately.

I. If provided, the copper neutral bus shall be mounted on stand off insulators to isolate it from ground. The equipment neutral bus shall be fully rated.

J. System shall be grounded and bonded as shown on the drawings. Where equipment needs to be considered as "Service Entrance Equipment" all applicable requirements of the National Electrical Code as interpreted by the local jurisdiction shall be followed.

K. The same material shall be used at the vertical-to-horizontal bus connections and at points where vertical bus connects to bus bars supplying power to circuit breaker compartments. All bus material and plating in the switchgear lineup shall be copper buses with full silver plating.

L. All bus hardware shall be high tensile strength zinc chromate plated steel. Split washers or similar shall be provided at all bus joints.

M. The vertical bus shall be held rigid in support structure of short circuit resistant, molded glass reinforced polyester bases to inhibit the spread of arcing faults. All bus bars shall be arranged to permit the addition of future additions.

N. The switchgear shall have rear cable terminal compartments. The cable bending space shall meet National Electrical Code requirements.

O. In all cases sufficient space shall be provided to accommodate conduit openings, cable entrance or bus entrances as indicated on the contract drawings or conductor schedules.

P. The lineup shall be painted using a two-step process. In step one, a light gray paint shall be applied using an epoxy electro-deposition process. In step two, the paint shall be over sprayed on the exterior surfaces. The final color of the equipment shall be ANSI 61 gray or similar.

2.3 EQUIPMENT OPTIONS – ELECTRICAL

A. Identification of the control wiring within the equipment lineup shall be provided with wire sleeves. To assist in tracing circuitry, the sleeves will identify the origin and destination of that specific wire/circuit. As the control circuitry in the lineup will tie into other control circuits and as there is a need for unique/individual/specific/non-repeating wire tags, the sleeves will follow “steel mill” configuration.

B. Wire terminals for the control wiring within the equipment lineup shall be special ring insulated terminals, and where ring terminals are used to connect C/T circuits.

C. Minimum wire size for the control wiring within the equipment lineup shall be a more robust No. 12 AWG, extra flexible, stranded, tinned-copper, type SIS cross-linked polyethylene, rated 600 volts, except for specific circuits requiring larger wire.

D. Wire terminals for the C/Ts (current transformers) within the equipment lineup shall be crimp-type, insulated ring terminals.

E. Minimum wire size for the C/Ts (current transformers) with 5 ampere secondary, within the equipment lineup, shall be No. 12 AWG, extra flexible, stranded, tinned-copper, type SIS cross-linked polyethylene, rated 600 volts.

F. Short circuit terminal blocks shall be provided for all current transformer connections. The screw terminals shall have no more the 2 wires under a single screw to allow field swapping of wires (6 screw block for 3 C/Ts with no neutral circuit / 8 screw block for 3 C/Ts with a neutral circuit. Short circuit terminal blocks are not required if the current transformers are provided with integral open circuit protection.

2.4 EQUIPMENT OPTIONS – MECHANICAL

A. The following general equipment options shall be provided:

1. A breaker door interlock is required as there is a need to prevent the compartment door from opening unless the breaker is in the TEST or DISCONNECT position.

2. Rear floor plates are required, provide metal plates in the bottom of the power cable compartment along the floor to seal off the compartment. The installer/contractor shall be responsible for punching the plates to provide access for the conduits.

3. Provide a test kit unless system is self-monitoring with an extensive diagnostic routine.

4. A remote racking mechanism is required, provide the standard local manual racking wrench as breaker can be racked in/out in front of the equipment with the door closed is required as there is a need to minimize arc flash opportunity. This will allow the operator rack a breaker in/out up to 30 feet away from the front of the equipment.

5. Provide an external test cabinet for the circuit breakers for testing the breaker charging, tripping and closing functions.

6. The equipment lineup needs a compact and integral system to lift the fully withdrawn circuit breakers off their rail assemblies. A set of hoist rails shall be provided on top of the switchgear lineup. The rail system shall be affixed to every vertical section that contains a circuit breaker cubicle. Additionally a hoist unit shall be supplied which will serve as the lifting mechanism. If required, a spreader-lifting unit shall be supplied for lifting every circuit breaker frame size contained in the lineup.

7. Section barriers consisting of metal and polyester-glass vertical barriers between sections shall be provided between all sections.

8. Drawout compartment shutters used to protect operators from accidental contact with breaker stabs when the breaker is withdrawn from its cubicle shall be provided on all breaker cubicles in the lineup.

9. The equipment line-up will rest on a traditional housekeeping pad to raise the equipment lineup up off the ground. This sub base shall be bolted to the standard equipment base frame

10. The following equipment certifications shall be provided:

11. A UL 1558 label shall be provided on the equipment verifying that the lineup meets all requirements of UL for metal-enclosed low voltage power circuit breaker switchgear.

12. The equipment shall be manufactured to meet the applicable requirements of the governing bodies cited in the REFERENCES section.

13. There is a requirement for a UL service entrance label. Provide all the modifications to make the lineup compliant with the SEL (incoming line isolation barriers, neutral connection to switchgear ground for solidly grounded wye systems, etc.

14. The following door, cover and latch requirements shall be provided:

15. The rear of the switchgear shall be provided with hinged rear-doors to allow easier access into the rear cable-compartment, in lieu of bolted covers. These doors shall be full height such that they will provide unobstructed access to the entire rear cable section.

16. Access to the rear compartment of the switchgear shall require rear door padlock provisions to provide secured access to the cable section of the equipment lineup.

17. Opening the rear doors shall be accomplished using a T-handle mechanism.

18. Securing the rear doors shall be accomplished using a three point catch to secure the door at the top, bottom and side.

19. Service into the rear sections shall be accomplished using rear door stops, this will allow the doors to be locked into to open position.

20. Locks on the rear section doors or panels shall be provided.

21. The switchgear front doors shall have ¼ turn latches with padlocking provisions to prevent unauthorized entry into the front compartment.

22. The equipment lineup shall be supplied with the following cable lugs, pull boxes and cable supports:

23. Conductors shall terminate into compression lugs – two-hole long barrel type shall be provided for every cable connection. Refer to the project drawings for quantity and size information.

24. The direction of the cables feeding / being fed from the equipment is bottom only or as detailed on the project drawings.

25. The switchgear lineup shall be provided with [rear cable space, all cables shall enter and exit using the manufacturer defined power cable conduit areas. No additional pull box accessory is required.

2.5 SPECIAL FUNCTIONALITY

A. Rovide the protective functions indicated on the drawings.

B. The following metering capability shall be supplied in the equipment lineup.

C. The BASIC metering package shall include the following metering functions and every breaker in the lineup shall contain these functions. The values listed below shall be displayed on the equipment lineup HMI

D. Amperes phase A, amperes phase B, amperes phase C, amperes of the neutral (on a 4 wire system)

E. Volts phase A-B, volts phase B-C, volts phase C-A

F. When the lineup is connected to a WYE system, these additional functions shall also be available - Volts phase A-N, volts phase B-N, volts phase C-N.

G. In addition to the metering functions included in the BASIC metering package, the following EXPANDED metering package shall be provided. The values listed below shall be displayed on the equipment lineup HMI. The specific metering parameters are listed below:

H. Positive Real Energy (+ watt-hours) – 3 phase total and per phase (on wye connected systems)

I. Negative Real Energy (- watt-hours) – 3 phase total and per phase (on wye connected systems)

J. Positive Reactive Energy (+ var-hours) – 3 phase total and per phase (on wye connected systems)

K. Negative Reactive Energy (- var-hours) – 3 phase total and per phase (on wye connected systems)

L. Apparent Energy (volt-ampere-hours) – 3 phase total and per phase (on wye connected systems)

M. Real Power (watts) – 3 phase total and per phase (on wye connected systems)

N. Reactive Power (vars) – 3 phase total and per phase (on wye connected systems)

O. Apparent Power (volt-amperes) – 3 phase total and per phase (on wye connected systems)

P. Power Factor (PF) – 3 phase total and per phase (on wye connected systems). Measurement shall be real power factor, not just fundamental.

Q. Minimum Power Factor (PF) – 3 phase total and per phase (on wye connected systems) with date and time

R. Maximum Power Factor (PF) – 3 phase total and per phase (on wye connected systems) with date and time.

S. The signaling/status information required on this project will mostly be provided via the system Ethernet interface. This open architecture (Modbus RTU/TCP-IP) interface provides a vast number of metering, status, alarm, etc. signals specifically related to the switchgear lineup; however, as there is a need to provide some specific discrete signals, a 64 point I/O (digital Input / digital Output) device shall also be incorporated into the lineup for this requirement.

T. Coordinate the total number of digital input points and the total number of digital output points with the Owner.

U. These discrete I/O points do not require I/O redundancy.

V. Provide software which shall be installed on a remote PC/laptop (installation and computer by others) and which shall have the following functionality.

W. USER INTERACTIVE software. Provide one USER INTERACTIVE software package.

X. The following diagnostics tools shall be supplied in the equipment lineup.

1. Standard sequence of event recording shall be provided. This feature will enable the user to view any trip, alarm, logged event, etc. The system will have unified time synchronization so that all recorded occurrences will be time stamped.

2. The waveform capture enhancement shall be provided. This feature will enable the user to view waveforms that are triggered from a trip, an alarm or a manual initiation. The specifics of the waveform capture are detailed below:

3. Current waveforms for phase A, phase B, phase C and neutral when the lineup is connected to a WYE power source.

4. Voltage waveforms for phases A-B, phases B-C, phases C-A and when the lineup is connected to a WYE power source, the additional voltage waveforms shall be provided – phase A-N, phase B-N, phase C-N.

5. The same waveform capture capability detailed above MUST be provided on every breaker (mains, ties, feeders) in the equipment lineup using a dedicated waveform capture meter on each circuit.

6. The system will be provided with 3 (three) copper 10/100 Base T user ports (RJ-45 female receptacle) as standard. The communications protocol for the system will be an open architecture Modbus RTU/TCP-IP. In addition to the standard copper connection ports, a fiber optic external communication port shall be provided.

7. As the equipment lineup shall have various network connections into and out of it for various monitoring, viewing, controlling, signaling, etc. capability; and as there is a need to restrict access into this communications environment, the manufacturer shall provide a Virtual Private Network (VPN) or firewall.

2.6 CIRCUIT BREAKER REQUIREMENTS

A. Use of, or substitution by, UL489 insulated case circuit breakers or molded case circuit breakers is unacceptable.

B. Each breaker shall be a 3-pole, electrically and mechanically trip free unit with self-aligning primary and secondary disconnecting contacts, arc quenchers, position indicator and the necessary hardware to mount on a drawout mechanism in the compartment.

C. All circuit breakers shall be draw-out type and the primary connections shall be fully silver-plated copper-to-copper.

D. For personnel safety considerations, it is preferred that a true closed-door draw out mechanism be employed to permit the circuit breaker to be moved from the connected to disconnected position without opening the cubicle door. If closed-door racking is not available, the manufacturer's quotation must note this exception to be considered as a possible acceptable alternative.

E. The draw out mechanism shall provide four distinct positions: connected, test, disconnected, and withdrawn. An indicator shall be provided to show the position status. The cubicle door shall be able to close when circuit breaker is in the connected, test or disconnect position.

F. Each circuit breaker compartment shall have grounded barriers at top, bottom, front and sides. Furnish each compartment with draw-out rails and the necessary secondary control contact points.

G. Padlocking provision shall permit locking the breaker in the test and disconnected positions while in the cubicle.

H. Grounding of the breaker frame to the switchgear steel frame shall be maintained throughout the travel of the draw out mechanism.

I. Each breaker cubicle shall be designed so that only the frame for which the cubicle was designed (or one with higher short circuit ratings or combination of higher short circuit and continuous current ratings) can be inserted. Devices of equal frame size shall be interchangeable.

J. Manual or electrical closing mechanisms shall use an energy storage spring between the operator and the breaker contacts. This spring shall provide a constant closing speed not influenced by operator speed or control power voltage level.

2.7 MAIN AND TIE CIRCUIT BREAKER REQUIREMENTS

A. The main breaker frame and function shall be as detailed below:

B. The breaker control shall be electrically operated type via a motor to charge the closing springs. Closing shall be accomplished by pressing a close push button. Opening shall be accomplished by pressing an open / trip push button. Manual charging of the closing springs may still be accomplished via the front mounted handle. The spring charging motor shall have a nominal control voltage rating of 120VAC @ 60Hz.

C. The main breaker compartment shall be provided with the options / requirements detailed below:

1. The main breaker shall be bottom fed.

2. A Service Entrance label and lineup modifications are required for the main device.

3. The power flow through this device shall be [Normal – in that power shall flow from the upper portion to the lower portion of the circuit breaker or as shown on the project drawings.

4. The compartment door shall be provided with a defeatable compartment door interlock to prevent inadvertent opening of the compartment door unless the breaker is in the disconnected position.

5. The compartment shall be equipped with a position switch (2 form “a” and 2 form “b” contacts) shall signal to the automatic throwover system if the breaker is in the racked-in or disconnected position.

6. The main breaker compartment cable connections shall be as detailed below:

7. The feed direction shall be as indicated on the drawings.

8. The neutral connection type shall be the same as the phase connections.

9. The following are the specific protective, signaling and control functions requirements that must be supplied with the main circuit breaker:
   (a) LONG TIME protection shall be provided with adjustable PICKUP and DELAY.

   (b) GROUND-FAULT protection is required and should be provided with adjustable PICKUP and DELAY. It should be provided with adjustable PICKUP and DELAY.

   (c) The GROUND-FAULT function must be non-defeatable as the equipment must be UL listed and labeled.

   (d) SHORT TIME protection shall be provided with adjustable PICKUP and DELAY.

   (e) INSTANTANEOUS protection shall be provided with adjustable PICKUP, but set to off. This function shall be a true adjustable with lo range settings (not with only high range or fixed high range).

   (f) To provide field coordination flexibility, either the SHORT-TIME or INSTANTANEOUS functions must be capable of being switched turned off.

10. As the breaker is electrically operated, the breaker closing springs will be charged via a spring charging motor. Control voltage/power of 120VAC @ 60 Hz shall be provided.

11. The breaker shall be capable of performing independent tripping functions. A 120VAC 60Hz shunt trip shall be provided on electrically operated breakers.

12. The breaker shall be provided with a bell alarm to provide an additional signal that the breaker tripped. This bell alarm shall be provided with a lockout function such that the breaker cannot be closed until the lockout has been reset.

13. The breaker shall be provided with network interlock. This accessory shall be a logic-operated mechanical interlock that will establish the breaker's ability to be closed. The network interlock shall be "SET" = breaker mechanism is in a trip-free status or "RESET" = breaker can be closed via a command over the communications network. This accessory requires an electrically operated breaker and cannot be provided when a bell alarm is installed as it provides similar functionality.

14. As there is a need to provide a preemptive alert of a critical breaker tripping (abnormal loading / above nominal ampere draw), the breaker shall be provided with the high current alarm option. The user adjustable pickup point shall send a signal when the breaker exceeds the established value]

15. The breaker shall be provided with a frequency and reverse power relay package. This relay package shall be capable of providing an alarm signal and/or tripping the breaker in the event that the power system experiences an over frequency situation, an under frequency situation or opposite flow of power.

16. The breaker shall be provided with the voltage relay package. This relay package shall be capable of providing an alarm signal and/or tripping the breaker in the event that the power system experiences an over voltage situation, an under voltage situation or a phase loss.

17. The instrumentation configuration shall be as follows:

    (a) CTs for each individual main circuit breaker shall be located on the line side of the breaker.

    (b) Key interlocking of the breaker is not required on this project and should not be provided.

2.8 FEEDER CIRCUIT BREAKER REQUIREMENTS

A. The feeder breaker frame and function shall be as detailed below:

B. The breaker control shall be electrically type via a motor to charge the closing springs. Closing shall be accomplished by pressing a close push button. Opening shall be accomplished by pressing an open / trip push button. Manual charging of the closing springs may still be accomplished via the front mounted handle. The spring charging motor shall have a nominal control voltage rating of 120VAC @ 60Hz.

C. The feeder breaker application shall be as a single device outgoing to a load.

D. The feeder breaker frame size shall be as shown on the project drawings.

E. The feeder circuit breaker is a non-fused style breaker. It has no open fuse lockout device, no integral fuse, nor does it have an associated fuse truck compartment.

F. The feeder breaker compartment shall be provided with the options / requirements detailed below:

1. The compartment connection to the top shall be a cable tap-off connection for the conductors to terminate to the main bus of the equipment.

2. A Service Entrance label and lineup modifications are not required for the feeder device.

3. The power flow through this device shall be Normal – in that power shall flow from the upper portion to the lower portion of the circuit breaker.

4. The compartment door shall be provided with a defeatable compartment door interlock to prevent inadvertent opening of the compartment door unless the breaker is in the disconnected position.

5. The compartment shall be equipped with a position switch (2 form “a” and 2 form “b” contacts) to communicate if the breaker is in the racked-in or disconnected position be equipped with a position switch (2 form “a” and 2 form “b” contacts) shall signal to the automatic throwover system if the breaker is in the racked-in or disconnected position.

6. Following are the specific protective, signaling and control functions requirements that must be supplied with the feeder circuit breaker.

   (a) LONG TIME protection shall be provided with adjustable PICKUP and DELAY.

   (b) GROUND-FAULT protection is required and should be provided with adjustable PICKUP and DELAY. It should be provided with adjustable PICKUP and DELAY.

   (c) The GROUND-FAULT function must be non-defeatable as the equipment must be UL listed and labeled.

   (d) SHORT TIME protection shall be provided with adjustable PICKUP and DELAY.

   (e) INSTANTANEOUS protection shall be provided with adjustable PICKUP. This function shall be a true adjustable with Io range settings (not with only high range or fixed high range).

(f) To provide field coordination flexibility, either the SHORT-TIME or INSTANTANEOUS functions must be capable of being switched turned off

(g) As the breaker is electrically operated, the breaker closing springs will be charged via a spring charging motor. Control voltage/power of 120VAC @ 60 Hz shall be provided].

(h) The breaker shall be capable of performing independent tripping functions. A 120VAC 60Hz shunt trip shall be provided on electrically operated breakers.

7. The breaker shall be provided with a bell alarm to provide an additional signal that the breaker tripped. This bell alarm shall be provided with a lockout function such that the breaker cannot be closed until the lockout has been reset].

8. The breaker shall be provided with network interlock. This accessory shall be a logic-operated mechanical interlock that will establish the breaker's ability to be closed. The network interlock shall be "SET" = breaker mechanism is in a trip-free status or "RESET" = breaker can be closed via a command over the communications network. This accessory requires an electrically operated breaker and cannot be provided when a bell alarm is installed as it provides similar functionality.

9. As there is a need to provide a preemptive alert of a critical breaker tripping (abnormal loading / above nominal ampere draw), the breaker shall be provided with the high current alarm option. The user adjustable pickup point shall send a signal when the breaker exceeds the established value]

10. The breaker shall be provided with a frequency and reverse power relay package. This relay package shall be capable of providing an alarm signal and/or tripping the breaker in the event that the power system experiences an over frequency situation, an under frequency situation or opposite flow of power.

11. The breaker shall be provided with the voltage relay package. This relay package shall be capable of providing an alarm signal and/or tripping the breaker in the event that the power system experiences an over voltage situation, an under voltage situation or a phase loss.

12. The instrumentation configuration shall be as follows:

13. CT's for each individual feeder circuit breaker shall be located on the load side of the circuit breaker.

2.9 ACCESSORIES

A. Accessory Set: Furnish tools and miscellaneous items required for circuit-breaker and switchgear test, inspection, maintenance, and operation.

1. Racking handle to manually move circuit breaker between connected and disconnected positions.

2. Portable test set for testing all functions of circuit-breaker, solid-state trip devices without removal from switchgear.

3. Relay and meter test plugs suitable for testing switchgear meters and switchgear class relays.

B. Circuit-Breaker Removal Apparatus: Portable, floor-supported, roller-base, elevating carriage arranged for moving circuit breakers in and out of compartments.

C. Storage for Manual: Include a rack or holder, near the operating instructions, for a copy of maintenance manual.

2.10 IDENTIFICATION

A. System Power Riser Diagrams: Depict power sources, feeders, distribution components, and major loads. Include as-built data for low-voltage power switchgear and connections as follows:

1. Frame size of each circuit breaker.

2. Trip rating for each circuit breaker.

3. Conduit and wire size for each feeder.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine elements and surfaces to receive switchgear for compliance with installation tolerances and other conditions affecting performance.

1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Anchor switchgear assembly to 4-inch ((100-mm)), channel-iron floor and attach by bolting.

1. Sills: Select to suit switchgear; level and grout flush into floor or concrete base.

B. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, brackets, and temporary blocking of moving parts from switchgear units and components.

3.3 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 16 Section "Electrical Identification."

B. Bus Diagram and Instructions: Frame and mount under clear acrylic plastic on the front of switchgear.

C. Operating Instructions: Printed basic instructions for switchgear, including control and key-interlock sequences and emergency procedures.

3.4 CONNECTIONS

A. Install equipment grounding conductors for switchgear with ground continuity to main electrical ground bus.

B. Tighten bus joints, electrical connectors, and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.5 FIELD QUALITY CONTROL

A. Prepare for acceptance tests as follows:

1. Test insulation resistance for each switchgear bus, component, connecting supply, feeder, and control circuit.

2. Test continuity of each circuit.

B. Manufacturer's Field Services: Engage a factory-authorized service representative to inspect field-assembled components, installation, and connection of switchgear, and to pretest and adjust switchgear components. Report results in writing.

C. Testing: After installing switchgear and after electrical circuitry has been energized, demonstrate product capability and compliance with requirements.

1. Perform each electrical test and visual and mechanical inspection indicated in NETA ATS. Certify compliance with test parameters.

a. Switchgear: Perform tests and inspections stated in NETA ATS, Section 7.1.

b. Circuit Breakers: Perform tests and inspections stated in NETA ATS, Section 7.6.

c. Protective Relays: Perform tests and inspections stated in NETA ATS, Section 7.9.

d. Instrument Transformers: Perform tests and inspections stated in NETA ATS, Section 7.10.

e. Metering and Instrumentation: Perform tests and inspections stated in NETA ATS, Section 7.11.

f. Ground-Fault Systems: Perform tests and inspections stated in NETA ATS, Section 7.14.

g. Battery Systems: Perform tests and inspections stated in NETA ATS, Section 7.18.

h. Surge Arresters: Perform tests and inspections stated in NETA ATS, Section 7.19.

i. Capacitors: Perform tests and inspections stated in NETA ATS, Section 7.20.

2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

D. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switchgear. Remove front and rear panels so joints and connections are accessible to portable scanner.

1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switchgear 11 months after date of Substantial Completion.

2. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

3. Record of Infrared Scanning: Prepare a certified report that identifies switchgear checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.6 ADJUSTING

A. Set field-adjustable, protective-relay trip characteristics.

3.7 CLEANING

A. On completion of installation, inspect interior and exterior of switchgear. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.

3.8 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions.

3.9 STARTUP SERVICES

A. Engage a factory-authorized service representative to perform startup service.

B. Verify that switchgear is installed and connected according to the Contract Documents.

C. Verify that electrical control wiring installation complies with manufacturer's submittal by means of point-to-point continuity testing. Verify that wiring installation complies with requirements in Division 16 Sections.

D. Complete installation and startup checks according to manufacturer's written instructions.

3.10 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain switchgear.

1. Train Owner's maintenance personnel on procedures and schedules for energizing and de-energizing, troubleshooting, servicing, and maintaining equipment and schedules.

2. Review data in maintenance manuals. Refer to Division 1 Section "Closeout Procedures."

3. Review data in maintenance manuals. Refer to Division 1 Section "Operation and Maintenance Data."

4. Schedule training with Owner, through Architect, with at least seven days' advance notice.

END OF SECTION 16430

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes service and distribution switchboards rated 600 V or less.

B. Related Sections include the following:

1. Division 16 Section "Enclosed Switches and Circuit Breakers" for overcurrent protective devices used in switchboards.

2. Division 16 Section "Fuses."

3. Division 16 Section "Selection of Overcurrent Devices" for overcurrent protection program.

4. Division 16 Section “Transient Voltage Suppression” for surge suppressors.

1.3 SUBMITTALS

A. Product Data: For each type of switchboard, overcurrent protective device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each switchboard and related equipment.

1. Dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings. Include the following:

(a) Enclosure types and details for types other than NEMA 250, Type 1.
(b) Bus configuration, current, and voltage ratings.
(c) Short-circuit current rating of switchboards and overcurrent protective devices.
(d) Descriptive documentation of optional barriers specified for electrical insulation and isolation.
(e) Mimic-bus diagram.

(f) Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

2. Wiring Diagrams: Power, signal, and control wiring.

C. Field Quality Control Test Reports: Including the following:

1. Test procedures used.

2. Test results that comply with requirements.

3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

D. Manufacturer's field service report.

E. Maintenance Data: For switchboards and components to include in maintenance manuals specified in Division 1. In addition to requirements specified in Division 1 Section "Contract Closeout," include the following:

1. Routine maintenance requirements for switchboards and all installed components.

2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.

3. Time-current curves, including selectable ranges for each type of overcurrent protective device.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain switchboards through one source from a single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by Underwriters Laboratories.

C. Comply with NEMA PB 2, “Deadfront Distribution Switchboards”.

D. Comply with NFPA 70, as amended by state and local codes.

E. Comply with UL 891.

F. Product Selection for Restricted Space: Drawings indicate space available for switchboards. Comply with code required or indicated clearances between switchboards and adjacent surfaces and other items and with space restrictions, including space indicated for future equipment.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver in sections of lengths that can be moved past obstructions in delivery path.

B. Store indoors in clean dry space with uniform temperature to prevent condensation. Protect from exposure to dirt, fumes, water, corrosive substances, and physical damage.

C. If stored in areas subjected to weather, cover switchboards to provide protection from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside switchboards; install electric heating (250-W per section) to prevent condensation.

D. Handle switchboards according to NEMA PB 2.1 and NECA 400.

1.6 PROJECT CONDITIONS

A. Installation Pathway: Remove and replace access fencing, doors, lift-out panels, and structures to provide pathway for moving switchboards into place.

B. Environmental Limitations: Rate equipment for continuous operation under the following conditions, unless otherwise indicated:

1. Ambient Temperature: Not exceeding 104 deg F (40 deg. C).

2. Altitude: Not exceeding 6600 feet (2000 m).

C. Service Conditions: NEMA PB2, usual service conditions, as follows:

1. Ambient temperatures within limits specified.

2. Altitude not exceeding 6600 feet (2000 m).

D. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:

1. Notify Architect not less than seven days in advance of proposed utility interruptions. Identify extent and duration of utility interruptions.

2. Indicate method of providing temporary utilities.

3. Do not proceed with interruptions of electric service without Architect's written authorizations.

1.7 COORDINATION

A. Coordinate layout and installation of switchboards and components with other construction, including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

1.8 EXTRA MATERIALS

A. Spare Fuses: Six spares of each type and rating of fuse and fusible devices used. Include spares for:

1. Potential transformer fuses.

2. Control power fuses.

3. Fuses and fusible devices for fused type current limiting circuit breakers.

4. Fuses for fusible switches.

B. Spare Indicating Lights: Six of each type installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the Work include, but are not limited to, the following:

1. Eaton Corp; Cutler Hammer Products

2. General Electric Co.; Electrical Distribution and Control Division.

3. Siemens Energy & Automation, Inc.

4. Square D Co.

2.2 MANUFACTURED UNITS

A. NEMA Class 1 type switchboard:

1. Main Devices: Fixed individually mounted.

2. Branch Devices: Panel and fixed individually

3. Nominal System Voltage: 480Y/277V.

B. Factory tests: Dielectric test, phase to phase and phase to ground, at twice the rated voltage plus 1,000 volts (1,500 volts minimum) for one minute. Date of test and the name and title of the individual certifying the test are indicated on a label affixed to the equipment.

1. Main Bus: As described hereinafter.

2. Switchboard arrangement shall be such that the lowest current carrying parts are at least 12 inches (30 cm) above finished floor, and the height shall be as required by space conditions, and no more than as indicated.

3. Service switches for fire pumps, emergency service, required standby power and optional standby power shall be painted fire red. Such switches shall be mounted in sections separated from the rest of the switchboard where local code enforcement authorities so require.

4. The neutral bus in switchboards containing a main service disconnect shall have, at an accessible point as close as practical to the incoming supply connection, a removable link section. The neutral bus shall be bonded to the ground bus hereinafter specified by means of a connection consisting of two paralleled 500 MCM copper insulated cables made on the line side of the removable link section.

5. "Spaces only" for overcurrent protection and switching devices shall be bussed for the maximum device that can be fitted into them.

6. Switchboard construction shall be such that where 100 percent rated overcurrent protection and switching devices have been specified such devices shall be able to carry 100 percent of their rated load continuously when mounted in its enclosure.

7. Fusible switch units shall incorporate fuse clips intended to prevent the use of improper fuses. Refer to specification section entitled "Selection of Overcurrent Devices" for fuse types. Modify or replace in field any incorrect fuse clips.

8. Enclosure: Steel. NEMA 250, Type 3R.

9. Enclosure Finish: Factory applied finish manufacture's standard gray finish over a rust inhibiting primer on treated metal surface.

10. Removable Hinged Rear Covers: Secured by captive thumb screws, for access to rear interior of switchboard.

11. Pull Box on Top of Switchboard: Provide where indicated or where required by installation conditions, and include the following features:

    (a) Adequate ventilation to maintain air temperature in pull box within same limits as switchboard.

    (b) Removable covers forming top, front, and sides. Top covers at rear shall be easily removable for drilling and cutting.

    (c) Bottom shall be of insulating, fire-resistant material with separate holes for cable drops into switchboards.

    (d) Cable supports shall be arranged to facilitate cabling, and adequate to support cables indicated including those for future installation.

12. Buses and Connections: Three-phase, four-wire except as otherwise indicated. Features shall be as follows:

    (a) Phase and Neutral Bus Material: Hard-drawn copper of 98 percent conductivity.

    (b) At load terminals of feeder breakers, provide silver-plated copper bus extensions equipped with pressure terminal connectors for outgoing circuit conductors.

    (c) Ground Bus: 1/4-inch by 3-inch (6mm by 75mm) minimum size, hard-drawn copper of 98 percent conductivity, and equipped with pressure connector terminations for feeder- and branch-circuit ground conductors.

    (d) Supports and Bracing for Buses: Adequate strength for indicated short-circuit currents.

    (e) Contact Surfaces of Buses: Silver plated.

    (f) Main Phase Buses, Neutral Bus, and Equipment Ground Bus: Uniform capacity the entire length of the switchboard main and distribution sections. Provide for future extensions from either end by means of bolt holes or other approved method and connecting links.

    (g) Neutral Buses: 100 percent of the ampacity of the phase buses except as indicated, equipped with approved pressure connector terminations for outgoing circuit neutral cables. Provide braced neutral bus extensions for busway feeders with neutral conductors.

13. Future Devices: Equip compartments with mounting brackets, supports, bus connections and appurtenances at full rating of device compartments.

2.3 TRANSIENT VOLTAGE SUPPRESSION DEVICES (TVSS’s)

A. Refer to Division 16 Section,“Transient Voltage Suppression” for devices.

2.4 SURGE ARRESTERS

A. Surge Arrester: Distribution class, metal-oxide-varistor type. UL listed for the purpose. One surge arrester for each ungrounded conductor.

1. Install in cable termination compartments and connect in each phase of incoming circuit ahead of any disconnecting device.

2. Coordinate rating with circuit voltage.

3. Comply with IEEE C62.11 and NEMA LA 1.

B. Comply with NFPA 70, Article 280 “Surge Arresters”.

C. Comply with NFPA 780, “Standard for the Installation of Lightning Protection Systems”.

1. Comply with UL 96A.

2.5 OVERCURRENT PROTECTIVE DEVICES (OCPDs)

A. Comply with requirements of Division 16 Section "Selection of Overcurrent Protective Devices" for types of OCPD’s indicated. Provide indicated features, ratings, characteristics, and settings.

B. Future Devices: Where provision for future overcurrent protective devices or space is indicated, equip compartments with mounting brackets, supports, bus connections, and necessary appurtenances, designed for the OCPD types and ampere ratings indicated for future installation of devices.

C. Fire Pump Devices: Include provision for locking in closed position.

2.6 INSTRUMENTATION

A. Instrument Transformers: NEMA Standard EI 21.1, IEEE for Instrument Transformers," and the following:

1. Metering: Include current transformers (and potential transformers if required) to permit non-revenue metering of each service switch not supplying a fire pump. Transformers shall have ratio and accuracy class suitable for connected meters, instruments and relays.

2. Control Power: Include control power transformer(s) if required by the instrumentation.

B. Multifunction Digital-Metering Monitors: For each set of metering instrument transformers specified above, provide a separate microprocessor-based unit suitable for three- or four-wire systems and with the following features:

1. Switch-selectable digital display of the following values with ANSI C12.20 and IEC 687 accuracy:

(a) Phase Currents, Each Phase and Neutral current.
(b) Phase-to-Phase Voltages, Three Phase.
(c) Phase-to-Neutral Voltages, Three Phase.
(d) Kilowatts.
(e) Kilovars.
(f) Power Factor.

(g) Frequency.
(h) Kilowatt Demand: demand interval programmable from 5 to 60 minutes.
(i) Accumulated Energy, Kilowatt Hours.
(j) Time stamped maximum and minimum readings for every measured parameter.

2. Mounting: Display and control unit flush or semiflush mounted in instrument compartment door.

3. Monitor shall provide multiple digital communications ports and support multiple open protocols.

(a) Standard RS-485 and RS-232 ports.
(b) Ethernet port as an available option.
(c) Internal modem as an available option.
(d) Modbus and DNP 3.0 open protocols as standard configurations. All instantaneous data, logged data, event data, power quality analysis and waveform information shall be available using these open protocols.

4. Monitor shall be equipped with non-volatile RAM for recoding logs; capable of storing 3 months of power demand data. Such data is accessible locally by downloading to a laptop computer, or remotely through RS-485 communications.

5. Monitor shall be programmable by software supplied by the meter manufacturer.

(a) Software shall have a user-friendly, Windows compatible interface.
(b) Software shall include capacity to program meter, download meter, and analyze downloaded data files.
(c) Software shall store all data in a ODBC compliant data base.

6. As manufactured by Power Management, Ltd; ElectroIndustries, or Cutler Hammer.

7. Ground fault current tripping of service disconnect devices larger than 800 amps shall be incorporated in the main switchboard(s) as described in the specification section titled "Selection of Overcurrent Protection Devices." Such tripping shall be as follows:

(a) It shall include all required current transformers and/or sensors, relays, power supplies, test provisions, miscellaneous items and interwiring. Such items may be integral with the overcurrent protection and switching device (OCD) and/or separately (factory) installed. Pickup and time delay settings shall be field adjustable, and shall be initially set in accordance with manufacturer's recommendations.

8. Where two stages of ground fault tripping have been specified for

incorporation in the main switchboard(s) and/or in downstream panelboards settings shall be such as to provide a fully coordinated system such that only the downstream device trips in response to ground faults downstream of it.

2.7 CONTROL POWER

A. General: Where required for electrically operated devices or ground fault relays, provide 120-V control circuits supplied through secondary disconnect devices from control power transformer.

B. Control Power Fuses: Include primary and secondary fuses for current-limiting and overload protection of transformer and fuses for protection of control circuits.

C. Control Wiring: Factory-installed, complete with bundling, lacing, and protection. Provide flexible conductors for No. 8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units.

2.8 RATINGS

A. Provide nominal system voltage, continuous main bus amperage, and short-circuit-current ratings as indicated.

B. Short circuit rating: Not less than 65,000 amps RMS symmetrical. Switchboard shall bear a manufacturer's label attesting thereto. If multiple labels are required to attest to complete compliance, such labels shall be provided. Compliance shall be on a "fully rated" rating basis.

C. Main bussing indicated on the drawings with an ampere designation shall be sized based on a rating of 1000 amps per square inch (155 amps per square centimeter). Where no designation is indicated, or where the sum of the service switches (switch sizes or circuit breaker frame sizes) exceeds the indicated ampere designation for the main bus, the main bus size shall be based on an ampacity equal to the sum of the service switches (except that it need not exceed 6 square inches (39 square centimeters) in cross section regardless of the indicated ampere designation. Where spaces for future service switches have been incorporated, the main bus sizing shall take this into account.

D. The size of bussing, from mains to line studs of devices, other than those in panelboard type sections shall be such that no section of bus shall have a rating less than the total of switch sizes or circuit breaker frame sizes which it supplies, if for (1) or (2) devices, nor less than 80 percent of the total if for (3) or (4) devices, nor less than 70 percent of the total if for more than (4) devices. In no case, however, shall it exceed the rating of the main bus. Bus ratings shall be based on current density of not more than 1000 amps per square inch (155 amps per square centimeter).

E. Where bussing is extended beyond the confines of the switchboards for ties to service connection points or ties between separately mounted switchboard sections it shall conform to all switchboard main bus requirements set forth above except that:-

1. It shall be sized based on a maximum current density of 500 amps per square inch (58 amps per square centimeter) subject to the limitation that it need not exceed 8 square inches (52 square centimeters) in cross section.

2. It shall have each of its bars wrapped with two half lapped layers of approved fireproofing tapes of types specifically manufactured for the purpose.

3. Its housing, for its full length, shall include on the inside a ground bar of at least 1-1/2 square inches (10 square centimeters) cross section or to which housing framing members are bonded. For ties between separately located switchboard sections, this ground bar shall be in addition to the switchboard ground bar hereinbefore specified.

2.9 ACCESSORY COMPONENTS AND FEATURES

A. Accessory Set: Include tools and miscellaneous items as required for overcurrent protective device test, inspection, maintenance, and operation.

B. Portable Test Set: Arranged to permit testing of all functions of solid-state trip devices without removal from switchboard. Include relay and meter test plugs suitable for testing switchboard meters and switchboard class relays.

C. Spare Fuse Cabinet: Suitably identified, wall-mounted, lockable, compartmented, steel box or cabinet. Arrange for wall mounting.

2.10 IDENTIFICATION

A. Mimic Bus: Continuously integrated mimic bus factory applied to front of switchboard. Arrange in single-line diagram format, using symbols and letter designations consistent with final mimic-bus diagram. Coordinate mimic-bus segments with devices in switchboard sections to which applied. Produce a concise visual presentation of principal switchboard components and connections.

1. Presentation Media: Painted graphics in color contrasting with equipment factory-finished background to represent bus and components, complete with lettered designations.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install switchboards and accessory items according to NEMA PB2.1.

B. Anchor each switchboard assembly to two 4-inch-minimum channel-iron sills arranged in accordance with manufacturer's recommendations. Attach by tack welding or bolting. Level and grout sills flush with switchboard mounting surface.

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from switchboard units and components.

D. Operating Instructions: Frame and mount printed, basic operating instructions for switchboards, including control and key interlocking sequences, and emergency procedures. Fabricate frame of finished wood or metal and cover instructions with clear acrylic plastic. Mount on the front of the switchboards.

3.2 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 16 Section "Electrical Identification."

B. Switchboard Nameplates: Label each switchboard compartment with engraved metal or laminated-plastic nameplate mounted with corrosion-resistant screws.

3.3 CONNECTIONS

A. Install equipment grounding connections for switchboards with ground continuity to main grounding electrode.

B. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.4 FIELD QUALITY CONTROL

A. Prepare for acceptance tests as follows:

1. Test insulation resistance for each switchboard bus, component, connecting supply, feeder, and control circuit.

2. Test continuity of each circuit.

B. Testing Agency: Engage a qualified independent testing agency to perform specified testing.

C. Testing: After installing switchboards and after electrical circuitry has been energized, demonstrate product capability and compliance with requirements.

1. Procedures: Perform each visual and mechanical inspection and electrical test indicated in NETA ATS, Sections 7.1, 7.5, 7.6, 7.9, 7.10, 7.11, and 7.14 as appropriate. Certify compliance with test parameters.

2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

D. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switchboard. Remove panels so joints and connections are accessible to portable scanner.

1. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

2. Record of Infrared Scanning: Prepare a certified report that identifies switchboards checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

A. Set field-adjustable switches and circuit-breaker trip ranges.

3.6 CLEANING

A. On completion of installation, inspect interior and exterior of switchboards. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.

END OF SECTION 16441

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Lighting and appliance branch circuit panelboards.

2. Power and distribution panelboards.

B. Related Sections include the following:

1. Division 16 "Selection of Overcurrent Devices" for overcurrent protection program.

2. Division 16 Section "Fuses".

3. Division 16 Section “Transient Voltage Suppression” for surge protection.

4. Division 16 Section “Lighting Control Panelboards Powerlink G3”.

1.3 DEFINITIONS

A. Overcurrent Protective Device (OCD) (OCPD): A device operative on excessive current that causes and maintains the interruption of power in the circuit it protects.

1.4 SUBMITTALS

A. Product Data: For each type of panelboard, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each panelboard and related equipment.

1. Dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings. Include the following:

(a) Enclosure types and details for types other than NEMA 250, Type 1.

(b) Bus configuration, current, and voltage ratings.

(c) Short-circuit current rating of panelboards and overcurrent protective devices.

(d) UL listing for series rating of installed devices where applicable.

(e) Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

C. Field Test Reports: Submit written test reports and include the following:

1. Test procedures used.

2. Test results that comply with requirements.

3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

D. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.

E. Operation and Maintenance Data: For panelboards and components to include in maintenance manuals specified in Division 1. In addition to requirements specified in Division 1 Section "Operation and Maintenance Data," include the following:

1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.

2. Time-current curves, including selectable ranges for each type of overcurrent protective device.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain panelboards, OCD’s, components and accessories through one source from a single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by Underwriters Laboratories Inc.

C. Comply with NEMA PB 1.

D. Comply with UL 50, 87, 486A, 869 and NEMA 250, AB1 and KS1.

E. Comply with NFPA 70 as amended by state and local codes.

1.6 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation under the following conditions, unless otherwise indicated:

1. Ambient Temperature: Not exceeding 104 degrees F (40 degrees C).

2. Altitude: Not exceeding 6600 feet (2000 m).

B. Service Condition: NEMA PB 1, usual service conditions, as follows:

1. Ambient temperature within limits specified.

2. Altitude not exceeding 6600 feet (2000 m).

1.7 COORDINATION

A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, and encumbrances to workspace clearance requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Panelboards and Accessories:

(a) Eaton Corp.; Cutler-Hammer Products.

(b) General Electric Co.; Electrical Distribution & Control Div.

(c) Siemens Energy & Automation, Inc.

(d) Square D Co.

2.2 MANUFACTURED UNITS

A. Factory tests: Dielectric test, phase to phase and phase to ground, at twice the rated voltage plus 1,000 volts (1,500 volts minimum) for one minute. Date of test and the name and title of the individual certifying the test shall be indicated on a label affixed to the equipment.

B. Enclosures: Flush- and surface mounted cabinets. NEMA PB 1, Type 1, to meet environmental conditions at installed location.

1. Outdoor Locations: NEMA 250, Type 3R.

2. Kitchen Areas: NEMA 250, Type 4X, stainless steel.

3. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.

C. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.

D. Finish: Manufacturer's standard enamel finish over corrosion-resistant treatment or primer coat.

E. Directory Card: With transparent protective cover, mounted inside metal frame, inside panelboard door.

F. Bus: Hard-drawn copper, 98 percent conductivity

G. Extra-Capacity Neutral Bus: Neutral bus rated 200 percent of phase bus and UL listed as suitable for nonlinear loads.

H. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment ground conductors; bonded to box.

I. Isolated Equipment Ground Bus: Adequate for branch-circuit equipment ground conductors; insulated from box.

J. Main and Neutral Lugs: Type suitable for use with conductor material.

K. Feed-through Lugs: Type suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.

L. Future Devices: Mounting brackets, bus connections, and necessary appurtenances required for future installation of devices.

M. Where wires or cables are used within panelboards to make up internal connections (factory installed or otherwise) such wire or cable shall have copper conductors only.

N. Where indicated or as required to assure ready accessibility of top switching and overcurrent device, they shall be arranged as multiple adjacent sections. A single overall cabinet shall be supplied for the multiple adjacent sections which constitute one panel. 1/4 inch (7 mm) minimum thickness plastic barriers having adequate angle iron framing support all around shall be included between sections. The entire assembly shall be such as to include wiring gutter space for each section as if it were an individual panelboard. Common bussing shall be arranged for adjacent sections unless there is indication that the individual sections are to be separately supplied. Sub-feed lugs with full capacity cable taps to adjacent panel sections will be accepted as the bussing method.

2.3 POWER OR DISTRIBUTION PANELBOARDS

A. Doors: Secured with vault-type latch with tumbler lock; keyed alike. Omit for fused-switch panelboards.

B. Main Overcurrent Protective Devices and Branch Overcurrent Protective Devices: as specified in Division 16, Section “Selection of Overcurrent Devices.”

C. Cabinet: width and a depth adequate for a three pole branch device equal in rating to the panel mains. In no case shall the cabinet be wider than 42 inches (106 cm) or deeper than 18 inches (46 cm).

2.4 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

A. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

B. Doors: Concealed hinges, secured with flush latch with tumbler lock.

C. Gutter space: adequate space for connecting to all active and spare branches.

D. Cabinet width: not to exceed 24 inches (61 cm).

E. Cabinet depth: not to exceed 6 inches (15 cm).

2.5 PANELBOARD BUSES

A. The neutral buses of 120/208 volt panels supplying "harmonic-rich" line-to-neutral loads shall have ampacities larger than those of the phase legs in such panels in accordance with the following criteria:

1. In no case shall the neutral bus ampacity of any panel supplied by a feeder with a neutral conductor which is larger than the phase conductors be less than the lesser of:

   (a) The ampacity of the neutral conductor of the feeder supplying the panel.

   (b) Twice the ampacity of the upstream overcurrent device protecting the feeder supplying the panel.

2. The above requirements for the sizing of panel neutral buses shall override any indications on the drawings that smaller neutral buses are acceptable.

3. Neutral buses shall be equipped with lugs capable of accepting single conductors (i.e., not paralleled) of an ampacity equal to the neutral bus rating (except where the neutral bus rating exceeds 400 amps).

4. If required by manufacturer in order to comply with increased neutral bus sizing criteria specified above, increase phase leg bussing, as well.

5. Refer to the light and power riser diagram or to other electrical drawings to determine which panels - if any - are supplied by feeders having "over-sized neutrals" and therefore require up-sizing of the panel neutral bus.

B. A ground bus shall be provided for each panel. The ground bus shall be insulated from the panelboard cabinet.

2.6 OVERCURRENT PROTECTIVE DEVICES

A. As described in Division 16 Section “Selection of Overcurrent Devices”.

2.7 ACCESSORY COMPONENTS AND FEATURES

A. Accessory Set: Include tools and miscellaneous items as required for overcurrent protective device test, inspection, maintenance, and operation.

B. Switch and fuse units incorporated as part of panelboards shall be equipped with factory installed rejection clips to restrict fuses to types specified in Division 16, Section "Selection of Overcurrent Devices." Modify or replace in field any incorrect fuse clips.

C. Provide "lock-on" clips for the toggle handles of 5 percent of the branches in all lighting and appliance panels. Apply these clips to circuits supplying clocks, fan coil units and others as directed in the field.

D. Furnish handle padlock attachments for 5 percent of the branches in lighting and appliance panels, and padlocks (with key) for 10 percent of these padlock attachments, but not less than 10 locks. Apply the padlock attachments to circuits (as directed in the field) for which the branch circuit device must be lockable in the "off" position in order to provide code-approved disconnect means.

2.8 PANELBOARD SHORT CIRCUIT RATINGS

A. Panelboards and Panelettes (load centers) shall bear U.L. labels attesting to the adequacy of the equipment to withstand and interrupt short-circuit currents not less than those available at their incoming terminals. Panels shall either be fully rated or shall be series rated in conjunction with integral or remote upstream devices in compliance with Division 16 Section “Selection of Overcurrent Devices”. U.L. labels shall include size and type of allowable upstream and branch circuit devices and series connected ratings.

B. Panelboard short circuit ratings shall comply with the coordination study per specification section 16055.

C. EMERGENCY SYSTEMS AND LEGALLY REQUIRED STANDBY SYSTEMS: Overcurrent devices shall be selected such that distribution system is selectively coordinated. Series rated devices shall not be used for distribution, regardless of any indication to the contrary. Short circuit rating of panelboards and devices shall be as required for a fully rated system. For lighting and appliance panelboards which are not available with integral main overcurrent devices, provide individually enclosed main device located adjacent to panel complete with interconnecting circuitry.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install panelboards and accessories according to NEMA PB 1.1.

B. Mount top of trim 74 inches (188 cm) above finished floor, unless otherwise indicated.

C. Mount plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish.

D. Install overcurrent protective devices and controllers.

1. Set field-adjustable switches and circuit-breaker trip ranges.

E. Install filler plates in unused spaces.

F. Stub four 1-inch (DN 25) empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch (DN 25) empty conduits into raised floor space or below slab not on grade.

G. Arrange conductors in gutters into groups and bundle and wrap with wire ties.

3.2 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 16 Section “Electrical Identification."

B. Create a directory to indicate installed circuit loads. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.

C. Panelboard Nameplates: Label each panelboard with engraved metal or laminated-plastic nameplate mounted with corrosion-resistant screws.

3.3 CONNECTIONS

A. Ground equipment according to Division 16 Section "Grounding and Bonding."

B. Connect wiring according to Division 16 Section "Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Prepare for acceptance tests as follows:

1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.

2. Test continuity of each circuit.

B. Perform the following field tests and inspections and prepare test reports:

1. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.5 for switches and Section 7.6 for molded-case circuit breakers. Certify compliance with test parameters.

2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

C. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes.

1. Measure as directed during period of normal system loading.

2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical 24-hour services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.

3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.

4. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.

D. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scanning of each panelboard. Remove panel fronts so joints and connections are accessible to portable scanner.

1. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

2. Record of Infrared Scanning: Prepare a certified report that identifies panelboards checked and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 CLEANING

A. In completion of installation, inspect interior and exterior of panelboards. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.

END OF SECTION 16442

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes dry-type distribution and specialty transformers rated 1000 V and less.

1.3 SUBMITTALS

A. Product Data: Include data on features, components, ratings, and performance for each type of transformer specified. Include dimensioned plans, sections, and elevation views. Show minimum clearances and installed devices and features. Also include kVA rating, frequency, primary and secondary voltages, % taps, polarity, impedance, k-factor, % regulation-no-load to full load, average temperature rise at 100% and 133% load, insulation rating and sound level.

B. Wiring Diagrams: Detail wiring and identify terminals for tap changing and connecting field-installed wiring.

C. Product Certificates: Signed by manufacturers of transformers certifying that the products furnished comply with requirements.

D. Field Test Reports: Indicate and interpret test results for tests specified in Part 3.

E. Maintenance Data: For transformers to include in the maintenance manuals specified in Division 1.

1.4 QUALITY ASSURANCE

A. Listing and Labeling: Provide transformers specified in this Section that are UL listed and labeled.

1. The Terms “Listed” and “Labeled”: As defined in NFPA 70, Article 100.

B. Comply with IEEE C2.

C. Comply with ANSI 57.76, ANSI/IEEE C57.12.01, NEMA ST20, TP-1 and TP-2, UL 486A, 506, 1561 and 1562.

D. Comply with NFPA 70.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit throughout periods during which equipment is not energized and is not in a space that is continuously under normal control of temperature and humidity.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the Work include, but are not limited to, the following:

1. Transformers:

(a) MagneTek, Inc.

(b) Olsun Transformers

(c) Square D; Groupe Schneider

(d) Acme

(e) Eaton/Cuttler-Hammer

(f) Siemens

2.2 TRANSFORMERS, GENERAL

A. Transformers: Factory-assembled and -tested, air-cooled units of types specified, designed for 60-Hz service.

B. Cores: Grain-oriented, nonaging silicon steel.

C. Coils: Continuous windings without splices except for taps.

D. Internal Coil Connections: Brazed or pressure type.

E. Enclosures: Class complies with NEMA 250 for the environment in which installed.

2.3 GENERAL-PURPOSE, DRY-TYPE TRANSFORMERS

A. Comply with NEMA Standard ST 20 and list and label.

B. Comply with NEMA Class 1 efficiency levels for Dry Type Distribution Transformers as tested and rated in accordance with NEMA Standard TP 1

C. Transformers: Two-winding type, 3-phase units using 1 coil per phase in primary and secondary.

D. Windings: Copper

E. Features and Ratings: As follows:

1. Enclosure: Indoor, ventilated

F. Insulation Class:

1. Insulation Temperature Rise: 115 deg C maximum rise above 40 deg C.

G. Taps: For transformers 3 kVA and larger, full capacity taps in high-voltage winding are as follows:

1. Six 2.5-percent taps, 2 above and 4 below rated high voltage.

H. K-Factor Rating: Comply with UL 1561 requirements for non-sinusoidal load current capability as noted below.

1. All transformers specifically identified as "K-Rated" shall be suitable for carrying continuously non-linear (i.e., non-sinusoidal) loads equal to 100% of their nameplate rating without exceeding an average temperature rise of 115°C. This suitability shall be based on loads having a "K-Factor" of 13, and shall apply regardless of the harmonic current distribution making up the "K-13" loading. These transformers shall comply with all of the requirements specified hereinbefore for transformers which are not K-Rated and additionally shall each comply with the following:

(a) It shall bear a UL label stating its suitability for K-13 loads.

(b) Its primary winding conductors shall be sized so as to limit temperatures to the values stipulated above taking into account the circulating currents produced by the 3rd, 9th and 15th harmonics.

(c) Its secondary winding neutral conductors and terminal shall be sized to have twice the ampacity of the phase conductors.

(d) Core and winding design shall be such as to minimize eddy current losses and to reduce the core flux density well below the saturation point to prevent core overheating caused by harmonic distortion.

(e) It shall be provided with an electrostatic shield between windings.

I. Mounting: Transformers up top and including 15 KVA shall be equipped with brackets suitable for wall mounting. Larger than 15 KVA, they shall be suitable for platform or floor mounting.

2.4 CONTROL AND SIGNAL TRANSFORMERS

A. Units comply with NEMA Standard ST 1, and are listed and labeled as complying with UL 506.

B. Ratings: Continuous duty. If capacity is not indicated, provide capacity exceeding peak load by 50 percent minimum.

C. Description: Self-cooled, 2-winding, dry type.

D. Enclosure: Suitable for the location where installed.

2.5 FINISHES

A. Indoor Units: Manufacturer's standard paint over corrosion-resistant pretreatment and primer.

2.6 SOURCE QUALITY CONTROL

A. Factory Tests: Design and routine tests conform to referenced standards.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with safety requirements of IEEE C2.

B. Arrange equipment to provide adequate spacing for access and for cooling air circulation.

C. Identify transformers and install warning signs according to Division 16 Section "Electrical Identification."

D. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not furnished, use those specified in UL 486A and UL 486B.

E. Wall mount transformers 15 KVA and less. Suspend transformers larger than 15 KVA and in sizes up to and including 75 KVA from the structure to overhead. Utilize trapeze type hanger arrangements for the purpose. Floor mount all transformers larger than 75 KVA.

F. Coordinate location of ceiling suspended transformers with building structure and with equipment in closet so as to insure accessibility and working clearances. If necessary, to so insure, floor mount transformers in lieu of suspending them. Modify closet layout accordingly.

G. Floor or wall supported transformers shall be resiliently isolated from the building structure by means of neoprene in shear isolators providing a minimum static deflection of 3/8 inch.

H. Ceiling supported transformers shall be resiliently suspended by means of neoprene in shear hanger rod isolators providing a minimum static deflection of 3/8 inch.

3.2 GROUNDING

A. Ground transformers and systems served by transformers according to Division 16 Section "Grounding."

3.3 FIELD QUALITY CONTROL

A. Test Objectives: To ensure transformer installation is operational within industry and manufacturer's tolerances, install according to Contract Documents, and suitable for energizing.

B. Test Labeling: Upon satisfactory completion of tests for each unit, attach a dated and signed "Satisfactory Test" label to the tested component.

C. Schedule tests and provide notification at least one week in advance of test commencement.

D. Report: Submit a written report of observations and tests. Report defective materials and workmanship.

E. Tests: Include the following minimum inspections and tests according to the manufacturer's instructions. Conform to IEEE C57.12.91 for test methods, and data correction factors.

1. Inspect accessible components for cleanliness, mechanical, and electrical integrity, for presence of damage or deterioration, and to ensure removal of temporary shipping bracing. Include internal inspection through access panels and covers.

2. Inspect bolted electrical connections for tightness according to manufacturer's published torque values or, where not available, those of UL standards 486A and 486B.

3. Insulation Resistance: Perform megohmmeter test of primary and secondary winding-to-winding and winding-to-ground.

(a) A minimum test voltage: 1,000 V d.c.

(b) Minimum insulation resistance: 500 megohms.

(c) Duration of Each Test: 10 minutes.

(d) Temperature Correction: Correct results for test temperature deviation from 20 deg C standard.

F. Test Failures: Correct deficiencies identified by tests and retest. Verify that equipment meets the specified requirements.

3.4 CLEANING

A. On completion of installation, inspect components. Remove paint splatters and other spots, dirt, debris. Repair scratches and mars on finish to match original finish. Clean components internally using methods and materials recommended by manufacturer.

3.5 ADJUSTING

A. After completing installation, cleaning, and testing, touch up scratches and mars on finish to match original finish.

B. Adjust transformer taps to provide optimum voltage conditions at utilization equipment throughout the normal operating cycle of the facility. Record voltages and tap settings to submit with test results.

END OF SECTION 16461

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes cartridge fuses, rated 600 V and less, for use in switches, panelboards, switchboards, controllers, and spare fuse cabinets.

1.3 SUBMITTALS

A. Product Data: Include dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings for each fuse type indicated.

B. Product Data: Include the following for each fuse type indicated:

1. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.

2. Let-through current curves for fuses with current-limiting characteristics.

3. Time-current curves, coordination charts and tables, and related data.

4. Fuse size for elevator feeders and elevator disconnect switches.

C. Maintenance Data: For fuses to include in emergency operation and maintenance manuals.

1. In addition to terms specified in Division 1 Section “Operation and Maintenance Data”, include the following:

(a) Let-through current curves fuses with current-limiting characteristics.

(b) Time-Current curve, coordination charts and tables, and related data.

1.4 QUALITY ASSURANCE

A. Source Limitations: Provide fuses from a single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with NEMA FU 1.

D. Comply with NFPA 70.

1.5 PROJECT CONDITIONS

A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F (4.4 deg C) or more than 100 deg F (38 deg C), apply manufacturer's ambient temperature adjustment factors to fuse ratings.

[1.6 COORDINATION

A. Coordinate fuse ratings with HVAC and refrigeration equipment nameplate limitations of maximum fuse size.

1.7 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged in original cartons or containers and identified with labels describing contents.

1. Fuses: Quantity equal to 10 percent of each fuse type and size, but not fewer than 3 of each type and size.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Cooper Bussman, Inc.

2. Eagle Electric Mfg. Co., Inc.; Cooper Industries, Inc.

3. Ferraz Shawmut.

2.2 CARTRIDGE FUSES

A. Characteristics: NEMA FU 1, nonrenewable cartridge fuse; class and current rating indicated; voltage rating consistent with circuit voltage.

2.3 SPARE FUSE CABINET

A. Cabinet: Wall-mounted, 0.05-inch-1.27-mm- thick steel unit with full-length, recessed piano-hinged door and key-coded cam lock and pull.
   1. Size: Adequate for storage of spare fuses specified with 15 percent spare capacity minimum.

   2. Finish: Gray, baked enamel

   3. Identification: "SPARE FUSES" in 1-1/2-inch (40-mm) high letters on exterior of door.

   4. Fuse Pullers: For each size fuse.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.

B. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 FUSE APPLICATIONS

A. Refer to Division 16, Section “Selection of Overcurrent Devices for Determination of Fuse Types for Installation Throughout the Distribution System.

3.3 INSTALLATION

A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

B. Install spare fuse cabinet[**s**].

3.4 IDENTIFICATION

A. Install labels indicating fuse replacement information on inside door of each fused switch.

B.

END OF SECTION 16491

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This section includes power, lighting, communications and alarm provisions for elevators.

1.3 QUALITY ASSURANCE

A. Comply with NFPA 70 for devices and installation.

B. Listing and Labeling: Provide products that are Underwriter's Laboratories listed and labeled for their applications and installation conditions and for the environments in which installed.

1. The Terms "Listed" and "Labeled": As defined in the National Electrical Code, Article 100.

PART 2 - PRODUCTS

Products shall be as specified in other Sections of Division 16.

PART 3 - EXECUTION

3.1 APPLICATION

A. In addition to the power feeder and disconnect switch at the entry to the room (whether incorporated in a power panelboard or individually mounted) for each elevator, as shown on the drawings, further electrical work is required as described hereinafter.

3.2 INSTALLATION

A. An additional disconnect switch shall be provided for any elevator where the hoist motor is not "in sight" of the disconnect switch (individual or in panelboard) located at the entry to the room. This switch shall be interposed in the feeder to the elevator controller at a suitable location approved as "in sight" by the authorities having jurisdiction.

B. For elevators supplied from panels not located in the elevator machine room, the disconnects switches located at the entry to the room shall be of the switch and fuse type regardless of any indication to the contrary on the drawings. Fuses shall be sized equal to those upstream of the switches.

C. For each hydraulic elevator, provide a relay (mounted adjacent to the elevator disconnect switch) with wiring so arranged as to prevent the normal “elevator lowering when power fails” sequenced during periods when the elevator controller is manually de-energized for maintenance or other purposes.

D. Unless exceeded by requirements shown on the drawings, or elsewhere in the specifications, provide equipment, circuitry and/or roughing for elevator appurtenances as follows:

1. For each elevator, provide a single circuit 20 amps, 120 volt supply including a fused padlockable disconnect switch located in the elevator machine room or machine space, from an emergency lighting/appliance panel to the elevator controller, numbered to correspond to the identifying number on the elevator cab.

2. For each elevator, provide a single circuit 20 amp, 120 volt supply from an emergency lighting/appliance panel to a “top of shaft trail cable outlet box”.

3. For each elevator, provide a vaportight switch, GFCI duplex receptacle and 100 watt lighting fixture with globe and guard. Devices shall be mounted in elevator pit at location as directed in field. Provide circuitry as required.

4. For each elevator provide a “run/by” switch, receptacle and light of type described above. Provide circuitry as required.

5. For each elevator provide secondary (sheave) level switch light and receptacle, complete with circuitry, as described hereinbefore.

6. For each elevator provide top of shaft communication and alarm facilities as follows:

   (a) Telephone outlet box, complete with 3/4" empty conduit to nearest telephone closet facility.

   (b) Fire protective alarm (FPA) system outlet box complete with cable for loudspeaker and intercom station (warden’s station) furnished as part of FPA system for installation in elevator cab. Cable should be run to nearest appropriate FPA system equipment cabinet.

   (c) Closed circuit TV (CCTV) outlet box at top of shaft, complete with 3/4" conduit extension to CCTV junction box located in elevator machine room as described hereinafter.

7. For the group controller in each electric hoist elevator machine room, provide a 30 amp, 3 phase, wire supply from the power panel supplying the elevators.

8. For each elevator machine room provide a single 20 amp, 120 volt emergency circuit to the elevator intercom panel (or to the group controller if there is not separate intercom panel).

9. Provide a fused disconnect switch, adjacent to the controller for each connection to a controller or group controller as described hereinbefore.

10. From each elevator shaft (including hydraulic elevators) provide empty conduit (intended for elevator communication, signaling and alarm) to the elevator dispatcher’s panel in accordance with the following:

    Up to (4) cars per shaft -- (2) 2 ½" conduits

11. For each elevator machine room provide a 2" empty conduit (intended for closed circuit TV cables) run to the concierges desk security office or elsewhere as directed by the Architect. Conduit shall terminate in CCTV junction box at both ends of run.

12. For each elevator machine room, provide ceiling fixed temperature 135°F heat detectors giving total coverage for the room. Provide similar detectors at the top of each elevator shaft. Connect the detectors together and into the fire alarm system. If any of the heat detectors goes into alarm, after a short, adjustable time delay, a signal shall be transmitted to shut down the power for all elevators served by the machine room. If any of the detectors at the top of the shaft goes into alarm, after a short, adjustable time delay, a signal shall be transmitted to shut down the power to all elevators in the bank. All elevator power shall be able to be re-energized from the fire command station. Provide appropriate electrically operated devices required for the elevator shut-down.

END OF SECTION 16496

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. Related Sections: The following Sections contain requirements that relate to this Section:

1. Division 16 Section “Basic Electrical Materials and Methods”.

2. Division 16 Section “Supporting Devices”.

3. Division 16 Section “Lighting Control Devices”.

4. Division 16 Section “Wiring Devices”.

1.2 SUMMARY

A. This Section includes interior and exterior light fixtures, emergency lighting units, exit signs, lamps, ballasts and accessories.

1.3 SUBMITTALS

A. For each type of light fixture, emergency lighting unit, or exit sign specified submit data on standard features and accessories, and the following:

1. Outline drawings indicating fixture dimensions.

2. Catalogue cuts for proposed lamps.

3. Performance data for proposed fluorescent and high intensity discharge ballasts.

4. Battery and charger data for emergency lighting units.

5. For air handling fixtures, submit air, thermal, and sound performance data. Provide certified results of independent laboratory tests indicating:

(a) Airflow as a function of pressure differential between plenum and occupied space.

(b) Noise criteria (NC) rating as a function of airflow.

(c) Heat transfer rate as a function of airflow (required for heat removal fixtures only).

B. For nonstandard fixtures, submit detailed shop drawings indicating dimensions, materials, weights, method of field installation and assembly, method of relamping and ballast access, and principal features.

C. Submit project-specific, factory-produced shop drawings for all fluorescent pendants and continuous fluorescent wall-slots. Drawings show housing lengths, joiners, supports, endcaps, corners, and unlighted end sections, as applicable, for all unique row lengths.

D. Submit dimming ballast compatibility certificates signed by the lighting control system manufacturer certifying that proposed dimming ballasts are compatible with proposed dimming systems.

E. Submit samples of fixtures as directed by Architect, Engineer, or Lighting Designer. Unless otherwise noted, all samples are provided with specified lamp(s) and ballast(s), and are equipped with a cord and plug for operation at 120V.

F. If shop drawings are submitted for a specific fixture type by a non-specified manufacturer, and approvals cannot be obtained by the third submission, then the proposed equipment will not be accepted and the specified equipment is furnished.

1.4 QUALITY ASSURANCE

A. Comply with NFPA 70 as amended by state and local codes.

B. Electrical Components of fixtures are listed and labeled by UL where applicable.

C. Provide fixtures and accessory components specified in this Section that are listed and labeled for their indicated use and installation conditions on Project.

1. Fixtures specified for installation in damp or wet locations are listed and labeled for use in such locations.

2. Fixtures specified for installation in insulated ceilings are IC-rated if insulation comes within 3 inches (76 mm) of sides of fixture housings, or within 6 inches (152 mm) of top of fixture housings.

3. Fixtures specified for installation in hazardous locations conform to UL 844.

4. Comply with UL 1570-1574.

D. The Terms "Listed" and "Labeled" are used here as per the definitions in the National Electrical Code, Article 100.

1.5 COORDINATION

A. For ceiling-mounted fixtures, coordinate fixtures, mounting hardware, and trim with ceiling system and other items, including work of other trades, which must be mounted on ceiling or in ceiling space.

B. Lighting fixtures, ballasts, lamps and other components meet or exceed the requirements of all applicable federal, state, and/or municipal energy codes.

C. Coordinate lamps and dimming ballasts with lighting control systems. Before ordering any equipment, verify with manufacturers that proposed dimming ballasts are compatible with proposed lighting controls, and that proposed lamps are compatible with proposed dimming ballasts.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with project requirements, fixtures that may be incorporated into the Work include, but are not limited to, the products specified in the Light Fixture Schedule. Where three or more manufacturers are indicated for each fixture type, no other manufacturers will be considered. Where one manufacturer is indicated for each fixture type, other manufacturers will be considered only if the engineer, architect, or lighting consultant can determine that the proposed equipment is equal to the specified equipment.

2.2 LIGHT FIXTURES AND FIXTURE COMPONENTS, GENERAL

A. Light fixtures and components are suitable for operation at the voltage of the building circuits to which they are connected.

B. Light fixtures are furnished complete with all appurtenances necessary for their proper operation, installation, and support.

C. Light fixtures conform to the following standards as applicable:
   1. Fluorescent Fixtures conform to UL 1570.

   2. Incandescent Fixtures conform to UL 1571.

   3. High Intensity Discharge (HID) Fixtures conform to UL 1572.

   4. Track-Lighting Systems conform to UL 1574.

   5. Exit Signs and emergency lighting fixtures shall conform to UL 924.

   6. Christmas-Tree and Decorative-Lighting Outfits conform to UL 588.

D. General Construction:

   1. Light fixtures are constructed with joints made only by means of welded, brazed, screwed, or bolted construction methods. Soldered joints will not

be permitted. No self-tapping screws, bled metal tapping methods, or rivets are employed for fastening any parts to or in any wireway or wiring chamber, for fastening any parts which must be removed to gain access to electrical components requiring service or replacing, or for fastening any electrical component or support for same.

2. All ferrous parts and supports, other than parts manufactured of stainless steel, are completely rustproofed after fabrication, and before finish coatings are applied. Rustproofing is by means of galvanizing, bonderizing, zinc plating, or by treatment with other industry standard rust-preventing processes providing rustproofing qualities equal to the processes mentioned above.

3. All screws, bolts, nuts and other fastening and latching hardware are cadmium or equivalent plated.

4. All metallic cast or extruded parts are close grained, sound, and free from imperfections or discolorations. Cast or extruded parts are rigid, true to pattern, and of ample weight and thickness. Cast or extruded parts are properly fitted, filed, ground buffed, and chased to provide finished surfaces and joints free of imperfection with all details or ornamentation brought out. Finished thickness of all cast parts is not less than 1/8 inch (3 mm).

5. Housings are constructed so that all electrical components are easily accessible and replaceable without removing housings from their mountings.

E. Sheet metal components are fabricated of steel, except as indicated. Form and support sheet metal to prevent warping and sagging.

F. Doors, frames, and other means of internal access operate smoothly, free from light leakage under operating conditions, and are arranged to permit relamping without use of tools, unless indicated otherwise on drawings. Arrange doors, frames, lenses, diffusers, and other pieces to prevent accidental falling during relamping and when secured in operating position.

G. Specular, semi-specular, and laminated silver metallized film reflectors have a non-iridescent coating when used with triphosphor fluorescent lamps. Reflectors have total hemispheric reflectances equal to or greater than the following values, unless otherwise noted:

1. White surfaces: 90 percent.

2. Specular surfaces: 87 percent.

3. Semi-specular surfaces: 84 percent.

4. Laminated silver metallized films: 95 percent.

H. Lenses and diffusers are 100 percent virgin acrylic, tempered annealed glass, or cast glass unless otherwise noted. When polycarbonate lenses are specified, they have a high resistance to yellowing or brittleness due to exposure to heat or ultraviolet radiation. Polystyrene lenses are not provided under any circumstances. Lens thickness is at least 1/8 inch (3mm), unless otherwise noted.

I. Fixture support components comply with Division 16, Section “Supporting Devices”

1. Single-stem hangers are 1/2-inch (13mm) minimum diameter steel or aluminum tubing with swivel ball fitting and ceiling canopy arranged so that stems hang vertically regardless of the angle of the surface they are mounted from. Finish of stems and canopy plates are same as fixture unless otherwise noted.

2. Hook hangers are only provided where specified. Hook hangers are integrated assemblies matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug.

3. Provide pendant mounting hardware for fixture types indicated as suitable for surface or pendant mounting in accordance with instructions issued during construction or as required by job conditions.

4. Wherever a fixture or its hanger canopy is applied to a surface mounted outlet box, a finishing ring (escutcheon) is utilized to conceal the outlet box.

5. Unless otherwise noted, linear fluorescent pendants are provided with aircraft cable supports, with power fed through a single straight white cord at one end of each row. When multiple independent feed points are required to satisfy circuitry requirements (e.g. when a continuous pendant row has both emergency and normal sections), locate feeds at two ends of row.

J. Lampholders are suitable for operation of the specified lamps and are set so that lamps are positioned in optically correct relation to all light fixture components. All lampholders comply with applicable requirements of ANSI C81. All fluorescent lampholders comply with UL 542.

K. Fixtures for use in damp or wet locations are suitably gasketed to prevent the entrance of moisture.

L. Air-handling fixtures comply with the following:

1. Sound Transmission Class (STC) conform to ADC Standard AD 63.

2. Supply Units are equipped with slots in one or both side trims and joined with air-diffuser boot assemblies specified in Division 15.

3. Heat Removal Units provide an air path through the lamp cavity to reduce heat buildup.

4. Air Return Units are equipped with slots on either side of the diffuser to allow air return through fixture into ceiling plenum.

5. Static Fixtures have slots blanked, with fixture appearance matching active

units.

M. Fixtures utilizing ballasts or transformers bear identification, by means of a label on the reflector or body, of the circuit voltage at which they are intended to operate.

N. All high intensity discharge (HID) fixtures circuited for emergency operation are equipped with auxiliary instant-on quartz systems (also known as a quartz restrike systems). Each fixture is equipped with an auxiliary quartz lamp that is automatically switched on whenever the fixtures are energized (e.g. after a temporary power interruption) and automatically switched off when the high intensity discharge lamp reaches approximately 60 percent light output. The control circuitry that switches the quartz lamp is integral to the fixture.

O. Recessed incandescent lighting fixtures incorporate integral thermal protection. When specified in fixture schedule, provide fixtures with special wattage reduction labels for compliance with energy codes.

P. All components of track lighting systems, including track, fittings, and fixtures, are provided by one manufacturer.

Q. Fixtures are complete with all internal wiring and all flexible conduits, pigtails, and the like necessary for external connections. All wire utilized for connections to or between individual lamp sockets and lamp auxiliaries (i.e., wires which do not constitute "through circuit" wiring) are minimum #16 gauge, industry standard, fixture wire suitable for the temperature, current and voltage conditions to which it is subjected. Internal wiring contains a minimum number of splices. Splices in internal wiring are made with approved insulated "wire nut" type mechanical connectors, suitable for the temperature and voltage conditions to which they are subjected.

R. Grounding-type flexible conduit is used for light fixture pigtails, and grounding type connectors are used for installing same. Include grounding conductor if upstream overcurrent device exceeds 20 amps.

S. Fluorescent fixtures specified with integral emergency battery packs (also known as emergency ballasts) incorporate a test switch and indicator light within the fixture. Test switch and indicator light are discretely located, so that they are not visible from ordinary viewing angles, but so that they are readily accessible to maintenance personnel, as required by code. Fixtures incorporating emergency battery packs are wired so that they may be switched or dimmed as part of their assigned lighting control zone without causing the battery pack to energize the lamps.

2.3 BALLASTS

A. General Requirements: Provide ballasts as indicated in the Light Fixture Schedule. If specific ballasts are not identified in the Light Fixture Schedule, provide ballasts as indicated below:

1. Fixtures with T-8 linear and U-bent fluorescent lamps are provided with instant start solid-state electronic ballasts.

2. Fixtures with T-5 standard and high-output linear fluorescent lamps are provided with programmed rapid start solid-state electronic ballasts.

3. Fixtures with T-5 "biax" 2G11-base lamps (excluding NEMA FT40W) are provided with programmed rapid start solid-state electronic ballasts.

4. Fixtures with 40W T-5 "biax" 2G11-base lamps (NEMA FT40W) are provided with instant start solid-state electronic ballasts.

5. Fixtures with T-4 "quad tube" and "triple tube" compact fluorescent lamps (NEMA CFQ and CFM) are provided with programmed rapid start solid-state electronic ballasts.

6. Fixtures with T-4 "twin tube" compact fluorescent lamps rated 13W or lower (NEMA CFT13W, CFT9W, and CFT7W) are provided with preheat electromagnetic ballasts.

7. Fixtures with HID lamps are provided with electromagnetic ballasts.

B. Instant start electronic ballasts comply with the following:

1. Ballasts for T-8 lamps operate from a 50/60 Hz input source of 108-305 volts with no damage to the ballasts.

2. Input current Total Harmonic Distortion (THD) does not exceed 10 percent.

3. Power factor is 0.90 or greater.

4. Provide 2-, 3-, or 4-lamp ballasts for multilamp fixtures wherever possible. All multilamp ballasts operate lamps in parallel, so that the loss of one or more lamps will not prevent the remaining lamps from functioning properly.

5. Ballast factor is between 0.85 and 0.90 for normal light output ballasts, and a minimum or 1.15 for high light output ballasts. Provide normal light output ballasts unless otherwise specified.

6. Ballasts operate lamps at a frequency of 40 kHz or greater.

7. Ballasts are UL 935 Listed, Class P, Type 1 Outdoor, and CSA certified where applicable.

8. Ballasts meet ANSI C82.11.

9. Ballasts comply with the Federal Communications Commission rules and regulations, Title 47 CFR Part 18 Non-Consumer Equipment for EMI (power line conducted) and RFI (radiated).

10. Ballasts withstand transients as specified in ANSI C62.41.

11. Ballasts have class "A" sound rating.

12. Lamp current crest factor is less than 1.7.

13. Ballasts operate lamps with no visible flicker (3 percent flicker index).

14. Ballasts start and operate T-8 lamps down to 0 degrees Fahrenheit (-18 degrees Celsius) or lower without shortening lamp life.

15. Ballasts are warranted for a minimum of five years. Ballast manufacturer provides replacement ballast and pays all labor costs associated with replacing ballasts that fail during their warranty period.

16. Ballasts are manufactured by one of the following: Universal "Triad HP", Osram/Sylvania "Quicktronic Professional", or Advance "Centium".

C. Programmed rapid start electronic ballasts comply with the following:

1. Ballasts are suitable for operation at the voltage and frequency of the building circuits to which they are connected, and sustained variations of +/- 10 percent (voltage and frequency) with no damage to the ballasts.

2. Input current Total Harmonic Distortion (THD) does not exceed 10 percent.

3. Power factor is 0.90 or greater.

4. Ballasts incorporate lamp shutdown circuitry for end of lamp life protection.

5. Ballast factor is between 0.95 and 1.05.

6. Ballasts operate lamps at a frequency of 40 kHz or greater.

7. Ballasts are UL 935 Listed, Class P, Type 1 Outdoor, and CSA certified where applicable.

8. Ballasts meet ANSI C82.11.

9. Ballasts comply with the Federal Communications Commission rules and regulations, Title 47 CFR Part 18 Non-Consumer Equipment for EMI (power line conducted) and RFI (radiated).

10. Ballasts withstand transients as specified in ANSI C62.41.

11. Ballasts have class "A" sound rating.

12. Lamp current crest factor is less than 1.7.

13. Ballasts start and operate lamps down to 0 degrees Fahrenheit (-18 degrees Celsius) or lower without shortening lamp life.

14. Ballasts are warranted for a minimum of five years. Ballast manufacturer provides replacement ballast, and pays all labor costs associated with replacing ballasts that fail during their warranty period.

15. Ballasts for T-5 standard and high output linear fluorescent lamps are manufactured by one of the following: Universal "Triad PRS", Osram/Sylvania "Quicktronic Professional PROStart", or Advance "Centium".

16. Ballasts for T-8 linear and U-bent fluorescent lamps be manufactured by one of the following: Universal "Accustart", Osram/Sylvania "Quicktronic Professional PROStart", or Advance "Mark V".

17. Ballasts for T-5 "biax" 2G11-base lamps (excluding NEMA FT40W) are manufactured by one of the following: Universal "Triad PRS" or Advance "Centium".

18. Ballasts for compact fluorescent lamps are manufactured by one of the following: Universal "Triad PRS", Osram/Sylvania "Quicktronic Professional CF Universal", or Advance "Smartmate".

D. Preheat electromagnetic compact fluorescent ballasts comply with the following:

1. Ballasts are encapsulated or potted to ensure maximum thermal and structural integrity.

2. Power factor is 0.90 or greater.

3. Ballast factor is between 0.95 and 1.05.

4. Ballasts are warranted for a minimum of two years. Ballast manufacturer provides replacement ballast and pays all labor costs associated with replacing ballasts that fail during their warranty period.

5. Ballasts are manufactured by Universal, Advance, or Robertson Worldwide.

E. Fluorescent dimming ballasts are solid-state electronic, providing smooth and continuous dimming over a minimum range of 100 percent light output to 1 percent light output unless connected to a daylight harvesting system. Ballasts connected to daylight harvesting systems dim lamps over a range of 100 percent light output to 10 percent light output. Dimming ballasts are endorsed by the manufacturer of the lighting control system to which they are connected. Unless otherwise noted, dimming ballasts are Lutron Hi-Lume or Lightolier PowerSpec HDF. Lutron ECO-10 ballasts area acceptable when connected to daylight harvesting systems.

F. Electromagnetic core and coil ballasts for HID lamps are combined with appropriate capacitors and starters, referred to collectively as ballast assemblies, for operation of specified lamps. Ballast assemblies comply with the following:

1. Ballast assemblies for HID lamps rated 100W or higher are constant-wattage autotransformer (CWA) type.

2. Ballast assemblies for HID lamps rated less than 100W are high-reactance autotransformer (HX-HPF) type.

3. Power factor is 0.90 or greater.

4. Ballast factor is 1.0.

5. Ballasts are designed in accordance with all applicable ANSI specifications, including ANSI C82.4.

6. Core and coil ballasts are designed with class "H" (180 degree Celsius) or higher insulation system and vacuum impregnated with resin.

7. Core and coil ballast and starter combinations are designed to provide reliable lamp starting down to negative 40 degrees Fahrenheit (negative 40 degrees Celsius) for High Pressure Sodium lamps and negative 20 degrees Fahrenheit (negative 30 degrees Celsius) for Metal Halide lamps.

8. Ignitors are designed to provide six months of lamp open circuit operation without failure.

9. Ballast assemblies are warranted for a minimum of two years. Manufacturer provides replacement ballast assembly, and pays all labor costs associated with replacing ballast assemblies that fail during their warranty period.

10. Ballasts are manufactured by Universal, Advance, Venture, or Robertson Worldwide.

G. Electronic ballasts for Metal Halide lamps comply with the following:

1. Ballasts operate from a 50/60 Hz input source of 108-305 volts with no damage to the ballasts.

2. Input current Total Harmonic Distortion (THD) does not exceed 15 percent.

3. Power factor is 0.90 or greater.

4. Ballast is thermally protected and incorporate lamp shutdown circuitry for end of lamp life protection.

5. Ballast factor is 1.0.

6. Ballasts operate lamps at a frequency of less than 200 Hz.

7. Ballasts comply with the Federal Communications Commission rules and regulations, Title 47 CFR Part 18 Non-Consumer Equipment for EMI (power line conducted) and RFI (radiated).

8. Ballasts have class "A" sound rating.

9. Lamp current crest factor is less than 1.5.

10. Ballasts are designed to provide reliable lamp starting down to negative 20 degrees Fahrenheit (negative 30 degrees Celsius).

11. Ballasts are warranted for a minimum of five years. Ballast manufacturer provides replacement ballast, and pays all labor costs associates with replacing ballasts that fail during their warranty period.

12. Ballasts are manufactured by one of the following: Aromat, or Advance "e-Vision".

H. Emergency battery packs (also known as emergency ballasts): An emergency battery pack incorporates a battery, charger, inverter circuit, and control electronics into one housing. Emergency battery packs comply with the following:

1. The emergency battery packs are designed to work in conjunction with the standard AC ballast in the fixture, and with an indicator light and test switch provided by the manufacturer of the battery pack.

2. Emergency battery packs are UL 924 Listed, and meet or exceed all National Electrical Code (NFPA-70) and Life Safety Code (NFPA-101) emergency lighting requirements.

3. Emergency battery packs incorporate maintenance-free Nickel-Cadmium (Ni-Cad) batteries.

4. Emergency battery packs are designed to provide a minimum of 90 minutes of emergency illumination. Provide longer duration when required by code.

5. Unless otherwise specified, emergency battery packs provide the following minimum initial lumen output per battery pack:

Lamp Type	Lumens
T-8, T-5	825
T-5 High Output	1,300
T-5 "biax" 2G11-base	825
Compact Fluorescent	650

6. Emergency battery packs are warranted for a minimum of five years. Manufacturer provides replacement emergency battery pack and pays all labor costs associated with replacing emergency battery packs that fail during their warranty period.

7. Emergency battery packs are manufactured by Iota Engineering or Bodine.

2.4 LAMPS

A. Conform to the ANSI C78 series that is applicable to each type of lamp.

B. Incandescent Lamps:

1. Unless otherwise noted, all 37W and 50W MR16 lamps are Osram/Sylvania "Tru-Aim IR". All other MR16 lamps are GE "Constant Color", Osram/Sylvania "Tru-Aim Titan", or Philips "Continuum Color" to insure consistent color. All MR16 lamps have an integral clear cover glass lens.

2. Unless otherwise noted, all 50W, 60W, and 100W PAR38 lamps, and all 50W PAR30 lamps incorporate "halogen infrared" technology, by the following manufacturers: GE "HIR", Philips "IRC", or Osram/Sylvania "IR".

C. Fluorescent lamps (T-8, T-5, and T-5 2G11-base):

1. Rated average life is a minimum of 20,000 hours when operated three hours per start. A shorter rated average life is acceptable for 50W and 55W T-5 2G11-base lamps only.

2. Unless otherwise noted, lamp phosphors are a composition that includes rare earth phosphors, with a correlated color temperature (CCT) of 3500 degrees Kelvin and a color rendering index (CRI) of not less than 80 (NEMA designation RE 835).

3. All T-8 linear fluorescent lamps are TCLP-compliant. Provide only GE "Ecolux", Philips "ALTO", or Osram/Sylvania "Ecologic" lamps.

D. Compact fluorescent lamps (T-4):

1. Rated average life is a minimum of 10,000 hours when operated at three hours per start.

2. Lamp phosphors are a composition that includes rare earth phosphors, with a correlated color temperature (CCT) of 3,000 degrees Kelvin and a color rendering index (CRI) of not less than 80 (NEMA designation RE 830).

3. T-4 "twin tube" compact fluorescent lamps rated 13W or lower (NEMA CFT13W, CFT9W, and CFT7W) have two-pin bases. Four-pin bases are required for all other compact fluorescent lamps.

E. Metal Halide Lamps:

1. Unless otherwise noted, all 20W, 39W, 50W, 70W, and 100W lamps incorporate ceramic arc tube technology. Provide only Philips "Mastercolor" or GE "CMH" lamps.

2. "Pulse Start" lamps, where specified, are combined with an appropriate ballast assembly to achieve manufacturer's rated performance.

3. Provide lamps with the highest color rendering index (CRI) available at the specified correlated color temperature (CCT). The minimum CRI for coated lamps is 70, and the minimum CRI for clear lamps is 65.

4. Provide “protected” or “open rated” lamps for use in all open fixtures.

F. All lamps are manufactured by GE, Osram/Sylvania, Philips, or Venture.

2.5 FINISHES

A. Provide metal finishes and paint colors as selected by the Architect.

B. Where a "Custom Color Finish" is specified but not identified, match sample provided by Architect.

C. Apply paint finishes over corrosion-resistant treatment or primer, free of streaks, runs, stains, blisters, and similar defects.

D. When the Architect issues no instructions pertaining to finishes, provide standard finishes as follows:

1. Unpainted non-reflecting surfaces are satin finished and coated with a baked-on clear lacquer to preserve the surface. Where aluminum surfaces are treated with an anodic process, the clear lacquer coating may be omitted.
2. Enamel coatings are of the high temperature baked-on type. Enamel reflecting surfaces are white with 90 percent minimum initial reflectance.
3. Porcelain enameled finishes meet or exceed R.L.M. standards in all respects.
4. Painted surfaces on fixtures for use outdoors or in damp locations exhibit weather and moisture resisting qualities equal to surfaces having epoxy based coatings. Unpainted aluminum are anodized.
5. Unpainted aluminum reflecting surfaces are treated with an Alzak or anodizing process to insure a permanent reflective surface with a minimum 87 percent reflectance.

2.6 EXIT SIGNS

A. Exit signs comply with the following:

1. Color, letter height, and letter stroke comply with all requirements of applicable state and local building codes.
2. Edge-lit exit signs which are visible from two directions have a mylar film inserted in the center of the panel, so that the letters are not visible from the wrong direction.

B. Self-illuminated exit signs equipped with integral battery packs for emergency operation comply with the following:

1. The battery is a sealed, maintenance-free nickel-cadmium battery with a five-year warranty.

2. The charger is solid-state, fully automatic with a sealed transfer relay.
3. When the input voltage drops to 80 percent of normal or below, the relay energizes the lamps from the battery pack, instead of the normal building power. When normal power is restored, the relay energizes the lamps from the normal building power, automatically recharge the battery, and float it on the charger.

2.7 LIGHTING CONTROLS

A. Lighting controls including - but not limited to - switches, occupancy sensors, photoelectric sensors, timeclocks, dimmers, relays, panels, and other miscellaneous devices are provided as part of the electric work.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Set light fixtures plumb, square, and level with ceiling, walls, and/or ground and secure according to manufacturer's written instructions and approved Shop Drawings. Support fixtures according to requirements of Division 16 Section “Supporting Devices”

B. Fixtures suspended more than 48 inches (1200mm) below ceiling are braced to limit swinging.

C. When lamps are not specified, lamp units according to manufacturer's instructions.

D. Light fixture locations shown on electrical drawings are approximate. For light fixtures in building equipment rooms (Mechanical, Electrical, Telecommunications, etc.), coordinate fixture locations with equipment, so that optimal light distribution is obtained, without obstructing access to equipment. All other light fixtures are installed as shown on architectural drawings, or as directed by Architect.

E. Fixtures with asymmetric light distributions are oriented as shown in manufacturer’s installation instructions. When manufacturer’s instructions are not clear, obtain clarification from Architect before proceeding with installation.

3.2 CONNECTIONS

A. Ground light fixtures. Tighten electrical connectors and terminals, including grounding connections, according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.3 FIELD QUALITY CONTROL

A. Inspect each installed fixture for damage. Replace damaged fixtures and components.

B. Verify normal operation of each fixture after fixtures have been installed and circuits have been energized with normal power source. Interrupt electrical power to demonstrate proper operation of emergency lighting.

C. Repair and retest malfunctioning fixtures and components. Repeat procedure until all units operate properly.

D. Replace fixtures that show evidence of corrosion during Project warranty period.

E. All permanent light fixtures used for temporary light during the construction phase for a period over 1,000 hours for fluorescent and HID sources and 100 hours for incandescent are relamped prior to acceptance.

3.4 ADJUSTING AND CLEANING

A. Clean fixtures after installation. Use methods and materials recommended by manufacturer.

B. Adjust aimable fixtures to provide required light intensities. Aim all adjustable fixtures after dark, under the direction of Lighting Consultant, Architect, or Engineer.

3.5 SPARES

A. Provide spare components to Owner at completion of project as outlined below:

1. For fluorescent, compact fluorescent, and HID lamps, provide one spare of each type for every ten installed (ten percent spare). Provide a minimum of four spare lamps of each type.

2. For incandescent lamps, provide one spare of each type for every five installed (twenty percent spare). Provide a minimum of four spare lamps of each type.

3. For ballasts and transformers, provide one spare of each type for every twenty installed (five percent spare). Provide a minimum of one spare of each type.

4. For interior lenses, louvers and diffusers, provide one spare of each type for every twenty-five installed (four percent spare). Provide a minimum of one spare of each type.

END OF SECTION 16500

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract including General and Supplementary Conditions and Division 1 Specification Sections, apply to this section.

B. Refer to Section 16010 – GENERAL ELECTRICAL.

C. Refer to Section 16714 “Communications Equipment Room Fittings.”

D. Refer to Section 16716 “Communications Backbone Cabling.”

E. Refer to Section 16717 “Communications Horizontal Cabling.”

1.2 SUMMARY

A. The premise distribution system shall be based on "open system architecture" (OSA) to create state of the art voice and data integrated wiring system to support voice and local area network application up to 1.2 Gbps (Gigabit per Second) data speed.

B. The premise distribution system shall include, but is not limited to the following major components:
1. Communication Equipment Room.
2. Communication Backbone Cabling.
3. Communication Horizontal Cabling
4. Network Electronics.

C. The premise distribution systems shall include all of the individual products certified for use by an approved manufacturer and an installer who is also certified by the same manufacturer to provide a complete system which shall carry a 25-year product and system assurance warranty. All certified components including but not limited to Category 6 and fiber optic cables, patch panels, modular jacks shall be tested and certified for individual applications. The manufacturer shall have design and installation rules for certified end-to-end applications and shall meet the standards as defined in the TIA 568 series industry standards. The manufacturer shall provide a certification or other similar means of assurance that the shop drawings as submitted includes all the components approval for end-to-end application and meets their design guidelines. The final system as installed shall be fully tested and warranted by the manufacturer for 25 years. Upon successful completion of the installation and subsequent inspection, the customer shall be provided with a numbered certificate from the manufacturing company registering the installation.

D. The premise distribution system shall support data rates of 1.2 Gbps (Gigabit per Second).

1.3 SUBMITTALS

A. Upon completion of installation, provide a letter to Owner, for Owner's signature, acknowledging that instruction in system operation has been received. One copy to be retained by Owner and one copy sent to Contractor for inclusion in O & M manuals.

B. Manufacturer's Instruction: As part of the O & M manual, provide copies of manufacturers' installation specifications for the major components of the system, including:
   1. UTP Cabling
      a. UTP Cables.
      b. Closet Termination Hardware and Equipment.
      c. Electrical Protection Hardware.
      d. Splice Hardware.
      e. Cross Connects.
   2. Fiber Optic Cabling System
      a. Fiber Optic Cables.
      b. Closet Termination Hardware and Equipment.
      c. Connectors.
      d. Inner Duct.
      e. Cross-Connect.
   3. Blown fiber tube system for backbone fibers.

1.4 QUALITY ASSURANCE

A. Contractor's Personnel Qualifications
   1. Project Manager: Provide project manager with a minimum of fifteen (15) years communications systems installation experience and a minimum of five (5) years experience as project manager. Prior to installation, submit resume and arrange an interview with the Owner, the Architect / Engineer, and the proposed project manager. During the course of the work, the Contractor shall replace project manager if requested by Owner or Architect / Engineer.
   2. Field Supervisor: Provide full-time Field Supervisor with a minimum of ten (10) years communications systems installation experience and a minimum of five (5) years experience as installation supervisor. Prior to installation, submit resume and arrange an interview with the Owner, the Architect / Engineer and the proposed field supervisor. The supervisor must be approved by the Owner and the Architect / Engineer. During the course of the work, the Contractor shall replace field supervisor if requested by Owner or Architect / Engineer.
   3. Installation Crews: Use trained, skilled journeyman installers for the installation, termination, and testing of the cabling system. Journeyman shall have a minimum of five (5) years experience installing communications cabling.
   4. Fiber Cable and Terminations: Placement, splicing, termination and testing of fiber optic cable shall be done by journeymen technicians specifically trained, certified and experienced in the installation of fiber optic systems. Cable pulling crews and testing crews shall have a minimum of 1 journeyman for each apprentice or helper. Splicing and termination to be done by journeyman only.

5. Telephone Cables and Terminations: Placement, splicing, termination, cross-connecting and testing of telephone cabling shall be done be journeymen technicians, specifically trained, certified and experienced in the installation of telephone cabling system. Cable pulling crews and testing crews shall have a minimum of 1 journeyman for each apprentice or helper. Splicing and termination to be done by journeymen only.

B. Refer to related sections for additional qualification requirements.

C. Final tests and inspection shall be demonstrated to the Architect / Engineer's and Owner's representatives. The Contractor shall supply personnel and required auxiliary equipment for this test without additional cost. Any deficiencies shall be corrected at no additional cost to the owner.

1.5 MAINTENANCE AND WARRANTY

A. Maintenance Service: The Contractor shall provide maintenance for one (1) year. Coordinate work with system vendors as necessary to ensure proper operation of all systems that utilize the cabling system. Maintenance service shall include:
   1. Testing: Provide testing as required for system initialization, operation, and trouble resolution.
   2. Trouble Resolution: Perform necessary investigations, reports, technical support, modifications and repairs or replacement of nonperforming components of the cabling system, to resolve operational problems. Support all systems that operate on cabling system. Provide service within twenty-four (24) hours of verbal notification.
   3. Repair or Replacement: Repair or replace any nonperforming component of the cabling system. Repair / Replacement schedule shall be approved by Owner. Components that are necessary for the operation of a system will be replaced immediately upon approval by the Owner.

B. The complete distribution wiring system shall be warranted for 1 year against defects in material and workmanship. The warranty period shall begin upon final acceptance of the system.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Refer to Sections 16714, 16716 and Section 16717 for detail product information.

PART 3 - EXECUTION

3.1 PLANNING

A. Prior to beginning of the work detail planning and lay-out shall be performed to meet schedule and ensure proper installation of cabling system.

B. Verify that the conduit and cable tray systems are properly grounded per NEC.

C. Refer to Sections 16714, 16716 and 16717 for additional requirements.

END OF SECTION 16710

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
1. Pathways.
2. UTP cable.
3. Optical fiber cabling.
4. Coaxial cable.
5. Cable connecting hardware, patch panels, and cross-connects.
6. Cabling identification products.

B. Related Sections:
1. Division 16 Section 16710 “Premise Distribution System.”
2. Division 16 Section 16714 “Communication Equipment Room Fittings.”
3. Division 16 Section 16717 “Communication Horizontal Cabling.”

1.3 DEFINITIONS

A. BICSI: Building Industry Consulting Service International.

B. CCITT

C. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.

D. EMI: Electromagnetic interference.

E. IDC: Insulation displacement connector.

F. LAN: Local area network.

G. RCDD: Registered Communications Distribution Designer.

H. TIPS

I. UTP: Unshielded twisted pair.

1.4 BACKBONE CABLING DESCRIPTION

A. Backbone cabling system shall provide interconnections between communications equipment rooms, main terminal space, and entrance facilities in the telecommunications cabling system structure. Cabling system consists of backbone cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for backbone-to-backbone cross-connection.

B. Backbone cabling cross-connects may be located in communications equipment rooms or at entrance facilities. Bridged taps and splitters shall not be used as part of backbone cabling.

1.5 PERFORMANCE REQUIREMENTS

A. General Performance: Backbone cabling system shall comply with transmission standards in TIA/EIA-568-B.1, when tested according to test procedures of this standard.

1.6 SUBMITTALS

A. Product Data: For each type of product indicated.
   1. For coaxial cable, UTP , and Optical Fiber cable include the following installation data for each type used:
      a. Nominal OD.
      b. Minimum bending radius.
      c. Maximum pulling tension.

B. Shop Drawings:
   1. System Labeling Schedules: Electronic copy of labeling schedules that are part of the cabling and asset identification system of the software.
   2. Cabling administration drawings and printouts.
   3. Wiring diagrams to show typical wiring schematics including the following:
      a. Cross-connects.
      b. Patch panels.
      c. Patch cords.
   4. Cross-connects and patch panels. Detail mounting assemblies, and show elevations and physical relationship between the installed components.
   5. Cable tray layout, showing cable tray route to scale, with relationship between the tray and adjacent structural, electrical, and mechanical elements. Include the following:
      a. Vertical and horizontal offsets and transitions.
      b. Clearances for access above and to side of cable trays.
      c. Vertical elevation of cable trays above the floor or bottom of ceiling structure.
      d. Load calculations to show dead and live loads as not exceeding manufacturer's rating for tray and its support elements.

C. Qualification Data: For Installer, qualified layout technician, installation supervisor, and field inspector.

D. Source quality-control reports.

E. Field quality-control reports.

F. Maintenance Data: For splices and connectors to include in maintenance manuals.

G. Software and Firmware Operational Documentation:
1. Software operating and upgrade manuals.
2. Program Software Backup: On magnetic media or compact disk, complete with data files.
3. Device address list.
4. Printout of software application and graphic screens.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
1. Layout Responsibility: Preparation of Shop Drawings Cabling Administration Drawings, and field testing program development by an RCDD.
2. Installation Supervision: Installation shall be under the direct supervision of Registered Technician, who shall be present at all times when Work of this Section is performed at Project site.
3. Testing Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

B. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
1. Flame-Spread Index: 25 or less.
2. Smoke-Developed Index: 450 or less.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. Telecommunications Pathways and Spaces: Comply with TIA/EIA-569-A.

E. Grounding: Comply with ANSI-J-STD-607-A.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project site.
1. Test optical fiber cable to determine the continuity of the strand end to end. Use optical loss test set.
2. Test optical fiber cable while on reels. Use an optical time domain reflectometer to verify the cable length and locate cable defects, splices, and connector, including the loss value of each. Retain test data and include the record in maintenance data.
3. Test each pair of UTP cable for open and short circuits.

1.9 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.10 COORDINATION

A. Coordinate layout and installation of telecommunications pathways and cabling with Owner's telecommunications and LAN equipment and service suppliers.

1.11 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Beginning with Substantial Completion, provide software support for two (2) years.

B. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within two (2) years from date of Substantial Completion. Upgrading software shall include operating system. Upgrade shall include new or revised licenses for use of software.
   1. Provide thirty (30) days' notice to Owner to allow scheduling and access to system and to allow Owner to upgrade computer equipment if necessary.

1.12 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Patch-Panel Units: One of each type.
   2. Connecting Blocks: One of each type.

PART 2 - PRODUCTS

2.1 PATHWAYS

A. General Requirements: Comply with TIA/EIA-569-A.

B. Cable Support: NRTL labeled for support of Category 6 cabling, designed to prevent degradation of cable performance and pinch points that could damage cable.
   1. Support brackets with cable tie slots for fastening cable ties to brackets.
   2. Lacing bars, spools, J-hooks, and D-rings.
   3. Straps and other devices.

C. Cable Trays:
   1. Refer to section 16127 for cable tray specifications

D. Conduit and Boxes: Comply with requirements in Division 16 Section "Raceways and Boxes." Flexible metal conduit shall not be used.

E. Outlet boxes shall be no smaller than 2 inches (50 mm) wide, 3 inches (75 mm) high, and 2-1/2 inches (64 mm) deep.

2.2 BACKBOARDS

A. Backboards: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches (19 by 1220 by 2440 mm). Comply with requirements in Division 6 Section "Rough Carpentry" for plywood backing panels.

2.3 UTP CABLE

A. Manufacturers: Subject to compliance with requirements of paragraph 1.2 C of Section 16710, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Belden CDT Inc.; Electronics Division.
2. Berk-Tek; a Nexans company.
3. CommScope, Inc.
4. Mohawk; a division of Belden CDT.
5. Nordex/CDT; a subsidiary of Cable Design Technologies.
6. Superior Essex Inc.
7. SYSTIMAX Solutions; a CommScope Inc. brand.
8. Tyco Electronics/AMP Netconnect; Tyco International Ltd.
9. or approved equal.

B. Description: 100-ohm, 100-pair or as shown on the drawings, UTP, formed into 25-pair binder groups covered with a gray thermoplastic jacket.
1. Comply with ICEA S-90-661 for mechanical properties.
2. Comply with TIA/EIA-568-B.1 for performance specifications.
3. Comply with TIA/EIA-568-B.2, Category 6.
4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:
   a. Communications, General Purpose: Type CM or CMG
   b. Communications, Plenum Rated: Type CMP, complying with NFPA 262.
   c. Communications, Riser Rated: Type CMR, complying with UL 1666.
   d. Communications, Limited Purpose: Type CMX.
   e. Multipurpose: Type MP.
   f. Multipurpose, Plenum Rated: Type MPP, complying with NFPA 262.
   g. Multipurpose, Riser Rated: Type MPR complying with UL 1666.

2.4 UTP CABLE HARDWARE

A. Manufacturers: Subject to compliance with requirements of paragraph 1.2 C of Section 16710, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. American Technology Systems Industries, Inc.
2. Dynacom Corporation.
3. Hubbell Premise Wiring.
4. KRONE Incorporated.
5. Leviton Voice & Data Division.
6. Nordex/CDT; a subsidiary of Cable Design Technologies.
7. Panduit Corp.
8. Tyco Electronics/AMP Netconnect; Tyco International Ltd.
9. or approved equal

B. General Requirements for Cable Connecting Hardware: Comply with TIA/EIA-568-B.2, IDC type, with modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of same category or higher.

C. Connecting Blocks: 110-style IDC for Category 6. Provide blocks for the number of cables terminated on the block, plus 25 percent spare. Integral with connector bodies, including plugs and jacks where indicated.

D. Patch Panel: Modular panels housing multiple-numbered jack units with IDC-type connectors at each jack for permanent termination of pair groups of installed cables.
   1. Number of Jacks per Field: One for each four-pair UTP cable indicated conductor group of indicated cables, plus 20% spares and blank positions adequate to suit specified expansion criteria.

E. Jacks and Jack Assemblies: Modular, color-coded, eight-position modular receptacle units with integral IDC-type terminals.

F. Patch Cords: Factory-made, 4-pair cables in 72-inch lengths; terminated with 8-position modular plug at each end.
   1. Patch cords shall have bend-relief-compliant boots and color-coded icons to ensure Category 6 performance. Patch cords shall have latch guards to protect against snagging.

2.5 OPTICAL FIBER CABLE

A. Manufacturers: Subject to compliance with requirements, provide products by the following:
   1. Sumitomo Air blown fiber system as shown on the drawings.
   2. Superior Essex.
   3. Allen Tel.
   4. Owens Corning.
   5. or approved equal.

B. Air Blown Fiber Installation (ABF)
   1. Furnish all labor, materials, tools and equipment to provide air blown fiber through compact cable infrastructure tubes. The air blown fiber equipment manufacture shall have at least 5 years of successful manufacturing of products with characteristics and capacities required by this section. All work shall comply with all applicable codes and standards.
   2. Provide rack and key lockable wall-mounted enclosures to terminate optical fibers from the air blown fiber bundles. The enclosures shall support and organize the fibers for termination. All accessories shall include, but are not limited to, breakout cables, tube couplings, plugs, caps and organizers. All couplings and caps shall be pressure rated to 200 psi.
   3. Install the system and all materials in accordance with manufacturer instructions.
   4. Provide all cable blowing heads and all equipment necessary for blowing the fiber in the tubes including any air or nitrogen gas required.
   5. All optical fibers shall be sufficiently free of surface imperfections and inclusions to meet the optical, mechanical and environmental

requirements of this specification. All fibers in the fiber bundles must be usable.

6. The fiber coating and buffer shall be removable with commercially available stripping tools without damaging the fiber.
7. All fibers in the bundles shall meet industry standards on attenuation, bandwidth and dispersion specifications outlined below. Attenuation specification shall be a maximum attenuation for each fiber over the entire operating temperature range of the cable.

C. Multimode Fiber 62.5/125 micron:

1. The multimode fiber utilized in the cable specified herein shall meet TIA/EIA standards. The 62.5/125 micron grade-index multimode optical fiber shall be plenum or non-plenum rated as required and shall meet the following optical characteristics:

850 nm:	maximum attenuation	3.5 dB/km
	typical attenuation	3.0 dB/km
	minimum LED bandwidth	200 MHz•km
	minimum Gigabit distance	500 m
1300 nm	maximum attenuation	1.0 dB/km
	typical attenuation	1.0 dB/km
	minimum LED bandwidth	600 MHz•km
	minimum Gigabit distance	1000m

2. The multimode fiber utilized in the cable specified herein shall conform to the following specifications:

Fiber Core:	62.5/125 micron
Cladding Diameter:	62.5 ± 3 μm
Fiber Identification:	Individually color-coded per TIA/EIA standards
Operating Temperature	-22°F to 158°F

D. Multimode Fiber 50/125 micron

1. The multimode fiber utilized in the cable specified herein shall meet TIA/EIA standards. The 50/125 micron grade-index multimode optical fiber shall be plenum or non-plenum rated as required and shall meet the following optical characteristics:

850 nm:	maximum attenuation	3.0 dB/km
	minimum bandwidth	500 MHz•km
1300 nm	maximum attenuation	1.0 dB/km
	minimum bandwidth	500 MHz•km

2. The multimode fiber utilized in the cable specified herein shall conform to the following specifications:

Fiber Core:	50/125 micron
Cladding Diameter:	50 ± 3 μm
Fiber Identification:	Individually color-coded per TIA/EIA standards
Operating Temperature	-40°F to 158°F

E. Singlemode Fiber:

1. The singlemode fiber utilized in the cable specified herein shall meet TIA/EIA standards. The 8.3 micron singlemode optical fiber shall be plenum or non-plenum rated as required and shall meet the following optical characteristics:

1310 nm:	maximum attenuation	.40 dB/km

1550 nm	maximum attenuation	.30 dB/km

F. Outdoor Fiber Tubes
1. The multi-tube shall have a polyethylene outer jacket with a dry tape waterblocked cable core and meet TIA/EIA standards. The operating temperature range shall be -40°F to 158°F. The minimum bending radius shall be 20 cable diameters during installation and 10 cable diameters after installation.

G. Indoor Plenum Rated Fiber Tubes
1. The plenum rated multi-tube shall have a low smoke, flame resistant outer jacket and meet TIA/EIA standards. The operating temperature range shall be 32°F to 122°F. The minimum bending radius shall be 20 cable diameters during installation and 10 cable diameters after installation. UL 910 OFNP Rated.

H. Tube Distribution Equipment
1. Provide rack and key lockable wall-mounted enclosures to terminate optical fibers from the air blown fiber bundles. The enclosures shall support and organize the fibers for termination. Include all accessories including but are not limited to breakout cables, tube couplings, plugs, caps and organizers. All couplings and caps shall be pressure rated to 200 psi.

2.6 OPTICAL FIBER CABLE HARDWARE

A. Manufacturers: Subject to compliance with requirements of paragraph 1.2 C of Section 16710, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. ADC.
2. American Technology Systems Industries, Inc.
3. Berk-Tek; a Nexans company.
4. Corning Cable Systems.
5. Dynacom Corporation.
6. Hubbell Premise Wiring.
7. Molex Premise Networks; a division of Molex, Inc.
8. Nordex/CDT; a subsidiary of Cable Design Technologies.
9. Optical Connectivity Solutions Division; Emerson Network Power.
10. Siemon Co. (The).

B. Cross-Connects and Patch Panels: Modular panels housing multiple-numbered, duplex cable connectors.

C. Patch Cords: Factory-made, dual-fiber cables in 72-inch lengths.

D. Cable Connecting Hardware:
1. Comply with Optical Fiber Connector Intermateability Standards (FOCIS) specifications of TIA/EIA-604-2, TIA/EIA-604-3-A, and TIA/EIA-604-12. Comply with TIA/EIA-568-B.3.
2. Quick-connect, simplex and duplex, Type SC connectors. Insertion loss not more than 0.75 dB.

3. Type SFF connectors may be used in termination racks, panels, and equipment packages.

E. Fiber SC Termination

1. The fiber building cable shall be terminated at the Fiber Interconnect cabinets, work area outlets and the communication equipment. The connector shall allow many reconnections with consistent repeatable performance.

F. Multimode

1. The only approved method of termination is the T568 SC multimode connector, manufacturer approved for the cable supplied. The connector shall be an approved component and meet the following requirements:

Mean Loss	0.3 dB
Standard Deviation	0.2 dB
Fiber OD	125 micron
Cable OD	3.0 mm
Loss Repeat	<0.3 dB, 200 insertions
Axial Load	30 lbs.
Temperature Stability	<0.3 dB Max. change
Connector Tip material	Ceramic
Connector Cap material	Poly Sulfone

2. The connector shall be installed on the fiber utilizing an approved tool kit. This kit contains all tools and instructions to mount the connector quickly and easily, utilizing the Manufacturer's installation procedures.

G. Single-mode

1. The only approved method of termination is the T568 SC single-mode connector, manufacturer approved for the cable supplied. The connector shall be an approved component and meet the following requirements:

Mean Loss	0.2dB
Standard Deviation	0.1dB
Fiber OD	125 micron
Cable OD	3.0 mm
Loss Repeat	<0.2dB, 200 insertions
Axial Load	30 lbs.
Temperature Stability	<0.3 dB Max. change
Connector Tip material	Zirconia Ceramic
Connector Cap material	Poly Sulfone

2. The connector shall be installed on the fiber utilizing an approved tool kit. This kit contains all tools and instructions to mount the connector quickly and easily, utilizing the Manufacturer's installation procedures.

2.7 FIBER JUMPER CABLES

A. Provide dual fiber FDDI grade fiber optic patch jumper assemblies for each fiber interconnect cabinet connector. Fiber cable shall be sized for the longest connection and installed in accordance with a schedule developed by the installation contractor. Fiber connectors shall match the fiber connector specifications. The patch cord fiber shall match the optical characteristics and specifications for the fiber cable specified and shall be covered by Aramid yarn and a jacket of flame-retardant PVC. The fiber patch cord shall meet the following specifications:

Minimum bend radius: 1.00 inch (2.54 cm)
Operating temperature: -4°F to 158°F (-20°C to 70°C)
Mated connector loss: 0.4 dB
minimum bandwidth: 200MHz•km at 850nm, 500MHz•km at 1300nm
maximum attenuation 3.4 dB/km @ 850 nm, 1.0 dB/km @ 1300nm
ISO 9001 Certified Manufacturer

B. Multimode Fiber Patch Cord Specifications
Mated Connector Loss μ = 0.3dB, s = 0.2dB
Operating temperature -4°F to 158°F (-20°C to 70°C)
Cable Retention: 50 lb. (220 N) minimum
Connection Repeatability: 0.20 dB maximum changer per 100 reconnects

C. Single-mode Fiber Patch Cord Specifications
Return Loss: -50 dB maximum
Mated connector loss μ = 0.35 dB, σ = 0.2dB
Cable Retention: 50 lb. (220 N) minimum
Connection Repeatability: 0.20 dB maximum changer per 200 reconnects

2.8 OPTICAL FIBER TELECOMMUNICATION OUTLETS

A. Provide fiber optical outlets with connectors as designated on the drawings or as required by the owner in single gang, dual gang, fiber optic and office furniture configurations. Provide recessed angled jacks to protect mating cables. Its modular design shall allow the adoption of interchangeable units for standard or customized voice, video, and data applications. The outlets shall include a decorative cover and all associated mounting hardware, modules, couplings, adapters and connectors. Submit color selection during submittal process, color to be determined after submittal. Covers shall come with recessed label space for circuit identifications.

B. All outlets shall be identified with clear permanent typewritten labels matching the numbering plan indicated on the drawings. Each module shall be labeled as to its current function using color-coded icons. All labeling must be permanent. All labeling shall be a minimum 12-point in size. All labeling systems shall be submitted to the owner’s representative for approval prior to fabrication. Labeling shall last as long as the system is in use.

C. Provide a surface mounted enclosure that attaches directly over the standard electrical box provided.

D. Provide a means of securing the fiber cables while maintaining a minimum bend radius of 30 mm. This fiber ring shall store a minimum of 1 meter of two-count fiber.

2.9 OPTICAL FIBER CABLE INTERCONNECT CABINET

A. All fiber cables will be terminated at the telecommunication room sites in fiber interconnect cabinets. These cabinets will be wall or rack mounted, as designated on the drawings, or as required by the Owner. Rack mounted interconnect cabinets shall be placed at the top of the rack and located to minimize jumper distance to electronic equipment. Provide quantities and configurations as shown on the drawings. The fiber interconnect cabinet shall be a certified component and will directly terminate the fiber building cable.

B. Assure that the connectors for each cabling segment are installed in the correct orientation to ensure proper polarity of an optical fiber system from the main cross-connect to the telecommunications outlet/connector.

2.10 OPTICAL FIBER CABLE SPLICES & CLOSURES

A. Fiber Splicing: All fiber cable splicing shall be performed using the fusion splicing method unless the client specifically requires the mechanical method.
   1. Fusion – The fiber splicer shall be fully automatic, calibrated and operate under the various jobsite environmental conditions (e.g. temperature, humidity, altitude, etc.) for all types of fiber cable being deployed.
      a. The mean splice loss for identical dispersion-unshifted singlemode fibers shall be equal to 0.05 dB at 1310 nm and 1550 nm wavelengths in accordance with CCITT G.652.
      b. The microprocessor controlled automatic positioning system shall control the fiber alignment, cleaning, gap-setting correlation of fiber positioning and fusing.
      c. The fusion splicer shall measure and document the splice losses of each splice. These measurements shall be saved and submitted to the TIPS Project Manager.
      d. Heat shrink protection shall be provided for each splice.
   2. Mechanical – The fiber splice module shall meet the following specifications:
      a. Accept 250 and 900 micron fibers.
      b. Reenterable, rearrangable and reusable.
      c. Require no polishing.
      d. Require no adhesives.
      e. No loose parts.
      f. Mean splice loss 0.15 dB.
      g. Blind splice loss < 0.5 dB.
      h. One part index matching gel.
      i. Stable from -40°C to 75°C.

B. Splice Closures: The fiber splice canister closure shall seal, bond, anchor and protect fiber optic cable splices. The splice closure shall be re-enterable with a maximum of six (6) cable entries in a butt-end configuration. The cap shall be capable of accepting additional cables without disturbing existing splices. The slice closure shall be designed for application required i.e., aerial, underground and direct buried. It shall use corrosion free construction designed for splicing fibers. The unit shall include slack storage and the splice trays required or the specific project installation.

2.11 COAXIAL CABLE

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Alpha Wire Company.
2. Belden CDT Inc.; Electronics Division.
3. Coleman Cable, Inc.
4. CommScope, Inc.
5. or approved equal.

B. General Coaxial Cable Requirements: Broadband type, recommended by cable manufacturer specifically for broadband data transmission applications. Coaxial cable and accessories shall have 75-ohm nominal impedance with a return loss of 20 dB maximum from 7 to 806 MHz.

C. RG-11/U: NFPA 70, Type CATV.
1. No. 14 AWG, solid, copper-covered steel conductor.
2. Gas-injected, foam-PE insulation.
3. Double shielded with 100 percent aluminum polyester tape and 60 percent aluminum braid.
4. Jacketed with sunlight-resistant, black PVC or PE.
5. Suitable for outdoor installations in ambient temperatures ranging from minus 40 to plus 85 C.

D. RG-6/U: NFPA 70, Type CATV or CMP
1. No. 16 AWG, solid, copper-covered steel conductor; gas-injected, foam-foam fluorinated ethylene propylene insulation.
2. Double shielded with 100 percent aluminum-foil shield and 60 percent aluminum braid.
3. Copolymer jacket.
4. Suitable for indoor installations.

E. NFPA and UL compliance, listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 1655 and with NFPA 70, "Radio and Television Equipment" and "Community Antenna Television and Radio Distribution" Articles.

2.12 COAXIAL CABLE HARDWARE

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Aim Electronics; a brand of Emerson Electric Co.
2. Leviton Voice & Data Division.
3. Siemon Co. (The).

B. Coaxial-Cable Connectors: Type BNC, 75 ohms.

2.13 GROUNDING

A. Comply with requirements in Division 16 Section "Grounding and Bonding" for grounding conductors and connectors.

B. Communication bonding and grounding shall be in accordance with the NEC, NFPA, NESC and ANSI/TIA/EIA Standard 607. Horizontal cables shall be grounded in compliance with ANSI/NFPA 70 and local requirements and practices. Horizontal equipment includes cross-connect frames, patch panels and racks, active telecommunication equipment and test apparatus and equipment.

C. #6 AWG stranded copper wire cable shall be extended between new ground bars located at each intermediate cross-connect and the building main service ground point. This ground conductor shall be utilized for equipment, termination, equipment rack and computer equipment grounding.

D. When the Telecommunications Rooms contains an electrical panel, provide a telecommunications ground utilizing a #6 AWG or larger bonding conductor that provides direct bonding between telecommunications rooms ground bar and connected to the telecommunications room electrical panel Alternating Current Equipment Ground buss ACEG.

E. All outside plant installation metallic cable elements shall be grounded at the building entry points and at each splice location.

2.14 TELECOMMUNICATIONS BACKBOARD

A. Provide ¾ inch, 8-foot high, void-free, A/C grade plywood as designated on the drawings or as required by the owner. Paint the backboard with one prime coat and one finish coat of fire retardant pearl gray latex paint. Securely fasten the backboard to the wall to support the weight of the attached cable, termination and equipment.

2.15 ELEVATOR CONDUIT & CABLE

A. Provide a one-inch conduit from the telecommunication room to each elevator control room. The conduit shall originate in the vicinity of the 110 termination blocks and terminate in a 4 square telecommunication outlet box, with a voice jack, located as requested by the elevator contractor. Provide one Category 5e cable from the outlet box to the voice demarcation point.

2.16 FIRE ALARM CONDUIT & CABLE

A. Provide a one-inch conduit from the telecommunication room located closest to the fire alarm panel. The conduit shall originate in the vicinity of the 110 termination blocks and terminate in a 4 square telecommunication outlet box, with two voice jacks, located as requested by the fire alarm contractor. Provide two Category 5e cables from the outlet box to the voice demarcation point.

2.17 T1 TRANSMISSION

A. Provide outlets and circuit wiring for video teleconferencing over T1 transmission lines. The T1 service cable shall be run from the T1 outlet jack to the T1 demarcation outlets as required by the project. Each T1 demarcation outlet shall include a RJ48X miniature, non-keyed, 8-position 8-wire jack for each T1 outlet. Each T1 outlet shall include two ANSI/TIA/EIA-568-B 8-position Category 5e modular voice (telephone) jacks connected to a four pair UTP Category 6 cable and one RJ48X miniature. This T1 jack shall be non-keyed, 8-position 8-wire jack with shorting bars on pins 1 & 4 and 2 & 5, 110 type terminations shall be connected to a four pair UTP Category 5e cable.

2.18 TELECOMMUNICATIONS BONDING BACKBONE

A. Provide a Telecommunications Bonding Backbone, as required, utilizing a #6 AWG or larger bonding conductor that provides direct bonding between equipment rooms and Telecommunications Rooms. This is part of the grounding and bonding infrastructure (part of the telecommunications pathways and spaces in the building structure), and is independent of equipment or cable. The permanent infrastructure for telecommunications grounding and bonding is independent of telecommunications cabling. The co-routed bonding conductor shall be installed as follows:

B. All cables entering a building must conform to the bonding and grounding requirements in the NEC.

C. Provide copper bonding conductors installed through every major telecommunications backbone pathway and directly terminated on a grounding busbar in each telecommunication equipment location. The grounding busbar shall be directly bonded to building structural steel and other permanent metallic systems. Each pathway bonding conductor must be terminated on the busbar. The busbar shall be visibly labeled and physically secured.

D. Route the #6 AWG copper conductor along each backbone cable route. Ensure a minimal separation between the conductor and the cables along the entire distance.

E. Bond each end at the nearest approved ground in the area that the associated cables terminate or are spliced/cross-connected onto other cables. Such bonding shall be done with a grounding busbar.

F. The main busbar shall be directly bonded to the electrical service grounding electrode system. The telecommunications grounding system shall be directly attached to the closet point in the building’s electrical service grounding system.

G. Telecommunication installers shall use the grounding busbars as the local approved ground. Backbone cabling shall be bonded at each sheath opening. All metallic cable trays shall be grounded.

H. Provide telecommunications bonding connections in accessible locations. Make all bonding connections with listed bolts, crimp pressure connectors, clamps, or lugs. Multiple grounding busbars placed in the building shall be directly bonded with a #6 AWG copper conductor.

I. Bonding conductors shall be routed with a minimum number of bends. The bends placed in the conductor shall be swiping.

2.19 PUBLIC AREA TELEPHONES

A. Provide a one-inch conduit from the telecommunication room located closest to each public area telephone location. The conduit shall originate in the vicinity of the 110 termination blocks and terminate in a 4 square telecommunication outlet box, with a voice jack, for each telephone. The telephone outlet box shall be located at a height that will permit the installation of both normal and ADA handicapped mounts without exposure of the telephone outlets for either location. Provide one Category5e cable from each outlet box to the voice demarcation point.

2.20 IDENTIFICATION PRODUCTS

A. Comply with TIA/EIA-606-A and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers. Use Panduit Ultimate ID Network Labeling System or equal.

2.21 SOURCE QUALITY CONTROL

A. Factory test cables on reels according to TIA/EIA-568-B.1.

B. Factory test UTP cables according to TIA/EIA-568-B.2.

C. Factory test multimode optical fiber cables according to TIA/EIA-526-14-A and TIA/EIA-568-B.3.

D. Cable will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 ENTRANCE FACILITIES

A. Coordinate backbone cabling with the protectors and demarcation point provided by communications service provider.

3.2 WIRING METHODS

A. Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, desks. Conceal raceway and cables except in unfinished spaces.
   1. Install plenum cable in environmental air spaces, including plenum ceilings.
   2. Comply with requirements for raceways and boxes specified in Division 16 Section "Raceways and Boxes."

B. Wiring within Enclosures: Bundle, lace, and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

3.3 INSTALLATION OF PATHWAYS

A. Cable Trays: Comply with NEMA-VE-2 and TIA/EIA-569-A.

B. Comply with requirements for demarcation point, pathways, cabinets, and racks specified in Division 16 Section "Communications Equipment Room Fittings." Drawings indicate general arrangement of pathways and fittings.

C. Comply with TIA/EIA-569-A for pull-box sizing and length of conduit and number of bends between pull points.

D. Comply with requirements in Division 16 Section "Raceways" for installation of conduits and wireways.

E. Install manufactured conduit sweeps and long-radius elbows whenever possible.

F. Pathway Installation in Communications Equipment Rooms:
1. Position conduit ends adjacent to a corner on backboard where a single piece of plywood is installed, or in the corner of room where multiple sheets of plywood are installed around perimeter walls of room.
2. Install cable trays to route cables if conduits cannot be located in these positions.
3. Secure conduits to backboard when entering room from overhead.
4. Extend conduits 3 inches (76 mm) above finished floor.
5. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.

G. Backboards: Install backboards with 96-inch (2440-mm) dimension vertical. Butt adjacent sheets tightly, and form smooth gap-free corners and joints.

H. Air Blown Optical Fiber Cable: Install the system and all materials in accordance with manufacturer’s instructions.
1. Do not install the fiber until fiber tube cable system is complete
2. Do not exceed manufacturer’s maximum bending radius on tubes and fiber bundles.
3. All spare strands shall be installed into spare splice trays, unless otherwise indicated on drawings.

3.4 INSTALLATION OF CABLES

A. Comply with NECA 1.

B. General Requirements for Cabling:
1. Comply with TIA/EIA-568-B.1.
2. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."
3. Install 110-style IDC termination hardware unless otherwise indicated.
4. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
5. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches (760 mm) and not more than 6 inches (150 mm) from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
6. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
7. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Use lacing bars and distribution spools.
8. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove

and discard cable if damaged during installation and replace it with new cable.

9. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
10. In the communications equipment room, install a 10-foot- (3-m-) long service loop on each end of cable.
11. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.

C. UTP Cable Installation:
1. Comply with TIA/EIA-568-B.2.
2. Do not untwist UTP cables more than 1/2 inch (12 mm) from the point of termination to maintain cable geometry.

D. Optical Fiber Cable Installation:
1. Comply with TIA/EIA-568-B.3.
2. Cable may be terminated on connecting hardware that is rack or cabinet mounted.

E. Open-Cable Installation:
1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend UTP cable not in a wireway or pathway, a minimum of 8 inches (200 mm) above ceilings by cable supports not more than 60 inches (1524 mm) apart.
3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

F. Outdoor Coaxial Cable Installation:
1. Install outdoor connections in enclosures complying with NEMA 250, Type 4X. Install corrosion-resistant connectors with properly designed O-rings to keep out moisture.
2. Attach antenna lead-in cable to support structure at intervals not exceeding 36 inches (915 mm).

G. Group connecting hardware for cables into separate logical fields.

H. Separation from EMI Sources:
1. Comply with BICSI TDMM and TIA/EIA-569-A recommendations for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
   a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches (127 mm).
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches (300 mm).
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches (610 mm).

3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
   a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches (64 mm).
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches (150 mm).
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches (300 mm).
4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
   a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches (76 mm).
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches (150 mm).
5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches (1200 mm).
6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches (127 mm).

3.5 FIRESTOPPING

A. Comply with requirements in Division 7 Section "Through-Penetration Firestop Systems."

B. Comply with TIA/EIA-569-A; Annex A, "Firestopping."

C. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.6 GROUNDING

A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.

B. Comply with ANSI-J-STD-607-A.

C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 2-inch (50-mm) clearance behind the grounding bus bar. Connect grounding bus bar with a minimum No. 4 AWG grounding electrode conductor from grounding bus bar to suitable electrical building ground.

D. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

3.7 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA/EIA-606-A. Comply with requirements for identification specified in Division 16 Section "Electrical Identification."
   1. Administration Class: 3.

2. Color-code cross-connect fields and apply colors to voice and data service backboards, connections, covers, and labels.

B. Comply with requirements in Division 9 Section "Interior Painting" for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.

C. Paint and label colors for equipment identification shall comply with TIA/EIA-606-A for Class 3 level of administration including optional identification requirements of this standard.

D. Comply with requirements in Division 16 Section "Communications Horizontal Cabling" for cable and asset management software.

E. Cable Schedule: Install in a prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.

F. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, backbone pathways and cables, entrance pathways and cables, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors.

G. Cable and Wire Identification:
   1. Label each cable within 4 inches (100 mm) of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
   2. Each wire connected to building-mounted devices is not required to be numbered at device if color of wire is consistent with associated wire connected and numbered within panel or cabinet.
   3. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 feet (4.5 m).
   4. Label each terminal strip and screw terminal in each cabinet, rack, or panel.
      a. Individually number wiring conductors connected to terminal strips and identify each cable or wiring group being extended from a panel or cabinet to a building-mounted device with name and number of particular device as shown.
      b. Label each unit and field within distribution racks and frames.
   5. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.

H. Labels shall be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in TIA/EIA 606-A, for the following:

I. Cables use flexible vinyl or polyester that flexes as cables are bent.

3.8 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Testing Requirements
1. Testing shall be performed after all components have been labeled and prior to system cutover. Test results shall meet or exceed manufacturer documentation data. All test equipment shall utilize the latest firmware and software recommended by the manufacturer. All test equipment shall be calibrated, tested and certified within one year of the commencement of the project testing. Otherwise, follow the manufacturer recommendations.
2. Telecommunications Bonding Backbone (TBB) Testing shall verify the integrity of all bonding connections and compliance to the NEC.
3. All cables and termination hardware shall be 100% tested for defects in installation and to verify cabling system performance under installed conditions according to the requirements of ANSI/TIA/EIA-568-B (B.1, B.2, and B.3). All pairs of each installed cable shall be verified prior to system acceptance. Any defect in the cabling system installation including but are not limited to cable, connectors, feed through couplers, patch panels, and connector blocks shall be repaired or replaced in order to ensure 100% usable conductors in all cables installed. All cables shall be tested in accordance with this document, the ANSI/TIA/EIA standards, the manufacturer's requirements and BICSI Standards. If any of these are in conflict, the contractor shall bring any discrepancies to the attention of the project team for clarification and resolution. Verify proper grounding at service entrance and at all surge suppression devices.

C. Tests and Inspections:
1. Visually inspect UTP and optical fiber jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with TIA/EIA-568-B.1.
2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
3. Test UTP copper cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross-connection.
   a. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-B.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
4. Optical Fiber Cable Tests:
   a. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-B.1. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
   b. Link End-to-End Attenuation Tests:

1) Horizontal and multimode backbone link measurements: Test at 850 or 1300 nm in 1 direction according to TIA/EIA-526-14-A, Method B, One Reference Jumper.
2) Attenuation test results for backbone links shall be less than 2.0 dB. Attenuation test results shall be less than that calculated according to equation in TIA/EIA-568-B.1.

c. OTDR (Optical Time-Domain Reflectometer).
1) Fiber testing shall be performed on all fibers in the completed end to end system.
2) Testing shall consist of a bidirectional end to end OTDR trace performed per TIA/EIA 455-61. The system loss measurements shall be provided at 850 and 1300 nanometers for multimode fibers and 1310 and 1550 for single mode fibers. The OTDR shall be used only to determine the length and the attenuation of that cable. A power meter shall be used to determine the overall link attenuation, including connectors.
3) Any link not meeting the requirements of the standard shall be brought into compliance by the Contractor, at no charge to the Owner.
4) Provide both hard copy and PDF copy on CD-ROM to the A/E for approval.

D. Data for each measurement shall be documented. Data for submittals shall be printed in a summary report that is formatted similar to Table 10.1 in BICSI TDMM, or transferred from the instrument to the computer, saved as text files, and printed and submitted.

E. Remove and replace cabling where test results indicate that they do not comply with specified requirements.

F. End-to-end cabling will be considered defective if it does not pass tests and inspections.

G. Prepare test and inspection reports.

3.9 SYSTEM ACCEPTANCE

A. Upon completion of the aforementioned tests and before system acceptance, sample system operations shall also be performed with contractor provided test equipment and documentation to verify that the system is operational and ready for acceptance. Testing shall be performed on a sample basis (10% of installed outlets) on various portions of the network as determined by the A/E. The test shall be performed by the contractor, and witnessed by the A/E or owner's representative.

END OF SECTION 16716

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
1. Pathways.
2. UTP cabling.
3. Multi-user telecommunications outlet assemblies.
4. Cable connecting hardware, patch panels, and cross-connects.
5. Telecommunications outlet/connectors.
6. Cabling system identification products.
7. Cable management system.

B. Related Sections:
1. Division 16 Section 16710 “Premise Distribution System.”
2. Division 16 Section "Communications Backbone Cabling" for voice and data cabling associated with system panels and devices.
3. Division 16 Section "Communication Equipment Room fittings" for voice and data cabling systems.

1.3 DEFINITIONS

A. BICSI: Building Industry Consulting Service International.

B. Consolidation Point: A location for interconnection between horizontal cables extending from building pathways and horizontal cables extending into furniture pathways.

C. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.

D. EMI: Electromagnetic interference.

E. IDC: Insulation displacement connector.

F. Ladder Cable Tray: A fabricated structure consisting of two longitudinal side rails connected by individual transverse members (rungs).

G. LAN: Local area network.

H. MUTOA: Multi-user telecommunications outlet assembly, a grouping in one location of several telecommunications outlet/connectors.

I. Outlet / Connectors: A connecting device in the work area on which horizontal cable or outlet cable terminates.

J. RCDD: Registered Communications Distribution Designer.

K. UTP: Unshielded twisted pair.

1.4 HORIZONTAL CABLING DESCRIPTION

A. Horizontal cable and its connecting hardware provide the means of transporting signals between the telecommunications outlet/connector and the horizontal cross-connect located in the communications equipment room. This cabling and its connecting hardware are called "permanent link," a term that is used in the testing protocols.
   1. TIA/EIA-568-B.1 requires that a minimum of two telecommunications outlet / connectors be installed for each work area.
   2. Horizontal cabling shall contain no more that one transition point or consolidation point between the horizontal cross-connect and the telecommunications outlet / connector.
   3. Bridged taps and splices shall not be installed in the horizontal cabling.
   4. Splitters shall not be installed as part of the optical fiber cabling.

B. A work area is approximately 100 sq. ft. (9.3 sq. m), and includes the components that extend from the telecommunications outlet/connectors to the station equipment.

C. The maximum allowable horizontal cable length is 295 feet (90 m). This maximum allowable length does not include an allowance for the length of 16 feet (4.9 m) in the horizontal cross-connect to the workstation equipment.

1.5 PERFORMANCE REQUIREMENTS

A. General Performance: Horizontal cabling system shall comply with transmission standards in TIA/EIA-568-B.1, when tested according to test procedures of this standard.

1.6 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings:
   1. System Labeling Schedules: Electronic copy of labeling schedules that are part of the cabling and asset identification system of the software.
   2. Cabling administration drawings and printouts.
   3. Wiring diagrams to show typical wiring schematics, including the following:
      a. Cross-connects.
      b. Patch panels.
      c. Patch cords.
   4. Cross-connects and patch panels. Detail mounting assemblies, and show elevations and physical relationship between the installed components.

5. Cable tray layout, showing cable tray route to scale, with relationship between the tray and adjacent structural, electrical, and mechanical elements. Include the following:
   a. Vertical and horizontal offsets and transitions.
   b. Clearances for access above and to side of cable trays.
   c. Vertical elevation of cable trays above the floor or bottom of ceiling structure.
   d. Load calculations to show dead and live loads as not exceeding manufacturer's rating for tray and its support elements.

C. Samples: For workstation outlets, jacks, jack assemblies, in specified finish, one for each size and outlet configuration and faceplates for color selection and evaluation of technical features.

D. Qualification Data: For Installer, qualified layout technician, installation supervisor, and field inspector.

E. Source quality-control reports.

F. Field quality-control reports.

G. Maintenance Data: For splices and connectors to include in maintenance manuals.

H. Software and Firmware Operational Documentation:
   1. Software operating and upgrade manuals.
   2. Program Software Backup: On magnetic media or compact disk, complete with data files.
   3. Device address list.
   4. Printout of software application and graphic screens.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
   1. Layout Responsibility: Preparation of Shop Drawings, Cabling Administration Drawings, and field testing program development by an RCDD.
   2. Installation Supervision: Installation shall be under the direct supervision of Registered Technician who shall be present at all times when Work of this Section is performed at Project site.

B. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
   1. Flame-Spread Index: 25 or less.
   2. Smoke-Developed Index: 450 or less.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. Telecommunications Pathways and Spaces: Comply with TIA/EIA-569-A.

E. Grounding: Comply with ANSI-J-STD-607-A.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project site.
   1. Test each pair of UTP cable for open and short circuits.

1.9 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.10 COORDINATION

A. Coordinate layout and installation of telecommunications pathways and cabling with Owner's telecommunications and LAN equipment and service suppliers.

B. Coordinate telecommunications outlet/connector locations with location of power receptacles at each work area.

1.11 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Beginning with Substantial Completion, provide software support for two (2) years.

B. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within two (2) years from date of Substantial Completion. Upgrading software shall include operating system. Upgrade shall include new or revised licenses for use of software.
   1. Provide thirty (30) days' notice to Owner to allow scheduling and access to system and to allow Owner to upgrade computer equipment if necessary.

1.12 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Patch-Panel Units: One of each type.
   2. Connecting Blocks: One of each type.
   3. Device Plates: 10 of each type.
   4. Multi-user Telecommunications Outlet Assemblies: 10 of each type.

PART 2 - PRODUCTS

2.1 PATHWAYS

A. General Requirements: Comply with TIA/EIA-569-A.

B. Cable Support: NRTL labeled for support of Category 6 cabling, designed to prevent degradation of cable performance and pinch points that could damage cable.
   1. Support brackets with cable tie slots for fastening cable ties to brackets.
   2. Lacing bars, spools, J-hooks, and D-rings.
   3. Straps and other devices.

C. Cable Trays: See specification section 16127

D. Conduit and Boxes: Comply with requirements in Division 16 Section "Raceways and Boxes." Flexible metal conduit shall not be used.
   1. Outlet boxes shall be no smaller than 2 inches (50 mm) wide, 3 inches (75 mm) high, and 2-1/2 inches (64 mm) deep.

2.2 BACKBOARDS

A. Backboards: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches (19 by 1220 by 2440 mm). Comply with requirements in Division 6 Section "Rough Carpentry" for plywood backing panels.

2.3 UTP CABLE

A. Manufacturers: Subject to compliance with requirements of paragraph 1.2 C., Section 16710, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Belden CDT Inc.; Electronics Division.
   2. Berk-Tek; a Nexans company.
   3. CommScope, Inc.
   4. Genesis Cable Products; Honeywell International, Inc.
   5. KRONE Incorporated.
   6. Mohawk; a division of Belden CDT.
   7. Nordex/CDT; a subsidiary of Cable Design Technologies.
   8. Superior Essex Inc.
   9. SYSTIMAX Solutions; a CommScope, Inc. brand.
   10. Tyco Electronics/AMP Netconnect; Tyco International Ltd.
   11. Or approved equal.

B. Horizontal Wiring: Provide plenum rated 100 Ohm Unshielded Twisted Pair (UTP) cable with the following physical characteristics:
   1. The diameter of the insulated conductor shall be .048 in. maximum and shall consist of (4) 22 to 24 AWG twisted pairs.
   2. Shall be suitable for the environment in which they are to be installed. For Plenum, shall meet applicable requirements of ANSI/ICEA S-80-576. All four pairs must be insulated with F.E.P. No 2x2 or 3x1 construction will be allowed. Plenum rated cable shall be UL certified to conform to UL 910, CMP and shall be marked as such. Riser rated cable shall be third party certified to conform to UL 1666, CMR, CMG and IEC 332-1 and shall be marked as such.
   3. The color-coding of pairs shall be:
      a. Pair 1 W-BL; BL
      b. Pair 2 W-O; O
      c. Pair 3 W-G; G
      d. Pair 4 W-BR;BR

C. Horizontal Category 6 Wiring: Provide high speed data cabling conforming to ANSI/TIA/EIA 568-B.3 Category 6. All Category 6 cables shall conform to ANSI/TIA/EIA 568-B Commercial Building Telecommunications Cabling Standard. Applications standards supported should include, but are not limited to, IEEE 802.3, 10BaseT-T, IEEE 802.5, 4 Mbps, 16 Mbps, 100 Base-T and 155 Mbps ATM1, 1000BaseT Gbps Ethernet, potentially 1.2 Gbps ATM and 2.4 Gbps ATM, Multitasked Split Screen Computing, Virtual Holographic Video Conferencing, 3D CAD/CAM Engineering, Internet-Intranet Communications / Commerce, as well as all 77 channels (550 MHz) of analog broad band video.

1. From each jack location there will be one sheath of plenum rated Inside Wiring Cable to the associated distribution frame.
2. The plenum cable shall be composed of 22 to 24 AWG bare solid copper conductors each with an insulation of Teflon. The insulated conductors are tightly twisted into pairs and jacketed with white low smoke PVC. It shall conform to a UL Type CMP listing for plenum and riser applications.
3. Each sheath shall contain four unshielded copper pairs. Each pair shall have a different twist ratio per foot.
4. The cables shall meet or exceed the following standards:
   a. ANSI/TIA/EIA 568-B “Commercial Building Wiring Standard
   b. UL listed
   c. National Electrical Code – Article 800
5. The cables shall meet the following representative electrical and transmission characteristics:

Frequency	Insertion loss	Pair to Pair	Power Sum	ELFEXT	SRL	Power Sum ELFEXT
MHz	cB/100m	NEXT dB	NEXT dB	DB	dB	dB
1.	2.0	74.3	72.3	67.8	20	64.8
4.	3.8	65.3	63.3	55.8	23	52.8
10.	6.0	59.3	57.3	47.8	25	44.8
16.	7.6	56.2	54.2	43.7	25	40.7
20.	8.5	54.8	52.8	41.8	25	38.8
25.	9.5	53.3	51.3	39.8	24.3	36.8
31.25	10.7	51.9	49.9	37.9	23.6	34.9
62.5	15.4	47.4	45.4	31.9	21.5	28.9
100	19.8	44.3	42.3	27.8	20.1	24.8
200	29.3	39.8	37.8	21.8	18	18.8
250.	32.8	38.3	36.3	19.8	17.3	16.8

6. Cable Manufacturer shall be ISO-9001 certified.
7. The cable packaging shall be constructed so as to prevent kinking and other damage to the cable during shipping and handling. All damaged cable will be replaced.

D. 25 Pair High Speed Data Tie Cable: Provide high speed data cabling conforming to ANSE/TIA/EIA 568-B Category 5e. All cables shall meet applicable requirements of ANSI/ICEA S-80-576. All Category 5e cables shall conform to ANSI/TIA/EIA 568-B Commercial Building Telecommunications Cabling

Standard, Horizontal Cable Section. Applications standards supported should include, but are not limited to, IEEE 802.3, 10BaseT-T, IEEE 802.5, 4 Mbps, 16 Mbps and TP-PMD. In addition, these cables shall be capable of supporting evolving high-end applications such as 100 Base-T and 52/155 Mbps ATM.

1. The cable shall be composed of 22 to 24 AWG bare solid copper conductors with a suitable plastic dielectric material.
2. Each cable shall contain 25 unshielded copper pairs. Installed in tight sub-units to meet power sum Near End Crosstalk, swept Insertion loss and SRL requirements. The insulated conductors shall be twisted into pairs and stranded into mini-units. The cable shall employ a honeycomb core construction, consisting of multiple three and four pair tightly stranded sub-units. A total of seven unjacketed sub-units will be stranded to comprise the cable core.
3. The cables shall meet or exceed the following standards:
    a. ANSI/TIA/EIA 568-B "Commercial Building Wiring Standard," Category 5e Backbone
    b. Cable Section
    c. Certified Category 5e Cable under UL's LAN Cable Certification Program
    d. UL Listed CMR or CMP as required, UL Verified Cat 5e
    e. National Electrical Code – Article 800
4. The cables shall meet the TIA/EIA electrical and transmission characteristics.
    a. Outside Diameter .48 inches
    b. Mutual Capacitance 5.6 nF/100m
    c. Impedance Z 100 ± 15% Ohms from 1-100 MHZ
    d. DC Resistance – Max. 9.38 Ohms/100 m
5. Cable Manufacturer shall be ISO-9001 certified.
6. The cable packaging shall be constructed so as to prevent kinking and other damage to the cable during shipping and handling. All damaged cable will be replaced.

2.4 UTP CABLE HARDWARE

A. Manufacturers: Subject to compliance with requirements of paragraph 1.2 C of Section 16710, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. American Technology Systems Industries, Inc.
2. Dynacom Corporation.
3. Hubbell Premise Wiring.
4. KRONE Incorporated.
5. Leviton Voice & Data Division.
6. Molex Premise Networks; a division of Molex, Inc.
7. Nordex/CDT; a subsidiary of Cable Design Technologies.
8. Panduit Corp.
9. Tyco Electronics/AMP Netconnect; Tyco International Ltd.
10. or approved equal.

B. General Requirements for Cable Connecting Hardware: Comply with TIA/EIA-568-B.2, IDC type, with modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of same category or higher.

C. Connecting Blocks: 110-style IDC for Category 6. Provide blocks for the number of cables terminated on the block, plus 25 percent spare. Integral with connector bodies, including plugs and jacks where indicated.

D. Patch Panel: Modular panels housing multiple-numbered jack units with IDC-type connectors at each jack for permanent termination of pair groups of installed cables.
   1. Number of Jacks per Field: One for each four-pair UTP cable indicated, plus 20% spares and blank positions adequate to suit specified expansion criteria.

E. Jacks and Jack Assemblies: Modular, color-coded, eight-position modular receptacle units with integral IDC-type terminals.

F. Patch Cords: Factory-made, four-pair cables in 72-inch lengths; terminated with eight-position modular plug at each end.
   1. Patch cords shall have bend-relief-compliant boots and color-coded icons to ensure Category 6 performance. Patch cords shall have latch guards to protect against snagging.

2.5 CONSOLIDATION POINTS

A. Manufacturers: Subject to compliance with requirements of paragraph 12. C of Section 16710, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. American Technology Systems Industries, Inc.
   2. Chatsworth Products, Inc.
   3. Dynacom Corporation.
   4. Hubbell Premise Wiring.
   5. Molex Premise Networks; a division of Molex, Inc.
   6. Nordex/CDT; a subsidiary of Cable Design Technologies.
   7. Ortronics, Inc.
   8. Panduit Corp.
   9. Siemon Co. (The).
   10. Or approved equal.

B. Description: Consolidation points shall comply with requirements for cable connecting hardware.
   1. Number of Terminals per Field: One for each conductor in assigned cables.
   2. Number of Connectors per Field:
      a. One for each four-pair conductor group of indicated cables, plus 25 percent spare positions.
   3. Mounting: Recessed in ceiling, wall, desk or furniture as shown on drawings.
   4. NRTL listed as complying with UL 50 and UL 1863.
   5. When installed in plenums used for environmental air, NRTL listed as complying with UL 2043.

2.6 MULTIUSER TELECOMMUNICATIONS OUTLET ASSEMBLY (MUTOA)

A. Manufacturers: Subject to compliance with requirements of paragraph 12. C of Section 16710 , available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Chatsworth Products, Inc.
   2. Hubbell Premise Wiring.
   3. Molex Premise Networks; a division of Molex, Inc.
   4. Nordex/CDT; a subsidiary of Cable Design Technologies.
   5. Ortronics, Inc.
   6. Panduit Corp.

B. Modular Category 6 Jacks: The category 6 jack shall meet or exceed the following standards:

C. ANSI/TIA/EIA 568-B “Commercial Building Wiring Standard”.

D. FCC Part 68, Subpart “F”
   1. The Category 6 modular jacks shall meet the following physical requirements:
   2. Connector-insulation displacement connectors accepting 22 and 24 gauge AWG solid conductor wire
   3. Jack wires-square copper alloy wires with 50 micro-inch lubricated gold plating over 100 micro-inch nickel plate
   4. High impact, flame retardant UL-rated 94V-O thermoplastic
   5. The Category 6 modular jacks shall meet the following mechanical requirements:
      a. Plug insertion life – minimum 750 plug insertions
      b. Contact Force – 100 grams minimum using FCC-approved modular plugs
      c. Plug Retention Force –(133N) minimum between modular plug and jack
      d. Temperature Range - -40° to 66°C
   6. The outlet shall be approved to work in all applications up to 250 MHz, including, but are not limited to 1000BaseT Gigabit Ethernet.

Frequency	Insertion loss	Pair to Pair	FEXT dB	SRL
MHz	dB/100 m	NEXT dB	dB/100 m	dB
		dB/100 m		dB/100 m
1.	.1	75	75	19.8
4.	.1	75	71.1	21.6
10.	.1	74	63.1	22.8
16.	.1	69.9	59	23.4
20.	.1	68	57.1	23.7
25.	.1	66	55.1	24
31.25	.11	64.1	53.2	23
62.5	.16	58.1	47.2	20
100	.2	54	43.1	18
200	.28	48	37.1	15
250	.32	46	35.1	14

2.7 HIGH SPEED CATEGORY 6 DATA CROSS-CONNECT PATCH PANELS

A. The data patch panels will be co-located on 19-inch racks with the network hubs and the fiber optical interconnection cabinets as designated on the drawings or as required by the owner. The configuration of the patch panels shall be in an arrangement that minimizes patch cord lengths.

B. The modular patch panels shall have eight wires, 8-position modular jacks with 110 terminations on the rear for connection of station cables. The horizontal Category 6 cables to the outlets will be directly connected to 110 insulation displacement hardware associated with each jack on the patch panel. These panels will be designed to operate at 100/250 MHz. Quantities sufficient for all positions of every outlet are required.

C. The patch panel shall be a Category 6 modular jack panel with the following characteristic:
   1. The patch panel will utilize a 110 insulation displacement connector field on the back of the panel to terminate the horizontal cables. The 110 field is to remain continuous to the 8-pin modular jack field in the front of the panel.
   2. The cross-connect patch panel shall meet the following standards: ANSI/TIA/EIA 568-B “Commercial Building Wiring Standard FCC Part 68, Subpart F.

D. The Cross-connect patch panel shall meet the following physical requirements:
   1. Wire termination – insulation displacement, gas tight, slotted beam contact
   2. Plug contact force – 100 grams
   3. Plug retention force – 133 Newtons

E. The cross-connect patch panel shall meet the following environmental requirements:
   1. Operating Environment
      Temperature: 32°F to 140°F (0° to 60°C)
      Humidity: 5% to 95% (noncondensing)
   2. Storage Environment
      Temperature -40°F to 150°F (-40° to 66°C)
      Humidity: 5% to 95% (noncondensing)

F. The Category 6 panels shall be approved to work in all applications up to 250 MHz, including, but are not limited to, 1000BaseT Gigabit Ethernet.

G. The Category 6 panels shall meet or exceed the following representative electrical and transmission characteristics:

Frequency	Insertion loss	Pair to Pair	FEXT dB	SRL
MHz	dB/100 m	NEXT dB	dB/100 m	dB
		dB/100 m		dB/100 m
1.	.1	75	75	30
4.	.1	75	71.1	30

10.	.1	74	63.1	30
16.	.1	69.9	59	30
20.	.1	68	57.1	30
25.	.1	66	55.1	30
31.25	.11	64.1	53.2	30
62.5	.16	58.1	47.2	28.1
100	.2	54	43.1	24
200	.28	48	37.1	18
250	.32	46	35.1	16

H. Category 5e/6 Modular Patch Cords

1. Provide 100% factory assembled and tested Category 6 plug-end cross-connecting patch cables for each modular patch panel jack. Cable shall be sized for the longest cross-connect and installed in accordance with a schedule developed by the installation contractor. The length of the patch cable or cross-connect jumpers shall not exceed 20 feet. Provide color-coded boot assemblies to match owner's requirements.

2.8 GROUNDING

A. Comply with requirements in Division 16 Section "Grounding and Bonding" for grounding conductors and connectors.

B. Comply with ANSI-J-STD-607-A.

2.9 IDENTIFICATION PRODUCTS

A. Comply with TIA/EIA-606-A and UL 969 for labeling materials, including label stocks, laminating adhesives, and inks used by label printers. Use Panduit Ultimate 10 Network Labeling system or equal.

B. Comply with requirements in Division 16 Section "Electrical Identification."

2.10 CABLE MANAGEMENT SYSTEM

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Basis-of-Design Product: Subject to compliance with requirements, provide comparable product by one of the following:

1. iTRACS Corporation.
2. Telsoft Solutions.
3. Or approved equal.

C. Description: Computer-based cable management system, with integrated database and graphic capabilities.

D. Document physical characteristics by recording the network, TIA/EIA details, and connections between equipment and cable.

E. Information shall be presented in database view, schematic plans, or technical drawings.
   1. AutoCAD drawing software shall be used as drawing and schematic plans software.

F. System shall interface with the following testing and recording devices:
   1. Direct upload tests from circuit testing instrument into the personal computer.
   2. Direct download circuit labeling into labeling printer.

2.11 SOURCE QUALITY CONTROL

A. Factory test UTP and optical fiber cables on reels according to TIA/EIA-568-B.1.

B. Factory test UTP cables according to TIA/EIA-568-B.2.

C. Cable will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 WIRING METHODS

A. Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces where unenclosed wiring method may be used. Conceal raceway and cables except in unfinished spaces.
   1. Install plenum cable in environmental air spaces, including plenum ceilings.
   2. Comply with requirements for raceways and boxes specified in Division 16 Section "Raceways and Boxes."

B. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

C. Wiring within Enclosures: Bundle, lace, and train cables to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

3.2 INSTALLATION OF PATHWAYS

A. Cable Trays: Comply with NEMA VE 2 and TIA/EIA-569-A-7.

B. Comply with requirements for demarcation point, pathways, cabinets, and racks specified in Division 16 Section "Communications Equipment Room Fittings." Drawings indicate general arrangement of pathways and fittings.

C. Comply with TIA/EIA-569-A for pull-box sizing and length of conduit and number of bends between pull points.

D. Comply with requirements in Division 16 Section "Raceways and Boxes" for installation of conduits and wireways.

E. Install manufactured conduit sweeps and long-radius elbows whenever possible.

F. Pathway Installation in Communications Equipment Rooms:
1. Position conduit ends adjacent to a corner on backboard where a single piece of plywood is installed, or in the corner of room where multiple sheets of plywood are installed around perimeter walls of room.
2. Install cable trays to route cables if conduits cannot be located in these positions.
3. Secure conduits to backboard when entering room from overhead.
4. Extend conduits 3 inches (76 mm) above finished floor.
5. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.

G. Backboards: Install backboards with 96-inch (2440-mm) dimension vertical. Butt adjacent sheets tightly, and form smooth gap-free corners and joints.

3.3 INSTALLATION OF CABLES

A. Comply with NECA 1.

B. General Requirements for Cabling:
1. Comply with TIA/EIA-568-B.1.
2. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."
3. Install 110-style IDC termination hardware unless otherwise indicated.
4. MUTOA shall not be used as a cross-connect point.
5. Consolidation points may be used only for making a direct connection to telecommunications outlet/connectors:
   a. Do not use consolidation point as a cross-connect point, as a patch connection, or for direct connection to workstation equipment.
   b. Locate consolidation points for UTP at least 49 feet (15 m) from communications equipment room.
6. Terminate conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
7. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches (760 mm) and not more than 6 inches (150 mm) from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
8. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
9. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Install lacing bars and distribution spools.
10. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.

11. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
12. In the communications equipment room, install a 10-foot- (3-m-) long service loop on each end of cable.
13. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.

C. UTP Cable Installation:
1. Comply with TIA/EIA-568-B.2.
2. Do not untwist UTP cables more than 1/2 inch (12 mm) from the point of termination to maintain cable geometry.

D. Optical Fiber Cable Installation:
1. Comply with TIA/EIA-568-B.3.
2. Cable may be terminated on connecting hardware that is rack or cabinet mounted.

E. Open-Cable Installation:
1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend UTP cable not in a wireway or pathway a minimum of 8 inches (200 mm) above ceilings by cable supports not more than 60 inches (1524 mm) apart.
3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

F. Installation of Cable Routed Exposed under Raised Floors:
1. Install plenum-rated cable only.
2. Install cabling after the flooring system has been installed in raised floor areas.
3. Coil cable 6 feet (1800 mm) long not less than 12 inches (300 mm) in diameter below each feed point.

G. Group connecting hardware for cables into separate logical fields.

H. Separation from EMI Sources:
1. Comply with BICSI TDMM and TIA/EIA-569-A for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
   a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches (127 mm).
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches (300 mm).
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches (610 mm).
3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:

a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches (64 mm).
b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches (150 mm).
c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches (300 mm).

4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
   a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches (76 mm).
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches (150 mm).
5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches (1200 mm).
6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches (127 mm).

3.4 FIRESTOPPING

A. Comply with requirements in Division 7 Section "Through-Penetration Firestop Systems."

B. Comply with TIA/EIA-569-A, Annex A, "Firestopping."

C. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.5 GROUNDING

A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.

B. Comply with ANSI-J-STD-607-A.

C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 2-inch (50-mm) clearance behind the grounding bus bar. Connect grounding bus bar with a minimum No. 4 AWG grounding electrode conductor from grounding bus bar to suitable electrical building ground.

D. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

3.6 IDENTIFICATION

A. Using cable management system software specified in Part 2, develop Cabling Administration Drawings for system identification, testing, and management. Use unique, alphanumeric designation for each cable and label cable, jacks, connectors, and terminals to which it connects with same designation. At completion, cable and asset management software shall reflect as-built conditions.

B. Comply with requirements in Division 9 Section "Interior Painting" for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.

C. Paint and label colors for equipment identification shall comply with TIA/EIA-606-A for Class 3 level of administration, including optional identification requirements of this standard.

D. Cable Schedule: Post in prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.

E. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, backbone pathways and cables, entrance pathways and cables, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors. Follow convention of TIA/EIA-606-A. Furnish electronic record of all drawings, in software and format selected by Owner.

F. Cable and Wire Identification:
1. Label each cable within 4 inches (100 mm) of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
2. Each wire connected to building-mounted devices is not required to be numbered at device if color of wire is consistent with associated wire connected and numbered within panel or cabinet.
3. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 feet (4.5 m).
4. Label each terminal strip and screw terminal in each cabinet, rack, or panel.
    a. Individually number wiring conductors connected to terminal strips, and identify each cable or wiring group being extended from a panel or cabinet to a building-mounted device shall be identified with name and number of particular device as shown.
    b. Label each unit and field within distribution racks and frames.
5. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.
6. Uniquely identify and label work area cables extending from the MUTOA to the work area. These cables may not exceed the length stated on the MUTOA label.

G. Labels shall be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in TIA/EIA-606-A.
1. Cables use flexible vinyl or polyester that flex as cables are bent.

3.7 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:
 1. Visually inspect UTP and optical fiber cable jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with TIA/EIA-568-B.1.
 2. Visually confirm Category 6, marking of outlets, cover plates, outlet / connectors, and patch panels.
 3. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.

C. UTP Performance Tests:
 1. Test for each outlet and MUTOA. Perform the following tests according to TIA/EIA-568-B.1 and TIA/EIA-568-B.2:
  a. Wire map.
  b. Length (physical vs. electrical, and length requirements).
  c. Insertion loss.
  d. Near-end crosstalk (NEXT) loss.
  e. Power sum near-end crosstalk (PSNEXT) loss.
  f. Equal-level far-end crosstalk (ELFEXT).
  g. Power sum equal-level far-end crosstalk (PSELFEXT).
  h. Return loss.
  i. Propagation delay.
  j. Delay skew.
 2. Final Verification Tests: Perform verification tests for UTP systems after the complete communications cabling and workstation outlet/connectors are installed.
  a. Voice Tests: These tests assume that dial tone service has been installed. Connect to the network interface device at the demarcation point. Go off-hook and listen and receive a dial tone. If a test number is available, make and receive a local, long distance, and digital subscription line telephone call.
  b. Data Tests: These tests assume the Information Technology Staff has a network installed and is available to assist with testing. Connect to the network interface device at the demarcation point. Log onto the network to ensure proper connection to the network.

D. Document data for each measurement. Data for submittals shall be printed in a summary report that is formatted similar to Table 10.1 in BICSI TDMM, or transferred from the instrument to the computer, saved as text files, and printed and submitted.

E. End-to-end cabling will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel in cable-plant management operations, including changing signal pathways for different workstations, rerouting signals in failed cables, and keeping records of cabling assignments and revisions when extending wiring to establish new workstation outlets. Include training in cabling administration software.

END OF SECTION 16717

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This section includes a Fire Protective Alarm (FPA) system of the addressable initiating device type, consisting essentially of the following components:

1. Central equipment (also referred to as head end equipment) including Fire Command Station (FCS).

2. A graphic annunciator.

3. Outlying analog-addressable smoke (and smoke-heat) sensor/detectors.

4. Outlying addressable manual fire alarm stations.

5. Outlying addressable heat detectors.

6. Outlying sprinkler and fire standpipe alarm and supervisory devices furnished and installed separate from the work of this section.

7. Outlying addressable modules (monitoring or control) in addressable module boxes or cabinets.

8. Outlying loudspeaker stations; each with integrally mounted visual fire warning (strobe) except as otherwise specified.

9. Outlying visual warning signals (strobes).

10. Outlying intercom stations (floor warden stations).

11. Outlying "area of rescue assistance" intercom stations.

12. Outlying annunciator(s).

13. Outlying system equipment control cabinets (also referred to as equipment control cabinets).

14. Central damper control panel.

15. Interfaces with pre-action sprinkler systems, clean agent systems, or other standalone sub-systems.

16. Printer.

17. Interconnecting circuitry and control circuit extensions (i.e., final connections to controlled equipment from addressable module boxes).

B. Related Sections: The following Sections contain requirements that relate to this Section:

1. Division 15 Section "Electric-Drive, Horizontal Fire Pumps" for coordinating fire alarm system interconnections.

2. Division 15 Section "Standpipes and Hoses" for coordinating flow, pressure, and valve tamper switch requirements.

3. Division 15 Section "Pre-action Sprinkler System" for coordinating fire alarm system interconnections.

1.3 DEFINITION

A. FCS: Fire Command Station. Used interchangeably with FACP (see below)

B. FACP: Fire Alarm Control Panel (see above).

1.4 SYSTEM DESCRIPTION

A. General: Zoned, noncoded, addressable, microprocessor-based fire-detection and alarm system with manual and automatic alarm initiation, analog addressable smoke detectors, and automatic alarm verification for alarms initiated by certain smoke detector zones as indicated.

B. Signal Transmission: Multiplex signal transmission dedicated to fire alarm service only.

C. Audible Alarm Notification: By sounding of "alert" tone signals followed by voice messages, followed by "alarm" signals for zones as described hereinafter.

D. Visual Alarm Notification: By xenon-strobe-type units.

1.5 SUBMITTALS

A. General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections.

B. Product Data for each type of system component specified including dimensioned plans and elevations showing minimum clearances and installed features and devices. Include list of materials and Underwriters Laboratories and Factory Mutual listing data.

C. Shop Drawings showing details of graphic annunciator.

D. Wiring diagrams from manufacturer differentiating clearly between factory- and field-installed wiring. Include diagrams for equipment and for system with all terminals and interconnections identified. Make all diagrams specific to this Project and distinguish between field and factory wiring.

E. Device Address List: Coordinate with final system programming.

F. System operation description covering this specific Project, including method of operation and supervision of each type of circuit and sequence of operations for all manually and automatically initiated system inputs and outputs. Manufacturer's standard descriptions for generic systems are unacceptable.

G. Operating instructions for mounting at the FACP (FCS).

H. Product certificates signed by manufacturers of fire alarm system components certifying that their products comply with specified requirements.

I. Maintenance data for fire alarm systems to include in the operation and maintenance manual specified in Division 1. Include data for each type of product, including all features and operating sequences, both automatic and manual. Include recommendations for spare parts to be stocked at the site. Provide the names, addresses, and telephone numbers of service organizations that carry stock of repair parts for the system furnished.

J. In addition to routine submission of above materials, make all filings with the Building Department, Fire Department, and any other agencies having jurisdiction. Where filings require the engineer's signature, documents will be submitted for his review and signature. This responsibility will include furnishing of required quantities of floor plans, descriptive notes and/or specifications, wiring diagrams, shop drawings and amendment forms, as well as the payment of any required filing fees.

K. Permits necessary for installation of the work will be obtained prior to the commencement of the work. All permit costs and inspection fees will be included as part of the required work.

L. Record of field tests of system.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Installing contractor has at least 5 years experience in the installation of multiplexed fire alarm systems. Provide services of a NICET Level IV technician supplied by the fire alarm system manufacturer to supervise installation, adjustments and tests of system.

B. Single-Source Responsibility: Obtain fire alarm components from a single source who assumes responsibility for compatibility of system components.

C. Compliance with Local Requirements: Comply with the applicable building code, local ordinances, and regulations, and the requirements of the authorities having jurisdiction.

D. Comply with NFPA 70 as amended by state and local codes.

E. Comply with NFPA 72.

F. Comply with ANSI/ASME 17.1, NFPA 101 and UL 268,2196.

G. Comply with Americans with Disabilities Act (ADA).

H. Listing and Labeling: Provide fire alarm systems and components specified in this Section that are listed and labeled by Factory Mutual and Underwriters Laboratories.

I. The system is complete with all components and wiring required for compliance with all applicable codes and regulations, and for its operation as described hereinafter. No exclusion from or limitation in the symbolism used on the drawings or the language used in these specifications will be interpreted as a reason for omitting any appurtenances or accessories required to enable the system to perform the specified functions.

J. Early completion of the Fire Protective Alarm system will be required so as to permit a certificate of occupancy to be obtained in a timely manner, in accordance with a schedule established by the Architect.

K. Upon completion of the installation (and as directed by the Architect), the work includes making all arrangements and providing any assistance necessary for inspection and test as required for approval by the Fire Department. Modifications, adjustments and/or corrective work necessary to obtain approval along with subsequent inspection and test resulting from the issuance of a "Notice of Defect" will precede any consideration of formal acceptance by the Architect. In conjunction with the above, training as deemed necessary to instruct authorized building personnel in the proper operation of the system also forms a part of the required work.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the Work include, but are not limited to, the following:

1. Edwards Systems Technology; General Signal Unit.
2. Simplex Fire Alarm, Inc.
3. Firecom, Inc.
4. Gamewell/FCI

5. Honeywell Fire Systems/Notifier

6. Siemens Building Technologies, Inc.

2.2 FUNCTIONAL DESCRIPTION OF SYSTEM

A. Include system functions and operating features as described below, plus those additional functions and features required by the authorities having jurisdiction. System design is such that neither the failure of the normal power source, the transfer to an emergency source, nor the retransfer to the normal source causes a change in system status (i.e., initiation of alarm signals or operation of equipment control relays).

B. The central equipment of the system incorporates redundant components so that the failure of any component does not interfere with system operation as described hereinafter. Submission of the system for approval includes a detailed description of how compliance with this requirement is accomplished.

C. System supervision is such that the ability of all addressable alarm initiating devices and addressable modules to communicate with the central equipment is constantly monitored, and such failure results in an audible signal at the Fire Command Station (FCS) and outlying annunciator(s) and a visual annunciation identifying the faulted device or module.

D. The system utilizes liquid crystal display (LCD) for the display of all required alarm and equipment status information, and an associated keyboard to permit manual access to the system. For fire department use, selector switch and pilot light modules are also included at the Fire Command Station for status and manual access to fans and dampers. The display is capable of displaying at least 20 lines, with 80 characters per line. System response time is such that alarm indications are displayed within 10 seconds of occurrence. No portion of the "executive" program is stored on magnetic media. It is entered into the system by means of "firmware."

E. Smoke detection devices (variously identified herein as "smoke detectors," "smoke sensors" and "smoke sensor/detectors") are understood to be of the <u>analog addressable smoke sensor type</u>, for which the decision to initiate an alarm in response to the presence of smoke is software-driven from the fire protective alarm system central equipment. Provisions are incorporated at the central equipment to manually test and/or adjust the sensitivity of each smoke detector individually by means of a keyboard or keypad without requiring any replacement of equipment and/or "burning in" of firmware, and to print out a record thereof. The system also incorporates "alarm verification" features enabling a time-delayed re-check of any smoke detection signal prior to acknowledging a smoke alarm condition and acting thereon.

F. Circuitry for the system complies with the following:

1. Circuits are of the following types:

(a) Signaling line circuits (SLC's) are utilized for the transmission of multiple signals from outlying addressable initiating devices, addressable control modules and addressable monitoring modules.

(b) "Trunk" signaling line circuits are SLC's originating directly from the system head-end equipment.

(c) "Branch" signaling line circuits are SLC's which are tapped off the "trunk" SLC's. Such circuits originate at outlying system equipment control cabinets, and are intended for the direct connection of outlying addressable initiating devices and/or modules.

(d) Initiating device circuits (IDC's) are utilized for the connection of non-addressable devices (such as sprinkler water flow switches) to their associated addressable modules.

(e) Notification appliance circuits (NAC’s) are utilized for the connection of outlying alarm notification devices as follows:

(1) "Audible" NAC's are intended for the connection of loudspeakers.

(2) "Visual" NAC's are intended for the connection of strobes.

2. Trunk" SLC's comply with the following:

(a) They are NFPA 72, Style 7 (Modified) incorporating isolators to limit the loss of signal transmission in the presence of wiring faults as describe hereinafter.

(b) They originate at the system head-end equipment, and each consist of a Class "A" loop, the sending portion of which feed through outlying equipment control cabinets in which "branch" SLC's are tapped from the loop. The return portion of the loop is run directly - without intervening connections - back to the head-end equipment for termination.

(c) The loop conductors are run in raceways (as specified hereinafter) throughout. The "sending" portion of the loops are physically separated from the "return" by a distance of not less than 50 feet (15 meters) except where they come together at the FACP, and each is 2-hour rated as hereinafter specified.

(d) Within each outlying equipment control cabinet, and at the "sending" and "return" connections at the system head-end equipment, each loop incorporates isolators to sectionalize the loops. Two isolators per loop are provided in each outlying equipment control cabinet. They are so arranged that the wiring within the cabinet and the outgoing branch circuits can be completely isolated from upstream or downstream faults on the trunk loops.

(e) The trunk SLC's - in conjunction with their associated isolators and head end equipment - function so as to provide bi-directional signal transmission enabling receipt of alarms and signals at the fire command station (FCS), and activation of addressable control modules from the FCS, in the event of a single open, a single ground, a wire-to-wire short or an open and a ground anywhere on the circuit. The only loss of transmission is for devices and/or modules connected to that portion of the loop (between isolators within the ECC) on which the wiring fault has occurred. Wiring faults on the loops, result in trouble signals at the FCS which identifies the location of the faults.

3. "Branch" SLC's comply with the following:

(a) They are NFPA72, Style 6, arranged to limit the loss of signal transmission as described hereinafter.

(b) They originate at outlying system equipment control cabinets (ECC's), and each consist of a Class "A" loop which is tapped from - and returns to - a "trunk" SLC, together with any transponders or other electronic components required to properly interface "trunk" and "branch" SLC's. Sending and return conductors are separated by a distance of not less than 20 feet (6 meters) except where they come together at ECC's, devices or modules.

(c) Where required for the accommodation of auxiliary control relays associated with outlying addressable control modules as described in later subsections, incorporate additional supervised power supply conductors originating at the ECC's.

(d) Include multiple "branch" SLC's within outlying system equipment control cabinets (ECC's) as required to insure that no more than 50 alarm initiating devices and/or addressable monitoring modules associated with non-addressable alarm or supervisory initiating devices are connected to a single "branch" SLC. Each "branch" SLC is tapped from a "trunk" SLC by means of isolators which will disconnect it from the "trunk" SLC in the event of a wire-to-wire short (and will initiate a trouble signal identifying the fault at the FCS) so as to allow the remaining "branch" SLC's originating within the same ECC to function normally.

(e) The loop conductors are run in raceways (as specified hereinafter)

(f) The "branch" SLC's function in conjunction with upstream circuitry and head-end equipment so as to provide bi-directional signal transmission enabling receipt of alarms and monitoring signals at the FCS, and activation of addressable control modules from the FCS, in the event of a single open, a single ground or an open and a ground on the circuit. Wiring faults on the circuits result in trouble signals at the FCS, identifying the faulted circuit.

4. Initiating device circuits (IDC's) comply with the following:

   (a) They are NFPA72, Style B, so arranged in conjunction with field installed end-of-line devices as to be operational in the event of a single ground, and transmit trouble signals to the FCS via their associated monitoring modules (AMM's) in the event of an open or ground on the circuit. Such signals identify the AMM.

   (b) Conductors for IDC's are installed in accordance with the requirements specified above for "branch" SLC's.

5. Notification appliance circuits (NAC's) comply with the following:

   (a) They are NFPA72 Style Y circuits, originating at the associated equipment control cabinets, and so arranged in conjunction with end-of-line devices as to permit audible or visual signal operation in the event of a single ground. Wiring faults cause receipt of trouble signals at the FCS identifying the faulted circuit.

   (b) Conductors for NAC's are installed in accordance with the requirements specified above for "branch" SLC's, with the additional requirement that each is 2-hour rated as hereinafter specified until they enter the evacuation signaling zone that they serve. .

6. Circuits supplying outlying intercom stations (floor wardens stations) and outlying annunciators comply with the requirements specified hereinbefore for notification appliance circuits (NAC's).

7. Alternate circuitry and equipment arrangements which provide equal reliability (i.e., the ability to transmit and receive signals in the event of wiring faults) will be considered acceptable subject to proof of the reliability equivalence. In particular, systems employing dual communications buses will be considered if automatic transfer between buses without the loss of existing information - occurs in the event of a wiring fault or equipment failure associated with one bus.

8. Risers or trunk circuits supplying multiple floors are so arranged as to protect against the inability to initiate evacuation signals on more than one floor (or zone) in the event of fire on a single floor. To accomplish this, sending and return portions of loops or dual communications buses are so located as to be separated by a distance of not less than 50 feet (15 meters), and each is 2-hour rated as hereinafter specified.

9. Note that the use of "T-taps" or other such wiring techniques that limit the ability of addressable devices, addressable modules, loudspeaker, strobes or other devices to function normally in the event of wiring faults as described hereinbefore will not be allowed.

10. Provide the following as 2-hour rated cable or cable system except where enclosed within 2-hour rated construction as indicated on the architectural drawings:-

    (a) Trunk signalling line circuits (Trunk SLC's).

(b) Notification appliance circuits (NAC's) until they enter the evacuation signaling zone that they serve.

G. System equipment is of a type which insures that all signal and communication circuits are of the "power limited fire protective limited fire protective signaling type" as defined in Article 760 of the National Electrical Code.

H. Outlying system equipment control cabinets (also referred to as equipment control cabinets or ECC's) are distributed throughout the project and incorporate all required circuit isolators, transponders, notification appliance addressable control and monitoring modules, power supplies, terminal strips and other equipment and wiring as required to provide all specified system features and functions. ECC's supplying multiple floors will be considered acceptable if they are contained, together with associated conductors in a two hour rated enclosure or space, and if they comply with the following:

1. Each floor supplied by an ECC is served by a separate "branch" SLC (or more than one if needed to comply with other criteria specified hereinafter), and such "branch" SLC(s) serve only that floor.

2. A cabinet is provided on each floor, complete with interconnecting circuitry to the ECC from which it derives, to make available (at a similar location on each floor) terminals for the connecting of circuitry extensions to all devices (addressable initiating devices, addressable modules, loudspeakers, strobes, intercom stations, sub-system interfaces, and other items) which maybe required for the floor when it is fully occupied and fitted out. Terminals and interconnecting circuitry are as required to permit all system features and functions described within this Fire Protective Alarm System specification to be incorporated for each floor.

I. ECC's are not located in electric closets. They are located in suitable 2-hour rated spaces as approved by the Engineer and/or where specifically shown on the drawings. Provide (coordinate with GC) 2-hour rated access panels where required. ECC's incorporate NEMA 1 enclosures, hinged lockable doors, electric supervision against unauthorized access and the removal of any components, and each have an attached engraved nameplate identifying the cabinet. If (as described hereinafter) distributed amplification for the fire evacuation public address system is optionally provided in lieu of the specified central amplification system, all required equipment is incorporated as part of the outlying ECC's - either in the same cabinets - or in separate supervised cabinets mounted adjacent thereto.

J. Outlying addressable module boxes (or cabinets) are distributed throughout the project and contain addressable monitoring and/or control modules as follows:

1. An addressable monitoring module ("initiating device" type, i.e., AMM/ID) is provided adjacent to each sprinkler or standpipe waterflow device and each non-addressable alarm or supervisory initiating device.

2. An addressable control module (ACM) is provided adjacent to each fan motor controller (or other device controller) for equipment whose operation must be automatically and/or manually controlled by the fire alarm system. Where two items are to be controlled at the same location, two such ACM units are provided.

3. An addressable monitoring module ("status" type, i.e., AMM/S) is provided adjacent to each fan motor controller (or other device controller) for equipment whose operational status must be monitored by the Fire Alarm System. Where two status indications are to be monitored for equipment items (such as smoke purge dampers), two such AMM/S units are provided.

4. Auxiliary relays are provided to comply with requirements specified hereinafter.

K. System supervision of outlying circuitry and equipment incorporate the following:

1. Supervision against circuitry wiring faults as described hereinbefore.

2. Supervision against unauthorized access and/or removal of components at ECC's as described hereinbefore.

3. Supervision of addressable alarm initiating devices, addressable control or monitoring modules, and other outlying devices against removal, or - as described hereinbefore - against malfunction.

4. Supervision of power supplies. Failure of any system power supply causes a trouble signal at the FCS identifying the affected power supply.

5. Supervision of smoke detector/sensor device sensitivity so as to provide a "dirty head" notification at the FCS identifying the affected device.

6. Supervision against loss of voltage at any system component requiring power for its proper operation. Such failure causes a trouble signal at the FCS identifying the location of the affected device(s).

7. Supervision against "off-normal" manually initiated actions at the FCS. Any such action causes an identifying trouble signal at the FCS.

L. Power supplies serving visual warning signals are of the regulated type having an output of 28 VDC (adjustable to 30 VDC) ±3 percent.

M. The system incorporates alarm (and other) operating features as follows:

N. Reset of all alarm initiating device circuits, alarm notification circuits, and equipment control relays is accomplished from the fire command station. Manual fire alarm stations require local reset before central reset from the fire command station is possible. <u>In no case will the above alarm reset procedure cause the re-setting of equipment control relays</u>. Such devices require <u>separate</u> reset from the fire command station.

O. It is possible to disconnect any floor, or any device or combination of devices on any floor, from the system to allow for maintenance, repairs, or the addition of system devices and wiring without disabling any other floor. Such disconnection causes a visual "disabled" annunciation at the fire command station identifying the floor and/or devices.

P. Each manual station, smoke or heat detector, sprinkler/standpipe alarm or supervisory actuating device, and sub-system alarm or supervisory initiating device constitutes a separate zone for reporting to the fire command station. For display at the fire command station (FCS) and at outlying annunciator(s), each reporting zone (i.e., device) is individually identified, except that multiple smoke detectors (or multiple heat detectors) located within a single space may be identified by a common display. It is possible to separately identify and display the address of the individual detector(s) in alarm within any such space by means of an appropriate command at the FCS keyboard or keypad.

Q. The system provides for intercom and fire evacuation public address features as follows:-

1. The system is of a dual channel type, capable of automatically broadcasting alert tones followed by recorded announcements repetitively to all floors followed by evacuation tones. No tone signals is broadcast in stairwells.

2. Manual "on-off" control from the fire command station of evacuation tone signals, recorded announcements and flashing of strobes through loudspeaker stations on any or all floors. Manual deactivation of the loudspeaker evacuation tones from the fire command station does <u>not</u> deactivate flashing strobes.

3. Initiation of voice announcements from the fire command station through loudspeaker stations on any or all floors, and separately through loudspeaker stations in stairwells.

4. Intercom between fire command station and any floor warden station, such intercom being controlled from the fire command station. Call initiation from warden stations to fire command station is possible.

5. Intercom use does not interfere with simultaneous broadcasting of evacuation signals, alert tones or voice announcements over system loudspeakers.

6. Patching in of voice announcements from any floor warden station to the loudspeaker stations on any or all floors, such patching in being controlled from the fire command station.

R. The fire evacuation public address equipment in the system includes the following features and functions:

1. Amplifiers are sized to accommodate a quantity of speakers equal to that shown on the drawings, plus an additional bulk quantity of 10 speakers intended for installation at locations as directed throughout the system. Sizing is based on an average requirement of 2.0 watts per speaker.

2. Amplifiers have a frequency response range of ±1.5 dB from 30 to 10,000 hertz and at rated output, less than 2 percent distortion over the frequency range of 60 to 15,000 hertz.

3. Failure of a power amplifier shuts down the amplifier and indicate a trouble condition. Amplifiers are arranged in such manner, either by pairing or automatic switchover, to provide redundancy.

4. Tone oscillators, microphone circuits and ancillary equipment are paired in a similar fashion to the amplifiers and be provided with either automatic or manual switchover to the redundant system.

5. Where the audio path consists of twisted pair "riser cables," it includes double the number of required pairs (as determined by the total number of speakers called for). Connections at the amplifiers are arranged to readily allow their "transfer" to future amplifiers as necessary.

S. In lieu of the central amplification system described above, distributed amplification may be provided, however, such equipment conforms to the redundancy requirements described hereinbefore, and the outlying equipment must derive its power from the central equipment.

T. Provide an outlying annunciator at each location shown on the drawings. Each outlying annunciator duplicates visually and audibly all "alarm," "trouble" and "supervisory" signals received at the fire command station. Each outlying annunciator also includes a master intercom station to duplicate all functions of the master intercom station at the fire command station. The annunciators are of the LCD type as utilized at the FCS. If local code authorities require other means of display, modify annunciator type so as to fully comply.

U. Each floor warden station is semi-recessed. The station is painted Fire Department red and is clearly identifiable as to its function. It contains detailed operating instructions on a plate or label which is clearly visible when the station is opened. The body of the station contains: a telephone handset, call-in pushbutton or alternate call initiation method, indicator lamp, circuit electronics, and terminal strips. The handsets are red molded thermoplastic with stainless steel armored cord, and utilize commercial type transistor components. In rooms with fire pumps or fire water tanks, stations incorporate a long extension cord and take up reel for "remote" handset operation. Furnish a warden station for each elevator, and turn over to the elevator manufacturer for flush mounting in each cab.

V. Whether indicated on the drawings, or not, a "rescue type" fire warden's station is provided in each "area of rescue assistance". Refer to the Architectural drawings for locations of such areas. "Rescue type" stations comply with the requirements for general floor warden's stations and additionally include a visual "call acknowledged" signal to indicate to hearing impaired persons that the call has been received at the fire command station. Include provisions at the fire command station to transmit an acknowledgment signal to "rescue type" fire warden's stations.

W. Loudspeakers are wall mounted (or column mounted) as noted on the drawings. They are approved for "Fire Alarm Service," with an audio power rating of at least 2 watts and a frequency response of 400 to 4,000 Hz. They have a typical sound pressure rating of at least 90 dBA at 10 feet (3 meters) when measured in an anechoic chamber. Where greater sound pressure levels are required to insure audibility, speakers of higher wattage are utilized. In particular, 15 watt speakers are utilized in mechanical rooms where the ambient sound level exceeds 70 db. Loudspeakers comply with UL Standards applicable to loudspeakers for fire alarm use. The speaker is able to withstand 150 degrees F (55 degrees C) for three hours and still operate. The speaker is equipped with a multi-tapped matching transformer and a line supervision capacitor. The work of this section includes coordination of matching transformers and field settings of taps as required to insure code compliant audibility throughout. <u>Each loudspeaker incorporates a visual warning signal (strobe) except as described hereinafter</u>.

X. Loudspeaker enclosures are in accordance with the following:

1. <u>Each loudspeaker enclosure assembly except those in stairs incorporates an integral visual warning signal (strobe) as described hereinafter.</u>

2. Where indicated as being of the flush mounted type, they each consist of a round or square grille plate and flush mounting back box.

3. Where indicated as being of the surface mounted type, they each consist of an integral assembly of grille and enclosure, fully enclosing the speaker and matching transformer.

4. Where indicated as being of the bracket type, they each consist of an assembly of bracket mounting frame and speaker enclosure. Where two loudspeakers are shown in a back to back configuration, or where the speaker is called-out as bi-directional, the two speakers are incorporated into a single assembly.

5. Loudspeaker enclosures are finished in red.

Y. <u>A visual fire warning device is incorporated as part of each loudspeaker assembly except as noted hereinbefore</u>.

Visual fire warning devices are as follows:

1. They are suitable for synchronized operation at a flash rate of 1 to 1.1 flashes per second, and are of the self-synchronizing type or are suitable for use with synchronizing control units integral with the power supplies, or interpolated in the circuitry between power supplies and strobes (visual warning devices). Where not of the self-synchronized type, provide a sufficient quantity of synchronizing control units to fully utilize the installed power supply capacity for the project.

2. Each visual warning device consists of a U.L. approved xenon flash tube (strobe) with matching socket, integral factory mounted diode or other device (to permit the supervision of circuitry) and domed plastic lens to flash the word FIRE when activated. The strobes have a U.L. 1971 listed intensity of at least 75 candela. Where installed in corridors or in a room having no dimension greater than 20 feet (6 meters), a strobe having a U.L. 1971 listed intensity of 15 candela <u>and a near-axis (i.e., non-polar distribution) intensity of at least 75 candela may be utilized.</u>

3. Strobes are suitable for operation at a nominal voltage of 24 volts D.C. from power supplied by the system.

4. Strobes continue to flash until the system is reset.

5. If approved speaker/strobe units are not available in timely fashion, separately mounted strobe units may be provided, installed at adjacent locations as approved by the Architect. <u>Under no circumstances are ceiling mounted strobe units be installed unless specific approval has been received in writing from the authorities having jurisdiction. Relocate any strobes indicated as ceiling mounted to locations approved by the Architect.</u>

Z. Where separately mounted visual fire devices are indicated on the drawings, each device is of the type described above for the combined loudspeaker/strobe unit except that it is equipped with backbox and mounting plate intended for flush or surface wall mounting as directed. Unit is finished as directed.

AA. Two or more loudspeaker circuits are provided to supply loudspeaker stations in each evacuation signaling zone. Loudspeakers in stairs are circuited separately from those on floors. Strobes are circuited as required, with no less than two circuits per evacuation signaling zone. Both speakers and strobes are connected to these circuits so that adjacent speakers are connected to different circuits, and similarly for strobes.

BB. In addition to the loudspeakers shown on the drawings, provide a bulk quantity of loudspeakers (each with integral or adjacent strobe) complete with circuitry as required, and installed at locations as directed, throughout the project. Information does not exist at this time as to the proper locations at which these loudspeakers are to be installed. The system includes adequate capacity to accommodate these loudspeakers and strobes from adjacent outlying equipment cabinets, assuming an equal distribution among the system cabinets. The work of this section includes the responsibility for determining such locations based on tenant occupancy space planning drawings on a floor by floor basis as they are prepared by the Architect and/or interior designers or space planners. As noted hereinafter, this bulk quantity of loudspeakers <u>is not to be included in the base bid</u> <u>quotation</u>, but is to be included as part of a separate "breakout" quotation.

CC. In addition to the loudspeakers described above, furnish one loudspeaker for each elevator cab, and turn over to the elevator manufacturer for flush recessed mounting in the cabs.

DD. In addition to the loudspeakers described hereinbefore, provide one weatherproof loudspeaker/strobe at each exit on to each roof. The speakers are each complete with circuitry and are exterior mounted over or adjacent to the bulkhead door.

EE. Each manual station is of the non-coded, electrically supervised type. The station is semi-flush, finished fire alarm red. The station is clearly labeled as to function and operation. The stations each include an integral addressable monitor module (AMM) to permit a separately identifiable signal to be transmitted to the fire command station via signaling line circuits as described hereinbefore. The station's "electronics" are mounted behind the body of the station, accessible by authorized personnel only. Alternately, the AMM may be separately mounted adjacent to the manual station and interconnected thereto, as described hereinafter. Manual stations located in unheated spaces have their associated AMM located in a nearby heated space as indicated or as directed by the architect.

FF. Smoke detectors (also referred to as smoke sensors or sensor/detectors) are of the analog-addressable spot detector type. They are UL approved and installed in accordance with the manufacturers recommendations as to spacing and suitability for use in the specific application with consideration for the number of air changes per hour, ceiling height, ceiling profile, normal space environment (i.e., office space as compared to boiler rooms, etc.) and the type of risk. Detectors, for ceiling mounting in finished spaces, are of the semi-flush type. It is understood that semi-flush mounting requires the device to be suitable for application to a concealed outlet box.

GG. Except as noted below, smoke detectors are of the ionization principle dual chamber type with UL approved field adjustable sensitivity features.

HH. Smoke or heat detection devices indicated in kitchens and boiler rooms are of the 190 degrees F (88 degrees C) "fixed temperature only" type.

II. Smoke detection devices in laboratories and maintenance shops and [garage areas are of the photoelectric cell type.

JJ. Smoke detectors indicated in mechanical equipment rooms are of the combination photocell plus fixed temperature/rate-of-rise type.

KK. Smoke detection devices have integrally mounted pilot lamps giving a "triggered" indication.

LL. Smoke detection devices which are mounted in ducts or under raised floors or in ceiling plenums are supplied with remote "triggered" indication pilot wired in parallel, in an approved manner, with the similar pilots included integrally with detection units. The pilots for duct detectors are each flush or surface mounted within 15 feet (4.5 meters) circuiting distance of its associated detector. Mounting and location are as directed by the Architect. The pilots for detectors under raised floors or in ceiling plenums are remotely mounted in a graphic annunciator panel at a location within the computer space as directed.

MM. Smoke detectors mounted in rooms with doors are each equipped with a remote "triggered" indication light wired in parallel with the pilot light integral with the detector. These remote pilot lights flush mounted in the corridor over or adjacent to the door to the room as directed by the Architect.

NN. Smoke detectors indicated as being located in floor or ceiling cavities of the air handling type are equipped with "air shields" where air velocities are such as to require these appurtenances for the proper detection of smoke.

OO. Heat detectors located in sprinklered elevator machine rooms or elevator shafts are of the 135 degrees F (57 degrees C) "fixed temperature only" type.

PP. Duct smoke detectors are installed in accordance with the manufacturer's recommendations as to suitability for use in the specific application with consideration to air changes, size of duct and location within duct, and include sampling chambers and pick up tubes where required. Where installed within ducts and/or above ceilings in air plenums, the provision of access doors and mounting holes in such ducts and plenums will be separate from this work. The installation of the tubes and sampling chambers, however, is part of the work of this section. In addition, responsibility for supplying detailed drawings showing exact dimensional locations of sampling tubes, etc., in the plenums and ducts, as required for the optimum operation will be part of this work. Where duct configuration is such as to interfere with laminar air flow, special provisions are included as follows:

1. For unducted return systems, provide area type detectors, suitable for 500 feet per minute (150 meters per minute) air velocity, pipe mounted in the ceiling at the entry to the fan room. While every attempt has been made to properly define the required quantity of detectors (labeled “d”), at each such location, it is understood that detectors are provided on the following basis, regardless of the indicated quantities:

Duct width	Quantity of detectors
not more than 36 inches (91 cm)	1
greater than 36 inches (91 cm) but not more than 72 inches (182 cm)	2
greater than 72 inches (182 cm)	2 + (1) per each additional 24 inches (61 cm)

QQ. Where combination photo-electric or ionization, plus heat, detectors are called for, separate units may be optionally substituted and their locations adjusted accordingly.

RR. Control and monitoring of audible and visual alarm notification devices (loudspeakers and strobes) and associated circuitry is by means of addressable modules located in outlying system control cabinets.

SS. Reporting of all required alarms and supervisory signals to the Fire Command Station (FCS) from initiating devices of the non-addressable type, including (but not limited to) sprinkler and standpipe waterflow and supervisory devices, manual fire alarm stations, sub-system (e.g., clean agent, pre-action sprinkler, etc.) alarm and supervisory contacts, and the like is accomplished in conjunction with addressable monitoring modules of the initiating device type (i.e., AMM/ID). AMM/ID's are of a type intended for connection of NFPA 72, Style 6 "branch" signaling line circuits (SLC) as described hereinbefore and are connected to the appropriate SLC on the floor on which they are located. Except where incorporated as part of manual fire alarm stations (or in the outlet boxes on which they are mounted), AMM/ID's are mounted adjacent to the associated initiating devices in outlying addressable monitor module boxes and are complete with engraved red nameplate. Each AMM/ID is interconnected to its associated initiating device by means of an initiating device circuit (IDC) as described hereinbefore. Provide an end-of-line resistor at each initiating device so as to permit supervision of the interconnecting circuitry. Terminals are incorporated in each addressable module box for the accommodation of all entering conductors.

TT. Control (automatic and/or manual) and status reporting (monitoring) of equipment via the fire protective alarm system as specified hereinafter is accomplished by means of addressable control modules (ACM's) and addressable monitoring modules of the status reporting type (AMM/S's) located within 3 feet (1 meter) of the controlled equipment in outlying addressable monitor boxes similar to those specified above for the AMM/ID's. Addressable modules (ACM's and AMM/S's) are provided in accordance with the following:

1. ACM's and AMM/S's are of a type intended for connection to NFPA 72, Style 6 "branch signaling circuits (SLC's) as described hereinbefore, and are connected to the appropriate SLC serving the floor on which they are located.

2. Each ACM provides (2) SPDT contacts suitable for use at voltages up to 250 VAC and capable of interrupting 10 amperes inductive, and derives its operating and supervisory current at 24VDC from the SLC. If necessary, these contact ratings are accommodated by means of auxiliary control relays mounted within or adjacent to the same addressable monitor boxes as the ACM's, and deriving their operating power from the associated ACM's, or directly from the associated ECC via separate supervised power supply conductors.

3. Each AMM/S functions so as to provide a readily identifiable status indication at the FCS in response to a 120 or 208 VAC signal from the associated controlled equipment. Incorporate an auxiliary status (monitoring) relay for each AMM/S to convert a 120 or 208 VAC AC signal to a "dry" contact if the AMM/S requires a "dry" contact for proper status signal initiation. Auxiliary status relays, if required, are mounted in the same outlying addressable module boxes as their associated AMM/S's.

4. At locations where multiple equipment controllers are installed, the addressable modules (and any associated auxiliary relays) may be grouped in common addressable module boxes.

UU. System operation is such as to provide automatic and/or manual control of fans larger than 2,000 CFM (56 cubic meters per minute), and of dampers and other equipment in response to alarm initiation, as well as central status reporting. Additionally, any fans over 2,000 CFM (56 cubic meters per minute) which are found not to require automatic control by the FPA system are provided with manual control (and status reporting) from FCS. Controls are provided in accordance with a schedule on the drawings and/or as described hereinafter. Include provisions at the FCS in outlying system equipment control cabinets, and in outlying addressable module boxes (or cabinets) - each located within 3 feet (1 meter) of the associated motor controller, smoke purge damper control device or other equipment control device, control circuitry extensions (i.e., final connections) from the addressable module boxes to the controlled equipment and connections, all as required to achieve this control.

VV. Outlying addressable module boxes, each complete as indicated, are provided for equipment requiring automatic or manual control by the FPA system on the basis of the following:-

1. One box including two ACM's ("stop", start") and one AMM/S ("running") for each fan over 2,000 CFM (56 cubic meters per minute) (including fans in self-contained air conditioning units).

2. One box including two ACM's ("purge", "override purge") and two AMM/S's ("open"/"closed") for each smoke purge damper system. Refer to HVAC floor plans and risers for quantity of smoke purge damper systems (i.e., one system for each penetration of any multi-floor duct which will be used for smoke purge, and for each fan system which includes direct outside exhaust provisions).

3. One addressable module box for each damper requiring individual manual control from the central damper control panel (specified hereinafter for normal after-hours control), but for which direct manual or automatic control by the fire alarm system is not specified. Include one ACM ("closed") and one AMM/S ("closed").

4. One addressable module box, including three ACM's ("recall", "recall to alternate floor", and "elevator not safe for use ") and one AMM/S ("elevators recalled") for each bank of elevators. Alternate floor recall: is initiated only in response to detector activation on the terminal floor. Elevator not safe for use: is initiated only in response to detector activation in associated elevator machine room or elevator shaft. Provide two additional ACM's ("de-energize/re-energize elevator power panel) for each bank of elevators if the elevator machine room and/or associated shaft is sprinklered. Also, include one AMM/S per bank ("panel de-energized").

5. One addressable box, including one ACM for the fire stair door unlocking system.

6. One addressable module box, including one ACM, for the fire/smoke door release system.

7. One addressable module box, including one ACM for each fire stair or elevator machine room smoke vent.

8. One addressable module box, including one ACM for each escalator controller.

9. Additional addressable module boxes as necessary to comply with the scheduled control of equipment in response to system alarm actuating devices.

WW. System operation includes manual over-ride control from -- and status reporting at -- the fire command station for each item of "controlled equipment" (such as fans, dampers, fire doors, elevators, etc.) which is to be automatically controlled in response to the operation of system alarm actuation devices as scheduled elsewhere, and for each smoke exhaust (purge) damper system and smoke purge fan. Re-start of fans shut down by an alarm is possible without clearing the alarm condition, (so as to assist in the smoke control) but only if a Fire Department key has been inserted <u>in the Fire Command Station</u>. Manual control of elevators will not be required, however, status reporting will be required on a per bank basis. Additional "manual only" control of certain fans and dampers (plus status) reporting) is provided if specified herein or scheduled on the drawings. To accomplish the aforementioned status reporting and manual control, include all required switching and status reporting devices at the Fire Command Station, and other necessary equipment at outlying equipment control cabinets and addressable module boxes, and all associated wiring, interwiring and final connections.

XX. Provide interface circuitry for each damper requiring individual after hours control from the central damper control panel as described hereinafter, run from the fire command station to the central damper control panel. Provide relay contacts and other necessary components, and connect as required to establish "over-ride" open/close control of the dampers from the fire command station regardless of any actions occurring at the central damper control panel.

YY. The project contains multiple smoke exhaust (purge) systems, each requiring automatic purge initiation. Manual "purge" and "override purge" control will be required and is such as to require resetting at the fire command station for each attempt to "purge" or "override". Any re-attempts to "purge" or "override" subsequent to failure of dampers to operate requires manual resetting, as does the restoration of the fire alarm system to "normal" after an "alarm" condition. To accomplish smoke purge, include:

1. Manual switching and status reporting devices, automatic control devices and other necessary equipment and wiring, at the fire command station (FCS) to automatically or manually re-open, on a floor-by-floor (or zone-by-zone) basis, dampers which have been automatically closed in response to smoke (and which must be opened to permit purge) and to open normally closed smoke exhaust dampers. Where multiple damper systems require control for purge of a single floor or zone, they are controlled as a group.

2. Include damper "open"/"closed" group status indications for the purge dampers and separately for the isolation dampers on a floor by floor basis.

3. Equipment and wiring at the fire command station to automatically or manually start the smoke exhaust system motors and to indicate system status as well. Where multiple fans are required for purge of a single floor or zone they are controlled as group. Where the smoke exhaust shafts are normally used for other purposes (minimum outside air, return, etc.), the starting of the smoke exhaust fan system motors is preceded by the automatic shutdown of all other fans served by the shaft. Include equipment and wiring at the fire command station to accomplish this.

4. Addressable modules at outlying system equipment central cabinets and addressable module boxes and interconnecting circuitry and control circuit extensions, as required to accomplish the aforementioned operation of motors and dampers in conjunction with smoke purge, as described hereinbefore.

ZZ. Control of smoke exhaust system dampers has been specified hereinbefore on a system by system basis. For the purpose of quantifying the systems, it is understood that a separate system is required for:-

1. Each fan system including recirculating air systems, which includes provisions for exhaust directly to the outside.

2. For each fan used for smoke exhaust, include three (3) additional damper systems.

Refer to HVAC air flow riser diagrams, control diagrams and/or floor plans for information as to the required smoke exhaust dampers. Refer to "Smoke Exhaust System Wiring Diagram" for detailed information regarding wiring arrangement. "No cost" modifications to this wiring arrangement will be considered for approval.

AAA. Include in the central equipment the means of controlling damper operation so as to allow smoke purge operation at any floor or combination there of for all control fan systems.

BBB. Manual control of supply and return floor isolation dampers on each floor will be required for normal building after-hours operation from a central damper control panel (CDCP), utilizing fire protective alarm system central equipment, outlying equipment control cabinets and circuitry as described hereinbefore. Additionally, these dampers will require manual override from the fire command station (FCS) and automatic control of dampers for smoke control as described below and/or specified hereinbefore. Note that the automatic control sequences and the manual control from the FCS overrides the CDCP control. To accomplish this control, include as part of the fire alarm system:

CCC. The central damper control panel (CDCP) consists of a code gauge sheet steel housing incorporating an open/close control switch and status pilot light for all dampers on each floor requiring individual floor manual control. It also includes all encoder transponders, power modules, equipment control and status reporting relays and ancillary devices as required for the proper operation of the dampers via the aforementioned tie to the fire command station as follows:

1. Open/close control and status reporting for each floor group of dampers. Control is so arranged that it will be overridden by fire alarm system automatic operation or by manual operation from the fire command station.

2. The central damper control panel is located adjacent to the Central Mechanical Panel as directed.

3. Addressable modules (and other necessary items) at the outlying cabinets and addressable boxes, control circuit extensions and interconnecting circuitry as specified hereinbefore, and/or as otherwise needed to provide the specified control functions.

DDD. For each central multifloor system supply fan whose return ductwork will be used for smoke purge provide (at the fire command station), equipment and wiring as required to automatically close all supply and return dampers on the floors served by the system, in response to alarm initiation, and to make available a control source (via a system "master" E.P. or process control device) for selectable floor by floor damper operation for smoke control. Provide a control module in the appropriate equipment control cabinet and control circuit extension to the "master" device. Modules for the individual dampers have been specified before.

EEE. At the fire command station, include devices to provide status reporting of the emergency generator ("running," "off") and each automatic transfer switch "normal," "emergency") plus manual control thereof. In addition, include an (8) wire control circuit extension from the fire command station to the emergency generator and each transfer switch and connect as required for status reporting and manual control. Include auxiliary relays if required.

FFF. At the fire command station, include devices to provide time delayed (adjustable 0-180 seconds) automatic "de-energize control" of each elevator power panel in response to EMR or elevator shaft heat detector operation, plus status indication and manual re-energize control therefrom.

GGG. Provide all system equipment and circuitry as required to provide supervisory indications at the fire command station in response to operation of fire suppression equipment contacts (furnished by others) as follows:

1. The fire pump.

    (a) "Pump running".

    (b) "Failure of Power."

2. Each water tank used for fire fighting purposes.

    (a) "Low Water Level".

    (b) “High Water Level".

3. Refer to sprinkler and/or plumbing drawings for location of fire pumps and water tanks.

HHH. The fire command station (i.e., the display and control section of the central equipment which requires operator interface) includes all components necessary for the system to function as specified, and incorporates a custom built display panel arranged to match the main lobby decor as directed by the Architect. The display panel is arranged to enable a minimum of four (4) simultaneous alarms to be displayed and include an overflow indicator and alarm advance feature. The display panel incorporates a back illuminated flashing fire sign module with 3 inch (76 mm) high red letters. Components of the central equipment which do not require operator interface are mounted in racks or cabinets. If space conditions so require such equipment is remotely located within 50 feet (15 meters) of the fire command station in a nearby, unfinished, ventilated space (as directed by the Architect). All required interconnections are included and are run in conduit.

III. Overall system supervision is accomplished by means of the response to continuous interrogating signals transmitted from the central equipment. The signal transmission rate is such that an "alarm" or "trouble" signal is processed and displayed within the 10 second maximum response time specified hereinbefore, and that subsequent initiation of automatic actions (fan shutdown, e.g.) is similarly initiated within 10 seconds.

JJJ. LCD displays and keyboards are "user friendly" incorporating the following features:

1. English language display.

2. Visually displayed <u>prompts</u> for access to "help screens," "system status files," etc.

3. Keyboard includes special function keys whose functions are clearly evident, e.g., "purge," "pressure," "start," "stop," "open," "close," "status," "fans," "damper," "help."

KKK. System software is such that the use of the aforementioned special function keys enable commands to be carried out with minimum effort. For example, purging of the 4th floor is accomplished by typing "4" followed by depressing the "purge" key. This either initiates all required control functions or displays any further action required for the purge.

LLL. In lieu of the special function keys and associated software as described above, system software may be of a type which permits direct "English language" keyboard entries (without the need for look-up tables) as required for the manual control of fans and dampers for smoke purge and other smoke control functions.

MMM. System display is prioritized so as to display alarms, controlled equipment status, supervisory indications and system test reports in a sequence and format as approved by the architect and by all authorities having jurisdiction. Specifically:

1. Equipment status display is derived from addressable monitoring modules controlled by limit switches or auxiliary contacts as indicated elsewhere.

2. Equipment status and/or changes in equipment status is not automatically displayed except that changes in status of equipment may be automatically displayed if they result from a fire alarm initiation event.

3. Where the status of equipment controlled by alarm initiation is not automatically displayed, the manual steps necessary to provide this display appear on the LCD along with the alarms.

NNN. Display formats which employ mnemonic codes and/or which depend upon written text material in order to properly operate the system are not considered as meeting these specifications.

OOO. The provisions for manual control and status reporting required at the Fire Command Station to comply with the specification requirements expressed hereinbefore, in addition to the LCD and keyboard control and status features, consist of maintained contact selector switches and pilot lights, assembled complete with engraved nameplates, into a readily accessible panel section of the Fire Command Station. Include all required equipment, devices and circuitry as necessary to interface with the central equipment of the system. Status is continuously displayed, and manual control of motors, dampers and other devices is possible without resorting to the use of the keyboard and/or keypad associated with the LCD display. Lamp test provisions is incorporated for the pilot lights. If this panel section cannot be accommodated within the confines of the enclosure allocated for the Fire Command Station, then it is separately wall (or other) mounted at an adjacent location approved by the Architect and the authorities having jurisdiction, and all required interwiring is included.

PPP. The fire command station includes a graphic annunciator panel in addition to the LDC display specified hereinbefore. The panel displays:

1. Each fire reporting zone (at least one zone per floor) an LED (or other) status indication for each of the reporting device types (i.e., manual station area smoke detector, duct smoke detector, heat detector, waterflow device, subsystem alarm).

2. All fans and the areas served by each, with a status LED for each.

3. All smoke purge or pressurization dampers with a status LED for each.

The panel display complies in all respects with Fire/Building Department requirements regarding size, format, construction and display.

QQQ. Provide detailed dimensional shop drawings of the fire command station to the party responsible for providing the enclosure. It is understood that the installation of the fire command station equipment within such enclosure is part of this work.

RRR. Include at the Fire Command Station (FCS) a Fire Department approved key switch which must be operated in order to permit manual initiation of smoke purge and any other smoke control sequences, including the re-start of equipment shut down by a system alarm prior to the clearing of the alarm condition. This key is in addition to the basic required means of securing the entire FCS against tampering by unauthorized personnel.

SSS. As part of this work, each outlying component requiring a power supply for its proper operation receives this supply over wires extended from the central equipment in a code approved manner. Power supply circuitry is 2-hour rated cable or cable system except where enclosed within 2-hour rated construction as indicated on the architectural drawings.

TTT. The system includes the following features associated with the analog addressable smoke detectors (sensors):

1. An independent "alarm verification" feature for each individual smoke detector. In response to activation of a detector, the system does not go into alarm until the detector has been reset, and has gone into alarm once again. A suitable, adjustable, time delay is incorporated into the reset procedure. Provisions are incorporated to bypass this alarm verification feature for any or all detectors so as to comply with Fire Department requirements.

2. An independent "maintenance alert" feature for each individual detector, providing a notification at the FCS identifying any detector which is operating at or above a pre-determined adjustable percentage of its alarm threshold.

3. An independent "sensitivity adjustment" feature for each individual detector, allowing the adjustment to be made from the FCS.

4. An independent "test" feature for each individual detector, allowing detector operation to be checked from - and its sensitivity reported at - the FCS.

5. A "status report" feature which provides status reports and detector sensitivity reports for each individual detector. Status reports include a summary of any initiating devices (smoke detectors or other) which have been manually disabled by operator action. Such reports are printed out in response to a command from the FCS.

UUU. The central equipment is supplied with an emergency power unit including batteries and battery charging equipment which maintains this cabinet and all outlying equipment that it subfeeds operational without any change in status for a minimum period of twenty-four (24) hours. The emergency power unit is sized to meet the following minimum requirements: operating in normal (supervisory) mode, twenty-four (24) hours, followed by 4 hours of emergency operation, except that voice alarm signaling need operate for only (15) minutes at maximum connected load. Increase if necessary to conform to additional requirements imposed by code enforcement agency. Optionally, emergency power to supply outlying equipment may be provided by local battery and charger units contained within the equipment. Battery low voltage alarm contacts activates "trouble" indication at the central equipment. Batteries are of the sealed maintenance free type.

VVV. The central equipment and outlying equipment cabinets incorporate power supply provisions capable of accommodating strobes (either individually mounted or incorporated integrally with loudspeakers) on the basis of the indicated quantity of strobes, including any strobes specified in bulk, plus 50 percent spare. Risers are sized to accommodate an "all call" arrangement for strobe operation. Emergency power for the strobes is provided by means of batteries and chargers located in the outlying equipment cabinets, and sized for 5 minutes of continuous operation after 24 hours of supervision. Batteries are of the sealed maintenance free type.

WWW. The system includes a station for manually activating the relay (called for elsewhere) at the central equipment intended for transmission of an alarm signal and to put the building fire protective alarm system into alarm. This station is located at the telephone switchboard (or at a location as specifically directed in the field) and includes all required circuitry.

XXX. Central equipment, signal transmission facilities and outlying control cabinets has capacity to handle spare points (which are in addition to those required for all functions hereinbefore specified and/or indicated in the drawings) in accordance with the following criteria:

1. "Trunk" and "branch" signaling line circuits (SLC's) are capable of accommodating enough spare alarm or supervisory initiating device points and spare equipment control points for future growth. Each equipment control point is understood to consist of two independent control functions plus two independent monitoring (i.e., "status") functions.

2. System equipment control cabinets accommodate trunk and branch circuits adequate for the required active points plus the spare points and devices specified above, and power supplies contained therein are adequate for these quantities.

3. The central equipment has capacity for the spare points described above, plus an additional capacity equal to 25 percent of those described above. The central equipment contains all equipment and devices necessary to activate these spare points. Any software necessary to support these points is also be included.

YYY. The system incorporates a "fail safe" control feature accounting for a lack of response to a fire alarm indication at the fire command station. The feature incorporates an "acknowledge" button on the fire command station, which if not depressed (following the appearance of a fire alarm indication) within a preset time period as stipulated by the Fire Department, will cause the evacuation tone signal to be sounded through all loudspeaker stations on the system.

ZZZ. The system is equipped with a "hard copy" printer located at the Fire Command Station or at another location as directed by the Architect. It incorporates the following features:-

1. It duplicates all alarm supervisory and trouble signals automatically generated by the system or operator action.

2. Changes in the status of fans, dampers and other equipment are not printed unless the change was automatically generated by an alarm initiation.

3. Print format is of alpha-numeric character which includes the month, day, year and time of occurrence, and the type and location of alarm, supervisory and trouble conditions which exist. Alarm, supervisory and trouble data are portrayed in English or mnemonic code which is readily identifiable (as approved by the Architect).

4. It prints out status and sensitivity reports for the analogue addressable smoke sensors automatically generated by the system or by the operator.

It also prints out on command a listing of any indicating devices which have been "disabled" by the system operator.

5. It includes a carriage which accepts standard (6 inch (150 mm) minimum width) roll or fan fold paper with tractor feed.

6. It operates at a print speed of a minimum of 30 characters per second and have a print density of 10 characters per inch (4 characters per cm).

AAAA. The printer is supplied with paper feed features (bails, baskets and the like) and a suitable printer stand.

BBBB. Physical features of the Fire Protective Alarm System complies with the following:-

1. Components indicated on the drawings are located where shown. Components which are required for proper operation, but which are not indicated on the drawings are located in mechanical or electrical rooms, at accessible locations within suspended ceilings or at locations for which express permission of the Architect has been obtained.

2. The visual aspect of all components of the system which are exposed to view is acceptable to the Architect.

3. Consoles are for desk or wall mounting or for setting into an architectural wall, cabinet or table as directed by the Architect.

CCCC. Unauthorized access to operable components at the Fire Command Station is prevented by means of lockable hinged doors on panels.

DDDD. Operating instructions are provided within the FCS or mounted beyond glass in a frame adjacent thereto.

EEEE. For the Central Station Service, provide a 3/4 inch (DN 21) empty rigid conduit from the Fire Command Station to the telephone frame room. Also provide a 2 #12 THWN in 3/4 inch (DN 21) conduit run from a 20 amp fuse cutout in the Fire Signaling System cutout panel to the telephone frame room. Terminate both runs as directed.

PART 3 - EXECUTION

3.1 GENERAL

A. Submit a separate "breakout" price quotation for the bulk quantity of loudspeakers (with integral strobes) specified hereinbefore. <u>As noted hereinbefore, this price is not to be included in the total base bid price</u>, and is intended only to identify the bulk quantity cost should the Owner choose to exercise the option either partially or totally. This cost includes furnishing, installation and circuitry as described hereinbefore. The unit price quotation requested below is equal to the "breakout" price divided by the bulk quantity.

B. Submit separate unit price for each of the items listed below. Each unit price quotation is for complete work, furnished, installed, complete with pro-rata interconnecting circuitry as required for its proper operation. Equipment, materials and installation methods are same as for base bid. Quotations are suitable for both additions and deductions. Unit price quotations are required for:

Item No. 1	Loudspeaker (with integral strobe unit)
Item No. 2	Manual fire alarm station
Item No. 3	Smoke detector for flush or surface mounting
Item No. 4	Smoke detector (with sampling tubes) for duct mounting
Item No. 5	Wardens intercom station
Item No. 6	Individually mounted strobe unit

C. Include as part of the base bid quotation the cleaning and sensitivity adjustment of smoke detectors and sampling tubes as needed during the warrantee period and the periodic regular testing of system devices to comply with Building Department and Fire Department requirements, during the warrantee period.

D. In addition to the base bid price quotation, submit separate quotations for each of the "Service Contract" components described hereinafter. It is understood that these quotations are for a one (1) year period commencing with the expiration of the warrantee period. The "contract" is renewable, at the Owner's option, for one (1) year periods up to a total of five (5) years. The renewal contracts are based on the original, escalated by the national C.P.I. index. The quotations are for the following:

1. Inspection and Test - Provide all material and labor to test system by actuating all outlying alarm initiating devices, all manual control devices at the fire command station and annunciators, as well as verifying operation of all loudspeakers/strobes and wardens stations. Adjust as required to provide optimum system performance. Cleaning and adjusting of smoke detectors is excluded. Parts and labor for repairs and/or replacements is also excluded. Provide unit prices for all components of the system, installed in place. This service is provided at regular intervals complying with the requirements of the Building Department and the Fire Department.

2. Cleaning and Adjusting Smoke Detectors - Provide all material and labor for cleaning and adjusting the sensitivity of all area and duct type smoke detectors and sampling tubes. Cleaning is performed every six months. The sensitivity is checked once per year, and adjusted as required to insure compliance with UL requirements. Where detectors cannot be adjusted to so comply, they are replaced. Quotations are on a per unit basis for the cleaning and adjusting, with a separate quotation for replacement of any head that cannot be field adjusted to be within UL specified limits.

3. Repairs and Replacement - Provide all labor and parts as necessary to repair and/or replace any and all defective equipment components.

E. If the fire alarm system is not manufactured locally, but is supplied by a local distributor, the manufacturer will provide a "letter of support" stipulating that when - in the opinion of the engineer - the distributors efforts require backup, the manufacturer will provide at no cost to the Owner, all required technical support manpower in a timely manner during the installation period, and for a one year two year warrantee period thereafter.

F. The fire alarm system manufacturer stipulates to the following:

1. Upon acceptance of the system, the manufacturer, or his factory authorized distributor will turn over to the Owner the job-specific program information (on disk) to enable the servicing, repair and expansion of the system by any factory-approved service agency the Owner opts to utilize.
2. Prior to award of contract, the manufacturer will furnish the names of (3) factory approved service agencies located within 50 miles of the project. Such agencies are capable of providing all levels of maintenance servicing and programming as may be required. Failure to comply will be sufficient grounds for disqualifying the system manufacturer.

3.2 INSTALLATION, GENERAL

A. Install system according to NFPA standards referred to in Parts 1 and 2 of this Section.

B. Each outlying component requiring a power supply for its proper operation receives this supply over wires extended from the central equipment in a code approved manner.

C. Comply with the applicable requirements of other sections of Division 16 for locating and routing circuitry, for installing circuitry, for firestopping and for identification.

D. Adjust the sensitivity of all smoke detector (sensors) on the basis of the actual environment to which each will be subjected (i.e., air movement, ambient dust/dirt levels and temperature, humidity levels) in accordance with manufacturers instructions.

E. Paint the outside parts of all equipment cabinets and all junction boxes, pull boxes and outlet boxes red.

3.3 EQUIPMENT INSTALLATION

A. Manual Pull Stations: Mount semiflush in recessed back boxes with top of operating handles 48 inches (122 cm) above the finished floor or lower as indicated.

B. Water-Flow Detectors and Valve Supervisory Switches: Connect for each sprinkler valve station required to be supervised.

C. Smoke Detectors: Install ceiling-mounted detectors not less than 4 inches (10 cm) from a side wall to the near edge. Install detectors located on the wall at least 4 inches (10 cm), but not more than 12 inches (30 cm) below the ceiling. For exposed solid-joist construction, mount detectors on the bottom of the joists. On smooth ceilings, install detectors not over 30 feet (9 meters) apart in any direction. Install detectors no closer than 60 inches (150 cm) from air registers.

D. Loudspeaker/Strobes: Install 80 inches (203 cm) (to bottom of device) above the finished floor <u>nor</u> less than 6 inches (15 cm) below the ceiling. Install on flush-mounted back boxes with the device-operating mechanism concealed behind a grille or as indicated. Provide box extension and furnish collar where wall depth cannot accommodate flush backbox. Combine audible and visual alarms at the same location into a single unit.

E. Control Panels: Surface mount with tops of cabinets not more than 72 inches (182 cm) above the finished floor. Conduits are not permitted to enter the top of control cabinets. Only side and bottom entries are permitted.

F. Provide final connections (i.e., control circuit extensions) from each addressable module box to the equipment "controller" it services, utilizing THWN wires run in conduit in accordance with the following:-

1. From each box supplying a fan motor, provide a 5 #14 control circuit run in conduit to the motor controller and connect as indicated on the drawings.

2. From each box supplying a supply or return damper which must be closed by the FPA system to isolate a floor served by multi-floor fan system which will be allowed to run during a fire, provide a 5 #14 THWN run in conduit to the damper control device and end switch. Provide, for each box, a 120 volt supply from a normal panel. Connect for damper closure and status indication in response to automatic alarm initiation on the floor or manual control from the Fire Command Station. Provide a 2 #14 in conduit circuitry run to an interface control device (relay or other) for each damper. Device will be provided within 10 feet (3 meters) of the damper as part of the automatic temperature control work. Connect as directed.

3. From each box supplying a damper requiring individual manual control from the central damper control panel (CDCP), but for which direct manual or automatic control by the FPA system is not specified, provide a 5 #14 run in conduit to the damper control device and end switch. Provide, for each box, a 120 volt supply from a "normal" panel. Connect for damper closure and status indication in response to manual control from the CDCP. Provide a 2 #14 in conduit circuitry run to an interface control device (relay or other) for each damper. Device will be provided within 10 feet (3 meters) of the damper as part of the automatic temperature control work. Connect as directed.

4. From each box supplying elevators, provide a 8 #14 run in conduit to the elevator group controller, and connect so that elevators are recalled to the terminal floor - or alternate floor - in response to operation of waterflow switch, elevator lobby detector, or elevator room smoke or heat detector, an "elevators recalled" status signal is activated at the FPA system central equipment, and an "elevators not safe for use" signal is activated in the elevators in response to operation of detectors in the elevator machine room or elevator shaft. If the elevator machine room and/or associated shafts are sprinklered, provide an additional 6#14 run in conduit from the box to an upstream device, arranged so as to provide a time delayed (adjustable 0 - 180 seconds) shutdown of the power to the elevator power panel, to permit a remote manual restoration of power from the FCS, and a "status" indication at the FCS.

5. From the box supplying the fire stair door unlocking system, provide a 2 #12 run in conduit to an adequate 120 volt supply and a 2 #12 extension in conduit to all fire stair door unlocking mechanisms. Provide any necessary low voltage supplies, and connect so that all doors are unlocked in response to the operation of any automatic alarm initiating device on the system or in response to all "elevators recalled" status signal generated by these automatic devices or by operation of the Firemen's Service key for Phase I recall. Include a 3 #12 run in conduit to a switch and pilot light station located adjacent to the FCS and manual unlocking.

6. From the box supplying the fire/smoke door release system, provide a 2 #12 run in conduit to an adequate 120 volt supply and a 2 #12 extension in conduit to all fire/smoke door release mechanisms. Provide door release mechanisms and any required low voltage power supplies, and connect so that all doors are released in response to the operation of any automatic alarm initiating device on the system. Include a 3 #12 run in conduit to a switch and pilot light station and connect for manual door release.

7. From each box supplying a fire stair or elevator machine room smoke vent, a 4 #12 run in conduit to the smoke vent release mechanism and limit switch. Include a release in response to a local smoke detector and status indication.

8. From each box supplying an escalator controller, a 4 #14 run in conduit to the controller and connect for shutdown and status indication in response to operation of any waterflow switch or smoke detector on the system.

3.4 WIRING INSTALLATION

A. Wiring Method: Install wiring in metal raceway in accordance with the following. Conceal raceway except in unfinished spaces and as indicated. Note that certain circuitry has been specified hereinbefore as 2-hour rated. These requirements are in addition to the requirements that follow.

1. Cable is run in conduit throughout, and conforms to the requirements for nonpower-limited fire protective signaling circuit cable as expressed in Article 760 of the National Electrical Code, and is U.L. classified to conform to these requirements. For conductors #14 AWG and larger, cable insulation types THHN, THHW or XHHW is considered as fulfilling these requirements. Smaller size conductors have insulation types specifically U.L. approved as type NPLF, and so identified by markings on the outer surface of the cable at regular intervals. Conduit is electric metallic tubing or threaded metallic conduit subject to the restrictions hereinbefore specified for light and power circuitry throughout the project.

B. Minimum conductor size for circuitry supplying loudspeakers or strobes is #16 AWG copper and for all other circuitry not specifically sized elsewhere minimum conductor size is #18 AWG copper.

C. Wiring within Enclosures: Install conductors parallel with or at right angles to the sides and back of the enclosure. Bundle, lace, and train the conductors to terminal points with no excess. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with the fire alarm system to terminal blocks. Mark each terminal according to the system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

D. Conduits are not permitted to enter the top of control cabinets. Only side and bottom entries are permitted.

E. Cable Taps: Use numbered terminal strips in junction, pull or outlet boxes, cabinets, or equipment enclosures where circuit connections are made.

F. Color Coding: Color-code fire alarm conductors differently from the normal building power wiring. Use one color code for alarm circuit wiring and a different color code for supervisory circuits. Color-code audible alarm-notification circuits differently from alarm-initiating circuits. Use different colors for visual alarm-notification circuits. Paint fire alarm system junction boxes and covers red.

3.5 GROUNDING

A. Ground cable shields and equipment according to system manufacturer's instructions to eliminate shock hazard and to minimize, to the greatest extent possible, ground loops, common mode returns, noise pickup, cross talk, and other impairments.

B. Signal Ground Terminal: Locate at main equipment rack or cabinet. Isolate from power system and equipment grounding.

C. Connect to grounding electrode specified in Division 16 Section "Grounding and Bonding." Install grounding electrode conductors of type, size, location, and quantity as indicated. Comply with installation requirements of Division 16 Section "Grounding and Bonding."

D. Ground equipment and conductor and cable shields. For audio circuits, minimize, to the greatest extent possible, ground loops, common mode returns, noise pickup, cross talk, and other impairments.

3.6 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Provide services of a factory-authorized service representative to supervise the field assembly and connection of components and the pretesting, testing, and adjustment of the system.

B. Include the services of an independent certified testing agency acceptable to the local fire department, where so required by the fire department or local regulations, for pretesting and final testing. Include costs to perform testing outside of normal working hours if required by fire department or by project schedule.

C. Pretesting: After installation, align, adjust, and balance the system and perform complete pretesting. Determine, through pretesting, the conformance of the system to the requirements of the Drawings and Specifications. Correct deficiencies observed in pretesting. Replace malfunctioning or damaged items with new ones and retest until satisfactory performance and conditions are achieved. Prepare forms for systematic recording of acceptance test results.

D. Report of Pretesting: After pretesting is complete, provide a letter certifying the installation is complete and fully operable, including the names and titles of the witnesses to the preliminary tests.

E. Final Test Notice: Provide a 10-day minimum notice in writing when the system is ready for final acceptance testing.

F. Minimum System Tests: Test the system according to the procedures outlined in NFPA 72. Minimum required tests are as follows:
   1. Verify the absence of unwanted voltages between circuit conductors and ground.
   2. Test all conductors for short circuits using an insulation-testing device.
   3. With each circuit pair, short circuit at the far end of the circuit and measure the circuit resistance with an ohmmeter. Record the circuit resistance of each circuit on the record drawings.
   4. Verify that the control unit is in the normal condition as detailed in the manufacturer's operation and maintenance manual.
   5. Test initiating and notification circuits for proper signal transmission under open circuit conditions. One connection each should be opened at not less than 10 percent of the initiating and notification devices. Observe proper signal transmission according to class of wiring used.
   6. Test each initiating and notification device for alarm operation and proper response at the control unit. Test smoke detectors with actual products of combustion.

   7. Test the system for all specified functions according to the approved operation and maintenance manual. Systematically initiate specified functional performance items at each station, including making all possible alarm and monitoring initiations and using all communications options. For each item, observe related performance at all devices required to be affected by the item under all system sequences. Observe indicating lights, displays, signal tones, and annunciator indications. Observe all voice audio for routing, clarity, quality, freedom from noise and distortion, and proper volume level.

   8. Test Both Primary and Secondary Power: Verify by test that the secondary power system is capable of operating the system for the period and in the manner specified.

G. Retesting: Correct deficiencies indicated by tests and completely retest work affected by such deficiencies. Verify by the system test that the total system meets the Specifications and complies with applicable standards.

H. Report of Tests and Inspections: Provide a written record of inspections, tests, and detailed test results in the form of a test log. Submit log upon the satisfactory completion of tests.

I. Tag all equipment, stations, and other components at which tests have been satisfactorily completed.

3.7 CLEANING AND ADJUSTING

A. Cleaning: Remove paint splatters and other spots, dirt, and debris. Touch up scratches and marred finish to match original finish. Clean unit internally using methods and materials recommended by manufacturer.

B. Adjusting: Adjust sensitivity of each detector based on the environment to which it will be subjected.

3.8 DEMONSTRATION

A. Startup Services: Engage a factory-authorized service representative to provide startup service and to demonstrate and train Owner's maintenance personnel as specified below.

1. Train Owner's maintenance personnel on procedures and schedules related to startup and shutdown, troubleshooting, servicing, adjusting, and preventive maintenance. Provide a minimum of 16 hours training.

2. Training Aid: Use the approved final version of the operation and maintenance manual as a training aid.

3. Schedule training with Owner with at least 7 days advance notice.

3.9 ON-SITE ASSISTANCE

A. Occupancy Adjustments: When requested within one year of date of Substantial Completion, provide on-site assistance in adjusting sound levels, controls, and sensitivities to suit actual occupied conditions. Provide up to 3 requested adjustment visits to the site for this purpose.

END OF SECTION 16721

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section. The Owner's General Conditions shall be considered part of this Specification. Unless this Section contains statements, which are more definitive or more restrictive than those contained in the Owner's General Conditions, this Specification shall not be interpreted as waiving or overruling any requirements expressed in the General Conditions.

1.2 SUMMARY

A. Location

1. This specification section applies to the paging system to be installed in the New Terminal of the Duluth International Airport in Duluth, MN.

B. Description

1. The Duluth Airport Authority has commissioned a new passenger terminal building to support four airline carriers.
2. The three story building features large expansive spaces, contemporary architectural design and high quality finishes to clearly establishing the terminal as a world class facility.
3. The facility will feature four gates; Gate 1 can be configured to receive international flights on an "as needed" basis.
4. The architectural team has programmed public space such as Check-in Lobby, Circulation, Passenger Waiting, TSA Checkpoints Gates, International processing and Baggage Claim.
5. Support spaces include offices for Administrative Staff, Maintenance workers, TSA staff, and Security staff.
6. A bar and servery space will provide food and vending for travelers and will feature independent AV systems designed by others.
7. The third floor of the building provides a large meeting and conference space. This area is multipurpose in nature and will facilitate community events, meetings, presentations, and emergency operations.

8. It should be noted that the Meeting and Conference Rooms, Bar and Multipurpose room independent AV systems are not included in this scope of work. However, the audio output from these systems should be routed to the Paging System and should be capable of accepting a signal from the paging that will 'duck' the local room audio source and amplify the paging system over each particular rooms amplification system. This arrangement will allow the ability to override the local systems with higher priority announcements.

C. The "Paging system" references the systems specifically identified for this project. These systems are identified as:

1. Paging Systems
   a. Including but not limited to:
      1) Paging Stations
      2) Ambient Noise Microphones
      3) Ambient Noise Compensation Devices
      4) PoE Network Switches
      5) 70V speakers (wall and ceiling type)
      6) BGM source (by others)
      7) Bar source (by others)
      8) Conference room source (by others)
      9) Sound Masking Generator/EQ
      10) Feed from Fire/Life Safety System (by others)
      11) 70V amplifiers with backup capability
      12) Audio input and output expansion devices
      13) Message Server
      14) Rackmount PC
      15) Rackmount KVM
2. Miscellaneous
   a. Including but not limited to:
      1) Equipment Racks
      2) Technical and Rack panels
      3) Power distribution and conditioning

D. General requirements

1. The paging system (PS) shall be based on IEEE 802.3af PoE Ethernet Network Infrastructure. All cabling, conventions, and equipment shall be consistent with this IEEE standard.

2. The PS shall use a VLAN (detailed below) for transport of all digital audio data, including all recorded and live voice messages, preambles, background music, and other audible signals. This same Network shall carry monitoring and control data to and from each PS device. This audio data traffic shall be standard Cobranet at a sample rate of 48 kHz.
3. All PS components shall be continuously monitors for presence, proper function, and faults. Each and every fault must be logged and be able to be viewed and copied the attached Monitoring Computer (detailed below) running software supplied by the Manufacturer.
4. All PS components shall be addressable on the Cobranet LAN (or vLAN).
5. All PS preambles, voice prompts, and recorded announcements shall be in a common audio format. The PS shall be capable of importing custom preambles, prompts, and announcements through software running on the attached Monitor Computer.
6. Each PS device shall have sufficient on-board memory to retain its configuration and settings in the event of a power loss.

1.3 RELATED WORK

A. Paging systems contractor shall coordinate with the General/Electrical Contractor on raceway/junction box location for paging systems equipment and routing of audio, control and power cables/raceway from equipment terminal, and pull boxes to system equipment racks as necessary.

B. Equipment and materials provided and installed by others shall include but are not limited to (unless otherwise shown).
   1. Telecommunications items for accessing building LAN.

1.4 DEFINITIONS

E. The following shall serve as general identifiers as specified herein.
   1. Owner – Duluth Airport Authority
   2. Paging Systems Consultant – Shen Milsom & Wilke, LLC
   3. Contractor – The Contractor is the firm submitting a proposal to furnish and install the Work as defined within this Specification. Note: Paging Systems Contractor is to be a subcontractor to the General Contractor for this project.
   4. Project – The Project is the Duluth International Airport New Terminal Design.
   5. Work – The term “Work” means all construction and services specified within this document. The Work includes all related

labor, materials, equipment, and services provided, or to be provided, by the Systems Contractor to fulfill the proposal's obligations.

6. Drawings – The term "Drawings" means all Paging Systems Drawings and associated sketches, details, riser diagrams, etc.

7. As used in the Drawings and Specifications for the Work, certain non-technical words and phrases shall be understood to have specific meanings as follows, regardless of indications to the contrary in the General Conditions or other documents governing the Work.

    a. "Furnish" – Purchase and deliver to the project site complete with every necessary appurtenance and support, all as part of the Paging Systems Work. Purchasing shall include payment of all sales taxes and other surcharges as may be required to assure that purchased items are free of all liens, claims, or encumbrances.

    b. "Install" – Unload at the delivery point at the site and perform every operation necessary to establish secure mounting and correct operation at the proper location in the project, all as part of the Work.

    c. "New" – Manufactured within the past year and never before used.

    d. "Provide" – Furnish and Install.

8. Regardless of their usage in codes or other industry standards, certain words or phrases as used in the Drawings or Specifications for the Work, shall be understood to have the specific meanings as ascribed to them in the following list:

    a. "Circuit" – Any specific run of circuitry

    b. "Circuitry" – Any Work which consists of wires, cables, raceways, and/or specialty wiring method assemblies complete with associated junction boxes, pull boxes, outlet boxes, joints, couplings, splices, and connections except where limited to a lesser meaning by specific description.

    c. "Concealed" (as applied to circuitry) – Covered completely by building materials, except for penetrations (by boxes and fittings) to a level flush with the surface as necessitated by functional or specified accessibility requirements.

    d. "Exposed" (as applied to circuitry) – Not covered in any way by building materials.

    e. "Normal Work Conditions" – Locations within building confines that are not damp, wet, or hazardous and that are not used for air handling.

f. “Patch Panel” – A System of terminal blocks, patch cords, and backboards that facilitate administration of cross-connecting cables.

g. “Raceway” – Any pipe, duct, extended enclosure, or conduit (as specified for a particular System) which is used to contain wires and which is of such nature as to require that the wires be installed by a “pulling in” procedure.

h. “Riser” – Shall refer to the portion of the installation that transmits between building floors (or between Paging Systems rooms), also referred to as “Backbone Cabling.”

i. “Paging System Closet” – The enclosed area or room specifically designated for the routing, termination, and/or cross connecting of Paging Systems cable (i.e. riser cable) to other Paging Systems cable and/or equipment.

j. “Paging Systems Control Room” and/or “Paging Systems Headend” – The enclosed area or room specifically designated for the routing, termination, and/or cross connecting of Paging System cable (i.e. riser cable) to other Paging System cable, and/or equipment and racks.

k. “PAGING System(s)” – Paging System(s), includes all components contained herein that work in conjunction to create and completely integrated and fully functioning system as described within the Drawings and Specifications

l. “Paging Systems Wiring” – see “Circuitry”

m. “Paging Systems Work” – See “Work”

n. “Standard” (as applied to wiring devices) – Not of a separately designated individual type.

o. “Subject to Mechanical Damage” – Exposed within 6 feet of the floor in mechanical rooms, manufacturing spaces, vehicular spaces, or other spaces where Paging items are moved around or rigged as a common practice or as required for replacement purposes.

p. “System” – See “PAGING Systems”

q. “Wiring” – see “Circuitry”

r. “PGC” – Paging Systems Contractor

s. “EMS” – Energy Management System

t. “DCS” – Distributed Control System

9. Where the word “conduit” is used without specific reference to type, it shall be understood to mean “raceway.”

10. Reference to “U.L. (Materials Construction) Standards” shall mean the “Standards for Safety” published by Underwriters Laboratories, Inc.

1.5 SCOPE OF WORK

A. General:

1. Provide Paging systems design, engineering, and installation within all phases and spaces of the Project. Systems are to include all devices, equipment, installation, programming and commissioning in accordance with requirements of the contract documents and drawings.

2. The Work detailed within the Contract Documents has been specified to meet certain requirements for performance, appearance, and costs. It shall be the responsibility of the Contractor to implement the guidelines and requirements contained in the Contract Documents and translate them into a complete design package containing all elements necessary for a complete, operational, and functionally integrated Paging System(s).

3. Provide all work as detailed in the Contract Documents as a turnkey installation including all material, labor, engineering, warranties, taxes, freight, and permits. Only items and requirements specifically stated to be provided by others shall not be a requirement for this Section of the Work.

B. Work Included:

1. Refer to Sections contained in PART 2, 16 7 26 for Scope requirement and System descriptions. See attached Appendix for the Master Recap form that must be completed as part of the bidding process. This is provided for the post bidding evaluation process.

C. Work Specified Elsewhere

1. Installation of raceway, pull-boxes, plywood backboards, and floor-boxes (provided under electrical Work). Coordination is required within the design to verify the appropriate raceways are in place.

2. Installation of Cable Tray.

3. Installation and termination of Data and Communication Structured Cabling and RF distribution systems for items that access building LAN.

4. Cutting, patching, and painting of walls, unless damaged performing the work described herein.

5. Lighting Control systems.

D. Coordinated Work

1. Coordinate with related trades to schedule the Work and ensure a complete installation in accordance with the schedule outlined by the Owner.
2. Coordinate all IP device requirements with the Data vendor, Owner, and Contractor.
3. Coordinate all network connectivity requirements with the low voltage cabling contractor and Owner for items that access building LAN.

1.6 GENERAL CONDITIONS

A. Work Experience Coordination and Compliance

1. The Contractor represents that they are familiar with, and have expertise in the Work of this nature and scope. The Contractor further agrees that they shall provide all Work as may be required to make a complete job of that which may not be fully defined in the Programmatic Documents.
2. The Contractor shall comply with all of the regulations, including safety regulations of national, city, local and other government agencies having jurisdiction concerning the work of the Contractor. The Contractor shall give all notices and comply with all laws, ordinances, codes, rules, and regulations bearing on the conduct of the Work. If the Contractor performs any work, which is contrary to such laws, ordinances, codes, rules and regulations, they shall make all changes for compliance and bear all associated costs.
3. The Contractor warrants that both they and their subcontractors are licensed as required by the authorities having jurisdiction and as required by local ordinances.
4. The Contractor must state if they intend to utilize a subcontractor, and provide said subcontractor's name and address. The subcontractor shall comply with all the same rules, regulations, laws and codes, licenses, etc. as required by the Contractor and as specified herein. The Owner reserves the right to approve or disapprove any subcontractor proposed by Contractor.
5. All of the Contractor's work shall be tested and inspected by all authorities having jurisdiction and in accordance with all Specifications. The Contractor shall coordinate and cooperate fully and shall provide at no additional cost to the Owner, manpower, blueprints, facilities, scaffolds, etc. to reasonably assist the inspectors.
6. All permits required for any part of the Contractor's work shall be procured and paid for by the Contractor. The Contractor shall determine all permits required and transmit this information to the Owner.

7. The Work called for under this Contract shall be carried on simultaneously with the Work of other trades and Owner functions in such a manner as to not delay the overall progress of the construction project. The Contractor is responsible for all coordination of the Work with other trades.
8. Include in the Work all necessary supervision and issuing of all coordination information to any other trades who are supplying work to accommodate the Paging Systems installation.

B. Quality of Workmanship

1. The Contractor, upon receiving notice from Owner that the Contractor has furnished inferior, improper or unsound work or materials (including equipment), or work or materials at variance with that which is specified, will, within 24 hours, proceed to remove such work or materials and make good all other work or materials damaged thereby, and, at the option of the Owner, the Contractor shall immediately replace such work or materials with work or materials as specified. The removal, replacement, and repair shall be performed at such times and with manpower sufficient, in the judgment of the Owner, so as to avoid disturbance to occupants, or other ongoing work for the Project.
2. If the Contractor does not remove such unsound Work within a reasonable time, the Owner may remove it and may store the material at the expense of the Contractor. If the Contractor does not pay the expenses of such removal within ten (10) days time thereafter, the Owner may, upon written notice, sell such materials at auction or at private sale and shall account for the net proceeds thereof, after deducting all the costs and expenses that should have been borne by the Contractor and all expenses of the sale.
3. The Owner shall have the authority at all times, until final completion and acceptance of the Work, to inspect and reject work and materials which in its judgment are not in conformity with the Drawings and Details, Room Data Sheets and Specifications, and its decision in regard to character and value of Work shall be final and conclusive on both contracting parties. If the Owner permits said Work or materials to remain, the Owner shall be allowed the difference in value or shall at its election have the right to have said Work or materials repaired or replaced, as well as the damage caused thereby, at the expense of the Contractor, at any time within one (1) year after the completion of the entire project, or within such longer period as may be covered by any guaranty; and neither payments made to the Contractor, nor any other acts of the Owner, shall be construed as evidence of acceptance, waiver, or estoppels.
4. Any expense incurred by the Owner in connection with the foregoing, shall be borne by the Contractor, and the Owner may withhold money due to the Contractor or recover money already paid to the Contractor, to the extent of such expense.

C. On-Site Storage

1. The Contractor shall be responsible coordinate and maintain a storage space.
2. If this storage space is required to be on-site it shall be the Contractor's responsibility to coordinate the size and spatial requirements with the Owner.
3. The Contractor shall assume full responsibility for the storage space and all contents, unless otherwise indicated by the Owner.
4. The Contractor shall examine the site and the Programmatic Documents and review with the Owner the designated areas of access, delivery, and storage for the Contractor's use. The Contractor agrees that such areas are satisfactory and sufficient for their needs in the completion of their work and in conformance with the terms of this Contract.

D. Protection from Damage

1. The Contractor shall provide all protection necessary to safeguard their work from damage by their operations and the operations of others. Unless the Contractor proves to the Owner’s satisfaction that the Work has been damaged by others, the Contractor shall promptly repair, adjust, and clean all defective installations and bear all associated costs.

E. Owner Furnished Equipment

1. The Owner reserves the right to furnish any materials necessary for the Project.
2. For items of equipment which are to be installed but not purchased as part of the Work, the Work shall include:
   a. Coordination of delivery
   b. Unloading from delivery trucks
   c. Safe handling and field storage up to the time of permanent placement in the project
   d. Correction of any damage to the item(s)
   e. Mounting in place and connection(s) as specified
3. Items which are to be installed, but not purchased as part of the Work shall be carefully examined upon delivery to the project. Claims that any of these items have been received in such condition that their installation will require procedures beyond the reasonable scope of the Work will be considered only if presented in writing within one (1) week of the date of delivery to the project of the items in question. The Work includes all procedures necessary to put in satisfactory operation all items for which no claims have been submitted as outlined above.

F. Design Intent

1. The project documentation is, in general, diagrammatic and/or developed to communicate design intent. The Contractor shall coordinate the installation of all devices and/or equipment with the Owner prior to installation based on the existing field conditions.

2. It shall be understood that the Specifications and Drawings are complementary. Where there are conflicts within the documents, the overall design intent shall govern.

3. To the extent that they govern the Work, the Program documents, Specifications and Drawings also govern change order Work, if any.

4. The Drawings for the Work utilize symbols and schematic diagrams that have no dimensional significance. The Work shall be installed to fulfill the diagrammatic intent expressed on the Drawings, field layouts, and shop drawings of all trades.

5. Certain details appear on the Drawings for the Work that are specified with regard to the dimensioning and positioning of the Work. These are intended only for general information purposes. They do not obviate field coordination for individual items of the indicated Work.

6. Information as to general construction and architectural general construction and architectural features and finishes shall be derived from the structural and architectural drawings and specifications, are may require ongoing coordination with the Architect.

7. Ratings of devices, materials, and equipment specified without reference to specific performance criteria shall be understood to be nominal or nameplate ratings established by means of industry standard procedures.

8. It is the intent of the Drawings and Specifications to provide complete operating Paging Systems. All Work necessary to provide such a System shall be performed. Any discrepancies shall be brought to the Consultant’s attention.

1.7 PROJECT MANAGEMENT

A. Project Manager

1. The Contractor shall provide a Project Manager to oversee and coordinate all activities on the Project

2. Project Manager’s Duties and Responsibilities:

   a. The Contractor shall provide to the Owner, as a part of the prefabrication submittal, the name of the Project Manager that will provide all duties and responsibilities as specified herein, during the term of the project.

b. The Project Manager shall maintain the ability of making all managerial decisions on behalf of the Contractor on a day-to-day basis, and shall retain the authority of accepting notices of deduction, inspection reports, payment schedules and any other project related correspondence on behalf of the owner.

c. The Project Manager shall schedule and attend project management meetings, during which time all System related issues are discussed, scheduled, confirmed, and/or resolved.

d. The Project Manager shall be available during normal business hours during the term of the project.

e. After normal business hours, the Project Manager shall be available within four (4) hours by telephone during the term of the project.

1) In the event that the Project Manager is not available within the allotted time frame, the Contractor may designate another employee to temporarily act as the Project Manager in all correspondence with the Owner.

2) The Contractor shall ensure that any individual temporarily assuming the duties of the Project Manager is at equal or higher level in the Contractor's managerial chain of command.

3. Upon notification by the Owner, of any project related installation issue, or issue that may contradict the Specifications as stated herein, the Project Manager shall respond to such issue, verbally and/or in writing within an eight (8) hour period.

a. Responses to such issues as stated above shall include a clear understanding of the issue, along with a tentative plan of action, reflecting milestones and/or deadlines to resolve the issue.

b. Where appropriate, based on the overall importance of the project issue, the Project Manager shall follow-up their initial response with a written response to the issue within 24 hours of identification of the issue.

4. Prior to the initiation of the Work, the Project Manager shall submit a schedule reflecting key milestones of the Work, including but not limited to the following:

a. Bid award

b. Kick-off meeting

c. Master Plan submittal

d. Prefabrication submittal

e. Ordering, delivery, and installation of head-end System equipment

f. Field equipment delivery

g. Project management schedule

h. Payment schedule

i. Installation completion date

j. System training

k. Delivery of As-Built documentation

l. Delivery of Operations & Maintenance Manuals

m. Final System test

n. Acceptance of System

5. The Project Manager shall update the schedule on a weekly basis to reflect the status of each key milestone as the Work progresses.

6. As the System installation progresses, the Project Manager shall be capable of discussing any/or all of the above mentioned items at the request of the Owner, and shall address each item, as it relates to the current status of the Work.

1.8 REFERENCES

A. The Paging Systems shall be installed in accordance with the latest applicable revisions pertaining to all applicable national, state, and local codes and standards including, but not limited to the following:

1. National Electrical Code (NEC), current state recognized edition.

2. Uniform Building Code (UBC), current state recognized edition.

3. Local Governing Authorities Having Jurisdiction

4. Telecommunications Industry Association (TIA).

1.9 SUBMITTALS

A. Sequence

1. Shop Drawings - Upon award of Contract, submittals shall be prepared and submitted for review by the Owner, Architect, and Paging Consultant prior to commencement of any work.

2. Record Documents - Upon completion of systems and Contractor System Check Out, Record Documents to be created and submitted for review prior to system final acceptance.

3. Operation and Maintenance Manuals– Shall be produced for review prior to Owner Training.

B. Furnish submittals in accordance with general requirements specified in Division 1, SUBMITTALS.

C. Prefabrication Submittals

1. NOTE: ELECTRONIC SUBMISSION OF SUBMITTALS IS ACCEPTABLE IF ACCEPTABLE BY OWNER.
2. Submit pre-fabrication submittals in accordance with the Owner's construction schedule.
3. Pre-fabrication submittals shall consist of product data, shop drawings, samples, and a detailed completion schedule. Partial submittals will not be accepted without prior written approval from the Architect.
4. Pre-fabrication submittals shall be furnished in electronic formats as defined by the General Conditions under Part 1 of the Project Specifications.
5. No portion of the Work shall commence nor shall any equipment be procured until the Architect has approved the pre-fabrication submittals in writing.
6. A letter of transmittal identifying the name of the Project, Contractor's name, date submitted for review, shall accompany pre-fabrication submittals and a list of items transmitted.
7. Product data required as part of the pre-fabrication submittal shall include the following:
   a. Product Submittals
      1) Equipment schedules listing all System components, manufacturer, model number and the quantity of each
      2) Submit manufacturer's product data sheets for all materials and equipment proposed for use on the project sorted by room and indexed.
      3) Mark each product data sheet to show applicable choices and options (sheets containing more than one device or component model number shall be clearly marked to delineate items included in the Work)
   b. Submit manufacturer's product data sheets for all fire stopping materials proposed for use on the project.
   c. A complete list of finishes and sample graphics, including custom art work and custom graphics (if applicable)
   d. DSP Program Matrix drawings or program print out.
   e. Project Calculations

f. Cable run sheets denoting cable type, signal type, termination type, cable number designation, start point and end point.

g. Shop Drawings

1) Detailed plan views and elevations of Paging Control and/or Headend rooms (in addition to relevant telecommunications rooms) showing raceway, sleeves, cable tray, cable paths, equipment racks, equipment cabinets, termination blocks, power receptacles and grounding bus bars.

2) Cable termination schedules showing cable transmission and device location. This can be shown on the drawings or in a separate spreadsheet.

3) Floor plan drawings indicating device locations with device legends

4) System riser diagram with all devices, wire runs, and wire designations

5) Schematic block diagrams for each System showing all equipment, interconnects, data flow, etc.

6) Fabrication shop drawings for all custom equipment (if applicable)

7) Plans and elevations of the Paging equipment racks and/or custom furniture (including consoles, desks, and lecterns) quantifying all equipment to be mounted therein

8) It is the responsibility of the Contractor to confirm all dimensions, quantities, and the coordination of materials and products supplied by the Contractor with other trades. Approval of shop drawings containing errors does not relieve the Contractor from making corrections at their expense.

D. Samples

1. The Contractor shall submit samples of any equipment components upon request of the Owner.

2. Samples submitted shall be the latest version of equipment.

E. Record Documentation

1. NOTE: ELECTRONIC SUBMISSION OF SUBMITTALS IS ACCEPTABLE IF ACCEPTABLE BY OWNER.

2. Shall include all information required in the Pre-fabrication Submittals but revised to reflect “as installed” conditions.

3. General Description and Requirements

   a. Submit Record Documentation in accordance with the Architect's construction schedule.

   b. Provide a letter of transmittal with Record Documentation identifying the name of the Project, Contractor's name, date submitted for review, and a list of items transmitted.

   c. Prior to the final acceptance of the Work, submit two draft sets of the Record Drawings portion of Record Documentation to the Architect. The draft copy shall be used during the final acceptance testing by the Architect.

   d. Update all record documentation to reflect changes or modifications made during final acceptance testing as required and submit three blue/black lines and one reproducible set.

   e. Provide cable test results for all cables installed under this Work, tested, and documented as described herein.

   f. Provide Owner with all systems programming on electronic media. The Owner is granted the rights to use and modify the code for the systems specified within this scope of work.

4. Record Drawings

   a. Produce all Record "as-built" Drawings using the latest version of AutoCAD and in PDF format. Record drawings shall, at a minimum, include the following:

      1) Floor plan drawings indicating device locations, with device legends indicating manufacturers and model numbers for each device

      2) Floor plan drawings indicating wire routing, wire routing shall be delineated in straight line runs and be tagged with cable identification and terminal strip numbers to coincide with the installation

      3) Mounting details for all equipment and hardware

      4) Functional block diagrams for each subsystem

      5) Wiring details showing rack elevations, equipment wiring and terminations, and inter-rack wiring

      6) Wiring diagrams for all custom circuitry including interfaces to various control output controlled devices, lighting control interfaces, projections screens, operable window treatments, motorized doors/partitions, etc.

      7) Wiring diagrams for each System, including a copy laminated and located within each equipment rack.

8) Typical point-to-point wiring diagrams for each piece of equipment and groups of equipment within the System

9) Layout details for each riser location, including Paging panels, power supplies, junction boxes, conduit, and any other Paging related equipment

5. Operation and Maintenance Manuals

a. Operation and Maintenance Manuals shall apply to all Paging related devices, equipment, and software modules.

b. Operation and Maintenance Manuals shall be formatted as follows:

1) Bind each manual in a hard-back loose-leaf binder.

2) Identify each manual's contents on the cover.

3) Provide a table of contents and tabulated sheets for each manual. Place tab sheets at the beginning of each chapter or section and at the beginning of each appendix if applicable.

4) Any hardware manual demonstrating more than one model number of device on any one page shall be clearly marked as to delineate which model has been implemented in the Work.

c. Operation and Maintenance Manuals shall include, at a minimum, the following:

1) Operational description of each subsystem

2) Detailed programming descriptions for each subsystem

3) Explanations of subsystem interrelationships

4) Electrical schematics for each piece of equipment specified

5) Power-up and power-down procedures for each subsystem

6) Description of all diagnostic procedures

7) A menu tree for each subsystem

8) Setup procedures for each component of the subsystems

9) A list of manufacturers, their local representatives, and subcontractors that have performed Work on the Project

10) Installation and service manuals for each piece of equipment

11) Maintenance schedules for all installed components

d. Operation and Maintenance Manuals shall include a separate section for each software program incorporated into the Project. The software section shall include, at a minimum, the following information:

1) Definitions of all software related terms and functions

2) Description of required sequences

3) Directory of all disk files

4) Description of all communications protocols, including data formats, command characters, and a sample of each type of data transfer

5) Instructions for manufacturer supplied report generation

6) Instructions for custom report generation

7) Database format and data entry requirements

8) Procedure for Resubmitting

e. Make corrections or changes in O & M and/or Record Drawings as required by the Architect and resubmit when the Architect’s stamp requires re-submittal.

f. Clearly identify changes made other than those specifically requested by the Architect when resubmitting Record Drawings. Changes shall be clouded or similarly highlighted as coordinated with the Architect. Only changes that have been specifically requested by the Architect or have been clouded by the Contractor will be reviewed on resubmittals.

g. Any drawing sheets added to the resubmittal shall be clearly identified and clouded, and shall not change the sheet numbering scheme for previously issued Record Drawings.

h. The Contractor shall be responsible for any delays caused by the re-submittal process.

6. Re-submittal Review Fees

a. If the Architect rejects the Contractor’s Record Submittal (Rejected, Revise, and Resubmit) more than two times, the Architect will be compensated for all subsequent reviews, whether partial or comprehensive. The amount of such compensation will be incorporated by Change Order and withheld from the Contractor’s Application for Payment.

1.10 QUALITY ASSURANCE

A. Contractor Qualifications

1. Work specified herein shall be the responsibility of a single Paging Systems Contractor. Bid submission shall document a minimum of five (5) years experience in the fabrication, assembly, and installation of Systems of similar complexity as specified herein. The documentation shall include the names, locations, and points of contact for at least three (3) installations of the type and complexity specified herein.
2. Installer Training Process: – Contractor’s labor force shall have certified installers who attended training programs of the proposed system preparing them to perform the work.
3. The Installer for this Project is to be certified by all manufacturers of the installed equipment that the Contractor proposes.
4. Registered and Certified supervisors- Contractor must have all supervisory personnel certified for the type of work they are overseeing (installation and design) from InfoComm International.
5. Quality assurances for Paging systems includes a multi-step program consisting of pre-qualification procedure for manufacturers and installation specialists; products phase; installation; operating instruction and training; and the submission of maintenance and operating manuals.
6. The Contractor shall have local in-house engineering and project management capabilities consistent with the requirements of the Work.
7. By submitting a bid, the Contractor thereby certifies that it is qualified in all areas pertaining to, directly or indirectly, the Work. In the event the Contractor becomes unable to complete the Work in accordance with the Contract Documents, or the satisfaction of the Owner, it shall be the responsibility of the Contractor to retain the services of applicable manufacturers’ representatives to expeditiously complete the Work in accordance with the Owner’s construction schedule with no additional cost to the Owner.
8. The Contractor shall maintain, or establish and maintain, a fully staffed office including a service center capable of providing maintenance and service to the Project. The Contractor shall staff the service center with factory trained technicians and adequately equip the office to provide emergency service within seventy-two (72) hours after being called, 24 hours per day.
9. The Contractor shall provide factory-certified technicians to install, commission, and maintain the Work. All installing personnel shall be licensed as required by local and/or state jurisdictions.
10. The Contractor shall ensure compliance with, and have a thorough understanding of, all local codes and contract conditions pertaining to this Project.

11. The Contractor shall maintain an inventory of spare parts and other items critical to System operation and as necessary to meet the emergency service requirements of this Project within the local service center.

B. Product Standards

1. All equipment and materials for contained herein shall be the products of recognized manufacturers and shall be new.
2. New equipment and materials shall:
    a. Be Underwriters Laboratories, Inc. (U.L.) listed and approved where specifically called for; or where normally subject to such U.L. labeling and/or listing services.
    b. Be without blemish or defect.
    c. Be products that meet with the acceptance of the agency inspecting the Paging Systems work.
3. It is the intent of these specifications that wherever a manufacturer of a product is specified, and the terms "other approved" or "approved equal" are used, the substituted item must conform in all respects to the specified item. Consideration will not be given to claims that the substituted item meets the performance requirements with lesser construction. Performance as delineated in schedules and in the specifications shall be interpreted as minimum performance.
4. Substituted equipment or optional equipment, where permitted and approved, must conform to space requirements. Any substituted equipment that cannot meet space requirements, whether approved or not, shall be replaced at the Contractor's expense. Any modifications of related Systems as a result of substitutions shall be made at the Contractor's expense.
5. The approval of shop drawings, or other information submitted in accordance with the requirements hereinbefore specified, does not ensure that the Paging Consultant, Architect, or the Owner attests to the dimensional accuracy, dimensional suitability of the material, or mechanical performance of equipment. Approval of shop drawings does not invalidate the Drawings and Specifications.
6. Substitutions of equipment shown on the schedules or designated by model number in the specifications will not be considered if the item is not a regular catalogued item carried by the manufacturer.
7. Within the Specifications, certain manufacturers have been listed. These manufacturers are listed for example purposes (unless followed by "No Exceptions"). The Contractor may substitute manufacturers and models that may be more cost effective or readily available than that specified. However, all substitutions shall meet or exceed the specified functional and technical

requirements. Acceptance of such substitutions is at the discretion of the Consultant and/or Owner.

C. Alternate Equipment Submittal Requirements

1. All bids shall be submitted on the basis of the systems and equipment used as the basis of design in the attached specification. The Bidder may propose alternate equipment. However, all such proposals shall be submitted separately and will be identified as “alternates” with equipment costs shown separate and apart from the costs of the equipment “as specified.” Additionally, systems incorporating alternate equipment are anticipated to require modification of the design of the attached specification and will require the bidder to provide revised design drawings as part of an alternate submittal, that detail the bidders intent to integrate alternate systems and equipment without modifying the design intent of the bid.
2. Proposals for alternate equipment will receive careful and equitable consideration if the differences do not depart from the overall intent of the design and operation of the system, are in the best interests of the Owner, and are equal to, or greater in functionality, durability, and usability.
3. All such proposals for alternate equipment shall be accompanied by full technical information, design drawings, cut sheets, and specifications for the equipment so proposed. The Bidder shall identify the substantive differences between the alternate and the specified equipment for consideration.
4. Submittals for alternate equipment/design will be required to include the following information at time of submittal, and as part of the bid response:
    a. Proposal response as provided in the bid specification, using bid forms as provided.
    b. Alternate proposal shall be submitted separately
    c. Alternate proposal must be separated from the base bid and identified as “alternate” with equipment costs shown separate and apart from the costs of the equipment “as specified.”
    d. Revised design drawings that detail the bidders intent to integrate alternate systems and equipment without modifying the design intent of the bid. Original design drawings that are part of this bid package will not be provided electronically to bidders until award of bid.
    e. Full technical information to include:
        1) Design drawings
        2) Cut sheets for proposed alternate equipment

3) Specifications for the proposed alternate equipment.

4) The Bidder shall identify the substantive differences between the alternate and the specified equipment for consideration.

1.11 WARRANTY AND MAINTENANCE

A. Systems Contractor shall provide a one (1) year warranty for the Work. The warranty shall cover all Work, Systems, and subsystems against defects in materials and workmanship. The Work as specified herein, including all materials and labor, but excepting any existing devices and equipment which are incorporated in the completed Work, shall be warranted to be free from defects in design, workmanship, and materials. Further, the Contractor shall warrant that the completed Systems, including all components (except those, which are existing or provided by others), are of sufficient size and capacity to fulfill the requirements of the Specifications.

B. The warranty shall be valid for a period of one (1) year following the date of System acceptance by the Owner. System acceptance shall commence when all parts, components, sub-Systems, and Systems have been tested, shown to be working in accordance with the Specification, and approved by the Owner

C. In cases where the manufacturer’s warranty period is greater than twelve months, the contractor must be prepared to honor that warranty for the full extent of the manufacturer’s warranty period. This shall exclude any labor costs incurred by the contractor removing and re-installing the defective items.

D. In cases where the manufacturer’s warranty period is less than 12 months, the contractor is liable for defects in the item up to-but not exceeding-the first twelve-month period on any contractor provided items.

E. To maintain certain manufacturer’s warranties, said equipment must be installed, aligned, and serviced by those installers authorized by said manufacturer to perform those duties. If the contractor is not authorized, by said manufacturer, it is his sole responsibility to make the appropriate arrangements and bear all cost and consequences thereof.

F. All manufacturers’ equipment warranties shall be activated in the Owner’s name and shall commence on the date of system acceptance. In the case of Contractor-modified equipment, the manufacturer’s warranty is normally voided. In such cases, the Contractor shall provide the Owner with a warranty equivalent to that of the original manufacturer.

G. Warranty Service:

1. In the event that defects in the materials and/or workmanship are identified during the warranty period, the Contractor shall provide all labor and materials as may be required for prompt correction of the defect.
2. Provide written notice to the Owner documenting any Work performed during the warranty period, including any preventative maintenance Work performed.
3. Provide loaner equipment that is fully compatible with the Paging Systems for any equipment not field repairable.
4. Loaner equipment for components that must be shipped to/from the manufacturer or distributor shall be on site and operational within 48 hours of the component failure. Furnish lists of equipment that will require shipment from the manufacturer or distributor and lead times associated with that equipment.

H. See attached Appendix for the Warranty costs form that must be completed as part of the bidding process. This is provided for the post bidding evaluation process.

PART 2 - PRODUCTS

2.1 PAGING SYSTEMS

A. All network based equipment will utilize PoE network switches furnished by others. Coordinate VLAN requirements with Owner and Network Contractor as required. Switches require the following:

1. Switches shall be managed-type with VLAN capabilities and Power-Over-Ethernet (PoE). Care should be taken to ensure that each Switch be able to supply adequate PoE power to the endpoint devices it serves. Uplink ports for each switch shall be via Optical Fiber. Either Multimode or Single-mode fiber may be used, as determined by the length of the required uplink runs. Each port on each Switch shall be capable of sustained 100MBit data rates.
2. One consistent VLAN (Virtual Local Area Network) shall be established across each managed Switch, with enough ports to accommodate the PS devices attached to it, plus 25% for future expansion.

B. Provide and integrate one (1) rackmount computer with rackmount keyboard, mouse, and monitor.

1. Computer shall meet the following minimum specifications
    a. Microsoft Windows 7 operating system, or XP-Professional

b. Intel Pentium Dual Core processors, 2.6 GHz.

c. 2 GB RAM

d. 160 GB SATA hard drive

e. Integrated video adapter, minimum 1280 x 1024 native output at 32-bit color

f. Dual integrated gigabit Ethernet ports

g. CPU shall be Lenovo ThinkCentre 158 or equivalent

C. Provide and integrate audio amplifiers, including all required amplifier module cards as required.

1. Amplifiers shall allow a total of eight amplifier modules per amplifier chassis. Seven channels shall be active, and one shall be a backup. Amplifier will automatically switch over to backup channel in the event of a module failure.

2. All amplifiers modules shall be 70V and shall be sized properly for their respective loads.

3. DSP shall be available at each module.

D. Provide and integrate ambient noise microphones as required.

E. Provide and integrate ambient noise compensators (ANC) as required.

1. Each ANC shall be PoE and wired to the Cobranet VLAN.

2. Each ANC shall be housed in a small surface-mountable enclosure.

3. Each ANC shall respond to its associated amplifier channel module, advising that channel of changes in ambient noise level.

4. Each ANC shall have two microphone inputs, both with 48V phantom power.

F. Provide and integrate audio input expansion devices as required.

1. PoE and wired to the Cobranet LAN

2. Ability to output a Multicast Bundle of 6 mono signals to the Cobranet VLAN.

3. Four pairs of unbalanced RCA inputs plus four balanced inputs.

4. DSP available for each channel

5. Four control inputs

6. Reporting and logging of any and all failure conditions.

G. Provide and integrate audio output expansion devices as required.

1. PoE and wired to the Cobranet LAN

2. Four balanced analog audio outputs.
3. DSP available for each channel
4. Four control inputs
5. Four Form-C contact outputs
6. Reporting and logging of any and all failure conditions.

H. Provide and integrate 4-button desktop paging stations as required.

1. PoE and wired to the Cobranet LAN
2. Four buttons, each assignable to a specific paging task, plus push-to-talk button and LEDs.
3. Cardioid gooseneck microphone.
4. Integrated DSP.
5. Internal page storage.
6. Backlit LCD display.
7. Reporting and logging of any and all failure conditions.

I. Provide and integrate 4-button wall/millwork-mounted paging stations as required.

1. PoE and wired to the Cobranet LAN
2. Four buttons, each assignable to a specific paging task, plus push-to-talk button and LEDs.
3. Dynamic noise-canceling close-talking microphone with push-to-talk button on heavy duty coiled cord. Microphone shall be replaceable in field.
4. Integrated DSP.
5. Internal page storage.
6. Backlit LCD display.
7. Reporting and logging of any and all failure conditions.

J. Provide and integrate one (1) Message Server (MS).

1. MS shall be a single space rack mounted Linux Server
2. MS wired to Cobranet VLAN and VoIP VLAN.
    a. Note: If phone system is not VoIP, additional equipment will be required to convert analog phone line into VoIP. It is the Paging Contractors' responsibility, in coordination with the Owner and Networking Contractor, to determine and provide this additional equipment.
3. MS shall have minimum hard drive capacity of 80 GB for storage and playback of recorded announcements and preambles.

4. MS shall act as a Configuration Server for the entire paging system.

5. MS shall include VoIP Trunk Server and support SIP (Session Initiation Protocol) calling to allow telephone-based paging.

    a. Note: If phone system is not VoIP, additional equipment will be required to convert analog phone line into VoIP. It is the Paging Contractors' responsibility, in coordination with the Owner and Networking Contractor, to determine and provide this additional equipment.

6. MS shall include scheduler.

7. MS shall store log data from all system components.

K. Provide and integrate ceiling and wall speakers as required. Speakers shall include all required mounting hardware, tile bridges, 70V transformers, backboxes, ceiling cans, and grills as required.

L. Integrate BGM source (provided by others) into paging system.

M. Integrate Bar source (provided by others) into paging system.

N. Integrate Conference Room source (provided by others) into paging system.

O. Provide and integrate one (1) sound masking generator/EQ.

P. Provide and integrate two (2) auxiliary input plates.

Q. Provide and integrate one (1) UPS, sized as required for anticipated power load.

R. Provide and integrate two (2) equipment racks with sides, fan tops, vertical and horizontal power strips, lacing bars, and all required accessories. Coordinate vertical power strip plug type and quantity with electrical drawings/engineer.

S. Provide all loose cables, connectors, etc. required to complete a full working system.

2.2 CABLES

A. Unless otherwise called for in these specifications and drawings, the following cables, or their approved equals, shall be used in these systems:

1. Control (4 conductor shielded)

   a. Non-Plenum: Belden 1502R
   b. Plenum: Belden 1502P
2. Control (12 conductor shielded)
   a. Non-Plenum: Belden 9556
   b. Plenum: Belden 6309FE
3. Audio
   a. Non-Plenum: Belden 9451/1266A
   b. Plenum: Belden 9451P
4. Audio (8 ohm program speakers)
   a. Non-Plenum: Belden 8473
   b. Plenum: Belden 1861A
5. Audio (70 Volt Speaker)
   a. Non-Plenum: Belden 8461
   b. Plenum: Belden 1863A
   c. Note: Gauges of above cables are only a recommendation. It is the Contractors responsibility to chose cable of the appropriate gauge for the required distance.
6. Multi-channel Audio
   a. Non-Plenum: Belden 8774
   b. Plenum: Belden 88778
7. Digital Audio (110 Ohm)
   a. Non-Plenum: Belden 1800B
   b. Plenum: Belden 1801B
8. Category 6 cable
   a. Non-Plenum: Belden 2412
   b. Plenum: Belden 2413
9. Note: These cable types are cited to illustrate the type and quality of cable required. Unless otherwise noted, cables from other manufacturers, i.e. Canare, CommScope, Extron, Gepco, Liberty, etc. will be considered acceptable **if data sheets are submitted prior to installation. Electronic submission of data sheets is acceptable.**

B. Connection Plate Receptacles:
1. Audio (microphone or line level) – XLR type.
2. Audio (loudspeaker level) – Neutrik Speakon® Type.
3. Data – RJ-45 type.

4. Note: All connectors on wall plates, or in other exposed locations, are to be recessed.

2.3 ALL ELECTRONIC PRODUCTS

A. Shall operate on 120 to 240 VAC at 50/60 Hz.

B. Shall be capable of operating continuously for 12 hours over the external ambient temperature range of +10°C to +65°C (20% to 95% humidity, non-condensing) without permanent damage.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions: Examine the areas to receive the work and the conditions under which the Work would be performed. Contractor shall remedy conditions detrimental to the proper and timely completion of the Work. Do not proceed until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General

1. All installation practices shall be in accordance with, but not limited to, these specifications and drawings. Installation shall be performed in accordance with the applicable standards, requirements, and recommendations of National and Local authorities having jurisdiction.
2. If, in the opinion of the Contractor, an installation practice is desired or required, which is contrary to these specifications or drawings, a written request for modification shall be made to the Consultant. Modifications shall not commence without written approval from the Consultant. Every effort will be made to respond to all written requests, in a timely manner, as to not delay the installation or completion of the project.
3. Prior to ordering equipment, the contractor shall coordinate the frequencies of all wireless devices to prevent unwanted interaction between devices and rooms. This includes, but is not limited to, wireless microphones, assisted listening system devices, wireless control panels, etc.
4. All accessories, including rack mounting hardware, power supplies, etc., shall be obtained from the original equipment

manufacturer. Unless otherwise noted or specified, third party accessories shall not be used.

5. All installation practices shall be in accordance with, but not limited to, these specifications and drawings. Installation shall be performed in accordance with the applicable standards, requirements, and recommendations of National and Local authorities having jurisdiction.

6. If, in the opinion of the Contractor, an installation practice is desired or required, which is contrary to these specifications or drawings, a written request for modification shall be made to the Consultant. Modifications shall not commence without written approval from the Consultant. Every effort will be made to respond to all written requests, in a timely manner, as to not delay the installation or completion of the project.

7. During the installation, and up to the date of final acceptance, the Contractor shall be under obligation to protect his finished and unfinished work against damage and loss. In the event of such damage or loss, the damage shall be replaced or repaired at no cost to the Owner.

B. Coordination

1. Power Distribution

   a. Coordinate power distribution requirements with the Electrical Contractor.

2. Communications Cabling

   a. Coordinate all communications cabling with Telecom Cabling Contractor.

C. Physical Installation

1. All equipment shall be firmly secured in place unless requirements of portability dictate otherwise.

2. All equipment shall have an engraved plaque permanently affixed, denoting its function.

3. Fastenings and supports shall be adequate to support their loads with a safety factor of at least five. All boxes, equipment, etc., shall be secured plumb and square.

4. In the installation of equipment and cable, consideration shall be given not only to operational efficiency, but also to overall aesthetic factors.

D. Trim and Escutcheon Components

1. To insure a proper finished appearance, the PAGING Contractor shall furnish and install trim/escutcheon components at all conditions where paging components pass through the finished

ceilings. This would include but not be limited to any component which is not specifically supplied with integral flanges/trim components; i.e. speaker mounts.

2. All trim components at the ceiling plane shall be finished to match the approved ACT ceiling grid system components. The paging contractor should obtain a sample from the General Contractor, including any custom color information, or standard color numbers. All trim components shall be submitted to the Architect for review and approval prior to fabrication.

E. Cable Installation

1. All wire bundles are to be neat and combed free of cable crossovers.
2. All cables, regardless of length, shall be marked with a permanent, self-laminating wrap-around number or letter cable marker at both ends, similar to the Panduit “Pan-Code” system. Labels must be computer-generated for legibility. Wire labels done by hand in the field must be replaced with computer generated labels. There shall be no unmarked cables at any place in the system. Marking codes used on cables shall correspond to codes shown on drawings and or run sheets.
3. All cables shall be grouped according to the signals being carried. In order to reduce signal contamination, separate groups shall be formed for the following cable families:
    a. Power cables
    b. Control cables
    c. Network cables
    d. Audio cables carrying signals less than – 20 dBm
    e. Audio cables carrying signals between – 20 dBm and +20 dBm
    f. Audio cables carrying signals above +20 dBm
4. As a general practice, all power cables, control cables, and high level cables shall be run on the left side of an equipment rack as viewed from the rear. All other cables shall be run on the right side of an equipment rack, as viewed from the rear.
5. Cables ties shall be placed at appropriate intervals of no greater than six inches for vertical bundles, two inches for horizontal bundles.
6. All vertical cable bundles shall be attached to the rack frame.

F. Wire Terminations

1. All cables shall be continuous lengths without splices.

2. All system wire, after being cut and stripped, shall have the wire strands twisted back to their original lay and be terminated by approved soldered or mechanical means.
3. Except where noted otherwise in the specifications, NO BARE WIRE TERMINATIONS WILL BE ACCEPTED. Heat-shrink tubing shall be used to insulate the ground or drain wire.
4. Unused wires at the end of a cable shall remain unstripped and shall be laid back and held in place with wire ties.
5. All solder connections shall be made with rosin-core solder using temperature-controlled solder stations. Care shall be taken to avoid cold or cracked solder joints. Any connections that do not appear to be clean and shiny, or which show signs of cracking, shall be re-soldered by the contractor before final acceptance of the system.
6. Mechanical connections using insulated, crimp-type connectors shall be bonded to the connector by soldering the wire to the metal part of the connector.
7. Connections made with screw actuated pressure type terminal strips shall be made by stripping approximately 1/4 inch of insulation from the stranded conductor. Then the un-tinned wire shall be inserted into the terminal and the screw tightened using a secure fitting precision screwdriver.
8. Terminal blocks, boards, strips, or connectors shall be furnished for all cables which interface with racks, cabinets, consoles, or equipment modules. No audio cables shall run directly to the audio patch panel jacks. Each audio patch panel shall be furnished with an audio terminal block and all audio cables to and from the audio patch panel shall terminate on this block.
9. All network cabling shall terminate to appropriate patch panels, and shall be then patched into the Network switches.

G. Cable Management

1. All wire markers shall face a common direction.
2. All cables shall have proper connector housing.
3. Cables shall not protrude from the back of racks.
4. All cable entry shall be through the tops of racks or through entrance holes in the base of the rack. No cable shall enter racks through front, rear or side panel openings.
5. Cables running in plenum areas without conduit shall be plenum rated cable, and match the specified cable above. It is the responsibility of the Bidder to inspect the electrical drawings, and verify in what spaces plenum cable shall be used. No claims for additional monies, based on the use of plenum cable, will be allowed.

6. All cables (except video and pulse cables, which must be cut to an electrical length) shall be cut to the length dictated by the run. No splices shall be permitted in any pull boxes without prior permission of the Consultant. For equipment mounted in drawers or on slides, the interconnecting cables shall be provided with a service loop of appropriate length.
7. No cable shall be installed with a bend radius less than that recommended by the cable manufacturer.
8. Where cables are installed in architectural niches, ensure that the cables are black, unless otherwise directed, to reduce visibility from the audience.
9. Where cables are installed that is visible, the cables will be sheathed in a color wrap that has been pre-approved for the location.

3.3 PERFORMANCE STANDARDS

A. Unless restricted by the published specifications of a particular piece of equipment, or unless otherwise required under the Detailed Specifications, the following performance standards shall be met be each system:

1. Audio
    a. Frequency Response
        1) Within plus or minus 0.5dB, 20 Hz to 20,000 Hz.
    b. Signal to Noise Ratio
        1) Greater than 90dB (including crosstalk and hum at all input/output levels)
    c. Total Harmonic Distortion
        1) 0.05% maximum from 20 Hz to 20,000 Hz.
    d. Input Levels
        1) Microphone (Nominal): -50dbu
            a) Overload (Minimum gain) : -5dbu
            b) Maximum Gain: -26dbu
        2) Line (Nominal): +4dbu
            a) Overload (Minimum gain):+24bu
            b) Maximum Gain: +9dbu
            c) Input Common Mode Rejection: >100db
    e. Output Levels
        1) Line (Nominal): +4dbu
            a) Maximum: +24dbu

2) Output Impedance: <0.5 Ohms

3) Load Impedance: >150 Ohms

2. Video (signal)

a. Frequency Response:

1) Within plus or minus 0.5dB, DC to 4.2 MHz.

b. Signal to Noise Ratio:

1) 55 dB minimum. (peak to RMS) unweighted, DC to 4.2 MHz

c. Crosstalk:

1) 45 dB minimum unweighted DC to 4.2 MHz

d. Line and Field Tilt:

1) 2% maximum.

e. Differential Gain:

1) 3% maximum.

f. Differential Gain:

1) 2 degrees maximum.

3. Network

a. As required by manufacturer for specified devices.

B. Performance Test Signal Paths

1. The signal paths for the above Performance Standards shall be as follows:

2. Audio:

a. From all source inputs (for microphones, Blu-Ray players, CATV receivers, etc.) through all mixers, switchers, etc., to all signal destinations.

3. Data

1) From all sources to patch panels.

3.4 CONTRACTOR SYSTEM CHECKOUT

A. Before Acceptance Tests are scheduled, the Contractor shall perform their own system check-out. They shall furnish all required test equipment and shall perform all work necessary to determine and/or modify performance of the system to meet the requirements of this specification. This work shall include the following:

1. Provide documentation that all Cobranet bundles and audio signal lines have been tested and verified, if applicable.

2. Test all audio/video systems for compliance with the Performance Standards, using the following test procedure:

3. Test Equipment: Assemble the following test equipment (or equivalent) on site.

B. Audio check:

1. Signal generator, Leader LAG-120B
2. AC millivoltmeter, Leader LMZ-181A
3. Audio test set, Audio Precision P1PLUS
4. Audio cable
5. Set of terminations, adapters etc.

C. Data checks:

1. Data line tester, as required.

D. Signal Paths

1. Audio
2. Connect the output of the video signal generator to a floor box/table/rack connector and select the “Full Field Color Bar” signal. Connect the combined waveform monitor/vectorscope to a final output point, e.g. an input to a picture monitor or video projector. Ensure that the test signal is routed to the selected output.
3. Measure and record the signal amplitudes.
4. Repeat item ‘2’ after selecting the “Multiburst, 50 IRE” test signal.
5. Measure and record the signal amplitudes.
6. Repeat item ‘2’ after selecting the “Modulated 5-step” test signal.
7. Measure and record the signal differential phase and gain.
8. Repeat item #’s ‘2’ through ‘7’ for other video signal paths.
9. Repeat item ‘2’ after selecting the Window test signal.
10. Measure and record the signal line and field tilt.
11. Repeat item ‘2’ after connecting the Black Burst signal from a rear mounted connector.
12. Measure and record the signal/noise ratio.
13. Connect the output of the audio test set to a floor box/table/rack program audio connector and connect the input of the audio test set to a final output point, e.g. an input to a program speaker power amplifier. Ensure that the test signal is routed to the selected output, that the volume control is set to 100% and that the equalizers are bypassed.

14. Measure and record the signal/noise ratio, total harmonic distortion and frequency response.

15. Repeat items '13' and '13' for other audio signal paths.

3.5 SYSTEM ACCEPTANCE TESTS

A. System Acceptance Tests will not be performed until the Contractor's System Checkout has been completed and the test results have been reviewed. The System Acceptance Tests will be supervised by the Consultant and will consist of the following:

B. A physical inventory will be taken of all equipment on site and will be compared to equipment lists in the contract documents.

C. The operation of all system equipment shall be demonstrated by the Contractor.

D. Both subjective and objective tests will be required by the Consultant to determine compliance with the specifications. The Contractor shall be responsible for providing test equipment for these tests.

E. All final, "as-built" drawings, run sheets, manuals, and other required documents, as detailed in Part I, shall be on hand. Two complete sets of these documents shall be delivered to the Owner at this time. (One complete set shall have been delivered to the Consultant prior to the scheduling of Acceptance Tests).

F. In the event further adjustment is required, or defective equipment must be repaired or re-placed, tests may be suspended or continued at the option of the Consultant.

G. Any charge for additional time incurred by the Consultant required to oversee the system tests, due to improper system installation or previous failed systems, shall be the responsibility of, and charged directly to the contractor.

H. Some specification sections have additional requirements. Refer to individual specifications section for more information.

3.6 BIDDING FORMS

A. See below Appendix for, Paging systems equipment list, Warranty and Master Recapitulation forms that must be completed as part of the bidding process. This is provided for the post bidding evaluation process.

Appendix A							
Section 16 7 26 – Paging System							
Item		**Product**	**Manuf**	**Model #**	**Unit**	**Qty**	**Ext**
1		PoE Network Switches	Provided By Others	Provided by Others	__________	Provided by Others	__________
2		Rackmount Computer	Dell	Precision Rack Workstation Series	__________	1	__________
3		Rackmount KVM	Middle Atlantic	RM-KB-LCD17	__________	1	__________
4		Audio Amplifier with Appropriate Amplifier Modules	Biamp	VA-8600 with AM-600 modules	__________	Quantity as required	__________
5		Ambient Noise Microphone	Clock Audio	C 007E	__________	Quantity as required	__________
6		Ambient Noise Compensator	Biamp	ANC-1	__________	Quantity as required	__________
7		Audio Input Expansion Device	Biamp	VI-6	__________	Quantity as required	__________
8		Audio Output Expansion Device	Biamp	VO-4	__________	Quantity as required	__________
9		4-Button Desktop Paging Station	Biamp	DS-4	__________	Quantity as required	__________
10		4-Button Wall/Millwork-Mounted Paging	Biamp	WS-4	__________	Quantity as required	__________

		Station					
11		Message Server	Biamp	MS-1	__________	1	__________
12		CS1 Ceiling Speaker	EV/Atlas	EV 205 series speaker with Atlas T7 series grill and appropriate backbox	__________	Quantity as required	__________
13		CS2 Ceiling Speaker	EV/Atlas	EV 205 series speaker with Atlas T7 series grill and appropriate backbox	__________	Quantity as required	__________
14		CS3 Ceiling Speaker	EV	EVID C8.2LC Ceiling	__________	Quantity as required	__________
15		CS4 Ceiling Speaker	Innovox	Micro MTM with 70V transformer	__________	Quantity as required	__________
16		CS5 Ceiling Speaker	Innovox	SLA-4.1-9035 with 70V transformer	__________	Quantity as required	__________
17		CS6 Ceiling Speaker	Atlas	PM4FA-B	__________	Quantity as required	__________
18		WS1 Wall Speaker	QSC	AD-S52	__________	Quantity as required	__________

19		WS2 Wall Speaker	Renkus-Heinz	CDT500K Series	__________	Quantity as required	__________
20		BGM source	By Others	By Others	__________	1	__________
21		Bar Source	By Others	By Others	__________	1	__________
22		Conference Room Source	By Others	By Others	__________	Quantity as required	__________
23		Sound Masking Generator/EQ	Atlas	ASP-MG24	__________	1	__________
24		Auxiliary Input Plates	Custom	Custom	__________	2	__________
25		UPS	APC	Smart-UPS series	__________	1	__________
26		Equipment Rack with sides, fan top, horizontal and vertical power strips, lacing bars, and all required accessories	Middle Atlantic	MRK-4431 with required accessories	__________	2	__________
27		Miscellaneous hardware, switches, relays panels, connectors, cabling, lamps, terminal blocks, etc., necessary to insure a complete and operating system.			__________	LOT	__________

28		Set audiovisual systems functional drawings, shall be photo-reproduced laminated & stored in pocket, audiovisual equipment racks.		________	LOT	________

Appendix A
Warranty

	SECOND YEAR WARRANTY PERIOD	
1	Preventative Maintenance, Four (4) PM Visits, and Service within 24 hours.	_________
2	Preventative Maintenance, Four (4) PM Visits, and Service within 4 hours.	_________
3	Emergency Service Hourly Rate	_________ Per/Hr.
4	In Shop Hourly Rate	_________ Per/Hr.
	THIRD YEAR WARRANTY PERIOD	
5	Preventative Maintenance, Four (4) PM Visits, and Service within 24 hours.	_________

6	Preventative Maintenance, Four (4) PM Visits, and Service within 4 hours.	________
	FOURTH YEAR WARRANTY PERIOD	
7	Preventative Maintenance, Four (4) PM Visits, and Service within 24 hours.	________
8	Preventative Maintenance, Four (4) PM Visits, and Service within 4 hours.	________
	FIFTH YEAR WARRANTY PERIOD	
9	Preventative Maintenance, Four (4) PM Visits, and Service within 24 hours.	________
10	Preventative Maintenance, Four (4) PM Visits, and Service within 4 hours.	________

Appendix A Master Recap.							
AREA	EQUIPMENT	ENGINEERING	PRE-INSTALL	INSTALL	G&A	TAXES	TOTALS
Section 16 7 26 – Paging System							

END OF SECTION 16726

PART 1. GENERAL

1.1 The Emergency Phone shall consist of a vandal resistant and ADA-compliant hands-free speakerphone communications device with a stainless steel faceplate and metal buttons.

1.2 The Emergency Phone shall have one tactile button labeled "EMERGENCY" and one red light emitting diode (LED) labeled "LIGHT ON INDICATES CALL RECEIVED".

1.3 Unit shall comply with Part 68 of the FCC rules for the United States.

1.4 Contractor shall submit manufacturer's product data and cut sheet.

1.5 Equipment shall be warranted against any defects in material and workmanship, under normal use, for a period of twelve months from date of installation. In the event system is found by manufacturer to be defective within the warranty period, manufacturer shall repair and/or replace any defective parts, provided the equipment is returned to manufacturer.

PART 2. PRODUCTS

2.1 Approved Manufacturers:
   A. Talk-A-Phone Model ETP 100MB (Basis of Design)
   B. Hubbell GAI-Electronics Model 296-297
   C. Code Blue Model FME

2.2 Chassis and face plate shall be constructed of stainless steel with a #4 brushed finish. Push button and switch shall be a single assembly rated for 1,000,000 cycles. Epoxy seals shall protect contacts and terminals from hostile environments and solder flux. Case shall be moisture-proof, dust-tight and designed to accommodate the high shock military specifications of MIL-STD-202, method 207. Case shall be aluminum alloy, anodized clear. Button shall be black anodized aluminum. Unit shall be designed for surface or flush mounting on a wall or in an elevator, as specified on the drawings.

2.3 Speaker and microphone shall be protected by non-ferrous metal screen to provide a barrier against vandalism. Signage shall be constructed of cast metal with lettering and Braille raised approximately 3/32" for ADA compliance. Word "EMERGENCY" shall be black

2.4 The unit shall be totally hands-free on both sides after connection is initiated at site or by attendant. The unit shall be programmable from a remote telephone via keypad entry. All programming shall be stored in non-volatile EEPROM memory.

2.5 Unit shall be programmable with two different telephone numbers of up to 18 digits each including pauses. If first number does not answer or is busy, unit shall automatically call the second number. If that number is busy or does not answer, unit shall call the first number again. Unit shall continue alternating until call is answered or call timer limit is reached. When call is finished, unit shall automatically shut off.

2.6 The unit shall be capable of operating on standard phone lines or analog PBX extensions and shall be phone line powered, requiring no outside power source or battery back-up. DIP switch programming, push to talk devices, and devices requiring external power are not acceptable. The unit shall have a dedicated communication line.

2.7 Unit shall be capable of automatically notifying attendant of location via programmable ID.

PART 3. EXECUTION

3.1 Install per manufacturer's instructions.

3.2 Demonstrate complete system operation to owner and Architect/EIngineer..

3.3 Provide two hours of training for owner's personnel.

End of Section 16730

DULUTH NEW TERMINAL DESIGN

BHS SPECIFICATIONS: MINI-INLINE CBIS

BID PACKAGE 2A

January 24 2011

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VERSION HISTORY

VERSION / REVISION	DATE	DESCRIPTION
0	15 October 2010	30% Design Documents
1	7 December 2010	70% Design Documents
2	20 December 2010	100% Design Documents
3	24 January 2011	Bid Package 2A

SECTION 34 77 16

SECTION PARTS

PART I - GENERAL SPECIFICATIONS

PART II - PRODUCT SPECIFICATIONS

PART III - EXECUTION SPECIFICATIONS

PART IV – QUALITY CONTROL SPECIFICATIONS

TABLE OF CONTENTS

PART III

SECTION 34 77 16

BAGGAGE HANDLING SYSTEM

PART I - GENERAL SPECIFICATIONS

1.01 SUMMARY

A. General

1. This Baggage Handling System Specification is divided into four (4) parts as follows:

   a. Part I specifies general administrative and procedural requirements for a BHS installation as specified herein and in the accompanying drawings.

   b. Part II specifies product information including approved equipment requirements.

   c. Part III specifies execution requirements for the BHS installation that are required.

   d. Part IV specifies quality control requirements

2. The BHS Specification and accompanying Contract Drawings are intended to outline the work define functional requirements and establish minimum standards of quality for the Project. Meet all local, state and federal laws, codes and safety standards and assures a safe and efficient system for all personnel who operate, maintain or have access to the completed baggage handling system.

3. New security requirements have been mandated by the Transportation Security Administration (TSA) for all outbound passenger checked baggage to be screened for explosive materials. Because of these requirements, the baggage systems at the Duluth New Terminal must be reconfigured as illustrated on the accompanying drawings to accommodate new Mini-Inline Checked Baggage Inspection System (CBIS) equipment.

4. The laws of the City of Duluth, the State of Minnesota, and the United States of America (USA) shall apply and govern the Contract.

5. Unless otherwise specified, all references to sums of money shall be in United States Dollars (USD), the currency of the United States of America (USA).

1.02 RELATED DOCUMENTS.

A. General

1. These written Specifications, in conjunction with the accompanying Contract Drawings, constitute the Contract Documents for the Project. If there are any discrepancies between these written Specifications and the Contract Drawings, the more stringent requirement shall apply as interpreted by the DAA or his representative.

2. As indicated throughout these contract documents (drawings and specifications) the BHS is considered a security system for In-Line baggage screening, and inbound baggage processing for the Project. Implement and demonstrate to the DAA, the TSA and their representatives the installed BHS and Mini-Inline CBIS in compliance with all the TSA's security protocols, BHS/EDS integration and all associated Performance and Commissioning requirements, as specified herein and consistent with the TSA's Planning Guidelines and Design Standards for CBIS.

3. These Contract Documents are confidential and are not to be distributed or copied, in part or in whole, without the written consent of an authorized representative of the DAA or BNP Associates, Inc.

B. Drawings

1. Specification Drawings (Ref. Drawing BG.001for listing), Architectural Drawings, Communications/Network Layout Drawings, Fire Protection System Drawings, MEP (Mechanical, Electrical and Plumbing) Drawings, Structural Drawings, Overall Program Phasing Plans, Addendum, Contract

Provisions, Special Provisions and Supplementary Provisions apply to the work of this Section.

2. The Architectural, MEP and Structural drawings that have been prepared under a separate package, define the facility modifications that will be performed to accommodate the Baggage Handling System alterations. These drawings shall be used for bidding purposes and preparation of design/engineering documents.
3. It shall be the BHS Contractor's responsibility to request and obtain architectural drawings, MEP (Mechanical, Electrical and Plumbing) drawings, Structural drawings and Project Phasing Plans applicable to the BHS from the DAA or his representative.

C. Special Related Documents

1. Division 00 – Contract Requirements
2. Division 01 – General Requirements
3. Division (16) (26) – Electrical Requirements
4. EDS Supplier Reference Documents – Reveal CT-80DR Site Planning, Installation, and Integration Documents
5. TSA's Checked Baggage Inspection Systems Performance and Commissioning Requirements
6. Planning Guidelines and Design Standards (PGDS) for Checked Baggage Inspection Systems, Version 3.0 (or later version if applicable).
7. Site Specific Test Plan (SSTP) for the Checked Baggage Inspection System (CBIS) Performance and Commissioning Requirements. The actual site specific document for the project will be generated by the TSA (Third Party) and will be given to the Contractor after contract award and prior to the specified acceptance test requirements.
8. Contact the appropriate firm or supplier to request the necessary documents that would be required for coordination, testing, interface and reference purposes.

1.03 DEFINITIONS

A. Abbreviations

1. ACAMS shall mean Access Control and Monitoring System
2. ANS shall mean American National Standards
3. ANSI shall mean American National Standards Institute
4. ASCII shall mean American Standard Code for Information Interchange
5. AT shall mean Advanced Technology X-Ray Machine
6. AOA shall mean Airport Operations Area
7. ATO shall mean Airline Ticket Office
8. BCR shall mean Baggage Control Room
9. BMA/BDD shall mean Baggage Dimensioning Device / Baggage Measuring Array
10. BIDS shall mean Bags Information Display System
11. BHS shall mean Baggage Handling System
12. BMS shall mean Building Management System
13. BNP shall mean BNP Associates, Inc., the Baggage Handling System Consultant/Engineer.
14. BMTT shall mean Bag Maximum Travel Time

15. BPM shall mean Baggage Processing Message
16. BSO shall mean Baggage Service Office
17. BVS shall mean Baggage Viewing Stations.
18. CBRA shall mean Checked Baggage Resolution Area and shall be synonymous with the terms Resolution Room, Baggage Inspection Room and ETD Area.
19. CBIS shall mean Checked Baggage Inspection System
20. CCTV shall mean Closed Circuit Television
21. CEMA shall mean Conveyor Equipment Manufacturers Association
22. CM shall mean Construction Manager
23. COF shall mean Coefficient of Friction
24. Cold Back-up shall mean that redundancy is based on the removal of a failed primary component (e.g. PLC) and subsequent replacement with a fully programmed component (PLC).
25. CT shall mean Computed Tomography
26. DAA shall mean the Duluth Airport Authority or the Owner
27. DCH shall mean Data Communication Highway. Communication line between PLCs, peripheral devices and computer systems.
28. DID shall mean Directional Input Device
29. EDS Shall mean Explosive Detection System (Computer Tomography)
30. EIA shall mean Electronic Industry Association
31. EPROM shall mean Erasable Programmable Read Only Memory
32. EOD shall mean Explosives Ordinance Disposal
33. ETD shall mean Explosive Trace Detection
34. FAA shall mean Federal Aviation Administration
35. FAT shall mean Factory Acceptance Test
36. FIS shall mean Federal Inspection Service
37. FLA shall mean Full Load Ampacity or Full Load Amperes
38. FPM shall mean Feet Per Minute
39. GC shall mean General Contractor - a firm or person other than the BHS Contractor who shall enter or has entered into a Contract with the DAA and who shall be identified by the Construction Manager for work at the Airport relating to this contract
40. GOVT shall mean Guaranteed Operator View Time
41. GSE shall mean Ground Service Equipment
42. HDD shall mean Hard Disk Drive
43. HMI shall mean Human Machine Interface.
44. Hot Back-up shall mean that in the event of a failure of the primary component (e.g. PLC, sortation computer or other redundant component) the hot back up component shall retain the latest current status of the related system (i.e. tracking information) and shall assume full operation automatically. Hot back up of components

shall provide bump less and seamless transfer of information. All tracking sortation of baggage shall continue without interruption

45. HSD shall mean High Speed Diverter
46. HVAC shall mean Heating, Ventilating and Air Conditioning
47. IATA shall mean International Airline Transportation Association
48. ID shall mean Identification
49. IEC shall mean International Electromechanical Commission
50. I/O Module shall mean Input/Output Module
51. ISAT shall mean Integrated System Acceptance Test – A full bank of tests detailed in the TSA's Site Specific Test Plan; testing will be conducted by the TSA's IV & V testing representative and shall be supported by the BHS Contractor.
52. IV & V shall mean the TSA's Independent Verification and Validation representative
53. RS&H shall mean the Architects of record.
54. LAN shall mean Local Area Network
55. DLH shall mean The Duluth International Airport.
56. LCD shall mean Liquid Crystal Display
57. LED shall mean Light Emitting Diode
58. MCP shall mean Motor Control Panel. The MCP contains the electrical control and power circuit devices for the control of the baggage system(s).
59. MDS shall mean Maintenance Diagnostics System
60. MEP shall mean Mechanical, Electrical and Plumbing System
61. MIS shall mean Maintenance Information System
62. MTBF shall mean - Mean Time Between Failures
63. NEC shall mean National Electrical Code
64. NEMA shall mean National Electrical Manufacturers' Association
65. NFPA shall mean National Fire Protection Association
66. NIC shall mean Not In Contract
67. NRT shall mean Near Real Time
68. NTP shall mean Notice-to-Proceed.
69. O & M shall mean Operations and Maintenance
70. OEM shall mean Original Equipment Manufacturer
71. OOG shall mean Out of Gauge
72. OSARP shall mean On-Screen Resolution Protocol
73. OSHA shall mean Occupational Safety and Health Administration
74. OSR shall mean On-Screen Resolution
75. OST shall mean the TSA's Office of Security Technology

76. DAA shall mean The Duluth Airport Authority
77. PAX shall mean Passenger
78. PDP shall mean Power Distribution Point. Designated location(s) to provide power for the BHS.
79. PE shall mean Professional Engineer
80. PGDS shall mean Planning Guidelines and Design Standards for Checked Baggage Inspection Systems, as prepared by the TSA.
81. PLC shall mean Programmable Logic Controller, which controls BHS operation.
82. PM shall mean Project or Program Manager
83. PSI shall mean Pounds per Square Inch
84. Pre-TRR shall mean pre-Test Readiness Review – shall be performed by the Contractor in conjunction and in coordination with the COTR and local TSA representatives to demonstrate that the system meets all of the requirements of the TSA's CBIS performance and commissioning requirements, per the TSA's PGDS, as well as the intent of the TSA's Site Specific Test Plan (SSTP) prior to the performance of the TRR testing
85. RFI shall mean Request For Information
86. ROW shall mean Right of Way
87. RRS shall mean Remote Resolution Station (alarmed bag viewing stations at Level 3 screening)
88. RT shall mean Real Time
89. SAC shall mean sortation allocation computer
90. SAT shall mean Site Acceptance Testing required for each EDS – will be performed on each EDS machine by the EDS supplier and the TSA's testing contractor, prior to integration to verify detection
91. SB shall mean Suspect Bag
92. SFS shall mean Secure Flight Selectee
93. SSI shall mean Security Sensitive Information
94. SSTP shall mean Site Specific Test Plan, prepared by the TSA's IV & V representative
95. TCU shall mean Threat Containment Unit
96. TOB shall mean Top of Belt
97. TRI shall mean Threat Resolution Interface
98. TRT shall mean Threat Resolution Tools
99. TRR shall mean Test Readiness Review – shall be performed by the CBIS contractor in conjunction and in coordination with the Airport's Security, the TSA's OST and local TSA representatives to demonstrate that the system meets all of the requirements of the TSA CBIS performance and commissioning requirements, per the TSA's PGDS, as well as the intent of the TSA's Site Specific Test Plan (SSTP).
100. TSA shall mean Transportation Security Administration
101. UL shall mean Underwriters Laboratories
102. UPS shall mean Uninterrupted Power Supply
103. USS shall mean Uniform Symbology Specification
104. User Airline shall mean those airlines that use the Baggage Handling System(s) related to this contract

105. VCR shall mean Video Cassette Recorder
106. VOM shall mean Volt Ohm Meter
107. VPN shall mean Virtual Private Network
108. WAN shall mean Wide Area Network
109. Warm Back-up shall mean that in the event of a primary component failure (e.g. PLC) the warm back up has to be manually switched to become the primary component.

B. Authorized Representative

1. The DAA may designate by written notice to BHS Contractor or by provision elsewhere in this Contract one or more persons, firms or corporation to act as its Authorized Representative in connection with the administration of this Contract. Except as otherwise provided in such written notice or elsewhere herein, such Authorized Representative shall have the authority to act for the DAA with respect to the performance of this Contract by the BHS Contractor with the objective of achieving full compliance by the BHS Contractor of the terms and provisions of the Contract.
2. Accept and comply with instructions from such Authorized Representative as though such instructions had been given by the DAA and the BHS Contractor shall deal directly with such Authorized Representative in all matters arising under this Contract, including but not limited to matters involving Contract interpretation, disputes and arbitration procedures. However, such Authorized Representative is authorized to act in connection with this Contract solely as the representative of the DAA and not as principal hereunder.

C. General

1. Baggage Handling System (BHS) shall mean all components, installation materials, interfaces and other components, all necessary hardware, software, installation coordination and construction supervision of computers/PLC, controls and control hardware and software, management and support services required to implement the work and supply a fully functioning system as described by the Contract Documents.
2. Baggage Handling System Contractor shall be synonymous with Equipment Contractor, Equipment Supplier, Baggage Contractor, BHS Contractor, Supplier and Contractor and shall mean the firm or company that is responsible for the design, engineering, manufacture, and installation of the conveyor equipment and systems required to implement the work and supply a fully functioning system as described by the Contract Documents.
3. In these written Specifications and on the Contract Drawings (unless inconsistent with the content or subject matter or unless a contrary intention otherwise appears) the following clarifications/definitions shall apply:
   a. As Built shall encompass all elements of the term As Executed.
   b. Bill of Quantities shall mean a document named therein as a Bill of Quantities issued to bidders by or on behalf of the DAA, stating quantities of work to be carried out.
   c. Completion shall mean:
      1.) That stage of the execution of the Work under the Contract when the Works are completed and all other things, which are required by the Contract to be performed by the Contractor before completion, have been performed and accepted.
      2.) Where contract or specifications provide a period of time for completion, the last day of the period.
      3.) However, if the DAA grants an extension of time for completion, it means the date resulting from the extension of time.
   d. Contract means this Deed of Agreement between the DAA and the Contractor for the performance of the Works, together with all schedules, attachments, annexure and other documents incorporated into this Contract.

e. Construction Manager shall mean a firm or person or such other manager as may be appointed by the DAA for the purpose of managing the Contract and, in so far as it concerns the functions exercisable by the Construction Manager, includes his nominated representatives.

f. Contract Sum means:

1.) Where the DAA accepted a lump sum, the lump sum.

2.) Where the DAA accepted rates, the sum ascertained by adding the products of the rates and the corresponding quantities in the Schedule of Rates.

3.) Where the DAA accepted a lump sum and rates, the aggregate of the sums referred to in paragraphs 1 and 2 above.

g. Date for Completion shall mean:

1.) Where contract provides a date for completion, that date.

2.) Where contract or specifications provide a period of time for completion, the last day of the period.

3.) However, if the DAA grants an extension of time for completion, it means the date resulting from the extension of time.

4.) The date certified by the DAA in a Certificate of Completion to be the date upon which the Works have reached completion.

h. Day means a calendar day.

i. Diversion Point shall mean the point at which a bag will either be routed into the BHS for final sortation or routed to the next level of security screening for further processing.

j. Other Contractor or Other shall mean a firm or person other than the BHS Contractor who shall enter or has entered into a Contract with the DAA.

k. Project shall mean the construction of the Duluth New Terminal BHS project at the Duluth International Airport, as described in these written Specifications and on the Contract Drawings.

l. Schedule of Rates shall mean any schedule included in the Contract, which, in respect of any section or item of work to be carried out, shows the rate or respective rates of payment for execution of that work, and which may also include provisional items, provisional sums, quantities and prices. The schedules of rates are fixed sums for the duration of the Contract with the DAA.

m. Site means the lands and other places made available or to be made available to the Contractor by the DAA for the purpose of the Contract.

n. Specifications means the Specification for the Works included in the Contract and any modification of such Specification thereafter.

o. Subsystem shall mean a set conveyor segments and it's related field elements (e.g., control stations, consoles, scanners, and the like), which is a system itself, and a part of the whole system

p. Temporary Work shall mean any work required in the execution of the Contract but not forming part of the Works.

q. The Contract Drawings shall mean the drawings referred to in these written Specifications or The Contract; the DAA may from time to time supply modifications/revisions of such drawings and other drawings to the Contractor for the purposes of the Contract.

r. The Works shall mean the whole of the work to be executed in accordance with the Contract, including variations provided for by the Contract.

s. Words importing the singular include plural and words importing the plural include the singular.

t. Words importing persons include a partnership and a body corporate.

u. Words importing the masculine gender include the feminine and neuter genders.

v. Work Under The Contract shall mean any work the BHS Contractor is or may be required to execute under the Contract and includes variations, remedial work and Temporary Work.

D. BHS Equipment Identification

1. General

a. The item numbering system and format used for physical identification of new and modified conveyors and associated equipment and in all documentation shall be consistent with the subsystem identification detailed on the contract documents. The equipment shall be numbered in consecutive order.

2. Equipment Identification

a. The item numbering system and format used for physical identification of conveyors and associated equipment and in all documentation shall be the same as that indicated on the Contract Drawings. The equipment in each subsystem shall be numbered in consecutive order.

b. The following is a listing of the subsystem abbreviations utilized in the contract drawings:

1.) **CB** means Clear Bag subsystem

2.) **CD** means Claim device subsystem

3.) **IB** means Inbound subsystem(s)

4.) **OG** means Out of Gauge subsystem(s)

5.) **RC/O**S means Recheck / Oddsize subsystem (combined function line)

6.) **SS** means Security Shunt subsystem(s)

7.) **TC** means Ticket Counter subsystem(s)

8.) **MU** means Make Up subsystem

1.04 SCOPE OF WORK

A. General

1. Provide a complete, operable, maintainable and safe system on a "turnkey basis", including all supports, header steel (unless otherwise specified), hangers, anchors, framing, trim, electrical power to the BHS systems from the sources indicated on the Control Drawings (such as but not limited to disconnect, wiring, and conduits), motors, motor starters, disconnects, controls, push buttons, conduit, wiring, cabinets, platforms, ladders, stairs, crossovers and all other components, whether specifically shown and described, or implied in the plans and specifications or wherever required to effectively accomplish the intended functions of the BHS. In all cases where a device or part of the equipment is herein referred to in the singular number, it is intended that such reference shall apply to as many such devices as are required to satisfactorily complete the installation.

2. Provide all labor, materials, and equipment required for implementing the BHS as defined by these specifications, including but not limited to installation, all required acceptance testing (including required support and participation for the TSA's SAT, Pre-ISAT/TRR, formal TRR and ISAT), all necessary wiring between BHS components, necessary protection of conveyor equipment that is under construction, materials, new conveyor equipment with all related components, provision of new BHS PLCs, PLC Networks, and other applicable components/devices, BHS PLCs and PLC Networks, all as required, for implementing the new Mini-Inline CBIS defined by these specifications.

3. The BHS Contractor shall coordinate with the TSA's Contractor, during the site planning and lay out, the BHS Phased-in Implementation, required BHS testing (i.e., SAT, Pre-ISAT/TRR, formal TRR and ISAT)

and all interface requirements between the security screening equipment (i.e., EDS Level 1 machines) and the BHS for all of the conveyor lines as they relate to this Project. In order to successfully accomplish the intended operation described herein, the details of all required interface(s) between the BHS and EDS machines shall be fully coordinated with the special systems contractor. The BHS Contractor shall be responsible for the interconnection of all BHS related PLC and data highway connections from the BHS to the EDS machines that are required to accommodate the interfaces between the two systems (hard-wired I/O, data interface cabling and software driven).

4. Submit implementation schedules and associated phasing plan documentation with the operating and maintenance documentation to the DAA or his representative, including required manuals, equipment parts lists and shop drawings - all in strict accordance with the specifications and applicable drawings, and subject to the terms and conditions of the Contract.

5. Provide all hardware, software, and construction supervision to insure that the BHS equipment operates on a fully integrated "Turnkey" basis.

6. The Contract Drawings are intended to generally outline the conveyor system configuration and function desired. Pertinent building dimensions are noted along with some specified conveyor dimensions and elevations. An attempt has been made to present approximate conveyor lengths and right-of-ways, but these shall necessarily be determined by review and inspection of building construction drawings and verified by actual field measurements by the BHS Contractor prior to preparing shop and erection drawings. An attempt has also been made to present the number, size and locations of the BHS Motor Control Panels (MCPs). It is within the BHS Contractor's scope of work to verify the final number of panels, panel size, panel locations, and total full load amps required by the system based on their electrical shop drawings within 30 days of contract award.

7. Coordinate with the EDS device provider as required to coordinate the details of the required interface(s) between the BHS and EDS systems in order to successfully accomplish the intended operation described herein. The BHS contractor shall, in all cases, be responsible for any wiring/conduit between the BHS and EDS systems that are required for these interfaces (hard-wired I/O, data interface cabling and software driven).

8. Preserve all mechanical and electrical right of ways for all deferred equipment depicted on the Contract Drawings.

9. Identify all building interface requirements necessary to install the BHS over and above those shown on the contract drawings in the bid documents. Verify as-built conditions and notify the DAA or his representative of conflicts. Any additional building modifications or alterations not so identified in the contract bid shall be borne by the BHS Contractor.

10. Coordinate the BHS maintenance platform design with the sprinkler system design, to permit the installation of the sprinkler pipes below the proposed platforms or areas where they are projecting below adjacent conveyors. The coordination between the sprinkler system design and the BHS equipment/platforms shall ensure the sprinkler pipes do not interfere with the BHS operation or related maintenance access.

11. All construction of all the new system shall be in accordance with all codes, standards, local laws, and regulations applicable to the design and construction of this type of equipment. Design all parts and sub-assemblies in accordance with good commercial practice and assure safe, efficient and practical design in keeping with requirements peculiar to this type of system. All equipment shall be in imperial dimensions.

12. Submit to the DAA or his representative any request for information, clarification of specification, and variance from the specifications as a Request For Information (RFI).

13. Obtain and pay for all permits, inspection fees, and certificates relative to all phases of BHS construction.

14. Be responsible for all employee badges as required by the Airport Authority for this project. The DAA shall not provide escort services for employees on the ATO and AOA side of the facility.

15. Submit all structural attachment detail/computations and electrical drawings signed and sealed by a

Professional Engineer licensed in the jurisdiction where this project is located.

16. Provide any and all temporary power and lighting that may be required for and during the course of the installation and testing of the BHS.

17. Cooperate and coordinate with the DAA and their Architect for the location of all Mechanical, Plumbing, Electrical, Right-of-Ways and access/egress between the BHS platforms and the building to confirm the final number and locations of the BHS associated stairs/ladders, conveyor maintenance crossovers, maintenance platforms, and all other BHS platforms and ladders over and above those shown on the contract drawings.

18. Cooperate with the Architect and other contractors for coordination of the building fire zones to confirm the number and location of the BHS associated fire/security doors and number of conveyors, which require emergency power.

19. All final conveyor equipment supports shall be designed, engineered and installed so as not to infringe on the airport and the DAA's operational areas, drive aisles or cart staging areas.

20. After installation of the BHS, demonstrate its operating capability. Accomplish prior to the start of the Systems Acceptance Testing all "debugging" and internal testing. In addition, carry out a "dry test run" of all Acceptance Tests prior to conducting such tests with the DAA or his representative to ensure that tests conducted with the DAA or his representative are successful. Submit to the DAA on a daily basis any and all records of internal testing and debugging (with corrective action) performed prior to Acceptance Testing.

21. Coordinate with all relative on-site disciplines/contractors. Coordinate and work closely with the TSA's EDS provider (Reveal) and the DAA's Security Representative for all BHS integration testing, including but not limited to providing the necessary support/participation and system demonstrations for the TSA's mandated certification testing, such as the Pre-ISAT customer testing, the formal TRR, and ultimately the ISAT. The BHS Contractor is required to complete, prior to the start of any customer or third party System Acceptance Testing, all "debugging" and internal testing. In addition, carry out a "dry test run" of all Acceptance Tests and Pre-ISAT/TRR prior to conducting such tests with the DAA and the TSA or their representatives, to ensure that tests conducted with the TSA and the DAA or their representatives are successful. Submit to the DAA or his representative on daily basis any and all records of internal testing and debugging (with corrective action) performed prior to Acceptance Testing.

22. Upon completion of the BHS installation, all related programming and internal testing/debugging, demonstrate the system's operating capability to the DAA and his representatives for acceptance and for Pre-ISAT/TRR to confirm compliance with the specified requirements. Provide all labor and test material as specified elsewhere in this document, including service technicians and test material handlers for the BHS Acceptance Testing, the Pre-ISAT/TRR and formal TRR period. These test demonstrations shall be carried out per the following requirements, as part of the base contract:

    a. Prepare BHS Test Plans in compliance with the specified requirements of Part 4, Section 4.02 (Testing and Acceptance) as well as the specified requirements of the latest version of TSA's Planning Guidelines and Design Standards (PGDS) document.

    b. The Site Specific Test Plans (SSTP) for the CBIS performance and commissioning requirements, prepared by the TSA's representative, shall be followed by the CBIS contractor in order to pass the Integrated Site Acceptance Test (ISAT). Meet with the DAA, the TSA, and their representative, at the Airport or other location as requested by the DAA, to review the SSTP, for use in the upcoming test procedures that are outlined below, to ensure the completed CBIS meets all the protocols and requirements contained within, prior to the TSA ISAT(s).

        1.) Customer Acceptance Testing - All Pre-ISAT/TRR testing (and retesting of failed tests) shall be carried out by the CBIS Contractor, and witnessed by the DAA, local TSA and their representatives, using the BHS approved test plans – per Part 4, Section 4.02 (Testing and Acceptance) of this specification, as well as the requirements of the PGDS, and the SSTP to certify that the CBIS passed per the pass/fail requirements of the test plans and is ready for a formal TRR by the TSA's OST representative. All testing data and related Pre-ISAT/TRR documentation that results from these tests, when passed, will be distributed by the DAA to the TSA's OST representative, for review and approval, along with a request for a formal TRR.

2.) Formal TRR - Upon successful completion of the above referenced local acceptance testing and Pre-ISAT/TRR, the TSA's OST representative will be invited by the DAA to witness a formal TRR, which shall be demonstrated by the CBIS contractor. The tests that will be performed during this period will be selected (from previous SSTPs that were performed during the Pre-ISAT/TRR) by the TSA's OST representative and those tests shall be demonstrated by the CBIS contractor, under the direction of the TSA's OST representative.

3.) ISAT - Upon successful completion of the formal TRR to the TSA's OST representative, a TRR report will be issued by the TSA's OST to the TSA or their IV & V representative and the DAA. The DAA will submit a letter of concurrence to the TSA regarding successful Pre-ISAT demonstration to schedule the TSA or their IV & V representative's on-site visit for the ISAT. It is anticipated that the TSA or their IV & V representative will provide all test personnel and testing material for the ISAT. However, it is within the BHS Contractors scope of work to provide the necessary manpower/labor and material, to support the TSA or their IV & V representative in performing the mandated Integrated System Acceptance Test (ISAT) for the CBIS.

23. It is mandatory to visit the project site prior to bidding, to thoroughly be acquainted with the scope of work and installation restrictions directly associated with the existing area of the facility. Coordinate a pre-bid walk-through with the DAA or his representative.

B. System Description

1. The Baggage Handling System (BHS) to be provided is illustrated on the accompanying Drawing Package (Ref. Drawing Number BG.001 for a complete listing of drawings).

2. Ticket Counter Subsystems: **TC1-1 through TC1-6**

a. A single ticket counter will be installed to transport all baggage from the ticketing area to the CBIS area. All bags inducted at the ticket counter will be read by a baggage measuring array located on the TC1-4 queue belt as they enter the CBIS area. All in gauge bags will be diverted to an open screening line (SS1 or SS2) which feed one of two (2) inline CT-80DR screening devices. All bags that exceed the allowable dimensions of the CT-80DR (as determined by the measuring array) will bypass both screening line diverters (SS1-DV and SS2-DV) and be transported to the out of gauge screening area.

3. Out of Gauge Subsystem: **OG1-1 through OG1-2**

a. All bags determined to exceed the size parameters set by Revel (CT-80DR) will be transported to the out of gauge screening area. A head and tail end photocell will be provided on the OG1-2 conveyor to provide indexing functionality with the ability to queue multiple out of gauge bags. An ADVANCE pushbutton control will be provided at the adjacent control station near the OOG ETD table to call a staged bag to the discharge end of the conveyor where it will trigger the head end "stop" photocell for TSA to safely transfer the out of gauge bag down an adjacent transfer slide onto the ETD screening table. A second transfer slide will be affixed to the table to allow a no-lift transfer of the bag to the outbound make-up once it has been screened.

4. CBIS Operation

a. The CBIS consists of two (2) inline CT-80DR screening devices with a designed throughput of 180 bags per hour. The system will feed bags to the CT-80DR devices in a round robin and first available mode depending on the baggage demand input into the system. Each SS subsystem upstream of the CT-80DR has the ability to queue four (4) bags during the peak processing duration to buffer surged demand.

b. Each SS screening line has a single Level 3 ETD station adjacent to an alarmed bag removal conveyor. Each station will have a single BVS (Baggage Viewing Station) to review Level 2 bag images and a RRS (Remote Resolution Station) that will display the alarmed bag image during the Level 3 screening.

c. All cleared Level 3 bags will be re-inserted at the reinsert/removal conveyors which merge onto the clear bag subsystem (CB3). The CB3 conveyors transport bags north to merge onto the outbound make-up sortation device.

5. CBRA Operation

a. If the CT-80DR alarms a bag, the system will allow for the required 30 seconds of decision time (mini In Line OSR time) for the BVS operator (OSR) to make a Level 2 screening decision on that bag. Note that typically the average resolution time is around 20 seconds depending on the complexity of the image. The CT-80DRs will be configured in a “hold outside” mode of operation where the pending decision bags (bags with images being viewed by the OSR) will remain on the first downstream conveyor post EDS until either the bag is alarmed or cleared by the operator, or the 30 second OSR time has elapsed. At this point, the bags will transition from the Level 2 pending conveyor to the suspect removal/reinsert conveyor.

b. A 15 inch touchscreen HMI will be installed above the removal/reinsert conveyor to display the information associated with the staged bag. The following information will be displayed per the PGDS:

1.) **EDS MACHINE ID (serial number)** – identification of the CT-80DR machine that has screened the bag.

2.) **BAG ID** – The BHS assigned bag ID

3.) BAG STATUS

a.) **Alarm Bags (AL) RED** – Bags that were not cleared by the Level 2 decision either due to the inability to clear the bag image, or because the maximum OSR view time had elapsed.

b.) **Error Bags / EDS Unknown YELLOW** – Bags that receive and error status from the CT-80DR devices.

c.) **Cleared Bags GREEN** – Clear bags will typically be conveyed directly past the removal/reinsert conveyor, but in the event the system is cascaded back to the Level 3 ETD station, a clear bag that is staged on the removal/reinsert conveyor will be indicated at the HMI that it is a clear bag.

d.) **BHS Unknown BLUE** – Bags that have become lost in tracking between the exit of the CT-80DR and the removal/reinsert conveyor.

e.) **Decision Pending RED** – Bags that during high peak volumes are not held on the first queue downstream of the CT-80DR and are instead still in OSR review when they reach the CBRA removal queue conveyor.

f.) **OSR Time Out RED** – If the 30 second OSR review time has expired these bags will continue to the CBRA removal queue conveyor and will display this status.

4.) **TRANSFER IMAGE** – HMI Input to transfer the bag information / image to the adjacent RRS.

5.) **PRINT BAG TAG** – HMI Input to print a tag with the bag information stated above.

c. Bags will be tracked from the CT-80DR exit to the removal/reinsert conveyor. If the bag is determined to be alarmed it will stop at the head end photocell of the removal conveyor at which point the system will transfer all relevant bag and status information to the touchscreen HMI installed above the conveyor.

d. The TSA operator will press the TRANSFER IMAGE input on the HMI and slide the alarmed bag onto the ETD table. The table will be flush with the shrouding on the removal conveyor to provide equal effort removing and reinserting the bag. After the bag has been removed and the head end photocell on the removal conveyor has been unblocked for a 3 second duration the removal/reinsert conveyor will restart. If the operator removes the bag prior to pressing the TRANSFER IMAGE input on the HMI, the HMI will display an alert to indicate it needs a directive. The conveyor will not restart until either the PRINT TAG or TRANSFER IMAGE input has been activated to prevent the bag information from being written over.

e. The PRINT TAG HMI input is available to print all the relevant bag information and bag status on a thermal adhesive backed tag to affix to the associated bag depending on local TSA protocol.

f. Once an alarmed bag has been searched and cleared, the TSO will press an INSERT BAG green illuminated pushbutton adjacent to the ETD table. This will stop the removal/reinsert conveyor and queue any bag upstream to allow the TSO to slide the clear bag to the reinsert conveyor. Once the INSERT BAG button has been pressed it will illuminate continuously until the bag has been placed onto the removal/reinsert belt and blocks the associated head end photocell. Once the photocell is blocked, the INSERT BAG button will illuminate in a flashing pattern indicating the TSO to press the button a second time to restart the conveyor and send the clear bag to merge onto the CB clear bag line.

6. Oversize Transport Subsystem: **OS1-1 through OS1-3**

a. An oversize transport conveyor will be installed to provide transportation of oversize items to the oversize screening area just west of the CBIS. Typically these bags will be too long or misshapen to effectively be processed through the CBIS conveyor system or the EDS devices. An over length and over height photocell will be installed at the discharge end of the ticketing conveyor prior to entering the CBIS to measure any bags that are too long to be transported by the conveyor system. The last conveyor on the OS line will be provided with indexing functionality to allow the system to stage multiple oversize bags for screening. A hinged gravity roller section will be provided to allow a no-lift transfer of the oversize bags to the ETD screening table. An additional gravity roller conveyor is provided to transfer the screened bag from the table to the oversize chute where screened bags will be staged until picked up by the respective airline. A photocell shall be installed on the unload side of the chute; when blocked shall trigger the stack up light alerting the Airlines personnel to pick up an oversize bag.

7. Inbound BHS: **IB1-1 through IB1-10, IB2-1 through IB2-9, CD1, CD2**

a. Two new inbound baggage transport conveyors are being installed to feed two new claim devices located west of the CBIS area. Both inbound load belts are aligned east west along grid line G. They both incline up and transport baggage above the DLH office and recheck space before declining into the claim hall to feed the new claim devices CD1 and CD2. An over length and over height photocell will be installed at the discharge ends of the load conveyors.

8. Inbound OS and Outbound Recheck conveyor: **RC/OS1-1 through RC/OS1-3**

a. A new straight subsystem will be provided to transport all inbound oversize baggage near the claim hall from the ramp. These conveyors will be reversible to also allow for the transport of rechecked baggage from the FIS facilities out to airside. RCOS1-01 and RCOS1-03 will be provided with indexing functionality. An overheight photocell will be installed at the discharge end of load conveyors.

C. New System Requirements

1. Ticketing Conveyors: New ticket counter conveyors as shown in the contract drawings with stainless steel to transport bags to the CBIS area just north of the ticketing lobby. The BHSC is to provide all stainless steel back guarding and fill between the conveyor and the adjacent wall.

2. Pre-EDS Transport Conveyors: New conveyors with related components for transport and queuing outbound baggage to the two (2) Level 1 Reveal CT-80DR EDS machines located in the CBIS area.

3. Diverters: New High Speed Diverters for sortation, load balancing and redundancy on the input lines to the CT-80DR screening devices.

4. EDS Installation: Provision for the transport and rigging of two (2) EDS machines to their permanent location located on BHS Contractor supplied CT-80DR elevating pads for Level 1 screening of Outbound bags, with associated input / output conveyors and all required interfaces between the BHS and EDS. The uncrating, leveling, calibration and final installation of the EDS machines in their permanent locations is NIC.

5. EDS Integration: Integration of the two (2) CT-80DRs with the BHS system controls.

6. Post-EDS Conveyors: Conveyors as required for transport and queuing of suspect/alarmed bags from the

Level 2 processing conveyor lines to the Level 3 ETD area.

7. Post-ETD Conveyors: Conveyors between the Level 3 ETD inspection tables (staffed by TSA) to provide return transport of cleared bags to the clear bag take-away conveyor and the outbound make-up device.

8. Reversible Inbound OS/Recheck Conveyor: Conveyors with appropriate reverse functionality, to provide a method for domestic inbound oversize bags to be transported from airside to landside and to transport any international outbound recheck baggage from the DLH re-check screening to the airside.

9. CT-80DR Image Quality Locations: Provide conveyors immediately upstream of the CT-80DRs with 2" high sideguards to assist TSA personnel in performing Image Quality Testing of the CT-80DR machines.

10. Removable Conveyors: The conveyor sections located at the input/output ends of the EDS machines, and the conveyors in the immediate EDS removal path detailed on drawing sheet B6102 shall be designed with "quick-disconnect" type electrical connections, and installed on lockable casters to aid in the removal of conveyor segments/components in the event of CT-80DR machine replacement.

11. Control Systems: New control systems shall be provided, including MCPs, PLCs, and BHS Computer Servers, workstations and all required communication cabling, networking and component wiring as required, to accommodate the specified functionality.

12. Fire/Security Doors: Provide, install and integrate all BHS fire/security doors (new and existing) as illustrated on the contract drawings. Also, provide and install all draft curtains at the new fire/security door locations.

13. Maintenance and TSA Access Platforms: Provide and install all BHS related maintenance platforms, ladders and cross-overs as illustrated in the contract drawings. Ensure all access ladders, platform widths, and stair rise is OSHA compliant and per code for the occupancy and typical access throughout the CBIS.

14. New Mini In-Line EDS and ETD Equipment Installation

    a. Coordinate with the TSA's Contractor during the site planning and layout, phased implementation, required testing (i.e., SAT and ISAT) and all interface requirements between the security screening equipment (i.e., EDS Level 1 machines, Level 2 workstations and ETD stations) and the BHS for all of the conveyor lines as they relate to this project.

    b. The new EDS and ETD equipment, which will be provided by the TSA, shall be installed (e.g., EDS internal system wiring, networking and related controls) at their permanent location by the TSA's contractor.

15. Provide additional components, equipment and systems as required and specified to fulfill the scope of work as described herein.

D. BHS Allowances

1. Provide a line item cost for each of the following allowances for the DAA's review and consideration to include to the project scope.

    a. Allowance 1: $100,000 to purchase from the estimated spare parts list developed by the BHSC for review by DLH.

1.05 SUBMITTALS

A. General

1. All submittals shall be in accordance with the Conditions of the Contract.

2. Submit the following documentation at the time specified during the course of the work, and in accordance with the following Submittal Deadlines.

3. Prepare all documents in the English language.

B. Bid Proposal Submissions

1. The BHS Contractor is deemed to have studied the system design and requirements presented in the drawings and specification respectively and accepted the design and requirements as suitable and appropriate to safely accomplish the functions and processes described herein. Identify in bid submission any design aspect or specification requirement that is believed to be inappropriate or inadequate and shall propose alternate solutions to alleviate the perceived problem but shall, in all cases, include in the bid submittal pricing for the base system presented in the drawings. Any alternate designs developed must meet or exceed the design criteria as listed in the specifications.

   a. System Price Schedule

   b. Unit Price Schedule

   c. Add Alternates Price Schedule if applicable

   d. Exceptions to the Contract

   e. Type and duration of the proposed training program if different to the minimum requirements as listed in Part III of these contract documents

   f. Allowance to purchase items from the Estimated Spare parts list as detailed in the contract documents

   g. Identification of any special environmental requirements more stringent than what is shown in the Specifications (if any).

   h. Notification of any perceived safety hazard with specified design of system or its components.

   i. Notification if an adjustment is required to the Contractor's Submittal Deadlines.

   j. Proposed equipment of non-standard design and equipment substitutions.

   k. Define the technical support to be provided during testing, conditional acceptance phase and after Final Acceptance has been granted.

   l. Requirements for lay down areas include line item cost if off site storage facility has to be rented.

   m. Project schedule outline for the phased-in implementation of the BHS (indicate number of weeks for completion of work after NTP).

   n. Related project list references (indicate client, location of project, type of work, year performed/completed and overall cost).

   o. Provide listing of staff with resumes and qualifications that shall be working on the project. Indicate project manager's name, names and number of programmers, technicians, instructors/ training personnel, and all other required information. Include on-site and off-site participating staff and the percent of anticipated participation on this project. In addition, provide training instructors professional qualifications. The DAA reserves the right to approve or reject key personnel from the list.

   p. Provide a line item cost for all BHS related acceptance testing including all required: SAT, pre-ISAT, and ISAT. This should clearly identify the types and quantities of required testing material as well as manpower.

C. Drawings Submitted for Review

1. Submit for review five (5) full size (Verify with the DAA and Division 1 specification requirements), and one (1) electronic copy of each shop and installation drawing.

2. The DAA or his representative shall review the drawings and return them for revision and re-submittal within 21 days, where re-submittals are required. Revise and re-submit drawings for final review by the DAA or his representative within 14 days. Any corrections or changes indicated on Shop Drawings shall not be considered as an extra work order. Do not start fabrication until receipt of the DAA or his representative's approval.

3. The comments from the DAA or his representative shall not be taken to imply that the arrangement has been

checked in detail. The BHS Contractor shall be fully responsible for the suitability, adequacy, integrity, durability and practicality of the arrangement or assembly, components and systems as set out in the drawings, specifications and other information submitted for acceptance by the DAA or his representative including all subsequent amendments. In no case shall the DAA's or his representative's review or comments relieve the Contractor in any way of his responsibility of ensuring that the equipment supplied complies with all specification and functions in accord with the wording and the intent of the applicable Specifications.

4. Do not submit drawings, which are not in full compliance with the specifications unless an Engineering Change Order Request (ECR) requesting a variable from the specifications accompanies the submittal. In this case the DAA or his representative will endeavor to respond within 21 days, but shall be under no obligation to do so.

5. Approved shop drawings shall be at the site at all times for use in the construction of the work. Failure to supply such drawings will be deemed sufficient cause to delay the work until such drawings are available for field use and reference.

6. Submit a drawing log that contains a complete list of all anticipated installation and shop drawings and submit an updated copy with each drawing submission.

D. Submittal Deadlines

1. Listed below are the submittals and dates referred to in the applicable sections. (Indicate in the proposal submission if an adjustment to these dates is required (days indicated are working days)).

Submittal Item	Deadline
Safety Program Manual	10 days after NTP
Project Management Team	10 days after NTP
Quality Control Manual	20 days after NTP
Configuration Management Plan	30 days after NTP
Detailed Master Schedule	30 days after NTP
Phasing Schedule	30 days after NTP
Structural Attachment Details	30 days after NTP
Environmental Requirements	30 days after NTP
Catalog Cuts and Equipment Specifications	20 days after NTP
System Power Requirements and MCP Sizes	30 days after NTP
BHS Equipment - Combined Heat Output Figures	90 days after NTP
Emergency Stop Zone Drawings	60 days after NTP
Controls System Description and BHS Redundancy Schematic Diagrams	90 days after NTP
Control Room Equipment	90 days after NTP
Shop Detail Drawings	60 days prior to fabrication
Motor Schedule	60 days prior to fabrication
Installation Drawings	60 days prior to fabrication
Revise & Re-issue Drawing Period	21 days
DAA Re-review Period	14 days
Training Program	90 days prior to testing
Estimated Parts List	90 days prior to testing
Functional Specification	60 days prior to testing

Inspection and Test Program	60 days prior to testing
System Endurance and Stability Test	60 days prior to test
Factory Acceptance Test	20 days prior to installation on site
Final Parts List	30 days prior to testing
Work Activities Bulletin	14 days prior to each activity
Test Reports	15 days after completion of testing
Certificate of Testing Compliance	
System Reliability Calculations	30 days after completion of testing
Certificate of Installation Compliance	15 days after completion of installation
Contractor Documentation for the development of the SSTP by the TSA's IV & V representative	180 days prior to testing
As-Built Drawings	30 days after acceptance of equipment
List of Lubricants	60 days prior to start-up
O & M Manual – Draft for DAA Review	60 days prior to start-up
O&M Manual Revisions (For an Existing BHS)	60 days prior to start-up
Periodic Maintenance Inspection and Lubrication Chart	60 days prior to start-up
O & M Manual – Final	15 days prior to start-up
Weekly Project Status Report	Last day of each week
Submittal Log	With each submittal or as required by the project.
Computer/Software/Hardware Inventory	At Conditional Acceptance / Updated as required at Final Acceptance
Computer Log	To be kept during Conditional Acceptance period and officially submitted at Final Acceptance

E. Detailed Master Schedule

1. Submit a detailed Master Schedule as specified below for review and approval by the DAA or his representative before commencing with any work. Display schedule in graphic form, large and spacious enough to be updated directly on the original submittal during the course of the project. Show the principal dates and commensurate activity times for each entry. Include in the schedule:

   a. Beginning and ending of mechanical, electrical and controls/computer engineering for each subsystem or construction phase.

   b. Drawing submittal and approval.

   c. Long lead item order placement and expected delivery date.

   d. Beginning and ending of fabrication per subsystem or construction phase.

   e. On-dock plant to on-site transportation.

   f. Beginning and ending of work per each subsystem or construction phase.

   g. Beginning and ending of mechanical, electrical and controls/computer installation per subsystem or construction phase.

h. Factory Acceptance Test dates.

i. Milestone dates for completion of pertinent facility interfaces (e.g., permanent system power).

j. Date(s) for CT-80DR EDS devices to be installed by (installation by others).

k. DAA/Engineer witnessed Factory Acceptance Testing (FAT) date(s).

l. EDS/BHS integration test plan.

m. EDS system SAT dates.

n. Contractor's internal specification conformance acceptance test dates.

o. Customer Testing Pre-TRR dates.

p. Mini In-line EDS TRR Testing dates.

q. Mini In-line EDS system ISAT dates.

r. Training and test plan submittals.

s. Submittal of operation and maintenance manuals.

t. Operation and maintenance training periods.

u. Submittal of manufacturer's recommended spare parts list.

v. System acceptance testing by subsystem.

w. Punch list rectification.

x. Final acceptance testing.

y. Submittal of As-Built documentation.

2. Maintain and update the Master Schedule weekly showing the actual progress made and any revisions in the schedules or at any time that changes in the design, construction, procurement and installation cause any major change in the overall schedule. Required reporting frequency intervals may be shorter during critical periods at the discretion of the DAA or his representative. Such additional reporting frequency shall not be grounds for additional cost claims.

3. If the weekly schedule update reflects, or the DAA or his representative determines, that the BHS Contractor is at least ten percent (10%) or fourteen (14) or more calendar days behind the original progress schedule (whichever is less) for the BHS project as a whole, a major Contract item, an item of BHS which is on the critical path, or an item of BHS not on the original critical path but that, because of the delay or anticipated delay, becomes a critical path item, then the BHS Contractor must submit its proposed recovery plan for bringing the BHS project back on schedule and for completing the BHS within the Date of Completion with the weekly schedule update.

4. The BHS Contractor shall allow for the co-ordination and interfacing of work in line with the construction work of the Duluth New Terminal Design, and other contractors associated with the Project. Such coordination and interfacing shall include for permitting the direct contractors to complete their work before proceeding to complete the balance of project under this BHS Contract. In the event of failure to allow for such coordination and interfacing, no claim whatsoever shall be entertained by the DAA or his representative for any additions, amendment, re-medial or abortive works to be carried out by the BHS Contractor or the contractors to ensure satisfactory completion of the project. Obtain the overall construction program and project schedule of the Duluth New Terminal Design and other such direct contractors and include them into his Master Schedule.

5. The BHS Contractor may also request revisions to the Project Schedule in the event the BHS Contractor's planning for the work is revised. If there are desired changes in the Project Schedule to reflect revisions in the method of operating and scheduling of the work, notify the DAA or his representative in writing, stating the

reason for the proposed revision.

6. Ensure there are sufficient personnel available for the purpose of coordination to ensure timely completion of the BHS and to ensure that the BHS Contractor does not hinder the work of other trades. Provide personnel with the required experience for coordination at meetings as required by the DAA or his representative so that decisions regarding coordination issues can be made during coordination meetings and the BHS Contractor

F. Construction (Phasing) Schedule

1. Construction phasing shall be in accordance with the General Construction Manager's schedule. Coordinate with the General Construction Contractor, the DAA or his representative to develop a BHS installation phasing plan

2. Submit a detailed phasing plan for each subsystem designated for installation, description of the work, staffing requirements and schedule per phase. The overall plan/schedule shall be broken down by subsystem of activity (as coordinated with the project team).

G. Structural Attachment Details

1. Submit structural and seismic attachment detail drawings and the design computations of all structural supports for the BHS and associated platforms/walkways signed and sealed by a Professional Structural Engineer licensed in the State of Minnesota, the same jurisdiction where this project is located.

2. Submit for review the design and locations of all structural attachment points, wherever the equipment is to be supported by the building structure. Show, as a minimum, the type of anchor device to be used and the amount of load to be imposed on the building structure.

3. Submit a complete vibration isolation-drawing package, showing isolation type, as well as method and location of installation.

4. Submit a list of successful projects, which used the type of BHS and vibration isolation package being proposed for this project.

5. Coordinate with the Architect's structural engineer to ensure that all State and Local codes for any seismic requirements are met and abided by for this project.

H. Shop Drawings, Installation Drawings, and As-Built Documents

1. General

a. All drawings submitted shall become the property of the DAA.

b. All drawing submittals shall be to scale. The scale utilized shall be clearly defined in the title block.

c. The North arrow shall also be shown on all mechanical drawings.

d. Drawings shall include the following items unless otherwise specified.

1.) Document Title Blocks

a.) In addition to information normally presented in a drawing title block, each drawing title block shall provide the following specific information:

(1.) Three letter airline code for airport designation of the project location

(2.) Name of the Baggage Handling System

(3.) Drawing scale

(4.) Drawing title

(5.) Drawing number/sheet number

(6.) Drawing date

(7.) Drawing revision date and revision number

(8.) NOTE: All drawing revisions shall be foot noted on the drawing face as well as in the appropriate revisions section of the title block.

e. Professional Engineer Approval Requirements

1.) Engage Professional Engineer(s) licensed in the State of Minnesota in the relevant disciplines, at its own cost, to design, review, verify and certify the BHS structural systems including all necessary temporary works and supports.

2.) Minimum requirements for Professional Engineer signed and sealed drawings and calculations to be submitted are defined below. Submit any additional signed and sealed drawings, calculations or submissions required by federal, state or local codes. As a minimum, the following drawings, calculations and submissions shall be signed and sealed:

a.) Mechanical/Structural

(1.) All structural and seismic attachment details and design computations for the BHS and associated platforms/walkways

(2.) All structural support details and design computations for the BHS and associated platforms/walkways

(3.) Drawings and design computations of all structural attachment points to the parent building including imposed load on the building

(4.) Drawings defining all structural supports and attachment types and locations. Generic details will not be acceptable for this purpose.

(5.) Drawings defining all maintenance platform/walkways and methods of platform/walkways access including details of handrails, access stairs and ladders, and platform/walkways construction details.

b.) Electrical

(1.) New PDP drop point load calculations

c.) Provide the above mechanical/electrical PE signed and sealed drawings/calculations as listed above in part a.) and b.) in two separate submittals:

(1.) "For Construction" drawings/calculations

(2.) Final "As-Built" drawings/calculations

2. Drawing Submittal Package Requirements

a. Submit a motor schedule listing: motor horsepower, voltage, source of feed, circuit breaker size, disconnect size, conduit and wire size and overload heater size selected to be used, prior to the installation of overload heaters on the controllers.

b. Submit to the DAA or his representative for review the BHS equipment combined heat output figures with calculations for the following areas of the facility. The information typically includes friction losses from conveyor equipment and heat outputs from the drive motors, motor control panels and computer equipment:

1.) BHS Control Room

2.) CBIS/CBRA Area

c. Submit As-Built drawings as per the specified submittal schedule (plans and associated sections/elevations) indicating the location of the BHS, including all mechanical components, maintenance platforms and electrical devices, operator's control panels, MCP, switches, and other control devices. All final “As-built” drawings shall be signed and sealed by a Professional Engineer licensed in the State of Minnesota, at no additional cost to the DAA.

d. Submit final assembly drawings, shop detail drawings and any other pertinent drawing files in AutoCAD.DXF format, version 2004 or higher, for all phases of the work, indicating BHS components, construction and assembly details of all components prior to releasing drawings for fabrication.

e. As-Built drawings shall be submitted on CD ROM in addition to other forms of media described herein.

3. BHS Mechanical Drawing Submittal Requirements

a. General

1.) If standard parts are purchased, reproduced details and identifying part numbers shall be provided.

2.) Each BHS device or conveyor that appears on plan, elevation and section drawings of the BHS shall be identified with the appropriate I.D., as established in this Specification.

3.) Number conveyor equipment and control devices starting at the beginning of each conveyor system or subsystem. If there are any discrepancies between the contract document-specified equipment I.D. numbers and the actual identification of existing (to be retained) equipment, such discrepancies are to be brought to the attention of the DAA or his representative for immediate resolution.

4.) All plan views of the BHS system shall be based on an overlay of the building structure as is appropriate.

5.) All plan, elevation and section drawings of the BHS shall also show the vertical and horizontal clearances between the related system equipment and the building structure with its related interferences.

b. Provide the following types of mechanical drawings:

1.) General arrangements with dimensions of all new equipment (plan, elevation, details and sections, as appropriate) for all mechanical, maintenance platforms, crossovers, ladders (coordinate with the Architect and the DAA or his representative for the final number and location of all maintenance access equipment), impact protection, electrical motor control panels, electrical equipment support, electrical control workstation, BDDs.

2.) Drawings with the appropriate level of detail, as noted in the contract documents, shall be provided for any equipment designed and manufactured for this project.

3.) Detailed drawings are required for all BHS equipment framing, supports, hangers, and other required supports.

4.) Detailed drawing indicating locations and type of safety signage.

4. BHS Electrical Drawing Submittal Requirements

a. General

1.) Each BHS device or conveyor and related control and power devices that appear on any electrical drawings of the BHS shall be identified with the appropriate I.D., as established in this Specification.

b. Submit the following types of electrical drawings:

1.) Plan view of the BHS noting the identity and location of each control device, control station, motor, limit switches, safety disconnect switches, and the like as related to each BHS device of the system.

2.) Layout of MCP control devices.

3.) Submit all power requirements for the subsystems of this project as per the specified submittal schedule. System power requirements shall be calculated in accordance with the recommended practice and shall include connected and demand power.

4.) Detailed drawing indicating locations and type of safety signage.

5.) Programmable Logic Controller (PLC) computer control system in block diagram format to include the data communication system showing the connections among all PLC, sortation computers and remote I/O units if utilized.

6.) Motor Manifest indicating type, part number of driven equipment, power in horsepower, full load amperes and speed.

7.) MCP general layout showing enclosure size, type, power requirements, equipment location and enclosed component general arrangement. Include a separate I/O list for each PLC or remote I/O in the panel. Identify I/O assignments with Equipment Item Numbers.

8.) Detailed block diagram representing internal layout of components within each motor control panel, both internal as well as external layout of components related to BHS workstations, and external layout of the BDD array.

c. Submit the following types of control system drawings:

1.) Plan view of the BHS noting the identity and location of all MCPs, control devices, remote I/O panels, control stations, motors, limit switches, safety disconnect switches, photocells, shaft encoders, HMI panels .

2.) Plan view of the BHS noting the identity and location of each motor with power in horsepower. Identify all motors that will have a VFD, or brake, and indicate the location of the VFD (either at the motor or located in the relevant MCP).

3.) Plan view of the BHS noting the identity of each conveyor with the design speed in feet per minute.

4.) Plan view of the BHS noting the identity of every photocell location annotated whether a tracking or non tracking device

5.) A set of drawings showing those conveyors that will stop by the activation of each specific Emergency Stop in the system as per the specified submittal schedule. The drawings should indicate (using different colors or hatches) the conveyors of the specific subsystem and any adjacent subsystems that will stop for each emergency stop or group of emergency stops as appropriate. The BHS Contractor should take into consideration the following when developing the e-stop zones:

a.) When splitting up e-stop zones, consideration must be given to the MCP breaks. If the down stream MCP is shut down, upstream bags that are left in the system should be able to divert prior to the equipment that is inoperable.

b.) 90-degree merge e-stops should be tied into the receiving or take-away conveyor.

d. Submit detailed shop drawings which include all interfaces between systems that are affected by the scope of work and shall include but is not limited to connection details (connector type, communication protocol) software protocol, transmission media, location of connections and any other required information. The types of interfaces include; the building life and safety fire system, EDS systems, FIDS (if provided) and BIDS (if provided).

e. Provide an approved 11" x 17" reduced copy of the schematic wiring diagram(s) of each MCP including outline and wiring diagram of all special devices which shall be placed in the door pocket of the MCP.

5. Control System Description Submittal

a. Submit Control System Description as specified in Part II of this specification.

6. BHS Control Room, Computer and Control System Descriptions

   a. Submit the Computer/Control Room requirements containing all information pertaining to the requirements of the proposed Computer/Control hardware (refer to Part II of these contract documents for full details on the BHS control room requirements), including:

      1.) A proposed room layout of new equipment with phasing drawings and final layout drawings showing spatial requirements.

      2.) Environmental requirements (temperature and humidity)

      3.) Submit HVAC requirements

      4.) Fire protection

      5.) Electrical and power requirements (e.g., the number and location of UPS electrical sources)

I. Catalog Cuts

1. Submit a catalog cuts manual for all manufactured and purchased items (mechanical, electrical and computer equipment) as per the specified submittal schedule.

2. The catalog cuts shall be contained in binders of the “presentation” type equipped with “D” rings. Additionally, the binders shall be equipped with a clear spine pocket to permit the insertion of the manual title. The catalog cut manual shall be contained within at least one volume of appropriate size and contain the following:

   a. Record of Revisions: A "Record of Revisions" sheet shall be provided at the beginning of the catalog cut manual.

   b. Table of Contents: A Table of Contents shall be provided at the beginning of the catalog cut manual.

   c. Index Tabs: Each catalog cut component shall be identified with an index tab with permanently printed information.

3. The catalog cuts must be completely legible and have the specific items used in the system highlighted with a shaded arrow. Where a variation occurs from the standard component or a special custom ordered part has been used as a replacement for the standard supply, additional details shall be submitted to clarify the identity of the component.

4. The catalog cuts shall include the following items (this list is not to be construed as being complete since it is provided only as a guide):

   a. Speed reducers

   b. Motors

   c. Bearings

   d. Pulleys and rollers

   e. Motorized pulleys

   f. Belting

   g. Roller chain and sprockets

   h. Belts and sheaves

   i. Queue conveyors

   j. Power turns

   k. HSDs

l. Wiring devices

m. Control devices

n. Soft starts, electronic

o. Electric brakes

p. VFDs

q. PLC and peripherals

r. Power regulators

s. Computer equipment

t. Video monitors

u. Flat Plate devices

v. Slope Plate devices

w. Baggage Dimensioning Device (BDD) components

x. Directional Input Device (DID) components

y. Hand held scan guns (if applicable to the CBRA operations)

5. Be responsible for a thorough site survey of the existing systems and submit catalog cuts of all components to be utilized for the project. Clearly identify those components that cannot be matched with the existing component, for the DAA or his representative's review and approval.

J. Operation and Maintenance Manuals

1. Purpose

a. The prime purpose of the Operation and Maintenance (O & M) Manual is to provide the DAA's operational and maintenance personnel with a thorough understanding of the layout of the system, its function, special features, operational requirements, maintenance requirements, parts information, warranty information, and safety considerations and requirements for operating and maintaining the system safely and effectively.

b. This specification is intended as a guide to indicate the basic requirements of the O&M Manuals. The Contractors standard O&M Manual shall be acceptable provided it is functionally equivalent to that specified below and the documents are suitable and usable for the intended purpose.

c. The manual is to be divided into two main sections:

1.) The Operational portion of the manual shall present the information required for personnel to be able to operate the system in a safe and efficient manner. The operational information shall be presented in easy to understand terms to ensure that personnel not familiar with the system will have a thorough understanding of the system upon reading the operational information.

2.) The Maintenance portion of the manual shall present the information required for personnel to be able to maintain the system in a safe and efficient manner. The maintenance information shall be presented in easy to understand terms to ensure that personnel not familiar with the system shall have a thorough understanding of the mechanical and electrical equipment operation and maintenance requirements so that they shall be able to effectively and safely perform maintenance functions such as troubleshooting, servicing, and repairing.

2. Binder Type

a. Binders shall be of the "presentation" type equipped with "D" rings. Additionally, the binders shall be equipped with a clear spine pocket to permit the insertion of the manual title.

3. Format

   a. The O & M Manual shall be contained within at least two (2) volumes of appropriate size. Note that additional volumes may be required to accommodate multiple operational or maintenance information chapters.

   b. The title information shall be generally as follows:

      1.) First line: Three letter code of the airport in which the system is located (DLH).

      2.) Second line: "Operations Manual" or "Maintenance Manual"

      3.) Third line: "For"

      4.) Fourth line: Type of system: (such as: Duluth International Baggage Handling System)

      5.) Fifth line: Date of System, as based on actual beneficial use date

      6.) Sixth line: Project Number (to be Coordinated with the DAA or his representative)

4. Contents of Manual

   a. Record of Revisions: A "Record of Revisions" sheet shall be provided at the beginning of the O & M Manual.

   b. Table of Contents: A Table of Contents shall be provided at the beginning of the O & M Manual.

   c. Chapter Index Tabs: Each chapter shall be identified with an index tab with permanently printed information.

   d. Chapter Index: Each chapter of the O & M Manual shall begin with an index for the related chapter.

5. Operational Information

   a. Chapter 1 - Glossary of Operational Terms

      1.) Chapter 1 shall include a glossary of operational related terms and equipment identification/designations.

   b. Chapter 2 - System Overview

      1.) Chapter 2 shall include, at a minimum, the following items:

         a.) A basic overview of the system showing overall layout and arrangement.

         b.) Identify locations, number of and types of inputs.

         c.) Identify locations, number of and type of sort areas (as appropriate).

         d.) Identify system and subsystem conveyor designations.

         e.) Processing rate of each subsystem as well as the total system-processing rate.

   c. Chapter 3 - Baggage Weight and Size Limitations

      1.) Chapter 3 shall include, at a minimum, the following items:

         a.) Normal Size Baggage

         b.) Baggage that can be processed by system but requires special considerations/handling such as but not limited to skis, and golf bags.

         c.) Fragile Baggage

         d.) Oddsize Baggage

   d. Chapter 4 - Detailed Description of System Operation

1.) Chapter 4 shall include, at a minimum, the following items written in a clear concise manner:

a.) The detailed operational description of system operation must be written to provide operational personnel a thorough understanding of how to operate the system. Operational personnel include:

(1.) Passenger Service Ticket Agents

(2.) Service Baggage Handlers

(3.) TSA Agents

b.) The operational information shall cover system start-up and shut down operational requirements.

c.) The operational information shall also provide a thorough understanding of the system fault annunciation system so that faults can be recognized and appropriate action can be directed.

d.) The operational information shall provide an operator's troubleshooting guide for the safe and effective correction of operational problems.

e.) The BHS shall be equipped with a BHS computer/server and a MDS workstation; Provide detailed information for the items noted below, affected by the specified requirements of this project (this list is not to be construed as being complete and is provided only as a guide):

(1.) All operator interface command entries

(2.) All operator initiated reports

(3.) All system automatically generated reports

(4.) All system fault alarm messages and reports

(5.) All graphic display information systems

(6.) Placing equipment "in" or "out" of service

(7.) BDDs

(8.) Hand Held Bar Code Scanner Guns (if applicable to the CBRA operation)

f.) The detailing of the above information shall include:

(1.) Thorough explanation and purpose of the command message or report.

(2.) Required keyboard or operator response.

(3.) Explanation of expected system response

g.) The operator’s information must also include procedures and recommendations for alternative modes of system operation as may be required due to various equipment or subsystem failures.

e. Chapter 5 - Operational Safety

1.) Chapter 5 must provide safety information related to the proper and safe operation of the specified system and its equipment from an operator's point of view and at a minimum must cover the following items (this list is not to be construed as being complete since it is provided only as a guide):

a.) Jam Detection, Jam Clearance and Restart Procedure

b.) System start up

6. Maintenance Information

1.) Chapter 1 - Glossary of Terms and Identification a.) Chapter 1 must include a glossary of all terms and equipment identification/designations associated with the specified system.

2.) Chapter 2 - Description of System Equipment

a.) Chapter 2 must include, at a minimum, the following items:

(1.) Detailed description of the mechanical conveyor equipment used in the system including widths of conveyors, general specifications and capabilities of the system.

(2.) Detailed description of the electrical equipment used in the system, including the location of motor control panels.

3.) Chapter 3 - Electrical Control Sequence of Operation

a.) Chapter 3 shall include a detailed description of the electrical control sequence of operation. The detailed description shall cover the following items (this list is not to be construed as being complete since it is provided only as a guide):

(1.) Location and operation of Control Stations

(2.) Location and operation of Photocells

(3.) Operation of MCP(s)

(4.) Operation of PLC(s)

(5.) Operation of Fire/Security Door(s)

4.) Chapter 4 - Maintenance Safety Procedures

a.) Chapter 4 must provide safety information related to the proper and safe operation and maintenance of the specified system and its equipment from a maintenance point of view and at a minimum, the following items shall be covered (this list is not to be construed as being complete since it is provided only as a guide):

(1.) Pre-operating Procedure

(2.) Start-up and Shut-down Procedure

(3.) Emergency Stop and Restart

(4.) Jam Procedure

(5.) Equipment Lockout/Tag Out Procedure (the procedure must reflect/refer to the most current OHSA, ANSI, and local codes, policies and standards)

5.) Chapter 5 - Service, Inspection and Preventive Maintenance

a.) Chapter 5 must provide detailed information for the proper servicing of all of the system equipment and at a minimum must cover (this list is not to be construed as being complete since it is provided only as a guide):

(1.) A general explanation, regarding what the servicing requirements is for the related system equipment.

(2.) Detailed preventive maintenance program outlining required functions and frequencies for the proper preventive maintenance of the components that make up the system equipment items such as belt conveyors, power turns, flat plate devices, slope plate devices, HSDs, security doors, motor control panels, and the BDD. At a minimum, the following items shall be covered however; this list is not to be construed as being complete since it is provided only as a guide. It shall be noted that the information shall be "brand specific" for the actual equipment provided for this system only. Information for equipment types and brands not provided in this system will not be acceptable.

(3.) Inspections for:

(a.) Straight Conveyors, Power Turns, Merge Conveyors, Diverters, Slope Pallet Devices, and BDD Arrays.

(4.) Lubrication of:

(a.) Motor Bearings, Pulley Bearings (as required), Drive Chains, Speed Reducers, and Power Turn Perimeter Chains/Guides, and all other items requiring lubrication.

(5.) Cleaning of:

(a.) Motors, Drive Chains, Speed Reducers, Photocells (and related reflectors), Motor Control Panels, Workstations, and BDDs.

(6.) Adjustment of:

(a.) Straight Conveyor Belt Tracking, Straight Conveyor Belt Tensioning, Power Turn Conveyor Belt Tracking/Tensioning, Merge Conveyor Belt Tracking/Tensioning, Flat Plate Devices, Slope Pallet Devices, Drive V-Belt and Sheave Alignment, Drive V-Belt Tensioning, Drive Chain and Sprocket Alignment, Drive Chain Tensioning, Photocell alignment and sensitivity, Drive Motor Clutches, Drive Motor Brakes.

6.) Chapter 6 - Warranty Information and Procedures

a.) Chapter 6 shall provide detailed information regarding the specific Warranty Conditions that prevail on the specified system.

b.) Additionally, the detailed information regarding the system warranty must include the following:

(1.) Date of Beginning and Expiration of Warranty Period.

(2.) Specific instructions regarding the procedures for the documentation and return of items under warranty.

(3.) Names and telephone numbers of the "point of contact" for warranty questions and discussions. Note that the "point of contact" information shall be provided for both "normal" 0800 to 1700 Monday through Friday hours as well as "after hours".

7.) Chapter 7 - Troubleshooting

a.) Chapter 7 shall provide detailed information for the proper troubleshooting of the system equipment.

b.) At a minimum, the following items must be included in a detailed "problem and correction" type of troubleshooting chart (this list is not to be construed as being complete since it is provided only as a guide):

(1.) All mechanical equipment

(2.) All electrical equipment

(3.) All control equipment

(4.) All computer equipment

(5.) BHS/EDS Interfaces

c.) The troubleshooting information provided in the chart is to cover an exhaustive list of possible causes of system failure or malfunction.

d.) The information is to be arranged in a three (3) - column format with respective headings of:

(1.) Trouble

(2.) Probable Cause

(3.) Corrective Action.

e.) Empirical Readings: This chapter shall include the Empirical Readings, as noted in “Testing and Acceptance” section of this Specification, which were recorded at the time of the Conditional Acceptance Testing and Inspection of the system. This information is to be provided as a maintenance reference.

8.) Chapter 8 - Removal and Installation Procedures

a.) Chapter 8 shall provide detailed information for the proper removal and installation of all of the system equipment components.

b.) It must be noted that the information shall be "brand specific" for the actual equipment/components provided for this system only. Information for equipment/components types and brands not provided in this system will not be acceptable.

c.) At a minimum, the following items shall be included in this chapter (this list is not to be construed as being complete since it is provided only as a guide):

(1.) Basic Considerations

(2.) Safety Precautions

(3.) Procedural Orientation

(4.) List of special tools, gauges and equipment required for the maintenance of the system, together with illustrations and instructions as to how they are to be used. Sources for procurement of these items shall also be provided.

(5.) Torque Values

(6.) V-Belt Tension Procedures and Values

(7.) Drive Chain Tension Procedures and Values

d.) Component List (this list is not to be construed as being complete since it is provided only as a guide):

(1.) All the components for straight conveyors.

(2.) All the components for power turn conveyors.

(3.) All the components for merge conveyors

(4.) All the components for queue conveyors

(5.) All the components for slope pallet make up/claim devices

(6.) All the components for flat plate make up/claim devices

(7.) All the components for the MDS workstation

(8.) All the components for Baggage Control Computer

(9.) All the components for diverters.

(10.) All the components for BDD arrays

(11.) All the components for DIDs

(12.) All the components for MCPs

9.) Chapter 9 - Illustrated Parts Information

a.) Chapter 9 must contain detailed illustrated parts information. The illustrated parts information shall be provided in the following manner for all mechanical, electrical, workstation, computer, and BDD array.

b.) Clear, concise exploded view isometric drawings showing the parts, the relationship of adjacent parts with one another within a given conveyor equipment assembly as well as the diagram number that shall reference the specific part on the adjacent parts information sheet.

c.) The parts information sheet shall be adjacent to the isometric drawing and shall contain:

(1.) Part reference number from isometric drawing

(2.) Part description

(3.) Part Number

(4.) Manufacturer of part

(5.) Number of parts found in the conveyor equipment isometric drawings

d.) Provide the above information in a manner so that the isometric drawing (up to 11" x 17" that can be folded up) shall be on the left hand side of the open manual with the associated parts information sheet as the right hand page of the open manual.

e.) Include model and serial numbers (if applicable) for all equipment.

10.) Chapter 10 - Manufacturer's Literature

a.) Chapter 10 shall provide all of the manufacturer's literature for all of the conveyor equipment mechanical, electrical and electronic components.

b.) Information shall be "brand specific" for the actual equipment/components provided for this system only. Information for equipment/components types and brands not provided in this system will not be acceptable.

c.) At a minimum, only a first copy of a manufacturer's original literature will be accepted if the actual original manufacturer's literature cannot be provided.

d.) All such copies shall be clear and legible.

e.) All manufacturers' literature shall be appropriately highlighted with a legible solid black arrow for identification of the specific model or type of device used in the specified system.

f.) All manufacturers' literature shall include information adequate for proper servicing of the item, proper operation of the item as well as all required information for the ordering of the item.

g.) Complete list of parts manufacturers including address, telephone number and point of contact.

11.) Chapter 11 - Mechanical Drawings

a.) Chapter 11 shall contain a complete, clear and legible 11" x 17" set of "As-Built" BHS mechanical drawings.

b.) The 11" x 17" drawings are to be folded so that they will fit within the O & M Manual.

12.) Chapter 12 - Electrical Drawings

a.) Chapter 12 shall contain:

(1.) A complete list and definition of the electrical symbols used in the electrical drawings.

(2.) A complete, clear and legible 11" x 17" set of "As-Built" BHS electrical drawings. The As-built drawings shall contain as a minimum the following:

(a.) Detailed wiring connection drawing noting each control device, control station, motor, and all other controls devices, in block form with a detail of the actual "field wiring" numbers and configuration.

(b.) Detailed conduit routing diagram indicating size of conduit, size and number of conductors, junction boxes, control devices, motors, safety disconnect switches, motor control panels, BDDs, and workstations.

(c.) Detailed block diagram representing internal layout of components within each motor control panel, both internal as well as external layout of components related to workstations, external layout of scanner arrays (BDDs).

(d.) Schematic Wiring Diagram of each MCP, including outline and wiring diagram of all special devices. An additional approved 11" x 17" reduced copy shall be placed in the door pocket of the MCP.

(3.) The 11" x 17" drawings are to be folded so that they will fit within the O & M Manual.

13.) Chapter 13 - PLC Listings

a.) Chapter 13 shall include a complete, clear and legible set of "As-Built" BHS PLC listings. The listing shall include the following:

(1.) Complete set of PLC program ladder logic diagrams as well as PLC and Sortation controller listings for the related system.

(2.) A complete Sequence of Operation shall be included on the schematic diagrams or the PLC ladder logic diagrams.

(3.) PLC ladder logic diagrams shall have detailed "right hand" margin descriptors clearly identifying the function of each device and its associated contact rung locations.

(4.) Include a separate I/O list for each PLC or remote I/O in the panel. Identify I/O assignments with Equipment Item Numbers.

7. Draft O & M Manuals

a. Submit two (2) sets of a draft Operations and Maintenance Manual for review and approval to the DAA or his representative prior to Start-up of the system(s).

8. Final O & M Manuals

a. Four (4) Sets of the Final O & M Manuals shall be presented to the DAA in accordance with the submittal schedule. Timely submittal of a system's O & M Manual is absolutely essential to the proper operation and maintenance of the BHS.

b. All four (4) sets of the O & M Manuals must be updated by supplement to reflect any Field Changes, equipment changes due to warranty changes, and any other changes., that were made during the Warranty Period of the System, so that all sets of manuals shall reflect "As-Built" information.

c. An electronic medium copy of the O & M Manuals shall also be provided on CD.

K. Periodic Maintenance Inspection and Lubrication Chart

1. Provide a master chart or series of charts involving periodic maintenance of all equipment items in the system and defining, under equipment item subdivisions, the points and frequency of recommended periodic maintenance functions, including inspection, lubrication and replacement.

2. This chart need not detail the procedures involved with such periodic maintenance functions since such procedures will be found in the maintenance manual, but reference shall be made to specific sections or pages therein.

L. Training Program

1. Provide an operational and maintenance training program as specified in Part III of these Specifications.

2. The training program shall be submitted to the DAA or his representative for review and approval prior to the start of System Testing and in accordance with the schedule of submissions.

M. Environmental Requirements

1. Submit any special environmental requirements above and beyond what is shown in these specifications that may be essential for correct equipment operation (e.g., computer hardware, scanner arrays and any other items with special requirements).

N. List of Lubricants

1. Submit a complete list of lubricants to be used on the equipment components. This list shall be standardized on one supplier in order to minimize the number of different lubricants used.

O. Inspection, Functional Specification and Testing Program

1. Submit an Inspection, Functional Specification and Testing Program for the BHS to demonstrate compliance with all specified requirements. Prepare the inspection and test plans based on the information provided in this specification. Meet with the DAA, the TSA and their representatives, at the Airport or other location as requested by the DAA, to review the SSTP and obtain a copy, to ensure the completed CBIS meets all the protocols and requirements contained within, prior to the Pre-ISAT/TRR with the DAA, the formal TRR with the TSA's representative and ISAT with TSA representative (Battelle). The CBIS Contractor's test plan submittal shall include the tests that are associated with the SSTP for the TSA's CBIS Performance and Commissioning Requirements, which will include, as a minimum, the tests that are outlined in Part 3 of this specification. This program shall comply with the guidelines presented in the Acceptance and Testing section of Part 4 of these Specifications (34 77 16) and include the required support and participation by the BHS Contractor for the TSA's SAT testing of the EDS machines, separate Pre-ISAT/TRR, formal TRR and ISAT, all consistent with the Battelle Site Specific Test Plans (SSTP) for the Checked Baggage Inspection Systems Performance & Commissioning Requirements as well as the requirements of the TSA's PGDS. This program shall comply with the guidelines presented in the Acceptance and Testing section of this Specification.

2. The Functional Specification and Test Program shall identify and demonstrate all System Control Functions. The Functional Specification/Test Plan is to list each Control Station, and Control Device, and its related Control Function that is to be demonstrated/tested. Refer to the Acceptance and Testing Section of this specification for detail test plan content requirements.

3. The testing plan shall include testing of all systems integrated with the BHS e.g. fire system, ACAMS, EDS devices and other interfaced devices.

4. The Inspection, Functional Specification and Testing Program shall be submitted for the DAA or his representative's review and approval prior to the start of System Testing in accordance with Schedule of Submissions.

P. Test Reports

1. Submit a report after completion of the internal testing, debugging and system tests performed prior to Acceptance Testing summarizing the detailed results of the tests, to the DAA or his representative prior to requesting final acceptance testing by the DAA or his representative.

2. In addition carry out a "dry test run" of Acceptance Tests prior to conducting such tests with the DAA or his representative to ensure that tests conducted with the DAA or his representative are successful.

3. Provide the DAA or his representative, upon request; the results of all in-plant tests, conducted on assemblies or sub-assemblies of equipment or equipment of like that are to be installed.

Q. Certification of Installation Compliance

1. Submit certificates issued by Regulating Authorities (in compliance with work permits (electrical, mechanical, welding, Fire Marshall and other Authorities)), that the equipment has been properly installed, meets all safety standards and is operating within the required accuracy.

R. Certification of Test Compliance

1. Submit BHS Equipment Supplier's Certification that the system has been tested in compliance with the supplier's requirements for testing and has met all testing requirements.

S. Final Parts List

1. Provide a detailed listing and description of all individual system (subsystem) components with reference to layout and assembly drawings.

2. The listing of system parts shall include the following information:

a. Name of part

b. Complete description of part

c. Each specific location that the listed part is used in the system(s).

d. Total number of parts in system(s)

e. Manufacturer of part

f. Manufacturer's part number

g. Source of supply

h. Recommended quantity of spares per each item

i. Price per unit

j. Lead time or availability of part

k. Complete list of manufacturers, with addresses, telephone numbers and point of contact.

l. Manufacturer's catalog literature and specifications for all purchased parts.

T. System Power Requirements and MCP Sizes

1. Submit all the motor control panel (MCP) sizes and related power requirements for the all subsystems of this project. The power requirements shall indicate conveyor segment horsepower and the total connected load of the new BHS subsystems (horsepower and full load amps).

U. Estimated Spare Parts List

1. Submit a list of estimated spare parts required for the first year of operation for the DAA or his representative's review and consideration for a budgetary allowance - include unit price per unit for the estimated spare parts list based on reasonable airline market rates. Spare parts may/shall be purchased for each phase prior to the commissioning of that phase. Include recommended inventory and replacement levels for each phase prior to commissioning as well as part description and identification quantities in system, delivery times, manufacturers and suppliers (their part or ordering numbers).

2. Include any special test instruments required for maintenance beyond the normal inventory of a conveyor maintenance shop. Include a device for measuring conveyor speed and shaft rotational speed, a VOM and a clamp-on hand-held Ammeter.

3. Submit a spare parts list in accordance with Schedule of Submissions.

V. System Reliability Calculations

1. Submit system reliability calculations demonstrating compliance with the "System Reliability" requirements specified herein.

W. Weekly Status Reports

1. The BHS Contractor's Project Manager shall submit a Weekly Status Report to the DAA or his representative, which shall include schedule updates in accordance with the provisions of the contract terms. The DAA or his representative shall have the right to change the time of submitting and the details of the report. The weekly status reports shall cover, including but not limited to, the following information:

a. Percentage of mechanical, electrical and controls/computer engineering completion, per subsystem.

b. Percentage of fabrication completed

c. Equipment delivery schedule (month look ahead)

d. Percentage of equipment installed complete:

1.) Mechanical

2.) Electrical

3.) Controls

4.) Computer

e. Updated detailed Project Schedule

f. Two week look ahead schedule

g. BHS Engineering Issues

h. Interface Issues including but not limited to the following:

1.) Fire and Security Systems (ACAMS)

2.) EDS devices

i. Right of Way Issues.

j. Brief description with status of accepted and proposed change orders with associated cost.

k. Status of payments

l. Manning by trade

m. Percentage of testing completed

n. Any other issues

X. Submittal Log

1. Provide a log to the DAA or his representative listing all required project submittals to include, at a minimum, the following information:

a. Type of submittal

b. Submittal revision number. (The submittal revision number shall also be clearly identified within the submitted document as well.)

c. The date in which the submittal is sent out for review

d. Company or individual the submittal is sent to

e. Date in which the submittal was returned after review has been completed

f. Review status

Y. Computer/Software/Hardware Inventory

1. Provide to the DAA or his representative a detailed listing for each computer/PC to be submitted upon Conditional Acceptance.

2. Submit the listing (by computer) along with all program CDs, manuals, manufacturers information in an organized binder upon Conditional Acceptance.

3. It is to include in addition to the above, at a minimum, provide the following:

a. Complete software inventory by computer.

b. Complete hardware inventory by computer.

c. Registration numbers, serial numbers.

d. Computer emergency boot disks.

Z. Computer Log

1. Upon conditional acceptance it shall be the responsibility of the BHS Contractor to keep a computer log. The purpose of the log is to keep track of any system computer problems/issues, which occur during the conditional acceptance period for trouble shooting/tracking purposes during its operational life.

2. The log shall be compiled in an electronic format acceptable to the DAA or his representative and shall include, at a minimum, the following information:

a. Date/Time of Occurrence

b. Type of Issue(s)

c. Description of the issue.

d. Name/shift of individual that discovered the problem.

e. Resolution to the problem on site.

f. Effect on the system.

g. BHS Contractor Individual Contacted for support and troubleshooting.

h. Programs, files effected by the resolution to the issue.

3. As a minimum, the computer log should be issued to the DAA or his representative on a weekly basis, or as requested by the DAA or his representative.

AA. Contractor Documentation for the development of the SSTP by the TSA's IV & V representative

1. Submit the following completed and approved for construction documentation. These documents will be forwarded by the DAA to the TSA's IV & V representative for the development of the SSTP:

a. BHS Controls System Descriptions that shall include all subsystem Controls Descriptions of Operation (Detailed Functional Specifications)

b. BHS Redundancy schematic diagrams

c. E-Stop Zone Drawings

d. BHS Mechanical Drawings including Plan and Elevation Views

e. Sequenced Implementation Plans with associated Narrative and Drawings

f. Construction and Testing Schedule

2. The above referenced documents shall be submitted to the DAA, with accompanying cover letter, stating the purpose of this submittal. All accompanying drawings shall be clearly visible and legible when plotted on "D" size stock. All documents shall be submitted in both hard and soft copies (e.g. text documents in MS Word or PDF format and drawings in AutoCAD [.dwg or .dwf] or PDF format.)

1.06 QUALITY ASSURANCE GENERAL REQUIREMENTS

A. Laws, Codes, Rules and Regulations

1. Comply with applicable Local, State and Federal laws, rules and regulations pertaining to the following:

a. Installations including but not limited to the Federal Occupational Safety and Health Act and the Construction Safety Act.

b. Protection of the public during installations including but not limited to, requirements for safety of operations, noise control, removal and disposal of waste materials, control of dust, dirt, pollutants, flammable materials, explosive materials, corrosive substances, and protection against fire.

B. BHS Contractor Qualifications

1. The BHS Contractor must have a minimum of three years demonstrable experience as a contractor/installer of BHS components, including PLC systems, integration with EDS devices, TSA required ISAT testing procedures, with the completion of at least three installations with a minimum value of $1,000,000 per project.

C. Non-Standard Equipment

1. Any proposed equipment which is appreciably different from items previously fabricated or which has not displayed satisfactory performance in a similar environment for at least one year (for a minimum of 18 hours per day, 7 days per week), shall be so noted in the proposal.

2. Prior to the start of fabrication, a prototype of the new item shall be built and test data shall be presented showing that the item has successfully performed the equivalent of one full year of operation. The DAA or his representative shall be invited to witness the test and review the test data at no additional cost to the DAA.

3. The testing requirements and demonstration will identify such requirements as follows:

a. Number of hours of run time

b. Number of test cycles

c. Processing rates

d. Mean time between failures

e. Repair time, serviceability

4. The DAA or his representative must approve the design before the final design and fabrication, provided that the BHS is produced by a firm with at least 3 years of experience in manufacturing and installing such systems comparable to that required under this contract. The DAA or his representative must approve the use of firms with less than 3 years experience.

5. In lieu of developing a prototype, arrangements may be made for the DAA or his representative to inspect an existing component in operation at an airport at no additional cost to the DAA.

D. Factory Acceptance Testing (FAT)

1. The BHS Contractor shall invite the DAA or his representative to their facility for a demonstration and review of the BHS Contractor's developed controls systems software, and maintenance diagnostics computer software/hardware interfaces with other airport systems, devices and operator interfaces.

2. Demonstrate through simulation/analysis at the Factory Acceptance Testing that the system as designed by the BHS Contractor shall meet the minimum design/performance criteria as specified in this specification,

(i.e. OSR decision time from each CT-80DR device, and interfaces with airport systems).

3. Submit to the DAA or his representative a Factory Acceptance Testing agenda, based on the previously submitted Functional Specification and System Acceptance Test Plan, for review and approval. The Factory Acceptance Testing shall take place prior to the on-site installation of the computer software and associated hardware.

4. Items identified during the Factory Acceptance Test, as being deficient, shall be rectified prior to installation on-site. The BHS Contractor is solely responsible for any additional monies incurred regarding completion of this task and will not be granted any schedule variances.

5. If the BHS Contractor was not able to demonstrate all facets of the Factory Acceptance Testing, or provided documents stating that they had performed the tests internally prior to the DAA's or his representative arrival, the DAA reserves the right to back charge the BHS Contractor for the time and expenses of all who attended on the DAA's behalf.

1.07 PROJECT CONDITIONS

A. General

1. The DAA or his representative does not guarantee the accuracy or the completeness of the information relating to the new or existing utility services, facilities, or structures that may be shown on the drawings or encountered in the work. Any inaccuracy or omission in such information shall not relieve the responsibility to protect such existing features from damage or unscheduled interruption of operations and services.

2. Failure to give the 72-hour notice shall be cause for the DAA or his representative to suspend the BHS Contractor's operations in the general vicinity of the System, utility service or facility.

3. Should damage to or unscheduled interruption of airline operations, utility service or airline facility occur by accident or otherwise, the BHS Contractor shall notify the DAA or his representative and take all reasonable measures to prevent further damage or interruption of service. In such events, cooperate with the utility service, Airport Authority until such damage has been repaired and service restored to the complete satisfaction of the utility service or the Airport Authority.

4. Coordinate all building modifications performed by any trade to accommodate the installation of the BHS.

B. Installation Conditions

1. This BHS is to be installed within a new Duluth Terminal structure working simultaneously with other trades.

2. The BHS Contractor shall visit the site to familiarize himself with the site conditions and to understand local conditions that may affect the project before submitting his bid proposal. Where possible the BHS Contractor shall familiarize himself on the availability of temporary access, temporary lighting and power, telephone services, storage facilities, water supply, waste disposal facilities, labor supply, weather conditions, parking of vehicles, loading and unloading of materials, and equipment. In particular, he shall take into account in his bid proposal any effect that any adjacent construction, operations and maintenance works may have on the BHS installation. The BHS Contractor shall ascertain for himself and allow in his bid proposal for all necessary precaution and for any difficulties that may arise in the execution of the BHS Contract. No claims whatsoever arising out of the site constraints, difficulties of access, temporary services and facilities, labor, and any other charges will be entertained by the DAA.

C. Phasing Sequence

1. Coordinate with the overall project phasing requirements as developed by the project General Contractor.

D. Ramp Area Proximity

1. The portions of the construction/installation associated with this project shall take place immediately adjacent to an active aircraft ramp area and airline operations area.

E. Lay-down Area Restrictions

1. Lay-down and shake out areas may be limited to the confines of the immediate building. All Lay-Down areas shall be designated and approved by the DAA or his representative.

2. Refer to the Architectural Contract drawings for preliminary lay down areas that could be utilized by the BHS Contractor. Coordinate usage of lay-down areas with the General Contractor.

F. Restoration of Service Costs

1. Incur all restoration of service costs due to the negligent or accidental damage of any airport utility service or facility. The DAA reserves the right to deduct such costs from any monies due, or which may become due, from the BHS Contractor, or its surety.

G. Right-of-Ways

1. It is acknowledged by all parties that the BHS Contractor has first priorities to the right-of-ways available and/as provided by others. Cooperate with other contractors for coordination of all building right-of-ways performed by other trades to accommodate the installation of the BHS.

2. In addition, the BHS Contractor shall preserve all right-of-ways for deferred equipment depicted on the Contract Drawings.

1.08 PROTECTION OF THE WORK

A. General

1. Make such explorations and probes as are necessary to ascertain any required protective measures before proceeding with installation. Give particular attention to equipment supports and bracing requirements so as to prevent any damage to BHS equipment.

2. Provide, erect and maintain catch platforms, dust partitions, lights, barriers, warning signs and other items as required for proper protection of operating personnel, the public, occupants of building, workmen engaged in installation, and adjacent construction. Comply with the requirements and restrictions of the Contract Drawings.

3. Do not store or place materials in passageways, stairs or other means of egress. Do not close or obstruct walkways, passageways, stairways, streets, walks, terminals, runways, rights-of-way, or other occupied or used facilities without written permission from the DAA or his representative. Conduct operations with minimum traffic interference.

4. Utilize suitable coverings to protect existing work. Be responsible for any damage to the facilities or other contents by reason of the insufficiency of protection provided. Promptly repair damage caused to adjacent facilities and restore as new.

5. Repair any damage to work in place. This includes repair of fireproofing materials removed to allow the installation of BHS structural attachment supports, header steel, and any other BHS equipment.

1.09 SYSTEM DESIGN AND PERFORMANCE REQUIREMENTS

A. General

1. All equipment shall be in strict accordance with the specifications described herein. It should be noted and stressed that the system shall be engineered, fabricated and installed with the objective of being of rugged, heavy duty, impact resistant equipment capable of withstanding the abuse and exposure to damage experienced in an air transportation baggage handling facility. Other key factors to be considered in the development of the system and its elements shall be simplicity, reliability, maintainability, and safety.

2. The BHS Contractor is deemed to have studied the system design and requirements presented in the drawings and specification respectively and accepted the design and requirements as suitable and appropriate to safely accomplish the functions and processes described herein. Identify in the bid submission any design aspect or specification requirement that is believed to be inappropriate or inadequate and shall propose alternate solutions to alleviate the perceived problem but shall, in all cases, include in the bid submittal pricing for the

base system presented in the drawings. Any alternate designs developed by the BHS Contractor must meet or exceed the design criteria as listed in the specifications.

3. Consideration shall be given to the design, fabrication and installation of all projections, welds, and transfer points between conveyor segments and conveyor items to eliminate damage to the various types of baggage processed.

4. The system and subsystem layout configuration and item/component functional requirements are specifically described on the contract drawings. However, alternate solutions, may be proposed on an optional bid cost basis for consideration by the DAA. Any alternate designs developed by the BHS Contractor shall meet or exceed the design criteria as listed in the specifications.

B. Material and Equipment Approvals

1. Where manufacturer's name, brand or trademark is specified, it has been selected to establish a standard of quality for the materials, components or equipment required. Materials, components or equipment of different manufacture considered to be equal to the materials, components or equipment specified will receive full consideration and shall be subject to approval by the DAA or his representative before being incorporated into the work. The contract price shall in all instances be based only upon materials, components or equipment specified. A list of material, component or equipment suppliers shall be submitted to the DAA or his representative for approval. Provide a listing of sources where any material, component or equipment, for which a substitution approval is being requested, can be obtained.

2. Furnish all engineering data, engineering/shop drawings, literature, test results, calculations, and any other requested information, for review of substituted material, components or equipment. The BHS Contractor shall pay for any redesign necessary to accommodate an "approved equal".

C. Request for Deviations from Drawings or Specifications

1. Requests for deviations from drawing or specification requirements may be approved at the discretion of the DAA or his representative to permit use of standards inherent in the equipment when it has been determined by the DAA or his representative that such deviations will in no way be detrimental to the conveyor equipment, the safety, operation and maintenance of the specified system, system design, system reliability and its associated inventory of spare parts.

2. Any materials, components or equipment submitted for substitution for this BHS shall be previously proven under the loads as specified in Part I of this Specification in an operational or test equivalent environment for a minimum of 1 year, 18 hours per day, 7 days per week.

D. Baggage Conveyors

1. Conveyor Loads

a. Design the conveyors and their supports using the following loading criteria:

1.) The live and dead static load imposed on the building (composed of the conveyor components, supports and baggage) used for designing structural elements, rollers and pulleys shall be 100 pounds per linear foot except for merges and conveyors designated as Oddsize Conveyors, in which case it shall be 150 pounds per linear foot.

2.) All conveyor equipment shall be capable of supporting a single concentrated static load of 250 pounds.

3.) The live dynamic load to be utilized for sizing drives, belts, bearings, and other components, shall be 60 pounds per linear foot for load, unload and accumulating conveyors operating up to a speed of 120 feet per minute. For all other conveyors (e.g. transport, or sortation) it shall be 40 pounds per linear foot operating at a conveyor speed of 90 feet per minute and a throughput of 25 bags per minute adjusted proportional to speed and throughput. As an example, a sort line traveling at 360 feet per minute and rated at 60 bags per minute would have to be rated at 24 pounds per linear foot for load testing. The following formula shall be utilized to determine the test ballast for the purpose of load testing and preparation of related test plans during the BHS acceptance period:

4.) Formula: 40 lbs per Linear Foot x (90 FPM / actual conveyor speed) x (throughput rate / 25 bags/min) = xx lbs per linear feet

2. Conveyor Dimensions

a. All equipment shall be of U.S dimensions.

b. Unless otherwise specified on drawings, construct conveyors to the following dimensions:

Conveyor Type	Overall Width	Between Guide Width	Belt Width
Standard Conveyor and Power Turns	42"	39"	36"

Note: 1. Standard Power Turn Inside Radius shall be 4' 0" unless noted on the drawings otherwise.

3. Conveyor Side Guard Heights

a. Refer to Part II of this specification for side guard heights.

4. Conveyor Speeds

a. Unless otherwise specified, conveyors speeds shall be selected by the following criteria:

Type/Location	Speed (Feet/Min)
Public Area Load Conveyors	90
Flat Plate Make-up/Slope Pallet Claim	90
Non-Public Inbound Load Conveyors	120
CBRA Area Load / Unload Conveyors	30
EDS In-feed	96

b. Speed Changes

1.) Make speed changes between adjacent conveyors to increase or decrease a maximum speed (nominally 30 feet per minute) so as not to adversely affect baggage spacing or tracking. Conveyor speed changes between adjacent conveyor segments shall be set that the specified positive bag tracking requirements are not compromised.

2.) Feed conveyor speed onto the related make-up device will not be greater than 120 feet per minute, unless otherwise specified.

E. System Processing Rates

1. Unless otherwise specified, System Processing Rate shall be:

Conveyor Type	Minimum Processing Rate
Ticket Counter Lines (Each Subsystem)	25 bags per minute
Inbound Transport (Each Subsystem)	30 bags per minute
EDS Device	180 bags per hour
Transport to EDS	As required by EDS device manufacturer in order to satisfy TSA processing requirements.

2. The design of the system shall ensure the following:

a. An EDS Level-2 operator decision time of 45 seconds minimum of OSR time. Bags to be processed with a "hold outside" mode of screening with the bags waiting on the exit queue conveyor post CT-80DR while the Level 2 OSR screening is processing.

b. All "Non-Clear" bags shall stop at the CBRA removal/reinsert queue conveyor, and that the Error Rate shall be:

1.) Less than (<) 1% - if no Re-insertion belt/line is provided

a.) Error Rate = ((Total Bags at Reconciliation) – ("Non-Clear Bags" with valid tracking IDs)) / (Total Bags Inducted).

c. 1% or less of total bags Jam in the Checked Baggage Inspections System as measured in a 24 hour period. No more than three (3) bags (real or virtual) will be involved in any given bag jam event.

d. Fail-Safe features activate on all bags but activation rate is less than 0.5% of total bags.

e. Note: Throughput rates shall not be less than the above referenced amounts unless pre-approved by the DAA, the TSA or their representatives.

f. Note: EDS conveyor subsystem Error Rates shall be calculated using all EDS conveyor lines simultaneously and shall occur over a flow of bags of at least 100 bags per EDS.

F. Baggage Characteristics

1. Design the BHS to convey standard airline baggage tubs and to process baggage having the following characteristics:

2. Baggage Size Requirements:

Conveyor Type	Length	Width	Height
Standard Conveyor Maximum	54"	33"	34"
Standard Conveyor Minimum	12"	12"	4"
Oddsize Maximum	13'	38"	36"
Oddsize Minimum	12"	12"	4"
CT-80DR Max Bag	47.2"	31.5"	25"

Note 1: Average bag length for the purpose of rate testing shall be 33". The system shall be capable of accommodating 42" bag lengths without compromising the baggage-processing rate. The standard outbound conveyors shall also be capable of accommodating 54" bag lengths at lower processing rates. The specified dimensions for the standard baggage sizes are intended to provide the maximum individual dimension for each of the three magnitudes indicated, and not to exceed the maximum baggage weight. For any given length or width dimension, the baggage conveying surface area must not exceed 12 ft^2. For example:

(1.) Given a 54" max length dimension, the width must not exceed 32" wide.

(2.) Given a 33" max width dimension, the length must not exceed 52" long.

Note 2: The specified dimensions for oddsize baggage sizes are intended to provide the maximum individual dimension for each of the three magnitudes indicated and not to exceed the maximum baggage weight. For example, given a 10' length dimension, the width must not exceed 18"

b. Weight of Single Piece

Conveyor Type	Weight

Standard Conveyor Maximum	120 lbs.
Standard Conveyor Minimum	1 lb.
Oddsize Conveyor Maximum	150 lbs.
Oddsize Conveyor Minimum	1 lb.

c. Shape

1.) At least one flat conveyable surface. Baggage meeting the above size limitation but lacking a flat conveyable surface (such as baby carriages, round duffle bags, and the like) shall be processed in standard airline tubs.

2.) Design system to accommodate 90% of the baggage normally encountered with or without the use of standard airline tubs, including but not limited to, golf bags.

d. Surface Material

1.) Complete spectrum of package materials found in air transport baggage, including paper, cardboard, cloth/canvas, plastic, leather, wood, and metals in the following conditions:

a.) Dry to Wet

b.) With/Without:

(1.) Paper/cloth/plastic tape/wrapping

(2.) Plastic/steel bands

(3.) Fiber cord

(4.) Twine

(5.) Wheels

(6.) Straps

G. Physical Constraints

1. Design the BHS to accommodate the following physical constraints imposed on the System by either operational or facility considerations:

a. All conveyors, supports and related components (unless shown as floor supported, within the confines of protective guard rails, or within a confined and protected space) shall have a minimum underside clearance of 8'-0" from the bottom of the support structure to the floor, unless otherwise specifically noted on the Contract Drawings.

b. Minimum clearance on all conveyors from the top of the conveyor belt to the underside of any obstruction shall be 36 inches, unless otherwise specifically noted on the Contract Drawings.

c. All inclined and declined conveyors shall have the following:

1.) A maximum slope of 18° for non-tracking conveyors

2.) 12° for tracking conveyors unless otherwise indicated on contract drawings.

3.) In all cases, where space permits a shallower angle, the Contractor shall minimize the slope utilizing the least possible incline/decline angle to achieve the proper elevation change.

d. All inclined or declined spiral power turns shall have a maximum elevation change of 1 foot in rise or fall per 45° of turn.

e. If any of these design criteria cannot be maintained, notify the DAA or his representative in writing for resolution.

H. Vibration

1. Provide shaft mounted components (pulleys, sprockets, and other shaft mounted components) and other components subjected to vibration with some means of preventing loosening of the component such as snap rings, cotter pins, or other methods approved by the DAA or his representative.

2. Mount all conveyors on vibration isolation pads or hangars except those components supported from a ground floor slab or other structural floor whose characteristics prevent vibration from the conveyors from being transmitted to adjacent structure(s) or perceived surrounding area.

3. Vibration isolation devices shall be determined based on individual support loads, vibration frequency and vibration amplitude so that appropriate vibration isolation is proved.

4. Provide vibration isolation devices that prevent perceivable vibration from being transmitted to the surrounding building structure.

5. Ensure that all National, State, and Local codes for seismic requirements are met for the project.

I. Balancing

1. Dynamically balance all rollers and pulleys.

J. Service Conditions

1. Design each element to operate satisfactorily in its respective environment as follows:

a. Mechanical - Indoor (Bagroom Environment)

1.) Temperature: 32° to 120° F (0° to 48°C)

2.) Relative Humidity: 5% to 99% Non-condensing

3.) Protected from direct exposure to weather

b. Electrical/Electronic Equipment Inside Control Panels

1.) Temperature: 32° to 140° F (0° to 60°C)

2.) Relative Humidity: 5% to 99% Non-condensing

c. Electrical/Electronic Equipment - Indoor (Bagroom Environment)

1.) Temperature: 32° to 120° F (0° to 48°C)

2.) Relative Humidity: 5% to 99% Non-condensing

3.) Protected from direct exposure to weather

d. Mechanical - Outdoor or in Unheated Enclosures

1.) Temperature: -20° to 120° F (-30° to 48° C)

2.) Relative Humidity: 5% to 100% condensing

3.) Covered but not protected from driving rain.

e. Electrical/Electronic Equipment - Outdoor or in Unheated Enclosures

1.) Temperature: -20° to 120° F (-30° to 48°C)

2.) Relative Humidity: 5% to 100% condensing

3.) Covered but not protected from driving rain.

f. Electrical Equipment Inside Computer/Control Room

1.) Temperature: 55° to 80° Fahrenheit (13° to 27° Celsius)

2.) Relative Humidity: 5% to 50% Non-condensing

2. During construction if sealed office area is not available for the BHS related computer equipment, a filtered air environment area should be provided (by others).

3. Provide and clearly identify any special environmental requirements more stringent than what is shown in these specifications that may be essential for correct equipment operation (e.g., computer hardware, scanner arrays, and any other components with special environmental requirements).

4. The above listed requirements do not take into consideration separate requirements that may be required for any related non-BHS equipment that may be provided and installed by others (such as but not limited to EDS devices and EDS workstations) or personnel that may drive environmental requirements in various areas where BHS equipment also exists.

K. System Safety

1. Design, manufacture, supply, install and construct the BHS in accordance with all of the requirements in the Contract Documents, and shall meet or exceed all applicable laws rules, orders, regulations and codes. In this regard, the BHS Contractor shall be responsible throughout this Contract to bring to the attention of the DAA or his representative in writing any changes in such laws, rules, orders, regulations and codes and any condition(s), whether caused by its design or any BHS Contract requirements, which the BHS Contractor believes may result in or has resulted in an unsafe condition(s). Rectify at the BHS Contractor's own cost any such condition(s) resulting from its design and not directly as a result of any Contract requirement(s). Where the DAA and the BHS Contractor mutually determine that such condition(s) is directly a result of any Contract requirement(s) or any changes in laws, rules, orders, regulations and codes, then the DAA and the BHS Contractor shall seek a mutual resolution of the condition(s) to be effected by a Change to the Contract.

2. Utilize control methods and techniques, circuitry, mechanical and electrical equipment and operating/maintenance procedures to provide maximum safety for operation and maintenance personnel and to minimize potential damage to the equipment and to the baggage being processed. Incorporate fail-safe techniques to prevent the occurrence of unsafe conditions, which could result from an equipment failure or improper implementation of the operating procedures.

3. As employed herein, the failsafe principle shall be interpreted as follows: In the event an equipment failure or external influence such as improper operation, high temperature, power failure, or other adverse condition affects the proper function of a system or element involved with the safety of life or health, said system or element shall revert to a state known to be safe to all personnel interfacing with the equipment.

L. Personnel Safety

1. The operation of the system shall be convenient and safe to use, and control functions to be performed shall be simple to minimize possible errors. The BHS Contractor shall provide convenient means for emergency system shutdown.

2. Provide adequate means for ensuring the safety of all personnel who have access to the system in the system design.

3. Provide sufficient safety signage throughout the system.

4. Provide lockable devices such as disconnect switches and lockouts to prevent the accidental activation of those portions of the system shut down for maintenance. These devices shall be located in all areas.

5. Provide equipment and component guards on all drives for conveyors and sortation devices. House all moving parts in personnel areas with guards (such as bearings, return rollers, and return conveyor belts).

6. Provide sufficient work space in all limited access areas

7. Provide audible and visual warning signals along all areas of the system to make apparent any potential hazards to the public, operating and maintenance personnel resulting from moving or about-to-start

equipment.

8. Provide protection from falling objects in work areas or aisles located beneath overhead portions of the system with gap pans or netting.

9. Locate conduits and all other electrical components where they shall not be subject to damage by maintenance or operational personnel.

M. Noise Levels

1. Design, fabricate and install the BHS to limit combined equipment and controlled ambient noise levels to the following allowable maximum requirements. However, the BHS equipment shall not increase the ambient noise level by more than 15 dB (A). In any case, ambient noise levels for the BHS equipment shall not exceed OSHA standards.

2. Design, fabricate and install the BHS to limit combined equipment and controlled ambient noise levels to the following allowable maximums

Noise Level	Ambient
45 dB (A)	In adjacent or nearby office areas (measured at the center of room at a height of 5'-0" above the floor).
65 dB (A)	In public areas, CBRA, or ceiling above public areas and offices (measured at a number of positions normally occupied by passengers, public and staff).
75 dB (A)	In bagroom and all other associated non-public areas or unoccupied areas.

3. To accommodate noise levels of 65 dB (A) or less (in areas such as the CBRA, OSR room or public areas), the BHS Contractor shall consider the following items for conveyor segments installed in these spaces to minimize noise levels:

   a. Use low noise PVC belting.

   b. Use either shaft mounted drives or underslung drives with V-belts.

   c. Mount all safety guards with rubber isolation washers between fasteners and the conveyor frame.

   d. Mount all side guards with rubber isolation washers between fasteners and the conveyor frame.

   e. Use bolted shaft rollers (i.e., no spring loaded rollers).

   f. VFDs shall not be set with a minimum output frequency of less than 48 Hz or a maximum output frequency of greater than 72 Hz. This is to limit the amount of noise generated and difficulties stopping with output frequencies set beyond this range.

4. Unless otherwise specified the measurements shall be taken at a maximum distance of 5 feet vertically and 5 feet horizontally from noise producing components.

5. The noise level measurement shall be accomplished utilizing an integrating sound level meter supplied by the BHS Contractor. A qualified person employed by the BHS Contractor shall accomplish measurements and evaluation. The BHS Contractor shall provide a certificate of calibration to the DAA or his representative.

6. The noise level shall be the Equivalent Continuous Sound Pressure Level measured over a period of one minute or more at each location. In addition, to the overall A-weighted noise level, the Equivalent Continuous Sound Pressure Level shall be measured for each octave frequency band from 125 Hz to 4000 Hz.

7. Conveyor noise shall not be unduly impulsive. Observing the difference, between the measured Equivalent Continuous Sound Pressure Level and the instantaneous sound pressure level, shall test the impulsiveness of the noise. A component shall be considered unduly impulsive if the differences exceed 3 dB (A).

8. Conveyor noise shall not be unduly tonal. Tonality shall be determined by observing the difference in level

between any A-weighted octave band and each of its adjacent A-weighted octave bands. The sum of the differences shall not exceed 6 dB (A). All octave bands from 125 Hz to 4000 Hz shall comply with this requirement.

9. Every conveyor component shall be tested. The components shall be tested at full design speed under load conditions.
10. Where conveyors are located in the ceiling spaces of non-bagroom areas, the noise measurements shall be taken after the architectural ceilings are in place.
11. Noise level measurements shall be taken during non-operational hours to ensure passenger conversations or movements do not unduly increase the ambient noise levels in public areas.
12. Measurements shall be taken during a time when the ambient noise levels are at least 6 dB (A) below the conveyor noise level. The ambient noise level shall be determined both before and after the measurement of the components. The ambient noise level shall be determined as follows:
    a. The BHS equipment shall be turned off.
    b. All other equipment (i.e., air-conditioning and heating equipment) shall be on and outside noise sources (from aircraft and mobile ground equipment) shall be as normal.
    c. Noise level readings shall be taken throughout a zone 5 ft vertically and 5 ft horizontally from the BHS equipment using an integrated sound level meter set to the A-weighted network.
    d. After the ambient noise level has been determined, the BHS equipment shall be turned on and the total noise level shall be measured at the same points throughout the zone that the ambient levels were measured.
13. The BHS Contractor shall provide a written report to the DAA or his representative detailing the results of the noise level measurements.

N. Radio Frequency Interference/ Electro Magnetic Interference (RFI/EMI)

1. Ensure by design and shielding that system equipment shall not create electromagnetic emissions, which can, in any way, cause interference with communications within the airport or between the airport and aircraft or ground support vehicles.
2. Choose all electrical and electronic equipment (including computer and related equipment) to operate without malfunction in the presence of normal electromagnetic emissions generated by other equipment normally installed or used at the airport including but not limited to the aircraft communications bands, high-power radar systems, various electrical motors and controls, power tools, welding equipment, automotive vehicles, ground power units and air handling units. Provide isolation transformers and line suppression units, if required.
3. Radio frequencies, if used for communications or information transmission within the systems, shall be applied for to the relevant Airport and Government Authorities for their designation and assignment.

O. Maintainability, Life & Reliability

1. The requirements set forth in this section are minimum requirements and do not relieve the obligation to provide a system in which all required maintenance tasks can be readily performed.
2. Design all components so they can be easily disconnected and removed from the equipment without the necessity for extensive disassembly. Design the components for removal and replacement by two (2) staff in a period not to exceed two (2) hours. Be prepared to demonstrate that any maintenance task, not so listed, can be accomplished as described above. Correct any installation, without charge, as required to accomplish this demonstration.
3. Design the system so that equipment components requiring inspection and servicing are readily accessible. Provide suitable doors for this purpose. Where necessary, provide access holes in frames or guards but keep

them to a minimum number and size, and ensure that they do not create protrusions or discontinuities detrimental to the baggage being conveyed.

4. Design equipment to facilitate maintenance functions in preference to ease of fabrication.

5. Design equipment such that, whenever possible, assemblies shall not require dismantling in order to troubleshoot, repair or replace assemblies or components of assemblies involved in such servicing procedures.

6. Affix cover plate attachment hardware to, or hold captive in, the cover plate assemblies.

7. Provide all electric assemblies, panels, or boxes with the appropriate schematic, enclosed in a clear-faced envelope affixed in a location visible to personnel while servicing such items.

8. Provide one set of special test instruments and tools for each group of equipment items requiring such special test instruments and tools. These shall be provided in a metal toolbox with identification of the equipment for which the tools shall be used.

9. Provide a device for measuring conveyor speed and shaft/pulley rotational speed prior to commencement of Acceptance Testing for use by the DAA or his representative, during the Acceptance Testing period.

10. Provide fixed or mobile ladders, service platforms, lifting lugs or other applicable provisions to ensure easy access to components requiring servicing, either as shown on the specification drawings or as required to assure a safe and efficient system for all personnel who operate, maintain or have access to it.

P. Standard/Interchangeable Components

1. Minimize the number of different types and makes of components used in the BHS to simplify spare part inventory.

2. Design all equipment and components to definite standard dimensions, tolerances, and clearances to provide maximum inter-changeability.

3. Provide like types of equipment from the same manufacturer wherever practicable.

Q. Lifespan

1. Provide equipment components and items for a system equipment life of a minimum of 15 years and an operating duty cycle of 18 hours a day, 365 days per year. This provision is a design objective, not a warranty.

2. It is understood that PC based computer equipment may not have the identical hardware available for the full 15 year period (PLC equipment does not fall under this category), as such the BHS Contractor shall submit a list of the estimated spare parts required to maintain the PC based computer hardware for the 15 years of operation for the DAA or his representative review and consideration for a budgetary allowance - include unit price per unit for the estimated spare parts list based on reasonable airline market rates.

R. System Reliability

1. Reliability requirements of the total BHS shall be measured in terms of "System Availability" (A_s).

2. Failure

a. A failure is defined as any malfunction of a System component, assembly, or subassembly which stops normal operations. A failure shall be charged against only the one subsystem, which causes that failure. The following shall not be classified as failures:

1.) Malfunctions caused by a failure on the DAA’s part (after system acceptance) to properly maintain and operate the System in accordance with recommended procedures.

2.) Malfunctions due to causes outside the System such as but not limited to sabotage or general power outage.

3.) Malfunctions due to baggage jams not caused by failure of a system component, assembly or subassembly unless it is a defective part, a poor installation, or a failure of a component or subassembly to perform its intended function.

4.) Incipient failures, which are detected and repaired without affecting normal operation of the System.

5.) Malfunction of one of a redundant Computer/PLC pair where the repair time does not affect normal operation of the system. However, reliability of redundant computer pairs is defined elsewhere in this specification.

3. Sub-System Availability (As)

a. Sub-System Availability (As) shall be defined by the following equation:

$$As = \frac{(ST - RT)}{ST}$$

ST = Scheduled Operating Time: The scheduled time that the BHS is available for baggage processing (normally 18 hours per day).

RT = Repair Time: The interval of time between initiation of repairs due to a failure and return of the BHS to operation.

b. Each subsystem of the BHS shall have an availability of not less than 0.995 (99.5%) to be calculated on a monthly basis. However, the maximum allowable downtime in a single operating day shall be no more than 15 minutes on one subsystem; additionally the accumulative downtime for all subsystems shall not exceed 20 minutes.

c. No more than one failure per month of one of the computers, PLCs, workstations and any other control equipment within of any slave/master pair shall be acceptable.

d. All computer and control systems (including but not limited to BHS host computers, Sortation computers, and workstations) shall have an availability of not less than 0.999 (99.9%) to be calculated on a monthly basis. However, the maximum allowable downtime in a single operating day shall be no more than 2 minutes for a single event. The maximum downtime where both slave/master pair within computers, PLCs, and workstations fail simultaneously shall be 10 minutes in a year.

4. Tracking Accuracy

a. Tracking accuracy shall be defined as the percentage of successfully tracked bags from an encoding position (EDS device, BDD array, and decision point) to the final output device. Tracking accuracy shall be a minimum of 99.5% calculated on a daily basis, for the total number of bags input into the baggage system. Tracking accuracy is a measure of the system's ability to identify and control the location of the baggage from the point of encoding to the correct output. The intent of this requirement is to ensure system transit times are met and the baggage is sorted in a timely fashion with a minimum of manual encoding intervention. The tracking accuracy shall be based on missing/lost bag counts as reported/verified either by the MIS and operations/ramp personnel.

b. All bags, which are ID by the BHS and a security screening status by an EDS device shall not swap their tracking ID with the tracking ID of another bag during the course of transport through the BHS.

c. Bags that are proven (as reported by maintenance/operations/ramp or TSA personnel) to have lost tracking due to being incorrectly introduced into the system (i.e. bags on wheels), snag at a DID or are moved out a tracking window as a result of the clearance of a bag jam shall not be counted against the tracking accuracy.

d. Bags that are assigned an "EDS Error" from an EDS device are not to be treated/reported as mis-tracked bags, these bags are to be stopped at the CBRA removal/reinsert conveyor adjacent to the Level 3 ETD screening table.

e. If a bag has been successfully read by the scanner array but fails to appear at any tracking photocell, that bag shall be identified as a “missing bag” by the tracking control system. Three missing bags in succession at the same tracking photocell shall cause the tracking control system to automatically stop the associated conveyors and declare a “missing bag jam”. Note that all missing bag occurrences shall be reported regardless if they are singular or multiple occurrences.

f. Provide as part of the MIS day end report, tracking accuracy as a percentage of bags inducted per line versus number of bags that lost tracking on the respective line. The BHS Contractor shall also detail in the MIS reports a listing of all bags that lost tracking with associated BSM details, time and location tracking was lost.

5. Baggage Dimensioning Sizing Rates

a. The Baggage Dimensioning Device (BDD) shall accurately size 99% of all items that pass through the array. Any item that is detected by the bag present photocell but not sized by the BDD shall be treated and acted upon as an out of gauge item by the BHS.

S. Parts Availability

1. Maintain, for immediate delivery, an adequate inventory of spare parts (especially long lead time items) required for routine maintenance of the system. Ensure that critical spare and replacement parts required by the system are made available for a minimum of a fifteen (15) year operational period through the availability of shop and as-built drawings and through the availability of the actual parts. Additionally, ensure the availability of custom or "special" components.

2. If the BHS Contractor fails to make such parts available during the fifteen (15) year operation period or should pricing become unreasonably high on a competitive basis, the DAA has the right to permit the use of the project drawings, at their discretion, for fabricating such parts, or having such parts fabricated so as to maintain the specified system.

1.10 STANDARDS AND CONSTRUCTION CODES

A. General

1. The design and subsequent installation shall provide adequate safety factors and shall conform to all current standards and codes of the USA, the City of Duluth, and the Duluth International Airport Authority, whichever is more stringent.

B. Construction Codes

1. In the event no specific local codes or standards can be identified, the Contractor shall comply with the most recent version, applicable provisions and recommendations of the following:

a. American Welding Society (AWS)

1.) D-1.1 Welder Qualifications

2.) AWS-C1.1 Recommended Practice for Resistance Welding in Building Construction

3.) AWS-A2.0 Standard Welding Symbols

4.) D-1-0 Standard welding practice in building construction

b. American Gear Manufacturers Association Standards (AGMA)

1.) 6009-A00 Practice for Gear Motors

2.) 6035-A02 Practice for Worm Gear Motors

c. American National Standards Institute (ANSI)

1.) A-1264.1 Safety Code for Floor and Wall Openings, Railing, and Toe Boards

2.) B-20.1 Safety Code for Conveyors, Cableways, and Related Equipment

3.) B-29.10M Transmission Roller Chains and Sprocket Teeth

4.) C-33.1 Safety Standard for Flexible Cord and Fixture Wire

5.) Z535 Safety Color Code

d. National Bureau of Standards (NBS)

1.) Handbook H28 Screw-Thread Standards

e. National Fire Protection Association (NFPA)

1.) NFPA No. 70 National Electrical Code Volume 2, National Fire Code

2.) NFPA No. 79 Electrical Standards for Industrial Machinery

3.) NFPA No. 80 Standard for Fire Doors and Fire Windows

f. NEC National Electrical Code (most current version)

g. Underwriters Laboratories (UL) Standards (Components must be labeled appropriately)

1.) UL 508 Industrial Controls Equipment

2.) UL 508A Industrial Control Panels

3.) UL 508C Power Conversion Equipment

4.) UL 1998 Software in Programming Components

5.) IEC 61508 Functional Safety Standard for Electrical/Electronic/Programmable Electronic (E/E/PES) Safety Related Systems

h. National Electrical Manufacturers Association Standards (NEMA)

1.) ICS Industrial Controls and Systems

2.) MG1 Motors and Gear Motors

i. American Society for Testing Materials (ASTM)

1.) A-36 Structural Steel

2.) A-794 Sheets cold rolled

3.) A-659 Sheets & Strip - hot rolled

4.) A-307 Fasteners (Bolts)

5.) A-563 Fasteners (Nuts)

6.) F-844 Fasteners (Washers)

j. American Wood Preservers Association (AWPA)

1.) C-27 Fire Retardant Wood

2. All equipment and accessory items furnished and installed under this Contract shall be governed at all times by applicable provisions of federal laws, including but not limited to the revision of the following in effect as of the Contract date:

a. Williams-Steiger Occupational Safety and Health Act (OSHA), of 1970, Public Law 91.596, most current version.

b. Occupational Safety and Health Administration (OSHA)

1.) 29 CFR Part 1910 Subpart D (Walking-Working Surfaces)

2.) 29 CFR Part 1910 -211 (Definitions)

3.) 29 CFR Part 1910 – 212 (General Industry Standards and Requirements) for machines

4.) 29 CFR Part 1917.48 (Conveyors)

5.) 29 CFR Part 1926.555 (Conveyors, Construction Industry Standards)

6.) 29 CFR Part 1926.1053 (Ladders)

c. Office of State Health Planning and Development (OSHPD)

d. American Society of Mechanical Engineers (ASME)

1.)	ASME B20.1 – 2006	Safety Standards for Conveyors and Related Equipment, and all Addenda up to and including ASME B20.1-2006

e. Conveyor Equipment Manufacturers Association (CEMA)

1.)	ANSI/CEMA 402-2003	Belt Conveyors
2.)	ANSI/CEMA B105.1-2003	Specifications for Welded Steel Conveyor Pulleys with Compression-type Hubs

1.11 WARRANTIES

A. General Warranty

1. Warrant any new BHS equipment for one (1) year against defective parts and labor beginning on the Final Acceptance Date as related to this Project.

2. Warrant all new BHS equipment for three (3) years against design defects beginning on the Final Acceptance Date as related to this Project.

3. Warrant all new BHS software, high level and low level controls for three (3) years against design defects beginning on the Final Acceptance Date as related to this Project.

4. Assign the DAA all warranties for all materials and equipment received from Subcontractors and Suppliers.

B. Warranty Exclusion

1. This warranty shall not apply to any defects or inconsistencies, which are attributable to repair, alteration, misuse or abuses by any person other than authorized personnel or Subcontractors. Liability shall be limited to repairing or replacing defective or non-performing part(s) at no cost to the DAA.

C. Warranty Limitation

1. Liability shall be determined in the Contract Agreement and shall also include repairing or replacing defective or non-performing part or parts at no cost to the DAA.

D. Technical Support

1. Provide on-site technical support as defined by the Contract Documents and agreed upon by the DAA or the Engineer. This support shall be by personnel qualified to advise the DAA on training, provisioning, start-up and maintenance of the equipment.

2. The technical representative(s) for warranty support shall be within 6 hours travel distance of the Duluth International Airport, in the City of Duluth, State of Minnesota, where the equipment is to be located, as required by the DAA.

E. Royalties and License Fees

1. Pay all royalties and license fees and defend all suits or claims for infringements of any prior or patent rights

and save the DAA harmless from liability, expense of loss on account thereof, with respect to any processes, devices, methods, articles, inventions, things or procedures used in the project.

F. Labor Warranty

1. Warranty support shall be provided as follows:

a. Provide labor to accomplish any warranty repair work. In the event such labor is not provided in a timely fashion, pay the DAA to accomplish warranty labor repair with its maintenance staff.

b. The BHS Contractor shall provide labor for work related to design deficiencies.

G. Parts Warranty

1. Terms

a. Provide a parts warranty which states material and equipment furnished and installed shall be new and free from faults and defects in material, workmanship, detail or incorrect component selection; shall conform to the functional and technical requirements of this Section and Contract Drawings contained herein; shall comply with all laws, statutes, ordinances and codes applicable at the installation site; and shall be suitable for the intended purposes. Excessive wear shall be considered a defect within the provisions hereof.

b. Parts shall be shipped freight pre-paid to the location specified by the DAA. Failed/malfunctioned parts shall be returned to the BHS Contractor, FOB, within ten (10) days of notification of detection of such failed/malfunctioned parts.

2. Spare Parts

a. Spare parts for each phase, shall be made available for purchase by the DAA prior to the commissioning of the subsystem. The DAA may, taking the recommendations of the BHS Contractor, purchase such spare parts as it deems necessary, and said parts, shall be stocked on the Airport property. Stock control shall be by the DAA who shall grant reasonable access to the BHS Contractor's warranty service agency during the warranty period. All items withdrawn from stock shall be replaced, regardless of whether the item was purchased by the DAA or the DAA's Maintenance Group directly from the BHS Contractor or from a third party, pursuant to warranty services, within two weeks of such withdrawal.

b. Ending of the warranty period shall be contingent on the replacement of all stock withdrawn pursuant to warranty services whether the warranty service agency or the DAA accomplished such services. Where the BHS Contractor has cause to believe that an item or items may require stocking pursuant to the terms and conditions of warranty provisions, which item or items the DAA declines to stock, the BHS Contractor shall stock such items separately at no cost to the DAA. In no case shall the absence of appropriate spare parts in the DAA's spare parts stock be construed in any way to abridge or interfere with the responsibilities of the warranty services as defined herein.

H. Design Warranty

1. Terms

a. Provide a Design Warranty which states that the system, materials, equipment, software and high level and low level controls furnished and installed shall be free from faults and defects in design; shall conform to the functional and technical requirements of this Section and Contract Drawings contained herein; shall comply with all laws, statutes, ordinances and codes applicable at the installation site; and shall be suitable for the intended purposes. Excessive wear shall be considered a defect within the provisions hereof.

2. Design Failure

a. In the event a design failure occurs during the warranty period, replace all such components, assemblies or devices utilizing the design in a similar application in which the failure occurs by components, assemblies or devices redesigned to prevent such occurrences at no cost to the DAA. Submit proposed redesign drawings and re-selected component designations to the DAA for their approval. Issue a new warranty period upon the replacement of such redesigned items.

b. Components, assemblies or devices shall be considered as design failures if any of the following occurs during the warranty period:

1.) A leakage loss of over 10% of an operating fluid in any hydraulic assembly.

2.) A demand for frequent, unscheduled adjustment or other maintenance action in similar devices.

3.) Failure of a component to perform its specified function or a failure of a component to operate at its specified rate.

4.) Frequent activation of overload protection elements in similar devices.

5.) Loosening of anchoring or attachment provisions on similar devices.

6.) An increasing level of noise being generated by similar devices.

7.) A structural failure due to BHS supports, hangers, or headers.

8.) Inappropriate action of control or sensor elements during operational conditions.

9.) Occurrence of an accident or an imminent safety hazard revealed during operational conditions.

10.) Uncovering of a condition of specification non-compliance or degradation of specified functional requirements during the warranty period.

11.) More than 2 failures on one or more components or assemblies of components of similar construction or design, used in similar devices.

12.) More than 2 unscheduled replacements of an expendable component in similar devices.

c. The DAA shall act to resolve any disputes regarding the definition of a design failure in a fair and equitable manner.

3. Period and Responsibility

a. If, within three (3) years from the date of Final Acceptance of the work, the work or the system, or any equipment, material or software is found, in any respect, not to conform to the Warranty set forth herein, within forty-eight (48) hours of notification by the DAA, initiate the following series of steps in order to correct the deficiency:

1.) Determine the cause of failure.

2.) Prepare drawings showing recommended design changes and submit to the DAA or his representative.

3.) The DAA or his representative shall comment with a change request or approval.

4.) Make design changes if requested.

5.) After the DAA or his representative has approved the design, all components of the system incorporating the same design deficiency shall be modified as agreed upon by the DAA or his representative.

6.) The Parts Warranty period and the Design Warranty period shall start again for the changed item/system on the date that the design change has been incorporated if the make, manufacture or model is replaced.

\- END OF PART I -

PART II - PRODUCT SPECIFICATIONS

2.01 ACCEPTABLE MANUFACTURERS

A. BHS Contractors

1. Subject to compliance with requirements, the following firms are qualified to perform as BHS Contractors for this Project:

   a. Equipment Erectors, Inc., Somerset, NJ

   b. G & T Conveyor Company, Inc., Tavares, FL

   c. Glidepath LLC, Grand Prairie, TX

   d. Jervis B. Webb, Inc., Farmington Hills, MI

   e. Pteris Global (USA), Inc., Littleton, CO

   f. Siemens Airport Logistics, DFW Airport, TX

   g. The Horsley Company, Ogden, UT

   h. Vanderlande Industries, Inc., Marietta, GA

B. BHS Equipment Subcontractors

1. Subject to compliance with requirements, the following firms are qualified to perform as component subcontractors for this project:

   a. Equipment Erectors, Inc., Somerset, NJ

   b. G & T Conveyor Company, Inc., Tavares, FL

   c. Glidepath LLC, Grand Prairie, TX

   d. Jervis B. Webb, Inc., Farmington Hills, MI

   e. Pteris Global (USA), Inc., Littleton, CO

   f. Siemens Airport Logistics, DFW Airport, TX

   g. The Horsley Company, Ogden, UT

   h. Vanderlande Industries, Inc., Marietta, GA

C. BHS Equipment

1. In order to establish a minimum standard of quality and reliability, the following manufacturers have been listed for various components of the BHS.

2. This list has been presented to establish this standard and the manufactures on this list shall not be perceived or construed as favored or preferred. This list shall, in no way, preclude other manufacturers, provided that their equipment and components have been reviewed by the DAA or his representative and determined to be of equivalent or similar quality, functionality, and reliability. The DAA or his representative's decision in this regard shall be final.

   a. For Belting:

      1.) Ammeraal Beltech

      2.) B.F. Goodrich

      3.) Fenner/Dunlop

      4.) Goodyear Tire and Rubber Co

5.) Habasit Belting, LLC

6.) Midwest Conveyor Company, Inc. (Ashland Conveyor Products)

7.) Morrison Company, Inc.

8.) Siegling America, Inc.

9.) Sparks Belting Company

b. For Belt Lacing:

1.) Clipper Belt Lacer Company

c. For Bearings:

1.) Browning (Emerson Power Technologies)

2.) Dodge (Baldor Electric Company)

3.) Fafnir/The Timken Company

4.) Sealmaster/Morse Industrial Corp. (SF, SFT, ST, or STH Goldline Series)

5.) SKF Bearing Services Company

d. For Clutches:

1.) Dodge (Baldor Electric Company)

2.) Reliance Electric (Baldor Electric Company)

3.) Stearns Electric (Rexnord Industries)

4.) Warner Electric

e. For Brakes:

1.) Dodge ("D" Type) (Baldor Electric Company)

2.) Stearns Electric (Rexnord Industries)

3.) Warner Electric (Failsafe)

f. For Motorized Pulleys:

1.) Precismeca (Formerly Joki, Distributed by Interroll)

2.) Van der Graaf (model UMV)

g. For Power and Spiral Turns:

1.) Portec, Flo-Master Division

2.) Transnorm (Series TS1500)

h. For Incline Plate Claim Devices:

1.) G & T Conveyor Company, Inc.

2.) Glidepath LLC

3.) Jervis B. Webb, Inc.

4.) Siemens Airport Logistics

5.) Vanderlande Industries, Inc.

i. For Flat Plate Make-Up Devices:
   1.) G & T Conveyor Company, Inc.
   2.) Jervis B. Webb, Inc.
   3.) Siemens Airport Logistics
   4.) Vanderlande Industries, Inc.

j. For High Speed Vertical Paddle Diverters:
   1.) Pteris Global (USA), Inc.,
   2.) Siemens Airport Logistics

k. For Control/Communication Products:
   1.) Motor Starters:
      a.) Allen-Bradley
      b.) Cutler Hammer
      c.) Square D (Type S) – NEMA only
      d.) Telemecanique (TeSYS U-Line Series) – IEC only
   2.) Programmable Logic Controllers (PLCs):
      a.) Allen-Bradley
      b.) Siemens
      c.) Telemecanique-Modicon and Quantum series
   3.) Photoelectric Controls:
      a.) Allen Bradley
      b.) Banner Engineering Corp
      c.) Cutler Hammer
   4.) Variable Frequency Drives (VFD):
      a.) Allen Bradley/Rockwell Automation
      b.) SEW Eurodrive
      c.) Telemecanique (Altivar Series)

l. For Motor Control Panels (MCP Cabinets):
   1.) EMF Company, Inc
   2.) Hoffman Engineering Co.

m. For Motors:
   1.) Baldor
   2.) LeRoy Somers (Part of Emerson Motor Technologies)
   3.) Reliance Electric (Part of Baldor Electric Company)
   4.) SEW Eurodrive

5.) U.S. Motors (Part of Emerson Motor Technologies)

n. For Reducers (shaft mounted):

1.) Browning (Part of Emerson Power Transmission)

2.) Dodge ("TXT" ABHS Series) (Part of Baldor Electric Company)

3.) Link Belt, Inc.

4.) SEW Eurodrive

5.) Sumitomo

o. For Reducers (foot-mounted or base-plate mounted):

1.) Link Belt, Inc

2.) Reliance Electric (in-line, helical gear type) (Part of Baldor Electric Company)

3.) SEW Eurodrive

4.) Sumitomo

5.) Emerson Power Transmission

p. For Roller Chains:

1.) Acme

2.) Diamond Chain Company

3.) Dodge

4.) Morse Industrial (part of Bearing Distributors, Inc)

q. For Rollers and Pulleys:

1.) Precision, Inc

2.) The Chantland Company

r. For Baggage Dimensioning Scanners:

1.) Accu-Sort Systems, Inc.

2.) Mettler Toledo

3.) SICK Auto Ident, Inc.

s. For Signaling Devices (audible alarms):

1.) Allen Bradley

2.) Edwards Co. Signaling Products Div.

3.) Federal Signal Corporation

4.) Mallory Company

t. For Signaling Devices (visual alarms):

1.) Allen Bradley

2.) Cooper Crouse-Hinds

3.) Federal Signal Corporation

u. For Uninterrupted Power Supply (UPS):

1.) APC

2.) Eaton Powerware

3.) Leibert (Part of Emerson Network Power)

v. For Draft Curtains:

1.) TRAX Industrial Products

w. For Powered Fire/Security Doors:

1.) Raynor

2.) The Cookson Company

3.) Vigneaux Corporation

x. For Soft Start Devices:

1.) Allen-Bradley

2.) Nordic

3.) Reuland Electric

y. For Hour Meters:

1.) ENM Company

2.) Hobbs Corporation

z. For Power Regulators:

1.) Sola/Hevi-Duty Electric

2.02 MATERIALS

A. General

1. All welding and qualification of welders shall comply with AWS D1.1.

2. All fasteners shall be zinc-plated, cadmium plated or stainless steel. All fasteners shall be locked with lock nuts or lock washers.

3. Use of alternate materials

a. Whenever an article or any class of articles, devices or material are specified by the trade name or by the name of any particular patentee, manufacturer, or dealer, or by reference to the catalog of any such patentee, manufacturer or dealer, it shall be taken to mean and specify the articles, devices or materials specified and none other.

b. If the BHS Contractor desires to use any articles or materials which he believes are equal in quality, finish and durability, and equally as suitable for the purpose for which intended as the particular articles, devices or materials specified, he shall indicate his desire to the DAA or his representative in writing.

c. The articles, devices and materials specified shall not be changed except with the written consent of the DAA or his representative, and the BHS Contractor shall not contract, purchase or cause to be delivered any substitute articles, devices or materials prior to obtaining such consent.

B. Material

1. Structural Steel: ASTM A-36

2. Stainless Steel (Trim): AISC Type 304 with #4 Brush Finish
3. Plywood (FR-S Rated Fire retardant): Interior Type A requirements in AWPA Standard C-27.
4. Lumber (FR-S Rated Fire retardant): Interior Type A requirements in AWPA Standard C-20
5. Rubber/Neoprene: ASTM D-2000

2.03 FABRICATION

A. General

1. Fabricate equipment-using steel clean and free from rust, rust pits, kinks and sharp bends. Use forming methods that will not fracture or otherwise damage the metal. Remove burrs, sharp edges, and sharp corners. Smooth all joints and round all corners. Align joints in components to ensure smooth conveyance of baggage.
2. Holes in metal side guards for photocell beams are to be "punched", not burned, and tapered from the inside (wide) to the outside (narrow).
3. When two sections of conveyor bed meet, these joints shall be chamfered to ensure that there is no step-up condition between bed sections.

2.04 BELT CONVEYORS

A. Belting

1. General

a. All conveyor belting shall be flame retardant according to ISO 340, DIN 22103, ASTM D-378 and NFT-47108 or equal.
b. Belt widths shall be 3" less than the between frame (guard) dimension unless otherwise specified. Belt edges must be sealed after being cut to width.
c. Ensure that no belt slippage occurs in order to meet all tracking performance requirements specified herein.
d. The actual length of belting installed on each unit shall be included on the system's drawings and in the spare parts list.
e. All belting shall have a minimum acceptable working tension of 100 pounds per inch of belt.
f. The BHS Contractor shall ensure all ratings for proposed belting designated for exterior use exceed the local environmental weather conditions.
g. The BHS Contractor shall submit cut sheets for all types of belting being proposed for this project for review and approval by the DAA or his representative.

2. Conveyors

a. For level, general purpose baggage handling applications such as load, unload transport and inclines/declines of 7° or less use two ply urethane impregnate, solid woven fabric polyester or bare by bare (if not exposed to the public), top face of 0.02" PVC, smooth (public areas), maximum coefficient of friction of 0.3 with elongation of 1% maximum rated tension. For load conveyors provide belting that is flat laying, roll resistant and cut/wear resistant.
b. For incline and decline conveyors of greater than 7° use 0.08" PVC two ply urethane impregnate, solid woven fabric polyester or bare by bare, rough top, maximum coefficient of friction of 0.25 with elongation of 1% maximum rated tension.
c. For incline and decline conveyors or other locations where bag slippage may occur, the use of longitudinal rough top belt may be used. Habasit Trackmate, model 135 LR (or approved equivalent), shall be used.

3. Power Turns: Provide belts for power turns suitable for the application, as provided by the power turn manufacturer.

4. Spiral Turns: Provide belts for spiral turns suitable for the application, as provided by the spiral turn manufacturer.

5. HSDs: Provide belts for HSDs suitable for the application as provided by the HSD manufacturer.

B. Belt Splicing

1. Lacing

a. All belt lacing (except for power turns) shall be of the Clipper "Unibar" type with a minimum #2 hook-type of the size recommended by the belt manufacturer for the belt being used. When cutting belts for proper length, sufficient material shall be allowed for take-up pulleys to be at a maximum of one-half the take-up distance with the belt running.

b. Belt lacing for power turns shall be of the Clipper type with either #1 or #1A hook-type of the size recommended by the belt manufacturer for the belt being used or as recommended by the power turn manufacturer. When sizing belts for proper length, sufficient material shall be allowed for take-up pulleys to be at a maximum of one-half the take-up distance with the belt running.

c. Belting and related hardware must be trimmed in a 1" "V" notch fashion, lacing connecting pin must be either enlarged by heating lacing connecting pin nylon jacket or bent 90° to prevent lateral movement of the pin.

d. Belt lacing for applications in 45° merge conveyors shall be of the Clipper brand type of fastener.

e. Belt lacing connecting pins for the Clipper type-lacing materials shall be of the nylon covered steel cable type of appropriate diameter for the lacing hooks being used.

f. All rough top belting to be ground smooth within 1" of the cut end to allow proper seating of the belt lacing

2. Vulcanization

a. The option to vulcanize all belting material instead of utilizing belt lacing must be approved by the DAA or his representative.

b. All belts shall be supplied as endless, hot-overlap finger splice joints, as per the manufacturer's requirements. Provisions shall be made within the conveyor frame and side guard's to allow for future repair due to belt failure. For this purpose, removable side guards shall be provided at an appropriate location to allow for on-site positioning of a hot splice machine.

c. For power turns, new belting will be spliced prior to installation and installed as per manufacture's recommendations.

d. Provisions must be made to ensure future accessibility of the appropriate power requirements unique to the vulcanizer.

e. If the DAA approves the use of vulcanization, supply a hot splice machine for the DAA's Maintenance personnel's use at substantial completion of the project.

C. Pulleys

1. General

a. All shafts shall be designed to CEMA standard No. 402-1992 and all subsequent revisions. Shafts are to be AISI 1018 steel, polished and ground and within tolerances for the associated bearings.

b. All pulleys are to be dynamically balanced. Rollers of eccentric material, such as standard pipe, are to be dynamically balanced.

c. Run-out:

1.) The maximum shaft run-out of all assembled pulleys, shafts and bearings under a no-load condition, measured from the centerline of the bearing to the end of the related shaft furthermost from the conveyor, shall not exceed .0075" per inch.

2.) The maximum run-out of any pulley shell shall not exceed .060".

d. Machining:

1.) Swaged:

a.) Pulleys shall be 10-gauge (minimum) thickness with 3/8" (minimum) thick end plates.

b.) End pulleys are to be swaged between centers to create a trapezoidal face with a taper from the pulley end to a minimum 25% of the pulley length thereby having 50% of the pulley flat in the center.

2.) Machined:

a.) If end pulleys are machined (not swaged) using Schedule 40 pipe, center plates must be made from 1/2" thick steel plate and shall have bored centers to facilitate a slip fit on the shaft.

b.) Pulleys are to be turned between centers to create the crown or trapezoidal. Pulleys shall be crowned from each outer end to within 1/2" of the centerline leaving 1" straight but turned true to standard thickness required for each pulley application. When welding is involved, turn the assembly after welding to true the weldment and create the crown/trapezoidal.

c.) The recommended minimum wall thickness after crowning or trapezoidal shall be as follows:

Pulley Diameter	Minimum Wall Thickness
8-5/8"	5/32"
12-3/4"	7/32"
16"	11/32"
18"	11/32"

e. Hub plates shall be made from 3/8" (minimum) thick steel plate turned and bored to fit on the shaft or have a taper locking hub arrangement welded in the end plate.

f. All pulleys shall be manufactured for high-speed application.

g. All bearings shall be supplied pre-lubricated and sealed for life with plugs inserted into the grease fitting bore. Bearings are to be secured to their respective shafts with an approved form (as specified in the submittal procedure) of eccentric or squeeze locking type collar arrangement.

2. Powered Pulleys

a. Drive pulleys

1.) All drive pulleys for intermediate-type drives shall be lagged with vulcanized lagging of 50 - 60 Durometer rating with a minimum thickness of 3/8". Lagging material on individual pulleys shall be compatible with the type of belting used on the associated conveyor. Examples of lagging material are as follows:

a.) 85 durometer neoprene with a minimum of 70% neoprene content

b.) Minimum 70 durometer carboxiled nitrile

c.) Minimum 70 durometer thermo-set urethane

2.) Powered pulleys shall be steel, crown faced, flat faced, or trapezoidal (per the belting manufacturer's recommendation), shall be equipped with taper-lock type hubs with 1-7/16" minimum diameter shafts mounted in eccentric locking-type or squeeze locking type precision and ground flange-type ball-bearing units.

3.) The minimum acceptable belt wrap on drive pulleys shall be 210°.

4.) Drive pulleys for end-type drives must be lagged with a minimum 3/8" thick vulcanized lagging of 50 - 60 durometer, again using lagging material compatible with the type of belting used on the associated conveyor. In addition, powered pulleys shall be 6" with taper lock hubs with 1-7/16" minimum diameter C.R.S. shafts mounted in eccentric locking type precision and ground flange ball bearing units.

5.) Drive pulley and shaft sizes shall be determined by maximum belt pull. The following are provided as examples:

a.) Light-Duty: 250 lb. maximum belt pull. Consists of a 6-3/4" minimum diameter drive pulley with a 1-7/16" minimum diameter shaft. Bearings mounted with two bolts can be used with light duty applications.

b.) Normal-Duty: 500 lb. maximum belt pull. Consists of an 8-3/4" minimum diameter drive pulley with a 1-11/16" minimum diameter shaft. Roller chain, if used, shall not be less than RC - 60. Bearings mounted with two bolts can be used with normal duty applications.

c.) Intermediate-Duty: 1000 lb. maximum belt pull. Consists of a 10-3/4" minimum diameter drive pulley with a 1-15/16" minimum diameter shaft. Roller chain, if used, shall not be less than RC - 60. Bearings mounted with four bolts are to be used with intermediate duty applications.

d.) Heavy-duty: 1,500 lb. maximum belt pull. Consists of a 12-3/4" minimum diameter drive pulley with a 2-7/16" minimum diameter shaft. Roller chain, if used, shall not be less than RC - 80. Bearings mounted with four bolts are to be used with heavy-duty applications.

3. Non-Powered Pulleys

a. Snub Pulleys

1.) Snub pulleys are to be installed on all conveyors at all points where the slack portion (non-load carrying portion) of the conveyor belt makes a change in vertical or horizontal direction. At a minimum, such points of vertical or horizontal change shall include:

a.) Points immediately adjacent to head, tail, take up and drive pulleys.

b.) Points on the underside of any conveyor where the belt bends vertically or horizontally (nose-over sections).

2.) All snub rolls shall be a minimum of 4" in diameter and equipped with fixed (welded) 1-7/16" minimum diameter shafts mounted in eccentric locking-type or squeeze lock type precision and ground flange-type ball-bearing units.

3.) Bearings are to be secured to their respective shafts with an approved form (as specified in the submittal procedure) of eccentric or squeeze locking type collar arrangement.

4.) All snub rollers used for belt tracking shall be equipped with jacking bolts to facilitate adjustment. Jacking bolts must be equipped with jam nuts to prevent the jacking bolts from loosening.

b. Take-Up Pulleys

1.) All take-up pulleys shall be steel, crown faced, flat faced, or trapezoidal (per the belting manufacturer's recommendation), and at a minimum 4" in diameter. Take-up pulleys are to be equipped with taper-lock type hubs or squeeze lock type and 1-7/16" minimum diameter shafts mounted in eccentric locking-type precision and ground flange-type ball-bearing units. Pulleys must be mounted on threaded take-up devices with steel guides and have a minimum allowable adjustment of 10" (6" on conveyors less that 12' in length).

2.) All conveyors shall be provided with take-ups for field adjustment of 2% of the conveyor bed length. Take-ups shall be an integral part of the drive frames on all intermediate-drive conveyors.

3.) Automatic take-up devices shall be installed:

a.) On all conveyor sections in excess of 60' in length

b.) On conveyors which operate outside the building or are subject to extreme temperature and humidity changes.

c.) In areas where belts are subject to stretch/shrinkage that will cause weekly adjustment.

4.) Spring take-ups are not acceptable.

5.) Take-ups used in heavy-duty or high-speed applications shall be a minimum of 6" in diameter with a minimum 1-7/16" diameter shaft and shall otherwise comply with the above specifications.

6.) Bearings are to be secured to their respective shafts with an approved form (as specified in the submittal procedure) of eccentric or squeeze locking type collar arrangement.

7.) All take-up pulley bearing adjustors are to be chain coupled so that both bearings are tightened and slacked in equal increments. All belt lengths shall be adjusted so that the respective take-up pulley adjustments shall permit a further adjustment of 85% before the belt length needs to be shortened. The 15% maximum adjustment of the take-up pulley adjusters shall have been accomplished prior to Acceptance Inspection and Testing.

c. Head and Tail Pulleys

1.) All non-powered head and tail pulleys shall be steel, crown-faced or trapezoidal and equipped with taper-lock type hubs. Pulleys shall be equipped with shafts having a minimum diameter of 1-7/16" mounted with eccentric locking-type precision and ground flange type ball bearing units. All head and tail pulleys shall be a minimum of 6" in diameter x #10 gauge wall. In addition, all head and tail pulleys shall be of a single-piece construction having steel end discs attached to the rim by continuous welding.

2.) Slider beds shall be arranged to minimize the gap between the end section and the end pulley such that the gap does not exceed 1" with a 1/2" design objective.

3.) All head and tail pulleys used for belt tracking shall be equipped with jacking bolts to facilitate adjustment. Jacking bolts are to be equipped with jam nuts to prevent the jacking bolts from loosening.

4.) Bearings are to be secured to their respective shafts with an approved form (as specified in the submittal procedure) of eccentric or squeeze locking type collar arrangement.

5.) Finger Safety Guards:

a.) All end pulley rollers in staffed areas (manual encoding, load conveyors (public and non public areas), sort pier conveyors, or run out conveyors) shall be narrower than the belt width by a distance not less than two times the difference between the belt width and the between-guides width of the conveyor (usually 6 inches).

b.) A securely fastened steel finger guard matching the radius of the end roller shall take up the remaining width on each side of the roller. The BHS Contractor shall ensure that the outer surface of the finger guards are smooth and that the junctions between the finger guards and the slider bed and that between the finger guards and the pulley do not subject the belting to any undue damage or wear. Attachment of the finger guards shall be such that the guards will move with the pulley when it is adjusted, therefore ensuring proper alignment.

c.) At the tail end of load belts, pulleys shall also be covered with a removable metal shroud located just above, but not in contact with, the conveyor-belting surface. Where exposed to public view, these pulley shrouds shall be constructed of stainless steel matching that used on their respective conveyors (type 304 stainless steel with #4 brushed satin finish, unless otherwise specified).

d.) The BHS Contractor shall submit to the DAA or his representative the proposed finger safety guard design for review and approval.

4. Return Rollers/Idlers

a. Return rollers shall be constructed from 12-gauge steel and must be full-faced with a minimum 2-1/2" diameter equipped with an 11/16" hex axle for belt speeds up to 150 fpm and a minimum of 3-1/2" in diameter with a 11/16" hex axle for belt speeds above 150 fpm.

b. All hex shaft return idler rollers shall be equipped with sealed, permanently lubricated, caged, semi-precision type ball-bearings. Return idlers shall be located on centers not exceeding 10', with spacing being reduced in areas where belting may drag against the floor or conveyor structure. The shafts shall be mounted to the conveyor bed with adjustable retainers for proper belt tracking.

c. Provide two return rollers spaced on 5'-0" centers in each 10'-0" intermediate section from which lateral diversion of baggage takes place. Center the return rollers on the associated pusher or diverter.

d. Return rollers must not be used at snub points.

e. Provide a minimum of one return roller per 10'-0" section. The position of the return rollers shall assure that the return belt is routed and supported so that it does not contact any stiffening members. Mounting for the end of each return roller shall be adjustable for belt tracking.

f. For application where conveyors are exposed to inclement weather, provide a minimum of one return roller every 5'-0" on center on load and transfer belts to help the conveyors start when wet or frozen to the bed. The position of the return rollers shall ensure that the return belt is routed and supported so that it does not contact any stiffening members. Mounting for the end of each return roller shall be adjustable for belt tracking.

g. Provide return roller finger guards at all possible return roller mounting positions where accessible by personnel.

D. Drive Assemblies

1. Submit to the DAA or his representative for approval a schedule of all drive assemblies showing configuration of motor and reducer assembly. The selection of the drive assembly shall be based on efficiency, low noise, sized for the application, achieves long service life and has low maintenance.

2. End-type drive units may be used for conveyors 25' or less in length, with intermediate drives used for conveyors over 25' long.

3. For non-reversing conveyors, the drive assembly shall be located towards the head end of the conveyor.

4. For reversing conveyors, the drive assembly shall be located as close to the midpoint of the conveyor as possible.

5. Motors:

a. The conveyors shall be driven by AC induction motors (except where motorized pulleys are used). The motors shall conform to AIEE, NEC and NEMA standards. These motors shall be equipped with two-groove minimum, taper-lock type hubs, and “A” or 3VX -belt sheaves.

b. Motors shall be sized for maximum load and belt speed requirements under continuous operation (minimum of 1HP unless approved by the DAA or his representative) and, where applicable, shall be capable of withstanding shock caused by frequent starting and stopping under full load conditions.

Motor FLA will be measured with full load during load tests and any motor that draws more than the name plate FLA (after start up in rush current has flattened) must be replaced with a motor of appropriate size that will result in no more than the max name plate FLA during load test.

c. Motors shall also be of the constant speed (nominally 1800 RPM), continuous service, and ball-bearing type with a minimum of class "F" insulation. For 2hp motors and smaller class “B” insulation shall apply.

d. If overrun is critical to system control operation (i.e., wherever baggage tracking is required), motors shall be equipped with automatically applied brakes to prevent overrun after the motors are de-energized.

e. With the exception of “High-Slip” design motors, for applications that require dual drives, and motors that are controlled by “VFDs”, all of the BHS motors shall be copper-wound NEMA Design "B" open drip proof or TEFC with Class F insulation, utilize a "T-frame" base, and shall be provided with overload protection in the motor control panel. These motors shall have a minimum of 1.15-service factor. High-Slip Motors are required by specification where the use of dual drives is used. These motors shall be copper-wound NEMA Design "D", Class "H" Insulation at 1.0 Service Factor with Class "F" temperature limits. Inverter (Vector) Duty Motors shall be used at "VFD" controlled applications. These motors shall be copper-wound NEMA MG1 Rated Design "B", Class "H" Insulation at 1.0 Standard Service Factor with Class "H" temperature limits. All motors shall be of the "high efficiency - low energy" type.

f. All motors shall meet the following criteria:

1.) Low noise

2.) Removable conveyors (e.g. EDS device in feed and exit conveyors) shall be equipped with heavy-duty quick couplings for electrical connections

3.) Fitted with low noise fan reduction guard or equivalent.

g. Motor size selection shall be based on the design load and friction coefficient requirements as described in these specifications. Motor size shall not exceed 7-1/2 HP, unless otherwise approved by the DAA or his representative. Use minimum 1horsepower motors (unless other specified or approved by the DAA or his representative). All drive motors shall be provided in 1, 1½, 2, 3 or 5 horsepower. Size conveyor equipment drive motors to permit start-up under full load conditions at the specified frequency of start-up cycles per minute without exceeding a temperature rise of 68°C based on an ambient temperature of 40°C. Provide motors designed for 480 VAC, three phase, 60-Hertz operation.

h. C-faced motors (with VFD control) can be utilized. Such usage shall be coordinated with the DAA or his representative.

i. Motor mounts shall be equivalent in function to Dodge Type "A" slide motor bases with boltholes drilled and tapped, or tack-welded nuts under the holes in the top portion of the mounting plate. Use of loose nuts to hold the motor mount is unacceptable. Provide jacking bolts to resist effect of belt or chain pull on foot mounted motors.

j. On all belts with frequent start/stop operations, such as indexing belts, all motors shall be continuous-running NEMA-B design, coupled with VFD control.

k. In the case where the conveyor line configuration, related controls and baggage input/processing are directly associated with the EDS or is in a tracking zone, the conveyor shall be equipped with a VFD.

l. If clutch/brakes are provided the clutch plates/discs shall not contain any asbestos material.

6. Reducers

a. Shaft-mounted reducers shall be attached with tapered type bushings or full length bore with keyway.

b. Reducers shall be sized for a Class II application (minimum). Based on actual motor horsepower, the service factor required to obtain an L10 life of 70,000 hours shall be as follows:

1.) For reducers utilizing ball bearings the service factor used shall be 2.4

2.) For reducers utilizing roller bearings the service factor used shall be 2.2.

c. Reducers shall have adequate provisions for drain, fill, inspection ports and sight gauge. The manufacturer's recommended lubrication shall be attached to the reducer by means of a riveted, or bolted stamped metal tag. All units shall be installed with proper lubrication and vent plugs intact upon start-up of conveyor.

d. Reducers used on inclines where roll-back would be critical shall be equipped with “backstop" devices or brake motors.

e. All bearings within the reducer shall have a minimum L-10 life of 70,000 hours based on service factor and loading of conveyors, and on the manufacturer's published data showing load rating of each bearing used.

7. General Drive Requirements

a. Where applicable, all gear reducer-mounting frames shall be fabricated from 1/4" thick steel "C" channels. The mounting frame shall be so designed to allow bolting to both the bottom and sides of the conveyor bed. The mounting frame shall be a totally separate weldment that can be unbolted to allow for installation as either a right or left hand drive. The mounting frame shall span the full width of the conveyor bed and attach to both sides of the bed frame.

b. Electro-mechanical brakes, if required, shall be internally mounted. The stopping torque shall be at least equal to the starting torque of the motor.

c. The drive unit shall be provided with a factory warranty for 2 years or 15,000 operating hours, whichever is longer.

8. Mounting

a. C-Faced

1.) In-line foot mounted reducer is an acceptable mounting method.

2.) The C-faced configuration with VFD control used on conveyors capable of continuous stop/start operation (i.e. queues or indexing conveyors) shall be capable of a minimum of 60 continuous start/stop operations per minute in an unloaded condition.

b. Foot Mounted or Base-Plate Reducer and Motor Mount

1.) The gear reducer shall be mounted on a fully adjustable mount. To allow for fast, easy motor and gear reducer replacement and adjustment, the mount shall be designed as follows:

a.) The mount shall be a two-piece assembly:

(1.) The bottom portion can be bolted or welded to the mounting frame (as specified above).

(2.) The top portion shall be designed to slide over the bottom portion and be adjustable via a single bolt adjustment. The top of the motor mount shall have boltholes drilled and tapped to accept the layout pattern as the gear reducer mounting feet or the multi-mount feet.

b.) Use of tack-welded nuts under the holes in the top portion of the mounting plate shall be acceptable in lieu of tapped holes; however, the use of nuts to hold the motor in place shall not be acceptable.

c.) The purpose of this design is to allow replacing the motor by using an extension and properly sized socket from above without having to hold locking nuts.

d.) Use of Dodge Type "A" Slide Motor Bases is recommended, or an approved equal, for this application.

9. All drive units shall be equipped with a suitable guard of "clamshell" design with quick-release fasteners, and fabricated from a minimum of 16-gauge steel. All guards shall comply with applicable OSHA standards and have an expanded metal-screened window to allow belt inspection without removal of the guard.

10. All drive motors and reducers shall be equipped with drip pans. The drip pan shall be constructed out of minimum 14-gauge steel. The drip pan shall be appropriately mounted such that the pan must be secured in the horizontal attitude and shall not impact maintenance access.

11. Whenever possible, all drive sprockets and V-belt sheaves shall have a taper-lock type of hub construction, with keyways. When keyways are used, they shall be secured by two sets of screws, one on top of the other to ensure positive locking of keyway. Sprockets shall be steel with a minimum of thirteen Type B form teeth.

12. Driving and driven sheaves shall be (minimum) two-groove "A" or 3VX section sheaves with taper-lock type hubs.

13. Roller chain shall be compatible with the torque and horsepower requirements of the application and shall be RC-60 minimum size. The roller chain ends shall be connected with a removable connecting link.

14. All pulley and sprocket adjustments provided for the purpose of adjusting belt tension, belt tracking, drive chain tension, and drive chain alignment shall incorporate a positive means of adjustment and restraint (i.e., tensioning screws and locking nuts). Slotted holes for mounting bolts shall not in themselves be considered satisfactory.

15. Chain drive sprockets shall be designed for a sprocket ratio between the driven and drive sprockets as close as possible to 2:1, but not less than 1.5:1 or greater than 2.25:1. The maximum size for driven and drive sprockets shall be 35 and 18 tooth respectively. Wherever possible within the standard range of stock Taper lock-type sprockets, hardened tooth sprockets shall be provided.

E. Flexible Couplings

1. Mount coupling hubs to their respective shafts with keys and two setscrews, one of which shall be over the key and the other 90° from the key. When keyways are used, they shall be secured by two sets of screws, one on top of the other to ensure positive locking of keyway. The use of a screw-locking compound in lieu of two – (2) setscrews is acceptable.

2. Select the coupling so as to permit the replacement of internal parts without removal of the motor or reducer.

F. Intermediate Sections

1. Provide conveyor frames capable of supporting a uniform load as specified with supports at a maximum center distance of 10'-0".

2. Construct the slider bed shell of 12-gauge minimum hot rolled steel and designed to present a smooth surface to the belt. The slider bed shall be well braced for rigid construction with the side frames a minimum of 6" x 1-1/2" channel or equivalent. A minimum of 1 1/4" x 1-1/4" x 3/16" angle stiffeners shall be welded to the underside of the slider bed at a maximum center distance of 3'-4" on transport conveyors and 2'-6" centers on load conveyors. Butt-coupled joints shall be provided.

3. When two – (2) sections of slider bed meet, both sections shall have chamfered slider bed lips to ensure that there are no step-up conditions between slider beds.

G. Floor Supports

1. Provide floor supports for conveyors located within 7'-6" of the floor or any mezzanine that is shown on Contract Drawings. Locate floor supports at intermediate section splices or within 1'-0" of intermediate section splices at 10'-0" maximum spacing.

2. Supports shall be on 5'-0" centers on loading/unloading conveyors and on 10'-0" maximum centers

elsewhere. In all cases, each bed joint shall be supported.

3. All floor supports shall be of an “H” type design (i.e. two legs with a horizontal brace member) with vertical field adjustability of +/- 3". Floor support vertical members shall be constructed of 10 gauge, hot rolled formed steel channel with 10 gauge, hot rolled steel universal foot and head plates.
4. All conveyor floor supports shall be secured to the floor with a minimum of two (2) anchoring devices per leg (e.g., stud expansion anchor bolts).
5. All conveyors shall be adequately sway braced in order to ensure that there is no lateral or longitudinal displacement.
6. All support structure must be designed and installed so that maintenance access to the conveyor components and access to walkway(s), work areas and drive aisles are not blocked.
7. The location of the floor support shall not impede the installation/removal of the conveyor gap pan.

H. Overhead Supports

1. The BHS Contractor is responsible for the design and structural integrity of all bolts, hangers, and support structures, and is to provide all necessary materials required for installation.
2. Provide overhead supports for conveyors located 7'-6" or more above the floor or any mezzanine that is shown on the Contract Drawings. Locate overhead supports at intermediate section splices or within 1'-0" of intermediate section splices at 10'-0" maximum spacing.
3. All supports shall not exceed a 10'-0" maximum on-center spacing. In all cases, each bed joint shall be supported.
4. Ceiling hangers of threaded rod shall have a minimum diameter of 3/4" with structural angle, channel, unistrut or pipe sills. The hangers shall have provisions for anchoring to the building structure and header steel. A Structural Engineer must approve all hanger supports.
5. Threaded rods shall have a lock washer, a single flat washer, and a single nut above and below any header steel channel assembly. A 4” x 4” x ¼” minimum steel support plate shall be used on the load bearing side of the header between the channels and flat washer.
6. All conveyors shall be adequately sway braced in order to ensure that there is no lateral or longitudinal displacement, providing a rigid and rugged installation. Spacing must not exceed 20'-0".
7. Installation and layout of header steel and all support structure shall not pose interference to maintenance and operation access.
8. Repair/replace both new and existing fireproofing materials removed to allow the installation of BHS equipment header steel and support structures.
9. Equip all hangers with vibration isolators to ensure that there is no noticeable vibration transmitted to the building. Submit the proposed type of vibration isolator for review and approval by the DAA or his representative.
10. Where catwalks are specified, the conveyor and adjacent catwalks shall be supported by a double sill configuration wherever possible without inhibiting maintenance and operational access. A single sill application is permissible at specific locations as approved by the DAA or his representative.
11. To achieve maximum drive aisle clearance under the conveyor the BHS Contractor is permitted to utilize a side clip attachment configuration for the conveyor hanger to support the bed section instead of a sill type application. Submit drawings showing those areas where a side clip attachment configuration is to be utilized to the DAA or his representative for approval.

I. Safety Guards

1. Provide and install conveyor underpans on conveyors with clear heights between 18" and 7'-6" above the

floor or within an envelope around a catwalk, walkway, or platform defined as 7'-6" high and 4' wide on either side of such catwalk, walkway, or platform. Fabricate underpans of either solid sheet metal or expanded metal at least 14 gauge thick and fasten to the conveyor intermediate section. The underpans, regardless of type shall be hinged and pinned for easy maintenance access; the pin shall have a lanyard attached to reduce potential of loosing the pin. Sheet metal screws will not be accepted.

2. Protect all exposed moving parts of conveyors, such as, but not limited to, pulleys, rollers, lower or return belts, shafts and couplings less than 7'-6" above the floor or within an envelope around a catwalk, walkway, or platform defined as 7'-6" high and 4' wide on either side of such catwalk, walkway, or platform. The guards shall be made of sheet metal not less than 14 gauge thick, and hinged and pinned for easy maintenance access.

3. Enclose all drive chains and belts using sheet metal protection covers at least 16 gauge thick. Hinge the covers at one end for ease of maintenance and size the covers with sufficient clearance to prevent contact with the normal excursion of chains and belts. Fasten with hex head bolts with captured nuts or similar means of avoiding loosing parts.

4. Eliminate or round unguarded exposed sharp corners and edges of items such as, but not limited to, support legs, braces and trim, to prevent injury to personnel or damage to their clothing. Locate no overhead steel framework, conveyor part, or support structure less than 8' above any platform, walkway, catwalk, ramp or stair tread nose. If due to building constraints, support structure is less than 8', the structure, framework, and supports shall be encased in padding, identified with safety marking (yellow/black stripped tape) and a prominently positioned low overhead warning sign.

5. Install bearing covers on all exposed rotating shafts in workstation areas and in all maintenance areas with platforms. Workstation areas shall, at a minimum, include manual encode stations, sort devices/conveyors, load conveyors, CBRA work areas and EDS work areas. Install appropriate safety guarding on all exposed parts associated with the conveyor drive’s rotating shaft and direct drive gearbox, in compliance with OSHA Standards 1910.219. Ensure that the proposed safety guarding does not restrict maintenance access and it is easily removable, as the location requires, for maintenance access.

6. Install finger guards on all Return/Idler Rollers on conveyors not equipped with underpans.

7. Gap pans must be provided and installed on all conveyor-to-conveyor junction points or transfer locations, where there is any likelihood of small objects falling to the floor, mezzanine or catwalk. Gap pans must be solid sheet metal not less than 12 gauge, unless otherwise approved by the DAA or his representative, with minimum 2-inch high sides on the edges. The gap pan must be no wider than the conveyor width and a minimum of 18 inches long. Mounting must be such as to permit easy lowering and removal for cleaning.

8. Drive pans shall be provided and installed on all conveyor drive sections. Drive pans must be solid sheet metal. They shall be no wider than the conveyor and associated platform width, and no longer than the drive section.

9. All gearbox assemblies shall be equipped with drip pans, fitted with drain plugs to assist with clean up. Drip pans shall be solid sheet metal, not less than 12 gauge, unless otherwise approved by the DAA or his representative, with minimum ¾” high sides on all four edges. The drip pan shall be a bolt-mounted unit of the gearbox assembly.

10. Refer to “Head and Tail Pulleys” section of this specification for details on end pulley finger safety guards.

J. Side Guards

1. Provide side guards the full length of both sides of all conveyors and make-up units except at points that baggage is loaded or removed.

2. Provide hinged or removable sections only where overhead clearance restricts access for clearing jams. Design hinged or removable side guards to permit rapid removal (removable without tools). The design must preserve rigidity and alignment equivalent to fixed side guards. The DAA or his representative must approve all locations where hinged or removable sections are to be used.

3. Side guards shall be minimum 12-gauge hot rolled steel, integral to the slider bed. Side guards shall incorporate a formed 90° edge turned away from the conveyor and a formed 90° edge turned down to eliminate sharp edges. There shall be no gap between the side guard and bed section that can cause jams or baggage tags to be snagged/ripped off.

4. Use type 304 stainless steel with #4 brushed satin finish uniform throughout (if not otherwise specified by the DAA or Architect) in all passenger areas, ticketing check in, claim areas and through penetrations into non-public areas. Stainless steel in public areas shall incorporate smooth flush edge seams. Radius type edges are not acceptable.

5. All stainless steel back guards at the ticket counter load belts shall incorporate stiffening supports that are attached to the conveyor frame by means of a welded or bolted connection. The stiffening supports shall be attached to the stainless back guarding by means of a keyholed slot in the support and a welded stud on the back guarding.

6. Use cold rolled or hot rolled low carbon steel galvanized or hot dip, primed and painted on both surfaces in areas exposed to the weather.

7. Use cold rolled or hot rolled low carbon steel primed and painted on both surfaces in all interior areas.

8. Provide side guards with vertical stiffeners a maximum of 40" on center for transport conveyors and 30" on center for load conveyors. Make the stiffeners from steel angle at least 1-1/4" by 1-1/4" by 3/16".

9. Provide 30° transition panels between side and back guards of different heights.

10. Conveyor Side Guard Heights:

    a. Unless otherwise specified on drawings, construct conveyor side guards for this project to the following heights:

Conveyor Type	Side Guard Height
Check-in Take-away Back Guards (Stainless Steel)	21"
Transport Conveyors	12"
Incline/Decline conveyor Side Guards	12"
Power Turns (flat)	12"
Power Turns (spiral)	12"
Inbound Load Conveyor Back Guards	21"
EDS Device In-Feed and Exit Conveyor (operator side)	4"

11. Provide holes 1.5" in diameter 2.5" from the top of the belt to the center of the hole through side guides for photocell beams as required. Punch the holes with a dimple away from baggage flow to minimize the possibility of snagging a bag and causing a jam. Deburr all photocell holes so that they are free of sharp edges and burrs.

12. Provide removable side guards at locations where pusher diverters or 45°merges shall be installed at a later date.

13. Mounting of any mechanical or electrical equipment on the outside radius side guard of power turns is not accepted since it restricts maintenance access to the outer perimeter chain or guide bearings of the turn belt.

K. Break-Overs

1. Provide break-overs wherever conveyors follow a convex curve.

2. Vertical or horizontal to vertical bends shall be constructed in the same manner as slider bed conveyor sections. The bed shall have a 10'-0" radius break-over slider bed to effect a smooth change in belt direction.

3. For return belt idling, vertical horizontal to vertical bends shall be equipped with a snubber pulley to ensure that the return belt does not extend below the conveyor frame.

L. Bearings

1. All bearings shall be pre-lubricated, self-aligning, anti-friction and sealed for the specified life of the bearing. Lubrication fittings shall be removed (removal to be approved by the DAA or his representative) at the time of installation or at the factory and replaced with appropriate plugs.
2. All bearings shall have a minimum L-10 life of 70,000 hours based on service factor and loading of conveyors, and on the manufacturer's published data showing load rating of each bearing used.
3. All bearings shall be surface-mounted flange bearings attached to the outside of the conveyor bed.
4. Bearings are to be equipped with an eccentric or squeeze locking type collar arrangement to secure the bearing to the related shaft.
5. All bearings and exposed shaft ends at load conveyors, unload conveyors, manual encode workstations, ETD work areas and EDS work areas shall be covered with bearing covers.

M. Hardware

1. Provide zinc plated or otherwise treated fasteners. Use washers, lock washers and nuts.
2. All fasteners in public areas are to be made of stainless steel and are described elsewhere in these specifications.

N. Straight Belt Conveyor

1. Construct transport, queue, load, unload, incline and decline conveyors of components as specified previously.
2. Design each baggage handling belt conveyor with a length to width ratio less than 2.5 with special tracking provisions to ensure positive belt tracking.
3. The maximum length of a straight belt conveyor shall be 60' unless otherwise shown in the contract drawings.
4. In the case where the conveyor line configuration, related controls and baggage input/processing are directly associated with the EDS or is in a tracking zone, the conveyor shall be equipped with a VFD.

O. Ticket Counter Take-Away Conveyors

1. The end pulleys of the ticket counter take-away conveyors shall be such that there are no exposed gaps between the pulley and slider bed, nor shall it constrict the continuous gap between the belt edge and the guard (refer to “Head and Tail Pulleys” section of this specification for details on end pulley finger safety guards).
2. Bearings shall be installed on adjustable brackets.
3. Take-up and snub rollers shall be easily accessible and adjustable for belt tracking.
4. Bearings shall be pre-lubricated (grease-packed) and sealed for life.
5. The drive unit shall be of the center drive type.
6. All equipment with exposed surfaces visible to the public shall be covered with type 304 stainless steel with a #4 brushed satin finish uniform throughout, unless otherwise specified by the Architect or the DAA. Stainless steel in public areas shall incorporate smooth flush edge seams. Radius type edges are not acceptable.

P. Power Turns

1. All power turns shall be provided with a four (4) foot inside radius for standard conveyors unless noted on

the contract drawings. All power turn support structures are to be of metal construction. Power turn shafts shall be 1-7/16" diameter C.R.S.

2. The conveyor system layout shall be designed to permit maximum radius power turns of 180° for flat power turns.

3. Ensure that the outside circumference side guard shall remain readily removable for maintenance. Ensure that no conduit is fastened to it.

4. To minimize the gap between a power turn and straight conveyor, ensure the end rollers (both power turn and straight conveyor) are extended to gain a maximum gap of 1" between the faces of the belts.

5. Design the power turn conveyor so that trained maintenance personnel can easily replace belts.

6. Belt speed shall be measured on belt centerline.

7. Drive assemblies, bearings, and pulleys shall be designed as per straight conveyors detailed within this section of the specification.

8. If a power turn is installed prior to a 45-degree merge conveyor, the turn shall be equipped with a VFD so that baggage queuing can be achieved on the turn.

9. In the case where the conveyor line configuration, related controls and baggage input/processing are directly associated with the EDS or is in a tracking zone, the turn shall be equipped with a VFD.

Q. Spiral Turns

1. All spiral turns shall be provided with a four (4) foot inside radius for standard conveyors and five (5) foot inside radius for oversize conveyors, unless noted on the contract drawings. All spiral turn support structures are to be of metal construction. Spiral turn shafts shall be 1-7/16" diameter C.R.S.

2. The conveyor system layout shall be designed to permit maximum radius spiral turns of 225° where the rate of incline or decline is less than or equal to 24" in 90°.

3. Match side guard height with adjacent conveyors where rate of rise or fall is less than 12" per 90°. Provide 21" high side guards for other spiral turns with a greater degree of rise or fall.

4. Ensure that the outside circumference side guard shall remain readily removable for maintenance. Ensure that no conduit is fastened to it.

5. To minimize the gap between the spiral power turn and an adjoining straight conveyor, ensure the end rollers (both spiral power turn and straight conveyor) are extended to gain a maximum gap of 1" between the faces of the belts.

6. Belt speed shall be measured on belt centerline.

7. If an “S” spiral power turn configuration is incorporated in the project design, provide a “gap brush” between the power turns to fill the gap.

8. Design the spiral power turn conveyor so that trained maintenance personnel can easily replace belts.

9. Drive assemblies, bearings, and pulleys shall be designed as per straight conveyors detailed within this section of the specification.

10. In the case where the conveyor line configuration, related controls and baggage input/processing are directly associated with the EDS or is in a tracking zone, the turn shall be equipped with a VFD.

R. Queue Conveyors

1. Provide queue conveyors of the manufacturers approved design capable of sustaining continuous stop/start operation at thirty – (30) cycles per minute under loaded conditions.

2. Design the queue conveyors so that trained maintenance personnel can easily accomplish belt tracking.

3. Design of the queue conveyor shall be so that adjustments to belt tracking should only be required at a maximum of once every thirty- (30) days.
4. Design, manufacture and installation of queue conveyors shall be in accordance with the design specifications of transport conveyors.
5. In the case where the conveyor line configuration, related controls and baggage input/processing are directly associated with the EDS or is in a tracking zone, the conveyor shall be equipped with a VFD.

2.05 INCLINE PLATE/SLOPE PALLET CLAIM DEVICE

A. General

1. Incline plate/slope pallet devices shall be constructed of articulating contoured pallets or flights forming a continuous, rotating, sloped surface. They shall be arranged to receive baggage from a feed conveyor(s) at a point on the inside rim as shown on the contract drawings. The unit shall be automatically fed via belt conveyor(s).
2. The BHS Contractor as part of the bid proposal can submit their standard incline plate/slope pallet device specifications for review. Final approval of the qualified manufacturer shall be at the discretion of the DAA or his representative. The design, manufacture, and installation of the incline plate/slope pallet device must conform to all sections of this specification as is appropriate.

B. Dimensions

1. The height of incline/slope pallet devices shall be as follows unless otherwise specified by the DAA or his representative or shown on the Contract Drawings:
   a. Claim devices: 17"
2. The BHS Contractor can as part of the bid proposal, submit their standard incline plate/slope pallet device details for review and approval, if the height is different from those specified above.

C. Load Rating

1. All incline/slope pallet devices shall be capable of supporting a minimum dynamic load of 125 pounds per linear foot.

D. Operating Speeds

1. The device operating speed for incline/slope pallet devices shall be 90 fpm.
2. Incline/slope pallet devices shall be capable of accepting baggage per each in-feed conveyor at a rate of thirty – (30) bags per minute.

E. Drives

1. The drive shall consist of a heavy duty, double pitch roller chain driven by a motor through a gear reducer and drive sprocket. The roller chain shall engage at least two modular flight assemblies at all times. Connect motor and reducer-using double grooved sheaves and matched V-belts.
2. Drives shall be equipped with an appropriately sized electronic soft start device.
3. The design of the drive motor circuitry shall provide that the related drive motor safety disconnect switches shall also open the control circuitry of the device whenever the disconnect switch is turned to the off position. Whenever, the disconnect switch is turned back on, it shall be necessary to reactivate the appropriate device start controls, thus allowing the drive motor start-up to be controlled by the soft-start controller.
4. A minimum of two drive units are required for all baggage claim applications due to redundancy requirements. The device shall be designed and configured such that if one of the drive units should fail, the device shall continue to operate at 100% capacity including the ability to start-up under full load conditions with the remaining drive unit. Easy access and means for disconnecting failed drive unit shall be provided to

allow for system maintenance with a minimum of time and effort. Drive design and motor applications must provide for the potential of variations in “actual” motor speeds so that the drive motors are equally loaded. The motor used in the dual drive units is to be of the “high slip” design type.

5. High-Slip Motors are required by specification where the use of dual drive units is used. These motors shall be copper-wound NEMA Design "D", Class "H" Insulation at 1.0 Service Factor with Class "F" temperature limits. Inverter Duty Motors shall be used at "VFD" controlled applications. These motors shall be copper-wound NEMA Design "B", Class "H" Insulation at 1.0 Standard Service Factor with Class "F" temperature limits. All motors shall be of the "high efficiency - low energy" type.

6. For ease of drive synchronization, variable frequency controllers are acceptable.

7. The device drive and idler shaft sprockets must be restrained through the use of double setscrews to prevent any lateral movement of the sprockets on the respective shafts. Setscrews alone are not sufficient.

8. Drives shall be designed for operation from a 480 VAC, 3-phase, 60 Hz power source. The drive shall be sized to permit start-up under full load conditions.

9. One 120 VAC, single-phase, 60 Hz duplex outlet shall be provided as a maintenance outlet in the general vicinity of each drive assembly.

10. The baggage system control circuitry must be designed to assure that the claim device is running at full speed prior the start up of any feed conveyors.

11. Install in close proximity to one of the drive units a control station with a Maint/Auto switch and a jog pushbutton for use by maintenance personnel only. When the switch is in the maintenance position, the device can move (jog) in the forward direction only when the jog pushbutton is held in.

F. Pallet/Flight Assemblies

1. Each flight assembly shall consist of a steel support assembly with upper support wheel, a flight (cover pan) and a segmented, molded rubber bumper at the lower end. Each module shall be connected at its lower end to a continuous device linkage, which incorporates the lower support wheels. Upper and lower support wheels shall have polyurethane treads for quiet operation of the device. Flights shall be 14-gauge stainless steel with Teflon tape rub strip applied to the underside of each flight at the trailing edge to prevent scratching or scoring of pallets.

G. Frame and Track

1. The frame shall consist of standard modular assemblies bolted together to form a support structure and guide for the flight assemblies. The track shall be of rolled or formed structural steel. Structural supports for the tracks are to be spaced on a maximum of 4' centers.

2. Once the structure of the device has been installed and properly aligned, all track joints and cam follower guide rail joints shall be welded and ground smooth to assure that the related track and guide surfaces are smooth and without vertical and horizontal differences.

3. The design of the incline pallet device shall incorporate a means of expansion of the device to offset any wear in the main link bushings/connecting link pins or similar components.

4. The design of the means of device expansion shall include, at a minimum, the following items:

   a. Overlapping design of the cam follower guide track so that the cam follower surface is always in contact with some portion of the guide track at the expansion joint.

   b. Heavy-duty jacking-bolt arrangement to assist in expanding the device when needed.

   c. Special attention is to be given to the design, manufacture and installation of the inner and outer perimeter finger guards as well as the vertical front face skirting at the expansion point.

   d. The design, manufacture and installation of the special expansion joint perimeter finger guards must assure that they do not create a snag point.

e. To further reduce the potential of snagging baggage at these expansion joints, the special finger guards are to be welded and ground smooth on the upstream end of each of the special guards.

H. Finish and Trim

1. Baggage Claim Applications

a. All steel trim elements of the incline pallet device that are located in the public area of a terminal shall be 304 stainless steel with a #4 brush finish. Stainless steel shall incorporate smooth flush edge seams. Radius type edges are not acceptable. All stainless steel trim elements must be properly aligned both vertically and horizontally. Butt joints of adjacent stainless steel trim elements must provide a smooth surface. Sharp edges on any of the stainless steel trim elements as well as voids between adjacent element joints are not acceptable. In addition, all radii of trim elements must match.

b. Finger Guards

1.) A finger guard consisting of 6", minimum 12-gauge stainless steel formed angle stock side rails shall be installed. The gap between the pallets and the finger guard shall not exceed 3/32". The vertical and horizontal alignment of the adjacent butt joints of the finger guards must not be misaligned nor is there to be any gap between the adjacent guards.

2.) Special attention is to be given to the design, manufacture and installation of the stainless steel inner and outer perimeter finger guards as well as the vertical front face skirting at the expansion point of the incline pallet device.

3.) The design, manufacture and installation of the perimeter finger guards at the device expansion points must assure that they do not create a snag point. To further reduce the potential of snagging baggage at these expansion joint locations, the finger guards are to be designed and installed in an overlapping manner. The overlapping finger guards are to be welded and ground smooth on the upstream end of each expansion joint location.

c. Side Guards:

1.) An inner perimeter side guard shall be provided in the public area with stainless steel deck trim. The stainless steel trim for the interior decking of the device shall consist of a formed angle trim element 1" x 7-1/2" 12 gauge stainless steel. The formed angle trim shall effectively act as a vertical skirting for the elevation difference between the pallets and the raised decking. The 1" portion of the angle will provide a cap for the carpet (carpet is to be provided and installed by others) while the 7-1/2" portion of the angle will provide the vertical skirting.

d. Decking

1.) The BHS Contractor shall provide each incline pallet claim device with a 3/4" FR-S rated fire resistant "tongue and groove" plywood decking supported by a framework of FR-S rated fire resistant structural lumber, or steel, designed for a dynamic load of 75 pounds per square foot. All plywood joints are to be fully supported by the deck support framework/structure.

2.) Unless the drive is mounted outside the public area, a hinged access door(s) (with appropriate stainless steel trim as coordinated with the Architect) shall be provided in the decking in close proximity to the drive assembly. Additional access doors shall be provided as coordinated with the DAA and Architect over and above the access doors that are required at the drive locations to accommodate access under the decking for maintenance purposes. The access door(s) shall be of sufficient size to permit removal of the drive assembly components and allow for routine maintenance of the assembly. The access door(s) shall be equipped with flush mounted grab handles.

3.) Install a maintenance light in the general vicinity of each drive assembly in all applications where decking is provided as part of the installation. The maintenance light on/off switch should be installed under the decking adjacent to the access hatch. The BHS contractor is to coordinate the installation of the maintenance lighting with the DAA or his representative.

4.) The top of the deck is to be carpeted. Carpeting of the deck is not in the scope of the BHS Contractors installation. The BHS Contractor is to coordinate the installation of the stainless steel finishes with the deck carpet installation to provide a uniform finish.

e. Cove Molding

1.) A minimum 4-3/4" toe space shall be provided at the base of the front peripheral skirting. Black vinyl cove molding shall be installed by the BHS Contractor at the back of the toe space and must be flush with the finished floor of the baggage claim area.

f. Transition Plate

1.) A transition plate shall be designed and installed at the discharge end of each in-feeding conveyor and provided with angled sides as illustrated in the accompanying drawing package for a smooth snag-free transfer of baggage onto the device. Special care must be taken in the design and installation to ensure that re-circulating baggage on the device shall not be damaged or snagged by the plates. The discharge end of the plate should be extended and aligned with the inner perimeter back guard, which shall be installed past the outside edges of the slope pallets. In public claim areas, the plates must be of the same stainless steel type and finish as other trim elements.

g. All conveyor finishes and designs must be coordinated with the DAA or his representative and the Project Architect.

2.06 FLAT PLATE MAKE-UP SORTATION DEVICES

A. General

1. Flat plate devices shall be constructed of articulating, heavy duty, metal crescent-shaped pallets forming a continuous rotating flat surface.

B. Dimensions

1. The usable pallet width for flat plate devices shall be between 32" and 35" (pallet width will be dependent on the flat plate manufacture selected).

a. The height of flat plate devices shall be as follows unless otherwise specified or shown on the Contract Drawings:

1.) Make-up devices: 29"

C. Load Rating

1. All flat plate devices shall be capable of supporting a minimum dynamic load of 85 lb. per linear foot and a single concentrated static load of 200 pounds.

D. Operating Speeds

1. Device operating speeds for flat plate devices shall be 90 fpm.

2. Flat plate devices shall be capable of accepting a baggage input of thirty – (30) bags per minute.

E. Drives

1. The drive shall consist of a heavy-duty roller chain driven by a motor through a gear reducer. The motors and speed reducer assembly shall be connected using double grooved sheaves and matched V-belts. Drives shall be designed such that the speed reducer drives an endless chain equipped with a minimum of twelve heat treated dogs which shall engage drive pins in the main chain. The chain must engage at least two carrier assemblies at all times. The drive chain must be self-aligning and supported throughout its length.

2. Drives shall be provided with an appropriately sized soft-start controller.

3. The design of the drive circuitry shall be such that the drive motor safety disconnect switch will also open the control circuitry of the device whenever the disconnect switch is turned off. Whenever the disconnect switch

is turned back on, it shall be required to reactivate the appropriate device start controls, thus allowing the drive motor start-up to be controlled by the soft start controller.

4. A minimum of two drive units, are required for all baggage claim/make up applications due to redundancy requirements. The device shall be designed and configured such that if one of the drive units should fail, the device shall continue to operate at 100% capacity including the ability to start-up under full load conditions with the remaining drive unit. Easy access and means for disconnecting failed drive unit shall be provided to allow for system maintenance with a minimum of time and effort. Drive design and motor applications must provide for the potential of variations in “actual” motor speeds so that the drive motors are equally loaded. The motor used in the dual drive units is to be of the “high slip” design type.

5. High-Slip Motors are required by specification where the use of dual drive units is used. These motors shall be copper-wound NEMA Design "D", Class "H" Insulation at 1.0 Service Factor with Class "F" temperature limits. Inverter Duty Motors shall be used at "VFD" controlled applications. These motors shall be copper-wound NEMA Design "B", Class "H" Insulation at 1.0 Standard Service Factor with Class "F" temperature limits. All motors shall be of the "high efficiency - low energy" type.

6. For ease of drive synchronization, variable frequency controllers are acceptable.

7. The device drive and idler shaft sprockets must be restrained through the use of double setscrews to prevent any lateral movement of the sprockets on the respective shafts. Setscrews alone are not sufficient.

8. Drives shall be designed for operation from a 480 VAC, 3-phase, 60 Hz power source. The drive shall be sized to permit start-up under full load conditions.

9. One 120 VAC, single-phase, 60 Hz duplex outlet shall be provided as a maintenance outlet in the general vicinity of each drive assembly.

10. The BHS control circuitry must be designed to ensure that the flat plate device is running at full speed prior to the start-up of any feed conveyors.

11. Install in close proximity to one of the drive units a control station with a Maint/Auto switch and a jog pushbutton for use by maintenance personnel only. When the switch is in the maintenance position, the device can move (jog) in the forward direction only when the jog pushbutton is held in.

F. Pallet/Flight Assemblies

1. All pallets consisting of 5/16" thick steel plates shall be provided. These steel plates must have a black urethane coating.

2. Gaps between adjacent pallets of the device shall not exceed 1/8".

3. Elevation differences between adjacent pallets shall not exceed 1/16".

4. All exposed mounting screws shall be counter sunk.

G. Frame and Pallet Support System

1. A support system and guide for the chain and pallets constructed of standard modular assemblies bolted together shall be provided. The track space must be fabricated from rolled or formed structural steel and shall form an integral part of the support structure. The structural supports for the tracks shall be spaced at a maximum of 5' on center. Pallets must be supported by a minimum of two rows of polyurethane tired ball bearing wheels. Leveling screws located at the base of each frame module shall allow for easy adjustment of the assembly. Leveling screws should provide a minimum elevation adjustment of 1".

2. Once the structure of the device has been installed and properly aligned, all track joints and cam follower guide rail joints shall be welded and ground smooth to assure that the related track and guide surfaces are smooth and without vertical and horizontal differences.

3. The design of the sort/claim flat plate device shall incorporate a means of expansion of the device to offset any wear in the main link bushings/connecting link pins. At a minimum, this shall include the following

provisions:

a. Overlapping design of the cam follower guide track so that the cam follower surface is always in contact with some portion of the guide track at the expansion joint.

b. Heavy duty jacking bolt arrangement to assist in expanding the device when needed.

H. Finish and Trim

1. Baggage Make-Up Applications

a. All steel trim elements of flat pallet devices that are located in the make-up area shall be painted. As an alternative, a powder coat finish may be applied electrostatically to said surfaces. All painted steel trim elements must be properly aligned both vertically and horizontally. Butt joints of adjacent painted steel trim elements must provide a smooth surface. Sharp edges on any of the painted steel trim elements as well as voids between adjacent element joints are not acceptable. In addition, all radii of trim elements must match.

b. Finger Guards

1.) A finger guard consisting of 6 inch, minimum 12-gauge formed channel or angle side rails shall be installed. The gap between the pallets and the finger guard shall not exceed 3/32". The vertical and horizontal alignment of the adjacent butt joints of the finger guards must not be misaligned nor is there to be any gap between the adjacent guards.

2.) Special attention is to be given to the design, manufacture and installation of the inner and outer perimeter finger guards as well as the vertical front face skirting at the expansion point of the flat pallet device.

3.) The design, manufacture and installation of the perimeter finger guards at the device expansion points must assure that they do not create a snag point. To further reduce the potential of snagging baggage at these expansion joint locations, the finger guards are to be designed and installed in an overlapping manner. The overlapping finger guards are to be welded and ground smooth on the upstream end of each expansion joint location.

c. Side Guards

1.) Inner perimeter side guards shall be provided for the entire inner perimeter of flat pallet devices used for baggage make-up applications to prevent baggage from falling into the center of the device.

2.) Vertical side guards used as inner perimeter side guards shall be constructed of minimum 12-gauge steel. The inner perimeter side guards are to be 21" high with vertical stiffening bracing constructed of a minimum angle size of 1-1/4" x 1-1/4" x 3/16". The vertical stiffening bracing is to be located on a maximum center spacing of 2' - 6".

3.) Design and installation of the inner perimeter side guards must not restrict maintenance access to the flat pallet device or any other conveyor equipment.

4.) Any openings that are required in the inner perimeter side guards for photocells or their related reflectors are to be a maximum diameter of 1-1/2". These openings are to be punched with a dimple away from the flow of baggage to minimize the possibility of snags.

5.) Where the tip chute feeds onto the flat plate device, provide sufficient outer perimeter side guarding (nominally 6" high by 4' long, flared at the charge end (to prevent bag jams)) so that baggage does not fall off the device when they exit the discharge end of the tip chute.

d. Other Control Functions

1.) Ensure control logic is programmed so that any bag feeding onto the tip chute shall not discharge on top of a bag already on the flat plate unit.

2.07 EXPLOSIVE DETECTION SYSTEM – Reveal CT-80DR

A. TSA Equipment Responsibility

1. The EDS equipment will be supplied and installed by the TSA.

B. BHS Contractor Responsibility

1. Coordinate with the EDS device provider for all the required interface details between the BHS and EDS in order to successfully accomplish the intended operation described herein. The BHS Contractor shall in all cases be responsible for any wiring/conduits between the BHS and EDS systems that are required for these interfaces (hard-wired I/O, data interface cabling).

2. Coordinate the placement of the EDS equipment, in its final location, with the EDS supplier and ensure proper alignment/positioning with the respective conveyor line.

3. Assume responsibility for the EDS integration with the BHS.

4. Assume responsibility for the site acceptance testing of the integrated system, which shall be performed between the TSA's EDS provider and the BHS Contractor.

5. Provide CT-80DR platform to elevate the EDS device to the proper elevation to interface with the entrance and exit belts of the CBIS.

C. General

1. The following information is for reference only. Contact the EDS device provider to request the necessary documents that would be required for coordination, interface, and installation purposes; documents such as but not limited to: Technical Specifications, Installation Guidelines/Manual, BHS Integration Guide, BHS Interface Manual, and EDS testing guidelines.

2. Input/Output Conveyor Speed

   a. The Reveal CT-80DR is capable of achieving maximum throughput when the input speed is 100 feet per minute.

   b. The exit speed of bags from the CT-80DR can be as great as 100 feet per minute. This speed does not need to be matched, but a rough top belt is required to control and prevent bags from tumbling and sliding.

3. Removable/Flared Side Guards

   a. The side guards of the conveyor system before and after the CT-80 should be easily removable, to allow maintenance access and removal of the CT-80 infeed, transit, and exit conveyors.

4. PE Signal and PE location

   a. The PE (photoeye) signals from the end of the external infeed conveyor and the end of the external exit conveyor must be wired directly to the CT-80 PLC. The location of the PE at the end of these belts is critical. It is recommended that an adjustment be provided to vary the position of these PE's in order to optimize the system commissioning. A position of 18in/450 mm from the end of each belt is a good starting point, but this shall vary according to acceleration and deceleration parameters and response times.

5. Insert/Remove Station

   a. The orientation and alignment of test bag for daily calibration is critical. The CT-80 provides a special "Insert Mode" to allow this function. To utilize this function, the BHS contractor must provide an externally mounted key switch and re-start button must be mounted and wired back to the CT-80.

6. Minimum Bag Spacing

   a. A minimum bag spacing of 8 inches is required to overcome PEC de-bounce times and to allow bag acceleration and deceleration control.

7. Over-length Bags

   a. The Reveal CT-80 can accept bags up to 47 inches in length in standard pipelined mode. The BHS contractor should provide suitable upstream sensing and removal of over-length bags exceeding this dimension.

   b. The Reveal CT-80 can accept bags up to 25 inches in height in standard pipelined mode. The BHS contractor should provide suitable upstream sensing and removal of over-height bags exceeding this dimension.

   c. The Reveal CT-80 can accept bags up to 24 inches in width in standard pipelined mode. The BHS contractor should provide suitable upstream sensing and removal of over-width bags exceeding this dimension.

8. Baggage Holding Mode For Operator Inspection

   a. The Reveal CT-80 can be operated in two modes.

      1.) Hold Outside – Method to be used for Duluth screening

      2.) Hold Inside

   b. Hold outside mode:

      1.) The operator reviews images and other data at the console to render final decision, while the bag being reviewed is traveling along the conveyor to the decision point.

   c. Hold inside mode:

      1.) Alarmed bags are held inside the scanner while the Level 2 TSA OSR operator provides a Level 2 screening decision from the RRS viewing station.

9. Bag Presentation

   a. Bag presentation immediately upstream of the CT-80 device is critical to successful bag scanning. Therefore the BHS contractor shall be required to provide a means of centering/positioning bags prior to entrance into the CT-80 device.

   b. The method by which the centering of the bag shall be accomplished shall be clearly illustrated/identified in the design. The BHS contractor shall be required to submit for review any "non standard" equipment designs as outlined in Part I of this project specification.

10. Description of Integrated Mode

   a. The BHS transports a bag to the queuing conveyor at the entrance to the CT-80 and sets the Queue Bag Waiting signal to TRUE. The CT-80, when finished scanning previous bags and no longer has a bag in tunnel, sets the Ready For Bag signal to True. When both of these signals are TRUE, the CT-80 begins moving its main conveyor to take in the bag, and the BHS sends the bag into the tunnel. When the bag blocks the CT-80 input photocell, the CT-80 sets the Ready For Bag signal to False, and applies the last received bag ID to the bag. In the absence of an airport bag ID, the CT-80 generates a unique 14-digit bag ID based on serial number and a bag counter. The CT-80 scans the bag and, if necessary, takes CT slices and then renders either a CLEAR or REJECT decision. The CT-80 then sends its decision along with the bag ID to the BHS through a serial port. When the bag has finished scanning, the CT-80 sets the Ready for Exit signal to True, and sets either the Clear or Reject signal to TRUE, depending on the status of the bag.

   b. Depending on the configuration, the CT-80 then transports the bag to the BHS, or keeps it in the tunnel or on the outfeed conveyor while waiting for the BVS decision.

      1.) In "Wait for BVS Decision" configuration, the CT-80 keeps the bag in the tunnel, or on the outfeed conveyor, until a screener makes a decision on whether the bag is clear or suspect. When the CT-80 receives a decision, it transports the bag onto the BHS.

c. Regardless of the status of the BHS, the CT-80 is ready to load the next bag in the queue if there are no bags being held in the tunnel. When transporting the bag to the BHS, the BHS must first set the Exit Queue Conveyor Ready signal to True. If the Exit Queue Conveyor Ready signal is True, and the Ready for Exit signal is True, the CT-80 will send the bag out of the tunnel.

11. Interface Signals

a. The CT-80 supports signals for interfacing with BHS to facilitate airport integration. By integrating the Reveal System, the BHS automates the inspection process, thereby maximizing baggage throughput and improving baggage tracking techniques. To facilitate the cabling, the CT-80 provides one standard 44-pin, high density D-SUB connector on the machine's external panel for connecting to all interface signals not communicated through the RS232 serial Decision Port. Separate Ethernet connectors are also provided on the machine's external panel. The CT-80 interfaces with the BHS using interface signals, passed through the 44-pin connector (see attachment A, Reveal CT-80 EDS Integration Document). The BHS can make use of some, none, or all of these signals. All Relay outputs are Form A Normally Open (NO) Dry Contacts capable of switching up to 200 mA at up to 24 VDC, with the exception of the E-stop relay (see below). Each relayed signal is considered to be in the logical TRUE state when the relay contact is closed and in the logical FALSE state when the relay is open. The CT-80 updates its signals constantly, so each signal provided to the BHS reflects the state of the machine at the time it is sampled.

b. The E-stop signal is an indication of the mode of operation of the CT-80 specifically. As an option, the E-stop output relay is configurable to have either normally open or normally closed contacts.

c. Each input signal is an optically-isolated digital input. Less than 2 VDC switches the input to OFF state. These signals are considered to be in the logical TRUE state when the voltage applied is between 6 VDC and 24 VDC. These signals are considered to be in the logical FALSE state when the voltage applied is between 0 VDC and 2 VDC.

d. The Decision Port is a 3-wire RS232 serial port with send, receive, and ground wires, located on the interface panel of the CT-80. It operates at 9600 Baud in No parity bit, 8 data bits and 1 stop bit serial communication mode. It is designed to accept barcode input from the BHS (when the CT-80 is in Auto Mode), as well as send decisions to the BHS.

e. The ESTOP INPUT signal ties directly to CT-80 scanner's internal emergency stop loop operating at 200 mA and 24 VDC. It is recommended that the BHS use a normally open local dry relay contact as this input signal. When this relay contact is open, the e-stop condition is TRUE. In the absence of an input from the BHS, this signal can be internally bypassed to appear as normally closed.

2.08 MISCELLANEOUS MECHANICAL EQUIPMENT

A. Platforms and Walkways

1. Provide as a minimum, the maintenance and TSA access platforms as located on the Contract Drawings or as required to ensure safe access for all personnel who operate, maintain or have access to the BHS. The BHS Contractor shall be responsible to coordinate with the Architect, the DAA or his representative to confirm the final number and locations for all maintenance platforms, crossovers and walkways.

2. Design, provide and install all maintenance platforms and access ladders required to allow easy access to all CBRA screening stations by TSA agents who are responsible to both test the EDS devices and clear bag jams within the devices during the normal operational period. Submit to the DAA the design of the platform and access ladders for review and approval.

3. Include personnel protection at all platforms and walkways to ensure that any potential injury is minimized. This includes swing gates or off-sets at access locations per OSHA standards 1910.23, padding, rounded corners, smooth welds, deburred surfaces and any other measures as may be necessary.

4. Attach all platforms and walkways to the support structure, whether using decking of either sheet steel using

stitch welds every 24" or use open steel grating (Ry-Weld 19W4 or approved equal), or as dictated by OSHA standards. The BHS Contractor shall coordinate the type of platform deck (solid or open grate) with the DAA or his representative and the Project Architect to ensure fire code/protection measures and lighting considerations are complied with.

5. Design platforms and walkways to provide adequate space for operating and maintenance personnel.

6. Design structure to limit the deflection to 1/360 of the unsupported span length, under a concentrated 250-pound load.

7. Design all platforms and walkways capable of supporting a dynamic load of 65 pounds per square foot. The use of pan type walkways and platforms constructed of #12 gauge hot rolled steel is acceptable.

8. Notch the decking where needed to clear obstructions. Add angle clips as required to maintain adequate support of notched structure.

9. Where lengths of decking are butted end to end, ensure that the joint falls on a structural cross member.

10. Securely weld all pieces of decking to the platform frame and all structural cross members.

11. Any walkways with inclines of up to 8° will be equipped with an anti-skid walking surface. Walkways with inclines of more than 8° will be equipped with steps as well as the anti-skid material.

12. Provide steps at all locations where there is an elevation change in excess of 8". Paint the step “yellow”.

13. Minimum catwalk width shall be nominally 36" with a 3" gap between the conveyor and the catwalk.

14. Unless otherwise noted on the drawings, the top of platform shall be installed 8” below the top of belt at the intermediate section of the conveyor (between drive sections) and 15” below the top of belt at the drive sections.

15. Design and installation of access into the conveyor platform areas shall not be less than a 36” wide by 44”high, clear access envelope, to allow fire fighters with breathing apparatus enough room to climb up to and access the platform area.

B. Toeboards

1. Provide toeboards on both sides of all platforms, walkways and ramps 24" or more above the finished floor except where adjacent equipment or building structure provides the required function. Construct toeboards of 1/4" x 4" minimum steel flat stock and install so as to leave no gap between the access way walking surface and the lower edge of the toeboard. It is acceptable to use # 12 gauge rolled steel 4” high toeboard. Securely weld toeboards to vertical handrail posts and to the access way support structure.

2. Design toeboards in accordance with OSHA standards.

C. Access Stairs

1. Provide as a minimum the stairs as located on the Contract Drawings or as required to ensure safe access for all personnel who operate, maintain or have access to the BHS. Coordinate with the Architect, the DAA or his representative to confirm the final number and locations for all stairs/ladders.

2. Design stairs to the following specifications or per local code if more stringent:

a. Treads:

1.) Minimum of 10" deep

2.) Non-skid upper surface

3.) Extend front edge of tread over rear edge of lower tread a maximum of 1-1/4".

b. Risers:

1.) 8" (maximum)

2.) Equal in height in any one flight within 1/8"

c. Angle between stringer and horizontal - 38° (maximum)

d. Provide platforms as required so that intermediate flights do not exceed 15 steps.

e. Provide protective measures (i.e. swing gate or offset) at the top of stairs.

3. Design stairs in accordance with OSHA standards, section 1910.24 and 1910.23.

4. Provide stairs with handrails from top to bottom in accordance with OSHA sections 1926.500 and 1926.501.

5. Handrails shall be painted “yellow”.

D. Handrails

1. Provide handrails around all platforms more than 24" above the adjacent floor and on all stairways. Design handrails to withstand a minimum load of 200 lbs. applied in any direction at any point on the top rail. Vertical support posts shall be spaced not more than 8' on centers. Make handrails continuous.

2. Design all handrails to consist of a top rail with one intermediate rail positioned halfway between the top of the walking surface and the top of the top rail as per OSHA code of Federal Regulation Part 1926.500

3. In areas of restricted clearance (vertically or horizontally), make intermediate rails spanning across conveyor drive locations removable for drive maintenance access.

4. Close all open handrail ends, vertical or horizontal, by welding a metal cap.

5. Grind smooth all handrail welds.

6. Handrails shall be painted “yellow”.

E. Maintenance Ladder

1. Vertical Fixed Maintenance Ladders

a. Provide fixed, 90-degree ladders to reach platforms and catwalks as shown on the Contract Drawings. Provide additional maintenance ladders as required to ensure safe access for all personnel who operate, maintain or have access to the BHS. The BHS Contractor shall coordinate with the Architect, the DAA or his representative to confirm the final number and locations for all maintenance access ladders.

b. Design ladders to meet or exceed OSHA standards, section 1910.27 and 1910.23.

c. All fixed ladders shall be of steel construction as specified elsewhere in this document.

d. The distance between rungs shall be no more than 12 in. and shall be uniform throughout the height of the ladder. All rungs shall have a minimum diameter of 3/4 in. and shall withstand a 400-pound load when in use. All rungs shall be a minimum of 16/24 in. wide. The live loads imposed by personnel occupying the ladder shall be considered to be concentrated at such points as shall cause the maximum stress in the structural member being considered.

e. Grind smooth all rough surfaces and edges.

f. Side rails shall be of such cross section as to afford adequate gripping surface without sharp edges or burrs.

g. Allow a minimum of 4 in. between the back of the ladder and the nearest permanent object. Allow a minimum of 30 in. between the front of the ladder and the nearest permanent object. Allow 16 in. from the center of the ladder to the nearest object on each side. The step-across distance from the nearest ladder edge to the nearest equipment or structure edge shall be a minimum of 2-1/2 in. and shall not exceed 12 in.

h. Provide both a safety cage and self closing safety gate at the top of all ladders.

i. Provide fixed vertical ladders with handrails from top to bottom in accordance with OSHA section 1926.500 and 1926.501.

j. Paint all fixed vertical ladders in “yellow”.

F. Fire Door (Powered)

1. Assume the responsibility for the procurement, power and control design, mechanical and electrical installation of rolling shutter, slat-type, between-jamb-mounted and interior-face-mounted fire doors, including, as a minimum, the following features:

a. U.L. labeled hour rating to match fire partition walls where door is installed. For example, at 2-hour rated walls provide minimum UL labeled 2 hour rated doors. Obtain the proper fire rating from the DAA or Architect for all fire doors within the scope of the BHS Contract.

b. Electric Operator with 480 VAC, 3 phase, 60-hertz motor provided by the door manufacturer.

c. Up and Down limit or proximity switches connected to PLC input.

d. Electrical or pneumatic bottom edge strip for automatic return to open position upon contact. A photocell or proximity switch shall be used in conjunction with the bottom edge strip for detecting a bag under the door.

e. Fire/heat/smoke detectors located to sense approaching fire, heat or smoke source on the conveyor shall be provided by others as per the specified requirements of their Fire Alarm System Specification.

f. One set of normally open dry contacts for each fire door shall be provided, mounted and wired, inside the MCP controlling the conveyor line that the fire door(s) is mounted on. Coordinate the spatial and access requirements within the MCP for these contacts with the Fire Alarm System Contractor. Connect each normally open dry contact to the appropriate PLC I/O module. The contact shall close upon detection of a fire, heat or smoke condition requiring the closure of the fire door.

g. A 160°F fusible link which, when broken, will cause the door to close automatically and report to the central facility security/fire system the status of the door (e.g., open or closed). All wiring between the BHS MCP and the facility central security/fire alarm system for this reporting function shall be provided by others as per the specified requirements of their Fire Alarm System Specification. Provide the appropriate interface within the MCP/PLC to accommodate this reporting controls function and coordinate the interface requirements with the Fire Alarm System and Security System Contractors.

h. A means for manual operation. If operation is accessible from one side only, select the side offering the most danger should the door close and block a potential exit.

i. The door is to be equipped with an externally mounted limit or proximity switch. The limit or proximity switch shall be mounted in such a manner so that the "fully open" position of the door is sensed. If the door is sensed by the limit or proximity switch not be in the fully open position, the associated conveyor shall be stopped if running or shall not be permitted to start if the conveyor was not already running. Note that this limit or proximity switch is in addition to those limit switches provided with the door operator if the door is powered.

j. Provide all steel trim elements around door opening. Coordinate the trim requirements with the DAA and Architect.

k. Coordinate installation and framing of the fire door(s) with the DAA, Architect and other contracts.

l. Clearly define by way of detail plans and elevations (on the submitted mechanical drawings) all of the required operational and maintenance clear zone requirements in order to avoid any obstructions with other trades involved in building construction.

m. Coordinate the testing of fire doors the DAA or his representative, the fire system installation contractor and the appropriate authorities.

n. All fire doors that are directly associated with BHS shall be installed perpendicular to the conveyor centerline. Coordinate installation and framing of the fire door(s) with other contracts.

o. The design of the fire door control system is described in the BHS “Special Control Requirements” section of this specification (Part 3).

G. Security Door (Powered)

1. The mechanical and electrical installation, power and control of rolling shutter, slat-type, between-jamb-mounted and interior-face-mounted security doors, shall include as a minimum, the following features:

a. Electric Operator with 480 VAC, 3 phase, 60-hertz motor provided by the door manufacturer.

b. Electrical or pneumatic bottom edge strip for automatic return to open position upon contact. A photocell or proximity switch shall be used in conjunction with the bottom edge strip for detecting a bag under the door.

c. The door is to be equipped with an externally mounted limit switch, photocell or proximity switch to sense door position connected to PLC input. The limit, photocell or proximity switch must be mounted in such a manner so that the "fully open" position of the door is sensed. If the door is sensed, by the limit switch, photocell or proximity switch not be in the fully open position, the associated conveyor shall be stopped if running or shall not be permitted to start if the conveyor was not already running. Note that this limit switch, photocell or proximity switch is in addition to those limit switches provided with the door operator if the door is powered.

d. The BHS Contractor shall provide all stainless steel trim elements (around door opening etc.) for those security doors located in public view. The BHS Contractor shall coordinate the trim element requirements with the Architect, the DAA or his representative.

e. All security doors that are directly associated with the BHS shall be installed perpendicular to the conveyor centerline. The BHS Contractor shall coordinate installation of the security door(s) with other contracts.

f. The design of the security door control system is described in the BHS “System Control Requirements” section of this specification (Part 3).

H. Directional Input Device (DID)

1. Bag presentation immediately upstream of the CT-80DR device is critical to both successful bag scanning and in the reduction of jams at the EDS device entrance conveyor, to achieve this provide Directional Input Devices (DIDs). The DID shall position baggage such that there is less than 0.1% bag jams at the EDS device(s) entrance conveyor verses the number of total originating bags inducted into the system (e.g. total of number of jams shall not exceed 20 (combined for all EDS devices installed) per 20,000 originating bags).

2. The function of the DID is to position or rotate baggage (to present the bag in the correct orientation) into the center of the conveyor prior to the entrance of the EDS device. The typical location of the DID is illustrated in the Contract Drawings.

3. Special care must be taken in the DID design and installation to ensure baggage on the device shall not be damaged or snagged. Note that the design, manufacture and installation of the DID must be such to ensure that the device is heavy-duty and shall withstand the abusive environment of a high volume baggage operation.

4. Submit the method by which the centering of the bag will be accomplished to the DAA or his representative for review and approval prior to fabrication.

5. Submit for review any “non standard” equipment designs as outlined in Part I of this project specification.

I. Non Powered Portable Gravity Roller Bed Conveyor

1. The following locations will require gravity roller conveyors to be installed by the BHS Contractor:

a. Provide a hinged gravity roller section as illustrated in the Contract Documents to assist in the transportation of oversize bags from the oversize bag removal belt onto the oversize screening table. Also provide a section of non-hinged gravity roller conveyor to aid in the transfer of the oversize bags from the screening table to the oversize chute.

2. Construct the gravity roller bed sections using 3-1/2" inch steel channel. Cross bracing shall be 1-1/2" angle stiffeners welded to the underside of the bed at a maximum center distance of 2' - 3'.

3. Provide 1.9" diameter spring loaded return idler rollers equipped with hex shafts to be located on 2" centers. Idler rollers shall be equipped with sealed, permanently lubricated, caged, semi precision type ball bearings.

J. Draft Curtains

1. Provide draft curtains at all wall and floor penetrations between conditioned and non-conditioned space.

2. Construct the draft curtains with two staggered layers of black 8" wide by 1/8" thick vinyl strips with anti-static beaded belting.

3. Provide stainless steel fascia in public areas.

K. Conveyor Impact Protection

1. Provide impact protection as located and detailed on the drawings or elsewhere as required to adequately protect conveyors, make-up devices etc. Construct the impact protection and supports of structural steel, heavy walled sections in shapes as indicated. Securely fasten all impact protection components to each other and to the floor.

2. Field verify, all dimensions shown on the drawings to insure proper fit with the equipment system interface.

3. Ensure that the impact protection is able to withstand the impact of a fully loaded vehicle (tug and cart) when backing into position at a speed of 2 miles per hour.

4. Apply primer and then one coat of "yellow" paint to all impact protection steel members that are not exposed to the weather (e.g. within the bag room).

5. Hot-dip galvanize all impact protection steel members that are exposed to the weather.

6. Design impact protection so that maintenance access to the protected equipment is not restricted.

L. Bollard

1. Provide individual bollard-type impact protection where required. Construct bollards from steel pipe, concrete filled with crowned cap. The minimum diameter for the bollard is 8".

2. Bollards that are exposed to the weather shall be hot-dip galvanized.

3. Apply primer and then one coat of "yellow" paint to all bollards that are not exposed to the weather (e.g. within the bag room).

M. High Speed Diverter (HSD)

1. The function of the high-speed diverter is to selectively transfer baggage across the main sort conveyors onto the designated sortation device using either a transverse or linear motion.

2. Each high-speed diverter shall be capable of sorting baggage at a sustained rate of 60 items per minute.

3. The high-speed diverter must be capable of sorting all types of normal baggage, including but not limited to golf bags, etc. by imparting a smooth controlled impact on baggage, ensuring that damage does not occur to the items from impact, jamming, snagging or falling to the floor.

4. The design, manufacture, and installation of the high-speed diverter must conform to all sections of this specification as appropriate. Note that the design, manufacture and installation of the high-speed diverter must be such to ensure that the device is heavy duty and shall withstand the abusive environment of a high

volume BHS operation.

5. The high-speed diverter must be designed and installed so that the high-speed diverter powered faced paddle(s) always returns to the exact same home position, with no variation in the home position. Additionally, the return of the HSD paddle to the home position must not influence the bag travel on the adjacent downstream conveyor, where it may cause bags to mis-track; for example, in the case of high-speed diversion of bags from the main line onto a 45° merge input belt, the HSD must not affect the bag travel after the bag has been diverted and the paddle(s) returns to home position.

6. Design the high-speed diverter so that trained maintenance personnel can easily replace the powered faced paddle belts.

7. Design the high-speed conveyor and the take away conveyor such that there is a 3" drop from the HSD conveyor to the take away conveyor. The transition plate shall be provided with rollers to aid in the bag transition to the take away conveyor.

8. Ensure sufficient sway bracing in both directions and vibration isolation on all supports.

9. Provide each HSD with one Safety Disconnect switch to control both the clutch/brake or VFD and motor. The 3 phase Motor Safety Disconnect Switch shall also be used to interrupt the feed and neutral circuit to any externally powered electric clutch/brake or VFD device. The following describes how this shall be accomplished:

   a. Provide 120 Volt AC power to the line side auxiliary contact in the Motor Safety Disconnect Switch (located at the motor) from the MCP.

   b. Wire from the load side of the auxiliary contact of the Motor Safety Disconnect Switch (located at the motor) to the terminal strip in the respective MCP.

   c. At the respective MCP, run two (2) parallel wires from the MCP terminal strip to the following:

      1.) One parallel wire from the terminal strip to the PLC input to indicate that the Motor Safety Disconnect Switch (located at the motor (is in the "ON" or "OFF" position.

      2.) The other parallel wire shall be the input voltage either for the DC power supply that will supply DC power to the associated motor clutch/brake or for supplying power to the VFD.

10. The primary line (conveyor line that the HSD is installed on) conveyor belting shall be "bare by bare" with low COF.

11. Provide adequate safety guards for each HSD, between manned areas (e.g., maintenance platforms, etc,) and the HSDs paddles. The HSD safety guards shall be easily removable and shall mount on the top of the HSD and adjacent conveyor side guards to provide a physical barrier between the manned areas and the HSD paddles. Fabricate the HSD safety guards with expanded metal, at least 12 gauge thick, and incorporate a formed 90° edge turned away from the guard face and another 90° edge turned down to eliminate sharp edges (i.e., similar to a conveyor side guard configuration).

12. The design of the HSD control system is described in the Special Requirements section of this specification (Part 3).

13. A qualified manufacturer shall fabricate high-speed diverter, with previous installations in BHS applications. Final approval of the qualified manufacturer shall be at the discretion of the DAA or his representative.

2.09 SPECIAL MECHANICAL EQUIPMENT REQUIREMENTS

A. General

1. Over-height restriction bars shall be installed on all conveyors equipped with overheight detection photocells, at the appropriate height to restrict passage of baggage exceeding the maximum bag height requirements. In all cases, the overheight bar support structure may be used for mounting of the overheight detection photocell. In public areas, the overheight restriction bar shall be installed on the non-public side of the

associated fire/security door. Also over-height bars shall be installed on conveyors SS1-03 and SS2-03 at appropriate height for the CT-80DR EDS devices.

2. Ensure that the design and installation of all conveyor equipment provides maximum access for operation and maintenance personnel.

2.10 ELECTRICAL TECHNICAL REQUIREMENTS

A. Electrical Service to be Provided by the BHS Contractor

1. Power for the various subsystems shall be provided at locations shown on the Contract Drawings by the DAA's Electrical Contractor. Each power distribution point (PDP) shall consist of cable in an appropriately sized junction box (supplied and installed by the DAA's Electrical Contractor) connected at its source to an appropriately sized circuit breaker located at the building substation panel. The drop shall terminate with approximately 20' of coiled cable. The full load ampacity rating (FLA) shall be as indicated on the contract drawings (it shall be the BHS Contractors responsibility to verify the FLA requirements and notify the DAA or his representative of any increase/decrease). Supply power shall be 480 volts, 3 phase, and 60 hertz. Verify and advise the DAA and Engineer that the ampacity at each PDP is sufficient for the requirements of the system.

2. Provide and install all mains cable required from nominated Power Distribution Points (PDP) to the various BHS Distribution Boards and onward to the MCPs as necessary to meet requirements of the specification. The BHS Contractor shall be responsible for all electrical work "downstream" of the PDP locations including the BHS distribution boards, MCP and all other cabling in between. Size feeders from the power drops at 1.25 times the minimum NEC (or applicable local code) permitted size for the full-load amperage required. The BHS Contractor shall be responsible for all power connections from the various MCPs to all other BHS equipment.

3. Provide and install all services, feeders and disconnect switches for branch circuits to each control panel, with separate circuits for each subsystem as specified and provide and install all panel boxes, wireways, conduits, conductors, transformers, breakers/fuses, and any other equipment and materials required to complete the electrical power distribution for the operation of the system. Refer to NEC Article 300 for wiring methods.

4. Careful consideration shall be made to the distribution of power to sub-systems and its load center source such that the failure of power source does not effectively stop the baggage system in an entire zone. PDP locations shown in the contract drawings show typical locations that the BHS Contractor may locate electrical field distribution panels.

5. The amperage shown for each PDP in the subcontract drawings shall be confirmed by the bidder in his bid submission. The BHS Contractor shall, during the engineering phase, provide detailed power calculations for review and approval by the DAA or his representative in an effort to reduce the PDP amperage provided and thereby reduce the power provided to the system. Coordinate the detailed power requirements including any reductions with the DAA or his representative.

6. During design of power distribution to the various BHS sub-systems, coordinate with the building electrical supplier on distribution of emergency power to required BHS subsystems to enable operation of the required BHS subsystems to support the DAA's operational policy in a power outage condition. Provide and install equipment as necessary to connect to these emergency power supplies that will be located adjacent to the various main power sources.

7. Provide separate circuits for controlling programmable logic controllers (PLCs), powered fire/security doors, etc. Note that these circuits shall originate within the respective MCP.

8. Calculate the electrical power supply requirements on the basis of total connected load with a diversity factor. Size the conductors to ensure that the voltage drop does not exceed 3% at the farthest outlet of power, heating and lighting loads, or combinations of such loads. Also ensure that the voltage drop does not exceed 5% at the farthest outlet for both feeders and branch circuits.

9. Provide 120 volt, single phase, and 60-Hertz power for operation of the BHS control circuits.

10. Obtain the control power at each MCP by means of a transformer connected to the load side of the 480 volt input power.

11. All baggage systems that use programmable controllers shall be equipped with the appropriate number and size of power regulators to ensure that the power for the respective programmable controllers is properly conditioned. Regulators are to be of the type manufactured by the Sola Corporation (or approved equivalent).

12. All electrical components, devices, accessories, and equipment shall be listed, labeled and identified as suitable for use intended by testing agency acceptable to authorities having jurisdiction. This shall include MCPs and any control panels/cabinets, whether factory or contractor fabricated.

B. Raceways

1. General

a. Enclose all power and control wiring, including low-voltage wiring, in Rigid Metal Conduit (RMC), Electrical Metallic Tubing (EMT), Liquid Tight Flexible Metal Conduit or wireways. Intermediate Metal Conduit (IMC) is not acceptable.

b. Horizontal runs of conduit shall not be supported by power turns, their safeguards, or by any side guard that is designated to be removable for the purpose of maintenance access. Rack such horizontal runs and support them from the building roof or mezzanine steel in locations not interfering with the BHS, maintenance areas, or walkway areas.

c. Install drops to motors or other devices adjacent to the nearest available equipment or building column. Mezzanine supported equipment may be electrically fed from below the mezzanine from racked conduit supported below.

d. Avoid conduit runs on the floor. Provide minimum clearance of 6" below horizontal conduit to the floor. The DAA or his representative must approve exceptions to the above.

e. RMC and EMT Conduit runs must be mounted so as not to restrict maintenance access to the BHS equipment, conveyors and system/conveyor components that required servicing.

f. Conduit runs must not be run or mounted on outside guards or perimeter chain guards of power turns.

2. Rigid Metal Conduit (RMC)

a. Conform to all aspects of NEC Article 344 for RMC (or applicable local code).

b. Use a minimum 3/4" for all wiring.

c. Run all conduits parallel or at right angles to structural members and equipment.

d. Do not run conduits underground or in floor slabs unless provided for that purpose by the Building Contractor.

e. In public areas, make conduit runs inconspicuous by running under cover plates, behind conveyors or otherwise concealed from public view.

f. In non-public areas, run exposed conduit in protected locations to prevent damage by moving vehicles, equipment or maintenance personnel.

g. Use Rigid Metal Conduit in all areas of the BHS installation that are at elevations less than 8’-0” above the buildings local finished floor and in all areas that are exposed to vehicular traffic and possible damage by operating or maintenance personnel.

h. Use malleable iron or steel threaded fittings.

i. Include gaskets and covers for all fittings.

j. Use standard threaded couplings at all conduit joints.

k. Ensure that the ends of the conduit are cut square, reamed and joined butt-tight.

l. Electro-galvanize all conduit, elbows, fittings, couplings and nipples.

m. Make changes to conduit size only at pull boxes, distribution panels, or branches to motors. Do not use reducers for in-line reduction of conduit size.

n. Do not run communication, low voltage (less than 30 volts), or DC control wires in the same conduit with power wires.

o. It is acceptable to run 120 VAC minimum control wire and 480 VAC maximum power wire in the same conduit or wireway provided it is in conformance with local codes.

p. It is acceptable to run shielded 90 VDC clutch brake control wire and 480 VAC maximum power wire in the same conduit or wireway provided it is in conformance with local codes in lieu of running these clutch brake DC control wires in a separate conduit or wireway.

q. Remote control, signaling and power limited circuits shall be installed in compliance with NEC Article 725, (or applicable local code) as applicable.

r. Support conduit at intervals not to exceed 10'-0". Every individual conduit section must be supported. Install conduit supported from building walls with a clearance of not less than 1/4" from the wall to ensure against the accumulation of dirt and moisture behind the conduit, using one-hole malleable iron clamps and clamp backs. For parallel conduit runs provide trapeze hangers or wall brackets fabricated from preformed channel with conduit clamps. Make anchors in concrete of the expansion shield type. Limit conduit run on a given conveyor to that, which is required for that particular conveyor or directly adjacent (downstream/upstream) to that particular conveyor.

s. Ensure that metallic and non-metallic motor disconnect boxes, clutch/brake safety disconnect boxes and control stations, outlet boxes, junction boxes, pull boxes and cover plates are compatible with the RMC conduit used and conform to the National Electrical Code (or applicable local code) for minimum wiring space requirements and material thickness. Provide all boxes with screw fastened covers. Use NEMA 12 enclosures for interior equipment and NEMA 4 for all exterior equipment. BHS contractor shall only use metal boxes; non-metal boxes shall not be used.

t. Appropriately sized insulated bushings and jumpers shall be installed on all conduits and conduit fittings that enter metallic or non-metallic MCP(s), workstation/computer cabinet(s), outlet boxes, disconnects, or j-box/pull box(s).

3. Electrical Metallic Tubing (EMT)

a. Apply the above requirements for Rigid Metal Conduit to EMT except as noted below:

1.) Use rain and concrete type compression fittings with steel compression nuts.

2.) Use insulated throat type connectors with case hardened nuts.

3.) Use minimum size tubing of 3/4" diameter.

4.) Use EMT only in areas at elevations greater than 8' above the buildings local finished floor or in areas not exposed to vehicular traffic or possible damage by operating and maintenance personnel.

5.) Appropriately sized insulated bushings and jumpers shall be installed on all conduits and conduit fittings that enter metallic or non-metallic MCP(s), workstation/computer cabinet(s), outlet boxes, control stations, disconnects, or j-box/pull box(s).

6.) Ensure that motor disconnect boxes, and control stations, outlet boxes, junction boxes, pull boxes and cover plates are compatible with the EMT used and conform to the National Electrical Code (or applicable local code) for minimum wiring space requirements and material thickness. Provide all boxes with screw fastened covers. Use NEMA 12 enclosures for interior equipment and NEMA 4 for all exterior equipment.

b. Conform to all aspects of the more stringent between this specification and NEC Articles 300 and 358 for EMT (or applicable local code).

4. Flexible Metal Conduit

a. Conform to all aspects of the more stringent between this specification and NEC Articles 300 and 348 (or applicable local code) for flexible metal conduit and fittings.

b. Use liquid-tight flexible metal conduit for connection to motors, photocells, limit switches or any device, which may be subject to vibrations or require adjustment after installation. The use of non-liquid-tight flexible metal conduit such as “green field” is not acceptable.

c. Do not exceed 3' in length.

d. Every section of flexible metal conduit must be clamped/supported.

e. Appropriately sized insulated bushings and jumpers shall be installed on all conduits and conduit fittings that enter metallic or non-metallic MCP(s), workstation/computer cabinet(s), outlet boxes, control stations, disconnects, or j-box/pull box(s).

f. Use minimum 1/2" for power wire.

g. Use minimum 1/2" for control wire.

5. Wireways

a. Wireways may be used in place of rigid conduit provided the application conforms to the requirements of National Electric Code Articles 376 and 378 (or applicable local code).

b. Use wireways with hinged, solid covers.

c. Position wireways to permit access with the equipment fully operational.

d. Do not run communication, low voltage (less than 30 volts), or DC control wires in the same wireway with power wires.

e. It is acceptable to run shielded 90 VDC clutch brake control wire and 480 VAC maximum power wire in the same wireway provided it is in conformance with local codes in lieu of running these clutch brake DC control wires in a separate conduit or wireway.

f. Fasten covers using captive screws.

g. Do not use wireways in areas subjected to vehicular traffic.

h. Do not use terminal strips in wireways.

i. Use lay-in type wireways to avoid the necessity of threading wires through end connectors.

C. Wire and Cable

1. General

a. Use stranded copper conductors of appropriate gauge, Type THHN or approved equal, with insulation rated for 600 volts. Use type XHHW only if required by code or the governing Airport Authority prohibits the use of PVC insulation. Conform to all aspects of the more stringent between this specification and NEC or applicable local code.

b. Connect pre-wired electrical devices to terminal blocks mounted in junction boxes adjacent to the devices.

c. Do not use blade connectors (such as but not limited to fork or ring style) for connections.

d. It is acceptable to use multi-conductor cable for connecting portable electronic equipment. Refer to National Electrical Code (or applicable local code) for requirements on multi-conductor use.

e. Tag control and power circuit conductors with "machine" printed identification numbers at both ends of the wire. Tag method shall be of the sleeve or other permanent type submitted to and approved by the DAA or his representative. The use of multiple tags to create a single tag is not acceptable.

f. Keep all wires on reels while being pulled. Do not allow wires to contact the ground or floor.

2. Minimum wire size

a. Power #12 gauge

b. Control #14 gauge

c. PLC I/O #16 gauge(Connections between I/O modules and terminal strips inside MCPs)

d. Communication Circuits #18 gauge

3. Splicing

a. Splicing of 480VAC power wiring is unacceptable. All 480VAC wire pulls shall be from the MCP to the device (e.g. from MCP to the individual motor).

b. Splices are acceptable when parallel type connections are used for "hot" and "neutral" control wires (e.g. power wire for photocells, e-stop circuits etc. within a subsystem).

c. Do not splice signal wires between I/O panel and component.

d. Terminate control wires on terminal strips or on screw connectors at each component only.

4. Spare Conductors

a. Provide a minimum of 5% spare conductors in all conduit home runs, with a minimum of two spare control wires and one spare power wire.

b. Coil all spare conductors allowing sufficient length to permit future connection.

c. Tag spare conductors as required above, i.e., each spare conductor is to be identified as a spare with its own unique wire identification number and field termination location.

5. Wiring Identification

a. Color code all electric wire and cable as follows:

1.) MCP Power Wiring: Line Side

a.) Apply the following to all MCP power wiring from source to line and load side of Main Disconnect fuses for MCPs. Verify color-coding of phase conductors on the line side to ensure compatibility with normal electrical supply available at the airport. Terminate the neutral, if applicable, at the terminal board:

Item	Wire Color
Phase A (480 VAC)	Brown
Phase B (480 VAC)	Orange
Phase C (480 VAC)	Yellow
Neutral	Grey
Mechanical Ground	Green

2.) BHS Field Components Power and Control Wiring: Load Side

a.) Apply the following to power and control wiring from the load side of fuses in MCPs to all devices that are powered and controlled from the respective MCP as follows:

Item	Wire Color
Power (To Motors and Control Transformers)	Black (with labeled ends indicating L1, L2 and L3 referring to their respective phases) and the Brown, Orange and Yellow colored wires of the 3 phases from the MCP. Or as directed by local code.
AC Control:	Red
DC Control:	Blue
AC Neutral:	White
Mech. Ground	Green

b.) Submit to the DAA or his representative for review and approval the wire color method to be employed for this project.

D. Grounding

1. Ground all electrical equipment to building ground mat by a dedicated equipment-grounding conductor installed in accordance with the applicable codes. Obtain from the appropriate airport authorities, local codes or the DAA's Electrical Contractor the extent and type of grounding, wiring method and points of connection required.

2. Appropriately sized insulated bushings shall be installed on all conduits and conduit fittings that enter and exit the MCP or j-box/pull box.

3. Include a green 600V insulated copper ground conductor in each conduit (raceway).

4. Refer to National Electrical Code Article 348 (or applicable local code) for flexible metal conduit grounding requirements.

5. Refer to National Electrical Code Article 250 (or applicable local code) to determine grounding conductor requirements and sizes.

E. Support

1. Mount conduit supported from building wall using uni-strut type mounting channels to provide clearance to the wall.

2. Do not weld conduit to structural members.

3. Avoid conduit runs to the floor. Provide minimum clearance of 6" between horizontal conduit and the floor and do not allow runs to cross any walk or access aisles.

4. Support cordsets running to items such as, but not limited to, photocells and shaft encoders with cable mounting clips only. The cordset shall not be supported/secured with plastic wire ties.

F. Boxes

1. Provide outlet boxes, junction boxes, pull boxes and cover plates compatible with the conduit used. Provide boxes with screw fastened covers. Use NEMA 4 for all exterior equipment and NEMA 12 for interior equipment.

2. Conform to NEC Article 314 (or applicable local code) for minimum requirements for outlet boxes, junction boxes, pull boxes and cover plates.

3. Appropriately sized waterproof bushings/seals shall be installed on all conduits and conduit fittings that enter/exit the box(s).

4. Unused openings in boxes, raceways, cabinets, pull boxes etc., shall be effectively closed to afford protection substantially equivalent to the wall of the equipment.

2.11 ELECTRICAL COMPONENTS

A. Wiring Devices

1. Provide full size oil-tight operators.
2. As much as possible, use the same type sensors (photocells, limit switches, etc.) to minimize the number and type of spares. Select sensors with the same mounting system wherever practical.
3. Use plug-in type electrical components wherever available. Do not use blade connectors (such as but not limited to fork or ring style).

B. Control Devices/Stations

1. Control Device Locations

a. Control Stations, Control Devices, etc., shall be located as specified herein. The location of the Control Stations, Control Devices, etc., is to be such as to provide maximum possible access to the Devices for servicing of the devices. For example, all Jam Detector, Head End Sensor, etc., Photocell devices are to be mounted so that they are accessible from catwalks adjacent to conveyors. In certain areas, protective guarding may be required to protect the Control Station, Control Devices, etc. However, the design and installation of this protective guarding must not prevent quick access to the control devices for adjustment, servicing or replacements.

b. The location, mounting and guarding of control stations and control devices must not in any manner restrict the access and servicing of any mechanical components of the BHS.

2. Control Device Mounting

a. The mounting of Control Stations, Control Devices, etc., shall comply with the basic requirements established in the Contract Drawings and as noted in the following:

1.) Control Stations in Public View

a.) All Control Stations located in the view of the public shall be flush mounted with stainless steel cover plates. Such stainless steel cover plates must be secured to the adjacent wall or conveyor trim member with either Truss or Oval Head Phillips stainless steel machine screws of appropriate size. Control stations located in the view of the public shall not be mounted on the top surface of the conveyor front cladding. Pan Head screws are not acceptable.

b.) All Control Stations located in the view of the public at load conveyors (i.e. ticket counter conveyor control stations) shall be mounted flush to the adjacent wall in a location that someone operating the Control Device shall not have to lean over the conveyor to access it (either upstream or downstream of the load conveyor). E-stop Control Devices shall be mounted inside the stainless steel trim shrouding above the toe plate. A one (1) inch hole shall be provided in the face of the stainless steel shrouding to actuate the E-Stop and a hole on the underside of the face (above the toeplate) shall be provided to reset the E-Stop. Note that the design, manufacture and installation of the stainless steel shrouding on the collection conveyor must reflect these requirements.

c.) All Control Stations located in the view of the public on Claim Devices shall be mounted at the base of the stainless steel trim element in the toe plate of the Claim Device. Again, design of the Control Station mounting must provide maximum access for servicing/ replacement of the Control Station Devices.

2.) Control Stations in Non-Public View

a.) All Control Stations located on load conveyors in non-public view shall be mounted on the horizontal portion of a Control Station mounting assembly bridging the load conveyor. This assembly shall be located and built so as to also act as an Over-Height Photocell Mount and Bag Restraint. Consider the "chording effect" of baggage at the discharge end of a horizontal load conveyor feeding onto an incline conveyor when determining the location of such an assembly. The vertical element of the assembly may also be used for the mounting and protection of head end photocells, if applicable.

b.) All Control Stations located on Flat Plate make up devices in non-public view shall be mounted on a Control Station mounting assembly. Design, manufacture and installation of the Control Station mounting assembly for racetrack applications must be such as to provide a "solid", well braced mounting for the related Control Station and Control Devices. Note also that the Control Station mounting assembly must provide a minimum vertical bag clearance of 36" above the surface of the racetrack device. See contract drawings for specific details.

3.) Control Devices

a.) All photocells shall be mounted in a vertical attitude with the LED photocell status indicator clearly visible to operation and maintenance personnel from the side of the associated conveyor or conveyor equipment. Photocells that are used for jam detection; baggage tracking, and the like. are to be mounted so that the center of the photocell beam is 2-1/2" from the top surface of the conveyor belt.

b.) Limit switches that are used to sense the position of Fire doors shall be mounted as an external unit to the door adjacent to the track of the door so that the switch can detect when the door is in the fully open position.

c.) Indicating lamps, other than those associated with MCPs, are to be located as required to properly alert personnel.

d.) Shaft encoders used for determining conveyor speed must be directly coupled to either the head or tail pulley of the associated conveyor. Use of tension loaded friction drive types of shaft encoders is not acceptable.

e.) Start-up warning alarms (i.e., audible and visual) shall be located at strategic locations to alert operations and maintenance personnel of the imminent start-up of conveyor equipment. As a minimum provide start-up alarms at baggage input areas, on top of the MCPs and along the conveyor line right-of-ways (e.g., ceiling supported conveyors, etc.). Audible/Visual Fault Warning and Start-up Alarms may utilize the same control devices. However, the audible and visual indications shall differentiate between the two separate functions.

f.) Fault warning alarms (i.e., audible and visual) shall be appropriately located to alert operations and maintenance personnel of conveyor subsystem fault conditions. As a minimum provide fault alarms on top of the MCPs. Audible/Visual Fault Warning and Start-up Alarms may utilize the same control devices. However, the audible and visual indications shall differentiate between the two separate functions.

g.) System Start-up and Fault Indication Rotating Beacons: System start-up and fault indication beacons, with amber globes, shall be located on top of the MCPs, at the baggage input areas and along the conveyor right-of-ways (e.g., ceiling supported conveyor equipment).

h.) Emergency Stop Switch Rotating Beacons: Emergency Stop Switch beacon with red rotating globe shall be mounted on top of the associated subsystem MCP.

3. Types of Control Devices

a. Push-Button Switches: All Momentary Contact Push-Button switches shall be of the Allen Bradley Series 800T type (or Square D 9001K series, or equivalent as reviewed and approved by the DAA or his representative). The color coding for the Push-Buttons shall be as follows:

Function	Color
Start/Re-Start (non-public locations)	Green (flush head)
Normal Stop (non-public locations)	Red (flush head)
Alarm Silence (non-public locations)	Yellow (flush head)
Lamp Test (non-public locations)	Gray (flush head)
Jam Reset (non-public locations)	Orange (flush head)
Others (non-public locations)	Black (flush head)

b. Illuminated Push-Button Switches: All Illuminated momentary contact push-button switches shall be of the Allen Bradley 800T - PA16 type switch with guards (or Square D 9001K series, or equivalent as reviewed and approved by the DAA or his representative). The color coding for the Push-Buttons shall be as follows:

Function	Color
Start (for initial start up conditions at public areas)	Green
Jam Reset	Amber
Emergency Stop Reset	Red
Over-Height/Over-Length Reset	White

c. Emergency Stop Push-Button Switches: All Emergency Stop push-button switches shall be of the Maintained Contact, "Push to Stop" Illuminated Red Mushroom Head switch, Allen Bradley 800T - FXP16RA1 type (or Square D 9001K Series, or equivalent as reviewed and approved by the DAA or his representative). Note that the Emergency Stop push-button switches must be equipped with a manual lockout clip manufactured by the switch manufacturer for locking the switch in the “conveyor off” position.

d. Selector Switches: All Selector Switches shall be of the appropriate series based on the application, as specified, and of the Allen Bradley 800T type switch (or Square D 9001K Series, or equivalent as reviewed and approved by the DAA or his representative).

e. Key Operated Switches

1.) "Off/On Function" and "Start Function" Key operated Switches for application in Public Areas shall be of the type manufactured by the Best Lock Company (or Square D 9001K Series with Best Lock Company core, or equivalent as reviewed and approved by the DAA or his representative) but must use a six-pin lock cylinder and core. The DAA will provide the final Operational Core. The Construction Core, normally supplied with the lock, must be removed before the project will be accepted. The switch must provide a spring loaded center return.

2.) Key operated Switches for all functions other than the "Off/On Function" and "Start Function" in Public Areas shall be Allen Bradley type 800T, (or Square D 9001K Series, or equivalent as reviewed and approved by the DAA or his representative).

f. Status Map and MCP Indicator Lamps

1.) Indicator Lamps shall be of the Allen Bradley "Push to Test" Pilot Light type 800T - PST16, (or Square D 9001K series, or equivalent as reviewed and approved by the DAA or his representative) with appropriate color coded lens as noted below for Status Maps or MCPs with less than five Indicator Lamps.

g. Non-Status Map Emergency Stop Switch Indicator Lamps: Certain Baggage Handling Systems shall require the installation of Emergency Stop Switch indicator Lamps external to the related System Status Map adjacent to lanyard operated Emergency Stop Switches. Such Indicator Lamps are to be of the type manufactured by Crouse - Hinds, Cat. #BDA - 15GP, (or equivalent as reviewed and approved by the DAA or his representative) with Red Globes.

h. Audible Warning Alarms

1.) Start-Up Warning Alarms for mounting at Ticket Counter Control station locations shall be of the Sonalert device as manufactured by Mallory Company Stock #64F278 Type SC250E, or Allen-Bradley DEC/DEP Series alarm 855P-B10DEC22 for continuous tone or 855P-B10DEP22 for pulsing tone, to be determined by the DAA (or equivalent as reviewed and approved by the DAA or his representative). For those Control Stations located in higher ambient noise locations, an alarm of appropriate higher frequency and dB rating shall be used (or equivalent as reviewed and approved by the DAA or his representative). Selection must be made based on actual survey of the location.

2.) Start-Up Warning Alarms for other locations shall be of appropriate frequency and volume levels for the application location (such as baggage make-up areas, outbound transport line areas, inbound claim areas (public) etc.). Such Audible Warning Alarms shall be as follows:

a.) Inbound Claim Areas (Public): Edwards Horn Beacon #51 with Amber Dome. Allen-Bradley 855H Series horn with Amber Beacon, Catalog Number 855H-BCA10CDR5. Federal Horn #350 with 400F Light, Amber Dome and 400 HMK*AC Adaptor (or equivalent as reviewed and approved by the DAA or his representative).

b.) Baggage Make-up Areas: Edwards Bell #340-6N5. Allen-Bradley 855H Series horn, Catalog Number 855H-BA10CD. Federal Bell #46-500-WB (or equivalent as reviewed and approved by the DAA or his representative).

3.) Audible Fault Warning Alarms shall be of a horn type of appropriate frequency and volume level for the application location (such as baggage make-up areas, outbound transport line areas, etc.). Such Audible Fault Warning Alarms shall be as manufactured by Edwards Horn #876-N5, Allen-Bradley 855H Series horn, with Amber Beacon Catalog Number 855H-BCA10CDR5 or without Beacon 855H-BA10CD, or Federal Vibratone Horn #350-WB (or equivalent as reviewed and approved by the DAA or his representative).

i. Audible/Visual Combination Alarms: Combination alarms for start-up or fault warnings mounted to MCPs, EDS machines, or elsewhere as approved by the DAA or his representative, may be Allen-Bradley 855E Series with 120 VAC control.

j. Limit or Proximity Switches: Provide precision oil tight plug-in type limit switches with contacts rated for a minimum of 10 amperes continuous duty at 120 volts A.C. Limit switches that are used to sense the position of fire/security doors are to be mounted as an external unit to the door adjacent to the track of the door so that the switch can detect when the door is in the fully open position.

k. Lanyard Activated Switches

1.) Indexing Conveyors in non-public areas shall be equipped with a cable lanyard activated Index/Run Mode Switch that will change the index/accumulation mode of operation for an inch-and-feed conveyor to a run mode when the lanyard is activated. Release of the lanyard will return the control function to the normal indexing accumulation mode.

2.) The design and location of the supports for the cable lanyard shall be provided as not to be easily damaged by baggage equipment or personnel.

3.) Run lanyard operated limit switches, used for the advancing of baggage on indexing accumulation conveyors such as sort piers and indexing sort conveyors or CBRA runout conveyors are to be mounted on the side of the associated conveyor or above the conveyor mounted on the stanchions associated to the conveyor. The lanyard cable must be supported with a minimum of heavy-duty 3/4" eyebolts.

4.) Systems that will require the application of lanyard activated safety switches for either subsystem or system Emergency Stop Switches. Such Safety Switches must be of the "manual re-settable" type with padlock attachment as manufactured by Rees, Cat. #04944 - xxx, Conveyor Components Corporation, (or equivalent as reviewed and approved by the DAA or his representative).

5.) Emergency stop lanyard operated limit switches and their associated lanyard cables are to be mounted along the catwalk or above the conveyor mounted on the stanchions associated to the conveyor.

6.) Lanyard cables are to be color coded as follows:

a.) E-Stop Lanyard Red

b.) Run Lanyard Green

l. Motor Safety Disconnect Switches

1.) Provide motor safety disconnect switches of the 3-pole, heavy-duty type, horsepower rated and non-fusible with a quick-make and quick-break operating mechanism and a means of padlocking the switch in the OFF position.

2.) Provide a N.O. auxiliary contact for connection to a PLC input.

3.) Motor safety disconnect switches for motors equipped with soft start devices must have an auxiliary N.O. contact interlocked with the associated emergency stop circuit.

4.) Each Motor safety disconnect switch shall be identified with a permanently attached white phenolic plate, engraved with black characters, providing the identification of the conveyor with which the motor is associated. Dymo - type labels are not acceptable. Attaching the ID plate to the safety disconnect door is acceptable.

5.) Use NEMA 12 enclosures for interior equipment and NEMA 4 for exterior equipment.

6.) Clutch/Brake

a.) The 3 phase Motor Safety Disconnect is also to be used to interrupt the feed and neutral circuit to any externally powered electric clutch/brake device. The following describes how this shall be accomplished:

(1.) Provide 120 Volt AC power to the line side auxiliary contact in the Motor Safety Disconnect Switch (located at the motor) from the MCP.

(2.) Wire from the load side of the auxiliary contact of the Motor Safety Disconnect Switch (located at the motor) to the terminal strip in the respective MCP.

(3.) At the respective MCP, run two (2) parallel wires from the MCP terminal strip to the following:

(a.) One parallel wire from the terminal strip to the PLC input to indicate that the Motor Safety Disconnect Switch (located at the motor) is in the “ON” or “OFF” position.

(b.) The other parallel wire shall be the input voltage for the DC power supply that will supply DC power to the associated motor clutch/brake.

m. Fire/Security Door Safety Disconnect Switches

1.) Provide safety disconnect switches of the 3-pole, heavy-duty type, horsepower rated and non-fusible with a quick-make and quick-break operating mechanism and a means of padlocking the switch in the OFF position.

2.) Provide a N.O. auxiliary contact for connection to a PLC input.

3.) Each Fire/Security Door safety disconnect switch shall be identified with a permanently attached white phenolic plate, engraved with black characters, providing the identification of the door the disconnect is associated with. Dymo - type labels are not acceptable.

4.) Use NEMA 12 enclosures for interior equipment and NEMA 4 for exterior equipment.

n. Relays: Use general-purpose industrial, panel-mounted relays with convertible contacts rated at 10 amperes continuous current at 120 volts A.C. Ensure that all relays are capable of manual operation.

o. Timers: Provide solid state, motor driven timers or utilize timer functions by PLC logic. All timers are to be mounted within the appropriate MCP. Use of timer devices within photocells is not acceptable.

p. Magnetic Motor Starters (NEMA)

1.) All motor control equipment shall comply with NEMA Standard ICS-1, ICS-2, UL publication 845 and other applicable standards of NEMA, UL, IEEE, ANSI, NEC and National Electrical Safety Code (or applicable local codes).

2.) Provide a separate magnetic motor starter unit for each motor drive section.

3.) Provide one auxiliary contact on each starter and wire to a PLC input module.

4.) Use size "0" starters for motors of 5 HP and below and size "1" for those above 5 HP. All starters are to be equipped with:

a.) Thermal overload protection on all poles.

b.) Overload relays of the manual reset type.

c.) Control voltage of 120 volts.

d.) Electrical and mechanical interlocks where required for reversing applications.

e.) Open type for panel mounting.

f.) NEMA 12 enclosure for general-purpose application.

g.) NEMA 4 for weatherproof application.

q. Combination Magnetic Motor Starters

1.) In addition to the requirements listed for magnetic starters, equip each combination magnetic starter, if specified, with:

a.) An adjustable instantaneous trip circuit breaker interlocked with the enclosure cover with provisions for padlocking the disconnect switch in the "Off" position.

b.) An enclosure door capable of being opened only with disconnect switch in the "Off" position.

r. Overload Heaters

1.) Size overload heaters for each starter in accordance with the full load current rating shown on the actual nameplate of each manufacturers selection tables.

2.) Each individual motor starter should be equipped with overload heaters.

3.) Provide a N.O. auxiliary contact for each overload relay for connection to a PLC input.

4.) Enunciate individual overload failure on the Touch Screen Terminal /MDS fault reporting system.

s. Soft Start Devices

1.) Provide a soft start device for all drive units within any flat plate/slope pallet baggage make-up or claim device as recommended by the manufacturer. The use of a VFD device instead of a soft start device is acceptable.

2.) Provide an electrical/electronic soft start device with adjustable starting curve from 0 to 10 seconds for any conveyor drive equipped with a 7-1/2 horsepower motor or larger.

3.) Ensure that the electrical control circuitry design provides that the soft start device is always used whenever the associated drive motor(s) are started, regardless of start condition; i.e., regardless if drive motors are started with a control sequence or with activation of the related motor safety disconnect switch.

4.) The approved soft start devices, noted in the acceptable manufacturers listing, must be sized for the specific application.

t. Electric Brakes

1.) Provide brakes on all incline conveyors and decline conveyors, if not equipped with a VFD, and for any other conveyors where coasting of the conveyor would be detrimental to the operation of the baggage system.

2.) Provide an electric brake for decline conveyors that are equipped with a VFD. Wire the brake separately from the Variable Frequency Drive power source to prevent conveyor coasting.

3.) Provide dry friction, spring set, solenoid release type brakes integral with the drive motor.

4.) Incorporate automatic adjustment of brake disk wear or provide a brake, which requires minimal adjustment.

5.) Select the brake to be capable of cycling as required by the conveyor application under full load with no excessive wear.

6.) Choose brakes to have a minimum torque rating equal to the starting torque of the motor.

7.) Motor brakes that are installed on the end bell of the motors are to be equipped with an external means of "manual release" that would permit maintenance personnel to operate the motor in case of a failure of the brake.

u. Variable Frequency Drives (VFD)

1.) A programmable Variable Frequency Device (VFD) shall be utilized to control the operation of three-phase induction AC motors for queue, power turns, merge conveyors and all conveyors in all bag tracking zones (sortation and EDS) where coasting of the conveyor would be detrimental to the operation of the baggage system. Dynamic braking shall be provided for all conveyors within the CBIS bag tracking zones.

2.) For incline conveyors, on which bags are being tracked, that are equipped with a Variable Frequency Drive unit “anti roll back” provisions shall be provided on the associated gear box to prevent conveyor coasting.

3.) Provide an electric brake, wired separately from the Variable Frequency Drive power source, for decline conveyors, on which bags are being tracked, to prevent conveyor coasting.

4.) Type of VFD utilized shall be UL listed and IEC compliant.

5.) VFDs shall be typically installed within the respective Motor Control Panel (MCP). To conserve MCP space the BHS Contractor can propose to install the VFD remotely at the drive unit, the DAA or his representative must approve this type of configuration.

6.) Provide the ability to program and monitor all drive parameters. Provide programming devices with pre-programmed parameters for various types of VFD programs (e.g. standard queue, merge, etc.) to allow simple downloading of such programs when replacement or reprogramming of a VFD is required.

7.) Provide a local keypad control for start, stop, speed reference and reverse functions.

8.) Provide where required for faster stopping, dynamic braking resistors.

9.) VFDs shall be capable of permitting the appropriate number of engagement cycles per minute for the specific application under full load with no objectionable heating, overload tripping or other VFD faults. BHS Contractor shall factor this when designing the system and provide VFDs and dynamic braking resistors of a larger power rating if required to meet the application's requirements.

10.) The BHS Contractor shall factor in heat dissipation when designing the MCP and if excessive heat is anticipated from the braking resistors, then mount them in a separate NEMA 12 (for interior equipment) or NEMA 4 (for exterior equipment) rated panel.

11.) When using VFDs, VFD rated shielded cable needs to be used. Use Belden, O'flex or equivalent cable. The shield should be connected to both the motor and the PE (Potential Earth) ground on the AC drive.

12.) For cable length of 50 ft or more between the drive and motor, a minimum of 1 additional amp needs to be added to the drive rating to handle cable-charging current. For Cable greater than 100 ft in length, a minimum of 2 amps need to be added to the drive rating for cable charging current.

13.) If the transformer which is powering the MCP or MCC is greater than 10 times the drive rating, an input line reactor shall be provided for each AC drive.

14.) Enunciate all individual variable frequency drive (VFD) failures on the fault reporting system. Automatic resetting of certain faults shall be permitted; however, all such faults shall be enunciated and logged regardless of whether or not they have been automatically reset.

15.) The BHS Contractor shall submit to the DAA or his representative catalog cuts of the type of VFD proposed for review and approval.

v. Photocells (Photoelectric Sensors)

1.) Provide photocells of the self-contained, retro-reflective type using an infrared modulated light source with sensitivity adjustment and LED status indicator that is readily visible. Retro-reflective type photocells are to be used for applications where the distance between the photocell and the reflector is less than 10'.

2.) Photocell applications that require a scan distance of 10' or greater are to use a separate transmitter and receiver rather than the single retro-reflective photocell.

3.) Use photocells with quick disconnect cable for ease of replacement; the cable shall be UL recognized, 18AWG; one-piece molded design and be highly visible.

4.) Due to wiring constraints and noise on low voltage lines generating false triggers, DC type photocells are not permitted.

5.) Mount photocells to structural members or side guards using an adjustable bracket as supplied by the photocell manufacturer so that the photocell is mounted in a vertical, not horizontal, attitude. Alignment and status LEDs shall be easily visible for maintenance personnel. All sensors and cabling shall be firmly anchored and protected from equipment and personnel impact and from random forces imposed by maintenance personnel servicing the equipment or staff working in the area. Mounting and protection devices shall inhibit tampering with sensors and their setting by non-maintenance personnel.

6.) Photocell mountings are to be directly attached to the conveyor structure as required. Use of shims between the conveyor structure and the photocell mountings is not acceptable. No penetrations through the side guards or attachment by means of magnets or other non permanent attachment methods shall be permitted for photocell mountings or mounting brackets.

7.) Hex head 1/4" - 20 bolts of appropriate length and related 1/4" - 20 hardware (flat washers, lock washers and nuts) are to be used for the mounting of the photocells. Use of round head bolts is not acceptable.

8.) Mount reflectors to side guards using brackets providing both vertical and rotational adjustment. No penetrations through the side guards shall be permitted for reflector bracket mounting.

9.) Where holes through side guards are required, the holes shall be a maximum of 1.5" in diameter and located so that the center of the photocell beam is 2.5" above the conveyor belt. The holes in the side guards shall be dimpled away from baggage flow to minimize the possibility of snagging a bag and causing a jam. Oblong openings in the conveyor side guards are not acceptable.

10.) Only one side guard opening per photocell and one side guard opening per related photocell reflector would be accepted. Any unused photocell/reflector openings in the side guards must be properly filled with a welded circular blank, ground smooth and properly painted.

11.) Locate photocells on the side of a conveyor having the lesser chance of contact by operating personnel. Guard photocells if susceptible to personnel contact. The photocells are to be located on the catwalk side of conveyors to ensure maintenance access.

12.) Do not attach the white phenolic plate photocell device ID plate to the plug-in type photocell or its wired base. Mount the ID plate on the side guard adjacent to the photocell.

13.) Provide photocells as required by the functional needs of the BHS. Photocells shall indicate a reliable life of over 10 million cycles, and be repetitive and unaffected by environmental conditions such as vibration, rain, humidity, cold, heat, dust and sunlight. Provisions shall be made to effectively accomplish the sensing of any of the typical types of airline baggage and packages. Photocell installation shall minimize vibration and shall provide protection for both the sensor and its associated wiring. Specifically, care shall be exhibited in the mounting of the photocell and its control wiring to minimize the hazard of damage from the moving of baggage, contact with associated components or by personnel working on or in the vicinity of the system.

14.) The BHS Contractor shall supply cordsets of an appropriate length to connect to photocells such that there is no greater than 12" of excess cable length remaining. The excess cable shall be coiled and secured to the associated conveyor with the use of cable mounting clips. The BHS Contractor shall not use plastic cable ties to secure the cordset.

15.) Photocells shall not be subject to interference from standard communication systems employed at the airport location due to airport and airline radio ground communications, ground to aircraft communications, aircraft to aircraft communications or any form of radar equipment operation.

16.) For applications that require critical fail-safe operation (e.g. for EDS Applications), the following components must be used:

a.) Develop and program PLC logic to ensure that the PLCs are continuously crosschecking outputs from the photocells. The purpose of this code is to ensure failsafe operation of photocells, photocell output wiring, I/O cards, I/O racks, PLC communications, and PLCs themselves. This code shall be written in such a manner that the system will stop appropriate conveyors and alert personnel in the event that the photocell, I/O card, I/O rack, any communication cable or wire breaks, or PLC failure occurs. This code should also include programming to account for long baggage or multiple bags that may appear overlength due to the absence of baggage gaps (stop conveyors if a bag length exceeds the maximum system bag length). In addition, implement software programming filters to prevent erroneous conveyor stoppage due to the distance between photocell mounting locations and bag straps (that may instantaneously break the photocell beam). All applications must be submitted for review and acceptance to the DAA or his Representative prior to installation.

b.) (For applications requiring throughput of 10 bags per minute or less) – Allen-Bradley Area Access Control (AAC) units may be used. Catalog number 440L-T4F90018-Q for Transmitter and 440L-R4F90018-Q for Receiver.

c.) (For applications requiring throughput of greater than 10 bags per minute) – Allen-Bradley Safety Light Curtain units may be used. Catalog number 440L-P4D0300-N for this Point of Operation Control unit.

d.) As an option to (b.) or (c.) above: redundant Allen-Bradley Series 9000 transmitted beam photoelectric sensors with a diagnostic output may be provided. Implement PLC safety controls to prevent unintended use in case of a failure.

w. Shaft Encoders

1.) Shaft encoders used for determining conveyor speed must be directly coupled to either the head or tail pulley of the associated conveyor and shall be of appropriate industrial type.

2.) Install appropriate safety guarding on all exposed parts associated with the conveyor drive's rotating shaft and direct drive gearbox, in compliance with OSHA Standards 1910.219. Ensure that the proposed safety guarding does not restrict maintenance access and it is easily removable, as the location requires, for maintenance access. Submit shaft encoder attachment and guarding details to the DAA or his representative for approval.

3.) Use of tension loaded friction drive types of shaft encoders is not acceptable.

4.) The BHS Contractor shall supply cordsets of an appropriate length to connect to shaft encoders such that there is no greater than 12" of excess cable length remaining. The excess cable shall be coiled and secured to the associated conveyor with the use of cable mounting clips. The BHS Contractor shall not use plastic cable ties to secure the cordset.

5.) Ensure the shaft encoder model chosen is applicable to meet the subsystem tracking criteria based on conveyor belt speed/resolution required (i.e. shaft encoders utilized for tracking within an EDS system (slow speed tracking area) may be a different model compared to those required for sortation system tracking (high speed tracking area)). Submit to the DAA or his representative, the manufacturer's data for the proposed shaft encoder(s) for approval.

C. Electrical Device Identification

1. The electrical control stations, their related control devices, field wired control devices shall be identified with a permanently attached white phenolic plate, engraved with black characters, providing the identification of the control station, control device etc. Dymo-type labels are not acceptable. Do not attach the white phenolic plate to any field device that can be easily replaced due to failure ((i.e. plug-in type photocell or its wired base) as this would also require the removal and reattachment of the ID plate), attach the plate to the side guard or non-removable structure adjacent to the device.

2. The electrical control stations, their related control devices, field wired control devices and the electrical control devices mounted within the BHS related motor control panels (MCPs) shall use the following device identification format and designations. The format and identification that are used in this specification are to be used throughout the BHS project and are to appear on the designated equipment and the entire project related documentation.

a. Control Stations

1.) Control Stations shall be identified with the prefix CS followed by the actual Conveyor or BHS Equipment Identification Number to which the Control Station is related. For example, CS/TC1-6 identifies a Control Station located on Ticket Counter Subsystem #1 related Conveyor #6. Note that when there is more than one Control Station associated with a Conveyor or BHS Device, alpha designators will also be used. For example, CS/TC1-6A, CS/TC1-6B, CS/TC1-6C signifies that Ticket Counter, Subsystem #1 related Conveyor #6 has three Control Stations. The "A" prefix identifies the Station related to the charge end of the Conveyor while the last or highest letter indicates the Station closest to the discharge end of the Conveyor.

2.) Each Control Station shall be identified with a permanently attached white phenolic plate, engraved with black characters, providing the identification of the Control Station. Dymo- type labels are not acceptable.

b. Control Station Devices

1.) Control Station Devices shall be identified as follows:

Control Station Device	Identification
Start Re-Start Push-Button	SPB
Normal Stop Push-Button	PBS
Emergency Stop Push-Button	EPB
Reset Push-Button	RPB
Selector Switch	SSW
Key Operated Switch	KSW
Sonalert Warning Device	ALM
Bag Advance Switch	BAS
Alert Light Reset	LPB
Reverse Start/Re-Start Push-Button	PBR
Lamp Test Push-Button	TPB
Sortation Controller Jam Reset Push-Button	CRB
Alarm Silence Push-Button	APB
Door Close Push-Button	CPB
Door Open Push-Button	OPB
Forward Jog Push-Button	JFB
Reverse Jog Push-Button	JRB
Jog Push-Button	JPB
Jog Selector Switch	JSW
Colored Indicator Light (the first letter of the lamp color will appear instead of the underscore)	LT_

2.) For example: The designation CS/TC1-6/RPB identifies a Reset Push-Button in the Control Station located at Ticket Counter Conveyor TC1-6.

3.) Note that the above Control Station Device designations are to appear on all electrical drawings, including wiring and schematics.

4.) Control Station Control Devices (push-buttons, etc.) identification descriptors shall be clearly identified by permanently attached white phenolic plates, engraved with black characters, except emergency stop devices which are to be red with white letters, showing their operational relationships to the system(s) or subsystem(s).

5.) All e-stop pushbuttons shall clearly indicate all conveyors affected by that e-stop (i.e.: TC1-1/TC1-8 indicates that the E-stop will stop conveyors TC1-1 through TC1-8). Dymo - type labels are not acceptable.

6.) All Jam reset pushbuttons shall indicate the conveyor segments, which are controlled by that jam reset control station.

7.) Control Station Control Device Function I.D. Tags must be positioned for ease of reading. Align the tag's legend so that it is legible (oriented) from the operator's access side of the control station.

c. Field Wired Control Devices

1.) Photocells shall be identified as PE followed by the Identification of the Baggage Handling Device or Conveyor on which the Photocell is mounted. For example: PE/TX1-6 identifies a Photocell located on Transfer Conveyor TX1-6.

2.) Limit Switches shall be identified as LS followed by the identification of the Baggage Handling Device or Conveyor to which the Limit Switch is related. For example: LS/TC1-2 identifies a Limit Switch on Ticket Counter Conveyor TC1-2.

3.) Warning Alarms shall be identified as WA followed by the Identification of the Baggage Handling Device or Conveyor to which the Warning Alarm is related. For example: WA/CD-1 identifies a Warning Alarm associated with Claim Device #1.

4.) Lights shall be identified as LT followed by the identification of the Baggage Handling Device or Conveyor on which the light is mounted. For example: LT/OS1-1 identifies a light located adjacent or mounted on Oversize Bag Conveyor OS1-1.

5.) Hour meters shall be identified as HM followed by the identification of MCP to which the hour meter is related. For example: HM/MCP-l identifies an hour meter on motor control panel MCP-l.

6.) Emergency Stop Lanyards shall be identified as EL followed by the identification of the Baggage System Conveyor on which the Emergency Stop Lanyard Limit Switch is mounted. For example: EL/ML1-2 identifies an Emergency Stop lanyard related to Mainline Conveyor ML1-2.

7.) Run Lanyards shall be identified as RL followed by the identification of the Baggage System Conveyor on which the Run Lanyard Limit Switch is mounted. For example: RL/OS1-5 identifies a Run Lanyard mounted on Oddsize Sort Conveyor OS1-5.

8.) Shaft Encoders shall be identified as SE followed by the identification of the Baggage System Conveyor on which the Shaft Encoder is mounted. For example: SE/ML1-2 identifies a Shaft Encoder mounted on Mainline Conveyor ML1-2.

9.) Hand Held Scanner Guns shall be identified as SG followed by the identification of the Baggage System Conveyor to which the Hand Held Scanner Gun is related. For example: SG/ME1-25 identifies a hand held scanner gun related to Manual Encoding Conveyor ME1-25.

10.) Security Card Readers shall be identified as SR followed by the identification of the Baggage System Conveyor to which the Security Card Reader is related. For example: SR/TC1-1 identifies a security card reader related to Ticket Counter Conveyor TC1-1.

11.) Motor Safety Disconnect Switches shall be identified as "MSD" followed by the identification of the Baggage System Conveyor to which the Motor Safety Disconnect Switch is related. For example: MSD/TC1-09 identifies a Motor Safety Disconnect Switch related to Ticket Counter Conveyor TC1-09.

12.) Field Wired Control Devices (Security Card Readers, Photocells, Limit Switches, etc.) are to be clearly identified by permanently attached white phenolic plates, engraved with black characters with the control device I.D. Dymo type labels are not acceptable.

13.) All field installed Junction Boxes are to be provided with white phenolic plates engraved with black characters. The I.D. tags are to be located, so as to be easily read from the adjacent maintenance access areas. The I.D. tags must be consistent with the associated subsystem identifications noted on the wiring schematics. For example the second junction box from MCP-

TC1 would be "JB/TC1-02".

d. Control Devices within Motor Control Panels and Workstations

1.) The identification of control devices and components such as relays, timers, transformers, power supplies, overloads, fuses, PLCs, etc., within motor control panels, workstations and computer cabinets must be identified with I.D. tags.

2.) The I.D. tags must be constructed of a white phenolic plate engraved with black characters. Dymo type labels are not acceptable. The I.D. tags must be located so that they can be easily read when the related motor control panel, workstation or computer cabinet door is opened.

3.) The I.D. tags are not to be mounted on the covers of the Panduit wireways within the related cabinet or control panel.

4.) The I.D. tags for motor starters must contain the conveyor I.D. For example: The motor starter I.D. tag for conveyor TC1-1 would be “TC1-1M”.

2.12 MOTOR CONTROL PANELS (MCP)

A. General

1. All control equipment for the newly installed conveyors shall be housed within new motor control panel(s) for the associated subsystems. Ensure adequate capacity within the panel(s) for all necessary control devices.

2. Provide motor control panels that are UL listed employing NEMA 12 enclosures with fully gasketed doors for interior use or NEMA 4 enclosures for exterior located MCP(s) (or applicable local codes). Include a fusible switch with Class J or R fuses for the incoming power supply and interlock its door(s) to prevent accidental opening with the power on. The door opening mechanism must have a manual over ride provision to permit the opening the door by qualified personnel with the power on.

3. Provide a plexiglass Safety Shield with standoffs (or similar suitable protection provision) over the fuses for the incoming 480v.

4. The exterior of the MCP must be painted. The interior of the panel or cabinet including the mounting panel shall be painted white.

5. Ensure that all Motor Control equipment complies with NEMA Standard ICS-1, ICS-2, UL publication 845 and other applicable standards of NEMA, UL, IEEE, ANSI and National Electrical Safety Codes (or applicable local codes).

6. Provide thermostatically controlled cooling fans or air conditioning units within the MCP cabinet to monitor and prevent internal temperatures from exceeding 125°F or component environmental limits, whichever is less based on an ambient temperature of 100°F (configurable). Provide replaceable or cleanable filters on the intake vents. Configure, through appropriate controls functionality, the cooling equipment to run when the respective MCP internal temperature reaches 100°F and provide an audible and textual alarm at the MDS or Touch Screen Terminal applicable when the temperature exceeds 130°F (configurable).

7. Provide integral MCP air conditioning units should they be required to prevent the internal temperature of the MCP from reaching 125°F. Provide and install condensing unit drain tubes to the nearest drainage line and coordinate hookup of same with building contractor.

8. Prior to the installation of overload heaters on the controllers, submit a motor schedule listing motor horsepower, voltage, phase, source of feed, circuit breaker size, disconnect size, conduit and wire size and overload heater size selected to be used.

9. Base interrupting rating of all circuit breakers, fused disconnect switches, motor control centers, and panel boards on short circuit calculations and ensure they are compatible and coordinate with base contract equipment. Refer to National Electrical Code Articles 110 and 430 (or local applicable code) to determine short circuit and overload requirements.

10. Mount fuses or circuit breakers for each magnetic starter directly above the magnetic starter.
11. A laminated card showing motor schedule with horsepower, fuse size and heater size shall be affixed to the inside of the MCP door.
12. The working space in front of the MCP panel shall be a minimum of 36". In all cases, the workspace shall permit at least 90 degree opening of the MCP doors. Refer to National Electrical Code Article 110 (or local applicable code) to determine working space requirements.
13. Appropriately sized waterproof bushings/seals shall be installed on all conduits and conduit fittings that enter/exit the Motor Control Panel(s).

B. Installation requirements

1. Comply with the following design and installation requirements:
   a. Wire the line side of fuses or circuit breakers to a line side terminal strip for their incoming supply.
   b. Wire the load side of the magnetic starter to a load side terminal strip for the outgoing load.
   c. Connect all control wires to terminal strips designated for control wiring.
   d. Make vertical runs of power and control wiring within the panel on either or both of the right or left sides of the backboard.
   e. Run horizontal runs of power and control wiring between the horizontal rows of starter/fuse block units.
   f. Enclose all vertical and horizontal wiring in “Panduit” - brand plastic wireways.
   g. Make minimal wire runs to and from these wireways only to the nearest adjacent fuse block starter or terminal block.
   h. Use of “latching relays” is not acceptable.
   i. Use of “alternating relays” is not acceptable.
   j. Any “plug in” type device such as a relay, IEC starters or clutch/brake power supply must be equipped with a spring clip type restraint to prevent the “plug in” device from becoming loose in its socket.
   k. Splicing of control or power wiring within any MCP is not acceptable. All internal and external “field” wiring must be terminated on the appropriate MCP terminal strips.
   l. Appropriate sized waterproof bushings shall be installed on all conduits or conduit fittings that enter the related MCP.
   m. All fuses will be of the appropriate type and size of the FRN or FRS dual element type.

C. Panel Identification

1. Each Motor Control Panel must be identified with an I.D. Tag mounted on the outside face of the Panel Door to the immediate left of the MCP Main Disconnect. The Tag shall identify:
   a. MCP Designation
   b. Related Baggage Subsystem
   c. Related Conveyors or Devices Controlled by the MCP
2. Provide a permanently attached white phenolic plate, engraved with black lines and characters of the subsystem layout, on the door face of each new BHS Motor Control Panel, illustrating a graphic representation of the respective subsystem. Orientation of the graphic representation shall be the same as the actual subsystem. The MCP layout map shall be consistent with the Graphic Display of the MDS workstation equipment, which shall monitor the faults of the entire baggage handling system (Outbound and Inbound BHS).

3. The I.D. Tag shall be secured to the MCP door surface with a minimum of four rivets combined with an appropriate adhesive. Large tags shall require a minimum of four rivets, one for each corner of the tag.

D. Shop Drawings

1. Submit shop drawings to show:

a. General Layouts of new subsystem MCPs

b. Power, wiring and schematic diagrams

c. Outline and wiring diagrams of all special devices

d. Manufacturer's data for all components

E. Utility Outlet

1. In each enclosure or cabinet include a minimum of one appropriately fused grounded duplex receptacle utility outlet meeting locally applicable standards of 120 volt, 20-ampere capacity conveniently located within the panel.

2. The outlet is to be fed from the line side of the MCP, workstation, or computer cabinet power source (supplied by others unless otherwise noted) so that the outlet power will remain on regardless of the condition of the MCP, workstation, or computer cabinet power.

3. The hot wire providing power to the outlet shall be yellow. All terminations of this wire shall be guarded in order to protect personnel from accidental contact. Mount a warning on the outside of the panel, next to the disconnect switch stating: "CAUTION - THIS CONTROL CABINET CONTAINS YELLOW WIRES WHICH WILL REMAIN "HOT" WHEN THE DISCONNECT SWITCH IS TURNED OFF."

F. Lighting

1. Equip each enclosure or cabinet with an appropriately fused fluorescent lamp extending at least three quarters of the width of the panel. Operate the lamp by a switch located inside the enclosure on the latch side of the primary door so that the light becomes illuminated whenever the enclosure or cabinet door has been opened.

2. The lamp(s) is to be fed from the line side of the MCP, workstation, or computer cabinet power source (supplied by others unless otherwise noted) so that the fluorescent lamp will remain on regardless of the condition of the MCP, workstation, or computer cabinet power.

3. The hot wire providing power to the lamp shall be yellow. All terminations of this wire shall be guarded in order to protect personnel from accidental contact. Mount a warning on the outside of the panel, next to the disconnect switch stating: "CAUTION - THIS CONTROL CABINET CONTAINS YELLOW WIRES WHICH WILL REMAIN "HOT" WHEN THE DISCONNECT SWITCH IS TURNED OFF."

G. Control Devices

1. General

b. All MCPs are to be equipped with the following control devices regardless of the type of status monitoring being employed:

1.) System Ready Indication Lamp: The MCP shall be equipped with a Green Indicator Lamp, which shall become illuminated to indicate that the system is ready for start-up and no faults are indicated on the MDS, Touch Screen Terminal or MCP System Status Map.

2.) MCP Re-Start Push-Button Switch: A green momentary contact start push-button switch is to be provided for each system or subsystem that is controlled from the MCP. The MCP Re-Start Push-Button Switch shall not be able to start the subsystem from a non-operational mode. It shall only be able to Re-Start the subsystem if the MCP fault has been cleared.

3.) MCP Emergency Stop Push-Button Switch: Each MCP shall be equipped with a red illuminated maintained contact mushroom head push-button switch for each system or subsystem controlled from the MCP.

4.) Jam Indication: Amber Indicator Lamp shall be used to indicate a Jam condition. The Jam Indicator Lamp shall become illuminated whenever a Jam Detector within the subsystem has sensed a Jam Condition. The Indicator Lamp shall remain illuminated until the Jam Condition has been corrected.

5.) Motor Overload Indication: Blue Indicator Lamp shall be used to indicate Device or Conveyor Groups in which one or more Motor Overloads have tripped. The Motor Overload Blue Indicator Lamp shall become illuminated whenever a Motor Overload Condition develops and shall remain illuminated until the tripped Overload has been reset.

6.) Hour Meter: Each MCP shall be equipped with an Hour Meter that shall record the amount of time (in hours) that at least one of the conveyors or devices controlled by the MCP is in operation

7.) Alarms

a.) Start-Up/Fault Warning Alarm(s): Each MCP shall be equipped with one amber rotating beacon and one audible horn to indicate imminent subsystem start-up or faults (jams, motor overloads, etc.). The design of the control circuitry shall be such so that multiple faults will always activate the audible and visual alarms; i.e., if a jam condition has activated the fault alarms and the alarm silence push-button has been depressed but the actual fault has not yet been corrected, a second fault occurring after the alarm has been silenced shall again activate the alarm.

b.) Emergency Stop Warning Alarm(s): Each MCP shall be equipped with one red rotating beacon and one audible horn to indicate an Emergency Stop situation in the subsystem.

8.) Alarm Silence Push-Button Switch: Each MCP shall be equipped with a yellow momentary contact “Alarm Silence” push-button switch. Activating the Alarm Silence Push-Button shall silence the Audible Warning Alarm. However, the appropriate Indicator Lamp shall continue to be illuminated until the Fault Condition (jam, motor overload, e-stop, etc.) has been corrected.

H. System Status

1. Status Monitoring on the MDS Workstation

a. Each conveyor subsystem's status shall be monitored by the BHS Maintenance Diagnostics System (MDS) workstation as detailed within this specification.

2. Touch Screen Terminal at the MCP

a. Supply, install and program Touch Screen Terminal such as an “Allen Bradley”, family of “PanelView” terminals (or equivalent as approved by the DAA or his representative).

b. The Touch Screen Terminal shall be installed at the outbound MCP and inbound MCP as indicated on the contract drawings B7101 and B7102. The Touch Screen Terminal shall be constructed as a NEMA 4 rating (outdoor) or NEMA 12 for indoor use.

c. The Touch Screen Terminal shall be capable of accurately and clearly depict the entire BHS. The terminal shall be configured to display system status as described below, in both text and pictorial format. Submit to the DAA or his representative their functional design for approval.

d. The graphics portion of the terminal shall display, in real time, dynamic pictorial format, the operational status of the conveyors and make up devices that are connected to the system PLCs. Framed icons and specific conveyor I.D.s representing conveyor sections shall change color according to the following scheme. This shall immediately highlight problem areas so that the problems that arise may be corrected in the minimum amount of time:

Condition	**Color**

Normal Operation – Conveyor Drive On/Running	Green
Normal Operation – Conveyor Drive Off/Timed Out	Black
Conveyor stopped due to "Cascading"	Magenta
Conveyor Full Condition	White
Emergency Stop Actuation	Red
Overlength/Overheight Condition	Flashing White
Motor Overload	Blue
VFD Fault	Flashing Blue
Shaft Encoder Fault	Cyan
Conveyor Jam Condition	Yellow
Diverter Fail at Home Condition	Yellow
Diverter Failed Extended Condition	Yellow
Divert All	Flashing Green
PLC Communication Loss (Individual Components)	Red
Equipment Out of Service	Brown
Fire Alarm	Flashing Red
Over Temperature	Flashing Red
EDS Device Failure	Red
BHS/EDS Fault	Flashing Red

e. The textual portion of the terminal shall display, in color coded text format, the operational status of the conveyors and make up device that are connected to the system PLCs. The terminal provides color indications of a predetermined fixed area of the system. The text portion of the terminal shall not interfere with the graphical display area. The textual portion of the terminal shall automatically scroll to show the most current fault. The textual display must also have a scroll back function to display faults that have scrolled off the display. The condition and the specific conveyor I.D representing the conveyor sections and system devices change color according to the following scheme. This shall immediately highlight problem areas so that the problems that arise may be corrected in the minimum amount of time:

Condition	Color	Text Displayed
Normal Operation – Conveyor Drive On	Green	Running
Normal Operation – Conveyor Drive Off	Black	Timed Out
Conveyor stopped due to "Cascading"	Magenta	Cascade Stopped
Conveyor Full Condition	White	Full
Emergency Stop Actuation	Red	E-Stopped

Overlength/Overheight Condition	Flashing White	Oversize
Motor Overload	Blue	Overload
VFD Fault	Flashing Blue	VFD Fault
Shaft Encoder Fault	Cyan	Shaft Encoder Fault
Conveyor Jam Condition	Yellow	Jam
Divert Fail at Home Condition	Yellow	Failed Home
Divert Failed Extended Condition	Yellow	Failed Extended
Divert All	Green	Push All
EDS Device Failure	Red	EDS Failure
BHS/EDS Fault	Red	Interface Fault
PLC Communication Loss (Individual Components)	Red	Communication Error
Equipment Out of Service	Brown	Out of Service
Fire Alarm	Red	Fire Alarm
Over Temperature	Red	Over Temperature
Missing Bag Jam	Yellow	Missing Bag Jam

f. The Touch Screen Terminal shall be connected to an audio/visual alarm, which will be activated when a system alarm is triggered (i.e. jam condition, E-stop etc.).

g. Provide the Touch Screen Terminal with EPROM or similar to provide memory backup.

2.13 BHS WORKSTATION AND COMPUTER CABINETS

A. General Design Requirements

1. There shall be a control room located between gridline 7 and 8 as shown in reference drawing B2102 that houses one BHS workstation, the BHS Sortation Control Servers and the MDS server consoles. These consoles shall be designed to reduce worker's fatigue.

2. Provide a system capable of supporting all the specified electronics.

3. The system shall be comprised of floor mounted base pedestals, below the work surface base modules, (minimum of 14U per module), and above the work surface, top modules assembled together to form an operator console.

4. The system shall have a minimum 1-inch thick MDF core, laminated work surface. The work surface shall be not less than 18" deep overall and should include a 3" deep wrist support covering the work surfaces entire front width.

5. Modular top compartments shall allow for a minimum of 9" slope away from the operator for all electronics placed above 30" height from floor level.

6. Add-on top modules shall allow for a vertical or 12-degree or 15-degree tilt towards the user for all electronics placed above 6 feet in height from floor level.

7. Top modules shall be provided with removable equipment finishing masks or surrounds, cut to the size of the face of the specified electronics.

B. Standards

1. The system shall comply with Underwriters Laboratories (U.L.) listing 62Y4. Copy of the certificate of approval to be submitted upon request.

2. The system shall comply with Electronic Industry Association, (EIA), specifications for rack mounting ANSI/EIA standard RS-310.

C. Modular Pre-Engineering Construction

1. All components within the console system shall be:

   a. Of pre-engineered modular construction i.e. constructed from a series of independent sectional components.

   b. Be available from pre-defined set of manufacturers' model numbers.

   c. Has been in common production for at least two (2) years prior to the date of submission.

   d. Alterations to the design, either prior to or following installation, will be accomplished without the need for either welding or carpentry work.

   e. Cables or conduits shall be able to pass through the complete width of the system without obstruction.

   f. Modules may be supplied larger than 19" EIA specifications to accommodate specific electronics but all modules must be capable of supporting EIA standard 19" width rack mounted equipment, whether or not the originally specified electronics are of 19" width EIA dimensions.

   g. All modules shall be constructed of a steel superstructure framework with external attachable side panels in steel or wood.

D. Self Supporting Skeleton Framework

1. The self supporting skeleton framework shall:

   a. Be installed onto the site in advance of any external finishing panels. The framework shall be fully capable of supporting all specified electronics without the need for attachment of any external panels.

   b. Be supplied with four sets of standard EIA rack rails per module, measured in standard rack unit (U) sizes, i.e. inner rack rails and outer rack rails in pairs, one pair of each type mounted at the front and rear of each modular section. Outer racks rails shall be removable.

   c. Be capable of being supplied to site in knock down (flat packed) form and be capable of assembly using interlocking tie bars and secure with bolts, without welding or carpentry work.

   d. Front and rear elevation individual modular frame sections shall be pre-welded, before delivery to site, and constructed of 14, 16 and 18 gauge sheet metal. Front and rear frame sections shall be secured together by use of removable14 gauge interlocking the bars and 1/4-20 bolts. All welds exposed to the front shall be filed smooth and sharp contours eliminated.

E. Base Pedestals

1. Pedestals to be at least 2.5" in height and capable of supporting fully loaded top module cabinets, with a maximum loading of 1000 lbs per pedestal.

2. An 18-gauge stainless steel kick plate cover shall be attached to the front section of pedestal.

3. A central through cable way shall be provided within each pedestal to allow access from under a raised floor into the enclosed console or vertical rack assembly.

4. Each pedestal shall include adjustable levelers providing for an adjustment of +/- (1 inch) per leveler, fitted to the pedestals or together with heavy-duty (2.5 inch) plate casters, (four each per pedestal).

5. Once the console is placed in the desired position it shall become possible to adjust the leveler, to a position, which exceeds the casters, own fixed position from the pedestals base.

F. Steel Exterior Finishing Panels

1. Exterior steel finishing panels of minimum 20 (1.0mm) gauge sheet metal shall be provided and attached to the self supporting superstructure framework. All fastening to be unseen from external view.
2. Side and rear finishing panels shall be either slide on or lift off type to facilitate ease of access for servicing, and shall not require any further mechanical support to provide a secure connection to the system. For permanent connection, additional external fastening shall be supplied.
3. Steel or wood finishing panels may be applied following final termination test and commissioning of the specified electronics or earlier as directed, to facilitate a timely and efficient installation and to minimize potential damage to the exterior of the system by others.

G. Finish and color

1. All exterior and frame steel components, including drawers, blank panels, and shelving shall be zinc oxide wash primer with a baked enamel paint finish of the following specifications:
   a. Side, top, and rear panels, drawers, shelving and blank filler panels are to be in the color approved by the DAA or his representative.
   b. Self-supporting frames and work surface supports are to be supplied in the color; approved by the DAA or his representative.
   c. All wooden components are to be supplied with a high-pressure laminate covering the MDF core.

H. Mounting Hardware

1. Mounting hardware for the specified electronics shall be available upon request. Panel bolts; washers, and clips with captive nuts suitable for use with EIA standard punched rack rails shall be included.
2. Slide kits, where appropriate, (including drawers), shall be of ball bearing operation. Friction or roller type slides are not acceptable.

I. Instructions

1. Fully detailed assembly instructions in the English language shall be supplied with both written and pictorial descriptions for each item/model numbered component.

J. Installation Requirements

1. Comply with the following design and installation requirements:
   a. Wire the line side of fuses or circuit breakers to a line side terminal strip for their incoming supply.
   b. Connect all power wires to terminal strips designated for power wiring.
   c. Connect all control wires to terminal strips designated for control wiring.
   d. Make vertical runs of power and control wiring within the panel on either or both of the right or left sides of the backboard.
   e. Enclose all vertical and horizontal wiring in “Panduit” - brand plastic wireways.
   f. Make minimal wire runs to and from these wireways only to the nearest adjacent terminal block.
   g. Splicing of control or power wiring within any workstation is not acceptable. All internal and external “field” wiring must be terminated on the appropriate workstation terminal strips.
   h. Appropriate sized insulated waterproof bushings shall be installed on all conduits or conduit fittings that enter the related workstation.

K. Panel Identification

1. The workstation must be identified with an I.D. Tag mounted on the outside face of the Panel Door on the upper left workstation door. The I.D. Tag shall identify the Workstation Designation:

2. The I.D. Tag shall be secured to the MCP door surface with a minimum of four rivets combined with an appropriate adhesive. Large tags shall require a minimum of four rivets, one for each corner of the tag.

L. Shop Drawings

1. Submit shop drawings to show:

   a. General Layouts of the Workstation

   b. Power, wiring and schematic diagrams

   c. Outline and wiring diagrams of all special devices

   d. Manufacturer's data for all components

M. Receptacles

1. In each enclosure or cabinet, include a minimum of one receptacle per electrical component powered from that enclosure/cabinet. The use of relocatable power taps/power strips or the chaining of power strips is not allowed to satisfy the above requirement.

N. Utility Outlet

1. In each enclosure or cabinet include a minimum of one appropriately fused grounded duplex receptacle utility outlet meeting locally applicable standards of 120 volt, 20-ampere capacity conveniently located within the panel.

2. The outlet is to be fed from the line side of the workstation or computer cabinet power source (supplied by others unless otherwise noted) so that the outlet power will remain on regardless of the condition of the workstation or computer cabinet power.

3. The hot wire providing power to the outlet shall be yellow. All terminations of this wire shall be guarded in order to protect personnel from accidental contact. Mount a warning on the outside of the panel, next to the disconnect switch stating: "CAUTION - THIS CONTROL CABINET CONTAINS YELLOW WIRES WHICH WILL REMAIN "HOT" WHEN THE DISCONNECT SWITCH IS TURNED OFF."

O. Lighting

1. Equip each enclosure or cabinet with an appropriately fused fluorescent lamp extending at least three quarters of the width of the panel. Operate the lamp by a switch located inside the enclosure on the latch side of the primary door so that the light becomes illuminated whenever the enclosure or cabinet door has been opened.

2. The lamp(s) is to be fed from the line side of the workstation or computer cabinet power source (supplied by others unless otherwise noted) so that the fluorescent lamp will remain on regardless of the condition of the workstation, or computer cabinet power.

3. The hot wire providing power to the lamp shall be yellow. All terminations of this wire shall be guarded in order to protect personnel from accidental contact. Mount a warning on the outside of the panel, next to the disconnect switch stating: "CAUTION - THIS CONTROL CABINET CONTAINS YELLOW WIRES WHICH WILL REMAIN "HOT" WHEN THE DISCONNECT SWITCH IS TURNED OFF."

P. Cooling Fans

1. Provide cooling fans whenever necessary to prevent internal temperatures from exceeding component environmental limits based on an ambient temperature of 100°F. Provide replaceable or cleanable filters on the intake vents where fans are used.

2.14 CONTROL SYSTEM DESIGN

A. General Design Requirements

1. This control system specification is intended to define the overall functional requirements of the system. The BHS Contractor is responsible for the definitive architecture and design which shall be subject to review and approval by the DAA or his representative.

2. The term "Control System" shall be understood to cover the control of all conveyors and sortation devices, as part of the BHS. The Control System consists of both BHS computer and PLC control systems. The BHS computer system shall act as the interface between the PLCs, EDS Systems, Building Maintenance Systems and any other external computer/control system that requires interface to the BHS. The BHS Contractor shall coordinate the required computer interfaces/protocols with the DAA or his representative or User Airlines

3. The design philosophy adopted for the control system is one of hierarchical control. Centralized supervisory and maintenance control shall be accomplished by fully redundant workstation computers. All the DAA's Outbound conveyor and sortation subsystems shall be controlled by centralized programmable logic controllers (PLCs) with Hot Back-up (Warm back-up) for redundancy purposes. De-centralized programmable logic controllers shall control all inbound subsystems. The outbound and inbound system status will be monitored by the central MDS workstation.

4. Baggage tracking shall start at the BDD and end after the TSA removal/reinsert queue conveyor.

5. Identify the philosophy on which this proposal is based and clearly identify in detail the proposed control system architecture, the major components to be utilized and the methodologies employed for software development. In addition, the following philosophy shall be adopted in the BHS control system design:

   a. No single fault can bring down the entire control system i.e. no single point of failure

   b. The system can be easily and economically enhanced to meet the future requirements in the next fifteen (15) years (e.g. add/increase hard drive(s), RAM capacity, increase operating speed (CPU upgraded) etc.)

6. Submittal of the proposal shall acknowledge the functional intent of the control system specification. Understanding the design shall be the result of modifications/refinements to the minimum requirements established herein. These changes shall not be the basis for increased cost requests.

7. Submit for the DAA or his representative's review and approval, a comprehensive and detailed system description. This description shall include full details of operational procedures and control system provisions associated with the BHS, including but not limited to the following:

   a. Control system development and implementation master schedule

   b. Schedule of system hardware employed (main elements)

   c. Interfaces to EDS devices

   d. Interfaces to BDDs

   e. Hand Held Scan Guns for ETD CBRA operations

   f. Start-up/shutdown procedures

   g. Description of conveyor control logic outlined by subsystem

   h. Data input and output routines (i.e., management/maintenance information systems)

   i. Automatic operational/maintenance/defect/status routines (including format)

   j. Audio/Visual indications

   k. Control station layouts/functions/operations

l. Fall-back/Anti-grid lock procedures

m. Redundancy schematics/provisions

n. Power supply requirements (including UPS schematics/redundancy and layout)

o. BHS Computer operator interface routines

p. Typical programming blocks

q. Maintenance Diagnostics System (MDS) – i.e., screens

r. MIS Reporting Functionality with Sample Report Formats

s. Communications Highways – Redundancy, Schematics and product specifications

t. Proposed overall system architectural diagram clearly identifying both upper and lower level controls with respective data communication highways; at a minimum all system PLCs (for the security screening requirements, tracking and system status), all computers/PLCs with functions of each clearly identified, printers, any UPS unit, Hubs (Ethernet, serial), Drivers, BDD and all associated array components (i.e., tachometer boxes, photocells, multiplexers), proposed networking and VPN access. Additionally, submit a schematic diagram with an outlined description that will clearly define the approach that will be taken to satisfy the specified requirements for BHS redundancy.

8. The BHS Contractor shall be available on-site to attend all meetings as required and will actively project manage the BHS design, design review process, documentation process etc. The BHS Contractor shall also be required to attend a minimum of two mandated control system meetings at the job site or the DAA's office to review the Control System Functional Specifications and Electrical Control System design. Submit material to be reviewed at the meetings at least two weeks prior to the meetings. The control system meetings attendance will include as a minimum representatives from the BHS Contractor, the General Contractor, CM and the DAA or his representative. The meetings shall review the following discussion items:

a. Design Considerations - Meeting No. 1

1.) Computer and PLC System Architecture

2.) Baggage System Computers including Redundancy requirements

3.) PLCs including Redundancy requirements

4.) PLC/Computer Systems - Power Requirements (including UPS requirements) and MCP sizes

5.) BHS Computer Interface Requirements

a.) Hardware Requirements

b.) Software Requirements

c.) EDS Security Systems Interface Requirements

d.) BDD Hardware, Software and Interface Requirements

e.) Interface Requirements to the DAA's Reservation Network if required

f.) Fire/Security Door and Security Card Swipe Interfaces

g.) Production/Testing Schedule

h.) Redundancy Requirements

6.) Subsystem control functions Baggage Flow/Logic/PLC Control. As a minimum review the following:

a.) Start-up/Shutdown Procedures

b.) Jam Detection and "Restart" Procedures

c.) Cascade Operation

d.) Emergency Stop and "Restart" Procedures

e.) Audio/visual indications and locations

f.) Fire/Security Door and Security Card Swipe Procedures

g.) Anti-grid Lock Procedures for EDS and Sortation Subsystems

h.) Fallback Procedures

i.) General Control Logic per Subsystem

7.) EDS Subsystems. As a minimum review the following:

a.) Tracking requirements throughout the EDS system for all levels of screening

b.) Start up/shut down procedures

c.) Test Mode

d.) Insert Mode

e.) Bag ID# Assignment

f.) BMTT

g.) Fail safe measures

h.) EDS Device prioritization

i.) EDS Reports

j.) DID design

k.) Anti-grid lock measures for EDS and Sortation Subsystems

l.) CBRA Description of Operation

b. Design Review - Meeting No. 2

1.) Updates to previous meeting

2.)

a.)

b.)

c.)

d.)

e.)

f.)

g.)

h.)

i.)

3.)

a.)

b.)

c.)

d.)

e.)

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i.)

j.)

k.)

l.)

4.) Maintenance Information System (MIS) Review

a.) Reports to be developed as defined within this specification.

b.) Sample screens and sample reports

5.) Electrical System Drawing Review

6.) Maintenance Diagnostics System (MDS) Review

a.) Specification Requirements

b.) Problem Resolution

c.) Paging System Alarms and VPN network accessibility

d.) Sample Screens

7.) Subsystem Control Elements

9. Control System Elements

a. The control system (comprised of the High Level Controls and Low Level Controls) shall comprise (as a minimum) the following elements:

1.) MDS Computers which allow for the following functions:

a.) Automatic switching to a "hot back up" fully redundant MDS computer.

b.) Collect and store data from the field PLCs to include in reports and status displays at the BHS workstation.

c.) Software program(s) as required to accomplish the functions specified herein.

2.) BHS workstation which allow for the following functions:

a.) Software program(s) as required to accomplish the functions specified herein.

b.) Keyboard units for command and data input to the sortation control system.

c.) Video Display Units (VDU) for data output.

d.) High-speed line and laser printers.

e.) Communication modems.

f.) Transfer switches/interface modules/selector switches.

3.) Communications highways

4.) Local Area Networks (LANs)

b. The new control system shall comprise (as a minimum) the following elements which are considered to be a part of the Low Level Network:

1.) Subsystem MCPs

2.) Programmable Logic Controllers (PLCs), which control the BHS by communicating with the device, level equipment (photocells, motor starters, encoders, etc.)

3.) Remote I/O located in the subsystem MCPs grouped by mainline.

10. Hardware: All control systems hardware for the BHS Computer and the BHS PLC systems, and associated purchased software shall be supplied by manufacturers whose products are supported locally, and can demonstrate a minimum of five (5) years experience in providing control systems for conveyor systems of similar size. The DAA or his representative must approve any equipment that does not meet this requirement.

11. Computer/Controls Electrical Supply

a. The supplied computer/control systems and equipment shall be compatible with, and operate reliably and effectively with, the normal electrical supply typically available. The equipment shall not be unduly sensitive to fluctuations in supply voltage which may typically vary by plus or minus ten percent (10%) of nominal values. Electrical power supply filters/conditioners and regulators shall be supplied for all equipment, which cannot meet the specifications stipulated.

b. The electrical supply distribution system has been designed to provide flow redundancy in all cases, in effect creating two independently powered baggage-handling systems. For example, portions of the system are powered (and controlled) from independent conduit feeds, motor control panel, 480 volt MCP feeders, switchgear buses, transformers and high voltage feeders such that a failure of any power source element will not affect any more than 50% of the BHS processing capability of multiple subsystems of the same type. Ensure both power and control system design (including data communications highways, UPS etc.) are based on a minimum requirement of 50% systems redundancy.

c. All BHS Computers and all PLCs for outbound and EDS subsystems for which baggage tracking is required shall employ an Uninterruptible Power Supply (UPS) system(s) capable of storing data for a minimum period of two (2) hours should a power outage occur. All tracking data shall be stored in the PLCs during a power outage so that when power is restored and the conveyors begin running again, baggage will be sent to the appropriate output.

12. System Design Parameters

a. The system design shall pay particular attention to the following requirements (listed in random order):

1.) High throughput capacity

2.) Energy conservation

3.) Satisfactory environment

4.) Operational flexibility

5.) Component and system reliability (including back-up provisions)

6.) High storage capacity upstream of merge points and EDS devices to absorb input peaks, etc., without system saturation.

7.) Multiple flow paths to permit continued operations despite equipment failure or momentary peaks.

8.) Default capability (anti-grid lock) to ensure that in the case of saturation of any subsystem a back-up and fail-safe alternate process path or discharge point is available (i.e., in no case shall total system saturation occur). The BHS Contractor shall provide "anti-gridlock" software.

13. Environment: All communication and equipment must be capable of functioning in an industrial environment. Where special environmental conditions are essential for correct equipment operation (e.g. computer hardware), such requirements control must be clearly identified in the submittals identified in this specification. Factors such as dust, air contamination, and heat from local sources, abrasives, moving or falling objects, or vibration shall also be considered. Advise of the necessity for these provisions as well as the specific requirements for each system.

14. Responsibility for Supply and Installation

a. Supply and install all Baggage Handling Control Room and Control System hardware. This includes control consoles and mounting structures for the monitors.

b. The General Contractor shall supply hardware, which is designated in this specification document to be provided by the DAA.

c. The BHS Contractor shall be required to coordinate the requirements of the control system elements in the console with the console supplier, the DAA or his representative.

15. Responsibility for Programming

a. Program the BHS Computers and PLCs for all conveying, sortation, and reporting functions associated with the project. Program the control system interfaces between the BHS and any other interfacing system.

b. Program all monitoring system functions, associated with the BHS project. These functions shall include:

1.) The provision of audible and visual system alarms at the workstation(s) (e.g. both on the computer monitor and on the printers).

2.) Real time reaction to a failure and the capability of choosing alternate paths from the monitoring system.

c. Programming techniques, data structures, and documentation shall be acceptable to, and approved by, the DAA or his representative. Details of the above shall be made available to the DAA or his representative.

d. Submit the as-built programming documentation for the BHS computers, PLCs or system monitoring computers to the DAA as follows:

1.) Two complete (duplicate) CD sets covering all applicable computer, PLC and system monitoring programming documentation.

2.) Two complete (duplicate) sets of hard copy documentation (both programs).

3.) Software for the BHS computer systems as well as the BHS PLC control system including all PLC ladder logic shall be provided in both searchable .pdf format and software versions.

4.) The system software shall be written using as much non-proprietary software as possible.

5.) Delivered software shall include both executable files and fully commented source code for all applications (with the exception of purchased "off the shelf" software). The BHS Contractor shall also include all 3rd party software required to view or edit the source code. If the BHS Contractor wishes to invoke "prior intellectual property" rights and withhold source code for any system software a "software escrow account" for all withheld source code; as well as documentation required to reconstruct the executables, must be established with an reputable escrow service company at the BHS Contractors expense. This software escrow account must provide the DAA access to the source code and documentation for a minimum of 10 years. Access to the escrowed information will be authorized in the event of the BHS Contractors inability to correct design errors in the software, contract default, insolvency or termination of business activities.

16. System Redundancy

a. Failure of primary redundant equipment shall not degrade the response time of the control system. In the worst-case scenario where every piece of primary equipment has failed there shall be no impact on system performance whatever the combination of the failure.

b. The BHS shall reconfigure itself automatically after redundant hardware takes control (the secondary system will become the primary, the failed system will become the secondary when it comes back on-line). The switch over handled by the system shall be fully automatic without need for any operator intervention for the reconfiguration. The BHS shall report any hardware failure, power failure, communication loss, etc., raise a critical alarm and inform the maintenance personnel through both display on the text monitor(s) and by an audible alarm.

c. When the system is running on the UPS(s) during a power failure, the BHS shall monitor the UPS(s) battery level, raise a critical alarm and inform the maintenance personnel through display on the text monitor(s) and audible alarm when the battery level becomes critical, this will allow the BHS Control Room operator sufficient time to do a systematic shutdown of the BHS computer system. The system should monitor the state of the UPS at all times to insure that the required power backup functionality is always available, raise an alarm on the MDS if the battery level becomes critical.

d. Backup equipment where provided shall be used as redundant equipment. All hardware, software, networking and system architecture shall comply with the requirements for a redundant system.

B. Computer and PLC Control System Architecture

1. General

a. The Control System Architecture for the Duluth Outbound BHS and Mini In-line EDS security systems shall be one of centralized PLC design (with centralized or remote I/O) and centralized BHS computer design. The control system will primarily be controlled by new PLCs, these PLCs interface with two types of equipment:

1.) BHS field devices (motors, sensors scanners, encoders, etc.)

2.) BHS/MDS computers

b. The BHS conveyor control system shall be based on multiple Programmable Logic Controllers (PLCs), interconnected to each other by the BHS low-level data communication highways. The BHS has been designed with two main power feeds i.e. if one power feed fails at least 50% of the bag system will remain in operation with its own redundant PLC

c. Local area networks (high level communications) shall be employed to provide data messaging between the BHS computers.

d. The BHS computers shall provide two (2) ports for each of the interfaces on each of the BHS server computers. It shall be the BHS Contractors responsibility to ensure, that a single connection failure does not impede the BHS operation.

e. The BHS computers shall serve three primary functions:

1.) Database processing

2.) Monitoring of the status of the system

3.) Statistical information storage and presentation i.e. Reports

f. The Control system architecture presented herein is intended to convey the minimum functional system requirements. The BHS Contractor shall consider the following:

1.) Centralizing the entire DAA's outbound BHS computers (primary and hot back-up) and PLC equipment at the computer/operation room and utilizing remote or centralized I/O.

2.) Inbound BHS PLC equipment (primary and cold back-up) located within the Motor Control Panels with system status monitoring at the computer/operation room.

3.) Utilization of multiple PC based computers.

4.) The BHS contractor shall provide startup warning alarms and sufficient startup delay to comply with OSHA standards on all new and existing conveyors.

5.) The BHS contractor will be responsible for all necessary controls (photoeye, belt tachometers, control stations, etc.) for new conveyors.

2. Baggage System Computer System Functional Description

a. The primary function of the Baggage System Computers is the control of the baggage flow in the BHS.

b. The Baggage System Computers shall also accomplish the following management information system tasks:

1.) Online statistical report generation

2.) Online maintenance report generation

3.) It shall be possible to both view on screen and print any report.

c. Each Baggage System Computer shall be identical in that emulation of any subsystem or function can be accomplished from any workstation.

d. In the case of main power supply failure the system must protect the complete database by means of battery powered data storage, such that re-entry of data is not required after power has been re-established. The battery powered storage system shall give a minimum storage period of 2 hours. The system is to automatically perform a safe shutdown when the UPS registers a low power situation.

e. A simple means to test computers for online capability and subsystem control (if a failure is suspected) shall be provided by means of an operator initiated self-testing routine i.e. using pull down menus. In addition, computers shall carry out automatic self-testing routines each time they are switched on for operation.

f. Provide a means to monitor Computer System Performance. Provide a warning on the MDS when the computer system may be close to a "Gridlock" situation, i.e. less than 20% memory capacity.

g. Processor and data storage capacity shall be sized to permit up to a 33% increase of processing and storage capacity. Further capacity increase shall be possible by addition of expansion modules.

h. The process computers shall have the capability of storing, sorting and processing up to a minimum of one million (1,000,000) current bag tag number records.

3. BHS Computers/MDS Computers

a. The computer control system shall comprise all equipment that will be used for the tracking of all baggage input into the system baggage load points through the EDS device to the CBRA removal points.

b. The sortation control system equipment and function shall provide for both visual as well as hard copy fault and production monitoring at the workstation, as noted elsewhere in this section of the specification, for the entire outbound baggage system.

c. Application codes and configuration data shall preferably be executed directly from RAM reads instead of loading from mechanical devices such as hard disk. These application programs stored in the RAM should allow remote access for modification and the ability to download revised codes. Only voluminous operational field switching and status data shall be copied and archived to hard disk.

d. The task of the servers is the data administration on the entire control system. The servers handle the storage and retrieval of configuration data, graphics, and field switching records, BHS status, and other databases information. The computer systems require the use of “off the shelf” windows based operating system for both BHS computers and MDS computers.

e. The following applications, as a minimum, shall have their own redundant set of servers:

1.) MDS computers

2.) BHS computers

f. Redundant sortation controller servers shall be located in the baggage control room (BCR). These servers form a redundant arrangement with direct link data communication through the redundant arrangement such as Marathon with a heartbeat connection. Each set of servers keep identical data (data to include, but not limited to sort tables, etc.) so that in the event of a server failure, all data for operations are already resident and up to date with virtually no break except for time required for re-configuration. Failure of either main or backup server shall initiate a critical alarm (consisting of an audible alarm at the Operator Workstation and text/visual alarm annunciated on the MDS/Operator Workstation).

g. A dual redundant file server/ host computer configuration shall be provided for each sortation server set. In normal operation Server 1 will be the master. Should Server 1 fail due to a fault then, Server 2 shall take over control automatically with no loss of data or data integrity. Server 2 will then be the master and once server 1 comes back on line it will become the backup.

h. The redundant servers must be configured as high availability and in any case of failure switchover shall be seamless. The server configuration shall feature hot swappable components (hard drives, fans, power supplies and memory. Data storage shall feature as least the equivalent to RAID Level 5 redundancy.

i. Provide the latest available “state of the art” technology that will fulfill the system performance requirements, at time of procurement for the server hardware:

1.) Hard disk storage shall be sized for storage of minimum 1-years storage of all data records with a 50% spare capacity. This may need to be upgraded from specified minimum at BHS Contractor’s cost to cater for the specified archiving needs if found insufficient. The BHS Contractor shall also take into consideration the total BSM messages received per day in sizing the hard disk space required.

2.) Video adaptor card that supports at least 1024x768 resolution at 16 bit colors at refresh rate of 80hz

3.) Monitor: Two –(2) 15" Flat Panel LCD Monitors

4.) Dual processors, minimum of 2Ghz each

5.) Minimum 4 GB RAM expandable to 16 GB

6.) High speed network interface cards (10/100Mbps)

7.) DVD +/- R/W Drive or equivalent

8.) USB Keyboard and mouse.

9.) Dual hot-swappable power supplies with UPS.

10.) Dual hot-swappable fans

11.) All operating systems, diagnostic software, anti virus software, disk management software tools, software drivers for Hard disk arrays, CD-ROM drivers, etc, shall be provided.

j. All computer hardware shall be stored in standard off the shelf computer rack shelving systems that are made for industrial computer component racking.

4. Workstation System and Equipment

   a. The Operator Workstations shall provide the operator interface to the BHS Control and MDS systems. Operators shall be able to input and update sort correlation tables (if provided) from any workstation. Operators shall also be able to produce statistical reports as specified herein. The Operator Workstations shall also serve as the Operator interface to the MDS allowing operators to monitor the status of the system, respond to faults, configure equipment control, etc. Production of custom reports from the databases maintained by the BHS and MDS computers shall be possible with the use of off-the-shelf software supplied as part of the system.

   b. The workstations shall require log-on procedures with predefined user names and associated passwords. The workstations shall enable and disable certain functions depending on user name. Each Operator Workstation shall operate independently of the others, however, it shall be possible to determine the status of and users logged on to any other workstation (with appropriate user name and password).

   c. There shall be one (1) Operator Workstations in the control room, and shall be provided with two monitors and other hardware (e.g. CPUs, keyboards, etc.) as described elsewhere in this specification. The Workstation shall be capable of controlling the BHS. It shall be possible to configure the workstation in any of the modes listed below. Switching between modes shall take a maximum of five (5) seconds.

   d. Modes:

      1.) When accessing the MDS application - both monitors acting in concert to graphically display the entire system with a floating pointer between the two monitors. When zooming in on a section of the system, only the monitor that displays that section of the system in the overview screen shall show the larger scale area of the system requested by the operator while the other screen shall remain showing its half of the overview screen. In this mode, a three-line text bar shall appear at the bottom of one of the monitors to display system faults in text. The textual display shall scroll showing the most recent, unacknowledged or uncorrected, highest priority faults.

      2.) When accessing the MDS application - one monitor graphically displaying the entire system and one monitor providing a textual display of alarms. It shall be possible to configure the text display to display alarms based on different sort criteria such as highest priority, unacknowledged/uncorrected, by alarm time stamp, etc. It shall be possible to configure either screen as the text or graphics monitor.

      3.) When accessing other applications - one monitor graphically showing the system status with a five line text bar appearing at the bottom of one of the monitors to display system faults in text. The textual display shall scroll showing the most recent, unacknowledged or uncorrected, highest priority faults. The graphical display shall be that display which was left on that monitor when changing from the MDS application to another application. The other monitor shall provide the display for the application being accessed at the Operator Workstation and the keyboard and mouse shall provide input for the current application. It shall be possible to configure either screen to display the above information.

      4.) When accessing other applications - one monitor providing a textual display of alarms. The configuration of the textual display shall be that configuration which was last defined for the textual display in the MDS application. The other monitor shall provide the display for the application being accessed at the Operator Workstation and the keyboard and mouse shall provide input for the current application. It shall be possible to configure either screen to display the above information.

   e. All aspects of the BHS shall be controlled and monitored by the BHS workstations. The BHS workstation computer equipment shall be housed in workstation type cabinet(s) located in the control room.

   f. The MDS computer system shall be off the shelf, currently supported by the vendor. The type of computer equipment included in the bid shall be clearly identified. It should be noted that the below listed requirements are minimum requirements, all hardware and software to be provided shall be considered to be “state of the art” at the time of the bid award. The minimum hardware specification for the workstations comprises the following:

1.) Processor: 2.4 GHz or higher.

2.) Minimum 4 GB RAM expandable to 16 GB

3.) Minimum 2 MB Cache

4.) Hard disk drive (HDD): Mirror Fast SCSI-2 hard disk with redundant I/O channel. Minimum of two – (2) devices with each having a minimum storage capacity of 72 GB (10K rpm).

5.) Video adaptor card that supports at least 1024x768 resolution at 16 bit colors at refresh rate of 80hz with support for dual monitor

6.) Two –(2) 21" Flat Panel LCD Monitors

7.) High speed network interface cards (100 Mbps or better)

8.) Minimum 2 x 100 MB Ethernet ports

9.) DVD +/- R/W Drive or equivalent

10.) USB Keyboard and mouse.

11.) High Speed Laser Printer

12.) Built-in I/O should have serial interface ports, parallel interface ports and USB ports.

g. A detailed description of the workstations shall be submitted to the DAA or his representative prior to determining bid award.

h. All operating systems, diagnostic software, anti virus software, disk management software tools, software drivers for Hard disk arrays, DVD/CD-ROM drivers, etc, shall be provided.

5. Workstation Control System

a. The design and operation of the Workstation Sortation Control System is to be modeled after the design and operation as basically described herein.

b. The description of operation and required equipment is provided as a basic guideline and should not be construed as being all-inclusive.

c. The Workstation Sortation Control System software/logic shall be structured on "off the shelf" products that are readily available. The license for these products and any non "off the shelf" software/logic used for this specific baggage sortation control system shall become the property of the DAA. Such ownership will assure that the DAA will have all logic/software source codes, diagrams, passwords, keys, listings, and all other appropriate documentation to fully maintain and modify this system after the expiration of the Warranty Period.

d. The Workstation shall be protected with a continuously running computer virus protection program. The BHS Contractor shall submit details of the anti-virus protection program (i.e. manufacturer) to the DAA or his representative for approval.

e. To accommodate the normal daily flight schedules, this system shall be capable of running 24 hours a day, 7 days a week, 52 weeks per year. It is understood that there will be periods during the day/night (dependent on the flight schedule) when the BHS system will not be processing baggage to allow periodic maintenance etc. of the computer systems.

6. Workstation Basic Functions

a. All workstations shall house the same software and be interchangeable with any workstation. This process shall be as simple as unplugging one workstation and plugging in the replacement.

b. All workstations (with the correct security level) shall have the ability to program the PLCs

c. The Workstation is composed of multiple computing nodes configured in a redundant, independent arrangement to provide the following basic functions:

1.) Collect data from the PLCs to include in reports and status displays.

2.) Provide Operations and Maintenance Reports, both printed and on-screen, reflecting system status in the areas of the following. It shall be possible to print any viewed message on the screen. Reports shall be capable of selecting and printing weekly, monthly, and yearly updates. Specific report requirements are detailed elsewhere in this specification, however, in general, reports for the following shall be required:

a.) Throughput (number of bags processed for each subsystem). Selectable in 0 to 60 minute intervals.

b.) Equipment operating/malfunction performance summary for each subsystem and individual item

c.) System communications behavior

d.) Flight and Tag Table information

e.) Run out report

f.) EDS Report

g.) Day end report (selectable as Print Daily, Weekly, Monthly, Yearly)

h.) Active flight report

i.) Permanent flight report

j.) Inbound baggage report

k.) Computer and PLC status report

l.) Individual PLC status report

3.) Display system status and fault conditions on graphic screens, text screens, and printers, indicating the following (this listing is not to be construed as being all inclusive):

a.) Communications Integrity

b.) Tach/Shaft Encoder Status: Tach out of limits

c.) HSD Status: Overload, Failed Extended, E-Stopped, Failed at home, Divert All, etc.

d.) Conveyor Status: Timed out, Running, Cascade, E-Stopped, Jammed, Overload, etc.

e.) Oddsize Sort Pier Status: Timed out, Running, Cascade, E-Stopped, Jammed, Overload, Full, Reverse, etc.

f.) BDD Array Status: Array failure, statistics per array. Provide audible fault annunciation at the BHS Computer workstation for any failure that occurs at the BDD array. Failures include photocell failure, tach failure, head failure, etc.

g.) EDS Device Status: Timed out, Failed, Restart, etc.

4.) Monitor PLC I/O to sense bag movement; issue sort directives to PLCs to direct bag movement.

5.) Provide for system re-route/re-configuration.

6.) Allow maintenance and supervisory personnel password protected access to PLC programming software. Provide two (2) levels:

a.) Monitor mode

b.) Program mode

7.) Provide a visual indication (e.g. hour glass) to indicate that the computer processors are processing and are running. Display status of a process or processor that is predicated on another process or processor.

d. Main Menu Options

1.) The following list depicts the menu structure available to an operator from the remote Workstation. Menus are displayed as pop-up windows when the operator presses the associated letter or uses the cursor and enter keys to make choices. The escape key allows one to back out of a menu or dialog box. Some menu choices lead to interactive dialog boxes where the operator may be prompted to enter additional data, i.e., Flight Table information.

2.) Additionally, accompanying text identifies and describes each available Main Menu option. This same text is also to be displayed when corresponding items are chosen from the Help Menu screen.

3.) Main Menu Options and Help Menu Screen. The following are samples of the types of main menu and help menu screens that should be available, the BHS Contractor shall submit to the DAA or his representative examples of the screens that are to be utilized for review and approval:

a.) Using the Keyboard

b.) Utilities

c.) Operations Report

d.) Maintenance Report

e.) Problem Resolution Text

f.) Sortation Tables

g.) Sortation File Utilities

h.) Others as required to provide specified function

4.) Using the Keyboard/Mouse: The workstation system uses the keyboard or mouse to make menu selections and to accept data from the user.

5.) Utilities

a.) The Utilities Menu is a group of commands that are used for general-purpose needs. The options for this menu are noted below:

(1.) Clear all Statistics: Clears ALL of the statistics that are kept by the workstation, the sortation controller(s), and the programmable logic controllers. These statistics are kept on a daily basis. Once they are cleared, they cannot be recovered without a password entry and second level confirmation.

(2.) Change System Date: Used to set the system date on the workstation system.

(3.) Change System Time: Used to set the system time on the workstation system.

(4.) Coordinate System Times: Used to update the system time on all system sortation, computer and programmable logic controllers.

(5.) Off Line Editor: Used to access the Off-Line Flight Table editor to make changes to the flight tables or add flights.

(6.) Change Alarm Printout Spacing: Used to change the spacing between alarm messages on the alarms printer.

(7.) Exit to PLC Programming Software: Used to exit normal operational mode and enter into a password protected, maintenance function, for PLC programming and diagnostics functions.

(8.) Run Diagnostic Tools: Used to automatically run computer and software diagnostic tools to check on functionality of workstation computers and software.

(9.) Others as required to provide specified function

6.) Operations Reports: The Operations Reports are used to monitor the daily functions of the system. Reports may be printed to the printer or displayed on the screen or can be transferred to a file in CSV format. Specific report requirements are defined elsewhere in this specification.

7.) Maintenance Reports: The Maintenance Reports are used to monitor the status of the pieces of equipment in the system and to diagnose any problems that might arise. Reports may be printed to the printer or displayed on the screen. Specific report requirements are defined in the Management Information System (MIS) section in this specification.

8.) Problem Resolution Text

a.) Problem Resolution Text is a tool to help correct problems that arise with the conveyor system. When a fault occurs, it will have a number next to the description that appears on the system alarm printer.

b.) A selection can be made from the Problem Resolution option on the Main Menu for the appropriate text.

c.) The text will state the problem, followed with the proper primary action that should be taken. As is appropriate, additional actions for correction of the problem will also be listed in the text.

d.) A brief listing of the problems includes the following. However, this listing is not to be construed as being all inclusive:

(1.) Jammed Bag

(2.) HSD Jam

(3.) Motor Overload

(4.) HSD Failed at Home

(5.) Belt Tach/Shaft Encoder Failure (tach out of limits)

(6.) Missing Bag Jam

(7.) PLC Communications Line Failure

(8.) Off-Line Update Failure

e.) Operator shall have the ability to change, edit, and save all problem resolution text.

9.) Override Capability: It shall be possible, through appropriate operator input at the operator workstation to individually override automatic control of a conveyor thereby allowing the conveyor to run despite a sensor or other such failure. An appropriate graphical and text display shall be provided for conveyors in this “override” mode of operation. Override control of security critical components such as pushers to security screening shall require appropriate high level password protection. Any overridden condition of a security critical component shall be prominently annunciated on the MDS. Start up warning and e-stop functionality shall remain intact despite an override condition. Public area conveyors shall not have override capability. Coordinate the specific override requirements and functionality with the DAA or his representative

C. EDS Security Screening Devices

1. The System shall interface directly with the EDS security screening devices. Allow for the transmission of data pertaining to individual bag security status (e.g. cleared, suspect, etc.). The Control System shall allow for bag routing contingent on security status.

2. Allow for the initiation of an EDS security screening report to be included with the provided MIS reports. The security screening report shall include information regarding the number of bags assigned each security status (e.g. cleared, suspect, etc.), and the resulting bag routing.

3. Refer to the CT-80 Site Planning and Integration Guidelines for all interface requirements.

D. Building Fire System

1. The BHS System shall interface directly with the building fire system (via the DAA's network). The BHS Contractor shall be responsible to coordinate with the Fire Marshal for the location of all fire zones and for the shut down of conveyors, fire doors, etc. impacted by a fire alarm.

2. Clearly display alarmed fire zone(s) on the MDS display

3. Provide the ability to override a fire alarm signal if the alarm is proved to not be an actual alarm thereby keeping the BHS operational.

E. Programmable Logic Controller (PLC) Functional Description

1. Provide Programmable Logic Controller(s) (PLCs) for direct interface between all input and output devices in the BHS. Wire emergency stop circuits through mechanical control relays which, when interrupted, will remove all power from the output modules of the PLC.

2. Provide each PLC with an EPROM or similar safeguard to provide memory backup.

3. Provide PLCs with Ethernet capability for connection to external devices, such as workstations, etc.

4. Provide each PLC with a minimum of 35% excess memory or capacity for 25% expansion and each I/O with space for adding 25% more modules.

5. Input/output (I/O) modules shall have a visual indication of the status of each I/O point. The status displayed shall be for both signals input into each I/O module and the output signal from each I/O module

6. Provide a fully annotated printout as well as a software copy of the up-to-date PLC software and program.

7. All PLCs shall employ a battery back-up system capable of storing data for a minimum period of two hours, should a power outage occur.

8. In the event of an emergency stop or a power outage on a subsystem, the PLC shall retain all baggage tracking information such that upon restart of the conveyors, the subsystem shall route bags to the appropriate location(s).

9. Provide primary and backup PLCs. Each of the DAA's Outbound System PLC/subsystem shall be provided with a hot backup redundant fully programmed PLC, containing the same software/control functions of the respective primary PLC/subsystem. The minimum requirements for primary and back up PLC are described in the "Programmable Logic Controller Functional Description" section of this specification.

10. All inbound and oddsize system Programmable Logic Controllers (PLCs) shall be backed up with an arrangement that permits quick replacement of a failed controller processor with a pre-loaded replacement controller processor (cold back up). Quick replacement shall mean quick cable disconnection and removal of mounting bolts.

11. Provide additional "Hot-Back-up" PLC systems (to control e.g., separate subsystems) if the scan times of the primary "Hot-Back-up" PLCs are too excessive that they cannot carry all the operations of the system (e.g., controls, tracking, EDS interfaces, Communications, HMI. The PLC scan-times for periodic tasks and continuous tasks shall be monitored by the system controls and displayed on the MDS with three different LED indications (e.g., normal, above normal and critical). Above normal and critical PLC scan-time conditions shall be reported to the MIS. MDS and MIS reports shall be available at acceptance testing.

12. The primary function of the Programmable Logic Controllers (PLCs) shall be the control of all conveyors including, but not limited to:

    a. Tracking of baggage on conveyors from shaft encoders and strategically located photoelectric sensors for verification.

    b. Tracking shall be of shift register methodology; the use of FIFO shall not be implemented.

    c. Jam detection

    d. Normal Start/stop routines

    e. Auto-Stop/Auto-Start timing circuits and start-up routines

    f. Actuation of diverters, etc.

    g. Cascade stop control

    h. Inch-and-Store control, start/stop routines

    i. Control of associated feed conveyors

    j. EDS/BHS interfaces

    k. Confirmation of bag received on the make-up device

    l. Scanner Array Interfaces

    m. Statistical reporting to the host computers

    n. Selection of alternate flow paths in the event of a failure

    o. Self-diagnostics

13. All PLCs interface modules and I/O cards shall be located in MCP cabinets as specified herein.

14. Commonality of PLC manufacturers shall be maintained utilizing the minimum number of individual models.

15. All BHS equipment associated with the outbound automated sortation system shall have PLCs that are configured in "hot back-up mode". Hot Back-up refers to a control component that is concurrently tied into the I/O structure along with the associated primary component. In the event of a primary component failure, the hot back-up component shall retain the latest current status of the related system and shall assume full operation automatically. Up until primary component failure, no output from the back-up unit is transmitted. In the event of a failure, the back-up processor shall immediately take over control of the system without interruption to the processing of baggage. The configuration of the PLCs shall ensure that all bag tracking information shall be continuously updated to both the on-line as well as the hot back-up unit. All tracking information shall be maintained during the switch over from primary to back-up processor. However, only the on-line PLC shall be controlling the operating baggage system. It shall be possible to reset the failed processor without affecting baggage processing so that the system is once again in a fully redundant configuration. Failure of a processor shall be annunciated at the workstation or Touch Screen Terminal both visually and audibly.

F. Baggage Tracking Verification

1. EDS Baggage Tracking Verification

a. The system shall accurately track baggage in the EDS matrix to its final decision location. The BHS Contractor is responsible for ensuring the shaft encoder model chosen is applicable to meet the EDS subsystem tracking criteria based on conveyor belt speed/resolution required (i.e. shaft encoders utilized for tracking within an EDS system (slow speed tracking area) may be a different model compared to those required for sortation system tracking (high speed tracking area)).

b. If a bag gets out of its respective “tracking window”, that bag shall be tracked as an “unknown bag” to level 3. The Baggage System Computer System shall generate appropriate fault messages indicating the “unknown bag”.

c. All baggage dimensioned by the BDD arrays shall be verified for proper destination. If a bag has been successfully dimensioned by the BDD or tracked from the EDS device but fails to appear at any EDS subsystem tracking photocell, that bag shall be identified as a missing bag by the tracking control system. Three missing bags at a tracking photocell shall cause the tracking control system to automatically stop the associated conveyors and declare a “missing bag jam”. Note that all missing bag occurrences shall be reported regardless if they are singular or multiple occurrences.

G. Baggage Dimensioning Device

1. General

a. The Baggage Dimensioning Device shall operate without malfunction within a temperature range of 15° F to 120° F (-10 to 50°C) with a relative humidity of 0 to 90% non-condensing. If the Baggage Dimensioning Device or components cannot operate within this range, provide enclosures with the proper environmental control devices such as but not limited to heating, cooling, ventilation, and filtering of airborne contaminants to provide an operating environment to conform with the manufacturer’s electrical, and mechanical requirements. If the enclosures are fitted with access covers that must be removed for maintenance, hinge such covers and utilize integral fasteners.

b. Type of Baggage Dimensioning Device selected shall be UL listed and CE compliant.

c. Consider the accuracy, reliability and maintainability in the selection of the Baggage Dimensioning Device. Make the Baggage Dimensioning Device (and its major sub-assemblies) of modular design.

d. The Baggage Dimensioning Device must be capable of sizing length, width, height and volume of any item with the baggage characteristics specified within Part I of this specification regardless of the orientation of the item on the conveyor belt.

e. Design the Baggage Dimensioning Device capable of accurately sizing a minimum of 80 items per minute being transported at speeds of 400 fpm with a minimum separation of 3" between items.

f. The Baggage Dimensioning Device shall accurately size 99% of all items that pass through the array. Any item that is detected by the bag present photocell but not sized by the Dimensioner shall be treated and acted upon as an out of gauge item by the BHS.

g. Submit to the DAA or his representative the Baggage Dimensioner system control, interface and redundancy procedures for review and approval.

h. The continued operation of the Baggage Dimensioning device is very critical to the operation of the BHS for this project as such, do not allow any single failure to cause a total Baggage Dimensioning array shut down, i.e. there shall be a fully automatic redundant “Hot Back-up” dimensioning device, photocell, photo cell array, belt tach etc.

i. The Baggage Dimensioning system will detect when a photocell or belt tach failure occurs and enunciate the fault condition both at the dimensioning array locally as well as at the workstation computer. Report any Baggage Dimensioning Device failure to the BHS system monitoring system.

j. Provide as a minimum a RS232 or RS422 serial port, user selectable.

k. The type of belt tach selected shall be shaft mounted.

l. Supply appropriate communications software for the collection and analysis of statistical data for maintenance purposes. Provide to the DAA or his representative copies of all operating and diagnostic programs.

m. The types of Baggage Dimensioning that are acceptable for this project are:

1.) Over the Belt Type Dimensioner

n. Prior to selecting a Baggage Dimensioning Device, demonstrate to the DAA or his representative that the proposed baggage dimensioning system will successfully size all items as specified above.

2. Over the Belt Type Dimensioner

a. Design the Baggage Dimensioning Device to meet or exceed the Bureau of Radiological Health Safety Specifications for Class II laser devices.

b. Protect the laser beam window apertures, where recessed, by a transparent surface-mounted lens cover to facilitate cleaning of dust and dirt. A laser beam window aperture with an integral sealed lens is also acceptable.

c. To prevent the possibility of two items that are touching each other being sent to the sortation system, the Baggage Dimensioning array shall be able to detect multiple bags (one or more with wheels that are touching (seen as one (1) object) and treat them as an out of gauge item (regardless of actual length measured). In lieu of a single photocell to detect bag present the use of a 12" photocell array mounted in a gap in the conveyor sideguard is acceptable.

H. Network

1. General

a. The BHS high-level and low-level data communication networks specifications and requirements as mentioned in this specification are written based on the best hardware, software and network concepts/designs that are available in the market today. Install the latest and best hardware, software and network concepts/designs that is available in the market at the point of installation.

b. Submit the following information with regards to the network design issues at the point of bidding to the DAA or his representative:

1.) Performance of the network

2.) Security: No single point of failure

3.) All the protocols to be used

4.) Quality of service in terms of bandwidth management

5.) Installation and site management

6.) Evolution of the network devices

7.) Knowledge transfer

8.) Network architecture and design

2. High Level Network Coordinate network requirements with client; request if any specific components shall be used from client

a. The BHS high-level network is a critical component that powers the information and application infrastructure. Therefore, it shall be designed to be fully resilient with high requirement for good network and information security.

b. The BHS high-level network shall be designed to have good security, high performance, fully fault tolerant and compliant to open standards. The security measure shall address security at the port level, network equipment protection, network access protection through a combination of Virtual Private Network and Firewall, access to mission critical application and authentication mechanism used by mission critical applications. The performance and resiliency of the network design shall provide a completely reliable network where equipment or physical links failure should not cause or disrupt the availability of the network. It is also mandatory for the network to be based on open standards that are established, as this will ensure that the network is always able to accommodate newer equipment with superior performance when available. In addition, the use of IP addresses on the networks shall be well managed.

c. Protection against virus and trojan programs is extremely crucial to ensure minimal disruptions. Hence, there shall be anti-virus and content checking protection for all entry and exit points on the network. These security protections shall be installed at every interface that links to the network and also protect points of entry and exit for all LANs that hosts critical applications. The BHS Contractor shall submit details of the virus protection program (i.e. manufacturer) to the DAA or his representative for approval.

d. The network shall also be a fully resilient network and every measure shall be taken to ensure that the network availability is at its highest possible. In order to accomplish this provision of multiple source of electrical power supply, unlimited power protection, multiple routing of network cables inclusive of optical fiber, high availability network equipment and intelligent use of load balancing hardware shall be necessary.

e. The main network equipment for the network backbone shall have no single point of failure. There shall at least be two (2) network switches for the network backbone. There shall be multiple links between the network switches in a manner that failure in one (1) network link shall not disrupt the entire network backbone. In addition, each link shall use link aggregation technology, which is also known as port trunking. Through link aggregation, multiple physical links shall be grouped to work, as one (1) logical link and loss of a physical link shall not disrupt the logical link.

f. The optic fiber cables that form the main backbone shall not have the same cable-laying route and shall be routed a minimum distance of 15 feet apart from one another. This shall ensure that in the event of cable mishap all optic fiber cables that form the backbone will not be lost.

g. All network cabling (UTP and fiber optic) shall be carried in conduits and none shall be laid in an unprotected manner. This shall ensure that pests do not attack unprotected network cables.

h. All network cables should be clearly marked for easy connection tracing.

i. Network Switches

1.) The network switches for the backbone shall have the following features:

a.) Good use of high performance Application Specific Integrated Circuits (ASIC) chips for high performance switching and routing

b.) There shall be no single point of failure in the hardware design of the network switch

c.) The network switch shall have a chassis that accommodate multiple slots

d.) There shall be a hot standby for the Supervisory modules in the network switch

e.) All modules and power supply shall be hot pluggable

f.) No degradation of performance when gathering switching statistics

j. Workstations and PLC ports shall belong to all LANs because they need to speak to all application servers.

3. Low Level Network

a. For the BHS low-level network use a Data Communications Highway (DCH) (or approved equivalent) as an industrial network to link together distinct, remote stations. Each station may consist of a programmable controller (PLC), a computer, or an intelligent RS-232-C device (interface module). The DCH shall provide high-speed communication and fast data acquisition. It shall be of rugged construction and well suited to a bagroom environment.

b. The central trunkline of the Data Communications Highway shall consist of adequate cabling capable of high-speed inter-communication between up to 200 devices via interface modules. The central trunkline shall have the capability of being up to 15,000' long, with the remote stations being as far as 100' away from the trunkline. The network shall display a high degree of noise immunity and rejection from electromagnetic and radio frequency interference (EMI/RFI).

c. The DCH shall utilize a time-sharing method of communication control, thus eliminating the possibility of any one-interface module from dominating the network. The DCH shall allow for inter-communication of many types of ASCII devices, including, but not limited to:

1.) PLCs

2.) Maintenance Terminals

3.) System/Displays

4.) Computers

5.) Printers

6.) Modems

d. For the communication use a synchronous data stream from one interface module to another or to the primary baggage system computer, and provide data transfer, message acknowledgments, and error recovery. The data shall refer to ladder rungs; register data, I/O status, and other information.

e. Provide RS-232 D-shell connectors with captive retaining screws, “D” concentric twist-lock twin-axial connectors, or approved equipment. In any case, ensure that they provide easy connection to control and interfacing devices, and display a high degree of noise immunity and rejection from EMI/RFI.

f. Ensure that expansion may be accomplished by interface module-to-interface module linking with no limit.

g. Use standard protocols with error recovery on all DCH transmissions for error checking.

h. Place source/destination message routes in the command for each device wishing to communicate.

i. Provide repeaters as required along the length of the communications highway to boost signal strength.

j. Provide data ports at strategic points on the communications highway to allow for system monitoring by personal computers.

k. At a minimum, configure the DCH as a ring or provide redundant trunkline to ensure a single break in the trunkline does not render the system inoperable.

l. Network Architecture

1.) ControlNet (or approved equivalent) may be installed as an industrial network to link together and provide high-speed communications between distinct remote components of the (outbound or inbound) BHS. The network must have a minimum scan time of 5 ms and be capable of receiving, processing, and transmitting information within 50 ms or as required to facilitate baggage tracking. The network must be capable of operating in a hot backup configuration without any degraded functionality. The optic fiber cables that form the main backbone shall not have the same cable-laying route and shall be routed a minimum distance of 15 feet apart from one another. This shall ensure that in the event of cable mishap all optic fiber cables that form the backbone will not be lost

2.) A communications bridge (for example ControlLogix Gateway (or equal)) must be incorporated to provide interfacing between distinct communication interface modules. This bridge must be capable of providing a link between the High Level network, Data Communication Highway, and the BHS control network (PLCs etc).

3.) The network communication speed must not be less than 5 M bits/sec. The network architecture should be designed to optimize data transfer between network devices to fulfill the required time constraints.

4.) At a minimum, shielded cable shall be used as the physical media to connect components of the network. Cable must be capable of normal use in high noise environments. NEMA approved cable taps, connectors, and adapters suitable for use in a bagroom environment must be used. Fiber optic cable should be used wherever possible.

5.) Particular attention must be given to voltage across network components. Refer to manufacturer's literature for exact range of voltage potential.

6.) Appropriate power supply ratings must be considered and applied for network components.

7.) Repeaters must be used as recommended by the manufacturer to maintain network communication speed and reliability.

8.) The network architecture must be designed to operate in conjunction with multiple processors. A minimum of 99 addressable nodes must be available for communication. Communication with essential components shall be prioritized and used for reporting. The overall allowable length of the network cabling and remote components must be at least 15,000 feet.

9.) An Allen Bradley redundant ControlNet system (or equivalent as approved by the DAA or his representative) must be utilized.

10.) Network switch must be the DAA approved Cisco switch Verify Cisco is acceptable to DAA or indicate DAA's preference.

11.) No more than 32 I/O points may be assigned to each I/O module.

I. Maintenance Diagnostic System (MDS)

1. Provide a centralized diagnostic system for use by trained operations and maintenance employees to accomplish the following:

   a. Display and locate any system malfunction or failure through text or graphic simulation of the entire system and text display.

   b. Visually monitor the sortation system operational configuration, including conveyor flow direction, operational status (On/Off/E-Stop/Overload, etc.) and operating mode (cascade, indexing, etc.).

   c. Isolate location and cause of equipment failures.

   d. Initiate fallback procedures. (Submit fallback procedures to the DAA or his representative for approval).

   e. Display status of fire/security doors (open, closed, malfunctioning, etc.).

   f. The MDS system designed and installed by the BHS Contractor shall be such, that the DAA's maintenance personnel can easily modify/add subsystems, display faults, modify/add reports etc. in the event that additional/modified subsystems are installed as part of any future project (i.e. very user friendly).

2. Use the BHS Computer System to run this application.

3. The diagnostic monitors shall identify the following conditions (this listing is not to be construed as being all inclusive):

   a. Emergency Stop Actuated (identify location)

b. Motor Overload Tripped (identify location)

c. Excessive actuation time of a conveyor sensor (other than in a normal queue/accumulation condition) to identify a probable jam condition or similar operational problem (identify location).

d. Photocell failure (identify location)

e. HSD not in home position (identify location)

f. System configuration (Mode Of Operation)

g. Operational status

h. Failure of tracking encoder/pulse generator

i. Over Temperature Warning for any computer or PLC cabinets

j. Fire Alarm System Faults (if the BHS is tied to the fire system for local code compliance)

k. PLC Failure (identify location)

4. System Graphic Screens

a. The workstation shall have a minimum of two (2) 21" system graphic monitors or more as required that shall accurately and clearly depict the entire BHS.

b. The graphics screen shall display, in near real time, dynamic pictorial format, the operational status of individual conveyors and sort devices that are connected to the sortation control system and system programmable logic controllers. Framed icons and specific conveyor I.D.s representing the conveyor sections shall change color according to the following scheme. This shall immediately highlight problem areas so that the problems that arise may be corrected in the minimum amount of time.

Condition	Color
Normal Running Mode	Green
E-Stopped	Red
Fire Alarm	Flashing Red
Over Temperature	Flashing Red
Communications Loss (Individual Components)	Red
Jam	Yellow
Overlength/Overheight	Flashing White
Motor Overload	Blue
VFD Fault	Flashing Blue
Cascade Stopped	Magenta
Timed Out	Black
Out of Service	Brown
HSD fault	Yellow
Divert All	Flashing Green
EDS Device Failure	Red
BHS/EDS Fault	Flashing Red
Data Communications Error	Yellow

Shaft Encoder Fault	Cyan
Added Bag Fault	Yellow
Fail Extended	Yellow
Oddsize Running Mode – Forward or Reverse	Green with Arrow indicating direction of travel
Oddsize Pier/Conveyor Full	White

c. Graphics Manipulation

1.) The system operator shall have the capability to zoom in on any portion of the BHS on any of the two graphics monitors.

2.) Each portion of the BHS, split between the two screens, shall have predefined sectors for the purposes of the dynamic zoom function. Once selected, the individual conveyor shall be displayed in greater detail, with all functionality as described previously, such as color depiction of conveyor status. In addition, textual descriptions of all related status shall be displayed (i.e., motor disconnect on/off, motor starter normal/overload, conveyor running/E-stopped/ cascaded/jammed/ timed out, etc.).

3.) In the zoom steps, the overall system normally displayed on that associated graphics monitor shall be shown on a reduced scale in the corner of the screen with the zoomed sector shaded for reference. This reduced display shall disappear upon return to the overall system display.

4.) A single keystroke or mouse click shall return the operator to the previous zoom display.

5.) Should one graphics monitor fail, the second shall display the entire system with all zoom functionality as described above by means of an operator initiated command on the textual operator interface monitor.

d. Text Monitoring

1.) It shall be possible to configure the MDS application at the BHS workstations to provide system status in text format.

2.) In a manner similar to the graphic screens, the text format shall use dynamic text to represent conveyor sections status. The fields next to the conveyor I.D.s noted above change color and value according to the following scheme:

Condition	**Color**	**Text Displayed**
Normal Running Mode	Green	Running
E-Stopped	Red	E-Stopped
Fire Alarm	Red	Fire Alarm
Over Temperature	Red	Over Temperature
Communication Loss	Red	Communication Loss
Jam	Yellow	Jam
Missing Bag Jam	Yellow	Missing Bag Jam
Overlength/Overheight	White	Oversize
Motor Overload	Blue	Overload
VFD Fault	Blue	VFD Fault
Cascade Stopped	Magenta	Cascade Stopped
Timed Out	Black	Timed Out

Out of Service	Brown	Out Of Service
Failed at Home	Yellow	Failed Home
EDS Device Failure	Red	EDS Failure
Communication Error	Yellow	Communication Error
Fail Extended	Yellow	Failed Extended
Divert All	Green	Push All
Oddsize Forward Running Mode	Green (with arrow)	Running Forward
Oddsize Reverse Running Mode	Green (with arrow)	Running Reverse
Oddsize Pier/Conveyor Full	White	Full
Added Bag Fault	Yellow	Added Bag Fault
Shaft Encoder Fault	Cyan	Shaft Encoder Fault

e. Large Screen Graphics Display System

1.) The BHS Contractor shall provide as a minimum, 2 wall mounted "flat screen" video monitors, one will be installed in the BHS control room, the other to be installed in an area visible to the CBRA Operations. The size of each screen shall be 40-inch minimum (measured diagonally) and will be adequate to ensure legibility of screen contents from all viewing locations within the control room. The monitors can be either burn-in resistant LCD or Plasma with burn-in protection. The monitors shall display in real time, dynamic pictorial format, the operational status of the conveyors for the entire Duluth Outbound, and Inbound Baggage Handling Systems (no zoom capability).

2.) The actual screen layouts presented by the monitors will be selected by Control Room personnel from the workstations, and will be capable of displaying graphic or text images that are selectable and different than those displayed in the Workstation Monitors. It shall also be acceptable for the BHS Contractor to provide a separate controller specifically for the large screen display in lieu of having any of the workstation monitors providing control.

3.) The monitors shall be able to display either full system status screens (equivalent to a "mimic" panel sometimes used in large BHS control rooms), for instance displaying the graphics image from one of the Operator Workstation Monitor graphic displays.

4.) The display quality shall permit easy identification of screen contents from all areas of the Control Room from which viewing is possible, under all conditions of ambient lighting of the Control Room environment.

a.) All screen graphic layouts must be able to be displayed on the monitors.

b.) The images displayed by the Large Screen Display unit shall be computer generated, and therefore a hard-wired "mimic" displays shall not acceptable for this application.

f. Printers

1.) All printed messages shall be date and time stamped. Fault Alarm messages are to provide date and time of occurrence and date and topic of fault clear. Reports are to provide date and time of printing. All times shall be given in military time, e.g., one o'clock in the afternoon shall be printed as 13:00:00.

2.) Provide a local means of troubleshooting faults at each printer.

3.) A means to manually clear the printer queue (buffer) shall be provided.

4.) All dates printed out shall be in the order of Month/Day/Year.

5.) The BHS Contractor shall submit to the DAA or his representative the proposed printer(s) manufacturer's literature for review and approval.

5. Provide the capability to archive all records of statistical data on DVD (tape or CD-ROM is allowable if required by the DAA). Provide means of restoring archived data and view it in the original report format that it was generated in. Operations personnel shall have the ability to retrieve the reports and print them from the redundant hot back-up computer without affecting in any manner any active data or operations.

6. The MDS shall have the capability to render individual subsystems, check-in counter conveyors, and conveyors of the baggage system available or unavailable.

7. The MDS display must have an indicator to notify the operator that the display screens are not locked up.

8. The MDS shall be active for new equipment, as it becomes operational.

9. Diagnostics Reporting

a. Realistic graphical representations shall be employed to portray the equipment with details up to the actual position of all equipment installed position, metering positions, settings, indication, lamps, alarm messages, etc. Operation shall be accomplished by touch screen commands.

b. Automatic alarms will come up for the following events:

1.) Fault of any redundant component

2.) Fault of a individual conveyor (to distinguish overload and jam conditions)

3.) Fault of a component of the control and monitoring system

4.) Fault of a communication line of the control and monitoring system

5.) Number of faulty conveyors pass the alarm threshold (2 variable thresholds)

6.) Bag sent to problem bag output

c. All alarm filters shall be user definable and easily changed through drag and drop type interface with objects programming.

d. All alarms shall be logged into the historical database and printed out in the alarm printer. The following events will be written in the log:

1.) All fault of the BHS (overview and details)

2.) All faults of the control and monitoring system

3.) All control commands for the BHS

4.) Changes of the system configuration

5.) Changes of an alarm threshold

e. Alarm Condition

1.) An alarm condition is defined as the occurrence of a new situation, which requires acknowledgment by the operator. Thus an alarm can be:

a.) A logged equipment status has changed its status

b.) An alarm monitoring inhibited point has timed out and returned to normal alarm processing

c.) Another operator initiated or specified events

f. Alarm Handling

1.) The system shall manage the incoming alarms and warnings such that alarm/warning conditions are reported in a clear, concise and timely manner. The chronology of detection of alarm/warning conditions shall be retained and alarms shall be time stamped.

2.) It shall be possible for an operator to inhibit the alarming or the logging of an alarm condition for an equipment status point. Limit violation alarming shall have dead bands in determining return-to-normal conditions.

3.) It shall be possible to delay the alarming for a process variable for a defined period of time. So it shall be verified that an abnormal condition detected is permanent. The condition must persist for a specified time period.

4.) It shall be possible to automatically show the graphic of a selected alarm by selecting the alarm in the alarm list.

5.) Maximum use of the display generator capabilities shall be made to annunciate alarms by means of color and flashing. A new alarm shall be displayed with a quick flashing in a specified color (0.5 sec duty cycle) as an active alarm; but an acknowledged alarm shall have steady alarm color.

g. Alarm List should contain all active alarms, acknowledged or unacknowledged in chronological order. It is updated automatically when a new alarm appears.

h. Alarm List of Unacknowledged Alarms should contain all unacknowledged alarms, active or already reset in chronological order. It is updated automatically when a new unacknowledged alarm appears.

i. An alarm line containing the latest alarms (between 2 and 4) shall always be visible on the operator workstations. It shall provide the same features as the alarm list.

j. An alarm category shall be a set of options on the processing of alarms, return-to-normal, and information events/messages.

1.) Each alarm, return-to-normal and information event / message issued shall concern a single database item. For each item, the system database shall identify the alarm category for that item.

2.) An alarm category specifies processing for each type of alarm, return-to-normal, informative event / message. The processing options shall include but not to be limited to:

a.) Insert the message text in the chronological history file

b.) Print the message on alarm printer

c.) Acknowledgment required for this message

d.) Generate an information event message on acknowledgment

e.) Sound the audible alarm at operator workstation

3.) Each alarm category shall also specify the conditions under which an alarm or return-to-normal message shall be removed from alarm display lists. The alarm removal options shall include but not to limited to:

a.) Remove the alarm message upon acknowledgment

b.) Remove the alarm message if acknowledged and the point returns to normal

c.) Remove the return-to-normal message when it is acknowledged

4.) It shall be possible to generate group alarms. A group alarm is the linkage of several individual alarms to a common alarm.

k. Alarm Reporting Requirements

1.) The alarm reporting capabilities are to include but are not limited to:

a.) Alarms shall be time stamped and logged into the alarm and event logs in chronological order.

b.) Unacknowledged point alarms and return-to-normal messages shall be presented in the alarm section of the operator workstations.

c.) The appropriate alarm fields in the graphic displays shall flash or be clearly marked as an alarm condition whenever they are displayed.

d.) Point alarms and return-to-normal messages shall be added to the relevant latest alarm display lists. If the alarm lists are currently being displayed, they shall be dynamically updated with the alarm message. Colors shall be used to highlight unacknowledged messages.

e.) Point alarms can be defined to sound an audible alarm at the operator workstations.

l. Alarm Acknowledgment

1.) The acknowledgment of either an alarm or return-to-normal message shall perform several functions, including but not limited to:

a.) Acknowledgment shall prevent the alarm message from appearing in the alarm section of the operator workstations.

b.) Acknowledgment shall cause the symbols and messages associated with the alarm to stop flashing or change appearance on all displays on which they appear and on the map panel. They shall continue to appear in an alarm condition by changed color and shape unless the alarm signaled a return-to-normal.

c.) Acknowledgment shall cause the silencing of the audible alarm.

d.) Return-to-normal messages shall be removed (not displayed) from the latest alarm display lists.

e.) All workstations shall show an acknowledged alarm after that alarm is acknowledged from any workstation location.

2.) The acknowledgment of either an alarm or return-to-normal message shall be performed in several ways, including but not limited to:

a.) Sequentially as alarms appear in the alarm section of the operator workstations.

b.) Individually, by selecting then acknowledging the symbol or message for the individual alarm on the appropriate operator display or alarm display list. If more than one alarm is active for the same process variable, then all these alarms shall be acknowledged together.

c.) All alarms shown on a latest alarm display list with a global acknowledgment command.

d.) Individually within the graphic operator displays

m. Alarm Inhibiting

1.) The inhibiting of either an alarm or return-to-normal message shall perform several functions, including but not limited to:

a.) An inhibited point shall be processed as usual, its value in the database reflecting its current value. The flag for the point shall show it is alarm inhibited.

b.) The appropriate displays shall show the current value.

c.) Alarm conditions caused by the point shall not be logged.

d.) The audible alarm shall not be sounded.

e.) The symbol for the alarm shall not flash on the graphic display.

f.) The alarm message for the point shall not appear on the latest alarm display lists.

g.) There shall be a special monitoring inhibited alarm summary that shall list all points that have been inhibited.

2.) The inhibiting of either an alarm message shall be performed individually, by selecting the symbol for the individual alarm on the appropriate operator display or alarm display list.

n. The graphics screens for every application contain context sensitive on-line help for every function. Both operation and displays are designed for personnel who lack computer training. HTML type help navigation of related topics shall be provided. The operator can call up detailed information from the database by clicking the mouse on the lighting elements in the graphic image or by entering search codes on the keyboard. The detailed information is displayed in list and mask form.

o. The BHS Contractor may be permitted access by the DAA or their representative from a remote location to perform diagnostics on the application software, check on systems configurations and integrity of database.

p. A system Upset Condition is defined for use in evaluation of sort computer performance. It is the change during a one (1) second interval of fifty (50), percent of all the system's field wired discrete inputs. During a system upset condition, the logging printer shall print out all occurrences, but the printout need not be completed faster than the normal logger printer speed will allow. No messages shall be lost during the system upset.

q. During a system upset load condition, not more than five (5) seconds shall elapse from the time a status change occurs at a PLC until the change appears on the operator workstation displays.

1.) In order to meet this system update time, it shall be determined all data throughput related designs in the hardware and software such as, but not limited to PLC communications window size, PLC scan frequency, server master and communication processor's throughput, disk performance and display update speed.

2.) Dynamic data on the current operator workstation displays shall be updated within two (2) seconds from receipt of data from the PLCs. The time-of-day field on the operator workstation displays shall be updated at least every second.

3.) Supervisory control outputs at the workstations shall occur within two (2) seconds following the entry by the operator. However such operator entry shall be immediately acknowledged on screen. In the select-before-operate mode of operation, the blinking or other visual indication of the selected control device shall immediately appear on the operator workstation displays. If an operational parameter is changed or adjusted by the operator the change will be registered in all PLCs, computers, workstations and databases.

r. When a request is made by the operator to retrieve a different alphanumeric or graphic operator display or window, the new display shall appear on the operator workstation displays within two (2) seconds including update of 50 dynamic data fields based on the implemented database.

s. The sort computers must correctly follow the calendar date. The date keeping function shall incorporate leap year dates. Turn of the century and millennium date must be correctly and automatically followed.

t. Hardware reliability information of all major individual hardware for this project, including the Mean Time Between Failures (MTBF) and its standard deviation for all the equipment are required for all this equipment.

J. Maintenance Information System (MIS)

1. Provide the statistical information gathering and report generation capability to display and print certain defined information considered essential to the successful operation of the system.

2. Use the Baggage System Computer System to run this application.

3. Provide six (6) levels of usernames with password protection against unauthorized access to the system:

Level	User	Access
Level 1	Handling Agent	Ability to view, print and achieve reports regarding passenger and flights handled by the agent logged on
Level 2	Operator	Access to normal operational modes
Level 3	System Engineer	Access to all operational modes
Level 4	System Manager	Access to all operational modes plus ability to change software
Level 5	System Administrator	Access to all operational modes plus ability to change software and assign user names and passwords
Level TSA	TSA Manager	Access to all TSA only operational modes

4. Provide a standard “Report Generator” to permit compilation of additional statistical reports or to modify existing reports. Requires Level 4 and 5 protections for use of this function.
5. Use Baggage System Computer terminal(s) (keyboards, monitors, and printers) as input/output devices for the MIS system.
6. Employ a user-friendly Human Machine Interface (HMI) with menu-driven routines to permit access to the system.
7. The type of MIS employed by the BHS Contractor shall have the functionality (be user friendly) to allow the DAA to easily modify/generate/develop Operational and Maintenance reports to meet their own needs.
8. Provide ability to view all reports on screen as well as in printed format.
9. Provide ability to save, in buffer storage, and print on a first-in, first-out basis up to 20-flight closeout Reports or end of day reports in the event the printer is busy at any given time.
10. Provide ability to produce daily, hourly, weekly, monthly, quarterly, and annual reports as well as reports based on a user defined interval.
11. Provide a means to reset all non-SSI statistics and counters. This shall be accessible at levels 3, 4 and 5.
12. Provide a means to reset all SSI statistics and counters. This shall be accessible at level TSA.
13. Provide the capability to archive all records of statistical data on DVD (tape or CD-ROM is acceptable if required by the DAA).
14. Provide the ability for the sort allocation planning to be accomplished in Gantt Chart graphical presentation format.
15. Generate the following reports
    a. **EDS ID Report:** Printout of all PLC ID numbers during the operational period.
    b. **Inbound Report Query:** Printout of all inbound baggage during the operational period.
    c. **Immediate Equipment Malfunction and Correction Report**: Automatic printout upon detection of each equipment malfunction and each subsequent correction.
    d. **Equipment Operational Summary**: Printout, by subsystem, of diverter, photocell, and sorter statistics and summary of individual device malfunctions printed in Equipment Malfunction and Correction Report.
    e. **Computer and PLC Status Report**: Print out of which computer is on-line/offline and the computer status as well as which PLC is online/offline and the PLC status
    f. **Equipment Malfunction Summary**: Printout, by subsystem, of a summary of the Equipment malfunction and Correction Reports.

g. **EDS Report**: Print out of which EDS machine (by EDS Serial Number and EDS Conveyor ID) is on-line/offline and the machine status:

h. **Day End Report**: Printout of throughputs, laser stats and outputs. Automatically printed at the end of the operation period. Also provide a means to print report on demand or at selectable intervals.

i. **Bag Data**: Consisting of the following items (Assuming this information is available to the BHS):

1.) BHS Tracking ID Number for each bag (Shared by BHS and EDS)

2.) Bag Type (OOG or in-spec)

3.) Screened by EDS Machine with machine Serial Number

4.) Time Stamped when entering into the EDS machine or time Stamped when OOG bags are identified

5.) Level 1 Screening Status

6.) Time Stamped at Level 1 Screening Decision

7.) Level 2 Screening Status

8.) Time Stamped at Level 2 Screening Decision. Note: Not all EDS machines have the capability to time stamp at both Level 1 and decisions – Confirm with EDS OEM.

9.) Time Stamped when delivered to CBRA Unload Conveyors

10.) Time Stamped when removed from CBRA Unload Conveyors

11.) CBRA ETD Screening Station Number (if available to the BHS)

12.) Time Stamped when Resolved by CBRA Screening Station (if available to the BHS)

j. **EDS Statistics**: Consisting of the following items (The following statistics shall be considered SSI and treated accordingly) (*Assuming this information is available to the BHS*):

1.) Number of Bags Alarmed by Specific EDS Machine

2.) Number of Bags Cleared by Specific EDS Machine

3.) EDS Machine Faults (if known)

4.) EDS Machine Hours of Operation

5.) Start Time of Operation

6.) Start Time of Fault

7.) End Time of Fault

8.) End Time of Operation

k. **Critical Tracking PEC:** Immediately upstream and downstream of each EDS, prior to and after each tracked divert point, and at the last tracked photoeye entering the CBRA, the BHS shall report the following for each activation of these photoeyes:

1.) Bag ID

2.) Bag Disposition

3.) Time, in hours: minutes: seconds

4.) Totals for each disposition type

l. **PEC Tracking Statistics:** Consisting of the following items:

1.) Total number of bags seen at each PEC

2.) Total number of missing bags at each PEC

3.) Total number of unknown bags at each PEC

4.) Total number of jams at each PEC

5.) Total number of missing bag jams at each PEC

m. **Baggage Dimensioner Statistics**: Consisting of the following items:

1.) Total Number of Bags per array

2.) Total Number of OOG Bags per array

3.) Total number of standard items per array

4.) Total number of items not dimensioned per array

5.) Failures per array, detailing individual items that failed and duration of downtime

n. **OSR Statistics**: Consisting of the following items (The following statistics shall be considered SSI and treated accordingly) (*Assuming this information is available to the BHS*):

1.) Total Number of Bags through OSR

2.) Total Number of Bags through OSR by EDS Machine

3.) Total Number of Bags Cleared by OSR

4.) Average Time to Clear Bag by OSR

o. **CBRA Area Statistics**: Consisting of the following items (The following statistics shall be considered SSI and treated accordingly) (*Assuming this information is available to the BHS*):

1.) Total Number of Bags Received in CBRA

2.) Total Number of Bags Cleared by CBRA

3.) Total Number of Bags per CBRA ETD Screening Station

4.) Bag Time In/Out at each CBRA ETD Screening Station

5.) Number and Type of Alarmed Objects per bag

p. **Time in System Statistics**: Consisting of the following items (*Assuming this information is available to the BHS*):

1.) Minimum/Maximum Time Bag was in System (Measured from point positive bag tracking is established to security status identification on the exit conveyor of the CT-80)

2.) Average Time Bag was in System

3.) Average Time Bag was in System by Screening Level

q. **BHS Faults**: Consisting of the following items:

1.) Fault type (note: a "fault" is defined as a "cause" such as lost in track, motor overload, photocell failure, encoder failure, etc.)

2.) Fault location

3.) Fault time

4.) Fault time cleared

5.) Total fault time

r. **BHS Events**: Consisting of the following items:

1.) Event type (note: an "event" is defined as the "effect" of a fault, such as re-establish tracking, fail-safe, jams, etc., or the "effect" of human interaction on the system, such as via Human Machine Interface (HMI) or control station – e.g., pushing an e-stop)

2.) Event location

3.) Event time

4.) Total event time

s. Security sensitive information such as the following items shall only be released to the TSA:

1.) Screening Alarm %

2.) Time to Decision

3.) EDS Alarm Rates

4.) OSR Alarm Rates

5.) ETD Alarm Rates

t. Provide ability to view all reports on screen as well as in printed format or file format (CSV).

K. Baggage Control Room Equipment

1. Submit all Baggage Control Room tenant finishes required for supporting the BHS Control Room equipment. As a minimum, the submittal shall include:

a. Proposed layout (pending the DAA or his representative approval)

b. Phasing Layouts

c. Final Layouts

d. Required completion date

e. Environmental requirements (including HVAC)

f. Estimated combined heat output of computer equipment

g. Power requirements (including UPS sources)

h. Data transmission and communication drop locations (including number of telephone and fax/modem lines that are to be provided by the DAA)

i. Clear heights

j. Lighting and outlet requirements

k. Fire protection requirements

l. Architectural Requirements

m. Coordinated scheduled equipment delivery and installation dates

2. Provide readily available industrial equipment suitable for the purposes intended and functionally reliable within a Control Room environment.

3. Submit to the DAA or his representative for approval, quantities and manufacturer of proposed equipment. At a minimum, unless otherwise approved, the Control Room shall contain the following:

a. Workstation computers and related equipment (printers, monitors, keyboards, etc.) as described elsewhere loaded with application software for system monitoring and access system statistics.

b. If the centralized architecture is utilized, redundant master PLC cabinets housing the scanning and tracking processors. The cabinets shall be on separate power supplies (feeds).

c. Uninterrupted Power Supply(s) (UPS) shall be provided. Minimum protection time shall be two (2) hours.

d. Provide all interfacing conduit and cabling between equipment.

e. All equipment containing memory shall be backed up by an external source (e.g. tape drive, zip drive, read/write CD-ROM etc).

f. The backup source shall have the ability to download all computer equipment with back up memory programs.

g. Instructions shall be provided to aid operator in the download of memory back ups.

h. Communications System such as telephones, fax machines, intercoms, etc. (by the DAA).

L. Security

1. Provide a secure computer control environment for the BHS. To achieve this, the network operating system shall provide multiple levels of password access appropriate for the level and authorization of staff, workmen or operators working on the BHS.

2. Different passwords are used for different access combinations by:

   a. Personnel group: Handling agents, apron/baggage supervisors, maintenance staff, control room operators, the DAA's staff, maintenance contractors, manual encoding operators, TSA Managers, etc.

   b. Different operating modes: Operations, monitor, training/simulations configure, etc.

   c. Modes of access: From control room, backup sites and manual encoding consoles via dial-up modem lines.

3. Global commands that have a large impact on operations will require higher-level password e.g. invocation of fail-safe to BHS equipment.

4. Operator personnel shall monitor all security violations through system printer and alarms since operations is manned round the clock although group or operational staff may not have very high password levels. All security violations will be logged by the system. Security violations shall include the following as a minimum:

   a. Unsuccessful log-ins

   b. Expired password date

   c. Failure to log-off

   d. Attempting to gain access to a user level than logged on for

   e. Operator initiated event

5. Under Fail-safe conditions, BHS shall default to a pre-defined state (Normally ON). The Contractor shall provide details of how forced fail-safe mode is being invoked for the DAA or his representative's approval.

6. Provide a test mode to allow tests to be carried out off-line on any software modifications carried out before saving the modified program into the live systems.

7. All of the system workstations shall have identical functional capabilities. Selective access to the different functional capabilities shall be controlled through the use of log-on IDs and passwords.

8. The password system must have at least six (6) levels of security clearance, e.g.:
    a. Handling Agent
    b. Operator
    c. System Engineer
    d. System Manager
    e. System Administrator
    f. TSA Manager
9. These different levels of security clearance will differ in the access to the various system functions regarding system operation and configuration. Differentiation shall be at least performed for the following functions:
    a. Display modification
    b. Database modification
    c. Report modification
    d. System configuration
    e. Report display
    f. Command initiation
    g. Operator actions
    h. Access to operating system
    i. Application programs
10. Security shall be performed at the access level to a menu, configuration dialogue, command window, etc.
11. A user level will be assigned to every person who is given access to the system. The user shall be required to log-on to the system through the various interfaces. All log-on shall be recorded in the system event log. Unsuccessful log-ins shall raise an alarm. The system shall maintain a security database of the number of allowable unsuccessful log-ins and password expiry dates, which is maintained by the security officer. This feature shall allow identification of the operator responsible for all operations executed from the specific workstation or interface.
12. If, after eight ((8) configurable) hours an operator has not logged off, an alarm message shall be sent to that operator workstation until that operator is logged off. The intent of this action is to prevent log-on from extending across operator shift changes.
13. If, after fifteen ((15) configurable) minutes an operator has not logged off of the manual encoding console, the encoding console shall initiate an automatic log-off procedure. The intent of this action is to prevent log-on from extending across operator shift changes.
14. Any system event that is operator initiated shall be recorded with the ID of the operator and the workstation it was issued from.
15. Access to the security configuration shall only be allowed to the user with the highest level, e.g. system administrator.
16. Level of access by vendor dial-in shall be to the DAA or his representative's approval.

M. Software Design Requirements

1. Incorporate software/hardware consistent with industry standards, and where required software/hardware that is compatible with the DAA's equipment. Schedule a series of coordination meetings with the DAA or his representative (on-site) prior to detailed design to ensure the connectivity/compatibility between the DAA

reservation system and the proposed software/hardware system.

2. Provide all software proprietary information to the DAA upon Final Acceptance, but this shall not release the BHS Contractor of responsibility for any technical defects (bugs) that occur with the software. In addition, submit to the DAA or his representative a staffing schedule (supervisors and software engineers) to accomplish the specified work.

3. For all software unique to the BHS and not "commercially available" the As-Built Deliverables shall include, as a minimum, all of the information necessary to make revisions in the software program applications for the BHS for changes or expansions or extension of the BHS, such as functional, performance and interface requirements; descriptions of the supervisory, control, and operating software; source listings; flow charts; configuration control documentation; and programmer and user manuals incorporating appropriate modification and control procedures, including the name of any sub-contractor used for preparation of this software.

4. For all "commercially available" software used in the BHS, the As-Built Deliverables shall include all of the documentation that is available from the supplier of such software. Copies of all programmer and user manuals and other similar material shall be provided to the DAA along with a complete and fully documented listing of all software programs.

5. All systems, file servers and workstations shall be equipped with continuously running virus detection software to prevent virus infection. Submit details of the virus protection program (i.e. manufacturer, etc.) to the DAA or his representative for approval.

6. At a minimum, adhere to the following software architecture and provide all associated hardware required to accomplish intended functions of the BHS:

   a. Human Machine Interface (HMI)

      1.) Shall provide a user-friendly interface.

      2.) Shall be of the multi-tasking operating system type that can control multiple programs at once.

      3.) Shall incorporate object linking and embedding (OLE) technology, or similar.

      4.) Shall have the ability of running a software program that will automatically monitor the "wellness" of all installed software on the BHS workstation computers. Provide the capability of automatically initiating a self-test routine from any/all of the installed computers.

   b. Networking/Communication

      1.) Shall be compatible with the data communication highway(s) (DCH) protocols.

      2.) Shall provide fast interfacing between all communication/control tiers.

   c. Database/Sortation Controller

      1.) Shall provide the handshake between the system bar code tag types, and output destination.

      2.) Shall provide the means to route bags to correct output destination(s) in all modes of operation.

      3.) Utility

      4.) Shall aid in the linking of various applications (programming).

      5.) Shall generate, edit and provide tangible maintenance diagnostic and management information system reports.

N. Software Confidentiality

1. The BHS Contractor shall not disclose, or use in future work, any proprietary operation information of the DAA facility, or any information considered a trade secret by the DAA, which was obtained during the course of the project work.

2. Except as otherwise required by law, the DAA will not publicly disclose trade secrets or proprietary software information obtained from the BHS Contractor in the performance of the BHS Contractor's obligations pursuant to this Contract. To the extent it is necessary to provide BHS Contractor's trade secrets or proprietary software information in order to operate or maintain the BHS, the DAA, by contract, prohibit the DAA's operation and maintenance contractor from publicly or privately disclosing the BHS Contractor's trade secrets or proprietary software information.
3. Any information that the BHS Contractor believes is a trade secret or proprietary software information shall be specifically identified and marked as such. Blanket type identification shall not be permitted.
4. In the event the DAA receives a request for the BHS Contractor's specifically identified trade secrets or proprietary software information, the DAA will notify the BHS Contractor and the BHS Contractor will be required to fully defend, in all forums, the DAA refusal to produce such information. Otherwise, the DAA will make such information available.
5. All software version upgrades, bug fixes, etc. for proprietary software shall be provided during the one year warranty period.

O. Source Code

1. All software shall be delivered with well-commented source code in addition to the executable version. Software shall be delivered in both hard copy and machine-readable formats on a media acceptable to the DAA. The BHS Contractor may propose a non-disclosure agreement.
2. The DAA shall have permission to use the software as necessary to support operations at Duluth International Airport, Duluth, Minnesota once obtained from the BHS Contractor.
3. A backup copy of the configured system software shall be provided on CD-ROM media. All original distribution software shall be delivered with an installable backup. While CD-ROM is the preferred media, tape or diskette is acceptable if required by the specific software.

- END OF PART II -

PART III - EXECUTION SPECIFICATIONS

3.01 PREPARATION

A. General

1. Verify conditions in the field prior to start of work. If unanticipated mechanical, electrical, or other elements that conflict with intended function or design are encountered, investigate and measure both nature and extent of the conflict. Submit written report to the DAA in accurate detail. Pending receipt of directive from the DAA, rearrange work schedule as necessary to continue overall job progress without undue delay.
2. Cover and protect systems and equipment from damage and soiling during installation. Erect and maintain dust-proof partitions and closures to prevent spread of dust or fumes to occupied portions of the building.
3. Obtain and pay for all airport security badges, permits, inspection fees, and certificates relative to all phases of the BHS construction.
4. Provide supports or bracing to prevent movement, settling, or collapse in which an area is to be removed and adjacent system is to remain. If safety of system appears to be endangered, cease operations and notify the DAA immediately. Take precautions to support endangered work until determination is made for continuing operations.

3.02 WORKMANSHIP

A. General

1. Perform installations, work as shown within the specified BHS right-of-ways, with due care, including support, bracing, etc. Be responsible for damage, which may be caused by such work, to any part of the system.
2. Perform new work in accordance with applicable technical sections of the specifications. Where cutting and new work involve the exterior building envelope, consult the DAA to ascertain if existing guarantees, warranties or bonds are in force and execute the work so as not to invalidate such agreements.
3. Execute the work in a careful and orderly manner, with the least possible disturbance to the public and to the occupants of the building(s).
4. Materials installed by the BHS Contractor, whether provided by him or not, shall be installed in a neat and workmanlike manner. Particular attention shall be paid to manufacturers' instructions as to installation procedures.
5. Protect the employment and places of employment of each of his employees engaged in the construction work by complying with the appropriate standards as prescribed by OSHA.
6. Take necessary precautions to keep noise producing operations (such as impact hammering, Carborundum sawing, compressed air machinery and the like) to a minimum. Select equipment, which is of a quieter nature than others and enclose areas of operation with acoustical screens and partitions or other means necessary to accomplish reduction of noise.
7. Equip motorized equipment with mufflers or other types of sound control and blanket equipment with acoustical materials.
8. Locate installation equipment safely so that no part thereof shall endanger normal airport operations, including runways, terminals, terminal buildings, approach ways, and power utility, lighting and communication lines.
9. Promptly remove debris to avoid interference with system operations.
10. Cut out embedded anchorage and attachment items as required to properly provide for patching and repair of the respective finishes.

11. Ensure that the standard of work and materials throughout the Project shall be of first-class quality and workmanship in every respect, the DAA will not accept workmanship, which for any reason, is otherwise.

12. Ensure that all equipment, components and materials are free from defects.

3.03 FABRICATION & INSTALLATION SPECIAL CONSIDERATIONS

A. General

1. Equipment is to be designed to meet the requirements of handling airline baggage. This entails consideration and care to be used particularly in fabrication of all components to ensure that projections, welds, sharp corners and transfer points that may cause possible damage to various types of bundles, handbags, suitcases, and trunks are eliminated. Ensure that bottom glides on cases, strings, tags, straps, bag handles, destination tags, etc. are guarded against damage on side guards, transfer points, and all surfaces which baggage may contact on the conveyor system.

2. Coordinate all on-going site work and with concurrent airport/airline operations.

3. Take into effect any long lead procurement items and take the necessary actions required to complete any installation in the ceiling space.

3.04 DELIVERY, STORAGE, HANDLING AND ON-SITE RESPONSIBILITIES

A. Delivery, Storage, Handling

1. Assume responsibility for the receiving, unloading, storage, protection, security and distribution of all material delivered to the site associated with this Contract.

2. As necessary for the work, provide flagmen and erect proper barricades and other safeguards, post danger signs and other warnings as warranted by hazards and existing conditions.

3. Assume responsibility for receiving, storing, handling, setting and connecting all equipment required for the BHS installation.

4. Provide and maintain adequate protection against weather so as to preserve his work, materials, equipment, apparatus and fixtures free from injury, pilferage or damage.

5. Furnish to the DAA, on demand, Bills of Lading for all equipment being shipped to the work site. Identify on each Bill of Lading each component and assembly involved, the equipment items to which they belong, the date and time of pick-up and the expected date and time of delivery to site. The shipping of such material shall involve proper identification of items, proper packing and proper means for unloading them at the work site.

B. On-Site responsibilities

1. General

a. Erect all temporary barriers and barricades to separate work areas from areas of public access, if applicable.

b. Provide exhaust fans (e.g. hepafilter) to limit fumes/odors from welding, metal cutting etc., if the work being carried out is in an occupied/operational area.

c. Coordinate with any interfacing, on-going site work.

d. Provide adequate portable office facilities, communication, equipment and locker room for field force.

e. The BHS Contractor shall pay all costs of rental, installation, use and removal of accommodation and communication equipment.

f. Furnish shop drawings for any substitutions of equipment specified in this specification or shown on the drawings. During the progress of the job, revised drawings may be issued. Ensure all work is performed based on the latest drawings issued.

g. Clean and maintain work spaces, travel routes, and any other areas of work effected by his trade including but not limited to:

1.) Remove on a daily basis of all erection rubbish and discarded materials.

2.) The burning of waste material is prohibited. Remove and dispose of scrap and waste material in accordance with applicable laws, codes, regulation ordinances and permits.

3.) Be responsible for all fines received for failure to maintain or perform cleaning, and all costs due to damages directly caused by this Contractors work.

4.) The BHS Contractor shall use their hoisting material for rubbish removal.

h. Be cognizant that the equipment and lay down areas for the work may/will require relocation as directed by the Construction Manager or the DAA.

i. Be responsible for any employee parking and any site transportation that may be required to/from the construction site.

j. Be responsible for any escort service required for the transportation of materials and employees on the ATO side of the facilities.

k. Enforce the DAA's instructions, laws, and regulations regarding signs, advertisements, fires and the presence of liquor and firearms by any person at the job site.

l. Provide the services of a competent field superintendent during erection, wiring, testing and correction of any discrepancies occurring during the Final Acceptance period.

m. Smoking shall only be allowed in areas as designated by the DAA.

2. Mechanical Work

a. Provide and install all supports, anchors and any other special considerations or requirements not provided for in this Specification but necessary to facilitate the complete mechanical installation and safe operation of all equipment and components.

b. Provide electrical connections for heavy-duty machinery, such as welding machines, battery chargers, etc. as required for the installation of the BHS.

c. As construction proceeds, perform any additional site surveys which may be necessary.

d. Document in writing any mechanical, electrical or piping conflicts that may impact conveyor installation and submit to the DAA or his representative immediately following the site inspection and prior to the installation.

3. Electrical Work

a. Provide the necessary conduit, wiring and other electrical components to complete the electrical installation from power distribution points (PDPs), to the equipment and be responsible for all electrical interconnections within the equipment and system.

b. Provide all labor, materials, equipment and service necessary for and reasonably incidental to proper completion of all electrical work including electronic controls as required for the proper operation of the system as detailed in these specifications. Provide within the design standardization of components, function and maintenance procedures.

c. Drawings and specifications are to be considered as supplementing each other. Work specified but not shown, or shown but not specified, shall be performed or furnished as though mentioned in both specifications and drawings.

d. Provide and install as required, at no additional cost to the DAA, minor items, accessories or devices reasonably inferable, as necessary, to complete the electrical installation.

e. Refer all conflicts between the requirements of these specifications and drawings or between either and applicable codes to the DAA or his representative for clarification before proceeding with the affected portion of the installation.

f. Obtain and pay for all permits, inspection fees, and certificates relative to the electrical work. Deliver all certificates and letters of approval to the DAA upon completion of the work.

g. Locate all electrical equipment as shown on drawings. However, actual field conditions shall be checked to determine exact locations and avoid interference with other trades. The DAA or his representative must approve all deviations from the Contract Drawings.

h. At no additional cost do any reasonable location adjustment of electrical equipment requested by the DAA prior to installation.

i. At no expense to the DAA, correct work improperly installed due to lack of construction verification.

j. Install materials and components in a neat and proficient manner. Particular attention shall be paid to manufacturer's instructions as to installation procedures.

3.05 INSTALLATION

A. General

1. Installation of the BHS shall be in strict compliance with the Construction Drawings, to be prepared in compliance with this Specification document and Contract Drawing Package. These drawings shall show in detail the location of each conveyor and the relationships between adjoining conveyors, conveyors and slides or chutes and any other transfer, which might affect baggage movement.

2. Assume responsibility for all interfaces between the BHS and the Facility. Check the "As-Built" condition of the Facility as defined in drawings and as confirmed by site inspection prior to fabrication, installation or removal of any BHS equipment. The system arrangement and layout shall ensure equipment alignment and clearance when installed in the Facility.

3. Provide all equipment required to complete the total system. Furnish all tools and necessary equipment for the performance of the installation tasks and exhibit sufficient planning to ensure their availability at the job site as required by the workflow. The DAA will not furnish tools, forklifts or erection equipment.

4. Staff the project to ensure timely completion. The BHS Contractor shall accelerate construction as required if schedule milestones are not met.

5. Provide all supports, anchors and any other items necessary to facilitate the complete mechanical installation and safe operation of all equipment and components.

6. Where equipment is to be installed in an operating facility provide a construction schedule to the DAA or his representative for approval that will minimize interference with normal operations.

B. Tolerances

1. Maintain the following tolerances for BHS equipment installation:

a. Maintain dimensions to exterior building walls or building columns within 1/4".

b. Install all conveyors level from side to side, within 1/8" across the width of the conveyor. In the event that the floor/ceiling is sloped, install the conveyors parallel to the floor in the direction of belt travel.

c. In plan and in elevation, install conveyors straight to within 1/4" of a taut line stretched at the belt elevation over the length of each intermediate section of conveyor.

d. Plumb supports vertical within 1/8" per 3 feet.

e. Maintain side clearances to building elements including walls and columns a minimum of 6" unless otherwise specified.

f. Verify all “As-Built” and existing building conditions prior to final fabrication.

g. Shimming between adjacent intermediate sections of conveyors is permissible but do not exceed 1/4" of total shim stock at any one location.

h. As the building area becomes available, install all header steel (even if header steel is ahead of conveyor fabrication/delivery), to preserve conveyor right-of-ways. Preserve conveyor right-of-ways in all cases as soon as practicable.

i. The maximum allowable lateral offset in the conveyor slider bed shall be 1/8" in 40 feet of length.

C. Side Guards

1. Install side guards so that adjoining guards do not project into the flow of baggage. Clean any field cut edges and welds of burrs, and slag and grind smooth. Filler material at joints or seams is not permissible.

2. Notch the formed edge of the side guards around any vertical hanger or leg.

3. All side guard joints are to provide a snag-free surface. Side guards shall provide a continuous, uninterrupted surface the entire length and height of the joints. Lapped or out-of-line joints will not be accepted. Welding of joints is not permitted.

4. Care is to be used in the design and installation of the side guards at the point of intersection with the conveyor fire/security doors. This interface point must not act as a snag/catch point for baggage or baggage tags.

5. Conveyor side guards must be flared on the downstream side of the intersection with the conveyor fire/security doors. Additionally, special detail must be provided with the conveyor bed section at this point. Its width must be extended to close the void between the bedside rails and the flared side guards.

6. Adjacent side guard joints are to be of the bolted butt coupled joint type at power turns and conveyor sections. Coupling of adjacent side guards or head/tail pulley supports to power turns shall be in alignment with the effective belt width of the turn to prevent interference with baggage movement.

7. Side guards of power turns must not be welded to adjacent straight conveyor side guards.

8. Mounting of any mechanical or electrical equipment on the outside radius side guard of power turns is not accepted since it restricts maintenance access to the outer perimeter chain or guide bearings of the power turn belt.

D. Belt Splicing/Lacing

1. Belting material and the related lacing hardware must be trimmed in a 1" “V” notch fashion. Additionally, the nylon jacket of the lacing connecting pin (cable) must be enlarged with heat to prevent any lateral movement of the connecting pin (cable).

2. If “dutchmans" are used, the length of the "dutchman" must be at least equal to or greater than the circumference of the conveyor drive pulley.

3. All belt splices, shall be cut square, to ensure proper tracking.

4. Install each lacing with a single lacing pin (cable) extending the full width of the belt.

5. Assemble the lacing so that the centerlines of the matching belts are in line within 1/8".

6. The actual length of belting installed on each unit is to be included on system drawings and in the spare parts list.

7. All rough top belting to be ground smooth within 1" of the cut end to allow proper seating of the belt lacing

E. Belting

1. Check all pulleys and rollers for squareness to the centerline of the conveyor. Adjust when necessary.

2. Free conveyor beds of all foreign material and broom clean before pulling the belt.
3. Minimize number of belt lacings on each conveyor. Do not make belt segments shorter than 4'. Maximum acceptable number of lacings per conveyor belt segment is two (2).
4. Both sides of the pulley shaft elevations at the bearings shall be set within 1/32" of one another.

F. Belt Tracking

1. Ensure all belts track within 1 inch of center on any drive, tail pulley or intermediate point.
2. Run each conveyor for a minimum of 4 hours with no load and 4 hours with a baggage load as encountered in actual service before acceptance testing.

G. Floor Supports

1. All conveyors shall be adequately sway braced in order to ensure that there is no lateral or longitudinal displacement.
2. All support structure must be designed and installed so that maintenance access to the conveyor components, gap pans and access to walkway(s), work areas and drive aisles are not blocked.

H. Overhead Supports

1. The BHS Contractor is responsible for the design and structural integrity of all bolts, hangers, support structures etc, and is to provide all necessary materials required for installation.
2. All conveyors shall be adequately sway braced in order to ensure that there is no lateral or longitudinal displacement.
3. Locate conveyor supports at intermediate sections splices at 10 feet maximum to provide a rigid and rugged installation. Hanger rods shall be a minimum diameter of ¾ inch.
4. Installation and layout of header steel and all support structure shall not pose interference to maintenance and operation access.
5. The BHS Contractor shall repair/replace both new and existing fireproofing materials removed to allow the installation of BHS equipment header steel, supports structures etc.
6. Vibration isolators shall be used to ensure that there is no noticeable vibration transmitted to the building. For installation of vibration isolators, adhere to the following criteria:
   a. Where compression-type vibration isolators are installed below the sill, the threaded rod shall have a lock washer, a single flat washer, and a single nut above the sill while utilizing a single flat washer with a single nut and a single jam nut, installed in a jam configuration, below the vibration isolator. In this instance, the diameter of the flat washer must be equal to or greater than that of the contacting surface of the isolator.
   b. Where compression-type vibration isolators are installed above the overhead support structure, the threaded rod shall have a single flat washer (the diameter of which being equal to or greater than that of the contacting surface of the isolator) and one eccentric locking nut above the vibration isolator. Below the support structure the threaded rod shall have a lock washer, a single flat washer, and a single nut.
   c. Where spring-type vibration isolators are used, the threaded rod shall have an eccentric locking nut, a single flat washer, and a resilient washer in contact with the spring mechanism.
7. Provide means of height adjustment on all hanger rods. Once the proper heights are established, lock the adjustments by means of lock nuts.
8. Provide sufficient length of hanger rods to allow for height adjustment. Do not deform threads on threaded rod which would prevent the ability for height adjustment.

I. Anchoring

1. Firmly anchor all equipment and structures to the floor or building structure where permitted, subject to review and approval, by the DAA or his representative. Align, level and finish grout, as required.
2. Anchor floor supports to the floor with a minimum of two (2) stud expansion anchors per H-brace foot support having a minimum size of 1/2" diameter by 2-3/4" long, unless otherwise noted on the specification drawings.
3. Weld floor supports, which rest on a steel mezzanine or intermediate structure.
4. Anchor impact protection with a minimum of four 3/4" diameter epoxy adhesive anchors, each having a minimum tensile strength of 3000 psi, concrete of 20,000 pounds and a minimum shear strength of 18,000 pounds, and a minimum embedment of 6", unless otherwise noted on the specification drawings.

J. Lubrication

1. Fill all reducers to the proper oil level using oil recommended by the manufacturer.
2. Install breathers at the highest opening.
3. Clean roller chains of dirt or debris and manually lubricate per manufacturer's recommendations.
4. Replace all lubrication fluids if testing or checkout period exceeds manufacturer's suggested start-up change-out interval.
5. Apply grease per manufacturer's specifications to all grease fittings (unless they are sealed for life type bearings) prior to initial start-up of the equipment.

K. Motor Disconnect Installation

1. Wire each motor on all components to a separate disconnect switch which shall be mounted within sight of the motor but not more than 3 feet from the motor.
2. Provide a means of disconnecting power, including the capability of being locked in the "Off" position etc., that meet or exceed the requirements of NEC Article 430 (or applicable local code), to any clutch or brake (if separately or group powered) mounted as part of drive unit so as to minimize the potential of electrical shock during any servicing or maintenance operations.

L. Jacking Bolt Installation

1. Install all jacking bolts in conjunction with pulley and motor bearing housings based on the following criteria:
   a. When mounted in a threaded bracket, engage the bearing with the cup of the jacking bolt and lock the jacking bolt in position with a jam nut on the inside of the bracket (i.e., between the bearing housing and the bracket) to ensure the proper locking configuration.
   b. When mounted in a non-threaded bracket, engage the bearing with the cup of the jacking bolt, position a jam nut on the inside of the bracket, and position a single flat washer, lock washer, and finished or semi-finished nut on the outside of the bracket (i.e., between the jacking bolt head and the bracket) to achieve the proper locking configuration.
2. Use of socket male/female adapters in conjunction with the jacking bolt is unacceptable.
3. Allow for minimum adjustability of the jacking bolt on either side of the mounting bracket equal to the maximum amount of adjustability provided for the associated bearing by the mounting slots.

M. Sheave/Sprocket Alignment

1. Align shafts, sprockets and sheaves using a steel straight edge. The use of a string for this purpose is not acceptable. Demonstrate during Acceptance Test that corresponding surfaces of mating sprockets/sheaves are in line within 1/32" in 24". Misalignment shall be determined by placing the straight edge against the face of one sprocket/sheave and measuring the gap it makes with the opposite sprocket/sheave. The operation shall then be reversed so that a total misalignment can be determined.

N. Fasteners

1. Protect all fasteners (nuts, bolts, screws, setscrews, etc.) against accidental loosening by the use of lock nuts, lock washers, jam nuts, or other suitable means, and against corrosion by plating or the use of corrosion resistant materials such as zinc plating or stainless steel materials.

O. Shaft Mounted Components

1. Mount all shaft mounted components using keys, splines, or equivalent, with positive retention devices.

P. Painting and Finishing

1. Equipment Finish

a. Stainless Steel

1.) Cover all metal components and surfaces of conveyors in public view with Type 304 stainless steel with No. 4 brush finish. Stainless steel shall incorporate smooth flush edge seams. Radius type edges are not acceptable.

2.) The BHS Contractor shall also be responsible for the design; fabrication and installation of stainless steel trim frames around conveyor wall penetrations in public areas. The trim frames will be constructed of 12 gauge, 4" x 4" stainless steel angle. The BHS Contractor shall coordinate trim design/details with the Architect, the DAA or his representative.

3.) All stainless steel trim elements and related connections are to be smooth and flush without openings or projections on which bag tags, straps etc., may catch.

4.) All flat head screws used to attach the stainless steel shrouding, such as the horizontal portions attached to the conveyor bed, are to be completely countersunk so that no portion of the screw head is above the adjacent surfaces. Such flat head screws are to be of the Phillips Head type. Grinding or filing of the screw heads to accomplish the above is not acceptable.

5.) Field welding of any stainless steel trim element is not acceptable. Additionally, no blemishes of the stainless steel trim elements shall be accepted. This includes those blemishes that are caused by poor manufacturing practices as well as those caused in the field plus those caused by field attempts to remove any blemish.

b. Protect all metal surfaces from corrosion using one or more of the following methods:

1.) Electro-galvanize or use stainless steel for slides and chutes unless otherwise specified on the contract drawings.

2.) Electro-galvanize or hot-dip galvanize conveyor side guards if exposed to outdoor environment, and paint on the outside only if used in interior areas.

3.) Use cold rolled or hot rolled low carbon steel primed and painted on both surfaces in all interior areas.

4.) As an alternative to items .2) and .3) above, the BHS Contractor can offer Powder Coating as an alternative due to superior quality and resistance to the elements.

5.) Use as received pre-painted housings from component supplier, such as motors, gearboxes and bearing housings.

6.) Paint conveyor slider bed components only on the outside exposed surfaces. Do not paint the surface in contact with the belting.

7.) Finish paint electrical enclosures normally purchased primed prior to assembly and delivery to the construction site.

8.) Protect all unpainted surfaces (shafts, slider bed, side guards) with a suitable rust inhibitor during shipping and installation.

9.) Prime and finish paint all catwalks, stairways, ladders, maintenance platforms and support steel.

10.) Provide galvanized threaded rods. Protect the ends of all threaded rods with a suitable galvanizing spray after the threaded rods are cut to length.

11.) Apply an industrial quality primer and enamel to all to-be-painted surfaces in accordance with the manufacturer's directions. All paint shall be of the same make, type and color.

c. Prepare surface to be painted in accordance with paint manufacturer's requirements and as described below. If there is a discrepancy between the two, the manufacturer's requirements will take precedence. Suitable precaution shall be taken to ensure cleanliness during the period between cleaning and other finishing processes.

1.) Preparation of Surface

a.) Prior to the application of any finish, clean all surfaces to be free of dirt, grease, oil, flux, flash metal, spatter metal, sand, rust, scale, or oxides, and all other debris that might interfere with the effective application of the finish. Clean surfaces immediately before the finishing operation. Take suitable precaution to ensure cleanliness during the period (which shall be of minimum duration) between cleaning and other finishing processes. For galvanized surfaces, adhere to the following:

(1.) Clean: Prepare surfaces so prime coat bonds well and adheres permanently.

(2.) Rust-Inhibitive Wash: Use a compatible chemical solution such as phosphoric metal etches. Thoroughly remove solution with water and allow drying.

2.) General Application: Apply primer and enamel to provide a surface of high quality appearance free from runs, sags, cracks, flaking, peeling, blushing, or other defects which may affect drying characteristics, durability, and appearance of the painted surfaces. Apply primer and enamel by brushing, spraying, or dipping.

3.) Basic Application: Finish surfaces with not less than one coat of primer and one coat of enamel. Apply the primer and one coat of enamel at the factory and the touch up of enamel, if required, shall be applied at the installation site, after erection, by brushing. When primer or enamel applied to the equipment prior to erection has been burned, chipped, or otherwise removed during erection, or where new unfinished metal is installed, finish the exposed surfaces with not less than one coat of primer and a finish coat of enamel, of the same color and type as originally painted, after sanding the surface to be painted down to the bare metal. After installation, clean and touch up all scuffed or otherwise marred surfaces, as above.

4.) Masking: Do not obscure equipment nameplates, identification plates, or other identifying markings when painting the equipment. Whenever possible, apply the plates and markings after painting. In all cases where they cannot be applied after painting, mask or otherwise protect them to retain their legibility. After painting, thoroughly and effectively remove all masking and protective coatings.

2. Conveyor Identification

a. Permanently and indelibly mark all conveyor equipment such as conveyors (both powered and slave driven), merge conveyors, pushers, diverters, sort devices, make up units, claim devices, power turn conveyors, tapered pulleys, etc., with its respective (discrete) identification as defined on the contract drawings. All conveyor segments and other equipment such as diverters, vertical merges/sorters and the like shall be identified as specified elsewhere in this document by carefully and neatly painting with black paint the equipment identification characters utilizing a stencil, nominally 4" in height, in a conspicuous location (on both sides of a conveyor adjacent to the conveyor drive in the case of a conveyor). If a blue color is used for the conveyor equipment provide all ID’s with a white color for visibility. The only acceptable identification markings on any conveyor equipment, is to be of the specified conveyor identification numbers for this project. Any other form of identification or markings on the conveyor equipment is not acceptable and must be removed.

b. Identify conveyors in public areas by means of engraved plaques (riveted or bolted) with 2" high black lettering on a stainless steel background.

c. Conveyor identification shall be consecutive with no missing numbers in a sequence. In the event of any additions or deletions prior to each system installation, renumber the conveyors to adhere to this requirement.

d. Completely remove or print over any identification on reused equipment or any temporary markings associated on new conveyors for manufacture, shipping or installation.

e. Where temporary markings or labels on the conveyors or other equipment are required for installation, use a medium which is readily removable with water or a readily available commercial solvent, such that they may be removed without requiring any refinishing of the surface on which they appear. After installing, remove any temporary markings.

f. For queue conveyors with remotely mounted VFDs provide 4” vinyl or stenciled lettering on a removable plaque mounted in a visible location off a bracket on the sideguard.

Q. Safety Signage

1. Furnish and install safety signage throughout the BHS as described within these Contract Documents and any associated addendums. The safety signage shall be located in all area’s and locations where there is exposure to hazards for maintenance/operational personnel and the public. Refer to OSHA, ANSI, NEC, National Safety Council, local, federal and state codes for recommended location, size, shape, design and verbiage required for safety signage, examples of some of the types of signs are included in the contract drawings, these examples are not to be construed as the only signs required. The verbiage of the sign shall be appropriate for the particular location/hazard.

2. The safety signs shall be clearly visible and firmly affixed. The following is a list of locations where safety signage should be placed as a minimum, this list is not to be construed as being complete since it is only provided as a guide:

   a. All potential pinch points

   b. Rotating parts

   c. Chain and V belt guards

   d. On all conveyors that are under the control of auto start

   e. Outside of electrical cabinets and disconnects boxes

   f. On all catwalks including step up/step down locations

   g. At load and unload (make-up devices) areas

   h. At EDS devices

   i. Adjacent to diverters

   j. Areas of low overhead clearance

   k. Fire/Security doors

   l. Around areas of false ceilings

3. Safety chains and prominently displayed placards/signs shall be placed at the bottom of ladders and stairs to indicate restricted area for “authorized and trained personnel only”.

4. Placards/signs indicating locations of all E-stop control stations and lanyards shall be clearly visible.

R. Welding

BNP ASSOCIATES, INC.

1. Nationally certified welders shall perform all welding, and all welding shall be in strict compliance with local and national codes. Provide to the DAA or his representative upon request, copies of certificates verifying that the welder(s) are nationally certified.

2. Only compressed natural gas (CNG) and electric welders shall be used.

3. Connecting welding equipment to any MCP power supply shall not be acceptable.

4. Before approving any cutting or welding operation, a fire safety supervisor or appointee shall inspect the work area and confirm that the following indicated precautions have been taken in order to prevent fires:

   a. Ten pound ABC Dry Chemical Fire Extinguisher to be kept on site.

   b. No flammable liquids permitted within 50 feet of work.

   c. Floors swept clean of combustibles.

   d. All wall and floor openings covered.

   e. Covers suspended beneath work to collect sparks.

   f. Opaque screens placed between work and spectators.

   g. Fire watch is required to observe all work and shall remain on site for a minimum of 30 minutes after completion of work.

   h. The DAA is to be notified prior to beginning work.

S. Maintenance Access

1. Where walls immediately adjacent to conveyor equipment affect maintenance access, advise the DAA or his representative of the location and size of the wall opening that needs to be developed to permit access to drive components, bearings, and other equipment that would normally be inaccessible because of the wall.

3.06 SPECIAL CONTROL REQUIREMENTS

A. Control Stations

1. Mount controls, consisting of but not limited to push buttons, selector switches, indicator lights, in Control Stations. All controls shall be grouped to minimize the number of operating points throughout the system. In the application of a single control for a specific function, push-button stations may be employed.

2. Locate control stations as specified. Position control stations so as not to impede access to the equipment for servicing.

3. Mount all Control Stations located in public areas flush to the equipment and equip with stainless steel cover plates. Control stations located in the view of the public shall not be mounted on the top surface of the conveyor front cladding.

4. Locate Control Stations so as to be clear of normal vehicular and personnel traffic lanes. Install guards to prevent inadvertent actuation where this cannot be accomplished.

5. Control Stations shall contain the appropriate control elements such as push buttons, selector switches, and those indicator lights, which will augment operations.

6. Control Station functions shall be identified in English using elementary concise terms supplemented by graphic symbols. All identification plates shall be mechanically affixed to the console face.

7. Control Stations shall conform to the environmental requirements specified herein. Outdoor applications shall employ weather tight, corrosion resistant boxes, switches, push buttons, and lights.

8. Emergency Stop push buttons, disrupting electrical control power, shall be employed where an emergency may require immediate shut down. Where more than one emergency stop push-button is used in any circuit or subsystem, only the indicator lamp in the activated E-Stop push-button shall be energized. Actuation of any

emergency stop shall be announced on the respective status monitoring system.

9. Indicator lights, especially outside the facility, shall not be affected by extraneous light, and shall be clearly visible in all lighting conditions.
10. Control elements such as but not limited to switches, push buttons, and handles, shall be selected for ease of operation in an industrial "bag room" environment.
11. Control elements such as but not limited to switches, push buttons, indicator lights, and bulbs, shall be easily replaceable and reasonably protected from physical damage.
12. Freestanding control stations shall be mounted on extremely rugged and braced pedestals with large firmly anchored base plates. The design shall account for extraneous loading and generally abusive conditions.
13. Provide independently anchored impact protection wherever control panels, control consoles or control stations are exposed to work area traffic.

B. Photocell Functions

1. As a minimum, provide photocells to perform the following functions:
    a. Cascade Stop
    b. Jam Detection
    c. Over-Height Detection
    d. Over-Length Detection
    e. Length Measurement
    f. Baggage Tracking
    g. Missing Bag Jam
    h. Merge And Priority Control
    i. Auto Start
    j. Auto Stop
    k. Indexing Control (Accumulation)
    l. Diverter Timing
    m. Failsafe
2. Combine photocell functions wherever possible provided proper operation of each circuit is maintained.
3. Cascade Stop
    a. Locate a head end sensor photocell within 12" of the discharge ends of all straight conveyors and 6"on power turns and queue conveyors (or an appropriate distance from the discharge end to ensure that the piece of stopped baggage does not transition/stop on the downstream conveyor) so that the center of the photocell beam is approximately 2.5" above top of the conveyor belt to provide the signal for operation of cascade stop circuits.
    b. Should a downstream conveyor stop as a result of a jam condition or mechanical/electrical failure, the conveyor immediately upstream of the stopped conveyor shall continue to run until the head end photocell is blocked. At that moment, the conveyor shall stop. The preceding upstream conveyor will run until its head end photocell is blocked. This cascade stop function will continue through the upstream conveyors until the jam/failure is cleared or the first conveyor in the subsystem has stopped.
    c. The cascade stop photocell shall also be utilized for jam detection functions, but no control station shall be installed in conjunction with this photocell. Upon the detection of a jam at this photocell, initiate the

following steps:

1.) Stop the conveyor with the cascade stop photocell and the one immediately downstream.

2.) Provide a jam indication signal at the MDS, and MCP Touch Screen Terminal and a visual warning signal in the field (within the vicinity of the jam location).

3.) Illuminate the jam indicator light in the nearest jam reset/restart control station.

d. Cascade controls logic shall include programming to initiate the Ticket Counter Start Ready Pushbutton “Green light” to flash when the respective ticket counter (or curbside) conveyor subsystem has cascaded back to the load belt. This will notify the ticket counter/curbside agent that a jam/fault has occurred in the subsystem.

4. Jam Detection

a. Locate a head end sensor photocell to provide the signal for operation of jam detection circuits within approximately 12" of the discharge ends of all straight conveyors and 6"on power turns and queue conveyors (or an appropriate distance from the discharge end to ensure that the piece of stopped baggage does not transition/stop on the downstream conveyor). The center of the photocell beam is to be approximately 2.5" above top of the conveyor belt.

b. As a minimum, provide jam detection photocells and a jam indicator with a jam/restart/emergency stop control station in areas that have a relatively high frequency of jams. This shall include the discharge ends of all conveyors feeding onto power turns, at the bottom of inclines and decline conveyors, at all merges for both the primary and secondary lines, opposite all pushers and diverters and at any other location where experience indicates a potential jam point.

c. As soon as the photocell detects a jam (blocked for longer than an adjustable (0 to 10 seconds in the PLC), predetermined (nominally set to 6 seconds) length of time), initiate the following steps:

1.) Stop the conveyor with the jam detection photocell and the one immediately downstream, unless the photocell is mounted on a conveyor that feeds onto a power turn. In this case the conveyor with the jam detection photocell, the power turn and the conveyor immediately downstream of the power turn are to be stopped.

2.) Provide jam indication signal at the MDS and MCP Touch Screen Terminal.

3.) Illuminate the jam indicator light in the control station.

d. Whenever a conveyor stops for any reason, reset the jam detection timer and hold until the conveyor restarts.

e. The jam detection circuitry is only to function whenever the associated conveyor is running; i.e., if the conveyor is stopped and the jam detector photocell is blocked, the jam detection circuitry will not sense a jam condition and thus report a false jam condition.

f. Conveyors that cascade stop as a result of a jam are to be “latched stopped” through PLC logic until the jam reset push button has been activated.

5. Jam Indication/Restart

a. Provide an Illuminated Amber Jam Light (in a common enclosure with an Emergency Stop push-button and green re-start pushbutton) adjacent to all jam detection photocells as follows: As a minimum, provide jam detection photocells and a jam indicator with a jam/restart/emergency stop control station in areas that have a relatively high frequency of jams. This shall include the discharge ends of all conveyors feeding onto power turns, at the bottom of incline and decline conveyors, at all merges for both the primary and secondary lines, opposite all pushers and diverters, and at any other location where experience indicates a potential jam point.

b. Illuminate the Jam Lamp when the jam detection photocell senses a jam condition.

c. Restart the conveyor and extinguish the lamp only after the following sequence:

1.) Actuate (push in) Emergency Stop push-button (E-Stop indicator lamp goes on)

2.) Clear the jam

3.) The jam light shall "flash" (indicating the jam photocell has been cleared and the conveyor is ready for restart).

4.) Reset (pull out) emergency stop push-button (E-Stop indicator lamp extinguishes)

5.) Depress green "re-start" push-button (conveyors restart after warning alarm sequence)

d. Paint the control station enclosure with "Safety" yellow paint and label with the conveyor Item Designations of the conveyors being controlled in 1/2" high block letters. Jam detection reset control stations shall be placarded with the conveyor designations, which are being controlled.

e. In most cases the control stations shall be located adjacent to the conveyors under control and shall be accessible only to the personnel clearing the jam to avoid a subsystem being re-started in an unsafe condition (e.g. personnel on conveyor). Note that all such control stations shall be located on the catwalk side of conveyors so equipped with catwalks.

6. Over-Height Detection

a. Provide over-height detection photocells at every baggage input to the system to detect bags that are too high to clear the lowest downstream obstruction for all possible routes. This photocell shall be set at 36" above the top of the conveyor belt unless otherwise stated.

b. As soon as the photocell is interrupted, stop the conveyor.

c. Provide jam indication signal at the MDS, and MCP Touch Screen Terminal.

d. Provide an oversize indicator lamp in the control station; this lamp may be the same unit as that for over-length detection. Illuminate the oversize indicator lamp in the control station if an over-height bag is detected.

e. Program the over-height circuit to require the following sequence to reset:

1.) Actuate associated E-stop

2.) Clear the photocell by removing or re-positioning the over-height bag, the oversize indicator lamp shall extinguish

3.) Press the start push-button.

4.) Clear the fault on the MDS, and MCP Touch Screen Terminal.

7. Over-Length Detection

a. Provide over-length detection photocells at every baggage input in the system, both at inbound load belts and outbound ticket counter load belts to detect bags that are too long.

b. Program the over-length measurement circuit to stop the conveyor if a preset bag length (adjustable in the PLC) is exceeded.

c. Provide jam indication signal at the MDS, and MCP Touch Screen Terminal.

d. Provide an oversize indicator lamp in the control station. This lamp may be the same unit as that for over-height detection. Illuminate the oversize indicator lamp in the control station if a preset bag length (adjustable) is exceeded.

e. Program the over-length circuit to require the following sequence to reset:

1.) Actuate associated E-Stop

2.) Clear the photocell by removing the over-length bag, the oversize indicator lamp shall extinguish

3.) Press the start push-button. This push-button may be the same unit as that for over height detection.

4.) Clear the fault on the MDS, and MCP Touch Screen Terminal.

8. Length Measurement for Accelerated/Delayed and Added Bag Tracking in EDS matrices

a. Accelerated/Delayed Bag Tracking

1.) The CBIS shall be capable of detecting when a bag has been delayed or accelerated out of it's tracking window ("lost in track") by more than the minimum conveyable item identified in these specifications.

2.) Upstream of EDS (single bag): The CBIS shall reacquire the bag and continue tracking.

3.) Upstream of EDS (2 bags leading edge to trailing edge): The CBIS shall detect this and be able to prevent the bags from entering the EDS in this condition.

4.) Downstream of EDS (single bag): If already screened and downstream of the EDS, any security status assigned to the bag will no longer be considered valid and the bag shall be routed to the Resolution Room.

5.) Downstream of EDS (multiple bags): If multiple bags are involved and tracking windows have been infringed, then the CBIS shall be capable of detecting this and route the bags to the Resolution Room.

b. Added Bag Tracking

1.) The CBIS shall be capable of detecting when a bag has been added to the tracking zone as long as that bag is added anywhere other than on top of, underneath, or directly beside another bag. The system shall be capable of detecting the minimum size bag, as identified in these specifications, which has been added touching the leading edge or trailing edge of another bag.

2.) Upstream of EDS (single bag): The CBIS shall reacquire the bag and continue tracking.

3.) Upstream of EDS (2 bags leading edge to trailing edge): The CBIS shall detect this and be able to prevent the bags from entering the EDS in this condition.

4.) Downstream of EDS: If the addition occurs downstream of the EDS and only the added bag itself is affected (added bag does not infringe on the tracking window of another bag) then the added bag shall be routed to the Resolution Room.

5.) Downstream of EDS: If the addition occurs downstream of the EDS and the added bag infringes on the tracking window of another bag, then the CBIS shall be capable of detecting this and route the bags to the Resolution Room.

9. Bag Tracking

a. After bags have been scanned, their position shall be tracked by bag tracking photocells.

b. The tracking photocell shall be typically located at the head end of tracked conveyors.

c. All bag tracking photocells shall also be programmed to update the position of the bags and shall have diverter arming capability to cause bags to be diverted.

10. Missing Bag Jam

a. For EDS security screening and sortation systems a missing bag jam is defined as a jam that occurs when three (3) consecutive bags are sensed at a conveyor head end photocell and not detected at the next downstream photocell within a predetermined period.

b. All tracked conveyor subsystems shall incorporate missing bag jam detection logic.

c. Provide a means at the MDS to be able to override the missing bag jam logic. This shall be allowable within clear bag sortation subsystems only in order to prevent a gridlock type of situation in case of a failure.

11. Merge and Priority Control

a. 90° Merges

1.) Merge windows shall be dynamic in that the control system establishes a window only upon indication that a bag has arrived at either the merge or through line induction photocell (i.e., a fixed window control system will not be acceptable). Merge windows shall be variable and shall be established on the basis of bags per minute (BPM) throughput requirements per subsystem with associated window spacing. Bag length shall be measured by the control photocells to adjust the merge window length as required.

2.) Photocells, timers and appropriate control stations shall be located on the conveyor equipment in 90° merge situations with functionality as follows. For all intents and purposes for this project, the conveyor line onto which bags are to be merged shall be referred to as the primary line, while the conveyor line from which bags are merged from shall be referred to as the secondary line:

a.) A photocell shall be located at the discharge end of the secondary line merge conveyor. This photocell shall have the functions of jam detection, head end sensing and priority control. The jam detection function of this photocell shall detect a jam at the merge point resulting from bags being transferred from the secondary line onto the primary line. When this occurs, both belts involved shall be stopped until the jam is cleared (along with other appropriate conveyors upstream that will cascade stop as necessary).

b.) Merge window logic in the PLC is used to monitor and track the flow of bags on the primary conveyor line upstream of the merge. The merge window logic shall use a photocell and timer to measure bag length in order to determine the required merge window for proper transfer onto the primary line. The merge window logic is used to track the position of bags and the space between the bags on the primary line. The head end photocell on the conveyor immediately upstream of the merge conveyor on the secondary line shall be used to measure the length of bags as they move onto the feed conveyor. The PLC utilizes this length to calculate the bag window size required on the primary line to merge a bag into. If the required bag window is determined to be available on the primary line then the bag is not stopped and is merged onto the primary line. If the bag window is determined to be unavailable then the bag is stopped and held on the merge conveyor until the appropriate size window is detected on the primary line.

c.) The merging function shall be provided in two modes. Primary priority and reverse priority. In primary priority mode (to be considered normal mode of operation) bags on the primary conveyor line shall have priority over bags on the secondary conveyor line. The secondary line will have to wait for openings between bags on the primary line to be able to merge into. Priority control shall monitor the time in which the photocell on the primary line is being blocked, indicating that the appropriate merge window is being searched for.

d.) In the event that there are multiple merges onto the mainline each merge should receive equal priority in order to prevent any one of the merges from not being able to discharge bags onto the mainline.

12. Auto Start

a. Provide Auto Start photocells upstream of sections of transport conveyors not specifically controlled by START/STOP switches. The same photocell may control both Auto Start and Auto Stop circuits.

b. Program Auto Start circuits to start a string of conveyors whenever an Auto Start photocell is interrupted.

c. Before any conveyors may be started, audible start-up warning alarms shall be actuated, audible throughout the area to be affected by the starting of the conveyors. Activation of the alarms shall be through the PLCs. The horn shall sound and after a period of between 5 and 25 seconds (adjustable in the PLC) the conveyor subsystem shall start.

d. Each conveyor in the subsystem shall be sequentially started from output to input point with an appropriate delay between each motor starter actuation as to ensure electrical power surges are minimized. The next sequence of conveyors controlled by Auto Start functionality shall start in a similar manner, triggered by baggage at a predetermined location within the line.

13. Auto Stop (Time-Out)

a. Provide Auto Stop photocells upstream of sections of transport conveyors not specifically controlled by START/STOP switches. The same photocell may control both Auto Start and Auto Stop circuits.

b. Program Auto Stop circuits to stop a string of conveyors if an Auto Stop photocell does not sense a bag for an adjustable time period (adjustable in the PLC).

c. If a conveyor stops for any reason, reset the auto stop timer and hold until the conveyor restarts.

14. Indexing Control (Accumulation)

a. Provide a photocell at the discharge end of each conveyor feeding an indexing conveyor.

b. Program the indexing conveyor to run when the photocell is blocked and to stop when it is clear.

c. Include a time delay so that the conveyor can be programmed to continue for a preset interval after a bag clears the photocell and is completely on the indexing conveyor.

15. Diverter Timing

a. Provide a photocell at an appropriate distance upstream of each pusher with the center of the photocell beam at a height of 2.5" above the top of the conveyor belt for diverter timing/arming. The function of this photocell can also be combined with baggage tracking (not with jam or cascade functions)

b. Program the photocell function to ensure accurate diverter-bag contact; given bag size, belt speed, and paddle cycling speed.

16. Fail Safe

a. Provide a redundant photocell arrangement an appropriate distance downstream of the suspect bag removal conveyor with the center of the photocell beam at a height of 2.5" above the top of the conveyor belt for failsafe monitoring. The function of this photocell can also be combined with baggage tracking (not with jam or cascade functions).

b. Program the photocell as described in Additional EDS Controls Functions below.

c. BHS Contractor shall coordinate the fault requirements and resets with the local TSA operational requirements.

C. Motor Overloads

1. Size the motor overload heaters not to exceed 115% of the full load amps as indicated on motor nameplate.

2. In the event of any subsystem motor drawing excess current, appropriate protection shall be provided to isolate supply to all subsystem elements. Either the single "motor overload" indicator on the affected MCP panels shall illuminate, or if individual “motor overload” indicators are specified for each drive then the effected drive indicator will illuminate.

3. Following rectification of the cause of the overload and resetting of the overload protection device in the motor control panel or motor control center as applicable, the system may be restarted by actuation of the "start" button, at which stage, the "motor overload" indicator shall be extinguished and normal control shall resume.

4. "Motor overload" fault conditions shall be reported both visually and audibly on the MCP Touch Screen Terminal and on the MDS in the BHS Control Room.

5. In the event of individual conveyor motor overloads, all upstream conveyors shall revert to cascade stop mode, while all downstream conveyors shall continue to run in normal mode of operations.

D. Start-Up Warning

1. Provide amber rotating beacons and audible horn alarms as start-up warnings in areas as specified.

2. Activate the beacon and the horn for an adjustable period of time prior to the start-up of the conveyor system.

3. Appropriate audible start-up warning alarms shall be provided at public areas such as ticket counter, curbside check in, claim devices, and rechecked baggage input points.

E. Alarm Silence

1. Provide an ALARM SILENCE momentary contact push-button on the door of the MCP which, when depressed, shall silence the audible alarm. The design of the control circuitry shall be such that multiple faults shall always sound the associated fault warning alarm; i.e., if a jam condition has caused the alarm to have been sounded and the alarm has been silenced by the act fault but has not yet been corrected, a second fault occurring after the alarm has been silenced shall again cause the fault warning alarm to sound.

2. Do not extinguish the illuminated fault indicator until the fault has been corrected.

F. Emergency Stop Push-Buttons

1. Locate Push buttons as required to ensure that operating and maintenance personnel can easily and quickly reach an Emergency Stop Push-Button from anywhere in the system. In addition, ensure that Emergency Stop Push-buttons are installed at the following locations:

   a. Around the perimeter of all make-up and claim devices.

   b. At each end of load/unload conveyors.

   c. Along lengths of conveyors, whether running at floor level or overhead mounted on conveyor support legs or building columns a maximum of 50' apart.

   d. In each jam indication enclosure.

2. Wire all Emergency Stop push buttons for a single subsystem in series with the coils of one or more emergency stop relays. Size the normally open contacts of the relays in series with the power source of the PLC output module(s) controlling the conveyors in the subsystem. The PLC shall not be required to remove power from the associated conveyors for an emergency stop condition.

3. Upon actuation of an Emergency Stop push-button, stop the associated conveyors in the subsystem, illuminate the lamp in the head of the push-button in a steady burning mode, and illuminate the red emergency stop fault light at the MCP.

4. Restart the conveyors and extinguish the indicator lamp and MCP fault light only after the following sequence:

   a. Reset (pull out) emergency stop push-button (indicator lamp and MCP fault light extinguish)

   b. Depress the green “Re-Start” push-button (conveyors restart)

5. When a jam has been detected and an Emergency Stop push-button in the jam indication enclosure is activated, follow the same sequence of stopping the conveyors and illuminating the light in the head of the push-button, but do not activate the fault warning circuits at the MCP.

6. When the normal re-start switch for the conveyor is actuated, extinguish all emergency stop push-button lamps within the subsystem associated with that particular emergency stop actuation, actuate the start-up warning alarms and, after a delay, start all conveyors in the subsystem.

7. Note that the activation of an Emergency Stop push-button switch must not close any powered fire/security door within the area of control of the Emergency Stop switch.

8. "E-Stop" conditions shall be reported both visually and audibly on MCP Touch Screen Terminal and MDS.

G. Security/Fire Door

1. Provide a photocell to detect bags under the security/fire door.

2. The door is to be equipped with either a limit, photocell or proximity switch mounted in such a manner so that the "fully open" position of the door is sensed. If the door is sensed by the limit or proximity switch not be in the fully open position, the associated conveyor shall be stopped if running or shall not be permitted to start if the conveyor is not already running. Note that this limit or proximity switch is in addition to those limit or proximity switches provided with the door operator if the door is powered.

3. The fire door’s normal state shall be in the open position and close only upon detection of fire/smoke, per the appropriate interface with the building fire/security system. The BHS controls for the fire door and the associated subsystem(s) shall interface with the building fire/security system, as required, to provide the response to the fire alarm requirement for door closure (with related control functionality to stop the associated conveyor line.

4. The door is also to be equipped with a limit, photocell or proximity switch mounted in such a manner so that the "fully closed" position of the door is sensed. If the door is sensed by the limit or proximity switch not be in the fully closed position, annunciation shall be sent to the system fault monitoring system for rectification of the problem. Note that this limit switch is in addition to those limit or proximity switches provided with the door operator if the door is powered.

5. Interface and test the door interface with the building fire/security system for door open/closed status.

6. Program the security/fire door to operate as follows:

a. Normal Start/Stop

1.) Start: Open the security/fire door immediately. Ticket counter inputs, recheck and re-accommodation inputs require card swipe permissive start. PLC to provide Building Security System with “Running status”.

2.) Stop:

a.) Run the feeding conveyor for one minute, stop the conveyor and lower the security/fire door. PLC to provide Building Security System with “Door Closed” status.

b.) If a bag is detected under the door via the door clear photocell or the door pressure switch, continue to run the conveyors until the photocell is clear and reattempt to close the door. The door should continue attempting to close, however an alarm should be displayed on the fault monitoring system that the door has failed to close after the third attempt.

b. Upon fire detection:

1.) Close the dry contact

2.) If no bag is detected under the door by either the clear photocell or the door pressure switch, stop all conveyors and close the door.

3.) If a bag is detected under the door by either the door clear photocell or the door pressure switch, run the conveyors until the photocell is clear and immediately stop the upstream and downstream conveyors to allow the door to close. If the door is unable to close upon detection of a fire signal or system stop signal an alarm shall be displayed on the fault monitoring system that the door has failed to close.

c. Emergency Power:

1.) The fire doors and respective upstream and downstream conveyors shall be supplied with both normal and emergency power supply. Reference "ELECTRICAL & CONTROLS SPECIAL CONSIDERATIONS" paragraph related to "emergency power" for additional requirements.

d. A fire door control station shall be installed adjacent to each fire door for maintenance personnel use only (not accessible from the public side) which shall contain the following:

1.) MAINT/AUTO two position maintained contact switch

2.) E-STOP

3.) START Green Pushbutton

4.) Door OPEN Black Pushbutton

5.) Door CLOSE Black Pushbutton

6.) JAM Amber Indicator Light

e. When the MAINT/AUTO is in the MAINT position, the door OPEN and door CLOSE pushbuttons are active. Related conveyor systems are not active when in the maintenance mode. Activation of the ticket counter security card swipe is not required when in the maintenance mode.

f. All powered security/fire doors must be equipped with a manual release mechanism to permit the disengagement of the door drive unit so that the door can be either raised or lowered.

H. Fault Warning Alarm

1. Provide an audible/visual alarm on the MCP controlling the system.

2. Activate the alarm and one of the following indicator lights whenever any fault has caused a section of conveyor to stop or prevent it from starting:

Condition	Color
Jam	Amber
Motor Overload	Blue
Emergency Stop	Red

I. High Speed Diverter

1. Provide photocells at strategic upstream locations to synchronize diverter operation with bag position.

2. Provide a sensor at the "home" position of the diverter to stop the sort conveyor if the diverter does not return to the home position within a preset time after it has started its cycle. Report the fault condition to the MDS, and MCP Touch Screen Terminal. The sensor is to be of the shaft encoder type with proximity detector controlled by a Warner Electronic Controller (or approved equivalent) so that the "at home" paddle position shall always be the same.

3. Provide each diverter with one disconnect switch to control both the clutch/brake and motor.

4. Provide a photocell on the receiving conveyor spur to which the diverter discharges to report to the control system that a bag has successfully transferred and that no jam has occurred.

5. Each diverter feeding a conveyor spur shall have a four device control station installed adjacent to the photocell or on the housing of the diverter for maintenance personnel operation of the diverter:

a. START green pushbutton: Momentary contact Reset/Start push-button switch to allow for reset of the associated subsystem conveyors and energizing of the diverter motor following a jam condition and subsequent clearing of the photocell at the charge end of the associated receiving chute, opposite the HSD.

b. JAM amber indicator light: Illuminated Amber Jam Indicator Lamp to signal a jam condition of the photocell at the charge end of the associated receiving chute, opposite the diverter.

c. E-STOP: Maintained Contact Illuminated Red Mushroom Head Emergency Stop type switch to stop the associated subsystem conveyors and energizing of the diverter motor.

d. AUTO/MAINT/CYCLE: A three position selector switch with the AUTO/MAINT positions being fixed contact and the CYCLE position being momentary. This will allow for the manual cycling of the diverter for testing purposes.

6. If the diverter installed already includes these controls from the factory the BHS Contractor is to install a TYPE 1 jam/jam reset control station adjacent to each diverter location.

J. Interlocks

1. Provide Failsafe interlocks and limits in the system to ensure safe operation. Assume responsibility for the integration of all interlocks and limits that may be necessitated by the characteristics of the elements selected for combination into a total system. Interlocks and limits shall be included for the protection of personnel, equipment and baggage, and in the performance of the operational functions specified for the subsystem and elements comprising the system.

2. Provide electrical interlocks between the various conveyors in a subsystem to inhibit a conveyor from discharging baggage onto a stopped conveyor. Interlocks shall be cascaded from the last conveyor in a train to the first. This provision shall apply to all subsystems even if two different suppliers provide the equipment under separate contract.

3. Provide warning signals, which are activated automatically upon start-up, where appropriate. Flashing lights shall be visible from all points in the vicinity of the equipment concerned. Alarms shall be audible within the equipment vicinity and each alarm in the system must be distinctive from any sound within the hearing range, and shall not be unduly annoying to working personnel and shall comply with all applicable codes and regulations. Although not specifically mentioned in the control subsystem descriptions all automatic start-up functions shall be preceded with appropriate audible and visual indicators unless otherwise specified.

4. Inhibit further equipment action upon sensor failure should personnel safety be in doubt. Inform the involved equipment operator or maintenance personnel of such failure through the MCP Touch Screen Terminal and MDS. Sensors shall be selected and positioned such that false signals from debris, ambient light, and personnel movement do not cause activation.

5. Coordinate the facility fire zones with the Architect and to add a dry contact to the subsystems controls, so that if a fire is detected the system will perform the necessary shutdown. This feature shall be provided to the BHS control system, regardless if the system includes a fire door or not.

K. Run Lanyards (RL)

1. Provide pull-to-run conveyor advance control lanyards in non-public operational areas as detailed on the contract drawings.

2. Activation of the advance control shall cause the related conveyor to run for as long as the control is activated or until the respective pier full photocell is blocked.

3. The run lanyard cable shall be color coded – Green

4. Support the installation of the lanyard on stanchions, if provided.

3.07 ELECTRICAL & CONTROLS SPECIAL CONSIDERATIONS

A. Power Source

1. The electrical equipment and PLC control systems supplied by the BHS Contractor shall be compatible with, and operate reliably and effectively with, the normal electrical supply typically available at airport locations. The equipment shall not be unduly sensitive to fluctuations in supply voltage which may typically vary by

plus or minus ten percent (10%) of nominal values.

2. The BHS Contractor shall provide necessary electrical supply filters, conditioners, and regulators for all equipment, which cannot meet the specifications stipulated.

B. Emergency Power

1. Normal and emergency power shall be provided to all fire doors and their immediate upstream and downstream conveyors with all associated controls in order to provide a positive means for preventing obstructions (i.e. baggage) from interfering with the operation of the fire doors in accordance with the fire door mode of operation upon detection of heat, smoke, or fire elsewhere in the specification. The remaining conveyors and related equipment of the respective subsystem are to be controlled and power by normal building power supply.

2. To accomplish emergency power supply, the following shall be provided:

a. Emergency electrical power feed to a main disconnect box in the associated MCP area (by others).

b. Wiring from the main disconnect box to a distribution panel (by BHS Contractor).

c. Wiring from the distribution panel to the appropriate MCP(s) housing the subsystem components responsible for the fire door/associated conveyor operation (by BHS Contractor).

3. Functional Intent

a. The fire doors and their immediate upstream and downstream conveyors with all associated controls are to be normally powered by normal building power. In the event of loss of building power, the power-switching device shall detect this loss and apply the emergency power to the fire doors and their associated upstream and downstream conveyors and controls to assure the fire door pathway is clear prior to stoppage of conveyors and closure of the doors.

b. The BHS Contractor shall supply the power-switching device and associated controls.

3.08 BHS DETAILED CONTROL DESCRIPTIONS/REQUIREMENTS

A. General Design Requirements

1. The following subsystem control descriptions apply the referenced components and circuits to the operational aspect of the system and specify the actual elements under their control.

2. By means of suitable computer dialogue at the computer keyboard in the Computer/Control Room, (or by "Mouse" manipulation and using pull-down menus) it shall be possible to make changes to baggage flow in response to a variety of conditions such as:

a. Jams

b. Equipment Failure

c. Conveyor full condition

3. In each case an operator, having access to the proper passwords, as an example, will be able to:

a. Activate a diverter and set it to operate either continuously or in an alternating sequence.

b. Shut down a diverter or conveyor.

4. Reference the Contract Drawings for conveyor equipment power distribution and subsystem indication. Location for each of the new MCPs is referenced on the BHS Partial Plan and Control Plan Drawings. Power distribution point (PDP) locations for the new MCPs are at the immediate area of the respective MCP as shown on the BHS Partial Plans.

5. The Control Functions associated with the inbound system, outbound sort system the ticket counter check-in, and recheck/oversize subsystems are described in the following paragraphs. Apply the generic

subsystem/conveyor line functional description to the detail design of each electrical subsystem of similar type.

6. Provide software for the control system reflecting the sequence of operation for each subsystem as described in the following paragraphs. The paragraphs describe the particular subsystem specific controls that will be required in addition to those standard controls (i.e., Jam Detection, Jam Reset, Cascade Stop, Oversize Detection, Merge Control, Auto Start, Auto-Stop, Emergency Stop, and all other controls functionality described elsewhere in this document) that will be required for each subsystem (described elsewhere in this document).

B. Ticket Counter Subsystems

1. General

a. The outbound ticket counter consist of the following subsystems:

1.) TC1: Transports checked baggage from the ticketing counters for screening through the CBIS/CBRA and out to the sortation make-up carousel.

2. Control Equipment Components

a. A minimum of two control stations shall be provided for Start/Stop control of each ticket counter conveyor lines. One station shall be located on the wall, adjacent to the charge end of the TC1-01 conveyor, the second on the wall, adjacent to the discharge end of TC1-03 (as shown in reference drawing B7102). The location of these control stations shall be coordinated with the DAA or his representative.

1.) The control station located at the charge end of TC1-01 shall include the following operators/control devices:

a.) START: illuminated green pushbutton

b.) STOP: non-illuminated red pushbutton

c.) E-STOP: illuminated Push-Pull (Lockable) E-Stop

d.) START ALARM: Sonalert warning device

e.) Additionally the control station will be activated by an adjacent security card swipe. BHS Contractor to coordinate with special systems contractor for interface requirements.

2.) The station at the discharge end of the TC1-03 conveyor shall include the following operators/control devices:

a.) START: illuminated green pushbutton

b.) STOP: non-illuminated red pushbutton

c.) E-STOP: illuminated Push-Pull (Lockable) E-Stop

d.) JAM: illuminated amber jam light

e.) OVERSIZE: illuminated oversize bag alert, white pushbutton.

f.) START ALARM: Sonalert warning device

g.) Additionally the control station will be activated by an adjacent security card swipe. BHS Contractor to coordinate with special systems contractor for interface requirements.

b. Ticket Counter Conveyor Start Sequence:

1.) System Ready Indication

a.) A green indicator light, labeled SYSTEM READY and located on the door of each MCP shall serve to indicate that the devices under its control are ready to operate upon receipt of a START signal, from the BHS control system and local card swipe device. To accomplish this, the light shall illuminate under the following conditions, per the respective subsystem:

(1.) Power is applied to the MCP.

(2.) The local conveyor motor and Fire/Security door disconnect switches are in the "ON" position.

(3.) All Emergency Stop pushbuttons are reset.

(4.) No Motor overloads are tripped.

(5.) No Jam conditions are indicated

(6.) No oversize conditions are indicated.

(7.) All diverters are in the HOME position.

(8.) No other additional system faults are present.

2.) The conveyor line's local "Subsystem Start" shall be enabled via the "System Start" function, from the Master Control Room's BHS Workstation cabinet. This function shall allow the local "Subsystem Start" security card swipe to supply power to the respective **TC1** line Start/Stop control stations.

a.) Automatic System Cascade Start:

(1.) The conveyor segments downstream of **TC1-01** shall start via an "Auto Start" sequence. Provide auto start photocells upstream of sections of outbound transport conveyors, not specifically controlled by the "Start/Stop" control station. Program the auto start circuit to start conveyor segments **TC1-01** through **TC1-06** and the ED feed lines (if not already running) whenever the auto start photocell is interrupted. The downstream TC1 transport conveyors shall all start sequentially from **TC1-06** to **TC1-01** with an appropriate delay between each motor starter actuation to ensure electrical power surges are minimized.

b.) Automatic System Cascade Stop:

(1.) The conveyor segments **TC1-1** through **TC1-6** shall stop via an "Auto Stop" sequence. Provide auto stop photocells upstream of sections of outbound transport conveyors, not specifically controlled by the "Start/Stop" control station. Program the auto stop circuit to stop this subsystem whenever the auto stop photocell does not sense a bag for 5 to 30 minutes (adjustable). The same photocell may control both "Auto Start" and "Auto Stop" functions.

c.) Manual Stop:

(1.) Depressing the "Stop" pushbutton on any of the Ticket Counter Control Stations shall stop conveyors **TC1-01** through **TC1-03** and close the Fire/security door (if the Door Clear Photocells are not blocked); conveyor segments **TC1-04** through **TC1-06** shall run for a predetermined period to clear all bags on the conveyor segments, prior to the stoppage of the conveyor segments and closure of the door.

d.) Start-up alarms and fault alarms shall be located as required, along the outbound line and sort make-up device area. Start-up and Fault Warning Alarm(s) location and function shall be consistent with the specified requirements indicated elsewhere in this document.

e.) Jam Reset and Emergency stop control station(s) location and function shall be consistent with the specified requirements indicated elsewhere in this document. All Jam Reset and Emergency stop stations associated with the TC1 line's outbound transport conveyors in the departures floor level ceiling space shall be located adjacent to each conveyor drive on the maintenance platform side, so that they are accessible by maintenance personnel.

f.) The Ticket Counter conveyors shall be activated by the security card swipe. This action shall supply power to the pushbutton control stations located at the Ticket Counter area. Pressing a "Start" pushbutton on any ticket counter control station shall energize the TC1 Start-up alarm(s) in the check-in area, along the outbound transport line and the bagroom for 10 seconds (adjustable). The start-up alarms in the bagroom area shall sound only if the make up sort system is not already running. The Fire/Security door shall open while the "Run" 10-second start-up alarm sounds and flashes. After the 10 second "Run" alarm period and when the Fire/Security door is fully opened, the ticket counter check-in conveyors TC1-01 through TC1-02 shall start.

3. Other Control Functions:

a. Control Functions associated with the conveyor line's Fire/Security Door operation, Cascade Stop, Jam Detection/Restart, Oversize Detection/restart, Emergency Stop/Reset, Motor Control Panels, Motor Overload conditions and respective Alarm Silence function(s) shall be compliant with the specified requirements described elsewhere in this document.

b. Flash the Ticket Counter Start Pushbutton START illuminated green pushbutton when the respective ticket counter conveyor subsystem has cascaded back to the load belt. This will notify the ticket counter/curbside agent that a fault or dieback condition has occurred in the subsystem

C. EDS Security Screening System

1. General

a. The BHS Contractor shall submit as per Part 1 of this specification submittal process, to the Construction Manager for review and approval, the control sequence of operation and functionality of the mini-inline EDS Security System.

b. The type of EDS device to be provided and integrated into the Baggage Handling System for this project is the Reveal CT-80DR.

c. The BHS Contractor shall be responsible for obtaining all latest documentation from the EDS device manufacturer including as an example: Integration Guides, Site Planning and Design Guides and Interface Guides.

d. The control sequence of operation and functionality of the EDS system shall abide by the current TSA protocols. It shall be the BHS Contractors responsibility to obtain the latest TSA protocol.

e. The following paragraphs describe the particular subsystem specific controls that will be required in addition to other controls (e.g., Bag Tracking, Jam Detection, Jam Reset, Cascade Stop, Oversize Detection, Merge Control, Auto Start, Auto-Stop, Emergency Stop, etc.) that will be required for each EDS subsystem (described elsewhere in this document).

f. This description of operation is intended to define the unique overall functional requirements of the BHS control system that are related to the operation of the EDS subsystems regardless of the type of EDS device installed.

g. In the paragraphs below it should be noted that "decision point" refers to the point at which a bag will either be routed into the BHS for final make-up operations or routed to the next security screening Level.

h. Each of the EDS lines shall contain a number of queuing conveyors upstream of the EDS equipment device (as shown in contract drawing B2103 at a minimum), which shall provide separation of the bags and buffer the input flow to the individual machines and allow for a balanced distribution of the bags among the available equipment.

2. Coordination Responsibilities & Interfaces

a. As set forth elsewhere in these specifications, the definitive architecture, detailed design and any/all coordination required for the control system design in its entirety, including (but not limited to) the BHS-EDS interface requirements, shall be the responsibility of the BHS contractor. It shall be the BHS Contractors responsibility to tailor his system to meet the requirements of the EDS systems to ensure the functionality is provided as described herein. The operation described below shall be the primary operation for the system to be provided as a part of the scope of work specified herein.

b. The BHS contractor shall, as a part of this work, provide and coordinate with the EDS equipment manufacturer as required to coordinate the details of the necessary interface(s) between the BHS and EDS systems in order to accomplish the intended operation described herein. The BHS contractor shall, in all cases, be responsible for any electrical wiring and devices (e.g., communication bridges) between the BHS and EDS equipment systems that are required for these interfaces (hardware and software).

c. Through the required interfaces with the EDS equipment systems, the BHS shall receive an "active" or "inactive" (out of service) status for each of the EDS equipment devices which shall, on a real-time basis, be recognized by the BHS so as to determine whether bags should be sorted to the device and update the MDS displayed status for associated BHS conveyors and EDS equipment in the BHS control room. Provided that the associated devices are "active", the baggage shall then be diverted via diverter, to one of the lines feeding an in-line EDS equipment screening device. As soon as a machine becomes inactive, the diverter feeding that line shall immediately cease sending bags to that device. Should bags be queued upstream of the device after it has become inactive, an appropriate alarm shall be raised at the MDS indicating this situation.

3. EDS Subsystems

a. Reference the BHS Control Plan drawings for the layout and definition of the EDS security screening equipment, associated with the security screening subsystems. All originating checked bags shall be routed to the CBIS located in the bagroom. The following subsystems comprise the EDS security system matrix:

1.) SS1 and SS2

b. Upstream of each EDS machine shall be a number of queuing conveyors (as shown on contract drawings at a minimum). These queue positions shall provide separation of the bags and buffer the input flow to the individual machines and allow for a balanced distribution of the bags among the available equipment.

c. The BHS Contractor shall provide bag-centering functionality prior to every EDS device (whose belt width is smaller than a standard conveyor). As a minimum, attach fixed diverters to the conveyor side guards to force the bag to the center of the conveyor. Refer to Part II of this specification for the minimum requirements for a Directional Input Device (DID). The BHS Contractor shall provide to the Construction Manager the type of centering to be proposed for review and approval.

4. Three Status Levels of the CBIS

1.) Level 1 – EDS Machine

a.) All originating checked bags shall be routed to the Reveal CT-80DR device for security screening. The CT-80DR device software will automatically scan each bag.

b.) Bags entering the EDS device will have a unique bag security identification ID assigned by the BHS at the upstream BMA. The BHS shall pass this ID number to the EDS via the EDS/BHS interface for tracking purposes and status updates at the first photocell upstream of the CT-80DR.

c.) It is the BHS Contractors responsibility to coordinate and reference the latest revision of the Reveal CT-80DR EDS Inegration and Networking Reference Document for all require handshake signals and required data formats to properly interface with the BHS with the EDS.

d.) Upon bag arrival at the conveyor directly interfacing any of the EDS machines, the BHS shall, through the BHS-EDS interface, hand over the bag ID data to the CT-80DR by sending a bag ID number. The bag ID shall be easily recognizable as an EDS bag ID (i.e. start with 1 for EDS device #1, 2 for EDS #2 …). Upon receipt of a signal from the EDS equipment, the BHS shall then advance the bag into the EDS equipment device. The EDS equipment shall pass the bag back to the BHS by sending an appropriate message that includes status (e.g., clear, alarm, unknown/fault) and also echoes the bag ID number upon arrival at the exit conveyor, note: not all machines will pass the bag status back at the same time that the bag is passed back from the machine, it may happen at a downstream point and the BHS control system should be set up to allow for this. Upon receipt of the corresponding bag status/hand-over message the BHS shall send a message back to the EDS equipment acknowledging receipt of that status.

e.) The EDS will provide a status for the bag "clear" or "suspect" based on the assessment of the images and notify the BHS via the EDS/BHS interface described above.

f.) "**Clear**" Level 1 bags will be transported through the removal queue conveyor and merge onto the clear bag CB3 out to the sortation make-up.

g.) "**Suspect"** Level 1 bags shall be held at the first queue downstream of the CT-80DR until a decision is made by the Level 2 OSR operator or the 45 second OSR decision time expires, or the TSO chooses to print a tag associated with that bag and remove the bag prior to an OSR decision. The tag will contain the bag ID, time, and CT-80DR number corresponding to the prematurely removed bag.

h.) "**Unknown/Fault"** Bags that receive an "Unknown/Fault" status will advance to the CBRA removal queue conveyor for removal and processing by Level 3 ETD. The TSO can also carry the bag back upstream to re-input the bag upstream of the CT-80 to be rescreened.

i.) The EDS security screening subsystems (matrix) shall be configured so that any of the EDS machines can operate in either a fully-automated mode (machine decision) or in a "manual" mode of operation that will allow review of every scanned image by the OSR operator at the OSR/ETD stations located at the removal/reinsert point. The mode of operation will be software selectable through the Reveal Multiplexing Control Console.

j.) All bags will be tracked in dynamic PLC RAM via a memory model of the bag ID number, from the entry to the EDS equipment to the CBRA removal/reinsert conveyor.

2.) Level 2 –OSR Operator

a.) Level 2 shall refer to the process whereby the images/information acquired by the Level 1 EDS machine is presented to TSA personnel at the baggage viewing station located at each removal/reinsert conveyor for manual review and subsequent resolution.

b.) When the CT-80DRs are in Hold Outside mode, each Level 1 alarmed bag will stage at the first downstream conveyor post of the CT-80DR.

c.) The operator will view the image in the display for a configurable duration utilizing TSA protocols to determine if the bag is "Clear" or "Suspect". If the allocated GOVT period expires (to be determined by local TSA staff minimum of 15 seconds), and no decision has been rendered, the image and relevant bag status will be updated to "Suspect" Level 2 status and transitioned to the CBRA removal/reinsert queue for Level 3 review and appropriate handling. "Clear" Level 2 bags will be not be held on the removal/reinsert queue and will merge onto the CB3 subsystem and out the make-up device.

d.) Unknown, Lost or Faulted Bags are to advance to the Level 3 removal queue in the CBRA where the BSD will provide the appropriate corresponding information.

e.) The Level 2 OSR operator will press the 'Clear' button for resolved alarms.

(1.) These bags will be assigned a 'Clear' Level 2 status.

(2.) The information will be transmitted to the BHS via the EDS/BHS interface.

(3.) The BHS will update the information referenced to the Bag Security ID, illuminate the GREEN lamp on the stack light, allow the bag to continue to the CB3 45 degree merge.

(4.) If the BHS receives a Level 2 "clear" status after the bag has been staged and removed from the CBRA removal queue (with a printed tag) and removed to the Level 3 area, such message shall be ignored (however, appropriate logs of this event shall be kept and provided in reports).

f.) A Level 2 OSR operator will press the "Alarm" button for images that cannot be resolved in this process.

(1.) These bags will be assigned an "Alarm" Level 2 status.

(2.) The information will be transmitted to the BHS via the EDS/BHS interface.

(3.) The BHS will update the information referenced to the Bag Security ID and continue to track the bag to the Level 2 decision point (CBRA removal queue).

g.) In the absence of a Level 2 decision, the BHS control system shall automatically default a "pending" status at the Level 3 removal queue, this shall remain as pending until a decision is made (i.e., OSR operator (clear/alarm), bag time out, or a bag tag is printed and the bag is removed). Pending decision status will be indicated with the WHITE light on the stacklight.

(1.) During peak times the TSA may choose to remove bags that take too long to make a Level 2 decision.

(2.) A bag that has a "pending" status that is printed and removed, that is later cleared by the TSA will no longer have an image to reconcile; therefore, the TSA may choose to manually re-induct bags removed with a "pending" status printed on the tag.

(3.) Provide a "no decision/time out" status to indicate a GOVT timeout. This will send the timed out bags to the RRS for Level 3 and alleviate the number of "pending" bags arriving without images (as stated above). No decision status will be indicated with the RED light on the stacklight.

(4.) After a bag with "pending" status arrives at the Level 3 removal queue, a bag shall be given forty five (45) seconds (adjustable) to receive a decision (i.e., OSR operator (clear/alarm), bag time out). The BHS shall then change the status from "pending" to "no decision/time out".

3.) Level 3 – ETD Operator(s)

a.) Bags will stop at the CBRA removal queue if they have the following status: Level 2 "Suspect", Unknown, Pending/No Decision or Lost.

b.) The bag will arrive at the CBRA decision point removal queue and stop when the leading edge triggers the removal queue photocell. Once the photocell is blocked the associated touch screen Baggage Status Display (BSD) (as shown on contract drawing B7100 and B7102) with pull up and display the associated information for that bag. The touch screen BSD control station will also include a thermal tag printer installed on the same stanchion, or as required by local TSA.

c.) Each ED screening line has a single Level 3 ETD station adjacent to the alarmed bag removal/reinsert conveyor that in addition to the BVS shall have RRS (Remote Resolution Station) that will display the alarmed bag image during the Level 3 screening.

d.) Hold on Alarm Procedure

(1.) Bags will remain on the decision point removal queue while the ETD TSA personnel screener looks up the bag on their RRS.

(2.) The TSA will touch the “Transfer Image” virtual button on the HMI, slide the bag from the queue to their search table, the conveyor will begin to run after the photocell is clear for 3 seconds.

(3.) If the bag is removed before the “Transfer Image” virtual button is pressed, the button shall flash (the HMI will display an alert to indicate it needs a directive) and the conveyor shall not start until either the “Print Bag Tag” or “Transfer Image” input has been activated to prevent the bag information from being written over. The “Print Bag Tag” input is available to print all the relevant bag information and bag status on a thermal adhesive backed tag to affix to the associated bag depending on local TSA protocol.

e.) No Hold on Alarm Procedure (Peak times)

(1.) During peak times the TSA may choose to remove bags that take too long to make a Level 2 decision (or activate a Level 2 timeout).

(2.) Bags with a “lost, “unknown”, “pending” or “no decision” status that have been removed and a tag printed can be manually re-inducted upstream of a Level 1 device when available or Level 3 screened. TSA should remove tags before re-induction.

(3.) When bags will arrive at the decision point removal queue, the HMI will display the information, the TSA will touch the “Print Tag” virtual button. The information on the tag will include a scan-able barcode with the bag ID, EDS device, date/time and status. The tag will be affixed to the bag and the bag removed.

(4.) Bags will be placed in an order of reverse chronological order, so as to retain prioritization. They will then be re-inducted or screened in that order. From this group of bags, the TSA should be able to distinguish if a bag is able to be re-inducted to Level 1; and should attempt to re-induct these bags without the “re-inductable” bags waiting in the priority order with the “suspect” bags requiring to be ETD screened.

(5.) The TSA may provide a Level 2 time-out which will create the “TIME OUT BAG” status and will create less pending status bag tags to be printed. Also the potential of a “pending” bag being Level 2 cleared and that bag no longer having an image to reconcile would not be the case with a “no decision” bag.

f.) Level 3 ETD operations are necessary on all bags that arrive at the CBRA (i.e., bags not re-inducted to a Level 1 machine).

(1.) “Cleared” Level 3 bags would be re-introduced in the system after the following sequence: the TSA personnel will press the INSERT BAG green illuminated pushbutton on the control station located adjacent to the ETD table (as shown in contract drawings B7100 series) to stop the removal/reinsertion conveyor and queue any bags upstream to allow the TSA personnel to slide the clear bag to the reinsert conveyor. Once the INSERT BAG button has been pressed it will illuminate continuously until the bag has been placed onto removal/reinsert belt and blocks the associated head end photocell. After the photocell is blocked the INSERT BAG button will illuminate in a flashing pattern indicating the TSA personnel to press the button a second time to restart the conveyor and send the clear bag to merge onto the CB clear bag line.

(2.) “Failed” Level 3 bags shall be handled per the local EOD protocol.

5. Positive Bag Tracking Requirements

a. Added, Missing, Accelerated or Delayed Bags

1.) Refer to the most current TSA PGDS for description and procedure of tracking Added, Missing, Accelerated or Delayed Bags.

2.) Added Bag Functionality

a.) The BHS shall be capable of detecting when a bag has been added between the EDS device and the Clear Bag diversion points as long as that bag is added anywhere other than on top of, underneath, or directly beside another bag. If the bag is added in front of, between, behind or directly against the leading or trailing edge of another bag than the system shall detect this addition.

b.) If the addition occurs downstream of the EDS machines and only the added bag itself is affected, the system shall treat the bag as "Lost in Tracking" and the BHS shall ensure that the bag is sent to.

c.) If the addition occurs downstream of the EDS and the added bag infringes on the tracking of another bag, then both bags shall be declared "Lost in Tracking" and the BHS shall ensure that the bag is sent to Level 3 ETD screening.

d.) The BHS shall measure the bag as it exits the EDS device and as the bag approaches the Clear Bag diversion points to determine if there has been an "Added Bag" fault

b. Unknown/Lost-in-Track Bags

1.) Bags can be result in the status of "unknown" or lost-in-track from any number of failures; such failures include but are not limited to: power outages, EDS device faults/resets, bag mistracking or misreading, diverter malfunctions, and bag jams.

2.) Missing Bag Jam

a.) If three (3) consecutive bags have been successfully tracked but fails to appear at any downstream tracking photocell, that bag shall be identified as a missing bag by the BHS Controls System. When this bag is not verified to be received at a downstream tracking photocell, stop the conveyor the tracking photocell is mounted on and the immediate downstream conveyor and raise a distinctive alarm at the MDS (i.e., different from other audible alarm sounds at the BHS Control Room & TSA Satellite Workstation) identifying a missing bag jam and include the bag ID for the bag in the alarm (to assist staff in finding the bag that failed to track). Conveyors upstream of the conveyors stopped due to the missing bag jam shall cascade stop normally as required due to the missing bag jam condition. Reset of the missing bag jam fault condition shall be cleared according to local TSA protocols.

6. Throughput Sortation Priority

a. The BHS contractor shall provide programming to prioritize baggage throughput through the ED lines with the following functionality:

b. Round Robin (Non-Peak Only)

1.) During non-peak operations in-spec bags that are routed to the CT-80DRs will be diverted using a round robin prioritization.

c. First Available (Peak Only)

1.) During peak operations (to be coordinated with the Construction Manager) in-spec bags that are routed to the CT-80DRs will be diverted using a "first available" prioritization.

d. Minimal Staffing Option

1.) If the system demand is very low TSA has the ability to only staff the ED2 position which can handle the Level 2 OSR station, the Level 3 ETD, and the out of gauge ETD.

7. Fail Safe – Accurate Routing

a. Through appropriate fail-safe interlocks, the BHS Controls Functionality shall ensure that unscreened bags, bags that lost tracking or bags identified as suspect baggage are <u>not</u> transported to the clear bag lines.

b. The controls system shall provide for fail-safe controls at the last conveyor of the ETD subsystems and the first conveyor of the CB subsystems to ensure that all bags routing is performed according to the bag's security status.

c. Failsafe conditions: If the system detects and unknown bag at the next downstream photocell after the decision point suspect bag removal conveyor the system will stop both that associated conveyor and the clear bag takeaway conveyor that the failsafe queue is merging onto.

d. The baggage failsafe detection shall be activated by less than 0.5% of the total bag volume as measured by the number of individual bags causing the failsafe fault.

8. EDS Start Sequence

a. The Level 1 EDS device(s) shall be activated as detailed in the Reveal CT-80DR operations and maintenance guide and per local TSA protocol. This start up shall be independent of the baggage system at the beginning of the day to allow for sufficient warm-up time. As a minimum, the associated EDS conveyor lines (SS lines) must be running for the EDS device to start up or as required by the EDS device. Also refer to the EDS "TEST" mode of operation outlined in the following paragraphs.

9. EDS Stop Sequence

a. The Level 1 EDS device (s) shall be shut down as required by Reveal's operation and maintenance and by local TSA protocol independently of the baggage system at the close of the day.

b. The SS, CB, OG, and TC conveyor lines shall have an auto-stop function. Photocells located upstream on the outbound mainline (TC1) shall be on a 5 -30 minute timer (adjustable), if no bags are sensed all conveyors in the respective matrix shall shut down. If an Emergency Stop push button is activated or a jam occurs at any point during operation, the timers shall reset to zero.

10. E-Stop Functionality

a. Activation of any EDS machine e-stop will stop the interfaced upstream and downstream conveyors.

b. Activation of a SS conveyor subsystem E-stop will not E-stop the EDS machine scanning gantry, but shall stop the exit belt to prevent the unsafe condition of an active upstream belt and an inactive downstream belt.

11. IQ Test Functionality

a. A control station shall be installed at charge end of the last BHS conveyor prior to the EDS device entrance conveyor. The location of these control stations shall be coordinated with the Construction Manager and TSA. The control station shall contain the following operators/control devices:

1.) START-INSERT: green pushbutton, used to insert the IQ test bag when in IQ mode

2.) E-STOP: red Illuminated, maintained contact, lockable pushbutton

3.) JAM: amber illuminated pushbutton

4.) IQ INSERT/AUTO: Selector Switch used to place the ED line in IQ test mode

a.) The TSA staff shall wait for an available window and place the IQ INSERT/AUTO selector to INSERT mode (left hand position). This shall stop the last BHS conveyor prior to the EDS device's entrance conveyor.

b.) The TSA staff shall place the bag on the conveyor and press the START-INSERT pushbutton; the bag shall then be automatically transported into the EDS device. After processing through the CT-80DR, if the station is still in IQ INSERT mode the bag will stop at the decision point conveyor for removal. Upon completion of the Insert Mode operation, the selector switch shall be positioned to the right hand AUTO mode to place the system back to the automated mode of operation.

b. Coordinate with the EDS Contractor the necessary EDS/BHS interface, and provide the required BHS controls and exit interface conveyor BHS control station requirements for the EDS TEST mode of operation.

12. Decision Point Control Station

a. A control station shall be installed adjacent to the removal/reinsert CBRA queue conveyor (as shown in contract drawings B7100 series). The location of these control stations shall be coordinated with the TSA and the Construction Manager. The control station shall contain the following operators/control devices:

1.) "INSERT BAG" illuminated green pushbutton

2.) E-STOP: red Illuminated, maintained contact, lockable pushbutton

3.) Start Alarm: Sonalert warning device

b. A stack light shall be installed at the discharge end of each EDS device exit conveyor. The location of these control stations shall be coordinated with the TSA and the Construction Manager. The control station shall contain the following operators/control devices:

1.) Lighted green "Clear"

2.) Lighted red "Alarm"

3.) Lighted white "Pending"

4.) Lighted blue " EDS Error, BHS Unknown"

c. A 15 inch touch screen HMI will be installed above the removal/reinsert conveyor (reference drawings B7100 series) to display the information associated with the staged bag. The following information will be displayed per PGDS:

1.) "EDS Machine ID" (serial number) that shall display the identification of the CT-80DR machine that screened the bag.

2.) "Bag ID" that shall display the BHS assigned bag ID.

3.) "Bag Status" as described elsewhere in this document (AL - Alarm bags, ER – Error bags from CT-80DR, CL – Cleared Bag, UNK - BHS Unknown).

4.) "Transfer Image" that represents the input to transfer the bag information/image to the adjacent RRS

5.) "Print Bag Tag", an HMI input to print a tag with the bag information stated above.

13. Contingencies

a. The BHS Contractor shall present as part of the functional specification submission a detailed matrix clearly identifying all the possible security screening failure scenarios and the fallback action to be initiated (manually by the control room operator or automatic by the BHS Computer system).

14. Maintenance Access

a. The BHS Contractor shall be responsible for the design, provision and installation of maintenance platforms and access ladders required to allow easy access to all EDS machines. Access is required by TSA agents who are responsible to both test the EDS machines and clear bag jams within the machines. The BHS Contractor as part of the submittal processes shall provide to the Engineer, TSA and Construction Manager the design of the platform and access ladders for review and approval.

b. BHS Contractor is responsible for coordinating access provisions for TSA operators so as to minimize obstructions. Locations of control stations and electrical boxes are to be coordinated to support unrestricted access by TSA staff to the input/output EDS interface positions. The provisions of the conveyor supports; drive configurations, personnel guarding and side guards shall allow for maximum TSA operator accessibility.

15. EDS Reporting

a. The BHS reporting system shall provide for report generation of the security subsystem activities, in addition to the reports identified elsewhere in these specifications. Reports will need to reflect EDS activity, it shall be the BHS contractor's responsibility to provide a daily log of all bags processed at the EDS machines with appropriate filtering provisions to allow for sort by bag ID specifics, EDS device, decision rendered and lost tracking etc.

b. As a fault finding diagnostics tool, the BHS operator shall have (via a pull down screen at the MDS workstation) the ability to monitor the status of all EDS/BHS handshake/interface signals (per device) in real time. The BHS Contractor shall provide to Construction Manager a sample of the diagnostic status screen.

c. The BHS Contractor shall monitor the following EDS/BHS operations and generate fault messages both graphically and in text at the MDS and stop directing bags to the faulted ED line until the issue has been resolved:

1.) Multiple baggage IDs lost at the EDS

2.) Loss of communications between the EDS and BHS

3.) Multiple bags in a row with an "unknown" or "no" status (these are unknown/no bags not generated as a result of an EDS fault reset)

4.) Loss of bag tracking through the EDS line

D. Out of Gauge

a. To prevent "Out of Gauge" items (verify the EDS specification for maximum bag sizes) being introduced into the Level 1 EDS device the BHS Contractor shall provide a means to monitor for "out of gauge" items utilizing a BMA. "Out of gauge" items result in both increased downtime due to EDS device reset/restarts time and purged bags. The "out of gauge" monitoring should take place prior to the diverter into the EDS machine(s) line from the matrix. "Out of gauge" items shall be transported directly via OG conveyors to a dedicated Level 3 ETD station.

b. Bags on the TC1 outbound mainline will be scanned by a BMA and the out-of-gauge bags shall be transported by OG1to the oversize ETD screening station. Upon detection of a bag destined for the OG line, the OG line shall start using the standard "auto-start" functionality described above, if timed-out.

c. Bags at the last conveyor on the OG line shall index and a control station will be located at the head end of the indexing conveyor to advance a staged bag to the removal point of the conveyor. This station will have the following controls:

1.) START/ADVANCE: green illuminated pushbutton – This only needs to be pressed once. Once the furthest downstream bag on the indexing belt reaches the head end photocell, the conveyor will stop to allow TSA to remove the bag. While the head end PE is blocked, the conveyor will not index.

2.) E-STOP: illuminated Push-Pull (Lockable) E-Stop

3.) START ALARM: Sonalert warning device

E. Make-up and Claim Device Control Stations

1. Make Up Device

a. Provide "Start" Pushbutton control stations as shown in contract drawings for Manual Start-up operation of the make-up device; In case the flat plate make-up device times-out before all baggage has been sorted, activation of any start button on the flat plate make-up device shall cause the device to run for an additional twenty (20) minutes (adjustable) without the feed conveyors operating.

2. Claim Device

a. Provide four "E-Stop" Pushbutton control stations (as shown in contract drawing B7101) for Emergency Stop operation of the claim device.

3. Maintenace Controls.

a. In addition to the control station mentioned elsewhere in this document install a single maintenance control station inside the make up unit decking in an accessible location next to the motor.

1.) START: green pushbutton

2.) E-STOP: illuminated Push-Pull (Lockable) E-Stop

3.) AUTO/MAINT./JOG: Three position selector switch with the AUTO and MAINT. Positions as fixed contact positions and the JOG position as momentary to actuate the claim device intermittently for maintenance purposed.

F. Outbound Oddsize Subsystem

1. General

a. The Outbound Oddsize system consists of a three (3) single straight conveyors OS1-01 through OS1-03 for transporting oversize bags from the ticketing area to the oversize ETD screening area adjacent to the CB3 subsystem as shown in contract drawings B7102.

b. Start-up alarms and fault alarms shall be located as required, along the oversize lines and in the screening bag room. Start-up and Fault Warning Alarm(s) location and function shall be consistent with the specified requirements indicated elsewhere in this document. The location of the alarms shall be coordinated with the DAA or his representative.

c. Control functions associated with the conveyor line's Cascade Stop, Jam Detection/Restart, Emergency Stop/Reset, Motor Control Panels, Motor Overload conditions and respective Alarm Silence function(s) shall be compliant with the specified requirements described elsewhere in this document.

d. Start up of the oversize line will be identical to the activation of the ticket counter conveyors and shall be provided with an identical control station that will require an input from a security card swipe prior to pressing the associated control station START pushbutton. The control station will be located at the tail end of the conveyor at the ticketing level (reference drawing B7100 series). This station will have the following controls:

1.) START: illuminated green pushbutton

2.) STOP: non-illuminated red pushbutton

3.) E-STOP: illuminated Push-Pull (Lockable) E-Stop

4.) START ALARM: Sonalert warning device

5.) OVERHEIGHT: illuminated oversize bag alert, white pushbutton.

6.) Additionally the control station will be activated by an adjacent security card swipe. BHS Contractor to coordinate with special systems contractor for interface requirements.

e. The unload conveyor OS1-03 shall operate under inch and store controlled by the photocell at the discharge end of upstream conveyor.

f. A control station will be located at the head end of the indexing conveyor adjacent to the TSA oversize screening area that will allow control over the indexing belt to advance a staged bag to the removal point of the conveyor (as shown in contract drawings B7100 series). This station will have the following controls:

1.) START/ADVANCE: green pushbutton – This only needs to be pressed once. Once the furthest downstream bag on the indexing belt reaches the head end photocell, the conveyor will stop to allow TSA to remove the bag. While the head end PE is blocked, the conveyor will not index.

2.) E-STOP: illuminated Push-Pull (Lockable) E-Stop

3.) START ALARM: Sonalert warning device

g. A photocell shall be located at the discharge end of oddsize unload conveyor to indicate full lateral condition.

h. Over height photocell cell shall be provided on OS1-01 conveyor before the fire/security door.

i. Fire/Security Door Control Functions:

1.) The fire/security doors shall be provided with maintenance control stations with the following operators/controls devices:

a.) START: non-illuminated green pushbutton

b.) E-Stop: illuminated Push-Pull (Lockable) E-Stop

c.) MAINT./AUTO: selector switch used to place the door in maintenance mode or in auto

d.) DOOR OPEN: non-illuminated black pushbutton

e.) DOOR CLOSE: non-illuminated black pushbutton

f.) JAM: amber illuminated indicator button

G. Inbound Subsystems

1. General

a. The inbound system systems consist of the following:

1.) IB1-01 through IB1-10 and CD1

2.) IB2-01 through IB2-09 and CD2

2. Control Functions

a. Control functions associated with the inbound conveyor line's Cascade Stop, Jam Detection/Restart, Overlength/Overheight, Emergency Stop/Reset, Motor Control Panels, Motor Overload conditions and respective Alarm Silence function(s) shall be compliant with the specified requirements described elsewhere in this document.

b. Each slope pallet/flat plate claim device shall be powered and controlled from new Motor Control Panels, MCP-IB1 and MCP-IB2, and cold backup configured PLCs..

c. One control station shall be provided for Start control of each of the inbound conveyor lines. The station shall be located on a stanchion adjacent to the discharge end of the input conveyor (i.e., IB1-01, IB2-01). The location of the control station shall be coordinated with the DAA or his representative. The start up and stop functionality shall be identical with the ticket counter described above. The station shall include the following operators/control devices:

1.) START: illuminated green pushbutton

2.) STOP: red pushbutton

3.) E-STOP: illuminated Push-Pull (Lockable) E-Stop

4.) JAM: illuminated amber jam light

5.) OVERSIZE: illuminated oversize bag alert, white pushbutton.

6.) START ALARM: Sonalert warning device

d. Auto-stop photocells shall be provided. After no bags have been detected for approximately 3-5 minutes (adjustable), the conveyors will stop and the fire/security door will shut.

e. The claim devices will auto-stop 20 minutes after the conveyors have timed out.

f. Over height and over length photocells should be provided at the load conveyors.

g. Fire/Security Door Control Functions:

1.) All the fire/security doors shall be provided with maintenance control stations with the following operators/controls devices:

a.) START: non-illuminated green pushbutton

b.) E-Stop: illuminated Push-Pull (Lockable) E-Stop

c.) MAINT./AUTO: selector switch used to place the door in maintenance mode or in auto

d.) DOOR OPEN: non-illuminated black pushbutton

e.) DOOR CLOSE: non-illuminated black pushbutton

f.) JAM: amber illuminated indicator button

3. Claim Device Controls

a. Install three single E-stop control stations at each claim device perimeter face except where the claim feed discharge conveyor is (reference contract drawing B7101).

1.) E-STOP: illuminated push-pull (lockable) E-stop, installed flush mounted in the toe-kick of the stainless steel claim device trim.

b. Install a single control station adjacent to the claim feed conveyor discharge. This station will be utilized to enable the claim device for activation from the inbound load belt. Depressing the reset/start button shall cause the device to run for an additional twenty (20) minutes (adjustable) without the feed conveyors operating.

1.) RESET/START: green pushbutton

2.) E-STOP: illuminated Push-Pull (Lockable) E-Stop

3.) JAM: illuminated amber jam light

4.) ENABLE/DISABLE: key switch selector.

c. Install a single maintenance control station at each claim device drive inside the claim decking in an accessible location next to the motors.

1.) START: green pushbutton

2.) E-STOP: illuminated Push-Pull (Lockable) E-Stop

3.) AUTO/MAINT./JOG: Three position selector switch with the AUTO and MAINT. Positions as fixed contact positions and the JOG position as momentary to actuate the claim device intermittently for maintenance purposed.

H. Inbound Oddsize and Recheck Subsystem

1. General

a. The re-check subsystem RCOS1 consists of conveyor segments RCOS1-01 through RCOS1-3 for the transport of all the oversize inbound bags and re-checked baggage from the FIS facilities out to airside that shall be reversible as shown in reference drawing B7100 and B7101.

2. Control Functions

a. Two control stations shall be provided for Start/Stop controls for the RCOS1 odd size and recheck inputs (conveyor is reversible) mounted on the wall. The location of the control station shall be coordinated with The DAA/Program Manager. The station shall include the following operators/control devices:

1.) "Inbound" Illuminated green Pushbutton

2.) "Outbound" Illuminated green Pushbutton

3.) “Stop” Non-illuminated red Pushbutton

4.) E-STOP: Illuminated Push-Pull (Lockable)

5.) Overheight: Illuminated white Pushbutton

6.) Sonalert Warning Device

b. Depressing the “Inbound” or “Outbound” illuminated green pushbuttons when in solid green color state shall start the subsystem in its associated direction.

c. The conveyor segments downstream of RCOS1-01, or RCOS1-03 when running in either direction, shall start via an "Auto Start" sequence. The direction of travel shall be clearly displayed on the MDS. The downstream RC1 transport conveyors shall all start sequentially from the output to the input with an appropriate delay between each motor starter actuation to ensure electrical power surges are minimized.

d. The conveyor segments downstream of RCOS1-01 or RCOS1-03 when running in either direction shall stop via an "Auto Stop" sequence. Program the auto stop circuit to stop conveyor segments RCOS1-01 through RCOS1-03 whenever the auto stop photocell does not sense a bag for 5 to 30 minutes (adjustable). The same photocell may control both "Auto Start" and "Auto Stop" functions. Control functions associated with the conveyor line's Cascade Stop, Jam Detection/Restart, Emergency Stop/Reset, Motor Control Panels, Motor Overload conditions and respective Alarm Silence function(s) shall be compliant with the specified requirements described elsewhere in this document.

e. Depressing the “Stop” pushbutton on any of the RCOS1-01 or RCOS1-03 shall stop the conveyors and close the Fire/security door (if the door clear photocell are not blocked) after a predetermined period to clear all bags on the conveyor segments., prior to the stoppage of the conveyor segments and closure of the door.

f. The unload conveyors RCO1-01 and RC1-03 shall operate under inch and store controlled by the photocell at the discharge end of upstream conveyor.

g. A photocell shall be located at the discharge end of each oddsize unload conveyor to indicate the full pier condition. This condition will be shown on the MDS, on the “Inbound” and respectively “Outbound” illuminated green pushbuttons on the control stations located at both ends of the subsystem by a green color flashing pattern. Also presence of bags indexed at the unload conveyors for the RCOS1 subsystem shall be indicated in the same way. Subsystem shall not be allowed to run in reverse direction before the bags indexed and any other bags cascaded on the remaining belts are not removed at the unload conveyor. Continuously depressing the flashing illuminated green pushbutton shall advance the indexed and any cascaded bags to the discharge end photocell of the unload conveyor. After all the bags on the line have been removed and accounted for by the PLC programming at the discharge end of the unload belt in the current direction of travel, the lights on the illuminated green pushbuttons at the control station at both ends that indicate the current direction of running shall turn to a solid green color state.

h. Over height photocell cells and a lighted reset push button shall be provided for both the forward and reverse direction.

i. One maintenance control station shall be provided and shall be located on conveyor RCOS1-02. The location of the control station shall be coordinated with the DAA or his representative. The station shall include the following operators/control devices:

1.) START: green pushbutton

2.) E-STOP: illuminated Push-Pull (Lockable) E-Stop

3.) JAM: illuminated amber jam light

j. Start-up alarms and fault alarms shall be located as required, along the RCOS1 line. Start-up and Fault Warning Alarm(s) location and function shall be consistent with the specified requirements indicated elsewhere in this document.

k. Fire/Security Door Control Functions:

1.) All the fire/security doors shall be provided with maintenance control stations with the following operators/controls devices:

a.) START: non-illuminated green pushbutton

b.) E-Stop: illuminated Push-Pull (Lockable) E-Stop

c.) MAINT./AUTO: selector switch used to place the door in maintenance mode or in auto

d.) DOOR OPEN: non-illuminated black pushbutton

e.) DOOR CLOSE: non-illuminated black pushbutton

f.) JAM: amber illuminated indicator button

3.09 CONSTRUCTION PHASING SEQUENCE

A. General

1. Coordinate all work with the DAA/Program Manager, other disciplines working in the immediate area of construction, airline flight schedules and hours of operation, so as not to impact the Airport's normal functions and concurrent airline operations.

2. The contractor shall check and field-verify actual site conditions to determine and coordinate the schedule for any shutdown period. Notify the respective carrier 72 hours in advance and obtain approval before proceeding with the shutdown of the system(s).

3. Existing BHS equipment indicated for removal shall be removed, salvaged and turned over to the DAA. Storage of the salvaged components shall be coordinated with the construction manager and the DAA in compliance with the specified requirements of this section (Part III). Equipment shall be turned over to the DAA's Airport Operations and transferred to the designated area within a 5-mile radius of the Airport Property. Dispose any equipment not desired by the DAA, in compliance with the specified requirements of this section (Part III).

4. Reference the overall program phasing plans. The BHS Contractor shall include as part of his proposal the best duration period, per phase, that will require completing the specified work.

3.10 OPERATION AND MAINTENANCE TRAINING

A. General

1. Instruct and train the DAA operating and maintenance personnel at the work site. Conduct this training prior to Conditional Acceptance of each phase of the work and ensure competence in the operation and maintenance of the new equipment and the system/subsystems.

2. Training is to be provided by a professionally qualified instructor. Use of site supervisors, equipment or system designers as an instructor for the formal training will not be accepted unless approved by the DAA or his representative.

3. Furnish all tools, equipment, materials and supplies, and perform all functions and services required to complete the training as specified. With the exception of safety and overview training, training shall be divided into separate categories for operations training and maintenance training further broken down to specific trades.

4. No actual operations training of a piece of equipment will be permitted until the equipment is properly installed and is operational.

5. A detailed outline of the proposed training to be conducted shall be submitted to the DAA or his representative for review and approval in accordance with the schedule of submissions prior to the testing of the system. The training program submittal shall include, at a minimum, the following information for review:

   a. Types and durations of training/classes.

   b. Name and professional credentials for each instructor/trainer.

   c. Max/min number of persons allowed per class.

   d. Any specialty type of requirements such as classroom/conference room space, DVD Player, TV, or white board (to be coordinated with the DAA however the DAA is not responsible to supply the above mentioned space or materials)

   e. Copies of all training materials, to be used during training. All training binders/materials shall be submitted for review in the format in which they will be used during the on site training. It should be noted that the O&M manuals will not be allowed to be used for training purposes; however consolidated sections of the O&M manuals which have been tailored for classroom training are permitted.

6. Times and duration of the classes may involve irregular hours in order to provide training of the operational and maintenance personnel on different shifts.

7. All training sessions will be monitored and approved by the Engineer. Any session or portion thereof deemed unsatisfactory, based on evaluation of the training, shall be repeated by the BHS Contractor or the BHS Contractors representative at no additional cost to the DAA.

8. Develop and maintain a training attendance record for all operation and maintenance training sessions presented. The record is to note the following information in duplicate form. The original copy of the record is to be forwarded to the DAA with the second copy being retained by the BHS Contractor for his files. The recorded training information must include for each session:

   a. Date of training session

   b. Name of project

   c. Name of Instructor

   d. Subject of training

   e. Time of training session

   f. Signature and department of each attendee

9. Provide the DAA with two (2) copies and the Local TSA with one (1) copy of the video recording of one (1) complete operational and maintenance training class for this project. The video recording shall be provided to the DAA/Local TSA in a media acceptable to the DAA (DVD or VHS).

B. Operational Training

1. Provide formal instruction of the DAA's operational personnel at the site who will be charged with operation

of the BHS. Include a description and on-site demonstration of the electrical controls and their operation, modes of operation, the operating limitations of the equipment and the safety devices and their functions.

2. Provide a minimum of 10 hours of operational training per shift for this project, for a minimum of three (3) shifts.

C. Maintenance Training

1. Provide formal training of the DLH Mini In-Line CBIS/BHS maintenance personnel with the objective of preparing the employees to perform the required preventive maintenance to minimize breakdown and to perform necessary repairs when work stoppages or breakdowns of the equipment occur. The training shall include, but not limited to the following:

   a. Preventive and corrective maintenance procedures, including replacement of parts; lubrication quantities, types, frequencies and application points; and an estimate of the time to perform such procedures.

   b. Special tools, techniques, or procedures required for either preventative or corrective maintenance of the equipment, or it's auxiliary or support components.

   c. Procedures to perform adjustments required for alignment, wear and calibration for all preventative and corrective maintenance, and an estimate of time required to perform such procedures.

   d. Assembly and disassembly procedures, including parts lists required for appropriate and corrective maintenance. Models, "exploded" views, and audiovisual materials shall be used for training. These materials shall be handed to the Engineer upon completion of training. Hands on field training shall be provided, subject to the approval of the Engineer.

2. The formal training shall consist of classroom and on the equipment training, as required to properly train personnel for each shift, prior to the start of operation. The training must cover all aspects of the electrical and mechanical equipment provided in this project. The electrical aspects shall include but not be limited to, electrical controls and control systems and PLC control systems.

3. On-site training shall be scheduled to commence immediately following classroom training and shall stress hands-on performance based application of the classroom training. Equipment shall be started and relevant systems and components shall be demonstrated.

4. Off-site training, primarily for the technical trades e.g. electricians, controls technicians; mechanics shall focus on specialized, technical training and shall be provided by the manufacturer at their factory or training facility. In the event the Engineer requests specialized factory training on a particular piece of equipment, the BHS Contractor shall make arrangements with the applicable manufacturer to provide such training.

5. Provide maintenance training for any specialized equipment used in the related system that is not of the BHS Contractor's design or manufacture. The qualified representatives will present such training, from the manufacturer of the specialized equipment.

6. Provide a minimum of 40 hours of maintenance training per shift for this project, for a minimum of three (3) shifts.

7. Examples of specialized equipment and other BHS maintenance related training include, but are not limited to those items listed below:

   a. Safety Procedures including Lock out/Tag-out

   b. Operation and Maintenance Manual use

   c. Warranty Procedures

   d. System Preventative Maintenance

   e. EDS/BHS System Interface and Troubleshooting

f. Power Turns

g. Slope Pallet Devices

h. Flat Plate devices

i. Diverters

j. Fire/Security Doors

k. BDD/BMA Array

l. Programmable Logic Controller Systems including basic ladder programming techniques

m. Computer Systems Equipment

n. Interfaces to the DAA Networks

o. Problem Resolution Screens

p. System Reports

q. Paging System

r. MDS and MIS Systems including development of both new and modifying existing reports, adding new or modifying existing conveyor subsystems with associated fault annunciation to the graphic/text displays.

D. Supplemental Training

1. Should the DAA require supplemental training beyond that specified above, provide at a time and at rates as mutually agreed upon between the DAA and the BHS Contractor.

- END OF PART III -

PART IV - QUALITY CONTROL SPECIFICATIONS

4.01 FIELD QUALITY CONTROL

A. Quality Control Manual

1. Provide a Quality Control Manual acceptable to the DAA or his representative.

2. Indicate inspection lists and methods that will be utilized for quality control inspection and testing to confirm compliance with the specified requirements.

3. The Quality Control Manual shall assure that there is a system for final inspection and testing of completed products, construction and installation. Such testing shall provide a measure of the overall quality of the completed product and shall be performed so that it simulates product end use and function. Final inspection and testing shall provide for reporting to the DAA or his representative any difficulties, deficiencies, or questionable conditions. When modifications, repairs, or replacements are required after final inspection or testing, there shall be re-inspection and re-testing of any characteristics affected.

4. The Quality Control Manual shall provide instructions for handling, storage, preservation, packaging, and shipping to protect the quality of products and prevent damage, loss, deterioration, degradation, or substitution of products. It shall also require and monitor the use of procedures to prevent handling damage to articles. Products in storage shall be protected against deterioration and damage.

B. Quality Assurance

1. The BHS Contractor shall be responsible for all quality control of its Work, including work performed by any of its subcontractors. It shall be the BHS Contractor's responsibility to include in its own direct subcontracts those provisions which are necessary to assure that the quality of subcontracted work will be as good as that required of the BHS Contractor by the requirements herein.

2. The DAA or his representative shall have the right to audit and inspect the BHS Contractor's and its direct subcontractors' quality systems. Such audits may be conducted on a random or routine basis and may include an audit of the BHS Contractor's inspection and test records. The DAA or his representative shall have the right to witness any tests or inspections and shall have access to all test data including test procedures, test specifications, and test results. The DAA or his representative shall have the right to conduct independent tests or inspections at its own expense on any material or equipment to be used on the project. Should such the DAA or his representative directed independent test result in failure, the BHS Contractor shall reimburse the DAA's expense for the test. The objective of all audits, inspections, or tests conducted by the DAA or his representative is to ensure that all BHS Contractor-performed work is accomplished in compliance with the Contract Documents.

3. The DAA or his representative shall have the right to reject, and the BHS Contractor shall replace at the BHS Contractor's cost, any construction, production or installation, or portion thereof, which has not been accomplished or documented as accomplished in accordance with the accepted Quality Control Plan.

C. Quality Assurance Representative

1. Appoint a Quality Assurance Representative acceptable to the DAA or his representative who shall be responsible for the overall quality assurance implementation and monitoring of the general requirements.

2. The quality assurance representative shall be available on-site during the construction period at all times and be qualified to advise the DAA or his representative on the overall BHS scope of work (i.e., installation procedures, provisioning, start-up and maintenance of the equipment).

D. Configuration Management Plan

1. Maintain strict configuration control of all aspects of the design, construction, fabrication and installation of the BHS Systems. Submit a Configuration Management Plan for the DAA or his representative review and approval. The BHS Contractor shall be responsible for carrying out all aspects of this Plan.

2. Establish a system, to identify, organize and track all documents developed as part of the BHS Contract Work throughout the duration of the project. Serialize all correspondence and transmittals, and establish a logging system for incoming/outgoing correspondence showing action requirements and action taken. Drawings, specifications, subcontract documents, reports, estimates, studies, reviews, and computer files, shall be tracked by a logging system.

3. Tracking logs for correspondence and documents shall be provided when requested by the DAA or his representative. Establish a single source for transmitting and receiving documents and correspondence. Material from the BHS Contractors subcontractor’s shall be consolidated and submitted to the DAA or his representative by the BHS Contractor.

4. Logs for correspondence and document control shall be provided to the DAA or his representative on electronic media and in reproducible hard copy for use in the DAA’s document control system.

5. Once configuration for an element of the BHS System is established (for example, at Design Reviews), the configuration of all such elements shall not be changed by the BHS Contractor without proper approval as provided for in the Configuration Management Plan. Once configuration changes are approved, formal Change Order Documentation shall be circulated in accordance with a distribution list (which shall include the DAA or his representative) developed for that purpose.

6. The audit function shall track every change made to the BHS system and its operating programs, including detecting who, where and when changes were made. The archive file management function shall manage all revisions carried out to the system, as files are modified, revisions shall also be stored and be accessible for future use.

E. Safety Program Manual

1. Prepare a site-specific safety program manual acceptable to the DAA or his representative.

2. Designate a Safety Manager/Coordinator acceptable to the DAA or his representative.

3. The Safety Program shall be implemented by the BHS Contractor to identify and resolve hazards. The Safety Program shall emphasize the prevention of accidents by resolving hazards in a systematic manner. The Safety Program Plan, as described below, will identify the responsibilities of all parties for implementing the Safety Program.

4. The Safety Program shall demonstrate compliance with all applicable safety rules and regulations. The levels of compliance shall meet the OSHA Standards, ANSI Standards, NFPA Standards, NEC Standards, and trade association standards and recommendations as applicable.

5. The safety program manual shall contain as a minimum the following:

   a. Have as its objective to provide for the safety of the passengers, employees, general public and equipment.

   b. Encompass all elements within the BHS Contractor-provided BHS Systems.

   c. Include all interfaces with Facilities provided by others and identify all hazards within the Facilities that may result from the unique characteristics of the BHS System.

   d. Identify the safety roles and responsibilities of all the BHS Contractors' organizational elements and require accountability of each.

   e. Contain a hazard resolution process that includes the procedures necessary to identify and resolve hazards.

   f. Indicate safety inspection lists and methods that shall be utilized by all personnel employed on this project.

   g. A plan for furnishing and enforcing the use of individual protective equipment including hard hats, rain gear, protective footwear, protective clothing and gloves, eye protection, ear protection, respirators, safety belts, safety harnesses, safety lifelines and lanyards, and high visibility reflective safety vests.

h. A plan for providing first aid facilities, supplies, and trained personnel.

i. A plan for employee safety training to include employee safety orientation during the first week of work, weekly work crew safety meetings, periodic safety meetings for supervisory personnel, and special training prior to working with especially hazardous materials or operations.

j. Emergency plans for fire emergencies, severe weather, or flooding emergencies, seriously injured personnel, traffic accidents along the project site, and injuries of members of the public.

k. Pre-construction planning relative to safety and control of hazards including special tools, equipment, facilities, and individual protective gear.

l. A plan for periodic safety inspections, investigations of all accidents and injuries and submission of timely reports.

m. Submission of injury/accident/incident data for statistical analysis.

F. Project Management Team

1. Submit to the DAA or his representative for review and approval, the following listing of key personnel with resumes and qualifications that will be working on the project:

    a. Senior Project Manager

    b. On-Site Field Supervisor(s)

    c. Professional Engineer(s)

    d. Safety Manager

    e. Configuration Control/Schedule Manager(s)

    f. Quality Control/Assurance Manager(s)

    g. Project Manager(s) - Electrical and Control Systems Engineering

    h. Project Manager(s) - Mechanical Engineering

    i. Project Manager(s) - Computer Systems Engineering

    j. Instructors/training personnel (in addition, provide instructors professional qualifications)

2. Include on-site and off-site participating personnel and the percent of anticipated participation on this project. The DAA or his representative reserves the right to approve or reject key personnel from the list.

3. The Project Manager and on-site Superintendent(s) shall not be changed without the DAA's or his representative's written approval.

4. The BHS Contractor, individuals or entities constituting the BHS Contractor and the officers or directors of the BHS Contractor or entities or key members of the Project Management Team shall have records of past performance sufficient to assure the DAA or his representative that they have the experience, competence and integrity to successfully complete a project of this magnitude.

G. Project Management Office

1. Within one week of the date of commencement initiate the Project Management Office, inform the DAA or his representative of the details of the office, and authorize the Project Manager and on-site Field Superintendent to act as representatives

2. The Project Manager shall be given full authority to make decisions and enter into binding agreements with the DAA for all aspects of the project.

3. The BHS Contractor shall provide to the Construction/Program Manager, the DAA or his representative a

listing of all key project personnel with 24-hour contact details (cell phone number, pager number and e-mail addresses).

4. The BHS Contractor shall be responsible to supply all office equipment (e.g. telephones, copiers, fax, computers, plotters, furniture) required to establish their on-site project management office.

H. Workmanship

1. Ensure that all equipment is manufactured and installed in accordance with the best commercial practices consistent with the intended design and usage and is acceptable to the DAA or his representative.

2. Ensure that all materials and components are new and free from defects. Do not supply used equipment, whether refurbished or reconditioned, unless indicated in the specifications and drawings or without the express approval of the DAA or his representative.

3. The DAA or his representative shall reserve the right to inspect any conveyor component at the BHS Contractor's factory prior to shipment of said components. The BHS Contractor shall co-ordinate with the DAA or his representative, fabrication of any components that the DAA or his representative requests to inspect such that said components are fully assembled and available for inspection by the DAA or his representative at the previously arranged time of the factory visit.

I. Pre-Installation Meeting

1. Prior to the start of the installation; attend meetings on-site as required or requested by the DAA or his representative. The DAA or his representative will schedule the Pre-Installation meetings, for the purpose of coordinating the on-site installation with ongoing airport operations.

2. Provide at the initial pre-installation meeting to the DAA or the Construction Manager the following:

   a. Safety Program Manual

   b. Drug Policy Manual

   c. Submittal Schedule

   d. Project Organization Chart to include all Sub Contractors

   e. Principle suppliers to include long lead items and planned procurement dates

   f. Insurance enrollment forms

   g. Quality Control Manual

   h. Configuration Management Plan

   i. Diversity Program

   j. Updated Master Schedule

   k. Plans for coordination and notification for utility work

   l. Plans for coordination with the work of other contractors and procedures for sharing access to the work site.

   m. Schedule of deliveries of major equipment

J. Pre-Demolition Meeting

1. Prior to the start of any demolition; attend meetings on-site as required or requested by the DAA or his representative. The DAA or his representative shall schedule the Pre-Demolition meetings for the purpose of coordinating the on-site removal of the BHS equipment with ongoing airport operations.

K. Work Activities Bulletin

1. Submit a detailed work plan for ISAT (both BHS Contractor and TSA conducted), individual subsystem

testing, sortation testing, every planned cutover, demolition, and system outage. A BHS specific “Work Activities Bulletin” must be submitted by the BHS Contractor to the DAA or his representative for distribution to the impacted airlines, other impacted contractors (e.g. Reveal, BDD manufacturer) and the DAA a minimum of 7 days prior to the testing, demolition or cutover activity-taking place.

2. No work should be commenced unless the BHS Contractor has a signed “Work Activities Bulletin” in hand, and has distributed copies the User Airlines, the DAA or his representative.
3. The “Work Activities Bulletin” shall contain the following as a minimum:
    a. Contractor’s internal deadlines for completion of pertinent facility interfaces by other disciplines (e.g. permanent system power, support structure, or other facility interface requirements).
    b. Date and time planned activity to take place from start to finish
    c. Details of all conveyors to be installed with duration
    d. Electrical installation duration
    e. Contractors internal testing with duration
    f. Ticket counter/make up device requirements for loading/unloading of test bags. Coordination with the DAA or his representative and user airlines will/may be required
    g. Generation of airline 10-digit bag tags/BSMs required for testing. Coordination with the DAA or his representative and user airlines will/may be required
    h. Witnessed system testing with duration
    i. Full details of contingency plans
    j. Details of person(s) (with qualifications) overseeing the activity
    k. Details and number of personnel to be present who are qualified to troubleshoot all aspects of their respective equipment during the planned activity, for example:
        1.) Mechanics
        2.) Electricians
        3.) Controls Engineers
        4.) Computer programmers
    l. Other affected equipment manufacturers (e.g. Reveal, BDD manufacturer). Confirmation that these manufacturers have been notified and will be in attendance if required.
4. Detailed description of activities required when completing overnight changeovers to ensure that disruption to baggage handling system is kept to a minimum. Include all preparatory work by other trades. Provide back up plan for recovery of operations if changeover work will not be completed in time.
5. Coordination and operational interface to ensure on-going airline and airport operation is not disrupted.
6. Submit as part of the submittal process a sample of their proposed “Work Activities Bulletin” format for review and approval by the DAA or his representative.

L. Field Quality Control Services
1. Establish and maintain quality control for operations under this Section to ensure compliance with Contract Document requirements and maintain records of quality control for alteration and removal operations.
2. Submit quality control procedures for operations in conjunction with work under this Section for approval. Do not start work prior to receiving approval.
3. The procedures shall include a checklist of points to be observed.

4. The actual quality control observations and inspections shall be documented and a copy of the documentation maintained on file.
5. Any work found not to be in compliance with the Contract Documents, shall be promptly corrected in an approved manner, at no additional cost to the DAA.
6. If the facility is under construction or modification, cooperate with other contractors who may be working in the immediate area for coordination of right-of-way clearances and verify as-built conditions.
7. Where walls immediately adjacent to conveyor equipment affect maintenance access, advise the DAA or his representative of the location and size of the wall opening that needs to be developed to permit access to drive components, bearings, and other equipment that would normally be inaccessible because of the wall.
8. Ensure that the design and installation of all conveyor equipment provides maximum access for operational and maintenance personnel.

M. Approval to Proceed

1. Before starting any work affecting existing baggage handling equipment that shall temporarily discontinue or disrupt service to the existing system/operations, notify the DAA or his representative 72 hours in advance and obtain the DAA or his representative approval in writing before proceeding with this phase of the work.

N. Preparatory Inspection

1. To be conducted prior to commencing work:
    a. Check schedules, project conditions, protection, traffic arrangements, utilities services maintenance, and related preparatory work for conformance to submittals.
    b. Check to assure adequate protection against damage.
    c. Ensure that all workers are qualified.
    d. Review installation procedures to assure coordination of Contract Documents requirements with each person involved in performing the work.
    e. Verify as-built conditions and notify the DAA or his representative of conflicts.

O. Initial Inspection

1. To be conducted after a representative sample of the work is complete:
    a. Review the representative sample of the work against the specification and code requirements previously discussed at preparatory inspection.
    b. Check for workmanship.
    c. Check installation, of each item for conformance.
    d. Check for damage and ensure that damaged work is corrected, at no additional cost to the DAA.
    e. Submit documentation for review to the DAA or his representative detailing compliance of the above.

P. Follow-Up Inspection

1. Check completed work against results of initial inspection of representative sample of work against items mentioned in the preparatory inspection.
2. Verify that damaged work is corrected properly and approved by the DAA or his representative, at no additional cost to the DAA.
3. Submit documentation for review to the DAA or his representative detailing compliance of the above.

Q. Inspection Results

1. Certify inspection results: This certification shall state that the observations were performed by or under the direct supervision of the BHS Contractors Quality Assurance Representative and that the results are representative of the conditions being certified.

2. Work accomplished shall be considered satisfactory only when the records and inspections show that all variances have been corrected and that the work is in conformance with the Contract Documents.

3. Submit documentation for review to the DAA or his representative detailing compliance of the above.

4.02 TESTING AND ACCEPTANCE

A. Inspection and Testing Procedures

1. General

a. After installation of the BHS, the BHS Contractor shall demonstrate its operating capability. Accomplish prior to the start of the Systems Acceptance Testing all “debugging” and internal testing. In addition, carry out a “dry test run” of Acceptance Tests prior to conducting such tests with the DAA or his representative to ensure that tests conducted with the DAA or his representative are successful. Make available to the DAA on a daily basis any and all records of internal testing and debugging (with corrective action carried out) performed prior to Acceptance Testing.

b. The System shall be capable of handling the maximum and minimum specified sizes and weights without jamming, damage or toppling of the baggage.

c. Provide all actual baggage and simulated weighted baggage required for testing. Actual baggage provided shall be representative of the many different types of baggage pieces encountered during live operations, including the maximum sizes and weights as defined in this specification. Simulated weighted baggage used shall be either weighted tubs or boxes. All baggage used for testing purposes shall be approved by the DAA or his representative prior to testing. The ratio of actual to simulated test baggage for this project shall be 50% of each. If necessary during the testing period, replace any simulated or actual test baggage that becomes damaged to the extent that it is no longer useable in order to maintain a minimum of test pieces at all times.

d. All tests shall be conducted with the above ratio of actual and simulated baggage except for load tests, which shall be acceptable to be performed with simulated baggage only.

e. Provide appropriate service personnel "on-site" during the testing period to service or adjust, as required, the System equipment as well as to open all control boxes, control station covers, drive assembly chain/V-belt guards, and covers for the DAA inspection of the system equipment.

f. Provide all necessary test, measuring, and recording devices required to demonstrate the operational characteristics and performance of the equipment to the satisfaction of the DAA (clamp-on type ammeter, direct read FPM digital readout tachometer, and all other required devices).

g. Provide written notice (minimum 14 days) to the DAA prior to acceptance testing that they have completed all “dry test runs” of the acceptance tests and are ready for the witnessed testing. Ensure that the DAA or his representative witness all Acceptance Tests and shall indicate Acceptance by signing and dating the test data sheet. The DAA reserves the rights to back charge the BHS Contractor for the time and expenses of all who attended the Acceptance Testing on the DAA’s behalf should the requested acceptance test(s) be unsuccessful and require re-testing at a later date.

2. System Inspection and Test Plan Submittal

a. Prepare an Inspection and Test Plan for this Project based on the information provided below and submitted per the submittal schedule detailed Part 1 of this specification for review and approval by the DAA or his representative.

b. The BHS Contractor is to be aware that various subsystems may require testing independent of one another. Therefore, a number of tests will have to be conducted at the various stages of installation.

c. The test plan shall be provided in both hard copies for field use during the testing process and a completed (based upon acceptance testing) electronic format agreed upon by the DAA or his representative.

d. The test plan shall include as a minimum the following:

1.) Description of each Test

2.) Pass/Fail Criteria

3.) Expected duration of the test

4.) Number of test bags required and where they are to be positioned for the start of the test

5.) If required, confirm all bag statistics on the MIS reports have been reset

6.) Number of airline 10-digit bag tags/BSMs required for testing. Coordination with the user airlines will/may be required

7.) List all test equipment required

8.) Number of personnel required for the test to include:

a.) Test Supervisor

b.) Mechanical

c.) Electrical

d.) Controls/computer engineer(s)

e.) Personnel required to load and remove bags

f.) BCR operator

9.) List other affected equipment manufacturers (e.g. Reveal tech support) that may be required for the test. Confirmation that these manufacturers have been notified and will be in attendance.

10.) Details of all reports to be printed after the test

11.) Pass/Fail and Notes/Comments sections.

12.) Section for witnessed sign off, to include as a minimum BHS Contractor, the DAA or his representative

e. The following is intended to be a guideline, and is not to be construed as all-inclusive:

1.) Mechanical Static Inspection: Provide a comprehensive, easy to read mechanical equipment inspection plan for every piece of mechanical equipment installed as part of the BHS. This inspection plan shall verify adherence to the Specification for the following items:

a.) Belt Conveyors: Gaps between adjacent head and tail pulleys, - Vertical clearance, - Angle of incline/decline, 4" conveyor I.D. - Gaps between adjacent bed sections, - Gaps between adjacent side guard sections, - Baggage snag points, - Sharp edges or shear burrs, - Condition of painted surfaces, - Tightness of all hardware, - Alignment of stainless steel trim and bed section filler plate, - Spacing of vertical braces for side guards/back guards, - Spacing of conveyor supports, - Sway bracing, - Trim securement screw type and countersinking, - Safety guarding/belly pans, - Anchoring/mounting of access ladders, - Installation of right angle transfer transition plate, - Belting material and splicing, - Belt lacing size and cable, - 1" V-notch in belting splice, - Belt path routing, - Belt wrap, - Belt tension, - Pulley diameter, - Pulley shaft diameter, - Vertical alignment of head and tail pulleys, - Lateral position of pulleys, - Return roller diameter, - Return roller spacing, - Bearing mounting lock washers, - Bearing jacking bolts, - Bearing grease zerk removal, - Bearing caps, - Motor and speed reducer mounting lock washers, - Speed reducer drip pan, - Motor/speed reducer related sprocket/sheave and shaft alignment, - Motor/speed reducer related sprocket or sheave key tightness, - Motor/speed reducer related chain/V-belt tension, - Chain/V-belt safety guard, - Speed reducer leakage, - Speed reducer lubrication level, - Mounting of speed reducer torque arm, - Safety finger guards on end pulleys at staffed conveyors (ticket counter conveyors, sort piers, manual encoding) -- 25% take-up pulley position, - Installation of strip door type draft curtain, - Installation of fire/security doors, - Removal of construction related debris, - Maintenance access, - Protective guard railing installation, - Vertical clearance for traffic aisles.

b.) Diverters: Gaps between adjacent bed sections, - 4" pusher I.D., - Gaps between adjacent side guard sections, - Baggage snag points, - Sharp edges or shear burrs, - Condition of painted surfaces, - Mounting and anchoring of pusher assembly, - Tightness of all hardware, - Bearing mounting lock washers, - Bearing grease zerk removal, - Motor and speed reducer mounting lock washers, - Speed reducer drip pan, - Motor/speed reducer related sheave/shaft alignment, - Motor/speed reducer related sheave key tightness, - Motor/speed reducer related chain/V-belts tension, - Pusher safety guard, - Speed reducer oil leaks, - Speed reducer lubrication level, - Mounting of speed reducer torque arm, - Removal of construction debris, - Maintenance access, - Alignment of pusher blade/paddle, - Alignment and secureness of pusher blade/paddle pad, - Pusher blade/paddle face sweeper.

c.) Incline Plate/Slope Pallet Devices: Vertical clearance above plates/pallets, - Gaps between adjacent back guard sections, - Gap between perimeter finger guard and top of pallet not in excess of 1/8", - Skirting above and below device conveying surface, - Sharp edges or shear burrs, - Condition of painted surfaces, - Tightness of all hardware, - Trim securement screw type and countersinking, - Baggage snag points, - Drive assembly safety guarding, - Speed reducer drip pan, - Motor/speed reducer type and alignment, - Motor-driven sprockets/sheaves alignment, - Motor-driven chain/V-belt tension, - Speed reducer oil leakage, - Removal of construction debris, - Maintenance access, - Protective guard railing, - Pallet-driving sprocket alignment, - Pallet-driving chain tightness.

d.) Scanner Arrays: Array I.D, - Vertical and lateral clearances, - Baggage snag points, - Sharp edges or shear burrs, - Condition of painted surfaces, - Proper anchoring of scanner array framework, - Scanner support/mounting hardware tightness and lock washers, - Maintenance access – Bottom heads blower motors support/mounting hardware tightness.

e.) Flat Plate Devices: Tray vertical clearance -- gaps between adjacent back guard sections -- gap between perimeter finger guard and top of pallet not in excess of 1/8" -- skirting above and below conveying surface -- sharp edges or shear burrs -- condition of painted surfaces -- tightness of all hardware trim -- securement screw type and countersinking -- baggage snag points -- drive assembly safety guarding -- speed reducer drip pan -- motor/speed reducer type and alignment -- motor-driven sprockets/sheaves alignment -- motor-driven chain/V-belt tension -- speed reducer leakage -- removal of construction debris -- maintenance access -- protective guard railing gap between adjacent plates not in excess of 1/16" -- plate-driving sprocket alignment -- plate-driving chain tightness

2.) Electrical Static Inspection: Provide a comprehensive, easy to read electrical equipment inspection plan. For the determination of terminal tightness, all terminals in motor control panels or field mounted devices shall be tightened to the manufacturer's recommended torque specifications utilizing a certified calibrated torque wrench or appropriate tool. The BHS Contractor shall be required to demonstrate to the DAA or his representative that the screws are set at the proper torque value and the BHS Contractor shall include this information in the below referenced electrical static inspection reports. This inspection plan shall verify adherence to the Specification for the following items:

a.) Belt Conveyors: Control station I.D./function tags -- control station and disconnect switch accessibility/location -- illuminated push button switch protective guard ring -- tightness of all hardware -- photocell mounting -- tach mounting and coupling -- control circuit wiring size, type, color, and number tag -- power circuit wiring size, type, color, and number tag -- wire "whiskers" at terminal points -- wiring terminal point screw tightness -- splice point wire nuts within junction boxes -- conduit routing and mounting -- tightness of conduit/sealtite fittings -- junction box covers -- unused openings in junction boxes or control device boxes -- safety disconnect switch lockout capability -- lanyard cable supports and limit switch -- maintenance access -- record motor name plate data, size of motor overload heaters, and size of all fuses.

b.) Flat Plate Devices: Control station I.D./function tags -- control station and disconnect switch accessibility/location -- illuminated push button switch protective guard ring -- tightness of all hardware -- photocell mounting -- control circuit wiring size, type, color, and number tag -- power circuit wiring size, type, color, and number tag -- wire "whiskers" at terminal points -- wiring terminal point screw tightness -- splice point wire nuts within junction boxes -- conduit routing and mounting -- tightness of conduit/sealtite fittings -- junction box covers -- unused openings in junction boxes or control device boxes -- safety disconnect switch lockout capability -- maintenance access -- record motor name plate data, size of motor overload heaters, and size of all fuses.

c.) Diverters: Control station I.D./function tags -- control station and disconnect switch accessibility/location -- illuminated push button switch protective guard ring -- tightness of all hardware -- photocell mounting -- tach mounting and coupling -- control circuit wiring size, type, color, and number tag -- power circuit wiring size, type, color, and number tag -- wire "whiskers" at terminal points -- wiring terminal point screw tightness -- splice point wire nuts within junction boxes -- conduit routing and mounting -- tightness of conduit/sealtite fittings -- junction box covers -- unused openings in junction boxes or control device boxes -- safety disconnect switch lockout capability -- lanyard cable supports and limit switch -- maintenance access -- record motor name plate data, size of motor overload heaters, and size of all fuses.

d.) Baggage Dimensioning Device: Device I.D. tags -- tightness of all hardware -- control circuit wiring size, type, color, and number tag -- tightness of cable connections -- power circuit wiring size, type, color, and number tag -- wire "whiskers" at terminal points -- wiring terminal point screw tightness -- splice point wire nuts within junction boxes -- conduit routing and mounting -- tightness of conduit/sealtite fittings -- junction box covers --unused openings in junction boxes or control device boxes – bottom heads blower motors conduit routing and mounting -- maintenance access.

e.) Motor Control Panels: I.D. information for MCP and all devices contained within -- control station I.D./function tags -- illuminated push button switch protective guard ring -- location of control devices -- tightness of all hardware -- control circuit wiring size, type, color, and number tag -- power circuit wiring size, type, color, and number tag -- wire "whiskers" at terminal points -- wiring terminal point screw tightness -- panduit wire raceway -- splices in panduit wire raceway -- panduit wire raceway covers -- conduit routing and mounting -- tightness of conduit fittings -- conduit bushings and chase nipples -- "air-space" around programmable logic controllers -- MCP door(s) mechanical safety interlock -- safety shield over line and load terminals of MCP main breaker -- orientation of status panel -- restraint clips for plug-in type power supply --installation of hour meter -- hour meter I.D. tag.

f.) Slope Pallet Devices: Control station and disconnect switch accessibility/location -- control station I.D./function tags -- illuminated push button switch protective guard ring -- tightness of all hardware -- photocell mounting -- control circuit wiring size, type, color, and number tag -- power circuit wiring size, type, color, and number tag -- wire "whiskers" at terminal points -- wiring terminal point screw tightness -- splice point wire nuts within junction boxes -- conduit routing and mounting -- tightness of conduit/sealtite fittings -- junction box covers -- unused openings in junction boxes or control device boxes -- safety disconnect switch lockout capability -- maintenance access -- record motor name plate data, size of motor overload heaters, and size of all fuses.

3.) Mechanical Testing: Provide a comprehensive, easy to read mechanical test plan. This test plan, at a minimum, shall verify the specified functionality of the following:

a.) Belt Conveyors: Conveyor speed -- belt tracking -- shaft run-out on pulleys -- excessive vibration -- operation of clutch/brake units -- lateral movement of speed reducer on shaft during start/stops -- abnormal noises -- torsion flexing of drive assembly during start/stop operation -- operation of controls

b.) Flat Plate Devices: Operation of "soft-start" device -- engagement of plate cam followers with drive assembly -- vertical or horizontal displacement of plates through drive assembly section -- excessive vibration -- abnormal noises -- binding of perimeter finger guards with top surfaces of plates -- operation of controls.

c.) Diverters: Operation of clutch units -- abnormal noises -- cycling speed -- paddle height above belt during cycle -- paddle extension across full width of conveyor belt -- operation of controls--capability of processing all types of baggage, including but not limited to, golf bags.

d.) Slope Pallet Devices: Operation of "soft-start" device -- engagement of plate cam followers with drive assembly -- vertical or horizontal displacement of plates through drive assembly section -- excessive vibration -- abnormal noises -- binding of perimeter finger guards with top surfaces of plates -- operation of controls.

4.) Electrical Testing: Provide a comprehensive, easy to read electrical test plan that clearly identifies all installed control devices, the control device locations in the BHS, the function of the control device, all conveyors affected by the control device, and the expected field result with applicable system monitor message/display. The test plan shall be provided in both hard copy for field use during the testing process and a completed (based upon acceptance testing) electronic format agreed upon by the DAA or his representative.

a.) All Control Devices: Photocells -- limit switches -- status lights -- hour meter -- start-up alarms -- fault warning alarms -- fault warning alarms with multiple faults -- fault warning alarm silence buttons -- timer settings -- auto shut-down -- motor overloads -- motor disconnects – auto start – cascade operation – inch and feed operation – e stop function – run lanyard – overheight/over length function – jam function.

b.) Workstations: Graphical system status display – graphic fault warning and associated text display -- report generation (daily, weekly, monthly, annual and on demand) – accuracy of all reports -- redundancy operation between primary and back up workstations -- problem resolution text – modification to flight and tag tables – change sort pier assignments – system re-route/re-configuration – monitor redundancy functions – communication/interfaces with FIDS – access to all security levels – BSM retention control – ability to render individual equipment unavailable/available – statistics and counter reset capability –demonstrate statistical data back up functionality

c.) Baggage Dimensioning Device: Baggage sizing capability of baggage dimensioning device with bags in all orientations -- generation of "unable to size" error information -- generation of performance statistical information -- generation of fault warning alarm(s) and appropriate indications for multiplexing device failure -- generation of fault warning alarm(s) and appropriate indications for individual dimensioner output failure – verification of redundancy.

d.) Cable Testing: Test all cables, including all fiber optic, Cat-5e and Cat-6 telecommunication cables, and all cables to be connected as part of an interface to another system (e.g. fire system, host computers, ACAMS, Reveal CT-80DRs, MDS/HMI Terminals).

e.) Interface Testing: Test all interfaces with other systems (e.g. Reveal CT-80DRs, any additional building system interfaces) Coordinate with other trades in support of this testing.

5.) Empirical Readings

a.) The Empirical Readings which are to be taken at the time of Conditional Acceptance Testing are to include the following:

(1.) Main Feeds: Fuse size per phase, actual amperage per phase.

(2.) Transformers: Fuse size per phase, actual amperage per phase.

(3.) Conveyor/Device Speeds: Actual “center-line” speed of conveyor/device.

(4.) Motors: Nameplate data, horsepower, listed motor current; fuse size per phase, actual amperage per phase, overload heater size or designation.

(5.) VFDs: record all VFD settings

6.) Load Testing: Provide a comprehensive, easy to read test plan listing the expected load rating for each device, at a minimum, provide the following:

a.) Individual device identifications with the expected load rating for each device (including tilt tray sorter).

b.) Amperage readings per phase under No Load conditions.

c.) Fuse Sizes (if applicable) and motor heater settings.

d.) Motor nameplate FLA for each device drive and HP.

e.) Amperage readings per phase under Full Load conditions.

f.) Pass/Fail and Notes/Comments sections.

All FLA readings taken during load testing shall be recorded and included in the Final O&M Manual for record.

7.) Redundancy Testing: Provide a comprehensive, easy to read test plan, which will demonstrate the redundancy capability of the system:

a.) At a minimum, the test(s) shall verify the ability of the System to perform the following:

(1.) Redundancy Operation of the high level network

(2.) Redundancy Operation of the low level network

(3.) Redundancy Operation between primary and back up PLCs

(4.) Redundancy Operation between primary and back up sort computers

(5.) Redundancy Operation between primary and back up server computers

(6.) Redundancy Operation if main power feed A is lost

(7.) Redundancy Operation if main power feed B is lost

(8.) Redundancy Operation if an MDS monitor fails

(9.) Redundancy Operation of the Baggage Dimensioning device

(10.) UPS(s) Operation and redundancy

8.) EDS Matrix Testing: The BHS Contractor shall provide a comprehensive, easy to read test plan, which will demonstrate the EDS Matrix system.

a.) The BHS Contractor shall provide a comprehensive, easy to read test plan, which will demonstrate the EDS subsystem

b.) At a minimum, the test shall verify the ability of the EDS Matrix System to perform the following:

(1.) Transfer of bag ID information and screening status between the BHS and EDS device

(2.) Sortation through security screening Level 1

(3.) Sortation through security screening Level 2

(4.) Sortation through security screening Level 3

(5.) Bag Flow/Sortation through screening level 1 as individual EDS devices are made inoperable/operable

(6.) Redundancy Operation through all levels of EDS security screening system.

(7.) Level 2 decision timeout verification test

(8.) Tracking accuracy as specified within this specification

(9.) Tracking of lost tracking/missing bags

(10.) Functionality of the EDS Test and Insert modes

(11.) Operation of the decision point failsafe system. Correct functionality of control station (clear, suspect and unknown bag status indicator lights) located at the decision point.

(12.) Accuracy of EDS reports

(13.) EDS device Hold and Auto Modes of Operation with respect to the BHS system

(14.) Test bag insert after an EDS functionality (i.e. the unknown bag should be routed back into the level 1 device)

(15.) Test E-stop state between the EDS and BHS (all conveyor belts are stopped, no signal is sent to the EDS device gantry)

(16.) Test for a sustained maximum throughput rate for the complete EDS matrix

c.) Assist the TSA in performing the mandated Site Acceptance Testing (SAT) and Integrated System Acceptance Test (ISAT). Obtain the latest copy of the TSA ISAT test procedure (i.e. Battelle Checked Baggage Inspection Systems Performance & Commissioning Plan) to ensure their completed EDS system meets all the protocols and requirements contained within, prior to the TSA ISAT. Carry out a “dry test run” of the ISAT prior to the TSA testing.

9.) Test Failure

a.) A failure during any test period shall be defined as any design characteristic or malfunction of the furnished equipment or materials that damages product or reduces any operating rate below those “specified”.

b.) Conditions resulting from improper loading of product or loading product of sizes not included in specification requirements will not be considered as failures.

B. Conditional Acceptance

1. Conditional Acceptance for each phase will only be considered after the following are completed:

a. The Conditional Acceptance Inspection and Testing procedures presented below are successfully completed as specified.

b. Final Operation and maintenance manuals have been delivered.

c. Operation and maintenance training has been completed.

d. Spare parts as purchased by the DAA for that phase have been delivered.

e. All special tools and equipment required for maintenance purchased by the DAA have been delivered.

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f. The name, address and a 24-hour phone number of a representative who has the authority and experience to make immediate replacements and repairs for the full life of all warranties has been provided.

2. Conditional Acceptance Inspection and Testing

   a. The System, including all upper and lower level controls, shall demonstrate compliance with the approved Test Plan. The individual inspections and tests shall be performed in the order presented above. System deficiencies (punch list items) shall be corrected before performing the subsequent inspections or tests. The DAA at his discretion may request for reimbursement of costs from the BHS Contractor for multiple reinspections of system deficiencies/punch list items.

      1.) Mechanical Static Inspection

      2.) Electrical Static Inspection

      3.) Electrical Testing

      4.) Mechanical Testing

      5.) Empirical Readings

      6.) Load Testing

      7.) Sortation Testing

      8.) Redundancy Testing

      9.) EDS Matrix Testing

3. Upon successful completion of the specified Inspections and Testing, the DAA will issue a written notice of Conditional Acceptance.

4. A Conditional Acceptance status will indicate that the DAA or his representative have approved the equipment as worthy for operational use.

5. The Conditional Acceptance shall not relieve the responsibility for maintenance, security and insurance on the system.

6. In no case will Conditional Acceptance relieve the responsibility for performing all the work set forth in the Contract Documents.

7. At the time of Conditional Acceptance, the amount of retention held until issuance of a Certificate of Final Acceptance shall be a summation of 10% of the total value of the project and the assessed value of open punch list items (to be determined by the DAA).

8. Conditional Acceptance is applicable to each construction phase and must be issued in writing, by the DAA, prior to commencement of subsequent construction phases. Final Acceptance of individual construction phases or subsystems shall not apply.

9. Conditional Acceptance Operational Period

   a. Upon issue of a Certificate of Conditional Acceptance, a three (3) month Operational Period will commence in which the DAA will put all systems into on-line operations processing the daily flow of baggage.

   b. During this three (3) month Operational Period, provide full-time technical site representation during the actual hours of operation with a minimum of 16 hours per day, 7 days per week. Ensure that the representatives shall be capable and duly qualified to provide service for any problems, which occur during this period. At a minimum, the BHS contractor will have two qualified personnel per shift to trouble shoot and immediately resolve any problems which may arise. The BHS contractors on site personnel shall be capable of trouble shooting and resolving all electrical and controls related issues.

c. During the three (3) month Operational Period, the BHS Contractor shall be responsible for all maintenance required on the BHS. During this time period the BHS Contractor will be responsible for ensuring that the BHS is fully operational during Airport Operational hours.

Should any downtime occur during these hours due to major faults in the BHS (i.e., PLC fault, motor overloads, motor faults, Sort Controller Fault or any other faults deemed major by the DAA) the BHS Contractor will be responsible for immediate rectification and assisting the DAA in any way so that Operations is not impacted in any way.

d. During the three (3) month Operational Period, keep a detailed computer log, as detailed in the Submittal Requirements of this specification.

e. If, at the DAA's discretion, site representation is deemed unnecessary, it shall be discontinued and the DAA shall receive a prorated credit.

f. If a problem occurs within the BHS system, and the DAA has elected to not require full-time technical site representation during the three (3) month Operational Period, supply the name(s), address(s) and a 24-hour phone number of representative(s) that can be contacted who have the authority and experience to make immediate recommendations and assist the DAA or the DAA's Maintenance Contractor to return the system to a fully on-line state in the shortest possible time frame.

C. Conditional Acceptance With Defects

1. If the System is found to be unacceptable at the time of Conditional Acceptance Inspection and Testing, the DAA will issue a written "Defects List" report containing information about the particular defects that must be remedied before Final Acceptance will be granted. At this time, if the defects do not affect the functionality of the System, the DAA may elect to advise in writing that "Conditional Acceptance with Defects" has been granted. All terms presented in the "Conditional Acceptance" portion of this Specification shall apply.

2. A "Conditional Acceptance with Defects" status, if issued, will indicate that the DAA has approved the equipment as worthy for operational use. Subsequent to "Conditional Acceptance with Defects" issuance, the three (3) month Operational Period will commence in which the DAA will put the System into on-line operations processing the daily flow of baggage. The DAA will maintain the right to judge whether any hazard may exist to personnel or equipment due to unacceptable inspection results and revoke this approval. In the event the approval is revoked, the three- (3) month Operational Period will be suspended until the hazard is remedied.

3. The DAA will be entitled to retain from the project payments an amount commensurate with the value of work remaining to be accomplished. Further, all outstanding work must be performed at times during periods convenient to the DAA and to the requirements of a fully operating system.

4. The Contractor must notify the DAA within the three - (3) month Operational Period that all outstanding items on the "Defects List" have been corrected and that Inspection and Testing may continue. When all items have been approved in accordance with the Specifications, this shall conclude Inspection and Testing of the BHS. Only the remaining time of the three - (3) month Operational Period will be required prior to application of the Final Acceptance conditions.

D. Delayed Conditional Acceptance With Defects List

1. If the System is found to be functionally unacceptable at the time of Conditional Acceptance Inspection and Testing, the DAA will issue a written "Defects List" report containing information about the particular defects that must be remedied before the three (3) month Operational Period will begin.

2. Items appearing on the "Defects List" will be considered incomplete, defective or not in conformance with the Specifications. The failure to include certain items does not alter the responsibility to complete the System in accordance with the Contract Documents.

3. A maximum period of 15 days will be allowed to correct the outstanding items on the "Defects List".

4. After all the items on the “Defects List” have been corrected, notify the DAA or his representative that the System is ready for continuing Conditional Acceptance Inspection and Testing.

5. Upon completion of “Conditional Acceptance Inspection and Testing”, the terms presented in the “Conditional Acceptance” or “Conditional Acceptance With Defects List” portions of this Specification will apply, as appropriate.

E. Final Acceptance

1. Final Acceptance will only be considered after all phases have conformed to the Conditional Acceptance terms, all phases have successfully completed the three (3) month Operational Period, and the following criteria is met:

   a. The System has not experienced repeated repairs and adjustments and is achieving the specified rate, accuracy and availability standards as required by this Specification.

   b. The System has successfully completed the specified Inspections and Testing, with no outstanding punch list items.

   c. The System is in full compliance with the Contract Documents.

   d. The DAA and all other governing agencies have made their inspections and given their approvals.

   e. Certificates of Installation Compliance have been issued to the DAA (e.g. weigh scale certifications)

   f. Warranties for all materials and equipment received from Subcontractors and Suppliers have been assigned to the DAA.

   g. A spare parts and tools audit has been conducted and all tools have been turned over to the DAA. All spare parts purchased by the DAA have been delivered.

   h. The PLC and source codes for all programs in the BHS Computer System have been provided to the DAA

   i. Accurate "As-built" drawings and all manuals as specified in this Specification have been delivered.

   j. Operation and maintenance training have been completed.

- END OF PART IV -