SECTION 15000 - MECHANICAL SYSTEMS DESCRIPTION

MECHANICAL

1.1 CODES AND STANDARDS

A. Codes:

1.	Minnesota State Building Code	(MSBC)
2.	Minnesota State Fire Code	(MSFC)
3.	National Electrical Code	(NEC)
4.	Occupational Safety and Health Administration	(OSHA)
5.	Other application local codes and ordinance.	

B. Standards:

1.	Air Conditioning and Refrigeration Institute	(ARI)
2.	Air Diffusion Council.	
3.	Air Movement and Control Association, Inc.	(AMCA)
4.	American National Standards Institute	(ANSI)
5.	American Society of Heating, Refrigeration,	
6.	and Air Conditioning Engineers (Handbooks, 91-94) Standard, 55-B1 Standard and 91.1 -89	(ASHRAE)
7.	American Society of Mechanical Engineers	(ASME)
8.	American Society for Testing and Materials	(ASTM)
9.	American Water Works Association	(AWWA)
10.	Institute of Boiler and Radiator Manufacturers	(IBR)
11.	National Electrical Manufacturers Association	(NEMA)
12.	National Fire Protection Association NFPA	
13.	Sheet Metal and Air Conditioning Contractors National Assoc.., Inc.	(SMACNA)
14.	Underwriters' Laboratories	(UL)
15.	USGBC – LEED NC – 2.2	(LEED)

1.2 DESIGN CRITERIA

A. Outside Temperatures:

Heating	Cooling
-21	81˚F DB, 67˚F WB 1% ASHRAE Design Conditions

B. Inside Temperatures:

Heating	**Cooling**
Office: 75˚F -2˚F	75˚F +2˚F 50% RH ± 5% RH
Landside: 70˚F -2˚F Ticketing/Baggage Claim	78˚F ± 2˚F 50% RH ± 5% RH
Airside Holding	75˚F +2˚F 50% RH ± 5% RH
Elevator machine Rooms: 65˚F	85˚F ± 5˚F
Parking:	Natural Ventilation
Mechanical Rooms: 65˚F	Ventilated
Transformer, Switchgear and Telephone Equipment Rooms:	Ventilated
Airside Holding:	75˚F -2˚F
Baggage Tug Tunnel and Receiving: 68˚F -2˚F	Ventilated

C. Equipment Selection:

1. All equipment shall be selected with the capacity to maintain 75ºF DB. indoor conditions year round.
2. Heating system equipment will be selected with the capacity to maintain 75ºF DB indoor temperature with -10ºF outdoor temperature.
3. In Addition, allow additional equipment capacity as follows:
   a. Fans, Coils, Filters - plus 15%
   b. Chillers and pumps - plus 10%
   c. Boilers and pumps - plus 10%.

D. Outside Air Quantity: (per ASHRAE 62.1-2004)

Office:	0.085 CFM/sq. ft.
Perimeter Offices:	As required by load.
Landside/Airside Open Area:	0.8 CFM/sq. ft. minimum
Toilets:	1.0 CFM/sq. ft. supply 1.0 CFM/sq. ft. transfer air
Others:	As required by Code and/or load

E. Supply Air Quantity:

Office Interior:	0.85 CFM/sq. ft. minimum.
Perimeter Offices:	As required by load.
Landside Open Area: Airside Holding Area:	2 CFM/sq. ft. 1 CFM/sq. ft.
Toilets:	1.0 CFM/sq. ft. supply 1.0 CFM/sq. ft. transfer air
Others:	As required by Code and/or load
System Capacity:	Average 0.85 CFM/sq. ft. minimum for typical office floors.

F. Exhaust Air Quantity:

Public Toilets and Janitors Closets:	2 CFM/sq. ft.
Baggage Tug Tunnel:	Six (6) air changes per hour minimum with mechanical supply natural ventilation for above grade.
Transformer Rooms:	3 CFM/KVA
Others:	As required by Code and/or load.

G. Load and Power:

Office Area	
Lighting:	1.0 watts/sq. ft.
Power:	3.0 watts/sq. ft.
Lighting and Power:	4.0 watts/sq. ft. (total)

H. People:

Offices	100 sq. ft. / person
Landside/Airside Open Area:	10 sq. ft. / person

I. U-Factors (Btu/Hr./ºF/Sq. Ft.):

Roof:	0.063
Walls:	0.84
Windows:	0.26
Exposed Soffits and Floor Over Unheated Space:	0.10
Slab on Grade Floor (Slab Edge):	0.084 BTU/F-Hr per LF

J. Shading Co-efficient:

Windows:	0.43

1.3 SYSTEMS

A. Primary Heating Systems:
1. Fuels: Natural Gas
2. Three (3) 2000 MBH natural gas-fired forced-draft hot water boilers will be pro vided in the west mechanical room. A circulation pump will be provided for each boiler with a 100% and standby main distribution pump serving the building. Boilers will be sealed combustion with side wall venting.

B. Primary Cooling Systems:
   1. Two (2) 200-ton air-cooled chillers will be located on the west low roof adjacent to a mechanical room. The chilled water pumps (100% plus standby) and other ancillary equipment will be located in the west mechanical room.
   2. Chilled water systems will include flanged connection for temporary start-up conical screen filtering assembly, “Y” type strainers at each pump suction, piping, valves, anchors, guides, expansion loops, expansion tanks, bypass type pot feeder for chilled water, valved connections for system flushing and drainage, system fill and make-up, etc. Blind flanges will be provided and pump heater ends for future expansion.
   3. Chilled water system will be provided with 30% ethylene glycol solution.

C. Secondary Heating Systems (Hydronic):
   1. Hot water baseboard heaters with controls will be installed exterior window wall in the landside and core areas.
   2. Horizontal, vertical, or cabinet type hot water unit heaters with controls will be provided at the tug tunnel, electrical, telephone, power generation, mechanical and elevator equipment rooms, entrance, exit and other areas as required. Air curtains will be provided in the entrance vestibules.
   3. The top level core heating system will utilize multiple ceiling mounted, low pressure heating/cooling, constant volume fan powered mixing unit (ducted VAV box, induced return air and fan powered box mounted in one unit with air flow in series arrangement, primary air mixes with induced recirculating air prior to being drawn by the fan), with hot water heating coil and motorized induced return air damper. Fan runs continuously under occupied mode. Fan runs intermittently under unoccupied mode for heating only.
   4. The airside area will utilize in-slab 2-pipe change-over radiant heating/cool with zone controls.

D. Air Conditioning Systems:
   1. Central Systems:
      a. Three (3) central factory packaged, modular variable air volume supply system will be provided in top level mechanical rooms to serve all floors. The system will be equipped with 2" throw-away prefilters and 85% efficiency afterfilters, individually supported chilled water coils, stainless steel drip pans with insulated bottom, hot water preheat coils, centrifugal fans, motor, VFD, tight shut-off motorized maximum and minimum air intake dampers, recirculating dampers, inlet and discharge sound traps, 3" thick acoustically lined fan housing for fans and sound trap assemblies (including ceiling, sides and floor) 2" lined apparatus housing (other than the fan and sound trap housing), access doors, chilled water control valves, air mixing baffles if required, fan mounting

and service platform, vibration isolators, site monitoring devices(s), trapped condensate drain, controls, etc.

b. Ceiling space will be utilized as return air plenum.

c. Supply and return/exhaust fans will be provided with variable speed drives.

d. The landside slab-on-grade area will utilize in slab “air-floor” for radiant cooling.

e. The airside will utilize in-slab 2-pipe change-over radiant heating/cooling with zone controls.

E. Ventilating Systems:

1. Mechanical cooling system(s), air cooled or water cooled type, will be provided for elevator machine rooms, as required, to maintain required space temperature.
2. Ventilation system(s) will be provided for mechanical rooms, transformer rooms, switchgear room, telephone equipment rooms, etc., as required, to maintain space temperature and meet Code requirements.

F. Exhaust Systems:

1. Exhaust systems will be provided for public toilets, janitor’s closets, typical floor electrical closets, etc., as required.

G. Life Safety Systems:

1. Base air-handling systems will be provided with sequence of operation for smoke removal as required per code.
2. Fan status panel (with manual override control switches) of major air handling systems for fireman operation will be provided adjacent to central fire alarm panel.

H. Duct Distribution Systems:

1. Core Areas (All Floors):
   a. All ductwork construction shall be based on SMACNA medium and low pressure type. All medium and low pressure air conditioning supply ductowork will be sealed.
   b. 1" thick rigid board or 1.5" thick blanket glass fiber insulation, with vapor barrier if required, will be provided for all medium pressure and low pressure air conditioning supply ducts, except where sound lined. Sound lining of the same thickness can be used in lieu of insulation.
   c. Interior spaces cooling on 1st and 2nd floors will utilize low pressure variable volume terminal units with low pressure duct distribution system and medium pressure primary air duct mains.

d. Top floor space heating and cooling will utilize multiple ceiling mounted low pressure heating/cooling constant volume fan powered mixing units, low pressure duct distribution system, and medium pressure primary air duct mains. (Refer to Secondary Heating System).
e. Each supply diffuser will be equipped with integral air pattern controller and volume damper. Diffusers will be compatible with ceiling system.
f. Ceiling mounted diffusers will be utilized for air return.
g. A 5'-0" maximum insulated, flexible duct will be provided to each air supply outlet.
h. 4'-0" minimum, straight, rigid lined or insulated duct inlet connections will be provided for constant volume fan powered mixing units, etc.
i. Rigid lined duct connections will be provided at the outlets of constant volume fan powered mixing units, etc.
j. Tapered spin-in fitting, with locking quadrant and volume damper, will be provided from branches to diffusers for low pressure ductwork.
k. All branch duct take-offs will be equipped with tapered fittings.
l. Fire dampers will be provided per Code and utility company's requirements.
m. Volume dampers will be provided in each branch to each supply, return and exhaust for air balance purposes.
n. Install duct smoke detectors (refer to Electrical Section).

I. Landside Public Area:
1. The slab-on-grade area on the south side of the building (primarily ticketing and baggage claim) will utilize in-slab "air floor" air distribution with supply air slots integrated into the perimeter sill and core wall furring. The "air floor" will be fed from buried fiberglass ductwork.
2. The mezzanine level will be served by a interior overhead ductwork system (see core areas description). Supply air diffusers will be long-throw type and located at the core. System will be constant volume, variable temperature.
3. Air will be returned to the air-handling unit through return air diffusers communicating with a ceiling plenum and located at the core.

J. Air Side Area:
1. The required ventilation and air circulation will be served by the interior overhead system (see Core Areas description). Supply air diffusers will be long-throw type and located at the core. System will be constant volume, variable temperature.
2. Air will be returned to the air-handling unit through return air diffusers communicating with a ceiling plenum and located at the core.

K. Duct Friction Loss Sizing Criteria:

1. Low Pressure: 0.1 inch W.G. maximum/100 equivalent feet of duct run.
2. Medium Pressure: 0.3 inch W.G. maximum/100 equivalent feet of duct run.
3. Relief of Transfer: 0.03 inch W.G. maximum/100 Equivalent feet of duct run.

L. Duct Velocity Criteria:

1. Low Pressure:
   a. 1,500 FPM Maximum for supply duct
   b. 1,500 FPM Maximum for exhaust or return duct.
   c. 1,000 FPM Maximum for intake or return air shaft.

2. Medium Pressure:
   a. 2,500 FPM Maximum for floor distribution.

M. Coil Face Velocity:

1. Cooling Coil (6 Rows Minimum):
   a. Central Built-up Unit:
      (1) 500 FPM maximum to avoid moisture carry-over. Velocity above 500 FPM will require moisture eliminators.
      (2) Maximum air pressure drop: 1.0 in W.G.

   b. Package Unit:
      (1) 500 FPM maximum.
      (2) Maximum air pressure drop: 1.0 in W.G.

2. Heating Coil:
   a. 1,000 FPM maximum, 400 FPM minimum.
   b. Maximum pressure drop: 0.05 in. W.G. for electric type.

N. Filter Face Velocity:

1. Central Built-up and Typical Air Handling Unit:
   a. 500 FPM Maximum
   b. Maximum pressure drop: 0.5 in. W.G. when clean.

O. Ductwork Cleaning - All ductwork will be cleaned and cleared of debris, dirt, etc.

P. Test - All duct systems, except low pressure type, will be tested for pressure and leakage.

Q. The Air Balance - All air handling systems will be balanced for specified design flow rate and system static pressure, including submitting air balance reports.

R. Piping Distribution Systems:

1. Water System:

a. System pressure will be 150 psi maximum.
b. Refrigeration machines and hot water heating boiler systems will each be arranged for parallel machine operation with individual pumps through each machine and with cross connections. The hot water system will include separate building distribution pumps piped in parallel with the primary boiler loop.
c. Pumps will be provided with variable speed drives.

2. Pipe Sizing Criteria (C=130):

8” diameter and larger	10.0 feet / second
6”	8.0 feet / second
4”	6.5 feet / second
3” diameter	5.5 feet / second
2.5” diameter	5.0 feet / second
2” diameter	4.0 feet / second

a. Gauges, thermometers, gouge cocks, thermowells, shut-off valves, balancing valves and other instruments will be provided for each piece of equipment for operation, maintenance and balancing purposes. Pete’s (pressure and temperature) plug will be provided at each cooling coil.
b. 3/4" valved and capped connections and air vents will be provided at the supply and return main branch pipes for the water coils of each air handling unit, after the shut-off valves, for coil draining in winter.
c. Chilled/hot water will be distributed to all air handling units utilizing chilled water coils.
d. Water flow balancing devices will be provided at individual return mains and the return branch of each floor.
e. Provide 1.25" cross connection with balancing valve between supply and return mains at the furthest units for flushing and maintaining proper supply water temperature.

3. Water Temperatures:

Chilled Water:		Heating Hot Water:	
Supply	42˚F	Supply	180˚F
Return	58˚F	Return	120˚F

a. Guides, anchors, expansion loops, supports, vents, drains, make-up water, controls, etc., will be provided as required for the piping system.

4. Pipe Cleaning:

a. All piping system will bed thoroughly cleaned and flushed with temporary start-up conical screen filter and proper chemicals, as required.

b. Test:
(1) All piping systems will be tested for pressure and leakage.

c. Water Balance:
(1) All hydronic system will be balanced for specified design flow rate and system pump head, including submitting balancing reports.

S. Noise and Vibration Control:

1. It is recommended that final requirements be stipulated by an acoustical consultant. The following are interim basic guidelines:
   a. Lobby, toilets, corridors NC 40
   b. Space Adjacent to fan rooms NC 40 to 45
   c. Offices NC 35

2. Acoustical and vibration treatment will be provided, as required, to maintain space noise criteria specified, including fan powered mixing units, equipment, etc.
3. Vibration isolators and flexible connections will be provided, as required for pumps, fans, refrigeration machines, cooling towers, temperature control air compressor, etc.
4. Vibration isolation hangers will be provided within 50 feet of all pumps and refrigeration machines, and other rotating equipment.
5. Acoustical treatment will be provided for all equipment, as required to meet Code, and as recommended by acoustical consultant.
6. Additional run test will be made after modifications have been completed, and will be witnessed by the same parties.

7. All typical floor fan rooms will be constructed in accordance with final accepted fan room mock-up construction.

T. Temperature Control:

1. Temperature control will be low voltage electric direct digital.
2. A central building management system will be provided. System shall utilize all non-proprietary communication protocols.
3. All temperature controls and equipment interlock and logic wiring, including conduits, will be provided as required.
4. The supervisory control center will be located in the engineer's office. This panel will provide start-stop capability and run indication for all major items of building equipment with timers, switches, relays and critical alarms. Smoke detection alarms and other related fire command system requirements will be provided under the Electrical Section.
5. Critical alarms will include, but not necessarily be limited to the following:
    a. Pipe heating cable low temperature.
    b. House pump malfunction.
    c. Sewage ejector high level.
    d. Sump pump high level.
    e. Fire alarm control panel alarm condition. (Upon receiving alarm signal from Fire Alarm Control Panel (FACP), building HVAC equipment fire and life safety mode of operation will be activated as required).
    f. Ground fault alarm.
    g. Expansion tank high-low level.
    h. Elevator machine room high temperature.
    i. Refrigeration machine malfunction.
    j. Transformer room high temperature.
6. Each fan system, water system, etc., will be provided with main control panels and sub-panels to mount all required thermostats, gauges, relays, switches, timers, regulators, receivers/controllers, and sub-master controls, with proper identification of the control devices.
7. Water control valves will be of 2-way modulating type.
8. Control sequence and interlocking will be arranged such that supply fan and its associated exhaust/recirculating fan can be started or stopped independently under fire/life safety mode operation as required.
9. Outside air damper, exhaust air damper and recirculating damper of each air handling system will be equipped with individual actuators and controls, permitting independent damper operation under fire/life safety mode as required.

10. Provide time delay between damper opening and fan start to avoid the build-up of excessive positive or negative system pressure and the triggering of freeze-stat alarm. Outside air damper actuator will be slow open and quick close type.
11. Freeze-stat with manual reset will close outside air dampers, stop fans and activate alarm. Freeze-stat control will be overridden by fire/life safety mode operation as required.
12. Air handling systems will be provided with enthalpy air economizer controls.
13. Morning warm-up (Winter) and cool-down (Summer) cycle, with timer and return air thermostat, controls, etc., will be provided for all air handling systems.
14. All wall mounted room thermostat covers will be tamper proof.
15. Landside and airside space thermostats will maintain the space temperature by modulating the cooling coil and heating coil. Thermostat sensor will be concealed electronic type with remote adjustment.
16. Modulating valve control will be provided for all heating coils.
17. Outside air intake quantity will be modulated by space pressure sensor to maintain set positive pressure.
18. Top core floor heating system constant volume fan powered mixing unit will be controlled by the associated room thermostat. When it is under unoccupied condition, the night set-back thermostat with timer control will energize individual zoned perimeter heating system through relay provided in room thermostat DDC control system. Minimum one night set-back zone will be provided for each exposure for every floor.
19. Core area VAV terminals will be controlled from built-in DDC thermostats in master control unit to maintain space temperature.
20. Motorized isolation dampers will be provided for each supply and return of multiple fan systems and/or interconnected common fan systems to allow the operation of single fan under partial load conditions.
21. A single or several common average static pressure sensor(s) and controller(s) will be utilized for the variable air volume control of all supply and exhaust/recirculation fans which are interconnected by common duct loops or mains. Sensor(s) will be located at the end of the medium pressure duct mains.
22. Central air conditioning system air volume will be modulated by variable speed drives. Variable speed drive will be controlled by static pressure sensor(s) at end of riser(s). Air monitoring device(s) utilizing Pitot tube sensor will be provided to maintain proper supply air and return air differential for building pressurization.
23. Pressure limit sensors will be provided for central systems at supply fan suction and discharge and at return fan suction and discharge to stop fan in case of excessive positive or negative system pressure to prevent damage of fan housing and ductwork.

24. Proper time delay switch will be provided for the control of fan, variable speed drives, and dampers to ensure that system pressure is being built-up properly.

25. The core area air conditioning system will be divided into multiple vertical zones (one zone per floor). The motorized isolation damper at the medium pressure supply branches at each vertical zone (one zone per floor) could be either closed (unoccupied mode) or open (occupied mode), independent to the other zones by means of control from the central zoned temperature control air switches located in the engineer's office. Isolation dampers, controls and logic wiring under the fire/life safety mode will be provided as required.

1.4 MATERIALS

A. Insulation:

1. Glass fiber type pipe insulation with all-service jacket will be provided for chilled water system, condenser water pipes (exposed to outdoor), make-up water systems, etc.

B. Piping - All piping and fittings will be black steel standard weight, except where noted otherwise.

C. Air-Cooled Refrigeration Machines:
1. Multiple compressor, multi-circuit self-contained low noise factory-packaged unit.
2. Pressure rating 250 psi, fouling of 0.001.
3. Manufacturers will be Carrier, Trane or York.

D. Pumps:
1. Pumps will be single stage, single suction centrifugal type, complete with motor, cast-iron casing, bronze impeller, seals, casing and impeller wearing rings, cast-iron or steel base, stainless steel shaft supported on ball bearings and direct connected through flexible couplings. Provide flushing fittings with micro-filters for seals, as required.
2. Mechanical seals will be provided for chilled water pumps and condenser water pumps.
3. All pump motor selections will be based on non-overloading though the full range of the pump curve.
4. All pumps (except boiler circulators) to be provided with independent variable speed drives.
5. Manufacturer will be Taco, Bell & Gossett, Armstrong, or equal.

E. Motors:
   1. All motors will be build with high-efficiency, inverter duty NEMA Standard and high temperature winding insulation. Capacitor will be provided to maintain power factor of 0.9 minimum.
   2. Reduced voltage motor winding (wye/delta closed transition) will be provided (refer to Electrical Section).

F. Ductwork - All air distribution ductwork will be galvanized and of construction to comply with SMACNA Standards.

G. Tight Shut-Off Damper - Damper shall be 99.5% shut-off type as manufactured by Johnson Control Proportion/Aire model DI300, Honeywell Moduflow model D642 or D643, Arrow United Industries model Arrow Pin-Lock, or equivalent.

H. Sound Lining:
   1. 2" rigid board, glass fiber type duct lining will be provided in all outside air intake plenums and ducts, air mixing plenums, fan plenums, air exhaust plenums.
   2. 20'-0" minimum, 2" rigid board, glass fiber type duct lining with perforated plate will be provided in supply ducts downstream of air handling units.
   3. 15'-0" minimum, 1" rigid board, glass fiber type duct lining will be provided for exhaust ducts upstream of roof exhausters and exhaust fans.
   4. 10'-0" minimum 1" sound lining will be provided downstream of all constant volume fan powered mixing units, etc.

I. Flexible Ducts - Insulated Connectors to Diffusers: Thermo flex Type MKA, Wiremold WK, Cleve Pak Type Q or equivalent.

J. Below slab duct – factory constructed fiberglass reinforced plastic ductwork. Minimum wall thickness will be D.125” up to 20” diameter. Units will come pre-engineered and pre-insulated with 1” of insulation and double wall application, K-factor of .14 and R value of 7. All joints shall be sealed using a wet lay-up field application. Ductwork to sit in a 4” pea gravel bed and slope down to riser. Manufacturer: Perry Fiberglass Products, or equal.

K. Constant Volume Fan Powered Mixing Boxes:
   1. VAV box and fan powered box mounted in one unit with air flow in series. UL listed, ETL labeled packaged units of fail open type with direct drive centrifugal fan, ECM motor with anti-backward rotation device, hot water heating coil and controls as required, system pressure independent, DDC operated air volume opposed blade damper assemblies at variable air volume primary air inlet and induced recirculating air inlet, and flow cross sensor to automatically ensure within 10% accuracy of factory set air volume under all conditions, access door and air volume under all

conditions, and factory wired control panel. Unit shall be low leakage (less than 3% with 4" S.P.) and low pressure drop type.

2. Units shall meet space noise criteria as specified.
3. Manufacturer will be Nailor type 35 SWST, or equivalent.

L. Factory Mock-Up Test for Constant Volume Fan Powered Mixing Units:

1. Mock-up test will be provided in factory to verify equipment performance and noise criteria.
2. Test(s) will be witnessed by Architect/Engineer, Owner's Representatives and Acoustical Consultant.

END OF MECHANICAL