CITY of DULUTH
PROJECT SPECIFICATIONS

Park Point Communications Tower

City of Duluth, MN
411 West 1st St.
Duluth, MN  55802

City Project #: 12-027
MSA Project #: 00616038

Bid #: 12-23DS Park Point Communications Tower

Opening Date: 11/28/2012
Time: 2:00 PM
Place: RM 106A City Hall
SPECIFICATIONS SIGNATURE PAGE

I HEREBY CERTIFY THAT THIS PLAN, specification or report was prepared by me or under my direct supervision and that I am a duly Licensed Professional Engineer under the laws of the State of Minnesota.

Signature

Jared DeMaster, P.E.

11/01/2012

Date

448815

License No.
SPECIAL PROVISIONS
Job Number: 12-027
Park Point Communications Tower
November, 2012

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(APPENDIX A)  Geotechnical Report

Certified Payroll Checklist CDBG Funding Only rev 4/5/11
Data for Labor Cost Bidding
Instructions to Bidders – Engineering 6/02/10
MNOPS Intrastate Anti-Drug/Alcohol Misuse Prev Asmt
Operator Qualification Contractor Covered Tasks
Prevailing Wage Rate(s) US DOL, Highway, MN120001, 6/15/12; US DOL Heavy, MN120105, 7/6/12, MN DLI, 7/5/12
Project Insurance Requirements 7/13/09
Request for Bids form
The following forms and regulations/rules/statutes and interpretations, which are incorporated by reference in this contract, are available on the World Wide Web at the sites listed below. The City of Duluth will use its best efforts to ensure that the most recent, applicable forms and regulations/rules/statutes and interpretations are included on the web sites provided; however, if you are the successful bidder, prior to signing the contract, you are responsible for comparing the versions of the forms and regulations/rules/statutes and interpretations attached to the contract which you are signing with the versions on the web to ensure conformity.

THE VERSIONS OF THE FORMS AND REGULATIONS/RULES/STATUTES and INTERPRETATION ATTACHED TO THE CONTRACT WILL BE CONTROLLING. HARD COPIES OF ALL FORMS ARE AVAILABLE AT THE ENGINEERING DIVISION, EXCEPT THE NON-COLLUSION AND AFFIRMATIVE ACTION POLICY STATEMENT, WHICH ARE AVAILABLE AT THE CITY OF DULUTH PURCHASING DEPARTMENT.

Item listing from web:

<table>
<thead>
<tr>
<th>FORM</th>
<th>WEB SITE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Affidavit of Non-Collusion (required by awarded contractor only)</td>
<td><a href="http://www.duluthmn.gov/engineering/construction_documents.cfm">www.duluthmn.gov/engineering/construction_documents.cfm</a></td>
</tr>
<tr>
<td>Bidder's Label for submitting project bids</td>
<td><a href="http://www.duluthmn.gov/engineering/construction_documents.cfm">www.duluthmn.gov/engineering/construction_documents.cfm</a></td>
</tr>
<tr>
<td>Certified Payroll Report form WH347 (front side only)</td>
<td><a href="http://www.dol.gov/whd/forms/WH347.pdf">www.dol.gov/whd/forms/WH347.pdf</a></td>
</tr>
<tr>
<td>Contractor's Haul Route</td>
<td><a href="http://www.duluthmn.gov/engineering/construction_documents.cfm">www.duluthmn.gov/engineering/construction_documents.cfm</a></td>
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<td>Debarment/Suspension Notice 6-8-2012</td>
<td><a href="http://www.dot.state.mn.us/pre-letting/prov/order/suspension.pdf">www.dot.state.mn.us/pre-letting/prov/order/suspension.pdf</a></td>
</tr>
<tr>
<td>IC-134 form</td>
<td><a href="http://www.taxes.state.mn.us/Forms_and_Instructions/ic134.pdf">www.taxes.state.mn.us/Forms_and_Instructions/ic134.pdf</a></td>
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<tr>
<td>IC-134 on-line submittal (click: Submit Contractor Affidavit; r-side of screen)</td>
<td><a href="http://www.mndot.state.mn.us/">www.mndot.state.mn.us/</a></td>
</tr>
<tr>
<td>MN Statutes 177.41 to 177.44</td>
<td><a href="http://www.revisor.mn.gov/statutes/?id=177">www.revisor.mn.gov/statutes/?id=177</a></td>
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<td>Month End Trucking Report Form A &amp; B (12-10)</td>
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</tr>
<tr>
<td>Month-End Trucking Report Statement of Compliance (12-10)</td>
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</tr>
<tr>
<td>Notice to Bidders Prompt Payment to Subs</td>
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</tr>
<tr>
<td>One-Call Instructions</td>
<td><a href="http://www.duluthmn.gov/engineering/construction_documents.cfm">www.duluthmn.gov/engineering/construction_documents.cfm</a></td>
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<td>Operator Qualification Contractor Covered Tasks</td>
<td><a href="http://www.duluthmn.gov/engineering/construction_documents.cfm">www.duluthmn.gov/engineering/construction_documents.cfm</a></td>
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<td>Purchasing Division General Specifications</td>
<td><a href="http://www.duluthmn.gov/engineering/construction_documents.cfm">www.duluthmn.gov/engineering/construction_documents.cfm</a></td>
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<td>Request to Sublet TP-21834 (5-12-09)</td>
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<tr>
<td>Statement of Compliance Form (12-10)</td>
<td><a href="http://www.dot.state.mn.us/const/labor/forms.html">www.dot.state.mn.us/const/labor/forms.html</a></td>
</tr>
<tr>
<td>Supplemental General Conditions Part II 4/15/11</td>
<td><a href="http://www.duluthmn.gov/engineering/construction_documents.cfm">www.duluthmn.gov/engineering/construction_documents.cfm</a></td>
</tr>
</tbody>
</table>
NOTICE TO ALL BIDDERS:


SP-1 SCOPE OF WORK
In general, the Work of this Project includes the construction of a new 140 foot tall self-supporting communications tower. The work will include excavation, backfill, foundation, steel self-supporting communications tower, site grading, demolition of existing tower and support wires, removal of existing communication building, and related items of construction.

SP-1.2 CONSTRUCTION ACTIVITIES SEQUENCING RESTRICTIONS
These construction activity sequencing restrictions are intended to manage the inconvenience to residents due to very limited right of way, maximize safety, and maintain constructability. The Contractor shall coordinate with the Engineer on a regular basis to evaluate construction sequencing effectiveness.

A) The existing tower and telemetry building must remain in operation during construction of the new tower.
B) The existing tower may not be demolished before the new tower is constructed and ready to operate. Operations must be transferred from the existing tower to the new tower with less than 12 hours of downtime.
C) Contractor shall coordinate with the City for communication service disruption, such as but not limited to transferring service from the existing tower to the new tower. The Contractor shall provide notice three weeks in advance of any planned communication service disruption.
D) Per City request, the contractor shall be required to allow beach access from 22nd Street South during construction. The existing path to the north shall not be obstructed during construction to allow beach access.
E) Contractor follows all provisions of permanent and temporary easements.

SP-1.3 CONTACT INFORMATION
Questions regarding this project shall be directed to: Joe Miller with City of Duluth at 218-730-4432; or Tari Rayala with the City of Duluth at 218-730-4434.

SP-2 (1606) CONTRACTOR STORAGE AREA
The provisions of Mn/DOT 1606 are supplemented with the following:

The contractor shall have access as shown on the construction drawings.

SP-3 (1702) PERMITS, LICENSES, AND TAXES
The provisions of Mn/DOT 1106 and Duluth Standard Specifications are supplemented with the following:

SP-3.2 The State of Minnesota through its Department of Natural Resources (DNR) requires license agreements for utility crossings. The license agreement between the City and the State includes coordination, safety, insurance provisions. The Contractor shall comply with all State’s requirements.

SP-3.3 Prior to using any privately acquired disposal areas or borrow material sources, the Contractor shall furnish the Engineer copies of the agreement with the owners of such property.

SP-4 (1717) PROTECTION AND RESTORATION OF PROPERTY
The provisions of Mn/DOT 1717 are supplemented as follows:

Private Property are immediately adjacent to the area of work and include several houses near the area of construction. The Contractor shall protect both the structures and private property during construction. The Contractor shall perform a building and site inspection as directed by the Engineer and provide a documentation report prior to performing the construction work. A copy of the documentation report, including photographs, shall be provided to the Engineer. All costs for site condition inspections shall be considered incidental to the contract and no separate compensation will be made.

SP-5 (1806) DETERMINATION AND EXTENSION OF CONTRACT TIME
The Contract Time will be determined in accordance with the provisions of Mn/DOT 1806 and the following:
SP-5.1 Construction operations shall be started on or before December 15, 2013 or within ten (10) calendar days after the date of award by City Council resolution, whichever is later; however, the Notice to Proceed letter will be the official authorization to commence construction operations.

SP-5.2 All work required under this Contract shall be finally completed by October 11, 2013.

Phase 1 shall include a minimum of the following:
- Successful installation of the new communications tower (complete).

Phase 2 shall include a minimum of the following:
- Switchover of all existing equipment from the existing communications tower to the new communications tower.
- The new communications tower is operational.
- Coordinate reconstruction of telephone, cable, power utilities.
- This work cannot start until the City is finished building the RTU Telemetry Building.

Phase 3 shall include a minimum of the following:
- Complete disposal of construction and misc. debris and materials.
- The existing tower, guy wires, telemetry buildings has been demolished.
- Complete disposal of construction and misc. debris and materials.
- Completion of the restoration of all misc areas disturbed by construction activities.

SP-5.3 All work required under this contract shall be final by September 1, 2013.

Final Completion shall include completion of all remaining items including, but not limited to:
- Restoring the work site to an equal or better than condition which existed prior to starting the work.
- Restoration vegetation shall be well established.
- Cleaning and restoration of any material derived for the construction area.
- Completing all items addressed in final project closeout punch list.
- Submittal of all required testing and installation reports and notice of substantial completion.
- Conduct and coordinate final project walk-through with owner, engineer, and stakeholders.
- Submitting final project closeout documentation inclusive of closeout letter and final pay request.

SP-5.4 CONSTRUCTION MILESTONES
The Contractor shall meet the following dates for substantial and final completions.

<table>
<thead>
<tr>
<th>Calendar Date</th>
<th>Contract Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>December Council Meeting</td>
<td>Tentative Notice to Proceed</td>
</tr>
<tr>
<td>May 21, 2013</td>
<td>Phase 1 Complete</td>
</tr>
<tr>
<td>July 30, 2013</td>
<td>Tentative Phase 2 Begins (Tentative Operation Transfer to New Tower)</td>
</tr>
<tr>
<td>August 16, 2013</td>
<td>Tentative Phase 2 Complete</td>
</tr>
<tr>
<td>August 30, 2013</td>
<td>Tentative Phase 3 Existing Communications Tower Demolished and Project Substantial Completion</td>
</tr>
<tr>
<td>October 11, 2013</td>
<td>Final Completion</td>
</tr>
</tbody>
</table>

SP-5.5 The provisions of Mn/DOT 1806.1C(3) are modified to the extent that the phrase “during the inclusive period from November 15 to April 15,” is deleted. A similar phrase set forth in the second paragraph of Mn/DOT 1807.2 is also deleted.

SP-5.6 No work which will restrict or interfere with traffic shall be performed between 12:00 noon on the day preceding and 6:30 a.m. on the day following any consecutive combination of a Saturday, Sunday, and legal holiday without written permission from the Engineer. If the Contractor chooses not to work at all on the day preceding the holiday period, no working day charges will be assessed. If the Contractor chooses to work prior to 12:00 noon on the day preceding the holiday period or if the Contractor obtains written permission to work after 12:00 noon on the day preceding the holiday period, working day charges will be assessed only for the actual hours worked.

SP-5.7 When all, or a portion, of the Contract Time is specified as a calendar completion date, as provided in Mn/DOT 1103, the time is presumed to have been determined by considering the Proposal quantities, normal weather for the locality and season of the year, and the necessity of having the work completed by the specified date. The time may be extended by the Engineer only in accordance with the following:
When the Contract Time is specified as a fixed calendar completion date, any time extensions granted must be justified on the basis of unavoidable delay in starting or completing the progress controlling operations, and then, only when and to the extent that it is shown that delay time could not be overcome and the work brought back on schedule through reasonable adjustments in the Progress Schedule. Provided the Contractor has made all reasonable efforts to maintain an adequate and acceptable Progress Schedule, the specified completion date may be extended as the Engineer determines to be justified, for any of the following reasons:

1) Delays caused by failure of the City Council to award the Contract at least 10 calendar days in advance of the latest date specified for beginning construction operations.

2) Delays caused by an earthquake, flood, cloudburst, cyclone, tornado, or other cataclysmic phenomenon of a nature beyond the power of the Contractor to foresee and make preparations in defense against.

3) Delays caused by acts of the Government or a political subdivision, or by acts of the public enemy, including fires, epidemics, and strikes not caused by improper acts or omissions of the Contractor.

4) Delays caused by an action or non-action of the Department, such as suspension of work by order of the Engineer through no fault on the Contractor.

5) Delays caused in incompletion of work being done by other Contractors or utility owners, or due to other unforeseeable interferences not the fault of the Contractor.

6) Delays direction attributable to the performances of Extra Work or increased quantities or work.

7) Extraordinary delays in delivery or materials, resulting from strikes, lockouts, freight embargoes, governmental acts, or sudden disaster, or a nature beyond the power of the Contractor or his/her supplier to foresee and forestall.

Delays caused by plant and equipment failure, and delays due to unsuitable weather or conditions resulting therefrom, will not be allowed as justification for time extension except when and only to the extent the Engineer considers justified in view of unavoidable circumstances or events. Normal weather delays and the usual plant and equipment failures must be allowed for establishing work schedules. An extension of time may be granted for such delays as are considered to be in excess of the normal, but only when it is shown that the lost time would not reasonably be made up through acceleration of the remaining work. Failure to prosecute the work continuously and effectively for the full time allowed, with adequate work force and schedule, will be cause for denial of any such time extension that may otherwise be allowed.

SP-6 (1807.1) FAILURE TO COMPLETE WORK ON TIME
Liquidated damages will be assessed at a rate of $10,000 for each calendar day that Phase 1 objectives are not satisfied.

Liquidated damages will be assessed at a rate of $1,000 for each calendar day that Phase 2 objectives are not satisfied.

Liquidated damages will be assessed at a rate of $1,000 for each calendar day that Phase 3 objectives are not satisfied.

Liquidated damages will be assessed at a rate of $1,500 for each calendar day that Final Completion objectives are not satisfied.

The liquidated damages as set forth above may apply equally, separately, and may be assessed concurrently.

SP-7 COLD WEATHER PRECAUTIONS
The Contractor shall be prepared to provide construction blankets or ground thawing as needed to facilitate construction activities if required. Ground thawing or insulating shall be incidental to the construction of the associated general roadway, piping, and buried utilities.

SP-8 METHOD OF PAYMENT
Payment for construction items described below shall be included with the bid items listed in the “Request for Bids”. Any construction activities, items, or materials not specifically listed under one of the following payment items shall be incidental to the Mobilization tank lump sum price.

SP-9 TRAFFIC SIGNS
All street signs shall be protected per City Specification 2564. Signs shall be maintained in service for the duration of the project. Temporary installations of signs shall be as approved by the Engineer.

SP-10 RECORD DRAWINGS
The Engineer will provide the Contractor with a suitable set of contract drawings on which the Contractor shall record daily records of changes and deviations from the contract. All buried or concealed piping, conduits, or similar items shall be located by dimensions and elevations on the record drawings.
SP-10.1  The daily record of changes shall be the responsibility of Contractor's field superintendent. No arbitrary mark-ups shall be permitted. At completion of the project, the Contractor shall submit the marked-up record drawings to the Engineer.

SP-10.2  The contractor shall coordinate with engineer GPS documentation of all underground items. Cost is uncover any items not documented shall be the responsibility of the contractor. Proper notice and coordination with the engineer shall be the responsibility of the contractor.

SP-11  TRAFFIC CONTROL
Contractor shall abide by all requirements of the Minnesota Manual of Uniform Traffic Control Devices (MMUTCD), including field manual, latest edition. Traffic control signs and devices shown on drawings shall be provided at a minimum, and additional signs and devices may be required based on Contractor staging.
REQUEST FOR BID

DATE 11/28/2012
BID # 12-23DS Park Point Communications Tower

RETURN BY BID OPENING TIME TO:
PURCHASING DIVISION
100 CITY HALL
Duluth, MN 55802
Dennis Sears
PHONE: 218-730-5340
FAX: 218-730-5921

City of Duluth Park Point Communications Tower
PROJECT NO. 12-027

BID OPENING DATE At 2:00 PM, Wednesday, November 28th, 2012

Note: all bids must be written, signed and transmitted in a sealed envelope, plainly marked with the bid number, subject matter, and opening date. The City of Duluth reserves the right to split award where there is a substantial savings to the City, waive informalities and to reject any and all bids. Bidder should state in proposal if bid price is based on acceptance of total order. Sales tax is not to be included in the unit price. Bidder to state freight chargers if the proposal F.O.B. is shipping point, freight not allowed. Low bid will not be the only consideration for award of bid. All pages shall be signed or initialed by authorized bidder's representative as indicated at the bottom of the page(s) of the request for bid form.

RETURN BID IN DUPLICATE WITH DUPLICATE DESCRIPTIVE LITERATURE
FOR BID RESULTS, ENCLOSE A SELF-ADDRESSED, STAMPED ENVELOPE WITH BID

BID DEPOSIT REQUIREMENTS: 5% OF BID AMOUNT
Deposit shall mean cash, cashier's check or corporate surety bond payable to or in favor of the City of Duluth.

A PERFORMANCE BOND AND A PAYMENT BOND shall be required of the successful bidder, BOTH in the full amount of the bid.

INSURANCE CERTIFICATE required per attached requirements.

Designated F.O.B. Point:
Engineering Division
Tax:
Federal Excise Tax Exemption
Account No. 41-74-0056

Vendor Email Address: ____________________________ FREIGHT CHARGE $ __________

NAME: ________________________________________ TOTAL BID PRICE # __________
ADD1: ________________________________________ TO INCLUDE ANY ADDITIONAL PAGES.
ADD2: ________________________________________
ADD3: ________________________________________

BY: ____________________________ PAYMENT TERMS $ __________
(Print) ____________________________ F.O.B. POINT $ __________
(Title) ____________________________ DELIVERY DATE $ __________
(Signature) ____________________________ (Tele. #)

The City of Duluth is an Equal Opportunity Employer.
**********SCHEDULE OF PRICES**********

Make all extensions and total the bid.

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Spec. #</th>
<th>Qty</th>
<th>U/OM</th>
<th>Item Description</th>
<th>Unit Price</th>
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<tr>
<td>001</td>
<td></td>
<td>1</td>
<td>Each</td>
<td>Exhibit A (Must Be Returned With The Bid)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

TOTAL $ __________________________

PRE-QUALIFIED SYSTEM INTEGRATOR:

ADDENDUM RECEIPT ACKNOWLEDGEMENTS:

ADDENDUM NO. __________ , DATED ______________________

ADDENDUM NO. __________ , DATED ______________________

ADDENDUM NO. __________ , DATED ______________________

TOTAL BID IN WORDS: __________________________________________

CONTRACTOR NAME: ____________________________________________

THE CONTRACTOR AGREES TO ALL OF THE PROVISIONS CONTAINED IN THE CONTRACT DOCUMENTS. ENCLOSED HEREWITH FIND A CERTIFIED CHECK OR BID BOND IN THE AMOUNT OF AT LEAST 5% OF THE AMOUNT OF PROPOSAL MADE PAYABLE TO THE CITY OF DULUTH AS A PROPOSAL GUARANTEE WHICH IT (see additional page(s))

(Initial)
IS AGREED BY THE UNDERSIGNED WILL BE FORFEITED IN THE EVENT THE FORM OF CONTRACT AND BOND IS NOT EXECUTED, IF AWARDED TO THE UNDERSIGNED.

The bidder hereby certifies that he/she has received the City of Duluth Public Works/Utilities Department - Engineering Division Standard Construction Specifications 2007 booklet and has incorporated the terms hereof in its bid.

SIGNED: ____________________________ FOR

A PARTNERSHIP (OR)

A CORPORATION INCORPORATED UNDER THE LAWS OF THE STATE OF:

_________________________ ___________________________
PRESIDENT VICE-PRES.

_________________________ ___________________________
SECRETARY TREASURER

_________________________
ADDRESS(ES)

BEING DULY SWORN, DEPOSES AND SAYS THAT THERE ARE NO OTHER PERSONS COMPRISING ABOVE COMPANY OR FIRM THAN THE ABOVE NAMES, AND THAT THERE ARE NO PERSONS OR CORPORATIONS INTERESTED IN THE FORGOING PROPOSALS, EITHER AS PRINCIPAL OR SUBCONTRACTOR, OTHER THAN THE ABOVE NAMES; ALSO THAT THE PROPOSALS ARE MADE WITHOUT ANY CONNECTION WITH ANY PERSON OR PERSONS MAKING ANY PROPOSAL FOR THE ABOVE WORK; THAT THEY ARE IN ALL RESPECTS FAIR AND WITHOUT COLLUSION OR FRAUD; AND THAT NO PERSON ACTING IN ANY OFFICIAL CAPACITY FOR THE CITY OF DULUTH IS DIRECTLY OR INDIRECTLY INTERESTED THEREIN, OR IN ANY PORTION OF THE PROFIT THEREOF.

(see additional page(s))
IMPORTANT NOTE BIDDERS:
PLEASE DISREGARD THE NOTE ON PAGE 1 REGARDING SALES TAX FOR THIS BID. ALL APPLICABLE SALES AND/OR USE TAXES ARE TO BE INCLUDED IN BID PRICING. ALSO, ALL BIDS ARE TO BE F.O.B. JOBSITE. THE BLANK ON PAGE ONE FOR FREIGHT IS TO BE LEFT BLANK.

Delivery Contact: Joe Miller
Facility Management
218-730-4430

(Initial)
# BID # 12-23DS Park Point Communications Tower

**EXHIBIT A**

Park Point Communications Tower  
CITY OF DULUTH PROJECT NO. 12-027

<table>
<thead>
<tr>
<th>LINE NO.</th>
<th>SPEC. NO.</th>
<th>ITEM DESCRIPTION</th>
<th>UNIT OF MEASURE</th>
<th>ESTIMATED QUANTITY</th>
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<td>MOBILIZATION/DEMOBILIZATION, BONDING, INSURANCE PHASE 1</td>
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<td>33 81 15</td>
<td>NEW COMMUNICATIONS TOWER PHASE 1, COMPLETE</td>
<td>LS</td>
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<td>$</td>
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<td>$</td>
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<td>EXISTING TOWER TELEMETRY BUILDING DEMOLISHED PHASE 3, COMPLETE</td>
<td>LS</td>
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<td>$</td>
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</tbody>
</table>

**NEW COMMUNICATIONS TOWER WEIGHT CAPACITY**  

**POUNDS**

**ADDITIVE ALTERNATES**

| A1 | - | NEW 1/2 INCH COMMUNICATIONS CABLE INSTALLED | LS | 1 | $ | $ | $ |
| A2 | - | NEW 7/8 INCH COMMUNICATIONS CABLE INSTALLED | LS | 1 | $ | $ | $ |
| A3 | - | NEW 1-1/4 INCH COMMUNICATIONS CABLE INSTALLED | LS | 1 | $ | $ | $ |

**GRAND TOTAL**
INFORMATION AVAILABLE TO BIDDERS

Portions of reports and drawings used by the Engineer in the preparation of the Bidding Documents are attached to this document. Bidders are responsible for their own interpretation, verification, and use of the Technical Data contained in these reports and drawing. These Technical Data include:

Geotechnical Report of soil borings performed at the project site.

Sketches depicting information on the existing communications tower to be demolished.

Specification Sheets on Existing Tower Antennas

END OF SECTION
Geotechnical Evaluation Report

Proposed Park Point Communications Tower
22nd Avenue South
Duluth, Minnesota

Prepared for the

City of Duluth

Professional Certification
I hereby certify that this plan, specification, or report was prepared by me or under my direct supervision and that I am a duly Licensed Professional Engineer under the laws of the State of Minnesota.

Joseph C. Butler, PE
Project Engineer
License Number: 47600
October 16, 2012

Project DU-12-05256

Braun Intertec Corporation
October 16, 2012

City of Duluth
c/o Jared DeMaster, PE - MSA Professional Services, Inc.
301 West First Street
Duluth, MN 55802

Re:  Geotechnical Evaluation
     Proposed Park Point Radio Tower
     22nd Avenue South
     Duluth, Minnesota

Dear Mr. DeMaster:

We are pleased to present this Geotechnical Evaluation Report for the proposed Park Point Radio Tower. A summary of our results, and a summary of our recommendations in light of the geotechnical issues influencing design and construction, is presented below. More detailed information and recommendations follow.

Summary of Results

Two standard penetration test borings were completed for the project. Both borings encountered poorly graded sand and poorly graded sand with silt to the termination depths of the borings.

Penetration resistances in the borings indicated the sands above an elevation of 137 1/2 (on our assumed datum) were loose to medium dense with average blows per foot (BPF) of about 10. Below this elevation the penetration resistances generally ranged from 38 BPF to 50 blows for 6 inches of drive, indicating they were dense to very dense.

We would like to note that the increase in relative density corresponded closely to the groundwater elevation observed in the borings.

Groundwater was measured or estimated to be down approximately 10.8 and 16.3 feet as our borings were advanced. These depths correspond to an elevation of about 137 1/2 on our assumed datum. We also measured the water surface of Lake Superior; this elevation was about elevation 137 on our assumed datum. We would expect the groundwater elevation to coincide with and fluctuate in unison with the water surface of Lake Superior.

Summary of Recommendations

The geologic profile appears to be suitable for support of the tower on a mat footing (pad and pier) foundation type, or on drilled piers. We would like to note that if a mat footing is considered, we recommend the bottom of mat be set at or above elevation 139 to avoid excavation dewatering.
For purposes of this report, we recommend assuming a groundwater level at a depth of about 10 feet, or an elevation of 137 1/2. Submerged unit weights should be used for soils and concrete below this depth.

From a construction perspective, the project team should be aware that excavations for footings or the construction of a pier foundation will penetrate moist sands to near the 10-foot depth, where the sands will become water bearing. The need for casing and drilling slurry to support the sides of a drilled excavation should be anticipated.

Since the sands are non-cohesive, the edges of excavations will tend to slough and the sands will be likely to erode during a rain event.

Remarks

Thank you for making Braun Intertec your geotechnical consultant for this project. If you have questions about this report, or if there are other services that we can provide in support of our work to date, please Joe Butler at 218.624.4967 or jbutler@braunintertec.com.

Sincerely,

BRAUN INTERTEC CORPORATION

Joseph C. Butler, PE
Associate Principal / Project Engineer

Mark W. Gothard, PE
Principal Engineer
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### Appendix
- Boring Location Sketch
- Log of Boring Sheets ST-1 and ST-2
- Descriptive Terminology
- Drilled Pier Soil Strength and p-y Parameters
A. Introduction

A.1. Project Description

The City of Duluth is planning a new radio tower. The radio tower is referred to as the park point radio tower and will be located about 60 feet southeast of an existing radio tower located 375 feet northeast of the intersection of 22nd Avenue East and Minnesota Avenue in Duluth, Minnesota.

The proposed tower will be self supported and will have an equipment shelter building (ESB).

A.2. Purpose

The purpose of a geotechnical evaluation is to characterize subsurface geologic conditions at selected exploration locations and evaluate their impact on the design and construction of the radio tower foundation.

A.3. Reference Documents

To facilitate our evaluation, we were provided with or reviewed the following information or documents:

- Sheet G-3 – Proposed Site Plan, Sheet G-4 – Proposed Site Layout, and Sheet S-1 Tower Base.

A.4. Site Conditions

The proposed tower site is currently occupied by a guyed radio tower. The proposed tower will be located about 60 feet southwest of the existing tower base. The proposed tower will be located on an existing walking path. The path will be relocated as part of the project.
The site topography is rolling, with sand dunes and there is a beach to the northeast. Lake Superior is located about 200 feet northeast of the proposed tower.

A.5. Scope of Services

Our scope of services for this project was submitted to Mr. Jared DeMaster of MSA Professional Services as a Proposal dated September 26, 2012. We received authorization to proceed from Mr. DeMaster on September 28, 2012. Tasks performed in accordance with our authorized scope of services included:

- Performing a reconnaissance of the site to evaluate equipment access to exploration locations.
- Staking and clearing exploration locations of underground utilities.
- Performing 2 penetration test borings to a nominal depth of 50 feet.
- Preparing this report containing a boring location sketch, exploration logs, a summary of the geologic materials encountered, and recommendations for structure subgrade preparation and the design of the proposed tower foundation.

Our scope of services was performed under the terms of our Master Services Agreement between MSA Professional Services and Braun Intertec Corporation.

A.6. Boring Location and Elevations

The desired boring locations were chosen by MSA Professional Services. We staked the borings in the field by measuring with a cloth tape and estimating right angle from the existing radio tower fence.

Ground surface elevations at the boring locations were referenced to the top of the base of the existing radio tower foundation. We assigned this reference an arbitrary elevation of 150.0.
B. Results

B.1. Exploration Logs

B.1.a. Log of Boring Sheets
Log of Boring sheets for our penetration test borings are included in the Appendix. The logs identify and describe the geologic materials that were penetrated, and present the results of penetration resistance tests performed within them, and groundwater measurements.

Strata boundaries were inferred from changes in the penetration test samples and the auger cuttings. Because sampling was not performed continuously, the strata boundary depths are only approximate. The boundary depths likely vary away from the boring locations, and the boundaries themselves may also occur as gradual rather than abrupt transitions.

B.1.b. Geologic Origins
Geologic origins assigned to the materials shown on the logs and referenced within this report were based on: (1) a review of the background information and reference documents cited above, (2) visual classification of the various geologic material samples retrieved during the course of our subsurface exploration, (3) penetration resistance and other in-situ testing performed for the project, and (4) available common knowledge of the geologic processes and environments that have impacted the site and surrounding area in the past.

B.2. Geologic Profile

B.2.a. Geologic Materials
Two standard penetration test borings were completed for the project. Both borings encountered poorly graded sand and poorly graded sand with silt to the termination depths of the borings.

Penetration resistances in the borings indicated the sands above an elevation of 137 1/2 (on our assumed datum) were loose to medium dense with average blows per foot (BPF) of about 10. Below this elevation the penetration resistances generally ranged from 38 BPF to 50 blows for 6 inches of drive, indicating they were dense to very dense.

We would like to note that the increase in relative density corresponded closely to the groundwater elevation observed in the borings.
B.2.b. Groundwater
Groundwater was measured or estimated to be down approximately 10.8 and 16.3 feet as our borings were advanced. These depths correspond to an elevation of about 137 1/2 on our assumed datum. We also measured the water surface of Lake Superior; this elevation was about elevation 137 on our assumed datum. We would expect the groundwater elevation to coincide with and fluctuate in unison with the water surface of Lake Superior.

Seasonal and annual fluctuations of groundwater should also be anticipated.

C. Basis for Recommendations

C.1. Design Details

C.1.a. Radio Tower Structure Loads
We understand the proposed radio tower will be a self supporting tower with an equilateral triangular cross-section. Center to center spacing between the three tower touchdown points will measure about 14 feet. We have assumed uplift and compression loads will be less than 500 kips per tower leg.

We anticipate uplift will be resisted by:

- the weight of the mat foundation and the soil placed on top of it, or
- The weight of concrete in the drilled piers and the total friction of soils on the sides of drilled piers.

We understand the foundation designs typically considered for similar self supporting towers include a mat foundation and drilled piers (shafts).

C.1.b. Equipment Shelter Building
We anticipate loads associated with the equipment shelter building (ESB) will be very light, less than 1,000 pounds per foot of wall. ESB buildings are typically constructed on a thickened edge structural floor slab and are heated in winter. We understand settlement and heave are not considered critical to the performance of the structure.
C.1.c. Anticipated Grade Changes
We have assumed the finished grade at the base of the proposed radio tower will be set near the existing grade at Boring ST-1, which is located near the elevation of the existing radio tower.

For the purpose of this report we have assumed the finished grade will be set at or about elevation 148 on our assumed datum. This will require a cut of about 5 feet near Boring ST-2.

C.1.d. Precautions Regarding Changed Information
We have attempted to describe our understanding of the proposed construction to the extent it was reported to us by others. Depending on the extent of available information, assumptions may have been made based on our experience with similar projects. If we have not correctly recorded or interpreted the project details, we should be notified. New or changed information could require additional evaluation, analyses and/or recommendations.

C.2. Design Considerations

The geologic profile appears to be suitable for support of the tower on a mat footing (pad and pier) foundation type, or on drilled piers. We would like to note that if a mat footing is considered, we recommend the bottom of mat be set at or above elevation 139 to avoid excavation dewatering.

For purposes of this report, we recommend assuming a groundwater level at a depth of about 10 feet, or an elevation of 137 1/2. Submerged unit weights should be used for soils and concrete below this depth.

Our recommendations for support of the tower and ESB are presented below in Section D.

C.3. Construction Considerations

From a construction perspective, the project team should be aware that excavations for footings or the construction of a pier foundation will penetrate moist sands to near the 10-foot depth, where the sands will become water bearing. The need for casing and drilling slurry to support the sides of a drilled excavation should be anticipated.

Since the sands are non-cohesive, the edges of excavations will tend to slough and the sands will be likely to erode during a rain event.
D. Recommendations

D.1. Site Subgrade Preparation

D.1.a. Topsoil Stripping
We recommend removing topsoil (if any) and vegetation from the tower foundation area. If deeper excavations are necessary to remove soft or organic materials, to provide lateral support to replacement backfill and additional required fill, we recommend oversizing (widening) the excavations horizontally by one (1) foot beyond the outer edges of the tower location for each one (1) foot the excavations extend below bottom-of-footing, slab, or pavement subgrade elevations.

D.1.b. Selecting Excavation Backfill and Additional Required Fill
On-site soils free of organic material and debris can be considered for reuse as backfill and fill during general site grading, although the onsite sand soils are likely below their optimum moisture content for compaction. Moisture-conditioning (wetting) may be necessary to achieve the required compaction levels. We recommend that imported material needed to replace excavation spoils or balance cut and fill quantities during grading, consist of similar mineral soils.

D.1.c. Placement and Compaction of Backfill and Fill
We recommend spreading backfill and fill in loose lifts of approximately six (6) to twelve (12) inches, depending on the type of compaction equipment. We recommend compacting backfill and fill in accordance with the minimum criteria presented below in Table 1. The relative compaction of utility backfill should be evaluated based on the structure below which it is installed, and vertical proximity to that structure.

Table 1. Compaction Recommendations Summary

<table>
<thead>
<tr>
<th>Reference</th>
<th>Relative Compaction, percent (ASTM D 698 – standard Proctor)</th>
<th>Moisture Content Range from Optimum, percentage</th>
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<tr>
<td>Below foundations</td>
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<td>65 percent to 102 percent</td>
</tr>
<tr>
<td>Below slabs and above foundations</td>
<td>95</td>
<td>65 percent to 115 percent</td>
</tr>
<tr>
<td>Below aggregate surfaces and pavements, within 3 feet of subgrade elevations</td>
<td>100</td>
<td>65 percent to 102 percent</td>
</tr>
<tr>
<td>Below pavements, more than 3 feet below subgrade elevations</td>
<td>95</td>
<td>65 percent to 115 percent</td>
</tr>
<tr>
<td>Below landscaped surfaces</td>
<td>95</td>
<td>65 percent to 115 percent</td>
</tr>
</tbody>
</table>
D.2. Tower Spread Footing (Mat) Foundation Design

D.2.a. Embedment Depth
For frost protection, we recommend embedding the tower footing at least 72 inches below the lowest adjacent grade. At that depth, we anticipate the footing subgrade soils will consist of compacted fill or native lacustrine sand.

D.2.b. Surface Compaction
To improve the density of the bearing soils, we recommend the sands exposed at the footing excavation bottom be surface-compacted using a large (750 pounds minimum) plate compactor.

D.2.c. Net Allowable Bearing Pressure
For the typical roughly 30-foot square mat foundation, we recommend the tower footing exert a maximum net allowable bearing pressure of 2,000 pounds per square foot (psf), including all transient loads. This value includes a safety factor of at least 3.0 with regard to bearing capacity failure.

D.2.d. Settlement
We estimate that total settlements of the described mat footing foundation will amount to less than one-half inch under the reported loads.

D.2.e. Lateral Resistance and Uplift
Lateral loads transmitted to foundations can be resisted by passive resistance on the sides of the foundation and friction along the base of the foundation. An unfactored coefficient of sliding friction of 0.35 can be used for the interface of the concrete foundation and the bearing soil when calculating resistance to sliding. The designer should select and apply an appropriate factor of safety to the sliding friction value.

We recommend using an unfactored unit weight of 110 pounds per cubic foot (pcf) for design of shallow foundation elements to resist uplift. For foundations cast against an undisturbed vertical face of soil or where engineered fill is placed beside the foundation, the allowable passive pressure acting on the vertical projection of the foundation edge may be calculated using an equivalent fluid pressure of 330 pcf; this value does not include a factor of safety and is based on an effective unit weight of 110 pcf and a passive earth pressure coefficient ($K_p$) of 3.
D.3. Tower Pier Foundation Design

D.3.a. Design Parameters
Design parameters for drilled pier design are provided in the tables in the Appendix. We have provided one set of design parameters, which apply to both the sustained and transient loading conditions.

D.3.b. Pier Diameter
To facilitate removal of potential boulders during construction and shaft inspection and evaluation, we recommend a minimum drilled shaft diameter of 36 inches.

D.3.c. Drilled Shaft Support
We anticipate that the pier shaft will have to be at least partially cased to prevent caving. A drilling slurry will also be necessary to excavate the shaft in the sand soils throughout the depth explored. Telescoping casings may be required for longer shafts. With telescoping casings, the largest casing is set at the top of the shaft, and subsequent casings becoming progressively smaller with the smallest casing having a diameter equal to the design diameter of the pier. To help accommodate telescoping casings for this project, we recommend assuming a 6-inch increase in diameter per casing.

D.3.d. Concrete Placement
Care should be taken during concrete placement to avoid segregation of the concrete caused by the material striking reinforcing steel or the side of the casings/excavation. A tremie may be required.

It is possible to pull telescoping casing in such a way as to construct the drilled pier at its design diameter for its entire length. This practice, however, risks leaving loose material against the pier and effectively reducing confinement offered to the pier. To avoid problems associated with this situation, we recommend that the concrete be placed to the full diameter of the drilled shaft.

If, prior to placing concrete, more than two (2) inches of water or drilling fluid are present in the shaft, we recommend placing the concrete with a tremie pipe, although the concrete should then be designed for a slump between approximately four (4) and six (6) inches.

D.3.e. Obstructions
As the shafts for the piers are drilled, obstructions may be encountered that cannot be removed with conventional drilling equipment. In our opinion, an obstruction can be considered to consist of a dense concentration of cobbles, boulders, detached rock slabs or other material, natural or man-made, that impedes drilling with conventional augers and requires special equipment including but not necessarily
limited to, core barrels, air compressors, or hand excavation tools to penetrate. The obstruction can be considered to have been penetrated once conventional augering can resume.

D.3.f. Inspection
We recommend having the pier drilling observed by geotechnical engineer or a technician working under a geotechnical engineer. The excavated soils should be classified and compared to the soils encountered by the soil boring to verify the friction and cohesion recommendations.

D.4. Equipment Shelter Building
We recommend the ESB slab be embedded a minimum of one foot for erosion protection. Based on the conditions encountered in the borings, we anticipate that the equipment shelter building will be underlain by native or filled poorly graded sand that is considered non frost susceptible.

D.5. Aggregate Pavement

D.5.a. Subgrade Proof-Roll
Prior to placing aggregate surface material, we recommend proof-rolling pavement subgrades to determine if the subgrade materials are loose, soft or weak, and in need of further stabilization, compaction or subexcavation and recompaction or replacement.

D.5.b. Materials and Compaction
We recommend specifying crushed aggregate meeting the requirements of Minnesota Department of Transportation (Mn/DOT) Specification 3138 for Class 5. We recommend that the aggregate surface be compacted to a minimum of 100 percent of its maximum standard Proctor dry density.

D.6. Construction Quality Control

D.6.a. Excavation Observations
We recommend having a geotechnical engineer, or a technician working under a geotechnical engineer, observe all excavations related to tower foundation construction. The purpose of the observations is to evaluate the competence of the geologic materials exposed in the excavations and the adequacy of required excavation oversizing.
D.6.b. Materials Testing
We recommend density tests be taken in excavation backfill and any required fill placed above or below spread footings.

We also recommend slump, air content and strength tests of Portland cement concrete.

D.6.c. Cold Weather Precautions
If site grading and construction is anticipated during cold weather, all snow and ice should be removed from cut and fill areas prior to additional grading. No fill should be placed on frozen subgrades. No frozen soils should be used as fill.

Concrete delivered to the site should meet the temperature requirements of ASTM C 94. Concrete should not be placed on frozen subgrades. Concrete should be protected from freezing until the necessary strength is attained. Frost should not be permitted to penetrate below footings.

E. Procedures

E.1. Penetration Test Borings

The penetration test borings were conducted with a floatation tire all terrain carrier-mounted drill rig equipped with hollow-stem auger. The borings were performed in accordance with ASTM D 1586. Penetration test samples were taken at 2 1/2- or 5-foot intervals. Actual sample intervals and corresponding depths are shown on the boring logs.

The penetration test boreholes were grouted with bentonite per Minnesota Department of Health (MDH) Environmental Borehole guidelines.

E.2. Material Classification and Testing

E.2.a Visual and Manual Classification
The geologic materials encountered were visually and manually classified in accordance with ASTM Test Method D 2488. A chart explaining the classification system is attached. Samples were sealed in jars or bags and returned to our facility for review and storage.
E.3. Groundwater Measurements

The drillers checked for groundwater as the borings were advanced, when drilling was complete and checked again prior to grouting and removal of the hollow-stem auger, as noted on the boring logs.

F. Qualifications

F.1. Variations in Subsurface Conditions

F.1.a. Material Strata
Our evaluation, analyses and recommendations were developed from a limited amount of site and subsurface information. It is not standard engineering practice to retrieve material samples from exploration locations continuously with depth, and therefore strata boundaries and thicknesses must be inferred to some extent. Strata boundaries may also be gradual transitions and can be expected to vary in depth, elevation and thickness away from the exploration locations.

Variations in subsurface conditions present between exploration locations may not be revealed until additional exploration work is completed or construction commences. If any such variations are revealed, our recommendations should be re-evaluated. Such variations could increase construction costs, and a contingency should be provided to accommodate them.

F.1.b. Groundwater Levels
Groundwater measurements were made under the conditions reported herein and shown on the exploration logs and interpreted in the text of this report. It should be noted that the observation period was relatively short and groundwater can be expected to fluctuate in response to rainfall, flooding, irrigation, seasonal freezing and thawing, surface drainage modifications and other seasonal and annual factors.

F.2. Continuity of Professional Responsibility

F.2.a. Plan Review
This report is based on a limited amount of information and a number of assumptions were necessary to help us develop our recommendations. It is recommended that our firm review the geotechnical aspects of the designs and specifications, evaluate whether the design is as expected and if any design changes
have affected the validity of our recommendations, and if our recommendations have been correctly interpreted and implemented in the designs and specifications.

F.2.b. Construction Observations and Testing

It is recommended that we be retained to perform observations and tests during construction. This will allow correlation of the subsurface conditions encountered during construction with those encountered by the borings and provide continuity of professional responsibility.

F.3. Use of Report

This report is for the exclusive use of the parties to which it has been addressed. Without written approval, we assume no responsibility to other parties regarding this report. Our evaluation, analyses and recommendations may not be appropriate for other parties or projects.

F.4. Standard of Care

In performing its services, Braun Intertec used that degree of care and skill ordinarily exercised under similar circumstances by reputable members of its profession currently practicing in the same locality. No warranty, express or implied, is made.
### Braun Project DU-12-05256
#### Geotechnical Evaluation
Proposed Park Point Radio Tower
22nd Avenue South
Duluth, Minnesota

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<td>28.0</td>
<td>SP</td>
<td>POORLY GRADED SAND, fine-grained, with a trace of roots, brown, waterbearing, medium dense. (Lacustrine Deposit)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Ground surface elevations at the boring locations were referenced to the top of the existing tower foundation. We assigned this reference an arbitrary elevation 150.0.

An open triangle in the water level (WL) column indicates the depth at which groundwater was observed while drilling. Groundwater levels fluctuate.

Mud rotary drilling techniques used below 16 feet.
### LOG OF BORING

**Braun Project DU-12-05256**  
**Geotechnical Evaluation**  
**Proposed Park Point Radio Tower**  
**22nd Avenue South**  
**Duluth, Minnesota**  

**BORING:** ST-01 (cont.)

**LOCATION:** See attached sketch.

<table>
<thead>
<tr>
<th>Elev. feet</th>
<th>Depth feet</th>
<th>Symbol</th>
<th>Description of Materials</th>
</tr>
</thead>
<tbody>
<tr>
<td>116.4</td>
<td>32.0</td>
<td>SP-SM</td>
<td>POORLY GRADED SAND with SILT, fine-grained, with lenses of Silt, brown, waterbearing, very dense. (Lacustrine Deposit)</td>
</tr>
<tr>
<td>115.4</td>
<td>33.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>97.4</td>
<td>51.0</td>
<td></td>
<td>END OF BORING. Water observed at a depth of 10.8 feet while drilling. Boring immediately backfilled with bentonite grout.</td>
</tr>
</tbody>
</table>

**DATE:** 10/1/12  
**SCALE:** 1" = 4'
Braun Project DU-12-05256  
Geotechnical Evaluation  
Proposed Park Point Radio Tower  
22nd Avenue South  
Duluth, Minnesota

BORING: ST-02  
LOCATION: See attached sketch.

DRILLER: M. Heinzen  
METHOD: 3 1/4" HSA, Autohammer  
DATE: 10/1/12  
SCALE: 1" = 4'

<table>
<thead>
<tr>
<th>Elev. feet</th>
<th>Depth feet</th>
<th>Symbol</th>
<th>Description of Materials</th>
<th>BPF</th>
<th>WL</th>
<th>Tests or Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>153.8</td>
<td>0.0</td>
<td>SP</td>
<td>POORLY GRADED SAND, fine-grained, brown, moist, loose. (Lacustrine Deposit)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>139.8</td>
<td>14.0</td>
<td>SP</td>
<td>POORLY GRADED SAND, fine- to medium-grained, brown, waterbearing, medium dense to very dense. (Lacustrine Deposit)</td>
<td>27</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>38</td>
<td></td>
<td>Mud rotary drilling techniques used below 21 feet.</td>
</tr>
</tbody>
</table>

LOCATION: See attached sketch.

TESTS OR NOTES: Mud rotary drilling techniques used below 21 feet.

(See Descriptive Terminology sheet for explanation of abbreviations)

LOG OF BORING  
(See Descriptive Terminology sheet for explanation of abbreviations)
POORLY GRADED SAND, fine- to medium-grained, brown, waterbearing, medium dense to very dense.
(Lacustrine Deposit) (continued)

END OF BORING.
Water observed at a depth of 16.3 feet while drilling.
Boring immediately backfilled with bentonite grout.
### Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests

| Gravels |
|-----------------
| More than 50% of coarse fraction retained on No. 4 sieve |
| More than 12% fines |
| Clean Gravels |
| 5% or less fines |
| Gravels with Fines |
| More than 12% fines |
| Clean Sands |
| 5% or less fines |
| Sands with Fines |
| More than 12% fines |

<table>
<thead>
<tr>
<th>Soils Classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group Symbol</td>
</tr>
<tr>
<td>Group Name</td>
</tr>
</tbody>
</table>

- **C**
- **D**
- **ML**
- **CL**
- **OL**
- **SM**
- **SC**
- **GM**
- **GW**
- **CH**
- **OH**
- **PT**

### Laboratory Tests

| DD | OC |
| Dry density, pcf | Organic content, % |
| WD | S |
| Wet density, pcf | Percent of saturation, % |
| MC | SG |
| Natural moisture content, % | Specific gravity |
| LL | C |
| Liquid limit, % | Cohesion, psf |
| PI | **qu** |
| Plasticity index, % | Unconfined compressive strength, psf |
| P200 | **qp** |
| % passing 200 sieve | Pocket penetrometer strength, tsf |

### Particle Size Identification

- **Boulders**
- **Cobbles**
- **Gravel**
- **Coarse**
- **Fine**
- **Sand**
- **Silt**
- **Clay**

### Relative Density of Cohesionless Soils

- **Very loose**
- **Loose**
- **Medium dense**
- **Dense**
- **Very dense**

### Consistency of Cohesive Soils

- **Very soft**
- **Soft**
- **Rather soft**
- **Medium**
- **Stiff**
- **Very stiff**
- **Hard**

### Drilling Notes

Standard penetration test borings were advanced by 3 1/4" or 6 1/4" ID hollow-stem augers unless noted otherwise. Jetting water was used to clean out auger prior to sampling only where indicated on logs. Standard penetration test borings are designated by the prefix "ST" (Split Tube). All samples were taken with the standard 2" OD split-tube sampler, except where noted.

Power auger borings were advanced by 4" or 6" diameter continuous-flight, solid-stem augers. Soil classifications and strata depths were inferred from disturbed samples augered to the surface and are, therefore, somewhat approximate. Power auger borings are designated by the prefix “B.”

Hand auger borings were advanced manually with a 1 1/2" or 3 1/4" diameter auger and were limited to the depth from which the auger could be manually withdrawn. Hand auger borings are indicated by the prefix “H.”

### BPF: Numbers indicate blows per foot recorded in standard penetration test, also known as “N” value. The sampler was set 6" into undisturbed soil below the hollow-stem auger. Driving resistances were then counted for second and third 6" increments and added to get BPF. Where they differed significantly, they are reported in the following form: 2/12 for the second and third 6" increments, respectively.

### WH: WH indicates the sampler penetrated soil under weight of hammer and rods alone; driving not required.

### WR: WR indicates the sampler penetrated soil under weight of rods alone; hammer weight and driving not required.

### TW: TW indicates thin-walled (undisturbed) tube sample.
### Summary of Strength Parameters

<table>
<thead>
<tr>
<th>Depth Interval, feet</th>
<th>Material Description</th>
<th>Estimated Unit Weight, pcf</th>
<th>Estimated Cohesion, psf</th>
<th>Estimated Friction Angle, degrees</th>
<th>Allowable Passive Pressure, psf</th>
<th>Allowable Uplift Adhesion/Friction, psf</th>
<th>Allowable Compressive Adhesion/Friction, psf</th>
<th>Allowable End-Bearing Capacity, psf</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-9</td>
<td>Sand(SP)</td>
<td>110</td>
<td>0</td>
<td>29</td>
<td>0-2900</td>
<td>0-70</td>
<td>0-90</td>
<td>0-90</td>
</tr>
<tr>
<td>9-12</td>
<td>Sand(SP)</td>
<td>63</td>
<td>0</td>
<td>41</td>
<td>4700-5600</td>
<td>70-90</td>
<td>100-120</td>
<td>100-120</td>
</tr>
<tr>
<td>12-28</td>
<td>Sand(SP)</td>
<td>68</td>
<td>0</td>
<td>47</td>
<td>7600-14700</td>
<td>90-160</td>
<td>110-220</td>
<td>110-220</td>
</tr>
<tr>
<td>28-33</td>
<td>Sand(SP)</td>
<td>60</td>
<td>0</td>
<td>34</td>
<td>7900-9000</td>
<td>170-190</td>
<td>230-260</td>
<td>5400-6200</td>
</tr>
<tr>
<td>33-51</td>
<td>Sand with Silt(SP-SM)</td>
<td>68</td>
<td>0</td>
<td>48</td>
<td>17900-26400</td>
<td>180-270</td>
<td>240-360</td>
<td>6200-9100</td>
</tr>
</tbody>
</table>

*Notes:*
- Dual values represent values at top and bottom of stratum, respectively.
- The allowable passive pressure values contain a factor of safety of three.
- Adhesion/friction values include a factor of safety of two.
- End-bearing capacities include a factor of safety of three.
Project: Park Point Radio Tower  
Boring(s): ST-1  
Loading Condition: Transient 

Summary of p - y parameters.

<table>
<thead>
<tr>
<th>Depth Interval, feet</th>
<th>Material Description</th>
<th>Adjusted BPF</th>
<th>Static &amp; Cyclic Modulus, “Dry” Sand, pci</th>
<th>Static &amp; Cyclic Modulus, Submerged Sand, pci</th>
<th>Static Modulus, Clay, pci</th>
<th>Cyclic Modulus, Clay, pci</th>
<th>$\varepsilon_{50}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-9</td>
<td>Sand(SP)</td>
<td>7</td>
<td>20</td>
<td>20</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>9-12</td>
<td>Sand(SP)</td>
<td>49</td>
<td>280</td>
<td>150</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>12-28</td>
<td>Sand(SP)</td>
<td>85</td>
<td>560</td>
<td>260</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>28-33</td>
<td>Sand(SP)</td>
<td>22</td>
<td>100</td>
<td>60</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>33-51</td>
<td>Sand with Silt(SP-SM)</td>
<td>96</td>
<td>660</td>
<td>300</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
</tbody>
</table>

File: ST-1 DRLPIR
PARK POINT
Tower
7/10/08 R.H.
PARK POINT
Tower
7/10/08 R.H.

4' OMNI @ 137'

4' OMNI @ 109'

20' OMNI @ A.E.M.S.
70' ALS-400
GOLD-X

ALL ANTENNAS @

10°
Product Description

Super Stationmaster VHF base station antennas incorporate the design features of 9 MHz broadband capability, improved lightning protection and true omnidirectional gain in excess of 5 dBi. Note: Below 150 MHz, rated gain is 4.8 dBi due to length constraints. Side mounting hardware is available for the 220 to achieve special radiation patterns.

Features/Benefits

- Fiberglass construction protects radiating elements in corrosive environments.
- DC grounded – affords lightning protection.
- Copper radiating elements minimize possibility of intermod generation.

Technical Specifications

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency Band</td>
<td>25-299.9 MHz</td>
</tr>
<tr>
<td>Horizontal Pattern</td>
<td>OmniDirectional</td>
</tr>
<tr>
<td>Antenna Type</td>
<td>Fiberglass Omni</td>
</tr>
<tr>
<td>Electrical Down Tilt Option</td>
<td>Fixed</td>
</tr>
<tr>
<td>Gain, dBi (dBd)</td>
<td>7.4 (5.3)</td>
</tr>
<tr>
<td>Frequency Range, MHz</td>
<td>151.5-159.5</td>
</tr>
<tr>
<td>Connector Type</td>
<td>N Female</td>
</tr>
<tr>
<td>Connector Location</td>
<td>Bottom</td>
</tr>
<tr>
<td>Mount Type</td>
<td>Fixed</td>
</tr>
<tr>
<td>Electrical Downtilt, deg</td>
<td>0</td>
</tr>
<tr>
<td>Orientation</td>
<td>Upright</td>
</tr>
<tr>
<td>Mounting Hardware</td>
<td>46 Clamp Set</td>
</tr>
<tr>
<td>Rated Wind Speed, km/h (mph)</td>
<td>160 (100)</td>
</tr>
<tr>
<td>Gain (Omnidirectional), dBi (dBd)</td>
<td>7.39 (5.25)</td>
</tr>
<tr>
<td>VSWR</td>
<td>&lt; 1.6:1</td>
</tr>
<tr>
<td>Vertical Beamwidth, deg</td>
<td>18</td>
</tr>
<tr>
<td>Polarization</td>
<td>Vertical</td>
</tr>
<tr>
<td>Maximum Power Input, W</td>
<td>500</td>
</tr>
<tr>
<td>Lightning Protection</td>
<td>Direct Ground</td>
</tr>
<tr>
<td>3rd Order IMP @ 2 x 43 dBm, dBc</td>
<td>-130</td>
</tr>
<tr>
<td>Impedance, Ohms</td>
<td>50</td>
</tr>
<tr>
<td>Overall Length, m (ft)</td>
<td>6.34 (20.8)</td>
</tr>
<tr>
<td>Element Housing Length, m (ft)</td>
<td>5.67 (18.6)</td>
</tr>
<tr>
<td>Mounting Pipe Diameter, m (in)</td>
<td>0.07 (2.75)</td>
</tr>
<tr>
<td>Support Pipe Length, m (ft)</td>
<td>0.69 (2.25)</td>
</tr>
<tr>
<td>Weight, kg (lb)</td>
<td>11 (24)</td>
</tr>
<tr>
<td>Radiating Element Material</td>
<td>Copper</td>
</tr>
<tr>
<td>Element Housing Material</td>
<td>Fiberglass</td>
</tr>
<tr>
<td>Support Pipe Material</td>
<td>Aluminum Alloy</td>
</tr>
<tr>
<td>Max Wind Loading Area, m² (ft²)</td>
<td>0.217 (2.34)</td>
</tr>
<tr>
<td>Survival Wind Speed, km/h (mph)</td>
<td>200 (125)</td>
</tr>
<tr>
<td>Bend Mom @ Rated Wind 1° Below Top of Mt Pipe, N m (ft lbf)</td>
<td>1196 (882)</td>
</tr>
<tr>
<td>Wind Load - Side @ Rated Wind, N lbf</td>
<td>418 (94)</td>
</tr>
<tr>
<td>Shipping Weight, kg (lb)</td>
<td>25 (55)</td>
</tr>
<tr>
<td>Packing Dimensions, HxWxD, mm (in)</td>
<td>6400 x 100 x 100 (251.96 x 3.94 x 3.94)</td>
</tr>
<tr>
<td>Packing Dimensions - HxWxD, m (ft)</td>
<td>6.4 x 0.1 x 0.1 (21 x 0.33 x 0.33)</td>
</tr>
<tr>
<td>Shipping Dimensions of Accessory - HxWxD, m (ft)</td>
<td>Packed w/antenna</td>
</tr>
<tr>
<td>Shipping Mode</td>
<td>Common Carrier</td>
</tr>
</tbody>
</table>

Notes
Super Stationmaster™ Omni Fiberglass Antenna, 151.5-159.5, 7.4dBi, N Female

Other Documentation

Vertical Pattern

Horizontal Pattern
Product Description

These antennas feature a very broad frequency band and rugged construction. Radiating elements are constructed of copper alloy, encased in a weather resistant low loss fiberglass radome. The BA1010 "Heavy Duty" is permanently affixed to a unique mounting fixture which allows mounting on top of or along-side of most vertical supports. Due to their wide bandwidth, they are ideal for use as emergency backup antennas. Their size and mounting fixtures allow for easy storage and fast installation. Alternative mounting hardware is available for most applications.

Features/Benefits

- Broadband – reduces backup inventory and the need for multiple antennas.
- Fiberglass radome protects radiating elements in hostile environments.
- Copper elements maximize system performance while minimizing the possibility of intermod.

Technical Specifications

<table>
<thead>
<tr>
<th>Feature</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency Band</td>
<td>25-299.9 MHz</td>
</tr>
<tr>
<td>Horizontal Pattern</td>
<td>OmniDirectional</td>
</tr>
<tr>
<td>Antenna Type</td>
<td>Fiberglass Omni</td>
</tr>
<tr>
<td>Electrical Down Tilt Option</td>
<td>Fixed</td>
</tr>
<tr>
<td>Gain, dBi (dBd)</td>
<td>2.1 (0)</td>
</tr>
<tr>
<td>Frequency Range, MHz</td>
<td>154-174</td>
</tr>
<tr>
<td>Connector Type</td>
<td>N Female</td>
</tr>
<tr>
<td>Connector Location</td>
<td>Bottom</td>
</tr>
<tr>
<td>Mount Type</td>
<td>Fixed</td>
</tr>
<tr>
<td>Electrical Downtilt, deg</td>
<td>0</td>
</tr>
<tr>
<td>Mounting Hardware</td>
<td>Stainless Steel U-Bolts (E380-03F)</td>
</tr>
<tr>
<td>Rated Wind Speed, km/h (mph)</td>
<td>160 (100)</td>
</tr>
<tr>
<td>VSWR</td>
<td>&lt; 1.5:1</td>
</tr>
<tr>
<td>Vertical Beamwidth, deg</td>
<td>80</td>
</tr>
<tr>
<td>Polarization</td>
<td>Vertical</td>
</tr>
<tr>
<td>Maximum Power Input, W</td>
<td>500</td>
</tr>
<tr>
<td>Lightning Protection</td>
<td>Direct Ground</td>
</tr>
<tr>
<td>Flexible Extensions</td>
<td>None</td>
</tr>
<tr>
<td>Impedance, Ohms</td>
<td>50</td>
</tr>
<tr>
<td>Overall Length, m (ft)</td>
<td>1.4 (4.6)</td>
</tr>
<tr>
<td>Mounting Pipe Diameter, m (in)</td>
<td>0.08 (3)</td>
</tr>
<tr>
<td>Support Pipe Length, m (ft)</td>
<td>0.3 (1)</td>
</tr>
<tr>
<td>Weight w/o Mtg Hardware, kg (lb)</td>
<td>4 (8.8)</td>
</tr>
<tr>
<td>Radiating Element Material</td>
<td>Brass</td>
</tr>
<tr>
<td>Element Housing Material</td>
<td>Fiberglass</td>
</tr>
<tr>
<td>Radome Color</td>
<td>White RAL9010</td>
</tr>
<tr>
<td>Support Pipe Material</td>
<td>Black Anodized Aluminum</td>
</tr>
<tr>
<td>Max Wind Loading Area, m² (ft²)</td>
<td>0.08 (0.86)</td>
</tr>
<tr>
<td>Shipping Weight, kg (lb)</td>
<td>6.1 (13.4)</td>
</tr>
<tr>
<td>Shipping Dimensions of Accessory - HxWxD, m (ft)</td>
<td>Packed w/ antenna</td>
</tr>
<tr>
<td>Shipping Mode</td>
<td>UPS</td>
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</tbody>
</table>

Notes

Other Documentation
Product Specifications

VHLP800-11-6WH
800 mm | 2.6 ft ValuLine® High Performance Low Profile Antenna, single-polarized, 10.700–11.700 GHz, CPR90G, white antenna, polymer white radome without flash, standard pack—one-piece reflector

CHARACTERISTICS

General Specifications

<table>
<thead>
<tr>
<th>Description</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Packing</td>
<td>Standard pack</td>
</tr>
<tr>
<td>Radome Color</td>
<td>White</td>
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<tr>
<td>Radome Material</td>
<td>Polymer</td>
</tr>
<tr>
<td>Reflector Construction</td>
<td>One-piece reflector</td>
</tr>
<tr>
<td>Antenna Input</td>
<td>CPR90G</td>
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<tr>
<td>Antenna Color</td>
<td>White</td>
</tr>
<tr>
<td>Antenna Type</td>
<td>VHLP - ValuLine® High Performance Low Profile Antenna, single-polarized</td>
</tr>
<tr>
<td>Diameter, nominal</td>
<td>800 mm</td>
</tr>
<tr>
<td>Flash Included</td>
<td>No</td>
</tr>
<tr>
<td>Polarization</td>
<td>Single</td>
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Electrical Specifications

<table>
<thead>
<tr>
<th>Description</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beamwidth, Horizontal</td>
<td>2.2°</td>
</tr>
<tr>
<td>Beamwidth, Vertical</td>
<td>2.2°</td>
</tr>
<tr>
<td>Cross Polarization Discrimination (XPD)</td>
<td>30 dB</td>
</tr>
<tr>
<td>Electrical Compliance</td>
<td>Brazil Anatel Class 2</td>
</tr>
<tr>
<td>Front-to-Back Ratio</td>
<td>59 dB</td>
</tr>
<tr>
<td>Gain, Low Band</td>
<td>36.9 dBi</td>
</tr>
<tr>
<td>Gain, Mid Band</td>
<td>37.4 dBi</td>
</tr>
<tr>
<td>Gain, Top Band</td>
<td>38.3 dBi</td>
</tr>
<tr>
<td>Operating Frequency Band</td>
<td>10.700 – 11.700 GHz</td>
</tr>
<tr>
<td>Radiation Pattern Envelope Reference (RPE)</td>
<td>7091C</td>
</tr>
<tr>
<td>Return Loss</td>
<td>17.7 dB</td>
</tr>
<tr>
<td>VSWR</td>
<td>1.30</td>
</tr>
</tbody>
</table>

Mechanical Specifications

<table>
<thead>
<tr>
<th>Description</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fine Azimuth Adjustment</td>
<td>±10°</td>
</tr>
<tr>
<td>Fine Elevation Adjustment</td>
<td>±25°</td>
</tr>
</tbody>
</table>
Product Specifications

VHLP800-11-6WH

Mounting Pipe Diameter  50 mm–115 mm | 2.0 in–4.5 in
Net Weight  22 kg | 49 lb
Side Struts, Included  0
Side Struts, Optional  0
Wind Velocity Operational  180 km/h | 112 mph
Wind Velocity Survival Rating  250 km/h | 155 mph

Wind Forces At Wind Velocity Survival Rating

<table>
<thead>
<tr>
<th>Force</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Axial Force (FA)</td>
<td>1500 N</td>
</tr>
<tr>
<td>Side Force (FS)</td>
<td>743 N</td>
</tr>
<tr>
<td>Twisting Moment (MT)</td>
<td>673 N•m</td>
</tr>
<tr>
<td>Weight with 1/2 in (12 mm) Radial Ice</td>
<td>35 kg</td>
</tr>
<tr>
<td>Zcg with 1/2 in (12 mm) Radial Ice</td>
<td>305 mm</td>
</tr>
<tr>
<td>Zcg without Ice</td>
<td>178 mm</td>
</tr>
</tbody>
</table>

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Product Specifications

VHLP800-11-6WH

Wind Forces At Wind Velocity Survival Rating Image

Packed Dimensions

| Gross Weight, Packed Antenna | 30.0 kg | 66.1 lb |
| Height                      | 650.0 mm | 25.6 in |
| Length                      | 900.0 mm | 35.4 in |
| Volume                      | 0.5 m³   |
| Width                       | 900.0 mm | 35.4 in |
Antenna Dimensions And Mounting Information

Regulatory Compliance/Certifications

<table>
<thead>
<tr>
<th>Agency</th>
<th>Classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>ISO 9001:2008</td>
<td>Designed, manufactured and/or distributed under this quality management system</td>
</tr>
</tbody>
</table>

*Footnotes*

**Axial Force (FA)**

Maximum forces exerted on a supporting structure as a result of wind from the most critical direction for this parameter. The individual maximums specified may not occur simultaneously. All forces are referenced to the mounting pipe.

**Cross Polarization Discrimination (XPD)**

The difference between the peak of the co-polarized main beam and the maximum cross-polarized signal over an angle twice the 3 dB beamwidth of the co-polarized main beam.

**Front-to-Back Ratio**

Denotes highest radiation relative to the main beam, at 180° ±40°, across the band. Production antennas do not exceed rated values by more than 2 dB unless stated otherwise.

**Gain, Mid Band**

For a given frequency band, gain is primarily a function of antenna size. The gain of Andrew antennas is determined by either gain by comparison or by computer integration of the measured antenna patterns.

**Operating Frequency Band**

Bands correspond with CCIR recommendations or common allocations used.
throughout the world. Other ranges can be accommodated on special order.

Packing
Andrew standard packing is suitable for export. Antennas are shipped as standard in totally recyclable cardboard or wire-bound crates (dependent on product). For your convenience, Andrew offers heavy duty export packing options.

Radiation Pattern Envelope Reference (RPE)
Radiation patterns determine an antenna’s ability to discriminate against unwanted signals under conditions of radio congestion. Radiation patterns are dependent on antenna series, size, and frequency.

Return Loss
The figure that indicates the proportion of radio waves incident upon the antenna that are rejected as a ratio of those that are accepted.

Side Force (FS)
Maximum side force exerted on the mounting pipe as a result of wind from the most critical direction for this parameter. The individual maximums specified may not occur simultaneously. All forces are referenced to the mounting pipe.

Twisting Moment (MT)
Maximum forces exerted on a supporting structure as a result of wind from the most critical direction for this parameter. The individual maximums specified may not occur simultaneously. All forces are referenced to the mounting pipe.

VSWR
Maximum; is the guaranteed Peak Voltage-Standing-Wave-Ratio within the operating band.

Wind Velocity Operational
The wind speed where the antenna deflection is equal to or less than 0.1 degrees. In the case of ValuLine antennas, it is defined as a maximum deflection of 0.3 x the 3 dB beam width of the antenna.

Wind Velocity Survival Rating
The maximum wind speed the antenna, including mounts and radomes, where applicable, will withstand without permanent deformation. Realignment may be required. This wind speed is applicable to antenna with the specified amount of radial ice.
Gold Series Directional Yagi antennas provide industry leading design features with long term optimal performance

Laird Technologies’ premium series Directional Yagi antennas are fully gold anodized for corrosion resistance. All UHF and above frequency antennas feature internal matching to assure broad bandwidth and resistance to severe weather conditions. There is no gamma match to ice up, corrode or detune. Our engineering staff has also optimized the product family for forward gain by computer analysis and then field-tested each for conformance.

Features and Benefits:
- All UHF and higher frequency antennas feature 360-degree welds around each element and an end-of-boom N connector feed with an internal transmission line feeding the driven element.
- Every Yagi is tuned on a network analyzer for best power match and lowest VSWR.
- All Yagi antennas ship complete with a high quality cast aluminum mounting kit that includes stainless steel hardware and allows vertical or horizontal orientation during installation. (VHF models require light assembly)

Applications
- Point to point directional and multiple point to omnidirectional outdoor antennas applications used by private organizations and government agencies around the globe.
- Typical applications include transportation such as railroad switching, remote locations reporting examples that include oil fields and weather conditions and meter data transmissions for utilities.

For sales information:
In the USA please telephone +1-800-323-3757
In Asia please telephone +886-2-2286-2828
In Europe please telephone +46-8-555-722-00
or visit: www.lairdtech.com
**SPECIFICATIONS:**

<table>
<thead>
<tr>
<th>Electrical</th>
<th>Mechanical</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Frequency Range:</strong> 896 – 970 MHz</td>
<td>Material: Aluminum</td>
</tr>
<tr>
<td><strong>Frequency Bandwidth:</strong> 74 MHz</td>
<td>Length: 27.688&quot;</td>
</tr>
<tr>
<td><strong>VSWR:</strong> &lt; 2:1</td>
<td>Height: 6.75&quot;</td>
</tr>
<tr>
<td><strong>Return Loss:</strong> -10dB max</td>
<td>Boom Diameter: .875&quot;</td>
</tr>
<tr>
<td><strong>Nominal Gain:</strong> 9 dBi</td>
<td>Weight: 3.9 lbs</td>
</tr>
<tr>
<td><strong>Front to Back Ratio:</strong> 20 dB</td>
<td>Rated Wind Velocity: 150 mph (241 kph)</td>
</tr>
<tr>
<td><strong>Maximum Power:</strong> 300 W</td>
<td>Rated Wind Velocity: 80 mph (130 kph) with 0.5&quot; radial ice</td>
</tr>
<tr>
<td><strong>Nominal Impedance:</strong> 50 Ω</td>
<td>Equivalent Flat Area: 0.2492 sq. ft.</td>
</tr>
<tr>
<td><strong>Polarization:</strong> Vertical or Horizontal</td>
<td>Cable: None</td>
</tr>
<tr>
<td><strong>Pattern:</strong> Directional</td>
<td>Termination: N-Female connector</td>
</tr>
<tr>
<td><strong>Horizontal Beamwidth:</strong> 56°</td>
<td>Color: Gold or Black Anodized</td>
</tr>
<tr>
<td>(For Horizontal Polarization)</td>
<td>Lightning Protection: Lightning Arrestor LABH350NN (Sold Separately)</td>
</tr>
<tr>
<td><strong>Vertical Beamwidth:</strong> 52°</td>
<td>Mounting Included: Heavy duty cast aluminum bracket accomodates up to 7/8&quot; mast</td>
</tr>
<tr>
<td>(For Vertical Polarization)</td>
<td></td>
</tr>
<tr>
<td><strong>Tuning:</strong> Fixed Tune</td>
<td></td>
</tr>
<tr>
<td><strong>Transmitting/Receiving:</strong> Both</td>
<td></td>
</tr>
</tbody>
</table>

**Mechanical**

- Material: Aluminum
- Length: 27.688"
- Height: 6.75"
- Boom Diameter: .875"
- Weight: 3.9 lbs
- Rated Wind Velocity: 150 mph (241 kph)
- Rated Wind Velocity: 80 mph (130 kph) with 0.5" radial ice
- Equivalent Flat Area: 0.2492 sq. ft.
- Cable: None
- Termination: N-Female connector
- Color: Gold or Black Anodized
- Lightning Protection: Lightning Arrestor LABH350NN (Sold Separately)
- Mounting Included: Heavy duty cast aluminum bracket accomodates up to 7/8" mast

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MFB Series, 900 MHz Fiberglass Omnidirectional Antennas

The MFB 900 MHz series consists of base matched half wave antennas encapsulated in heavy duty fiberglass radomes with a thick walled aluminum mounting base for reliable long term use. All models are DC grounded and UPS shippable.

Features

- White ultra-violet resistant pultruded fiberglass radome
- Thick walled aluminum mounting base
- Unity/3dB/5dB/7dB models (rated in dbd)
- Wideband models available
- UPS shippable
- Exceptional value

General Specifications:

Radiator Material:  Coated steel wire
Radome Material:  .65” pultruded white fiberglass
Termination:
- Unity and 3dB models: N Female
- Wideband models: N Male with 16” jumper
- 5dB and 7dB models: N Male with 16” jumper
- RPC: reverse polarity TNC
Lightning Protection:
- DC grounded
Mounting Method:
- Mast or wall mounted.
  Mounting hardware is sold separately.
- MMK1: light duty mast mount for antennas under 30”
- MMK3: light duty mast mount for antennas over 30”
- MMK4: heavy duty mast mount
- MMK6: cast mounting bracket
  MBSWM: wall mounting bracket for antennas over 30”
  (two are required)
Wind Survival:
- 100 mph
Mounting Base Diameter:
- 1-5/16”
Maximum Power:
- 150 Watts
Nominal Impedance:
- 50 Ohms
### Electrical Specifications

<table>
<thead>
<tr>
<th>Model #</th>
<th>Frequency Range</th>
<th>Factory Tuned Frequency</th>
<th>Gain</th>
<th>Bandwidth @ 1.5:1 VSWR</th>
<th>Vertical Beamwidth @ 1/2 Power</th>
</tr>
</thead>
<tbody>
<tr>
<td>MFB8960</td>
<td>896-940 MHz</td>
<td>898 MHz</td>
<td>Unity</td>
<td>40 MHz</td>
<td>75°</td>
</tr>
<tr>
<td>MFB9150</td>
<td>902-928 MHz</td>
<td>915 MHz</td>
<td>Unity</td>
<td>20 MHz</td>
<td>75°</td>
</tr>
<tr>
<td>MFB9300</td>
<td>928-932 MHz</td>
<td>930 MHz</td>
<td>Unity</td>
<td>5 MHz</td>
<td>75°</td>
</tr>
<tr>
<td>MFB9380</td>
<td>896-940 MHz</td>
<td>938 MHz</td>
<td>Unity</td>
<td>40 MHz</td>
<td>75°</td>
</tr>
<tr>
<td>MFB8963</td>
<td>896-940 MHz</td>
<td>898 MHz</td>
<td>3dB</td>
<td>30 MHz</td>
<td>40°</td>
</tr>
<tr>
<td>MFB9153</td>
<td>902-928 MHz</td>
<td>915 MHz</td>
<td>3dB</td>
<td>20 MHz</td>
<td>40°</td>
</tr>
<tr>
<td>MFB9303</td>
<td>928-932 MHz</td>
<td>930 MHz</td>
<td>3dB</td>
<td>5 MHz</td>
<td>40°</td>
</tr>
<tr>
<td>MFB9383</td>
<td>896-940 MHz</td>
<td>938 MHz</td>
<td>3dB</td>
<td>30 MHz</td>
<td>40°</td>
</tr>
<tr>
<td>MFB9155</td>
<td>902-928 MHz</td>
<td>915 MHz</td>
<td>5dB</td>
<td>20 MHz</td>
<td>22°</td>
</tr>
<tr>
<td>MFB9305</td>
<td>928-932 MHz</td>
<td>930 MHz</td>
<td>5dB</td>
<td>5 MHz</td>
<td>22°</td>
</tr>
<tr>
<td>MFB9385</td>
<td>896-940 MHz</td>
<td>938 MHz</td>
<td>5dB</td>
<td>20 MHz</td>
<td>22°</td>
</tr>
<tr>
<td>MFB8967</td>
<td>896-940 MHz</td>
<td>898 MHz</td>
<td>7dB</td>
<td>20 MHz</td>
<td>17°</td>
</tr>
<tr>
<td>MFB9157</td>
<td>902-928 MHz</td>
<td>915 MHz</td>
<td>7dB</td>
<td>20 MHz</td>
<td>17°</td>
</tr>
<tr>
<td>MFB9307</td>
<td>928-932 MHz</td>
<td>930 MHz</td>
<td>7dB</td>
<td>5 MHz</td>
<td>17°</td>
</tr>
<tr>
<td>MFB9387</td>
<td>896-940 MHz</td>
<td>938 MHz</td>
<td>7dB</td>
<td>20 MHz</td>
<td>17°</td>
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<tr>
<td>MFB9153RPC</td>
<td>902-928 MHz</td>
<td>915 MHz</td>
<td>3dB</td>
<td>20 MHz</td>
<td>40°</td>
</tr>
<tr>
<td>MFB9153STRPC</td>
<td>902-928 MHz</td>
<td>915 MHz</td>
<td>3dB</td>
<td>20 MHz</td>
<td>40°</td>
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<tr>
<td>MFB9157RPC</td>
<td>896-940 MHz</td>
<td>915 MHz</td>
<td>7dB</td>
<td>20 MHz</td>
<td>17°</td>
</tr>
<tr>
<td>MFBW8903</td>
<td>890-960 MHz</td>
<td>925 MHz</td>
<td>3dB</td>
<td>70 MHz</td>
<td>40°</td>
</tr>
<tr>
<td>MFBW8905</td>
<td>890-960 MHz</td>
<td>925 MHz</td>
<td>5dB</td>
<td>70 MHz</td>
<td>22°</td>
</tr>
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</table>

### Mechanical Specifications

<table>
<thead>
<tr>
<th>Model #</th>
<th>Equivalent Flat Plate Area</th>
<th>Lateral Thrust @ Rated Wind</th>
<th>Bending Moment @ Rated Wind</th>
<th>Height</th>
<th>Weight</th>
<th>List Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>MFB8960</td>
<td>.06 sq ft</td>
<td>2.3 lbs</td>
<td>1.4 ft-lbs</td>
<td>14”</td>
<td>.75 lbs</td>
<td>$88.40</td>
</tr>
<tr>
<td>MFB9150</td>
<td>.06 sq ft</td>
<td>2.3 lbs</td>
<td>1.4 ft-lbs</td>
<td>14”</td>
<td>.75 lbs</td>
<td>$88.40</td>
</tr>
<tr>
<td>MFB9300</td>
<td>.06 sq ft</td>
<td>2.3 lbs</td>
<td>1.4 ft-lbs</td>
<td>14”</td>
<td>.75 lbs</td>
<td>$88.40</td>
</tr>
<tr>
<td>MFB9380</td>
<td>.06 sq ft</td>
<td>2.3 lbs</td>
<td>1.4 ft-lbs</td>
<td>14”</td>
<td>.75 lbs</td>
<td>$88.40</td>
</tr>
<tr>
<td>MFB8963</td>
<td>.12 sq ft</td>
<td>4.3 lbs</td>
<td>4.7 ft-lbs</td>
<td>26”</td>
<td>1.25 lbs</td>
<td>$132.60</td>
</tr>
<tr>
<td>MFB9153</td>
<td>.12 sq ft</td>
<td>4.3 lbs</td>
<td>4.7 ft-lbs</td>
<td>23.25”</td>
<td>1.25 lbs</td>
<td>$132.60</td>
</tr>
<tr>
<td>MFB9303</td>
<td>.12 sq ft</td>
<td>4.3 lbs</td>
<td>4.7 ft-lbs</td>
<td>26”</td>
<td>1.25 lbs</td>
<td>$132.60</td>
</tr>
<tr>
<td>MFB8965*</td>
<td>.22 sq ft</td>
<td>8.0 lbs</td>
<td>14.2 ft-lbs</td>
<td>48”</td>
<td>1.75 lbs</td>
<td>$176.80</td>
</tr>
<tr>
<td>MFB9155*</td>
<td>.22 sq ft</td>
<td>8.0 lbs</td>
<td>14.2 ft-lbs</td>
<td>48”</td>
<td>1.75 lbs</td>
<td>$176.80</td>
</tr>
<tr>
<td>MFB9305*</td>
<td>.22 sq ft</td>
<td>8.0 lbs</td>
<td>14.2 ft-lbs</td>
<td>48”</td>
<td>1.75 lbs</td>
<td>$176.80</td>
</tr>
<tr>
<td>MFB9385*</td>
<td>.22 sq ft</td>
<td>8.0 lbs</td>
<td>14.2 ft-lbs</td>
<td>48”</td>
<td>1.75 lbs</td>
<td>$176.80</td>
</tr>
<tr>
<td>MFB8967*</td>
<td>.44 sq ft</td>
<td>15.8 lbs</td>
<td>62.5 ft-lbs</td>
<td>96”</td>
<td>4.00 lbs</td>
<td>$194.48</td>
</tr>
<tr>
<td>MFB9157*</td>
<td>.44 sq ft</td>
<td>15.8 lbs</td>
<td>62.5 ft-lbs</td>
<td>96”</td>
<td>4.00 lbs</td>
<td>$194.48</td>
</tr>
<tr>
<td>MFB9307*</td>
<td>.44 sq ft</td>
<td>15.8 lbs</td>
<td>62.5 ft-lbs</td>
<td>96”</td>
<td>4.00 lbs</td>
<td>$194.48</td>
</tr>
<tr>
<td>MFB9387*</td>
<td>.44 sq ft</td>
<td>15.8 lbs</td>
<td>62.5 ft-lbs</td>
<td>96”</td>
<td>4.00 lbs</td>
<td>$194.48</td>
</tr>
<tr>
<td>MFB9153RPC</td>
<td>.12 sq ft</td>
<td>4.3 lbs</td>
<td>4.7 ft-lbs</td>
<td>23.25”</td>
<td>1.25 lbs</td>
<td>$145.29</td>
</tr>
<tr>
<td>MFB9153STRPC</td>
<td>.12 sq ft</td>
<td>4.3 lbs</td>
<td>4.7 ft-lbs</td>
<td>23.25”</td>
<td>1.25 lbs</td>
<td>$145.29</td>
</tr>
<tr>
<td>MFB9157RPC</td>
<td>.44 sq ft</td>
<td>15.8 lbs</td>
<td>62.5 ft-lbs</td>
<td>96”</td>
<td>4.00 lbs</td>
<td>$210.64</td>
</tr>
<tr>
<td>MFBW8903</td>
<td>.12 sq ft</td>
<td>4.3 lbs</td>
<td>4.7 ft-lbs</td>
<td>26”</td>
<td>1.25 lbs</td>
<td>$145.29</td>
</tr>
<tr>
<td>MFBW8905</td>
<td>.22 sq ft</td>
<td>8.0 lbs</td>
<td>14.2 ft-lbs</td>
<td>48”</td>
<td>1.75 lbs</td>
<td>$176.80</td>
</tr>
</tbody>
</table>

* For N female connector add $10.00
PART 1  GENERAL

1.01  APPLICABLE PROVISIONS

A.  Applicable provisions of Division 01 shall govern work of this section.

1.02  DESCRIPTION OF WORK

A.  The City will construct a new radio telemetry building next to the new communications tower. The City will construct this new radio telemetry building after the new communications tower is completed.

B.  The City will be performing this work approximately from May 31, 2013 to July 29, 2013.

C.  The new radio telemetry building shall be completed before the Contractor transfers service and antennas from the existing communications to the new communications tower.

PART 2  PRODUCTS AND MATERIALS  (N/A)

PART 3  CONSTRUCTION METHODS  (N/A)

PART 4  MEASUREMENT AND PAYMENT  (N/A)

END OF SECTION
SECTION 01 29 73

SCHEDULE OF VALUES

PART 1 GENERAL

1.01 APPLICABLE PROVISIONS
A. Applicable provisions of Division 1 shall govern work of this section.

1.02 APPLICABLE PUBLICATIONS (NONE)

1.03 DESCRIPTION OF WORK
A. Provide a detailed breakdown of the Contract Price showing amounts and quantities allocated to each of the various parts of the Work, as specified herein and as required by General Conditions.
B. Upon request of Engineer, support amounts and quantities with data substantiating their correctness.

1.04 RELATED WORK ELSEWHERE
A. Procurement and Contracting Requirements - Division 00 (All Sections)

1.05 SUBMITTALS (NONE)

1.06 OPERATION/MAINTENANCE MANUALS AND INSTRUCTIONS (NONE)

1.07 FORM AND CONTENT OF SCHEDULE OF VALUES
A. Schedule shall be typed on 8-1/2-inch by 11-inch white paper. Contractor’s standard forms and automated printout will be considered for approval by Engineer upon request. Include following:
1. Project title.
2. Project location.
3. Owner.
4. Engineer.
5. Engineer’s project number.
6. Name and address of Contractor.
8. Date.
B. Identify installed value of Work in sufficient detail to serve as basis for computing values for progress payments during construction.
C. Provide a separate listing of general items, such as bonds, insurance, mobilization, field supervision, construction facilities, allowances, and record documents.
D. Follow Project Manual table of contents as format for listing component items. At a minimum, listing shall include material cost and total installed cost for each Specification Section for each structure as listed in this Section.
   1. Identify each line item with number and title of respective Specification Division and Section.
   2. Include directly proportional amount of Contractor’s overhead and profit.
   3. For items on which progress payments will be requested for stored materials, break down value into:
      a. Cost of materials, delivered and unloaded.
      b. Total installed value.

E. Provide listing of items for sitework and for each structure as follows:
   1. Sitework
   2. Testing
   3. Mobilization/demobilization
   4. Bonds and insurance
   5. Field Office

F. Sum of values listed shall equal total Contract Price.

PART 2 PRODUCTS AND MATERIALS  (N/A)
PART 3 CONSTRUCTION METHODS  (N/A)
PART 4 MEASUREMENT AND PAYMENT  (N/A)
END OF SECTION
SECTION 01 31 19

PROJECT MEETINGS

PART 1 GENERAL

1.01 APPLICABLE PROVISIONS

A. Applicable provisions of Division 01 shall govern work of this section.

1.02 APPLICABLE PUBLICATIONS (NONE)

1.03 DESCRIPTION OF WORK

A. Preconstruction Meeting. A Preconstruction Meeting will be scheduled and conducted by the Engineer and shall be attended by representatives of the Owner, Contractor and all subcontractors as deemed required by the Engineer. The purpose of the meeting will be to identify all project participants, review project requirements and specifications, establish the method of making pay requests and other matters that may be deemed necessary to be discussed. At this meeting, the Contractor shall submit the proposed construction schedule for review, consensus by the parties and approval. The Contractor shall also submit a schedule of values for the work to be used as the accounting format for all progress payments.

B. Construction Progress Meetings. Brief weekly meetings, as deemed necessary by the Engineer, will be held and shall be attended by all Contractors. The purpose of the meeting will be to coordinate work schedules, review the project progress and other matters that may be deemed necessary to be discussed.

1. A construction progress meeting agenda shall be prepared as deemed necessary to the Engineer.

2. All construction progress meeting attendees shall be fully prepared prior to the meeting and shall be ready to discuss issues raised as they relate to their work. This shall include, but not be limited to, providing revised schedules, milestone activities, specific requirements for subordinate construction and any proposed or completed changes required for their work.

1.04 RELATED WORK ELSEWHERE

A. Procurement and Contracting Requirements - Division 00 (All Sections)

1.05 SUBMITTALS (NONE)

1.06 OPERATION/MAINTENANCE MANUALS AND INSTRUCTIONS (NONE)

PART 2 PRODUCTS AND MATERIALS (N/A)

PART 3 CONSTRUCTION METHODS (N/A)

PART 4 MEASUREMENT AND PAYMENT (N/A)

END OF SECTION
PART 1 GENERAL

1.01 APPLICABLE PROVISIONS

A. Applicable provisions of Division 01 shall govern work of this section.

1.02 APPLICABLE PUBLICATIONS (NONE)

1.03 DESCRIPTION OF WORK

A. The work under this section shall cover furnishing submittal information as required by the contract drawings, other specification sections and as specified herein.

1.04 RELATED WORK ELSEWHERE

A. Procurement and Contracting Requirements - Division 00 (All Sections)

B. Submittal Log - Section 01 33 23

1.05 SUBMITTALS

A. As soon as possible after Notice to Proceed, submit brochures of catalog cuts and specifications for all new equipment. Submittal of product data shall comply with the requirements for Submittals.

B. Prior to fabrication or installation, submit Submittals for review. Each submittal shall consist of the minimum number of copies as listed on the submittal log. Two will be returned to the Contractor. Should more than two copies of reviewed Submittals be necessary for Contractor’s use and distribution, the Contractor shall supply additional sufficient number of Submittals for review as required.

C. Submittals shall include layout details, schedules, setting instructions, and manufacturer’s literature. Concrete reinforcing steel Submittals shall include a concrete pouring sequence for structures with vertical construction joints.
   1. Submittals shall be identified with the name of the project, numbered consecutively and bear the stamp of review of the Contractor as evidence that all drawings have been checked by the Contractor for accuracy and compatibility with contract requirements. Drawings not so checked and noted will be returned without being examined.
   2. Partial lists will not be considered; Submittals for each part of work shall be complete in one submittal.

D. If information on previously submitted Submittals is altered, in addition to the notations made by the Engineer, the Contractor shall bring all changes to the
attention of the Engineer. Corrections or changes indicated on reviewed Submittals shall not be considered an order for extra work.

E. Submittals will not be considered reviewed unless they bear the stamp of review and signature of the Engineer. Drawings will be reviewed for general design only. Dimensions and fit of units of various parts shall be the Contractor’s responsibility.

F. Prior to work at the site, submit samples allowing reasonable time for review and testing. Submit samples in sufficient quantity (minimum of five), of adequate size showing quality, type, color range, finish and texture. Label each sample stating material, description, applicable specification sections, intended use, project name, and Contractor’s name.

G. Order no materials subject to sample review until receipt of written shop drawing review. Materials installed shall match reviewed samples. No review of samples shall be taken in itself to change or modify contract requirements beyond the expressed stipulations of the review letter.

H. All Submittals for major equipment must be reviewed and delivery dates scheduled prior to performing any work at the site. A revised work schedule shall be submitted weekly showing corrected delivery dates.

1.06 OPERATION/MAINTENANCE MANUALS AND INSTRUCTIONS

A. Prior to start up of the equipment, the Contractor shall provide the Engineer with operation and maintenance manuals as listed on the submittal log. The manuals shall include the following:

1. Supplier and manufacturer’s name, address, telephone number, and local representative’s name, address and telephone number. Sources of service and parts and a list of local repair services, supply houses, and potential sources for the types of repairs and equipment parts.

2. Complete and accurate set of record drawings including drawing dimensions, schematics of hydraulics, wiring, and piping.

3. Warranties and bonds shall be included in manual.

4. Catalog literature complete with test data and performance data and ratings.

5. Specify equipment function, normal operating, and limiting conditions.

6. Assembly, installation, alignment, adjusting, and checking instructions.

7. Operating instructions for start-up, shutdown, routine and normal operation.

8. Emergency operating instructions indicating range and flexibility during emergencies.

9. Detailed service information including schedule of recommended maintenance.

10. Troubleshooting, common operating problems, problems that might occur in unit/process. List probable causes and discuss control/prevention.

11. Detailed safety section covering the operation and maintenance of unit. Contractor shall supply a complete list of equipment service numbers, model numbers, electrical requirements, manufacturer’s names, etc.
12. The correct model number shall be designated where the literature covers more than one model.

13. For items assembled by the Contractor, the Contractor shall write and provide duplicate operation and maintenance instructions.

14. Data shall be folded to 8-1/2 inch x 11 inch size and placed into hard cover binders. Material shall be grouped according to specifications section and filed behind individual filing tab pages on which the following is to be typed: Item, Manufacturer, Contractor’s Order Number, Supplier’s Order Number, Manufacturer’s Order Number.

15. Manuals shall be delivered to the Engineer for approval prior to job completion.

1.07 PERMITS AND APPROVALS

A. Obtain and submit copies of all permits, code inspections, and approval documents, as specified.

1.08 CONSTRUCTION SCHEDULE

A. Submit a minimum of five copies of a schedule of operation prior to construction. The schedule shall provide for activities of the various trades and shall be sequenced to provide a minimum of interruption to the operation of existing facilities. Allow ample time for the Owner to alter operations as required by the construction of the various components of the work. Revised and updated construction schedule shall be provided throughout the construction as deemed necessary and requested by the Engineer.

B. The construction schedule shall be supplemented by a list of Submittals, dates they will be submitted for approval and a reasonable time allowance for review.

1.09 START-UP REPORTS

A. Where equipment startup by a factory-trained representative is required, a minimum of three copies of the start-up report shall be submitted which describe the representatives activities and installation approval.

1. Start-up report shall be a typewritten document containing descriptive information specifically identifying the piece by equipment, all tests conducted, and the results of the tests.

2. Start-up role log, with the dated signatures of those conducting and accepting all start-up instructions and tests shall be provided as part of the report.

B. Substantial completion will not be issued until all start-up reports have been submitted.
1.10 RECORD DRAWINGS

A. The Engineer will provide the Contractor with a suitable set of contract drawings on which daily records of changes and deviations from contract shall be recorded. All buried or concealed piping, conduit, or similar items shall be located by dimensions and elevations on the record drawings.

1. The daily record of changes shall be the responsibility of Contractor’s field superintendent. No arbitrary mark-ups will be permitted.

2. At completion of the project, the Contractor shall submit the marked-up record drawings to the Owner.

1.11 SUBMITTAL LOG

A. A submittal log is included as Section 01 33 23 of this Project Manual, which lists the minimum required Submittals, product data, samples, and operation and maintenance manuals. Additional submittals not listed on the log may be required by the Engineer during the course of construction. All submittals to the Engineer shall include the submittal number shown on the log. The minimum number of copies to be submitted is shown on the submittal log. Any additional copies required by the Contractor may be submitted in addition to the number shown on the log.

PART 2 PRODUCTS AND MATERIALS (N/A)

PART 3 CONSTRUCTION METHODS (N/A)

PART 4 MEASUREMENT AND PAYMENT

4.01 GENERAL

A. Submittals shall be paid for at the bid price in accordance with one of the following methods, unless indicated otherwise in the Bid Schedule or Special Procedures - Division 01.

B. All work specified herein shall be considered in each of the measurement and payment method(s) stipulated, unless indicated otherwise in the Bid Schedule or Special Procedures - Division 01.

4.02 SUBMITTALS

A. Submittals, Inclusive. The cost for all submittals shall be considered inclusive to payment for work related to the respective equipment, associated construction, or utility, unless indicated otherwise in the Bid Schedule or Special Procedures - Division 01.
SECTION 01 45 00

QUALITY CONTROL

PART 1 GENERAL

1.01 APPLICABLE PROVISIONS

A. Applicable provisions of Division 01 shall govern work of this section.

1.02 APPLICABLE PUBLICATIONS (NONE)

1.03 DESCRIPTION OF WORK

A. Provide quality control for all work performed under this contract as described in this section.

1.04 RELATED WORK ELSEWHERE

A. Procurement and Contracting Requirements - Division 00 (All Sections)
B. Submittals - Division 01
C. Material and Equipment - Division 01

1.05 SUBMITTALS (NONE)

1.06 OPERATION/MAINTENANCE MANUALS AND INSTRUCTIONS (NONE)

1.07 QUALITY ASSURANCE

A. Monitor quality control over suppliers, manufacturers, products, services, site conditions, and workmanship, to produce work of specified quality.
B. Comply with manufacturers’ instructions, including each step in sequence.
C. Should manufacturers’ instructions conflict with Contract Documents, request clarification from Engineer before proceeding.
D. Comply with specified standards as minimum quality for the Work except where more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship.
E. Perform work by persons qualified to produce workmanship of specified quality.
F. Secure products in place with positive anchorage devices designed and sized to withstand stresses, vibration, physical distortion, or disfigurement.
1.08 TOLERANCES

A. Monitor tolerance control of installed products to produce acceptable work. Do not permit tolerances to accumulate.

B. Comply with manufacturers’ tolerances. Should manufacturers’ tolerances conflict with Contract Documents, request clarification from Engineer before proceeding.

C. Adjust products to appropriate dimensions; position before securing products in place.

1.09 REFERENCES

A. For products or workmanship specified by association, trade, or other consensus standards, comply with requirements of the standard, except when more rigid requirements are specified or are required by applicable codes.

B. Conform to reference standard by date of issue current on date of Contract Documents, except where a specific date is established by code.

C. Obtain copies of standards where required by product specification sections.

D. The contractual relationship, duties, and responsibilities of the parties in Contract nor those of the Engineer shall not be altered from the Contract Documents by mention or inference otherwise in any reference document.

1.10 MOCK-UP

A. Tests will be performed under provisions identified in this section and identified in the respective product specification sections.

B. Assemble and erect specified items with specified attachment and anchorage devices, flashings, seals, and finishes.

C. Accepted mock-ups are representative of the quality required for the work.

D. Where mock-up has been accepted by Engineer and is specified in product specification sections to be removed; remove mock-up and clear area when directed to do so.

1.11 INSPECTING AND TESTING LABORATORY SERVICES

A. Contractor shall be responsible for concrete testing as outlined in Division 03 of these specifications. For other testing, Owner will appoint, contract, and pay for the services of an independent firm to perform inspecting and testing.
B. The independent firm will perform inspections, tests, and other services specified in individual specification sections and as required by the Engineer or the Owner.

C. Inspecting, testing, and source quality control may occur on or off the project site. Perform off-site inspecting or testing as required by the Engineer or the Owner.

D. Reports will be submitted by the independent firm to the Engineer indicating observations and results of tests and indicating compliance or non-compliance with Contract Documents.

E. Cooperate with independent firm; furnish samples of materials, design mix, equipment, tools, storage, safe access, and assistance by incidental labor as requested.
   1. Notify Engineer and independent firm 24 hours prior to expected time for operations requiring services.
   2. Make arrangements with independent firm and pay for additional samples and tests required for Contractor’s use.

F. Testing or inspecting does not relieve Contractor from the responsibility to perform Work to contract requirements.

G. Retesting required because of non-conformance to specified requirements shall be performed by the same independent firm on instructions by the Engineer. Payment for retesting will be charged to the Contractor by deducting inspecting or testing charges from the Contract Sum/Price.

1.12 MANUFACTURERS’ FIELD SERVICES AND REPORTS

A. When specified in individual specification sections, require material or product suppliers or manufacturers to provide qualified staff personnel to observe site conditions, conditions of surfaces and installation, quality of workmanship, start-up of equipment, and test, adjust and balance of equipment as applicable, and to initiate instructions when necessary.

B. Report observations and site decisions or instructions given to applicators or installers that are supplemental or contrary to manufacturers’ written instructions.

C. Submit report within 30 days of observation to Engineer for information.

PART 2 PRODUCTS AND MATERIALS (N/A)

PART 3 CONSTRUCTION METHODS (N/A)

PART 4 MEASUREMENT AND PAYMENT (N/A)

END OF SECTION
SECTION 02 41 16.23

DEMOlITION – EXISTING COMMUNICATIONS TOWER

PART 1 GENERAL

1.01 APPLICABLE PROVISIONS

A. Applicable provisions of Division 01 and Special Provisions shall govern work of this section.

1.02 APPLICABLE PUBLICATIONS

A. The following publications of the issues listed below, but referred to thereafter by basic designation only, form a part of this specification to the extent indicated by the reference thereto.

1. Code of Federal Regulations (CFR), Title 29, Chapter XVII - Occupational Safety and Health Administration (OSHA), Department of Labor, Part 1926 Regulations:


1.03 DESCRIPTION OF WORK

A. The work under this section shall cover the demolition of the existing communications tower, guy wires, concrete foundations, guy wire anchors, and existing telemetry buildings. The existing communications tower is approximately 140 feet tall.

B. The existing communications tower will not be demolished before the new communications tower is ready for operation. Operations must be transferred from the existing tower to the new tower with as little service interruption as possible prior to demolition of the existing communications tower. Contractor will coordinate with the City for planned communication service disruption, such as but not limited to transferring service from the existing tower to the new tower.

C. The existing antenna equipment on the existing communications tower will be retained by the City.

D. It will be the Contractor’s responsibility to obtain and pay for any permits required.

1.04 RELATED WORK ELSEWHERE

A. Procurement and Contracting Requirements – City of Duluth, Special Provisions
B. Submittals - Division 01

C. Sequencing and Scheduling – Special Provisions


E. Trenching and Backfilling – Special Provisions

F. Seeding and Sodding – Special Provisions

1.05 SUBMITTALS

A. Provide a detailed sequence of operation for demolition and removal work in accordance with Submittals - Division 01 of these specifications to ensure the minimum interruptions of the Owner’s operations.

1.06 OPERATION/MAINTENANCE MANUALS AND INSTRUCTIONS (NONE)

PART 2 PRODUCTS AND MATERIALS

2.01 EXPLOSIVES

A. The use of explosives will not be permitted.

PART 3 CONSTRUCTION METHODS

3.01 GENERAL

A. All demolition work shall comply with the State of Minnesota, Department of Transportation, Standard Specifications for Construction, Current Edition and with Subsection 1926, Subparts N, P, T and U of the Code of Federal Regulations, Title 29, Chapter XVII - Occupation Safety and Health Administration, Department of Labor.

3.02 PROTECTION OF UTILITIES

A. Before commencing demolition work, preserve in operating condition active utilities traversing the project site; protect property, including but not limited to mains, manholes, catch basins, valve boxes, poles, guys and other appurtenances.

3.03 TRAFFIC

A. Conduct demolition operations and the removal of debris to ensure minimum interference with roads, streets, walks, and other adjacent occupied or used facilities. Do not close or obstruct streets, walks or other occupied or used facilities without permission from authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by governing regulations.
3.04 PROTECTIONS

A. Provide barricades to ensure the public safety. Conduct operations to prevent damage by falling debris or other cause to adjacent buildings, structures, and other facilities as well as persons. Provide interior and exterior shoring, bracing, or support to prevent movement or settlement or collapse of structures to be demolished and adjacent facilities to remain. Excavations, shorings and barricades shall with the requirements of the Code of Federal Regulations (CFR), Title 29, Chapter XVII - Occupational Safety and Health Administration (OSHA), Department of Labor, Part 1926.

3.05 DAMAGES

A. Promptly repair damages caused to adjacent facilities by demolition operations, as directed by the Engineer and at no cost to the Owner.

3.06 EXISTING CONDITIONS

A. The Owner assumes no responsibility for the actual condition of the tower to be demolished.

3.07 DEMOLITION, GENERAL

A. Proceed with demolition in accordance with approved sequence of operations. Provide controls as practicable to confine dust and dirt in the immediate area of demolition.

3.08 BELOW GRADE DEMOLITION

A. Demolish all abandoned structures to a depth of not less than 24 inches below the existing ground surface. In addition, demolish and remove all below grade wood, metal and floor construction.

3.09 DISPOSAL OF DEMOLISHED MATERIALS

A. Remove from the site all debris, rubbish, and other materials resulting from demolition operations. Items of salvageable value shall become the property of the Contractor. Storage or sale of items of salvageable value on the site will not be permitted. Debris, rubbish, and other materials must be transported from the site as they are removed.

3.10 RESTORATION

A. The site shall be restored to the existing grades and conditions after the demolition is complete.
   1. All disturbed turf areas shall be restored with similar materials and to a condition equal to or better than previously existed. Refer to Special provisions.
2. Any pavement or sidewalk disturbed shall be replaced with similar construction equal to or better than the items removed.

B. Temporary erosion control measures shall be provided by the Contractor in accordance with SWPP.

PART 4 MEASUREMENT AND PAYMENT

4.01 GENERAL

A. Demolition – Existing Communications Tower shall be paid for at the bid price in accordance with one of the following methods, unless indicated otherwise in the Bid Schedule or Special Procedures - Division 01.

B. All work specified herein shall be considered in each of the measurement and payment method(s) stipulated, unless indicated otherwise in the Bid Schedule or Special Procedures - Division 01.

1. Demolition – Existing Communications Tower, Lump Sum. Payment shall be made at the contract lump sum price bid for all work relating to demolition of the Existing Communications Tower and Telemetry Building.

END OF SECTION
SECTION 03 11 13

STRUCTURAL CAST-IN-PLACE CONCRETE FORMING

PART 1  GENERAL

1.01  APPLICABLE PROVISIONS

A. Applicable provisions of Division 01 shall govern work of this section.

1.02  APPLICABLE PUBLICATIONS

A. The following publications of the issues listed below, but referred to thereafter by basic designation only, form a part of this specification to the extent indicated by the reference thereto.

1. American Concrete Institute (ACI) Annual Book of ACI Standards:
   b. ACI 301 - Specifications for Structural Concrete, Current Edition.
   d. ACI 311.4R - Guide for Concrete Inspection, Current Edition.
   e. ACI 318 - Building Code Requirements for Structural Concrete, Current Edition.
   g. ACI ASCC-1(05) - The Contractor’s Guide to Quality Concrete Construction, Third Edition.
   h. ACI SCM-24 - Concrete Repair Basics, Current Edition.
   i. ACI SP-4 - Formwork for Concrete, Current Edition.

2. American Plywood Association (APA) Specifications and Standards:

1.03  DESCRIPTION OF WORK

A. The work covered under this section shall consist of furnishing all materials, equipment and labor required to furnish all formwork for cast-in-place concrete as shown on the contract drawings and specified herein.

B. The work shall include formwork, shoring for cast-in-place concrete, and installation into formwork of items by other such as anchor bolts, setting plates, bearing plates, anchorages, inserts, frames, nosings and other items to be embedded in concrete.
1.04 RELATED WORK ELSEWHERE

A. Procurement and Contracting Requirements - Division 00 (All Sections)
B. Concrete Accessories - Division 03
C. Concrete Reinforcing - Division 03
D. Cast-in-Place Concrete - Division 03
E. Joint Sealers – Division 07

1.05 SUBMITTALS (NONE)

1.06 OPERATION/MAINTENANCE MANUALS AND INSTRUCTIONS (NONE)

PART 2 PRODUCTS AND MATERIALS

2.01 DESIGN

A. The design and engineering of the formwork and its accessories shall be the responsibility of the Contractor. Formwork shall be designed, erected, supported, braced and maintained so as to safely support all vertical and lateral loads until such loads can be supported by the concrete structure.

B. Determination of loads and design shall be in accordance with ACI 301 and ACI 347.

2.02 FORMS

A. Forms may be wood, plywood, concrete-form-grade hardboard, metal or other acceptable material which will produce smooth, true surfaces.
   1. Provide lumber dressed on at least two edges and one side for tight fit.
   2. Metal forms shall have smooth surfaces free from any pattern, irregularities, dents, bends and sags.

2.03 SHORING

A. All shoring members shall be of such design and material to safely support all dead and working loads throughout the placing and curing period. Shoring shall be placed to prevent sagging and settlement.

2.04 FORM TIES AND ACCESSORIES

A. Form ties shall be factory-fabricated, adjustable-length, removable or snapoff metal, designed to prevent form deflection, and to prevent spalling concrete surfaces upon removal.
B. For exposed concrete surfaces, provide ties so that the portion remaining with the concrete after removal is 1 inch to 1-1/2 inches inside the finished face of the concrete.

C. Unless otherwise indicated, provide form ties which will not leave holes larger than 1 inch in diameter in concrete surfaces.

2.05 FORM COATING COMPOUND

A. Form coating compound shall be a commercial formulation that will not bond with, stain, nor adversely affect concrete surfaces and not impede the wetting of surfaces to be cured with water or curing compounds. Forms for concrete surfaces requiring subsequent treatment shall receive a type of coating that will not impair bond or adhesion.

B. Form coating compound for steel forms shall conform with all requirements stated above and shall be of rust-preventative type.

PART 3 CONSTRUCTION METHODS

3.01 GENERAL

A. Responsibility. The design and construction of formwork shall be the sole responsibility of the Contractor.

B. Earth forms are not acceptable or permitted.

C. Construct forms to the exact sizes, shapes, lines and dimensions shown, as required to obtain accurate alignment, location, grades, level and plumb in finished construction and to maintain tolerances in accordance with ACI 301. Provide for openings, offsets, sinkages, keyways, recesses, moldings, rustications, reglets, chamfers, blocking, screeds, bulkheads, anchorages and inserts, and other features required. Chamfer all corners of concrete exposed to view using chamfer strips. Use selected materials to obtain required finishes.

D. Forms shall be sufficiently tight to prevent leakage of concrete. Temporary openings shall be provided in the inside form of all wall forms and in column forms to facilitate cleaning and inspection immediately before placing concrete.

E. Assemble forms so their removal will not damage concrete and adjacent materials.

3.02 FORMWORK

A. Forms shall conform in general to shape, line, grade and dimensions of members as shown on contract drawings, and shall have the strength and stability to insure finished concrete within the tolerances specified in ACI 347.
1. Provide openings in concrete formwork to accommodate work of other trades. Determine size and location of openings, recesses and chases from those other trades.

2. Exterior edges of all exposed concrete, unless otherwise specified, shall have a chamfer strip placed in form to provide bevel of sharp edges. Chamfer strips shall be 3/4-inch by 3/4-inch by 45° wood, plastic, or rubber.

3. Accurately place and secure in position, prior to placing concrete, all anchors, bolts, inserts and other items furnished under other sections of the specifications and for other contractors on the project.

B. Formwork shall be mortar-tight and sufficiently rigid to prevent displacement or sagging between supports.

C. Formwork shall be properly braced or tied together so as to maintain position and shape and insure safety to workman and passersby.

D. Temporary openings may be provided on all wall and column forms to limit the free fall of the concrete to less than 4 feet and should be so located as to facilitate the placing and consolidation of the concrete. The ports shall be spaced no more than 6 feet apart to limit the horizontal flow of concrete.

E. All forms shall be cleaned and rubbed smooth prior to placing to insure true forming surfaces for all concrete surfaces.

3.03 FORM TIES AND ACCESSORIES

A. Internal wall ties shall contain positive stops at the required wall thickness. The exterior clamp portions of the pipe shall be adjustable to permit tightening of forms. Ties shall provide a positive disconnection 1 inch to 1-1/2 inches inside the finished face of the concrete. Cutting ties back from face of wall or use of wire ties will not be permitted. All tie and plug holes shall be filled with non-shrink grout after forms are removed.

B. All concrete tie locations shall be watertight. Wall ties shall be fitted with tapered rubber plugs at all locations specified under Special Procedures - Division 01.

C. Accessories shall be used only for the purpose intended and shall in no way interfere with the placing of concrete. Removal of accessories shall in no way impair or disturb finish concrete surfaces. Accessories shall be compatible with formwork and ties and shall maintain the watertight integrity of the formwork system.

D. Design of all form ties and accessories shall be adequate for all concrete placement, horizontal and vertical, to prevent failures and blowouts.
3.04 FORM COATINGS

A. Coat form contact surfaces with form bond breaker compound before reinforcement is placed. Do not allow excess form coating material to accumulate in the forms or to come into contact with surfaces against which fresh concrete will be placed. Apply in compliance with manufacturer’s instructions.

B. Coat steel forms with form oil or otherwise protect against rusting. Rust-stained steel formwork is not acceptable.

C. Clean reinforcing steel that has become contaminated with form coating to the satisfaction of the Engineer prior to placing concrete.

3.05 EMBEDDED ITEMS

A. Items embedded in concrete shall be properly cleaned to be free from oil or foreign matter that would weaken the bond of the concrete to these items.

B. Install in the formwork requisite inserts, anchors, sleeves and other items specified under other sections of these specifications; close end conduits, piping and sleeves embedded in concrete with caps or plugs.

C. Conduits or pipes embedded in slabs of larger outside diameter than 1-1/2 inches, or when pipes and conduits come closer than 1 inch from either the upper or lower surface of the slab, provide expanded metal or wire mesh laid and extended beyond conduit or piping at least 8 inches on all sides; space conduits or pipes closer than 3 diameters on centers, place to avoid changing locations of reinforcement for indicated locations.

3.06 CONSTRUCTION JOINTS

A. Make construction joints where indicated on the contract drawings; additional construction joints are subject to prior approval of the Engineer; locate additional construction joints to least impair the strength of the structure.

B. Form keyways and joints as indicated on the contract drawings.

C. Continue reinforcing steel and wire fabric across construction joints, unless noted otherwise.

D. Install premolded joint filler at locations indicated on the contract drawings; extend filler from bottom of concrete; joints shall be carefully cleaned, free from dust, mortar or other loose materials before installation; seal as indicated on the contract drawings.

E. Make splices in premolded filler in manner to preclude penetration of concrete between joint faces.
3.07 EXPANSION JOINTS

A. Expansion joints shall be placed where indicated on the contract drawings; reinforcement, corner protection angles or other fixed metal items embedded in or bound to continuously shall not extend through expansion joints; finish concrete slab edges along expansion joints neatly with slightly rounded edging tool; leave joints in the completed work carefully tooled and free of mortar and concrete.

B. Joints between slabs on earth and vertical surfaces, including columns, piers, walls, machinery foundation and other fixed structures shall have expansion joint material placed on abutting vertical surfaces.

C. Joints to receive joint compound shall have premolded expansion filler strips at proper level placed below finished floor with slightly tapered, dressed, oiled wood strip secured temporarily to top thereof; install wood strip of depth to form groove at least 1 inch deep; after concrete has set, remove strip; fill groove with light colored joint compound for poured application; fill joint grooves flush, to be slightly concave, after drying as specified in Joint Sealers - Division 07.

3.08 CONTROL JOINTS

A. Install vertical control joints as indicated on the contract drawings, and where not indicated not more than 20 feet apart; locate specifically as follows:

1. Align with window jambs or at center of window openings; place not over 10 feet from corners or offsets; where concrete walls change either thickness or height; where change in wall sections occurs.
2. At each control joint, extend only alternate horizontal reinforcement bars through the joint; seal control joints with concrete colored joint compound.

B. Install control (contraction) joints in slabs as indicated on the contract drawings, and where not indicated locate specifically as follows:

1. Space at a minimum of 25 feet on center; locate at column spacings where practical; at each joint, cut reinforcing mesh so only alternate wires extend through joint.
2. If column spacing exceeds 25 feet on center, provide intermediate joints as well; resulting panels shall be approximately square; elongated and L-shaped panels shall not be acceptable.
3. Provide 1/4 inch wide saw - cut control joints to a depth equivalent to 1/3 the slab thickness; cut as soon as the slab will support the weight of the saw and operator and not damage the surface and not more than 8 hours after completion of concrete placement.

C. Apply joint compound to all control and construction joints after concrete has sufficiently cured; clean joint slot; fill joint with light colored compound for poured application; fill joint grooves flush, to be slightly concave after drying, as specified in Joint Sealers - Division 07.
3.09 WATERSTOPS

A. Install waterstops of the sizes and shapes indicated on the contract drawings; support and protect that portion of the waterstop which extends beyond the bulkhead during placing of concrete and subsequent removal of forms.
   1. Continuous at construction and expansion joints.
   2. Material, size and shape as indicated on the contract drawings and in Concrete Accessories - Division 03.

B. Make field splices by heat-sealing, maintaining the continuity of the ribs and bulbs, and allow the splice to cool before stressing; field splice must be watertight; repair damaged waterstops.

3.10 FORM/SHORING REMOVAL

A. Arrange forms to allow stripping without removal of principal shores, where required to remain in place.

B. Removal of forms shall be accomplished in such a manner as will prevent injury to concrete and insure complete safety of structure. Removal times listed below are minimum and may be increased by the Engineer as job conditions warrant.
   1. Where structure as a whole is supported on shores, vertical forms such as beam and girder sides, columns, and similar vertical forms may be removed 24 hours after completion of pour, providing concrete has hardened sufficiently to sustain its own weight and to prevent injury.
   2. Wall forms shall not be removed in less than 24 hours after pouring, unless otherwise required for curing.
   3. Supporting forms and shoring must remain in place until concrete can carry any loads to be imposed upon it and in no case shall be removed in less than seven (7) days.
   4. Forms ties, requiring any operation in removal of forms which would tend to destroy bond between tie and concrete in order to remove form, shall not be disturbed for seven (7) days after completion of pour.
   5. The time periods stipulated above may be reduced if strength results of concrete so indicate adequate conditions.

C. Notify the Engineer before the forms are removed in order that an examination of the newly-stripped surfaces may be made prior to patching.

3.11 REPAIR TIE HOLES

A. After removal of form tie, the holes shall be filled as follows:
   1. Thoroughly clean and dampen.
   2. Fill solid with patching mortar.

B. Make repairs uniform in color and finish with surrounding concrete.
3.12 EXPOSED SURFACES

A. Exposed surfaces shall be Carborundum rubbed to take off fins; fill pores, stone pickets, honeycombs, etc., with non shrink grout as follows:
   1. Repair immediately after form removal and inspection by the Engineer.
   2. Remove concrete surrounding defect to sound concrete, then wet affected area.
   3. Brush on bonding agent, mixed and applied in accordance with manufacturer’s recommendations.
   4. Consolidate patch grout and strike off to leave the patch slightly higher than the surrounding surface.
   5. Finish the repaired area flush with the surrounding area after the patch has been in place for one hour, or as prescribed by the manufacturer.

B. Perform patching before curing compound is applied; cure patched areas in the same manner as adjacent concrete; make repairs uniform in color and finish with surrounding concrete.

C. Exposed surfaces shall be protected from excessive sun, wind and rain, and kept wet until curing compound is applied. When ambient temperature falls below 40ºF heat aggregate and mixing water; clear all forms, reinforcement and subgrade of snow and ice; cover all freshly placed concrete with tarpaulins, and provide heat to maintain a temperature of 70ºF for at least three days or 50ºF for five days; rate of cooling after end of protection period shall be accomplished in a manner approved by the Engineer.

3.13 REUSE OF FORMS

A. Clean and repair surfaces of forms to be re-used in the work. Split, frayed, delaminated or otherwise damaged form facing material will not be acceptable. Apply new form coating compound material to concrete contact surfaces as specified for the new formwork.

B. When forms are extended for successive concrete placement, thoroughly clean surfaces, remove fins and laitance, and tighten forms to close all joints. Align and secure joints to avoid offsets.

C. Do not use “patched” forms for concrete surfaces exposed to view.

PART 4 MEASUREMENT AND PAYMENT

4.01 GENERAL

A. Structural cast-in-place concrete forming shall be paid for at the bid price in accordance with one of the following methods, unless indicated otherwise in the Bid Schedule or Special Procedures - Division 01.
B. All work specified herein shall be considered in each of the measurement and payment method(s) stipulated, unless indicated otherwise in the Bid Schedule or Special Procedures - Division 01.

4.02 STRUCTURAL CAST-IN-PLACE CONCRETE FORMING

A. Structural Cast-in-Place Concrete Forming, Inclusive. When no quantity is provided, structural cast-in-place concrete forming shall be considered inclusive to payment for work associated with cast-in-place concrete.

END OF SECTION
SECTION 03 20 00

CONCRETE REINFORCING

PART 1 GENERAL

1.01 APPLICABLE PROVISIONS

A. Applicable provisions of Division 01 shall govern work of this section.

1.02 APPLICABLE PUBLICATIONS

A. The following publications of the issues listed below, but referred to thereafter by basic designation only, form a part of this specification to the extent indicated by the reference thereto.

1. American Concrete Institute (ACI) Specifications and Standards:


3. American Welding Society (AWS), Specifications and Standards:

4. American Association of State Highway Transportation Officials (AASHTO), Specifications and Standards:
   a. AASHTO M182 - Specification for Burlap Cloth Made from Jute or Kenaf, Current Edition

5. Concrete Reinforcing Steel Institute (CRSI) Specifications and Standards:
   b. CRSI - Recommended Practice for Placing Reinforcing Bars, Current Edition.
   d. CRSI - Recommended Practice for Reinforcing Bar Splices, Current Edition.
1.03 DESCRIPTION OF WORK

A. The work under this section shall cover furnishing and installing concrete reinforcing as shown on the contract drawings and as specified herein.

1.04 RELATED WORK ELSEWHERE

A. Procurement and Contracting Requirements - Division 00 (All Sections)
B. Concrete Accessories - Division 03
C. Cast-in-Place Concrete - Division 03

1.05 SUBMITTALS

A. Contractor shall submit such product literature and catalog cuts of materials to be supplied to relate these materials to the specification. Information shall be in conformance with requirements of Submittals - Division 01 of these specifications.

1. Submit detailed reinforcing drawings prepared in accordance with ACI 315, including bar schedule with bar marks and bends indicated.
2. Comply with CRSI Manual of Standard Practice showing bar schedules, stirrup spacing, diagrams of bent bars and arrangements of concrete reinforcement. Include special reinforcement required at openings through concrete.
3. Verify dimensions and make proper allowance for fitting together work of other trades.

B. Submit a certification attesting that reinforcing steel meets the requirements of ASTM A615, including Supplementary Requirements S1, and that welded steel wire fabric meets the requirements of ASTM A185.

1. Submit certified copies of mill reports, tensile and bend tests for reinforcing steel on projects where the quantity of reinforcing exceeds 15 tons.
2. For information only, submit manufacturer’s data and instruction for proprietary items, including reinforcement and accessories.

1.06 OPERATION/MAINTENANCE MANUALS AND INSTRUCTIONS (NONE)

PART 2 PRODUCTS AND MATERIALS

2.01 REINFORCEMENT

A. Steel Bar Reinforcement. Main reinforcing and stirrups; ASTM A615, Grade 60.

B. Welded Wire Fabric. Welded wire fabric, ASTM A185, 6 x 6 - W1.4/W1.4, unless otherwise specified or indicated on the contract drawings.

C. Steel Tie Wire. Steel tie wire, ASTM A82, plain, cold-drawn, 16 gauge or heavier.
PART 3 CONSTRUCTION METHODS

3.01 FABRICATION

A. Fabricate and place to shapes and dimensions indicated or required to carry out intent of contract drawings and these specifications.

B. Bends for stirrups and ties shall be made around a pin having a diameter not less than four times the diameter of reinforcing bar. Bends for other bars shall be made around a pin having a diameter not less than six times diameter of bar, except that for bars larger than 1 inch, pin shall be not less than eight times diameter of bar.

1. Perform cutting and bending in the shop; bend and cut steel cold. Heating of reinforcement will not be permitted. Do not bend or straighten bars in a manner that will injure the material.

2. Field bending of bars shall not be allowed without the Engineer’s approval.

C. Tagging shall be with metal, linen, or rope fiber tags filled in with machine or waterproof ink. Paper tags shall not be allowed.

D. Reinforcing bars shall conform accurately to the dimensions shown on the contract drawings.

3.02 PRODUCT DELIVERY, STORAGE AND HANDLING

A. For reinforcing steel fabricated on-site, shop from the mill in bundles, limited to one size and length, tagged with a waterproof tag showing the name of the mill, heat number, grade and size of the bars and identifying number.

B. For reinforcing steel fabricated off-site, deliver in bundles identified as to structure and shop drawing number. Identify each individual bar with a waterproof tag showing the grade, size and bar mark from the approved bar schedule.

C. Protect reinforcing steel and wire fabric from damage and from dirt, oil grease, other foreign matter, and rust-causing condition. Do not store reinforcement in direct contact with the ground.
3.03 CLEANING

A. Before placing and before pouring concrete, all reinforcement shall be thoroughly cleaned of all oil, dirt, loose mill scale, loose rust, or foreign matter that will destroy or reduce bond.

3.04 PLACING REINFORCEMENT

A. Placement. Metal reinforcement shall be accurately placed in accordance with approved Submittals and adequately secured in position by concrete or metal chairs or spacers. Nails shall not be driven into forms to support reinforcement nor shall wire ties come in contact with forms.

B. Splicing. Lap at splices shall be sufficient to transfer stress between bars by bond and shear.
   1. Furnish reinforcing bars in full lengths as indicated on the contract drawings and approved Submittals.
   2. Do not splice bars unless indicated on the contract drawings or approved by the Engineer in writing. When authorized, make splices in accordance with ACI 318; perform welding in accordance with AWS D12.1.
   3. Splices generally shall be avoided at points of maximum stress. Minimum splice lap for stressed bars shall be forty times bar diameter.

C. Offsets in longitudinal bars at change of cross section shall be placed in region of lateral support. Slope of inclined portion of offset shall not be more than one in six and, in tied columns, ties shall be spaced not over 3 inches on centers for a distance of 1 foot below actual point of offset.

D. Embedded Items. The Contractor shall provide for the installation of all items embedded in the concrete, such as coil rod inserts, anchor bolts, dowels, etc., as shown on the contract drawings or as provided for in other Divisions of these specifications.
   1. All dowel bars shall be tied securely in place before pouring concrete.
   2. Provide for clearances with appurtenant materials and devices.

E. Drilled and Grouted or Epoxy Dowel Installation. Existing concrete which will be incorporated into new work and requiring integration with new concrete will be doweled as indicated on the contract drawings and as follows:
   1. Drill hole in existing concrete of size that is 3/4 inch larger in diameter than diameter of dowel bar. Incline the hole in the concrete such that the non-shrink grouting or epoxy will be retained in the hole.
   2. Fill hole with non-shrink grouting or epoxy.
   3. Immediately place dowel bar into hole.
   4. Allow grout or epoxy to take initial set before disturbing dowel bar.
F. **Steel Reinforcing Fabric.** Reinforce as detailed on the contract drawings; and where not indicated, reinforce with wire fabric, place 2 inches from the top of the slab.

1. Flat sheets shall be used whenever available. Wire fabric shall lap 6 inches on side joints and 12 inches on end joints. Properly secure with annealed wire. Fabric shall be raised and secured in the correct location using permanent supports. Raising the fabric by hook during placement of concrete shall NOT be permitted.

2. Alternately, in tight quarters and around appurtenances and openings, lap mesh reinforcement not less than one mesh space plus 2 inches, and tie.

G. **Concrete Cover.** The minimum cover of concrete for all reinforcement shall conform to the dimensions indicated on the contract drawings, which indicate the clear distance from the edge and end of the reinforcement to the face of the concrete surface. Provide clearance and spacing indicated on the contract drawings and approved Submittals, where so indicated.

1. Where no clearances are indicated, the thickness of the concrete cover over reinforcement shall be as follows:
   a. Concrete cast against and permanently exposed to earth - 3 inches;
   b. Formed concrete exposed to earth or weather - 2 inches;
   c. Formed concrete not exposed to earth or weather - 1-1/2 inches;
   d. Slabs not exposed to earth or weather - 1 inch.

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PART 4 MEASUREMENT AND PAYMENT

4.01 GENERAL

A. Concrete reinforcing shall be paid for at the bid price in accordance with one of the following methods, unless indicated otherwise in the Bid Schedule or Special Procedures - Division 01.

B. All work specified herein shall be considered in each of the measurement and payment method(s) stipulated, unless indicated otherwise in the Bid Schedule or Special Procedures - Division 01.

4.02 CONCRETE REINFORCING

A. **Concrete Reinforcing, Inclusive.** When no quantity is provided, concrete reinforcing shall be considered inclusive to payment for work associated with cast-in-place concrete.

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END OF SECTION
PART 1 GENERAL

1.01 APPLICABLE PROVISIONS

A. Applicable provisions of Division 01 shall govern work of this section.

1.02 APPLICABLE PUBLICATIONS

A. The following publications of the issues listed below, but referred to thereafter by basic designation only, form a part of this specification to the extent indicated by the reference thereto.

1. American Concrete Institute (ACI), Annual Book of ACI Standards:
   e. ACI 302.1R - Guide for Concrete Floor and Slab Construction, Current Edition.
   g. ACI 305R - Hot Weather Concreting, Current Edition.
   k. ACI 311.4R - Guide for Concrete Inspection, Current Edition.
   m. ACI 530/530.1/530R/530.1R - Building Code Requirements for Commentary for Masonry Structures and Specification for Masonry Structures and Related Commentaries, Current Edition.
   o. ACI CP-10/PACK - Craftsman Study Package for ACI Certification of Concrete Flatwork Technician/Finisher, Current Edition.
   q. ACI SCM-24 - Concrete Repair Basics, Current Edition.
   r. ACI SP4 - Formwork for Concrete, Current Edition.


American Society for Testing and Materials (ASTM), Annual Book of ASTM Standards:

w. ASTM C618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzlan for Use in Concrete, Current Edition.
3. Portland Cement Association (PCA) Standards and Specifications:
a. PCA - Design and Control of Concrete Mixtures, Current Edition.

1.03 DESCRIPTION OF WORK

A. The work covered under this section shall cover furnishing all materials, equipment and labor required to construct all cast-in-place concrete as shown on the contract drawings and as specified.

1.04 RELATED WORK ELSEWHERE

A. Procurement and Contracting Requirements - Division 00 (All Sections)
B. Submittals - Division 01
C. Concrete Quality Control - Division 01
D. Structural Cast-in-Place Concrete Forming - Division 03
E. Concrete Accessories - Division 03
F. Concrete Reinforcing - Division 03

1.05 SUBMITTALS

A. Submit such product literature and catalog cuts of materials to be supplied to relate these materials to the specification. Information shall be in conformance with requirements of Submittals - Division 01 of these specifications.

B. Concrete Design Mix
1. Prior to the start of placing of concrete, submit the design mix for each class of concrete, indicating that the concrete constituents and proportions will result in a concrete mix meeting the physical requirements for each class of concrete specified. Submit with the design mix, laboratory test reports and manufacturer’s certificates attesting the conformance of constituents with these specifications.

2. Do not vary the proportions of the constituents or source of material of the approved mix without submitting corresponding test result documentation to the Engineer for review and approval.

3. Design mix shall indicate proportions of cement, aggregate and water, and names and proportions of admixtures and air-entraining agents.

4. Provide certification that the design mix complies with all ACI and ASTM requirements.

1.06 OPERATION/MAINTENANCE MANUALS AND INSTRUCTIONS (NONE)

PART 2 PRODUCTS AND MATERIALS

2.01 CEMENT

A. Cement shall be Portland Cement ASTM C150 Type I or IA, except as otherwise noted or approved. Type III cement shall only be used for Class L concrete, or when approved by the Engineer.

B. A singular brand and manufacturer of cement shall be used for the entire work.

2.02 FLY ASH

A. Fly ash shall conform to ASTM C618 Class C.

B. A singular source of fly ash shall be used for the entire work.

2.03 SLAG

A. Slag shall be ground granulated blast furnace slag conforming to ASTM C989.

2.04 AGGREGATE

A. Aggregate shall consist of clean, hard durable sand, gravel, crushed gravel or crushed rock.

B. Aggregate shall conform to the requirements of ASTM C33. Fine and coarse aggregate shall meet ASTM C33 grading requirements. Coarse aggregates shall be graded in accordance with ASTM gradations as follows:

1. 3/4 inch maximum coarse aggregate - ASTM No. 67

2. 1-1/2 inch maximum coarse aggregate - ASTM No. 467
C. Maximum aggregate size shall be as defined in the Concrete Schedule, or where not defined in the Concrete Schedule, as defined by dimensional constraints for cast-in-place concrete as follows.

1. Not larger than one-fifth of the narrowest dimension between sides of the forms;
2. Not larger than one-third the thickness of the slab;
3. Not larger than three-fourths of the minimum clear spacing between individual reinforcing bars or wire, bundles of bars, or prestressing tendons or ducts.

2.05 MIXING WATER

A. Mixing water shall be natural or treated water, clean and free from injurious amount of oil, acid, alkali, chlorides and sulfates, other common salts, organic matter or other deleterious substances.

B. Mixing water shall yield cement paste complying with the requirements ASTM C109 and ASTM C191.

2.06 ADMIXTURES

A. All admixtures are subject to the written approval of the Engineer and shall be used in strict accordance with the manufacturer’s recommendations.

1. Air-Entraining Admixture
   a. All concrete exposed to weather and freeze-thaw cycles shall be air-entrained, unless otherwise specified.
   b. Air-Entraining admixture shall conform to ASTM C260.
   c. Air-Entrainment shall be as indicated for each class as in the Concrete Schedule.

2. Water-Reducing, Set-Controlling Admixtures
   a. Water-Reducing, Set-Controlling admixtures shall conform to ASTM C494, Type A for water-reducing, Type C for accelerating, Type D for water-reducing and retarding, and Type E for water-reducing and accelerating.

B. Admixtures containing calcium chloride or soluble chloride shall not be used.

2.07 CURING AND SEALING COMPOUND - INTERIOR

A. Membrane-forming curing compound shall meet the moisture retention requirements of ASTM C309, Type 1. Kure-N-Seal, Sonneborn Division of BASF; Sealtight Seal Cure-309, W.R. Meadows, Inc.; Eucocure, Euclid Chemical Co.; or equal.

B. Shall be compatible with surface finish.
2.08 CURING COMPOUND - EXTERIOR

A. Curing compound shall comply with ASTM C309, Type 2; resin, white pigmented.

PART 3 CONSTRUCTION METHODS

3.01 COORDINATION

A. Examine the drawings and specifications for work of other sections or other contractors and coordinate such work with the requirements of this Section; make provisions for installation of such items as sleeves, pipes, conduits, inserts and hangers in a manner that will not impair or weaken concrete construction.

3.02 READI-MIX CONCRETE

A. Acceptability and Use. Readi-mix concrete shall be designed on the basis of strength, durability, impermeability, and exposure condition, as required for the intended use of the structure by methods specified in ACI 211.1 and ACI 318. All readi-mix concrete shall comply with the water-cement ratio for each specific class of concrete as specified in the Concrete Schedule. Concrete design mix, complete with sample test results shall be submitted to the Engineer for approval prior to placing any concrete.

1. Failure to Meet Strength Requirements. Failure to meet strength requirements shall be as defined in Concrete Quality Control- Division 01 of these specifications.

2. Watertight Concrete. All concrete exposed to earth or water shall be watertight, shall have a water-cement ratio as specified, and shall be air-entrained as specified in the Concrete Schedule.
   a. Construct keyways as indicated on the contract drawings.
   b. Provide damp-proofing membrane as indicated on the contract drawings.

3. Waterproof Concrete. All concrete for water retaining structures shall be waterproof, shall have a water-cement ratio as specified, and shall be air-entrained as specified in the Concrete Schedule.
   a. Construct keyways and waterstops as indicated on the contract drawings.

B. Mix Proportioning. Mix proportioning shall be the responsibility of the Contractor and shall be submitted for review and approval by the Engineer, in accordance with these specifications.

1. Select proportions for concrete to obtain the quality requirements for the class of concrete as specified in the Concrete Schedule. Contractor, at their expense, shall have an approved independent laboratory prepare design mixes for each specified concrete class.

2. Slump. Slump for class of concrete shall be as specified in the Concrete Schedule. The Contractor shall at their expense, make field slump tests in
3. Adjustment to Concrete Mixes. Design mix adjustments may be requested by the Contractor when characteristics of materials, conditions, weather, test results, or other circumstances warrant. Laboratory test data for revised design mixes and strength results shall be submitted and approved before using in the work. No change in contract price will be allowed for these changes.

4. Addition of Water to the Batch. Addition of water to the batch delivered to the site shall be in strict accordance with ASTM C94. This shall be the Contractor’s responsibility and by their direction, following consultation with the Engineer.
   a. Addition of water to the batch shall be one time only. Total gallons of water added to the batch shall be recorded on the load ticket, which shall be supplied to the Engineer prior to that delivery truck leaving the site. If water is permitted to be added to mixed concrete upon arrival at the job, an additional mixing of 30 revolutions of the drum shall be required.
   b. Contractor shall adjust the water-cement ratio of the batch to the corresponding value based on the addition of water to the batch and shall submit this information to the Engineer with adjusted strength data for the final batch proportion.
   c. At no time shall the addition of water cause the water-cement ratio specified in the concrete class schedule to be exceeded.

3.03 GENERAL

A. Unless otherwise specified, conform to ACI 304, 305, and 306 for concrete installation requirements such as preparation, mixing, conveying, depositing, curing, and cold and hot weather requirements; consolidate concrete in accordance with ACI 309.

B. Concrete not placed within 90 minutes or 300 revolutions, whichever occurs first, after the first mixing of the cement and aggregates will be rejected.

C. Contractor shall indicate on record set of Drawings at site, for review prior to installation, a pouring program for concrete work showing unit of operation, method of pouring, installation of construction/control joints, expansion joints and all necessary work.

D. Proper grade marker or stakes shall be used by Contractor to establish grades for ramps, platforms, sidewalks, slopes to drains, inlets, etc.

E. Trenches, forms, conveying equipment shall be prepared to receive concrete in accordance with ACI 304.
F. Place concrete footings upon undistributed clean surfaces, free from frost, ice, mud and water; when foundation is on dry soil or pervious material, lay waterproof sheathing paper over earth surfaces to receive concrete.

G. Rock surfaces upon which concrete is to be placed, make level, clean, free from all objectionable coatings, water, mud, debris, loose semi-detached or unsound fragments; level surfaces to receive sand cushion placed to minimum thickness of 2 inches.

H. Immediately after placement, protect concrete from premature drying, excessively hot or cold temperature and mechanical injury; maintain with minimum moisture loss and relatively constant temperature for the period necessary for hydration of the cement and hardening of the concrete.

I. All freshly cast concrete shall be protected from damaging effects of the elements freezing, rapid drop in temperature and loss of moisture and from future construction operations.

3.04 PREPARATION OF EQUIPMENT AND PLACE OF DEPOSIT

A. Before placement, clean equipment for mixing and transporting the concrete; remove debris and ice from all surfaces upon which concrete is placed; clean reinforcement of dirt, loose rust, and mill scale, or other coatings.

B. Remove water from all areas before depositing concrete; before depositing new concrete on or against concrete that has set, thoroughly roughen; clean existing surfaces of laitance, foreign matter or loose particles; retighten forms; slush existing surfaces with neat cement grout coat; place new concrete before grout has attained initial set; give horizontal construction joints grout brush coat of cement, fine aggregate, in same proportions as concrete to be placed.

C. Thoroughly wet the stone base on which slabs are to be placed where no vapor barrier is indicated.

D. Check compaction of fill and proper grade for slabs-on-grade. Check screeds and exercise care to prevent disturbing screeds during placement. Provide for construction joints in slabs-on-grade at 20 feet maximum in each direction unless shown otherwise on the contract drawings. Place expansion joint material at junctures of slabs-on-grade with vertical walls and as otherwise shown.

E. Remove debris, excess form oil, and water from formwork; avoid washing newly deposited concrete.

3.05 MIXING

A. Ready-mixed concrete shall be mixed and delivered in accordance with ASTM C94 and ACI 304. The production facilities shall comply with the requirements of the
National Ready Mixed Concrete Association Certification Plan as regards materials storage and handling, batching equipment, central mixer, truck mixers, agitators, non-agitating units, ticketing system, etc.

B. Do not over-mix; do not use concrete which is retained in mixers so long as to require additional water in excess of design mix water to permit satisfactory placing; retempering of mix is not permitted.

C. Concrete shall be delivered to the site of the work and the mixed concrete discharged completely within 1-1/2 hours after water has been added to cement. In hot weather, or under conditions contributing to quick stiffening of concrete, this time may be reduced by the Engineer.

D. Concrete delivered shall arrive at the site having a temperature not less than 50 Degrees F nor greater than 85 Degrees F, unless otherwise permitted by the Engineer.

3.06 CONVEYING

A. Convey concrete from the mixer to the final deposit by methods that will prevent segregation or loss of materials.

B. Use of aluminum conveyances is not permitted.

3.07 CONCRETE PLACEMENT

A. Place concrete, including drops greater than 60 inches using recommended practices in accordance with ACI 304 and ACI 318. Once pouring operation commences, it shall be carried out as a continuous operation until a section is completed.

B. Deposit concrete as nearly as practical in its final position to avoid segregation due to rehandling or flowing; do not use vibrators to move concrete horizontally within the forms.

C. Do not use retempered concrete or concrete contaminated by foreign material.

D. Plan and conduct concrete placement to insure that the concrete is kept plastic and that the concrete is free of cold joints.

E. Where there is a time delay greater than 45-minutes between adjacent concrete placement, a bulkhead construction joint, complete with waterstops where required, must be installed.

F. Do not commence placing when the sun, heat, wind or limitations of facilities provided prevent proper finishing or curing.

G. Discontinue concreting when the descending natural air temperature falls lower than 40 Degrees Fahrenheit unless preparations are made and in place to heat or insulate.
concrete in accordance with the cold weather concreting requirements of this specification.

H. Concrete for walls shall be deposited in approximately horizontal layers not to exceed 18 inches in height to avoid segregation due to rehandling and flowing.

I. Concrete shall not be placed or poured in water. Water level shall be removed or lowered in a manner approved by Engineer. Excess water shall not be permitted. Powdering a mixture of cement to absorb excess water shall not be permitted.

J. Concrete shall be placed before initial set has occurred. Placing should be carried on in such manner that the concrete in the form is still plastic and can be integrated with fresh concrete.

K. Contractor shall notify Engineer of concrete pouring schedule one day in advance of pour to allow for inspection of reinforcing and forms.

L. Bottom dump buckets may be used for transporting mixed concrete to the desired location. Particular care shall be taken to avoid jarring or bumping as this may cause segregation.

M. Where chutes are used to transport concrete, they shall be of metal or wood with metal lining and should have a slope not exceeding 1 vertical to 2 horizontal and not less than 1 vertical to 3 horizontal so that the concrete will travel fast enough to keep the chute clean but slow enough to avoid segregation of materials. The end of each chute shall be provided with a baffle to help prevent segregation, or the concrete should be discharged through a tremie or elephant trunk directly into the form.

N. Elephant trunks and/or tremies shall be used in walls and columns to prevent free fall of the concrete and to allow the concrete to be placed through the cage of reinforcing steel.

O. Pumping equipment shall be of suitable type, without Y-sections, and with adequate pumping capacity. Loss of slump in pumping shall not exceed 1-1/2 inches.

3.08 CONSOLIDATION

A. Each concrete layer placed shall be compacted by mechanical internal vibrating equipment supplemented by hand spading, rodding, or tamping.

B. The period of concrete vibration shall not be less than two seconds nor more than five seconds at any one point.

C. Consolidate concrete thoroughly as it is placed in order to secure a dense mass; work concrete well around the reinforcement and embedded items and into the corners of the forms.
D. Use internal vibrators inserted vertically over the entire area of the placement; form vibrators not permitted; internal vibrators shall maintain a minimum of 5000 impulses when submerged in concrete.

E. Vibrate until voids are eliminated, coarse aggregate is suspended in mortar, and entrapped air bubbles begin to rise to the surface; concrete should move back into the space vacated by the vibrator; vibration duration shall be limited only to the time necessary to produce consolidation without causing segregation.

F. Space vibrator insertions such that the area visibly affected by the vibrator overlaps the adjacent just-vibrated area by a few inches.

G. Penetrate at least 6 inches into previously placed layers in order to bond between layers and avoid cold joints.

H. Take care not to over-vibrate air entrained concrete; place vibrator to eliminate honeycombing but avoid excess vibrating that bleeds all entrapped air from the mix.

I. Do not use vibrators to transport concrete.

3.09 JOINTS AND KEYWAYS

A. Construct expansion, control, and isolation joints and keyways only where indicated on the drawings or at additional locations approved by the Engineer (and as shown on the Standard Details).

B. Where the placing of concrete is discontinued, clean off laitance and other objectionable material to a sufficient depth to expose sound concrete as soon as concrete is firm enough to retain its form; smooth the top surface of concrete adjacent to the forms with a trowel to minimize visible joints on exposed faces.

C. Immediately upon completion of the work of placing concrete, remove accumulations splashed upon the reinforcement and the surfaces of the forms; perform this removal before concrete takes its initial set; clean reinforcing steel carefully to prevent damage to the concrete steel bond.

D. Do not halt work within 18 inches of the top of any face.

E. For bonded horizontal joint construction, roughen the surface and expose the aggregate; clean the surface thoroughly by wet sandblasting, by cutting with high-pressure water jet or by other approved methods; perform cleaning after the concrete has hardened to prevent raveling of the surface below the desired depth.

F. Before bonding concrete is placed, clean the surface of loose or soft particles or other objectionable materials and keep wet for a minimum period of 12 hours.

G. Cover the cleaned and saturated surface with a coating of neat cement grout and deposit new concrete before the grout has attained its initial set.
3.10 CURING

A. Concrete shall be wet cured by immersion of moisture-retaining covers in conformance with ACI 308 or shall receive curing compound in accordance with ACI 309.

B. Water curing is the preferred method of protection for curing concrete other than under hot weather conditions; cover exposed surfaces with a saturated material (burlap or cotton mats) and keep wet continuously with a soil soaker hose for 7 curing days for all concrete except high early strength concrete; leave covering in place, without wetting, for an additional 3 days.

C. A curing day is defined as 24-hour day when the concrete surfaces are kept moist and the uniform temperature of the concrete mass is between 55 Degrees Fahrenheit and 75 Degrees Fahrenheit.

D. Curing shall start as soon as free surface water disappears after finishing. Where forms are not removed immediately, curing shall be accomplished in a manner acceptable to the Engineer.

E. Curing compounds may not be used on surfaces that are to receive additional concrete, paint or tile.

F. Curing and sealing compound shall not be applied to steel reinforcing anchors, water stops, construction joints, or surfaces to be bonded to other concrete.

G. When using a curing compound, keep surfaces moist after the forms are removed, and the form tie holes repaired; after the surfaces are finished, apply the curing compound according to the manufacturer’s recommendations; remove forms only as required to advance repair of tie holes and minor defects.

H. Slabs: Immediately following slab finishing, apply liquid membrane-forming curing compound or begin water curing before the surface becomes dry.

I. Vertical Surfaces: When the forms are removed entirely, spray the surface with water and allow it to reach a uniformly damp appearance with no free water on the surface; apply curing compound or begin water curing.

J. For curing concrete under hot weather conditions, see Hot Weather Requirements in this section.

K. For curing concrete under cold weather conditions, see Cold Weather Requirements in this section.

3.11 CONCRETE WALL FINISHES

A. Complete screeding and darbying of top of walls before excess moisture or bleeding water is present on the surface.
B. Do not begin subsequent finishing operations until surface water has disappeared.

C. Refer to Concrete Schedule, included in this specification section, for finish type at each location, defined as follows:

1. Rough Form Finish: (Type W1)
   a. No form facing materials specified.
   b. Patch tie holes and defects.
   c. Chip off fins 1/4 inch or more in height.

2. Smooth Form Finish: (Type W2)
   a. Use a form facing material that will produce a smooth, hard, uniform texture on the concrete.
   b. Keep seams to a practical minimum.
   c. Patch tie holes and defects.
   d. Remove all fins.

3. Smooth Rubbed Finish: (Type W3)
   a. Produce a Smooth Form Finish.
   b. Wet surface and rub with a Carborundum brick until uniform color and texture are produced.
   c. Perform rubbing no later than 24 hours after forms are removed.
   d. Do not use any cement grout other than the paste drawn from the concrete itself by rubbing.
   e. Thoroughly wash the surface with water.

4. Smooth Troweled Finish: (Type W4)
   a. Produce a Smooth Rubbed Finish.
   b. After wet-rubbing, finish with a steel trowel to increase compaction of fines and to provide maximum density.

5. Smooth Finish (Grout Cleaned): (Type W5)
   a. Use for architectural surfaces exposed to general view, unless other indicated.
   b. Mix 1 part portland cement and 1-1/2 parts fine sand with sufficient water to produce grout having consistency of thick paint; use white portland cement in combination with normal portland cement to achieve uniform surface color after drying.
   c. Wet surface of concrete and uniformly apply grout with brush or spray gun completely filling air bubbles; surface with a wood float scouring wall vigorously.
   d. Allow grout to partially set for one to two hours, depending on weather conditions; in hot dry weather, keep damp, using fine fog spray.
   e. When grout has hardened sufficiently to be scraped from wall with edge of steel trowel without removing grout from small air holes, cut off all grout that can be removed with trowel.
   f. Allow surface to dry thoroughly then rub vigorously with dry burlap to completely remove dried grout; there shall be no visible film or grout remaining after this rubbing.
   g. The entire cleaning operation for any area must be completed the day it is started; no grout shall be left on overnight, and sufficient time
shall be allowed for grout to dry after it has been cut with trowel so it can be wiped off clean with burlap.

h. After entire surface has been grout cleaned, wipe off any slightly dark spots or streaks with fine abrasive hone.

3.12 CONCRETE SLAB FINISHING

A. Complete screeding and darbying slabs before excess moisture or bleeding water is present on the surface.

B. Do not begin subsequent finishing operations until surface water has disappeared and the concrete will sustain foot pressure with only approximately 1/4 inch indentation.

C. Refer to Concrete Schedule, included in this specification section, for finish type at each location, defined as follows:

1. Smooth Float Finish: (Type S1)
   a. Consolidate concrete with a power-driven disc-type float or a combination floating-troweling machine with metal float shoes attached.
   b. Machines which have a water attachment for wetting the concrete during the finishing operation are prohibited.
   c. Check and level surface plane to a tolerance not exceeding 1/4 inch in 10 feet when tested with a 10-foot straightedge. Cut down high spots and fill low spots; immediately after re-leveling, refloat surface to a uniform, smooth, granular texture.
   d. Where slab drainage is indicated, take care to maintain accurate slopes for drainage.

2. Steel Troweled Finish: (Type S2)
   a. Produce a Smooth Float Finish.
   b. After float finishing, steel trowel surface as specified in Concrete Schedule to increase the compaction of fines and to provide maximum density and wear resistance.
   c. Steel Troweled Finish: Screed and bull float or darby. Give preliminary float finish, true, even and free from depressions; float surface with hand or machine floats; compact surface with not less than 2 thorough and complete steel troweling operations.
   d. Tolerance on finished steel troweled floors in no instance shall exceed 1/8 inch in 10'-0” on surface; where floor drains occur, slope floors to drains.
   e. Buffing: After concrete floors have been properly cured, buff thoroughly to remove soluble salt incrustation or other foreign substances.

3. Integral Finishes: (Type S3)
   a. Use for slabs where some material other than concrete will be the final wearing surface.
b. Screeded Finish - Place screed blocks at frequent intervals and strike off to surface elevations desired; unless otherwise indicated, use on base slabs upon which grout finish, regular mortar bed ceramic tile, sand cushion terrazzo or similar type wearing surface is applied.

4. Broom Finish: (Type S4)
   a. Draw stiff broom over previous Smooth Float Finish, to obtain non-slip finish.

5. Abrasive Aggregate Non-slip Finish: (Type S5)
   a. Screed and float concrete to the required finish level with no coarse aggregate visible.
   b. Uniformly sprinkle abrasive aggregate over the floated surface at a rate of not less than 1/4-pound per square foot.
   c. Steel trowel surface to a smooth even finish, uniform in texture and appearance and free from blemishes, including trowel marks.
   d. Immediately after curing remove cement coating covering the abrasive aggregate by steel brushing, rubbing with an abrasive stone or sandblasting to expose abrasive particles.

6. Hardener Floor Treatment: (Type S6)
   a. Hardener shall be installed in strict accordance with manufacturer’s printed instructions; experienced workmen shall apply hardener at a minimum of 45 pounds per 100 square feet.

3.13 CONCRETE SIDEWALKS
   A. Concrete sidewalk construction shall be as specified in Concrete Sidewalks, Steps, Driveways and Retaining Walls - Division 32 of these specifications.

3.14 CONCRETE CURB AND GUTTER
   A. Concrete curb and gutter construction shall be as specified in Concrete Curb and Gutter - Division 32 of these specifications.

3.15 CONCRETE WHEEL BUMPER BLOCKS
   A. Shall be reinforced precast concrete, minimum 4000 psi, with air entrainment; maximum height 6 inches; install where indicated on Drawings.

3.16 CONCRETE SPLASH BLOCKS
   A. Reinforced precast concrete splash blocks formed of 4000 psi concrete with air entrained concrete; shall be 2 inches thick x 2’-0” wide x 2’-6” long; front shall be turned up 4 inches for 6 inches overall height; upper corners of turned up lip shall be cut off at 45 Degree angle; wire mesh reinforcing turned up in front lip.
3.17 CONCRETE FILL FOR COMPOSITE FLOOR DECK

A. Fill over composite floor deck shall be lightweight aggregate concrete; no admixtures containing chloride salts or other deleterious materials shall be used; lightweight concrete shall not exceed 100 pcf weight.

3.18 PERIMETER INSULATION

A. Install perimeter insulation at building foundation wall and under floor slab as shown on the contract drawings.

3.19 HOT WEATHER REQUIREMENTS

A. Comply with ACI 305R unless otherwise specified herein below.

B. Hot weather conditions are deemed to exist when the temperature in the forms is 75 Degrees Fahrenheit or above, or a combination of high air temperature, low relative humidity and wind velocity impair the quality of fresh or hardened concrete; take protective measures for mixing, transporting and placing concrete in accordance with ACI 305R.

C. The temperature of the concrete at the place of discharge may not exceed 85 Degrees Fahrenheit.
   1. If ice is used to lower temperature, place crushed, shaved or chipped ice directly into the mixer as part or all of the mixing water; mix until ice is completely melted.
   2. Record the concrete temperature at the time of discharge.

D. Do not add water that will cause the proportions to exceed the maximum water-cement ratio shown in Table I.
   1. Notify the Engineer before adding any water to the concrete mix.
   2. Record the amount of water added to the concrete at the jobsite.

E. Discharge concrete within 45 minutes or 100 revolutions, whichever occurs first, after the first mixing of cement and aggregates.

F. Placing and Curing:
   1. Place concrete promptly upon arrival.
   2. Provide at least one standby vibrator for each 3 vibrators in use.
   3. Protect concrete from direct sunlight; keep forms covered and moist by means of water sprinkling or the application of continuously wetted burlap or cotton mats for a minimum of 24 hours. Windbreaks and/or sunshades shall be provided as directed by the Engineer.
   4. When forms are removed, provide wet cover to the newly exposed surfaces to avoid exposure to hot sun and wind.
   5. Continue specified water curing methods for 10 days; leave covering in place 4 additional days; do not permit alternate wetting and drying cycles.
6. For slabs on grade, beam and deck concrete, and other horizontal placements protect the surface between finishing operations using one or more of the following methods:
   a. Careful use of a fog nozzle.
   b. Spreading and removing polyethylene sheeting between finishing operations.
   c. Application of mono-molecular film after the strike-off.

G. During extremes in weather, floor slabs shall not be cast unless the slab is protected by a roof and other suitable protective measures are provided. After curing has been completed, the floor shall be exposed to the air for 48 hours prior to allowing traffic on the floors.

3.20 COLD WEATHER REQUIREMENTS

A. Comply with ACI 306.1 (R2002) unless otherwise specified herein below.

B. Cold weather is defined any time when the daily temperature is 40 Degrees Fahrenheit or lower during placement and the protection period. If at any time during the progress of the work, the temperature drops below 40 Degrees F., the Contractor shall make suitable provisions to protect the concrete by use of insulation materials such as blankets, mats, etc., and equipment for providing artificial heat.

C. Combustion type temporary heating devices shall be vented outside of any temporary enclosure and building envelope. Combustion gases shall not be allowed in any temporary enclosure and building envelope.

D. Protect concrete surfaces from freezing for at least 24 hours after placement.

E. All surfaces in contact with newly-placed concrete including formwork, reinforcement and subgrade must be above 35 Degrees Fahrenheit.

F. Use preparation methods capable of producing concrete with a temperature not more than 85 Degrees Fahrenheit, and not less than 55 Degrees Fahrenheit, at the time of placement.

G. Do not heat concrete ingredients to a temperature higher than that necessary to keep the temperature of the mixed concrete, as placed, within the specified temperatures. (Do not heat water in excess of 140 Degrees Fahrenheit.)

H. Concrete shall have a temperature of not less than 55 Degrees Fahrenheit when placed; mix concrete at a temperature between:
   1. 60 Degrees Fahrenheit and 70 Degrees Fahrenheit when outside air temperature is above 30 Degrees Fahrenheit.
   2. 65 Degrees Fahrenheit and 75 Degrees Fahrenheit when outside air temperature is between 0 Degrees Fahrenheit and 30 Degrees Fahrenheit.
3. 70 Degrees Fahrenheit and 80 Degrees Fahrenheit when outside air temperature is below 0 Degrees Fahrenheit.

I. Follow concrete placement with tarpaulins or other readily movable coverings, so only a few feet of concrete is exposed to the outside air at any time.

J. Maintain the temperature and moisture conditions specified in all parts of the newly placed concrete by covering, insulating, housing or heating; arrange for protection methods in advance of placement.

K. Maintain concrete at a temperature of not less than 55 Degrees Fahrenheit nor more than 70 Degrees Fahrenheit for a period of 3 days after placement.

L. A thermometer accurate to plus or minus 2 Degrees F shall be placed under the curing blanket. Additional insulation shall be supplied as required to maintain the temperature above 55 Degrees F.

M. After the curing period, the temperature of the exposed surface shall not be permitted to drop faster than 30 Degrees F in 24 hours.

N. Do not remove forms during the initial protection period.

O. Protect insulation against wetting that will impair its insulating value using moisture-proof cover material; keep insulation in close contact with concrete.

P. Construct enclosure to withstand wind and snow loads and be reasonably airtight; provide sufficient space between the concrete and enclosure to permit free circulation of heated air.

Q. Use vented heaters; do not permit heaters to heat or dry concrete locally. Unvented salamanders or other heaters which produce carbon dioxide as by-products shall not be permitted within enclosures or inside buildings. If heaters are used, precautions shall be taken to prevent drying of the slab through the use of water jackets or other suitable methods.

R. Maintain relative humidity above 40% within heated enclosures before construction supports are removed.

S. Monitor temperature to insure concrete is kept within specified limits recording time and concrete temperature every 8 hours.

T. Assure concrete has developed necessary strength before removing forms; provide additional test cylinders with the same protection as the structure they represent to verify concrete strength before construction supports are removed.

U. If water curing is used, terminate at least 12-hours before end of temperature protection period. Permit concrete to dry.
V. After the required protection period gradually reduce the concrete temperature within an enclosure or insulation at a rate not to exceed 20 Degrees Fahrenheit per day until the outside temperature has been reached.

W. Apply membrane forming curing compound to concrete surfaces during the first period of above-freezing temperatures after forms are stripped and before air temperature rises to 50 Degrees Fahrenheit; apply membrane forming curing compound to slabs as soon as finishing operations are completed, except where live steam curing is used.

3.21 DELIVERY TICKETS

A. With each load of concrete delivered to the job there shall be furnished by the ready-mixed concrete producer duplicate delivery tickets, one for the Contractor and one for the Engineer. Delivery tickets shall provide the following information:

1. Date and serial number of ticket;
2. Name of ready-mixed concrete plant;
3. Job location;
4. Contractor;
5. Type and brand name of cement;
6. Mix number or specified cement content in bags per cubic yard of concrete;
7. Truck number;
8. Time dispatched stamped by a time clock;
9. Amount of concrete in load in cubic yards;
10. Admixtures in concrete, if any;
11. Maximum size of aggregate;
12. Water added at job, if any;
13. Slump of concrete ordered
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<thead>
<tr>
<th>Parameter Value</th>
<th>Compressive Strength (PSI) 28-Day</th>
<th>Water-Cement Ratio Maximum</th>
<th>Air Content Range (%) Minimum-Maximum</th>
<th>Slump Range (Inches) Minimum-Maximum</th>
<th>Coarse Aggregate (Inches) Maximum</th>
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## TABLE 2
### CONCRETE SCHEDULE
#### USES AND PROPERTIES

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<tr>
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<td>Foundations and footings, (non-exposed)</td>
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<td>Exposed foundations</td>
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<td>Class C</td>
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<td></td>
<td>S2 Top, W5 Sides</td>
<td>Class D</td>
</tr>
<tr>
<td>Buried walls and footing walls, (Interior)</td>
<td>W1</td>
<td>Class A</td>
</tr>
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<td>Class B</td>
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<td>Buried walls and footing walls, (Exterior)</td>
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<td>Class C</td>
</tr>
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<td></td>
<td>W1</td>
<td>Class D</td>
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<tr>
<td>Exposed walls</td>
<td>S2 Top, W5 Sides</td>
<td>Class C</td>
</tr>
<tr>
<td></td>
<td>S2 Top, W5 Sides</td>
<td>Class D</td>
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<tr>
<td>Slabs and floors, (Exterior)</td>
<td>S2 or S4</td>
<td>Class C</td>
</tr>
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<td></td>
<td>S2 or S4</td>
<td>Class D</td>
</tr>
<tr>
<td>Slabs and floors, (Interior)</td>
<td>S2 or S4</td>
<td>Class A</td>
</tr>
<tr>
<td></td>
<td>S2 or S4</td>
<td>Class B</td>
</tr>
<tr>
<td>Beams, joists, bond beams, spandrels and lintels</td>
<td>W5</td>
<td>Class A</td>
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<td>Topping for precast decking, (Interior)</td>
<td>S2 or S4, Top</td>
<td>Class E</td>
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<td>W5 Sides</td>
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<td>Topping for precast decking, (Exterior)</td>
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<td>W5 Sides</td>
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<td>Equipment pads and bases</td>
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<td>Class E (Interior)</td>
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<td></td>
<td>S2 Top, W5 Sides</td>
<td>Class F (Exterior)</td>
</tr>
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<td>Curbing, sidewalk, endwalls, staircases, driveways and ramps</td>
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<td>Class C</td>
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<td>S4 Top, W5 Sides</td>
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<td>Manhole bases and benches</td>
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<td>Pavement base, cradles and inlet walls</td>
<td>Special Construction</td>
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<td>Mass and fill</td>
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<td>Traffic areas requiring early access or use</td>
<td>Special Construction</td>
<td>Class L</td>
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<td><strong>Water Retaining Structures</strong></td>
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<td>Slabs and bases (Exterior)</td>
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<td>Class I</td>
</tr>
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<td>Buried walls, (Interior)</td>
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<td>Class H</td>
</tr>
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<td>Buried walls, (Exterior)</td>
<td>W1</td>
<td>Class J</td>
</tr>
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<td>(Exterior) W1</td>
<td>(Interior) W1</td>
<td>Class K</td>
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<tr>
<td>--------------</td>
<td>--------------</td>
<td>---------</td>
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<tr>
<td>Exposed walls S2 Top, W5 Sides</td>
<td>S2 Top, W5 Sides</td>
<td>Class J</td>
</tr>
<tr>
<td>Fillets S2 Top, W5 Sides</td>
<td>S2 Top, W5 Sides</td>
<td>Class E</td>
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</table>

**Severe Exposure (Chemical Resistant)**

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<tr>
<th>Slabs and bases S2</th>
<th>Slabs and bases S2</th>
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<tbody>
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<tr>
<td>Exposed walls S2 Top, W5 Sides</td>
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<tr>
<td>Fillets S2 Top, W5 Sides</td>
<td>Fillets S2 Top, W5 Sides</td>
<td>Class F</td>
</tr>
</tbody>
</table>

**PART 4 MEASUREMENT AND PAYMENT**

4.01 GENERAL

A. Cast-in-place concrete shall be paid for at the bid price in accordance with one of the following methods, unless indicated otherwise in the Bid Schedule or Special Procedures - Division 01.

B. All work specified herein shall be considered in each of the measurement and payment method(s) stipulated, unless indicated otherwise in the Bid Schedule or Special Procedures - Division 01.

4.02 CAST-IN-PLACE CONCRETE

A. **Cast-in-Place Concrete, Lump Sum.** When so provided, payment for cast-in-place concrete shall be made at the contract lump sum price bid or as specified in Special Procedures - Division 01.

B. **Cast-in-Place Concrete, Inclusive.** When no quantity is provided, cast-in-place concrete shall be considered inclusive to payment for work associated with the related structure, utility, or improvement.

END OF SECTION
SECTION 33 81 15
FREE STANDING COMMUNICATION ANTENNA TOWER

PART 1  GENERAL

1.01  APPLICABLE PROVISIONS

A.  Application provisions of Division 1 shall govern the work of this section.

1.02  APPLICABLE PUBLICATIONS

A.  The following publication of the issues listed below, but referred to thereafter by basic designation only, form a part of this specification to the extent applicable.

   1.  [Specific list of publications]

B.  CODES STANDARDS AND SPECIFICATIONS

   1.  The manufacturing, construction and installation of all the equipment associated with this tower shall follow all of the codes, standards, and specifications sited in the TIA Standard, local building codes, and this document.

      a.  In the event of a conflict between the TIA Standards, local Building Codes, or this document, the document with the most stringent requirement shall govern.

   2.  Materials and construction of the tower foundations will conform to the concrete foundations installation and quality control specifications listed in the appropriate section of the standards listed in the American Concrete Institute (ACI) and the American Society for Testing and Materials (ASTM) documents.

C.  

1.03  DESCRIPTION OF WORK

A.  The work specified herein shall include the furnishing of all materials, equipment, labor, and supervision necessary to design, fabricate, deliver, install, and test a complete freestanding tower as identified on the contract drawings.

B.  The labor specified herein includes but is not limited to engineering, software, development, fabrication, equipment installation, testing, and documentation.

C.  The work specified herein includes coordination with the City and the Engineer. Additional costs due to inadequate coordination as required herein shall be borne solely by this contractor.

D.  The manufacturing, construction and installation of the tower and its associated equipment shall follow all of the codes, standards, and specifications sited in the
E. The work specified herein includes the design of a complete freestanding communication tower and foundation. The design must be performed by a Licensed Professional Engineer. The structure shall meet and comply with all guidelines and codes based on the loads and location.

F. The new freestanding tower height is 130.98 feet. The top of the new freestanding tower will be at elevation 749.48. The overall structure height shall not be higher than 752.48 feet in elevation.

G. The work specified herein includes the fabrication, delivery, offloading, and storage of one freestanding communication tower to the proposed location shown in the contract documents.

H. The work specified herein includes relocating existing antennas from the existing communications tower and installing on the new communications tower on new supports.

I. The work specified herein includes on-site factory representation to assist owner and contractor in the erection and installation of the structure. The tower provided shall provide written certification the tower is installed per the design requirements.

1.04 SCOPE

A. This section of the specifications establishes the requirements for the fabrication and erection of a freestanding self-supporting communication tower for use in a regional Public Safety telecommunications system.
   1. The tower shall be designed as a Class III structure.
      a. The primary use for this tower will be for essential Public Safety Communications.

B. Two (2) full sets of drawings detailing the foundation design and assembly instructions for the tower must be supplied to the City's Project Manager before construction at the site begins.

C. Contractor must provide the City of Duluth, MN a complete and orderly summary of the tower stress analysis showing loading considerations, tower and base reactions, member sizes, allowable stresses and maximum computed forces in members.
   1. The analysis is to be certified by a registered professional engineer licensed in the State of Minnesota with experience in tower design.

D. Contractor shall provide a dedicated, full-time field supervisor.
   1. This contractor-employee will be assigned and available through all phases of construction.
   2. Responsibilities will include, but not be limited to:
a. All building permits required for the project.
b. Verification of the tower location.
c. Finished grade and construction of foundations.
d. Delivery and erection of tower.
e. Joint inspection of construction.

E. Analysis and Design
1. All design and analysis computations and installation drawings of the tower and foundation shall be certified and stamped by a registered professional engineer licensed in the State of Minnesota with experience in tower design.

F. The GENERAL, SUPPLEMENTAL and other CONDITIONS of the Contract and the GENERAL REQUIREMENTS (Division 1) are hereby made part of this Section.

G. This Section includes all labor, materials, equipment and related services to furnish and install antennas and towers for telemetry.
1. Locations and height as shown on the Drawings.
2. Evaluation of existing conditions and installation locations.
3. New equipment and accessories including towers, foundations, cable attachments and accessories.
4. Installation.

H. SOIL CONDITIONS (PROVIDED BY OWNER)
1. Soil conditions shall not be assumed.
   a. A Geotechnical Engineering Report of the tower site is included in Attachment A.

1.05 SUBMITTALS

A. Submit shop drawings in accordance with Division 01.
B. Submit complete design with all design calculation for Tower and Foundation. MFR shall release information and grant owner and agents or the owner to use information in the bidding and construction of the site and foundation.
C. Submit copies of all shop drawings to the Engineer to include the following:
   1. Dimensions.
   2. Descriptive data.
   3. Foundation designs stamped by a professional engineer for the State of Minnesota.
   4. Installation instructions.
D. Upon completion of the job, as built drawings and a complete operation and maintenance manual (3 copies) shall be furnished to the Engineer for transmittal to the Owner.

1.06 OPERATION & MAINTENANCE MANUALS AND INSTRUCTIONS

A. The manuals shall include operating and maintenance literature for all components provided, including cut sheets, performance data, diagrams, and maintenance schedules. The submitted literature shall be in sufficient detail to
allow for the installation, operation, adjustment, calibration, maintenance and removal of each component provided.

B. Preparation of this document shall be in conformance with the requirements stated in Submittals Division 01 of these specifications. The Contractor shall submit to the Engineer for review, an outline of any variations of information for the operation and maintenance manuals and other documentation he proposes to prepare.

1.07 QUALITY ASSURANCE

A. All materials, equipment, and parts shall be new and unused of current manufacture.

1.08 WARRANTY

A. The manufacturer shall warranty the tower being supplied to the owner against defects in workmanship and materials for a period of five (5) years.

1.09 PRODUCT DELIVERY, STORAGE AND HANDLING:

A. Deliver equipment in manufacturer's original, unopened cartons.
B. Cover and store equipment to prevent damage.
C. Handle so as to prevent damage during installation

PART 2 PRODUCTS

2.01 MANUFACTURE

A. Acceptable manufactures include
1. EEI Tower, Ehreshmann Engineering as represented by Larson Data Communications
2. Glenn Martin Towers
3. Titan Towers
4. Sabre Towers and Poles
5. Or pre-approved equal.

2.02 DESIGN:

A. The tower manufacturer shall provide tower structural and foundation designs, certified by a Professional Engineer licensed in the state of the final installation.
1. Design shall be in accordance with ANSI/TIA-222-G (county and state), with design loads for the location of tower installation.
2. Provide certified design. Design shall include documentation showing tower face widths, member sizes, tower steel weights and base reactions.
3. Design shall include foundations based on the site specific geotechnical report, as attached (if not attached, then a presumptive soils foundation
design should be used for bidding purposes).

B. Design Parameters:

1. 90 MPH wind with no ice.
2. 50 MPH wind with ¾ inch radial ice on all exposed tower and antenna surfaces.
3. Structure use Class III, essential communication services.
5. Topographic Category 1, flat or rolling.

C. Tower Design.

1. Hot dipped galvanized steel construction, 3 legged triangular tower.
2. Minimum 3 foot face width at top of tower.
3. Maximum 40 feet of straight section at top of tower.
4. Provide step bolts up one tower leg, and on all legs of 2-bay sections, for erection purposes.
5. Provide a cable type safety climb system on the climbing leg to the full height of the tower. Ninety (90) degree cable guide brackets shall be installed at a spacing of no more than twenty five (25) feet. Attachment of the cable guide bracket slots shall be alternated, slot openings left and right, so as to prevent the cable from being easily freed from the cable guides by wind and weather.
6. Feed lines shall be up one face of the tower with no stacking.

D. Accessories:

1. Nine (9) hole wave guide ladder, to the full tower height, up one face. The waveguide/cable ladder shall have snap in and bolt in capacity with waveguide/cable ladder rail spacing at no more than three (3) feet.
2. A halo ground ring shall be provided around the perimeter of the foundation and attached to each tower leg. Details of the halo ground shall include a minimum of two (2) ground rods, each a minimum of 10 feet, and EIA grounding kit with 2/0 lead and attachment to leg for each of three (3) legs.
3. Provide steel leg to leg templates for tower legs for foundation construction. Provide tower leg bolts and required anchors.
4. One (1) waveguide/cable bridge kit including two (2) direct bury posts and three (3) trapeze hangars. The waveguide/cable bridge shall be twenty-four (24) inches wide minimum.

2.03 ANTENNAS:

E. TOWER DESIGN CRITERIA
1. Refer to Drawing S-2 Tower Requirements for tower antenna loading and placement.
2. The supports shall be 4’ minimum truss support arms, or equal. The support shall be designed to connect to the tower and support the project identified antenna and the loads for Duluth, MN.

PART 3 EXECUTION

PART 4 PAYMENT

2.04 FREE STANDING COMMUNICATION ANTEENA TOWER
A. Progress payments for the contract shall be made on the following schedule:
   1. 40% upon completion of the tower foundation.
   2. 30% upon completion of the tower erection.
   3. 20% upon installation of the antennas and accessories
   4. 10% upon final acceptance of all work and punch list completion.

END OF SECTION