S.P. 27-753-13
CSAH 153 ; C.P. 041603
Minn. Proj. TCSP-STP10 09MN(005)
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Definition of Terms Used in Special Provisions

As Built Plans – Copies of the original Plan and Plan Detail sheets with changes and additions due to the Contract marked in the color red.

Component Operations and Maintenance (O&M) Manuals – Operations and Maintenance Manuals pertinent to the F&I components for the Project.

System O&M Manuals – Operation and Maintenance manuals pertinent to the system installed.

Shop Drawings – Mechanical drawings sufficiently detailed to construct a component. Shop drawings are compliant with Plan detail.

Specifications – Detailed descriptions of a device or devices including physical and operating characteristics.

Submittal – Documentation of proposed equipment or processes.

Schematics – Diagrams using standard symbols to show the function.

Has Met – A Manufacturer's product that has been in conformance with the specifications required in these Special Provisions in the past. The Contractor may submit any other Manufacturer's product of equal quality for approval.

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SPECIAL PROVISIONS

DIVISION SZ

SPECIAL REQUIREMENTS

SZ-1 GENERAL

This portion of the specification identifies specifications related to the anti-icing system. Sleeves, hanger systems and cast in place bridge deck penetrations have been designed into the bridge structure to accommodate the anti-icing system. All plans, drawings and specifications submitted by Contractor shall reflect consideration of the constraints of the planned bridge.

SZ-1.1 Purpose

Along with the Plans, these Special Provisions detail the process for furnishing and installing a complete anti-icing system at the Lowry Avenue Bridge in Minneapolis, Minnesota.

The scope shall consist of performing work necessary to install an anti-icing system, furnishing and installing materials and electrical equipment, and installing materials as specified herein, all to provide a complete operational anti-icing system, in accordance with the applicable provisions of Mn/DOT Standard Specifications for Construction 2005 edition, with the current edition of the National Electrical Code, Plans, and in these Special Provisions. The work also includes system integration, testing, warranty and project documentation.

A pump house and anti-icing system were designed into Phase 1 of the Lowry Avenue Bridge. This phase of the project shall integrate with the Phase 1 system and shall be controlled with the same hardware and software. The pump house and the anti-icing system handhole immediately outside the pump house shall remain in place. No other Phase 1 equipment west of Pier 3 shall remain in place for Phase 2.

The work shall consist of the design, construction, testing, and maintenance of a fixed automated anti-icing system for the bridge and roadway approaches. The work shall include all labor, materials, equipment, and services necessary to perform all the tasks to complete the design, installation, testing, start-up, training, and maintenance of the anti-icing system.

The anti-icing system is a fixed automated system that allows automatic treatment of the traffic lanes and other targeted areas. The anti-icing system dispenses a liquid anti-icing agent by delivering the chemical through a series of solenoid-controlled valves to nozzles mounted in sections of nylon tubing and embedded in the roadway and bridge deck. Upon actuation, a remote processing unit (RPU) controller opens the solenoid valves in an automated sequence to spray the anti-icing liquid over the targeted area. The anti-icing cycle shall be initiated automatically, requiring no human activation, based on information provided by active and passive sensors mounted in the bridge deck, and atmospheric sensors. The anti-icing cycle shall also be capable of being

activated using a remote computer. The system will also provide manual activation from the pump house for testing and demonstration purposes. The system shall be capable of dispensing varying quantities of liquid anti-icing agent by varying the duration of the spray time depending on road surface conditions including black ice, snow, or freezing rain.

The system shall operate with a maximum fluid pressure of 16 bar (230 psi). The complete anti-icing system shall be a fully integrated system, with individual components designed, manufactured, and tested to operate specifically as part of the anti-icing spray system. The system shall be a proven design and shall not be a prototype.

The system shall be connected via modem to allow the system to be remotely operated and monitored.

SZ-1.2 Vendor Qualifications

The vendor shall have at least ten years of experience in the design, installation, and maintenance of fixed automated anti-icing spray systems for roadways and bridges, and shall have been responsible for the complete installation of at least ten fully functioning fixed automated anti-icing spray systems. The vendor shall have at least five years of experience in the installation of the active pavement sensors and shall have been responsible for the complete installation of at least ten fully-functioning systems based on active pavement sensor technology.

The work shall be performed under the supervision of the vendor's designated superintendent, who shall be fully knowledgeable and experienced, as defined herein, in the design, installation, and maintenance of similar fixed automated anti-icing spray systems. The vendor's designated superintendent performing the work shall have at least five years of experience in this work. The vendor's personnel and equipment shall have the capacity to undertake the work, and shall be sufficient to complete the work within the specified contract time.

The vendor shall provide documentation of his qualifications, experience record, prior project references, and the availability of the designated personnel. All prior project references shall be currently available personnel who can verify the quality of the vendor's previous work, and shall include name, address, and telephone number. This documentation shall reference the experience of the vendor and his designated superintendent in the complete design, installation, and maintenance of fixed automated anti-icing spray systems for roadways and bridges.

SZ-2 DESIGN OF FULLY AUTOMATED BRIDGE ANTI-ICING SYSTEM

The Contractor shall provide plans, drawings, and specifications as part of the proposal submittal. Prior to authorization of the anti-icing system, all necessary drawings and specifications must be submitted in English units and submitted as Released for Construction Documents to Hennepin County for review and approval. Whenever a metric part is used, it shall be so noted on the drawings and specifications and labeled with dual units.

Wherever possible, the parts of the system shall be standard English Units parts, including but not limited to gaskets, bolts, fasteners, gauges and piping. All Metric parts used shall be clearly identified and labeled with dual units.

SZ-3 MATERIALS

Materials and equipment conform to these special provisions, the Plan, the 2005 edition of Minnesota Department of Transportation Standard Specifications for Construction, local codes and ordinances, the National Electrical Manufacturers Association (NEMA); the Electronics Industries Association (EIA), and the Telecommunications Industries Association (TIA).

A. Use stainless steel hardware (e.g. mounting bolts, nuts, washers, and external hinges, etc.) on outdoor components.

B. Use only components designed for 10, or more, years of industrial use.

C. The Contractor warranties all system materials and workmanship for three years from completion and acceptance of the work. The warranty period begins when system is fully accepted by the Engineer in writing.

D. The Contractor is responsible for rounding and smoothing sharp corners and edges of all systems components.

SZ-3.1 Conduit and Bored Conduit

Conduit for electric and electronic cables complies with 3801, 3802, 3803, and the specifications included in this section.

One 3" NMC conduit shall be installed from "HH 1" (see sheets Z1 and Z4) and serve as a drain to the fine filter aggregate adjacent to the geofoam. See the roadway plans for more information about the fine aggregate filter. The intention of this drain is to allow for drainage if there is a leak in the handhole marked "HH 1." This conduit shall be installed at a minimum 2% grade to provide drainage from the handhole.

Two-inch conduits (incidental to the Anti-Icing System) shall penetrate the bridge deck at valve unit locations 2, 3 and 4 (see sheet Z5). The conduits shall run from the valve box, up through the bridge deck and through the median to the edge of the median as shown in the plans.

The staging of the concrete and conduit work at the specified valve unit locations shall be as follows:

- **Construct the bridge deck with 2" conduit cast-in-place (vertical)**
- **Construct the median with cast-in-place conduit (horizontal)**
- **Construct the bridge deck pavement overlay**
- **Locate the conduit openings at the edge of the median**
- **Sawcut the pavement overlay from the spray strip to the edge of the median to meet the conduit**
- **Install tubing**

E. The Contractor shall furnish and install either rigid steel conduit (RSC), segmented non-metallic rigid conduit (NMC), or High Density Polyethylene (HDPE) continuous length conduit at the locations indicated in the Plans. Conduit must be sized to the desired system and must fit within the sleeves, hangers, and block outs designed into the bridge. All conduit shall be in accordance with the following:

1) Rigid Steel Conduit (RSC): Shall be in accordance with Mn/DOT 3801.

2) Rigid Non-Metallic Conduit (NMC) and High Density Polyethylene (HDPE) Continuous Length Conduit:

Shall be in accordance with Mn/DOT 3803, except as follows:

Shall be Schedule 80 conduit and fittings for all installations.

Conduit fittings shall be appropriate for use with HDPE continuous length conduit.

Shall be capable of being installed by plowing, trenching, or directional boring methods.

Shall be marked on the outside of conduit indicating manufacturer's name, size of conduit, HDPE, ASTM F 2160, UL Listing, and any other markings required by the N.E.C.

F. Before the cables and conductors are installed, non-metallic conduit bell ends (appropriately sized for the HDPE type conduit) shall be installed to prevent damage to the cables and conductors.

G. All conduit from concrete foundations to the nearest handhole shall be either RSC or rigid NMC. HDPE continuous length conduit is not allowed for use between concrete foundations and the nearest handhole.

H. Open ends of all installed conduit shall be immediately capped until cables are installed.

I. Standard bell ends shall be installed on all conduit ends to prevent damage to the installed cable.

J. Install Locator Balls at the ends of all conduit runs. Bury the locator ball within one foot of the finished grade.

SZ-3.2 Grounding

All electrical and electronic grounding meets **"SINGLE POINT" GROUNDING** requirements. Single point grounding means referencing all grounded devices to a Single Point, one single piece ground rod, via the shortest and straightest route. Collect the devices' chassis and electrical grounds at a ground bus before connecting them to the earth ground rod. Connect the ground busses via conductors that meet the requirements of single point grounding.

A. Provide single point grounding by:

1) Grounding all equipment to meet the requirements of the manufacturer;

2) Routing each ground conductor to the ground bus via the straightest route that does not hinder maintenance or installation activities; and

3) The Contractor shall clean each grounding component with 300-grit emery cloth before bonding. Apply a mineral oil based oxide inhibitor to the bond area.

B. An oxide inhibitor is applied over bonded connections to ground rods. The Oxide Inhibitor:

1) Provides an airtight seal around the conductor and ground rod;

2) May be applied to the bonded area between the temperatures of

3) -22 °C (-30°F) and 149 °C (300 °F);

4) May be used on copper conductors;

5) Prevents oxides from forming; and

6) Is mineral oil based.

Selected Oxide Inhibitor shall be approved by the County Engineer.

C. The ground rod complies with Mn/DOT 2545.3R except that it is 15 feet long and one-piece.

D. Bonding the ground conductor to the ground rod is accomplished by one of three methods; compression bond, exothermic welding and irreversible compression bond. The irreversible compression bond is achieved by:

1) Using an hydraulic press with a connector die,

2) Using a solid copper connector with a run for a 5/8 inch ground rod and a tap for the specified ground conductor,

3) Using connectors that can accommodate a conductor range from #6 solid copper through 500 Kcmil, and

4) Using connectors that are pre-filled with an antioxidant compound and are strip sealed.

The selected bonding method shall be approved by the Engineer.

The Contractor may propose other methods and materials for implementing an irreversible compression bond and submit the associated products and procedures of equal quality for approval.

SZ-3.3 Electric and Electronic Cable

Electric, electronic, video and telephone cables are found within the project limits and may be impacted or replaced by construction activities. The Contractor shall exercise caution when working near existing cables.

A. Exercise caution and dig by hand when exposing the existing cables. Seal all nicks or abrasions with rubber splicing tape. If the cable jacket is nicked so deeply that the armor is exposed, install an approved epoxy repair kit over the damaged area.

B. The "industry accepted lubricants" referenced in 2550.3, used during cable pulling operations, are compatible with cable insulation materials and do not deteriorate the cable insulation.

C. The Contractor stocks approved splice kits to repair any cable, damaged by Construction activities.

1) Use button style, gel filled, crimp-on butt splices enclosed in zippered poly bags, when making temporary, twisted pair, control cable splices. Protect the splices in an approved manner, above ground, until the permanent splices are installed.

2) Install new cable between existing terminations or vaults, as appropriate, for cable severed by contract activities.

3) The devices, enclosures, and material required for severed cable repair/replacement are incidental to the Contract.

4) Seal all nicks or abrasions, caused when exposing a cable by hand digging, with rubber splicing tape. Seal a nick penetrating the cable jacket to the armor with a cast epoxy kit.

Selected splice kit shall be approved by the Engineer.

Jerry is this really the appropriate word to use?

D. Permanent repairs to twisted pair cables are done using rigid-body, non-reenterable, enclosures in combination with button style, crimp-on butt splices. The closure is made of translucent polypropylene and packed with a urethane Compound. Rubber tape is used to seal the ends of the closure. The closure is available in 4-pr, 18-pr, and 50 pr sizes.

E. The electric and electronic cables comply with the following specifications. Splices are not allowed in electric or electronic cables without the Engineer’s approval. Power, Control, and RF cables are one-piece cables between termination points.

F. When using crimp-on connectors, install the insulation of electrical cables deep enough into the lug that the insulation acts as a strain relief. Crimp both the conductor and the insulation to the lug. When using crimp-on connectors, make the crimps with a ratchet style crimp tool. The AMP 59250 has met this specification.

G. Maintain the electrical continuity of the cable shields. Ground all cable shields entering the pump house. Shield bonding complies with RUS

splicing Standard PC-2, Section 3.3. Use bonding connectors complying with RUS standard PE-33 (Cable Shield Connectors).

H. Test power cables according to the following procedure:

1) Measure the insulation resistance on each conductor using a megohms meter test at 500 VDC;

2) Check for insulation breakdown by energizing the megohms tester for 15 seconds on each conductor (100 megohms is the minimum measurement accepted);

3) Measure each conductor to ground using the pump house ground bar for power conductors;

4) The Contractor ensures that unwanted grounds do not exist before final connections are made;

5) The Contractor documents test results and furnishes them to the Project Engineer within one week of making final connections; and

6) Conductor-to-conductor insulation tests are performed on multi conductor cables only.

7) All testing shall be documented on the Power Cable Insulation Test Results form that follows.

I. All cables, not terminated immediately and stored below ground (in a handhole), are protected from moisture intrusion. Provide epoxy encapsulation for cable ends. It is not necessary to provide epoxy protection for cable ends stored above ground, but all cables must meet performance tests prior to acceptance. Protecting power cable ends is incidental to the anti-icing system.

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Power and Control Cable Test Documentation

POWER CABLE INSULATION TEST RESULTS

SP NUMBER _____ DATE _____.

DESCRIPTION _____ CONTRACTOR_____.

LOCATION _____ INSPECTOR_____.

SOURCE OF POWER ADDRESS_____ METER # _____.

TEST EQUIPMENT MANUFACTURER/MODEL

TEST EQUIPMENT CALIBRATION/CERTIFICATION DATE

***** ALL MEASUREMENT RESULTS ARE RECORDED IN MEGOHMS *****

Power Conductor Resistance Test Results

Conductor Insulation Resistance / Conductor to Conductor Insulation Resistance						
Conductor	**120/240 Resistance 240/480**			**Conductor Combination**	**120/240 Resistance 240/480**	

Cable Type _____
Source Power (**Check Which**) ____120/240 VAC Service, ____240/480 VAC Service

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SZ-3.4 Labeling Cables and Components

Secure identifying labels to each cable and component. Permanent markings on electrical tape shall not be used. Submit sample label materials to the Project Engineer for approval recommendation.

Labeling components, wire, and cable is incidental to the anti-icing system.

SZ-3.5 Pump house

A. General

A pump house designed for Phase 1 shall be used for this project. The Phase 2 anti-icing system shall integrate with the Phase 1 system and shall use the same control equipment where possible. The system installed for Phase 2 shall integrate with the listed instrumentation.

B. Instrumentation in Pump house

1) Pressure Gauges: Analog type, industrial grade, all Type 316 stainless steel, minimum pressure range = 0 to 300 PSI. Pressure gauge and pressure control regulator for liquid pressure and flow readings.

2) Flowmeter Transmitter: senses flow rate in system and sends signal to RPU spray system controller. Flowmeter shall be fabricated from durable noncorrosive materials. All metallic parts shall be non-corrosive. Minimum flow rate range = 0.3 to 6 meters (feet) per second.

3) Pressure Switch Transducer: senses pressure in system and sends signal to RPU spray system controller. All metallic parts shall be Type 316 stainless steel. Pressure range = 0 to 2,000 kPa (ft/lbs).

4) (Ultrasonic) Level Sensor: ultrasonic device to detect the level of chemical in the storage tanks. The ultrasonic level sensor will be connected to an alarm horn mounted on the exterior of the pump house to alert personnel filling the tanks when the tanks are full. The ultrasonic level sensor shall also send signals to a digital level display located in the housing for the chemical fill tube on the exterior of the pump house.

5) Pumps with salt or acetate (sodium chloride, calcium chloride, potassium acetate and/or magnesium chloride) tolerant seals and bearings.

6) Pressure control device, safety return bypass with control valve, and flow transmitter measuring outflow and connection of pressure pipe.

7) Two liquid filters in stainless steel housing pressure rated to 250 PSI, PP25 or better w/pressure gauge on the inlet & output lines.

8) Valves to control tank overflow and automatic control of security collection basin

9) Two 2000-gallon cylindrical chemical tanks must be approved by the Engineer.

10) Complete external fill pipe assembly, schedule 80 two-inch PVC pipe with ball valve, swing check valve and locking cap assembly. A 2-inch hose that will remain flexible in extreme cold temperatures, with quick connect couplings, at a length for easy filling of the anti-icing tanks.

11) Test 500-gallon water storage tank, (for summer flushing) and Engineer-approved polyethylene tank. 1 ¼" drainage flange and cap and automatic flow level control. The chemical tank shall have an entry port through the top and removable cover. The tank shall be vented at the top. The tank shall be rated for a maximum fluid specific gravity of 1.5 or greater and shall be made from polyethylene material. Any metal components of the tank shall be Type 316 stainless steel. Galvanized steel is not permitted. Note: All pump station equipment shall be contained within pump house building.

SZ-3.6 Spray Strip System

The spray strip system shall be produced by a series of thermo-plastic blocks of 40mm x 24mm x 35mm (L x W x H) spaced at 5m and connected by a polyamide 11 tubing (OD = 10mm /ID = 8mm) in a total length of 100m. Each spray block shall contain the nozzles that will provide the mist spray. The nozzle assembly shall include two orifices of 0.5mm diameter maximum, orientated at 180 degrees of separation between them, and shall be fabricated of electro-polished 316 stainless steel. The nozzle design shall have an integral conical non-return valve to prevent penetration of dirt or other particles present on the road surface.

The spray block will be fabricated of black acetyl copolymer sourced from a recognized plastic manufacturer, the vendor shall provide a warranty that the plastic will remain stable under exposure to sunlight, weather, traffic and continuous exposure to any anti-icing chemical.

The array of nozzles "spray strips" shall be assembled at the vendor's facilities to ensure the proper functioning and sealing procedure. The spray strips shall be fixed in the bridge deck or roadway surface by using specially designed mounting templates and bond it to the pavement using an approved sealing compound. The nozzle top surface shall be at least 2 mm below the surface of the bridge deck or roadway, and shall be capable of withstanding high-volume interstate traffic and snow plowing procedures conducted with maintenance trucks. The mist produced by the nozzles shall be nearly invisible to the drivers.

The spray nozzles shall be located a maximum 5 meters apart from each other. This will allow for optimum surface coverage of anti-icing chemical and lessen the dependence on vehicle tracking of chemical.

In order to apply the chemical as quickly and efficiently as possible, the spray system will have the ability to treat up to 200 lineal meters (or 400 lane meters) of road surface simultaneously. The system shall have the ability to provide a continuous spray from the nozzle for up to 90 seconds.

The nozzles shall be fabricated in such a manner that nozzle directions can be adjusted while the block that contains them is embedded in the bridge deck or roadway surface without removal of any of their components. The nozzles shall be self-cleaning and maintenance free.

All nozzles shall spray perpendicular to the direction of travel.

SZ-3.7 Piping

The tanks, piping and cables shall have the following requirements:

A. Main chemical pressure piping - The main chemical pressure pipe/tubing shall be Polyamide 11, also known as Nylon 11, tubing, with 18 mm outside diameter, and 14 mm inside diameter, or approved equal, except within the pump house. Polyamide 11 tube couplings are not permitted in tubing runs between junction chambers, or in remote, inaccessible locations. All pipe connections, joints, elbows, fixed points, and pipe clamps shall be type 316 stainless steel. Chemical pressure pipe within the pump house shall be polyethylene rigid pipe with socket or butt fused joints, rated for the system pressure.

B. Conduit for chemical pressure piping - Chemical pressure piping shall be routed within a protective conduit system consisting of non-metallic conduit where embedded in concrete or buried in the ground, and galvanized steel conduit where exposed. Conduit and all fittings, connections, elbows, and mounting hardware shall be in accordance with the local specifications, and shall be sized as shown on the plans.

1) Pressure Gauges: Analog type, industrial grade, all Type 316 stainless steel, minimum pressure range = 0 to 20 bar.

2) Flow meter Transmitter: Senses flow rate in system and sends signal to RPU spray system controller. Flow meter shall be fabricated from durable non corrosive materials. All metallic parts shall be Type 316 stainless steel. Minimum flow rate range = 0.3 to 6 meters per second.

3) Pressure Switch Transducer: Senses pressure in system and sends signal to RPU spray system controller. All metallic parts shall be Type 316 stainless steel. Pressure range = 0 to 20 bar.

4) Ultrasonic Level Sensor: Ultrasonic device to detect the level of chemical in the storage tanks. The detected level is reported back to the system controller for display in the software. The ultrasonic

level sensor shall be connected to an alarm horn mounted on the exterior of the pump house to alert personnel filling the tanks when the tanks are full.

C. Valve units - Each 100 meter section of spray strip will be connected to a solenoid valve unit assembly located according to the project design. Valve units shall control the flow of anti-icing chemical from the main supply line to each spray strip. Valve units shall consist of electromagnetically-controlled solenoid valves and electronic solenoid control cards. Solenoid valves and control cards shall operate on a 24-volt system. Each control card shall have the capability to independently control the operation of two solenoid valves. The system shall be capable of controlling up to 32 control cards through a single pair of conductors. The control cards shall allow each solenoid valve to be remotely activated using different spray programs from the RPU controller. Each control card shall be addressable via a signal frequency allowing individual control from the RPU. The control cards shall have remote fault testing capability. No accumulator tanks are permitted throughout the system.

D. Solenoid main control cable - Type SJEOOW 2 conductors 14 AWG for valve system control operated with 24 VDC.

E. Conduit for Sensor Control Cable and RPU Slave Unit Power Cable. Sensor control cable and power cable for RPU Slave Unit shall be routed within a protective conduit system consisting of non-metallic conduit where embedded in concrete except as shown on the plans, and galvanized steel conduit where buried or exposed. Conduit and all fittings, connections, elbows, and mounting hardware shall be in accordance with the local Specifications, and shall be sized as shown on the plans.

SZ-3.8 Anti-Icing Spray Control System

The anti-icing system shall be controlled by a microprocessor-based RPU (installed in Phase 1) controller with capacity for 256 valve unit assemblies and the ability to monitor pump functions, system pressure and flow characteristics, and tank fluid levels. The RPU spray system controller shall be able to interpret between various signals from sensors to initiate at least 16 different spray programs to apply measured amounts of liquid anti-icing chemical to the roadway surface.

The control of the application of anti-icing chemical shall be fully automated, with provisions for operator intervention and notification. The automated control system shall include atmospheric sensor capabilities and active and passive pavement sensor technology. The RPU spray system controller shall be capable of storing and running 16 different software programs for automatic spray activation sequences. The RPU spray system controller shall have the capability to vary the length of time each solenoid valve is opened from 30 to 90 seconds, thus varying the quantity of liquid anti-icing agent that is applied to the roadway

surface, and shall be capable of changing the length of time for pauses between sprays, according to different conditions on the roadway surface.

Fully automatic operation shall have manual override capability, with the options for manual pushbutton operation from the pump house, operation via telephone call with password, and computer activation from Windows-based PC software. The system shall provide surge protection for the incoming telephone line. The RPU shall have the capability of detecting failures of system components and initiating automatic system shutdown in the event of a failure.

The RPU spray system controller shall be contained within a pump house with lockable door. The Contractor shall be able to demonstrate a minimum of ten years of proven field operation of the RPU spray system controller software in automated liquid anti-icing spray systems.

The System provided shall be capable of controlled applications of liquids.

SZ-3.9 Atmospheric and Pavement Sensor Technologies

The system shall integrate with inputs from the atmospheric and pavement sensor technologies installed as part of the Phase 1 system. The Phase 1 system includes:

A. ***Active Pavement Sensor***: The active pavement sensor shall be capable of cooling the sensor surface temperature using an electronic device to a point approximately 2 degrees Fahrenheit below the current pavement temperature, and returning the sensor surface to an above freezing temperature, in a continuous cycle; and shall be capable of detecting ice formation on its surface. The sensor shall be capable of continually measuring the "freeze point temperature" of the moisture/chemical mixture on the roadway surface. This sensor shall be capable of accurately detecting freeze point temperature in the range of 32 degrees to minus 4 degrees Fahrenheit using an electronic device.

B. ***Passive Pavement Sensor*:** The passive pavement sensor shall be capable of measuring the passive conductivity reading of the moisture/chemical mixture on the pavement surface to compare the active sensor measurement to the passive conductivity measurement. The passive pavement sensor shall measure the pavement surface temperature for comparison with the other pavement sensor measurements.

C. ***Air Temperature & Relative Humidity Sensor***: Temperature measurement range equal to -40° C to +70° C, temperature sensing accuracy throughout range = ± 0.3° C, relative humidity measurement range 10 percent to 100 percent, with an accuracy of less than ±5 percent in the range from 10 percent to 100 percent RH.

D. Sensor shall have a wind and solar radiation shielded housing. Sensor shall be mounted in such a manner as to achieve the optimal readings above the bridge deck.

E. ***Precipitation Sensor***: The precipitation sensor shall be able to detect the rate and type of precipitation by sensing falling particles, and shall be capable of distinguishing between rain, freezing rain, drizzle, and snow. Operating temperature range shall be between -50° C to +50° C. False alarm error rate for precipitation shall be less than 0.2 percent based on manufacturer specifications. Precipitation intensity error rate shall be less than 5 percent for the range 10 mm/hour to 100 mm/hour, and less than 10 percent for the range 3 mm/hour to 500 mm/hour. The sensor shall be mounted in such a manner as to achieve the optimal readings above bridge deck.

F. ***Wind Measurements:*** The anemometer shall be capable of measuring wind speeds in excess of 100 mph and wind detected from any direction between 0 and 360.

SZ-3.10 Remote Operation of System

The Contractor shall integrate the Phase 2 system with the Phase 1 system to provide fully automatic remote control operation with data collection and graphical user interface capability. The following items were installed as part of the Phase 1 system:

Cellular Modem

The system shall communicate with a computer at a designated County facility for operation of the system.

Software

The Contractor shall supply the necessary software to operate the system and collect data. The software shall be capable of being installed on systems with Microsoft Windows 2000/XP and the current version of Microsoft Windows Server.

Graphical User Interface to include the following functions:

A. Pull-down menus and icons

B. Visualizing of meteorological data, time and alarms in a graphical and numerical format

C. Summer and winter scale and visualization of a two and 24-hour history of selected values and periods

D. Window for system messages

E. Complete software description shall be included in the bid.

The specified software and hardware shall provide for system operation from a manual control in the pump house, and from Hennepin County. All software supplied to Hennepin County shall include installation media (CD).

SZ-3.11 Anti-Icing System Operations

A. Ambient Environment – The system shall be able to withstand temperatures in the range of -40° C to +65° C with no permanent loss of function or component failure. The pavement sensors and nozzles shall withstand temperatures up to +85° C.

B. Operating Environment – The system shall accurately apply liquid anti-icing chemicals to a pavement surface in the temperature range of -30° C to +5° C.

C. Chemical Environment – The system shall be able to safely store and apply the commonly encountered liquid anti-icing chemicals. Those liquid chemicals include but are not limited to: Calcium Chloride – CaCl2, Magnesium Chloride – MgCl2, Potassium Acetate – KAc, Sodium Chloride – NaCl, Calcium Magnesium Acetate – CMA, and CMA/KAc blend – CMAK

D. The entire anti-icing spray system shall consist of materials that are resistant to corrosion from anti-icing chemicals listed above. All metallic valves, connections, elbows, fixed points, and pipe clamps shall be non-corrosive.

E. Communications and Software – The system communication software shall be delivered that meets standard communication protocol specifications and the needs of the County. The system shall communicate functions such as automatic system operation and display, the system software programs in the controller, tank level, pressure and fluid flow control along with manual operation of the system. The system data collection software shall run as a background service on the central computer. The central computer need not be logged on to continue to log data from the anti-icing system.

F. Software/Firmware – Client software shall not require Windows administrative privilege to operate. The software/firmware manufacturer shall revise software/firmware to improve usability and performance if problems are encountered. The software/firmware shall be updated for maintenance upgrades for a minimum of five years after system acceptance. The Contractor shall provide software upgrades to the County as part of this agreement for the five year period.

G. Communications and Software – The System communication software shall be delivered that meets standard communication protocol specifications. The System shall communicate functions such as automatic system operation and display, the system software programs in the controller, tank level, pressure and fluid flow control along with manual operation of the system. The system data collection software shall run as a background service on the central computer. The central computer need not be logged on to the Department's network to continue to log data from the anti-icing system.

H. Users – The system shall permit a minimum of five simultaneous users with user-configurable and changeable web access.

I. Software Licensing – The Contractors shall provide a minimum of five (5) remote access licenses.

J. Security – All communication to and from the RPU shall be verified by user name and password. The system shall provide two levels of password security, one with administrative configuration abilities, and the other as read-only access.

1) All passwords shall be stored in an encrypted format with no clear text.

2) User account names and passwords shall be user definable and changeable.

3) The system shall support a minimum of two user accounts within the RPU.

K. Regulatory Requirements – The System shall comply with all applicable national, state, and local construction and safety codes.

1) The System provided shall be capable of two-way communication with the users using all of the following methods:

2) Computer Network: The System provided shall be capable of networking with wide area networks. The System provided shall be capable of running on Microsoft Windows XP/2000 and the current version of Microsoft Windows Server.

3) The server provided shall network with standard computers via modem, network router, and frame relay, etc.

4) Telephone Modem: The System provided shall be capable of supporting conventional telephone modem operation. This capability shall include the ability to originate, or receive, calls to remote control sites. It is not necessary to connect a phone line if other communications methods are used.

5) Wireless Modem: The System provided shall be capable of supporting wireless modem operation. This capability shall include the ability to originate, or receive, calls to remote control sites.

6) Onsite Hook-up: The System provided shall provide for local on-site connection of a portable computer to the RPU spray controller and RWIS RPU using the supplied RS-232C serial interface protocol.

User Control Options

The system shall allow for the control of the liquid chemical application with full automation. The system shall be capable of the following control modes:

A. Fully Automated: The System operation shall be automatic utilizing user defined parameters and the pavement and weather conditions sensed by the environmental sensors. The system shall be configured to send email or pages when activation occurs.

B. Manual Override: The System provided shall allow for manual override of the automated mode. The system shall make this available locally at the site and at the County maintenance facility.

C. Short distance remote controlled. The System provided shall allow for maintenance personnel driving by to manually activate the system using a push-button device with a range of 800 feet.

D. Fully Manual: The System provided shall respond only to a user–generated command. Manual control options shall include the override ability by networked computers, modem and manual onsite switch.

Fault Detection and Remediation

The System provided is able to detect problems, compensate for these problems and notify the user of the problems by the following methods:

A. Self-Check: The System provided shall be able to detect chemical leakage and restrictions within the spray system. Additionally, the System provided shall be capable of detecting hardware failures in all other connecting systems including pavement sensors and alerting the system user of the problem. The Contractor shall propose an isolation system in the event of a failure or other leakage.

B. Remediation: The System provided shall provide for a single push button reset of normal functions upon completed system repairs or inspections. The system shall automatically detect system defects and take action without operator intervention to prevent system damage or environmental damage.

C. User Notification: The System shall automatically notify system user through the central computer of detected problems including location of abnormalities and actions taken. The notification system shall include user-definable and configurable alarms/notifications.

Inventory Tracking and Control

As part of the software, the system shall automatically provide tracking of material used by the anti-icing system. The system shall provide inventory control. The system shall have the ability to detect and report liquid levels in the tank throughout the range from full tank to empty tank. The status of the tank level shall be reported to the user using the communications system. The system also shall have alarms for low level requiring refilling, and empty - not sufficient chemical to operate the system, providing an alarm to the operator and system shut-off to prevent system damage. All level alarms shall be configurable by system user.

Basic Operating Capabilities

The system shall have the following basic operating capabilities as a minimum:

A. Automatic system tests on a preprogrammed and timed basis. The system shall measure system pressure and quantity of liquid flow and prevent system operation if parameters exist outside of acceptable operating conditions.

B. The system shall monitor and alarm for tank levels for two conditions: low and empty.

C. The system shall monitor and alarm for liquid in the containment area.

D. The system shall have the ability to activate a warning device before the spraying operation commences.

E. The system shall be capable of going through a system evaluation before activating the spraying operation. This system evaluation shall check for system leaks, low chemical reservoir levels, and other system defects and shall not activate the system if any of these conditions exist. During system activation, the system shall evaluate if individual spray valves do not activate and shall document in the system log and alert the operator of these conditions.

F. The system shall operate autonomously based on various weather parameters in the environmental sensors.

G. The environmental sensors shall include the following:

    1) The sensor technology must insure that the sensor works with any anti-icing chemical, multiple chemicals, varying water depths, oils, dirt, and other remaining residuals on the road surface that can change the freezing point temperature. This includes any potential chemical applied on the surface by maintenance trucks.

    2) The technology must allow user definable parameters. The pavement and atmospheric sensors shall allow the following detection of the system:

        a. Comparison of active and passive pavement sensors utilizing the advantages of each.

        b. Detection of accurate pavement temperature freeze point on the pavement which does not require recalibration with each chemical used; can work with multiple chemicals, for example when exposed to various combinations of truck-applied chemicals; allows for system activation at different thresholds before freezing, for example, 1, 2, or 3 degrees before freezing, and provides accurate detection of freeze point temperature to -20 degrees Fahrenheit.

H. The System provided shall allow for software logic programs that utilize all of the capabilities of the atmospheric and pavement sensors to

properly interface with the anti-icing spray system controller. The System provided shall have user settable thresholds for adjusting automatic operation of the system:

1) System activation when road moisture is at or near freezing via user settable thresholds.

2) System activation when freeze point temperature sensors detect when pavement surface moisture is near freezing via user settable thresholds.

3) System activation when chemical dilution is occurring via user-settable thresholds.

4) System activation and accurate freeze point temperature measurements even when multiple chemicals are used via user settable thresholds.

5) Accurate system activation without calibration of pavement sensors with changing chemicals.

6) Immediate system activation when falling snow or freezing precipitation is detected via user settable thresholds.

7) The ability to include other weather parameters in the system logic such as low pavement temperature lockout according to different anti-icing chemicals for minimum temperature, relative humidity, wind via user settable thresholds.

I. The system shall allow a portion of the system to be disabled by the operator, while allowing the remaining aspects of the system to function in its treatment of the roadway and bridge.

J. Manual override of system operation from any of the manual options.

K. Manual operation locally and remotely; system options:

1) Manual pushbutton at the site.

2) Activation by web-based software.

SZ-4 CONSTRUCTION REQUIREMENTS

SZ-4.1 General Requirements

The construction requirements for this Contract comply with 2550.3 and these additions.

A. The Contractor locates all underground utilities installed under this Contract until the County accepts all contract work in writing. The County will forward the appropriate requests for underground location via facsimile to the Contractor within 8 hours of receipt. The Contractor shall furnish their facsimile number to the County.

B. The Contractor shall notify the Engineer when all work requirements have been satisfied. The County will accept the Contract work after the

County has verified proper operation of all installed components and after the Contractor meets these conditions:

1) Approval of all tests by the Engineer - The Contractor shall conduct installation tests to verify that the systems function in accordance with the plans and specifications. The Contractor shall prepare an acceptance test plan and submit it to the Engineer for approval. Testing will include a functional (one-day) test and a reliability (30-day) test. The Contractor shall be on site during the test activities. The County will accept the system after satisfactory performance of both the functional (one-day) test and the reliability (30-day) test as well as having completed all construction activities. Additional testing will be required if the systems fail to pass testing.

2) Approval of all required documentation;

3) All junction boxes and valve boxes are clean and arranged in a professional manner

4) Punch list is complete; and

5) General cleanup is complete.

SZ-4.2 Component Requirements:

Conduit

Conduit in this project is to be installed with typical Mn/DOT methods. Conduit shall be installed in accordance with Mn/DOT 2565.3D and plan, except as follows:

Rigid Non-Metallic Conduit Joints:

1) The applied joint cement shall be allowed to set-up for six (6) hours before pulling the conduit through a directional bored channel.

SZ-4.3 System Integration

System integration will be completed for all system components. This includes integration of specific components both individually and as a complete system. Testing will verify the site is fully complete and fully functional system in conformance with the plans and specifications.

SZ-4.4 Proposed Component, Test and Project Documentation

The Contractor is required to prepare plans, drawings special provisions, and submit proposed component, test, and project documentation. All documentation shall be submitted directly to the Engineer unless directed otherwise by the Engineer.

Project Documentation and Submittals

The Contractor shall submit to the Engineer for review and approval in accordance with the local Specifications the following items:

A. Detailed design and installation working drawings for the complete anti-icing spray system with sufficient detail to allow review of all power and communications for compliance with the Specifications. Working drawings shall clearly indicate any and all deviations from the contract documents. The working drawings shall include specific details and exact locations of all system components including proprietary equipment.

B. Compliance Traceability Matrix for computer and electronic device hardware and software that gives evidence of the compliance of each component with the requirements in the Specifications.

C. Communications Infrastructure Plan showing routing of electronic communications between devices in the field, between devices and computers, between systems, and between the field computers/systems and remote users.

D. Installation schedule that shall outline the steps the Contractor intends to make to complete the contract. The installation schedule shall be revised and resubmitted if there is a significant change to the schedule.

E. Contractor qualifications and resumes.

F. Documentation of ten years of proven field operation of the active pavement sensors in automated liquid anti-icing spray systems.

G. Documentation of ten years of proven field operation of the programmable system controller software in automated liquid anti-icing spray systems.

H. Working drawings for atmospheric sensor mounting pole and foundation.

I. Product data sheets or certificates of conformance with the Specifications for the following system components:

1) Spray Strips;
2) Pavement sensors;
3) Chemical pressure piping;
4) Conduit for chemical pressure piping;
5) Valve units;
6) System control cable;
7) Conduit for sensor control cable and RPU slave unit power cable;
8) Anti-icing chemical;
9) Anti-icing chemical storage tanks;
10) Flush water storage tank;
11) Pump and motor;
12) RPU spray system controller;

13) Atmospheric and pavement sensor RPU;

14) Communications schematic including modem to be installed as part of the CCTV camera system;

J. Operations and Maintenance Manual – The Contractor shall furnish an Operations and Maintenance Manual, or O&M Manual, for the anti-icing system. The O&M Manual shall include operation and maintenance instructions for all systems and items of equipment provided under the contract. The O&M Manual shall be in the form of neatly formatted bound ring binders and electronic format in the form of CD-ROM disks. Prior to completion of the work, and at least 90 days prior to final payment, the Contractor shall furnish for the Engineer's review three O&M Manual draft copies.

K. The O&M Manual shall consist of product data sheets, brochures, bulletins, charts, schedules, approved working drawings corrected to as-built conditions, assembly drawings, wiring diagrams, operation and maintenance information for equipment, and other information necessary for the Department to establish an effective operating maintenance program. The O&M Manual shall include:

1) Title page giving the name and location of the facility, bridge plan numbers, and Project Numbers;

2) Approved working drawings of each component;

3) Approved product data sheets and dimensioned drawings of each piece of equipment, and details of all replacement parts;

4) Manufacturer's installation, operation, and maintenance instructions for each piece of equipment and complete listing of nameplate data;

5) Complete wiring diagrams of all individual pieces of equipment and systems including one line diagrams, schematic or elementary diagrams, and interconnection diagrams;

6) Complete piping and interconnection drawings;

7) Complete parts list with parts assembly drawing, recommended list of spare parts to be kept on hand by the Department.

8) Instructions with easily understood schematics or diagrams for disassembling and assembling the equipment for overhaul or repair.

L. Electric and Electronic Cable Documentation

1) Electric and Electronic cable test documentation is required. Cable test documentation includes:

2) Power and signal control cable test documentation is required. Use the form provided in these Special Provisions.

3) Test equipment calibration information and certification documentation is required.

4) Electric and Electronic cable test documentation is incidental to the Anti-icing system.

Project Documentation is incidental to the lump sum Anti-icing System.

The following submittals were required for the Phase 1 system.

A. Structural engineering design calculations and working drawings for the pump house precast concrete building prepared and sealed by a Professional Engineer registered in Minnesota.

B. Working drawings and product data for doors, louvers, frames and all accessories and hardware for the pump house.

C. Design calculations and working drawings for the pump house stair framing that have been prepared and sealed by a Professional Engineer registered in Minnesota.

SZ-4.5 Commissioning, Testing, and Training

A qualified representative shall provide for the installation of the automatic anti-icing system including the start up, alignment, and testing of the entire system. The chemical storage tanks and the entire system shall be filled to capacity with anti-icing chemical at commissioning by the system owner. The flush water storage tank shall be filled to capacity with clean, potable water at commissioning by the system owner.

Testing Requirements:

Installation Testing: An installation test of the system shall be conducted at the conclusion of installation in the presence of the Engineer. The installation test shall simulate the full range of functions the anti-icing system is intended to provide. A successful installation test is required before the endurance test may begin.

Training

A minimum of one eight hour day of on-site training shall be provided by a qualified representative. This training shall cover operation, commissioning, seasonal commissioning/decommissioning and maintenance of the permanent automatic anti-icing system.

SZ-5 WARRANTY AND SUPPORT PERIOD

The Contractor shall warranty all parts and materials for the complete system for a period of three full years after the County's acceptance of the completed project based on satisfactory Contractor completion of all tasks as determined by the Engineer. All necessary replacement parts and materials shall be shipped to the County within three days of notification by the Engineer.

Software/firmware manufacturer shall support usability and performance upgrades for a minimum of five years. The Software/firmware

manufacturer shall also support maintenance upgrades for a minimum of five years after system acceptance. The Contractor shall provide software upgrades to the County as part of this agreement for the five year period.

The Contractor shall provide technical support at no charge to County for a period of three years after the warranty period. This support shall include any technical expertise requested by the County for repair and/or replacement of any system component or software. It shall include on-site technical support (maximum of two days per occurrence) during system start up and shut down.

The Contractor shall provide a rate for future system maintenance at a yearly rate to be accepted at the County's discretion to continue the warranty after the three year initial warranty period.

SZ-6 MEASUREMENTS AND PAYMENTS

The system detailed in the plans and special provisions Item No. 2100.601 (exclusive of handholes and conduit outside the bridge) shall be measured and paid for as an integral unit and shall be paid for at the Contract price per LUMP SUM, which price shall be compensation in full for all costs incidental thereto.

Payment for Item No. 2565.603 "3" NON-METALLIC CONDUIT" outside the bridge will be made at the Contract price per foot and shall be compensation in full for all costs for supplying and installing the conduit. This item includes the conduit drain described section SZ-3.1.

Payment for Item No. 2545.553 "HANDHOLE" will be made at the Contract price per unit and shall be compensation in full for all costs for supplying and installing the handholes described in the plans and special provisions.