

Research Project # 2001-056
Fixed Automated Spray Technology
August 19, 2011

Introduction

This research project evaluated the construction and performance of Boschung's Fixed Automated Spray Technology (FAST) system. The FAST system automatically sprays de-icing material on the bridge when icing conditions are about to occur. The FAST system includes the installation of a Road Weather Information System (RWIS) to monitor the roadway and weather conditions. The data collected from the RWIS determines if the de-icing material should be released on the bridge deck. The roadway sensors are programmed to submit to the RWIS a temperature reading up to three degrees less than the actual temperature, so the de-icing material is dispensed in anticipation of icy conditions. The FAST system provides a benefit to the traveling public, since de-icing materials are deployed at the appropriate time to prevent hazardous road conditions. The Department would receive a benefit with de-icing material being deployed only when required, instead of pre-treating in anticipation of freezing conditions.

Evaluation

Engineering District 1-0 provided two demonstration sites on SR 4034 in Erie County to document the installation of the FAST system and the RWIS during new bridge construction. The projects were located on the Wintergreen Gorge Bridge at Segment 0180 Offset 0092, and the bridge that spans over CSX and Zum Industries at Segment 0100 Offset 2100. The project had a minimum three (3) year evaluation period that began with placement of the system. Wintergreen Gorge Bridge installation was completed in November 2003. The bridge that spans over the CSX and Zum Industries was completed December 2004.

The work plan required the observation of the construction process and documenting any lessons learned from construction, so required revisions to the special provision could be made for future installation. Prior to the system being placed into service, the FAST system was tested to demonstrate that it could meet the operating requirements of the special provision; examples are the timing and sequencing of the spray operation, application rate, and spray height. The system was reviewed for the remaining evaluation period for UV damage, durability from traffic and resistance to snowplow damage.

Findings

During the construction and evaluation period of this research project, the following findings were discovered and should be considered during the design phase of the FAST system:

- The de-icing equipment should not interfere with or cause safety hazards for bridge inspection.
- There should be adequate available and accessible right of way for the pump house.

- The design of the anti-icing system should take place in conjunction with the design of the bridge. This should eliminate the need to cut and splice the rebar for proper placement of the spray disks.
- Review weather history to determine the appropriate storage tanks size for the de-icing solution. If the storage tanks are too small, frequent refilling will be required
- The special provision did not require an automatic shut-off for the filling valve. The tanks had to be watched as they were filled, so there was no overflow of the anti-icing material.
- Rigid galvanized steel (RGS) conduit should be used for exposed electrical and solution lines. PVC conduit for electrical and solution lines should be embedded in concrete or buried in soil.

During the long-term performance of the FAST system, the following lessons were learned from the evaluation:

- The spray disks were switched from the initial plunger disk to a micro disk. The micro disks are less intrusive to the structure, easier to maintain and less spray disk are required compared to the plunger disk.
- Salt brine was initially used with the system, since it lowers the surface freezing temperature to 15 °F. The salt brine was having an adverse effect on the plunger disk, and the disks were sticking open. Potassium acetate was used in the system for a short time to prevent this problem. When the plunger disks were replaced with the micro disk, the District switched back to the salt brine.
- There were not any excess maintenance issues with the FAST system. The District maintenance staff was able to perform most of the maintenance required on the FAST system, but the RWIS issues were resolved by the vendor.

Guidelines for Bridge Selection

The FAST system would be a benefit to many of the Commonwealth's bridges, but financial resources are not available to install the system on every bridge. The Department has developed guidelines to prioritize existing bridges that will receive the most benefit from the FAST system. Some major factors to be considered in the installation of the FAST system on a bridge are the following:

- History of crashes attributed to icing.
- Bridges located in an area susceptible to ice, for instance over streams and/or susceptible to high winds.
- Bridges with a high average daily traffic.
- Adequate space for equipment and the availability of electric and phone lines to run the system.

Implementation Plan

Bureau of Maintenance and Operations developed criteria to select candidate bridges for installation of automated anti-icing bridge system. Standard drawing for the bridge anti-icing system were included in the Index of Standards for Bridge Construction under standard drawing number BC-723M. The standards provide design procedures for both new and retrofitted bridges.

List of Attachments:

Work Plan

Field Reports

Guidelines for Selection of Bridges for Installation of Automated Anti-Icing Bridge System

Submitted by: Sheri Little, Research Project Manager, ETI, BOCM, PennDOT

Work Plan

RP# 2001-056 Evaluation of an Automated Anti-Icing System Installation

Introduction

As a continued effort to use Intelligent Transportation Systems (ITS) to improve our highway services, the Department would like to install an Anti-Icing System during the construction process on several bridges in Erie County District 1-0. Previously the Department has retrofitted one structure in Westmoreland County, one in Allegheny County, one in Warren County and two in Erie County with Anti-Icing devices. These structures were done through a Request for Proposals (RFP). The Anti-Icing system chosen was a proprietary system manufactured by Boschung America. Boschung's system is called the Fixed Automated Spray Technology (FAST).

FAST is an automated flush pavement nozzle that uses information from a Roadway Weather Information System (RWIS) and an active sensor. RWIS determines what the local weather conditions are through air and pavement sensors. If the RWIS is getting readings that icing conditions are about to occur, the FAST system will spray an anti-icing material on the bridge deck surface. This will reduce the chances of black ice occurring on that section of bridge deck. For more information and to see pictures of the FAST system go to www.boschungamerica.com under products.

To remain compatible with the other installations done so far, the Department would like to use Boschung's FAST system on several bridge construction projects proposed for Erie County. This evaluation would monitor this product for ease of construction, performance, durability, and any cost benefits.

Scope of Work

The project locations for the FAST construction installation would be the Wintergreen Gorge Bridge, SR 4034 Section A80 and the bridge over CSX and Zum Industries, SR 4034 Section A60. Both are in District 1-0 Erie County. See Work Plan Attachment A for location map.

Evaluation Period

A minimum three (3) year evaluation period that will begin with construction placement of the system. During construction, the installation and working demonstrations will be inspected and monitored. Following construction, field view investigations of the completed system will be conducted at one (1), two (2) and three (3) years after the final working demonstration.

Plan of Study

During installation of the FAST system in the bridge decks, District 1-0 and Bureau of Construction and Materials (BOCM) will inspect and monitor placement. Observations of any difficulties or changes that should be made to the special provision will be recorded for future installations. For special provision see Work Plan Attachment B.

After installation each system will be demonstrated before it is put into service. During the demonstration, the FAST system should show that it meets all of the requirements in the special provision. The adjustable pattern and spray height can be measured by using water in the system.

The system durability will be evaluated with respect to everyday weather conditions such as UV damage, traffic conditions, and resistance to snow plow damage over the three-year evaluation period.

Determining if the system has any cost benefits over current methods of removing ice will be looked at after the system has been in place for the evaluation period. During the evaluation Maintenance will be able to track material and repair costs of the system. The Bureau of Maintenance and Operations (BOMO) will provide this information to BOCM, so a comparison of the Automated Anti-Icing system to current practice can be analyzed.

Staff

The Project Manager for this research project will be Robin Sukley, PE, Section Chief, Engineering Technology and Information Division BOCM. The Principal Investigator will be Marcella Jo Lucas, Research Project Manager ETI Division BOCM.

Also assigned to this project will be:

Tom Fox, PE, Assistant Bridge Engineer and as needed Paul Miller, PE, Project Manager, both from District 1-0.

Alfred Uzokwe, PE, from New Technology Implementation, BOMO.

Reporting

Inspection and documentation of construction for this project will be completed by District 1-0 and ETI personnel. Construction includes the performance of a working demonstration of the system. All information will be forwarded to the Project Manager at BOCM.

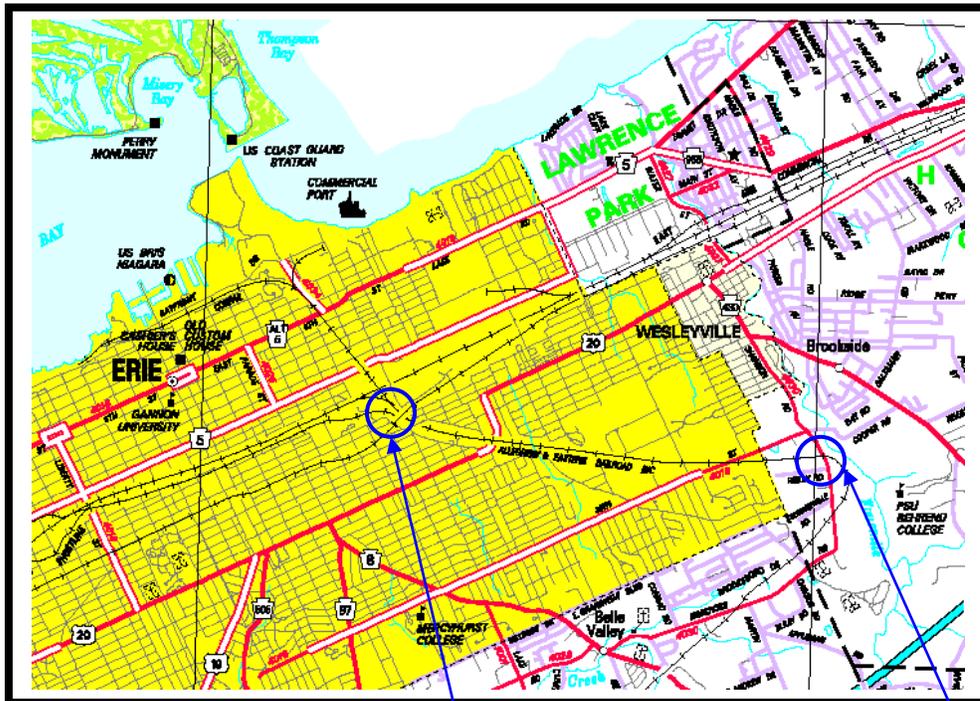
BOMO will assist the Bureau of Construction and Materials with any testing, report writing and specification writing that will be needed to complete this project.

A final report will be written after the completed system has gone through at least two winter cycles.

Attachment A

RP# 2001-056

Evaluation of an Automated Anti-Icing System Installation



Bridge over CSX and Zum Industries
SR 4034 Section A60
Erie County, Pa
District 1-0

Wintergreen Gorge Bridge
SR 4034 Section A80
Erie County, Pa
District 1-0

Location Map

Attachment B

RP# 2001-056

Evaluation of an Automated Anti-Icing System Installation

ITEM 9000-0101 - AUTOMATED ANTI-ICING SYSTEM

DESCRIPTION - This work consists of designing, furnishing and installing a permanent automated anti-icing system intended to prevent snow and ice from bonding to the pavement of the Wintergreen Gorge Bridge, SR 4034. The system includes the autonomous operation (no human activation required) being accomplished by the interface with a fully integrated Roadway Weather Information System (RWIS) utilizing active and passive pavement sensor probes as well as atmospheric sensors. This system will interface with and be controlled by the Engineering Office. Provide RWIS data to PENNDOT's Central Office for display on the internet. This item also includes the furnishing and installing of a salt brine production unit, at the Erie County Maintenance Building location, intended as a generator of salt brine that is used as a Pre-wetting, anti-icing, and/or a de-icing agent on pavement or roadways.

MATERIAL - Furnish and install a permanent automated anti-icing system, as manufactured or supplied by Boschung Co., Inc., 4115 Castle Butte Drive, Castle Rock, CO. 80104, Contact: Mr. Jerry R. Waldman 303-681-8942, to work automatically based on advance warning of imminent icing conditions from active and passive pavement sensors of an Roadway Weather Information System RWIS. Provide a permanent automated anti-icing system that operates in the temperature operating range of -30 degrees C (-22 degrees F) to +70 degrees C (158 degrees F).

1. Pump House

Construct a pump house to enclose the elements of the System as approved by the Engineer. The pump house is to be large enough to house the following:

- One 18,900 Liter (5,000 gallon) chemical reservoir
- One 950 Liter (250 gallon) water-flush reservoir
- Pump station control assembly
- Manual control box (wall mounted)
- RWIS driver board cabinet (wall mounted)
- High voltage cabinets for each pump (wall mounted)
- Power supply cabinet (wall mounted)
- Containment basin with a minimum of 110 percent chemical reservoir capacity
- 50 mm (2") sump pump

The features of the pump house are to include:

- 100 mm (4') thick reinforced high resistance concrete outside and dividing walls
- Flat roof with appropriate drainage
- Ventilation and aeration openings

- Containment basin insulated with approved epoxy sealant. The containment basin to have a minimum capacity of 110 percent of the chemical reservoir.
- Adequate support system for chemical reservoirs
- All reservoirs to be accessible for filling from vehicles parked at the Shannon Road pull-off area.
- Pit large enough for the supplied sump pump
- Concrete base for pump
- Plumb the chemical reservoir for re-circulation. Provide a pump capable of operating on a timer to re-circulate the material once a day.
- Fiberglass grating platform accommodating a minimum design live load of 3.8 kN/m(2) (80 psf) raised above the containment basin. The platform to cover the entire containment basin area up to 150 mm (6"), maximum of the storage tanks.
- 1.2 m (4'-0") clear area, minimum, for the wall with the electronic controls
- Door opening, above the containment basin, large enough for each individual item stored within the pump house to be removed through the opening while the other items remain in their permanent positions.
- Sheet-steeled door(s), that swing outward, for the outside wall opening
- Door lock(s)
- Fluorescent lighting with a single switch at the doorway opening. Provide High output fluorescent lights with low temperature ballast.
- Minimum of one 120 volt duplex receptacle on each outside wall (inside the pump house). The location of each receptacle to have unobstructed access.
- 70-watt high pressure sodium security light located on the outside of the pump house. This light to illuminate the house access door entrance area. Include a photoelectric sensor to provide automatic on/off capability during dark/light conditions.

2. Chemical reservoir

The system provided storage tank to be one - 18,900 Liter (5,000 gallon) tank. The tank to have a specific gravity of 1.5 or better.

3. Water-flush reservoir

A 950 Liter (250 gallon) water reservoir to be supplied for flushing the system and roadway. The tank to have a specific gravity of 1.5 or better.

4. Pump Station Control Assembly

A pump station control assembly including pump(s) and motors as required. The system provided pumps to be sized to adequately assure proper operation of the system and operate on 220 VAC.

5. Programmable system controller

Provide a system controller that controls the operation of Boschung Co., Inc. equipment for compatibility with the Department's existing systems.

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

Software in a Windows NT - based platform.

System logic that incorporates the atmospheric meteorological sensors and the pavement sensor parameters to determine proper automatic system operation and flexible system control for the user.

Software programs that can be set to automatically activate the system prior to freezing conditions for a truly automatic anti-icing system. Software to allow for system activation at different thresholds before freezing (1,2,3 degrees before freezing).

Capability of working with multiple chemicals (pre-wetting of truck loaded material).

System to not require re-calibration with each different chemical used.

System activation when road moisture is at or near freezing (user settable thresholds)

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

System activation when chemical dilution is occurring (user settable thresholds)

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

Accurate system activation without calibration of pavement sensors with changing chemicals

Immediate system activation when falling snow or freezing precipitation is detected (user settable thresholds)

The ability to include other weather parameters in the system logic such as low temperature lockout, wind speed lockouts/thresholds, relative humidity, etc. (user settable thresholds)

The ability to have different software programs apply different application rates with different weather conditions (examples only):

59 liters per lane/kilometer (25 gallons per lane mile) rate for anti-icing mode for frost.

83 liters per lane/kilometer (35 gallons per lane mile) during snow event.

Rates varied by nozzle spray timing and number of firings.

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

The system to monitor and alarm for tank levels of low and or empty.

Ability to activate a warning device before the spraying operation commences.

Capability of going through a system evaluation before activating the spraying operation. This system evaluation to check for system leaks, low chemical reservoir level, and other system defects and to not activate the system if any of these conditions exist. During system activation, the system to evaluate if individual nozzles do not activate and to document in system log and alert the operator (at the Windows NT Server) of these conditions.

The system to be able to apply measured amounts of liquid de-icing chemicals to the roadway sections. Control of the application of the liquid chemicals to be fully automated with provisions for operator intervention and notification. The automated control system to include full atmospheric sensor capabilities and include the active and passive pavement sensor technology.

The system to have different spray programs available for activation of the various nozzles and separate timed sequences. The capability to be available for each spray nozzle to be programmed to spray for a specific length of time (selectable to be open between 1 - 10,000 milli-seconds). The capability to be available to change the length of pauses between "nozzle spraying" (selectable from 1-10,000 seconds).

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

Manual operation either locally or remotely; system options:

Manual pushbutton at the site.

Wireless activation from any phone (pager activation).

Computer activation from a Windows based PC software.

Ensure that the entire system is capable of automatic interface with other ITS components such as variable message signs and highway advisory radio systems.

The system to provide for a single push button reset of normal functions upon completed system repairs or inspections. The system to automatically detect system defects and takes action without operator intervention to prevent system damage or environmental damage.

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

Fully Automated - The system operation to be automatic utilizing user-defined parameters and the pavement and weather conditions sensed by the RWIS.

Manual Override - The system to allow for manual override of the automated mode. The system to make this available locally at the site or remotely.

Fully Manual - The system to respond only to a user-generated command. Manual control options to include the override ability by networked computers, modem, manual on-site pushbutton (locking), telephone, or hand held remote controller.

The system to be able to detect chemical leakage and restrictions within the spray system. This includes the main feed lines as well as laterals feeding individual nozzles. Additionally, the system to be capable of detecting hardware failures in all other connecting systems and alerting the system user of the problem.

The system to be able to detect problems and compensate for these problems. The system to automatically notify system user of detected problems including location of abnormalities and actions taken.

The system to automatically provide tracking of material used by the anti-icing system. The system to provide inventory control. The system to have the ability to detect and report tank levels at all levels (percentage of chemical in tank). The status of the tank level to be reported to the user using the communications system. The system also to have alarms for full tank, low level requiring refilling, and low level (not enough chemical to run system) providing an alarm to the operator and system shut-off to prevent system damage. All level alarms to be settable by system user.

Install and test the control software on three of the following computers:

New computer (provided as part of this item) at the Erie County Maintenance Office.

Existing computer at the District Engineering Office in Oil City, PA

Existing Erie County Maintenance Office laptop computer

Provide two (2) software packages with full documentation to the Department.

Notify the County and District Offices at least 120 days in advance if dedicated phone lines are required in these offices for this system.

6. Spray and application system hardware

Provide hardware to operate Boschung Co., Inc. equipment for compatibility of the Department's existing systems.

The entire permanent anti-icing spray system components to consist of material that is resistant to corrosion from whatever chemical is selected for use in the system at normal environmental conditions at the bridge site.

Any equipment/materials provided to be weather resistant and UV stabilized.

The system provided spray and application system hardware to be capable of storing, re-circulating, pumping, and spraying any selected liquid

de-icing chemical. This operation to be under the control of the automated system controller.

The system to be capable of returning the chemical within the system application equipment back to the storage reservoir prior to beginning flushing of the system with water.

The system to be capable of providing a constant pressure of 1 M Pa (145 psi), minimum, at each spray disk location regardless of the spray disk location.

The system provided must be designed for automatic system shut-down if during system checks prior to system chemical applications or during system operations of any kind, a system leak is detected by monitoring system pressure and flow, the system will automatically be put in shutoff mode.

There is to be no exposed tubing. All tubing used for carrying liquid to be enclosed within conduit.

Install all conduits under the bridge along the inspection walkways. The conduits cannot interfere with inspection access. Provide for expansion and contraction of conduits at the bridge expansion bearings located at the abutments.

Seal the entire system to prevent de-icing chemicals from leaking onto the steel superstructure.

Provide system access to system components for future maintenance.

The system to involve no cutting of, or welding to, any steel beams. Bolting to flanges without damaging paint is acceptable.

The system to be able to safely store and apply the commonly encountered liquid de-icing chemicals. Those liquid chemicals include but not limited to: Calcium Chloride (CaCl), Magnesium Chloride (MgCl), Potassium Acetate (Kac), Sodium Chloride (NaCl), Calcium Magnesium Acetate (CMA), CMA/Kac blend (CMAK).

The system to be capable of controlled applications of liquids in the range of 20 to 330 liters per lane/kilometer or 0.006 to 0.10 liters per square meter (3- 55 gallons per lane mile).

Interface the system with the Department's web page for Roadway Weather Information Systems. Provide hardware and software as required by the Bureau of maintenance and Operations.

7. Spray disks

Provide spray disks manufactured by Boschung Co. Inc.

The system provided spray disks to be flush mounted in the roadway surface and be able to withstand normal traffic and snow plowing procedures conducted with maintenance trucks.

The spray disks to be preformed into the bridge deck within the 50 mm (2") concrete cover area above the reinforcement bars. Seal the spray

disks, fittings and couplings to prevent de-icing chemicals from leaking. The maximum conduit/pipe size through the bottom of the bridge deck that accesses the spray disks is 50 mm (2"). There is to be no drilling or coring of the bridge deck after the concrete is cured. Re-space and provide additional deck reinforcement bars as required.

The height of the liquid stream from the spray disks not exceed 400 mm (15") above the traveled lane when applying the liquid. The spray disks to have individual spray nozzles (minimum of six) that can be replaced to adjust spray pattern, the spray disk must be adjustable after it is set in place, and inner spray assembly to be easily replaced when damaged or if different spray patterns are required. The spray disk to be capable of providing for spray coverage for up to 4 lanes of traffic.

The spray disks to be located within the pavement at spacing distances that provide adequate coverage for the spray pattern, including vehicle tracking. Locate spray disks so that they do not spray directly onto the expansion dams at each end of the bridge. The spray disks are to be spaced to prevent snow and ice from bonding to the pavement of each travel lane on the bridge, including turning bays.

Spray disks are not permitted in the parapets.

The spray nozzles to be made of a synthetic material to prevent the potential of corrosion.

The spray disks to be capable of adjustment for future pavement overlays.

8. Roadway Weather Information System

Provide RWIS equipment from Boschung Co., Inc.

RWIS integration for automated activation/monitoring of the anti-icing system. The RWIS System and the remote processing unit will allow for total flexibility in the selection of meteorological sensors and the system adaptability. The system to include the integration of active and passive pavement sensors.

The RWIS provided to communicate to a Windows NT Server with a Graphic User Interface (included with this project) by phone communication. The RWIS system to interface with the Department's RWIS Web Page.

The RWIS provided to have the capability of adding future optional atmospheric sensors.

Air Temperature - The system to provide air temperature sensor reports from the range of -40 degrees C (-40 degrees F) to + 60 degrees C (140 degrees F).

Relative Humidity - The system to provide relative humidity range from 0 to 100 percent.

Wind Speed and Direction - The system to provide wind speed and direction sensor with a threshold 1.61 km/hr (1 mph) and is able to report wind speeds of up to 209 km/hr (130 mph).

Dew Point - The system to provide a Relative Humidity Sensor that is used to calculate the dew point. The dew point to be calculated in 1-degree increments ranging from -18 degrees C (0 degrees F) to +38 degrees C (100 degrees F).

Barometric Pressure - The system to provide for the option of an atmospheric pressure sensor: measuring in the range of 920 - 1080hPa with accuracy of 0.2hPa.

Precipitation - The system to provide for a precipitation sensor that will measure the type of precipitation (rain, snow, hail) and the rate from the range of -40 degrees C (-40 degrees F) to + 60 degrees C (140 degrees F).

Still Frame Video - The system to include still frame color video as part of the system and also advanced video image processing for full traffic detection such as counting and classifying traffic as well as measuring wrong way traffic, incident detection, etc.

Locate this equipment at appropriate locations on a fold-over tower so that the equipment can operate as specified by the manufacturer.

Install an instrument fold-over tower so that the tower can be lowered parallel to SR 4034 and each instrument is accessible, by someone standing at ground elevation, while the tower is in the lowered position.

Subsurface Sensor - Provide a subsurface temperature probe that can measure the temperature below the roadway pavement surface. Provide temperature-sensing element that operates over the temperature range from -30 degrees C (-22 degrees F to 80 degrees C (176 degrees F)), and that provides heat flux and frost depth data with an error rate of less than 5 percent.

Roadway Condition Sensors - The system to include RWIS pavement sensors that consist of active and passive pavement sensors.

The system provided pavement sensors to be capable of providing temperature in the range of -34 degrees C (-30 degrees F) to +43 degrees C (110 degrees F) and the sensors shall be capable of surviving the temperature extremes of minus range -40 degrees C (-40 degrees F) to +80 degrees C (175 degrees F).

The system provided pavement sensors to report the conditions of wet, dry, or icy roadway surface conditions.

The system provided pavement sensors to report the freeze point temperature present on the roadway surface and display the correlating concentration of chemical. The sensors to provide this information regardless of the selected chemical and have the capability of working with multiple chemicals.

Install the surface and subsurface sensors in the SR 4034 shoulder near the RWIS unit.

This sensor technology to work with any anti/de-icing chemicals, multiple chemicals, dirt, traffic friction and other remaining

residuals on the road surface that can change the freezing point temperature. This sensor to also allow for "stand-alone use", in that, additional meteorological sensors are not required for the system logic.

Additional Sensors - Provide two sensors, one active and one passive for the proposed System.

9. Salt Brine Production Unit

Furnish and install a salt brine production unit as manufactured by Sprayer Specialties, 5149 NW 11th Drive, Des Moines, IA 50111, 515-986-3259 or Dultmeier Sales LLC, 13808 Industrial Road, Omaha, NE 68137, 1-800-228-9666 or approved equal and meeting the following minimum specifications:

Designed to convert rock salt to salt brine.

System is to produce a minimum of 11,360 liters (3,000 gallons) per hour of 23 percent salt brine and store/maintain a supply of salt brine.

Discharge system is to have a minimum 530 liters/minute (140 gallons/minute) stainless steel water pump, or equal, with minimum 5 cm (2 inches) inlet and minimum 3.8 cm (1.5 inches) outlet and 2,240 watts (3 hp) minimum size motor.

System is to be capable of pumping the brine into application and storage tanks.

Main water inlet is to be 5 cm (2") diameter coupling.

Frame and tanks are to be of 304 grade stainless steel construction.

Equip mixing tank with a mechanical cleaning system. Shoveling, vacuuming, or flushing sludge through drain cleanout methods is not acceptable.

Furnish all necessary components, hoses, wiring, mounting brackets and clamps to facilitate the complete installation and to provide a complete working system.

Supply two manuals for each unit and include installation, operation, service and parts information as well as a complete illustrated parts list, also include plumbing and wiring schematics.

Provide appropriate plumbing and plumbing components to properly operate and control salt brine production unit.

Provide an electrical service that is protected from hazardous shock through a 15 AMP, minimum, 110 VAC Ground Fault Interrupter Circuit Receptacle with trip and reset - Enclose in a waterproof outdoor service PVC plastic junction box and weatherproof plastic outlet cover. Provide an outdoor weatherproof remote toggle switch to pump. Provide watertight plastic strain relief connectors on both ends of remote cable.

Upon acquisition of the salt brine production unit, coordinate delivery and installation with Mr. George Puskar, Erie County Maintenance Office at 9031 Peach Street, Waterford, PA 16441, phone (814) 871-4411.

10. Warning Signs

Install "Anti-Icing In Progress" (W8-22) and "When Flashing" (W8-22-1) advance warning signs at the following locations and as indicated on sketch entitled "Anti-Icing Signs" attached to the proposal.

Westbound SR 4034 prior to the bridge structure as shown. Sign size to be 1200 mm X 1200 mm for the W8-22 sign and 600 mm X 750 mm for the W8-22-1 sign.

Eastbound SR 4034 prior to the Shannon Road intersection as shown. Sign size to be 1200 mm X 1200 mm for the W8-22 sign and 600 mm X 750 mm for the W8-22-1 sign.

Northbound Shannon Road prior to the SR 4034 intersection as shown. Sign size to be 900 mm X 900 mm for the W8-22 sign and 450 mm X 600 mm for the W8-22-1 sign.

Southbound Shannon Road prior to the SR 4034 intersection as shown. Sign size to be 900 mm X 900 mm for the W8-22 sign and 450 mm X 600 mm for the W8-22-1 sign.

The signs to include flashing warning lights. The signs with flashing lights to be installed on ground mounted posts. Refer to Publication 149 Traffic Signal Design Handbook. The system to activate the flashing warning lights when anti-icing is in process.

Provide the necessary flasher controller, conduit and wiring to operate the flashing warning lights.

11. Communication Methods

Provide communication equipment for Boschung Co., Inc. equipment.

The system to allow the user to exercise all user-controlled functions from either a remote or on site connection using a standard computer. The system to also be capable of transmitting pavement condition and weather reading information from the RWIS site to remote site.

The system provided to be capable of two-way communication with the user using any or all of the following methods:

Computer Network - The system to be capable of networking with user computer networks. The system to utilize a Window NT Server. The server to network with standard computers via modem, network router, and frame relay, etc.

Telephone Modem - The system to be capable of supporting conventional telephone modem operation. This capability to include the ability to originate, or receive, calls to remote control sites.

Onsite Hook-up - The system to provide the capability for local (on-site) connection of a portable computer using RS-232C serial interface protocol.

Provide standard equipment and software with TCP/IP (Transmission Control Protocol/Internet Protocol), PPP (Point to Point Protocol), and SNMP (Simple Network Management Protocol) to assure the RWIS and the vendor have the capability to support the future NTCIP-ESS data communication standard when available.

12. Cable and Conduit

No direct burial wiring. All wiring to be copper or approved equals and be installed in appropriate conduit. Install wiring in accordance with NEC and local electrical codes.

Install electrical cable and conduit in excavated trenches and attached to structures as required. Install the cable and conduit within unpaved areas and attached to the bridge structure.

Provide expansion joints as required for the installation.

Raceways (housing for chemical pressure piping and low voltage control wiring), to be galvanized rigid conduit on the bridge structure and PVC in buried approaches to structure. The raceways on the bridge structure are to be within holes on the inspection walkway handrail.

All attachments to the structure must be approved by the District Bridge Engineer.

The material to be in accordance with applicable portions of Sections 350.2, 431.2, 501.2, 503.2, 910.2, 1101, 1104 and as follows:

Conduits. Section 1101.09, and as follows: At locations where rigid metal conduit (RMC) is used, provide conduit meeting the requirements of Section 1101.09(c)1.

Electrical Cable. Furnish and install power distribution cable in new conduit or aerial. Provide XHHW cable in accordance with Section 1101.08(c) for XLP cable.

The construction to be in accordance with Section 910.3(q); Section 910.3(h), except paragraphs 6, 7, and 9; Section 920.3(h); Section 920.3(I) paragraph 1; Section 954.3(b); and as follows

Electrical Wire and Cable. Furnish and install all necessary spade lugs, crimped solderless connectors, recessed-screw barrier-type terminal blocks, tape, Engineer-approved waterproofing material, wire wrap, UV resistant nylon wire ties (if used external to cabinet), grounding wire, ground rods and all other material necessary to install and connect the wire and cable to form a fully functioning system.

Where wire or cable is installed in conduit, use only a cable pulling lubricant approved by the Engineer. Seal all wire and cable ends with an approved material and technique to exclude moisture until properly spliced or terminated.

Dress all field wiring entering a cabinet against the walls of the cabinet. Harness, clamp, or lace field wiring as required. Additional clamping, lacing, or harnessing may be required by the Engineer for an acceptable installation. Terminate all electrical wire on binding post termination blocks.

Do not make any electrical splices at any point in the work required by this contract except at recessed-screw, barrier type terminal strips in the equipment cabinets. Do not install terminal strips on the floor or bottom of equipment cabinets.

Do not make any electrical splices in conduits. Do not make any electrical splices in junction boxes except as specifically approved by the Engineer.

Protect all new conductors and cables from damage and from moisture and water absorption.

Conduits: This item includes all installation hardware, such as: fittings, spacers, warning tape, etc.

General. Plug all unused conduits at every cabinet and junction box.

Trenching and Backfilling. In accordance with Section 910.3(c) and as follows:

Make necessary adjustments to avoid obstructions and underground utilities. Place warning tape in the last lift of backfill, within the last 50 to 200 mm (6 to 8") of the trench, for the entire trench length.

Trenching in unpaved areas (Trench and Backfill, Type A). In embankment areas with existing guide rail, excavate the trench a minimum of 0.3 m (1') behind guide rail. Replace disrupted or damaged guide rail at no additional cost to the Department. In cut areas install the trench a nominal 0.6 m (2') from the edge of shoulder, unless otherwise indicated or directed by the Engineer.

Replace any concrete paved ditches removed for trenching operations to the original condition.

Conduit Installation on bridge structure - Attach the proposed conduit to bridge structure abutment. The raceways on the bridge structure are to be within holes on the inspection walkway handrail.

All attachments to the structure must be approved by the District Bridge Engineer.

Risers. Furnish and install risers with screw-on weather heads as indicated. Provide risers that meet the requirements for rigid metal conduit specified.

Conduit Installation. In accordance with applicable portions of Section 910.3(q) as indicated, as shown on the Standard Drawings and as follows:

Multiple conduit trenches. When installing multiple conduits in a single trench, install the conduit as indicated and as follows: Provide 150 mm (6") minimum vertical clearance between successive rows of conduit.

Provide 50 mm (2") minimum between the trench edges and the conduit.

Maintain a minimum vertical of 0.96 m (38") for trenches in unpaved areas, between the top of trench and the top of the upper layer of conduit.

Install high-impact plastic spacers a maximum of 2.4 m (8') or center, when more than two conduits are installed in a common trench.

13. Common Electrical Provisions

Install new power distribution equipment to provide the necessary electrical distribution to the proposed field equipment.

The material to be in accordance with the following:

Junction Boxes. Section 1101.10(a) and as follows:

Modify the size of junction boxes shown in the Standard Drawings as required to meet the requirements of the National Electrical Code, Article 370-28.

Exposed Junction Boxes. Section 1101.10(a) and Section 1102.06, sized to meet the requirements of the National Electrical Code, Article 370-28.

Surge Protection.

General Requirements. Equip all ungrounded conductor wires entering or leaving any equipment cabinet with surge protectors suitable for protection of electrical systems operating at 600 volts and less. Surge protection is incidental to the protected equipment and will not be paid separately. Arrange the equipment and cabinet wiring such that the distance between each conductor's point of entry and the protector is as short as possible, and locate the protector as far as possible from electronic equipment. Ensure that all wiring between the surge protectors to the ground rod serving the cabinet or to the cabinet wall. For purposes of this section, multiple cabinets on single foundation are considered a single cabinet. Store all conductor cable slack in junction boxes, not in equipment cabinets.

Provide surge protectors for the following types of conductors and cables: low-voltage signal pairs; cables carrying power for VMS heaters; 120-volt electric power lines; power cables carrying more than 120 volts; telephone lines; and cables carrying video signals. Provide surge protectors meeting the following general requirements:

Maximum continuous operating voltages must not be less than 115% of the nominal system operating voltage.

All surge protectors must be UL 1449 listed and bear the UL label.

All metal oxide varistors used for surge protection are to be 20 mm (0.8 inches) in diameter or larger and rated in the appropriate voltages.

Low-voltage Signal Pairs. Protect low-voltage signal pairs with two-stage, plug-in surge protectors. Provide protectors meeting or exceeding the following minimum requirements:

Suppress a peak surge current of up to 10,000 amps.

Response time of five nanoseconds or less.

The protector is to clamp the voltage between the two wires at 8 volts and clamp the voltage between each wire and ground at 50 volts.

The first stage of protection is to be a three-element gas discharge tube, and the second stage consists of silicon clamping devices.

There are to be no more than two pairs per protector.

Replaceable without using tools.

Power Cables for Heaters. Protect cables carrying power for heaters with ground metal oxide varistors of appropriate voltages.

120-volt Electric Power Lines. Protect 120-volt electric power lines at the cabinets with a filtering, two-stage surge protector. Install the protector on the load side of the main circuit breaker. The two stages are to be electrically separate, so that the first stage protects all equipment using the power, while both the first and second stages protect electronic equipment.

There is no maximum load for the first stage. The second stage must be capable of protecting equipment drawing a total of 10 amps. Have the protector clamp both the main line and the main neutral at 250 volts, both relative to each other and relative to cabinet ground. Provide surge protectors meeting or exceeding the following minimum characteristics:

Capable of accommodating a continuous service current to electronic equipment of up to 10 amps at 120 VAC and 60 Hz, and having no limit on the continuous current drawn by devices that are protected by the first stage.

Suppress surges of up to 20,000 amps.

Electric Power Lines Above 120 Volts. Power at voltages above 120 volts is converted to 120 volts by use of a step-down transformer located outside the cabinet. (This transformer is provided as part of the cabinet electrical service.) Equip the primary side of this transformer with a surge protector that can withstand 10,000 amps surge (8/20 microsecond combination wave) and is designed for outdoor installation. Connect the protector to the load side of the main breaker. Protect the secondary side of the transformer inside the cabinet as described above for 12-volt power lines.

Telephone Lines. Equip telephone lines with surge protectors meeting or exceeding the following minimum characteristics:

Clamping voltage of 200 volts between the conductors.

Response time of five nanoseconds or less.

Bipolar silicon avalanche diode technology is to be used in a single stage device.

Dissipate a minimum of 5 Joules.

Video Signal Cables (if required). Equip cables carrying video signals with surge protectors meeting or exceeding the following minimum characteristics:

Clamping voltage of 11 volts between the shield and center conductor signal line.

Response time of five nanoseconds or less.

Bipolar silicon avalanche diode technology is to be used in a single stage device.

Dissipate a minimum of 50 Joules.

BNC connectors.

Pass signals from DC to 80 MHz with less than 2 dB insertion loss.

Electrical Service. Section 1104.05(d) as indicated, and as follows:

Provide a circuit breaker panel for incoming power, equipped with enough breakers to supply all the equipment powered from the cabinet. No breaker to be smaller than 15 amps. If power is supplied using a step-down transformer, install the breaker panel on the secondary side of the transformer. Provide a removable, clear Plexiglas shield over all exposed terminal blocks carrying 60 volts or more.

For cabinets with 240-bolt electrical service, provide step-down transformers and a circuit breaker on the primary side of the transformer. House the transformer in a weatherproof enclosure mounted to the outside of the equipment cabinet it is servicing. Calculate the final total electrical load presented at each cabinet and size the transformer and breaker accordingly. Where multiple cabinets are on a single foundation or pole, one transformer and breaker will serve all the cabinets. Prior to purchasing any transformers, submit all calculations to the Engineer for approval. No separate payment will be made for step-down transformers.

Wooden Utility Pole. Provide a wooden utility pole as described in Section 1101.11(a) necessary for the installation of electrical services as indicated.

Additional Utility Cost. Include all costs charged by the utility company in order to deliver the required service to the roadside equipment cabinet.

The construction to be in accordance with the following:

Bonding and Grounding. Section 910.3(q), Section 810.3(u), Section 954.3(c), and as follows:

Field Equipment.

Grounding. Install all equipment cabinets, weather monitoring station poles, and sign structures with ground connections to one or more driven ground rods. If multiple cabinets are located on the same foundation or pole, only one set of driven ground rods is required.

Based on the soil conditions in the project area, and where space is available, several shorter ground rods may be installed rather than attempt to install one long rod. The installation of two or more ground rods connected in parallel provides a means of reducing the grounding system resistance. When two or more vertically-driven ground rods are installed, they should be separated by not less than six feet, in accordance with NEX Section 250-84, and preferably at least twice the rod length, to minimize mutual resistance. Only drive ground rods into undisturbed earth or thoroughly-compacted filled areas.

Measure the system resistance-to-ground as soon as the installation is completed. Measure the resistance-to-ground by a ground tested using either the "Fall of Potential/Three-Point Measurement Method" or the "Empirical 62% Method." If the measured resistance is greater than 25 ohms, enhance the ground system by installing additional ground rods or by using ground treatment materials that are permanent, environmentally-safe, moisture-independent, and non-corrosive. Ground treatments containing metallic salts are not acceptable. Record and report the measured ground resistance to the Engineer.

Electrical Service. Construct the electrical service according to Section 954.3(e).

Wooden Utility Pole. Install the wooden utility pole according to Section 910.3(k).

14. Utility Coordination

Coordination with the utility agencies to be performed in order to identify the locations of existing aerial and underground utilities.

For any work that involves trenching and excavation, contact all utility agencies (aerial and underground) located within the work areas for marking of their existing facilities prior to any operations, in accordance with the provisions of Act 287-1974 and as amended by Act 187-1996. In addition, comply with all Department and utility industry safety provisions/codes.

Act as the agent of the Department in locating the existing ITS Systems cables and conduits for any agency or Contractor doing work in the vicinity of the systems. Stakeout cables and conduits as necessary to prevent damage to the systems communications and power systems.

15. Computers

Provide and install one window-based desktop and one laptop computer capable of running the software to monitor the Boschung Co., Inc. system with the following minimum system configuration:

IBM compatible with Intel Pentium III CPU operating at 800 MHz and a minimum 200 watt power supply. Windows 2000 software to match the central computer, and approved by the Department.

Minimum of 256 megabytes of Random Access Memory (RAM).

Internal (20) gigabyte hard drive and internal 3.5", 1.44 MB floppy drive.

Super Video Graphics Array (SVGA) color graphics capability with 256 colors.

17" digital color monitor, SVGA, 1280X1024 non-interlaced resolution.

8 MB PCL Video Card with accelerator.

CD R/RW Drive at least 32 speed internal.

Standard 101 key keyboard and two-button mouse.

Internal 56 kilobytes per second (Kbps) modem with communications software allowing dial-up connections to a central computer station.

Sufficient parallel and serial data ports and card slots as required for interfacing with other equipment provided.

Provide a 56 K modem

Upon acquisition of the computer and modem, deliver to Mr. George Puskar, Erie County Maintenance Office at 9031 Peach Street, Waterford, PA 16441, phone 814-871-4411 for verification and acceptance. Upon verification, install the computer in the Erie Maintenance Office and the modem at the portable system controller location.

Provide all necessary hardware and software to be compatible with a windows-based 2000 platform. Display data output in both text and graphics by site. Provide all necessary programming to include system interoperability between the County office, Engineering District and Central Office in Harrisburg, PA. Provide all hardware to compute, print and display data.

16. Training

Provide training to Department staff on the operation of the equipment and software being supplied as part of the entire anti-icing system. Videotape all training courses, using VHS cassettes. Deliver the cassettes to the Department at the conclusion of training.

Operator Training. Conduct training courses at a Department-provided location at a time mutually agreed upon by the Engineer and the Contractor. The course to be a minimum of 12 hours in duration, for up to 12 people. Conduct the course in increments of between four and six hours (e.g. provide three days of training for four hours each day, or

provide two days of training for six hours each day). Initiate the course no later than 14 days prior to the initiation of the System Completion Test. Provide training material for the courses containing "hand-outs" for each attendee which will serve not only as subject guidance, but a quick reference material for future use by the students. Deliver all course material, in reproducible form, to the Engineer immediately following course completion.

The course must utilize, to the greatest extent possible, the provided system operation and maintenance manual documentation. Use the training course to familiarize the students with all documentation that has been provided as part of this project.

At least 30 days prior to commencement of the training course, submit to the Engineer a detailed course curriculum, draft manuals and materials, and resume(s) of the instructor(s). The Engineer will review and approve the course submittal data as appropriate. Provide three copies of the approved course materials at least seven days in advance of the scheduled course, and another 12 copies on the day the course starts.

Provide qualified instructors and training material in order to present formal classroom as well as "hands-on" user training in the operation of the equipment and software being supplied as part of the system expansion. At a minimum, the course must include use of all relevant features of the software for all subsystems.

Operational Support Training. Provide operational support training that entails additional as-needed training during the two-year warranty period. Upon notification during normal business hours, provide assistance to District operators either by phone (within 24 hours of the request) or with an on-site visit (within one week of the request). Operational support training associated with malfunctioning or improperly installed equipment will not be paid under this bid item, and instead will be considered part of the in-service warranty described in Section 106.14.

Includes all course materials, student hand-outs, manuals, and time and expenses for the instructor(s) to successfully carry out the training described in the Special Provision.

17. Documentation

The following drawings to be provided.

Construction and system Layouts (90 days prior to bridge anti-icing installation operations). Have all equipment attached to the structure approved by the District Bridge Engineer in advance of system layouts.

Hydraulic Schematic (upon project completion).

Electrical Schematics (upon project completion).

As Built Drawings (upon project completion).

System operation and maintenance manuals (3 sets) with a preventative maintenance schedules (upon project completion).

18. Warranty

Warrant all components of the Automated Anti-icing System and the Salt Brine Production Unit for defects in material and workmanship for a period of two (2) years, after a 30-day test period and project acceptance. Both material and labor to be covered by this warranty.

Provide a "Parts Only Replacement" warrantee on the pavement sensors and spray nozzles of the Automated Anti-icing System for a period of one (1) year after expiration of the above two (2) year warranty.

Repair faulty workmanship, repair or replace defective materials or equipment and correct all system malfunctions within 48 hours after commencing repairs.

Commence repairs or replacements no later than the working day following notification of failures or malfunctions.

Guarantee repairs or replacements for the balance of the 2 year warrantee period, or 30 days, whichever is the longer period.

Provide the Engineer with the name and telephone number of the person to be notified in the event of failures or malfunctions during the warrantee period. Satisfactorily restore areas damaged by construction.

Have a technical representative from Boschung Co., Inc. present during installation of the Automated Anti-icing System.

MEASUREMENT AND PAYMENT - Lump Sum.

FIELD REPORT

TO: ROBIN SUKLEY, PE
FROM: MARCELLA JO LUCAS
SUBJECT: RP# 2001-056 FAST ANTI-ICING DISTRICT 1-0 ERIE COUNTY

DATE: MAY 7, 2004
CC: JOHN HUGHES, FILE

WEDNESDAY MAY 5, 2004

We went to the SR 4034 Sec A60 site for research project # 2001-056. At the site met Michelle Morningstar Project Manager for PENNDOT at the Field Trailer (814-454-2005) to discuss the progress so far of Boshung's design and placement of the FAST Anti-Icing system. Boshung is continuously updating the design as the structure is placed. ETI will need to get a complete set of 1/2 size plans for the file when the design is final. The structure is being placed in half-length construction, due to the three railroads that cross under the structure. Bruce Merrilees is the sub-contractor for the FAST system. At this point conduit has been placed in the deck area and along the parapet area. The valve boxes are being placed in the shoulder area, this is different, then the SR 4034 Sec A80 Wintergreen Gorge site that placed them underneath the deck in the catwalk area. The wooden puck forms have been placed in the deck area. These forms are where the spray disks will be placed in the final deck. The concrete will be placed in the next couple of weeks. From here, we drove over to the SR 4034 Sec A80 site, the structure was completed last year and the system was put into use in October of 2003. This site will need to be monitored at least for two more winters.

FIELD REPORT

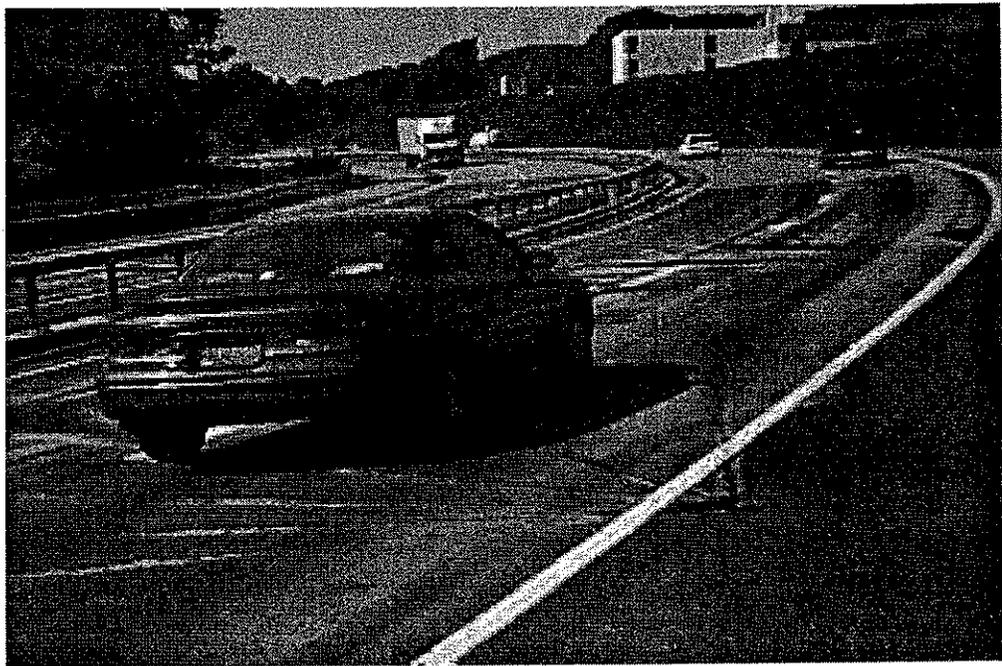
TO: ROBIN SUKLEY, PE
FROM: MARCELLA JO LUCAS
SUBJECT: RP# 2001-056 FAST ANTI-ICING
DISTRICT 1-0 ERIE COUNTY
DATE: 10/26/2004
CC: RODNEY KLOPP, FILE

THURSDAY OCTOBER 21, 2004

We traveled to the FAST A60 location. The prime contractor has most of the work on the bridge structure complete. The sub-contractor Bruce and Merrilees Electric Company had the conduit, junction boxes and forms placed before the deck was poured. They are now working on removing the forms and placing the FAST spray heads (hockey pucks) and weather sensors in the deck. It looked like two of the spray heads had been placed before we arrived, since the weather is damp and starting to mist the epoxy that the heads are placed in will not set up very well today. The Blockhouse arrival should be in the next couple of weeks. Project completion should be before the end of the year. Running test cycles of the system with a salt solution or Potassium Acetate will be in the next couple of weeks.

5

Guidelines for selection of bridges
for installation of automated anti-
icing bridge systems.



Bureau of Maintenance and Operations
Pennsylvania Department of Transportation

Acknowledgements

Many thanks to the following for their contributions towards the development of the guidelines either by providing or reviewing provided material:

- * Gary Hoffman, P.E. – Chief Engineer
- * Robert M. Peda, P.E.- Maintenance Bureau Director
- * Asst District Engineers - Maintenance
- * Donald F. Wise – Maintenance Division Chief
- * Alfred Uzokwe, P.E.- New Technology Implementation Mgr.
- * Doug Schmitt- Roadway Program Mgr
- * Paul Miller – RWIS Coordinator, 1-0
- * Scott Christie, P.E,- Bridge QA Chief
- * Bryan Spangler, P.E.- Bridge Division
- * Larry Billotto – Maintenance Programs Engr.
- * Members- Winter Technology Research Committee.



March 19, 2001

Introduction:

Black ice is a phenomenon whereby condensed moisture settles on the road or bridge surface. At temperatures below 32 degrees, this creates a thin but dangerous layer of "shiny" ice. Freezing of pavement moisture is more prevalent on bridges since cold air passes above and below the bridge decks, increasing their propensity for freezing.

Black ice on the bridge deck is not very visible to the naked eye, as a result, unsuspecting motorists run into it with consequent loss of traction. Sometimes this unfortunate occurrence results in deadly crashes.

Frost is another culprit that wreaks as much havoc as ice on bridge decks. These two phenomena are almost treated as one and the same by maintenance operatives, because the consequence of leaving them on the deck can be lethal.

To alert motorists of possible danger on bridges that may be caused by ice or frost, transportation agencies post warning signs that read, "bridge may be icy" on bridge approaches. These signs help the situation somewhat, but they remain on the bridges all year round, thereby losing effectiveness.

Maintenance personnel in Pennsylvania and indeed the Snow Belt have done a good job of promptly responding whenever ice forms on bridge decks. They spread salt or anti-skid on bridge decks to forestall accidents attributable to loss of traction. This action is however reactive in nature and sometimes is too late to make much difference.

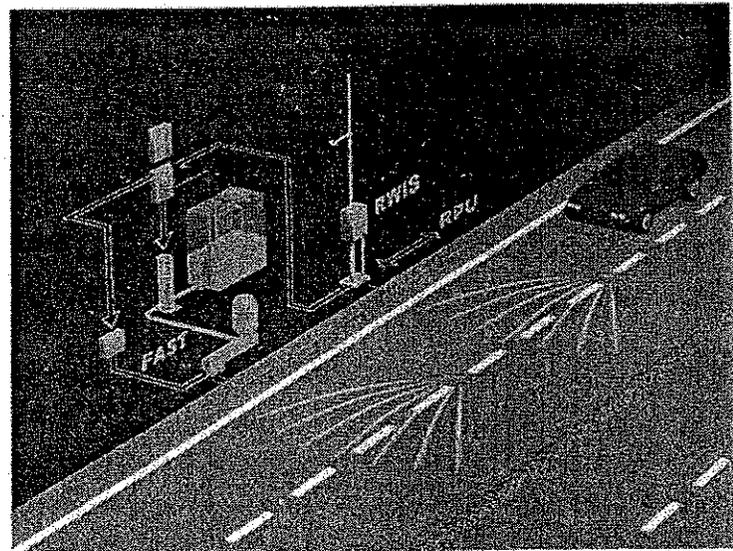
Automated Fixed Location anti-icing/de-icing system:

The automated fixed location anti-icing spray system is a revolutionary winter technology that is largely taking the guesswork out of forecasting the probability of ice formation on bridge decks. It takes preemptive action to forestall ice formation and this is accomplished without human intervention. A typical system consists of in-deck pavement sensors, spray disks, anti-icing liquid container, atmospheric meteorological sensors, controller and valve units. These devices are installed on the bridge. When the atmospheric sensors in conjunction with the pavement sensors detect the formation of ice or frost on the bridge deck, the spray disks are activated to release measured amounts of the anti-icing chemical on the deck. The chemical prevents the formation of ice or frost on the deck. The chemical is a freeze point depressant and works by lowering the eutectic temperature (freeze point temperature) of the moisture on the deck surface thereby preventing freezing.

The in-deck sensor probes continuously freeze the moisture on the deck within their vicinity to determine the freeze point. When the pavement temperature falls to within 2 degrees of the moisture freeze point, the system deploys and sprays anti-icing chemical on the deck to prevent formation of ice or frost.

Warren County system deploys and sprays anti-icing chemical.

Model of a system layout



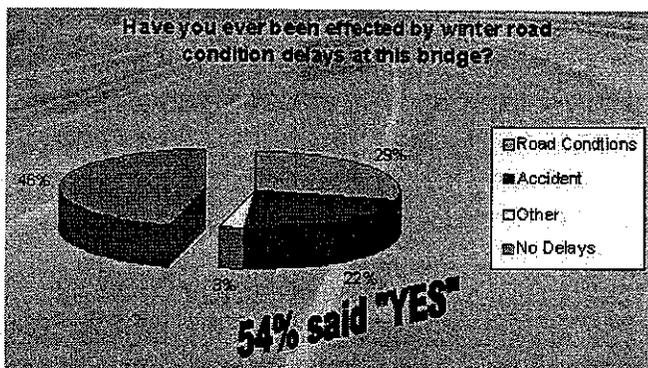
PENNDOT pilot systems

More than 2 years ago, Maintenance installed 3 Automated Fixed Location Anti-icing/De-icing Systems on bridges in Warren, Westmoreland and Allegheny Counties. As an emerging technology at the time, the aim of the pilot installations was to determine whether the systems would be beneficial to the Commonwealth. It was the understanding at the time, that after installation, the systems would be monitored and evaluated over the winter season both functionally and operationally. Evaluation results would determine whether more systems would be deployed in their current forms or with modifications.

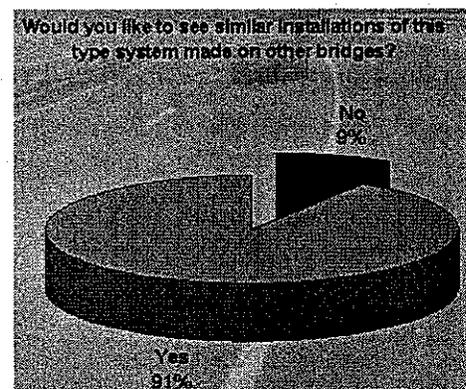
Preliminary evaluation results indicate that while there are some installation concerns (especially in the Westmoreland County installation), the systems performed well functionally; they deployed as programmed in the system logic, spraying anti-icing chemical onto the bridge decks when conditions indicated the imminence of ice or frost formation.

According to information cited on district 1-0 web page and credited to Conewago police unit, in the two years before installation of the system on the Warren County Bridge, 25 crashes were recorded on that site. Since installation of the system, no crashes have occurred on the site; the system seem to be fulfilling one of its most essential functions – reducing crashes on bridge decks during adverse winter conditions.

On-line surveys conducted by district 1-0 of motorists that use the warren county bridge.

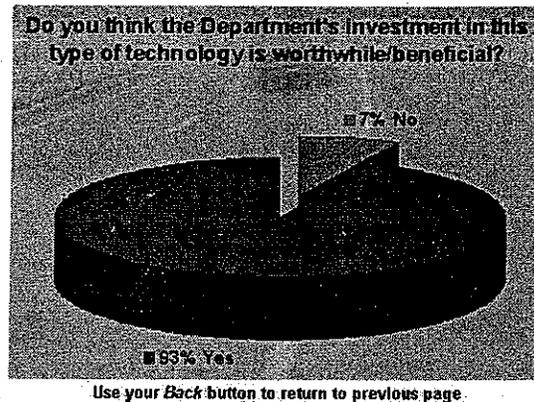


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District 1-0 conducted online customer survey of motorists, who used the Warren county bridge during the winter season prior and after installation of the system. The general consensus (based on initial returns) is that customers would like the systems to be installed on more bridges.



On-line surveys conducted by district 1-0 of motorists that use the warren county bridge.

The anti-icing spray system appears to be performing as intended functionally and our customers are reacting favorably toward more installations. However, not all bridges are suited for the systems; either by virtue of their designs, age, location, etc. Furthermore, the Commonwealth cannot afford to install the systems on all our 25,000 bridges at an average installation price tag of \$150,000 each! It therefore makes logical sense to install the system, only on bridges that will benefit the most. This will ultimately reduce financial burden this might put on PENNDOT.

Maintenance has therefore developed criteria or guidelines (described below) for selecting candidate bridges for installation of the systems. Before a bridge is selected for system installation, it is envisioned that it will meet some of the guidelines.

Criteria (Guidelines) for selection of candidate bridges for installation of anti-icing spray systems:

Major Considerations

Bridge with history of crashes attributable to snow, icing and frosting:

Some bridges have a history of crashes that can be attributed to snow, ice, frost, etc. Such information is readily obtainable from the county police or through the PENNDOT CRASH program. For such bridges, installation of this system means that the incidence of slipperiness or reduced traction can be brought down to manageable levels consequently reducing crashes.

Bridge on a grade more than 2.5% where slipperiness could be a factor:

Snow, ice, freezing rain, frost, etc. all reduce traction on bridge decks and roadways. This condition becomes exacerbated when the bridge deck is on a steep enough grade. The severity of this situation depends on the how steep the grade is. As a result of this, it is being recommended that bridges on vertical curves with 2.5% grade or more may be considered for installation of the system.

Bridge located in an area susceptible to black ice or frost:

Black ice is very difficult to detect by motorists when they are traveling at speeds in excess of 30MPH. This system senses the formation of ice/frost on the bridge deck and then proactively sprays measured amounts of chemical to prevent ice/frost formation. This system may therefore provide some benefit to bridges susceptible to black ice including elevated bridges over rail tracks or steam crossings, where cross winds contribute to deck freezing.

Bridges with speed limit >45MPH:

Bridge with speed limit more than 45MPH may be considered for installation of the anti-icing system. At this speed, it is very difficult, if not impossible for a motorist to notice the presence of ice or frost on a bridge deck. Also, even if it is noticed, at this speed, it will be very difficult to react fast enough to forestall any potential danger resulting from slipperiness or loss of traction. It is therefore logical that such a bridge be considered for installation of the system.

Bridges with super-elevated decks greater than 5%:

Tests show that super-elevation of more than 8% could cause slipping across a highway or bridge deck when a vehicle stops or attempts to gain momentum from a stopped position. This problem is compounded further when there is ice on the roadway. Under icy conditions, coefficient of friction on such bridge decks could go as low as from .050 to 0.200. Bridges with super-elevation over 5%, may get some benefit from the anti-icing bridge system.

Bridge with high average daily traffic-specify ADT:

The higher the ADT on a bridge, the more dangerous slipperiness or loss of traction on the bridge deck can be. A crash on a bridge with high ADT could trigger a chain reaction, which could involve several vehicles.

Bridge structurally sound to accommodate attachment of anti-icing system:

Bridges considered for installation of this system, may need some type of structural analysis to determine that they are structurally sound to carry additional load that the system fixtures might impose on them. Even though the extra load is negligible and therefore incapable of jeopardizing the structural integrity of the bridge, this analysis is still warranted. *This provision means that all districts seeking to install the system need to work with their bridge units and get their buy-in before proceeding with the installation.*

Other Considerations

Bridge located 30 minutes or more from the nearest maintenance stockpile;

Sometimes, the closest maintenance stockpile yard is so far away from a bridge that in the event of snow, ice or frost (especially in quick freeze areas) maintenance will not be able to get to the bridge in good time for salting or anti-icing. The anti-icing system needs no human intervention and so can deploy proactively on its own; this buys maintenance time to concentrate on other bridges and roads. A bridge that is more than 30 minutes from the closest stockpile and subject to the quick freeze phenomenon may benefit from this system.

Bridge strategically located to provide winter weather warning for nearby bridges:

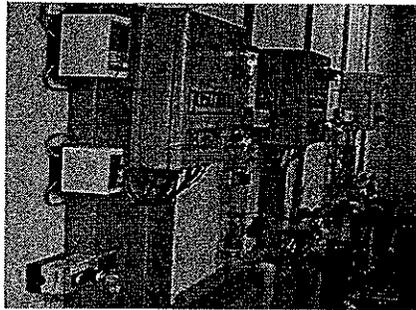
Sometimes a bridge location can be so strategic that the sensor readings on that bridge can be used to make snow removal operational decisions about adjacent bridges or highway. A bridge that is centrally located vis-à-vis other bridges, could have the anti-icing spray system installed on it. Whenever the system indicates that black ice or frost is about to form on the bridge, maintenance may infer that the same condition is prevalent on surrounding bridges and take necessary action. In this way, this bridge will act as a warning system for operational decisions on other bridges. This is true especially for the fact that there is not enough money to install the system on all bridges.

Adequate right of way to construct, store and maintain necessary hardware:

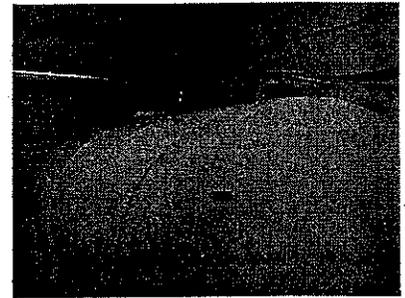
This system comes with hardware like storage tanks, RWIS tower, storage tank pedestal, controllers, etc. which require that enough space be provided for their accommodation.

Such issues as ease of accessibility to the hardware by the road crew for maintenance must be considered. Also, enough right of way must be provided for housing the hardware to discourage vandalism. It is therefore essential during the planning stages to review the site and ensure that enough right of way is available in the immediate vicinity of the bridge for placing the systems.

Multiple Controls, MnDOT



Large storage tank, MnDOT



Located near moisture generating areas-cooling towers, dams, industrial complexes, etc:

Moisture generating structures as listed above when located close to bridges, can bring about increased incidence of frost or ice formation on the bridge deck. The moisture constantly saturates the air and condenses onto the deck when the dew point and air temperatures converge. Under the right temperature (below freezing), the condensed moisture freezes. This factor may be considered in conjunction with other factors in selecting a candidate bridge for installation of the system.

Bridge with Maintenance Deficiency Rating of 50 or less

Maintenance Deficiency rating signifies what state a bridge is in. The rating has a range between 1 to 100 with 100 representing a bridge in dire need of repair. As stated before, a bridge that will be undergoing maintenance repair should not have the system installed only to be removed later. However, installation could be done in conjunction with rehabilitation.

Availability of electric, phone to run system:

This system needs electric power, phone lines, etc. to become functional. It must be ascertained that these utilities are either available or can be easily obtained for running the system before a bridge is considered a candidate for installation of the spray system.

System attachments will not adversely affect vertical clearances below bridge.

Some older bridges already have vertical clearance limitations resulting in restriction on the type of vehicles that can be driven under them. For such bridges, if it becomes clear that installation of the spray system fittings will further compound the vertical clearance problem, then, they may not be installed on them.

Bridge in area susceptible to high winds and freezing:

High crosswinds during winter of course increase the chances of a bridge deck freezing before the adjacent road surface.

Bridge with span greater than 150ft

Installation of the system on a bridge with a span smaller than 150ft would essentially amount to overkill at this time. As the cost of the system continues to come down, this may change.

Important notes:

The above guidelines are not etched in stone! They are simply meant as a guide in helping our personnel make an initial or preliminary assessment of bridges that may need to have the system installed on them. *Also, all of the suggested guidelines do not have to exist before a bridge can be considered for system installation.*

Other factors like availability of funds, district program priority, buy in from the Assistant District Engineer for Maintenance and Maintenance Manager, etc will ultimately influence final determination of which bridges are selected.

It should also be borne in mind that some criteria bear more weight than others which is the reason the guidelines are categorized into two: *major and other*.

It is the responsibility of individual districts to prioritize the criteria based on their needs and prevalent condition.

The information in this handout should not be construed as exhaustive, complete or immutable. This is due in part to the fact that this technology is still evolving. This material is based on available information at the time of writing and is subject to revision as more information becomes available or as technology changes. Individual judgment is therefore needed when using material contained in this handout.

CONCLUSION

To develop this guideline, input was solicited from District and Central Office Bridge units, Bureau of Maintenance and Operations personnel and Bridge Maintenance Coordinators. I thank them immensely for their contribution without which this could not have been written.

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