EVALUATION OF A FIXED ANTI-ICING TRACKING SYSTEM FOR SNOW REMOVAL AND ICE CONTROL

Final Report Draft
April 2003

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TECHNICAL REPORT DOCUMENTATION PAGE

1. REPORT NO.	2. GOVERNMENT ACCESSION NO.	3. RECIPIENT'S CATALOG NO.
FHWA/OK 03(04)		

4. TITLE AND SUBTITLE	5. REPORT DATE
Evaluation of a Fixed Anti-icing Tracking System for Snow Removal and Ice Control	April 2003
	6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S)	8. PERFORMING ORGANIZATION REPORT
Bryan K. Hurst and Gary Williams	
9. PERFORMING ORGANIZATION NAME AND ADDRESS	10. WORK UNIT NO.
Oklahoma Department of Transportation Planning & Research Division 200 N.E. 21st Street, Room 3A7 Oklahoma City, OK 73105	11. CONTRACT OR GRANT NO. Item 2120
12. SPONSORING AGENCY NAME AND ADDRESS	13. TYPE OF REPORT AND PERIOD COVERED Final Report Draft February 2002 - April 2003
	14. SPONSORING AGENCY CODE

15. SUPPLEMENTARY NOTES

16 . ABSTRACT

The Fixed Anti-icing Tracking System is a stand alone, anti-icing liquid chemical spray system normally mounted on preselected highway bridges. These systems are designed to help prevent a strong bond of snow and/or ice from developing on a bridge deck. This, in turn, aids in reducing traffic accidents related to snow and/or ice events by producing safer highway driving conditions for the public. This is achieved by the application of anti-icing liquids onto a pavement prior to and even during a snow and/or ice event. As motorists drive across the treated bridges, the chemical is "tracked" onto, across and off the end of the bridge. While performing snow removal and ice control obligations, maintenance managers and personnel are potentially provided with more options when possessing this kind of technology. Furthermore, the anti-icing chemicals used by this system are less corrosive than traditional methods and cause less damage to bridges, roads, equipment, cars, etc. Fixed anti-icing tracking systems are fabricated to be low maintenance, affordable and user friendly. The system can be connected to any Windows-based computer, and monitored for humidity, precipitation accumulation, dew point, wet or dry pavements, road temperature and if freezing is developing along with other important system information.

In November 2001, the Oklahoma Department of Transportation (ODOT) placed a fixed anti-icing tracking system consisting of four (4) on-site stations which treat six (6) preselected bridges on US-412 in Division VI, Woodward County, Oklahoma.

The fixed anti-icing tracking system has been evaluated since it's inception. Evaluation activity includes the monitoring and documentation of system construction, data collection of system operation by way of monitoring and documentation prior to, during, and subsequent to inclement winter weather conditions. Other surveys consist of compiling and processing data regarding system capability, capacity, and effectiveness.

In the two (2) years since the placement of this system, road and traveling conditions during snow and/or ice events at this location have improved. The main problem encountered was the traveling public not driving in the inside lane to produce the "tracking" effect in that lane. However, the splashing of the anti-icing chemical and air turbulence from vehicles in the outside lane did provide some coverage to the inside lane. Upgrades and inventive concepts of this system are constantly in progress and although some minor maintenance may be needed on occasion, this system has been and is performing well.

17. KEY WORDS	18. DISTRIBUTION STATEMENT
Fixed Anti-Icing Tracking System, treated bridges, snow removal, ice control, freezing, inclement winter weather.	No restrictions. This publication is available from the office of Planning & Research Division, Oklahoma DOT.

19. SECURITY CLASSIF. (OF THIS REPORT)	20. SECURITY CLASSIF. (OF THIS PAGE)	21. NO. OF PAGES	22. PRICE
Unclassified	Unclassified	34	

SI (METRIC) CONVERSION FACTORS

Approximate Conversions to SI Units					*Approximate Conversions from SI Units*				
Symbol	**When you know**	**Multiply by**	**To Find**	**Symbol**	**Symbol**	**When you know**	**Multiply by**	**To Find**	**Symbol**
		LENGTH					**LENGTH**		
in	inches	25.40	millimeters	mm	mm	millimeters	0.0394	inches	in
ft	feet	0.3048	meters	m	m	meters	3.281	feet	ft
yd	yards	0.9144	meters	m	m	meters	1.094	yards	yds
mi	miles	1.609	kilometers	km	km	kilometers	0.6214	miles	mi
		AREA					**AREA**		
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yd^2	square yards	0.8361	square meters	m^2	m^2	square meters	1.196	square yards	yd^2
ac	acres	0.4047	hectacres	ha	ha	hectacres	2.471	acres	ac
mi^2	square miles	2.590	square kilometers	km^2	km^2	square kilometers	0.3861	square miles	mi^2
		VOLUME					**VOLUME**		
fl oz	fluid ounces	29.57	milliliters	mL	mL	milliliters	0.0338	fluid ounces	fl oz
gal	gallon	3.785	liters	L	L	liters	0.2642	gallon	gal
ft^3	cubic feet	0.0283	cubic meters	m^3	m^3	cubic meters	35.315	cubic feet	ft^3
yd^3	cubic yards	0.7645	cubic meters	m^3	m^3	cubic meters	1.308	cubic yards	yd^3
		MASS					**MASS**		
oz	ounces	28.35	grams	g	g	grams	0.0353	ounces	oz
lb	pounds	0.4536	kilograms	kg	kg	kilograms	2.205	pounds	lb
T	short tons (2000 lb)	0.907	megagrams	Mg	Mg	megagrams	1.1023	short tons (2000 lb)	T
		TEMPERATURE (exact)					**TEMPERATURE (exact)**		
˚F	degrees Fahrenheit	(˚F-32)/1.8	degrees Celsius	˚C	˚C	degrees Fahrenheit	9/5(˚C)+32	degrees Celsius	˚F
		FORCE and PRESSURE or STRESS					**FORCE and PRESSURE or STRESS**		
lbf	poundforce	4.448	Newtons	N	N	Newtons	0.2248	poundforce	lbf
lbf/in^2	poundforce per square inch	6.895	kilopascals	kPa	kPa	kilopascals	0.1450	poundforce per square inch	lbf/in^2

EVALUATION OF A FIXED ANTI-ICING TRACKING SYSTEM FOR SNOW REMOVAL AND ICE CONTROL

FINAL REPORT DRAFT

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April 2003

TABLE OF CONTENTS

LIST OF FIGURES and TABLES

INTRODUCTION

The Oklahoma Department of Transportation (ODOT) is seeking out new technologies to improve current snow removal and ice control operations. Although ODOT has progressed in their quest for a more efficient method in clearing and maintaining Oklahoma highways and bridges of snow and/or ice throughout the winter season, there are new alternatives available.

The purpose of this project was to evaluate the short term performance and utilization of Fixed Anti-icing Tracking Systems for snow removal and ice control on Oklahoma's bridges.

This evaluation includes the monitoring and documentation of system placement and construction, data collection of system operation by observation and documentation prior to, during and subsequent to actual inclement winter weather conditions. Other surveys include evaluating the effectiveness and short term performance regarding system capability, capacity and ease of maintenance and repair.

Careful surveillance and appraisal of this system has provided ODOT with valuable information concerning the application of fixed anti-icing tracking systems on Oklahoma's bridges. These systems have been implemented to assist ODOT maintenance managers and personnel in meeting their snow and/or ice fighting responsibility in order to provide the safest possible road conditions during inclement winter weather. Each of these benefits could be of considerable value to ODOT as well as our customers.

OBJECTIVES

The objectives of this study are as follows:

- Monitor and document construction of Fixed Anti-Icing Tracking Systems.
- Monitor and document Fixed Anti-Icing Tracking System operation.
- Collect, compile and process data regarding system capability and effectiveness.
- Evaluate and assess system capacity and effectiveness.

TASKS

The tasks for the project are outlined in this section. All tasks were coordinated and performed by the Engineering Services Branch of the ODOT Planning & Research Division.

- Conduct Literature Search and Review Material
- Prepare work plan
- Organize Product Personnel Meeting
- Observe Current Site Locations
- Observe Proposed/New Site Locations
- Evaluate Current Systems Placement
- Observe Proposed/New Systems Placement
- Observe Proposed/New Systems Installation
- Monitor Systems Operation
- Evaluate System Capacity
- Evaluate Ease of Use
- Evaluate Ease of Maintenance and Repair
- Evaluate Systems Effectiveness
- Compile and Process Data
- Prepare Final Report

BACKGROUND

In years past ODOT has exercised traditional techniques of removing snow and/or ice from roadways. This is predominately achieved with the use of "hopper type" spreaders (See Figure 1) for applying the solid chemical sodium chloride (NaCl) or rock salt, combined with sand, routinely known as salt and sand mix. Considerable amounts of salt and sand mix application are standard during a winter storm event. This approach is recognized as "deicing," which is the removal of snow and/or ice after it has bonded to the pavement surface. Although this style of snow removal and ice control has worked well in the past, there are problems that accompany this procedure. The application of salt and sand mix too early or too late can have significant negative effects and hamper the overall goal of clearing the roadway. Another problem with this style of snow and/or ice control (during spreading operations) salt and sand mix is thrown from the roadway thus being wasted. This can result in extensive cleanup operations after the storm has passed and spreading operations have ceased.

Figure 1. Hopper Type Spreader

For several years anti-icing liquid chemicals have been implemented to aid in the war to accomplish snow removal and ice control across the United States. Studies suggest that the application of such chemicals onto a roadway pavement or bridge, prior to and even during a snow and/or ice event can help prevent a rigid bond of snow and/or ice to the pavement surface.[1,2] Likewise, the use of these chemicals can provide maintenance personnel more capability of maintaining and producing suitable road conditions during these adverse situations. This plan of attack is known as "anti-icing."

The Oklahoma Department of Transportation is no stranger to this strategy. In recent years ODOT has used an advanced version of the traditional approach, widely acknowledged as "prewetting." Prewetting can be defined as the saturation of salt and sand mix, with an anti-icing liquid chemical as it leaves the hopper type spreader. Because of the use of anti-icing liquid chemicals, this style is accepted as a form of anti-icing. There are several anti-icing liquid chemicals available, but ODOT elected to use magnesium chloride or ($MgCl_2$) for a number of reasons. This chemical is less corrosive than salt and ultimately results in less destruction to vehicles, roadways and bridges. Areas treated with this product often remain treated for several days before and after a winter storm event, due to residual capabilities. Another reason for using $MgCl_2$ is cost effectiveness. As indicated by David Maloy, inventor of "Optimal Systems, Fixed Anti-icing Tracking Systems", the cost of liquid chemicals is well below that of salt and sand mix operations. With this, prewetting and anti-icing applications become even more practical. A final motive for utilizing $MgCl_2$ is for "tracking" characteristics. Tracking can be defined as the movement of anti-icing liquid chemicals across a pavement surface or bridge deck by highway traffic.

The prewetting procedure is the same as that used in traditional methods with the added effect of the $MgCl_2$. The spreading equipment used in this procedure is outfitted with $MgCl_2$ polyethylene tanks which are mounted beside the hopper type spreader in the bed of the truck. (See Figures 2 and 3).

Figure 2. Hopper Type Spreader with Polyethylene Anti-icing Tanks

Figure 3. Mounted Hopper Type Spreader with Polyethylene Anti-icing Tanks

These tanks are plumbed with two (2) pumps, (one for each tank) and a network of nozzles which are controlled from the operators position inside the cab. As the salt and sand mix leaves the hopper, it is soaked with $MgCl_2$ by prewetting spray nozzles (See Figure 4) before it reaches the spinners and is broadcast across the pavement surface. The prewetting style of snow removal and ice control is essential in that it offers several advantages. Because the salt and sand mix is saturated by the $MgCl_2$, it tends to cling to the surface better and comes to rest on it's target, the bridge deck or pavement surface, rather than highway shoulders and right of ways. Prewetting produces a longer lasting effect, mainly accomplished by the residual qualities of the $MgCl_2$. Furthermore, this manner of anti-icing reduces the amount of salt and sand mix to be applied, which in turn, aids in less clean up time afterwards, thus lowering the cost of the overall operation.

Figure 4. Prewetting Spray Nozzles

Because the results of the prewetting program yielded such an impressive impact, ODOT purchased several Truck-Mounted Mobile Anti-icing Systems and placed them into action on Oklahoma's highway system in the winter of 1999/2000. (See Figures 5 and 6).

Figure 5. Truck Mounted Mobile Anti-icing System

This system was deployed to apply $MgCl_2$ alone, directly to the roadway pavement or bridge deck without the use of the more corrosive salt and sand mix. Once calibrated, the system allows maintenance personnel to pre-treat targeted areas of concern or entire roadways and bridges. This can be accomplished hours or even a day in advance of a winter development. Applications of this nature can also be performed throughout the duration of a winter event. In doing so, the accumulation of snow and/or ice on the pavement surface is dramatically reduced. As with the prewetting operations, treated areas often remain treated several hours or even days after a winter storm event has passed.

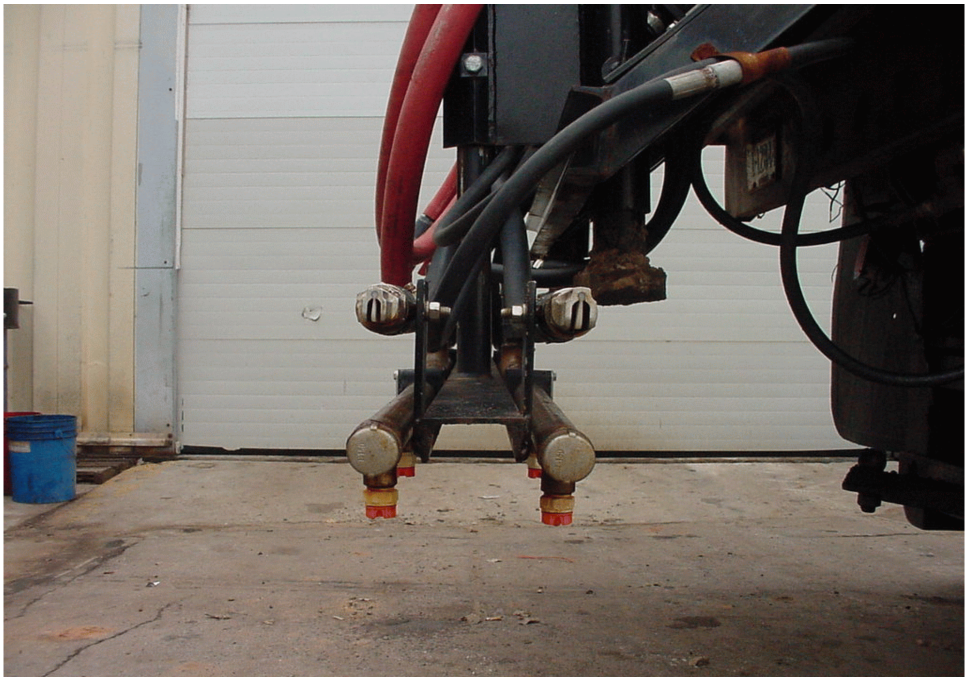

Figure 6. Truck Mounted Mobile Anti-icing System Spray Bar

In recent years another innovative procedure of anti-icing has been developed. This latest strategy is the "Fixed Anti-icing Tracking System" and is being utilized by various states and other countries.[1,3] (See Figures 7 and 8).

In November of 2001, ODOT took advantage of this technology. With the help of David Maloy, a consultant to ODOT, a fixed anti-icing tracking system was placed at bridges located on US-412 in Division VI, Woodward County, Oklahoma. (See Figure 9).

Figure 7. Electrical Powered Fixed Anti-icing Tracking System Master Station

Figure 8. Solar Powered Fixed Anti-icing Tracking System Master Station

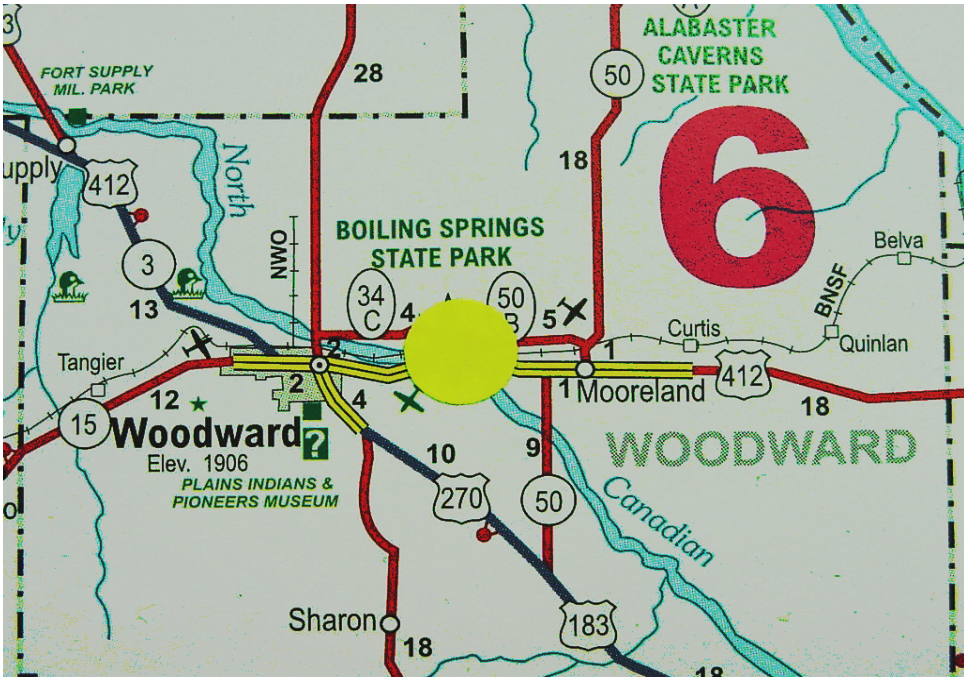

Figure 9. Fixed Anti-icing Tracking System Site in Div. VI, Woodward County, Oklahoma

The fixed anti-icing tracking system is an anti-icing liquid chemical spray system normally mounted on the right-of-way of preselected highway bridges. Factors such as high ADT and frequent traffic accidents during snow and/or ice events are considered in determining these sites. Fixed anti-icing tracking systems are an independent type system and are unlike traditional salt and sanding, prewetting, and truck mounted anti-icing system operations. Where the deployment of maintenance personnel and equipment must be imposed in order to apply the deicing or anti-icing treatment for these methods, all that is necessary to use the fixed anti-icing tracking system is any Windows based computer equipped with the software that comes with each system.

David Maloy and his team at Optimal Systems have developed their fixed anti-icing tracking systems to be a low maintenance, affordable and user-friendly winter maintenance tool. Optimal Systems applies recent technology which allows conditions at each site to be screened for humidity, precipitation accumulation, dew point, wet or dry pavement, road temperature and ice development. Low chemical level and anti-icing liquid chemical flow can be confirmed as well.

All of these circumstances become crucial information and are monitored in real time. This is accomplished with onsite pavement sensors and a modern roadway weather information system or RWIS tower (See Figures 10 and 11) located at the "master station" of each system.[4,5] Master stations and slave stations will be discussed later in the report.

Figure 10. Pavement Sensor

As with the truck mounted mobile anti-icing systems, dispersion occurs prior to and even during a snow and/or ice event without the use of harsh caustic chemicals such as salt. Although the results of these systems are approximately the same as that of the truck mounted system, the incomparable factor is the response time.

Areas of concern can be treated more rapidly because these systems can be remotely activated in the convenience of the field maintenance offices via computer connected by a modem or by a telephone call. In less time that it would take for maintenance personnel to prepare a truck mounted mobile anti-icing system and transport the load to the same location, the area of concern can already have been treated with the fixed anti-icing tracking system. This allows maintenance managers to route forces and equipment to other locations where these systems are not currently established.

Figure 11. Roadway Weather Information System Tower

SITE LAYOUT

The following describes the layout of the fixed anti-icing tracking system in Division VI, Woodward County, Oklahoma and the four (4) stations at this site:

This system consists of four (4) on-site stations which treat six (6) bridges. The two (2) center bridges span the North Canadian River, while the other four (4) bridges are overflow relief, two (2) on either side.

One (1) station supplies bridge # 7712 0659NX W.B. and bridge # 7712 0659SX E.B.
One (1) station supplies bridge # 7712 0587NX W.B. and bridge # 7712 0587SX E.B.

One (1) station supplies bridge # 7712 0622NX W.B. only. (Master Station)
One (1) station supplies bridge # 7712 0622SX E.B. only.

All four (4) of the stations at this site are mounted on the west bound right-of-way or, the north side of US-412.

SYSTEM MATERIALS AND EQUIPMENT

Each fixed anti-icing tracking system exhibits two (2) types of stations per site, the “Master” station, and the “Slave” stations. The master station is the primary station of the system. This is the station that is remotely activated through a computer or telephone in the maintenance field offices of ODOT. Once the master station is contacted, it, in turn, activates the other slave stations that treat adjacent bridges as well. This is executed by a signal that is transmitted through buried communication cables that link the master and slave stations together. When the master station is activated by a computer or telephone call, the entire system is activated. If maintenance personnel choose to turn stations on individually, this must be performed manually at the station of choice. This may treat more than one bridge depending on the layout of the system.

Each of the systems at the investigation site in Woodward County, Oklahoma are electrically (110V) powered, which was installed by a local electric company. The following list details standard components of each system:

- One three hundred (300) gallon polyethylene liquid chemical storage tank that can be manually refilled from a stockpile of liquid chemical stored at the respective ODOT maintenance facility
- Submergible 12 volt stainless steel pump capable of pumping chemical distances between one thousand (1,000') feet to two thousand (2,000') feet

- 3/4" PVC liquid chemical supply and spray lines
- Liquid chemical flow meter
- Data logger and modem communication system along with existing windows software
- Communication cables
- Low chemical sensors
- Pavement sensor (master station only)
- Roadway Weather Information System Tower (master station only)
- Necessary hardware for right-of-way containment

Figures 12 and 13 portray the layout and illustration of a fixed anti-icing tracking system.

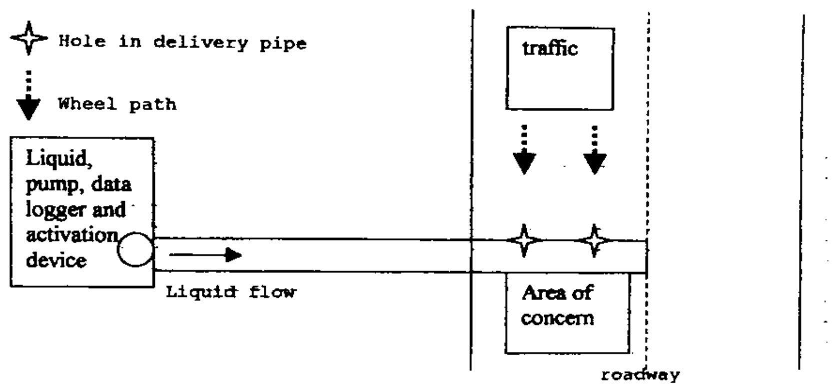

Figure 12. View of Anti-icing Tracking System

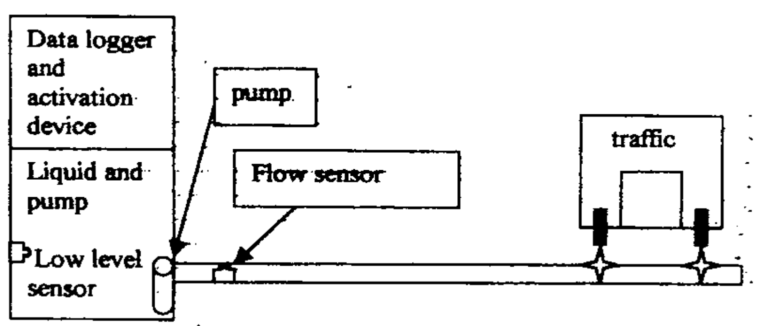

Figure 13. Cross Section View of Anti-icing Tracking System

Once the system installation has been completed, the system is calibrated and tested for accurate treatment quantities. Calibration valves throughout the system make fine tuning the system a simple operation and also act as shut-off valves necessary for system repairs and/or in the instance of an emergency. At this point, the system is poised and can be activated remotely or manually at any time for testing or in the event of a winter development.

SYSTEM OPERATION

Upon the approach of a winter storm system, a decision is made to activate the system at the onset of the storm. The master station data logger/modem at the site is contacted either by a computer or a telephone call by authorized personnel at the corresponding ODOT maintenance facility. (See Figure 14) This switches on the power supply which, in turn, triggers the slave stations through buried communication cables. The submerged pumps inside the liquid chemical storage tanks are automatically activated. Each master and slave station possesses a timer inside the data logger that is set for each pump to operate for a calibrated amount of time.

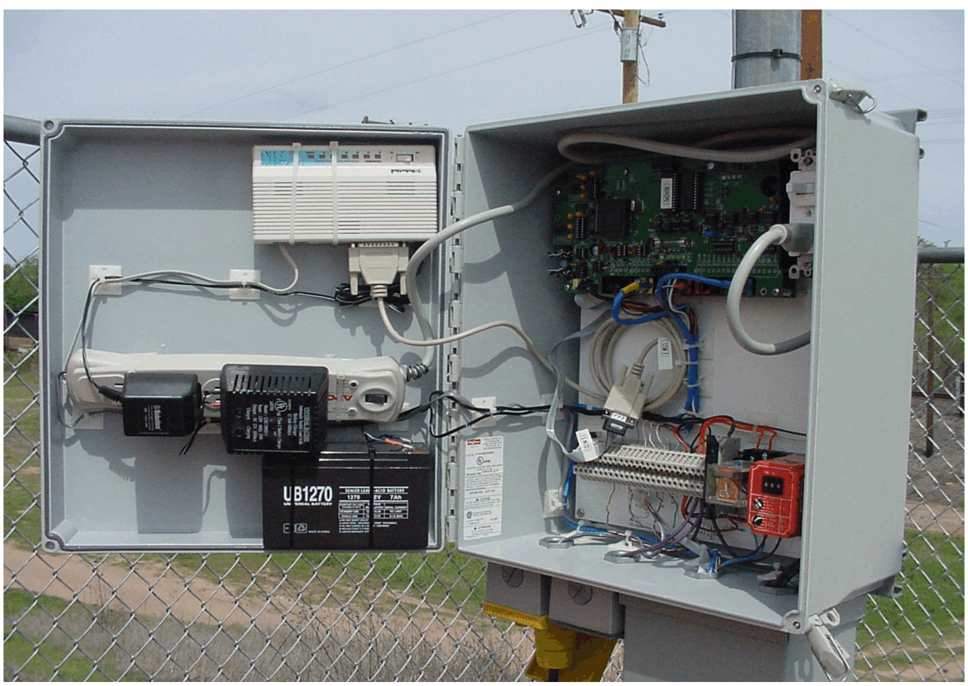

Figure 14. Master Station Data Logger

The $MgCl_2$ is pumped through 3/4" PVC supply lines mounted on the outside bridge walls (See Figure 15) and channeled to designated spray lines.

Figure 15. PVC Supply Lines

Occasionally, PVC supply lines are placed in a saw cut that extends across both lanes of traffic and then epoxied in place. This is done to transport $MgCl_2$ across one expressway of a divided highway to a neighboring bridge that is to be treated by the same fixed anti-icing tracking system station. The spray lines and, as mentioned, some PVC supply lines, are positioned in saw cuts in the bridge approaches and on the bridge decks and then covered with epoxy. (See Figure 16)

There can be one (1) to several spray lines per bridge depending on the structure length. As the $MgCl_2$ reaches it's mark, it exits the spray lines through 1/8" holes drilled in the spray line near the wheel paths on the uphill side of the bridge deck. As the anti-icing liquid chemical departs the spray lines it runs downhill (down the cross slope) across both lanes of traffic. (See Figure 17)

Figure 16. Spray Line

Figure 17. Magnesium Chloride

As with most liquids, anti-icing liquid fluids can also be easily tracked with suitable traffic. As motorists drive across the $MgCl_2$, the chemical is tracked onto, across and off the end of the bridge. (See Figure 18)

Figure 18. Tracked Magnesium Chloride

The capacity of the liquid chemical storage tanks allows for several applications of $MgCl_2$ throughout a winter season, and are easily refilled from a tank housed at the ODOT maintenance facility. This procedure is common and intended with these systems depending on the duration of the winter event. In applying and tracking the $MgCl_2$, the accruement of snow and/or ice is immensely depressed and the element of safety for motorists is increased.

As with prewetting and truck mounted mobile anti-icing system applications, treated areas frequently remain treated for several days after the application. This becomes beneficial in the event of consecutive winter snow and/or ice occurrences or where freezing temperatures remain present.

SYSTEM INVESTIGATION

The fixed anti-icing tracking system in ODOT's Division VI, Woodward County, Oklahoma has been investigated since it's inception in November of 2001. This includes the 2001/2002 and 2002/2003 winter seasons.

The installation of this system was conducted at the beginning of the 2001/2002 winter season. Because of this, David Maloy and Optimal Systems construction personnel, were caught in the first winter development of the season before the installation was completed. This eliminated the first opportunity to observe the fixed anti-icing tracking system perform during an actual winter situation.

Upon the approach of the following seasonal winter event, the fixed anti-icing tracking system was activated and functioned properly. All six (6) bridges at the site location were treated as intended and the system produced excellent results. The pavement conditions on each of the bridges deteriorated to only a slushy wintery mix which was easily plowed from the roadway. The development of a compressed snow and ice bond to the pavement surface did not occur.

For the remainder of the 2001/2002 winter season the fixed anti-icing tracking system did not operate appropriately. Without the assistance of Optimal Systems personnel or ODOT maintenance managers and/or personnel manually activating the system stations, the system would not function as intended. This was spawned by a barrage of frequent failures of system components such as broken spray lines, broken or cracked supply lines, rodents chewing through unprotected buried communication cables which resulted in partial system activation rather than all stations triggering simultaneously, incorrect calibration settings which caused erratic $MgCl_2$ distribution, etc.

Six (6) bridges were affected by these episodes. Until the fixed anti-icing tracking system could be properly repaired, snow and ice control was performed by traditional hopper-type salt and sanding, prewetting and truck mounted mobile anti-icing operations rather than with the newly established fixed anti-icing tracking system.

After numerous site and system inspections through spring, summer and fall of 2002, other fixed anti-icing tracking system deficiencies became apparent as well. The "popping-out" of epoxies being used to secure supply and spray lines became a constant recurrence. Substantial obvious $MgCl_2$ residue on the pavement surface, caused by year round leaking spray lines or persistent bridge movement "pumping", became another.

Accompanied by David Maloy, Optimal Systems personnel made several attempts to rectify these system failures only to return again on different occasions. This continued throughout the 2002/2003 winter season as well.

CONCLUSIONS

Although the present methods that ODOT practices in clearing Oklahoma's bridges and highways of snow and ice are not inappropriate, there are other strategies which can assist and improve these procedures. The fixed anti-icing tracking system, has the potential to become a valuable snow and/or ice control instrument.

The fixed anti-icing tracking system in Woodward County, Oklahoma was the first of it's kind established on Oklahoma highway bridges. Optimal Systems introduced their system to ODOT while it's design was still under development. Despite early system malfunctions, the majority of these setbacks required little effort to correct.

Continuous upgrades of this system are constantly in progress. As of March 6, 2003, Optimal Systems has performed a complete fixed anti-icing tracking system upgrade at the site in Woodward County, Oklahoma. Plans to install a wireless communication system to replace the original buried communication line system are in progression and could possibly be standard equipment for new fixed anti-icing tracking system installations in the future.

There is little doubt that Optimal Systems fixed anti-icing tracking systems have supported ODOT maintenance personnel in fulfilling snow removal and ice control obligations throughout the winter season. When functioning properly, these systems become an impressive winter management tool.

In the two (2) winter seasons since the placement of this system, road and traveling conditions during snow and/or ice events at this location have improved. Regarding system performance, the primary problem encountered was motorists not driving in the inside lanes to produce the "tracking" effect in those lanes. Although not adequate, the splashing of the $MgCl_2$ and air turbulence from vehicles in the outside lanes did provide some coverage to the inside lanes.

A major purpose of this system is to perform the preventive maintenance (anti-icing) without sending a truck to the bridge(s). When the systems functioned as intended, they did this well. However, they did not function as intended one hundred percent (100%) of the time. Table one (1) summarizes winter events during the evaluation period and system performance.

EVENT DATE	ACTIVITY	CAUSE	CORRECTIVE ACTION
March 2, 2002	System activated from field office - worked properly.	N/A	N/A
December 3, 2002	System activated from field office - not working properly.	Three (3) E.B. bridges not treated due to broken spray lines and incorrect calibration.	Broken lines replaced by Optimal Systems personnel and system re-calibrated.
December 23, 2002	System activated from field office - not working properly.	Only one (1) of the three (3) E.B. stations was working due to broken PVC lines.	Broken lines replaced by Optimal Systems personnel.
January 15, 2003	System was to be activated from field office but called off.	Broken and/or missing PVC lines and bad leaks.	Broken and missing lines replaced and repaired by Optimal Systems personnel.
February 6, 2003	System activated from field office - worked properly.	N/A	N/A

Table 1.

EVENT DATE	ACTIVITY	CAUSE	CORRECTIVE ACTION
February 7, 2003	System activated from field office - not working properly.	One (1) station not working at all due to gophers chewing through buried communication cables.	Communication cables located and replaced by Optimal Systems personnel.
February 10, 2003	System activated from field office - not working properly.	Two (2) stations not working due to broken PVC lines.	Broken PVC lines replaced by Optimal Systems personnel.
February 23, 2003	System activated from field office - Only two (2) stations can be activated from the field office, the other two (2) must be manually activated. In both cases the system works properly.	Two (2) stations not activating properly due to gophers chewing through buried communication cables in an undetermined amount of locations.	Plans to install wireless communication system are in progress - until this system can be tested., no corrective action has been taken to repair buried communication cables.

Table 1. - continued

EVENT DATE	ACTIVITY	CAUSE	CORRECTIVE ACTION
February 24, 2003	System activated from field office - Only two (2) stations can be activated from the field office, the other two (2) must be manually activated. In both cases the system works properly.	Two (2) stations not activating properly due to gophers chewing through buried communication cables in an undetermined amount of locations.	Until the wireless communication system can be tested, no corrective action has been taken to repair buried communication cables.
February 25, 2003	System activated from field office - Only two (2) stations can be activated from the field office, the other two (2) must be manually activated. In both cases the system works properly.	Two (2) stations not activating properly due to gophers chewing through buried communication cables in an undetermined amount of locations.	Until the wireless communication system can be tested, no corrective action has been taken to repair buried communication cables.

Table 1. - continued

EVENT DATE	ACTIVITY	CAUSE	CORRECTIVE ACTION
February 26, 2003	System activated from field office - Only two (2) stations can be activated from the field office, the other two (2) must be manually activated. In both cases the system works properly.	Two (2) stations not activating properly due to gophers chewing through buried communication cables in an undetermined amount of locations.	Until the wireless communication system can be tested, no corrective action has been taken to repair buried communication cables.
February 27, 2003	System activated from field office - Only two (2) stations can be activated from the field office, the other two (2) must be manually activated. In both cases the system works properly.	Two (2) stations not activating properly due to gophers chewing through buried communication cables in an undetermined amount of locations.	Until the wireless communication system can be tested, no corrective action has been taken to repair buried communication cables.

Table 1. - continued

This system is still under development. Most of the malfunctions were corrected by changes which then became standard features on systems installed after the initial problems surfaced. Because of this, these problems should not recur. ODOT feels that this system has the potential to become a valuable asset and expects to continue installing these systems.

RECOMMENDATION

Snow removal and ice control operations will always be of major concern in ODOT's winter maintenance program. Although the capabilities and advantages of the fixed anti-icing tracking system should not be overlooked, other issues accompany this system which could impact it's continued utilization.

However, improvements to the original system have been evolving which have been designed to make the system more reliable and demand less maintenance and repair. The systems which were installed with the improvements are now available for utilization and have been installed on additional Oklahoma highway bridges.

Considering that this system is still being improved and developed, it is recommended that further observation and assessment, of current and future variations of Optimal Systems fixed anti-icing tracking systems continue.

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