

Analysis of Halliday Real-Time Traction Tool (RT3) Deployment & Potential Cost Savings for ODOT

Franklin County: Winter 2008-2009



Division of Highway Operations
Office of Maintenance Administration
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EXECUTIVE SUMMARY

BACKGROUND

Every year hundreds of accidents nationwide are reported that can be attributed to a loss of vehicular traction. Many can be associated with snow and ice accumulation on roads, or by the formation of pavement frost or 'black ice'. As a result, billions of dollars in damages are incurred through injuries, loss of life, property damage, and economic impacts. In order to minimize the number of these accidents and reduce the cost of damages incurred, the Ohio Department of Transportation (ODOT) has been utilizing another 'tool' in its snow and ice operations – the ReaT-Ime Traction Tool (RT3). Twenty RT3's were utilized by the department during the 2008-2009 winter season.

The RT3, developed and manufactured by Halliday Technologies, Inc., provides continuous, "real-time", objective road grip/friction information to the operators of vehicles fitted with this equipment via an in-cab mounted display box. (RT3 development was the result of a 2001 meeting in which Keith Swearingen, ODOT Assistant Director & Chief Engineer, inquired whether Halliday's road grip measuring technology used in the auto racing industry could also be applied to snow trucks.)

Besides minimizing the number of accidents and reducing the cost of damages incurred, the RT3 can also assist the department in reducing various costs. In 2008 fuel costs increased at an unprecedented rate and, while those costs have since decreased, there is considerable concern that the high costs experienced earlier will return. Ohio has also seen a dramatic increase in the price of salt, with those increases ranging from 50 to 300 percent among counties. The general overall availability of salt from vendors has also been a difficult issue with several counties in the southern half of the state unable to secure bids; as such, transfers of salt from one county to another were common throughout the winter.

During the 2007-2008 winter season ODOT's snow trucks drove nearly 11,000,000 miles (including patrolling duty), and more than 900,000 tons of salt were used. Also, the average fuel economy for single-axle dump trucks is approximately just 6 miles per gallon, and the average cost to operate them is nearly \$1.90 per mile (excludes the material applied).

These facts point out the need for ODOT's snow truck operators to conserve fuel, salt and equipment to the greatest extent possible.

SUMMARY OF FINDINGS

Although ODOT has gradually increased its deployment of the RT3 since the product's inception in 2001, much of its use thus far has been 'experimental' in nature. The purpose of the experimentation was to evaluate the unit's durability/ruggedness, and to verify the accuracy, repeatability, and reliability of the grip readings that were obtained. A significant amount of data was collected and analyzed over multiple years by the Office of Maintenance Administration. The analyses performed indeed confirmed the accuracy, repeatability, and reliability of the readings, as well as the durability of the unit.

Prior to the onset of the 2008-2009 winter season it was established that the primary goal of that season's RT3 program would be to determine to what extent departmental cost savings could be realized through ODOT's deployment of RT3's. Given the economic conditions cited below, the department has a strong interest in minimizing fuel, salt and equipment costs, while ensuring continued safety on our roads.

Three separate winter events from the 2008-2009 winter season were analyzed. Through usage of the RT3, cost savings for each event were estimated to be \$9,662 (a 69% reduction from the normal course of treatment), \$11,918 (26% reduction), and \$20,651 (40% reduction). Per-event savings of up to 20% appear to be conservative.

SUMMARY OF RECOMMENDATIONS

Expanding the current RT3 program incrementally (i.e., over a number of years) in a systematic manner would be the most cost efficient way for the program to grow. A number of different expansion scenarios are mentioned in this report but a county garage should give consideration to equipping a pickup truck(s) first, before its snow trucks. As noted elsewhere, patrolling worked well this past winter and was utilized frequently by the Transportation Managers in Franklin County. Sending a tow-behind RT3 out prior to a storm to monitor changing road conditions is less costly than deploying an entire fleet of snow trucks, whose miles per gallon is low and operating cost is high. Once the garage has an optimal number of pickup trucks equipped, its focus could then turn to equipping its optimal number of snow trucks.

As with any new technology, there is often a reluctance to adopt and utilize it. ODOT's Road Weather Information Systems (RWIS) and use of liquids in treating roadways are two examples of technologies that were initially slow in receiving acceptance but today their use by the districts is routine. In due time, the RT3 is expected to receive the same acceptance and will become yet another valuable tool in our snow and ice operations.

I. INTRODUCTION

Every year hundreds of accidents nationwide are reported that can be attributed to a loss of vehicular traction. Many can be associated with snow and ice accumulation on roads, or by the formation of pavement frost or ‘black ice’. As a result, billions of dollars in damages are incurred through injuries, loss of life, property damage, and economic impacts. In order to minimize the number of these accidents and reduce the cost of damages incurred, the Ohio Department of Transportation (ODOT) has been utilizing another ‘tool’ in its snow and ice operations – the ReaTime Traction Tool (RT3).

The RT3, developed and manufactured by Halliday Technologies, Inc., provides continuous, “real-time”, objective road grip/friction information to the operators of vehicles fitted with this equipment via an in-cab mounted display box (see Figure 1 below). RT3 development was the result of a 2001 meeting in which Keith Swearingen, ODOT Assistant Director & Chief Engineer, inquired whether Halliday’s road grip measuring technology used in the auto racing industry could also be applied to snow trucks.

Snow truck operators have traditionally used subjective judgment based on their past experience in determining when, and at what rate, to apply material. Consequently, material can be over-applied unnecessarily on roads that don’t need as much (or any), and under-applied on those that require more. When unsure of a road’s slipperiness, an operator will often err on the side of caution and maximize the use of salt, not wanting an accident to occur on one of his assigned routes ⁽¹⁾. Such overuse and waste is costly, and becoming costlier, in today’s economy. The under-application of salt on roads that require more, such as those with black ice that cannot be detected by the human eye, can also be quite costly when accidents occur that could have otherwise been prevented. Finally, the impact of excessive salt use on the environment (e.g., roadside trees), motor vehicles, and infrastructure (bridge decks) also cannot not be ignored.

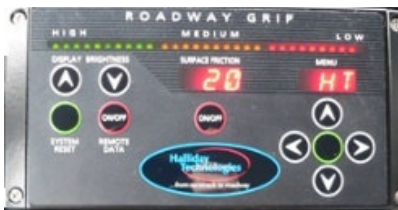


FIGURE 1

The Halliday display conveys the objective data via 1.) a numerical grip value and, 2.) a corresponding series of green, yellow, or red lights. As more lights are displayed and their color changes, the value becomes lower, indicating the grip on the road has become reduced and conditions have deteriorated.

Green lights and a corresponding high value (71-100) are synonymous with a road that has good grip. Yellow lights correspond with grip values in the 51-70 range and indicate the operator should exercise more caution; a value of 60, for example, means that a 40% (i.e., 100–60) grip loss has occurred. Finally, red lights and values in the 19-50 range are indicative of roads with even less grip and more extreme driving conditions; a reading of 20 means an 80% grip loss has occurred.

Two types of RT3 systems are utilized by ODOT and are shown in Figure 2 below: 1.) an “underbody” style, attached to the underside of snow trucks, and 2.) a “tow-behind” style, attached to pickup trucks via a Reese-style hitch. The underbody style is used by an operator responsible for treating pre-assigned routes while the tow-behind style is suited for a supervisor who wishes to have roads in his jurisdiction ‘patrolled’ to determine if, or when, snow trucks should be deployed, or whether an existing deployment/treatment can be terminated.

[This report does not describe the technical details of how the RT3 system works. In short, a fifth wheel is attached either behind or under a vehicle at an approximately 1.5° skew to the straight-ahead direction. As the vehicle travels the tire ‘scrubs’ the roadway and an electrical signal is transmitted from the wheel to the Halliday display box. There the grip readings are displayed to the vehicle operator as a numerical value and series of lights.]



Tow-behind RT3



Underbody RT3

FIGURE 2

The RT3 is not intended to completely replace an operator’s judgment in treating roadways but is instead another available snow-fighting tool that can be used to supplement the decision-making process. With training, the operator will eventually learn that salt application rates can be adjusted up or down based on the predominant numerical values and/or lights displayed on the box through a particular road section.

II. ODOT's RT3 USAGE & EXPERIENCE PRIOR TO 2008-2009 WINTER SEASON

Although ODOT has gradually increased its deployment of the RT3 since the product's inception in 2001, much of its use thus far has been 'experimental' in nature. The purpose of the experimentation was to evaluate the unit's durability/ruggedness, and to verify the accuracy, repeatability, and reliability of the grip readings that were obtained. A significant amount of data was collected and analyzed over multiple years by the Office of Maintenance Administration. The analyses performed indeed confirmed the accuracy, repeatability, and reliability of the readings, as well as the durability of the unit.

A recent report by the University of North Dakota ⁽²⁾ validates these findings. It states:

- * *"...the RT3 unit proved to be a very reliable platform..."*
- * *"...the RT3 unit is capable of distinguishing changes in roadway traction conditions over very fine scales (~ 15m) with good fidelity and repeatability."*
- * *"...the RT3 has considerable potential for both real-time operational use (as a tool to help guide wintertime snow and ice control maintenance activities prior to, during, and after snow and ice events)..."*

Although it has been quite evident to ODOT for a few years that the RT3 provides accurate, reliable, consistent data, and is structurally very durable, incorporation into the department's winter operations has evolved rather slowly as it has determined how best to utilize them.

Prior to the onset of the 2008-2009 winter season it was established that the primary goal of that season's RT3 program would be to determine to what extent departmental cost savings could be realized through ODOT's deployment of RT3's. Given the economic conditions cited below, the department has a strong interest in minimizing fuel, salt and equipment costs, while ensuring continued safety on our roads.

III. SNOW AND ICE OPERATIONS: ODOT'S DIFFICULT ECONOMIC CONDITIONS

In 2008 fuel costs increased at an unprecedented rate and, while those costs have since decreased, there is considerable concern that the high costs experienced earlier will return. Ohio has also seen a dramatic increase in the price of salt, with those increases ranging from 50 to 300 percent among counties. The general overall availability of salt from vendors has also been a difficult issue with several counties in the southern half of the state unable to secure bids; as such, transfers of salt from one county to another were common throughout the winter.

During the 2007-2008 winter season ODOT's snow trucks drove nearly 11,000,000 miles (including patrolling duty), and more than 900,000 tons of salt were used. Also, the average fuel economy for single-axle dump trucks is approximately just 6 miles per gallon, and the average cost to operate them is nearly \$1.90 per mile (excludes the material applied).

These facts point out the need for ODOT's snow truck operators to conserve fuel, salt and equipment to the greatest extent possible.

IV. USE OF RT3's AND GRIP DATA IN SNOW & ICE OPERATIONS - \$\$\$ SAVINGS POTENTIAL

As noted above, two types of RT3's currently exist: 1.) tow-behind, and 2.) underbody.

The **tow-behind type** is typically used for patrolling or "snow-spotter" purposes, either before or after a winter event.

Prior to the expected onset of a winter event, a manager can send out a tow-behind unit (or units, depending on the number of lane miles in his jurisdiction) to patrol routes and monitor road grip conditions. As long as conditions are good the manager can keep his snow trucks at the garage, conserving fuel, salt and equipment. When the tow-behind unit operator begins to detect deterioration in road grip he can communicate to the manager that the trucks need to be deployed. Without tow-behind RT3's to utilize, a manager would likely continue doing 'business as usual' – i.e., sending most of his snow trucks out, using fuel unnecessarily and possibly salt.

When the winter event has weakened and the manager is assessing whether road conditions warrant further treatment, he can again send out the tow-behind unit(s) to monitor road grip conditions. If grip values are not yet in the acceptable range, that information can be conveyed to the manager who would then keep his snow truck operators out treating the roads. If the values are good, however, the manager can call the operators in, saving fuel and preventing unnecessary (i.e., wasted) applications of salt.

The **underbody type** is typically used by the snow truck operator during an event. (A garage that does not have any tow-behind models could, however, utilize some of these units in the patrolling capacity explained above.)

The operator can, through repeated use of the RT3, become familiar enough with the numerical grip values displayed in the Halliday box that he will eventually associate ranges of values with the needed salt application rates.

For example, a driver may learn that a road with grip values in the 30 – 40 range suggests an application rate of 400 lbs/ln-mi while one with values in the 60 – 70 range suggests an application rate of just 100 lbs/ln-mi. In addition, an operator may eventually learn that when a certain minimum reading is displayed consistently (e.g., readings are always above 70), he can return to the garage because the roads are safe.

Given the significant increase in the price of salt and its possible limited availability, it is essential that it be applied only when necessary and not wasted. And, with high fuel costs, it is critical that it be conserved as much as possible, and operators are not driving their routes when it is evident from the grip values they don't need to. Operators who become familiar with the grip values displayed in the Halliday box, and apply material accordingly, will conserve both.

V. PRE- 2008-2009 WINTER SEASON: RT3 MEETINGS WITH MQS PERSONNEL

It had been suggested in the summer of 2008 that the Office of Maintenance Administration's Maintenance Quality Survey (MQS) inspectors may be able to assist with the RT3 program (particularly Franklin County's snow and ice operations) during the months of January, February, and March 2009.

Consequently, three meetings were held to discuss this issue.

On July 24th, 2008 Office of Maintenance Administration personnel met with District 6's Highway Management Administrator (Thomas Lyden) and Franklin County's Transportation Administrator (Jack Marshall) to discuss Franklin County's possible use of MQS personnel during the months noted above.

Since it had been recently decided that Maintenance Quality Surveys would not be conducted during those months, the four employees who perform them would be available to assist this county with its snow and ice operations. As a result of the meeting it was determined that each MQS employee would be assigned a tow-behind unit and perform primarily pre- and post-event "patrolling" duties. Two would work nights (11:00 p.m. – 7:30 a.m.) at the 5th Avenue garage, one would work days (7:00 a.m. – 3:30 p.m.) at the Westerville garage, and one would work days at the Grove City garage.

The second meeting was held December 8th, 2008. Maintenance Administration personnel met with the four MQS employees (Dan McNeil, Roger Alton, Steve Purcell, and Bob Meyer) to familiarize them with the RT3 program's history, the specifics of RT3 system, and to discuss their upcoming work with Franklin County. At the conclusion of the meeting the employees were shown an RT3 truck and how to perform routine maintenance items that would be required during their work with the county.

The third meeting was held December 22nd, 2008. Maintenance Administration personnel met again with the four MQS employees to further finalize the details of their upcoming work. Other attendees included Shawn Rostorfer (Acting Transportation Administrator, Franklin County), Chuck Rumery (Transportation Manager, Grove City), David Shackelford (Transportation Manager, 5th Avenue), Mike Taylor (Transportation Manager, 5th Avenue), Tim Peddicord (Roadway Services Manager, District 6), and Don Halliday, President of Halliday Technologies.

Specific garage-reporting assignments were determined for the four employees and their duties during non-snow and ice weather were discussed. Mr. Peddicord and Mr. Rostorfer stated that inventories of various roadway appurtenances (e.g., guardrail, barrier wall) were needed and that the employees would assist with that work.

It was determined that the MQS personnel would report to their respective garages on Monday, January 6th, 2009.

VI. 2008-2009 WINTER SEASON: USE OF RT3 VEHICLES

Twenty (20) trucks with RT3s were deployed for the 2008-2009 winter season. Fifteen (15) were the underbody style and five were the tow-behind style. Most were located at various garages throughout District 6, with the others in District 2.

The breakdown was as follows:

| | DISTRICT (LOCATION) | RT3 TYPE | TRUCK PLATE NO. |
|----|-------------------------------------|------------|--------------------------------------|
| 1 | 2 (Ottawa) | Underbody | T2_660 |
| 2 | 2 (Williams) | Underbody | T2_737 |
| 3 | 2 (Williams) | Underbody | T2_804 |
| 4 | 6 (Franklin – Grove City) | Tow-Behind | T_502 (MQS driver 1 – Dan McNeil) |
| 5 | 6 (Franklin – Grove City) | Underbody | T6_550 |
| 6 | 6 (Franklin – Grove City) | Underbody | T6_692 |
| 7 | 6 (Franklin – Grove City) | Underbody | T6_694 |
| 8 | 6 (Franklin – Grove City) | Underbody | T6_711 |
| 9 | 6 (Franklin – Grove City) | Underbody | T6_757 |
| 10 | 6 (Franklin – Grove City) | Underbody | T6_773 |
| 11 | 6 (Franklin – Grove City) | Underbody | T6_781 |
| 12 | 6 (Franklin – Grove City) | Underbody | T6_819 |
| 13 | 6 (Franklin – Westerville) | Tow-Behind | T_457 (MQS driver 2 – Bob Meyer) |
| 14 | 6 (Franklin – Westerville) | Underbody | T6_769 |
| 15 | 6 (Franklin – Westerville) | Underbody | T6_772 |
| 16 | 6 (Franklin – Hilliard) | Underbody | T6_753 |
| 17 | 6 (Franklin – 5 th Ave.) | Tow-Behind | T_653 (MQS driver 3 – Steve Purcell) |
| 18 | 6 (Franklin – 5 th Ave.) | Tow-Behind | T_663 (MQS driver 4 – Roger Alton) |
| 19 | 6 (Franklin – 5 th Ave.) | Underbody | T6_785 |
| 20 | 6 (Delaware Dist. Office) | Tow-Behind | T6_758 |

TABLE 1

This report focuses mainly on the sixteen (16) RT3 trucks utilized in Franklin County during the months of December, January, February and March. For events that occurred in January, February, and March the managers were asked to provide the following information (from 1/6/09 e-mail):

- 1.) Did you utilize the MQS driver(s) stationed at your facility for this particular event?
- 2.) If so, how did you utilize them? What was your approach/reason for using them in this manner? (e.g., sent them to the southern part of the county to monitor road conditions, in anticipation of freezing rain approaching from the south...or whatever the case may be.)
- 3.) If you did not use them, please let us know why as well (e.g. during the 3rd shift the weather was not an issue yet....)
- 4.) For this event, were you able to delay deploying your fleet any by having the MQS driver(s) patrolling the roads? (e.g., yes, the MQS driver allowed us to keep our drivers in the garage an extra hour. i.e., without the MQS driver we would've deployed the fleet x hour(s) earlier.)

Comments were not received for every event from each manager, probably because of other duties - particularly during the rather severe January when they were involved with snow and ice events seemingly almost every day. Several 'positive' comments were provided throughout the winter, however. (Note: Shawn Rostorfer indicated that he delegated Chuck Rumery to provide comments on his behalf.) A sample of comments received includes:

"I actually had trucks on the road at 6:30 a.m. and pulled them off of the road approx. 9:00 a.m. and pulled out at 9:30 a.m. and was assisted in my decision-making thanks to the readings on the wheels; under normal situations (pre-RGT) we would have waited until the pavement dried off, especially with the extreme cold air temp and low pavement temps. But the wheels indicated no re-freeze was present and the fact the sun came out.. we saved several hours of patrolling and overtime that would have normally been worked." (C. Rumery, 1/21/09)

"Since we have been using the RT3 wheels they have been very helpful. The first week we did not have too bad of weather. The following week we had some off and on freezing rain; temps were right between 33 & 32 so I sent the wheels out and about four dump trucks to help cover the county and was able to use my other crews to do pothole patching for about four hours before I had to send them out on the road for patrol. This last week before the snow started the wheels were out on the road again. We had a lot of work to get done on our trucks and were able to keep most of our fleet off the road for awhile to get the repairs done. Also, it helped out on having to bring the day shift in at a later time in the morning. I know it is hard for two trucks to cover the whole county but it has been very helpful and has saved the department some money on fuel - not a lot but every little bit helps....." (D. Shackleford, 1/22/09)

Usage of RT3 vehicles during these four months was logged on an Excel spreadsheet (see Appendix A for January; the other months are available upon request). On days when 1.) a county reported a snowfall amount of ¼ inch or greater, and/or 2.) salt usage was greater than 50 tons (definition of an 'event'), usage was checked. When neither was met, it was not. (To determine whether the vehicle used its grip wheel on such days a website was referenced. It provides the following information, generally every ten seconds: vehicle ID (license plate number), date, time, latitude, longitude, road temperature, air temperature and the grip value. See Appendix B.)

The spreadsheet is coded so that:

- (●) indicates grip data was received (i.e., showed on the website) by that vehicle that day.
- (x) indicates that grip data was not received. (Among the reasons a vehicle would show an x include: a mechanical issue(s) that prevented the vehicle from running that day, or a manager decided it was not necessary to have all of a garage's vehicles out for a particular event.)

December – (As noted previously, MQS inspectors did not report to their assigned locations until Monday, January 6th.)

| |
|---|
| # Days when 50+ tons salt was used <u>and</u> ¼" + of snow reported: 1* |
| # Days when 50+ tons of salt was used, but less than ¼" of snow: 8 |

* Although there was only one day when ¼"+ of snow was reported, freezing rain/sleet occurred frequently, thus explaining the 50+ tons salt usage on the other eight days.

RT3 usage on these days was high on December 23rd and 24th, with almost all of the Franklin County vehicles collecting grip data. Usage on the other days was not as high with about half of the vehicles typically collecting data. Again, this could be attributed to mechanical issues or an event that did not require all of a garage's vehicles to be utilized.

January - The MQS inspectors reported to their assigned locations on Monday, January 6th.

| |
|---|
| # Days when 50+ tons salt usage was used <u>and</u> ¼" + of snow reported: 12 |
| # Days when 50+ tons of salt was used, but less than ¼" of snow: 5 |

This month easily showed the most winter activity. A recent, local news weather (television) report stated that the Columbus-area received approximately 20 inches of snowfall in January and just 3 inches for the months of November, December, February (.2") and March (.3") combined.

RT3 usage on these days was high as can be seen in the Excel spreadsheet. A significant percentage of the vehicles ran on most of these days.

(Note: Dan McNeil, the MQS inspector assigned to the Grove City garage, began Disability Leave on January 27th and was not scheduled to return to work until after March 9th.)

February –

| |
|--|
| # Days when 50+ tons salt usage was used <u>and</u> ¼" + of snow reported: 0 |
| # Days when 50+ tons of salt was used, but less than ¼" of snow: 4 |

This month had very light winter activity with just .2" of snowfall. RT3 usage on the four days was good with most vehicles collecting grip data. (Two of the four events occurred on weekends, when MQS inspectors did not work.)

Note: On February 19th Maintenance Administration personnel met again with Shawn Rostorfer, Chuck Rumery, David Shackelford and Bob Meyer. The purpose of the meeting was to gauge the effectiveness of the RT3 program thus far and to solicit feedback, pro and con, from the managers and MQS drivers. The managers' comments were unanimously positive with each mentioning that they consider the RT3 a very valuable tool. Each cited instances when a small number of RT3 vehicles had been sent out in advance of a predicted storm to patrol and gather grip data; otherwise, they stated that a larger number of vehicles would have been deployed, wasting fuel unnecessarily and possibly salt.

March – During the week of March 2nd it was decided that Friday, March 6th would be the final day the MQS inspectors would report to their locations. On Monday, March 9th they would resume their normal MQS inspection duties in order to complete work that had a June 30th deadline.

This month also had very light activity with just .3" of snowfall.

| |
|--|
| # Days when 50+ tons salt usage was used <u>and</u> ¼" + of snow reported: 0 |
| # Days when 50+ tons of salt was used, but less than ¼" of snow: 0 |

December, January, February, and March (Summary) –

| |
|---|
| # Days when 50+ tons salt usage was used <u>and</u> ¼" + of snow reported: 13 |
| # Days when 50+ tons of salt was used, but less than ¼" of snow: 17 |

Note re. MQS personnel usage: Monday, January 5th through Friday, March 6th, the reporting period for MQS personnel, encompasses 43 workdays. This excludes the two holidays in January and February and weekend days, since it was generally agreed they would not work then unless unusual circumstances (e.g., a large winter event) required them to. Fourteen (14) of their 43 workdays had 50+ tons of salt usage. During the other days, the MQS personnel performed various other duties including inventory of roadway appurtenances.

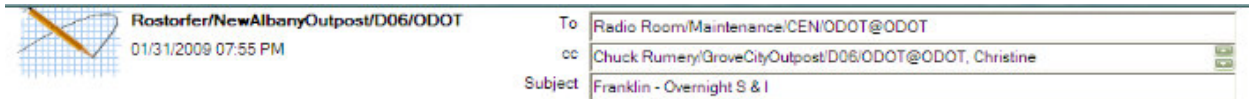
VII. 2008-2009 WINTER SEASON: EXAMPLE COST SAVINGS ACHIEVED WITH RT3

To determine whether the use of RT3's is saving the department money, actual costs from three events this past winter - in which RT3's were utilized - were compared to those that would have resulted had no RT3's been used for the same events (i.e., a 'theoretical' cost). For each event, the managers were asked what the deployment scenario likely "would have been" if they did not have any RT3's to use.

Obtaining actual cost information for an event is rather straightforward while determining a 'theoretical' cost requires a number of assumptions to be made.

EVENT 1 (FRANKLIN COUNTY) –

This ‘black ice’ event occurred in the morning hours of Sunday, February 1st. (The Halliday RT3 is especially useful for this type of event since the slipperiness of the roadway cannot be detected by the human eye.) On Saturday evening Shawn Rostorfer, Franklin County Manager, sent the following e-mail to Transportation Managers in Franklin County. The four snow trucks listed in the e-mail have RT3s attached. (There was no patrolling by the MQS personnel since this event occurred on a weekend.)



Please Post for Operators

There is a potential for freezing fog/drizzle overnight. We will have four trucks patrolling Franklin County from 1:00 AM through 8:00 AM. If conditions warrant, we will bring in additional crews.

The four trucks on patrol will be as follows.

From Rt. 70 South:
T6-781 - Skeeter Wolfe (614.332.0442)
T6-694 - Tom Murphy

From Rt. 70 North:
T6-772 - Curtis George (614.325.4913)
T6-769 - Steve Johnson

Shawn Rostorfer

Actual Treatment (i.e., with RT3's):

The four RT3 trucks began patrolling at 1:00 a.m. Conditions deteriorated very slowly throughout the night but became significantly worse around 4:00 a.m. At that time the drivers noted, from the very low values displayed in the Halliday box and roads that appeared clear, that black ice was indeed present.

At 4:30 a.m. the drivers requested additional help from the other three garage locations: Worthington, Grove City, and Hilliard. A total of 16 drivers patrolled and treated from approximately 5:00 a.m. to 10:00 a.m.

| EVENT 1 (FEBRUARY 1, 2009) – ACTUAL COSTS (w/RT3’S) | |
|---|---|
| Labor | 4 operators (1:00 a.m. – 10:00 a.m.) + 12 add’l operators (5:00 a.m. – 10:00 a.m.); 36 + 60 = 96 man-hours; 96 hrs x \$27.66/hr (OT) = \$2655 |
| Material | 75 tons salt used (Franklin Co.) x \$55/ton = \$4125 |
| Equipment | \$2.76/mi x 30 mi/hr (est.) x 96 hrs = \$7949 |
| TOTAL | \$2655 + \$4125 + \$7949 = \$14,729 |

“Theoretical” Treatment (i.e., with no RT3’s):

According to Shawn Rostorfer and Chuck Rumery, if RT3 units had not been available, they likely would have utilized all 16 trucks beginning at 1:00 a.m. and ending well beyond 10:00 a.m.

| EVENT 1 (FEBRUARY 1, 2009) – ‘THEORETICAL’ COSTS (no RT3’s) | |
|---|--|
| Labor | 16 operators x 11 hours (est.) = 176 man-hours; 176 hrs x \$27.66/hr = \$4868.....[an 83 % increase] |
| Material | Est. a 20% increase (conservative) - \$4950 |
| Equipment | \$2.76/mi x 30 mi/hr (est.) x 176 hrs = \$14,573.....[an 83% increase] |
| TOTAL | \$4868 + \$4950 + \$14,573 = \$24,391.....[a 69% increase] |

| | |
|---|---|
| Event 1 Cost Savings: Theoretical – Actual | \$24,391 - \$14,729 = \$9662 savings |
|---|---|

EVENT 2 (5th AVENUE) - uses 2 MQS patrols

From David Shackelford e-mail...

“On 2-19-09 all weather stations were calling for snow, maybe half inch to a inch. I made the choice not to send the road inventory crew (i.e., MQS inspectors) out for inventory (in MQS van) but to send them out in the pickup truck with the wheels to check for bad spots on the road and black ice. I also sent six of my dump trucks out just in case there were some spots that my need some attention which it was a good call on my part because around 3:00 a.m. there was some precipitation that made the roads have some problems so I called all six trucks and told them to put a light round of salt down.

Also, the MQS truck also made two calls to me saying that they had run into some bad spots. So while other parts of the counties were having problems, we had Franklin county under control, so rush hour went very well. I was still able to send out two sweeping crews and two pothole crews to complete some priority work that needed done so if we did not have the MQS guys here at night we would have sent out all fourteen dump trucks out patrolling which it would have cost us a lot of money in fuel and wear and tear on the truck, not to mention all the labor hours we would have had just for them running around in the trucks."

| EVENT 2 (FEBRUARY 19, 2009) – ACTUAL COSTS (w/RT3's) | |
|---|--|
| Labor | 2 MQS (12:00 a.m. – 6:00 a.m.) + 6 operators (12:00 a.m. – 6:00 a.m.) + 6 add'l operators (3:00 a.m. – 6:00 a.m.) = 66 man-hours; 66 hrs x \$27.66/hr (OT) = \$1826 |
| Material | 40 tons salt used x \$55/ton = \$2200 |
| Equipment | \$2.76/mi x 30 mi/hr (est.) x 66 hrs = \$5465 |
| TOTAL | \$1826 + \$2220 + \$5465 = \$9491 |

| EVENT 2 (FEBRUARY 19, 2009) – 'THEORETICAL' COSTS (no RT3's) | |
|---|--|
| Labor | 14 operators x 6 hrs (est.) = 84 man-hours; \$84 x \$27.66/hr (OT) = \$2323...[a 27% increase] |
| Material | Est. a 20% increase (conservative) - \$2640 |
| Equipment | \$2.76/mi x 30 mi/hr (est.) x 84 hrs = \$6955.....[a 27% increase] |
| TOTAL | \$2323 + \$2640 + \$6955 = \$11,918....[a 26% increase] |

| | |
|---|---|
| Event 2 Cost Savings: Theoretical – Actual | \$11,918 - \$9491 = \$2427 savings |
|---|---|

EVENT 3 (FRANKLIN COUNTY) –

From Chuck Rumery e-mail... (It pertains to the third day of the major event that occurred on January 28th – 30th, 2009.)

"Scott,

.... here is what I came up with, keep in mind these numbers are averages.

The event that occurred on 1/28/09 lasted into 1/30/09, we scheduled crews to stay until 11:00 p.m. at the tail-end of the storm. With temps. falling and dark setting in we would have normally covered the event through the remainder of the shift (three additional hours) but made the decision with the aid of the wheels and management skills to pull out at 8:00 p.m. which saved three hours.

43 crews @ \$27.66 per hour = \$1,189.38 (I got this average from payroll, this is a Franklin County average at time and one half for O.T.)

43 trucks @ \$2.76 per lane mile X 30 miles per hour = \$3,560.40 (this is an average consisting of 22 tandems and 21 single axles)

[30 Average hourly miles driven per hour]

\$3,568.14 = \$1,189.38 per hour = 43 hourly wages X 3 hours @ time and one half
 \$10,681.12 = \$2.76 per lane mile X 30 miles = \$3,560.40 X 3 hrs X 43 trucks (90 miles per truck)

1 hour savings \$4,749.78 driver and truck included
 3 hour savings \$14,249.34 " " "

Let me know if you need more info.

Thanks,

Chuck Rumery
 Transportation Manager 2
 Grove City Outpost "

| EVENT 3 (JANUARY 30, 2009) – ACTUAL COSTS (w/RT3's) | |
|--|--|
| Labor | \$8481 (from EMS GQL for 1/30/2009) |
| Material | 582 tons salt used x \$55/ton = \$32,010 |
| Equipment | \$10,681 (from EMS GQL for 1/30/2009) |
| TOTAL | \$8481 + \$32,010 + \$10,681 = \$51,172 |

| EVENT 3 (JANUARY 30, 2009) – 'THEORETICAL' COSTS (no RT3's) | |
|--|---|
| Labor | \$8481 + (43 operators x \$27.66/hr x 3 hrs) = \$12,049 |
| Material | Est. a 20% increase (conservative) - \$38,412 |
| Equipment | \$10,681 + (\$2.76/mi x 30 mi/hr x 3 hr x 43) = \$21,362 |
| TOTAL | \$12,049 + \$38,412 + \$21,362 = \$71,823....[a 40% increase] |

| |
|---|
| Event 3 Cost Savings: Theoretical – Actual \$71,823 - \$51,172 = \$20,651 savings |
|---|

The cost information for these three events show that significant cost savings result when RT3's are utilized efficiently. Per event savings of up to 20% would appear to be conservative.

VIII. ODOT SNOW & ICE OPERATIONS - COST INFORMATION

The following table was developed from information obtained via an EMS/GQL query.

| 6242* (TMS ACTIVITY CODE) | | | |
|----------------------------------|---------------------|--------------------------------|---|
| | EQPT. (DIRECT COST) | MAT'L (TONS): (DIRECT COST) | TOTAL: DIRECT COST (for EQPT. & MAT'L) |
| FRANKLIN COUNTY | | | |
| (11/15/04 – 3/15/05) | \$433,792 | \$1,102,224 | \$1,536,016 |
| (11/15/05 – 3/15/06) | \$260,263 | \$400,877 | \$661,140 |
| (11/15/06 – 3/15/07) | \$314,456 | \$700,557 | \$1,015,013 |
| (11/15/07 – 3/15/08) | \$578,436 | \$1,026,651 | \$1,605,087 |
| (11/15/08 – 3/15/09) | \$467,938 | \$743,441 | \$1,211,379 |
| 5 YEAR AVERAGE | \$410,977 | \$794,750 | \$1,205,727 |
| DISTRICT 6 | | | |
| (11/15/04 – 3/15/05) | \$1,101,534 | \$2,876,911 | \$3,978,445 |
| (11/15/05 – 3/15/06) | \$683,815 | \$1,531,636 | \$2,215,451 |
| (11/15/06 – 3/15/07) | \$1,058,875 | \$2,137,097 | \$3,195,972 |
| (11/15/07 – 3/15/08) | \$1,803,839 | \$3,499,304 | \$5,303,143 |
| (11/15/08 – 3/15/09) | \$1,641,186 | \$2,429,393 | \$4,070,579 |
| 5 YEAR AVERAGE | \$1,257,850 | \$2,494,868 | \$3,752,718 |
| STATEWIDE | | | |
| (11/15/04 – 3/15/05) | \$10,969,642 | \$26,174,244 | \$37,143,886 |
| (11/15/05 – 3/15/06) | \$8,198,642 | \$17,098,039 | \$25,296,681 |
| (11/15/06 – 3/15/07) | \$11,651,184 | \$22,617,335 | \$34,268,519 |
| (11/15/07 – 3/15/08) | \$17,327,778 | \$35,138,170 | \$52,465,948 |
| (11/15/08 – 3/15/09) | \$16,753,321 | \$24,151,902 | \$40,905,223 |
| 5 YEAR AVERAGE | \$12,980,113 | \$25,035,938 | \$38,016,051 |

* 6242 – Plowing Snow and Applying Chemicals and/or Abrasives. (Does not include Patrolling.)

TABLE 2

IX. HALLIDAY RT3 COST INFORMATION

The information in the first two columns of Table 3 was recently provided by Halliday Technologies, Inc.

| # OF UNITS PURCHASED | COST (EACH) | TOTAL COST |
|-----------------------------|--------------------|--------------------|
| 100 | \$24,000 | <i>\$2,400,000</i> |
| 200 | \$23,000 | <i>\$4,600,000</i> |
| 300 | \$22,000 | <i>\$6,600,000</i> |
| 400 | \$21,000 | <i>\$8,400,000</i> |

TABLE 3

Table 4 was developed from the information provided.

| COST TO EQUIP VARIOUS # OF ODOT SNOW TRUCKS w/RT3's | | | |
|--|-------------------------|------------------------|--------------|
| NOTES | NUMBER | COST | |
| | 1 | 1 x \$24,000 | \$24,000 |
| | 10 | 10 x \$24,000 | \$240,000 |
| <i>To Equip: ½ of All Franklin County Trucks (16 are currently equipped)</i> | 28 (-16 current units) | = 12 x \$24,000 | \$288,000 |
| <i>To Equip: All Franklin County Snow Trucks</i> | 55 (-16 current units) | = 39 x \$24,000 | \$936,000 |
| | 50 | 50 x \$24,000 | \$1,200,000 |
| <i>To Equip: ½ of All District 6 Trucks</i> | 83 (-16 current units) | = 67 x \$24,000 | \$1,608,000 |
| | 100 | 100 x \$24,000 | \$2,400,000 |
| <i>To Equip: All District 6 Trucks</i> | 166 (-16 current units) | = 150 x \$24,000 | \$3,600,000 |
| | 500 | 500 x \$20,000 (est.) | \$10,000,000 |
| | 1000 | 1000 x \$19,000 (est.) | \$19,000,000 |
| <i>To Equip: All ODOT Trucks Statewide</i> | 1600 | 1600 x \$19,000 (est.) | \$30,400,000 |

TABLE 4

X. EXPANSION OF RT3 PROGRAM

Because of the economic situation the state is currently confronted with, it does not appear financially feasible to expect that ODOT's entire fleet of approximately 1600 snow trucks could be equipped with RT3's prior to the onset of next winter. The cost to do this, assuming a further reduced RT3 cost of \$19,000 each, amounts to approximately \$30,000,000. (In addition, Halliday Technologies, Inc. is presently not able to handle an installation of this magnitude for an upcoming winter.)

Experience has shown that equipping every snow truck in a garage with an RT3 is probably not necessary anyways. One view that has been expressed is that perhaps half a counties' fleet, on average, should be equipped. (More than half would likely be needed in Ohio's northern counties, with less in its southern counties.) This still amounts to \$15,000,000+, however. To equip each county with a tow-behind unit or two for patrolling purposes, which seems like an optimal approach, increases the amount even more.

Table 4 above presents various scenarios related to equipping ODOT’s snow trucks with RT3’s. For example, to get all of District 6’s snow trucks equipped would cost approximately \$3,600,000, while getting half equipped would amount to approximately \$1,608,000.

One idea that has been stated regarding expansion of the RT3 program would be to ‘grow it outward’ in an incremental, systematic fashion each year. For example, getting Franklin County fully equipped – whether that is all or half its fleet – could be a first step. Then, surrounding counties within District 6 could be addressed. After that surrounding districts could be looked at.

Several other expansion scenarios can obviously be considered. One would be to incorporate an RT3 unit or two in each district’s ‘neediest’ county next winter. Doing it in this manner would not be nearly as costly to a single district as that noted above. Another option would be to expand the program in the northern districts first, and then consider the southern districts.

The best expansion scenario for a county garage, however, may be to initially focus on equipping a pickup truck(s). As noted elsewhere in this report, patrolling worked very well this past winter and was utilized heavily by the Transportation Managers in Franklin County. Sending a tow-behind RT3 out prior to a storm to monitor changing road conditions is less costly than deploying an entire fleet of snow trucks, whose miles per gallon is low and operating cost is high. Once the garage has an optimal number of pickup trucks equipped, its focus could then turn to equipping its optimal number of snow trucks. The cost savings realized from patrolling with a pickup truck(s) and keeping snow trucks in the garage until needed could be utilized toward future RT3 purchases.

The tables below focus on the growing outward approach. Various scenarios related to equipping either Franklin County’s trucks or all of District 6’s truck are presented.

| DISTRICT 6 - # SNOW TRUCKS & RT3’s (CURRENT SITUATION) | | | |
|---|----------------------|----------------|-----------------------|
| COUNTY | # SNOW TRUCKS | # RT3’s | % TRUCKS w/RT3 |
| Delaware | 20 | | |
| Fayette | 15 | | |
| Franklin | 55 | 16 | 29% |
| Madison | 17 | | |
| Marion | 15 | | |
| Morrow | 14 | | |
| Pickaway | 14 | | |
| Union | 16 | | |
| TOTAL | 166 | 16 | 10% |

TABLE 5

| DISTRICT 6 SALT USAGE PER FY – IN TONS, BY COUNTY | | | | | | |
|---|---------------|---------------|---------------|---------------|---------------|---------------|
| COUNTY | FY 2004 | FY 2005 | FY 2006 | FY 2007 | FY 2008 | AVERAGE |
| Delaware | 5,623 | 8,517 | 5,119 | 5,491 | 11,230 | 7,196 |
| Fayette | 5,315 | 7,088 | 3,651 | 6,316 | 9,040 | 6,282 |
| <i>Franklin</i> | <i>21,708</i> | <i>30,279</i> | <i>11,452</i> | <i>19,803</i> | <i>27,553</i> | 22,159 |
| Madison | 7,031 | 9,287 | 6,964 | 8,925 | 12,285 | 8,898 |
| Marion | 6,530 | 6,429 | 5,655 | 5,264 | 8,359 | 6,447 |
| Morrow | 7,871 | 9,150 | 6,996 | 7,854 | 11,945 | 8,763 |
| Pickaway | 2,907 | 3,449 | 1,850 | 4,265 | 5,494 | 3,593 |
| Union | 6,947 | 9,278 | 5,382 | 4,367 | 7,609 | 6,717 |
| TOTAL | 63,932 | 83,477 | 47,069 | 62,285 | 93,515 | 70,056 |

TABLE 6

| FRANKLIN COUNTY – RT3 PURCHASE SCENARIOS (BASED ON SALT SAVINGS ONLY) | | | |
|---|-------------|-------------|-------------|
| 22,159 tons (5 yr avg use) | @ \$50/ton | @ \$60/ton | @ \$70/ton |
| | \$1,107,950 | \$1,329,540 | \$1,551,130 |
| 10% salt savings via RT3 usage | \$110,795 | \$132,954 | \$155,113 |
| <i># RT3's purchased w/savings (@ \$24,000 ea.)</i> | 5 | 6 | 6 |
| 15% salt savings via RT3 usage | \$166,193 | \$199,441 | \$232,670 |
| <i># RT3's purchased w/savings (@ \$24,000 ea.)</i> | 7 | 8 | 10 |
| 20% salt savings via RT3 usage | \$221,590 | \$265,908 | \$310,226 |
| <i># RT3's purchased w/savings (@ \$24,000 ea.)</i> | 9 | 11 | 13 |

TABLE 6A

| DISTRICT 6 – RT3 PURCHASE SCENARIOS (BASED ON SALT SAVINGS ONLY) | | | |
|--|-------------|-------------|-------------|
| 70,056 tons (5 yr avg use) | @ \$50/ton | @ \$60/ton | @ \$70/ton |
| | \$3,502,800 | \$4,203,360 | \$4,903,920 |
| 10% salt savings via RT3 usage | \$350,280 | \$420,336 | \$490,392 |
| <i># RT3's purchased w/savings (@ \$24,000 ea.)</i> | 15 | 18 | 20 |
| 15% salt savings via RT3 usage | \$525,420 | \$630,504 | \$735,588 |
| <i># RT3's purchased w/savings (@ \$24,000 ea.)</i> | 22 | 26 | 31 |
| 20% salt savings via RT3 usage | \$700,560 | \$840,672 | \$980,784 |
| <i># RT3's purchased w/savings (@ \$24,000 ea.)</i> | 29 | 35 | 41 |

TABLE 6B

| 6242 – USING 5 YEAR AVERAGES (FROM TABLE 2, ABOVE) | | | |
|---|---------------------------|-----------------------------------|---------------------------|
| | EQPT. (DIRECT COST) | MATERIAL (TONS): (DIRECT COST) | TOTAL (DIRECT COST) |
| FRANKLIN COUNTY | \$410,977 | \$794,750 | \$1,205,727 |
| 10% Reduction in Costs via RT3 usage | \$41,097 | \$79,475 | \$120,572 |
| # RT3'S purchased w/savings (@ \$24,000 ea.) | | | 5 |
| 20% Reduction in Costs via RT3 usage | \$82,194 | \$158,950 | \$241,144 |
| # RT3'S purchased w/savings (@ \$24,000 ea.) | | | 10 |
| DISTRICT 6 | \$1,257,850 | \$2,494,868 | \$3,752,718 |
| 10% Reduction in Costs via RT3 usage | \$125,785 | \$249,487 | \$375,272 |
| # RT3'S purchased w/savings (@ \$24,000 ea.) | | | 16 |
| 20% Reduction in Costs via RT3 usage | \$251,570 | \$498,974 | \$750,544 |
| # RT3'S purchased w/savings (@ \$24,000 ea.) | | | 31 |
| STATEWIDE | \$12,980,113 | \$25,035,938 | \$38,016,051 |

* 6242 – Plowing Snow and Applying Chemicals and/or Abrasives. (Does not include Patrolling.)

TABLE 7

Table 7 illustrates RT3 cost and savings information. (As noted earlier in the report, based on the 2008-2009 winter events analyzed, per-event savings of up to 20% appear to be conservative.)

For example, If Franklin County were to purchase 10 RT3's (10 x \$24,000, or \$240,000) the cost savings that would be expected in the first year would be approximately \$241,000. Similarly, if District 6 were to purchase 31 RT3's (\$744,000) the cost savings expected in the first year would be approximately \$750,000. In subsequent years, the savings achieved would not be offset by the purchase cost of the RT3's. Only occasional, minimal maintenance costs would be required.

| FRANKLIN COUNTY B/C ANALYSIS: 2009-2010 WINTER | |
|---|--|
| BENEFITS: | |
| 20% EQUIPMENT SAVINGS = \$82,194 (using Table 7) | |
| 20% MATERIAL (SALT) SAVINGS = \$158,950 (using Table 7) | |
| TOTAL: \$82,194 + \$158,950 = \$241,144 | |
| COSTS: | |
| RT3 PURCHASE = 9 (x \$24,000 ea) = \$216,000 | |
| ANNUAL MAINTENANCE COST = \$500 PER RT3; 9 x \$500 = \$4500 | |
| TOTAL: \$216,000 + \$4500 = \$220,500 | |
| BENEFIT/COST RATIO: \$241,144 / \$222,000 = 1.1 | |

TABLE 8A

| FRANKLIN COUNTY B/C ANALYSIS: 2010 - 2011 WINTER & BEYOND | |
|--|--|
| BENEFITS: | |
| 20% EQUIPMENT SAVINGS = \$82,194 (using Table 7) | |
| 20% MATERIAL (SALT) SAVINGS = \$158,950 (using Table 7) | |
| TOTAL: \$82,194 + \$158,950 = \$241,144 | |
| COSTS: | |
| RT3 PURCHASE = \$0 | |
| ANNUAL MAINTENANCE COST = \$500 PER RT3; 9 x \$500 = \$4500 | |
| TOTAL: \$0 + \$6000 = \$6,000 | |
| BENEFIT/COST RATIO: \$241,144 / \$4500 = 53.6 | |

TABLE 8B

| DISTRICT 6 B/C ANALYSIS: 2009-2010 WINTER | |
|--|--|
| BENEFITS: | |
| 20% EQUIPMENT SAVINGS = \$251,570 (using Table 7) | |
| 20% MATERIAL (SALT) SAVINGS = \$498,974 (using Table 7) | |
| TOTAL: \$251,570 + \$498,974 = \$750,544 | |
| COSTS: | |
| RT3 PURCHASE = 30 (x \$24,000 ea) = \$624,000 | |
| ANNUAL MAINTENANCE COST = \$500 PER RT3; 30 x \$500 = \$15,000 | |
| TOTAL: \$624,000 + \$15,000 = \$639,000 | |
| BENEFIT/COST RATIO: \$750,544 / \$639,000 = 1.2 | |

TABLE 8C

| DISTRICT 6 B/C ANALYSIS: 2010-2011 WINTER & BEYOND |
|--|
| BENEFITS: |
| 20% EQUIPMENT SAVINGS = \$251,570 (using Table 7) |
| 20% MATERIAL (SALT) SAVINGS = \$498,974 (using Table 7) |
| TOTAL: \$251,570 + \$498,974 = \$750,544 |
| COSTS: |
| RT3 PURCHASE = \$0 |
| ANNUAL MAINTENANCE COST = \$500 PER RT3; 30 x \$500 = \$15,000 |
| TOTAL: \$15,000 |
| BENEFIT/COST RATIO: \$750,544 / \$15,000 = 50.0 |

TABLE 8D

XI. CONCLUSIONS & RECOMMENDATIONS

Every year hundreds of accidents nationwide are reported that can be attributed to a loss of vehicular traction. Many can be associated with snow and ice accumulation on roadways, or by the formation of pavement frost or ‘black ice’.

Further, it is often difficult for the managers and operators responsible for keeping Ohio’s roads clear in the winter to produce a consistent result when using equipment with a set, defined material (salt) application guideline, while the judgment being used for the protocol is totally ‘subjective’. For example, a study of the March 7th and 8th, 2008 major storm revealed that, among counties within the same district, a large variance existed in the amount of salt applied per lane mile. Even with an established departmental material application guideline, maintenance crews for the same storm can have a large variation in product application. With the high price of salt and fuel, this suggests there is a significant cost savings to be made in the winter maintenance process by moving the operator judgment from a subjective to objective basis by using the RT3.

ODOT’s recent experience with the RT3 has confirmed that it is reliable, durable and, perhaps most importantly, provides accurate, real-time road grip data to snow truck operators or those patrolling. For the driver it removes any ‘guesswork’ regarding a roadway’s true condition, thus assisting in the decision of whether material needs applied or not; essentially, it provides reinforcement that the correct treatment is being applied. It also allows the operator to quickly identify trouble spots on a roadway that might otherwise appear to be in good condition. And, by providing an accurate depiction of the pavement’s actual condition, it provides a level of safety for the operator while on his route. As shown in this report, its use can result in significant cost savings through a reduction in salt and equipment use. (The reduction in salt usage appears to support ODOT’s recently announced “Go with Green” initiative.)

Expanding the current RT3 program incrementally (i.e., over a number of years) in a systematic manner would be the most cost efficient way for the program to grow. A number of different expansion scenarios were mentioned but a county garage should give consideration to equipping a pickup truck(s) first, before its snow trucks. As noted elsewhere in this report, patrolling worked well this past winter and was utilized frequently by the Transportation Managers in Franklin County. Sending a tow-behind RT3 out prior to a storm to monitor changing road conditions is less costly than deploying an entire fleet of snow trucks, whose miles per gallon is low and operating cost is high. Once the garage has an optimal number of pickup trucks equipped, its focus could then turn to equipping its optimal number of snow trucks.

As with any new technology, there is often a reluctance to adopt and utilize it. ODOT's Road Weather Information Systems (RWIS) and use of liquids in treating roadways are two examples of technologies that were initially slow in receiving acceptance but today their use by the districts is routine. In due time, the RT3 is expected to receive the same acceptance and will become yet another valuable tool in our snow and ice operations.

APPENDIX A

(attachment provided separately)

APPENDIX B

(attachment provided separately)

APPENDIX C

OTHER RT3 APPLICATIONS (WORLDWIDE & DOMESTIC)

WORLDWIDE:

- The Swedish Road Administration has chosen the RT3 (or device with RT3 capabilities) to be used exclusively to measure the performance of their winter maintenance contractors. This protocol will be written into their system by September 2009 and implemented from 2010 onwards. The accuracy and resolution of the RT3 has allowed this type of evaluation process for the first time anywhere in the world.
- The Swedish Road Administration has decided to use the RT3 as the only surface reference tool for referencing the performance of all winter road tires for use on Swedish roads. Eventually all tires will be categorized to the public based on these tests. This is the first time this has been done in the world.
- This spring the Swedish Road Administration will test the RT3 with an RT3 water system (designed for the FAA RT3 unit) to determine safe levels of reflective bead concentrations in road paint.
- The Japanese government is in the 3rd year of investigation of RT3 and Halliday Technologies, Inc. has recently had discussions about deployed use of the underbody version in the Hokkaido region.
- Halliday Technologies, Inc. will supply the Swedish Road Administration with a two wheeled RT3 version that will allow the authority to measure any of their roads at any time of year with any contaminant and/or construction type. This reference grip value using a treaded Standard Reference Test Road Tire has never been done and is also a world first. It is the beginning of road authorities worldwide being able to compare objectively relative road surfaces with and without surface contamination.
- Halliday Technologies, Inc. is about to receive accreditation by the FAA for use of the RT3 at airports around North America both during summer and winter.
- Ontario and Quebec are currently investigating the use of the RT3.

DOMESTIC:

- Other state DOT's investigating the use of the RT3 include: Indiana, Utah, Wyoming, Michigan and New York.

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