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Recording Material Usage in Winter Maintenance Operations: A Survey of State Practice

Prepared for
Clear Roads Pooled Fund Study

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Request for Report

Maintaining accurate inventories of materials used in winter maintenance operations can be challenging. Manual recording of material usage data may require operators to make assumptions about quantities used, and inconsistencies are often identified when trying to reconcile data recorded by operators or spreader controls with material stockpiles. Members of the Clear Roads winter maintenance pooled fund study are interested in learning how states are addressing the difficulties inherent in monitoring material usage. As the lead state for the Clear Roads pooled fund, Wisconsin DOT asked us to document the state of the practice for recording material usage.

Summary

We conducted a brief survey of three groups—SNOW-ICE listserv members, Clear Roads technical advisory committee representatives, and attendees of the 2007 National Winter Maintenance Peer Exchange—consisting of the following questions:

1. What method do you use to gather material usage data for the salt, sand and liquid chemicals used in your winter maintenance operations? For example, are you using loader bucket counts, spreader control readouts, GPS/AVL, or other methods?
2. What quality checks are in place to ensure accuracy of the material usage data?
3. How frequently do you verify the accuracy of your method to gather material usage data?
4. What issues have you encountered in ensuring that material usage is recorded properly?

Sixteen state DOTs, the District of Columbia, one city, one Canadian agency, and the New York State Thruway Authority responded to the survey. (See **Survey Results**.)

Key findings from the survey include:

Gathering Usage Data

- More than half of the agencies **(55 percent) use loader bucket counts** as one of their primary methods to gather material usage data.

- Almost half of the agencies **(45 percent) use spreader control readouts** as one of their primary methods to gather material usage data. Three other agencies—Iowa DOT, Nebraska Department of Roads, and the New York State Thruway Authority—have spreader control reporting systems but make limited use of this measurement method.

- **Five agencies use or will be using Global Positioning System or Automatic Vehicle Location technology** to measure material usage to some degree. Washington DOT reports that 10 to 15 percent of its fleet has AVL technology, with one maintenance area completely reliant on the automated system's data gathering capabilities. Portions of the New York State DOT and Ontario winter maintenance fleets use GPS or AVL technology. For other agencies, AVL technology is new or just on the horizon; for example, the city of Dubuque reports that it is installing a GPS/AVL system in all city deicer trucks, and implementation of AVL and Maintenance Decision Support System technologies is in process on Minnesota DOT's winter maintenance fleet.

Checking Data Quality

- Almost half of the agencies **(45 percent) use more than one method to check data quality**. Only three agencies reported no quality checks.

- Half of the agencies **(50 percent) use stockpile verification** to check the accuracy of material usage data. Timing of the verification varies, from annually (Minnesota DOT) to monthly (Michigan DOT) to weekly (Illinois DOT).

- Almost half of the agencies **(45 percent) compare usage logs or reports** against material ordered and the amount on hand.

- Almost half of the agencies **(40 percent) calibrate spreader controls** or **verify spreader control data** to confirm that spreaders are calibrated accurately.

Verifying Measurement Methods

- Three-quarters of the agencies **(75 percent) verify the accuracy of their methods to measure material usage** at least once during the snow season. The city of Dubuque checks data after each storm as the city continues to work on its new system, while Maine DOT's region management reviews usage on a weekly basis and uses this data to reconcile stockpiles periodically throughout the season. Only three agencies indicated that they do not verify the accuracy of their reporting methods. Two other agencies do their verification at the beginning or end of the season, with no periodic checks during the season.

Challenges in Recording Material Usage Data

- Almost two-thirds of the agencies **(60 percent) cite reporting inaccuracies or inconsistencies** as a challenge in effectively monitoring material usage. For Indiana DOT, the lack of tools for operators to determine the weight of a bucket load contributes to inaccurate reporting. Illinois DOT reports that some operators intentionally report inaccurate data to understate the amount of material used.

- Respondents also cited **inexperienced personnel**, **equipment problems** and **lost data** as challenges to accurately recording usage data.

- **Three agencies look to automation to address the problem of inaccurate or inconsistent reporting**. Minnesota DOT's implementation of AVL technology replaces the department's current system of gathering operator-recorded data, and Washington DOT's long-term goal of full deployment of automated data collection will address problems encountered with manual reporting. An Arizona DOT research project is investigating a process to transfer data from the spreader control head by phone line for upload to a Web-based program. Investigators hope to automate uploading of this data to the department's operations management reporting system.

Survey Results

Arizona

1. Currently within ADOT several methods are practiced. The most common is loader bucket count and estimates based on what is left or used during the course of a storm. This includes prewet liquids, which we apply at an average of 7 gallons per ton of dry chemicals. Some areas do use the spreader controller to retrieve use amounts while others use handwritten TAPER logs. [The TAPER log is a form developed by Washington State DOT and used by maintenance employees to record weather, road surface and maintenance operation information. TAPER is an acronym for the data elements collected: temperature, application rate, product used, event and results.]

   One district is currently doing a research project that will use data directly from the spreader control head transferred via phone service to a data housing company that makes all the data available in a Web-based program. This system is also being evaluated to see if this data can be loaded directly into our operations management reporting and tracking system. If this system is proven and robust enough to hold up, it could become in the future the way we do business. [See http://rip.trb.org/browse/dproject.asp?n=14993 for details.]
2. Currently our quality checks are verification of spreader control data and evaluation of stockpile quantities.
3. This varies from organization to organization. Some verify after each storm, while others may wait until the stockpile is gone to verify if inventories match use. Usage data is available to us as soon as daily work reports are entered into our management system. This system gives us reports by route, MP and time frames as to what was reported and used against what was planned.
4. As the above shows, many inconsistencies can happen and over or under applications occur. Ability to measure stockpiles accurately is a challenge, since in some cases they are used up and replenished within very short time frames.

Colorado

1. The only official material usage mechanism we have is our SAP/ERP accounting system, where our operators enter on a work order the quantity of materials they used on each route. In some instances, this is an approximation as the loads are not metered.
2. TAPER logs and physical checks of the materials stockpile pre- and post-storm.
3. This varies from area to area, so I would say every few storms.
4. Accuracy of reporting and, in the end, inventory control. For the most part, the field supervisors have a pretty good handle on monitoring and adjusting to have applications match inventory by the end of the season.

Additional comments:

We purchased one of the portable scales and sent it across the maintenance section, calibrating every sander. The scale is from Scale Tech.

District of Columbia

1. Although we don't use sand, our salt is tracked by truck size and number of loads. First, all the trucks are entered into an online database, and when a truck picks up a load of salt, the truck number is entered into a computer, and the system recognizes that a truck is a 6-ton, 10-ton, 17-ton truck, etc. The liquid we use is a brine and GeoMelt mixture, which is tracked through a computer attached to the brine mixing machine. Since the mixing and calculation are predetermined, the machine is very accurate in tracking the amount of liquids used.
2. We try to ensure accuracy by having all trucks entered and updated throughout the season, to reduce the human error factor.
3. See above.
4. [No response.]

Illinois

1. Two methods are currently being used:
   - Truck load counts. Trucks are loaded and weighed to determine the quantity per truck load. Truck loads are then reported after each storm.
   - Quantities taken directly from the spreader control system.

2. We have several quality checks that we use:
    - Spreader controls are calibrated each year.
    - Periodic/random catch tests are performed to verify accuracy of calibrations.
    - Data from a limited number of trucks are downloaded from the spreader control after each storm to verify the amount used and application rates.
    - Total quantities reported are checked weekly against the material on hand.
    - Total storage capacity is calculated (and adjusted when needed) to ensure accurate numbers.
3. This answer varied wildly across the state. Anywhere from after each storm to annually.
4. We have the following issues:
    - Nonfunctioning spreader controls (malfunctions and/or clogged augers causing inaccurate reporting)
    - Inexperienced personnel not knowing how to extract quantity usage data from the spreader controls
    - Lack of consistency in reporting load counts
    - Intentional inaccurate reporting to show that they used less than they actually did
    - Entry errors into data recording system

Indiana

1. Material usage data is collected in our Work Management System. Generally, loader bucket counts are used for salt usage.
2. Stockpiles are periodically checked during the season to verify reordering needs. All checks on salt are visual analysis.
3. There is no set frequency.
4. Operators don't have any tools to determine the weight of a bucket load.

Iowa

1. Most of our trucks are equipped with spreader control systems that can track the amount of dry and liquid materials used, but much of our tracking is done by measuring the amount of buckets that were loaded on each truck during a storm. The buckets are usually calibrated at the start of the season to determine how much salt or other material is in a bucket load. All quantities are then entered daily into a computer application that tracks the amount of salt used by each maintenance garage.
2. No quality checks are currently in place to ensure accuracy, although garages are asked frequently to update the quantity of material they have on hand throughout the winter season.
3. Reporting is done daily through our reporting system and adjusted periodically throughout the season.
4. During a storm it is easy to lose track of the number of bucket loads used and how much of the material was put back into the shed after the storm. When salt is mixed with abrasives at different ratios it is difficult to determine the amount of salt in a bucket load of 70/30 (salt/sand) or 50/50 mixes. In a 3,000-ton-capacity storage facility it is very difficult to estimate the amount of salt at any one time.

Iowa (City of Dubuque)

1. We are installing a GPS/AVL system into all of the deicer trucks and downloading the information from the controllers.
2. We have average load information available and cross-check the information we receive in the office and compare it to what the controller in the truck is reading.
3. All trucks are calibrated once a year and we check the data after each storm since we are still working on the system.
4. The problem we are currently working on is lost data. We are losing data due to the way we transfer data (radio).

Maine

1. Ground speed control spreader devices, with bucket counts as a backup verification.
2. Periodic stockpile verification and correction by Independent Assurance personnel that report centrally.
3. Region management reviews usage on a weekly basis through our work reporting/asset system (MATS, which is shared with New Hampshire and Vermont). Stockpiles are reconciled by crews periodically throughout the winter and verified at least once per season as indicated above.
4. Ironically, whenever the numbers don't agree, we have lost salt. It's never the other way around (go figure!). Seriously, though, the load counts are not too accurate, so when the ground speed controls have issues or get plugged temporarily with chunks, the backup method leaves a lot of room for error. Since we have moved away from dedicated loader operators, this is compounded by the fact that some people have a hard time accurately

estimating what was loaded or offloaded. As far as the reporting system is concerned, we are very happy with MATS.

Maryland

1. The Maryland State Highway Administration (SHA) uses loader bucket counts for determining salt usage during a storm. Some shops use a visual inspection of their storage tanks to determine the amount of liquid used in a storm. Others use metered devices on liquid applicator trucks to capture this data followed up with a visual inspection of their storage tanks.
2. The salt usage information is verified through a visual inspection of the salt domes or barns by a maintenance shop manager prior to placing an order to replenish the material used. Some SHA shops use spreader control printouts to further verify material usage, while others do not use this method. The SHA does not have a statewide policy on this issue.
3. Some shops weigh a loader with and without a full scoop of salt prior to winter to determine the pounds of salt per scoop. Other shops rely on a previously determined weight if they are using the same loader from a previous year.
4. Even without a uniform policy, SHA's current material usage captured at the statewide level is probably accurate enough. Still, I can visualize the benefits of a uniform policy in recording material usage. To be sure, more accurate material usage data at the snow-route level would allow for more analysis of the efficiency of the individual components of the overall operation.

Michigan

1. We typically use spreader control readouts.
2. We compare our monthly material usage reports with our amount of material that has been ordered and the amount we have in storage.
3. Monthly.
4. Operators sometimes forget to record the material usage after their shift. We haven't found a way to measure material usage that is both accurate and easy.

Minnesota

1. The operators are required to capture this information in their time sheets at the end of every shift they are out on snow and ice operations. The time sheet and our Workflow Management Systems are tied together. We use the WMS to write monthly material reports. We realize that the info is only an approximation since the guys are only giving us their best guess as to how much material they used. We capture salt, brine, sand, alternative chemicals (CaCl, MgCl, CF7, LCS, etc.), equipment usage, etc.
2. At the end of the season we try to reconcile the field data with the stockpile at hand, and with the purchase orders. In regards to the stockpile measurement, we are experimenting with 3-D surveying.
3. Every season, at the end of the season (no periodic checks in between).
4. Training and reliance on the employees to do their best at accurately capturing their material usage. We are in the midst of implementing AVL and MDSS on our winter maintenance fleet; once this is done, the material coming out of the spreader (salting and sanding) and out of the nozzles (anti-icing and deicing) will be automatically recorded.

Missouri

1. We do not have one standard method to compute material usage. I know some areas use loader bucket counts and some others use the spreader controller information.
2. None; we rely totally on the field employees to report this information as accurately as possible.
3. N/A
4. No issues have occurred.

Nebraska

1. Loads/loader bucket counts. Each operator reports their salt usage to their supervisor when they turn in their miles and hours at the end of their shift. The supervisors then report to the superintendent with how much salt was used. We can get the information from our truck spreaders but haven't really found a need to.
2. Our spreaders are calibrated every fall before winter operations and then whenever we do any repairs on the spreader. We also periodically check to see how much salt the truck actually put out during a snow event and at what rate (if the driver switched over to manual).

3. Again, we calibrate our spreaders every fall and whenever the spreader is worked on.
4. Our crews do very well at keeping records of their material usage.

New York
1. Loader bucket counts, spreader control readouts, and good old estimating by looking at the pile; limited AVL.
2. Supervisors review material usage records after storms.
3. After each storm, and by reconciling supply totals with delivery tickets and estimated remaining stockpiles.
4. Lack of full automation, data transposing mistakes and spillage that is not accounted for.

New York (New York State Thruway Authority)
1. We generally use loader bucket counts for tracking usage. We also have inventory control monitoring and spreader control readouts, but these are used more or less as checks for the driver reports.
2. We use spreader control readouts to check driver report accuracy at the garage level, and gross inventory control monitoring to check for ballpark accuracy on a systemwide level.
3. Spreader control readouts are checked on a frequent basis; inventory control one or two times per season.
4. Relying on truck operators to accurately fill out logs can be problematic, especially during long and intense events. Also, reliably measuring bucket capacities and counting loads (what's a full load vs. a half load).

North Dakota
1. Loader bucket counts; very limited in scope and do not do it all of the time.
2. We don't have any.
3. We don't check it.
4. We have a very limited program/process to track material usage.

Ontario, Canada
1. All our spreaders have electronic spreader controls and some are equipped with GPS, allowing download of electronic data. We also reconcile material inventories based on beginning inventory, material deliveries and ending inventory, and adjust reported quantities on various reports, including our Maintenance Management System.
2. Random audits on document, calibration of spreaders and material usage reports.
3. Randomly throughout the winter, but a minimum of five storms per season per yard location.
4. Inconsistencies between electronic controller data, quantities reported by truck operators and measured quantities.

Tennessee
1. Bucket loads.
2. Survey stockpile.
3. After events.
4. Human error.

Utah
1. Counting buckets.
2. Scanning the data at the end of the season.
3. As of now, never.
4. Materials used are adjusted on a bulk basis at an annual inventory conducted by warehouse staff.

Washington
1. Nearly all of our application equipment has precision controllers that measure and record output. (Equipment without precision controllers is calibrated such that material applications can be quantified by distance traveled times rate of application.) Approximately 10 to 15 percent of the fleet has AVL technology, which electronically transmits application data into vendor and/or WSDOT databases. The majority of applications are manually recorded on PDAs, which when docked sync the info into another database. Some applications are recorded into a diary or notebook and then entered into the database on PCs at end of shift. The PDA database can be queried by single application report, by date of application, by equipment number, by product, by area and by route. The cumulative data populates a monthly report, which is used to display total usage for the previous month and for year to date for all products.

2. Application reports are compared against inventory issue (all products kept in inventory) and against vendor reports, which are received monthly. Additionally, material stockpiles are physically inspected throughout the year to reconcile material usage reports with stock on hand. Discrepancies are handled through review of application reports and inventory issues. Inventory adjustments are made, if necessary.
3. Area Supervisors are responsible for checking all application reports on the database. This is high-priority work and is accomplished as often as possible. HQ staff also query the database and reconcile inventory issues and vendor reports with application reports. Monthly reports are processed and reviewed, and discrepancies are identified and rectified.

4.
- Some lag time and some degree of error is assumed in the reporting of applications. A single decimal point error can have a significant effect on total usage figures, which is why the emphasis on Supervisor review is so critical.
- There is some degree of reluctance to use PDAs by operators, particularly older operators who are uncomfortable with technology. They will typically hand-record application data for later entry.
- Sand/salt mixes vary across the state. There is no single ratio used, so salt use must be estimated in many cases when applied as a mix with sand.
- During extended storms, operators are particularly pressed to respond to conditions and recording of application data becomes spotty when having to be manually entered. The expansion of automated data collection technology should address this problem and 100 percent deployment is the eventual goal of WSDOT.
- The automated data collection system produces data in a much different format than the PDA report database. We're still in the process of reconciling the two. We have only one maintenance area that is 100 percent reliant on the automated system at this time.