1.0 Automatic Vehicle Location – Global Positioning System (AVL-GPS) and Sensors

The Wisconsin Department of Transportation (WisDOT) has implemented new technologies that allow for improved safety to the traveling public and provide effective winter storm management on state maintained highways. The AVL-GPS technology also provides for increased operational and fleet management information for year-round benefits.

The AVL-GPS technology used in conjunction with the Maintenance Decision Support System (MDSS) described in HMM 6-25-10, is installed in trucks used on state maintained highways. The sensors and AVL-GPS feedback collects various real-time information about the vehicle such as location, speed, heading, engine RPM, trip fuel, oil pressure, coolant level, battery voltage, tail gate (up or down), plow (up or down), salt used, liquid used, application rates, weather, etc.

Monitoring of this information is done via a separate website and supports improved storm management based on real time information received. This real-time information includes current road conditions (icy, compact snow and ice, bare and wet, clear). The information is accessed by the Wisconsin Department of Transportation (WisDOT) to populate information in MDSS. These technologies are used by the service provider and WisDOT to improve storm management and management of material usage statewide.

All service provider trucks used on state maintained highways should be equipped with AVL-GPS and corresponding sensors described in section 4.0 of this procedure. For trucks that are not AVL-GPS equipped, the service provider will not be eligible for the winter readiness reimbursement as discussed in HMM 02-20-95, Section 4.0. State financed AVL- GPS units and sensors shall not be removed from trucks used on state maintained highways unless the units are being repaired, replaced or transferred to another truck used on the state highway system.

2.0 Responsibilities

Service providers will operate and maintain an AVL-GPS systems. They will be responsible for the procurement of the equipment, sensors, communications, and installation. All equipment will be operated and maintained according to the manufacturer's recommendations. Minimal equipment requirements are described in section4.0 of this procedure.

3.0 System Operations and Access

The information provided by the AVL-GPS vendor used by the service provider can be made available to WisDOT if requested for operational needs. The AVL-GPS vendor used by the service provider must be integrated with MDSS so truck data can be viewed by WisDOT staff.

Service providers will act as system administrator for access rights to their personnel and other identified members that need it. Open records requests for data directly from the AVL-GPS vendor source, will be forwarded to the service provider for processing.

4.0 System Requirements

These requirements listed below are minimum specifications for the AVL-GPS unit and sensors.

	Requirements
Category 1	**General**
4.1.1	MDSS Integration
a	In vehicle mobile data collection units with integrated maintenance decision support systems, in accordance with the Specifications – The unit purchased shall be of such design and construction as to comply with the requirement hereinafter stated and any parts or attachments necessary to form a complete, functioning unit must be furnished, whether specifically mention herein or not.
b	State Roadway System - The AVL-GPS unit shall function properly anywhere on the state's entire roadway system.
c	Required NTCIP Compliance – All equipment and software must be compliant with NTCIP standard 1204.
d	Compatibility with Existing MDSS Server Hardware – All equipment must be fully able to communicate with existing MDSS servers and processers using protocols specified in NTCIP standard 1204. Vendor must be able to provide proof of compatibility. All costs to enable proper communication between the MDSS and the servers will be borne by the contractor
e	MDSS data format requirements –
	1. Vehicle Identifier (required) This should be an identifier that is unique to the organization from which the data is being collected. It can be either textual or numeric. It does not need to be the same as the organization's vehicle identifier system, but a mapping between that AVLGPS identifiers and that system should exist. 2. Time (required) This should be a complete description of the date and time of the report to within 1 second of accuracy. It can be in the form of a string (e.g., "1/20/2005 3:43 AM CST" or "1-20-2005 9:43 UTC") or numeric (such as a Unix timestamp, which is a count of seconds since a certain point in history). The form of string representations of the date & time is flexible, but should include at least the year, month, day, hour, minute, second and time zone of the observation. Observations in UTC (Universal Coordinated Time, also known as Greenwich Time) are preferable but not necessary so long as the time zone is described in a standard manner (e.g., MST, CDT, etc.). 3. Location (required) Location information should be provided in the form of a GPS latitude and longitude associated with the vehicle's location at the time of the report. Three or more decimals of accuracy are desirable if possible. 4. Lane Identifier (required) This should be an identifier that can be used to uniquely determine the lane or lanes that a report applies to. A standard lane identification system across organizations is not necessary. However, an organization's lane identification system should be capable of representing both a single lane as well as combinations of lanes on a roadway. For example, if the digit "1" represented the passing lane and "2" represented the driving lane of a two-lane unidirectional roadway, a report that applied to both lanes might be represented as a "3", a "12", or some other logical identifier. For bidirectional highways it is advisable that an identifier representing both the present lane and oncoming lane be available. 5. Maintenance Data a. Plow Position (required) This can be represented as a 0 or 1, or as a string (e.g., "up" or "down"). If the numeric representation is chosen a value of 0 is generally used to indicate that a particular piece of equipment is inactive, so a value of 0 would indicate plow up while a value of 1 would indicate plow down. b. Scraper/Underbody Position (optional) The same explanation as for "Plow Position" applies. c. Wing Position (optional) The same explanation as for "Plow Position" applies.

d. Material Applied (required)
This field should uniquely describe the freeze-point depressant(s) and/or grit being applied to the roadway. Representation in the form of either a numerical or string identifier is acceptable. In either case, the identifier itself need not fully describe the mixture so long as it is unique and can be associated with a more detailed description of the mixture at the time of processing. For example, if Joe Driver uses a 20/80 mixture of granular NaCl and grit pre-wetted with 10 gallons / ton of $MgCl_2$, the most efficient way to convey this information might be to identify that particular mixture as something like mixture 1 or "Joe's Mix" and place that identifier into the AVLGPS data files. The specific composition of this mixture should be on file with those responsible for processing the data (Meridian at present) so that it can interpreted appropriately. The reason for using an identification system instead of the specifics of the mixture is twofold. First, the complexity of some mixtures would necessitate carrying a large number of fields in the data file in order to accommodate the more complex cases. A second and related issue is that the increased data file size this would necessitate could pose problems for the limited bandwidth that may be available between the trucks and the data collection facility in a real-time setting.

e. Material Form (required)
This field, although required, could also be provided through the "Material Applied" field discussed above. However, in some existing systems the choices for "Material Applied" might be limited to something like "NaCl", "$MgCl_2$", etc., and not be descriptive of the form of that salt. In those cases, this field should be present and populated with either a numerical or string identifier that indicates whether the material is in brine (liquid), prewet, or dry form.

f. Application Rate (required)
This field should represent the application rate of the material(s) being applied. It can be in the form of either a string or a number, although a number is generally preferable.

g. Application Rate Units (required)
This field should provide the units to associate with the application rate if they are not uniquely identifiable based upon the "Material Applied" field. For example, if a material identification system similar to the "Joe's Mix" discussed above is used no "Material Form" field is needed and it may already be uniquely known (off-line) that the units to associate with reported application rates of that mixture are in lbs per lane mile. However, under the alternative situation also discussed above, if the specifics of the mixture being applied are being described in the AVLGPS data files themselves (such as by supplying "NaCl" at the "Material Applied" and "brine" as the "Material Form") then the specifics of the entire application should be represented within the files, so it would be desirable to include something like "lbs/ln-mi" or "ga/ln-mi" as a string identifier for the application rate within the MDC files.

6. Road Observations
   a. Condition (optional)
   This field should represent the road condition to associate with each report from the AVLGPS system. A numerical or string identifier for each condition is acceptable. In the case of a numerical identifier a look-up table will need to be available off-line to convert numbers into conditions.
   b. Road Temperature (required)
   This numeric field could contain infrared pavement temperature measurements to associate with each report.
7. Weather Observations
   a. Precipitation (optional)
   This field should represent precipitation that is observed to be falling (by the driver) at the time and location of the report. A numerical or string identifier for various optional precipitation reports is acceptable. In the case of a numerical identifier a look-up table will need to be available off-line to

	convert numbers into observations. A preferred set of precipitation reports has not yet been defined. b. Visibility & Obstruction (optional) Same as for "Precipitation" above. c. Air Temperature (optional) Same as for "Road Temperature" above. 8. Camera Feed (optional) Programmed to collect a forward camera image when option is installed. Notes: • If maintenance activities data is not collected automatically by the truck but rather through a touchscreen, keyboard, or similar in the truck, it is advisable for the driver to have a way of toggling an indicator of when maintenance is and is not being performed without having to clear the plow & material application entries. • There are several ways of constructing this information: All data can be logged to a file at regular intervals (from seconds up to no more than every 5 minutes) and distributed back to Meridian when communications allow. This is the most straightforward way of storing the data but does require more data storage space (and communications bandwidth, if applicable). ○ Time & location data can be logged at regular intervals and the other data can be logged only when changes occur. For example, if the user enters a road condition of "wet" on a touchscreen, that entry and the time it was made would be logged to the file. The "wet" road condition would be assumed to be valid from that time / location forward until a different condition is entered and would be associated with all locations and times during that period. It is therefore advisable that the "wet" road condition that is being assumed to be valid be visible on the display in the truck so that the driver is conscious of what he or she is reporting. This latter method of data storage is slightly less end-user friendly but is also much less bandwidth and storage space intensive. • Even if data can be streamed back from the trucks to a central collection point in near real-time, it is imperative that the system continue to record data regardless of whether or not it is in communications range. If the truck moves out of range for a period, then reenters an area where communications are possible, all data collected during the period it was out of range should be sent back to the central collection point at that time.
4.1.10	AVL Management and Access – The AVL information collection, storage, and display system shall be designed, owned and operated by the vendor at a location of the vendor's choice, outside of the State or purchaser's network and accessible to the purchaser, the State and other agencies via the internet, using a standard web-browser.
4.1.11	The server shall receive information from all maintenance vehicles with AVL purchased.
4.1.12	The system shall be uniform in design and operation across all vehicle types.
Category 2	**Sensors**
4.2.1	The AVL system shall be programmable in common full programming language such as JAVA, to accept input from sensors provided by the contractor, or third party.
4.2.2	The sensors shall be connected to the system through hard-wire ruggedized connections.
4.2.3	The AVL system shall include sensors able to collect data from the spreader controllers for the following data: a. Plow Sensor (front plow, wing, underbody) b. Pavement Temperature and Ambient Sensor c. Auger Feedback Sensor d. Gate Sensor e. Flow Meter Sensor