



# Anti-icing equipment Recommendations & Modifications

# Introduction

The Anti-Icing Planning Committee recognized after the first winter of anti-icing the Interstate system in 1998-99 that there were several shortfalls in equipment and facilities that needed to be addressed before further expansion of anti-icing. A sub-committee was formed to look at the existing processes in the production, storage and delivery of liquid deicers for anti-icing and deicing operations. The subcommittee was asked to look at current practices and facilities to make recommendation on how they can be improved with a emphasis on safety and improved efficiency.

The group identified the following areas in their discussions as the primary processes in the use of liquid deicers and concentrated their efforts on these topics:

- **Brine Makers-** the group looked at the existing brine maker models that are used in the state and made recommendations on how each model can be improved to be more efficient in the production of brine. They also made recommendations on how future brine makers should be built to meet our needs in the future.
- **Facilities and storage-** this area gives a formula for garages to use when trying to determine how much storage is required to meet current and future liquid deicing needs. The section contains information on modifications that can be made to brine buildings to reduce the effects of corrosion and also gives contact information on containment.
- **Fittings and Connections-** A major obstacle in the first year's anti-icing efforts was the variety of hosing fittings and connecting devices that were being used around the state. Efforts were made by this group to standardize all plumbing fittings so that trucks can stop at any maintenance facility in the state to load or unload liquid deicers without need for adapters.
- **Onboard Equipment-** in this section the group looked at the variety of equipment used around the state to deliver liquid deicers for prewetting and anti-icing. Several equipment designs have been included to show how to build a low cost, gravity based anti-ice unit using readily available parts to the more sophisticated units with multiple material application abilities and a pressurized system. Trailer mounted, slip-ins, prewetters, prewet/anti-icing combinations and combination units that can carry large quantities of both liquid and dry deicing chemicals that can be used for anti-icing, prewetting and dry applications. Consideration should be given to the type of system required, for example, average daily traffic counts, speed of application due to safety concerns, lane miles to treat, costs and resources tracking.

- Pumps, spray bars and nozzles- this area concentrates on how the liquid deicers can efficiently be moved from the brine maker to the roadway using pumps, hoses, spray bars and nozzles. The group investigated the types and ideal locations where pumps should be located to maximize the volume of liquids that can be pushed or pulled along the brine production and delivery path. The different types and sizes of spray bars are covered along with how many holes to drill and their spacing for anti-icing operations. Nozzles and their uses are covered and samples of methods used to reduce drifting are also presented.
- Tracking Resources- in this section the variety of on-board material control units are discussed along with a simple chart that shows each units capabilities. Also included is a conceptual view of what the group felt would be the ideal control heads that would meet our needs now and in the future.

We hope the document can be used as a guide for building or purchasing equipment and facilities to support the use of liquid deicers. The guide can be used by those that have used liquids for many years to help tweak their system for more efficiency and can also be used for those just getting started with anti-icing or expanded use of liquids.

Any questions about this document should be directed to any of the members listed on page 3 of this document. They have put in many hours in the development of this document and can be a valuable resource tool.

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# Facilities

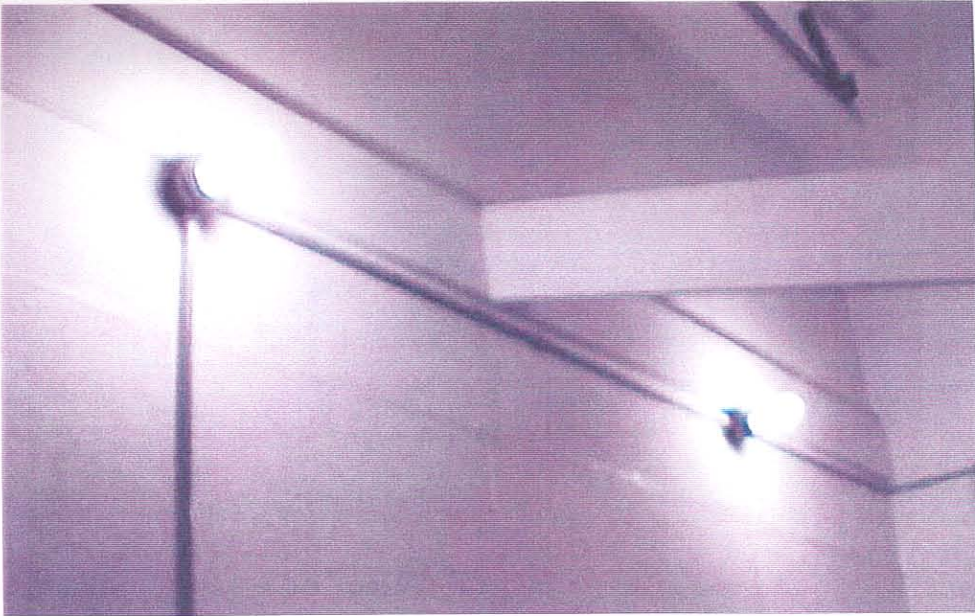
The following pictures are improvements made to brine buildings to deal with moisture and corrosion problems.



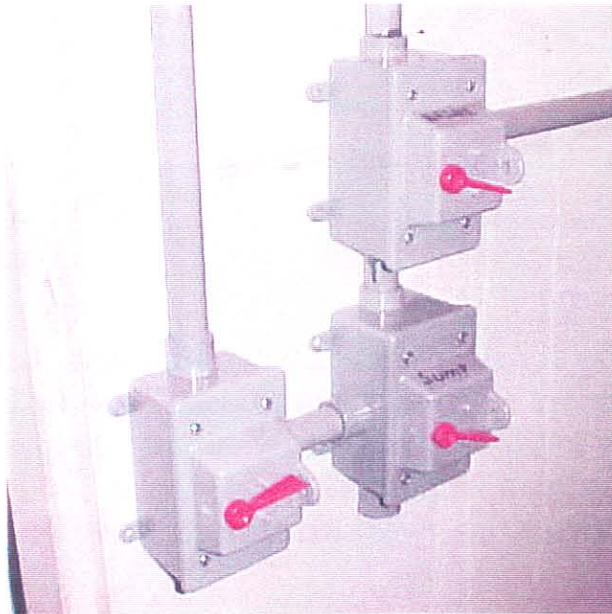
Transparent stainless steel door to brighten the inside and will hold up to corrosion better. A licensed electricians and HVAC technicians should be used for electrical and heat/ ventilation system. Cost approximately \$5,000.



Exterior mounted door opener with weatherproof cover removed. Cost approximately \$3,100 including high clearance door.

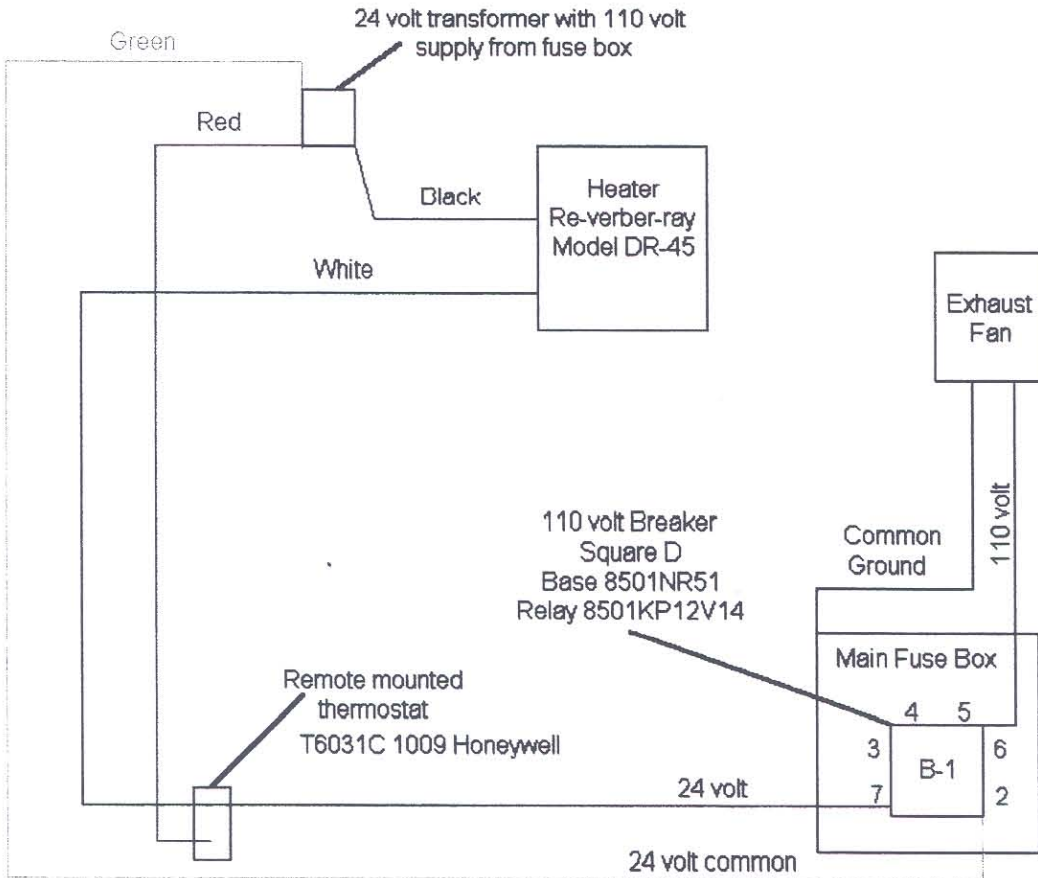


Moisture proof lights with wiring in plastic conduit to protect from corrosion. Cover assembly 15050, Base assembly A0434.



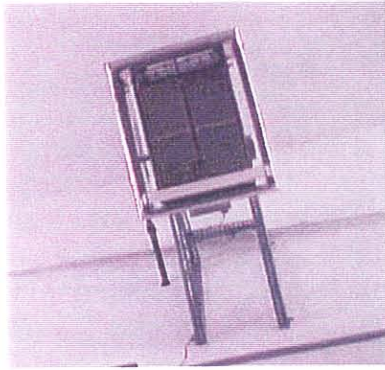
Weather proof switches and plastic conduit to protect wiring from corrosion.

# Heater/ Exhaust Fan for Brine Building



This is a typical wiring diagram for the installation of an exhaust system that is incorporated with a heater. Once the heater is activated the exhaust fan turns on to help circulate air. Wiring and equipment will last longer if they are installed on the exterior of the building in weatherproof boxes and conduit. Exhaust fans and vents are shown on the next page.





Radiant heater with thermostat that also activates ventilation system when turned on. This system only pulls in outside air when the heater is operating to reduce moisture buildup and reduce corrosion inside building. Power requirements and special wiring are shown on previous page.



Inside vent fan mounted just below level of heater so heated air is not exhausted.



Outside vent fan



Fresh air intake with bucket keeps cold air from entering building when heater air isn't operating. The heated air in the bucket will rise above the cold outside air, trapping it in the bucket.

# Storage

Due to various sizes and types of tanks available and currently in use, one specific storage unit has not been recommended over another. When planning a storage unit, contact the Environment Unit for containment requirements. A basic rule of thumb to determine storage needs is 1.5 times total lane miles to treat x recommended gallons per lane mile = amount of storage.  
(ex:  $1.5 \times 200 \times 50 = 1,500$ )

The 2500 gallon storage tanks are normally purchased because the cost per gallon is considerably less than other storage tanks. Other size tanks are available for limited space needs. The following are examples of different storage units with containment:



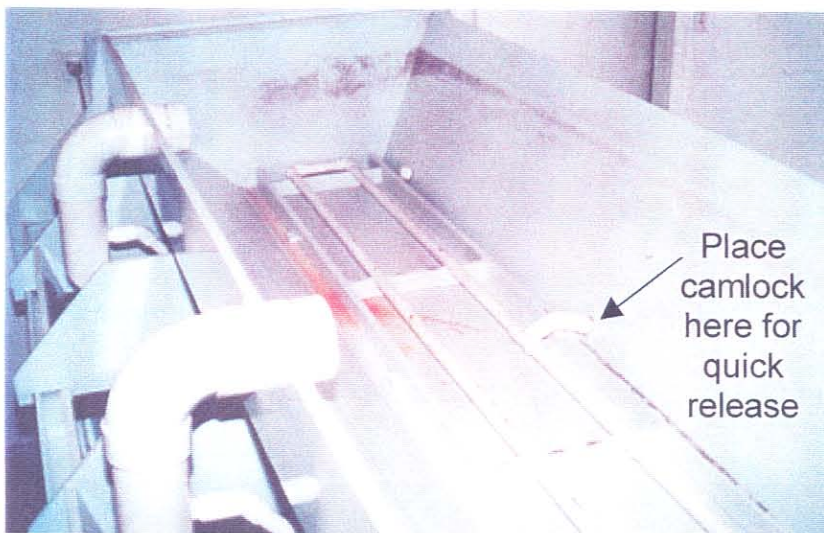
External brine storage with containment



Internal brine storage

# Optional Modifications to VariTech Plastic Welded Brine Maker

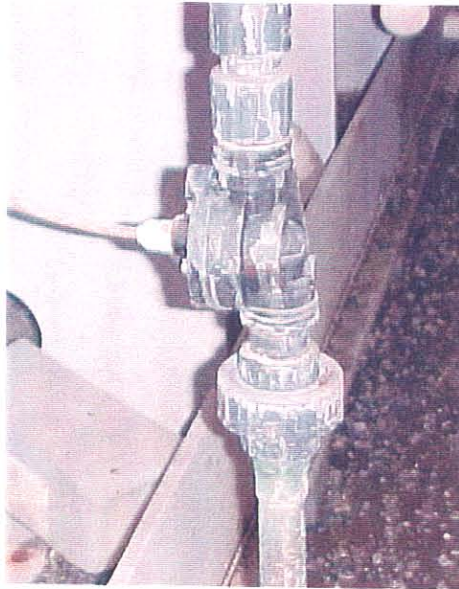
- Use angel hair fiberglass to seal leaking seams and repair structural damage and cracks.
- Replace pump with 1-1/2 inch, 1-1/2 HP pump or better and mount outside of original compartment to prevent brine contamination of pump motor.
- Replace original hard plumbing to percolation manifold with flex hose and camlock coupler to permit removal of manifold and stands for tank cleaning.



- Add a third overflow tube to the mixing tank to increase the production (available from VariTech)



- Change electric float in brine holding tank with a more reliable pilot operated diaphragm valve and float kit (available from VariTech)



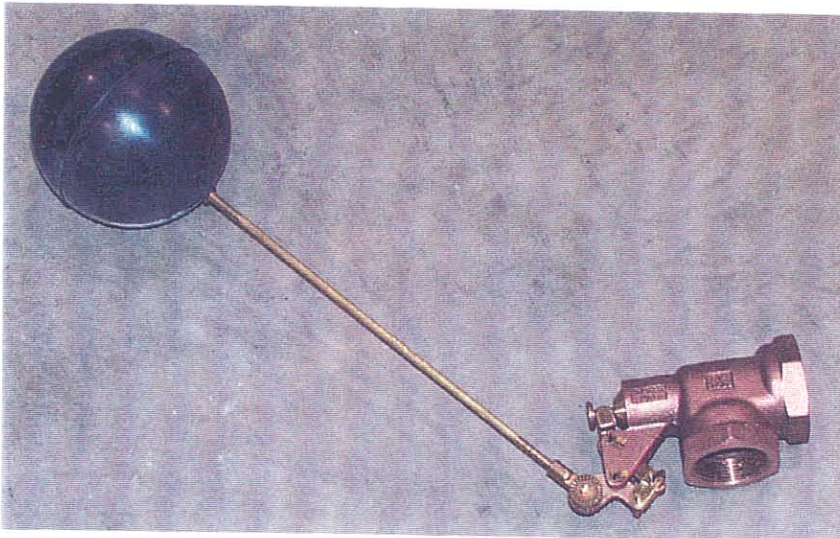
- Replace tank clean-out bung with ball valve for drain hose.
- Add feeder hopper to increase salt capacity (3 loader buckets) fabricated from old signs.



# Recommended Modifications to Sprayer Specialties SB 1400 Brine Maker



- Replace the  $\frac{3}{4}$  inch brine holding tank float with a 1  $\frac{1}{2}$  inch mechanical float. This will increase production and is more reliable. Valve part number 4664K52 from Sprayer Specialties. Approximately. \$125



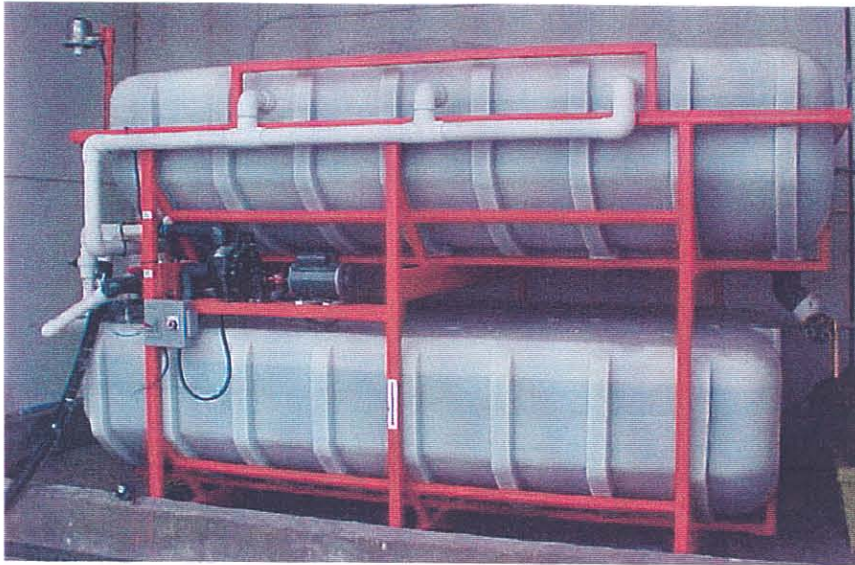
- Replace center mounted clean out in mixing tank with 3 or 4 inch flush mounted at end of tank. Replace bung with ball valve for drain hose to aid in clean out of system.

- Add overflow tube vents to prevent air lock in the tubes. Kit available from Sprayer Specialties \$30.
- Add 2 inch elbows part number SE200 to inlet of mixing tank overflows turned down so screens are below water level line to eliminate plugging of the screens.



- Add three 4" x 34" PVC pipe roof supports down the center of the brine holding tank to keep roof from dropping.
- Add 4 inch perforated PVC pipe hydrometer well, with perforated bottom cap so that hydrometer can stay in solution to lessen chance of breakage.

# Recommended Modifications to 1999 VariTech HI-CAP1200 Brine Makers



- Change percolation manifold to dual runner full loop design on 2 inch stands. Replace original hard plumbing to flex hose with quick coupler for manifold and stand removal during tank cleaning. (see page 7)
- Remove original manifold stands from tank for easier clean out.
- Move brine holding tank clean out to opposite end of tank from access hole to make the clean outs on the same end.
- Add vents to overflow tubes to prevent air lock.
- Add a protective shield over motor to pump drive to prevent injury from contact with rotating shaft.
- Rewire pump motor from 110 volt to 220 volt to reduce amperage.
- Add motor control to junction box to accommodate amperage to start motor.
- Add forklift tubes to frame between tanks to aid in maintenance.
- Replace frame when it gets rusted out with stainless steel from manufacturer.

# Recommended Modifications to Specifications for a Standard Prewet System



Spec. No. 32-A-0899  
Page 30-31 of 39

## SPECIFICATIONS for 140 GALLON TAILGATE MOUNTED PRE-WETTER

### 1. GENERAL

- A. Pre-wetter will be used to apply liquid ice control material onto granular material at the spreader spinner.
- B. Pump system should have a design rating of 4 GPM @ 1725 RPM.
- C. Tank shall be of a trapezoidal shape with a 140 US gallon capacity.
- D. System must be fully tested and calibrated to a 10 gallon per ton rate upon delivery to the Department. System shall be flushed and winterized with a suitable antifreeze solution to prevent freeze damage.
- E. All components, parts, pieces, fasteners, etc., shall be manufactured for nonferrous/non-rusting materials.
- F. Liquid ice control material hoses shall be 1/2 inch polyester braid reinforced clear PVC, suitable for cold weather use.
- G. All hoses and cables shall be long enough to allow the dump body tailgate to open for dumping over the spreader.



## 2. TANK

- A. Tank shall be purpose designed to fit a Department snow removal truck tailgate in the open spreader charging position. When installed it shall square-off the rear of the truck to a point even with the back of the installed spreader.
- B. Trapezoidal tank shall be approximately 19 inches wide at the top and 10 inches at the bottom. Height shall be 29 inches, overall length shall be 80 inches.
- C. Tank shall be constructed from rotationally molded UV stabilized polyethylene dyed opaque orange. It shall have a minimum average wall thickness of 0.400 inch. Design liquid rating of shall be a minimum of 14.5 lbs. per gallon.
- D. There shall be three molded-in stiffeners, each approximately 6 inches wide, evenly spaced in the tank length.
- E. Gallon markings shall be molded into the right rear face of the tank directly above the sump where the "pump-fill" connector will be installed.
- F. Tank shall have a top center mounted 12-inch fill lid. Lid shall be tethered.
- G. A 4" x 8" x 6" sump shall be molded into the right side bottom. Sump shall have three molded-in female 1-1/4" NPT threaded ports.
- H. A suitable recess compartment shall be molded into the right tank end, large enough to hold the integral board mounted pumping system. Stainless steel bosses shall be molded into the tank to allow the entire pump system to be securely bolted into place, employing stainless steel bolts.
- I. Additional stainless steel bolt bosses shall be molded into the right end to allow the installation of a stainless steel cover door over the pump system to protect it. Cover shall have a full-length vertical stainless steel piano hinge bolted into the molded-in bosses down one side. The opposite side shall latch using two stainless steel thumbscrews threading into two of the molded-in bosses. Entire cover shall be easily removed.

## 3. FITTINGS

- A. The left rear facing port shall have a 1-1/4 NPT plug screwed into it. It shall be for quick draining or clean out of the tank.
- B. The left port shall have a serviceable "Y-type" mesh strainer plumber in so all anti-icing material pumped on via the bulk fill must pass through it.
- C. Right port shall have a 1-1/4 inch three-way ball valve installed to allow bulk fill, shutoff or suction to be selected. A 1-1/2 inch male cam-lock connector shall be installed to allow bulk filling A matching cam-lock cover cap shall be provided.

- D. A 3/4-inch 2-way valve shall be installed into the suction plumbing. When this valve is closed, normal flow of the anti-ice material shall occur. When the 3-way valve is turned to the closed position and this valve opened, flush material shall be sucked into the plumbing and pumping system, thoroughly displacing all corrosive materials. An approximate 12-inch hose piece shall be attached to this fitting to allow easy flush material introduction via a plastic jug.

#### 4. PUMP SYSTEM WITH FLOW METER

- A. Material pump shall be a solid brass gear type, direct coupled to the hydraulic motor that will power the pre-wetter.
- B. Pre-wetter hydraulic system shall obtain its flow from the exhaust oil of the spreader auger motor circuit. Auger oil shall flow to a flow control valve, which will divert oil either to the hydraulic motor or back into the return oil circuit. Flow control must limit the oil flow so the pump never exceeds the design maximum RPM.
- C. Flow control shall be electrically controlled by the Raven spreader control in the truck cab, allowing precise metering of the oil flow.
- D. Pump system shall incorporate a calibrated Raven model RFM15 turbine style flow meter. Flow meter signal shall be sent to the spreader control, allowing a precise ground oriented liquid application rate. Rate shall be adjustable up to the limits of the pump design output.

#### 5. MOUNTING SYSTEM

- A. Pre-wet system shall attach to the dump body tailgate via a full stainless steel framework. Frame shall fully support the tank with three main hangar brackets.
- B. Framework shall be fully adjustable, allowing the system to be mounted on most tailgate type and designs under standard production.
- C. Polyethylene tank shall be retained in the stainless steel mounting cradle with three 2-1/2 inch wide UV stabilized nylon tie down straps. Straps shall have a heavy duty threaded t-bolt mount on each end. Bolts shall pass through the mounting framework and be tension adjustable with stainless nuts.

6. NOZZLE DELIVERY SYSTEM

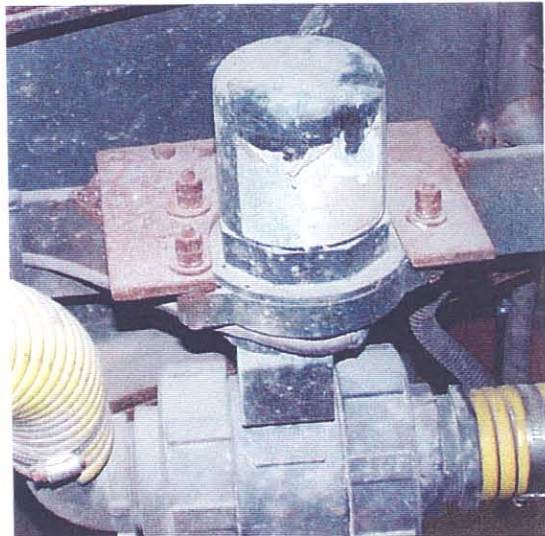
- A. Pre-wet liquid shall travel from the pump out to be applied on the spreader spinner.
- B. Two brass nozzles, each rated 1.0.GPM flow shall be mounted onto a bracket, attached to the spreader spinner with stainless bolt. Nozzles shall be directed to spray on the centerline of the spinner.
- C. A suitable cam-lock style quick connector shall be installed in the delivery line running to the nozzles. It shall be positioned in the line to approximately correspond to where the hydraulic quick connectors for the spinner assembly are, allowing the entire spinner assembly to be easily removed with the nozzle bracket assembly attached.
- D. A one-way check valve must be installed in the delivery line directly before the nozzles to prevent line drain down when the system is shut-off.

# Recommended Changes for Future Standard Prewet Systems

- Capable of prewetting dry materials at the rate of 8-20 gallons per ton.
- Tank 100-150 gallon tailgate mounted. Bottom fill with 2 inch ball valve and camlock nipple. Six-inch vented lid with tether.
- Dark orange color with external liquid level site gauge
- Check valve in-line
- Liquids sprayed on spinner or auger with preference to the spinner to avoid problems with freezing of materials.
- 2- fan spray nozzles with sufficient hole openings to prevent clogging
- Tank and plumbing designed for quick installation and removal
- Tanks mounted on tailgates such that no portions of the assembly become a hazard to people working around truck. Caution should be taken to protect employees from possible head injuries since prewet tanks typically hang at approximately head level and protrude from the back of the truck
- Stainless steel framework with retracting legs. All plumbing below tank within frame and extended legs to protect plumbing from being damaged. Lift hooks should be strong and have the ability to keep the tank assembly level when mounting or removing the tank system

# Optional Modifications to Standard Prewet System to use to Pretreat Bridge Frost and Limited Anti-icing (no data collection gravity system)

- At 40 gallons per lane mile  
A 100 gallon tank = 2 miles of bridges  
A 140 gallon tank = 3 miles of bridges
- Install a 2-inch motorized electric ball valve in bottom fill plumbing to control flow to spray bar. DOT stock number 022-002800



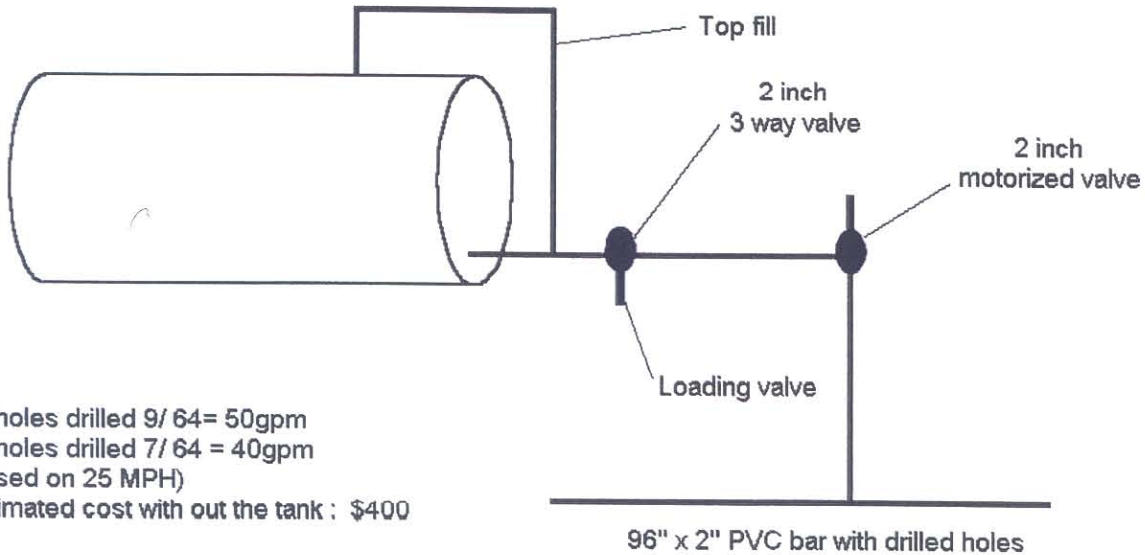
- 2-inch hose with camlock coupler to spray bar for quick disconnect.
- Spray bar = 2 inch schedule 40 PVC 96 inch long or width of truck, mounted on rear bumper mounted or as low as possible.
- At application speed of 25 MPH:  
50-gallons per lane mile requires 42- 9/64 inch holes drilled evenly distributed  
40 gallons per lane mile requires 42- 7/64 inch holes evenly distributed
- Approximate \$300 cost.

# Drawings and Descriptions of Basic Low Cost Shop Built Anti-icing Equipment

The following section contains drawings, descriptions and photographs of various anti-icing systems, all of which will accomplish anti-icing needs.

## Gravity System:

Requires calibration and chart (see Tables page 53)  
(single lane limited to 25 MPH and no data collection)



- Load should not exceed gross vehicle weight. (1 gal salt brine is approx. 10 lbs, Calcium Chloride allow 11 lbs.) Minimum application rate of 40 gallons per lane mile will determine length of run.
- 2-inch electric ball valve controls the flow of liquid to spray bar from inside the cab. (available at DOT warehouse)
- Spray bar and plumbing = 2-inch schedule 40 PVC with two end caps.

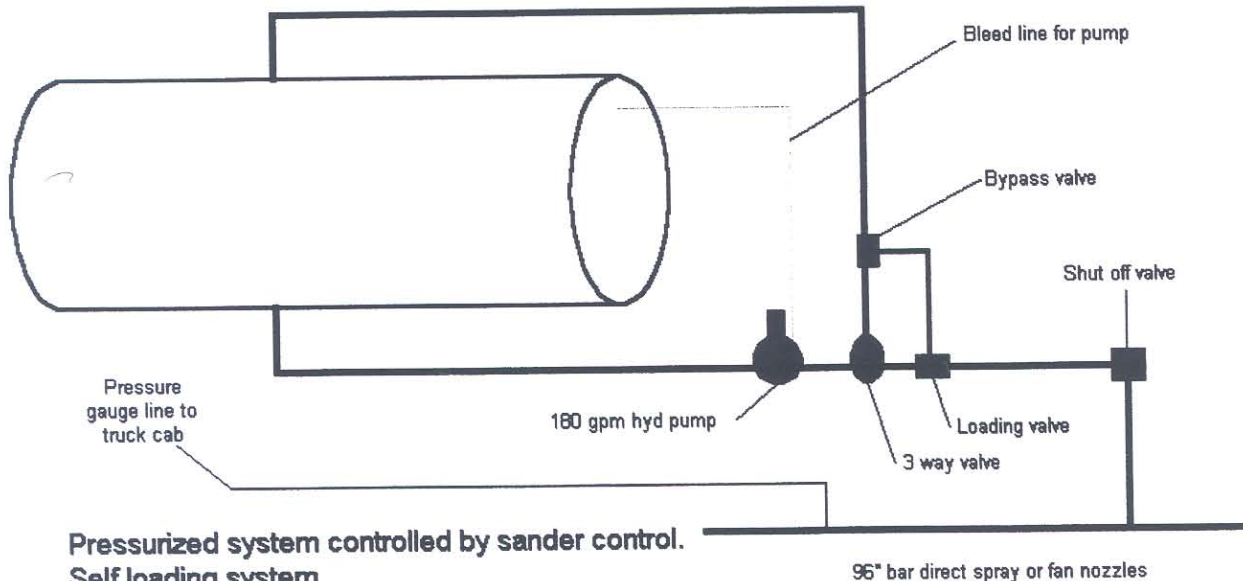


## Pressurized system:

With no electronic control

Requires calibration and chart (see Tables page 53)

(single lane not ground speed oriented)



Pressurized system controlled by sander control.

Self loading system.

Estimated cost: \$1,000

- Tanks should not exceed gross vehicle weight. (1 gal salt brine is approx. 10 lbs, Calcium Chloride allow 11 lbs.) Minimum application rate of 40 gallons per lane mile will determine tank size needed to meet route length.
- 2-inch electric ball valve for positive shutoff to spray bar.
- Hydraulic motor driven brine pump 2-inch inlet, 1 1/2 inch outlet = 190 GPM brine output. Hydraulic motor rated at 10 GPM maximum oil flow polymer impeller with stainless steel wear ring. (Hypro 9304C-HM1C)
- Adjust hydraulic motor relief for 70 PSI of brine pressure maximum to protect system from damage due to over pressure.
- Pressure gauge (100 PSI) in the cab optional with isolator and pressure tubing filled with antifreeze to monitor brine output. ( See page 31)
- Spray bar made of 1 1/2 inch schedule 40 PVC with two end caps or end plugs to flush bar. If multiple lane application, additional manual or electric ball valves are needed for control of the booms.
- The spray bar will have to be tailored to the speed and desired gallons per mile of application. A useful chart is located in the back of this document under Tables.

## IOWA DEPARTMENT OF TRANSPORTATION

## OFFICE OF EQUIPMENT SUPPORT

## SPECIFICATIONS

for

## ANTI-ICE SPRAYER SYSTEM, 1800 GALLON, TRUCK MOUNTED

The following specifications shall apply to the purchase of an Anti-Ice Sprayer system to be installed by the successful vendor. Model bid shall be of current production for which parts and accessories are readily available from the successful bidder.

The Anti-Ice Sprayer systems listed here shall establish the minimum acceptable levels of design, construction and performance.

Sprayer Specialties DI-1800

Monroe 00012560

A current model will be available for inspection by prospective bidders prior to the bid opening. Inspection can be arranged by contacting Mike Tjelmeland in the Office of Equipment Support at (515)-239-1069.

Other makes may be considered provided they meet the following minimum specifications. Items to be bid differently than as specified will require the review and approval of the Office of Equipment Support. See "Supplemental Terms and Conditions" under "Exceptions or Equals" in the bid package for more details. Please include all literature and technical data needed to support such a request.

The Department may, at its discretion, require a bidder to demonstrate a representative example of the exact model they are proposing. Demonstration will be at a work site of the Department's choosing within the State of Iowa. The Department will decide if the unit demonstrated is acceptable.

The Department reserves the right to waive compliance on minor technicalities on this specification; to reject any or all bids and to accept that bid which, in the opinion of the Department, is in the best interest of the State.

ITEM 1 - ANTI-ICE SPRAYER SYSTEM1. GENERAL REQUIREMENTS

- A. Sprayer will be used to apply a 23% salt brine solution directly to the road surface as an anti-ice treatment and will be mounted in a 13 foot dump body on a 50,000 pound GVWR tandem axle snowplow truck. Inside dump body dimensions are 84 inches wide x 156 inches long x 36 inches high.



- B. Sprayer shall have a three section boom and shall be capable of applying brine solution to three 12 foot lanes. Maximum boom width shall be 8 foot. Each boom section shall be capable of applying up to 60 gallons per lane mile at 50 MPH (right, center and left) simultaneously.
- C. Sprayer shall have the capability to apply brine solution through any one section of boom (right, center, or left) or any combination of sections.

## 2. TANKS

- A. Two separate non-corrosive polyethylene tanks with sumps and a total capacity of 1,800 to 2,000 gallons shall be supplied. Single tank with bulkhead for two compartments is not acceptable. Tanks shall be rated for 14 pound solutions and be UV stabilized.
- B. Two different methods for filling the tanks shall be provided:
  - a. First method: Tanks shall fill from the top through a single 2 inch hose, teed between the tanks. Tanks shall be capable of accepting up to 200 gallons per minute, from Department storage tanks, with tanks filling evenly. Fill hose shall terminate at rear of tank skid with ball valve, cam-lock nipple and cap. Transfer pump, used to fill tanks, will be supplied by the Department.
  - b. Second method: Plumbing shall be provided to allow tanks to bottom fill using the Hypro pump/motor assembly provided with the anti-ice unit. Hypro pump will be supplied material from storage tanks by either gravity feed or transfer pump. Transfer pump will be supplied by the Department.
- C. Both tanks shall gravity drain completely from 2 inch hoses connected to sumps. Each tank will have a shutoff valve as close to the sump as possible for stopping material flow to allow servicing of the pump/motor assembly or other components without draining all material from tanks. An extra ball valve shall also be included to drain both tanks, if necessary, without going through the pump.
- D. Exterior metal tie down hoops shall hold tanks to mounting frame. To keep tanks from moving when full, straps across the tie down hoops and/or stops along the base of the tanks will need to be provided. All threads, on tie down hoop bolts, shall be protected to keep from damaging tanks. (See Figure #1)
- E. Tanks shall be equipped with upper lids with vents. Vents shall meet fill requirements.
- F. Rear tank face shall have conspicuity tape installed to meet Federal requirements. "LIQUID DEICER" shall be stenciled on the rear tank face, 4 inch lettering height minimum. (See Figure #2)

## 3. FRAME

- A. Heavy duty metal frame shall meet tank sump clearance requirements.
- B. Frame shall have front fold up and rear telescoping parking stands for tank storage when not in use. (See Figure #3)

- C. Front of mounting frame shall have a minimum of 4 inch steel rollers for installing and removing tank assembly from truck dump body. Rollers shall extend far enough on frame to allow tank assembly to be easily installed with tailgate sander on truck. (See Figure #3)
- D. Frame shall have tailgate pins for securing tank assembly to rear of truck dump body. Two (2) ratchet straps shall also be provided to help secure tank assembly to dump body. Straps shall be 2 inch wide, 27 foot long and have a 10,000 pound rating, Securall SA10x27, Redneck 802HD-27F or approved equal.
- E. Frame assembly will also be equipped with bumper guides, two per side, to keep tank/frame assembly from shifting sideways in dump body. Width of guides shall be 83 inches. (See Figure #4)
- F. Rear of frame shall have conspicuity tape installed as well as red parabolic reflectors on both rear and side surfaces. (See Figure # 2)

#### 4. CONTROLLER

- A. A Raven DCS 400 controller shall be supplied, no exceptions. At least 34 foot of cabling with two sets of breakaway connectors shall also be supplied.
- B. Auto rate control shall be based off ground speed using speedometer pickup options of truck. DLA336 glorified 400, uses same cable as 710
- C. Controller, flow meter and control valve shall be capable of metering application rates from 1 to 50 MPH, with a programmable minimum pressure/rate override to maintain spray patterns at low speed/rates.

#### 5. PLUMBING

- A. Hypro 9304C-HM1C pump/motor assembly shall be supplied, no exceptions. Pump/motor assembly shall be hydraulically driven from the sander system on the Department's tandem axle truck with 20 gallons per minute available. Supply and return couplers will be supplied by the Iowa DOT to match sander couplers.
- B. Tee-Jet 480 series valve manifold, with DIN connectors, shall be supplied, no exceptions. Manifold shall have 1-1/2 inch female NPT inlet and outlet ports.
- C. Raven RFM100 flow meter shall be supplied, no exceptions, with hose saver connectors.
- D. Raven hydraulic adjustable control valve, 063-0171-057, shall also be supplied, no exceptions.
- E. Nozzles shall consist of two (2) inside Flood-Jet 150 nozzles and four (4) outside (two per side) Tee-Jet offset 300 nozzles. No exceptions. Nozzles shall be stainless steel with brass nuts.
- F. Boom/nozzle height shall be adjustable.

#### 6. COMPLETENESS

All equipment catalogued as standard and shown in the manufacturer's standard literature shall be provided and included in the bid price. All component parts of the machine shall be of proper size and design to safely withstand the maximum stresses imposed by all phases of operation.

7. PAIN

Metal surfaces shall be etched and completely painted with rust-inhibitive epoxy primer sealer. Primer shall be top coated with black polyurethane paint. Paint and its application shall be of high quality. Finish shall be smooth, shiny and free of runs, over spray and/or other defects.

8. MANUALS

Twenty-five (25) manuals will be supplied. Manuals will include installation, operator's, service and parts information with an complete illustrated parts list. Plumbing and wiring schematics shall also be included. Manual sets will be delivered to the Office of Equipment Support on or before delivery of the first unit.

9. WARRANTY

Entire unit(s) shall be covered under warranty for at least one (1) year. Warranty shall include all parts and labor to correct any material, workmanship or manufacture defects. If component manufacturer's warranties are for a longer period they shall apply. Warranty shall begin when units are installed and training completed.

10. INSTALLATION AND TRAINING

- A. Installation shall include installing sprayer in dump body of truck, fitting tailgate latch pins to tailgate latch, securing sprayer assembly to dump body with two (2) ratchet straps (Section C., Subsection 4.), installing controller in truck cab, installing speedometer pickup and all related wiring.
- B. Sprayer shall be calibrated and tested with water.
- C. Successful vendor shall supply all parts necessary to complete installation.
- D. Operator shall be trained in all modes of operation and maintenance.
- E. Installation and training may be conducted at vendor's location, if in Iowa, or at a Department assigned location.

ITEM 2 - ANTI-ICE SPRAYER SYSTEM LESS CONTROLLER

Please bid a separate cost for the installation, testing and training of an anti-ice system as listed in ITEM 1 - ANTI-ICE SPRAYER SYSTEM excluding Section D. CONTROLLER. Anti-Ice unit would be installed in trucks already equipped with Raven 710 controllers and will need to be wired accordingly.

The following photos are of various anti-icing equipment being used in the State of Iowa.



900 gallon single axle, with dry capacity of 3 tons of salt



1800 gallon slip-in



1,800 gallons mounted on a 15 ton trailer



2,700 gallon trailer with skirting



3,600 gallon trailer



5,000 gallon trailer

# Recommendations for Anti-icing Spray Bar Options

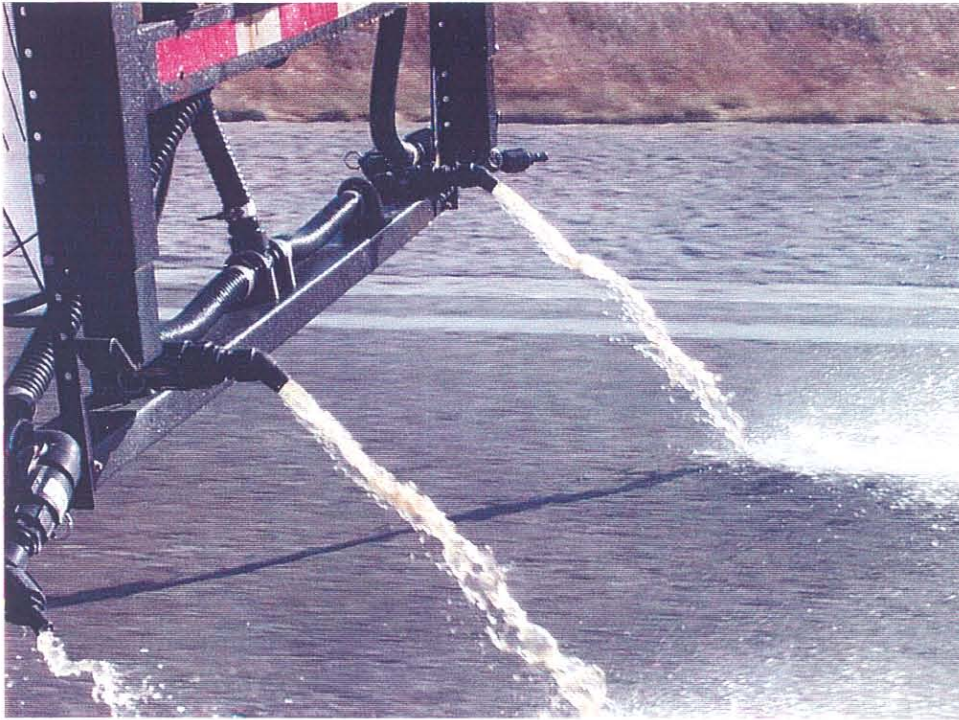
The following pages show pictures of spray bar configurations used throughout the state.



2 inch PVC pipe with drilled holes or clip-on nozzles. (Gravity System)



1 ½ inch PVC pipe with clip-on nozzles that can also be converted to prewetting onto the spinner. (Pressure System)



2" Hoses connected to  $\frac{3}{4}$ " hose barb spray nozzle concentrating liquid in wheel tracks on roadways. This can be applied at speeds of 50+ mph without excessive spray.



Flood Jets in a multi lane application.





Factory made streamers delivered with new purchase.

# Recommended Modifications to Reduce Brine Drift

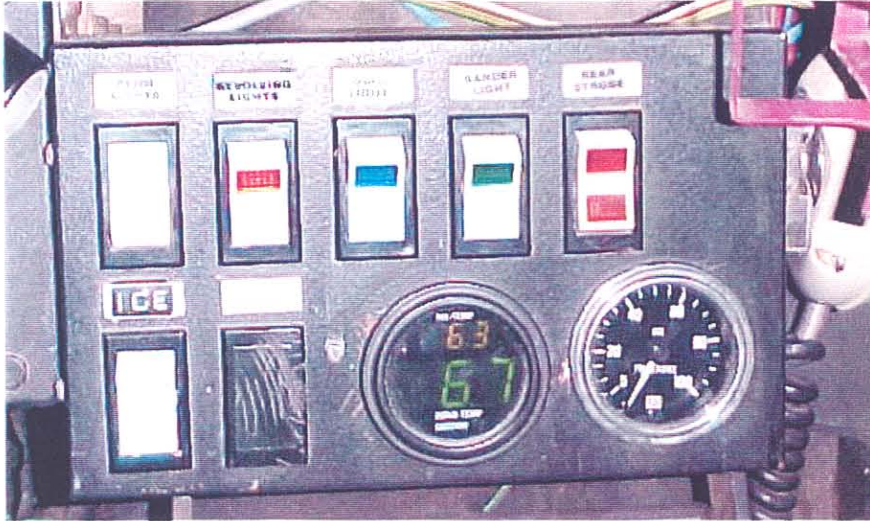
The following modifications can be done to purchased or shop built anti-icers to reduce spray during application of liquids.

- Replace flood nozzles and use streamer nozzles.
- Install rubber belting or similar material just in front of the spray bar. (photo on page 18)
- Install rubber belting or similar material completely around spray bar.



# Controllers and Monitors

The following photographs and descriptions are of controllers mounted in the truck cab, currently used by the Iowa DOT for snow and ice operations.



**Pressure Gauge** is used for shop made anti-ice units, using spinner control to control brine pump. The system only monitors the pressure rates that control the rate of application.



**Sprayer Specialties DT-981**, dry track model, is a spreader monitor to view granular output, record material usage and is ground speed oriented. This was developed in 1999 to track materials.



**Tee Jet 834** is a liquid monitor without data collection capabilities.

\*The following Raven Model controllers are all GPS compatible.



**Raven DCS 400** spreader control can control a single product and will adjust rates as vehicle speed changes. (ground speed oriented)



Raven DCS 700 spreader controller will control either salt or sand only or with a liquid simultaneously. (ground speed oriented)



Old Raven DCS 710, with boom control, will control granular (salt/ sand) or granular with prewet, or anti-ice liquid only.

New Raven DCS 710, with boom control, controls four granular products: salt, sand, product 1 and product 2, or this unit can do granular, granular with prewet or granular anti-ice or anti-ice only.



Raven SCS 760 control unit will control five products independently.



1998 Concept Vehicle has a separate Raven granular and Tee Jet liquid spreader controls.

The following chart shows the capabilities of each of the material control systems currently used.

	In-Cab Monitoring Capabilities	Records Total Material Used	Ground Speed Oriented	GPS Capabilities	Product Control	Comments
Pressure Gauge	X					
Sprayer Specialties DT-981	X	X				
Tee Jet 834	X	X	X			
Raven DCS 400	X	X	X	X	A	
Raven DCS 700	X	X	X	X	G, P	
Old Raven DCS 710	X	X	X	X	G, P, A	Prewet is proportional to gallons per ton.
New Raven DCS 710	X	X	X	X	G, P, A, GA	Prewet is also capable of gallons per lane mile.
Raven SCS 760	X	X	X	X	G, P, A, M, I	Must be used with boom box selector control to control multiple lane applications.

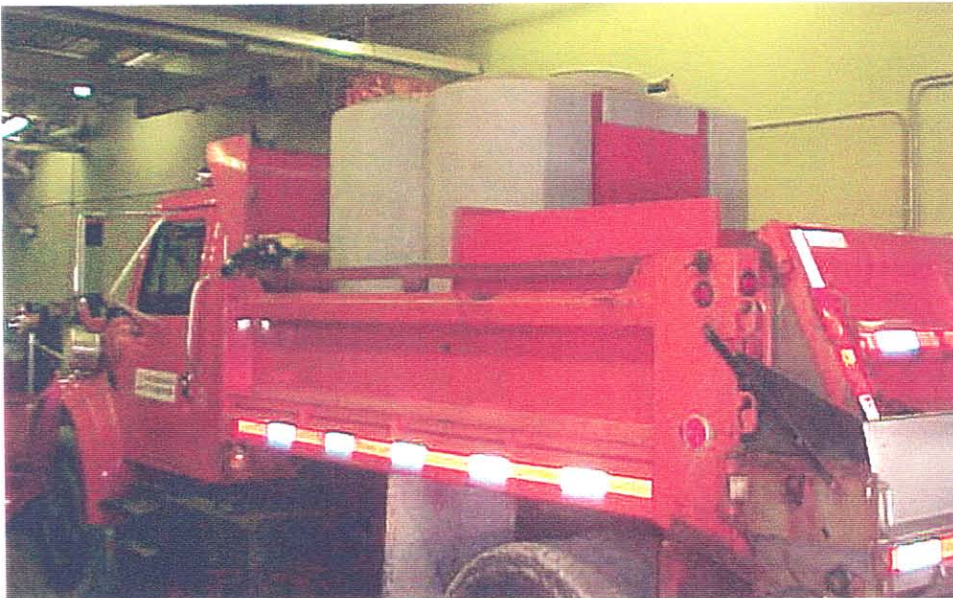
A = Anti-icing  
 G = Granular  
 P = Prewet  
 GA = Granular and Anti-icing  
 I = Injection

# New Concepts

The following pages contain concepts and work in progress that are being tested in various locations in the state of Iowa.



2 – 220 gallon ice ban/ brine tanks in a tandem axle that can carry an additional 9.5 tons of dry material.



2 – 375 gallon brine tanks on a M.D. single axle truck that can carry an additional 2 tons of dry material.





2 – 375 gallon tanks mounted on a tandem axle truck that can carry an additional 8 tons of dry material.



1-900 gallon tank mounted on a tandem axle truck, capable of dry and liquid salt applications simultaneously and carry an additional 7.4 tons of dry material.



1 – 900 & 1 – 375 gallon slide in to be mounted in a tandem axle truck with an additional 900 gallon drop in (pictured below) used for multiple liquid applications.



Liquid Calcium Chloride is being injected into the salt brine before it is applied to the road surface as a pilot project.



75 gallon prewetter & 1,000 gallon slip in tank for anti-icing. The 375 is used for anti-icers and prewetting when the 1,000 gal is removed. This unit is capable of using multiple liquid products.



A new brine building with inside storage and containment with raised platform for the City and County trucks to spray loads.



A used single axle V box installed on a tandem axle truck with a 220 gallon tank that will be replaced with a 900 gallon tank. This will allow liquid and dry applications simultaneously, without having to raise the dump body.

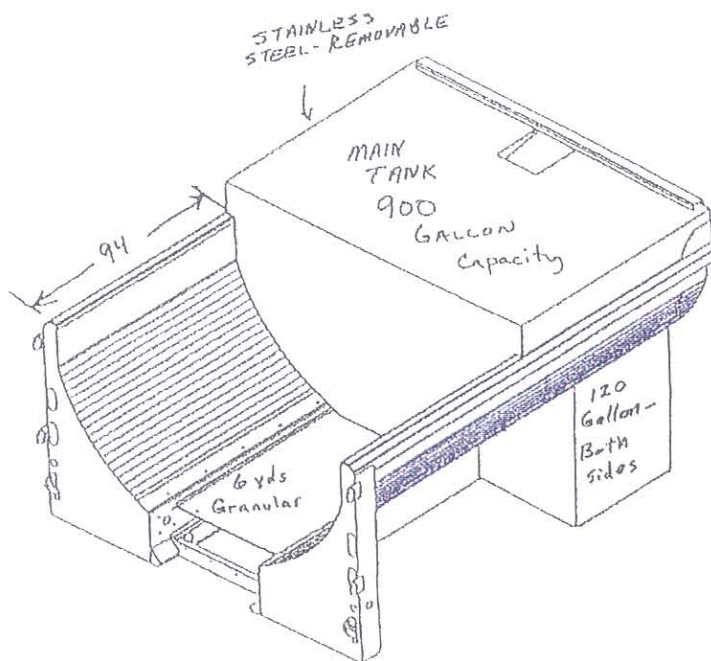
# 2000 Concept Vehicle

A new concept vehicle has been developed that will be ready to plow snow starting in the winter of 2000-2001. The new concept vehicle will be outfitted with the following technologies:

- Multi-purpose dump box centerbelt to distribute materials. Multiple removable tanks have been included in the box that will maximize the available space and hauling.
- Global Positioning/ Automated Vehicle Location systems will be included with the vehicle and will be interfaced with all sensors on board to provide both the operator and supervisor with near real-time information about the vehicle. Several new applications for this technology will be developed during the first year.
- Friction wheel- A new friction wheel from Saltar will be included with this new vehicle that will be able to measure the coefficient of friction of the roadway so operators can see how slippery the roadway is.
- Infrared thermometer- A Sprague unit will be installed on the truck to provide air and pavement temperatures.
- Salt Sensors- a device to measure the salt solution on the roadway will be tested for the first time this coming winter. The device collects a sample from the roadway and provides the operator with the salt concentration on the roadway.
- Engine analysis- The vehicle will be equipped with a computerized engine analysis feature that will provide information about the performance of the engine and help with repair diagnosis and service needs.

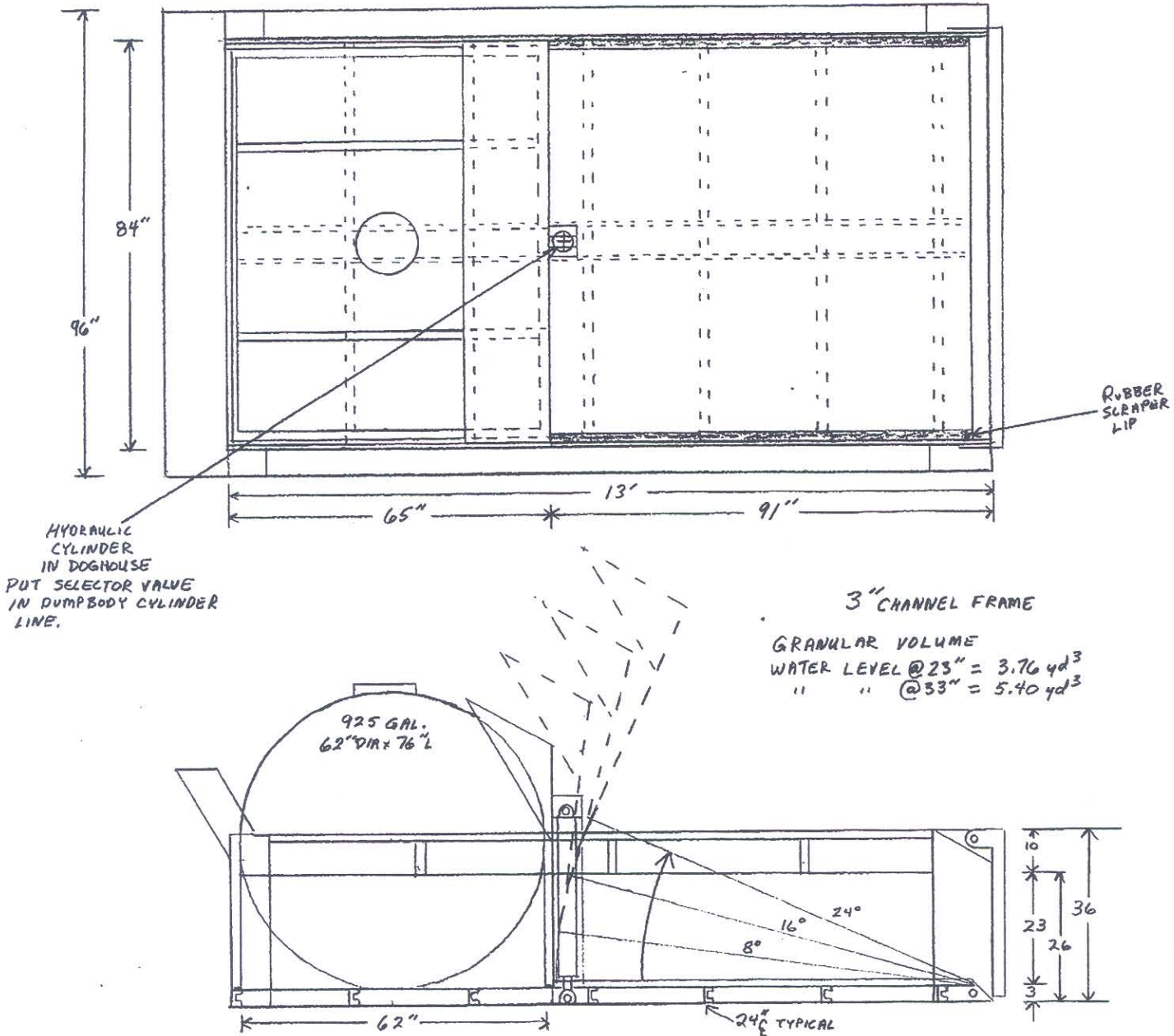


2000 Iowa DOT concept vehicle currently being built at Monroe Equipment.



2000 Prototype dump body for concept vehicle.

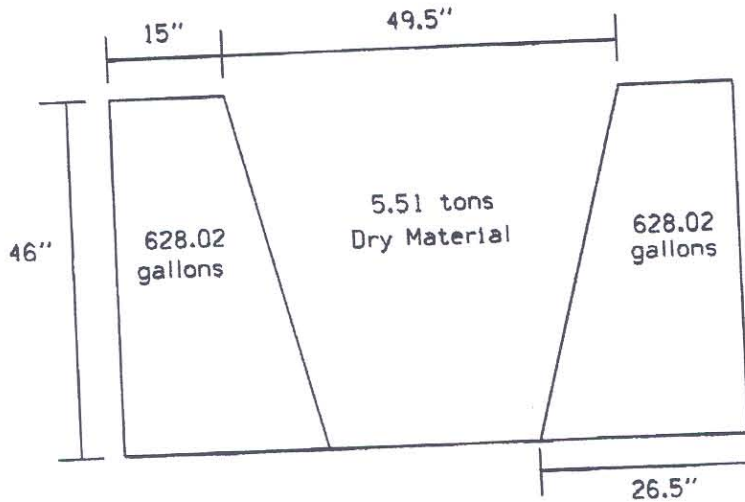
# Concept Dump Box in a Dump Body



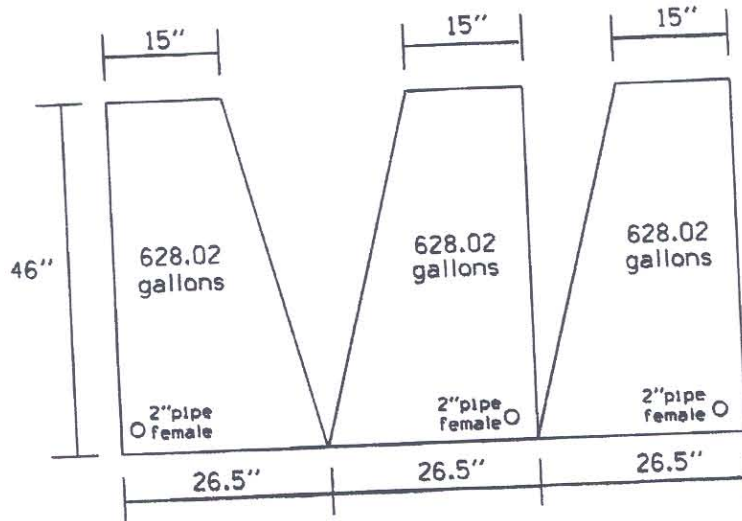
Idea for a concept dump body that would eliminate raising the liquid tank during operations

# Tank Design Configuration

The following design is for tandem duty trucks that can be used for prewet, deicing or anti-icing. This is currently being built and evaluated.



Tandem 156" Box Length  
De-ice Combining Materials



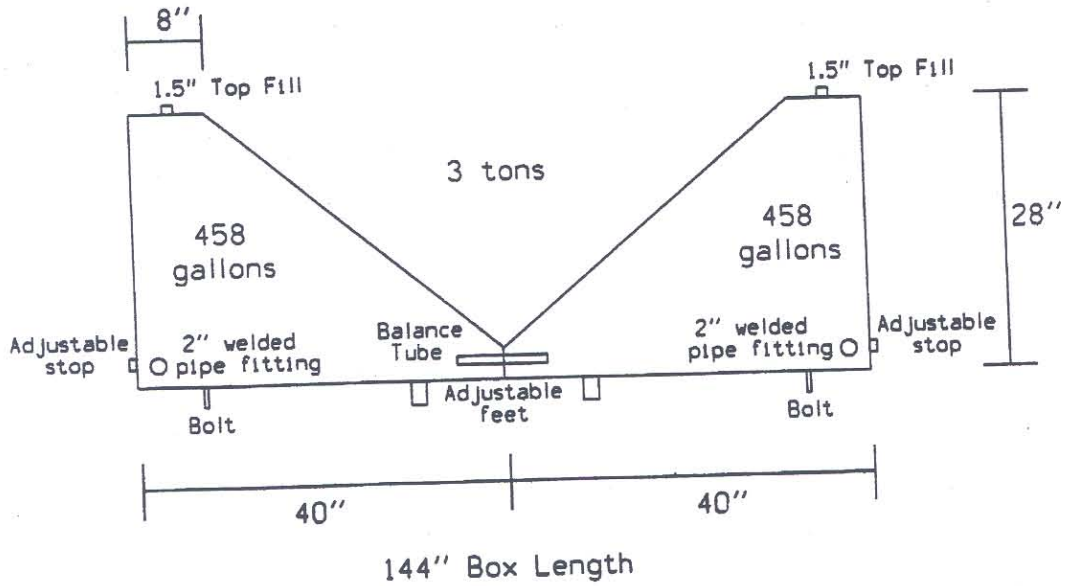
Tandem 156" Box Length  
Ant-ice with removable 3rd tank

Current prototype is being built out of stainless steel. If concept proves positive, the tanks may be built out of plastic in the future

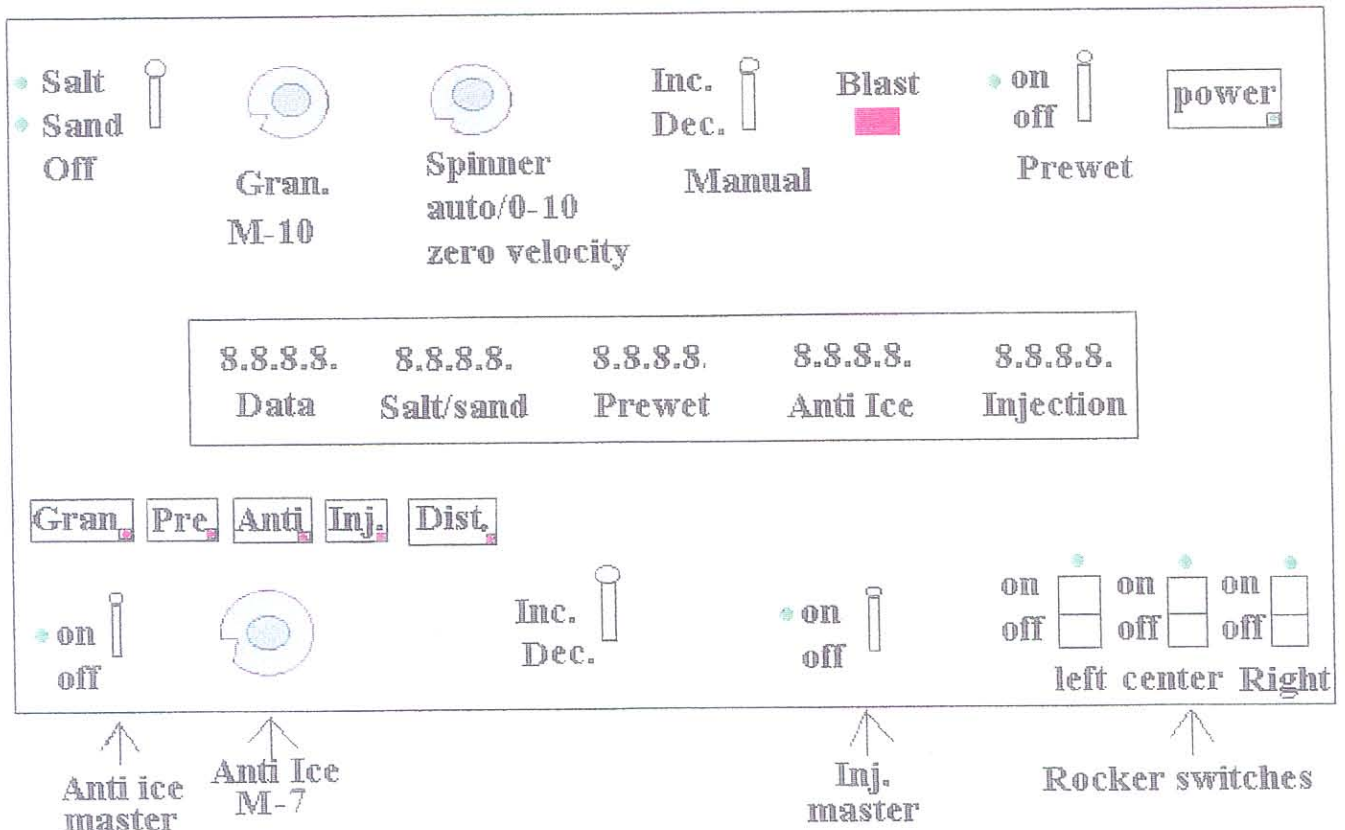


# Tank Design Configuration

The following design is for tandem duty trucks that can be used for prewet, deicing or anti-icing. This is currently being built and evaluated.



The following is a proposed electronic control head for anti-ice winter road management



## DESCRIPTION OF CONTROL CONSOLE

- Off/Salt/Sand Switch
- Granular Control adjustable knobs
- Spinner
- Manual Increase Decrease for granular will increase/decrease prewet when prewet feature is selected
- Blast Button
- Prewet will be ground speed oriented, and be read as gallons per lane mile, and be able to use at the same time as the anti ice and injection mode.
- Power key should be flat panel style.
- Granular, anti ice, injection and prewet need to be read in gallons per 12-foot lane mile.
- Prewet will read out in gallons.
- Distance will read out in feet and miles

- Be capable of a three tier boom control
- Anti ice master will be a separate rate control and injection will be its own separate rate control. Anti ice and injection will need to read out in gallons per 12-foot lane mile.
- Increase/decrease for anti ice will work for the injection side when injection is selected When just anti ice is selected increase/decrease will work while in the manual mode of anti ice.
- Boom switches will be labeled left, center, and right and will be a mini rocker switch style.
- Will be programmed and data collected from lap top or remote site (GPS compatible)
- Will be able to run pulse width modulated 12-volt valve coils with out external amplifiers or run a combination of linear and pulse width valves.
- Green and red dots are LED's that light up when function is selected.
- Backlighting for all controls
- Display should be one piece design with fiber optics backlighting and largest available.
- All keys to be flat key pad style. (Granular, prewet, anti-ice, injection, distance., and power)
- Increase/decrease levers to be spring loaded for center off
- Granular, spinner, prewet, anti ice and injection need to be ground speed oriented.
- Gran Key - sand, salt, day and year's totals
- Pre key- prewet sand, prewet salt, day and year's totals
- Anti ice key- total gallons used day and year
- Inj. key- total gallons used day and year of injection
- Dist. Key- miles that have been treated for day and year, second push of key will read feet traveled.
- All Day totals will be able to zero out from face of console by holding down on key selected for 4 seconds.
- Year totals will zero out by laptop or GPS

# Glossary

**Anti-icing-** The snow and ice control practice that attempts to prevent the formation or development of bonded snow and ice by timely applications of a freezing point depressant.

(This does not refer to the use of only liquids for anti-icing and does not state that the application needs to be applied several hours in advance. Typically anti-icing is performed by liquid application before precipitation begins but is not a requirement if application can be made before the bond forms)

**Bar Clips-** Clips used to hold spray nozzles onto bars that are easy to adjust or remove.

**Boom-** Individual sections of spray nozzles that can be controlled simultaneously for desired spray application from the cab.

**Deicing-** The snow and ice practice of removing bonded snow and ice from the roadway using mechanical methods. Typically associated with using freezing point depressants to melt through a layer of snow and ice to get to the underlying surface or by the use of plows or ice blades to remove snow and ice.

**Electronic Ball-** Motorized on/off valve.

**Fan Nozzle-** A nozzle system designed to spray liquids in a fan pattern covering the entire surface of the roadway with liquids.

**Flow Based system-** System used flow meter to measure liquid flow.

**GPH-** (Gallons Per Hour) A way to measure liquid flow.

**GPLM-** (Gallons Per Lane Mile) Gallons of liquid used to treat roadway based on one mile (5,280 by 12 feet wide)

**GPM-** (Gallons Per Mile) A way to measure liquid flow.

**GPS-** (Global Positioning System) Measures the time it takes a signal to reach a satellite and then uses triangulation methods to determine a location on the earth's surface.

**Gravity Feed-** No pump is used, the material is free flowing to the ground.

**Ground Speed Oriented-** Application rate controlled directly by speed of vehicle.

**GVWR-** (Gross Vehicle Weight Rate) Manufacture's recommended maximum total vehicle weight rate).

**Injection-** A process to add multiple products from different tanks to one boom section.

**Liquid Calcium Chloride-** Generally a 32% solution of calcium chloride.

**Liquid Chemical-** A chemical solution.

**Liquid Sodium Chloride-** Generally a 23-24% solution of sodium chloride in water and commonly referred to as brine.

**Pressured Based system-** Equipped with a low or high volume pump.

**Prewetting-** A snow and ice control practice of wetting a dry freezing point depressant before application to the roadway.

**Servo (butterfly)-** Inline valve to regulate flow of pressure.

**Solenoid valve-** 12 volt magnetic on/off valve.

**Streamer nozzle-** Nozzles designed to provide a direct stream of liquid onto the surface of the roadway. The purpose of using these nozzles is that when liquids are applied with these nozzles motorists are still provided a partial roadway that is dry, avoiding a totally liquid surface and reduced traction.

**Three Bank Manifold Electric Ball valve-** Three motorized ball valves mounted together to control three individual spray bars.

**Specific Gravity-** The ratio of the density of a substance to the density of some other known substance (such as pure water) taken as a standard when both densities are obtained by weighing in air. For example, water has a specific gravity of 1.0 and weighs 8.33 pounds. If a liquid deicing chemical has a specific gravity of 1.20 we can multiply  $1.20 \times 8.33$  (weight of water) = 10 pounds, the weight of one gallon of the liquid deicer.

# Tables of Weights and Measures for Anti-Icing

1 cubic foot of salt = 67-75 pounds (avg. 70 lbs.)

1 cubic yard of salt = 1800-2025 pounds (avg. 1913 lbs.)

1 gallon of salt brine = 10.26 pounds

The tare weight capacity of a IDOT single axle truck is 7.5 tons

The tare weight capacity of a IDOT tandem axle truck is 12 tons

1 gallon of water = 8.33 pounds

1 cubic foot = 7.48 gallons

1 cubic yard = 201.96 gallons

# Applying Liquid Brine

Many types of tip configurations have been used. There are three basic types of tip configurations; streamers, flood, straight hose barbs. The following chart from Sprayer Specialties Inc. displays GPM needed to apply liquid brine at different ground speeds.

$$\text{GPM (gal. per minute)} = \frac{\text{GLM} \times 1.45 \times \text{WIDTH (inches)} \times \text{MPH}}{5940}$$

5940

One 12' Lane Mile = 1.45 Acres

i.e. 60 Gallons Per Lane Mile  $\times$  1.45 = 41.38 Gallons Per Acre

To Figure Gallonage Usages Per 12' Lane - See Chart Below  
Gallons Per Lane Mile

	45 GPLM	50 GPLM	55 GPLM	60GPLM <-Per 144" (12')
10 MPH	7.52	8.36	9.19	10.03
15 MPH	11.28	12.54	13.78	15.04
20 MPH	15.04	16.72	18.38	20.06
25 MPH	18.8	20.90	22.97	25.07
30 MPH	22.56	25.08	27.57	30.09
35 MPH	26.32	29.26	32.17	35.11
40 MPH	30.08	33.44	36.76	40.12
45 MPH	33.84	37.62	41.36	45.14
50 MPH	37.60	41.80	49.95	50.15
55 MPH	41.36	45.98	50.55	55.17
60 MPH	45.12	50.16	55.14	60.18

GPM (Gallons Per Minute)

Above Chart is Based on a 12' Lane Mile

Current specifications for anti-icing are adequate for those that are purchasing additional equipment through the plan and no other specifications need to be added or modified.