Brine Workshop
How to make brine work for you!

Southwestern Pennsylvania Commission

Sam Gregory
Buffalobills1951 @gmail.com
717-903-8923

" If you are not willing to learn no one can help you.
If you are determined to learn no one can stop you."

Brine Workshop
How to make brine work for you!

Southwestern Pennsylvania Commission

Topics

- Best Practices for an effective & efficient winter maintenance program
- How chemicals work
- Environmental concerns
- Anti-icing & Pre-wetting
- Sensible Salting Concepts

Why Winter Maintenance?

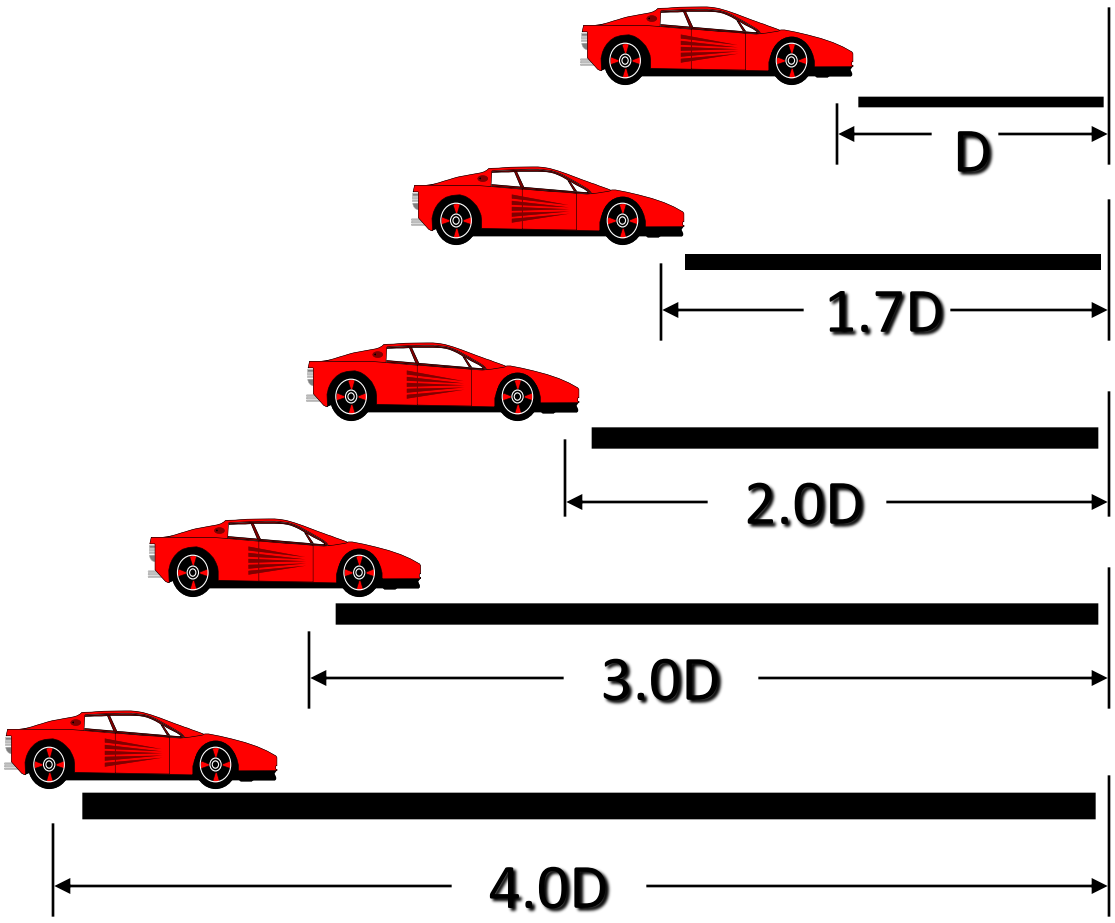
Unsafe Driving Conditions

Snow Covered Roads

Why Winter Maintenance?

- **Slippery Snow-Covered Roads Create Havoc.**
  - **Vehicular crashes multiply**
  - **Congestion causes frustration & lost work**
  - **School closings & delays affect families**
  - **Emergency Operations are hampered**
  - **Businesses suffer lost profits**

Stopping Distance



Dry Surface:
S.D. = D

Wet Surface:
S.D. = 1.7D

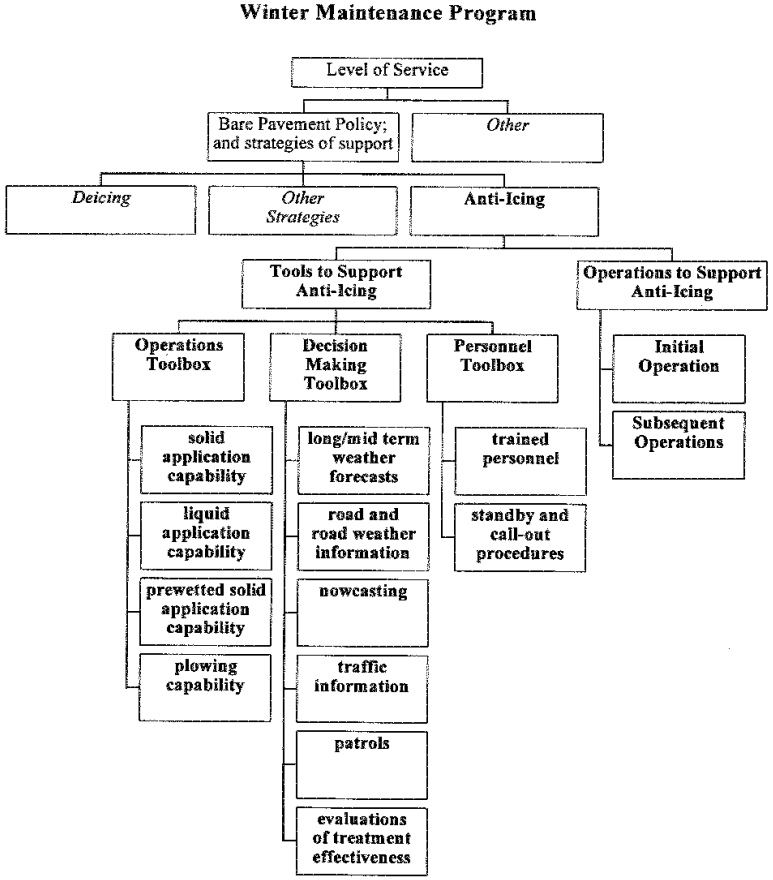
Slush: S.D. = 2.0D

Soft, Loose Snow: S.D. = 3.0D

Compacted Snow:
S.D. = 4.0D

Creating a Winter Maintenance Plan

Goals and level of service for an effective & efficient operations



Liquid Chemicals
“Another tool for your toolbox”

- Liquids
  - Instant action
  - Not displaced by traffic
  - Residue remains effective
  - Versatile
    - Used directly
    - Treat solids

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Chemicals: How do they work?

- Depress the freezing point of water, turning ice or snow into liquid or slush
- Solid salts dissolve to form brine solution

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Chemicals: What do they do?

Chemicals applied to:

- prevent bonding of ice and snow to road surface
- prevent ice or frost from forming
- prevent buildup of snowpack
- melt ice that has formed

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Chemical Terms

- Concentration
  - % by weight of chemical in solution
- Eutectic Temperature
  - Lowest Temp solution will melt ice
- Endothermic
  - Requires heat when going into solution
- Exothermic
  - Gives off heat when going into solution
- Hygroscopic
  - Draws water from the air

Common Road Treatment Materials

Chemicals

- Salt (Sodium chloride)
- Calcium Chloride
- Magnesium Chloride
- Potassium Chloride

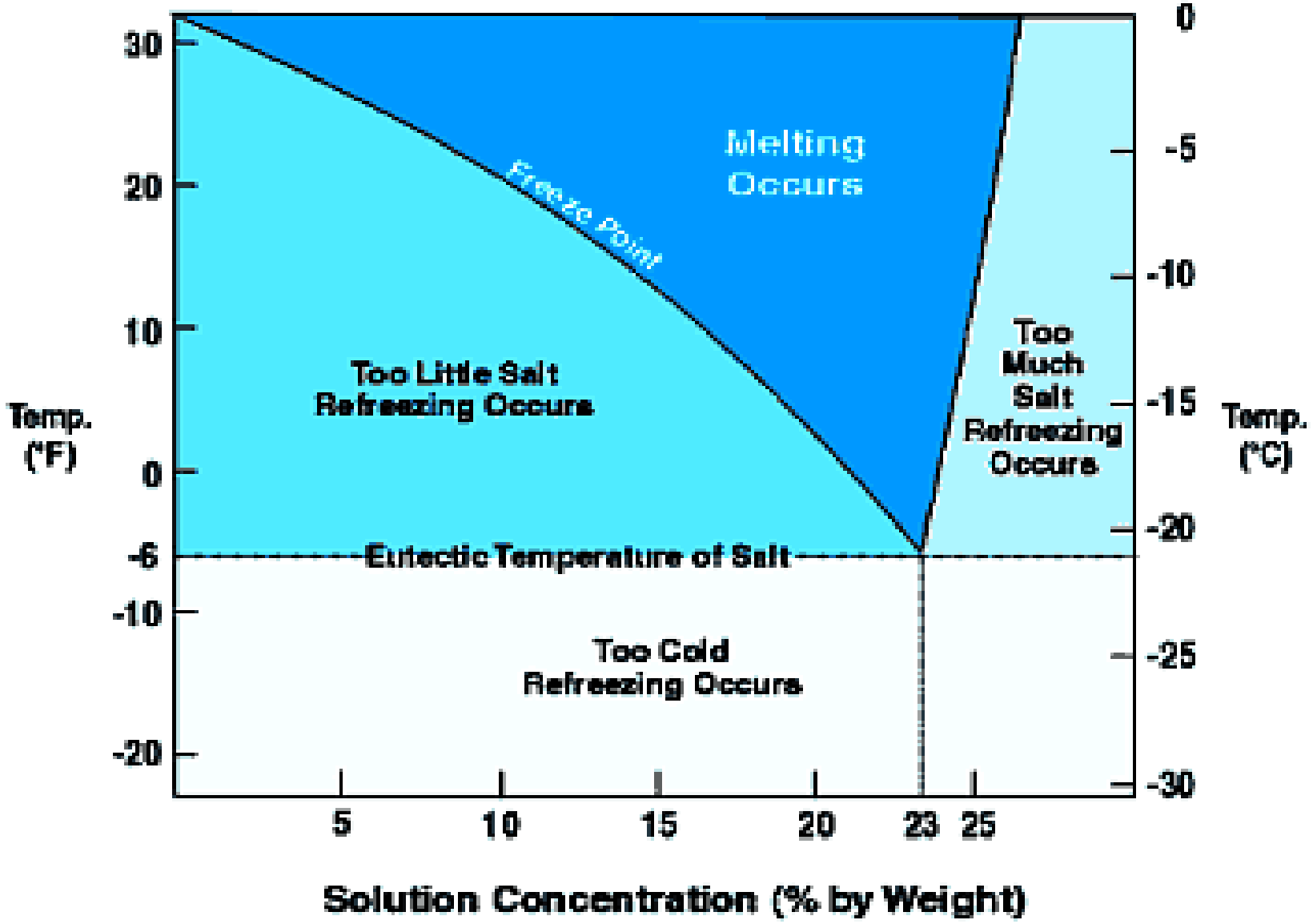
Natural Occurring Salts

- Brines (by-product of gas production)
- Potassium Acetate
- Calcium Magnesium Acetate
- Urea
- Agricultural By-products
- Other Proprietary Materials
- Abrasives

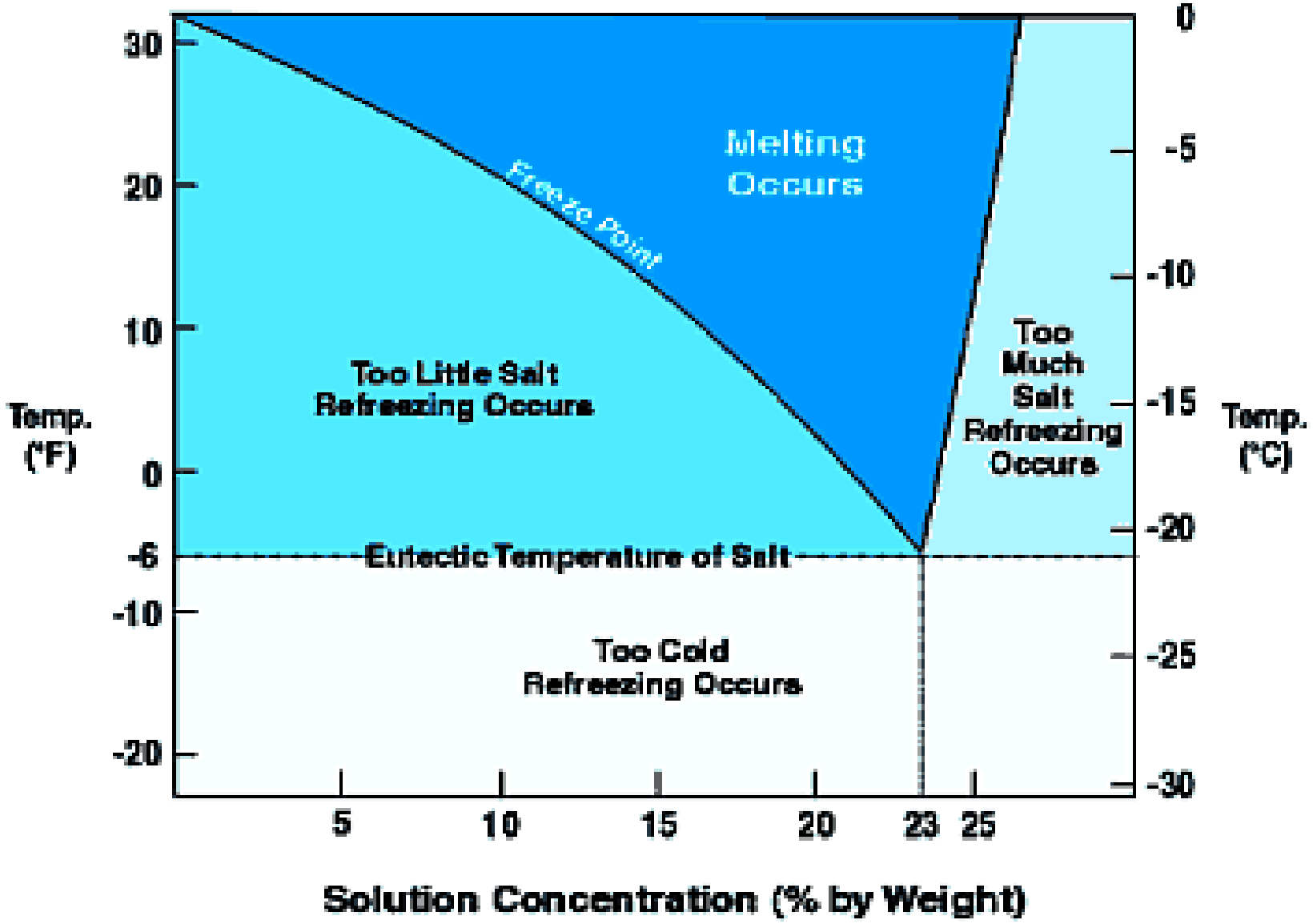
Chemicals

Iowa Department of Transportation Video (click on picture to start)

Phase Diagram for Salt



Phase Diagram for Salt



Dilution of Solution

- Explains why one application rate will not fit all winter events.
- Application effectiveness will depend on:
  - Road surface temperature
  - Application rate
  - Concentration
  - Moisture

Solid vs Liquid Advantages

- Solids
  - Less costly
  - Easier to handle
  - Dilute slower (retention)
  - Initial skid resistance (salt)
- Liquids
  - Instant action
  - Not displaced by traffic
  - Residue remains effective
  - Versatile
    - Used directly
    - Treat solids

Solid vs Liquid Disadvantages

- Solid
  - Need moisture
  - Takes time
  - Not good for anti-icing (bounce & scatter, displaced by traffic)
- Liquid
  - Mostly water
  - Not useful for thick ice
  - Rain will wash off pavement
  - Can cause slippery conditions

Salt

- Has been... (Sodium Chloride)
- Is...

Our

#1 Deicer

“Use it sensibly!”

Salt: Advantages

- Melting action
- No cleanup (as with abrasives)

“Enhanced Safety & Reduced Liability”

Road Salt Basics for Sensible Salting

- The use of salt is an important part of strategies to keep roadways safe in the winter
- Any measure developed must never compromise human safety
- Options must be based on optimization of winter maintenance practices so as not to jeopardize road safety while minimizing the impact on the environment

Road Salt Basics for Sensible Salting

- Salt can result in adverse effects on the physical and chemical properties of soils
- Effects are associated with areas adjacent to stockpiles and roadsides
- Based on available data salts are entering the environment in a quantity and concentration that may have an immediate or long term harmful effect on the environment.

Characteristics of Salt & Melting Capacity

WHAT IS SMART SALTING?

THE RULE OF RIGHT

The *RIGHT* amount of
The *RIGHT* material at
The *RIGHT* time

Smart Salting

Characteristics of Salt & Melting Capacity

Pounds of Ice Melted Per Pound of Salt	
Temperature Degrees F	One Pound of Sodium Chloride (Salt)
30	46.3 lb of ice
25	14.4 lb of ice
20	8.6 lb of ice
15	6.3 lb of ice
10	4.9 lb of ice
5	4.1 lb of ice
0	3.7 lb of ice
-6	3.2 lb of ice

Other Natural Salts

- Calcium Chloride
  - Natural State - Liquid
- Magnesium Chloride
  - Natural State - Liquid
- Potassium Chloride
  - Natural State - Solid

Common Use:

Prewetting

Anti-icing

Other Natural Salts

- **Calcium Chloride**
  - Exothermic: gives off heat
  - Hygroscopic: attracts moisture
  - Eutectic Temp: -60^{o}F
  - 30-33% concentration in solution
- **Magnesium Chloride**
  - Exothermic: gives off heat
  - Hygroscopic: attracts moisture
  - Eutectic Temp: -28^{o}F
  - 22-26% concentration in solution

AGRICULTURAL PRODUCTS

BEET JUICE

- All natural, agricultural product
- Anti-icing @ 20 gallons/lane mile
- Mixed with salt brine lowers freezing point to -15F
- Prewetting agent
- Treat mix piles
- Less corrosive than salt brine

Eutectic vs Effective Temp

Chemical	Eutectic °C	Eutectic °F	Effective* °C	Effective* °F
NaCl (salt) sodium chloride	-21	-6	-9	+20
CaCl calcium chloride	-51	-60	-32	-25
MgCl magnesium chloride	-33	-28	-15	+5
KCl potassium chloride	-11	+13	-4	+25
KAc potassium acetate	-60	-76	-26	-15
CMA calcium magnesium acetate	-27	-17	-6	+21
Urea	-12	+10	-4	+25

Corrosion

- More corrosive
  - Calcium Chloride
  - Sodium Chloride
  - Magnesium Chloride
  - CMA
  - Urea
- Less Corrosive

MS4 Requirements & Environmental Stockpile

Pollution Prevention and Good Housekeeping for Municipal Operations

MCM #6 – Pollution Prevention…

3800-PM-BPNPSM0200h Rev. 4/2013
Sample Appendix A

pennsylvania
DEPARTMENT OF ENVIRONMENTAL PROTECTION

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL PROTECTION
BUREAU OF POINT AND NON-POINT SOURCE MANAGEMENT

MCM #6: Pollution Prevention/Good Housekeeping for Municipal Operations

The following are the requirements for MCM #6 that are included in the Federal Regulations:

- *Develop and implement an operation and maintenance program that includes a training component and has the ultimate goal of preventing or reducing pollutant runoff from municipal operations (40 CFR Part 122.34(b)(6)(i)).*
- *Provide employee training to prevent and reduce stormwater pollution from activities such as parks and open space maintenance, fleet and building maintenance, new construction and land disturbances, and stormwater system maintenance (40 CFR Part 122.34(b)(6)(i)).*

The following requirements, Best Management Practices (BMPs) and Measurable Goals are to be implemented and achieved:

Winter Material Storage and Use

- Material stored in buildings
- Containment
- Run off control
- Impermeable pads
- Clean up
- Equipment calibrated

Salt Brine

Overview:

- **Salt brine use is a best practice for fighting winter storms**
- **Municipalities can use liquid fuels funds to purchase equipment to make brine**
- **Municipalities can sell brine to other municipalities**

Salt Brine

Overview:

Cost of making salt brine includes

- **Equipment**
  - **Brine maker**
  - **Storage tank**
- **Labor**
  - **Loader operator**
  - **Brine maker**
  - **Clean out of tank**
- **Materials**
  - **Salt**
  - **Water**
  - **Electricity**

PennDOT Publication 447

Salt brine is now eligible for liquid fuels funds

MS-0470-0010
Salt Brine
I. DESCRIPTION — Salt Brine is a liquid mixture of potable water and approved Sodium Chloride.
II. MATERIAL— Approved Sodium Chloride is mixed with potable water in a specially designed machine which circulates the water through the salt, in one tank, to a holding tank which holds the finished product.
The machine can be purchased from a vendor or can be constructed locally but must have two tanks. One for mixing and one for holding the finished product. When product is stored it must be remixed every thirty days, or before its use, or sale to insure the solution is in proper condition.

Salt Brine Making Process & Storage

Overview:

- **Various methods have been used**
- **Batch - Water passes through a bed of rock salt producing a solution saturated at the water**
- **Continuous Flow – Water is forced under pressure through a bed of salt, solution flows into storage receptacle**
- **Brine strength is checked with a hydrometer or a salometer**
- **Rock salt can contain impurities**
- **Quality control is essential!**

Salt Brine

Salt Brine Production Units

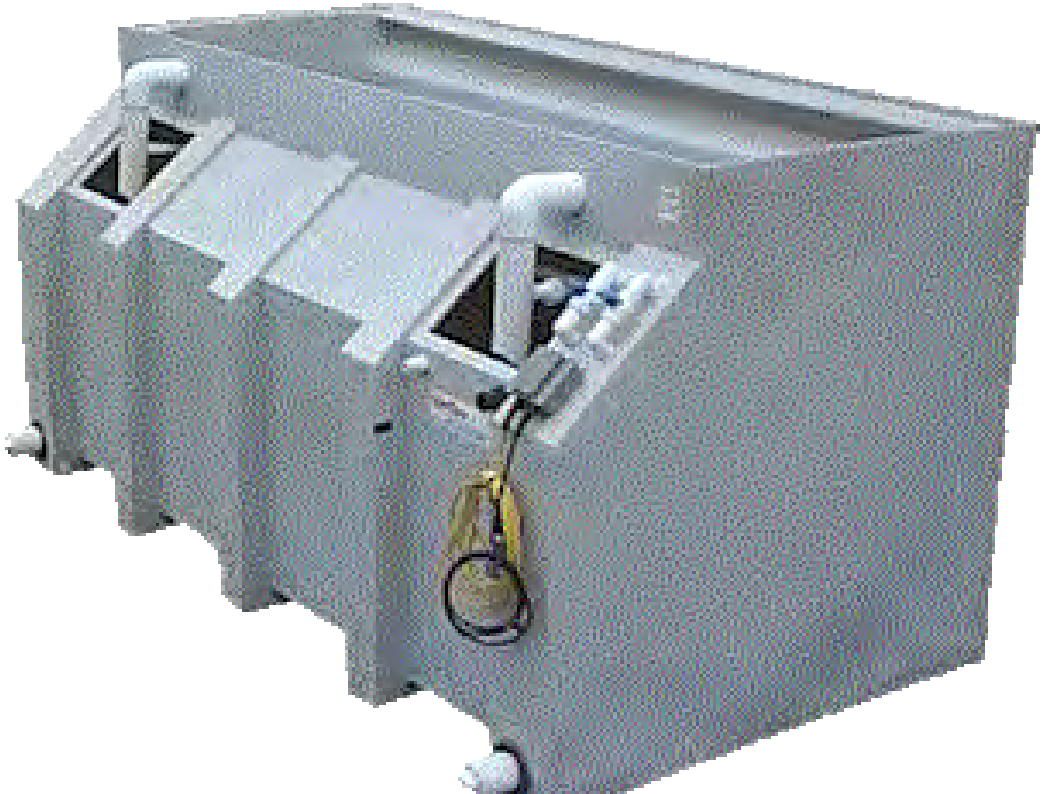
% of concentration at the eutectic temperature

hydrometer

Hydrometer / Salometer Chart for Salt Brine (59°F)			
% Salt	Salometer Using 0 - 100%	Hydrometer Specific Gravity	Eutectic Tempature
0	0	1	32
1	4	1.007	31
2	7	1.014	30
3	11	1.021	29
4	15	1.028	27
5	19	1.036	26
6	22	1.043	25
7	26	1.051	24
8	30	1.059	23
9	33	1.067	21
10	37	1.074	20
11	41	1.082	19
12	44	1.089	17
13	48	1.097	15
14	52	1.104	13
15	56	1.112	12
16	59	1.119	9
17	63	1.127	7
18	67	1.135	4
19	70	1.143	2
20	74	1.152	0
21	78	1.159	-2
22	81	1.168	-4
23	85	1.176	-6
24	89	1.184	2
25	93	1.193	16
26	96	1.201	30
27	100	-	32

Prewet Equipment:
Salt Brine Production Units

- Commercial Units available
- Converts road salt to salt brine automatically



Salt Brine Making Process

Salt Brine Making Process & Storage

Storage of Liquid Deicers

Salt Brine Making Process & Storage

Liquid Storage tanks should have containment & or spill prevention plans

Containment may be the easiest means of Addressing pollution prevention

Handling of Liquid Deicers

Prewetting Salt with Brines

- Prewetted Salt: Salt which has been coated with a liquid solution prior to being spread.
- Prewetting solutions:
  - Sodium Chloride
  - Calcium chloride
  - Magnesium chloride

Prewetting Salt

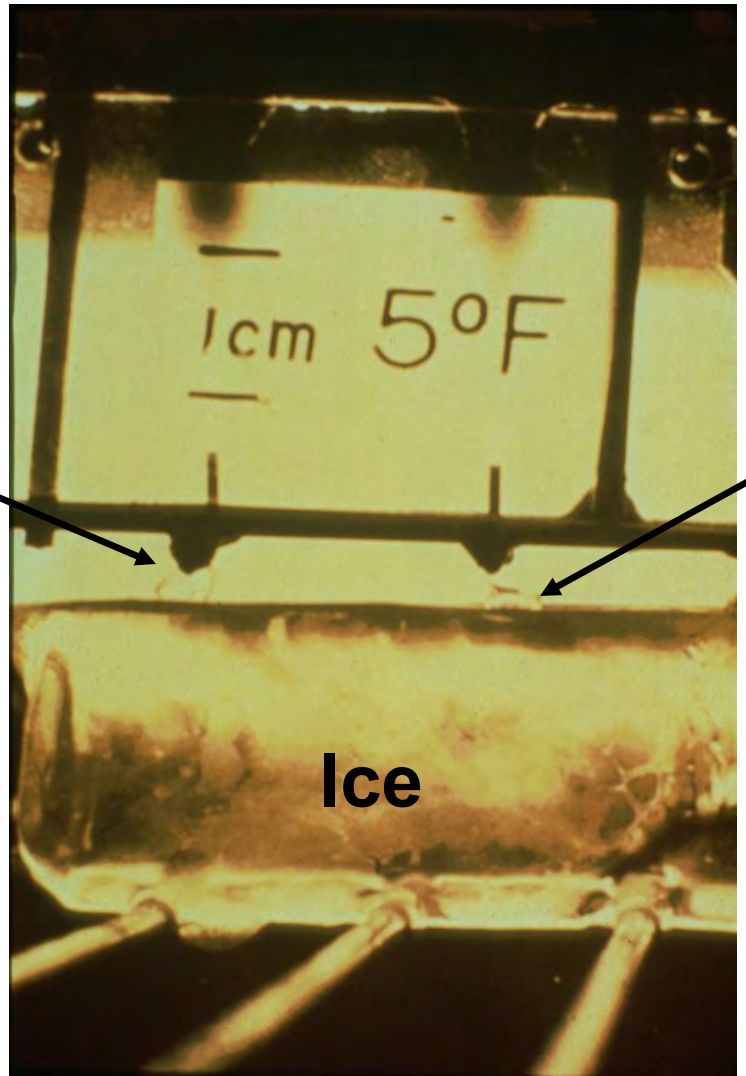
Iowa Department of Transportation Video (click on picture to start)

Definition and Advantages of Pre-wetting

Prewetting Salt: Benefits

- Less bounce & scatter
- Faster reaction time
- More effective melting action
- Less salt needed resulting in:
  - reduced costs
  - reduced environmental concerns

Melting Action: Untreated Salt vs. Prewetted Salt



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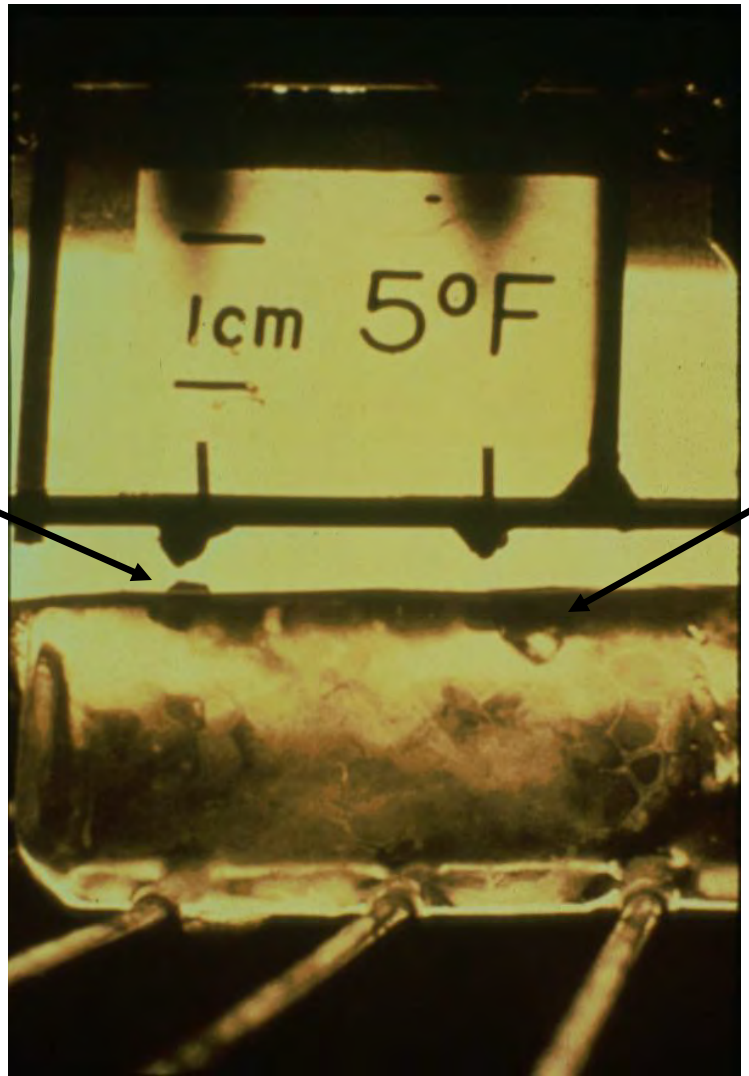

Salt

Prewetted Salt

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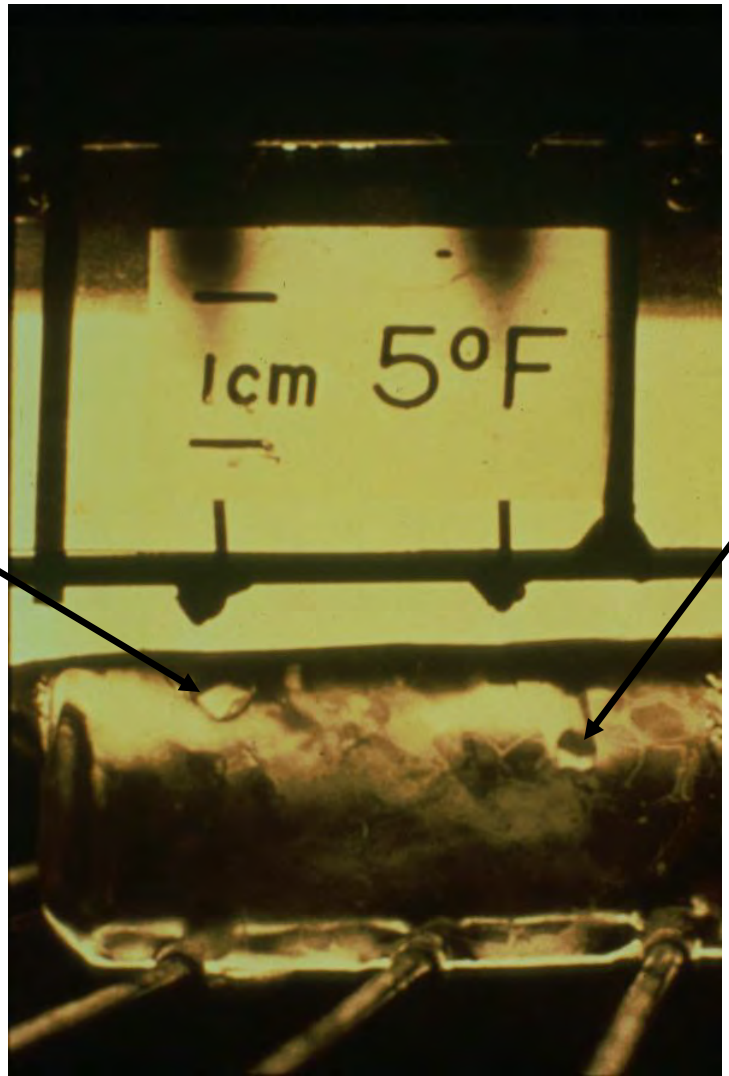
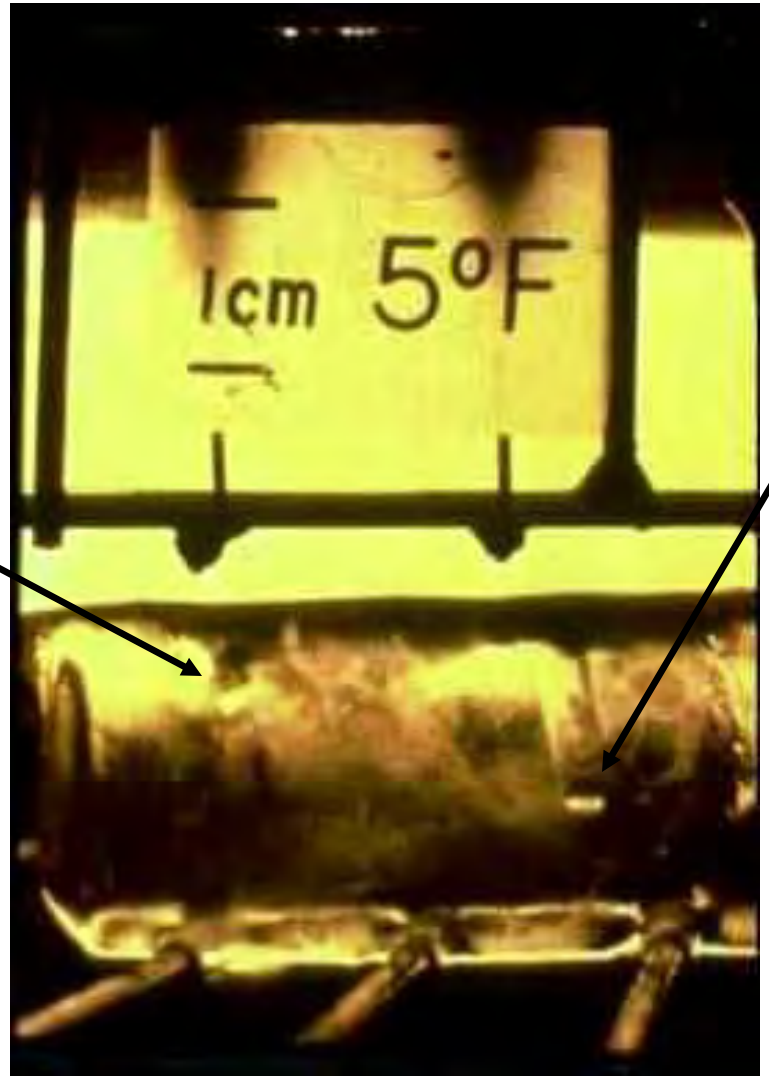


Salt

Prewetted Salt

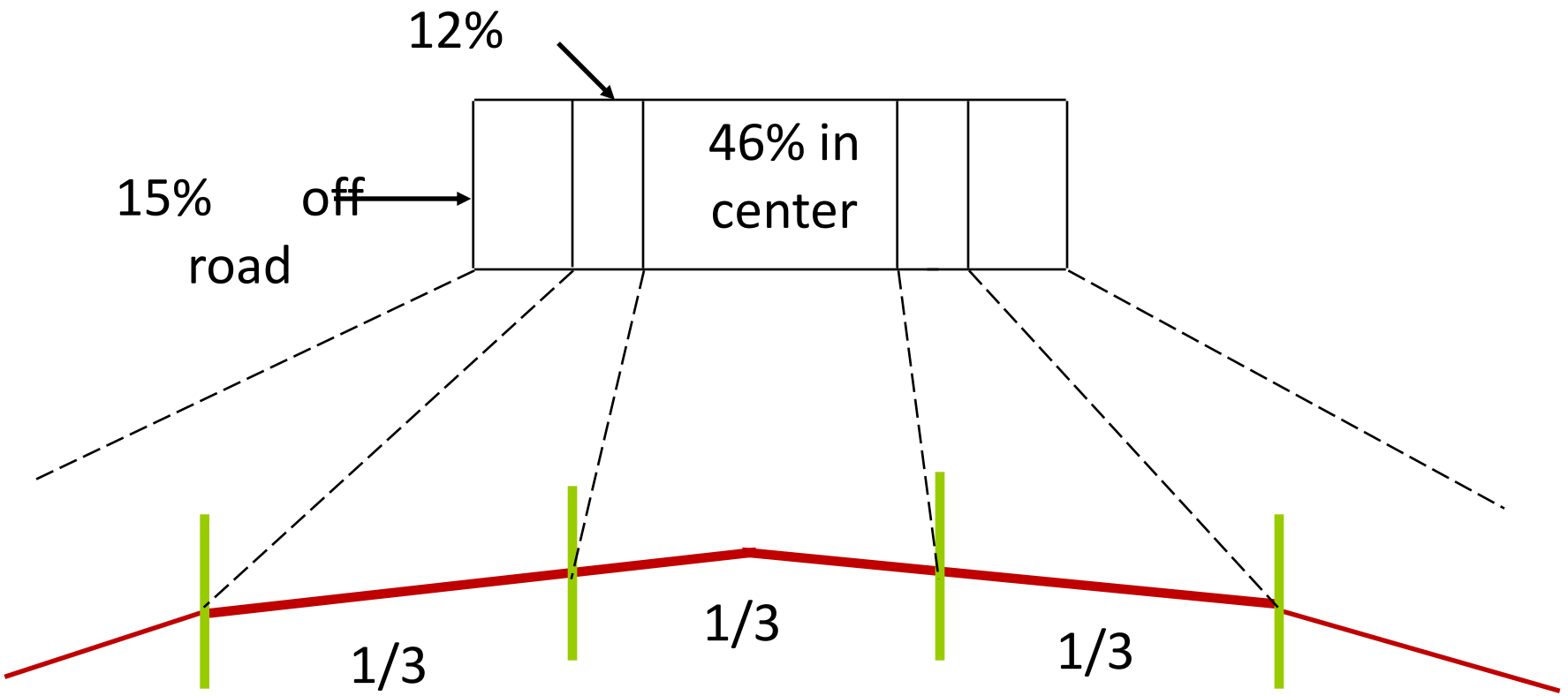
Melting Action: Untreated Salt vs. Prewetted Salt



Salt

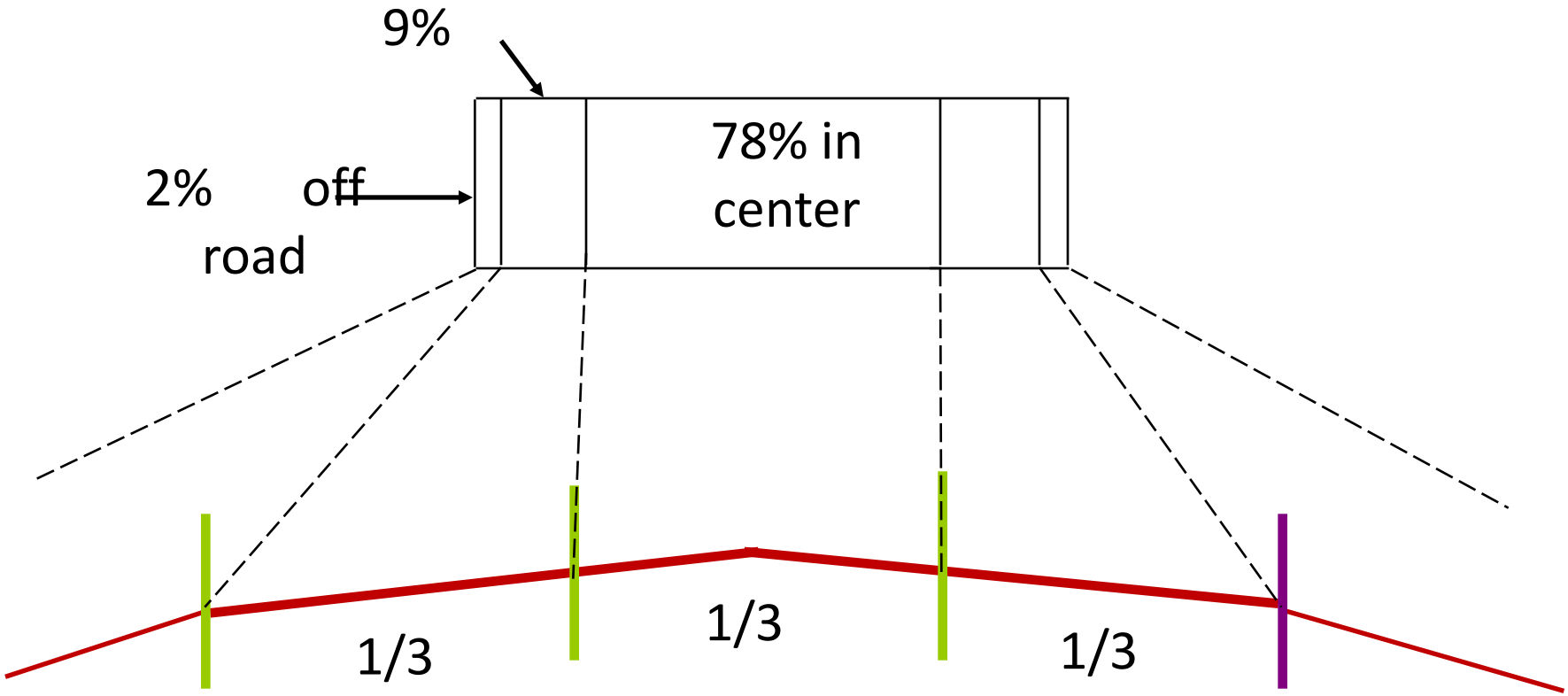
Prewetted Salt

Definition and Advantages of Pre-wetting



100% <u>dry</u> salt spread in center 1/3 of road

Definition and Advantages of Pre-wetting



100% <u>pre-wetted</u> salt spread in center 1/3 of road

Example: Data

- Usage: 1000 Tons Per Year of Salt
- Cost of Salt: $65.00 Per Ton
- Cost of Salt Brine: $0.15 Per Gallon
- Rate: 10 Gallons Per Ton of Salt
- % Reduction of Salt: 26%

Material Cost Savings

- Amount of Salt Saved:1000 Tons x 26% = 260 Tons/Year
- Cost of Salt Saved:260 Tons x $65.00/Ton = $16,900
- Cost of salt brine used: 740 Tons x 10 Gal/Ton x $0.15/Gal = $1,110
- $16,900 – $1,110 = $15,790 savings

Material Cost Savings

- Annual Net Material Savings:
  $20,500 - $5,950 = $14,550
- + Annual Labor Cost Savings:
  - Less Salt to Spread
  - Return Trips to Re-Salt Eliminated

Definitions and Advantages of Pre-wetting

Application Rates

Pre-wetting Application Rates			
Liquid Chemicals at Eutectic Concentration	**NaCl (Sodium Chloride)**	**$MgCl_2$ (Magnesium Chloride)**	**$CaCl_2$ (Calcium Chloride)**
Surface Temperature Above 25°	Pre-wet with 8 to 10 Gallons/Ton	Not Recommended	Not Recommended
Surface Temperature Between 0° and 25°	Not Recommended	Pre-wet with 6 to 8 Gallons/Ton	Pre-wet with 6 to 12 Gallons/Ton

Pre-wetting Methods & Equipment

Iowa DOT photo

Pre-wetting Methods & Equipment

Iowa DOT photo

Iowa DOT photo

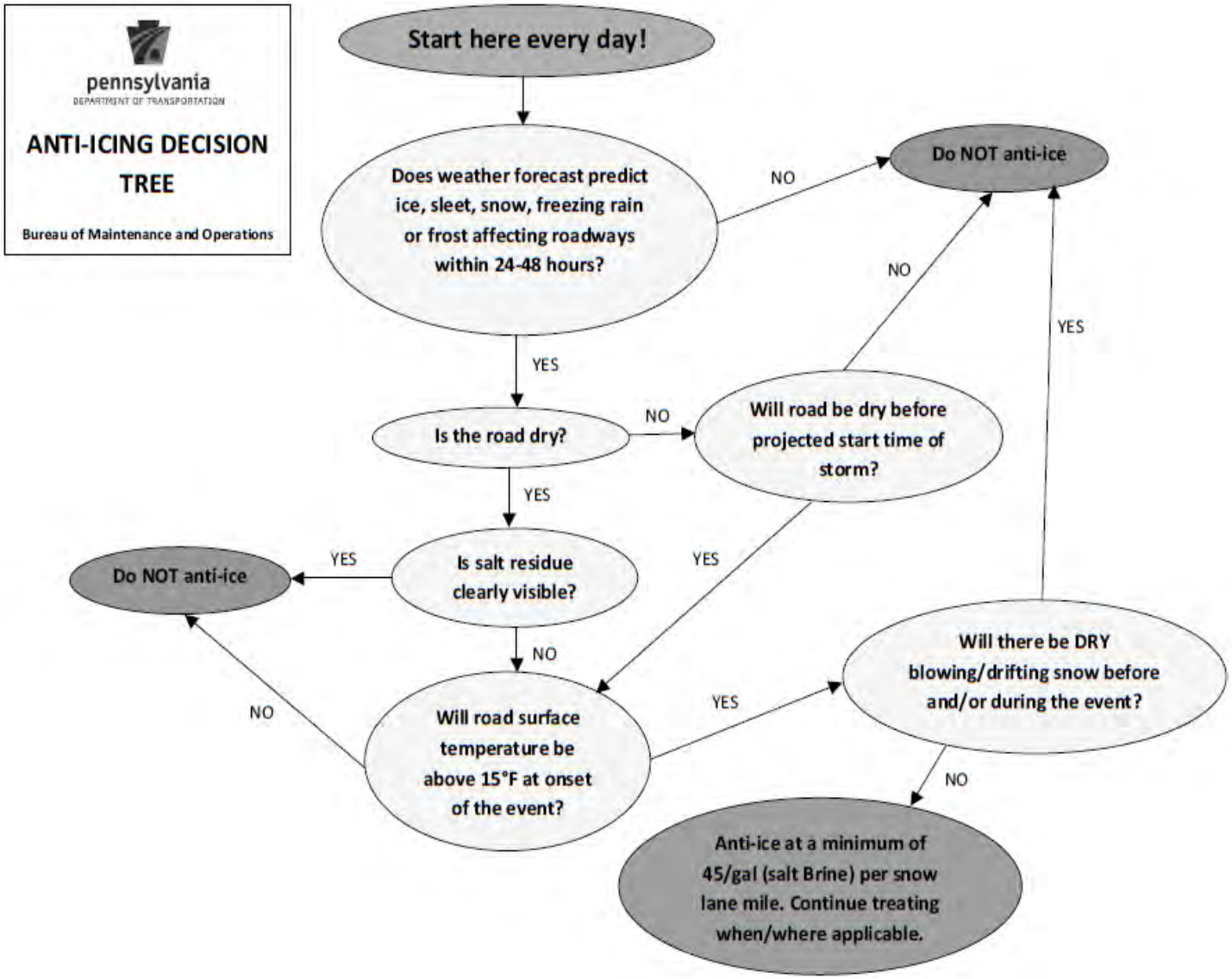
Anti-icing with Brines

Definition and Advantages of Anti-icing

Definition and Advantages of Anti-icing

Anti-icing

Anti-icing Decision Tree



Salt Brine, Additives, and Enhancers

Concentrations for Chemical Solutions		
NaCl (Sodium Chloride) **23.3% Concentration**	**MgCl (Magnesium Chloride)** **21.6% Concentration**	**$CaCl_2$ (Calcium Chloride)** **29.8% Concentration**
2.3 lb. of Salt* **per gallon of water**	Proprietary liquid mixtures available containing 20% to 25% $MgCl_2$	4.1 lb. of 77% Flake/Solid* per gallon of water. Proprietary liquid mixtures available.

Salt Brine, Additives, and Enhancers

Brine Additive Solution Ratios		
NaCl (Sodium Chloride)*	**NaCl (Sodium Chloride) with $MgCl_2$ (Magnesium Chloride) Additive***	**NaCl (Sodium Chloride) with $CaCl_2$ (Calcium Chloride) Additive***
No Additive	80% Sodium Chloride with 20% Magnesium Chloride	80% Sodium Chloride with 20% Calcium Chloride

Salt Brine, Additives, and Enhancers

Approved Brine Enhancers

AQUASALINA+ http://naturesownsource.com/

BEET HEET CONCENTRATE http://www.ktechcoatings.com/

GEOMELT 55 http://snisolutions.com/

BIOMELT AG http://snisolutions.com/

AMP by EnviroTech Services http://envirotechservices.com/

Tom Welker | Municipal Services Specialist
PA Department of Transportation|Bureau of Planning & Research
Municipal Research and Outreach Section | Research Division
400 North Street, 6th Floor | Harrisburg, PA. 17120
Phone: 717.783.3721
twelker@pa.gov

Anti-icing Application Rates

Anti-Icing Application Guidelines	
Liquid Chemicals	NaCL (Salt) 23.3%
Relative Humidity	Any Snow Event
Surface Temperature 25° and Above	45 Gallons per Snow Lane Mile
Surface Temperature 15°-24°	64 Gallons per Snow Lane Mile
Surface Temperature 14° and Below	Pre-treatment at lower temperatures could lead to trapping the first snow on the roadway surface and is not recommended.

Anti-icing Equipment

Anti-Icing

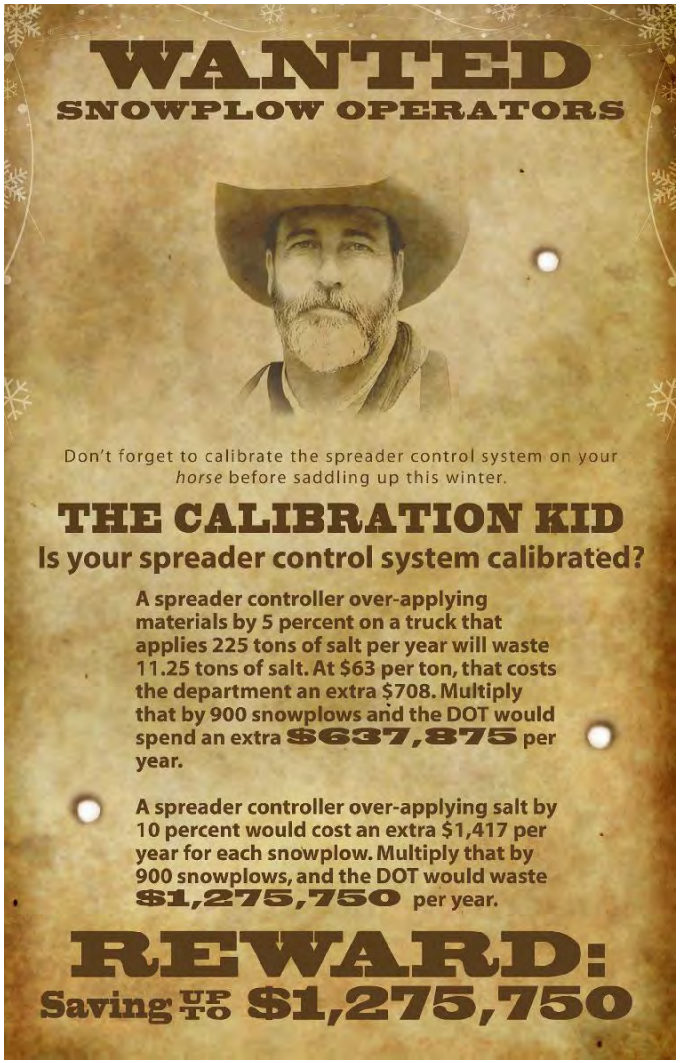
Upper Leacock Township

Sensible Salting & Winter Operations

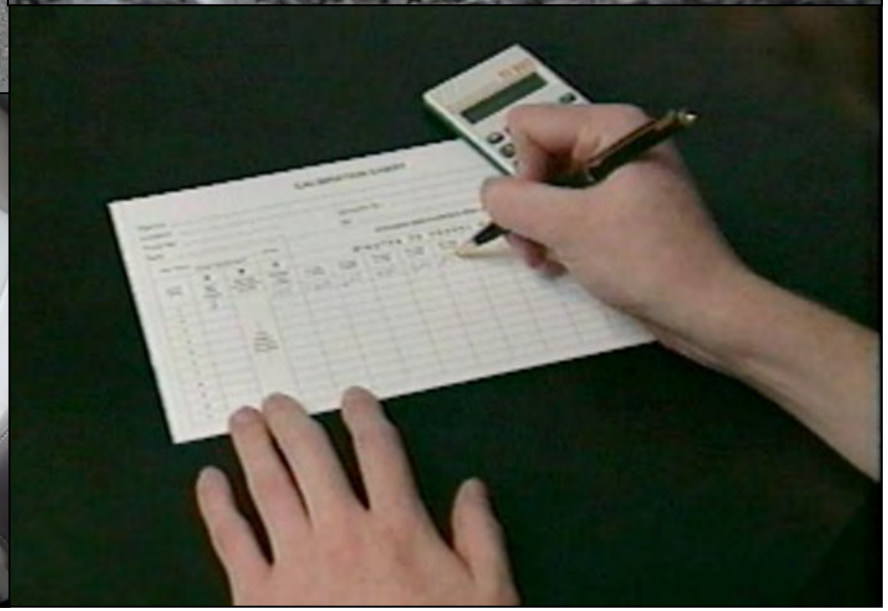
Remember!!!!

Calibration is the Key to Sensible Salting!

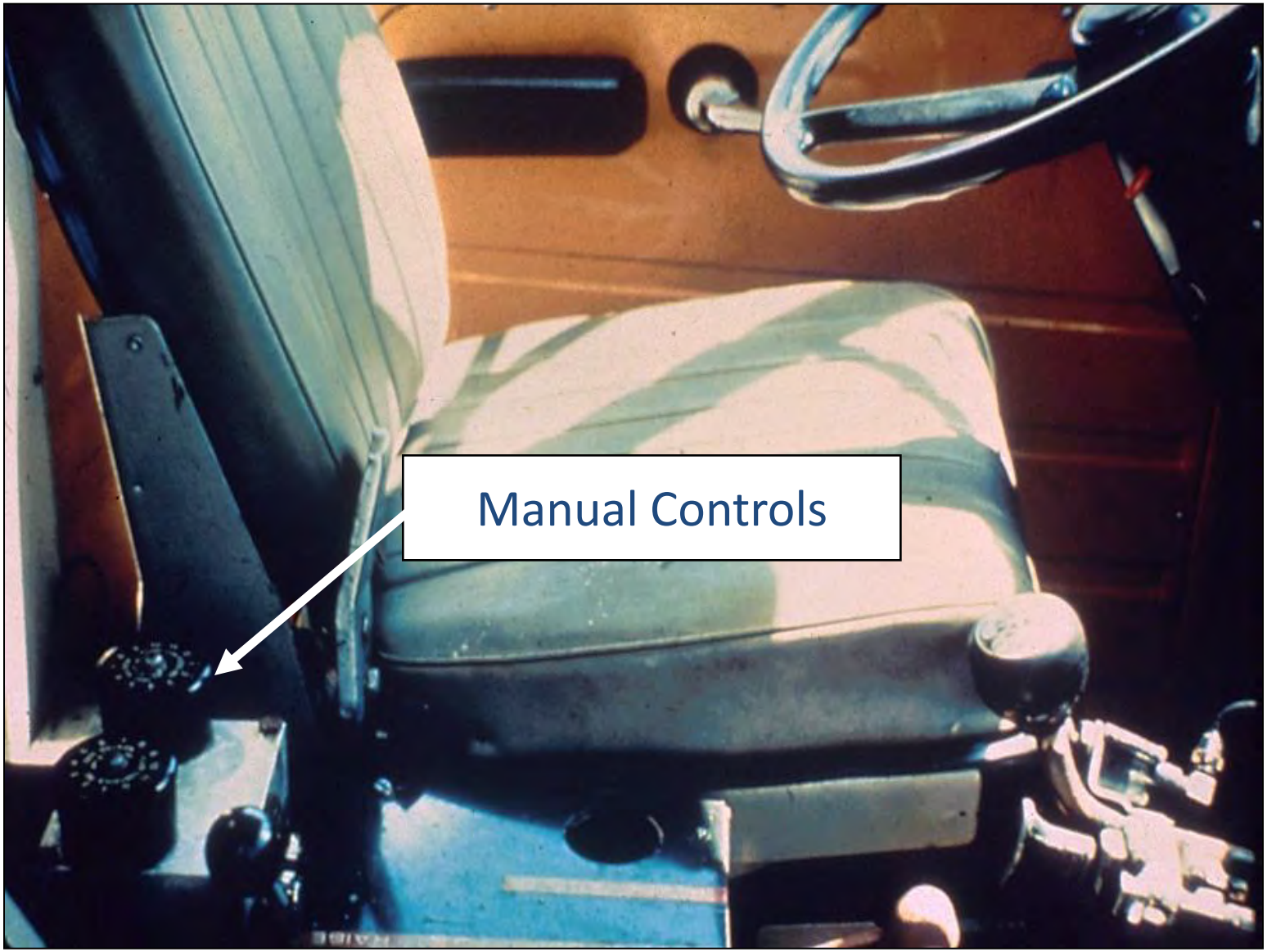
- **Using the right amount to make the roads safe!**
- **Preventing excessive salt use**
  - **Saving $$$$$$**
  - **Protecting the environment**



Calibrating the Spreader = Sensible Salting



Manual Spreader Control



Automatic Spreader Control

Computer Spreader Control

Calibrating the Spreader = Sensible Salting

Calibrating the Spreader = Sensible Salting

Spreader Calibration Process Walk Through

Spreader Calibration Step 1

Spreader Calibration Step 2

Spreader Calibration Step 3

Calibrating a V-box

Spreader Calibration Step 4

- **Set engine RPMs at normal operation range**

- **Set Auger control at setting to be measured**

- **Use stopwatch to count auger shaft revolutions per minute (60 seconds)**

Spreader Calibration Step 4

Spreader Calibration Step 5

Spreader Calibration Step 6

Spreader Calibration Step 7

CALIBRATION CHART

Agency: _____

Location: _____

Truck No.: _____ Spreader No.: _____

Date: _____ By: _____

Gate Opening _____ (Hopper Type Spreaders)

	A	B	C	POUNDS DISCHARGED PER MILE							
				MINUTES TO TRAVEL ONE MILE							
Control Setting	Shaft RPM (Loaded)	Discharge Per Revolution (Pounds)	Discharge Rate (Lbs/Min)	5 mph × 12.00	10 mph × 6.00	15 mph × 4.00	20 mph × 3.00	25 mph × 2.40	30 mph × 2.00	35 mph × 1.71	40 mph × 1.50
1											
2										t	
(3)	5	20	100	1200	600	400	300	240	200	171	150
4											
5		This Weight Remains Constant		SAMPLE CALCULATIONS							
6											
7											
(8)	20	20	400	4800	2400	1600	1200	960	800	684	600
9											
10											
11											

Spreader Calibration

Making Brine Work for You

- **Questions / Comments**