ITS COMING! OCTOBER 2 2017
WHY DO WE NEED ROAD SENSORS?

• Pavement temperature
• Road condition (surface state)
• Surface Grip
• Snow, ice or water depth
• Forecasting
• Road Conditions
Air Temperature

• Critical in telling us the type of precipitation.

• How do we measure it?
  • Measured from 6ft off the ground
  • In a white vented enclosure

• Combined with wind it has an impact on our road surface
Thermodynamics

To Understand How The Air Impacts Our Pavement We Must Understand How Heat Transfers From Objects

Bridges and overpasses freeze first and sensors are needed on both
Temperature

THINK
PAVEMENT
TEMPERATURE!
Thoughts On Temperature

• When We Are Using Chemicals,

• **We Are Only Concerned with the Pavement Temperature!**
Pavements do act differently
What Happens When Materials Hit the Road?

First, the Material Must Go Into Solution

Once In Solution (i.e. Mixed with Water)

It Lowers the Freezing Point

As Soon as It Goes Into Solution, It Starts to Dilute Out

How Long? Depends On:

Pavement Temperature

Cycle Time

Storm Type & Amount of Precipitation

Amount of Material Used
Pounds of Ice Melted Per Pound of Salt

<table>
<thead>
<tr>
<th>Pavement Temp. °F</th>
<th>One Pound of Salt (NaCl) melts</th>
<th>Melt Times</th>
</tr>
</thead>
<tbody>
<tr>
<td>30</td>
<td>46.3 lbs of ice</td>
<td>5 min.</td>
</tr>
<tr>
<td>25</td>
<td>14.4 lbs of ice</td>
<td>10 min.</td>
</tr>
<tr>
<td>20</td>
<td>8.6 lbs of ice</td>
<td>20 min.</td>
</tr>
<tr>
<td>15</td>
<td>6.3 lbs of ice</td>
<td>1 hour</td>
</tr>
<tr>
<td>10</td>
<td>4.9 lbs of ice</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>4.1 lbs of ice</td>
<td>Dry salt is ineffective and will blow away before it melts anything.</td>
</tr>
<tr>
<td>0</td>
<td>3.7 lbs of ice</td>
<td></td>
</tr>
<tr>
<td>-6</td>
<td>3.2 lbs of ice</td>
<td></td>
</tr>
</tbody>
</table>

It is not cost-efficient to apply salt (sodium chloride) at pavement temperatures less than 15° F.
Temperature

- the Lower the TEMPERATURE
  the Longer It Takes to Make Brine
- MORE SALT WILL NOT SPEED UP THE PROCESS!
- Below 15 Degree Pavement Temperature Salt Really Starts to Lose Its Effectiveness
## Salt Application Rate Guidelines

### Prewetted salt @ 12' wide lane (assume 2-hr route)

<table>
<thead>
<tr>
<th>Surface Temperature (° Fahrenheit)</th>
<th>32-30</th>
<th>29-27</th>
<th>26-24</th>
<th>23-21</th>
<th>20-18</th>
<th>17-15</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heavy Frost, Mist, Light Snow</td>
<td>50</td>
<td>75</td>
<td>95</td>
<td>120</td>
<td>140</td>
<td>170</td>
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<tr>
<td>Drizzle, Medium Snow 1/2&quot; per hour</td>
<td>75</td>
<td>100</td>
<td>120</td>
<td>145</td>
<td>165</td>
<td>200</td>
</tr>
<tr>
<td>Light Rain, Heavy Snow 1&quot; per hour</td>
<td>100</td>
<td>140</td>
<td>182</td>
<td>250</td>
<td>300</td>
<td>350</td>
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</table>

### Prewetted salt @ 12' wide lane (assume 3-hr route)

<table>
<thead>
<tr>
<th>Surface Temperature (° Fahrenheit)</th>
<th>32-30</th>
<th>29-27</th>
<th>26-24</th>
<th>23-21</th>
<th>20-18</th>
<th>17-15</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heavy Frost, Mist, Light Snow</td>
<td>75</td>
<td>115</td>
<td>145</td>
<td>180</td>
<td>210</td>
<td>255</td>
</tr>
<tr>
<td>Drizzle, Medium Snow 1/2&quot; per hour</td>
<td>115</td>
<td>150</td>
<td>180</td>
<td>220</td>
<td>250</td>
<td>300</td>
</tr>
<tr>
<td>Light Rain, Heavy Snow 1&quot; per hour</td>
<td>150</td>
<td>210</td>
<td>275</td>
<td>375</td>
<td>450</td>
<td>525</td>
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</table>
Pavement Sensors

- Mobile, fixed and subsurface
- Monitoring, planning, treatment strategies, forecasting
- Invasive and non-invasive
Handheld Infrared Gun

- Easy to use! Point and Shoot!
- Cheap!
- No training Required!
- Sensor must be acclimated to environment
- Not originally designed for outdoor use
- Typical accuracy comments:
  - ± 4°F from 32°F to 55°F
  - Assumes ambient operations temperature of 73°F to 77°F
  - One model does not work below 32°F
  - It’s best to allow some time (about 20 minutes is usually enough) for your IR thermometer to come to the temperature of its surroundings when bringing the thermometer into surroundings that are significantly warmer or colder than where it has been stored (errors of 5-6°F possible)
Mobile: Why?

Inexpensive

Provides much more accurate reading than handheld

Gives you conditions as you drive

Provides a broad view of road weather conditions
Mobile Weather Conditions

- **Standard Equipment**
  - Pavement Temperature
  - Air temperature

- **Advanced Equipment**
  - Dew point / Relative humidity
  - Road Condition
  - Friction
RWIS Installations and Weather Stations

- Provides Weather Conditions Along The Road 24/7
- Useful For Assessing Success Of New Road Maintenance Techniques
- Salt Management Plan Performance
Fixed Roadside Sites

**Sensors Measure:**
- Wind Speed, Gusts & Direction
- Precipitation
- Temperature & Humidity

**Cabinet Contains:**
- Processing Unit
- Telecommunications & Power Connections
- Digital Barometer – Pressure

**Optional Equipment:**
Visibility, Cameras, Traffic Counters, Precipitation Type And Amounts
Embedded sensors are the standard

Non-intrusive offer less lifetime cost

Non-intrusive offers new value: friction
Cameras and your eyes are not enough. Which conditions are slippery?
Did You Get Them Right?

Air Temp: 25°F
Road Temp: 30°F
Road State: Slush
Grip: Good

Air Temp: 36°F
Road Temp: 39°F
Road State: Dry
Grip: Excellent

Air Temp: 20°F
Road Temp: 28°F
Road State: Ice
Grip: Poor

Air Temp: 23°F
Road Temp: 28°F
Road State: Ice
Grip: Poor

Air Temp: 25°F
Road Temp: 50°F
Road State: Dry
Grip: Excellent

Air Temp: 23°F
Road Temp: 28°F
Road State: Wet
Grip: Good

Air Temp: 25°F
Road Temp: 50°F
Road State: Dry
Grip: Excellent

Air Temp: 23°F
Road Temp: 28°F
Road State: Wet
Grip: Good

Air Temp: 28°F
Road Temp: 43°F
Road State: Wet
Grip: Good

Air Temp: 24°F
Road Temp: 28°F
Road State: Ice
Grip: Very poor

Air Temp: 14°F
Road Temp: 21°F
Road State: Dry
Grip: Excellent

Salt Residue
RoadDSS on Demand means these are not just for States any more

City of West Des Moines site on existing infrastructure
Frost & Black Ice!

**Frost**

- If the air & pavement temperature is below freezing...
  - Pavement temperature becomes colder than the dew point temperature
  - The moisture in the air crystallizes onto the pavement below freezing surface, forming frost.

**Black Ice**

- Liquid moisture appears on the pavement (can happen in a variety of ways)
  - The pavement temperature then falls below freezing
  - Water freezes clear to the pavement – because it was a liquid first!
Subsurface Probes

Generally 16 inches below the surface to measure heat below the pavement.

Will help determine if frost will form or falling precipitation will affect the pavement. Remember 41 degrees!
Weather Information Sources

- Media
- Internet
- Government Services
- Event Specific
- Value Added Meteorologists (VAMs)

Daily Use
Is this **really** relevant to your job?

<table>
<thead>
<tr>
<th>Right Now</th>
<th>Next 36 Hours</th>
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<tbody>
<tr>
<td><strong>Cloudy</strong></td>
<td><strong>Tonight</strong></td>
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<tr>
<td><strong>43°F</strong></td>
<td><strong>33°F</strong></td>
</tr>
<tr>
<td>Feels Like: 36°</td>
<td>Low</td>
</tr>
<tr>
<td>Get FREE weather on your desktop</td>
<td><strong>49°F</strong></td>
</tr>
<tr>
<td>Past 24-hr Snow: 0 in</td>
<td>Snowfall: 0 in</td>
</tr>
<tr>
<td>Past 24-hr Precip: 0.95 in (est.)</td>
<td>No significant snow accumulations</td>
</tr>
<tr>
<td>Wind: From SW at 12mph</td>
<td>Chance of Precip: 50%</td>
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<tr>
<td></td>
<td><strong>Tomorrow</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Snow Showers Late</strong></td>
</tr>
<tr>
<td></td>
<td><strong>High</strong></td>
</tr>
<tr>
<td></td>
<td><strong>No significant snow accumulations</strong></td>
</tr>
<tr>
<td></td>
<td>Chance of Snow: 30%</td>
</tr>
<tr>
<td>Wind: SW at 19 mph</td>
<td>Wind: SSW at 11 mph</td>
</tr>
<tr>
<td>Hoorly</td>
<td>10-Day Forecast</td>
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</table>
What kind of forecast is right for us?

- Provides specific timing
- Provides accurate and meaningful percentages
- Provides road temperatures
- Significant road weather event information
  - Frost
  - Black ice
  - Freezing Rain (freezing where?)
- Consultation
- Updates that are there when you make your decisions
We need data that includes what the road conditions and pavement temperatures are predicated to be.

Getting a pavement temperature forecast is key to making decisions.
Weather Provider Examples
Reviewing Data and Grip
Combining AVL with Weather Data to Measure Performance

The **pink** line is grip and the **red** line is pavement temperature.
DATA FROM THE TRUCK IS SHOWN ON THE ROAD CONDITIONS PAGE
THE PERFORMANCE DURING A STORM IS EASILY SEEN
## Storm Performance Index Report

**Generation date**: 31-Oct-2012 09:03

### Storm Performance Index Legend

- **0**: Successfully treated
- **0.00 - 0.30**: Significantly accelerated grip recovery
- **0.31 - 0.49**: Some success at grip recovery
- **0.50 - 0.69**: Very little success at deicing
- **0.70 -**: Limited maintenance or no deicer success
- **-**: Observation data / parameter missing or temp is below threshold

<table>
<thead>
<tr>
<th>Station</th>
<th>Date</th>
<th>Time Range</th>
<th>Event</th>
<th>Duration (hours)</th>
<th>Max Wind Speed (mph)</th>
<th>Max Ice Layer (mm)</th>
<th>Max Snow Layer (mm)</th>
<th>Max Water Layer (mm)</th>
<th>Min Surface Temp (°F)</th>
<th>Severity Index</th>
<th>Performance Index</th>
<th>Mobility Index</th>
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<td>28.04</td>
<td>19.37</td>
<td>0</td>
<td>100%</td>
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</tr>
</tbody>
</table>
Times Have Changed!

• Public expectations are increasing

• We need safe & reliable roads

• Environmental concerns are increasing

• Right treatment, right amount at the right time.
THANK YOU

Mark DeVries
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