HIGHWAY FACTORS GROUP CHAIRMAN'S FACTUAL REPORT

PENWELL, TX

HWY15MH004

(22 pages)

NATIONAL TRANSPORTATION SAFETY BOARD
OFFICE OF HIGHWAY SAFETY
WASHINGTON, D.C.

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A. CRASH INFORMATION

Location:	Interstate 20 (I-20) in Ector County near Penwell, Texas
Vehicle #1:	2015 Bluebird bus
Operator #1:	Texas Department of Criminal Justice
Vehicle #2:	Union Pacific Train Q40927, consisting of 4 locomotives, 58 cars
Operator #2:	Union Pacific Railroad
Date:	January 14, 2015
Time:	Approximately 7:49 a.m. CST
NTSB #:	**HWY15MH004**

B. HIGHWAY FACTORS GROUP

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C. CRASH SUMMARY

For a summary of the crash, refer to the *Crash Summary Report* in the docket for this investigation.

D. DETAILS OF THE HIGHWAY FACTORS INVESTIGATION

The highway group examined the design, maintenance, and operation of the highway facility to determine if any of these areas contributed to or caused the accident. The Highway Factors Group along with the NTSB Technical Reconstruction Group documented the accident scene. The placement, design, and inspection of the guard rail and bridge structure were documented. Road and weather conditions were documented by the NTSB Meteorologist, and through observations of Texas Department of Transportation (TDOT) personnel along with observations described by the drivers involved in accidents before this accident occurred. Previous damage to the guard rail in this area was documented and recent accident reports were obtained.

1. Prefatory Data

The accident occurred on Interstate 20 (I-20) about 918 feet east of mile marker 103 near Penwell, in Ector County, Texas, in the westbound lanes near station no. 989.00[1]. The accident scene was located at latitude 31.751389 degrees and longitude-102.561667 degrees. (See Figure 1.)

[1] See State project Plans Project No. Federal-Aid Project I-20-1(76)098, 1979. Station numbers are official numbers describing dimensional project lengths.

Figure 1

In this area I-20 was originally constructed in 1956 with a 50-foot-wide median that had a design nominal slope of 1V:8H.[2] The roadway in this area had full access control, a posted 75 mph speed limit, and dual 12-foot-wide asphalt lanes in each direction with 10-foot-wide outside or right-hand shoulders and 4.5-foot-wide inside or left-hand shoulders. The right-hand shoulders were delineated from the travel lanes by a solid white pavement stripe and the left-hand or median shoulders were delineated by a solid yellow pavement stripe. The dual east and westbound travel lanes were delineated by dashed white pavement stripes that were 10 feet in length and spaced at 30-foot intervals. The wearing surface of the pavement was last resurfaced in 2009.[3] Both right and left-hand shoulders in both directions had milled alert grooves or rumble strips in the pavement to aid in reducing roadway departure accidents. There were warnings signs posted 750 feet in advance of each bridge approach warning drivers that the bridge may ice in cold weather. There was highway safety lighting in the accident area.[4]

2. Traffic Metrics

Interstate 20 in the accident area had an Average Daily Traffic (ADT) of 13,748 vehicles per day. The total heavy truck counts for this area was 6,192 trucks per day or a truck ADT of 45 percent. The 85th percentile speeds for vehicles in this area were 76 mph for the westbound lanes and 77 mph in the eastbound lanes.[5] The speed study was performed between MP 109 and MP 110 on November 15, 2011.

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[2] The slope measurement corresponds to a one foot drop in elevation for every 8 feet of horizontal measurement. Scene measurements showed that for the first 3-31/2 feet into the median the slope was 1V:4H and then if flattened out to approximately 1V:7H.

[3] See Texas Highway Federal-aid Project IM 0201 (172)

[4] See Highway Factors photographs 1&2 for a general view of the westbound approach to the accident site, photographs 3&4 for a view of the eastbound approach to the bridge, and photographs aerial photographs 5&6 courtesy of DPS that shoe the overall accident scene.

[5] The speed at which 85 percent of the traffic is traveling at or below

3. Accident History

Records for accidents from TXDOT were requested for an area on I-20 extending for ½ mile on both sides of each bridge. The records showed that eight accidents occurred within these limits between 2010 and 2014. One accident was a fatal crash, one involved injuries and six were property damage only accidents. An additional request was made to TXDOT for fatal accidents occurring statewide for the period 2010-2014 where a vehicle travelled between parallel bridge structures similar to this accident. TXDOT indicated that 17 fatal crashes occurred during the requested time period where a vehicle travelled between parallel structures. The Fatal Accident Reporting System (FARS) that is operated by the National Highway Traffic Safety Administration (NHTSA) was unable to query and isolate these type of fatal crashes nationwide.

Each year nationwide, approximately 2,200 people are fatally injured in crashes during snowfall and sleet or in crashes where the pavement is covered with snow, slush, or ice. About 192,500 are injured in these type of crashes each year.[6]

4. Guard Rail Design, Placement, and Previous Recent Damage

The 225-foot-long guard rail or Metal Beam Guard Fence (MBGF) was placed in the median to the left of the left-hand lane where this accident occurred. It was comprised of a 50-foot-long end-treatment that was flared or offset at 25:1, a 157-foot-long main element, and an 18-foot-long thrie-beam transition into the concrete T 201 bridge railing. In other words the end treatment was placed laterally about four feet from the road edge and flared inward so that the main element was about two feet from the road edge. The end terminal was manufactured by SKT Inc. and designated as an SKT 350 Test level – three.[7][8] The guard rail was a strong-post W-beam with 14-inch by 8-inch by 6-inch blocks. The barrier was originally 27 inches in height. The post spacing in the end-terminal and main element were at 6-foot, three-inch intervals. The post spacing in the thrie-beam transition were at three-foot, 1 ½-inch intervals followed by 18 ¾-inch intervals to stiffen the rail where it connected to the parapet bridge railing. The Texas T201 bridge railing also meets NCHRP Test-Level three impact conditions so long as the barrier height is maintained at 27 inches.

4.1 Previous Recent Guard Rail Damage

On Tuesday morning January 13, 2015, about 3:50 a.m. another accident occurred on I-20 near this same location that extensively damaged the guard rail or MBGF that was struck in

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[6] Snow and Ice Data book 2014, Published by the world Road Association PIARTC Technical Committee 2.4 Winter Maintenance 2014.

[7] The strong-post, blocked W-beam barrier is designated as a SGR04a and accepted for use by the Federal Highway Administration (FHWA)as a test level-three barrier by FHWA Acceptance letter B64. The SKT 350 end treatment is also accepted as a test-level three end treatment. Test-level three barriers are test in accordance with the impact conditions found in National Cooperative Research Program Report 350 (NCHRP 350) at 62 mph with a 4,400 pound pickup at a 25- degree impact angle and with a 1,800-pound small sub-compact car at 62 mph and a 20-degree angle.

[8]

this westbound accident involving the prison bus. In the 3:50 a.m. accident on Tuesday a 1999 white Ford pick-up truck that was traveling eastbound lost control on what the driver described as an icy surface. Next, the pick-up traveled over the median striking the back side of the guard rail for westbound traffic. The impact damaged nearly all of the posts and guard rail was disabled with its' beam separated from the posts. The next day about noon TXDOT personnel removed the guard rail from shoulder further toward the median and photographed the damage.[9] On Wednesday January 14, 2015, about 1:30 am TXDOT workers were applying salt brine to prevent ice build-up on the bridges at this location. The workers later reported to the NTSB that they saw law enforcement vehicles on the westbound side with flashing lights on, indicating to them that an accident probably had occurred. Texas Department of Public Safety (DPS) accident records showed that about 0009 hours on Wednesday January 14, 2015, a westbound Toyota Rav 4 in the westbound left-hand lane changed to the right-hand lane to avoid a wrecked vehicle in the left-hand lane. During the maneuver, a westbound Chevrolet pick-up truck in the right hand lane skidded into the rear of the Toyota. There was not an accident report taken for the earlier accident. However, wrecker drivers indicated that it was a white Ford pick-up truck that had skidded across the median and struck the guard rail and then ended up in the left-hand westbound lane. Three other accidents occurred at this location before the prison bus accident. One occurred about 5:50 a.m., one occurred about 6:05 a.m., and a third occurred about 7:37 a.m. Both the 5:50 am. and 7:37 a.m. accidents were eastbound pick-up trucks that lost control, skidded over the median, and struck the previously damaged guard rail. Since the day before, this guard rail had been struck in 4 separate accidents. The DPS trooper that was on-scene indicated that in the next to the last accident before the prison bus crash that the damaged guard rail had been pushed onto the shoulder almost to the travel lane. During the last or 7:37 a.m. accident, which was recorded on the troopers in-car video, the guard rail was pushed onto the westbound left-hand lane. After this accident, and moments before the prison bus arrived a westbound vehicle can be seen traveling by. This person later provided a statement to the NTSB and DPS stating that the guard rail was in the travel lane and he swerved to miss it. When the prison bus came buy the video recorded a metal object rotating upward in the path of the bus. Scars and gouges in the pavement began about 18 inches north of the shoulder stripe, moving toward the dashed white pavement stripes. After the prison bus went out of control and traveled toward the median, it collided with the guard rail again about 28 feet from the concrete bridge rail, and then dropped off of the apron to the dirt area about 20 feet below the twin bridges.[10]

4.2 TXDOT Guard Rail Inspection and Repair Policy

The following guidelines were obtained from the TXDOT statewide maintenance operations manual.

"Section 7 — Guardrail, Barriers and Attenuators"

Overview

[9] See Highway Factors photographs 7-9 taken by TXDOT workers Ruben Reyes and Paul Perez from the Odessa District.

[10] See Highway Factors Photographs 10-12, Courtesy of Texas DPS that show gouges in the pavement where the guard rail was struck.

"When a rail or barrier has been damaged to the extent that it will not function properly, it should be replaced or repaired as soon as practical. Minor repairs should be made when scheduling will allow."

Guardrail

"When a guardrail installation is damaged, a review should be made to determine whether it is feasible to upgrade the installation to current design standards. "Guardrail Damage Ahead" signs should be installed only when substantial damage occurs to guardrail barriers or attenuators which cause them to not function properly. Repairs should be made as soon as practical. The following items should generally be considered in this analysis:"

- Is the section of guardrail still required under current design standards?
- Can the guardrail installation be avoided with the elimination of the hazard or the flattening of the slope?
- If it is determined that the guardrail is still necessary and more than approximately 25 percent or more of the installation requires replacement, the installation should be upgraded to current design standards.

Attenuators

Damages which result in inadequate protection or which cause the attenuator not to function properly should be repaired as soon as possible. Minor damage should be repaired as soon as practical.

The Texas guardrail inspection and repair policy was consistent with the guidelines found in the Federal W-Beam Guardrail Repair Guide.[11]

4.3 Previous Repairs for the Accident Guard Rail

The only work order for this guard rail in the TXDOT maintenance file showed that it was reported as damaged on December 10, 2013, and repaired on January 14, 2014. The repair consisted of replacing a 25-foot rail section and the guard rail end treatment.

TXDOT relies heavily on daily travels of its employees throughout the district to discover and report damaged guard rail. Once the damage is assessed a work order is sent to a contractor requesting repair in 7 days. The Odessa district is responsible for 8,144 lane miles of highway and 1,090 bridges. TXDOT indicated it can vary widely

[11] W-Beam Guardrail Repair: a Guide for Highway and Street Maintenance Personnel, Fitzgerald, William J., 2008, FHWA-SA-08-002,

but in general about &500,000.00 is spent each year for guard rail repair.

5.0 Bridge Information

The structure over the Union Pacific Railroad (UPRR) at this location is designated as structure No. 23 in District 6 county 069 section 0004-07. The bridge was originally constructed in 1956 and widened in 1979. It is a 5 span continuous steel stringer bridge on concrete bents. Biennial inspection records were examined from 2005-2013. The structure has been maintained and is currently coded as being in satisfactory condition. Similarly structure 22 on the westbound side was constructed and reconstructed at the same time and is also in satisfactory condition. After the bus traveled off of the highway above and collided with the train, it departed into Bent number 4 on the eastbound structure 23. Each structure has 6 bents. The first bent on the eastbound bridge is the abutment followed by 4 intermediate, 4-column bents, and then ending with bent 6, which is the abutment on the east side of the bridge. Bent 4 is located 9.3 feet from the centerline of the UPRR track, so in accordance with the American Railway Engineering and Maintenance of Way Association (AREMA) concrete structure standards it was built of heavy construction. This standard is required when highway bridge owners locate piers or bents within 25 feet of the railroad centerline. All of the bents had 4, 30-inch diameter columns, and bent number 4 in structure 23 had the columns encased in a heavily constructed pier wall that was 10 feet in height, 2-feet thick and 42 feet long. There were tire marks on the first and 4th column of the bent, approximately 13 feet above the ground level, corresponding to oval shaped compression dents in the left side and rear of the bus.

6.0 Snow and Ice Control

The TXDOT Snow and Ice Control Maintenance supervisors from the Odessa section and the Monahans sections along with crew members were interviewed on January 16, 2015, to gain an understanding of TXDOT's response to the winter storm event on Wednesday January 14, 2015, the day of this accident. The Odessa District Snow and Ice Control plan identified Interstate 20 and its bridges priority code 1 to provide the highest level of service to this freeway. The area east of the accident location beginning about Mile post 104 and extending to Mile post 126 had about 20 interstate bridges and approximately 80 other roadway bridges assigned for treatment. A 14-person crew worked on the east end of this section with 2, 10-yard and one 6-yard truck. Because of the large number of bridges a granular solid mix of salt and pea gravel was applied. The solution was pre-wetted to assist in in adhering to the surface and not blowing away.

On the other end of the district crews from Monahans applied a liquid 23.2 percent salt brine solution to prevent ice build-up on the interstate and bridges from Mile post 53 near Barstow going east to milepost 104 past the accident site. They applied approximately 30 gallons per lane mile in a continuous application. Anti-icing solutions were not applied on Monday before the first eastbound accident occurred that damaged the guardrail

TXDOT indicated that Texas in accordance with guidance from the American Association of State Highway Transportation Officials (AASHTO) was using liquid solutions more often because of their effectiveness in pretreating pavement to prevent ice from bonding with pavements, and they cause less environmental problems, and are more economical to use.

On Tuesday evening the night crew had been briefed to expect freezing drizzle and rain during the night. The tank truck in use applied a 23 percent solution of salt brine from gravity feed nozzles. The truck had a capacity of slightly over 40 42-gallon capacity barrels or approximately 1,700 gallons of material. The crew began a constant application by driving 30 mph and releasing the liquid solution in the right-hand lane of eastbound I-20**.** They indicated that they slowed to 25 mph on bridges to allow a greater amount of brine to coat the bridge decks. The area around bridge structure 23 near Mile Post 103 was treated approximately 6 p.m. on Wednesday. The crew turned around about Mile Post 104 and refilled their tank with the anti-icing solution, and treated the right-hand lane all the way back to the Barstow area in the vicinity of Mile Post 53. Next, the truck was re-filled, and about midnight a different crew began applying the brine solution in the left-hand or passing lane of I-20. The crew made a continuous application and treated the bridges at the accident location about 1:30-2:00 a.m. While making the eastbound pass they observed several flashing police lights near the bridges and assumed some type of accident had occurred. They made their turn around at Mile Post 104 near FM 866, re-filled their tanker again and continued to treat the left-hand lane going west back to Monahans. See Attachment 1 Witness Interviews for more details.

During this application, their supervisor followed behind the application truck making observations about the weather conditions, and making sure the brine solution was streaming properly onto the pavement. He indicated he had his windshield wipers on intermittent speed and a light misting-type drizzle was falling.[12] He recorded temperatures that ranged from 30-32 degrees, but did not notice any ice accumulations on the mainline lanes or on any of the approximate 20 bridges on I-20 in this treatment area. Since no problems areas had yet emerged the decision not to place any type of additional warning was executed. A large permanent Dynamic message sign is located about Mile Post 82 or about 23 miles west of the accident area. Again, since no problems had yet emerged, the sign was not activated.

Temperatures recorded in the area varied between 30-32 degrees F from 6 p.m. on Tuesday evening until the accident occurred the following morning. The national Weather Service (NWS) issued an Area Forecast Discussion (AFD) at 0357 CST noting the presence of light freezing fog and freezing drizzle across the area. For more detailed weather information see Meteorologists Factual Weather Report.

The following information was obtained about the pavement conditions from driver/witnesses that drove through the accident area travelling westbound on Interstate 20 and from the drivers of the four accident-involved vehicles that were traveling eastbound on I-20:

Westbound Driver/Witnesses –

[12] The Federal Meteorological Handbook (FMH) No.1 defines light rain as, "Small liquid droplets falling at a rate such that individual drops are easily detectable splashing from a wet surface." Include drizzle in this category.

1. A westbound pick-up truck drove through the accident area about three to five minutes before the bus crash. The driver indicated he was driving 75 mph and the traction was good.

2. A pick-up truck driver that passed through the accident area moments before the bus crash stated he driving about 65 mph and traction was good.

3. A Truck tractor semi-trailer driver that passed through moments after the bus crash said he was traveling 55-60 mph and braked hard without losing traction.

Eastbound Driver/Witness

1. An eastbound pick-up truck driver lost control on the bridge, crossed the median, struck the damaged westbound guardrail on the south side of the high then crossed the westbound lanes and collided with and overrode the guardrail on the north side of the highway. The driver indicated the pavement was damp but bare, with no accumulation of ice, snow, or standing water. He said when he departed Monahans that morning it was 36 degrees by his truck temperature gauge and that he never checked it again. He said his first indication of any icing problem was when he spun out on the bridge and went out of control.

6.1 TXDOT Snow and Ice Control Operations Manual

The statewide snow and ice control operations manual provides the following guidance about the application of liquid anti-icing compounds:

A variety of factors should be taken into account when deciding upon a course of action to treat roadways during a winter storm event. Product application combinations are chosen after maintenance personnel have evaluated many factors including, but not limited to:

- air temperature
- pavement temperature
- humidity levels
- dew point temperatures
- cloud cover vs. sunshine
- type and rate of precipitation
- weather forecast
- weather radar data
- traffic conditions (volume, route, etc.).

Operational treatments are continuously evaluated before, during and after a winter storm. Road treatment and applications are modified through all phases of a storm based on careful analysis of intensity, duration and type of precipitation.

Whereas anti-icing operations are conducted to prevent the formation or development of bonded snow and ice for easy removal, deicing operations are performed to break the bond of already bonded snow and ice. The AASHTO Winter Roadway Maintenance Computer- Based Training provides comprehensive training in all aspects of winter roadway maintenance. Each district has a copy. Check with your Director of Maintenance or Operations to locate your district's copy.It is important for maintenance personnel to understand the uses and limitations of each of the materials and techniques explained in this chapter.

When to Use Liquid Chemicals

There are advantages for using liquids at pavement temperatures of 23 degrees Fahrenheit and above. These include:

A bond breaking film is created between the pavement and any buildup of snow and ice that may occur allowing easier removal of the snow or ice

Reducing time and effort required to plow and clear roadways.

However, this means putting the chemical down before enough snow has accumulated to prevent the chemical from reaching the pavement or from being excessively diluted. In some situations it may be beneficial to remove snow and slush from the road using traditional mechanical methods.

Traffic plays an important part in the use of liquid chemicals. They should not be applied as a fog on the entire roadway. Instead, liquid chemicals should be applied by the drip method, allowing traffic to track the material across the roadway. Therefore, there must be sufficient traffic volume to track and spread the material on the road.

Liquids can be used at pavement temperatures below 23 degrees Fahrenheit by following the manufacturer’s suggested rate of application for varying conditions. The cost effectiveness of using liquid chemicals at lower pavement temperatures needs to be evaluated on a case by case basis.

Application should be made by stream nozzles allowing traffic to spread the material over the pavement surface. Fan nozzles should not be used due to the possibility of creating a slick pavement situation. An example of a stream nozzle applicator follows in figure 2.

Figure 2 *Application of liquid chemical by stream nozzles.*

Section 5 — Recommendations for Use of Liquid Chemicals

Using for Snow Storms

For snowstorms, initial liquid applications can be made either as a pretreatment in advance of the storm or as an early-storm treatment, (i.e. soon after snowfall has begun and/or when the pavement temperature is dropping toward freezing).

Pretreatment

A pretreatment can be made prior to a storm, as long as the storm does not start out with above freezing temperatures and rain, washing the chemical away.

Benefits from liquid pretreatments can include higher friction and better pavement conditions early in a storm. These benefits are generally short-lived and should not be expected over a long period. Subsequent chemical applications should be made as soon as conditions begin to deteriorate. Pre-treatments can be thought of as "buying time" in the early stages of a storm until subsequent chemical applications become effective.

Early-Storm Treatment

In the case of early-storm treatment, the application may be made onto dry, wet, light slush, or lightly snow covered pavement. Late applications onto pavements with more than a light covering of slush or snow can result in excessive dilution of the chemical, lowering its effectiveness.

Preventing Black Ice

To prevent the formation of frost or black ice, the chemical should be applied before ice is expected to form so the water component of the chemical will evaporate or be removed by traffic action. This will leave only the chemical on the road surface and result in the greatest concentration when frost or black ice conditions would otherwise occur.

Use Caution During Liquid Precipitation Storms

The use of a liquid pretreatment is questionable during an event which has rain prior to freezing temperatures due to potential loss of pretreatment material.

Salt/Brine

Brine is a solution of salt (Sodium Chloride-NaCl) in water. There are two primary sources of salt: solar salt and rock salt. Rock salt exists naturally across the world and is mined for use in numerous industries. Brine also occurs naturally across the world and is a by-product of many industrial processes, such as oil and gas exploration. Brine solutions range from about 3.5% (a typical concentration of seawater) up to about 26% (a typical saturated solution).

Anti-icing should be the first in a series of treatment strategies for winter storms. Anti-icing is a proactive approach and one of the most cost-effective and environmentally safe practices in winter road maintenance. Anti-icing, when performed correctly, prevents ice and snow from bonding to the pavement, thus achieving one of the most important goals of winter storm management. Once frozen precipitation has bonded to the pavement, the cost to break that bond in terms of materials, equipment, and labor increases substantially.

Brine can be used for anti-icing or de-icing, but its optimal use is in anti-icing operations. Brine produces similar results as other anti-icing chemicals, but at a fraction of the cost. Brine can be applied with typical TX DOT equipment, such as modified herbicide trucks. Brine is applied at rates ranging from 30-60 gallons per lane mile at a 23.3 percent solution. Brine is applied with stream nozzles similar to other liquid anti-icing chemicals.

Currently, TX DOT is using brine on a wider scale due to the cost and ease of use. Storage is also easier since brine does not have to be re-circulated when stored for long periods. TX DOT has constructed five 500 cubic yard salt barns in strategic locations to help support this program.

When questioned about maintenance personnel being trained using AASHTO materials TXDOT indicated this was the first time the Odessa District had used the liquid anti-icing materials and none of the maintenance personnel had been trained using AASHTO's 24-hour long winter maintenance computerized training system. The Odessa Maintenance district is responsible for 12 counties and has 13 maintenance sections located throughout the district with 168 maintenance section employees.

6.2 NCHRP 527 GUIDELINES

In figure 3 below which is Table A-5 in NCHRP 526 it can be seen that with a pavement temperature of 30-32 degrees F, a high dilution potential since the cycle time exceeded 3 hours, no ice pavement bond at the time of treatment, that the application guide recommends an application rate of 70 gallons per lane mile of liquid sodium chloride or 160 pounds per lane mile of solid pre-wetted sodium chloride.

TABLE A-5 Application rates for solid, prewetted solid, and liquid sodium chloride

Pavement Temperature (°F)	Adjusted dilution potential	Ice pavement bond	Application rate Solid (1) lb/LM	Application rate Liquid (2) gal/LM
Over 32° F	Low	No	90 (3)	40 (3)
		Yes	200	NR (4)
	Medium	No	100 (3)	44 (3)
		Yes	225	NR (4)
	High	No	110 (3)	48 (3)
		Yes	250	NR (4)
32 to 30	Low	No	130	57
		Yes	275	NR (4)
	Medium	No	150	66
		Yes	300	NR (4)
	High	No	160	70
		Yes	325	NR (4)
30 to 25	Low	No	170	74
		Yes	350	NR (4)
	Medium	No	180	79
		Yes	375	NR (4)
	High	No	190	83
		Yes	400	NR (4)
25 to 20	Low	No	200	87
		Yes	425	NR (4)
	Medium	No	210	92
		Yes	450	NR (4)
	High	No	220	96
		Yes	475	NR
20 to 15	Low	No	230	NR
		Yes	500	NR
	Medium	No	240	NR
		Yes	525	NR
	High	No	250	NR
		Yes	550	NR
15 to 10	Low	No	260	NR
		Yes	575	NR
	Medium	No	270	NR
		Yes	600	NR
	High	No	280	NR
		Yes	625	NR
Below 10°F	A. If unbonded, try mechanical removal without chemical. B. If bonded, apply chemical at 700 lb/LM. Plow when slushy. Repeat as necessary. C. Apply abrasives as necessary.			

NR = Not recommended.

Specific Notes:
1. Values for "solid" also apply to prewet solid and include the equivalent dry chemical weight in prewetting solutions.
2. Liquid values are shown for the 23-percent concentration solution.
3. In unbonded, try mechanical removal without applying chemicals. If pretreating, use this application rate.
4. If very thin ice, liquids may be applied at the unbonded rates.

General Notes:
5. These application rates are starting points. Local experience should refine these recommendations.
6. Prewetting chemicals should allow application rates to be reduced by up to about 20% depending on such primary factors as spread pattern and spreading speed.
7. Application rates for chemicals other than sodium chloride will need to be adjusted using the equivalent application rates shown in Table A-6.
8. Before applying any ice control chemical, the surface should be cleared of as much snow and ice as possible.

Figure 3

Winter weather management specialists from the FHWA were also consulted concerning TXDOTs' snow and ice control execution. They indicated TXDOT had a plan in place that was consistent with AASHTOs' in NCHRP 526, but cautioned that if the mist had turned to a light rain then the pre-treatment could wash away.

7. U.S. Snow and Ice Control Efforts

Maintenance and operation of U.S. roadways cost approximately 31.8 billion dollars annually, of which costs for winter road maintenance are over 2.7 billion per year.[13] One third of winter road maintenance expenditures are for treatment materials.

Winter maintenance involves controlling snow and ice with mobile techniques or fixed systems. Mobile strategies include plowing snow, spreading abrasives, such as sand, ash and crushed stone, to improve vehicle traction, and applying anti-icing or de-icing chemicals to lower the pavement freezing point and minimize the bonding of snow and ice to the pavement surfaces. In regions that have heavy snowfall maintenance workers often erect snow fences adjacent to roadsides to reduce blowing and drifting snow. Surveys by AASHTO show that over 40 states are now using anti-icing strategies. Approximately 23 states also use fixed anti-icing/de-icing systems on bridges, sharp curves and other locations prone to icing.

Fixed systems typically consist of controller units, tanks, pumps, conduit, and nozzles that dispense chemicals on a pre-determined area of pavement. The applications can be manually activated or automatically dispensed based on an Environmental Sensor Station (ESS).

The states coordinate their efforts through AASHTO's Snow and Ice Cooperative Program (SICOP) for implementation of advancements and training. SICOP has developed an interactive Road Weather Information System (RWIS)/Anti-icing training program. This computer based training consists of seven lessons for a combined total of approximately 24 hours of training:

1. Introduction to anti-icing and winter maintenance
2. Winter road maintenance management
3. Winter roadway hazards and principles of overcoming them
4. Weather basics
5. Weather and roadway monitoring for anti-icing decisions
6. Computer access to road weather information
7. Anti-icing practice in winter maintenance operations

The national training program is being used by 90% of the Snowbelt states, the

[13] FHWA, "Highway Statistics Publications, 2011, Table FA-3 and FA-2," Office of Highway Policy Information, http://www.fhwa.dot.gov/policy/ohpi/hss/hsspubs.cfm

American Public Works Association (APWA) and the National Association of County Engineers (NACE). The computer based training systems were distributed to users in April 2003.

7.1 Weather Information

Maintenance personnel use road weather information to assess the nature and magnitude of snow and ice threats, make operational decisions about road treatment strategies, and manage material resources. States and local agencies use various sources to obtain road weather information and forecasts including the National Weather service (NWS), private sector weather service providers, RWIS, and thermal mapping. The NWS is a Federal agency operated by the National Oceanographic and Atmospheric administration (NOAA). The NWS is chartered with weather forecasting; issuing storm warnings, disseminating weather and flood warnings for the benefit of agriculture, commerce and navigation, and taking meteorological observations to record the climatic conditions of the U.S.

In practice, the NWS provides general weather information and warnings for public safety. NWS products include observations from surface sensors, Doppler radars, geostationary and polar satellites; national forecasts and numerical model guidance from the National Centers for Environmental Prediction (NCEP) along with regional forecasts and warnings from 125 Weather Forecast offices and 13 River Forecast Centers.

Generally, the observations provided by the NWS are inadequate for characterizing the details of the road environment such as pavement conditions and localized visibility conditions. Because it is not the mission of the NWS to provide customized forecasts to support operational decision making, tailored road weather information is often provided by private sector service providers who are contracted to provide route-specific "nowcasting" services.

NOAA has embraced surface transportation weather by establishing a Surface Weather Program in its Commerce and Transportation Goal Team, a component of the agency's budgeting process. Additionally, NOAA has added Surface Transportation Weather to its Strategic Plan. Under this goal, NOAA is partnering with the FHWA Road Weather Management Program to improve safety and make more efficient the movement of people and goods on the Nation's highways. In 2007, NOAA and FHWA conducted the 3rd National Surface Transportation Weather Symposium to provide a forum for members of the surface transportation operations, research and user communities to work together to enhance collaboration and partnerships to improve surface transportation weather products.

The FHWA has been active in trying to integrate observations from state-owned Environmental Sensor Stations (ESS) with NWS surface observations. ESS are employed along roadways and other transportation facilities to provide their agencies with observations of surface weather and pavement conditions. Most ESS are deployed as field components of RWIS. RWIS has been widely used in the U.S. since the 1980's. There are over 2,500 ESS in the U.S. Over 2,000 of these are part of State-owner RWIS. See Figure 4 for state-owned Environmental Sensor Stations as of 2008.

As of 2014 TXDOT has the following Environmental Sensor Stations on Texas roads: Shown in Figure 4

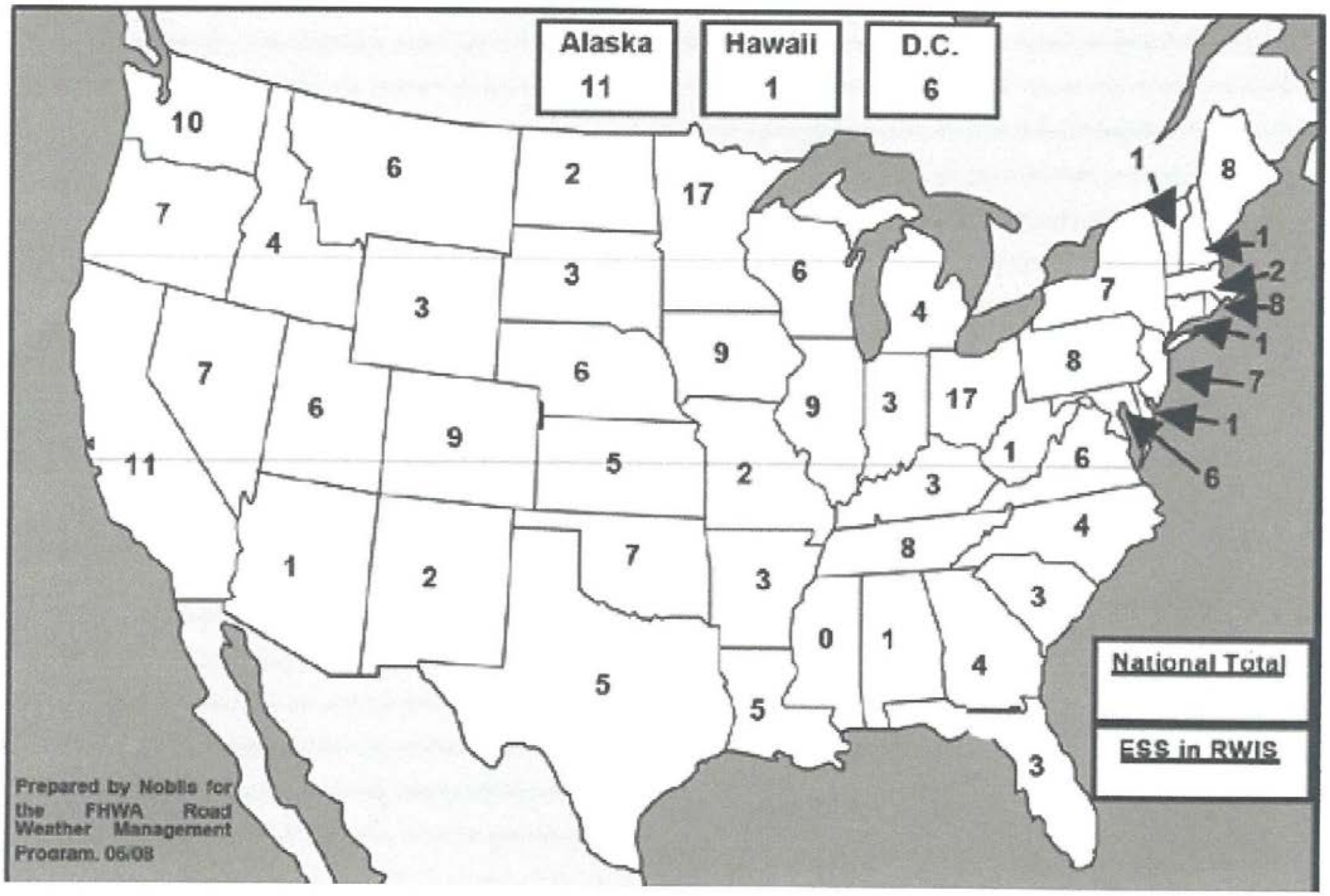
TxDOT Envoronmental Sensor Stations Inventory

Updated: 3/16/2015

					# of Sensors within each ESS & Broken Down by the Environmental Condition Being Monitored									
Nbr	Abrvn	Name	Total # of ESS in The District	ESS Location(s) in The District	Road Temp	Road Moisture	Air Temp	WindSpeed	Wind Direction	Precipitation	Humidity	Flood Warning	Visibility	District Contact
03	WFS	Wichita Falls	5	I44NB at SP325	1		1	1						Randy Jenkins
				I44SB at Wichita River	1							1		
				I44NB Loyd Ruby Flyover	1									
				I44NB Loyd Ruby Flyover	1									
				US82 SB at US281 Split	1		1	1						
05	LBB	Lubbock	3	IH27/N. LP289 (Lubbock)								3		Ricky Lawrence
06	ODA	Odessa	1	SL 250 at Tremont Ave (Midland, TX)	1			1					1	Kelli Williams
12	HOU	Houston	86	*Unconfirmed*	48		48	48	48	48		38		Dock Gee
15	SAT	San Antonio	26	*Unconfirmed*								26		Dale Picha
18	DAL	Dallas	2	IH35E/W Merge (Denton)	1		1	1	1	1	1			Joe Hunt
				IH35E at US287 (Waxahachie)	1		1	1	1	1	1			
19	ATL	Atlanta	4	*Unconfirmed*	4									Gary Barnett
21	PHR	Pharr	1	SH 100 (Queen Isabella Causeway) Bridge connecting Port Isabel (Mainland) with South Padre Island	1	1	1	1	1	1				Jesus Leal
22	LRD	Laredo	5	SL480 (Eagle Pass) #1								1		Jose Saldan
				SL480 (Eagle Pass) #2								1		
				US90 (Del Rio) #1								1		
				US90 (Del Rio) #2								1		
				US90 (Del Rio) #3								1		
TxDOT Statewide Total			133		61	1	53	54	51	51	2	73	1	

Records highlighted in Yellow indicate that quantities provided during the ITS Euipment Inventory taken at the end of 2014. These records were not verified during a subsequent inventory request issued in March 2015.

Figure 4



ESS owned by State Transportation Agencies

Figure 5

Maintenance personnel can also use thermal mapping to obtain information on pavement temperatures. Thermal mapping involves the use of infrared sensors which can be hand-held, vehicle mounted, or satellite-based. Thermal mapping data have been used to optimize siting of ESS, predict pavement temperatures in locations without ESS temperatures, and plan road treatment strategies.

7.2 On-going Research to Improve Weather Management

Since 2000, the FHWA Road Weather Management Program has sponsored the development of a guidance tool for winter road maintenance decision makers. The tool, known as Maintenance Decision Support System (MDSS) prototype, was created by a consortium of U.S. national laboratories with significant input and feedback from numerous state DOT's and commercial weather information providers. The MDSS capitalizes on existing road weather data sources, fuses data to present integrated road weather observations and predictions, and generates recommendations on road treatment strategies with anticipated consequences of action or inaction. Treatment recommendations are based on standard practices for effective winter road maintenance, such as anti-icing, de-icing, plowing and sanding. The MDSS prototype was field tested during the winters of 2003 and 2004 in the State of Iowa. The FHWA has cultivated relationships with private vendors to foster integration of prototype modules into their product lines and development of applications tailored to the needs of state DOT's. Currently, MDSS technologies are being incorporated into the product generation routines of several private sector companies.[14]

By 2004, MDSS technologies were mature enough for private vendors to incorporate MDSS capabilities into their product lines for State DOT clients. By 2007, 21 state DOT's were using or developing MDSS tools. Thirteen states have joined the MDSS Pooled Fund Study led by South Dakota DOT to develop an enhanced version based on the federal MDSS prototype, while others are in the process of procuring the software or have contracted with private vendors. In 2008, the FHWA released an MDSS Deployment Guide(http:www.itsdocs.fhwa.dot.gov/JPODOCS//REPTS_TE/14439.htm) From 2007 to 2009 FHWA conducted evaluations of operational MDSS applications being used by the pooled fund states, the Maine DOT, and the City and County of Denver, Colorado

Additionally, in late 2004, the Road Weather Management Program began a multi-year initiative called Clarus. The Clarus initiative is an effort to develop and demonstrate an integrated surface transportation weather observation data management system, and to establish a partnership to create a Nationwide Surface Transportation Weather Observing and Forecasting System.

From 2004 to 2006, the U.S. DOT developed the Clarus advanced data management system that assimilates all ESS observations across the United States and provides quality checked road weather observations for any user. The Clarus System can be accessed at www.clarus-system.com. The system is an experimental product that is being used for evaluation and demonstration purposes. The transition of the Clarus system functionality to the NWS operational system was expected to take place in 2011.

The U.S. DOT Joint Program Office (JPO) for Intelligent Transportation Systems is also sponsoring research for road weather systems. Foundational research on the characteristics and feasibility of using vehicles as environmental sensors was performed.

In order to enhance observation capabilities and define requirements for road weather observing systems, the Road Weather management Program partnered with the Aurora Pooled Fund Program, and the AASHTO Snow and Ice Cooperative Program to develop siting

[14] National Center for Atmospheric Research (NCAR) "Maintenance Decision Support System (MDSS) Website" , Research Applications Programs, www.rap.ucar.edu/projects/rdwx-mdss/

guidelines for ESS in the roadway environment. The RWIS ESS Siting Gu8idelines, released in April 2005, provide a set of recommendations to support uniform siting of sensor stations that collect road and weather observations for RWIS. In 2006, the Road Weather Management Program initiated a project to implement and evaluate the guidelines in a field environment to ensure that the recommendations are realistic and that the contents are credible, understandable, and useful to the deployers. The results of the study are being used to refine the guidelines.

The Road Weather Management Program also sponsored a research project to study how weather information is integrated into operations at 38 Traffic Management Centers (TMC's). In general, very limited integration and application of weather information for TMC operations were observed. Clearly there was a need to advance the state of the practice and help agencies overcome the challenges associated with weather integration in TMC's. As in this case, if real-time freezing temperatures had been integrated into the structure, real-time warnings could have been displayed on the Large DMS sign 20 miles in advance of the accident area.

E. DOCKET MATERIAL

The following attachments and photographs are included in the docket for this investigation:

LIST OF ATTACHMENTS

Highway Attachment 1 - (Interview Summaries)

Highway Attachment 2 - (Police Reports of Accidents)

LIST OF PHOTOGRAPHS

Highway Factors Photo 1 - (Westbound approach on I-20 to accident site)

Highway Factors Photo 2 - (Additional westbound approach on I-20 to accident site)

Highway Factors Photo 3 - (Eastbound approach on I-20 to Bridge where passenger vehicles lost control)

Highway Factors Photo 4 - (Additional eastbound approach to bridge structure

Highway Factors Photo 5 - (Aerial View of Accident Site, Courtesy of DPS)

Highway Factors Photo 6 - (Additional aerial view of accident site

Highway Factors Photos 7-9– (View of Damage to guard rail after January 13th accident)

Highway Factors Photos 10-12 – (View of cars in pavement from movement of guard rail during impact).

END OF REPORT

David S. Rayburn
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