ICE DETECTION SYSTEMS

Experimental Feature
Final Report

by

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DISCLAIMER

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INTRODUCTION

In the fall of 1980, an experimental ice detection system was installed on the Fremont Bridge in Portland, Oregon. This bridge, which carries I-405 over the Willamette River, has a history of icing problems when the deck is wet and the temperature hovers near freezing. The upper deck of the main span is especially vulnerable because of its height and thin deck section. The ice detection system allows bridge surface conditions and temperatures to be monitored constantly from a remote location, and assists maintenance workers in their response to the deicing needs of the bridge.

The experimental feature of this project was to evaluate, under actual field conditions, the mechanical and electrical reliability of an ice detection system and the validity of its output in Oregon.

SYSTEM EQUIPMENT

The system to be evaluated was originally the Surface Systems Inc. (SSI) "Surface Condition Analyzer (SCAN) System 16". It included eight unheated surface sensors, two atmospheric sensors, two remote processor units (RPU's), one central processor unit (CPU), two ADDS video terminals (model VPT A2) and an Okidata M82A Micro-line printer. The terminals and printer are standard off-the-shelf models selected and modified by SSI.

In April 1983, the System 16 Model CPU was replaced with a model 16EF (Extended Format) CPU. Replacement was not due to any equipment problems, but to expand the system's capacity. The 16EF can ultimately handle data from 32 RPU's, allowing for future monitoring on additional structures.

The Sensors

The system's sensors are 5 1/4 inches in diameter (see Diagram 1) and are installed in the upper deck and the approach spans of the Fremont bridge. The color shade and construction material of the sensors approximate that of the surface to ensure nearly identical absorption and dissipation of heat. These sensors monitor surface conditions by measuring the capacitance and conductance of the precipitant on the sensor head. Surface temperature is measured by a thermistor in the sensor head. Additional atmospheric sensors monitor wind direction and speed, relative humidity, and air temperature. The dew point* is calculated in the CPU by combining data from the surface and atmospheric sensors.

The Remote Processor Units

All data collected by the sensors are transmitted by cables through the deck to one of two Remote Processor Units (RPU's) located under the deck on opposite ends of the bridge. Each RPU receives data from four sensors in the form of a DC analog signal. The RPU processes this into a digital signal which is then relayed by microwave to the Central Processor Unit (CPU) located at the Highway Division's District 2B Maintenance office in Milwaukee, Oregon (see Figure 1).

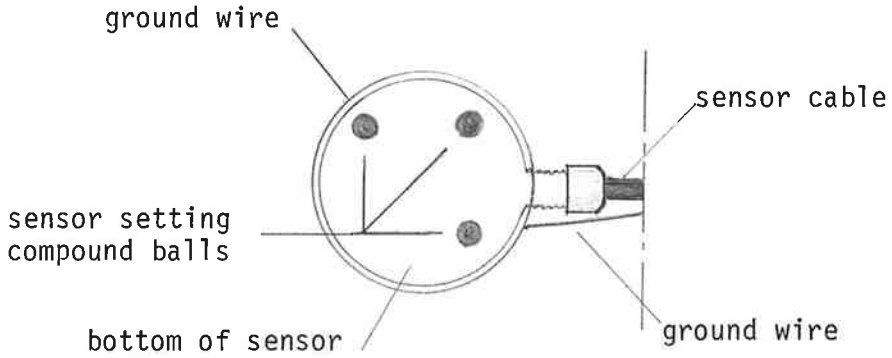
The Central Processor Unit

The CPU analyzes, stores and formats the data received from the RPU's and displays it on terminals located in both the Highway Division's office in Milwaukee and at the Columbia River Interstate Drawbridge operator's house (see Figure 2). The drawbridge house is staffed 24 hours a day, allowing for nonstop monitoring of the system. The terminals display RPU and sensor locations, air and surface temperatures, dewpoint temperature, relative humidity, wind direction and velocity, and the current date and time. The system updates the data on these screens every 15 seconds.

All information displayed on the screen can be printed on command in various formats depending on desired information (see Appendix, pages A-2 through A-7).

* The dew point represents the temperature at which the air is saturated with moisture. If air temperature reaches the dew point, moisture such as rain, snow, sleet or fog is likely. Bridge deck surfaces quite often reach a surface temperature lower than the air temperature. If the bridge deck reaches the dew point temperature, moisture or frost (black ice) may form.

PLAN VIEW



CROSS-SECTION VIEW

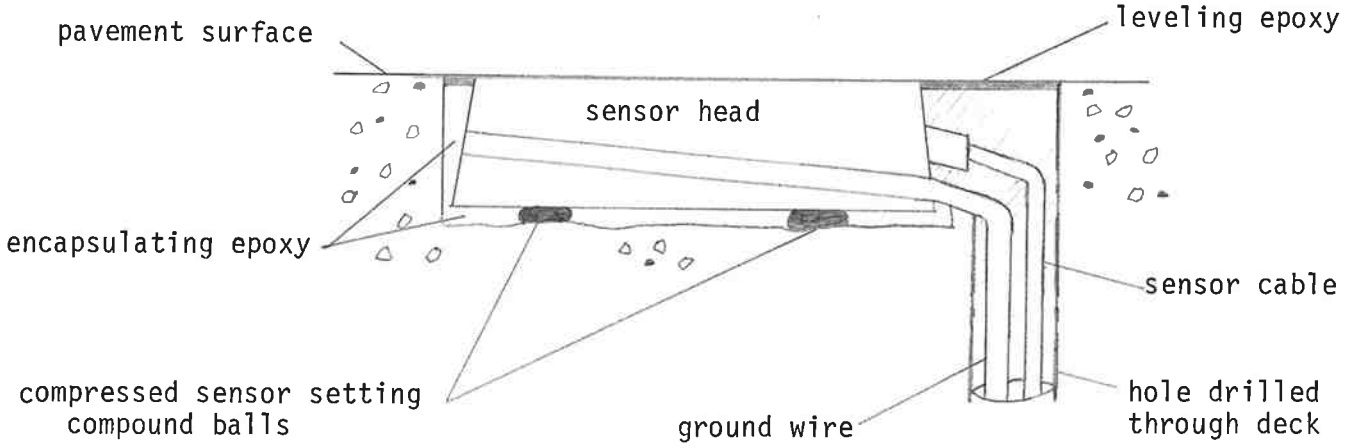


FIGURE 1

Central Processor Unit (CPU)

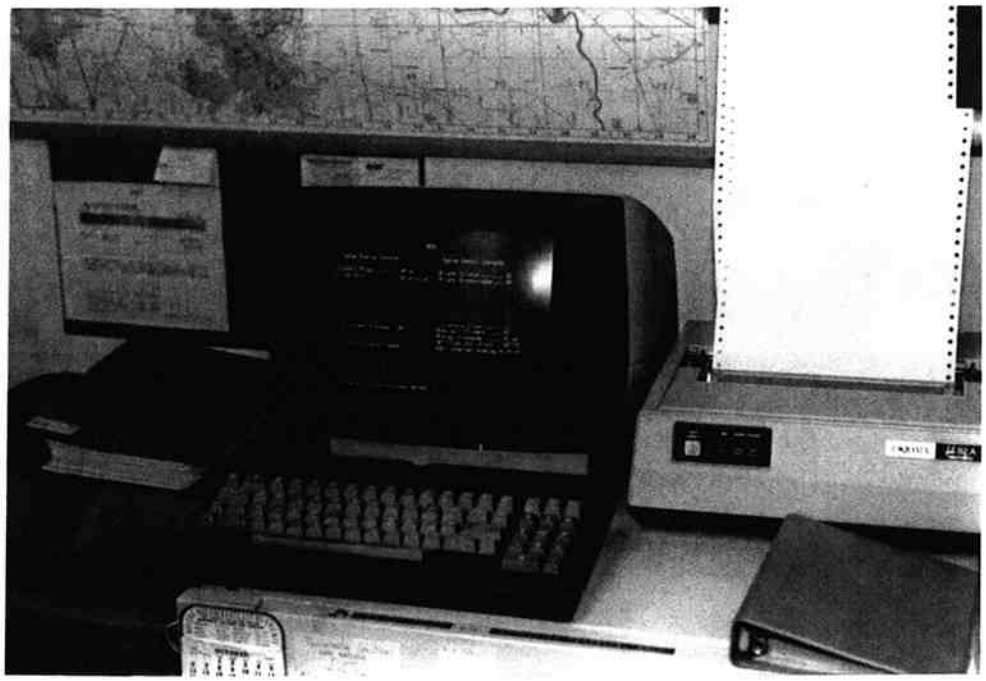


FIGURE 2

CPU Terminal and Printer

The surface condition is reported as dry, wet, dew, frost, moisture, absorption or snow/ice alert for each of the eight sensors (see Appendix, page A-1).

"Snow/ice alert" (previously designated as surface critical") indicates the presence of light frost or conditions likely to pose problems for motorists. "Frost" indicates the presence of ice or frost that is likely to cause hazardous driving conditions. The amount of ice or frost formation needed to change "wet" to "alert" is preset by the manufacturer but the sensitivity levels are adjustable and may be reset to satisfy the needs of any particular location.

The system retains data for a period of 12 hours only. Graphs of individual sensor temperatures and conditions can only be printed for the current hour. If permanent data records are desired, it is necessary to make hard copies by screen printing the history page and the individual graph pages.

INSTALLATION

Installation of the system began in October, 1980, with the construction of a building to house the microwave transmitter equipment. Microwave transmitting equipment was subsequently installed by OSHD Radio Technicians. During January and February, 1981, the atmospheric sensors, surface sensors and their associated sensor cables were installed in the upper deck and approach spans of the bridge. All building, sensor and cable work was performed by OSHD Building and Bridge crews.

For installation of each sensor, Sensor Setting Compound was rolled into three balls, then stuck to the bottom of the sensor in a tripod pattern. A ground wire was wrapped around the sensor head and passed through the bridge deck with the sensor cable (See Figures 3 and 4) and the sensor placed into a 6" circular cavity, with the head slightly above the surrounding pavement. Using a straight-edged board, the sensor head was then pressed flush with the pavement surface (Figures 5 and 6).

Encapsulating epoxy was injected into the sensor cavity so that it flowed under and around the sensor, filling the cavity to within 1/8" of the surface (Figures 7 and 8). After it set up (approximately 15 to 45 minutes) leveling epoxy was troweled around each sensor (Figures 9 and 10) and allowed to set slightly before a thin layer of sand was applied (Figure 11). This sand was allowed to "cure" into the epoxy.

No problems were encountered during the installation of the deck surface sensors or with the placement of detector cables between the sensors and the RPU's. Work was completed in July, 1981, when the system's supplier installed and tested the SCAN 16 CPU.

FIGURE 3

6" circular cavity before sensor is placed.

FIGURE 4

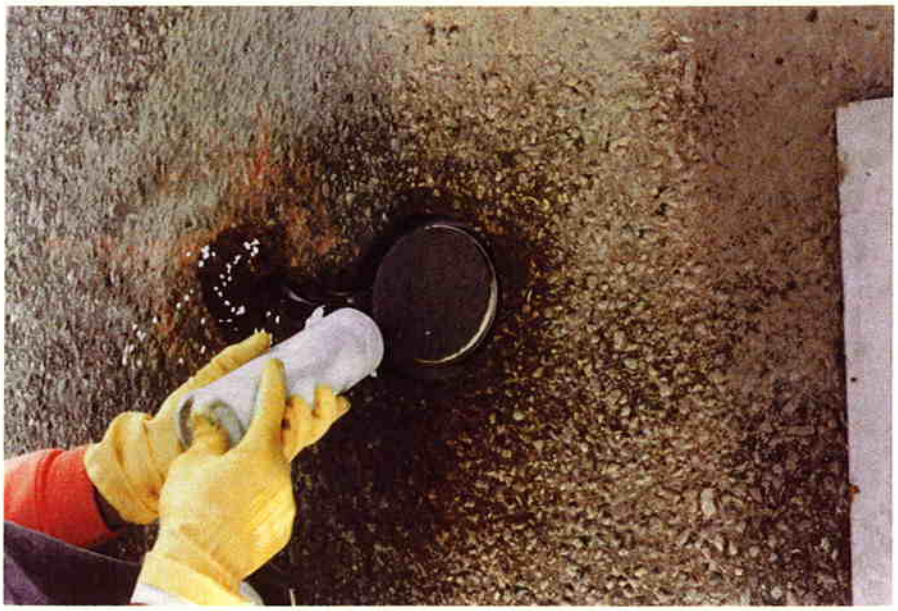
Sensor cable, along with ground wire, is passed through deck.

FIGURE 5

Placing sensor in cavity

FIGURE 6

Sensor flush with pavement surface. Note ground wire wrapped around sensor head.



FIGURES 7 and 8

Encapsulating epoxy is injected into sensor cavity so that it flows under and around the sensor.

FIGURE 9

Leveling epoxy was troweled around each sensor...

FIGURE 10

...and allowed to set slightly...

FIGURE 11

...before a thin layer of sand was applied. This sand was allowed to "cure" into the epoxy.

PERFORMANCE and EVALUATION

Evaluations were made by comparing system-recorded conditions with actual field observations. This was an additional task for maintenance personnel, so field readings were not always concurrent with system recordings. However, it was found the two readings agreed when the data was recorded simultaneously.

During the summer and fall months of 1981, operation of the system was satisfactory except for some minor problems resulting from the video monitor unit being located too far from the CPU. These were corrected by the installation of additional software and by moving the video display unit closer to the CPU.

During the winter of 1981-82, several problems developed. The printer units furnished with the equipment did not perform well and required replacement twice during the season. Also, on various occasions, the RPU's did not restart after momentary power losses. The interruptions were investigated but the cause could not be identified. To correct the problem, software was designed to restart the RPU's when any power loss occurred.

The system performed as anticipated during the winter of 1982-83, with no equipment problems or breakdowns. However, this was a relatively mild winter, and although the system data was accurate when compared to manual field checks, state officials felt it was necessary to continue monitoring the system to get performance data during periods of more severe weather.

Monitoring of the ice detection system continued through the winters of 1983-84 and 1984-85, and although severe weather conditions were infrequent, the system performed well (see Appendix, pages A-8 through A-11).

In 1983, two additional sites utilizing one RPU and two sensors each were added to the system. These sites are located on the Glenn Jackson Bridge, which spans the Columbia River between Oregon and Washington, and on the Halsey Street structure at the intersection of I-205 and I-80 in Portland. The installation of the Extended Format CPU enables these additions to relay data from the RPU's on request via dial telephone lines instead of microwave. The telephone communication reduced the installation costs and has also decreased operating costs.

DAMAGE

The system is visually inspected for damage each fall and spring. To date, no major damage related to traffic or weather has been detected in any of the system components. Minor cracking and flaking has been found in the epoxy surrounding the sensor heads in three locations, but this damage does not appear to affect system's operation.

CONCLUSION

The benefits of this system are many. Along with the obvious advantage of improved safety, there are also savings of money and manpower. Previously, during threatening weather, personnel were assigned to monitor the bridge's surface conditions. This would often involve premium pay for shift changes or working overtime. The system has proven reliable and physical monitoring is no longer necessary. This allows personnel to monitor other critical areas.

Two unanticipated benefits were received from this system. Wind sensors in the system accurately relayed wind velocities, enabling the state to close the bridge to mobile home traffic during periods of high winds. The system has also provided proof of existing deck conditions when accidents have occurred. This has helped with lawsuits against the state when motorists have claimed hazardous deck conditions were present and safety measures were not implemented by maintenance personnel.

The three full seasons of trouble-free operation and the comparison of visual observations with printout data have demonstrated the validity and reliability of the system. However, additional evaluation under different climatic conditions could prove advantageous, and installations of the advanced SCAN System 16EF are now scheduled in both Southern and Central Oregon. While these advanced systems perform essentially the same functions as the system evaluated in this report, they have been modified to utilize off-the-shelf IBM PC computers for the CPU. The computers will also have unused capacity available to perform additional, unrelated tasks.

Status Titles

The Status Titles listed below describe the surface condition at a surface sensor location. The titles and their descriptions are:

DRY: An absence of precipitation or moisture on the surface sensor.

WET: Precipitation/moisture present in liquid form on the surface, and surface temperature above 32 degrees Fahrenheit (0 degrees Celsius).

DEW: Moisture present on surface, the dew point has been reached and surface temperature above 32 degrees F.

FROST: Frost present on surface, the dew point has been reached and surface temperature below 32 degrees F.

FROST ABOVE DEW POINT: Frost conditions have been reached and the surface temperature is no longer at or below dew point.

ABSORPTION: Moisture present on surface in an insufficient amount to present a hazard.

ABSORPTION AT DEW POINT: Moisture present on surface in an insufficient amount to present a hazard and dew point has been reached.

CHEMICAL WET: Precipitation/moisture present in liquid form on the surface and surface temperature at or below 32 degrees F.

SNOW/ICE ALERT: a) Precipitation/moisture in liquid form on the surface starting to freeze.
b) Precipitation/moisture on the surface which has frozen.

SENSOR DOWN: An inoperative surface sensor.

COMMUNICATION FAILURE: Disrupted communication between the RPU and CPU.

Menu Page

MENU

System Display Commands

```
(H)istory (P)age ......... HP sn
(G)raph (A)ir ............ GA sn a1 a2
(G)raph (S)urface ........ GS sn a1 a2
  a1 = Time scale; 1-24 hours
  a2 = Temp increment; 1-10 F / .5-9.9C
(R)equest (S)tatus page .. RS sn
(H)old display ........... H
(E)xit display ........... E
(P)rint current page...... P
(D)isplay user (M)essage   DM

  sn = desired sensor number
```

System Control Commands

```
(A)larm (S)tatus ......... AS
(A)larm (A)cknowledge ... AA
(T)ime and (D)ate ........ TD
(C)all (S)ensor ......... CS sn
(F)ormat (O)ptions ...... FO
  (C)hange (D)ata ....... CD
  (H)istory (P)age ...... HP
  (S)tatus (P)age (1) ... SP1
  (S)ummary (P)age (2) .. SP2
(R)pu call (T)imers ..... RT
(R)elay (C)ommands ...... RC sn
(SET)(T)op (O)f (F)orm .. SETTOF
(ESC) interrupt display or print
```

STATUS PAGE

for RPU #3

Oregon Dept. of Transportation Status Page Time 10:29 December 18, 1985
Power on at: 07:32 on 12/11/85
Glen Jackson Bridge RPU # 3 Last report: 10:29 on 12/18/85

Atmospheric conditions

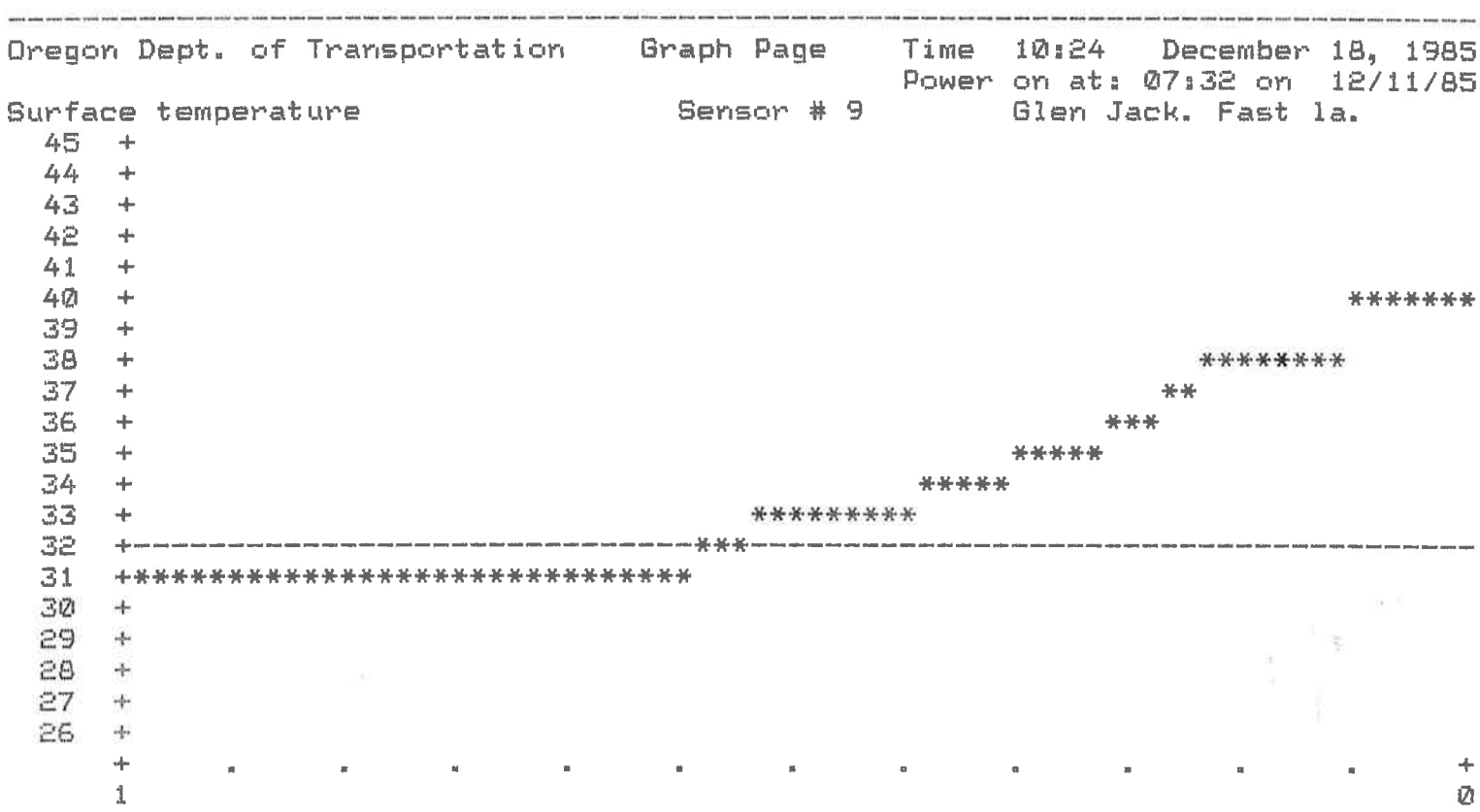
Air Temperature	Dew point Temperature	Relative Humidity	Wind Dir. Min.	Wind Dir. Avg.	Wind Dir. Max.	Wind Speed Avg.	Wind Speed Gust
33	* 33.0	100				Calm	Calm

Surface conditions

Sensor No.	Sensor location	Status	Precip	Surface Temperature	Chem. Factor
9	Glen Jack. Fast la.	Dry	Y	41	
10	Glen Jack. Slow la.	Dry	Y	41	

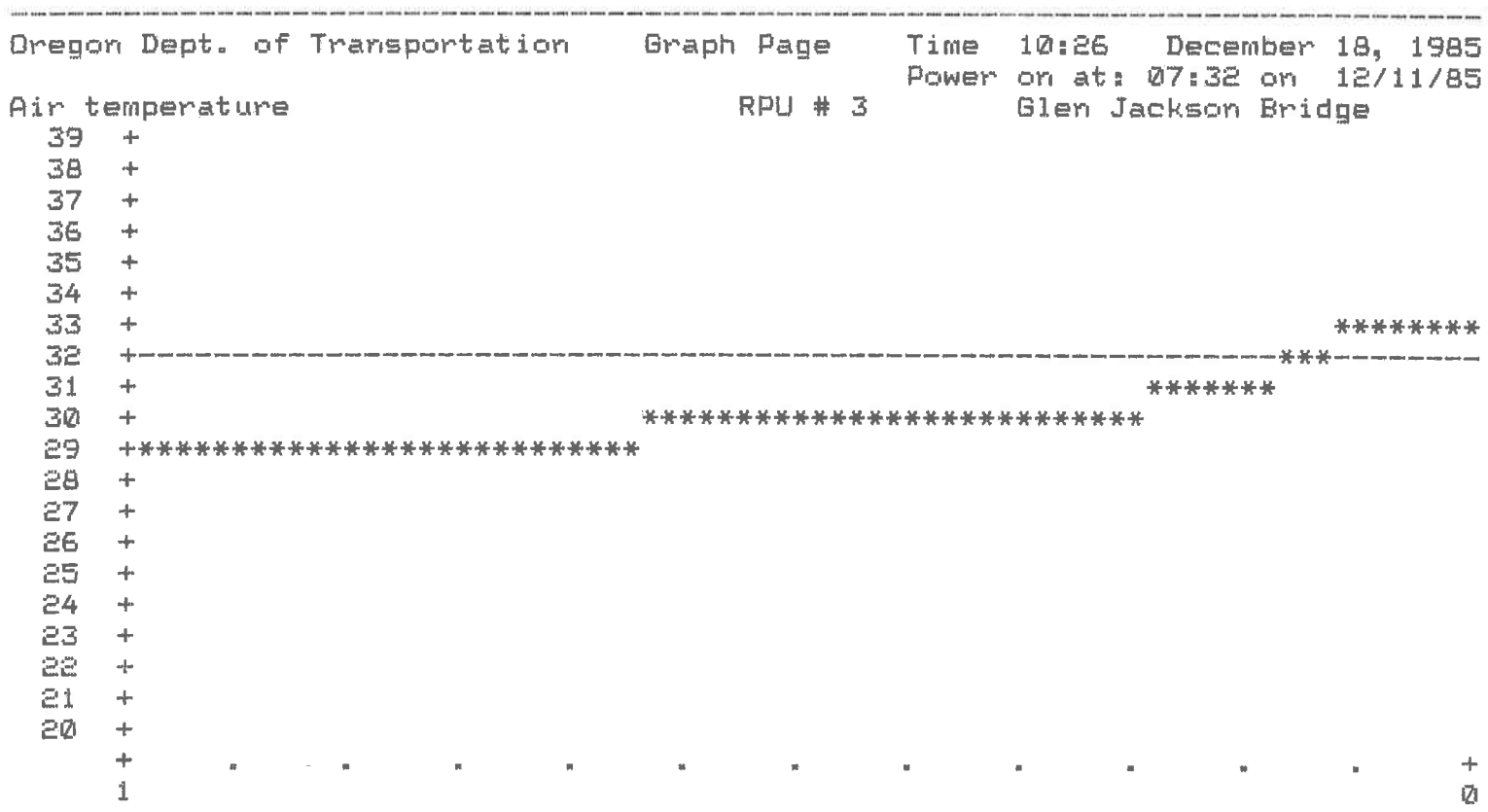
SENSOR #9

SURFACE TEMPERATURE GRAPH



RPU #3

AIR TEMPERATURE GRAPH



HISTORY PAGE

for Sensor #9

Oregon Dept. of Transportation History Page Time 10:27 December 18, 1985
Power on at: 07:32 on 12/11/85
Sensor # 9 Glen Jack. Fast 1a.

Time	Day		Status	Precip	Rel. Hum.	CF		Surf.		Temperatures Air	Dew	Wind Dir/ Vel.
10:23	18		Dry	Y	100		*	40	*	33	33.0	/ Calm
10:18	18		Dry	Y	100			38	*	32	32.0	/ Calm
10:15	18		Dry	Y	100		*	38		31	31.0	/ Calm
10:10	18		Dry	Y	100			37	*	31	31.0	/ Calm
10:08	18		Dry	Y	100		*	36		30	30.0	/ Calm
10:05	18		Dry	Y	100		*	35		30	30.0	/ Calm
10:00	18		Dry	Y	100		*	34		30	30.0	/ Calm
09:55	18		Dry	Y	100		*	33		30	30.0	/ Calm
09:46	18		Dry	Y	100		*	32		30	30.0	/ Calm
09:43	18		Dry	Y	100			31	*	30	30.0	/ Calm
09:41	18	*	Dry	Y	100			31		29	29.0	/ Calm
09:35	18		Snow/Ice Alert	Y	100	05	*	31		29	29.0	/ Calm
08:58	18		Snow/Ice Alert	Y	100	10	*	30		29	29.0	/ Calm
08:28	18		Snow/Ice Alert	Y	100	05	*	29		29	29.0	/ Calm
07:35	18		Snow/Ice Alert	Y	100	05		27	*	29	29.0	/ Calm

SUMMARY PAGE

Oregon Dept. of Transportation Summary Page Time 10:30 December 18, 1985
Power on at: 07:32 on 12/11/85

Sensor No.	Sensor location	Status	Precip	Temperatures Surf	Air	Dew pt	CF
1	West Upper Deck	Dry	N	^ 36	^ 30	* 30.0	
2	West Off Ramp	Dry	N	^ 37	^ 30	* 30.0	
3	I-405 North Bound	Dry	N	^ 37	^ 30	* 30.0	
4	I-405 South Bound	Dry	N	^ 37	^ 30	* 30.0	
5	I-5 N.B. Off Ramp	Dry	N	^ 35	^ 30	* 30.0	
6	I-5 N.B. On Ramp	Dry	N	^ 34	^ 30	* 30.0	
7	I-5 S.B. Off Ramp	Dry	N	^ 34	^ 30	* 30.0	
8	East Upper Deck	Dry	N	^ 35	^ 30	* 30.0	
9	Glen Jack. Fast la.	Dry	Y	^ 41	^ 33	* 33.0	
10	Glen Jack. Slow la.	Dry	Y	^ 41	^ 34	* 33.0	
11	Halsey East Bound	Dry		^ 42	^ 31	* 31.0	
12	Halsey West bound	Dry		^ 42	^ 31	* 31.0	

TEMPERATURE AND SURFACE CONDITION COMPARISON
SSI Ice Detection System
Fremont Bridge
Stadium Hwy. #61
Information usually taken at West end of bridge
WINTER SEASON 1982 - 1983

Ice Detector Sensor Readout					Manual On Site Check		
Date	Time	Surface Condition	Temperature Surface	Air	Time	Surface Condition	Temperatur
12/09/82	7:37 a.m.	Dry	30	34	6:30 a.m.	Dry	34
12/13/82	7:30 a.m.	Wet	39	41	5:30 a.m.	Wet	34
12/14/82	7:44 a.m.	Wet	40	41	6:45 a.m.	Wet	41
12/15/82	7:55 a.m.	Wet	45	46	6:45 a.m.	Wet	46
12/16/82	7:40 a.m.	Wet	45	50	6:45 a.m.	Wet	50
12/17/82	7:34 a.m.	Wet	39	43	4:00 a.m.	Wet	42
12/20/82	Machine down until noon				3:00 a.m.	Wet	36
12/21/82	8:15 a.m.	Dry	40	42	6:45 a.m.	Wet	42
12/22/82	8:07 a.m.	Wet	36	39	6:45 a.m.	Wet	38
12/23/82	7:57 a.m.	Wet	36	38	4:00 a.m.	Wet	34
12/24/82 - 12/27/82 machine down unknown reason							
12/27/82	8:41 a.m.	Dry	30	37	6:45 a.m.	Dry	29
12/28/82	8:00 a.m.	Dry	28	30	5:38 a.m.	Dry	30
12/29/82	8:58 a.m.	Dry	29	31	6:45 a.m.	Dry	30
12/30/82	8:00 a.m.	Surface Alert	25	27	4:30 a.m.	Frosty	22
1/03/83	8:26 a.m.	Surface Critical	32	33	4:00 a.m.	Freezing	29
1/04/83	8:04 a.m.	Wet	48	50	4:00 a.m.	Wet	45
1/05/83	5:07 p.m.	Dry	48	49	5:00 a.m.	Dry	50
1/06/83	7:40 a.m.	Wet	48	50	6:00 a.m.	Wet	47
1/07/83	8:06 a.m.	Wet	49	51	5:00 a.m.	Wet	52
1/10/83	8:13 a.m.	Wet	43	45	5:00 a.m.	Wet	44
1/11/83	11:53 a.m.	Dry	51	44	7:00 a.m.	Wet	36
1/12/83	5:02 p.m.	Dry	38	37	4:00 a.m.	Dry	31
1/13/83	8:01 a.m.	Dry	35	36	4:30 a.m.	Dry	33
1/14/83	8:05 a.m.	Surface Alert	31	33	7:00 a.m.	Wet	32
1/17/83	8:21 a.m.	Wet	40	42	6:00 a.m.	Dry	42
1/18/83	2:35 p.m.	Wet	41	42	6:00 a.m.	Wet	42
1/19/83	8:16 a.m.	Wet	41	44	6:00 a.m.	Wet	42
1/20/83	7:53 a.m.	Dry	39	40	6:00 a.m.	Dry	39
1/21/83	7:56 a.m.	Dry	34	35	6:00 a.m.	Dry	35
1/24/83	7:59 a.m.	Dry	44	49	5:30 a.m.	Wet	48
1/25,26,27/83 machine down for change over to new display							
1/28/83	6:46 a.m.	Dry	38	39	4:00 a.m.	Dry	41
1/31/83	7:45 a.m.	Moisture	44	43	7:00 a.m.	Dry	41
2/01/83	6:22 a.m.	Dry	38	40	6:00 a.m.	Dry	36
2/02/83	3:16 a.m.	Dry	40	44	4:50 a.m.	Dry	40
2/03/83	9:07 a.m.	Dry	44	42	6:00 a.m.	Dry	42
2/04/83	7:18 a.m.	Dry	38	39	4:00 a.m.	Dry	40
2/08/83	5:41 a.m.	Moisture	39	38	5:45 a.m.	Wet	38
2/09/83	6:09 a.m.	Moisture	42	43	4:55 a.m.	Wet	43
2/10/83	7:23 a.m.	Dry	45	45	5:50 a.m.	Dry	44
2/11/83	4:59 a.m.	Dry	44	47	4:05 a.m.	Wet	48
2/14/83	7:33 a.m.	Moisture	44	44	6:30 a.m.	Dry	45
2/15/83	7:39 a.m.	Dry	45	43	5:45 a.m.	Dry	41
2/16/83	7:51 a.m.	Dry	47	48	5:50 a.m.	Wet	44
2/17/83	7:08 a.m.	Moisture	48	50	6:00 a.m.	Wet	46
2/18/83	8:29 a.m.	Moisture	45	43	5:45 a.m.	Wet	44
2/22/83	8:26 a.m.	Dry	54	51	6:30 a.m.	Wet	51
2/23/83	4:13 a.m.	Moisture	51	52	2:30 a.m.	Wet	52
2/25/83	7:25 a.m.	Dry	45	45	4:30 a.m.	Wet	45
2/28/83	8:08 a.m.	Moisture	46	45	5:20 a.m.	Wet	44

TEMPERATURE AND SURFACE CONDITION COMPARISON
SSI Ice Detection System
Fremont Bridge
Stadium Hwy. #61
Information usually taken at West end of bridge

WINTER SEASON 1983 - 1984

Ice Detector Sensor Readout					Manual On Site Check		
Date	Time	Surface Condition	Temperature Surface	Air	Time	Surface Condition	Temp.
12-08-83	9:32 AM	Moisture	46	45	7:15 AM	Wet	48
12-19-83	8:04 AM	Moisture	33	31	9:15 AM	Dry	31
12-20-83	7:41 AM	Dry	28	26	6:10 AM	Dry	28
12-21-83	7:10 AM	Dry	14	16	4:45 AM	Dry	17
12-22-83	7:12 AM	Dry	15	15	5:30 AM	Dry	16
12-23-83	7:12 AM	Dry	10	14	4:45 AM	Dry	12
12-27-83	7:28 AM	Moisture	33	16	12:30 AM	Dry	26
12-27-83	12:45 PM	Moisture	35	16			
12-28-83	7:15 AM	Dry	25	16	12:00 AM	Dry	28
12-29-83	9:48 AM	Surf. Critical	31	16	10:30 PM	Dry	32
12-30-83	7:11 AM	Moisture	35	0	11:40 PM	Wet	35
********							
01-03-84	7:35 AM	Moisture	51	55	6:15 AM	Wet	53
01-04-84	10:02 AM	Dry	57	55	4:00 AM	Wet	59
01-05-84	8:09 AM	Dry	52	50	1:30 AM	Wet	50
01-06-84	7:47 AM	Dry	48	45	5:30 AM	Wet	49
01-10-84	11:57 AM	Moisture	47	47	7:10 AM	Wet	40
01-10-84	5:06 PM	Moisture	48	48			
01-11-84	12:27 PM	Dry	55	48	7:10 AM	Dry	46
01-12-84	5:07 PM	Dry	41	42	6:30 AM	Dry	40
01-16-84	7:46 AM	Dry	28	27	6:45 AM	Dry	30
01-17-84	2:57 PM	Dry	47	37	5:35 AM	Dry	29
01-24-84	7:38 AM	Dry	51	52	6:00 AM	Wet	55
01-25-84	7:49 AM	Dry	47	50	6:30 AM	Wet	48
01-26-84	7:43 AM	Moisture	41	39	6:30 AM	Wet	42
01-27-84	7:38 AM	Dry	48	46	7:00 AM	Dry	47
01-28-84	6:23 AM	Dry	48	44	7:30 AM	Dry	47
01-29-84	5:11 AM	Dry	48	44	6:30 AM	Dry	46
01-30-84	4:31 AM	Dry	38	40	5:45 AM	Dry	42
01-31-84	7:59 AM	Dry	39	41	7:15 AM	Dry	41
02-02-84	7:44 AM	Dry	38	36	5:35 AM	Dry	35
02-07-84	10:22 AM	Dry	52	43	6:40 AM	Dry	43
02-14-84	3:41 PM	Dry	53	48	6:45 AM	Dry	39
02-15-84	3:05 PM	Dry	60	46	6:30 AM	Wet	43
02-16-84	7:44 AM	Dry	39	39	6:35 AM	Dry	38
02-22-84	7:42 AM	Dry	38	37	7:00 AM	Dry	37
02-23-84	10:08 AM	Dry	48	44	6:40 AM	Wet	43

TEMPERATURE AND SURFACE CONDITION COMPARISON
SSI Ice Detection System
Fremont Bridge
Stadium Hwy. #61
Information usually taken at West end of bridge

WINTER SEASON 1984 - 1985

	Ice Detector Sensor Readout				Manual On Site Check		
Date	Time	Surface Condition	Temperature Surface	Air	Time	Surface Condition	Temp.
12-13-84	7:17 AM	Wet	42	42	5:15 AM	Wet	40
12-14-84	5:41 AM	Dry	45	45	5:30 AM	Dry	48
12-15-84	5:06 AM	Wet	36	34	2:45 AM	Dry	34
12-16-84	9:28 AM	Dry	37	35	5:10 AM	Dry	36
12-17-84	7:56 AM	Dry	39	36	5:00 AM	Dry	38
12-18-84	6:03 AM	Dry	23	28	6:30 AM	Dry	29
12-19-84	12:23 PM	Dry	38	26	4:45 AM	Dry	24
12-20-84	6:44 AM	Dry	19	20	2:30 AM	Dry	20
12-21-84	6:16 AM	Snow/Ice Alert	32	32	6:00 AM	Ice	30
12-26-84	3:21 AM	Wet	38	38	3:00 AM	Wet	40
12-27-84	6:43 AM	Wet	39	40	6:15 AM	Wet	40
12-29-84	5:28 AM	Wet	40	41	5:10 AM	Wet	42
12-31-84	6:14 AM	Dry	30	32	6:00 AM	Dry	32
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01-01-85	4:54 AM	Dry	27	29	6:30 AM	Frosty	26
01-02-85	6:43 AM	Dry	31	31	6:00 AM	Dry	31
01-03-85	6:21 AM	Dry	29	32	6:10 AM	Dry	33
01-04-85	5:26 AM	Dry	29	31	6:00 AM	Dry	31
01-06-85	9:13 AM	Dry	35	34	6:00 AM	Dry	35
01-07-85	6:08 AM	Dry	35	188	6:20 AM	Dry	41
01-08-85	6:51 AM	Dry	34	188	5:20 AM	Dry	37
01-09-85	8:18 AM	Dry	30	188	6:30 AM	Dry	35
01-10-85	8:18 AM	Dry	29	188	5:15 AM	Dry	33
01-11-85	8:18 AM	Dry	30	188	6:00 AM	Dry	33
01-12-85	7:31 AM	Dry	31	188	6:10 AM	Dry	33
01-13-85	8:21 AM	Dry	31	188	5:00 AM	Dry	33
01-14-85	6:11 AM	Absorption	33	188	6:00 AM	Wet	36
01-15-85	7:59 AM	Absorption	40	188	5:00 AM	Wet	38
01-16-85	7:46 AM	Dry	37	37	4:05 AM	Dry	37
01-17-85	5:51 AM	Dry	32	34	5:05 AM	Dry	35
01-18-85	5:01 AM	Dry	33	34	5:00 AM	Dry	34
01-19-85	5:46 AM	Dry	34	33	5:35 AM	Dry	36
01-20-85	7:31 AM	Wet	39	39	3:40 AM	Wet	39
01-21-85	6:21 AM	Wet	39	36	6:45 AM	Dry	36
01-22-85	7:23 AM	Dry	39	40	6:45 AM	Dry	42
01-23-85	6:53 AM	Dry	35	38	5:30 AM	Dry	38
01-24-85	5:32 AM	Dry	34	37	5:50 AM	Dry	39
01-25-85	7:24 AM	Dry	30	31	6:45 AM	Dry	31
01-29-85	7:44 AM	Dry	38	36	6:30 AM	Dry	36
01-30-85	5:19 AM	Dry	27	28	6:45 AM	Frost	28
01-31-85	7:24 AM	Dry	35	34	6:15 AM	Wet	34

NOT WORKING

WINTER SEASON 1984 - 1985 cont.

Ice Detector Sensor Readout					Manual On Site Check		
Date	Time	Surface Condition	Temperature Surface	Air	Time	Surface Condition	Temp.
02-01-85	3:32 AM	Dry	33	34	2:30 AM	Dry	33
02-02-85	5:27 AM	Dry	31	31	5:45 AM	Dry	30
02-03-85	4:55 AM	Dry	23	26	5:00 AM	Dry	26
02-04-85	6:47 AM	Dry	17	20	6:30 AM	Dry	17
02-05-85	4:37 AM	Snow/Ice Alert	29	28	6:00 AM	Snow	28
02-06-85	9:00 AM	Wet	39	38	9:15 AM	Wet	36
02-07-85	6:18 AM	Wet	38	39	5:15 AM	Wet	38
02-08-85	6:00 AM	Wet	35	37	6:00 AM	Wet	34
02-09-85	5:48 AM	Wet	35	37	5:40 AM	Wet	35
02-10-85	6:48 AM	Wet	37	38	5:25 AM	Wet	38
02-11-85	7:40 AM	Wet	42	42	5:45 AM	Wet	41
02-12-85	1:53 AM	Dew	37	39	12:30 AM	Dry	43
02-13-85	2:25 AM	Snow/Ice Alert	31	34	2:30 AM	Damp	32
02-14-85	8:18 AM	Dry	42	37	5:30 AM	Dry	44
02-15-85	8:13 AM	Dry	43	40	5:30 AM	Dry	42
02-16-85	6:33 AM	Absorption	33	31	6:20 AM	Dry	32
02-17-85	5:58 AM	Dew	33	32	5:40 AM	Dry	34
02-19-85	5:58 AM	Dry	42	43	6:15 AM	Wet	41
02-20-85	4:33 AM	Wet	40	42	4:20 AM	Dry	42
02-21-85	5:38 AM	Absorption	43	43	5:30 AM	Dry	46
02-23-85	5:38 AM	Dry	48	47	6:10 AM	Dry	48
02-24-85	1:25 AM	Dry	51	49	2:02 AM	Dry	50
02-27-85	5:55 AM	Dew	35	37	6:30 AM	Dry	34
02-28-85	5:03 AM	Dry	40	41	6:00 AM	Dry	38
03-01-85	7:56 AM	Dry	47	45	5:40 AM	Dry	41
03-02-85	1:58 AM	Dry	36	40	12:55 AM	Dry	38
03-03-85	6:43 AM	Dry	39	39	3:30 AM	Dry	39
03-04-85	7:10 AM	Wet	37	38	6:25 AM	Wet	38
03-05-85	6:13 AM	Dry	40	41	6:05 AM	Dry	42
03-06-85	7:21 AM	Dry	41	38	6:45 AM	Dry	38
03-07-85	1:46 AM	Dry	34	36	1:30 AM	Dry	36
03-09-85	1:28 AM	Dry	46	47	1:40 AM	Dry	46
03-10-85	2:08 AM	Dry	46	47	2:15 AM	Dry	48