Report No. CDOT-DTD-R-91-10

Ice-Detection System Evaluation

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Colorado Department of Highways

Final Report
August, 1991

Prepared in cooperation with the
U.S. Department of Transportation
Federal Highway Administration

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16. Abstract

This evalution consisted of interviews with SCAN system users and evaluations of the manpower and material savings associated with the use of the system as well as the possible influences the system may have on accident which occur during winter conditions.

It appears that salt/sand usage and overtime costs have been reduced by the use of the SCAN system. Anecdotal information suggests that there have been fewer winter accidents at one instrumented site.

Implementation

The system provides relevant information to maintenance decision makers. The overall effectiveness of the system is dependant on how users accept and will use the information.

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BACKGROUND

The Colorado Department of Highways (CDOH) has been investigating the feasibility of using ice detectors to warn of icy bridges since the late 1960's. However, the legal issues of providing this information (with a chance for errors) directly to motorists were never satisfactorily resolved. The idea of ice detection equipment as a tool for improving snow and ice control strategies was first used at airports and later became practical for highway applications. Advances in personal computers (PC) and PC communications have made it possible to display the results from ice detection stations at a central location. More recent technology allows inter-communication between regional clusters of stations. In addition, the reliability and sophistication has increased in ice detection equipment. The cost of ice detection equipment has been relatively constant in comparison to the winter maintenance budgets of states with significant snowfall.

The decision was made in 1985 to install an ice detection system in the Denver area. The use of this system was expected to reduce costs and improve response times for snow and ice control.

SYSTEM DESCRIPTION AND COSTS

Equipment and Location

The SCAN ice detection system from Surface Systems Inc. (SSI) is the system used in the Denver-metro area. Initial plans called for the installation of atmospheric and pavement sensors in two bridge decks (C-470 at I-25 and I-70 at Washington St.). Shortly after the first two sites were commissioned, two more sites were instrumented (Evans at Santa Fe and the Walnut St. viaduct) and a request for approval of four more sites was announced (C-470 at SH 121, C-470 at I-70, SH 7 at I-25, and I-70 at Chambers Rd). As of this date, the Colorado Department of Highways has eight operational sites in the Denver-metro area.

A typical site contains equipment to furnish the following information: wind speed, wind direction, air temperature, relative humidity, precipitation, pavement temperature, relative amount of deicing chemicals, pavement condition (i.e. wet, icy) and subsurface temperature.

Since the CDOH system was commissioned, several other local agencies have put stations on the system. The City and County of Denver has two instrumented locations and the city of Thornton has one location. This sharing of information has been to the benefit of all parties--the cities have access to all the data from around the metro area and CDOH is able to augment its sensor network. One minor problem with this arrangement is that all agencies on the system need to be careful about equipment maintenance and calibration so that accurate information is furnished to the other users.

Other operational CDOH sites outside the metro area include:

I-25 at Monument Hill (between Denver and Colorado Springs)
Garden of the Gods Road in Colorado Springs
I-76 near Sterling
I-76 near Julesburg
Wolf Creek Pass northeast of Pagosa Springs
La Veta Pass west of Walsenburg
I-25 near Berthoud
US 287 near the Wyoming border

These sites report to other districts in Colorado but may eventually be able to be linked to the system in Denver.

Although the first two locations in Denver became operational early in 1987, the system was not fully relied upon until the following winter. During the winter of 1987/88 the system was used extensively by maintenance personnel. Since the winter of 1987/88, the system has become a standard tool for winter maintenance.

Purchase Costs and Conditions

The Colorado Department of Highway's ice detection system consists of eight instrumented locations linked by radio and phone lines to a central computer. The computer and the support equipment is located at Section 8 maintenance headquarters, 2000 S. Holly in Denver. A system diagram is on shown in Figure 1 and a system map is shown as Figure 2. The system has now been used for four full winters.

The initial cost of each ice detection station was approximately $35,000. This included commisioning and some installation by SSI. The equipment required to access each station (computer hardware and software) cost approximately $108,000. Total expenditure for the system at Section 8 has been $457,000 spent over four years.

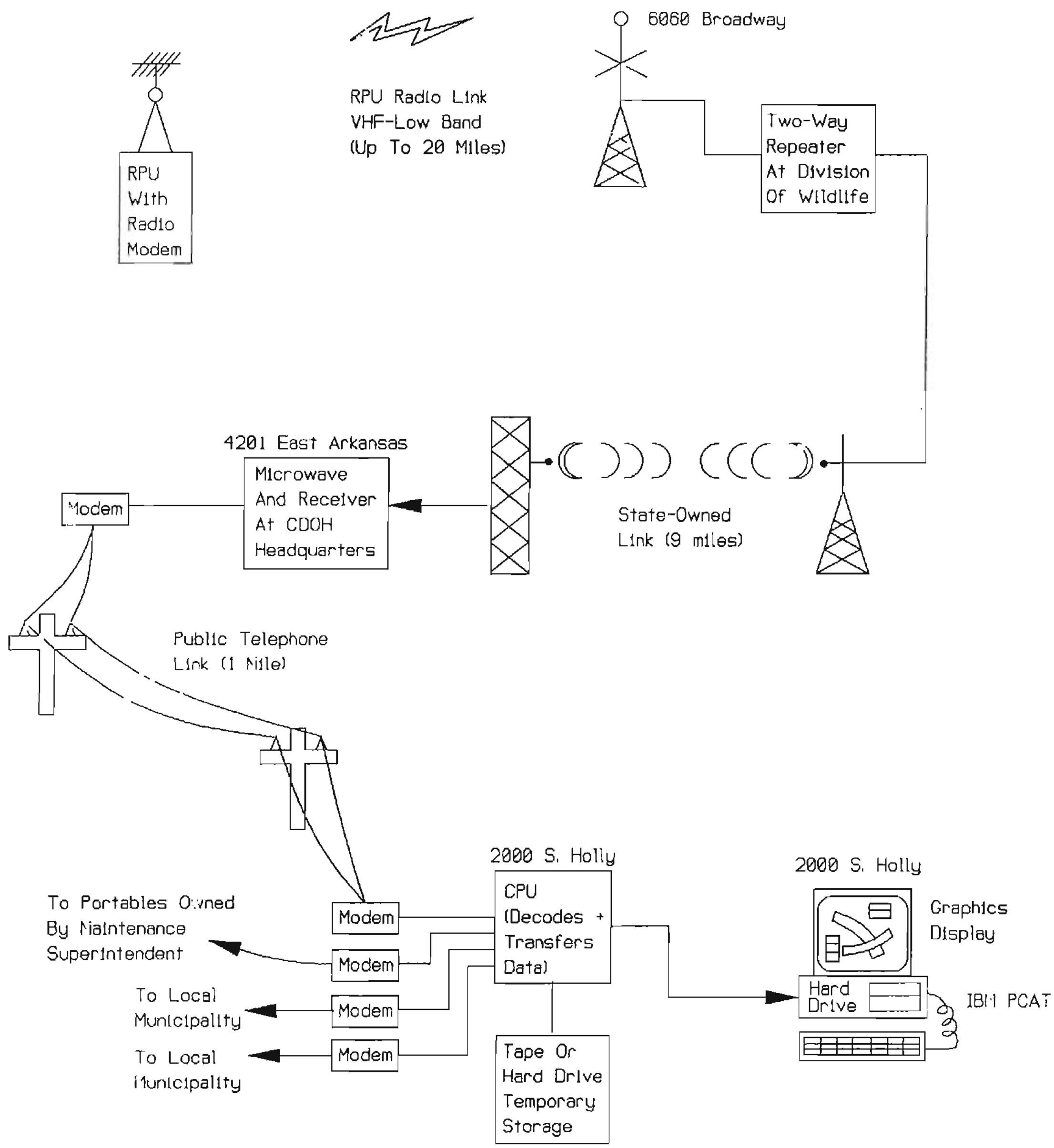


Figure 1. System Diagram

EXISTING SITES IN SECTION 8

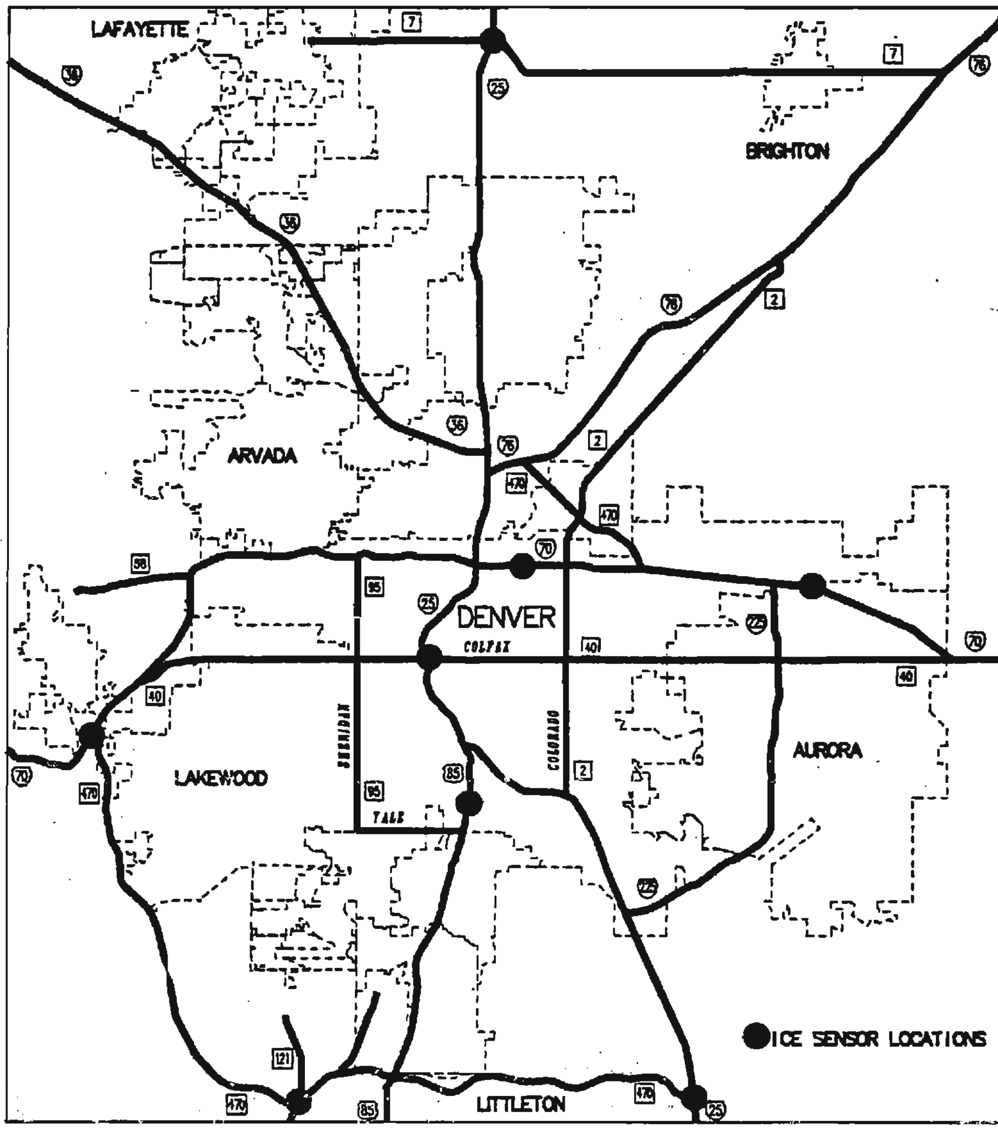


FIGURE 2.

Vendor support has been needed primarily for the software running on the central computer. Several problems occurred with the original mass storage device and the long-term history files were not always saved. SSI has since furnished a more reliable product.

CDOH has used a Maintenance Contract with SSI for maintaining and calibrating the SCAN system in the metro area. After several seasons, it was felt that CDOH crews could respond quicker and at a lower cost than SSI's maintenance people for typical maintenance problems.

Operating Costs

Operating costs per year have been approximately $6,200 per season for calibration, equipment repairs, or replacement of damaged equipment. On the average, two to three pavement sensors and a modem or radio have been replaced each season [3]. This work has been performed by CDOH traffic forces who have had some training with the SSI equipment.

System reliability has been good with the main problem (interference) occurring in the communication links. The sensor readings have been accurate with the exception of the original relative humidity sensor (since improved by SSI). However, the reported pavement temperatures tend to be higher than actual during clear-sky conditions.

DESCRIPTION OF MAINTENANCE OPERATIONS

Resources

Section 8 Maintenance is responsible for snow and ice removal on most state highways in the Denver-metro area. However, some of the highways are cleared by local government agencies under contract with CDOH. Section 8 has responsibility for approximately 3130 lane miles in the Denver area and has had an annual winter maintenance budget of $1.9 to $2.1 million for the last several years. This budget has been fairly stable despite additional traffic and lane-mile coverage in the section.

There are 30 maintenance patrols in Section 8, each with three to five people. However, during snowstorms other maintenance crews are brought in (sweeper operators, traffic signal crews, and paint striping crews). During snowstorms there are typically about 60 snowplows out on the roads in the section.

Method of Operation

The Section maintenance superintendent is responsible for all maintenance activities in a section. There are six maintenance foremen, each responsible for a portion of the metro area, who report to the superintendent. Under each foreman, are several patrols which are responsible for certain sections of roads in the vicinity of the patrol garage. Each patrol has three to five people who work different shifts so that roads are covered with basic maintenance during weekdays. On weekends minimal coverage is provided and standbys are called in if necessary.

Decisions on whether to call for snow shifts are made at the section level. These decisions are often based on information from the SCAN system or on the current SCANCAST forecast.

During very large storms, local contractors are alerted that their equipment and personnel may be needed. However, standby time is not paid for. In most cases, the SCAN system is used in the decision when to use contractors and when to stop using them (e.g. when a storm is abating and pavement temperatures are rising).

EVALUATION

It has been difficult to establish cost differences due to the use of the SCAN system mainly due to the large effort required to track the decision-making process during winter storms and due to the many variables which influence the costs of snow and ice control. Another major difficulty is that it is often not possible to determine what decisions might have otherwise been made, had the SCAN information **not** been available. Variations in the severity of every winter make before/after type comparisons difficult.

Ease of Use

As the accuracy of the various pavement and atmospheric sensors has been documented in other studies [1], this evaluation focused rather on the use of the system and whether the information provided is worth the costs of buying and maintaining the system. In addition to the collected data, efforts were made to determine how the information provided by the system actually was used in snow and ice control strategies. It was planned to use this information to estimate maintenance cost savings and reductions in salt/sand usage.

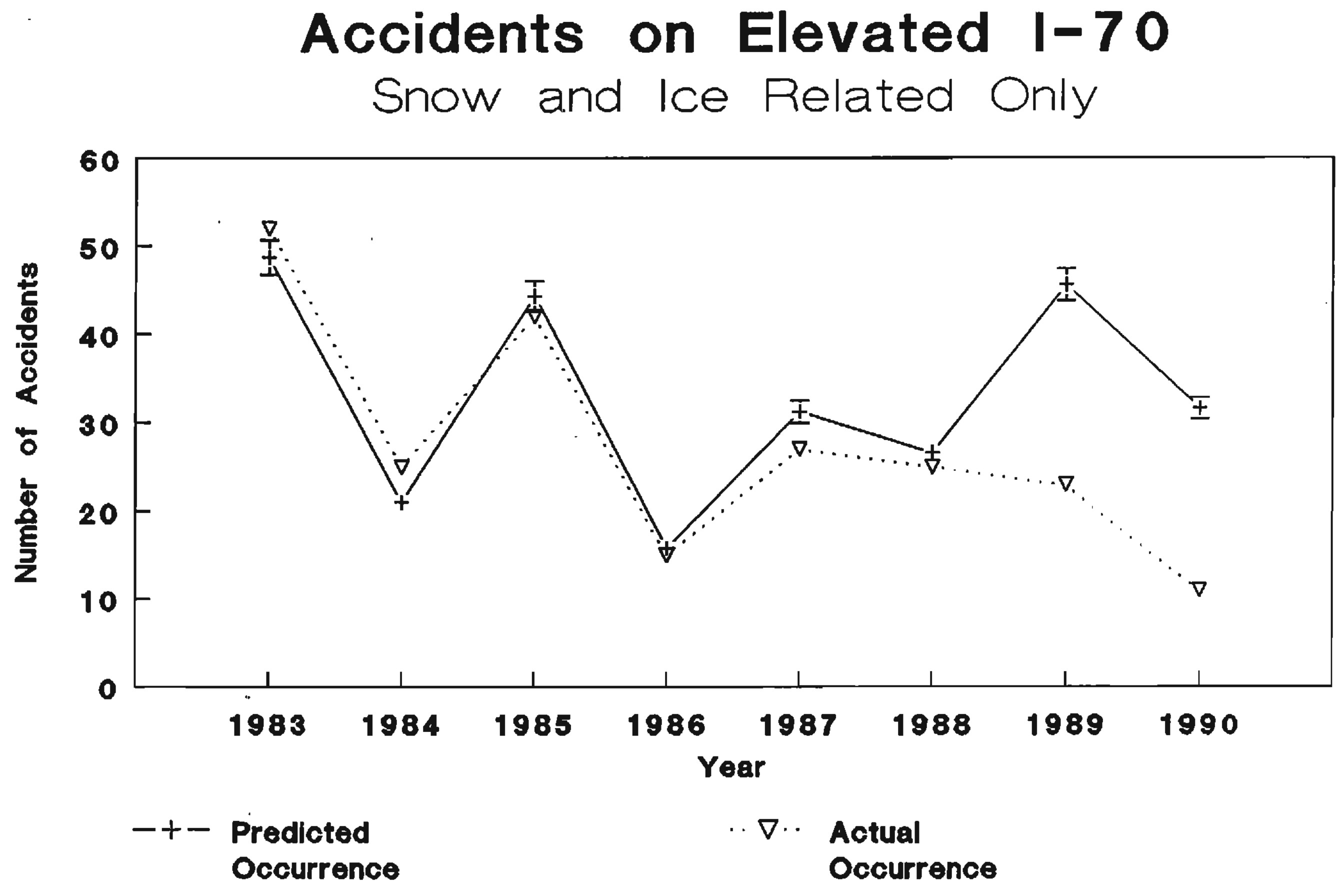
The SSI software provides the main link between the user and the large amount of collected data. The software runs on an IBM AT or compatible and, because of its graphic capabilities, works best with a higher resolution (EGA/VGA) monitor attached. The program is able to display the data in either text or graphic form depending on the situation. The text listing provides an overview of the system as well as more specific data (current readings, past readings, tendencies, etc.). The text data is also color coded (at the central location only) to draw attention to hazardous or near hazardous conditions.

The graphic mode is useful in order to quickly scan the stations and determine where trouble spots are. The graphics are also able to show several layers of detail for the system (please see Photographs 2-6 in Appendix B). At the system level, each station is shown on a map with several color codes to represent different pavement conditions and the communication status of each station. At the station level, a graphic of the structure (with sensor locations) is shown with color coded information about individual pavement sensors and the atmospheric conditions at the station.

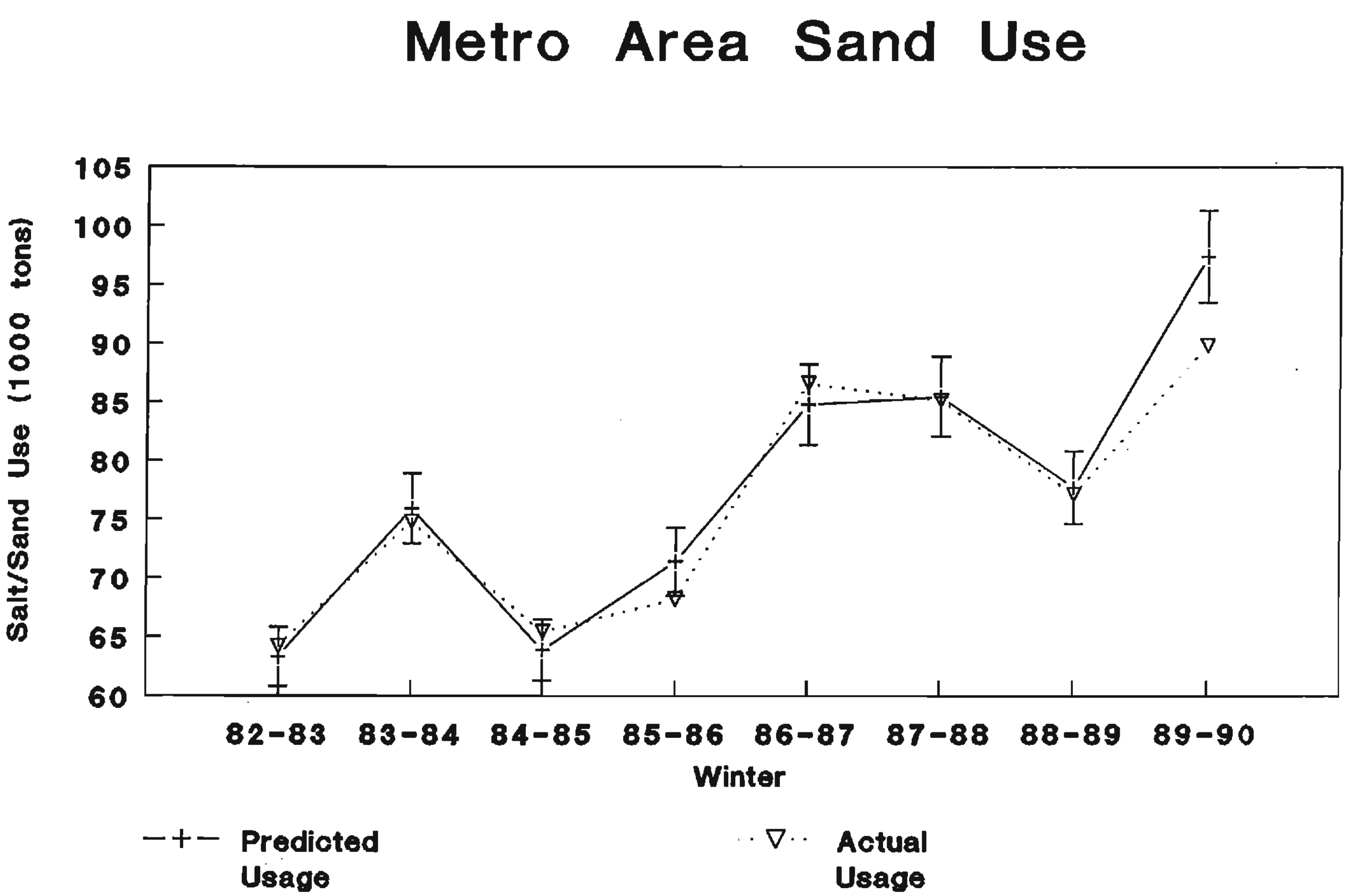
It appears that both modes of data display are useful. However, field supervisors are not able to use the graphic displays if calling in from another location since the information is sent as plain ASCII text.

Safety Aspects

Data was gathered on the effect of the SCAN ice detection equipment on accidents rates. Elevated I-70 in Denver, is a 9066 foot structure which was one of the first sites to be instrumented. Accident data for this site was compiled for the years 1983-1990, inclusive. The number of accidents occurring when pavement conditions were snowy or icy were tabulated. Since these types of accidents depend on the number and intensity of winter storms, the multiple regression technique was used to predict the number of accidents based on the number of storms and the amount of snowfall for each winter season. An equation was developed based on the years previous to the installation of the ice-detection equipment. This equation predicted the number of accidents reasonably well (R^2 = 0.96). For the period after the installation of the ice-detection equipment, the actual number of accidents fell to half the predicted numbers (see Figure 3). This indicates that some factor was reducing winter accidents.



Accidents on Elevated I-70
Snow and Ice Related Only
Number of Accidents
0
10
20
30
40
50
60
1983
1984
1985
1986
1987
1988
1989
1990
Year
Predicted Occurrence
Actual Occurrence



Metro Area Sand Use
Salt/Sand Use (1000 tons)
60
65
70
75
80
85
90
95
100
105
82-83
83-84
84-85
85-86
86-87
87-88
88-89
89-90
Winter
Predicted Usage
Actual Usage

Figure 3.

However, after talks with traffic engineers, it was discovered the reporting threshold for accidents was raised from $500 to $1000 beginning January 1, 1988. Further, the effects of "accident alerts" were discussed on these statistics. Accident alerts are called when local police cannot investigate the large number of accidents which occur during major winter storms. During accident alerts, if no injuries occurred or the use of alcohol was not involved in an accident, motorists need only to call the information into the local police within 24 hours. However, CDOH accident records do not include accident data which were not filled out at the scene. This means that many of the accidents which occurred during winter storms were never entered into the CDOH database. In light of these complications, there were no further attempts at quantifying the effect of the ice-detection equipment on winter accident rates.

Maintenance forces in Section 8 have pointed out that there have not been major multi-car accidents on elevated I-70 since the SCAN system was installed [2]. This had occurred several times during winter storms previous to 1987.

Salt/Sand Usage

The amount of salt/sand used during the winters 1982-1983 through 1989-1990 was also investigated. The amount of salt/sand used is weather dependent and the multiple regression technique was again used to predict salt/sand use based on three factors: the sum of the deviation from the mean monthly temperatures for winter months, the average snowfall for the winter, and the number of lane miles plowed (all for the years prior to installation of the SCAN system). The equation developed predicted the salt/sand usage well for all eight winters ($R^2 = 0.96$). A plot of the salt/sand use vs. the predicted use is shown in Figure 3. The reduction in salt/sand use outside the error bar shown during the winter of 1989-90 can possibly be attributed to the use of the ice-detection system. The reduction in use of these 1800 tons represents a approximate savings of $18,000 in material costs, $16,000 in labor costs (to distribute the material only), and $10,000 in vehicle operating expenses. This one-year savings represents approximately 10% of the cost of the installed ice-detection system.

Overtime

Overtime paid for snow and ice control was another parameter which was investigated. The additional information provided by the ice-detection system has the potential to reduce overtime though more efficient scheduling.

The quantitative comparison of overtime before and after the installation of the ice-detection equipment was not possible due to several problems. The records previous to 1988-89 were stored on another computer which has since been decommissioned. The data is stored on tape but as of this time, the data is inaccessible. Another factor is that maintenance workers often take their overtime in "comp time" which would not show up in the records.

Users of the system have stated that overtime reductions have occurred during storms. These reductions are hard to quantify but seem to occur at the beginnings and ends of storms and generally during fall and spring storms. The reasons for this is that often pavement temperatures are higher in the fall and spring and the crews can be delayed several hours at the onset of a storm or released earlier at the end of a storm based on accurate pavement temperature information.

Based on the available information, it appears that overtime has been decreasing for the last several years despite the fact that one winter (89-90) has been more severe than the previous winter.

Winter	88-89	89-90	90-91 (YTD)
Overtime charged to Activity code 402 (Snow Removal).	$ 307,385	$ 237,529	$ 194,471

While overtime costs decreased between the winters of 88-89 and 89-90, the amount of salt/sand used increased by 16% and the number of lane-miles plowed increased by 29%. In this case, the amount of overtime may be influenced by the timing of storms (e.g. whether they occur on weekdays, holidays) or the length of the storm. In the case of the winter of 90-91, this has been an unusually mild winter and little overtime has been needed. It appears that some of the savings in the winter of 1989-90 could be attributed to the use of the ice-detection system.

RESULTS

This evaluation consisted of interviews with SCAN system users and estimations of the manpower and material savings associated with the use of the system and possible influences the system may have on traffic safety during winter conditions. These estimations are based on the best information available but with the many variables present in a metropolitan highway system, these numbers need to be treated with some caution.

It appears that material usage and overtime costs have both been reduced by the use of the SCAN system. Anecdotal information suggests that there may be some reductions in winter accidents for one site.

There exists a learning period for the effective use of the SCAN system in which the users develop a "feel" for the numbers and begin to trust the information seen on the computer screen. Therefore, it seems reasonable that there will not be dramatic changes in a given parameter immediately after commissioning an ice-detection system but rather a gradual increase in the efficiency of winter operations. Acceptance by the users plays a large role in possible efficiency gains.

Recommendations

At least one weather station should be installed in the direction from which major winter storms arrive. Typically, problem sites are instrumented first with the idea that these sites will provide a warning of future conditions at other sites.

Weather instrumentation is very useful; however, if two stations are very close to each other, then one set of instruments will be unnecessary.

Determine ways to encourage maintenance people to "buy into" the system. This may require several days of training in both how to use the equipment and strategies for improving efficiencies.

OTHER USES OF SYSTEM

The SCAN system generates data that has other applications within a transportation agency. The system has been used during summer months by nighttime paving crews to establish if pavement and air temperatures meet the minimum specifications for paving. The long-term history files provide a record of the actions taken during snowstorms (mainly by the chemical factor) which can be used as documentation in legal actions involving road conditions during accidents. In addition, the system may have other applications in pavement designs where the number of freeze/thaw cycles is a factor.

OTHER SYSTEMS

Several other companies are becoming active in the U.S. market as of this date. Several Europe-based corporations are importing road weather systems which have been used extensively in other countries. These systems provide information similar to the SCAN system.

At this time, the various systems are not compatible although standards may be recommended by the contractor working on Strategic Highway Research Program (SHRP) contract H-207. However, even if standards are recommended, it may be several years before these standards are implemented. In the meantime, organizations which have begun with one system are obligated to purchase additional equipment from the same manufacturer for expansion.

In Colorado (and most likely in other western states), there is a need for low-cost equipment for low-volume roads. This equipment would have applications, as an example, on remote mountain passes where the traffic is very low but the distance involved in making a routine "run" is large. Low-cost equipment would also bring road weather information capability to counties, smaller cities, or school districts.

FUTURE USES

Ice-detection equipment is only one area in which highway agencies need information from remote sites. For the sake of economy, future road weather information systems should be capable of a variety of tasks. Weigh-in-motion, traffic volumes, vehicle classification, and stream water level information are only a few of the applications which could "piggyback" onto the logic and communication equipment already used at a typical ice-detection site.

References:

[1] Nelson, Thane, "Evaluation of Ice Warning Systems" Oklahoma Department of Transportation, February, 1989

[2] Conversation with Gordon Bell, Assistant Maintenance Superintendent, Section 8

[3] Conversation with Chris Lillie, Traffic Signal Electrician

Appendix A

User Interviews

USER INTERVIEWS

The following information is presented to give the reader an indication of the use of the SCAN system by field supervisors. Each supervisor is responsible for a portion of the metro-Denver area.

Supervisor 1

Uses portable mostly after storms to see how well crews kept up with the storm.

Supervisor 2

Uses portable from home (keeps it home during winter).

Uses it mostly at beginning of storms.

Thinks portables are easy enough to use if set up correctly.

Likes SCANCAST and thinks it is useful and trusts data.

Overall useful.

Supervisor 3

Uses from home but has had trouble getting into system sometimes during storms (no lines free).

Uses portable mostly at beginning of storm and to check on reports from dispatcher.

Easy enough to use if set up right.

SCANCAST as accurate as anything else.

Is sceptical of sensor data, thinks it is about 50/50 (right/wrong).

Overall system is useful, but could be better.

Supervisor 4

Used the system quite often from home. He had trouble getting a free line sometimes.

Used portable mostly at beginning and sometimes during storms.

Thought portable was easy to use.

Found SCANCAST to be good.

Thinks that data is accurate and that system is overall good.

Would like to see more sites in NW area (Golden to Brighton).

Supervisor 5

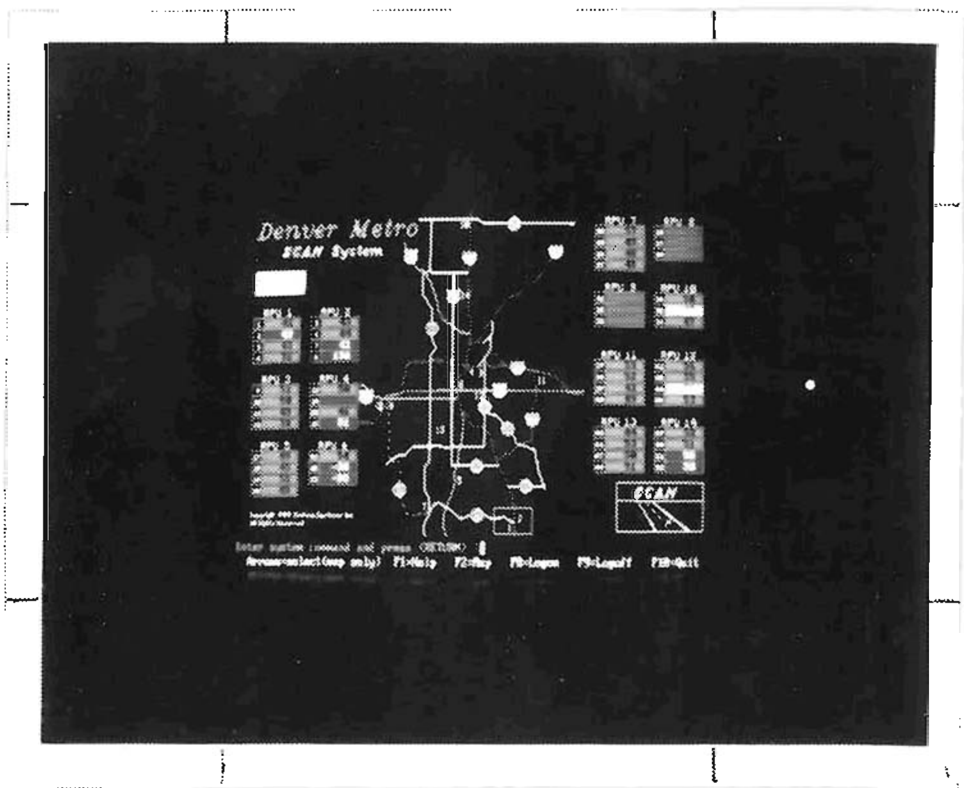
Does not have portable so he did not have access to system.

He thinks that since maintenance forces will be out anyway, the system doesn't give any new information.

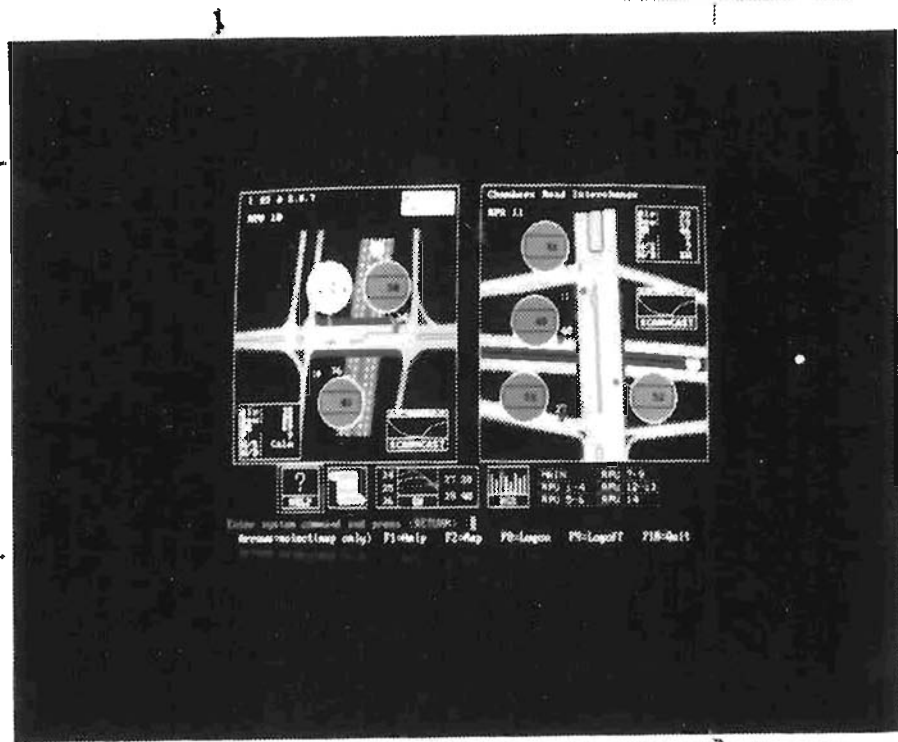
Appendix B

Photographs of System

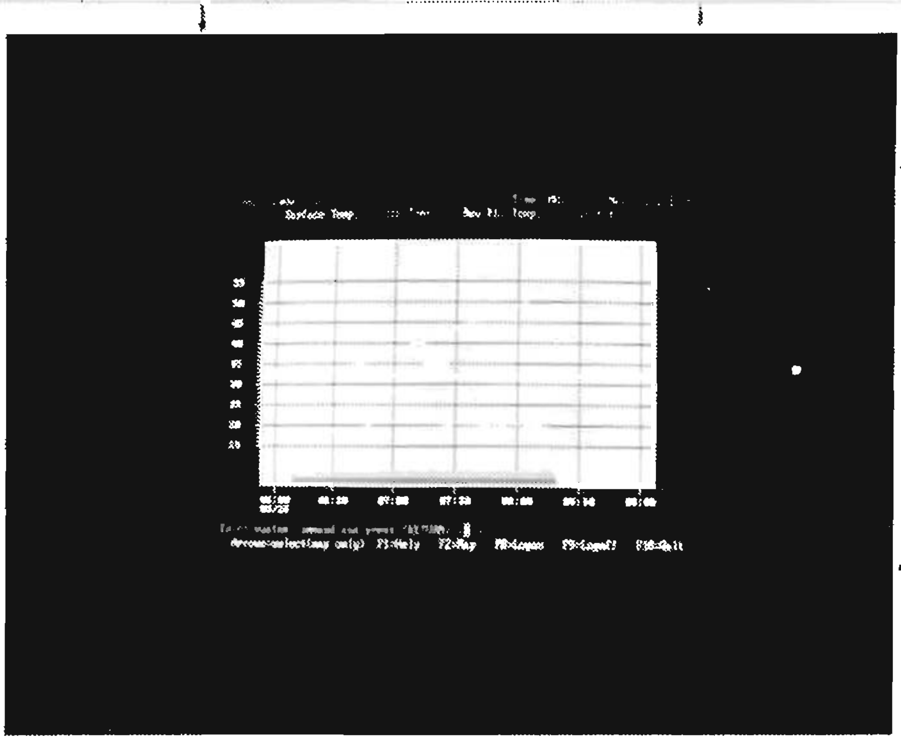
Photograph 1. View of operations room at Section 8 Maintenance office.



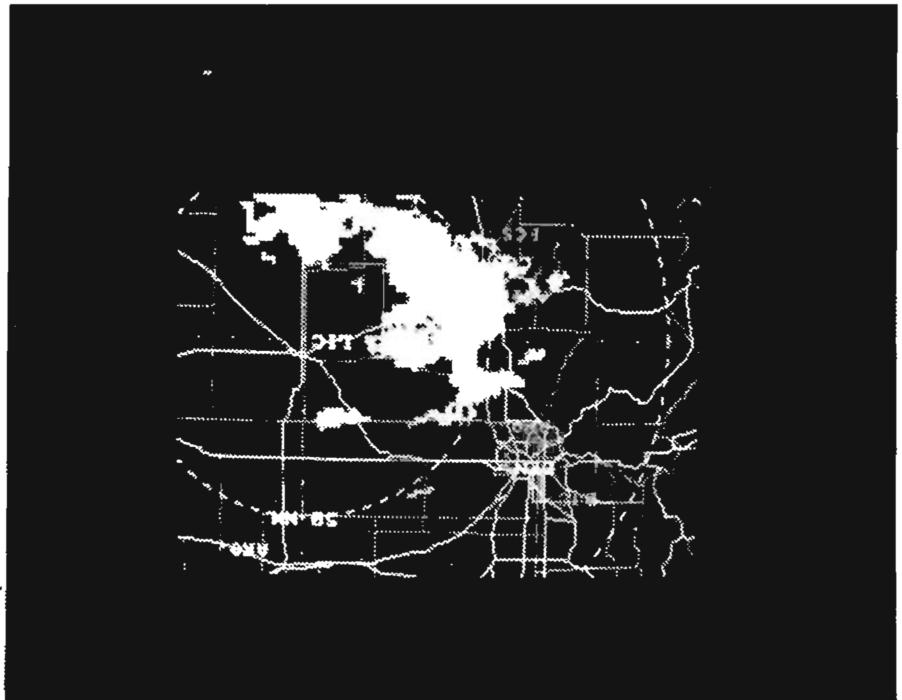
Photograph 2. Network level map of sites displayed by SCAN software.



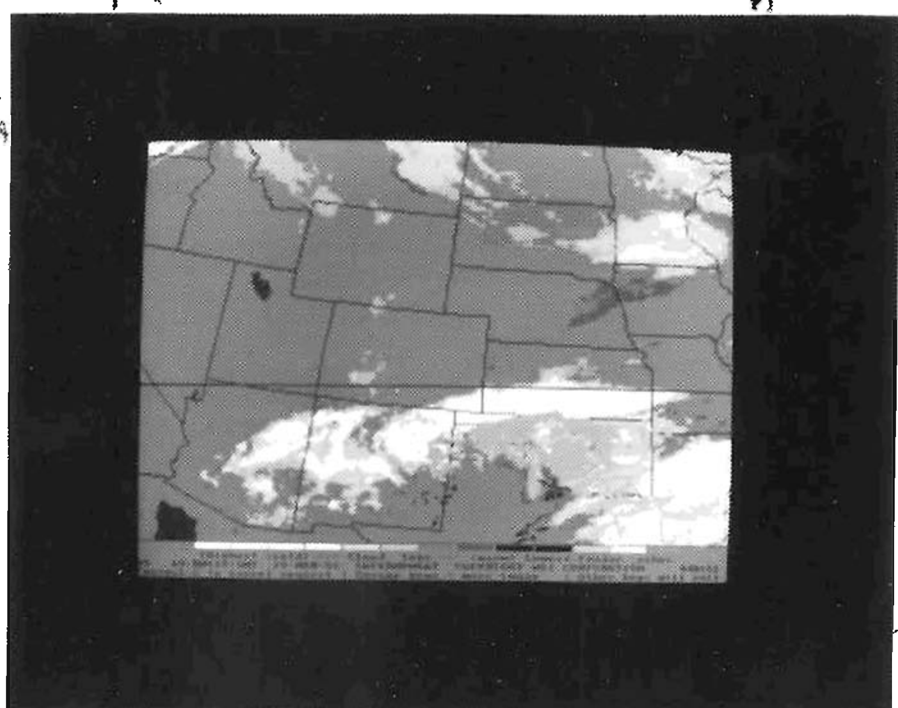
Photograph 3. Detailed map of instrumented interchange.



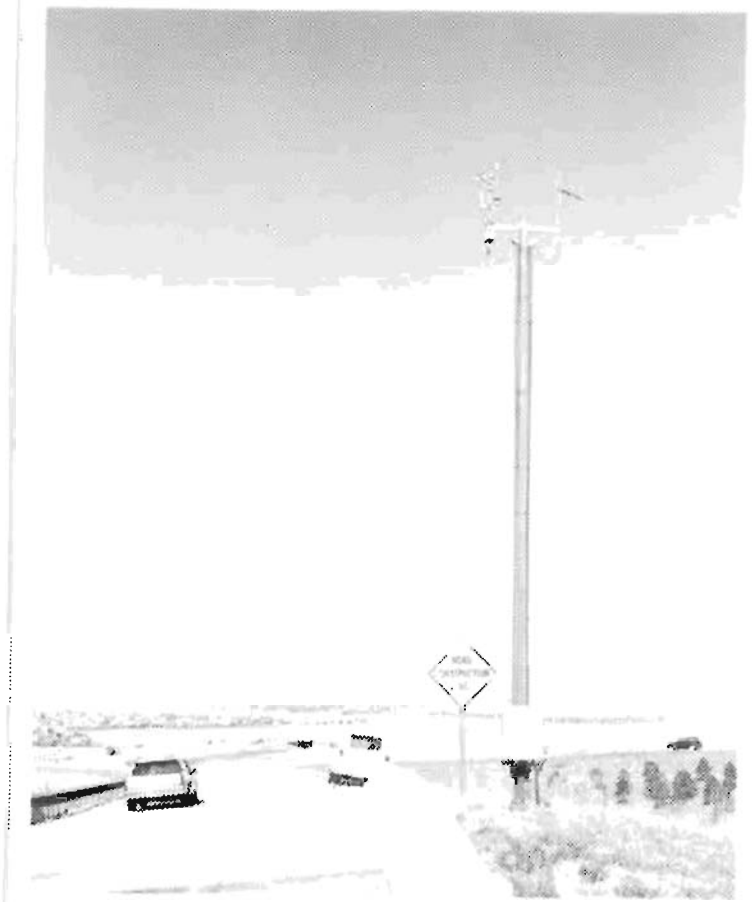
Photograph 4. The software allows graphing of long-term history files.



Photograph 5. Radar images can also be displayed using WSI software.

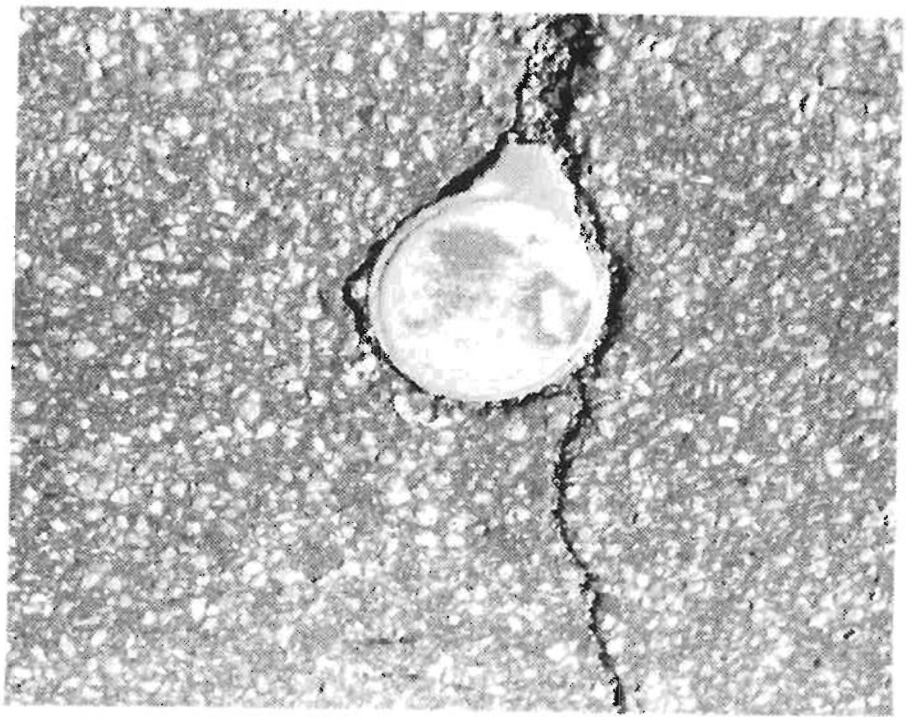


Photograph 6. Satelite images can be downloaded and displayed using WSI software.



Photograph 7. Instrument tower at C-470 and I-25 just south of Denver.

Photograph 8. Closeup view of weather instruments on tower.



Photograph 9. In-pavement sensor installed in bridge deck. Sensor measures pavement temperature and the presence of deicing chemicals.

Appendix C

Typical Text Screens

Summary Page of All Sensors

COLORADO D.O.H. DIST. 6 Summary Page Time 07:48 April 12, 1991
Power on at: 07:00 on 03/27/91

Sensor No.	Sensor location	Status	Precip	Surf		Temperature Air		Dew pt		CF
1	I25NB-C470WB-WAP-SHD	Snow/ice alert	N	v	32	v	26	*	26.0	v05
2	I25NB-C470NB-WDK-LN1		N	^	31	v	26	*	26.0	
3	I25NB-C470WB-EDK-LN1	Snow/ice alert	N	^	32	v	26	*	26.0	
4	I25NB-C470WB-EAP-SHD	Wet	N	v	34	v	26	*	26.0	^05
5	C470EB-I25NB-DK-LN1	Chemical wet	N	^	31	v	26	*	26.0	^85
6	C470EB-I25NB-AP-SHDR	Chemical wet	N	^	32	v	26	*	26.0	^95
7	C470EB-I25NB-DK-LN2		N	^	47	v	26	*	26.0	
8	I25NB-C470-ML-LN3		N	^	128	v	26	*	26.0	
9	I70WB-ML-AP-LN3	Wet	Y	^	36	^	32	*	30.1	^75
10	I70WB-ML-DK-LN1	Wet	Y	^	36	^	32	*	30.1	^75
11	I70WB-ML-DK-LN3	Wet	Y	^	36	^	32	*	30.1	v65
12	I70WB-ML-VAS-LN3	Wet	Y	^	34	^	32	*	30.1	^75
13	I70EB-ML-AP-LN3	Wet	Y	^	40	^	32	*	30.1	^50
14	I70EB-ML-DK-LN3		Y	^-	42	^	32	*	30.1	
15	I70EB-ML-WSH-DK-LN1	Wet	Y	^	35	^	32	*	30.1	^45
16	I70EB-WSH-GRDPRB		Y	v	52	^	32	*	30.1	
17	EVNS-EB-SANFE-AP-LN3	Wet	N	^	35	^	32		29.1	^75
18	EVNS-EB-SANFE-DK-LN2	Chemical wet	N	^	32	^	32		29.1	^75
19	US85-SB-OFFRMP	Wet	N	^	35	^	32		29.1	v60
20	US85-NB-ML-LN3	Wet	N	^	38	^	32		29.1	v40
21	WLNT-WB-AP-LN3	Wet	Y	^	33	^	32	*	30.7	^95
22	WLNT-WB-DK-LN2		Y	v	38	^	32	*	30.7	
23	WLNT-WB-DK-LN1		Y	^	38	^	32	*	30.7	
24	121NB-C470-LN2	Wet	Y	^	38	^	20	*	19.0	v30
25	C470EB-121-AP-LN2	Wet	Y	^	34	^	20	*	19.0	v40
26	C470WB-121-DK-LN2	Wet	Y	^	35	^	20	*	19.0	v45
27	C470WB-121-AP-LN1	Wet	Y	^	35	^	20	*	19.0	v35
28	C470SB-I70-DK-LN2	Communication Fail								
29	C470SB-I70-AP-LN2	Communication Fail								
30	I70WB-C470-LN2	Communication Fail								
31	C470NB-I70-DK-LN2	Communication Fail								
32	C470NB-I70-AP-LN2	Communication Fail								

Summary Page (Cont'd)

COLORADO D.O.H. DIST. 6 Summary Page Time 07:49 April 12, 1991
Power on at: 07:00 on 03/27/91

Sensor No.	Sensor location	Status	Precip		Surf		Temperature Air		Dew pt	CF
33	I70EB-C470-LN2	Communication Fail								
34	SH7WB-I25-DK	Communication Fail								
35	SH7EB-I25-AP	Communication Fail								
36	SBI25-SH7-LN3	Communication Fail								
37	I70EB-CHMB-RAMP	Wet	Y	^	35	v	30	*	30.0	v05
38	CHMBNB-I70-DK-LN2	Chemical wet	Y	^	32	v	30	*	30.0	^50
39	CHMBSB-I70-AP-LN2	Wet	Y	^	34	v	30	*	30.0	v50
40	I70WB-CHMB-LN3	Chemical wet	Y	^	32	v	30	*	30.0	^50
41	CLFXEB-COLO-LN2	Absorption	N	^	36	v	32	*	30.7	
42	CLFXWB-COLO-LN2	Absorption	N	^	37	v	32	*	30.7	
43	COLONB-CLFX-LN3		N	^	36	v	32	*	30.7	
44	COLOSB-CLFX-LN3	Absorption	N	^	35	v	32	*	30.7	
45	SHERSB-NYALE-LN2	Absorption	N	^	35	^	31	*	30.1	
46	SHERSB-@YALE-LN1	Absorption	N	^	37	^	31	*	30.1	
47	SHERNB-@YALE-LN1	Absorption	N	^	37	^	31	*	30.1	
48	SHERSB-@BATES-LN2	Absorption	N	^	56	^	31	*	30.1	
49	THRNPRKY-I25SB-RAMP	Wet	Y	^	38	^	31	*	29.3	^25
50	THRNPRKY-EB-LN1	Wet	Y	^	36	^	31	*	29.3	v10
51	THRNPRKY-WB-LN1		Y	^	34	^	31	*	29.3	
52	THRNPRKY-WB-LN2		Y	^	35	^	31	*	29.3	

Enter system command and press <RETURN> :

History Page for Sensor 1

COLORADO D.O.H. DIST. 6   History Page   Time 07:51   April 12, 1991
Power on at: 07:00 on 03/27/91

Sensor # 1   I25NB-C470WB-WAP-SHD

Time	Day	Status	Precip	Rel. Hum.	CF	Temperatures Surf.	Air	Dew	Wind Dir/ Vel
05:12	12 *	Snow/ice alert	N	100	05	32	27	27.0	/ Calm
05:07	12 *	Communication Fail							
02:46	12	Snow/ice alert	N	100	05	32	* 27	27.0	/ Calm
00:49	12	Snow/ice alert	*N	100	05	32	28	28.0	/ Calm
23:38	11	Snow/ice alert	Y	100	05	32	* 28	28.0	/ Calm
23:27	11 *	Snow/ice alert	Y	100	05	* 32	29	29.0	/ Calm
23:24	11	Wet	Y	100	05	* 33	29	29.0	/ Calm
23:21	11	Wet	Y	100	05	* 34	29	29.0	/ Calm
23:16	11	Wet	Y	100	05	* 33	* 29	29.0	/ Calm
23:11	11	Wet	Y	100	10	* 34	30	30.0	/ Calm
23:04	11	Wet	Y	100	05	* 33	30	30.0	/ Calm
22:59	11	Wet	Y	100	05	* 34	30	* 30.0	/ Calm
22:52	11	Wet	Y	99	05	* 33	30	29.8	/ Calm
22:47	11	Wet	Y	99	10	* 34	30	29.8	/ Calm
22:42	11	Wet	Y	99	20	* 33	30	29.8	/ Calm

History Page for Sensor 3

Enter system command and press <RETURN> :HP 3

COLORADO D.O.H. DIST. 6   History Page   Time 07:51   April 12, 1991
Power on at: 07:00 on 03/27/91

Sensor # 3   I25NB-C470WB-EDK-LN1

Time	Day	Status	Precip	Rel. Hum.	CF	Temperatures Surf.	Air	Dew	Wind Dir/ Vel.
07:38	12 *	Snow/ice alert	N	100		32	26	26.0	/ Calm
07:29	12	Snow/ice alert	N	100	45	* 32	26	26.0	/ Calm
06:50	12 *	Snow/ice alert	N	100	05	31	26	26.0	/ Calm
06:46	12 *	Chemical wet	N	100	25	31	26	26.0	/ Calm
05:12	12 *	Snow/ice alert	N	100	05	31	27	27.0	/ Calm
05:07	12 *	Communication Fail							
03:19	12	Snow/ice alert	N	100	05	* 31	27	27.0	/ Calm
02:46	12	Snow/ice alert	N	100	05	32	* 27	27.0	/ Calm
00:49	12	Snow/ice alert	*N	100	05	32	28	28.0	/ Calm
23:38	11	Snow/ice alert	Y	100	05	32	* 28	28.0	/ Calm
23:16	11	Snow/ice alert	Y	100	05	32	* 29	29.0	/ Calm
22:59	11 *	Snow/ice alert	Y	100	05	* 32	30	* 30.0	/ Calm
22:47	11	Wet	Y	99	15	* 33	30	29.8	/ Calm
22:37	11	Wet	Y	98	05	* 34	30	29.4	/ Calm
22:33	11	Wet	Y	98	05	35	* 30	29.4	/ Calm