

1405-SR 522 Interchange
Woodinville, Washington

Cathodic Protection and Corrosion Monitoring Check-Out

WA-RD 87.1.1
November 1986



Washington State Department of Transportation

Planning, Research and Public Transportation Division
Research Office

in cooperation with the

United States Department of Transportation
Federal Highway Administration

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16. ABSTRACT The cathodic protection system on the I-405/SR 522 interchange near Woodinville, Washington was evaluated for proper operation. Three of the five zones on the bridge appeared to be cathodically protected. The current was increased in one of the unprotected zones to provide protection. The remaining zone could not be fixed due to the nonfunctional nature of thermistors, reference electrode and structure cables. A recommendation was made to deactivate the entire system for a period of two weeks to allow for depolarization. Following depolarization, native state potential valves should be measured to establish a basis of comparison before activating the system. Monitoring on a three month interval for one year should be done to ensure that all problems have been solved.			
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CATHODIC PROTECTION AND CORROSION MONITORING
CHECK - OUT
1405 - SR 522 INTERCHANGE
WOODINVILLE, WASHINGTON

By
ETCO Engineering Services, Inc.
Redondo, WA

Prepared for
Washington State Department of Transportation
In Cooperation with
U. S. Department of Transportation
Federal Highway Administration

November 1986

DISCLAIMER

The contents of this report reflect the views of the author who is responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official views or policies of the Washington State Department of Transportation or the Federal Highway Administration. This report does not constitute a standard, specification or regulation.

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WOODINVILLE INTERCHANGE
CATHODIC PROTECTION SYSTEM
WOODINVILLE, WASHINGTON

OCTOBER 1986

INTRODUCTION

The cathodic protection system on the subject bridge deck was installed in May, 1985. Initial system start-up and activation was completed in November, 1985. A corrosion monitoring system was also installed in 6 sites at this location.

This annual check-out was completed by Intermountain Corrosion Service, Inc, on October 23, 1986. Monthly monitoring has been performed by WSDOT forces.

TEST PROCEDURES

Potential values were obtained with a solid state high impedance voltmeter, Model LC-4 or 372-MI as manufactured by M. C. Miller Co. Potential values were referenced to permanently installed silver silver-chloride reference electrode or a portable copper copper-sulfate reference electrode.

Thermistor values were measured with an Omega Model 865 thermometer.

Resistance values were measured with a Nilsson Model 400 Soil Resistivity Meter.

TEST RESULTS AND ANALYSIS

A. Cathodic Protection System

- I. Temperature and resistance values of the thermistors is presented in Table I. Some fluctuations were noted in the temperature readings which could have been due to the midmorning rapid rise in temperature. The Zone 5 thermistor is ineffective.

- II. The rectifier output data is listed in Table II. The current in Zone 2 was found to be near zero. Inspection of system components revealed no apparent reason for the low current output in Zone 2, therefore the current was increased to 5.3 amperes. The start-up current in January, 1985 for Zone 2 was 4.0 amperes.

- III. The rectifier has five individual output circuits that are controlled automatically. The automatic control units are operated from ON to OFF by the value of the reference electrode potential. The reference and set potential values are presented in Table III. The set potential value is the upper limit potential that the rectifier will attempt to achieve by supplying current to the system. The reference potential is the potential value being supplied to the rectifier controller. Once the reference potential equals the set potential, the current will be automatically decreased so the set potential value is not exceeded. The Zone 5 reference electrode is ineffective as it was during the start-up period. The start-up values are shown

in the attached report by HARCO dated October 1, 1986. The Zone 5 current is apparently being controlled by the circuit resistance.

- IV. Table IV values are duplicates of the values in Table II but obtained at the rectifier panel as compared to the junction box panel.
- V. The reference electrode potential values presented in Table V are the same values as the reference values in Table III but with test points at different locations.
- VI. The rebar probe potential values are in reference to permanent reference cells. Probe P-2 and P-5 have electrically discontinuous cables which was verified by using an alternative negative meter connection.
- VII. Table VII lists the resistance between the rebar probe and the structural rebar indicating there is no contact between the two metal components.
- VIII. The values in Table VIII would be the same as the potential values presented in Table VI but at a different test point location.

The original contract specifications required that ". . . resistance type corrosion rate probes . . ." be installed as a component to the deck instrumentation. This type of probe is basically a length of metal with similar composition as the reinforcing steel with a calibrated resistance. Corrosion rates of the reinforcing steel can be

determined by measuring the change in resistance of the resistance probe. Changes in resistance would be caused by reduction in cross section of the resistance wire caused by corrosion cell activity.

The rebar probes installed on this project will not function as a resistance type probe. The rebar probes can be used to determine the corrosion rate of steel rebar not being cathodically protected. However, potential values will not indicate magnitude or presence of corrosion cells. The probes will normally exist in an anodic condition due to their chloride laden environment. Corrosion rates of the probes can be calculated by measuring the current flow from the probe with the rectifier off. No current flow was detected during this check-out, therefore, we must assume corrosion cell activity has not been indicated. This method of corrosion rate measurement must be used with caution because the bridge deck rebar may be in a different and less corrosive environment than the rebar probe in the fabricated corrosion cell.

- IX. The depolarization test values for a three hour period are shown in Table IX. The Zone 5 values are referenced to a copper copper-sulfate reference electrode, however, the test values appear to be inconsistent and would require additional testing to properly analyze the problems involved.

B. Corrosion Monitoring System

X. Table X-1 through X-6 presents the corrosion monitoring system values with the addition of the thermistor resistance. The following monitoring system components appear to be ineffective:

- * Indicates locations determined as possible ineffective thermistors at original start-up period.
- ** Indicates locations determined as ineffective reference cell components at original start-up period.

Site 1

<u>Location</u>	<u>Thermistor</u>	<u>Reference Cell</u>
* 850 + 40E	X	
851 + 24E		X
* 852 + 92W	X	
* 854 + 60W	X	
* 855 + 44E	X	
* 855 + 44W	X	

Site 2

<u>Location</u>	<u>Thermistor</u>	<u>Reference Cell</u>
858 + 80W	X	X
859 + 64E	X	
860 + 48E		X
* 861 + 32W	X	
862 + 16E	X	
* 863 + 00W	X	

Site 3

<u>Location</u>	<u>Thermistor</u>	<u>Reference Cell</u>
* 851 + 24W	X	
* 853 + 76W	X	
* 855 + 44E	X	X

Site 4

<u>Location</u>	<u>Thermistor</u>	<u>Reference Cell</u>
* 857 + 12E	X	
* 857 + 12W	X	X
857 + 96E		X
858 + 80E		X
* 858 + 80W	X	X

859 + 64E		X
859 + 64W		X
860 + 48E		X
** 860 + 48W		X
* 861 + 32E	X	X
861 + 32W		X
862 + 16E		X
* 862 + 16W	X	X
* 863 + 00E	X	X
863 + 00W	X	X

Site 5

<u>Location</u>	<u>Thermistor</u>	<u>Reference Cell</u>
* 44 + 97W	X	
* 50 + 85E **	X	X
* 50 + 85W **	X	X
53 + 79E **	X	X

Site 6

<u>Location</u>	<u>Thermistor</u>	<u>Reference Cell</u>
* 58 + 20E **	X	X
* 58 + 20W **	X	X
* 61 + 14E	X	
* 62 + 61W **	X	X

CONCLUSIONS

1. The thermistor, reference electrode, and structure cables at Zone 5 are not functioning properly.
2. The Zone 2 structure cable was determined to be discontinuous during the field testing.
3. Using the 100-mv polarization decay or the 300-mv shift from native potential values as the criterion for acceptable levels of cathodic protection, Zones 1, 3, and 4 appear to be cathodically protected. The instant off potential value of a mortar coated steel structure is extremely difficult to measure with common field test instruments. Past experience has shown that accurate instant off potential values can only be measured with a laboratory oscilloscope that will time instant off as the alternating current reversal between the 60 cps frequency. Testing for instant off on a mortar coated structure with an oscilloscope has shown decreases in potential values from the "ON" position to the rectifier "OFF" to be less than 15-mv, and in some cases no detectable change. Portable test equipment is being developed that will accurately measure the instant off potential values to facilitate field testing. Portable test equipment and techniques will have to employed to accurately test the system.

The test values obtained at Zone 2 were below an acceptable level during this investigation, however with the increased current output the Zone should be polarized with time resulting in increased potential values.

RECOMMENDATIONS

1. Ineffective reference electrodes should be replaced for accurate testing and monitoring.
2. Continue monitoring by WSDOT forces with present established procedures.
3. Portable reference electrodes should be used for monitoring at the locations which have ineffective reference electrodes.
4. This system is complex due to the various zones established on the deck and there may be interference from one zone to another. To properly access the condition of the deck and properly adjust the cathodic protection system, the cathodic protection system should be deactivated and allowed to depolarize for a minimum of two weeks. Following depolarization, native state potential values should be measured to establish a basis of comparison before activating the system. Following this reactivation, the system should be monitored at three month intervals for one year by a qualified Corrosion Engineer to insure all problems have been identified and the system adjusted to provide continuous acceptable levels of cathodic protection.
5. This system should be monitored by an experienced Corrosion Engineer at three month intervals for one year to properly analyze the effects of seasonal changes on the operation of the system.

APPENDIX A

TABLES

TABLE I
WOODINVILLE INTERCHANGE
CATHODIC PROTECTION SYSTEM
WOODINVILLE, WASHINGTON

October 1986

MONITORING JUNCTION BOX DATA
THERMISTORS

	<u>THERMISTOR DEGREES - F</u>	<u>THERMISTOR RESISTANCE ohms</u>
ZONE 1	45.2	3150
ZONE 2	44 FLUCTUATING	5000
ZONE 3	48 FLUCTUATING	4950
ZONE 4	45 FLUCTUATING	4650
ZONE 5	+0 FLUCTUATING	5800

AIR TEMP - 46F

TIME 9:30 A.M.

(TEST LEAD RESISTANCE ohms)

TABLE II
WOODINVILLE INTERCHANGE
CATHODIC PROTECTION SYSTEM
WOODINVILLE, WASHINGTON

October 1986

MONITORING JUNCTION BOX DATA
RECTIFIER OUTPUT, ANODE COLLECTOR CABLES

	<u>AMPERES</u>	<u>VOLTAGE VOLTS</u>
ZONE 1	4.04	7.9
ZONE 2	5.3	11.5
ZONE 3	4.1	15.2
ZONE 4	4.12	5.1
ZONE 5	4.06	5.0

AIR TEMP - 46F

TIME 9:30 A.M.

TABLE III
WOODINVILLE INTERCHANGE
CATHODIC PROTECTION SYSTEM
WOODINVILLE, WASHINGTON

October 1986

RECTIFIER DATA

	<u>REFERENCE</u>	<u>SET</u>
ZONE 1	300	460
ZONE 2	210	500
ZONE 3	540	630
ZONE 4	310	710
ZONE 5	0	330

AIR TEMP - 46F

TIME 9:30 A.M.

TABLE IV
WOODINVILLE INTERCHANGE
CATHODIC PROTECTION SYSTEM
WOODINVILLE, WASHINGTON

October 1986

RECTIFIER OUTPUTS

	<u>SHUNT RATING</u>	<u>VOLTS</u>	<u>AMPS</u>
ZONE 1	10A - 50 mv	8.09	4.02
ZONE 2	10A - 50 mv	11.5	5.2
ZONE 3	10A - 50 mv	15.87	4.08
ZONE 4	10A - 50 mv	5.16	4.08
ZONE 5	10A - 50 mv	5.01	4.08
TOTAL	50A - 50 mv		21.42

AIR TEMP - 46F

TIME 9:30 A.M.

TABLE V
WOODINVILLE INTERCHANGE
CATHODIC PROTECTION SYSTEM
WOODINVILLE, WASHINGTON

October 1986

REFERENCE ELECTRODE POTENTIALS (-mv)

	<u>AT JUNCTION BOX</u>	<u>AT RECTIFIER</u>
CELL 1	237	.258
CELL 2	197	.200
CELL 3	559	.545
CELL 4	321	.333
CELL 5	.002 UNSTABLE (-)	.306 FLUCTUATING

AIR TEMP - 46F

TIME 10:20 A.M.

TABLE VI
WOODINVILLE INTERCHANGE
CATHODIC PROTECTION SYSTEM
WOODINVILLE, WASHINGTON

October 1986

MONITORING JUNCTION BOX
REBAR PROBE POTENTIALS (-mv)

PROBE 1	330		
PROBE 2	.009 302	UNSTABLE	REBAR CONN. NO GOOD ALT. (-) CONN.
PROBE 3	358		
PROBE 4	422		
PROBE 5	.006 111	UNSTABLE	REBAR CONN. NO GOOD ALT. (-) CONN.

AIR TEMP - 46F

TIME 9:30 A.M.

TABLE VII
WOODINVILLE INTERCHANGE
CATHODIC PROTECTION SYSTEM
WOODINVILLE, WASHINGTON

October 1986

RESISTANCE REBAR TO PROBE 1 OFF

CURRENT - OFF

CIRCUIT	RESISTANCE - ohms
1	110,000
2	33,000
3	68,000
4	43,000
5	29,000

AIR TEMP - 46F

TIME 1:50 P.M.

TABLE VIII
WOODINVILLE INTERCHANGE
CATHODIC PROTECTON SYSTEM
WOODINVILLE, WASHINGTON

October 1986

RECTIFIER PANEL
PROBE TO REFERENCE CELL (+) POTENTIALS (-mv)

CIRCUIT	CURRENT OFF
1	326
2	120
3	461
4	324
5 (TEMPORARY Cu-CuSO4)	320

AIR TEMP - 46F

TABLE IX
WOODINVILLE INTERCHANGE
CATHODIC PROTECTION SYSTEM
WOODINVILLE, WASHINGTON

October 1986

DE-POLARIZATION TESTS - mV

		ZONE 1		ZONE 2		ZONE 3		ZONE 4		ZONE 5	
		R	P	R	P	R	P	R	P	R (1)	P
ON		237		197		559		321			
<u>FIRST OFF</u>	11:30	241	333	207	239	424	305	298	381	240	149
	15 MIN.(11:45)	184	346	136	049	371	410	114	344	044	298
	30 MIN.(12:00)	172	350	124	+026	356	429	118	388	+011	351
	45 MIN.(12:15)	164	351	117	+015	348	438	089	333	+049	388
	60 MIN.(12:30)	156	348	113	+007	340	443	063	328	+080	413
	90 MIN.(1:00)	151	349	107	005	325	451	023	322	+130	457
	120 MIN.(1:30)	142	351	104	013	316	457	002	323	+163	487
	150 MIN.(2:00)	135	354	101	019	306	461	+011	324	+183	503
	180 MIN.(2:30)	130	357	104	024	296	465	+028	322	+197	516

R + REFERENCE

P = PROBE

(1) Portable Cu:CuSO4 reference electrode values.

TABLE X-1
 WOODINVILLE INTERCHANGE
 CATHODIC PROTECTION SYSTEM
 WOODINVILLE, WASHINGTON

October 1986

SITE NO. 1

<u>THERMISTOR DEGREES - F</u>	<u>THERMISTOR ohms</u>	<u>RESISTANCE STATION</u>	<u>REFERENCE CELL POTENTIAL - mV</u>
427	3	850 + 40E	188
54	3300	850 + 40W	149
51	4300	851 + 24E	-58
52	4000	851 + 24W	245
52	4200	852 + 80E	64
54	2900	852 + 80E	311
49	4500	852 + 92E	263
382	0	852 + 92W	173
50	20	853 + 76E	108
50	4400	853 + 76W	294
53	3400	854 + 60E	192
350	23	854 + 60W	82
F(-) 196	230	855 + 44E	35
F .200+	110	855 + 44W	63
52	3900	856 + 28E	302
51	4200	856 + 28W	245

AIR TEMP - 46F

TIME 12:50 P.M.

SHEET 1 of 6

TABLE X-2
 WOODINVILLE INTERCHANGE
 CATHODIC PROTECTION SYSTEM
 WOODINVILLE, WASHINGTON

October 1986

SITE NO. 2

<u>THERMISTOR DEGREES - F</u>	<u>THERMISTOR ohms</u>	<u>RESISTANCE STATION</u>	<u>REFERENCE CELL POTENTIAL - mV</u>
53.8	3900	857 + 12E	375
55.3	3700	857 + 12W	131
54.8	3900	857 + 96E	227
55.5	3700	857 + 96W	282
54.6	3900	858 + 80E	254
NR	480	858 + 80W	-19
NR	3900	859 + 64E	190
51.5	4300	859 + 64W	173
53.5	1700	860 + 48E	-137
54.3	3900	860 + 48W	329
56.2	3700	861 + 32E	63
NR	12	861 + 32W	374
(-)40.2	375	862 + 16E	286
51.6	4200	862 + 16W	133
51.0	4300	863 + 00E	310
NR	3.9	863 + 00W	343

AIR TEMP - 46F

TIME 12:40 P.M.

SHEET 2 of 6

TABLE X-3
WOODINVILLE INTERCHANGE
CATHODIC PROTECTION SYSTEM
WOODINVILLE, WASHINGTON

October 1986

SITE NO. 3

<u>THERMISTOR DEGREES - F</u>	<u>THERMISTOR ohms</u>	<u>RESISTANCE STATION</u>	<u>REFERENCE CELL POTENTIAL - mV</u>
50.8	4300	850 + 40E	220
47.3	2200	850 + 40W	112
56.7	2600	851 + 24E	193
F(-) 100	-0-M&B	851 + 24W	215
51.7	4200	852 + 08E	256
52	4000	852 + 08W	175
51.7	4200	852 + 92E	149
52.3	4100	852 + 92W	308
52.5	3000	853 + 76E	263
(-)F	140	853 + 76W	170
51.7	4200	854 + 60E	121
51	4300	854 + 60W	213
F 68.3	1500	855 + 44E	-113
52.5	3600	855 + 44W	217
51.7	4100	856 + 28E	269
53.1	4100	856 + 28W	189

AIR TEMP - 46F

TIME 12:30 P.M.

Sheet 3 of 6

TABLE X-4
 WOODINVILLE INTERCHANGE
 CATHODIC PROTECTION SYSTEM
 WOODINVILLE WASHINGTON

October 1986

SITE NO. 4

<u>THERMISTOR DEGREES - F</u>	<u>THERMISTOR ohms</u>	<u>RESISTANCE STATION</u>	<u>REFERENCE CELL POTENTIAL - mV</u>
325	31	857 + 12E	86
326	31	857 + 12W	-125
52.4	4100	857 + 96E	-305
56.6	3400	857 + 96W	223
50.8	4400	858 + 80E	-178
-48 F	120	858 + 80W	NR
52.3	3900	859 + 64E	NR
51.0	4300	859 + 64W	-40
59.5	2400	860 + 48E	-60
56.6	3600	860 + 48W	NR
-30 F	330	861 + 32E	NR
51.8	4300	861 + 32W	NR
55.5	3600	862 + 16E	-144
NR	9.4	862 + 16W	NR
NR	3.4	863 + 00E	NR
NR	45	863 + 00W	-324

AIR TEMP - 46F

TIME 1:20 P.M.

Sheet 4 of 6

TABLE X-5
 WOODINVILLE INTERCHANGE
 CATHODIC PROTECTION SYSTEM
 WOODINVILLE, WASHINGTON

October 1986

SITE NO. 5

<u>THERMISTOR DEGREES - F</u>	<u>THERMISTOR RESISTANCE ohms</u>	<u>RESISTANCE STATION</u>	<u>REFERENCE CELL POTENTIAL - mV</u>
49.2	4500	43 + 50E	56
50.1	3400	43 + 50W	155
51.7	4200	44 + 97E	93
124 F	3900	44 + 97W	100
54.5	3800	46 + 44E	94
54.9	2200	46 + 44W	105
53.6	4000	47 + 91E	71
55.2	3800	47 + 91W	153
50.7	4400	49 + 38E	85
55	3900	49 + 38W	32
-30 F	75,000	50 + 85E	NR
-30 F	70,000	50 + 85W	NR
52.8	3800	52 + 32E	24
53.9	4000	52 + 32W	113
OFF SCALE 268	51	53 + 79E	NR
53	3900	53 + 79W	103

AIR TEMP - 46F

TIME 1:00 P.M.

Sheet 5 of 6

TABLE X-6
 WOODINVILLE INTERCHANGE
 CATHODIC PROTECTION SYSTEM
 WOODINVILLE, WASHINGTON

October 1986

SITE NO. 6

<u>THERMISTOR DEGREES - F</u>	<u>THERMISTOR ohms</u>	<u>RESISTANCE STATION</u>	<u>REFERENCE CELL POTENTIAL - mV</u>
55.4	3500	55 + 26E	152
54.5	3900	55 + 26W	80
55.7	3800	56 + 73E	377
59.7	3900	56 + 73W	101
NR	64,000	58 + 20E	NR
NR	59,000	58 + 20W	NR
57.6	3600	59 + 67E	101
56.6	3500	59 + 67W	73
NR	26	61 + 14E	86
55.5	3800	61 + 14W	130
56.3	3800	62 + 61E	171
NR	90,000	62 + 61W	NR
55.5	3800	64 + 08E	212
59.9	2900	64 + 08W	232
59.0	3000	65 + 55E	197
59.8	3400	65 + 55W	170

AIR TEMP - 46F

TIME 1:35 P.M.

Sheet 6 of 6

APPENDIX - B
PREVIOUS REPORTS AND TEST DATA

DEPARTMENT OF TRANSPORTATION
BRIDGE & STRUCTURES

DATE 5/15/86

FROM DESK OF Tom Roper

ROUTING ORDER

NOTED

DATE

EHH

Subject: Woodinville Interchange
C.P. System
Deck Instrumentation System

Dist. 1 personnel & I met with Kerri Howell at Woodinville Interchange. Kerri gave instruction to Dan Jones, Dave Deede, Jim Lowe now to monitor the above systems. She also provided Forms. Monitoring is to be done on a monthly basis with copies of reports sent to the bridge branch. Dist. personnel understood the monitoring technique, and there should be no problem with district taking the readings.

It appears from the readings that approx. 20 of the thermistors are not functioning properly, also 5 reference cells are not operating. There are a total of 96 thermistors and 96 reference cells. The C.P. system appears to be functioning O.K.

CORROSION MONITORING SYSTEM
WASHINGTON DEPARTMENT OF TRANSPORTATION

WOODINVILLE INTERCHANGE
SITE NO. 1

THERMISTOR	STATION	REFERENCE CELL
<i>Over Scale</i>	850 + 40 E	+ .228
57.5	850 + 40 W	+ .170
55.6	851 + 24 E	+ .249
56.1	851 + 24 W	+ .297
56.7	852 + 08 E	+ .085
58.7	852 + 08 W	+ .300
54.3	852 + 92 E	+ .310
<i>Over scale</i>	852 + 92 W	+ .213
55.1	853 + 76 E	+ .161
54.6	853 + 76 W	+ .349
55.5	854 + 60 E	+ .214
<i>Over scale</i>	854 + 60 W	+ .434
58-78 <i>Varying</i>	855 + 44 E	+ .143
<i>Over scale</i>	855 + 44 W	+ .347
55.5	856 + 28 E	+ .316
55.4	856 + 28 W	+ .291

DATE: 5/14/86 TIME: 11:01 WEATHER: ~60° Cloudy

NOTES:

RECORDED BY: _____

**CORROSION MONITORING SYSTEM
WASHINGTON DEPARTMENT OF TRANSPORTATION**

**WOODINVILLE INTERCHANGE
SITE NO. 2**

THERMISTOR	STATION	REFERENCE CELL
55.9	857 + 12 E	+383
56.4	857 + 12 W	+353
56.1	857 + 96 E	+247
55.9	857 + 96 W	+275
53.9	858 + 80 E	+323
53.6	858 + 80 W	+267
55.6	859 + 64 E	+160
54.6	859 + 64 W	+243
56.5	860 + 48 E	+349
55.3	860 + 48 W	+353
55.4	861 + 32 E	+001
Overscale	861 + 32 W	+325
54.7	862 + 16 E	+272
54.7	862 + 16 W	+135
55.5	863 + 00 E	+329
Overscale	863 + 00 W	+325

DATE: 5/14/86 TIME: 11:16 AM WEATHER: 260° Cloudy

NOTES:

RECORDED BY: _____

CORROSION MONITORING SYSTEM
WASHINGTON DEPARTMENT OF TRANSPORTATION

WOODINVILLE INTERCHANGE
SITE NO. 3

THERMISTOR	STATION	REFERENCE CELL
56.3	850 + 40 E	+289 +.302
60.9	850 + 40 W	⊖ +.195
60.3	851 + 24 E	⊖ +.286
-110	851 + 24 W	⊖ +.226
56.2	852 + 08 E	+ .309
56.7	852 + 08 W	+ .274
56.1	852 + 92 E	+ .280
56.6	852 + 92 W	+ .317
54.4	853 + 76 E	+ .279
- Low Battery	853 + 76 W	+ .120
55.8	854 + 60 E	+ .305
55.1	854 + 60 W	+ .155
45-54 ^{Varying} _{Constantly}	855 + 44 E	+ .145
54.9	855 + 44 W	+ .004
56.3	856 + 28 E	+ .307
56.1	856 + 28 W	- .046

DATE: 5/14/86 TIME: 10:48 WEATHER: ~ 60°F CLOUDY

NOTES:

RECORDED BY: KM HOWELL
HARCO

CORROSION MONITORING SYSTEM
WASHINGTON DEPARTMENT OF TRANSPORTATION

WOODINVILLE INTERCHANGE
SITE NO. 4

THERMISTOR	STATION	REFERENCE CELL
31 Ω Overscale	857 + 12 E	+124
31 Ω Overscale	857 + 12 W	+274
4K Ω 55.9	857 + 96 E	+063
4K Ω 55.0	857 + 96 W	+168
53.9	858 + 80 E	+163
30K Ω - Low Battery	858 + 80 W	+042
56.6	859 + 64 E	+359
54.4	859 + 64 W	+391
59.9	860 + 48 E	+272
57.7	860 + 48 W	-071
10K Ω - Low Battery	861 + 32 E	+043
54.8	861 + 32 W	+302
55.0	862 + 16 E	+224
8 Ω Overscale	862 + 16 W	+307
4.8 Ω Overscale	863 + 00 E	+193
54.7	863 + 00 W	+190

DATE: 5/14/86 TIME: 11:21 A WEATHER: R. 60°F Cloudy

NOTES:

RECORDED BY: _____

CORROSION MONITORING SYSTEM
WASHINGTON DEPARTMENT OF TRANSPORTATION

WOODINVILLE INTERCHANGE
SITE NO. 5

THERMISTOR	STATION	REFERENCE CELL
57.7	43 + 50 E	+ .062
60.6	43 + 50 W	+ .199
58.7	44 + 97 E	+ .130
- Low Battery	44 + 97 W	+ .163
61.0	46 + 44 E	+ .144
61.3	46 + 44 W	+ .151
60.0	47 + 91 E	+ .094
60.4	47 + 91 W	+ .184
51.0	49 + 38 E	+ .111
59.6	49 + 38 W	+ .033
- Low Battery	50 + 85 E	0
- Low Battery	50 + 85 W	+ .010
57.9	52 + 32 E	+ .063
53.0	52 + 32 W	+ .146
53.2	53 + 79 E	0
57.8	53 + 79 W	+ .046

DATE: 5/14/86 TIME: 11:59 A WEATHER: ~60°F Cloudy

NOTES:

RECORDED BY: _____

CORROSION MONITORING SYSTEM
WASHINGTON DEPARTMENT OF TRANSPORTATION

WOODINVILLE INTERCHANGE
SITE NO. 6

THERMISTOR	STATION	REFERENCE CELL
55.8	55 + 26 E	+114
56.0	55 + 26 W	+093
55.5	56 + 73 E	+327
59.6	56 + 73 W	+141
- Low Battery	58 + 20 E	0
- Low Battery	58 + 20 W	0
59.1	59 + 67 E	+125
56.3	59 + 67 W	+104
Overscale	61 + 14 E	+111
57.4	61 + 14 W	+148
56.2	62 + 61 E	+248
- LOW Battery	62 + 61 W	0
57.0	64 + 08 E	+271
58.6	64 + 08 W	+269
58.6	65 + 55 E	+254
60.0	65 + 55 W	+247

DATE: 5/14/86 TIME: 11:36 WEATHER: 26° Cloudy

NOTES:

RECORDED BY: _____

DATE: June 27, 1986

FROM: ^{Raw} Ralph L. Wessels / MS-29

PHONE: Scan 443-4258

SUBJECT: Woodenville I/C
Cathodic Protection
Monitoring
C-2814 SR 405 & 522

TO: Tom Roper - HQ's Bridge;
Kerri M. Howel - Harco Corp.

Attached are the current test results for the monitoring instrumentation on the above project.

Change in reference cell readings exceeding ± 150 mv.

Site No. 2
Sta. 858+80 W

Site No. 3
Sta. 855+44 W

Site No. 4
Sta. 857+12 E
Sta. 859+64 E
Sta. 860+48 W
Sta. 862+16 W

DAJ:kal

Attachments

File: HR0902

Serial No. 86-282

**CORROSION MONITORING SYSTEM
WASHINGTON DEPARTMENT OF TRANSPORTATION**

**WOODINVILLE INTERCHANGE
SITE NO. 1**

THERMISTOR	STATION	REFERENCE CELL
over scale	850 + 40 E	+ .221
66.1	850 + 40 W	+ .180
63.5	851 + 24 E	+ .244
64.2	851 + 24 W	+ .312
66.2	852 + 08 E	+ .102
68.5	852 + 08 W	+ .332
61.5	852 + 92 E	+ .306
over scale	852 + 92 W	+ .232
62.1	853 + 76 E	+ .156
61.8	853 + 76 W	+ .349
63.7	854 + 60 E	+ .251
over scale	854 + 60 W	+ .300
- 56.2	855 + 44 E	+ .070
63.6 ^{varying}	855 + 44 W	+ .309
64.1	856 + 28 E	+ .315
63.6	856 + 28 W	+ .284

DATE: 6-18-86 TIME: 10:40 AM WEATHER: Partly sunny 65° F

NOTES: VOLT METER
TINKER & RASOR
CPV-4
Set. No. 1086

RECORDED BY: Pan Jones

CORROSION MONITORING SYSTEM
WASHINGTON DEPARTMENT OF TRANSPORTATION

WOODINVILLE INTERCHANGE
SITE NO. 2

THERMISTOR	STATION	REFERENCE CELL
65.1	857 + 12 E	+ .406
65.8	857 + 12 W	+ .352
66.8	857 + 96 E	+ .289
66.5	857 + 96 W	+ .292
61.4	858 + 80 E	+ .323
54.0 ^{LOW} battery	858 + 80 W	+ .119
65.0	859 + 64 E	+ .220
63.2	859 + 64 W	+ .240
66.0	860 + 48 E	+ .172
64.5	860 + 48 W	+ .363
65.9	861 + 32 E	+ .253
over scale	861 + 32 W	+ .362
- 43.3	862 + 16 E	+ .304
64.4	862 + 16 W	+ .140
64.1	863 + 00 E	+ .336
over scale	863 + 00 W	+ .396

DATE: 6-18-86 TIME: 11:05 AM WEATHER: PARTLY SUNNY 65° F.

NOTES: APPARENT FAILURE, THERMISTOR
STA. 858 + 80 W

RECORDED BY: Dan Jones

**CORROSION MONITORING SYSTEM
WASHINGTON DEPARTMENT OF TRANSPORTATION**

**WOODINVILLE INTERCHANGE
SITE NO. 3**

THERMISTOR	STATION	REFERENCE CELL
64.1	850 + 40 E	+ .288
67.1	850 + 40 W	+ .191
70.2	851 + 24 E	+ .264
- 66.5 ^{LOW} BATTERY	851 + 24 W	+ .271
65.5	852 + 08 E	+ .300
65.3	852 + 08 W	+ .273
64.5	852 + 92 E	+ .269
65.9	852 + 92 W	+ .325
62.5	853 + 76 E	+ .283
- 64.7 ^{LOW} BATTERY	853 + 76 W	+ .114
64.1	854 + 60 E	+ .239
62.9	854 + 60 W	+ .192
73.4	855 + 44 E	+ .104
62.7	855 + 44 W	+ .220
64.5	856 + 28 E	+ .307
65.4	856 + 28 W	- .022

DATE: 6-18-86 TIME: 10:30 AM WEATHER: 65°F. PARTLY SUNNY

NOTES:

RECORDED BY: Dan Jones

CORROSION MONITORING SYSTEM
WASHINGTON DEPARTMENT OF TRANSPORTATION

WOODINVILLE INTERCHANGE
SITE NO. 4

THERMISTOR	STATION	REFERENCE CELL
overscale	857 + 12 E	+ .313
overscale	857 + 12 W	+ .285
64.9	857 + 96 E	- .010
63.3	857 + 96 W	+ .138
63.2	858 + 80 E	+ .168
50. ^{Low} BATTERY	858 + 80 W	+ .020
64.0	859 + 64 E	+ .209
63.1	859 + 64 W	+ .396
71.1	860 + 48 E	+ .318
68.1	860 + 48 W	+ .102
68.3	861 + 32 E	- .021
62.9	861 + 32 W	+ .300
62.5	862 + 16 E	+ .254
overscale	862 + 16 W	+ .138
overscale	863 + 00 E	+ .241
Low battery	863 + 00 W	+ .127

DATE 6-18-86

TIME: 11:15

WEATHER: PARTLY SUNNY 65° F

NOTES:

RECORDED BY: Dan Jones

**CORROSION MONITORING SYSTEM
WASHINGTON DEPARTMENT OF TRANSPORTATION**

**WOODINVILLE INTERCHANGE
SITE NO. 5**

THERMISTOR	STATION	REFERENCE CELL
64.2	43 + 50 E	+ .068
66.1	43 + 50 W	+ .214
65.7	44 + 97 E	+ .116
-Low Battery	44 + 97 W	+ .158
67.7	46 + 97 E	+ .152
68.3	46 + 44 W	+ .151
66.4	47 + 91 E	+ .182
67.9	47 + 91 W	+ .186
59.2	49 + 38 E	+ .107
66.6	49 + 38 W	+ .033
Low Battery	50 + 85 E	0
Low Battery	50 + 85 W	+ .001
64.0	52 + 32 E	+ .057
62.3	52 + 32 W	+ .154
Low Battery	53 + 79 E	0
63.8	53 + 79 W	+ .053

DATE: 6-18-86 TIME: 10:50 AM WEATHER: Partly Sunny 65°F

NOTES:

RECORDED BY: Dan Jones

**CORROSION MONITORING SYSTEM
WASHINGTON DEPARTMENT OF TRANSPORTATION**

**WOODINVILLE INTERCHANGE
SITE NO. 6**

THERMISTOR	STATION	REFERENCE CELL
64.2	55 + 26 E	+ .101
64.1	55 + 26 W	+ .100
64.5	56 + 73 E	+ .300
67.9	56 + 73 W	+ .153
Low battery	58 + 20 E	0
Low battery	58 + 20 W	0
67.4	59 + 67 E	+ .116
64.8	59 + 67 W	+ .089
overscale	61 + 14 E	+ .113
65.7	61 + 14 W	+ .146
65.7	62 + 61 E	+ .246
Low battery	62 + 61 W	0
67.7	64 + 08 E	+ .271
70.0	64 + 08 W	+ .286
68.0	65 + 55 E	+ .238
69.7	65 + 55 W	+ .235

DATE 6-18-86 TIME: 11:30 AM WEATHER: PARTLY sunny 65°

NOTES:

RECORDED BY: Dan Jones

DATE: July 24, 1986

FROM: Ralph L. Wessels / MS-29

PHONE: Scan 443-4154

SUBJECT: Woodenville I/C
Cathodic Protection
Monitoring
C-2814 SR 405 & 522

TO: Tom Roper - HQ Bridge / KF01

Attached are the current test results for the monitoring instrumentation on the above project.

Change in reference cell readings exceeding ± 150 mv. are highlighted.

DAJ:kal

Attachments

cc: Kerri M. Howel - Harco Corp.

File: HR0902

Serial No. 86.331

**CORROSION MONITORING SYSTEM
WASHINGTON DEPARTMENT OF TRANSPORTATION**

**WOODINVILLE INTERCHANGE
SITE NO. 1**

THERMISTOR	STATION	REFERENCE CELL
<i>over scale</i>	850 + 40 E	+ .216
74.3	850 + 40 W	+ .795
71.6	851 + 24 E	+ .250
72.8	851 + 24 W	+ .310
72.8	852 + 08 E	+ .130
73.9	852 + 08 W	+ .351
71.9	852 + 92 E	+ .305
71.9	852 + 92 W	+ .162
71.6	853 + 76 E	+ .001
71.7	853 + 76 W	+ .354
72.1	854 + 60 E	+ .280
72.1	854 + 60 W	+ .131
- 60.0	855 + 44 E	+ .296
86.1	855 + 44 W	+ .106
72.3	856 + 28 E	+ .302
71.9	856 + 28 W	+ .290

DATE: 7-22-86 TIME: 1:30 PM WEATHER: CLOUDY 68° F

NOTES: VOLT METER
TINKER & RASOT
CPK-4

80° F on 7-21-86

SU No. 7086

RECORDED BY: Dan Jones

**CORROSION MONITORING SYSTEM
WASHINGTON DEPARTMENT OF TRANSPORTATION**

**WOODINVILLE INTERCHANGE
SITE NO. 2**

THERMISTOR	STATION	REFERENCE CELL
72.6	857 + 12 E	+ .399
72.7	857 + 12 W	+ .275
72.6	857 + 96 E	+ .263
72.7	857 + 96 W	+ .316
71.6	858 + 80 E	+ .330
<u> </u>	858 + 80 W	+ .073
70.9	859 + 64 E	+ .215
70.3	859 + 64 W	+ .241
72.0	860 + 48 E	- .181
71.2	860 + 48 W	+ .383
71.1	861 + 32 E	+ .033
<u> </u>	861 + 32 W	+ .381
-39.6	862 + 16 E	+ .322
71.9	862 + 16 W	+ .247
73.0	863 + 00 E	+ .360
72.7	863 + 00 W	+ .403

DATE: 7-22-86 TIME: 1:50 WEATHER: Cloudy 68° F.

NOTES:

RECORDED BY: Dan Jones

**CORROSION MONITORING SYSTEM
WASHINGTON DEPARTMENT OF TRANSPORTATION**

**WOODINVILLE INTERCHANGE
SITE NO. 3**

THERMISTOR	STATION	REFERENCE CELL
73.1	850 + 40 E	+ .275
70.9	850 + 40 W	+ .178
76.1	851 + 24 E	+ .241
LOW BATTERY	851 + 24 W	+ .264
22.3	852 + 08 E	+ .297
73.6	852 + 08 W	+ .241
72.7	852 + 92 E	+ .237
72.8	852 + 92 W	+ .333
73.4	853 + 76 E	+ .281
LOW BATTERY	853 + 76 W	+ .220
72.3	854 + 60 E	+ .034
71.8	854 + 60 W	+ .171
80.2	855 + 44 E	+ .050
72.4	855 + 44 W	+ .244
73.1	856 + 28 E	+ .299
72.3	856 + 28 W	- .032

DATE: 7-22-86

TIME: 2:00

WEATHER: Cloudy 68° F

NOTES:

RECORDED BY: Dan Jones

CORROSION MONITORING SYSTEM
WASHINGTON DEPARTMENT OF TRANSPORTATION

WOODINVILLE INTERCHANGE
SITE NO. 4

THERMISTOR	STATION	REFERENCE CELL
—	857 + 12 E	+ .351
—	857 + 12 W	+ .295
72.7	857 + 96 E	- .004
72.2	857 + 96 W	+ .131
69.1	858 + 80 E	+ .174
-50 —	858 + 80 W	- .102
73.4	859 + 64 E	+ .296
71.1	859 + 64 W	+ .420
77.2	860 + 48 E	+ .320
74.3	860 + 48 W	+ .142
78.0	861 + 32 E	+ .004
72.3	861 + 32 W	+ .264
71.3	862 + 16 E	+ .246
—	862 + 16 W	+ .247
—	863 + 00 E	- .090
—	863 + 00 W	+ .125

DATE: 7-22-86 TIME: 1:45 WEATHER: cloudy 68° F

NOTES:

RECORDED BY: Dan Jones

CORROSION MONITORING SYSTEM
WASHINGTON DEPARTMENT OF TRANSPORTATION

WOODINVILLE INTERCHANGE
SITE NO. 5

THERMISTOR	STATION	REFERENCE CELL
74.5	43 + 50 E	+ .071
74.6	43 + 50 W	+ .221
75.4	44 + 97 E	+ .127
—	44 + 97 W	+ .158
75.6	46 + 97 E	+ .148
75.9	46 + 44 W	+ .157
74.1	47 + 91 E	+ .106
74.5	47 + 91 W	+ .197
73.6	49 + 38 E	+ .127
75.3	49 + 38 W	+ .031
—	50 + 85 E	— 0
—	50 + 85 W	+ .002
72.8	52 + 32 E	+ .070
73.0	52 + 32 W	+ .153
—	53 + 79 E	0
73.3	53 + 79 W	+ .077

DATE: 7-22-86

TIME: 1:30

WEATHER: cloudy 68° F.

NOTES:

RECORDED BY: Dan Jones

CORROSION MONITORING SYSTEM
WASHINGTON DEPARTMENT OF TRANSPORTATION

WOODINVILLE INTERCHANGE
SITE NO. 6

THERMISTOR	STATION	REFERENCE CELL
75.6	55 + 26 E	+ .092
73.7	55 + 26 W	+ .101
75.0	56 + 73 E	+ .320
76.0	56 + 73 W	+ .163
—	58 + 20 E	— 0
—	58 + 20 W	— 0
76.2	59 + 67 E	+ .141
74.4	59 + 67 W	+ .112
—	61 + 14 E	+ .141
73.8	61 + 14 W	+ .168
74.7	62 + 61 E	+ .227
—	62 + 61 W	⊖ —
73.8	64 + 08 E	+ .259
75.6	64 + 08 W	+ .273
77.1	65 + 55 E	+ .238
77.2	65 + 55 W	+ .205

DATE: _____ TIME: 2:10 WEATHER: cloudy 68° F

NOTES:

RECORDED BY: Dan Jones

68°

DATE: August 26, 1986
RUC

FROM: Ralph L. Wessels / MS-29

PHONE: Scan 443-4154

SUBJECT: Woodenville IJC
Cathodic Protection
Monitoring
C-2814 SR 405 & 522

TO: Tom Roper - HQ Bridge / KF01

Attached are the current test results for the monitoring instrumentation on the above project.

Change in reference cell readings exceeding ± 150 MV from July 1986 readings are highlighted.

Please refer to note on the monitoring junction box data sheet for additional data.

DAJ:kal

Attachments

cc: Kerri M. Howel - Harco Corp.

File: HR0902

Serial No. 86-450

CORROSION MONITORING SYSTEM
WASHINGTON DEPARTMENT OF TRANSPORTATION

WOODINVILLE INTERCHANGE
SITE NO. 1

THERMISTOR	STATION	REFERENCE CELL
over scale	850 + 40 E	+ .212
84.0	850 + 40 W	+ .790
80.5	851 + 24 E	- .008
81.8	851 + 24 W	+ .295
81.9	852 + 08 E	+ .039
84.1	852 + 08 W	+ .352
76.8	852 + 92 E	+ .275
<u>No 200 d</u>	852 + 92 W	+ .210
78.4	853 + 76 E	- .008
78.0	853 + 76 W	+ .346
80.1	854 + 60 E	+ .273
over scale	854 + 60 W	+ .064
-37.2	855 + 44 E	+ .235
Low BATTERY	855 + 44 W	+ .070
80.8	856 + 28 E	+ .291
80.3	856 + 28 W	+ .286

DATE 8-22-86 TIME: 1:25 PM WEATHER: clear 80° F

NOTES:

RECORDED BY: Dan Jones

CORROSION MONITORING SYSTEM
WASHINGTON DEPARTMENT OF TRANSPORTATION

WOODINVILLE INTERCHANGE
SITE NO. 2

THERMISTOR	STATION	REFERENCE CELL
82.0	857 + 12 E	+ .401
83.5	857 + 12 W	+ .217
82.7	857 + 96 E	+ .265
83.2	857 + 96 W	+ .314
80.3	858 + 80 E	+ .314
<u>no good</u>	858 + 80 W	+ .048
-44.7 ^{no} _{good}	859 + 64 E	+ .193
79.6	859 + 64 W	+ .201
83.1	860 + 48 E	- .172
82.1	860 + 48 W	+ .369
84.8	861 + 32 E	+ .123
<u>no good</u> ^{over} _{scale}	861 + 32 W	+ .388
-40.0	862 + 16 E	+ .335
79.7	862 + 16 W	+ .216
81.4	863 + 00 E	+ .367
80.9	863 + 00 W	+ .390

DATE: 8-22-86 TIME: 1:45 PM WEATHER: Clear 80° F

NOTES:

RECORDED BY: Dan Jones

CORROSION MONITORING SYSTEM
WASHINGTON DEPARTMENT OF TRANSPORTATION

WOODINVILLE INTERCHANGE
SITE NO. 3

THERMISTOR	STATION	REFERENCE CELL
80.4	850 + 40 E	+ .241
78.3	850 + 40 W	+ .171
87.6	851 + 24 E	+ .237
<u> </u>	851 + 24 W	+ .247
83.5	852 + 08 E	+ .287
83.0	852 + 08 W	+ .230
82.8	852 + 92 E	+ .215
84.1	852 + 92 W	+ .331
79.8	853 + 76 E	+ .282
<u> </u>	853 + 76 W	+ .163
81.3	854 + 60 E	+ .027
80.2	854 + 60 W	+ .189
94.2	855 + 44 E	+ .004
81.4	855 + 44 W	+ .215
82.4	856 + 28 E	+ .295
84.3	856 + 28 W	- .040

DATE: 8-22-86 TIME: 1:15 PM WEATHER: Clear 80° F

NOTES:

RECORDED BY: Dan Jones

CORROSION MONITORING SYSTEM
WASHINGTON DEPARTMENT OF TRANSPORTATION

WOODINVILLE INTERCHANGE
SITE NO. 4

THERMISTOR	STATION	REFERENCE CELL
81.1 No good	857 + 12 E	+ .077
	857 + 12 W	+ .108
82.5	857 + 96 E	+ .052
82.5	857 + 96 W	+ .070
75.7	858 + 80 E	+ .091
- 47.5 <u>no good</u>	858 + 80 W	+ .029
81.6	859 + 64 E	+ .087
80.3	859 + 64 W	+ .114
91.2	860 + 48 E	+ .095
89.7	860 + 48 W	+ .069
Low battery	861 + 32 E	+ .038
81.4	861 + 32 W	+ .088
78.2	862 + 16 E	+ .087
over scale	862 + 16 W	+ .075
over scale	863 + 00 E	+ .061
Low battery over scale	863 + 00 W	+ .057

DATE: 8-11-86

TIME: 1:55 PM

WEATHER: Clear 80° F

NOTES:

RECORDED BY: Dan Jones

CORROSION MONITORING SYSTEM
WASHINGTON DEPARTMENT OF TRANSPORTATION

WOODINVILLE INTERCHANGE
SITE NO. 5

THERMISTOR	STATION	REFERENCE CELL
80.9	43 + 50 E	+ .078
81.9	43 + 50 W	+ .206
83.9	44 + 97 E	+ .122
<u>no good</u>	44 + 97 W	+ .174
88.2	46 + 97 E	+ .148
86.2	46 + 44 W	+ .155
86.6	47 + 91 E	+ .074
88.2	47 + 91 W	+ .203
78.0	49 + 38 E	+ .126
87.2	49 + 38 W	+ .033
<u>no good</u> ^{LOW} _{BATTERY}	50 + 85 E	<u>no good</u>
<u>no good</u> ^{LOW} _{BATTERY}	50 + 85 W	+ .002
84.0	52 + 32 E	+ .042
82.6	52 + 32 W	+ .161
<u>no good</u> ^{over} _{SCALE}	53 + 79 E	<u>no good</u>
83.6	53 + 79 W	+ .084

DATE: 8-22-86

TIME: 1:35 PM

WEATHER: Clear 80° F

NOTES:

RECORDED BY: Dan Jones

CORROSION MONITORING SYSTEM
WASHINGTON DEPARTMENT OF TRANSPORTATION

WOODINVILLE INTERCHANGE
SITE NO. 6

THERMISTOR	STATION	REFERENCE CELL
85.0	55 + 26 E	+ .093
85.0	55 + 26 W	+ .077
86.7	56 + 73 E	+ .372
92.5	56 + 73 W	+ .155
<u>Low battery</u>	58 + 20 E	<u>no good</u>
<u>Low battery</u>	58 + 20 W	<u>no good</u>
89.8	59 + 67 E	+ .124
87.1	59 + 67 W	+ .100
<u>over scale</u>	61 + 14 E	+ .138
87.3	61 + 14 W	+ .151
87.7	62 + 61 E	+ .207
<u>Low battery</u>	62 + 61 W	<u>no good</u>
86.1	64 + 08 E	+ .264
91.6	64 + 08 W	+ .280
90.8	65 + 55 E	+ .259
93.8	65 + 55 W	+ .191

DATE: 8-22-86 TIME: 2:10 PM WEATHER: Clear 80° F

NOTES: VOLTmeter
TINKER & RASOR
CPV-4

ALL READINGS

RECORDED BY: Dan Jones

Seq. No. 1086

HARCO CORPORATION

Corrosion Engineering Division



3411 ARDEN ROAD • HAYWARD, CALIFORNIA 94545 • (415) 783-0924

October 1, 1986
KMH-086-081

Mr. Tom Roper
State of Washington
Department of Transportation
13737 S.E. 26th Street
Bellevue, WA 98005

RECEIVED

OCT 2 1986

PROJ. ENGR. MILLER

Subject: CORROSION MONITORING AND CATHODIC PROTECTION SYSTEM
INSTALLATION, I 405-SR 522 INTERCHANGE, WOODINVILLE,
WASHINGTON

Dear Mr. Roper:

Enclosed please find one copy of the report and drawings covering the results of the subject survey. We trust you will find it complete and satisfactory.

We would like to thank you for the opportunity of working with you on this project. Should you have any questions concerning this matter or any other corrosion problems, please do not hesitate to contact us at (415) 783-0924.

Sincerely,

HARCO CORPORATION

A handwritten signature in black ink, appearing to read "Kerri Howell", is written over the typed name.

Kerri M. Howell, P.E.
Special Project Coordinator

KMH/v

cc: Job File
Steve Miller/Wash. DOT (2 copies of report)

encl./report

CORROSION MONITORING AND
CATHODIC PROTECTION SYSTEM INSTALLATION

I 405-SR 522 INTERCHANGE
WOODINVILLE, WASHINGTON

OCTOBER, 1986

PREPARED FOR:

STATE OF WASHINGTON
DEPARTMENT OF TRANSPORTATION
13737 S.E. 26TH STREET
BELLEVUE, WASHINGTON 98005
ATTN: TOM ROPER

PREPARED BY:

HARCO CORPORATION
3411 ARDEN ROAD
HAYWARD, CALIFORNIA 94545

KMH-086-081

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CORROSION MONITORING AND CATHODIC PROTECTION SYSTEM INSTALLATION

I 405-SR 522 INTERCHANGE
WOODINVILLE, WASHINGTON

INTRODUCTION

Beginning in May, 1985, corrosion monitoring instrumentation and a cathodic protection system was installed at the I 405/SR 522 Interchange in Woodinville, Washington. The corrosion monitoring or deck instrumentation system consists of 96 silver-silver chloride reference cells with thermistors. Thirty-two (32) reference cells were to have been located on each of the following ramps; 405/70E, 405/70W, 522/30WS. An embedded wire non-overlay (slotted) was installed on the 522/30 E-S ramp.

OBJECTIVE

Harco Corporation performed two surveys of the cathodic protection system, the first being the energization survey in November 1985 and the second which was an evaluation survey in January 1986. The corrosion monitoring system was not surveyed until May 1986 due to delays in completing that portion of the work.

CATHODIC PROTECTION SYSTEM

The cathodic protection system was installed in saw cut slots spaced 12 inches apart in the longitudinal direction and 15 feet from either end of the 60' zones in the lateral direction. Mechanical connections were made to platinum coated niobium cored anode wires placed in the lateral slots. The platinum wires contact the longitudinally placed carbon fibers at the

intersection of the saw cuts. The slots were then backfilled with conductive polymer.

The system was designed to facilitate operation of five individually controlled zones. The rectifier unit may be operated in any of three modes; current control, voltage control or potential control. The monitoring devices installed in the deck include silver-silver chloride reference electrodes and rebar probes.

CATHODIC PROTECTION SYSTEM ENERGIZATION SURVEY

The initial energization of the cathodic protection system took place in November, 1985. As requested by the Department of Transportation, the rectifier was set to operate in the potential control mode. The set potentials in all zones were determined by statistical analysis of the native potentials taken prior to energization and are approximately equal to the mean value plus one standard deviation.

The current output of each zone was set so as not to exceed 4 amps. This equates to a maximum of 2 milliamps per square foot of concrete surface area. Voltage outputs were calculated from the circuit resistances to allow maximum current output if required to achieve the desired potentials. The electrical measurements shown on the following pages were made using a Miller LC-4 high input impedance multimeter.

RECTIFIER OUTPUTS (NOV. 1985)

	VOLTS	AMPS
ZONE 1	12.0	4.0
ZONE 2	18.0	4.0
ZONE 3	21.0	4.0
ZONE 4	5.0	4.0
ZONE 5	6.0	4.0

REFERENCE ELECTRODE SET POTENTIALS (MILLIVOLTS)

CELL 1	373
CELL 2	370
CELL 3	368
CELL 4	366
CELL 5	366

REFERENCE ELECTRODE POTENTIALS (RECTIFIER ON)

CELL 1	359
CELL 2	372
CELL 3	772
CELL 4	1145
CELL 5	3600

REBAR PROBE POTENTIALS (MILLIVOLTS)

PRIOR TO ENERGIZATION

PROBE 1	393
PROBE 2	435
PROBE 3	369
PROBE 4	399
PROBE 5	348

REBAR PROBE POTENTIALS (MILLIVOLTS)

RECTIFIER ON

PROBE 1	581
PROBE 2	621
PROBE 3	993
PROBE 4	1419
PROBE 5	3900

CATHODIC PROTECTION SYSTEM EVALUATION SURVEY

The basis of the cathodic protection system evaluation survey is the data included in the attached polarization decay. The accepted criteria in the industry at present is a polarization decay of 100 millivolts from the "instant off" potential value over a four hour time period.

The structure in questions was allowed to depolarize for 3 hours and 15 minutes. At that time the changes in potential were as follows:

ZONE	POTENTIAL (MILLIVOLTS)
1	96
2	132
3	56
4	47
5	83

Extrapolation of these changes indicates that the criteria has been met in zones one and two with zone five achieving better than 80 percent of the desired potential shift. Zones three and four do not meet the recommended criteria. Because it is important to maintain current density at the anode to concrete interface of less than 10 milliamps per square foot, it is not advisable to increase the current outputs in these zones.

As in the previous survey, all electrical measurements were made with high input impedance multimeters.

POLARIZATION DECAY

TIME	REFERENCE ELECTRODE POTENTIAL (MILLIVOLTS)				
	ZONE 1	ZONE 2	ZONE 3	ZONE 4	ZONE 5
RECTIFIER ON	441	514	729	748	164
INSTANT OFF	384	509	522	491	150
1 MIN.	420	488	502	507	116
2 MIN.	409	475	498	493	105
3 MIN.	404	471	496	489	101
4 MIN.	401	467	496	486	099
5 MIN.	398	464	495	483	098
10 MIN.	390	456	494	479	093
15 MIN.	382	449	493	476	088
20 MIN.	375	443	491	473	087
30 MIN.	349	433	486	467	080
40 MIN.	355	427	481	462	077
50 MIN.	350	422	482	461	076
60 MIN.	344	417	481	458	074
75 MIN.	336	410	479	455	071
90 MIN.	329	404	479	452	069
105 MIN.	323	399	470	447	068
120 MIN.	316	394	469	446	067
135 MIN.	310	390	469	445	069
150 MIN.	304	386	468	445	067

REFERENCE ELECTRODE POTENTIAL (MILLIVOLTS)

TIME	ZONE 1	ZONE 2	ZONE 3	ZONE 4	ZONE 5
165 MIN.	298	383	467	445	067
180 MIN.	293	380	468	445	067
195 MIN.	288	377	466	444	067

RECTIFIER OUTPUTS (JAN. 1985)

	VOLTS	AMPS
ZONE 1	5.5	A.0
ZONE 2	4.0	4.0
ZONE 3	6.5	4.0
ZONE 4	3.8	4.0
ZONE 5	4.5	4.0

REFERENCE ELECTRODE POTENTIALS (MILLIVOLTS)

(AT JUNCTION BOX)

CELL 1	441
CELL 2	534
CELL 3	835
CELL 4	738
CELL 5	120

REBAR PROBE POTENTIALS (MILLIVOLTS)

PROBE 1	455
PROBE 2	515
PROBE 3	697
PROBE 4	953
PROBE 5	201

CORROSION MONITORING SYSTEM SURVEY

The corrosion monitoring system was surveyed in May, 1986 shortly after its completion. Potential measurements and deck temperatures were taken at the six junction box locations from reference electrode thermistor combinations located at the stations indicated on the attached data sheets. An Omega thermometer was used to measure the thermistor readings and a high input impedance voltmeter was used to measure reference electrode potentials.

CATHODIC PROTECTION SYSTEM

WASHINGTON DEPARTMENT OF TRANSPORTATION
WOODINVILLE INTERCHANGE

DATE: 5/14/86 TIME: 12:30 WEATHER: SUNNY

RECTIFIER DATA:

	PANEL METER			PORTABLE METER	
	REF.	AMPS	VOLTS	AMPS	VOLTS
ZONE 1	.320	4.0	5.0	+.020/4.0	+5.46
ZONE 2	.42	3.8	5.0	+.019/3.8	+5.81
ZONE 3	.36	4.0	7.0	+.020/4.0	+6.95
ZONE 4	.40	4.0	4.5	+.020/4.0	+4.66
ZONE 5	0	4.0	4.5	+.020/4.0	+4.94
TOTAL		4.0	0		

MONITORING EQUIPMENT DATA:

	REBAR PROBE	REFERENCE CELL	THERMISTOR
	VOLTS	VOLTS	°F
ZONE 1	+.293	+.303	56.6
ZONE 2	+.563	+.430	56.1
ZONE 3	+.484	+.562	56.3
ZONE 4	+.694	+.422	55.9
ZONE 5	+.160	+.105	60.2

CORROSION MONITORING SYSTEM
WASHINGTON DEPARTMENT OF TRANSPORTATION

WOODINVILLE INTERCHANGE
SITE NO. 1

THERMISTOR	STATION	REFERENCE CELL
Over scale	850 + 40 E	+.228
57.5	850 + 40 W	+.170
55.6	851 + 24 E	+.249
56.1	851 + 24 W	+.297
56.7	852 + 08 E	+.085
58.7	852 + 08 W	+.300
54.3	852 + 92 E	+.310
Over scale	852 + 92 W	+.213
55.1	853 + 76 E	+.161
54.6	853 + 76 W	+.349
55.5	854 + 60 E	+.214
Over scale	854 + 60 W	+.434
58-78 varying	855 + 44 E	+.143
Over scale	855 + 44 W	+.347
55.5	856 + 28 E	+.316
55.4	856 + 28 W	+.291

DATE: 5/14/86 TIME: 11:01 WEATHER: 60° cloudy

NOTES:

RECORDED BY: _____

CORROSION MONITORING SYSTEM
WASHINGTON DEPARTMENT OF TRANSPORTATION

WOODINVILLE INTERCHANGE
SITE NO. 2

THERMISTOR	STATION	REFERENCE CELL
55.9	857 + 12 E	+ .383
56.4	857 + 12 W	+ .353
56.1	857 + 96 E	+ .247
55.9	857 + 96 W	+ .275
53.9	858 + 80 E	+ .323
53.6	858 + 80 W	+ .267
55.6	859 + 64 E	+ .160
54.6	859 + 64 W	+ .243
56.5	860 + 48 E	+ .349
55.3	860 + 48 W	+ .353
55.4	861 + 32 E	+ .001
Over scale	861 + 32 W	+ .325
54.7	862 + 16 E	+ .272
54.7	862 + 16 W	+ .135
55.5	863 + 00 E	+ .329
Over scale	863 + 00 W	+ .385

DATE: 5/14/86 TIME: 11:16 am WEATHER: 60° cloudy

NOTES:

RECORDED BY: _____

CORROSION MONITORING SYSTEM
WASHINGTON DEPARTMENT OF TRANSPORTATION

WOODINVILLE INTERCHANGE
SITE NO. 3

THERMISTOR	STATION	REFERENCE CELL
56.3	850 + 40 E	+ .302
60.9	850 + 40 W	+ .195
60.3	851 + 24 E	+ .286
-110	851 + 24 W	+ .276
56.2	852 + 08 E	+ .309
56.7	852 + 08 W	+ .274
56.1	852 + 92 E	+ .280
56.6	852 + 92 W	+ .317
54.4	853 + 76 E	+ .279
low battery	853 + 76 W	+ .120
55.8	854 + 60 E	+ .305
55.1	854 + 60 W	+ .155
45-54 varying	855 + 44 E	+ .145
54.9	855 + 44 W	+ .004
56.3	856 + 28 E	+ .307
56.1	856 + 28 W	- .046

DATE: 5/14/86 TIME: 10:48 WEATHER: 60° cloudy

NOTES:

RECORDED BY: _____

CORROSION MONITORING SYSTEM
WASHINGTON DEPARTMENT OF TRANSPORTATION

WOODINVILLE INTERCHANGE
SITE NO. 4

THERMISTOR	STATION	REFERENCE CELL
31 Ω overscale	857 + 12 E	+ .124
31 Ω overscale	857 + 12 W	+ .274
4K Ω 55.9	857 + 96 E	+ .063
4K Ω 55.0	857 + 96 W	+ .168
53.9	858 + 80 E	+ .163
38K Ω low battery	858 + 80 W	+ .042
56.6	859 + 64 E	+ .359
54.4	859 + 64 W	+ .391
59.9	860 + 48 E	+ .272
57.7	860 + 48 W	- .071
10K Ω low battery	861 + 32 E	+ .043
54.8	861 + 32 W	+ .302
55.0	862 + 16 E	+ .224
8 Ω overscale	862 + 16 W	+ .307
4.8 Ω overscale	863 + 00 E	+ .193
54.7	863 + 00 W	+ .190

DATE: 5/14/86 TIME: 11:21 am WEATHER: 60° cloudy

NOTES:

RECORDED BY: _____

CORROSION MONITORING SYSTEM
WASHINGTON DEPARTMENT OF TRANSPORTATION

WOODINVILLE INTERCHANGE
SITE NO. 5

THERMISTOR	STATION	REFERENCE CELL
57.7	43 + 50 E	+.062
60.6	43 + 50 W	+.199
58.7	44 + 97 E	+.130
low battery	44 + 97 W	+.163
61.0	46 + 44 E	+.144
61.3	46 + 44 W	+.151
60.0	47 + 91 E	+.094
60.4	47 + 91 W	+.184
51.0	49 + 38 E	+.111
59.6	49 + 38 W	+.033
low battery	50 + 85 E	0
low battery	50 + 85 W	+.010
57.9	52 + 32 E	+.063
53.0	52 + 32 W	+.146
53.2	53 + 79 E	0
57.8	53 + 79 W	+.046

DATE: 5/14/86 TIME: 11:59 am WEATHER: 60° cloudy

NOTES:

RECORDED BY: _____

CORROSION MONITORING SYSTEM
WASHINGTON DEPARTMENT OF TRANSPORTATION

WOODINVILLE INTERCHANGE
SITE NO. 6

THERMISTOR	STATION	REFERENCE CELL
55.8	55 + 26 E	+ .114
56.0	55 + 26 W	+ .093
55.5	56 + 73 E	+ .327
59.6	56 + 73 W	+ .141
low battery	58 + 20 E	0
low battery	58 + 20 W	0
59.1	59 + 67 E	+ .125
56.3	59 + 67 W	+ .104
overscale	61 + 14 E	+ .111
57.4	61 + 14 W	+ .148
56.2	62 + 61 E	+ .248
low battery	62 + 61 W	0
57.0	64 + 08 E	+ .271
58.6	64 + 08 W	+ .269
58.6	65 + 55 E	+ .254
60.0	65 + 55 W	+ .247

DATE: 5/14/86 TIME: 11:36 WEATHER: 60° cloudy

NOTES:

RECORDED BY: _____

DEPARTMENT OF TRANSPORTATION
BRIDGE & STRUCTURES

DATE 5/15/86

FROM DESK OF Tom Roper

Subject: Woodinville Interchange
C.P. System
Deck Instrumentation System

ROLLING ORDER	NOTED	DATE
EHH		

Dist. I personnel & I met with Kerri Howell at Woodinville Interchange. Kerri gave instruction to Dan Jones, Dave Deede, Jim Lowe now to monitor the above systems. She also provided Forms. Monitoring is to be done on a monthly basis with copies of reports sent to the bridge branch. Dist. personnel understood the monitoring technique, and there should be no problem with district taking the readings.

It appears from the readings that approx. 20 of the thermistors are not functioning properly, also 5 reference cells are not operating. There are a total of 96 thermistors and 96 reference cells. The C.P. system appears to be functioning O.K.

CATHODIC PROTECTION SYSTEM

WASHINGTON DEPARTMENT OF TRANSPORTATION WOODINVILLE INTERCHANGE

DATE: 5/14/86 TIME: 12:30 WEATHER: SUNNY

RECTIFIER DATA:

	PANEL METER			PORTABLE METER	
	Ref.	AMPS	VOLTS	AMPS	VOLTS
ZONE 1	.320	4.0	5.0	+.020 / 4.0A	+ 5.46
ZONE 2	.42	3.8	5.0	+.019 / 3.8A	+ 5.81
ZONE 3	.36	4.0	7.0	+.020 / 4.0	+ 6.95
ZONE 4	.40	4.0	4.5	+.020 / 4.0	+ 4.66
ZONE 5	0	4.0	4.5	+.020 / 4.0	+ 4.94
Total		4.0	0		

MONITORING EQUIPMENT DATA:

	REBAR PROBE		REFERENCE CELL	THERMISTOR
	VOLTS	MILLIAMPS	VOLTS	OF
ZONE 1	+.293		+.303	56.6
ZONE 2	+.563		+.430	56.1
ZONE 3	+.484		+.562	56.3
ZONE 4	+.694		+.422	55.9
ZONE 5	+.160		+.105	60.2

NOTES:

DATE: June 27, 1986

RAW

FROM: Ralph L. Wessels / MS-29

PHONE: Scan 443-4258

SUBJECT: Woodenville I/C
Cathodic Protection
Monitoring
C-2814 SR 405 & 522

TO: Tom Roper - HQ's Bridge;
Kerri M. Howel - Harco Corp.

Attached are the current test results for the monitoring instrumentation on the above project.

Change in reference cell readings exceeding ± 150 mv.

Site No. 2
Sta. 858+80 W

Site No. 3
Sta. 855+44 W

Site No. 4
Sta. 857+12 E
Sta. 859+64 E
Sta. 860+48 W
Sta. 862+16 W

DAJ:kal

Attachments

File: HR0902

Serial No. 86-282

**CATHODIC PROTECTION SYSTEM
WASHINGTON DEPARTMENT OF TRANSPORTATION
WOODINVILLE INTERCHANGE**

DATE: 6-18-86 TIME: 1:00 PM WEATHER: Partly sunny
 READINGS TAKEN BY: Dan Jones 65° F

MONITORING JUNCTION BOX DATA:

LOCATION	THERMISTORS (°F)	REF. CELL (VOLTS)	REBAR PROBE (VOLTS)
ZONE 1	62.9	+ .280	+ .384
ZONE 2	62.5	+ .349	+ .560
ZONE 3	63.4	+ .528	+ .457
ZONE 4	63.8	+ .390	+ .686
ZONE 5	66.8	+ .057	+ .090

OUTPUTS

	CURRENT		VOLTAGE VOLTS
	VOLTS	$I = V / .005 \Omega$	
ZONE 1	.020	4.0	5.74
ZONE 2	.019	3.8	6.30
ZONE 3	.020	4.0	7.97
ZONE 4	.020	4.0	4.74
ZONE 5	.020	4.0	5.04

RECTIFIER DATE: _____

PANEL METERS

	AMPS	VOLTS	REF CELL
ZONE 1	3.9	5.0	.30
ZONE 2	3.8	6.0	.34
ZONE 3	3.9	7.2	.12
ZONE 4	4.0	4.2	.35
ZONE 5	4.0	4.7	0

NOTES:

DATE: July 24, 1986

FROM: Ralph L. Wessels / MS-29

PHONE: Scan 443-4154

SUBJECT: Woodenville I/C
Cathodic Protection
Monitoring
C-2814 SR 405 & 522

TO: Tom Roper - HQ Bridge / KF01

Attached are the current test results for the monitoring instrumentation on the above project.

Change in reference cell readings exceeding ± 150 mv. are highlighted.

DAJ:kal

Attachments

cc: Kerri M. Howel - Harco Corp.

File: HR0902

Serial No. 86.331

CATHODIC PROTECTION SYSTEM
 WASHINGTON DEPARTMENT OF TRANSPORTATION
 WOODINVILLE INTERCHANGE

80° F on
 7-21-86

DATE: 7-22-86 TIME: 2:30 WEATHER: Cloudy 68° F.

READINGS TAKEN BY: Dan Jones

MONITORING JUNCTION BOX DATA:

LOCATION	THERMISTORS (°F)	REF. CELL (VOLTS)	REBAR PROBE (VOLTS)
ZONE 1	69.1	+ .001	+ .366
ZONE 2	68.0	+ .302	+ .556
ZONE 3	68.5	+ .490	+ .483
ZONE 4	67.8	+ .358	+ .610
ZONE 5	72.9	+ .045	- .123

OUTPUTS

	CURRENT		VOLTAGE VOLTS
	VOLTS	$I = V / .005 \sim$	
ZONE 1	.020	4.0	6.44
ZONE 2	.019	3.8	6.79
ZONE 3	.020	4.0	8.68
ZONE 4	.020	4.0	5.00
ZONE 5	.020	4.0	5.11

RECTIFIER DATE:

PANEL METERS

	AMPS	VOLTS	REF CELL
ZONE 1	3.9	6.0	.3
ZONE 2	3.7	6.1	.29
ZONE 3	4.0	8.0	.08
ZONE 4	4.0	4.8	.32
ZONE 5	4.0	5.0	.0

NOTES:

Washington State
Department of Transportation

INTRA-DEPARTMENTAL COMMUNICATION

DATE: August 26, 1986
FROM: Ralph L. Wessels / MS-29
PHONE: Scan 443-4154
SUBJECT: Woodenville I/C
Cathodic Protection
Monitoring
C-2814 SR 405 & 522
TO: ~~Tom Roper - HQ Bridge / KE0F~~

Attached are the current test results for the monitoring instrumentation on the above project.

Change in reference cell readings exceeding ± 150 MV from July 1986 readings are highlighted.

Please refer to note on the monitoring junction box data sheet for additional data.

DAJ:kal

Attachments

cc: Kerri M. Howel - Harco Corp.

File: HR0902

Serial No. 86-450

**CATHODIC PROTECTION SYSTEM
WASHINGTON DEPARTMENT OF TRANSPORTATION
WOODINVILLE INTERCHANGE**

DATE: 8-22-86 TIME: 2:25 PM WEATHER: Clear 80° F

READINGS TAKEN BY: Dan Jones

MONITORING JUNCTION BOX DATA:

LOCATION	THERMISTORS (°F)	REF. CELL (VOLTS)	REBAR PROBE (VOLTS)
ZONE 1	80.7	+ .249	+ .403
ZONE 2	80.4	+ .259	+ .499
ZONE 3	80.6	+ .084 ³⁶ ₃₂₅	+ .484
*ZONE 4	FLUCTUATING 54° TO 92°	+ .021	+ .427
*ZONE 5	FLUCTUATING 52° TO 97°	ROLLING - .329 Numbers	+ .027

OUTPUTS ↑ ALL

	CURRENT		VOLTAGE VOLTS
	VOLTS	$I = V / .005$	
ZONE 1	+ .020	4.0	6.21
ZONE 2	+ .019	3.8	6.19
ZONE 3	+ .020	4.0	7.96
ZONE 4	+ .020	4.0	5.06
ZONE 5	+ .020	4.0	5.23

RECTIFIER DATE:

PANEL METERS

	AMPS	VOLTS	REF CELL
ZONE 1	3.90	6.0	.28
ZONE 2	3.70	6.0	.25
ZONE 3	3.90	7.5	.15
ZONE 4	4.0	5.0	.29
ZONE 5	3.95	5.0	0 below zero on scale

NOTES: MONITORING JUNCTION BOX DATA

Thermistors Zone 4 and 5 fluctuating numbers
Reference Cell - All zones - rolling numbers,
difficult to get accurate readings.



Washington State
Department of Transportation

INTRA-DEPARTMENTAL COMMUNICATION

DATE: September 29, 1986
FROM: ^{R.L.W.} Ralph L. Wessels / MS-29
PHONE: Scan 443-4154
SUBJECT: Woodenville I/C
Cathodic Protection
Monitoring
C-2814 SR 405 & 522
TO: Tom Roper / HQ Bridge / KF-01

Attached are the current test results for the monitoring instrumentation on the above project.

Change in reference cell readings exceeding + 150 MV from August 1986 are highlighted.

Other changes noted:

1. High ref. cell and voltage readings Zone 3 monitoring Junction Box Data.
2. High Voltage Zone 3 rectifier panel.
3. Very high reference cell readings all locations site No. 4

DAJ:kal

cc: Kerri M. Howel - Harco Corp.

File: HR0902

Serial NO. 86-489

**CATHODIC PROTECTION SYSTEM
WASHINGTON DEPARTMENT OF TRANSPORTATION
WOODINVILLE INTERCHANGE**

DATE: 9-24-86 TIME: 10:30 AM WEATHER: cloudy 50° F

READINGS TAKEN BY: Dan Jones

MONITORING JUNCTION BOX DATA:

LOCATION	THERMISTORS (°F)	REF. CELL (VOLTS)	REBAR PROBE (VOLTS)
ZONE 1	51.7	+ .246	+ .341
ZONE 2	FLUCTUATING 41 52.2 53	+ .202	+ .013
ZONE 3	FLUCTUATING 35 52.6 52	+ .551	+ .389
ZONE 4	FLUCTUATING 19 -12 TO 58	+ .340	+ .441
ZONE 5	FLUCTUATING -20 TO 52	+ .003 ROLLING numbers	+ .007 ROLLING numbers

OUTPUTS

	CURRENT		VOLTAGE VOLTS
	VOLTS	$I = V / .005 \Omega$	
ZONE 1	+ .020	4.0	7.09
ZONE 2	+ .018	3.6	8.45
ZONE 3	+ .020	4.0	13.19
ZONE 4	+ .020	4.0	5.12
ZONE 5	+ .020	4.0	5.03

RECTIFIER DATE:	PANEL METERS		
	AMPS	VOLTS	REF CELL
ZONE 1	4.0	6.5	0.30
ZONE 2	3.8	8.0	0.18
ZONE 3	4.0	12.5	0.53
ZONE 4	4.0	4.7	0.34
ZONE 5	4.0	4.5	0 off scale

NOTES: MONITORING JUNCTION BOX DATA

FLUCTUATING numbers on all zones except zone 1
High voltage zone 3

RECTIFIER DATA

Very high voltage and Ref. cell readings on zone 3

CORROSION MONITORING SYSTEM
WASHINGTON DEPARTMENT OF TRANSPORTATION

WOODINVILLE INTERCHANGE
SITE NO. 1

THERMISTOR	STATION	REFERENCE CELL
over scale	850 + 40 E	+ .194
56.1	850 + 40 W	+ .149
52.8	851 + 24 E	- .062
54.1	851 + 24 W	+ .270
54.8	852 + 08 E	+ .048
55.7	852 + 08 W	+ .329
53.4	852 + 92 E	+ .274
over scale	852 + 92 W	+ .225
53.1	853 + 76 E	- .036
53.2	853 + 76 W	+ .286
54.2	854 + 60 E	+ .203
over scale	854 + 60 W	+ .198
-39.3	855 + 44 E	+ .003
low battery	855 + 44 W	+ .068
54.4	856 + 28 E	+ .297
53.3	856 + 28 W	+ .280

DATE: 8-24-86 TIME: 9:40 AM WEATHER: Cloudy 50°F

NOTES: VOLTMETER - ALL SITES

TINKER & RASOR

CPV-4

Set. No. 1086

RECORDED BY: Dan Jones

**CORROSION MONITORING SYSTEM
WASHINGTON DEPARTMENT OF TRANSPORTATION**

**WOODINVILLE INTERCHANGE
SITE NO. 2**

THERMISTOR	STATION	REFERENCE CELL
53.8	857 + 12 E	+ .374
53.3	857 + 12 W	+ .152
54.9	857 + 96 E	+ .252
54.9	857 + 96 W	+ .298
54.3	858 + 80 E	+ .260
- 41. ^{no} _{good}	858 + 80 W	- .022
Low battery	859 + 64 E	+ .204
53.4	859 + 64 W	+ .185
53.3	860 + 48 E	- .117
53.6	860 + 48 W	+ .331
54.1	861 + 32 E	+ .003
over scale	861 + 32 W	+ .378
- 39.5 ^{no} _{good}	862 + 16 E	+ .317
33.7	862 + 16 W	+ .125
54.0	863 + 00 E	+ .322
54.7	863 + 00 W	+ .369

DATE: 9-24-86

TIME: 10:00 AM

WEATHER: cloudy 50°F

NOTES:

RECORDED BY: Dan Jones

**CORROSION MONITORING SYSTEM
WASHINGTON DEPARTMENT OF TRANSPORTATION**

**WOODINVILLE INTERCHANGE
SITE NO. 3**

THERMISTOR	STATION	REFERENCE CELL
54.4	850 + 40 E	+ .205
50.0	850 + 40 W	+ .133
57.2	851 + 24 E	+ .178
— N9	851 + 24 W	+ .231
53.3	852 + 08 E	+ .251
54.2	852 + 08 W	+ .197
53.3	852 + 92 E	+ .189
53.2	852 + 92 W	+ .315
55.0	853 + 76 E	+ .252
— N8	853 + 76 W	+ .151
53.3	854 + 60 E	+ .130
53.2	854 + 60 W	+ .212
68.4	855 + 44 E	- .116
54.0	855 + 44 W	+ .202
53.2	856 + 28 E	+ .287
52.4	856 + 28 W	+ .039

DATE: 9-24-86 TIME: 7:30 AM WEATHER: Cloudy 50° F

NOTES:

RECORDED BY: Dan Jones

**CORROSION MONITORING SYSTEM
WASHINGTON DEPARTMENT OF TRANSPORTATION**

**WOODINVILLE INTERCHANGE
SITE NO. 4**

THERMISTOR	STATION	REFERENCE CELL
158.9	857 + 12 E	+ .754
No good ^{over} scale	857 + 12 W	+ .733
53.6	857 + 96 E	+ .493
53.9	857 + 96 W	+ .572
53.1	858 + 80 E	+ .652
- 47.5 ^{no} good	858 + 80 W	+ .360
54.1	859 + 64 E	+ .608
52.8	859 + 64 W	+ .853
57.6	860 + 48 E	+ .764
54.2	860 + 48 W	+ .569
LOW BATTERY	861 + 32 E	+ .438
53.3	861 + 32 W	+ .679
54.3	862 + 16 E	+ .676
OVER SCALE	862 + 16 W	+ .625
OVER SCALE	863 + 00 E	+ .526
OVER SCALE	863 + 00 W	+ .493

DATE: 9-24-86 TIME: 10:10 AM WEATHER: Cloudy 50° F

NOTES: ALL VERY HIGH REFERENCE CELL READINGS
HIGH THERMISTOR READING STA. 857+12 E

RECORDED BY: Dan Jones

**CORROSION MONITORING SYSTEM
WASHINGTON DEPARTMENT OF TRANSPORTATION**

**WOODINVILLE INTERCHANGE
SITE NO. 5**

THERMISTOR	STATION	REFERENCE CELL
53.2	43 + 50 E	+ .059
54.0	43 + 50 W	+ .160
53.2	44 + 97 E	+ .092
No good	44 + 97 W	+ .094
52.7	46 + 97 E	+ .088
55.1	46 + 44 W	+ .099
52.1	47 + 91 E	+ .067
53.8	47 + 91 W	+ .144
47.0	49 + 38 E	+ .087
53.4	49 + 38 W	+ .033
Low battery	50 + 85 E	+ no good
Low battery	50 + 85 W	+ .001
51.6	52 + 32 E	+ .024
49.7	52 + 32 W	+ .111
over scale	53 + 79 E	No good
52.7	53 + 79 W	+ .136

DATE: 9-24-86 TIME: 9:50 AM WEATHER: Cloudy 50° F.

NOTES:

RECORDED BY: Dan Jones

CORROSION MONITORING SYSTEM
WASHINGTON DEPARTMENT OF TRANSPORTATION

WOODINVILLE INTERCHANGE
SITE NO. 6

THERMISTOR	STATION	REFERENCE CELL
50.7	55 + 26 E	+ .105
52.7	55 + 26 W	+ .075
50.8	56 + 73 E	+ .380
54.2	56 + 73 W	+ .107
LOW BATTERY	58 + 20 E	+ .000 ^{NO} good
LOW BATTERY	58 + 20 W	+ .001 ROLLING
53.7	59 + 67 E	+ .087
52.9	59 + 67 W	+ .064
OVER SCALE	61 + 14 E	+ .082
52.2	61 + 14 W	+ .127
51.8	62 + 61 E	+ .172
LOW BATTERY	62 + 61 W	+ .0 ^{NO} good ROLLING
54.4	64 + 08 E	+ .226
57.4	64 + 08 W	+ .239
56.1	65 + 55 E	+ .214
54.7	65 + 55 W	+ .176

DATE: 9-24-86

TIME: 10:20 AM

WEATHER: CLOUDY 50° F

NOTES:

RECORDED BY: DAN JONES

**CATHODIC PROTECTION SYSTEM
WASHINGTON DEPARTMENT OF TRANSPORTATION
WOODINVILLE INTERCHANGE**

DATE: 11-25-86 TIME: 11:15 AM WEATHER: CLOUDY 46° F

READINGS TAKEN BY: Dan Jones / Todd Kramer

MONITORING JUNCTION BOX DATA:

LOCATION	THERMISTORS (°F)	REF. CELL (VOLTS)	REBAR PROBE (VOLTS)
ZONE 1	41.1	+ .230	+ .321
ZONE 2	ROLLING 41.4	+ .235	+ .068
ZONE 3	ROLLING 40.1	+ .556	+ .299
ZONE 4	ROLLING 43.0	+ .343	+ .478
ZONE 5	ROLLING	ROLLING # + .002	ROLLING # + .005

OUTPUTS

	CURRENT		VOLTAGE VOLTS
	VOLTS	$I = V / .005 \sim$	
ZONE 1	+ .020	4.0	+ 7.81
ZONE 2	+ .025	5.0	+ 11.82
ZONE 3	+ .020	4.0	+ 15.05
ZONE 4	+ .020	4.0	+ 5.57
ZONE 5	+ .020	4.0	+ 5.17

RECTIFIER DATE:

PANEL METERS

	AMPS	VOLTS	REF CELL
ZONE 1	3.9	7.5	0.32
ZONE 2	5.0	11.5	0.24
ZONE 3	4.0	15.0	0.56
ZONE 4	4.0	5.5	0.33
ZONE 5	3.9	5.0	0.04

NOTES: # ROLLING - METERS WILL NOT STABILIZE

RECTIFIER DATA - MUCH HIGHER READINGS THAN IN SEPTEMBER, 1986

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inspection and evaluation

**CATHODIC PROTECTION SYSTEM
WASHINGTON DEPARTMENT OF TRANSPORTATION
HOODINVILLE INTERCHANGE**

DATE: 12-31-86 TIME: 11:30 AM WEATHER: Cloudy Temp 42°

READINGS TAKEN BY: Dan Jones

MONITORING JUNCTION BOX DATA:

LOCATION	THERMISTORS (°F)	REF. CELL (VOLTS)	REBAR PROBE (VOLTS)
ZONE 1	35.4	+ .231	+ .308
ZONE 2 *	34.0	+ .248	+ .062
ZONE 3 *	28.0	+ .565	+ .299
ZONE 4 *	-11° TO +39°	+ .347	+ .502
ZONE 5 *	-26° TO +30°	+ .000 *	+ .005 *

OUTPUTS

	CURRENT		VOLTAGE VOLTS
	VOLTS	$I = V / .005 \sim$	
ZONE 1	+ .020	4.0	+ 7.87
ZONE 2	+ .026	5.2	+ 11.98
ZONE 3	+ .020	4.0	+ 15.24
ZONE 4	+ .020	4.0	+ 5.55
ZONE 5	+ .021	4.2	+ 5.0

RECTIFIER DATE:

PANEL METERS

	AMPS	VOLTS	REF CELL
ZONE 1	3.95	8.0	0.32
ZONE 2	5.0	12.0	0.26
ZONE 3	4.0	15.0	0.58
ZONE 4	4.0	5.0	0.33
ZONE 5	3.9	5.0	0.04

NOTES: * UNSTABLE - NUMBERS ROLL

INCREASED VOLTAGE READINGS FROM 11-25-86

inspection and evaluation