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1	1	Design Authority	GP Janicek	2/18/97	ST-12	1	1	Eng. Author Mgr: CE Hanson	[Signature]	2/19/97	ST-12
		Design Agent				1	7	CPO: CB Bryan	[Signature]	2/20/97	ST-12
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1	1	QA ML	McElroy	2-18-97	ST-12						
1	1	Safety JA	Ranschau	2-18-97	ST-12						
1	1	Eng Author:	AJ Kostelnik	2/18/97	ST-12						

18. A.J. Kostelnik Signature of EDT Originator 2/18/97		19. JS Schofield Authorized Representative Date for Receiving Organization 2/18/97		20. JS Schofield Design Authority/Cognizant Manager 2/18/97		21. DOE APPROVAL (if required) Ctrl. No. ☐ Approved ☐ Approved w/comments ☐ Disapproved w/comments	
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TEST REPORT FOR EXHAUSTER ENVIRONMENTAL ENCLOSURE AND HEATER

Alois J. Kostelnik

SGN Eurisys Services Corporation, Richland, WA 99352

U.S. Department of Energy Contract DE-AC06-87RL10930

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Key Words: core sampling, exhauster, Whittaker, RMCS

Abstract: The attached Test Report documents the results of testing for the function of an environmental enclosure and heater to support the rotary mode core sampling exhauster's flammable gas detection system.

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Marc Willison
Release Approval

2/20/97
Date

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Approved for Public Release

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1.0 Introduction

The test showed that a dependent relationship between the thermocouples on the FGI carts and the Whittaker cell can not be achieved. The recommended action is to affix a thermocouple to the Whittaker cell and interlock it with the FGI system logic accordingly.

2.0 Scope

The scope of this report is the results of testing performed per HNF-SD-WM-TP-258 Rev.0 for the functional test of the environmental enclosure and associated heating system to support the rotary mode core sampling exhausters's flammable gas detection system.

3.0 Discussion of Results

This section contains a discussion of the objectives of the test and the results from testing.

- 3.1 The first objective was to determine the optimum equipment arrangement, tent ventilation flow through configuration, settings, and operation limits for ensuring that the interlocked thermocouples on the Flammable Gas Interlock (FGI) carts are at the same or colder temperature than the Whittaker cell during adverse weather conditions. The objective could not be achieved for the following reasons.
 - 3.1.1 The cold air flowing through the exhauster duct and spool piece provided an effective heat sink which kept the Whittaker cell cooler than the Flammable Gas Interlock (FGI) cart thermocouples. Based on the nearly 12 hours of testing it would be impractical to further attempt to establish a control sequence which relies upon the thermocouples of the FGI carts to verify the Whittaker cell temperature is within limits. If thermocouples are affixed to the Whittaker cell there is no required equipment arrangement.
 - 3.1.2 The cool exhauster flow inside the exhauster duct would also cool the Whittaker cell more rapidly than the FGI cart thermocouples should the heater shut down for any reason. This conclusion is based upon the rapid cooling which occurred after the exhauster was initially started. An observation was that the temperatures indicated by the FGI thermocouples appeared to be independent of the rate of rise and fall of the temperature of the Whittaker cell at start up.
- 3.2 The second objective was to demonstrate that the Whittaker cell can be maintained by the tent and heater at temperatures between 60°F and 120°F during adverse weather conditions. The Whittaker cell can be maintained by the tent and heater at temperatures between 60°F and 120°F during periods of calm weather at 30°F to 41°F based upon the results of testing.

- 3.2.1 The heater maintained the Whittaker cell within the operating envelope. The cell was maintained between 80°F and 92°F for approximately 12 hours while the ambient temperature fluctuated between 30°F and 41°F.
- 3.2.2 If the thermocouples are affixed to the Whittaker cell and wired in to the shutdown logic accordingly, the operator will need to observe the Whittaker cell temperatures, consider the current weather/operating conditions and adjust the thermostat accordingly to keep the cell within its operating range based upon the calibration.
- 3.3 The third objective was to demonstrate that the tent, heater, exhauster duct/spool piece, and FGI carts would interface together without compromising safety or integrity of the components was achieved.
 - 3.3.1 The simulated calibration of the Sierra Monitoring Corporation flammable gas detector was not performed during the testing period because that portion of the test was not reached. The Sierra Monitoring Corporation flammable gas detector will be calibrated as part of HNF-SD-WM-OTP-228 Rev.0.
 - 3.3.2 None of the equipment was damaged. One item of interest is that, because of unforeseen delays in starting the exhauster, the Whittaker cell was being warmed by direct flow of the warm air from the heater and that the temperature of the Whittaker cell exceeded the 120°F upper limit for operation.

Per Whittaker specifications, prolonged exposure to high temperatures should be avoided as it will shorten the life of the cell. The Whittaker cell used for testing had not been calibrated and would require calibration prior to use.

4.0 Summary

The tent and heater concept was proven to adequately support the temperature requirements of the Whittaker cell between 60°F and 120°F. However, a dependent spatial relationship could not be determined that could ensure that the FGI cart thermocouples would always be cooler than the Whittaker cell.

There is less test data than anticipated. The reason for the lack of data is the approach taken in the test to informally find the optimum set-up and then formally document its performance. Since an optimum arrangement was not found very little data was taken.

HNF-SD-WM-TRP-276

REV.0

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APPENDIX A - TEST COPY

1.0 Introduction

Rotary Mode Core Sampling (RMCS) in Flammable Gas Watch List Tanks requires a qualified exhaustor with flammable gas detection capability and shutdown interlocks for high hydrogen concentrations. The flammable gas detectors used on the RMCS exhaustor include a Whittaker hydrogen detector and a Sierra Monitoring Corporation flammable gas detector. The Whittaker cell requires the operating temperature to be within limits for accurate sensing. Hanford environmental conditions often exceed these temperature limits, particularly on the low temperature side. Therefore, a controlled environment is being considered for sensor field deployment when environmental conditions are not conducive to proper operation.

2.0 Scope

The scope of this plan is the functional test of the environmental enclosure and associated heating system to support the rotary mode core sampling exhaustor's flammable gas detection system. Testing will be performed under the current ambient conditions which will be recorded. Equipment performance at temperatures other than tested must be evaluated based upon interpretation of test results.

3.0 Objectives

- 3.1 Determine the optimum equipment arrangement, tent ventilation flow through configuration, settings, and operation limits for ensuring that the interlocked thermocouples on the Flammable Gas Interlock (FGI) carts are at the same or colder temperature than the Whittaker cell during adverse weather conditions.
- 3.2 Demonstrate that the Whittaker cell can be maintained by the tent and heater at temperatures between the minimum temperature determined by the *"Test Procedure for Measurement of Performance VS Temperature of Whittaker Electrochemical Cell, HNF-SD-WM-TC-072"* and 120°F during adverse weather conditions.
- 3.3 Demonstrate that the tent, heater, exhaustor duct/spool piece, and FGI carts will interface together without compromising safety or integrity of the components.

4.0 Responsibilities

- 4.1 The Test Director shall be a design engineer or field engineer from the Characterization Equipment Engineering organization as named below.
 - 4.1.1 Jim Robinson
 - 4.1.2 Al Kostelnik
 - 4.1.3 Troy Farris
 - 4.1.4 Eric Waldo

- 4.2 The Test Director shall ensure that the work is performed as described in this test plan.
- 4.3 The Test Director shall be present during testing.
- 4.4 The Test Director shall make all data entries or designate as required. (The name of the person entering the data should be printed in the comment section of the data sheet next to the entry if other than the Test Director.)
- 4.5 The PIC shall direct all operation and maintenance personnel functions for equipment set-up, operation, and maintenance and control the job site.
- 4.6 The PIC shall initial on the exception sheet to show concurrence with the exception description and justification.

5.0 Test Deviations and Exceptions

All discrepancies, deviations or deficiencies involving the test plan or equipment performance are to be described and justified on the attached exception sheet in section 13.0. Exceptions shall be assigned a sequential number and the number shall be recorded in the margin next to the particular step. The Test Director shall determine if there is an exception and the PIC shall initial for agreement with the exception and the disposition.

6.0 Quality Assurance

This test provides the verification that design requirements are satisfied. Documentation of test equipment identification and calibration dates is required for all temperature detection devices.

7.0 Safety

The work package shall provide all necessary industrial safety related controls.

8.0 Equipment Required

- 8.1 Skid mounted, propane fired, forced air heater with 280,000 BTU/hr output including controls. Nominal flow rate of 3000 CFM with plenum and duct for controlling the air flow.
- 8.2 Tent which has been modified per figures 1 and 2. (End wall and adjacent portions of the side walls have been replaced with conductive rubber matting and sealed.)
- 8.3 Exhauster system with flammable gas detection spool piece, approved conductive duct, and two (2) FGI carts.
- 8.4 Power supply as required for the heater and operation of the exhauster and FGI carts.

- 8.5 Two (2) thermocouples which have been characterized with matching calibrated output device(s).
- 8.6 Mercury thermometer or equivalent for measuring outside ambient temperature.
- 8.7 Miscellaneous items including, tape measure, tape, knife, calibration tools necessary per 6-ES-449.

9.0 Set-up

- 9.1 Record the minimum temperature determined by the "Test Procedure for Measurement of Performance VS Temperature of Whittaker Electrochemical Cell, HNF-SD-WM-TC-072 Rev.0".

Temperature: 60 °F

- 9.2 Set-up the tent and exhauster in the general configuration shown in the attached sketches, (Figures 1 and 2). Refer to exhauster set-up procedure, TO-020-451, as required for exhauster set-up. Power is required for both of the FGI carts and for the exhauster.
- 9.3 Set-up the heater in the general configuration shown in figure 1 and per the following.
 - 9.3.1 Level the heater
 - 9.3.2 Attach flex hose to both outlets of metal heater ducting and position flex hose as required. Attach the diffusers which were supplied with the heater to the end of the flexible hoses.
 - 9.3.3 Position the thermostat control inside the exhauster tent and plug the thermostat cable into the receptacle on the heater.
 - 9.3.4 Connect propane supply hose from the propane tank to the heater.
 - 9.3.5 Connect the heater electrical supply cable to a 2-pole 240V, 1Ø, 20 amp minimum receptacle.
- 9.4 Affix a thermocouple to the surface of the Whittaker cell, (VTP-NT-2205), per figure 3 and route the leads to a temperature indicator at a location for observation from outside of the tent.
- 9.5 Place a thermocouple next to the thermostat for the heater and route the leads to a temperature indicator at a location for observation from outside of the tent.
- 9.6 Place the thermometer in the shade outside of the tent to detect outside air temperature

Exception #1

10.0 Test

10.1 Inspection

- ✓ 10.1.1 Verify test equipment is properly positioned and record identification numbers and meter calibration expiration date in section 12.2.
- ✓ 10.1.2 Ensure the heater is set-up and verify the following.
 - ✓ 10.1.2.1 Heater positioned and leveled.
 - ✓ 10.1.2.2 Flexible duct installed and sealed.
 - ✓ 10.1.2.3 Propane connected.
 - ✓ 10.1.2.4 Electrical connected including thermostat.
- ✓ 10.1.3 Ensure the exhauster is set-up per TO-020-451 and verify the following.
 - ✓ 10.1.3.1 Positioned and leveled.
 - ✓ 10.1.3.2 Flexible conductive duct installed on stands and sealed. Ensure the inlet is positioned and secured to not suck up debris.
 - ✓ 10.1.3.3 Electrical connected to the exhauster and the FGI carts.
- ✓ 10.1.4 Ensure the exhauster duct exclusion zone of 18 inches is maintained for all electrical equipment inside the tent except for the test thermocouples and meters.
- ✓ 10.1.5 Set the heater thermostat to maximum.
- ✓ 10.1.6 Ensure the tent is constructed as shown in figures 1 and 2 and ensure all the tent openings are closed and sealed.

10.2 Start-up

- ✓ 10.2.1 Record the temperature of each thermocouple and the time (hr:min) it was taken in section 12.7.
- ✓ 10.2.2 Energize the breaker for the receptacle used to power the heater.
- ✓ 10.2.3 Start the heater per its operator aid placard instructions and adjust the dampers on the plenum as required to ensure warm air flows to the tent.

Exception #2
Exception #3

- 10.2.4 Start the exhauster and FGI carts per procedure T0-060-347. Perform steps 5.2.1 through 5.2.5, 5.3.4, and 5.3.6 through 5.3.9.

5.3.3 *OK*
2-7-97

Exception #4
Exception #5
Exception #6

10.3 Scoping test

- 10.3.1 Per engineering directions, arrange the equipment, vent the tent, and adjust the controls as required to achieve the requirements in section 3.0. Record weather conditions and the equipment control set points in section 12.3.
- 10.3.2 After the temperature requirements have been met. Monitor the heater operation and observe that the requirements are satisfied for 1 continuous hour without operator intervention. If intervention is required comment on the data sheet, restart the "1 hour clock", and continue.

10.4 Required testing

- 10.4.1 Record the time and actual temperature of each thermocouple, including thermocouples VTP-TE-2207 and VTP-TE-2208 located on the FGI carts, (Temperatures are indicated on VTP-TI-2207 and VTP-TI-2208), in section 12.7 when there has been approximately a 5°F change or on approximately 15 minute intervals, whichever is shorter.
- 10.4.2 Monitor the temperatures and the heater operating characteristics every 20 minutes throughout the completion of the following shift. Make note of any operator required actions and record the time and the five temperatures.
- 10.4.3 During the second shift, perform steps 7.1, 7.2, 7.3, 7.7, 7.12, 7.14, 7.15 and 7.16 of Daily Combustible Gas Detector Calibration Check procedure 6-ES-449. Document observations of accessibility, temperature fluctuations and the time of completion of this step in section 12.4.

11.0 End of Test

- 11.1 Record final equipment set points for all adjusted controls in section 12.5.
- 11.2 Shut-off the exhauster and FGI carts per procedure T0-060-347. Perform steps 5.4.1, 5.4.3, 5.5.3, and 5.5.4.
- 11.3 Shut-off the heater per the operator aid placard and the test is complete. No further testing is required.

11.4 Sketch the final equipment arrangement as required to document the test conditions in section 12.6. Include all relevant dimensions.

11.5 The test is complete and has been performed per this test plan and the results satisfy the objectives with exceptions noted.

Objective 3.1 Y/N No

Objective 3.2 Y/N No

Objective 3.3 Y/N No

Exceptions: N/A

Test Director: Alis Kostelnik

Operations Representative: _____

12.0 Data

12.1 Test Director printed name and signature.

Alis Kostelnik Alis Kostelnik 2-7-97

12.2 Identification numbers and calibration expiration dates.

12.2.1 Thermocouple at Whittaker cell and meter

TC #1 8177 8177906018 Exp. 1-6-98 Initial\Date AK 2/7/97

12.2.2 Thermocouple at thermostat and meter.

TC #2 8177906018 Exp. 1-6-98 Initial\Date AK 2/7/97

12.3 Initial weather conditions and equipment set points (Reference section 10.3.1)

Ambient 36°F, No wind, Thermostat
on high (110°F), Primary Damper for flow to
exhauster tent in shut position. All
louvers on heater duct open and directed
at Whittaker Cell.

Initial\Date AK 2/7/97

12.4 Simulated SMC calibration (Reference Section 10.4.3)

Not Performed
N/A

Initial\Date G/K 2/11/97

12.5 Final equipment set points (Reference Section 11.1)

Not Performed
N/A

Initial\Date G/K 2/11/97

12.6 Sketch of final equipment arrangement.

N/A
GPK 7-11-97

12.7 Temperature observations (Reference section 10.2.1 and 10.4.1)

Temperature Observations and Comments						
TIME (hr:min)	Whittaker Cell (°F)	Thermostat (°F)	Outside (°F)	VTP-TI-2207 (°F)	VTP-TI-2208 (°F)	Comments (equipment adjustments, weather conditions, recorder names, etc...)
0130	32.7	34.8	30	54.7	56.0	Initial Conditions, Slight Breeze < 5mph.
0235	116.6	98.3	32	71.5	80.6	Exhauster not running per Exception 3
						Stopped Test to resolve Exhauster Alarms.
1000	122	102	36	84.5	95.2	Restart Exhauster and continue test.
1020	104.9	94.8		85.7	93.8	Closed all horizontal dampers on duct
1027	99.2	93.4	36	85.6	92.4	
See	exception	# 4				
1053	85.9	81.6	37	84°	88.5	Whittaker cooler than VTP-TI-2208 so opened lower slightly
1108	85.3	88.6	36	83.4	86.4	left set up as is.
1123	86.5	88.1	36	85 82.4	85.5	Opened middle lower to 1/4, bottom fully shut
1138	86.1	89.4	35	82.9	85.5	No change to set up
1153	85.5	89.7	36	83.0	85.3	Arranged heater outlet to discharge more directly in Whittaker
1208	84.9	90.7	37	83.0	85.4	Opened all ltr louvers (100%) and positioned outlet closer
1250	84.7	88.9	40	83.3	87.0	Moved heater discharge to opposite side of duct —
1305	83.7	87.5	38	83.2 85.4	85.9	No change
1320	81.9	89.5	38	82.6	85.9	Moved ltr discharge as close as possible with duct available
1335	82.7	91.3	38	83.2	87.1	Shut Off TI 2208 from heater duct
1350	85.6	93.4	38	83.7	88.4	No Change

Make additional copies as required.

02-07-97

Temperature Observations and Comments

[illegible]

11 of 15

Temperature Observations and Comments

[illegible]

Make additional copies as required.

13.0 Exceptions

Exception	Description	Justification (PIC initial/date)
#1	Changed IV mounting to matrix test per HWF-SD-WM-2002 wrong. OK 2-7-97	original sketch was
	configuration	
#2	Had to add step 5.1.3 from Exhauster procedure TO-060-347	Process test procedure Error OK 2-7-97
#3	Exhauster Alarms for temperature and humidity. Per TO-060-347 must return to Standby Mode.	Process test procedure OK 2-7-97 direction also. Attempt test
#4	Pressure transmitter WTP-PT-2216 was adjusted (at the transmitter) to display -.075 " tank pressure No PIC present to initiate	This was done to avoid relay K-11 "chattering" at the alarm point (-.1 "wg). OK 2-7-97
#5	Moved Thermistor used to measure ambient to inlet duct	Determine true inlet air temp
#6	Moved ambient thermistor back to original location.	Reading influenced by heat from tank

Make additional copies as required.

Figure 1

Figure 2

DETAIL OF TENT WALL REPLACEMENT

CUT AWAY THE TENT WALL BELOW THE GROMMETS.
ATTACH THE RUBBER MAT TO THE REMAINING TENT MATERIAL
AND SEAL THE SEAMS AS SHOWN.

Figure 3

WHITTAKER CELL