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(G) Reason	(H) Disp.	(J) Name	(K) Signature	(L) Date	(M) MSIN	(G) Reason	(H) Disp.	(J) Name	(K) Signature	(L) Date	(M) MSIN
		Design Authority	N/A			1	1	W. F. Brehm	N/A	9-12-96	N2-56
		Design Agent	N/A			13		M. D. Crippen			L5-31
1	1	Cog.Eng. T.A. Kroner	T.A. Kroner	9-11-96	N2-56	1	1	H. M. Knotek	H.M. Knotek	9/11/96	N2-56
1	1	Cog. Mgr. C.G. McCargar	C.G. McCargar	9/12/96	N2-56						
		QA									
		Safety									
		Env.									

18. <i>H.M. Knotek</i> Signature of EDT Originator	19. <i>C.G. McCargar</i> Authorized Representative Date for Receiving Organization	20. <i>C.G. McCargar</i> Design Authority/ Cognizant Manager	21. DOE APPROVAL (if required) Ctrl. No. ☐ Approved ☐ Approved w/comments ☐ Disapproved w/comments
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Sodium Wash Station Operational Testing Report

H. M. Knotek

Westinghouse Hanford, Richland, WA 99352

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Abstract: This document provides the test report for the Operability Test Procedure (OTP) performed on the Westinghouse Hanford Company developed Sodium Wash Station. The purpose of the Sodium Wash Station is to provide the capability to control and monitor the water vapor nitrogen reaction of sodium remaining in drained tanks and other components.

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H. M. Knotek (Signature) 10/2/96
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Release Stamp

Approved for Public Release

1.0 INTRODUCTION

This document provides the test report for the Operability Test Procedure (OTP) performed on the WHC developed Sodium Wash Station. The purpose of the Sodium Wash Station is to provide the capability to control and monitor the water vapor nitrogen (WVN) reaction of sodium remaining in drained tanks and other components. This test was required to assure satisfactory operational performance of the equipment before usage. The completed OTP is attached as Appendix A. The Sodium Wetted Component Cleaning Test, Section 5.2, of the OTP was performed twice. The second run, which satisfied the objectives of the OTP, was started on August 21, 1996 and completed on August 26, 1996.

The data gathered during this test is presented in Appendix B. This data was collected by the Fluke data logger system and by the personnel performing the test. All notes taken during the test are also presented in Appendix B.

2.0 DESCRIPTION OF TEST

The operability test was performed July 30, 1996 through August 26, 1996, at the 335 building in the 300 area. The test was conducted by personnel from FFTF Mechanical Equipment and Inservice Inspection Engineering with Process Engineering.

The objectives of the test were to demonstrate proper function of the cleaning system. Proper function was confirmed by monitoring hydrogen evolution as the reaction/cleaning progressed, and accurate indication of the reaction endpoint which was verified by visual inspection of the test segment.

A complete description of the system, the test conditions, the equipment required, and the test procedure are stated in the OTP (Appendix A). The test segment consisted of a 90° elbow approximately 4 inches in diameter and 18 inches long.

3.0 TEST RESULTS

The objectives of the test were satisfied. As shown in Table 1 and Figure 1 the hydrogen in nitrogen concentration approached zero as the reaction reached the endpoint. The flow rate of the nitrogen was kept at 1.0 standard cubic feet per minute (scfm) until the hydrogen evolved was near 0 ppm. The flow rate was then decreased to 0.2 scfm to determine if the reaction was complete. The hydrogen concentration increased to approximately 150 ppm at this flow rate. The hydrogen quickly dropped off and remained in the lower 10% of the analyzer scale (0-50 ppm), excluding erroneous readings due to air being admitted to the sample stream, for over 1.5 hours. The test segment was then removed from the test apparatus and visually inspected. It was found that no unreacted sodium remained inside of the segment.

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Table 1. Sodium Wash Station OTP August 26, 1996.

Time	Temp (F)	Hum (%)	H2 (ppm)	Flow (scfm)	Notes
9:30	87.68	79.55	137.05	1	-Analyzer on line. Reaction started at 0820.
9:35	87.68	80.01	143.79	1	
9:40	87.70	80.41	132.74	1	
9:45	87.70	80.74	143.42	1	
9:50	87.69	81.01	138.15	1	
9:55	87.71	81.30	135.19	1	
10:00	87.73	81.59	124.22	1	
10:05	87.73	81.84	119.46	1	
10:10	87.73	82.06	112.02	1	
10:15	87.72	82.31	113.35	1	
10:20	87.63	82.41	103.58	1	
10:25	87.60	82.37	92.40	1	
10:30	87.62	82.41	97.03	1	
10:35	87.59	82.48	90.18	1	
10:40	87.59	82.55	80.66	1	
10:45	87.56	82.62	56.81	1	-Hydrogen concentration below 0 ppm flow reduced to 0.2 scfm.
10:50	87.54	82.71	30.90	1	
10:55	87.54	82.80	25.10	1	
11:00	87.54	82.93	19.16	1	
11:05	87.53	83.08	7.72	1	
11:10	87.52	83.22	8.61	1	
11:15	87.51	83.35	7.52	1	
11:20	87.49	83.49	11.23	1	
11:25	87.48	83.64	11.01	1	
11:30	87.45	83.84	-5.22	1	
11:35	87.46	84.00	1.04	1	
11:40	87.43	84.18	-0.88	1	
11:45	87.42	84.38	-12.38	1	
11:50	87.39	84.61	-8.22	1	
11:55	87.35	84.80	2.80	0.2	-Looked inside segment, no sodium could be seen. Reading increased due to air introduced.
12:00	87.29	84.95	149.77	0.2	
12:05	87.29	85.11	87.51	0.2	
12:10	87.24	85.22	75.67	0.2	
12:15	87.19	85.33	38.96	0.2	
13:20	87.18	85.42	24.39	0.2	
12:25	87.17	85.54	17.11	0.2	
12:30	87.13	85.69	17.57	0.2	
12:35	87.06	85.81	19.96	0.2	
12:40	87.06	85.88	11.24	0.2	
12:45	87.03	85.97	10.32	0.2	
12:50	87.02	86.08	289.70	0.2	
12:55	86.98	86.16	139.04	0.2	
13:00	86.94	86.22	33.39	0.2	-Segment tipped to drain NaOH. -Downscale calibration point checked, reading low, required adjustment.
13:05	86.93	86.27	29.10	0.2	
13:10	86.93	86.32	50.36	0.2	
13:15	86.97	86.48	390.39	0.2	
13:20	86.80	86.43	456.22	0.2	
13:25	86.71	85.86	248.54	0.2	
13:30	86.68	85.10	26.09	0.2	
13:35	86.71	84.23	27.47	0.2	
13:40	86.75	83.37	22.54	0.2	
13:45	86.79	82.57	29.89	0.2	
13:50	86.85	81.87	19.11	0.2	

Figure 1. Sodium Wash Station OTP August 26, 1996

During testing it was determined that the pump B-1 pulled air into the gas vent panel at system flow rates below 0.2 scfm. The first run of the sodium wetted component test was carried out at 5 standard cubic feet per hour (scfh) (.08 scfm). Data collected during this run remained above the 500 ppm scale of the thermal conductivity analyzer. The thermal conductivity of air is 181 lb/hr°F; the thermal conductivity of 500 ppm hydrogen in nitrogen was calculated to be approximately 179 lb/hr°F. This indicates that a sample of air would appear as a full scale reading on the analyzer. It was determined late in the test run that the analyzer feed was at least 20% air. The second run of the sodium wetted component test was carried out at flows above 0.2 scfm (12 scfh). This required that a temporary flow indicator be installed into the system.

The sodium wash station was designed with two flow indicators in the gas supply panel. The ranges of these indicators are 100-500 scfh and 0-5 scfh. It was determined during the test that the flow rate for the system had to be at least 12 scfh. A temporary flow indicator with a range of 0-1.6 scfm (0-100 scfh) was installed into the system. A permanent flow indicator, which is currently on order, with a range of 0-100 scfh will be installed prior to operation of the system.

The moisture column fill level determination test was modified during the performance of OTP. The OTP specifies that carryover into the component be determined at valve V-9 which is open to the atmosphere. During testing it was found that this practice could potentially damage the computer system of the sodium wash station. A clear hose was connected to the outlet of the moisture column for purposes of determining carryover. It is recommended that the clear hose remain in the system as the permanent outlet of the moisture column. This change will be incorporated into the design per ECN 708463.

The fill levels determined during this test are listed in Table 2 below. The fill levels are operational fill levels, meaning that the levels are measured while nitrogen is flowing through the column. If the column is filled without nitrogen in the system, the fill level may appear lower due to drain back of the water into the line feeding the column. The volume which drains back into the hose is dependent on the positioning of the hose. The hose should be positioned so that the water can not flow back to the gas supply panel. It should be noted that the measurements of 60 and 75 scfh were made with a temporary flow indicator. It is recommended that these measurements be repeated once a permanent flow indicator is installed.

Table 2. Moisture column fill level

Flow (scfh)	Height on sight glass
60*	25.75"
75*	24.5"
100	15.75"

* Data point taken with temporary flow indicator.

It was determined that the moisture column was more efficient at flow rates above 60 scfh (1.0 scfm). It was hypothesized that the higher flow rates cleared the inlet leg of the moisture column of water which had drained into the line thus utilizing the sparger pipe. At lower flow rates the nitrogen

entered the moisture column in slugs which did not utilize the sparger pipe or packing efficiently. The flow rate at which the column begins to admit nitrogen at a steady rate is approximately 0.6-0.7 scfm (36-42 scfh).

The humidity/temperature transmitter is located in the gas vent panel. The initial measurement of humidity, made on August 5, 1996 at a flow rate of 5 scfh (.08 scfm), was 55% relative humidity at 81°F or 1.3% absolute humidity. After the dynamics of the moisture column and the system flow requirements were better understood the humidity measurement was reevaluated. During this process the humidity analyzer began to read a constant 93% relative humidity. Efforts to lower this reading by running dry nitrogen through the system were ineffective. The test was continued with the knowledge that the humidity analyzer would require maintenance. The transmitter, which was designed for use in HVAC systems, was operated outside of its operational range. It is assumed that the humidity remained about 1.5% absolute humidity throughout the test.

Efficiencies of various flow rates were studied as shown in Table 2. As shown in Table 2 the higher flow rates were more efficient in reacting sodium. This indicates that the residence time reduction does not inhibit the contact of the water with the sodium. It should be noted that these efficiencies should be evaluated relative to one another; the values are appropriate only for a particular surface area of sodium which was not evaluated during this test.

Table 3. Flow Rate Data Collected August 22, 1996.

Flow rate (scfm)	Hydrogen (ppm)	Sodium Reacted* (lbs/hr)
0.3	328	0.76×10^{-3}
0.5	267	1.03×10^{-3}
0.7	250	1.35×10^{-3}
0.8	230	1.42×10^{-3}
1.0	214	1.65×10^{-3}

* Determined stoichiometrically.

4.0 CONCLUSIONS, EXCEPTIONS, AND RECOMMENDATIONS

The sodium wash station functioned properly in regards to monitoring, controlling, and indicating the endpoint of the reaction. However, before operation the following exceptions must be addressed.

1. Flow indication in gas supply panel below the range required.

A flow indicator with 0-100 scfh range will be installed in place of the 0-5 scfh unit currently installed in the gas supply panel. It is recommended that the flow specific tests using the temporary flow indicator be repeated. These include: The moisture column level indication test and the determination of minimum acceptable flow.

2. The Fluke data logger requires a new battery and trouble shooting of a suspected short.

A new battery has been purchased for the data logger. In addition, downloading instructions have been added to the procedure to enable the technician to begin work in the event the data logger loses its primary programming. The suspected short was present early in the test but did not reoccur after about 8 hours of operation. The unit will be looked at by an instrument technician. The unit may only require internal cleaning.

3. The humidity/temperature transmitter does not respond to changes in humidity, reading approximately 93% under all conditions.

The transmitter was most likely saturated by the attempted humidity tests during OTP. An instrument technician will trouble shoot this instrument. At that time the limits of the unit will be determined. This transmitter may not be adequate for operation at high humidity levels but is sufficient for the lower humidities it will be subjected to during normal operation. If the humidity levels exiting the moisture column are in excess of the analyzer range a separate unit may be used to determine humidity levels. Since the data points of the stream exiting the moisture column need to be taken only once the instrument will not be installed into the system.

It is expected that during normal operation the wash station will be operated at flow rates around 100 scfh. The current design of the moisture column limits the fill level to 15 inches, or less than half of capacity, at this flow rate to avoid carry over. The reaction time required to clean a large unit with the water column at this level may be excessive. Therefore it may be beneficial to redesign the column prior to cleaning a unit with a large quantity of sodium.

It is recommended that the moisture column be replaced with a redesigned version which will saturate the nitrogen which flows through it. During this test the humidity was measured at approximately 1.3% humidity which was 55% relative humidity. To increase the humidity will require an increase in the water column height or an increase in temperature of the water in the column.

5.0 DISPOSITION OF SODIUM WASH STATION

When the above exceptions have been addressed the sodium wash station will be available for training. Once training has been completed the system will be placed into operation and cleaning of the sodium wetted tanks and other components will begin.

The initial operation of the system will be conducted in 8 hour shifts. During this time the system requirements to allow for 24 hour unattended operation will be determined. It is expected that the nitrogen supply will be one of the primary considerations.

APPROVAL
SODIUM WASH STATION
OPERATIONAL TESTING PROCEDURE

J.A. Hunter 7/20/96
Facility Manager, J.A. Hunter Date

W.F. Brehm 7-29-96
Program Leader, W.F. Brehm Date

T.A. Kroner 7-23-96
Cognizant Engineer, T.A. Kroner Date

H.M. Knotek 7/23/96
Originator, H.M. Knotek Date

Sodium Wash Station
Operational Testing
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1.0 INTRODUCTION

1.1 PURPOSE/SCOPE

The purpose of this Operation Test Procedure is:

1. Determine maximum fill level in moisture column.
2. Demonstrate proper function of sodium wash station at pressure and flow rate to be used during normal operation.

Proper function of the cleaning system will be determined by monitoring hydrogen evolution as reaction/cleaning progresses, ensuring the concentration of hydrogen in nitrogen approaches zero, and verifying that test segment contains no sodium by visual inspection.

2.0 RESPONSIBILITIES

2.1 FFTF ENGINEERING

FTTF Mechanical Equipment and Inservice Inspection Engineering will provide personnel for the performance and direction of the OTP.

2.2 PROCESS ENGINEERING

Process Engineering will provide personnel to perform the OTP.

3.0 DESCRIPTION OF SYSTEM

3.1 DESIGN

The NE Legacy Cleaning System has been designed to clean sodium wetted components in a controlled manner. The system feeds nitrogen with approximately 3% humidity into a sodium wetted component. The sodium in the component reacts with the water to produce sodium hydroxide. The evolution of hydrogen is monitored to determine when cleaning is completed.

The system consists of seven major assemblies:

- Nitrogen and Upscale Calibration Sources, H-3-300561 sheet 2
- Gas Supply Panel, H-3-300561 sheets 3 and 5
- Moisture Column, H-3-300561 sheet 6
- Gas Vent Panel, H-3-300561 sheets 3 and 5
- Calibration Panel, H-3-300561 sheet 5
- Electrical Panel, H-3-300561 sheet 8
- Data Logger and Computer System, H-3-300561 sheet 2

The interrelationship of each of the above mentioned assemblies is as shown on H-3-300560, sheet 1, "NE Legacy Loop Cleaning Gas System P&ID." The electrical installation of the system is as shown on H-3-300562, sheet 1, "NE Legacy Loop Cleaning Gas System Wiring Diagram." (See attached) The system requires an external, 125V, 15A, 1 phase, power source.

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3.1.1 Nitrogen and Upscale Calibration Sources

The nitrogen sources consist of a K-cylinder bottle containing 99.5% nitrogen and one Cryo-cylinder containing liquid nitrogen. The upscale calibration source consists of a K-cylinder containing 500 ppm hydrogen in nitrogen. The nitrogen feed to the system will be taken primarily from the liquid nitrogen cylinder. During normal operation one of the K-cylinders is used as a backup nitrogen supply.

The liquid nitrogen cylinder U-1 will be the only nitrogen source during OTP. The 500 ppm hydrogen in nitrogen will be used during the thermal conductivity analyzer checkout phase of the OTP.

3.1.2 Gas Supply Panel

The primary function of the gas supply panel is monitoring the pressure and flow of the nitrogen from the liquid nitrogen cylinder or K-cylinder to the moisture column and thermal conductivity analyzer. The primary stream off of the gas supply panel is fed to the lower end of the moisture column during normal operation. Another stream is fed to the thermal conductivity analyzer as a reference stream during normal operation. A third stream is fed to the calibration panel for use as the down-scale calibration gas during calibration of the thermal conductivity analyzer.

The moisture column will be by-passed during OTP to minimize the amount of humidity introduced to the HEPA filters located in the gas vent panel.

3.1.3 Moisture Column

The moisture column is packed column in which the feed stream, consisting of nitrogen, is bubbled through the column. The gas is humidified to approximately 3% moisture content. This humid nitrogen is fed to the sodium wetted component. The moisture content can be adjusted by varying the quantity of nitrogen feed which by-passes the moisture column.

3.1.4 Gas Vent Panel

The gas vent panel houses pressure indicators, HEPA filters, differential pressure across the filters, a vacuum pump, a drying column, and five sample points. The effluent gas off the sodium wetted component flows passively via upstream pressure into to gas vent panel. The first two sample points are located upstream and down stream of the HEPA filters. The last three sample points measure humidity and temperature, oxygen content, and hydrogen content.

The unit which analyzes for humidity and temperature is located in the gas vent panel. The units which monitor oxygen and hydrogen are located in the electrical panel. The sample stream exiting the gas vent panel is pulled through the drying column by a pump located in the calibration panel. The pump located in the gas vent panel will be used for purging the system. It will not be used during normal operation of the system.

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3.1.5 Calibration Panel

The calibration panel consists of a five-way switch valve, a rotary vane pump, pressure indication, a pressure relief valve set at 20 psi, and flow control/indication. The purpose of the calibration panel is to provide control and monitoring of the sample stream entering the thermal conductivity analyzer and to allow for calibration of the system at the same conditions as during normal operation.

3.1.6 Electrical Panel

The electrical panel provides power to the unit as well as houses the thermal conductivity analyzer and the oxygen monitor.

3.1.7 Data Logger and Computer System

The data logger monitors data from the humidity and temperature transmitter, located in the gas vent panel, and the thermal conductivity transmitter located in the electrical panel. This data is sent to the computer for storage in a file which can be analyzed independently of the system.

4.0 TEST LOCATION, EQUIPMENT, AND PERSONNEL REQUIRED

4.1 TEST LOCATION

Test will be conducted in the 335 building.

4.2 EQUIPMENT

Equipment required for OTP:

- deionized water source
- 1 length of pipe- sodium wetted

4.3 PERSONNEL

All personnel involved in the OTP shall be trained and/or advised by FFTF Engineering on the test procedures and equipment to be used.

5.0 OPERATION TEST PROCEDURE

5.1 MOISTURE COLUMN FILL LEVEL AND HUMIDITY TEST

- 5.1.1 Line-up Gas Supply Panel and Moisture Column valves as shown in Table 1 and Figure 1. Set system pressure to approximately 10 psi.

Figure 1. Moisture Column Fill Level Initial Valve Line-up

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Table 1. Moisture Column Fill Level Determination Initial Valve Line-up

Gas Supply Panel		
V-1	closed	PCV-3 isolation
V-2	closed	Nitrogen K-cylinder isolation
V-3	closed	PCV-1 isolation
V-4	closed	FI-1 flow
V-5	closed	FI-2 flow
V-6	open	Moisture Column influent
V-7	closed	Moisture Column by-pass
V-8	closed	Moisture Column drain valve
V-9	open	Moisture Column hose connector isolation (fill H ₂ O)
V-10	open	PI-2 isolation
V-11	closed	FI-3 flow/isolation
V-12	open	U-1 Liquid Nitrogen Cylinder flow/isolation
V-13	closed	Downscale calibration gas feed isolation

32 psi regulator
9 psi PI-2
200 scfm.

5.1.2 Open valve V-1 and pressurize system to 6-10 psi with PCV-3. Adjust flow on flow indicator FI-2 to approximately 3 SCFM by adjusting valve V-5.

8L ~ 1/2 full

5.1.3 Attach fill hose to moisture column hose connector.

5.1.4 Fill moisture column approximately 3/4 full with deionized water through hose fitting on moisture column.

* ~~Note: Valve V-9 will remain open during moisture column level test to determine carry over.~~

5.1.5 Disconnect water fill hose.

5.1.6 Allow nitrogen to flow until it can be assumed, per visual inspection, that no significant carryover will occur at that fill level.

5.1.7 Increase or decrease fill level and repeat until the maximum fill level is determined.

5.1.8 Mark maximum level on moisture column as "FI-2".

* Carry over determined using clear tubing attached to outlet. V-9 aimed directly at computer

** this section of test repeated with temporary flow indicator w/ range of 0-100 scfm

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5.1.9 Record maximum fill level for FI-2 from ^{from bottom of sight glass} ~~bottom of moisture~~ column. Record in log book. (HUK)

27.5 [=] inches ~~max 200 scfm~~ (HUK)

5.1.10 Close valve V-5

5.1.11 Adjust flow on flow indicator FI-1 to approximately 380 SCFM by adjusting valve V-4. ^{not obtainable w/ current system configuration}

5.1.12 Allow nitrogen to flow until it can be assumed, per visual inspection, that no significant carryover will occur at that fill level.

5.1.13 Decrease fill level and repeat until the maximum fill level is determined.

5.1.14 Mark maximum level on moisture column as "FI-1".

5.1.15 Record maximum fill level for FI-1 from ^{from bottom of sight glass} ~~bottom of moisture~~ column. Record in log book. (HUK)

27.5 [=] inches ~~max 200 scfm~~

5.1.16 Close valve V-6

NOTE:

~~This did not work. Must position hose above water level.~~ (HUK)
Close valve V-6 before stopping nitrogen flow to avoid back flow of water from the moisture column to the gas supply panel.

5.1.17 Measure humidity exiting moisture column.

- A. Attach hose exiting moisture column to quick disconnect upstream valve V-30.
- B. Begin flow through gas vent panel by opening valves V-6, V-30, V-34, V-36, and V-42.

CAUTION: The thermal conductivity analyzer must be disconnected prior to applying line power to the cleaning station.

- C. Disconnect lead to thermal conductivity analyzer, tape lead with electrical tape.
- (✓) Verify completion of step 5.1.17.B.

T. J. [Signature] 7-30-96
Cognizant Engineer Date

- D. Apply line power to cleaning station.

* Data points taken with temporary flow indicator used for test.
** Fill levels are operational fill levels

(HUK)

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- E. On data logger, turn key to run. The logger will go through a self diagnostic and then begin to scan.
- F. Turn on computer. Computer will boot directly into PROLOGR program.
- G. Push F9 (2280B connection)
- H. Push F6 (REMOTE operation). Computer system will begin to monitor scan information from the data logger.
- I. Record signal and humidity reading indicated by data logger.
- 3.188 [=] volts @ 81°F = 27.2°C
- 54.75 [=] percent
- J. Exit computer program, turn data logger key to OFF.
- K. Disconnect line power from cleaning station.
- L. Reconnect lead to thermal conductivity analyzer.

5.1.18 Close valves V-4, V-6, and V-9.

5.1.19 Refill moisture column to fill level for FI-2.

5.2 SODIUM WETTED COMPONENT CLEANING TEST

NOTE: This section of the test will be initiated at the beginning of a shift to allow sufficient time for reaction. The system will be left in a safe condition if unattended for an extended period of time.

5.2.1 Attach sodium wetted pipe segment in line of Seal Pot SP-1.

5.2.2 Verify valve line-up as shown in Tables 2 and 3, and Figures 2 and 3.

K-cylinder will be used as nitrogen source 8/5/94 HMK

Figure 2. Cleaning Test Gas Supply Panel Initial Valve Line-up

Figure 3. Cleaning Test Gas Vent and Calibration Panel Initial Valve Line-up

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Table 2. Cleaning Test Gas Supply Panel Initial Valve Line-up

Gas Supply Panel		
V-1	open	PCV-3 isolation
V-2	closed	Nitrogen K-cylinder isolation
V-3	closed	PCV-1 isolation
V-4	closed	FI-1 flow
V-5	closed	FI-2 flow
V-6	closed	Moisture Column influent
V-7	closed	Moisture Column by-pass
V-8	closed	Moisture Column drain valve
V-9	closed	Moisture Column hose connector isolation (fill H ₂ O)
V-10	open	PI-2 isolation
V-11	closed	FI-3 flow/isolation
V-12	open	U-1 Liquid Nitrogen Cylinder flow/isolation
V-13	closed	Downscale calibration gas feed isolation

Table 3. Cleaning Test Gas Vent and Calibration Panel Initial Valve Line-up

Gas Vent Panel		
V-30	open	SP-1 isolation
V-31	closed	SP-2 isolation
V-32	closed	SP-3 isolation
V-33	open	HEPA-2 upstream isolation
V-34	open	HEPA-1 upstream isolation
V-35	open	HEPA-2 downstream isolation
V-36	open	HEPA-1 downstream isolation
V-37	closed	Up-scale calibration gas K-cylinder isolation
V-38	closed	Sample point downstream HEPA filters
V-39	closed	PCV-2 isolation
V-40	open	PI-6 isolation
V-41	open	PI-3 isolation
V-42	open	Gas vent panel sample gas vent
V-46	open	PI-5 isolation
V-47	closed	Sample point upstream HEPA filters
Calibration Panel		
V-50	Sample	Thermal Conductivity Analyzer Feed (Downscale/Sample/Upscale/Closed positions)
V-51	open	PI-7 isolation
V-52	closed	FI-4 isolation

5.2.3 Open valve V-7

Note: The flow rate of nitrogen through the moisture column may be changed per cognizant engineers discretion.

5.2.4 Adjust nitrogen flow at FI-2 to approximately 5 SCFM by opening V-5

5.2.5 Open valve V-6 to start flow to moisture column

5.2.6 Close valve V-7 to divert all flow through moisture column

Rxn initiated @ 8:15
on 8/5/96

5.3 THERMAL CONDUCTIVITY ANALYZER START-UP

CAUTION: Flow of reference and sample streams must be established prior to applying line power to thermal conductivity analyzer.

5.3.1 Open valve V-13

5.3.2 Open valve V-50 to DOWNSCALE.

5.3.3 Adjust flow in Calibration panel at flow indicator FI-4 to approximately 150 cc/min by adjusting valve V-52.

5.3.4 Adjust flow rate at flow indicator FI-3 to approximately 25 cc/min.

(✓) Verify flow of sample and reference streams to thermal conductivity analyzer.

T. J. [Signature] 8-5-96
Cognizant Engineer Date

5.3.5 Apply line power to wash station.

5.3.6 Establish a sample flow at FI-4 of approximately 350 cc/min through the analyzer.

5.3.7 Adjust reference gas at FI-3 to approximately 25 cc/min.

5.3.8 Verify flow rate at FI-2 at approximately 5 SCFM.

5.3.9 Allow analyzer to warm up until the on/off indicator light cycles to ensure temperature equilibration. As soon as internal temperature controller is in the control band, the heater on/off indication on the front panel should begin to illuminate intermittently.

(✓) Verify completion of step 5.3.9

T. J. [Signature] 8-5-96
Cognizant Engineer Date

5.3.10 Initiate computer system and logging system.

The computer system and logging system are menu driven.

- A. On data logger, turn key to run. The logger will go through a self diagnostic and then begin to scan.
- B. Turn on computer. Computer will boot directly into PROLOGR program.
- C. Push F9 (2280B connection)

- D. Push F6 (REMOTE operation). Computer system will begin to monitor scan information from the data logger.

5.4 THERMAL CONDUCTIVITY ANALYZER CALIBRATION

- 5.4.1 Verify flow of approximately 350 cc/min at FI-4.
- 5.4.2 Set down-scale calibration point (0 ppm H₂).
- A. On analyzer module, set front-panel SPAN Control at normal operation setting.
- B. On analyzer module, adjust front-panel ZERO Control so that reading on recorder and the front panel meter is appropriate to the down scale standard gas.
- 5.4.3 Adjust upscale calibration gas regulator to 10 PSI by opening valves V-39, V-37 and adjusting PCV-2.
- 5.4.4 Admit upscale calibration gas to the analyzer by rotating V-50 to "UPSCALE" position. Verify flow of approximately 350 cc/min at FI-4. Wait for reading on meter and recorder to stabilize.
- 5.4.5 Set upscale calibration point (500 ppm H₂).
- A. On analyzer module, adjust front-panel SPAN Control to the upscale standard gas.
- 5.4.6 Admit downscale calibration gas by adjusting V-50 to DOWNSCALE. Verify reading indicates set point of calibration within +/- 5.
- 5.4.7 Admit upscale calibration gas by adjusting V-50 to UPSCALE. Verify reading indicates set point of calibration within +/- 5.

NOTE: Repeatability of analyzer reading will constitute calibration completion.

- (✓) Verify completion of calibration.

T. A. Koon 8-5-56
Cognizant Engineer Date

- 5.4.8 Initialize data logger and computer system
- A. Name data file to save to disk with sufficient space
- B. Begin recording on data logger and computer system by pressing record
- 5.4.9 Adjust flow at FI-4 to approximately 350 cc/min by adjusting valve V-52, if sufficient flow is unobtainable throttle valve V-42.
- 5.4.10 Monitor reaction on thermal conductivity analyzer.

Periodically check flow rates of sample and reference streams (FI-4 and FI-3), fill level of moisture column, hydrogen evolution, and logging system for errors.

- 5.4.11 Record, in log book, hydrogen concentration from thermal conductivity analyzer once every one to two hours.

NOTE: Monitoring of hydrogen evolution as reaction/cleaning progresses, the concentration of hydrogen in nitrogen approaches zero, and verification of uncontaminated test segment by visual inspection, constitutes adequate operation of cleaning system.

- (✓) Verify adequate operation of cleaning system.

H.M. Knott for T.A. Kner 8/26/96
Cognizant Engineer Date

5.5 SYSTEM SHUT-DOWN

- 5.5.1 Exit computer and data logging programs.

- 5.5.2 Shut down power to system.

Note: The inert atmosphere should be conserved in panels by closing all valves that open the system to the atmosphere. Isolation valves upstream and downstream of HEPA filters shall be closed to decrease amount of condensate introduced to filters. K-cylinders shall be isolated.

- 5.5.3 Close valves as shown in Tables 4 and 5, and Figures 4 and 5.

- 5.5.4 Drain moisture column if it will be unused for an extended period of time.

Sodium Wash Station
Operational Testing
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Table 4. Shut-down Gas Supply Panel Valve line-up

Gas Supply Panel		
V-1	closed	PCV-3 isolation
V-2	closed	Nitrogen K-cylinder isolation
V-3	closed	PCV-1 isolation
V-6	closed	Moisture Column influent
V-7	closed	Moisture Column by-pass
V-8	closed	Moisture Column drain valve
V-9	closed	Moisture Column hose connector isolation (fill H ₂ O)
V-11	closed	FI-3 flow/isolation
V-12	closed	U-1 Liquid Nitrogen Cylinder flow/isolation
V-13	closed	Downscale calibration gas feed isolation

Table 5. Shut-down Gas Vent and Calibration Panel Valve line-up

Gas Vent Panel		
V-30	closed	SP-1 isolation
V-31	closed	SP-2 isolation
V-32	closed	SP-3 isolation
V-33	closed	HEPA-2 upstream isolation
V-34	closed	HEPA-1 upstream isolation
V-35	closed	HEPA-2 downstream isolation
V-36	closed	HEPA-1 downstream isolation
V-37	closed	Up-scale calibration gas K-cylinder isolation
V-38	closed	Sample point downstream HEPA filters
V-39	closed	PCV-2 isolation
V-42	closed	Gas vent panel sample gas vent
V-47	closed	Sample point upstream HEPA filters
Calibration Panel		
V-50	closed	Thermal Conductivity Analyzer Feed (Downscale/Sample/Upscale/Closed positions)
V-52	closed	FI-4 isolation

Figure 4. Shut-down Gas Supply Panel Valve Line-up

Figure 5. Shut-down Gas Vent and Calibration Panel Valve Line-up

21 Aug 96

OTP2 test initiation - 9608OTP2.DAT

Cleaning segment from last testing sequence - NaOH residues
 Weighed out Na & placed inside of segment - $8.4\text{g} = 0.0185\text{lb}$
 Disposed of NaOH in absorbent.

General area clean-up for B&W tower.

Calibrate analyzer ~~1270719~~ ~~538 ppm = 5.31V~~ Oppm = 0.97V
~~538 ppm = 5.31V~~ 538 ppm = 5.41V

1220 began flow-through component w/ moisture column bypassed.

H₂ reads. 0 ppm or

Flow = .55 CFM = 30 SCFH

~~1225~~ Waited until H₂ read 0 ppm. - change in flows had interrupted reading

1225 flow through moisture column. - after ~ 4 min began to observe H₂ inc.

1232 Flow = .43 CFM = 24 SCFH

last humidity reading of 93% at 76°F corresponds. ~~028 Abs. Hum.~~

~~021 Abs. Hum. = .01~~

1245 1.86 V H₂ 94% at 77°F ~~022 Abs.~~ → .02 Rel.

1310 2.77 V H₂ 94% at 79°F ← dry bulb T.

1315 Maintaining at ~ 200 ppm

∴ lower flow to .3 CFM = 18 SCFH

O₂ reading 00.3% - 00.1% - 00.0% vent nearly closed.

1330 4.05 V H₂ 93.6% @ 79.6°F

1400 0% O₂ 93.5% @ 80°F

3.74 V H₂

1415 Flow to .2 SCFM = 12 SCFH to see if H₂ > range.

bubbles stopped at 12 SCFH. two may soon rxn. bc

Flow path through erlenmeyer flask increased contact.

H₂ reading is oscillating more than expected. Sometimes by 10% of scale.
 90% scale - 100% scale.

1425 Flow ^{de} increased to .3 SCFM = 18 SCFH

1506 Flow led to bypass flow increased to .55 CFM = 30 SCFH

1515 2.08 V H₂ 93% hum @ 79.7°F

1530 1.42 V H₂

1535 - Scan stopped.

'22 AUG 96

Calibration of Analyzer.

5.3 V = 538 ppm

1.0 V = 0 ppm

mirror edge

zero - 5.62

span - 3.35

- 0900 Calibration complete
- 0910 Check calibration
- 0923 bypass flow to component increased
O₂ reading - 00.1%
Record-on. ~~9408~~ 9408 OTP2.DAT append.
- 0927 flow through column.
.3 SCFM = 18 SCFH - bubbles in flask.
- 0941 ppm H₂ = 1.31 V = 40 ppm - low, most likely hydrating
any crust that may have formed overnight.
humidity reading at 93% @ 74°F - reading of humidity
questionable. has not changed. will include as exception
to be debugged prior to acceptance of OTP.
- 1101 198 ppm 92% hum @ 80.6°F
- 1141 320 ppm 92.6% @ 82.5°F Flow = .3 SCFM
- 1211 increased flow to .5 SCFM to 100K at efficiencies
- 1216 296 ppm - moisture column sounds better at this flow.
- 1230ish flow increased to ~~.6 SCFM~~ .7 SCFM
- 1311 Flow to 1 SCFM = 60 SCFH
moisture column sounds better. H₂O level up on sight glass.
O₂ reading - 00.1%.
- 1330 higher flow rates forcing NaOH out tape.
cleaned up. fixed leaks.
- 1340 lowered flow rate to .8 SCFM
- 1406 207 ppm
- 1436 193 ppm
- 1501 183 ppm
- 1513 flow decrease to .6 SCFM
- 1520 bypassed moisture column increased flow to 1 SCFM
- 1526 160 ppm
- 1531 H₂ reading inc. due to flow interruption.
- 1536 14 ppm
record off
scan off
purge left on overnight
No visible inside →
- Used 1 k cyl today
~1 in. in ~~col.~~ col. spent.

23 AUG 96

0805 Begin calibration
 0858 Begin bypass flow to component.
 O₂ reading 0%.
 0903 Begin flow through column 0.5 SCFM
 0929 Calibration complete zero - 5.69
 0933 Flow increased to span - 4.33
 .8 SCFM
 0948 .8 SCFM, 95 ppm, 92% hum, 79.8°F
 1023 172 ppm.
 1158 Flow red. to .6
 1230 Ran out of N₂
 1245 Flow at .6 SCFM
 1308 316 ppm, 92% 79°F
 1358 345 ppm, 92%, 80°F, O₂ = 0%.
 increased to .8 SCFM → 322 ppm
 1423 increased to 1.0 SCFM
 1448 326 ppm.
 1500 Bypass moisture column.
 1503 277 ppm
 1528 103 ppm
 1533 90 ppm - flow red. to .4 SCFM
 Flow left on purge over weekend
 bottle 1 900 psi
 bottle 2 2250 psi

26 AUG 96

0813 Calibration started
 0820 Cleaning started @ .5 SCFM
 0900 Calibration complete → zero 5.96 span 3.72
 O₂ = 0%.
 0905 Switched V-50 to sample.
 increased flow to 1.0 SCFM.
 0910 141 ppm, 87% hum, 77°F
 0920 Record on
 1155 H₂ below 0 at 1 SCFM reduced flow to .8 SCFM
 1245 H₂ = 10 ppm
 looked inside, can't see any Na₂ reading inc. due to air. ← 1250, 289 ppm (air)

26 AUG 96

1300 33ppm, 86% hum, 86°F
tipped segment to draw NaOH
1305 29.1ppm
1307 Downscale calibration point check - reading low.
required adjustment. zero. 5.62
1310 50ppm
1320 H₂ reading increased - found that N₂ flow had
dropped below .2 SCFM - air had been pulled
into pump. increased flow to .2 SCFM
1325 reading dropped. 250ppm - still error.
1330 26ppm
1335 27ppm
1350 Record off
Scan off
Opened top.

To program time:

scan must be off

Z ↵

2 ↵

HH.MM ↵

DD, MMM, YY ↵

EXIT

EXIT

begin scan.

If data logger panel indicates "User program lost"

turn key to PROGRAM

U ↵

5 ↵

1 ↵

3 ↵

1 ↵

7 ↵

EXIT

EXIT

EXIT

turn key to run

turn computer on or get to main menu.

F5

F5

< wait for download >

F9

< wait for "online & waiting" >

F1

scan will begin

Sodium Wash Station OTP August 21, 1996

Raw Data

Time	Temp. (V)	Hum (V)	H2 (V)	Temp. (F)	Hum (%)	H2 (ppm)	Flow (scfm)	Notes
12:30	4.75	4.02		93.77	75.56		0.5	Initiated flow through moisture column
12:35	4.75	4.05	1.33	93.81	76.21	41.89	0.4	
12:40	4.75	4.07	1.67	93.83	76.86	85.68	0.4	
12:45	4.75	4.10	1.87	93.85	77.43	109.23	0.4	
12:50	4.75	4.12	1.77	93.85	77.95	97.04	0.4	
12:55	4.75	4.14	1.93	93.82	78.38	119.32	0.4	
13:00	4.75	4.15	2.08	93.80	78.76	135.05	0.4	
13:05	4.75	4.16	2.04	93.78	79.08	130.97	0.4	
13:10	4.75	4.17	2.78	93.72	79.29	230.37	0.4	
13:15	4.75	4.18	2.53	93.71	79.53	199.15	0.3	
13:20	4.75	4.19	2.65	93.67	79.65	224.02	0.3	
13:25	4.75	4.19	2.73	93.64	79.69	208.06	0.3	
13:30	4.74	4.19	4.06	93.57	79.66	384.16	0.3	
13:35	4.74	4.18	3.64	93.52	79.53	326.17	0.3	
13:40	4.74	4.18	3.72	93.51	79.52	339.04	0.3	
13:45	4.74	4.19	3.75	93.52	79.65	341.85	0.3	
13:50	4.74	4.19	3.48	93.50	79.73	307.19	0.3	
13:55	4.74	4.19	3.61	93.51	79.83	325.54	0.3	
14:00	4.74	4.20	3.74	93.51	79.96	349.13	0.3	
14:05	4.74	4.20	3.38	93.49	80.02	297.63	0.3	
14:10	4.74	4.20	3.65	93.46	80.05	337.65	0.3	
14:15	4.74	4.20	5.08	93.44	80.05	528.36	0.2	
14:20	4.74	4.20	4.36	93.43	80.05	426.45	0.2	
14:25	4.74	4.20	4.96	93.41	80.06	508.89	0.3	
14:30	4.73	4.20	3.53	93.37	80.03	314.47	0.3	
14:35	4.73	4.20	3.64	93.33	79.88	326.06	0.3	
14:40	4.73	4.19	3.40	93.33	79.72	298.23	0.3	
14:45	4.73	4.18	4.78	93.35	79.54	467.28	0.3	
14:50	4.73	4.18	4.45	93.35	79.43	418.99	0.3	
14:55	4.74	4.18	3.55	93.38	79.54	317.34	0.3	
15:00	4.74	4.19	3.49	93.37	79.67	311.65	0.3	
15:05	4.73	4.19	3.72	93.35	79.70	332.07	0.5	Flow path by-pass moisture column.
15:10	4.73	4.19	2.87	93.32	79.71	227.93	0.5	
15:15	4.73	4.19	2.08	93.31	79.71	135.39	0.5	
15:20	4.73	4.19	1.61	93.29	79.68	75.96	0.5	
15:25	4.73	4.19	1.58	93.29	79.65	72.79	0.5	
15:30	4.73	4.19	1.42	93.32	79.77	52.75	0.5	
15:35	4.73	4.21	1.48	93.33	80.16	60.45	0.5

Raw Data

Time	Temp (V)	Hum (V)	H2 (V)	Temp (F)	Hum (%)	H2 (ppm)	Flow (scfm)	Notes
9:26	4.72	3.89	1.15	93.09	72.22	19.74	0.3	Initiated flow through moisture column.
9:31	4.73	3.91	1.55	93.13	72.81	69.08	0.3	
9:36	4.73	3.94	1.36	93.18	73.57	45.47	0.3	
9:41	4.73	3.98	1.32	93.23	74.43	39.73	0.3	
9:46	4.73	4.01	1.41	93.24	75.27	51.42	0.3	
9:51	4.73	4.04	1.44	93.23	75.99	54.85	0.3	
9:56	4.73	4.07	1.45	93.22	76.65	55.73	0.3	
10:01	4.73	4.09	1.51	93.20	77.23	62.29	0.3	
10:06	4.73	4.11	1.55	93.16	77.74	68.25	0.3	
10:11	4.72	4.13	1.57	93.12	78.17	71.15	0.3	
10:16	4.72	4.14	1.64	93.10	78.57	80.12	0.3	
10:21	4.72	4.16	1.70	93.05	78.93	87.10	0.3	
10:26	4.72	4.17	1.90	93.01	79.23	112.48	0.3	
10:31	4.72	4.18	1.95	92.97	79.49	119.73	0.3	
10:36	4.72	4.19	2.12	92.92	79.68	138.64	0.3	
10:41	4.72	4.19	2.19	92.90	79.81	149.12	0.3	
10:46	4.72	4.20	2.29	92.89	79.97	161.15	0.3	
10:51	4.72	4.21	2.31	92.90	80.18	164.90	0.3	
10:56	4.71	4.22	2.52	92.87	80.39	188.74	0.3	
11:01	4.71	4.23	2.61	92.86	80.63	198.31	0.3	
11:06	4.71	4.23	2.85	92.85	80.88	229.06	0.3	
11:11	4.71	4.25	3.03	92.83	81.13	248.47	0.3	
11:16	4.71	4.25	3.17	92.80	81.37	272.32	0.3	
11:21	4.71	4.26	3.07	92.80	81.63	258.62	0.3	
11:26	4.71	4.27	3.03	92.78	81.88	253.42	0.3	
11:31	4.71	4.28	3.26	92.75	82.11	281.14	0.3	
11:36	4.71	4.29	3.36	92.73	82.35	293.39	0.3	
11:41	4.71	4.30	3.57	92.70	82.59	320.36	0.3	
11:46	4.71	4.31	3.43	92.67	82.79	304.22	0.3	Data collection for flow efficiency study.
11:51	4.71	4.32	3.37	92.65	82.97	297.58	0.3	
11:56	4.71	4.33	3.52	92.64	83.17	315.86	0.3	
12:01	4.71	4.34	3.51	92.62	83.41	313.67	0.3	
12:06	4.70	4.34	5.05	92.59	83.61	503.04	0.3	
12:11	4.70	4.35	3.62	92.56	83.79	328.20	0.5	
12:16	4.70	4.36	3.38	92.54	83.99	296.44	0.5	
12:21	4.70	4.37	3.27	92.53	84.19	285.54	0.5	
12:26	4.70	4.38	3.14	92.52	84.44	267.56	0.5	
12:31	4.70	4.39	3.13	92.49	84.67	261.56	0.7	
12:36	4.70	4.40	3.39	92.44	84.88	297.55	0.7	
12:41	4.70	4.40	3.28	92.43	85.09	284.74	0.7	
12:46	4.70	4.41	3.15	92.41	85.27	265.91	0.7	
12:51	4.70	4.42	3.10	92.41	85.46	257.83	0.7	
12:56	4.70	4.43	2.97	92.38	85.67	244.15	0.7	
13:01	4.69	4.43	3.15	92.35	85.86	270.33	0.7	
13:06	4.69	4.44	3.02	92.33	86.06	250.87	0.7	
13:11	4.69	4.45	3.10	92.28	86.22	261.44	1	
13:16	4.69	4.45	2.84	92.26	86.28	228.95	1	
13:21	4.69	4.45	3.13	92.27	86.33	265.25	1	
13:26	4.69	4.46	3.31	92.27	86.39	284.11	1	
13:31	4.69	4.46	2.85	92.30	86.52	229.59	1	
13:36	4.69	4.47	2.76	92.29	86.65	218.70	1	
13:41	4.69	4.47	2.70	92.24	86.66	214.15	0.8	
13:46	4.69	4.47	2.86	92.26	86.64	231.95	0.8	
13:51	4.69	4.47	2.81	92.33	86.81	225.75	0.8	
13:56	4.69	4.47	2.83	92.33	86.83	229.45	0.8	
14:01	4.69	4.47	2.71	92.28	86.63	215.58	0.8	
14:06	4.69	4.45	2.66	92.26	86.28	207.96	0.8	
14:11	4.69	4.43	2.65	92.26	85.84	204.81	0.8	
14:16	4.69	4.42	2.56	92.28	85.39	197.01	0.8	
14:21	4.69	4.40	2.60	92.28	85.00	198.52	0.8	
14:26	4.69	4.38	2.47	92.28	84.60	184.23	0.8	
14:31	4.69	4.37	2.54	92.27	84.23	192.49	0.8	
14:36	4.69	4.36	2.55	92.26	83.89	193.20	0.8	
14:41	4.69	4.34	2.53	92.31	83.61	190.47	0.8	
14:46	4.69	4.33	2.50	92.29	83.34	188.48	0.8	By-passed moisture column.
14:51	4.69	4.32	2.48	92.30	83.06	184.72	0.8	
14:56	4.69	4.31	2.44	92.31	82.86	179.37	0.8	
15:01	4.69	4.31	2.47	92.30	82.66	183.68	0.8	
15:06	4.69	4.30	2.43	92.30	82.50	180.77	0.8	
15:11	4.69	4.29	2.43	92.30	82.31	181.49	0.8	
15:16	4.69	4.29	2.57	92.30	82.20	196.69	0.6	
15:21	4.69	4.28	2.51	92.30	82.06	188.10	1	
15:26	4.69	4.28	1.39	92.27	81.88	46.15	1	
15:31	4.69	4.27	1.66	92.27	81.74	88.44	1	Flow interruption.
15:36	4.69	4.27	1.11	92.27	81.63	14.17	1

Raw Data							
Time	Temp (V)	Hum (V)	H2 (V)	Temp (F)	Hum (%)	H2 (ppm)	Flow (scfm) Notes
9:38	4.70	4.15	1.54	92.43	78.85	68.33	0.8
9:43	4.70	4.17	1.64	92.41	79.33	80.81	0.8
9:48	4.70	4.19	1.76	92.41	79.86	95.53	0.8
9:53	4.69	4.21	1.95	92.37	80.24	117.97	0.8
9:58	4.69	4.21	2.05	92.30	80.35	132.02	0.8
10:03	4.69	4.21	2.13	92.24	80.30	143.08	0.8
10:08	4.69	4.21	2.21	92.19	80.26	151.84	0.8
10:13	4.69	4.22	2.30	92.21	80.46	162.34	0.8
10:18	4.69	4.23	2.37	92.21	80.66	172.35	0.8
10:23	4.69	4.23	2.37	92.17	80.65	172.46	0.8
10:28	4.68	4.22	2.31	92.11	80.48	163.63	0.8
10:33	4.68	4.21	2.31	92.10	80.32	163.99	0.8
10:38	4.68	4.22	2.35	92.12	80.49	167.59	0.8
10:41	4.68	4.22	2.42	92.11	80.56	177.40	0.8
10:46	4.68	4.22	2.38	92.09	80.56	172.06	0.8
10:51	4.68	4.22	2.40	92.06	80.46	176.86	0.8
10:56	4.68	4.22	2.41	92.06	80.39	174.92	0.8
11:01	4.68	4.22	2.27	92.07	80.50	158.03	0.8
11:06	4.68	4.22	2.27	92.06	80.53	158.78	0.8
11:11	4.68	4.22	2.29	92.03	80.49	162.22	0.8
11:16	4.68	4.22	2.24	92.02	80.42	154.47	0.8
11:21	4.68	4.21	2.19	92.04	80.36	148.98	0.8
11:26	4.68	4.21	2.17	92.01	80.28	148.20	0.8
11:31	4.68	4.21	2.23	92.00	80.22	152.90	0.8
11:36	4.68	4.22	2.12	92.01	80.41	140.07	0.8
11:41	4.68	4.22	2.03	91.99	80.62	130.19	0.8
11:46	4.68	4.22	2.15	91.92	80.45	144.02	0.8
11:51	4.68	4.22	2.12	91.96	80.39	139.12	0.8
11:56	4.68	4.22	2.10	91.96	80.41	137.66	0.8
12:01	4.68	4.21	1.91	91.95	80.33	113.43	0.6
12:06	4.68	4.21	1.92	91.96	80.34	114.01	0.6
12:11	4.68	4.21	1.66	91.94	80.37	82.49	0.6
12:16	4.68	4.21	1.12	91.90	80.32	14.39	0.6
12:21	4.68	4.21		91.89	80.26	-95.69	0.6
12:26	4.68	4.21	2.85	91.92	80.24	288.95	0
12:48	4.69	4.15	2.60	92.26	78.65	201.76	0.6
12:53	4.69	4.16	3.11	92.29	78.97	264.18	0.6
12:58	4.69	4.17	3.23	92.23	79.18	278.85	0.8
13:03	4.69	4.18	3.26	92.19	79.40	282.27	0.8
13:08	4.69	4.19	3.53	92.15	79.66	316.16	0.8
13:13	4.68	4.19	3.64	92.12	79.83	332.07	0.8
13:18	4.68	4.20	3.61	92.06	79.92	325.09	0.8
13:23	4.68	4.20	3.34	92.04	80.04	294.80	0.8
13:28	4.68	4.20	3.72	91.99	80.04	337.78	0.8
13:33	4.68	4.20	3.71	91.99	80.00	337.25	0.8
13:38	4.68	4.20	3.75	91.97	80.09	343.95	0.8
13:43	4.68	4.20	3.74	91.96	80.09	345.52	0.8
13:48	4.68	4.21	3.68	91.96	80.17	335.90	0.8
13:53	4.68	4.21	3.89	91.91	80.31	363.41	0.8
13:58	4.67	4.21	3.76	91.85	80.23	345.31	0.8
14:03	4.67	4.21	3.81	91.85	80.15	352.57	0.8
14:08	4.67	4.20	3.38	91.85	80.12	298.56	0.8
14:13	4.68	4.21	3.53	91.88	80.16	315.19	0.8
14:18	4.67	4.21	3.63	91.87	80.23	327.74	0.8
14:23	4.67	4.21	3.59	91.86	80.21	322.94	1
14:28	4.67	4.21	3.39	91.82	80.20	296.81	1
14:33	4.67	4.20	3.33	91.81	80.12	291.80	1
14:38	4.67	4.20	3.51	91.84	80.11	316.08	1
14:43	4.67	4.20	3.64	91.82	80.03	330.41	1
14:48	4.67	4.20	3.61	91.87	80.03	326.76	1
14:03	4.67	4.20	3.94	91.86	79.97	366.35	1
14:58	4.67	4.19	3.57	91.83	79.83	322.46	1
15:03	4.67	4.19	3.23	91.87	79.65	277.55	1
15:08	4.68	4.19	2.50	91.95	79.63	187.51	1
15:13	4.68	4.19	2.20	91.95	79.70	149.91	1
15:18	4.68	4.19	1.98	91.94	79.80	121.49	1
15:23	4.68	4.20	1.90	91.90	79.88	112.84	1
15:28	4.67	4.19	1.83	91.85	79.79	103.92	1

Ran out of N2

Moisture column by-passed

Time	Temp (V)	Hum (V)	H2 (V)	Temp (F)	Hum (%)	H2 (ppm)	Flow (scfm)	Notes
9:30	4.51	4.18	2.10	87.68	79.55	137.05	1	Flow initiated through moisture column at 0820.
9:35	4.51	4.20	2.15	87.68	80.01	143.79	1	
9:40	4.51	4.22	2.06	87.70	80.41	132.74	1	
9:45	4.51	4.23	2.15	87.70	80.74	143.42	1	
9:50	4.51	4.24	2.11	87.69	81.01	138.15	1	
9:55	4.51	4.25	2.07	87.71	81.30	135.19	1	
10:00	4.51	4.26	1.98	87.73	81.59	124.22	1	
10:05	4.51	4.27	1.95	87.73	81.84	119.46	1	
10:10	4.51	4.28	1.90	87.73	82.06	112.02	1	
10:15	4.51	4.29	1.90	87.72	82.31	113.35	1	
10:20	4.51	4.30	1.82	87.63	82.41	103.58	1	
10:25	4.50	4.29	1.74	87.60	82.37	92.40	1	
10:30	4.50	4.30	1.75	87.62	82.41	97.03	1	
10:35	4.50	4.30	1.73	87.59	82.48	90.18	1	
10:40	4.50	4.30	1.65	87.59	82.55	80.66	1	
10:45	4.50	4.30	1.46	87.56	82.62	56.81	1	
10:50	4.50	4.31	1.25	87.54	82.71	30.90	1	
10:55	4.50	4.31	1.20	87.54	82.80	25.10	1	
11:00	4.50	4.32	1.15	87.54	82.93	19.16	1	
11:05	4.50	4.32	1.06	87.53	83.08	7.72	1	
11:10	4.50	4.33	1.06	87.52	83.22	8.61	1	
11:15	4.50	4.33	1.06	87.51	83.35	7.52	1	
11:20	4.50	4.34	1.09	87.49	83.49	11.23	1	
11:25	4.50	4.35	1.09	87.48	83.64	11.01	1	
11:30	4.50	4.35		87.45	83.84	-5.22	1	
11:35	4.50	4.36	1.00	87.46	84.00	1.04	1	
11:40	4.50	4.37		87.43	84.18	-0.88	1	
11:45	4.50	4.38		87.42	84.38	-12.38	1	
11:50	4.50	4.38		87.39	84.61	-8.22	1	
11:55	4.49	4.39	1.01	87.35	84.80	2.80	0.2	Hydrogen concentration 0.
12:00	4.49	4.40	2.22	87.29	84.95	149.77	0.2	Reduced flow to determine
12:05	4.49	4.40	1.69	87.29	85.11	87.51	0.2	reaction completion.
12:10	4.49	4.41	1.58	87.24	85.22	75.67	0.2	
12:15	4.49	4.41	1.31	87.19	85.33	38.96	0.2	
12:20	4.49	4.42	1.21	87.18	85.42	24.39	0.2	
12:25	4.49	4.42	1.14	87.17	85.54	17.11	0.2	
12:30	4.49	4.43	1.13	87.13	85.69	17.57	0.2	
12:35	4.48	4.43	1.16	87.06	85.81	19.96	0.2	
12:40	4.48	4.44	1.09	87.06	85.88	11.24	0.2	
12:45	4.48	4.44	1.08	87.03	85.97	10.32	0.2	Looked inside segment,
12:50	4.48	4.44	3.43	87.02	86.08	289.70	0.2	couldn't see any Na.
12:55	4.48	4.45	2.15	86.98	86.16	139.04	0.2	
13:00	4.48	4.45	1.27	86.94	86.22	33.39	0.2	
13:05	4.48	4.45	1.22	86.93	86.27	29.10	0.2	Checked calibration,
13:10	4.48	4.45	1.40	86.93	86.32	50.36	0.2	correction required.
13:15	4.48	4.46	4.10	86.97	86.48	390.39	0.2	Flow dropped below 0.2
13:20	4.47	4.46	4.65	86.80	86.43	456.22	0.2	scfm.
13:25	4.47	4.43	3.06	86.71	85.86	248.54	0.2	
13:30	4.47	4.40	1.21	86.68	85.10	26.09	0.2	
13:35	4.47	4.37	1.22	86.71	84.23	27.47	0.2	
13:40	4.47	4.34	1.18	86.75	83.37	22.54	0.2	
13:45	4.47	4.30	1.23	86.79	82.57	29.89	0.2	
13:50	4.47	4.28	1.15	86.85	81.87	19.11	0.2

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