Interoffice Correspondence

Civilian Radioactive Waste Management System
Management & Operating Contractor

TRW

TRW Environmental
Safety Systems Inc.

QA: NA

Subject	Date	From
Guidance for the Ventilation Test	June 29, 2000 LV.SSPTS.HNK.06/00-006	Hemendra N. Kalia
To	**cc**	**Location/Phone**
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1.0 Introduction

Ventilation is a key component for the purposes of maintaining sub-boiling conditions in the emplacement drifts. The System Design Description (SDD) for the Emplacement Drift System SDD-EDS-SE-000011, Rev 0 (MOL.20000121.0119), Section 1.2.4.5, states the subsurface ventilation system shall accommodate removal of 70 percent of the heat generated by the Waste Packages (WPs) during pre-closure.

Subsurface Design Section (SSDS) of the Subsurface Facilities Department (SSFD) has performed calculations to evaluate the effect of continuous ventilation on heat removal from the emplacement drifts during the pre-closure period. These calculations were used to predict the temperature of the rock in the emplacement drifts and WP during both pre-closure and post closure periods.

The calculation estimate effects of the physical mechanisms and parameters controlling the thermal response in the emplacement drifts, develops and describes the numerical methods that can be used to evaluate the effects of continuous ventilation (*ANSYS Thermal Calculations in Support of Waste Quantity, Mix and Throughput Study*, CAL-EBS-MG-000001 Rev 00) to maintain the temperature of the emplacement drifts to below boiling.

The SSDS requested the Subsurface Performance Testing Section (SSPTS) to perform a scaled ventilation test in four phases as per the request document using the form AP-3.14Q (R. S. Jurani/Yiming Sun) #00261 R, Enclosure 1.

The four phases of the pre-closure ventilation test are:

1. Phase I - Heat-only test using ambient air for ventilation
2. Phase II - Heat-only test using conditioned air (heated or cooled) air for ventilation
3. Phase III - Heat-Moisture test using moisture air for ventilation
4. Phase IV- Blast cooling test using ambient air ventilation

2.0 Test Objectives

The overall test objectives are to:

- Develop data to support the design of the ventilation system for the repository to maintain the emplacement drifts to a temperature of below boiling (≤ 96°C)
- Provide data to support the validation/verification of the ANSYS computer model used for the ventilation calculations by the SSFD

The AP-3.14 Q defines the test parameters to be measured such as:

- Air temperature inside and outside of simulated emplacement drift wall
- Surface temperature of the insulation
- Relative humidity of air inside simulated emplacement drift
- Air pressure inside simulated emplacement drift
- Heat generation rate of simulated WPs

3.0 Test Program

The four phases of this ventilation test will be performed in the Engineered Barrier System Test Facility located in North Las Vegas. The test set-up will utilize a large diameter (nominally 1/4 diameter of the emplacement drift) concrete pipe. The concrete pipe will have a length of at least 25 to 30 times the diameter of the pipe. Simulated, 1/4 scale 21 PWR, WPs will be fabricated from steel pipe. Electrical heaters will be used to simulate the heat produced by the decaying High-Level Radioactive Waste. Primary objectives of each phase of the test are described below. Actual test set-up will be documented in the as constructed description. This provides information to facilitate the design and implementation of the ventilation test.

Phase I. Heat Only Models with Ventilation with Ambient Air
This test will simulate the ability of the ambient ventilation air to maintain sub-boiling temperature at the emplacement drift wall.

Phase II. Heat Only Test Using Conditioned Air (heated or cooled) for Ventilation
This test will simulate the ability of the inlet air at different temperatures to maintain the emplacement drifts to below boiling temperature.

Phase III Heat-Moisture Test Using Moisture Air for Ventilation
This test will simulate moisture removal capability of the ventilation air. As necessary, moisture will be introduced in the test cell and ventilation will be forced through the test set-up to assess the moisture removal capability of the ventilation air.

Phase IV Blast Cooling Test Using Ambient Air Ventilation
This phase of the test will consist of forcing a large quantity of air to ascertain the ability to blast cool the emplacement drifts.

4.0 Test Configuration

The test configuration is expected to remain the same for all four phases, as described below and shown in Figure 1. The emplacement drift will be constructed by connecting segments of concrete pipes. The simulated WP will be fabricated from steel pipe. Both ends of the WP will be closed after the rod heaters have been installed. A steel invert structure designed to simulate current WP support will be used to place the simulated WP. Crushed tuff from the Yucca Mountain will be used as invert. Electric heaters will simulate decay heat.

Major features of the test are as described below:

• Simulated Emplacement Drift Diameter (D)	nominal 54 inches
• Simulated Emplacement Drift Length (L)	at least 25 to 30x(D) or 120 ft-135 ft
• Air inlet system length	nominal 25-30 ft
• Air exhaust system length	nominal 15-30 ft
• Simulated WP diameter	nominal 16 inches inside diameter
• Simulated WP diameter	nominal 16.625 inches outside diameter
• Test Power Output	nominal 0.35 kW/m of WP length
• Expected WP skin temperature	ambient - 200° C
• Air velocity	60 fpm to 150 fpm
• Maximum temperature at the crown of the emplacement drift	100° C

Key test parameters to be monitored are:

- Atmospheric temperature, barometric pressure and humidity
- Air inlet temperature, humidity and velocity
- Air temperature and humidity at selected points along the length of the emplacement drift
- Temperature in the drift wall at several locations
- Air outlet temperature, humidity and velocity
- Power consumed by the simulated WP heaters

Key aspects of test conduct are:

- Data will be continuously collected at an interval of up to four times per hour
- Temperature will be monitored to an accuracy of 1/2° C
- Allow for the test to be performed without ventilation
- Measure barometric pressure accurately to 0.50 millibar

5.0 Test Instrumentation

List of Required Instruments:
The inlet section of the test will be instrumented to measure input air mass flow, temperature, and humidity. The beginning of the simulated emplacement drift will be instrumented to measure humidity and temperature, as a function of location at various stations along the length of the test tunnel. Temperatures will be measured on the simulated WP, in the air stream and in the concrete.

Relative humidity will be also measured at the same locations. The air outlet section will be instrumented similar to the air inlet end of the test to monitor air velocity and the relative humidity. Table 1 shows the numbers, types and approximate location of the instruments to be installed.

The emplacement drift and the WPs will be instrumented as shown in Figure 1 (see Enclosure 2).

As much as possible, the instruments will be procured from the Yucca Mountain Project (YMP) qualified vendors. The vendors will be requested to provide calibrated instruments. Bechtel Nevada (BN) Calibration Laboratory will calibrate other instruments as needed.

6.0 Working Schedule for the Ventilation Test Phase I

Start setting up the test	07/10/00
Start test	08/15/00
Complete Phase I	FY2000
Complete Phase II of the Test	December of FY2000
Complete Phase III of the Test	June of FY2001
Complete Phase IV of the Test	September of FY2001

7.0 Test Constraints

1. It is required that the temperature of the test drift exterior and inlet air be maintained as consistent as possible. This requires climate control in the test area.
2. For the Phase II Test it is required that the air entering the test drift be at a controlled temperature. This may require heating or cooling the air entering the fan and subsequently entering the test drift.
3. Maintain the outside test drift wall temperature to below or near the boiling temperature of the water.
4. Maintain the ability to collect data under conditions of no ventilation in the test drift.
5. Data must be collected continuously once the test has been started. Make as many as four measurements per hour/instrument.
6. Testing must be performed in compliance with the applicable Project Quality Assurance requirements.
7. Submit the data collected to the technical database in a timely manner.

8.0 Health and Safety

The test will be performed in compliance with the YMP and as applicable to BN health and safety requirements. A detailed Job Safety Analysis (JSA) will be performed to identify potential hazards and mitigation thereof. The JSA will also identify emergency procedures for evacuation, heat stress related concerns, as well as working around heavy equipment and high voltage.

9.0 Quality Assurance

The tests will be performed in compliance with the YMP Quality Assurance requirements. The Principal Investigator (PI) will maintain a scientific notebook in accordance with AP-SIII.1Q

10.0 Use of Data from the Phase I of the Ventilation Test

The test data will be used as described below:

- The data will be used to develop appropriate input parameters for the ANSYS computer code.
- Temperature differences between air and drift wall will be used to obtain actual coefficient of convective heat transfer. The value from the measurement will be compared with the values derived from empirical equations and used in the current ventilation models.
- The measured temperature distributions for air flow, drift wall, and the WPs will be compared with the computer outputs from ventilation models.
- The measured air properties will be used to evaluate the effects of temperature change on heat transfer parameters.

11.0 Data Management

The data will be collected using a data logger. The Test Coordination Office staff will install and monitor the data collection system. The raw data will be converted into engineering units and transmitted to the PI for review and acceptance. The accepted data will be properly compiled and entered into the technical database in accordance with the applicable project procedures.

12.0 Technical Products

At the completion of each phase, a letter report will be prepared describing the test and documenting the test results. As appropriate conclusions, test performance and test results will be highlighted for the end data users. Interim test results will be provided as requested by the SSDS. A final test report will be prepared in FY2001.

13.0 Organization

The SSPTS will coordinate and integrate the data needs of the SSDS and the Subsurface Performance Modeling Section. The ventilation test will be performed by an integrated team consisting of the staff members from Sandia National Laboratories, Morrison Knudsen, Los Alamos National Laboratory, Lawrence Livermore National Laboratory, Science and Engineering Associates and Science Application International Corporation. BN will provide craft labor, test facilities, janitorial services and machine shop fabrication and as necessary acquisition of test materials.

14.0 References

CRWMS M&O 2000a, *Emplacement Drift System Description Document.* SDD-EDS-SE-000001 Rev 00. Las Vegas, Nevada: CRWMS M&O ACC: MOL.20000121.0119

CRWMS M&O 1999c, *ANSYS Thermal Calculations in Support of Waste Quantity, Mix and Throughput Study.* CAL-EBS-MG-000001 REV 00, Las Vegas, Nevada: CRWMS M&O ACC: MOL.2000119.134.

Enclosures:
1. Suggested List of Ventilation Test Instrument
2. Figure 1 - Conceptual Arrangement Simulated Emplacement Ventilation Test

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SUGGESTED LIST OF VENTILATION TEST INSTRUMENTS

INVENTORY RSJ Draft- 5/4/00

File: Instrument Inventory - Emplacement Vent Test	Bar.Pressure Sensor & Transmitter	VELTRON DPT 2500-plus (for air volume, velocity & diff. pressure) with VOLU-probe	Waste Package Skin Temp Sensor (0 - 200 ^oC) RTDs	Non-Waste Package Skin Temp Sensor (0 - 200 ^oC) RTDs	Air Temp Sensor (dry bulb) RTDs 20-25C	Air Temp Sensor (as part of RH probe)	Air Humidity Sensor & Transmitter (0 - 95%)	Waste Package Simulated Heat Energy Input (kW meter)
Station A (Mass Airflow & Air Psychrometry)								
Outside the station (ambient condition)	2							
Inside the 23.5' dia duct		3			2	2	2	
Total Simulated Waste Package Energy Heat Input (kW)								1
Station B (Mass Airflow & Air Psychrometry)								
Inside the 54 " duct before waste package					2	2	2	
Station C (Mass Airflow & Air Psychrometry)								
Inside the 54 " duct after waste package					2	2	2	
Station D (Mass Airflow & Air Psychrometry)								
Inside the 23.5' dia duct		3			4			
Emplacement Drift/Waste Package Section 1								
Skin of Waste Package			4					
Inside air temp. about 6 inches from drift wall					4			
Skin of inside concrete wall				4				
Skin of outside concrete wall				4				
Skin of outside insulation				4				
Waste Package Energy Simulated Heat Input (kW)								1
Ambient Outside Air					2			
Emplacement Drift/Waste Package Section 2								
Skin of Waste Package			4					
Inside air temp. about 6 inches from drift wall					2	2	2	
Skin of inside concrete wall				4				
Skin of outside concrete wall				4				
Skin of outside insulation				4				
Waste Package Energy Simulated Heat Input (kW)								1
Emplacement Drift/Waste Package Section 3								1
Emplacement Drift/Waste Package Section 4								
Skin of Waste Package			4					
Inside air temp. about 6 inches from drift wall					2	2	2	
Skin of inside concrete wall				4				
Skin of outside concrete wall				4				
Skin of outside insulation				4				
Waste Package Energy Simulated Heat Input (kW)								1
Skin of outside insulation								
Waste Package Energy Simulated Heat Input (kW)								
Total Instrumentation	2	6	12	36	20	10	10	6
Total RTDs	68	Total Humidity	12	Total Voluprobes		6	Total Energy	6
Barometric Pressure	2							

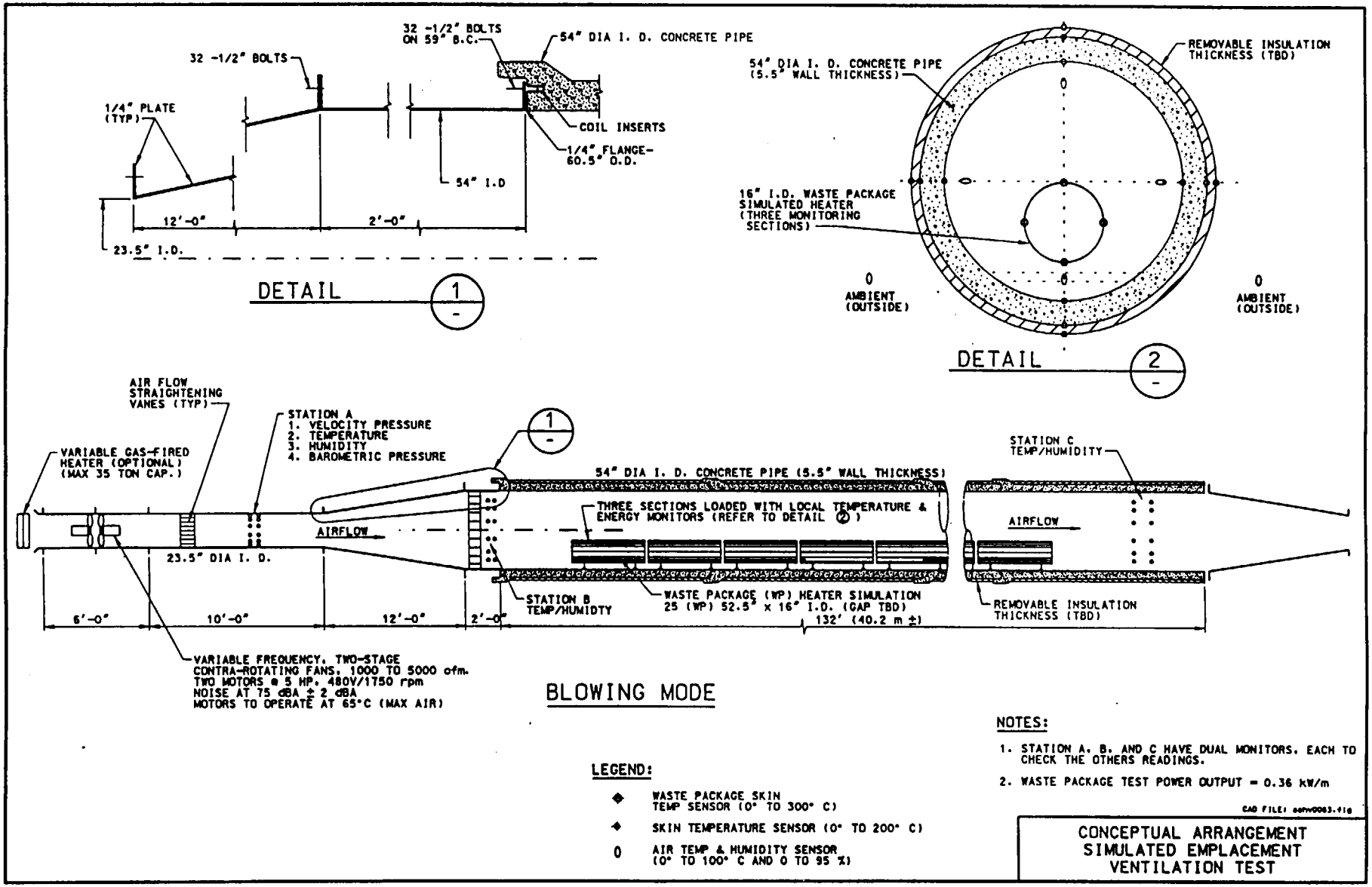

Figure 1

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