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1. OBJECTIVE

Provide a test facility for in-sodium simulations of conditions following a major loss-of-coolant accident. These tests are intended to provide information on the carry-over of fuel material from a boiling sodium pool.

2. TEST DESCRIPTION

2.1 Methods

A powder with appropriate physical and chemical properties (e.g., molybdenum) will be used to simulate the fuel material. A well-defined particle size distribution will be used in each experiment. Argon, injected into a static sodium pool, will impinge upon the powder in order to simulate sodium boiling. Samples of the sodium aerosols will be collected in one or more traps in a gas collection line off the sodium vessel's cover gas space. Sodium aerosols from inside the sodium vessel will also be collected. One or more samples will be taken from the sodium pool. All samples will be analyzed by techniques TBD for sodium and the simulated fuel material. A comparison of the concentration of simulated fuel material from samples at each collection point will provide the basis for calculation of the Decontamination Factor (DF) for each experiment. Particle size distributions will be determined for the simulated fuel material from selected samples described above.

2.2 System

Tests will be run in static sodium, contained in a 10-inch-diameter stainless steel test vessel presently included in Loop 1R (Figure 1). The test vessel shall be capable of isolation from Loop 1R. The test vessel shall be equipped with a sodium level indicator and independent heating/control for static mode operation at up to 550°C. The vessel head shall include ports for eight argon injectors and shall support the container

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of simulated fuel material. All-stainless steel construction is required. The test system shall include a separate dump tank such that the entire sodium content of the test vessel may be drained independently of the loop. An argon sparging/collection system will be installed to provide a gas source and effluent trapping facility. This system is a closed, recirculating argon loop which consists of eight stainless steel injectors which penetrate the head of the test vessel and direct argon onto a plate (also attached to the test vessel head) covered with simulated fuel material, two independent gas lines with traps for collection of sodium aerosols, an argon circulation pump, and required control and monitoring equipment (see Figure 2).

The sparging/collection system shall be equipped with a clean-up circuit for trapping sodium aerosols during heat-up of the test vessel sodium to test temperature. A separate cover gas system shall also be available for supply of argon to the test vessel when the sparging/collection system is not in operation.

2.3 Test Parameters

Parameters which may be important to the satisfactory performance of the sparging test are:

1. Gas flow rate
2. Gas pressure
3. Nozzle size
4. Pool height (above simulated fuel material)
5. Pool surface location (distance from outlet line)
6. Simulated fuel material
7. Sodium purity
8. Pool temperature
9. Cover gas pressure
10. Particle size distribution
11. Particle concentration
12. Test time.

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Items 1 - 3 (and possibly item 4) affect bubble size and shape, bubble density, and surface turbulence. Item 4 influences the length of time bubbles will be incontact with the sodium-fuel material suspension. Items 6-8 will probably influence the wetting characteristics of the [simulated] fuel material. Items 9-11 may affect particle carryover with the argon sparge gas. The test time and pool surface location (items 12 and 5.) are not believed to be important to the particle transport mechanism, but will be important to the experiment relative to quantities of sodium aerosol and simulated fuel material transported to the collection points.

All items noted above except items 7 and 11 shall be controlled within the precision requirements given in Section 3.3 and monitored per Section 3.3. Establishment of items 7 and 11 will be per the Run Plan. The Run Plan for each run shall specify the value of each of the items noted above.

3. REQUIREMENTS

3.1 Applicable Documents

a) General Electric Company Documents

"Sparging Tests", Specification 23A2832

"Sodium Sparging Test Operations Procedure" (L A T E R)

"Policy Governing Pre-Operational Safety Reviews of Sodium and High Pressure Systems", Procedure ADM - 7

"Safety Guidelines for Sodium Facility Design", Procedure ASP - 3.

"Cleaning of Stainless Steel Sodium Loop Components to be used in Loop Construction", Procedure DES - 1.

"Trace Heating Systems - Design and Installation", Procedure DES - 3.

b) Codes and Standards

Power Piping Code, ANSI B 31.1

ASME Boiler and Pressure Vessel Code, Section VIII

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3.2 Design Limits (STRUCTURAL)

- a) Sodium System: Maximum Temperature - 704°C (1300°F)
Maximum Pressure - 35 psig
- b) Gas Systems: Maximum Temperature - 704°C (injectors only)
 600°C (other components to first isolation valve)
 150°C (all other components)
Maximum Pressure - 40 psig

3.3 Precision and Monitoring Requirements

All measurements will be recorded manually at intervals specified in the Run Plan.

a) Gas Flow Rate:

Nominal Value 5 lpm
Range 1-15 lpm
Accuracy $\pm 3\%$ of Scale Range

b) Gas Pressure:

Gas pressure at each injector, in the test vessel cover gas, and at selected locations in the gas collection train shall be monitored per the Run Plan.

Nominal Value (s) 10 psig
Range 0 to 30 psig
Accuracy $\pm 5\%$ of Scale Range

c) Sodium Level: (Determines Surface Location and Pool Height)*

Nominal Value TBD
Range 40-70 cm (15.75 - 27.56 in.)
Accuracy ± 4.06 (1.6 in.)

d) Sodium Temperature:

Nominal Value 500°C (932°F)
Range $400-550^{\circ}\text{C}$ ($752^{\circ} - 1022^{\circ}\text{F}$)
Accuracy $\pm 5^{\circ}\text{C}$

e) Particle Concentration:

Cannot be determined on-line. Powder will be weighed (to nearest 0.1g) onto pan at start of run.

* Surface location will be held constant at 16.5 inches from top flange.

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f) Other:

Distance from test vessel head to pan shall be measured to the nearest 0.1 inch. Argon injectors shall be set 1.0 ± 0.1 inch above the pan.

For the initial experiments a nozzle (inside) diameter of 0.120 will be used.

4. OPERATION**4.1 Clean-up Runs**

Sodium shall be circulated through Loop 1R with maximum level in the sodium test vessel for the purpose of vessel clean-up. Argon injectors and the holding pan for the simulated fuel material will not be installed during the clean-up runs. The loop shall be filled from the loop storage tank, then circulated at 500°C (932°F) for a minimum of 50 hours. Sodium shall be cold-trapped continuously at a temperature less than 350°F throughout the run. The auxiliary dump tank will be filled by draining the contents of the test vessel into it. Two clean-up runs as described above shall be performed.

All further test operations will involve filling the test vessel from the auxiliary dump tank.

4.2 Test Runs

A detailed Sparging Test Operations Procedure shall be issued (L A T E R) providing detailed instructions on powder loading, vessel closure, pre-heating, start-up, and test operations.

The test vessel and collection system will be purged with argon gas through the clean-up circuit (see Figure 2). Preheat of the test vessel, auxiliary dump tank, and interconnecting piping shall proceed according to LATER. Once the desired sodium filling temperature ($\sim 400^{\circ}\text{F}$) has been reached, flow through the sparging/collection system should begin. Pressure in the test vessel must be maintained at less than 10 psi throughout this step. Sodium fill of the test vessel shall be performed by increasing the argon pressure over the auxiliary dump tank. Sodium level in the test vessel shall be adjusted to the value given in Section 3.3C and Figure 3.

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Note: Monitoring of the sparge flow is crucial during the sodium fill operation. This flow must be maintained to preclude sodium plugging of the injector tubes.

Once the desired sodium level has been attained, the test vessel shall be isolated from the dump tank and heat-up at a rate not exceeding 200°F/hour, may proceed. All gas collection shall be through the clean-up circuit until the desired temperature condition is achieved. One test leg of the gas collection system will be brought on line and the clean-up circuit isolated.

Sodium drain lines shall be maintained at >450°F, and the auxiliary dump tank at >350°F at all times during the test.

5. Quality Assurance Provisions

The overall classification for the sparging tests is QP-2. All new sodium pressure boundaries are classified QP-2. Other components, such as the argon injection system, are classified QP-3.

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* SUPPLEMENTARY EQUIPMENT REQUIRED

FIGURE 1 SODIUM MASS TRANSFER LOOP 1R

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FIGURE 2 SPARGING TEST CONCEPTUAL P AND ID

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FIGURE 3 SODIUM LEVEL INDICATOR - ARRANGEMENT OF THERMO-ELEMENTS

A containment analysis code, CONACS, is under development at HEDL. This code will replace the earlier developed CACECO code used for FFTF and CRBRP containment response analyses. The CONACS code is at an early development stage (development of code structure and selection of phenomenological models).