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MSRE DESIGN AND OPERATIONS REPORT

Part VI

OPERATING SAFETY LIMITS FOR THE MOLTEN-SALT EXPERIMENT

S.E. Beall
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Reactor Division

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S. E. Beall
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This document has been prepared at the request of the U.S. Atomic Energy Commission to set the limits for various parameters related to the Molten-Salt Reactor Experiment. In some cases the limits report the level at which the reactor will be shut down by automatic monitoring devices. In all cases the reactor operators are obligated to take steps intended to correct a parameter which is temporarily outside the specified range indicated herein.

1.0 Containment

1.1 Leakage from the primary system as indicated by the reactor and drain-tank-cell air activity will not exceed the equivalent of 4 liters of salt after 120 days of operation at full power, as estimated in the case of the Most Probable Accident.[1] Off-gas activity release will be limited to fission-product concentrations averaging less than 1.5×10^{-4} μc/cc in the stack.[2] Fission-product release will be monitored by radiation monitors on the off-gas lines and at the stack.

1.2 The cover-gas supply pressure will be kept at 30 psig or greater and the leak-detector system pressure above 50 psig to help prevent excessive exposure to operating personnel, as specified in Chapter 0524 of the AEC Manual.[3]

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[1] S. E. Beall *et al.*, "MSRE Design and Operations Report, Part V, Reactor Safety Analysis Report," USAEC Report ORNL TM-732, Oak Ridge National Laboratory, August 1964.

[2] Based on 3×10^{-9} μc/cc as permissible concentration at ground level downstream of the stack. An atmospheric dilution of 0.5×10^{5} is assumed.

[3] Chapter 0524, "Standards for Radiation Protection."

1.0 Containment (continued)

1.3 The radioactivity in the reactor cell service lines will be maintained at a level sufficiently low to prevent excessive exposure to personnel, as specified in Chapter 0524 of the AEC Manual.

1.4 The pressure in the reactor and drain tank cells will be maintained below atmospheric pressure during reactor operation.

1.5 The maximum reactor and drain-tank-cell leak rate will not be allowed to exceed 1% of the cell volume per day, calculated for the conditions of the Maximum Credible Accident.[1] The in-leakage rate will be determined at least once per week.

1.6 The maximum vapor-condensing system pressure (under nonaccident conditions) will not exceed 3 psig.

1.7 The building high-bay pressure will be maintained at slightly less than atmospheric pressure (~0.1 in. H_2O) during all operations in which the high bay serves as the secondary containment.

1.8 The ventilation system filters will be tested at least annually and after each change of filters.

1.8.1 The measured efficiency of the filters must be greater than 99.9% for 0.5 μ and larger particles, as indicated by the standard dioctylphthalate test.

2.0 Fuel System

2.1 The maximum steady-state power level is 10 Mw (administrative limit).

2.2 The power level for safety-rod scram trip is 15 Mw or less.

2.3 The temperature level for safety-rod scram trip is less than 1400°F. Adjustment of the trip between 1300 and 1400°F will require administrative approval.

2.4 The maximum fuel system cover-gas pressure is 50 psig.

2.0 Fuel System (continued)

2.5 The maximum salt fill rate while filling the core is 1.0 ft^3/min.

2.6 The maximum amount of ^{235}U which will be added at one time is 120 g. During operation fuel will only be added through the sampler enricher.

2.7 The maximum concentration of fissionable material in the fuel salt will not exceed by more than 5% the minimum required for full-power operation at 1200°F with equilibrium xenon and the control rods poisoning 0.6% δ k/k. The fuel salt will be sampled and the concentration measured at least once per week.

3.0 Coolant System

3.1 The maximum coolant system cover-gas pressure is 50 psig.

4.0 Control Rods

4.1 The normal complement of control rods is three, of which two are required to scram for safety action.

4.2 The maximum scram time (time from initiation of signal until a rod is on the seat) is 1.3 sec.

4.3 The rod speed (motor powered) is 0.5 $\pm$ 0.05 in./sec. This speed permits maximum reactivity additions in "start" of 0.1% δ k/k per sec and in "run" of 0.05% δ k/k per sec.

4.4 The scram time of the rods will be checked before each fill.

5.0 Nuclear Control and Safety Instrumentation

5.1 All nuclear safety instrumentation will be checked for proper operation before each fill.

5.2 A minimum of two safety-level chambers will be in service during reactor operation.

5.3 A minimum of two reactor fuel outlet temperature signals will be in service during reactor operation.

5.0 Nuclear Control and Safety Instrumentation (continued)

5.4 A minimum of one fission chamber with count-rate circuit must be in operation during startup filling operations.

6.0 Personnel Radiation Monitoring

6.1 Radiation level monitors

A minimum of two personnel radiation monitors will be in operation at all times, one in the high-bay area and one in the control-room area.

6.2 Air monitors

A minimum of two air activity monitors will be in operation at all times, one in the high-bay area and one in the office—control-room area.

7.0 Personnel and Procedures

7.1 Personnel qualifications

The reactor will be operated only by qualified personnel approved by the Chief of Operations. It will be operated in conformance with documented operating procedures which, in no instance, designate authorization to operate the reactor in excess of any operating safety limits listed above.

7.2 The minimum staff requirement for operation during any shift is that at least one supervisor and two technicians will be on duty during reactor operation. The control room will not be left unattended while fuel is in the reactor vessel.

8.0 Experimental Limits

Experiments will be conducted within the limits specified in this report. Experimental procedures will be approved in advance by the Head of the Operations Department, Oak Ridge National Laboratory Reactor Division, or his authorized assistant.

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