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Part 1: Test Facility Design

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Title of Summary Large Scale Sodium Interactions
Part 1: Test Facility Design

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Sincerely,

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ANS Technical Program Chairman
1977 Winter Meeting

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LARGE SCALE SODIUM INTERACTIONS*

Part 1: Test Facility Design

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For Submission to the American Nuclear Society

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Large Scale Sodium Interactions

Part 1: Test Facility Design

During the design of the test facility for large scale sodium interaction testing, an attempt was made to keep the system as simple and yet versatile as possible; therefore, a once through design was employed as opposed to any type of conventional sodium "loop." The initial series of tests conducted at the facility call for rapidly dropping from 20 kg to 225 kg of sodium at temperatures from 825°K to 1125°K into concrete crucibles.

Figure 1 details the basic system layout. A commercial drum heater is used to melt the sodium which is in 55 gallon drums and then a slight argon pressurization is used to force the liquid sodium through a metallic filter and into a dump tank. Then the sodium dump tank is heated to the desired temperature. A diaphragm is mechanically ruptured and the sodium is dumped into a crucible that is housed inside a large steel test chamber.

The test chamber is an all steel construction; walls and floor are of 0.95 cm mild steel with all seams welded. A rupture diaphragm prevents pressurization of the test chamber above the 0.10 MPa design limit. A headboard design

is used to enable the removal, by fork lift, of the crucible and its associated instrumentation from the test chamber as a single unit.

The design of the heating/dump tank utilizes all 316 stainless-steel construction. The ASME Boiler and Pressure Vessel Procedures were used in designing the tank assuming an allowable stress for 316 stainless of 6.9 MPa at 1125°K. The tank has 1.27 cm thick walls with an ellipsoidal bottom head and a stainless-steel gasketed plate flange top head. The internal volume of the tank is approximately 0.37 m^3. A Class I rating was stipulated for the tank and all of the welds were radiographically inspected.

Inconel sheathed resistance heaters are used to raise the temperature of the sodium dump tank to the desired level. The external tubular heaters stand off from the tank wall approximately 1.9 cm and are controlled in three separate zones: top - 6 kW, sides - 10 kW, and bottom - 9 kW. A fourth zone utilizes an internal immersion heater of 10 kW capacity. Three mode controllers with thermocouple feedback are utilized to control both the temperature and the rate of rise. The multiple control zones make it possible to maintain the entire tank in a reasonably isothermal condition, thus, mitigating possible thermal stress problems. The maximum rate of rise is limited to 2°K/min by thermal stress considerations.

The tank is supported by a three legged frame mounted on load cells. Monitoring the output from the load cells enables filling of the tank with a given quantity of sodium and determining the rate at which the sodium is dumped.

The sodium can be dumped from the heating tank by actuating a pneumatic shear that ruptures a 316 stainless-steel diaphragm at the bottom of the tank. After the dump is complete, the actuator is reversed and a conical shaped valve is pulled into a seat to prevent reaction products from contaminating the dump tank.

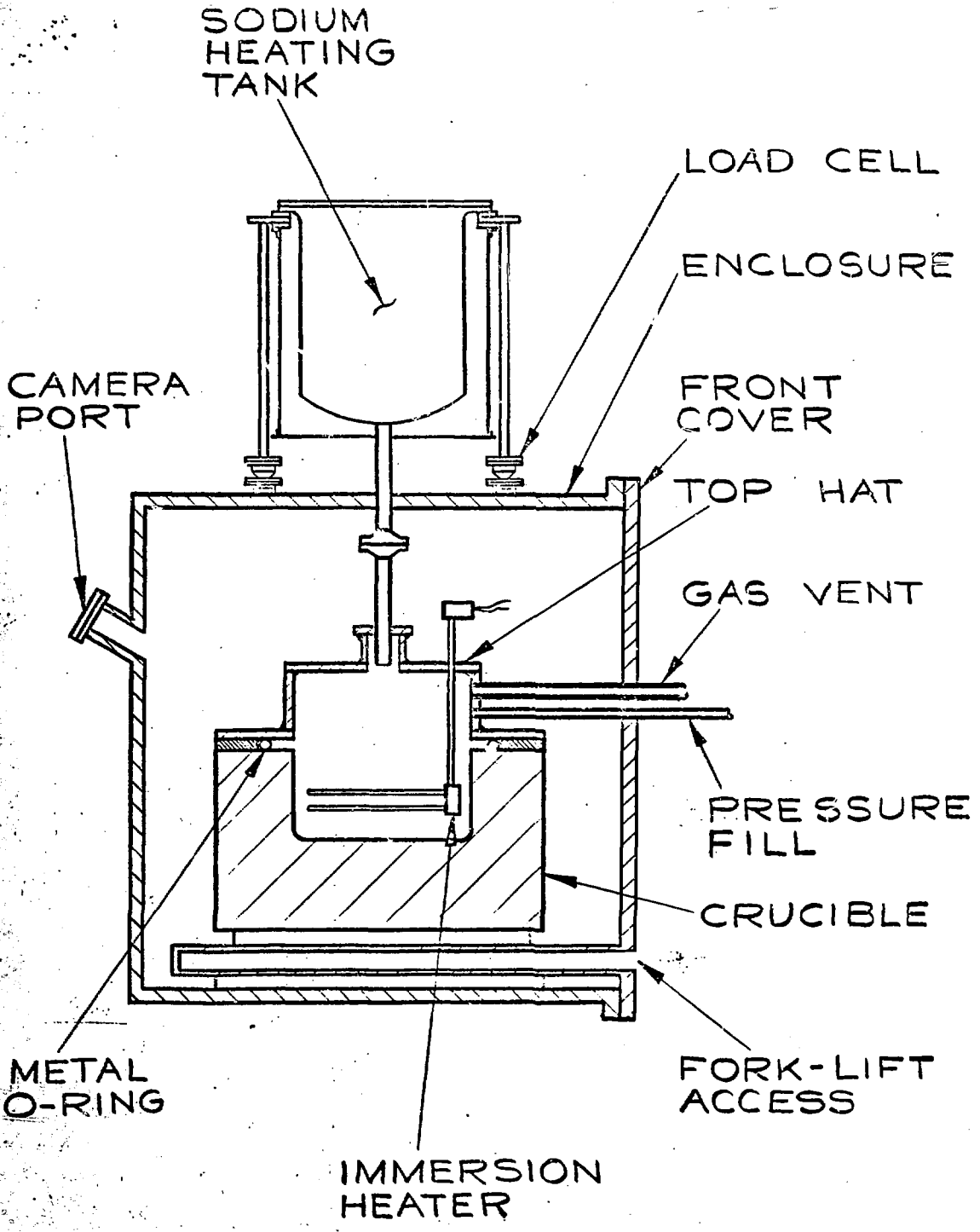
The facility data acquisition/control system consists of a HP 9825 desk top computer with a variety of perephiral gear including a process controller, a high speed analog/digital multiplexer unit, and magnetic tape storage. The system is being set up to provide automatic control of the entire experiment. Data obtained during the sodium/concrete tests includes: temperatures in both the pool and the concrete, moisture migration in the crucible, ultrasonic measurement of sodium penetration rate, audio and visual recording of the reaction process, and gas evolution rate and composition.

In summary, a versatile test facility has been developed for conducting sodium interaction experiments associated with sodium cooled reactor safety studies. Sodium/concrete interactions are currently being studied in the facility.

Follow on experiments will utilize a variety of configurations including: lined and unlined crucibles, heated and unheated pools, enclosed or open top hats, and dumping or spraying of sodium.

Title for Figure

Figure 1: Test Facility Schematic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