UNCLASSIFIED

CLASSIFICATION LEVEL
(S, C, OR U)

ATOMICS INTERNATIONAL
A Division of North American Aviation, Inc.

APR 8 1968

MASTER

NAA-SR-MEMO -8217

15

This document contains _____ pages

This is copy _____ of _____ series _____

Do not remove
this sheet

Facsimile Price \$ 1.60
Microfilm Price \$.80

Available from the
Office of Technical Services
Department of Commerce
Washington 25, D. C.

MASTER

CLASSIFICATION TYPE
(RD OR DI)

*NAA-SR-MEMOs are working papers and may be expanded,
modified, or withdrawn at any time,
and are intended for internal use only.*

This report may not be published without the approval of the Patent Branch, AEC.

released

LEGAL NOTICE

This report was prepared as an account of Government sponsored work. Neither the United States, nor the Commission, nor any person acting on behalf of the Commission:

A. Makes any warranty or representation, express or implied, with respect to the accuracy, completeness, or usefulness of the information contained in this report, or that the use of any information, apparatus, method, or process disclosed in this report may not infringe privately owned rights; or

B. Assumes any liabilities with respect to the use of, or for damages resulting from the use of information, apparatus, method, or process disclosed in this report.

As used in the above, "person acting on behalf of the Commission" includes any employee or contractor of the Commission to the extent that such employee or contractor prepares, handles or distributes, or provides access to, any information pursuant to his employment or contract with the Commission.

UNCLASSIFIED

CLASSIFICATION LEVEL
(S, C, OR U)

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency Thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.

ATOMICS INTERNATIONAL <small>A Division of North American Aviation, Inc.</small>		TDR NO. 8217	APPROVALS													
TECHNICAL DATA RECORD		PAGE 1 OF 15	<i>Bl Edwards</i> <i>Bl Kohl</i>													
AUTHOR <i>R.W. Atz</i> R. W. Atz	DEPT. & GROUP NO. 712-21	DATE 2/18/63														
		GO NO. 7519														
TITLE The Large Component Test Loop - Description and Operating Capabilities		S/A NO. 11160	TWR 41647													
		SECURITY CLASSIFICATION														
		(CHECK ONE BOX ONLY) <table style="width: 100%; border: none;"> <tr> <td style="width: 33%;"></td> <td style="width: 33%; text-align: center;">AEC</td> <td style="width: 33%; text-align: center;">DOD</td> </tr> <tr> <td>UNCL.</td> <td style="text-align: center;">☒</td> <td style="text-align: center;">☐</td> </tr> <tr> <td>CONF.</td> <td style="text-align: center;">☐</td> <td style="text-align: center;">☐</td> </tr> <tr> <td>SECRET</td> <td style="text-align: center;">☐</td> <td style="text-align: center;">☐</td> </tr> </table>				AEC	DOD	UNCL.	☒	☐	CONF.	☐	☐	SECRET	☐	☐
	AEC	DOD														
UNCL.	☒	☐														
CONF.	☐	☐														
SECRET	☐	☐														
PROGRAM ASCR		SUBACCOUNT TITLE Large Component Test Loop														
DISTRIBUTION R.J. Beeley* D.F. Casey* R. Cygan* R.W. Dickinson* D.T. Eggen* J.A. Falcon* K.W. Foster* R.C. Gerber* L.E. Glasgow* F.C. Gronemeyer* B.R. Hayward* A.L. Kohl* J.A. Leppard* J.E. Mahlmeister* J.S. McDonald* R.D. Michaelson* J.B. Williams* L.J. Zimmer* R.J. Edwards*		STATEMENT OF PROBLEM Efficient utilization of the ICTL as a test facility for the ASCR program requires dissemination of data, determined by recent performance tests, describing the flexibility and operating capability of the facility.														
ABSTRACT: The Large Component Test Loop is a facility providing experimental capacity for subjecting large components, such as moderator assemblies and control rods, to thermal gradients and transients at varying rates of sodium flow to simulate reactor operating conditions.		 Two separate loops are used for heating and cooling the sodium as the testing is performed. The 3-inch pump loop, modified to operate at 1200°F., was operated at a flow of 130 gpm and a head of 25 feet. The 6-inch pump loop, limited to 1000°F operation by materials of construction, was operated at a flow of 2000 gpm and head of 65 feet. The rest of the facility has operated satisfactorily at 1200°F.														
*Complete copies																

ATOMICS INTERNATIONAL

A Division of North American Aviation, Inc.

NO. 8217

DATE 2/18/63

PAGE 2 OF 15

I. INTRODUCTION

The construction of the ICTL was the result of the need for a test facility capable of subjecting reactor core components to conditions simulating those to be encountered during reactor operation. As a result of recent material changes in the piping it is possible to subject core and non-core components to thermal gradients and thermal transients that may be anticipated during 1200°F reactor operation.

The installation includes a 6-inch pump loop capable of 1000°F operation at 2000 gallons per minute and a recently rebuilt 3-inch pump loop capable of 1200°F operation at 130 gallons per minute. An auxiliary loop, attached to the 6-inch loop, has been used to subject test components to thermal shock conditions of 500 degrees F. temperature change in a 5 second period.

Other important components of the ICTL are the large vessel, core tank, supply tank and drain tank; the 275 kw immersion heater, the 3 hp sodium to air cooler and the sodium purification system.

With the exception of the 6-inch loop and some of the service lines the system has recently been operated satisfactorily at 1200°F.

II. DESCRIPTION

A. Buildings

The test facility consists of three major structures:

- 1) test tower
- 2) component test area
- 3) control building

The test tower is a roofed open frame structure 80-feet high that houses the core tank, an elevated sodium supply tank, a 5-ton bridge crane, and portions of the test loops. The component test area is a roofed open frame structure 50-feet wide, 80-feet long, and 26-feet high serviced by a 2-ton bridge crane. Located within this low-bay area are portions of the 6-inch loop, portions of the 3-inch loop, the 6-inch pump, the 3-inch pump, the 275 kw sodium heater, and the cold trap. The area is of sufficient size to house components and/or test equipment to be attached to stubs provided on the 3-inch test loop. The control building is a conventional metal-sheathed, metal-frame/prefabricated structure, 20-feet wide and 40-feet long. It houses the switching and instrumentation panels, the motor-generator sets for the pump motors, and provides area for the operating personnel to conduct tests and record data.

B. Sodium Systems

1. Piping Loops

All of the main sodium piping, with the exception of the portions in the flowmeters, EM pump throat, pump casings, and valves, was originally fabricated with seamless 2.25 Cr-1Mo alloy steel pipe (commonly called "Croloy"), ASTM-A335, Grade P22.

ATOMICS INTERNATIONAL

A Division of North American Aviation, Inc.

NO. 8217
DATE 2/18/63
PAGE 3 OF 15

The Croloy piping in the 3-inch loop and the 3-inch drainline has recently been replaced with pipe made of type 304 stainless steel to permit operation of this portion of the system at 1200°F.

All welds were radiographically inspected in accordance with the standard of acceptance as specified in Section VIII of the ASME Boiler Construction Code.

The 3-inch loop has four 3-inch stubs and two blocking valves for attaching components to be tested.

The loops are designed to circulate sodium either of two ways:
(a) through the core tank using the core tank as the expansion tank, or
(b) in a "closed" loop, valved off from the core tank, with the supply tank serving as expansion tank. Figure 7 (attached) shows the present piping arrangement of the LCTL.

a. Six Inch Pump Loop

This loop has a 6-inch pump capable of circulating sodium for extended periods at variable flows up to 2000 gpm and at temperatures between 350°F. and 1000°F. The system head curve for the "closed" loop is shown in Figure 1. The loop is heated by resistance heaters of sufficient capacity to heat the pipe and its contents to 1000°F. A 3-hp blower is used for cooling sodium that may be circulating in this loop. A 72 kw heater is installed in the 6-inch thermal shock loop on this system to aid in subjecting smaller components to thermal shock conditions.

b. Three Inch Pump Loop

This loop has a three inch pump capable of circulating sodium for extended periods at variable flow rates up to 130 gpm at temperatures from 350°F. to 1200°F. The 275 kw sodium heater is part of this loop. Preheating of the loop is accomplished by tubular heaters designed to heat the pipe to 800°F. The system head curve for the "closed" loop is shown in Figure 2.

c. Thermal Shock Drain Line

An additional 8-inch line terminating at the drain tank can be used to allow a piece of test equipment to be alternately subjected to hot and cold sodium without shocking the valves, fittings, and piping in the system. This arrangement permits maintaining sodium circulation and temperature in one circuit while subjecting other equipment to thermal shocks.

d. Sodium Purification System

Sodium is purified by use of a meshless forced flow cold trap. A liquid-cooled plugging meter is used to estimate the oxide level of the sodium. In use, the sodium flows from the supply tank through the cold trap and returns to the drain tank through valve 31B (see Figure 7). The EM pump returns the sodium to the supply tank through line 39. Plugging meter readings can be taken any time the system is flowing.

ATOMICS INTERNATIONAL

A Division of North American Aviation, Inc.

NO. 8217

DATE 2/18/63

PAGE 4 OF 15

2. Tanks

The three sodium tanks, constructed of type 304 stainless steel, were designed for operation at 1200°F. with an internal pressure of 20 psig. Externally mounted resistance heaters are utilized to preheat the tanks and maintain the sodium temperature at 1000°F. The tanks were fabricated to meet ASME Boiler Code Spec. Sections VIII and IX (rather than the more stringent specifications normally used for sodium and/or nuclear installations) to reduce the cost. All containment welds were radiographed and inspected to meet Sections VIII and IX of the ASME Boiler Code. The tanks were halogen leak tested, and the supply and drain tanks were hydrostatically tested to 190 psi.

a. Core Tank

The core tank has an inside diameter of 8-feet, a height of 31-feet, and a wall thickness of 5/8 inches. The tank is vertically mounted and supported at the top by a circular ring girder. The top cover is flanged and bolted to the tank to provide a full diameter access opening to the tank interior. The top cover is insulated and water cooled to maintain a maximum cover temperature of 150°F. Grid-plate supports are provided within the tank for future use. The tank is designed to hold a cluster of seven moderator cans of the Hallam Nuclear Power Facility (HNPF) design. The top cover cooling coils are designed so that the instrument thimbles may be relocated as required.

b. Supply Tank

The supply tank is horizontally mounted in the tower, elevated to provide sufficient operating head for draining through the two pump loops. This 9800 gallon tank is 8.5 feet inside diameter and 22-feet long with a wall thickness of 5/8 inch.

c. Drain Tank

The drain tank is horizontally mounted in a concrete, steel-plate-lined pit, below grade, to provide proper drainage from the supply and core tanks, piping, and equipment. This 11,500 gallon tank is 8.5 feet in diameter, 28-feet long with a wall thickness of 5/8-inch. The tank is sized to hold the contents of either the supply or core tank, but not both, and the contents of all the sodium loop piping.

3. Sodium Pumps

The pumps in the 6-inch and 3-inch loops are modified hot-oil pumps of the centrifugal type, vertically mounted and rated at 1200 gpm and 120 gpm respectively. Performance curves for these pumps are shown in Figures 3 and 4. The pumps are so designed that the main internal parts, that is, shaft, impeller, and bearing housing, can be removed from the outer case as a single assembly. This requires that both the shaft and the narrow annular space between the inner and outer case be sealed off to prevent sodium leakage into the upper section of the pump case. These seals are the frozen sodium type. Water is circulated through passages in the pump in such a way that, as sodium begins to leak through the narrow annuli, it freezes and forms its own seal. These pumps have an upper thrust bearing and a lower radial bearing near

ATOMICS INTERNATIONAL

A Division of North American Aviation, Inc.

NO. 8217
DATE 2/18/63
PAGE 5 OF 15

the shaft freeze seal. Water is circulated through the housing common to both bearings to maintain their temperatures near 150°F. A helium atmosphere is maintained inside the upper section of the pump casing at a pressure approximately equal to the pump suction pressure. This keeps the pressure difference across the shaft seal at a minimum when the pump is operating, thus minimizing sodium extrusion along the shaft. These pumps are driven by d.c. variable speed motors. Pump motor speeds are monitored for both mechanical pumps by remote reading tachometers located on the process panel. The armature currents are monitored by meters located adjacent to the tachometers.

An a.c. linear induction electromagnetic pump is used to transfer the sodium from the drain tank to the supply tank and to operate the sodium purification loop. This pump has a capacity of 100 gpm.

4. Sodium Instrumentation

a. Temperature

The process sodium temperatures are monitored with six immersion type thermocouples. Two of these, located in the supply and drain tank, are used to control the sodium temperatures in their respective vessels. The remaining four indicate the core tank inlet and exit sodium temperatures on both the 3-inch and 6-inch loops. Five hundred thermocouples are utilized to monitor the sodium piping and vessel temperatures during the preheating period. These thermocouples are welded to the piping and to the vessels. Switching of the preheat thermocouples is manual and readout is by means of two self-balancing potentiometers. Twenty-one additional thermocouples are used to control valve and piping temperatures by actuating controllers. All thermocouples are 16-gage chromel-alumel wire.

Temperature indicators and control instruments are located in the control room so that it is not necessary for operating personnel to be near the circulating systems during test runs.

b. Liquid Level

The sodium levels in the three sodium tanks are monitored using AI-built induction coil probes. In addition, there is a high-level alarm coil in the core tank, and a low level alarm coil in the supply tank. Either of these alarm coils will interrupt the power to the sodium pumps.

c. Flow

Three flowmeters of the electromagnetic type are used to indicate the sodium flow. These flowmeters are installed on the 3-inch and 6-inch sodium loop and the supply line between the drain and supply tanks. Readout of the flowmeters is recorded by strip-chart recorders.

d. Pressure

Pressure is monitored at seven points; four of the instruments have sensing elements located directly in the sodium stream. These gages are Taylor Instrument Co. NaK-filled "Transet" transducers which employ a stainless steel diaphragm to separate the process fluid from the NaK which transmits the pressure to a Bourdon tube. These gages are located on the suction and discharge nozzles of both mechanical pumps and are suitable for operation at 30 psig and at temperatures to 1200°F. The remaining three utilize silicone oil to transmit the pressure from a stainless steel diaphragm to a Bourdon type

ATOMICS INTERNATIONAL

A Division of North American Aviation, Inc.

NO. 8217
DATE 2/18/63
PAGE 6 OF 15

gage. These latter gages actuate alarms in the control room should the pressure in the sodium tanks reach 5 psig.

5. Sodium System Valves

The valves in the sodium system are of welded construction, made from type 304 stainless steel with double-disc gates. These valves have extended bonnets with convection cooled shaft freeze seals on their stems and are designed for service at a maximum temperature of 1200°F. with an ambient temperature of 70 degrees F. Nine of these valves are pneumatically operated from the control room to allow draining of the system in an emergency and for quick switching of flow patterns during thermal shock testing. Microswitches mounted on the four pneumatic valves give remote indication whether the valves are in the open or closed positions. Position readout is provided on the process panel for each valve.

6. Cold Trap

A forced flow cold trap is a part of the sodium purification system. The trap is operated in conjunction with a plugging meter to enable the operators to monitor and control the purity of the sodium.

7. Sodium Heater

The sodium heater is integral with the 3-inch loop and is used to raise the temperature of the sodium in the core tank from 350°F. to 1200°F. This is accomplished by circulating sodium through the loop, heater, and core tank. The heater is constructed in a manner similar to a conventional U-tube heat exchanger with a bank of 36 stainless steel sheathed, tubular, electrical resistance heaters placed in the interior of a length of 8-inch diameter type 304 stainless steel pipe. This unit has a total capacity of 275 kw. Each heater element is protected by a separate circuit breaker.

The rate of temperature rise of the system (with both loops flowing through the core tank) that can be attained with the heater operating alone and with preheaters on is shown in Figure 5.

8. Sodium Cooler

Cooling of the sodium is accomplished with the sodium-to-air cooler which is a part of the 6-inch loop. This consists of five finned tubes 5-feet long by 3-inch diameter over which ambient air is passed. The temperature reducing capability of this cooler for a specific set of operating conditions is shown in Figure 6.

C. Vent System

The vent piping network interconnects the three sodium tanks and the two piping loops. This system contains a single vapor trap and a pressure relief valve. Vent connections to each of the tanks and to each sodium loop may be isolated by blocking valves. This arrangement allows work to be performed on one section while pressure is maintained on the remaining sections. Gas connections are incorporated in the vent system to permit purging the system and to allow manual bleedoff.

ATOMICS INTERNATIONAL

A Division of North American Aviation, Inc.

NO. 8217

DATE 2/18/63

PAGE 7 OF 15

D. Helium System

A helium atmosphere is maintained throughout the sodium system to prevent oxidation of the sodium. The system consists of a conventional manifold, a low pressure storage tank, and necessary control valves to maintain a constant pressure on the piping, tanks, and two mechanical pump cases. A low pressure storage tank is provided to minimize pressure surges in the gas system.

E. Cooling Water System

The principal components of the cooling system are a conventional evaporative cooler, a storage tank, and two pumps. This system provides coolant for the sodium pump freeze seals and the top of the core tank. In addition to these cooling loads the capacity of the system is sufficient to handle the heat removal requirements of additional test components which may be added to the sodium systems. One operating and one standby pump is provided. A failure of the operating pump actuates a low pressure alarm in the control room and automatically starts the standby pump.

The sodium pumps require cooling for the outer case freeze seals, the shaft freeze seals, and the bearing housings. Both of these pumps are equipped with a primary water cooling system which rejects the heat taken from the freeze seals to the main cooling system. These primary water cooling systems are composed of a small pump and a heat exchanger and each contains less than 1 gallon of water.

The top flange of the core tank is sealed to the tank with a silicone O-ring. Water is circulated under this flange to maintain temperatures within the working range of the O-ring material. Instrument thimbles extending through the top lid are sealed with O-rings which are also cooled with water.

The water temperature and pressure are monitored entering and leaving the evaporative cooler; temperature and flow are measured on the individual sodium pumps and on the core tank lid circuits.

F. Electrical Equipment

The total power requirement of the facility is 750 kw. A substation of the unit type with 1000 kw capacity is located adjacent to the control building. The switch gear for the rotating equipment and heating devices is of the conventional panel mounted type. The two motor generator sets, which drive the d.c. sodium pump motors through a Ward-Leonard control system, are 60 and 6 kw units of conventional construction.

III. OPERATION

A. Steady State Operation

Isothermal testing on sodium components may be carried out inside the core tank or on components attached to either loop. These tests may be conducted with or without sodium flow. The loop which flows through the core tank passes sodium through and/or around the loop components and then into the bottom of the core tank. The sodium then flows through and/or around the core components into the pool above the components from which point it returns to

ATOMICS INTERNATIONAL

A Division of North American Aviation, Inc.

NO. 8217
DATE 2/16/63
PAGE 8 OF 15

the pump through the suction line. The normal operating level of the sodium in the core tank is four feet above the tank discharge nozzle. This level is maintained to prevent gas entrainment in the pump suction by a vortex action of the sodium.

B. Thermal Shock Testing

Thermal shock tests may be performed on components in the 6-inch loop (see page 3) and in the core tank.

Core tank thermal shock tests can be performed, the component being subjected alternately to 1000°F and 500°F sodium. The procedure is to heat the core tank to 1000°F. (using the 275 kw heater in the 3-inch loop) while sodium in the supply tank and the 6-inch loop is held at 500°F. The cycle is started by opening the 6-inch core tank inlet valve, the 8-inch thermal shock drain line valve and the 8-inch supply tank drain valve. The 500°F. sodium is forced into the bottom of the core tank by the 6-inch pump. The 1000°F. sodium flows from the core tank to the drain tank through the 8-inch thermal shock drain line for eventual return to the supply tank via EM pump.

C. Draining the System

The system is piped so that each of the loops and the core tank can be drained independently. The supply tank can be drained through the large loop or through the 3-inch thermal shock line. The low point in the system is the drain tank. This allows the system to be drained completely by gravity. The drain tank will contain only the volume in the core tank plus the two loops or the volume in the supply tank and the two loops.

FIGURE 1

System Curve
31 Loop - LCTL
(Closed loop)

FIGURE 2

RVA UNL

Performance Test of 6"x8" Pump LCPL

Shaft Speed - 1200 RPM
Sodium Temp. - 995°F

FIGURE 3

FIGURE 4

TYPICAL Rate of Temperature Rise
for LCTI as Measured
in Core Tank

(Data Taken 12-17-62
to 12-21-62)

FIGURE 5

FIGURE 6