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SRE HEAT TRANSFER SYSTEM DEMOLITION

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SRE HEAT TRANSFER SYSTEM DEMOLITION

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ATOMICS INTERNATIONAL
A DIVISION OF NORTH AMERICAN AVIATION, INC.

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I. INTRODUCTION

On February 15, 1964, SRE Core II operations were terminated and modifications were initiated to increase the power density, total power, and operating temperatures to provide a high temperature fuel irradiation facility. This overall program is known as the SRE-Power Expansion Program (SRE-PEP). Specific objectives of the program are to: (1) operate the SRE at a mixed mean outlet temperature near 1200°F with a significant number of uranium monocarbide (UC) fuel rods operating at a maximum centerline temperature near 1750°F and an additional quantity operating at maximum centerline temperatures near 2000°F, and (2) obtain, under these conditions, an average burnup of greater than 25,000 Mwd/MTU in the test elements within about two years.

To accomplish these objectives, extensive modifications to the SRE heat transfer systems (Figure 1) and the reactor core were required. The pipe diameter for the main heat transfer system was increased from 6 to 8 in. (the auxiliary systems remained at 2 in.), but system rerouting was required to provide for expansion at the higher operating temperatures. New free-surface sodium pumps of larger capacity were installed to replace the original freeze seal-type pumps in each of the four systems. The maximum power level for SRE-PEP will be 30 Mwt, however, the new sodium systems and components have been sized for 50 Mwt to allow for future expansion.

In the reactor core, the original zirconium-clad graphite moderator elements were replaced with zircaloy-II canned elements of improved design which are capable of operating in the 1200°F coolant outlet temperature. Poison elements, thimbles, in-core instrumentation, and pull tubes were replaced with elements designed for the higher temperature and specific power.

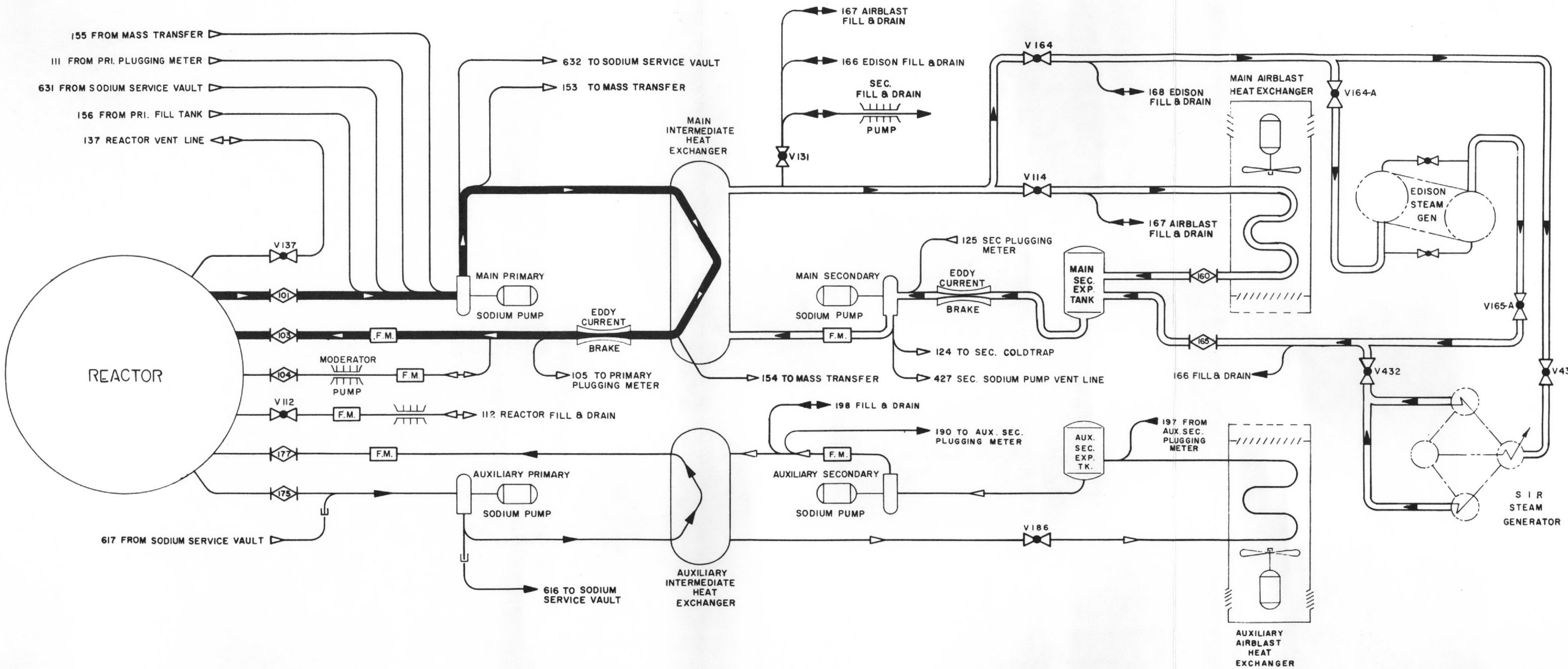


Figure 1. Process Flow Diagram
– SRE Heat Transfer Circuits

II. INITIAL PREPARATION

A. PRELIMINARY PLANNING

Due to the magnitude and nature of the task, a considerable amount of preplanning was done before the actual demolition was started. Flow charts were prepared for each system indicating the major steps to be taken, the estimated manpower requirements, and the required material and special tools (Figure 2). Based on these flow charts, materials were ordered and stockpiled, tools were obtained and checked out, and work load schedules for the various crafts were prepared.

Detailed procedures were not prepared in advance as all the required background material and information were not available. Rather, the flow charts served as general procedures, and specific, detailed procedures were written as the need arose.

B. PERSONNEL

The demolition portion of the SRE-PEP modifications was not included in the contract bid package as most of the work consisted of sodium system removal, half of which was radioactive. Instead, an Atomics International work force consisting of SRE personnel was assigned to a two-shift operation. Each crew was made up as follows:

1) Shift Leader — Engineer, in charge of shift and responsible for crew's activities; one per crew required.

2) Assistant Shift Leader — Chief Reactor Operator, second in charge, assists shift leader; one per crew required.

3) Instrument Technician — Instrumentation background, assigned normal demolition tasks; also served as instrumentation consultant; one per crew required.

4) Electrician — Maintenance mechanic or reactor operator having electrical background; assigned normal demolition tasks, also served as electrical consultant; one per crew required.

5) Mechanic — Maintenance mechanic or reactor operator, assigned to normal demolition tasks; required four per crew.

Activity	1. DRAIN SYSTEM	2. REMOVE BLOCKS	3. R/A SURVEY	4. SHIELDING AND DECONTAMINATION	5. KEROSENE COILS
Operation(s)	Drain primary systems per SOP No. 013.0.	Remove shield blocks from MP vault. Store by ETB. Have Health-Physics survey blocks.	Survey MP vault for radiation and contamination.	Shield local "hot" spots. Decontaminate to < 1000 dpm.	Remove kerosene cooling coils from vault per procedure.
Personnel Requirements	2 operators	3 operators	1 health-physicist	3 mechanics	4 mechanics
Time Required	8 hr	12 hr	8 hr	8 hr	3 days
Tool/Material Requirements	None	60 T crane, lowboy slings and shackles	MP vault map	Lead sheets, lead shot, bricks, decontamination material	Procedure, band saws, blades, buckets, pipe cutters

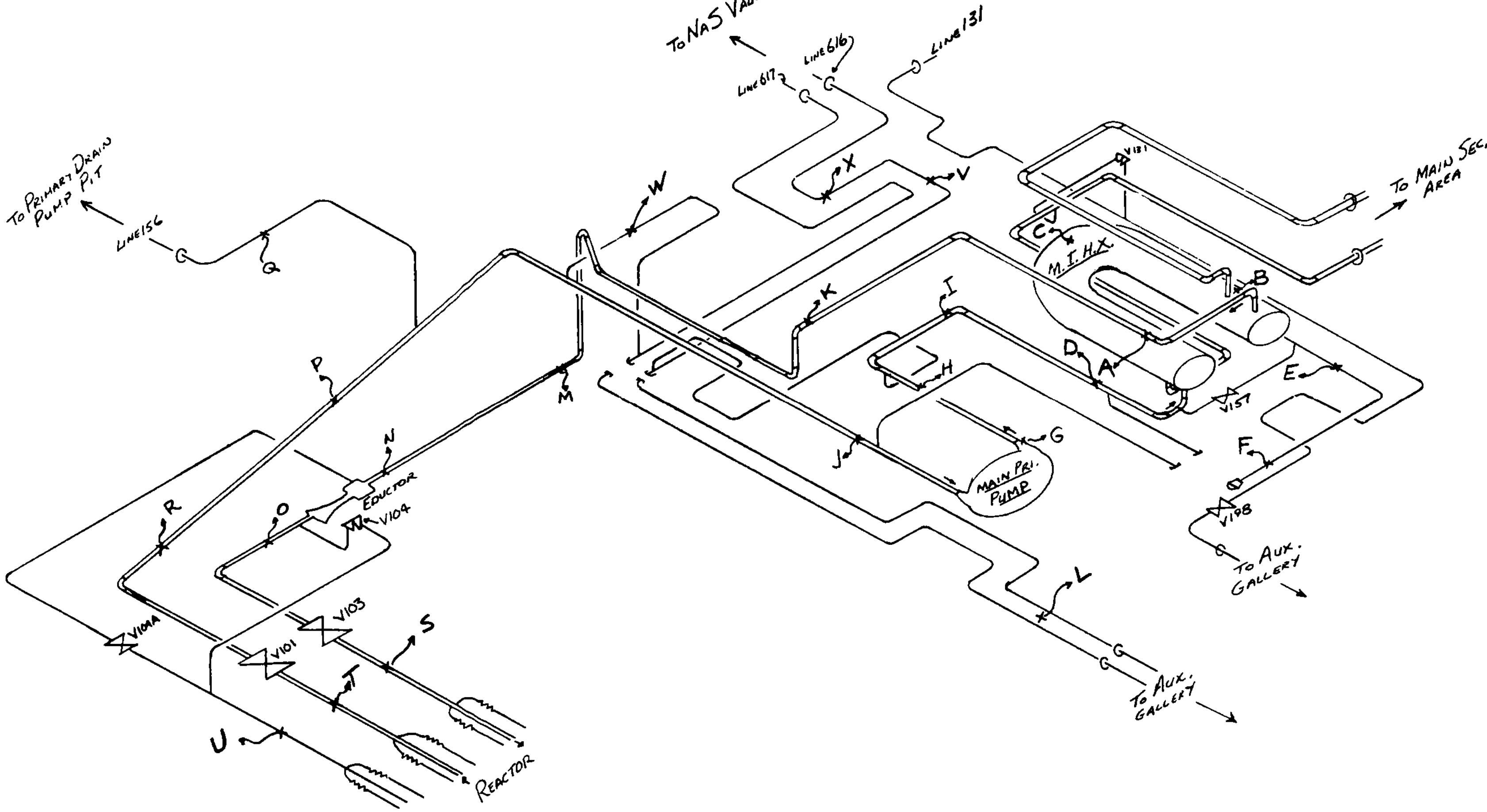
Activity	6. WIRING	7. INSULATION	8. PIPE	9. SURVEY	10. SHIELDING AND DECONTAMINATION
Operation(s)	Cut leads at pipe; bundle away from work area. At "hot" spots only.	Remove enough insulation to cut out "hot" spot. Have Health-Physics survey insulation. Place in plastic bags.	Cut out "hot" spots per procedure. Store in CERF	Health-Physics survey for radiation and contamination.	Shield local "hot" spots. Shield local "hot" spots. Decontaminate to < 1000 dpm.
Personnel Requirements	2 mechanics	4 mechanics	4 mechanics	1 health-physicist	3 mechanics
Time Required	8 hr	3 days	5 days	8 hr	8 hr
Tool/Material Requirements	Hand tools	Bags, Hachets, hand tools.	Pipe cutter, spare wheels, band saw, blades, plastic and steel caps.	MP vault map	Lead and decontamination material.

Figure 2. Flow Diagram, Main Primary System Demolition

Because the demolition crews consisted of SRE personnel, no additional formal training or indoctrination was required. Each crew reviewed the chapter of the Operator Training Manual pertaining to sodium system maintenance and attended a general meeting in which: (1) the flow charts were discussed, (2) safety requirements were stressed, and (3) radiation and contamination control was discussed. The importance of doing a safe and efficient job was emphasized and all participating personnel were urged to suggest alternate methods of attack to improve safety and/or efficiency.

C. PLANT PREPARATIONS

The SRE was shut down for PEP modifications on February 15, 1964. Following the unloading of Core II fuel, the sodium was drained from the systems to the storage tanks. Shield blocks were removed from the primary pipe vaults, and a radiation and contamination survey of the primary area was taken. Radiation levels varied from fields of about 50 mr/hr gamma by the service piping to 3 r/hr gamma at the heat exchanger (Figure 3). Contamination was 50 dpm per 100 cm^2 smear, or less. Because of the high background radiation in the primary work area, it was decided to proceed with both the nonradioactive secondary demolition work and the primary area work simultaneously. In this manner, a mechanic could work in the primary area until a permissible weekly radiation exposure was received (300 mrem maximum) and then transfer to the secondary area to complete the week.



Radiation Levels

I. MIHX & Related Piping	II. Main Pump & Related Piping	III. Eductor & Related Piping	IV. Core Ears	V. Service Piping
A. 1.2 R/hr	G. 300 MR/hr	M. 250 MR/hr	S. 120 MR/hr	V. 30 MR/hr
B. 3.0 R/hr	H. 150 MR/hr	N. 70 MR/hr	T. 75 MR/hr	W. 70 MR/hr
C. 250 to 300 MR/hr	I. 250 MR/hr	O. 50 MR/hr	U. 60 MR/hr	X. 50 MR/hr
D. 300 MR/hr	J. 200 MR/hr	P. 30 MR/hr		
E. 1.5 R/hr	K. 350 MR/hr	Q. 50 MR/hr		
F. 2.0 R/hr	L. 300 to 700 MR/hr			

NOTE: MIXH Radiation Levels obtained 55 days after reactor shutdown. The remaining readings were taken 61 days after shutdown.

Figure 3. Sketch of SRE Main Gallery

III. REMOVAL OF HEAT TRANSFER SYSTEMS

Following are the details of the actual demolition of the sodium systems and related components.

A. SECONDARY SYSTEMS

As the secondary systems (Figure 4) are located in the open and above ground, certain precautions were required to minimize the fire hazard. No disposal activities were allowed when the relative humidity was greater than 50% and all pipe cutting was performed in such a manner as to yield minimum friction heat. As each cut was made on the system, the exposed ends of the pipe were immediately covered with plastic pipe caps and sealed with plastic tape. All personnel involved with the demolition work were provided the following protective gear: flame retarding coveralls, leather or pollyette gauntlet gloves, goggles, and a hard hat complete with face shield. During the actual cutting operations, a fire standby was provided. In this manner, no fires were experienced during the system removal operations.

System demolition was accomplished in the following manner:

1) All system heater power breakers were opened and tagged out of service. Pump power breakers were also opened and tagged out. The system was allowed to cool to ambient temperature.

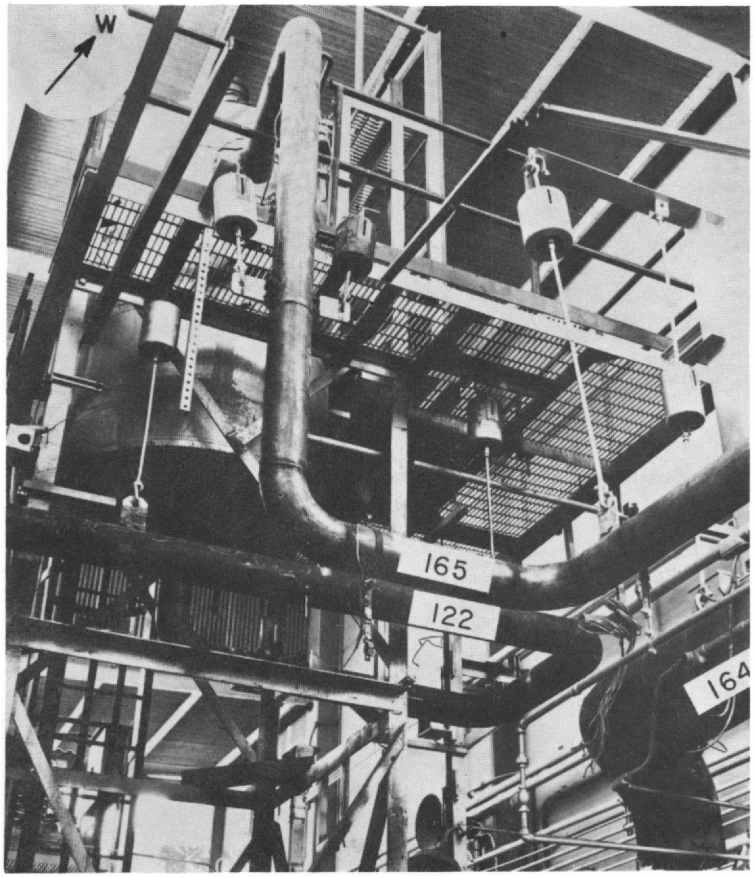
2) Signal and power leads for the system concerned were identified in the local pull boxes.

3) Signal and power leads were disconnected at the system and pulled back to the pull boxes. All associated conduit and terminal boxes were removed and disposed of.

4) Thermal insulation was removed and disposed of.

5) Location of pipe cuts were marked and the sections of pipe identified for future materials testing.

6) The relative humidity was checked and if 50% or less, a fire standby was arranged and demolition crews dressed in protective clothing.



4/10/64 Start of demoli tion;main secondary 6 in. lines after insulation was removed.

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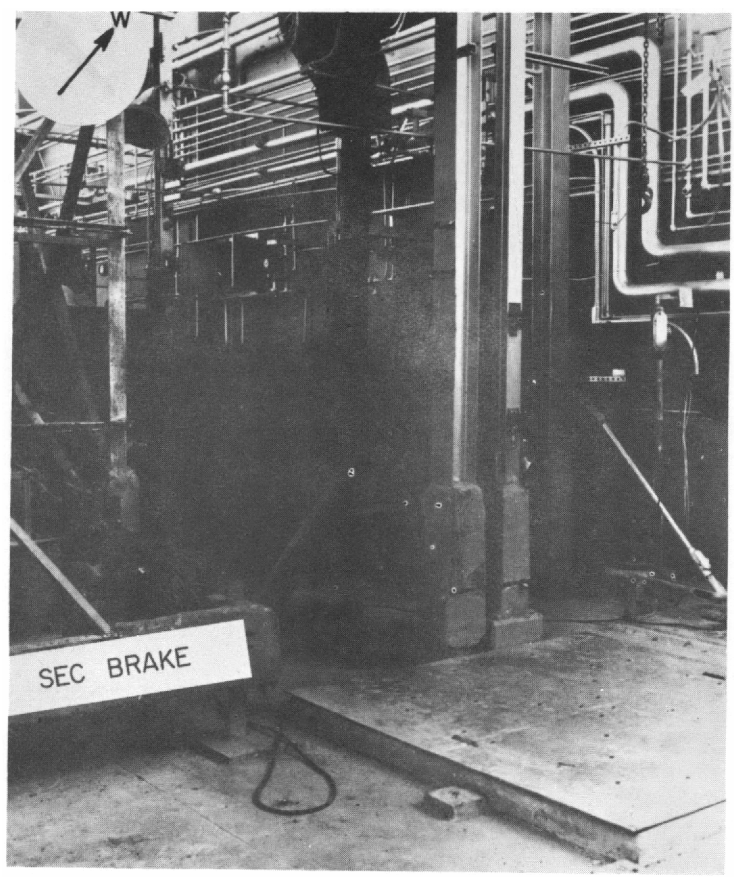
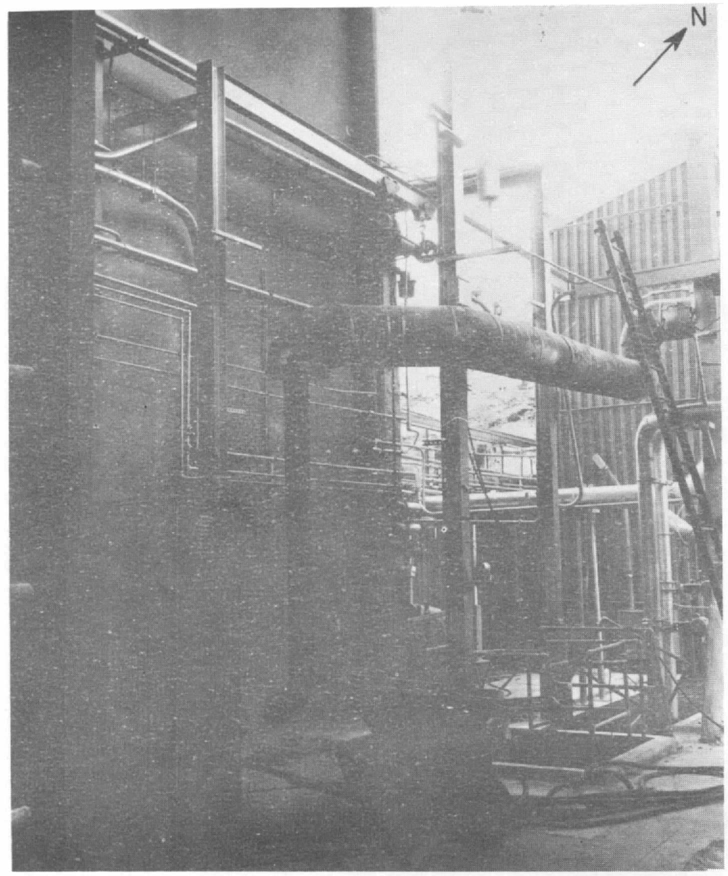
7594-5407



4/10/64 Start of demoli-tion;secondary eddy current brake removal.

Figure 4.
SRE Secondary
System Demolition
(Sheet 1 of 2)

5/15/64 Secondary demolition completed.



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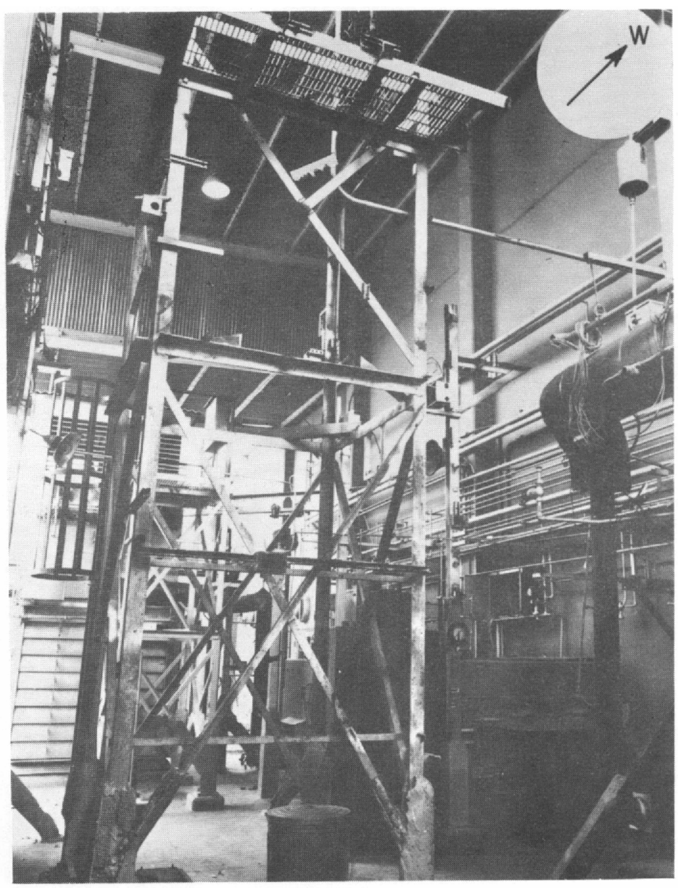
7519-5415



4/22/64 Secondary Demolition 80% completed.

Figure 4.
SRE Secondary
System Demolition
(Sheet 2 of 2)

7) The pipe was cut at the locations indicated and both ends capped and sealed.

NOTE

For 3-in. pipe and smaller, a portable band saw was used to cut the pipe. For pipe larger than 3 in., an air-driven pipe cutter (Figure 5) was used. This tool was modified to accept the conventional pipe cutter wheels rather than the standard cutting tool as the "Vee" chamfer was not required.

8) Removed sections of pipe were stored in a building until system removal was completed.

9) Miscellaneous pipe supports, pump pedestals, structures, and valve operators were removed and disposed of to complete the disposal operation.

B. PRIMARY SYSTEMS (Figures 6 and 7)

In addition to the fire prevention steps taken for the secondary systems, the reactor room was maintained at a negative pressure relative to the surrounding atmosphere to prevent release of radioactive contaminates in the event of a fire. Again, no fires were experienced during the entire primary system demolition operation.

System demolition was accomplished in the following manner:

1) All power breakers feeding the system heaters and pump power breakers were opened and tagged out of service. The system was allowed to cool to ambient temperature.

2) A complete vault survey was made for radiation levels and a map was made indicating results (Figure 3). Of interest here was the fact that the highest radiation levels were found where the sodium velocity was the lowest; i.e., the heat exchanger (A — 1.2 r/hr and B — 3.0 r/hr) and the pressure transmitter line (E — 1.5 r/hr and F — 2.0 r/hr). This indicated that fission products were plated out on the walls of the system, a fact which was later verified during the cleaning operation.

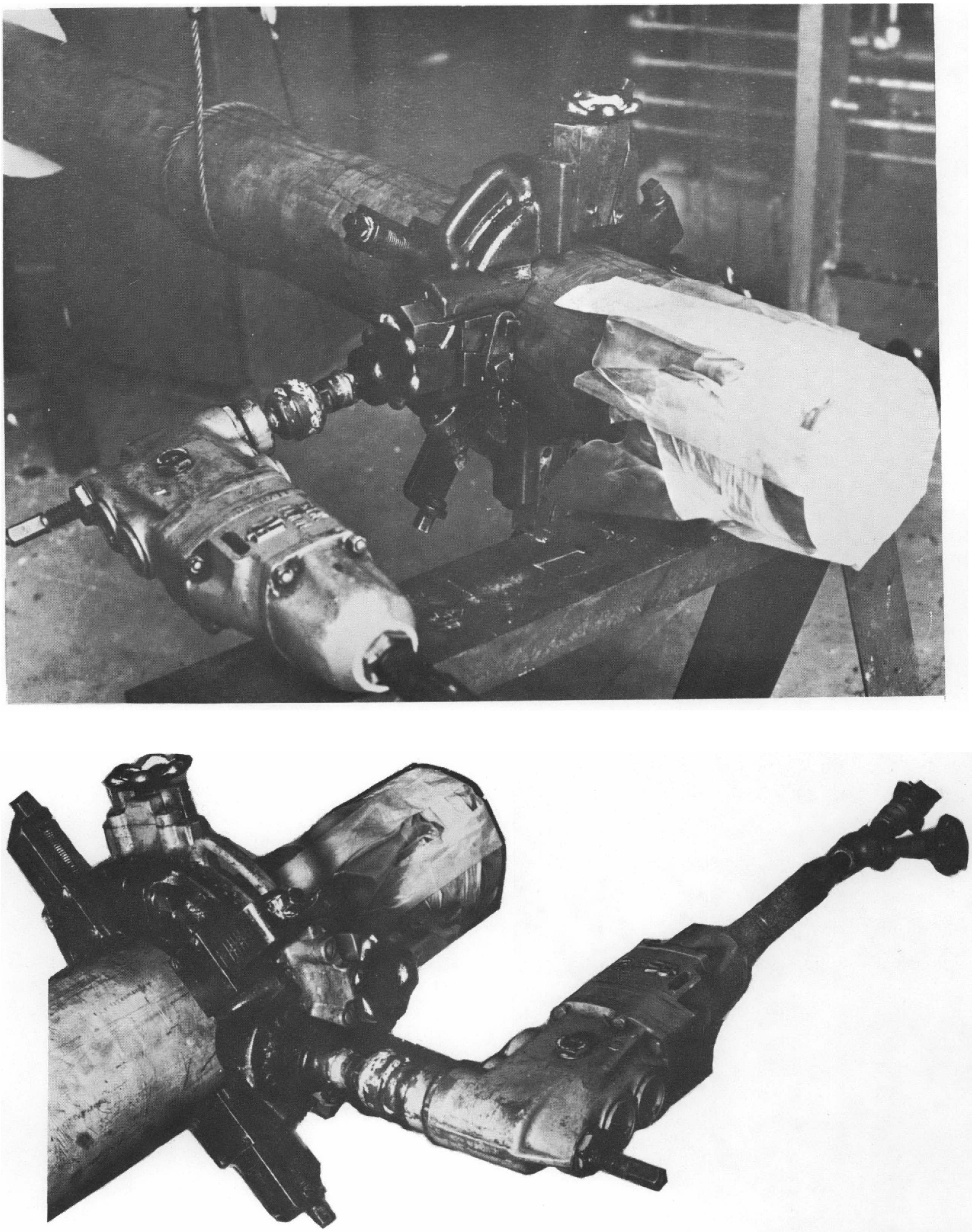


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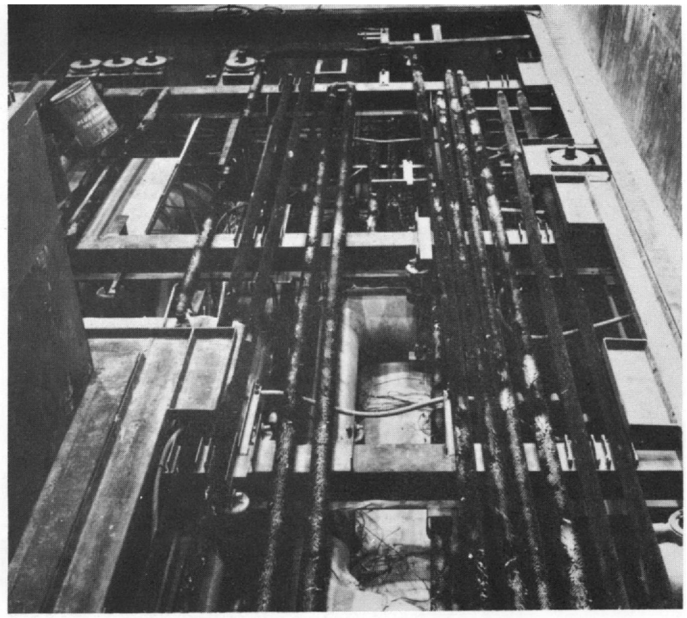
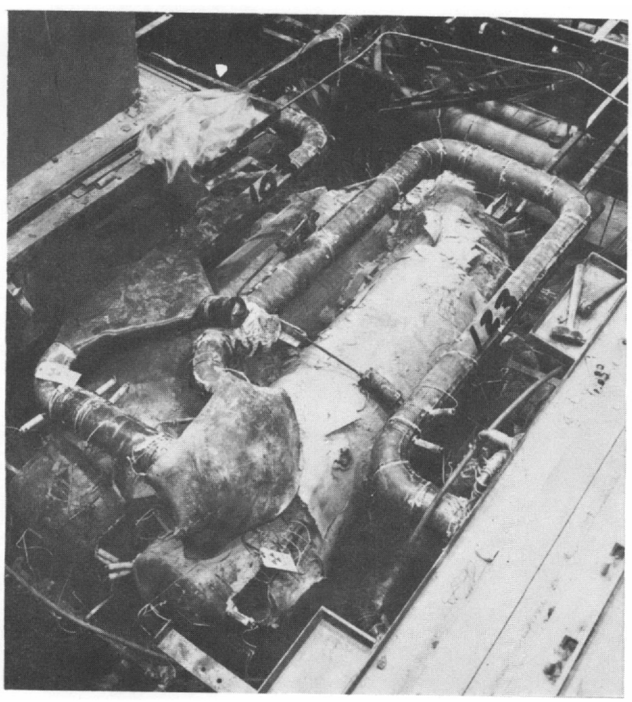
Figure 5. Sodium Pipe Cutting Tool

4/1/64 Main primary pipe gallery at start of demolition.





4/10/64 Cooling coils and insulation removed exposing main heat exchanger. Local shielding installed where required.

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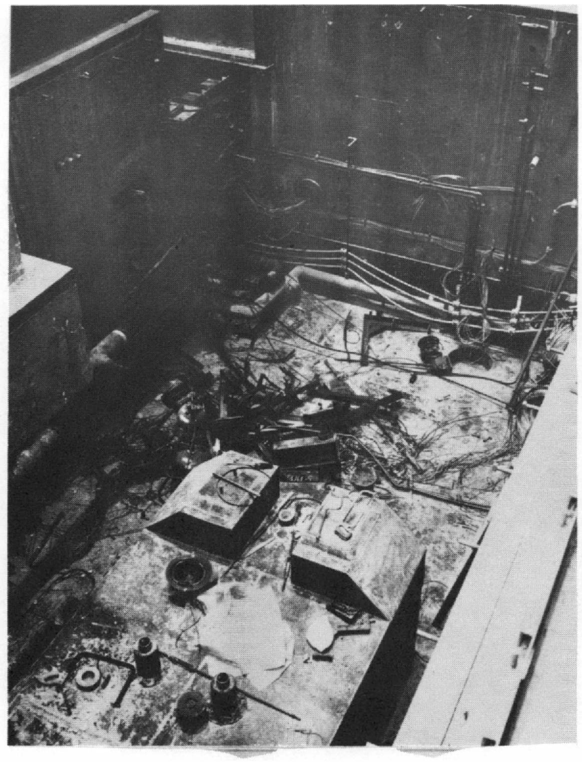
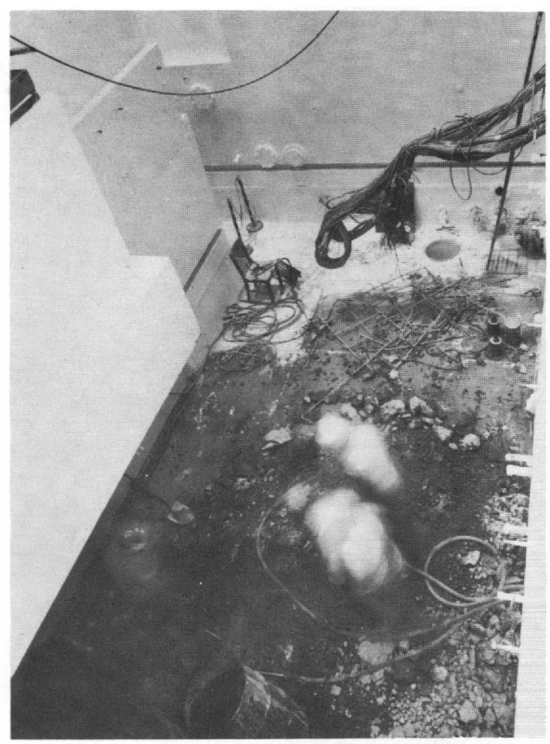
Figure 6. SRE Main Primary Demolition (Sheet 1 of 2)



7599-5410
4/22/54 Main heat exchanger and associated piping removed.

7599-5417

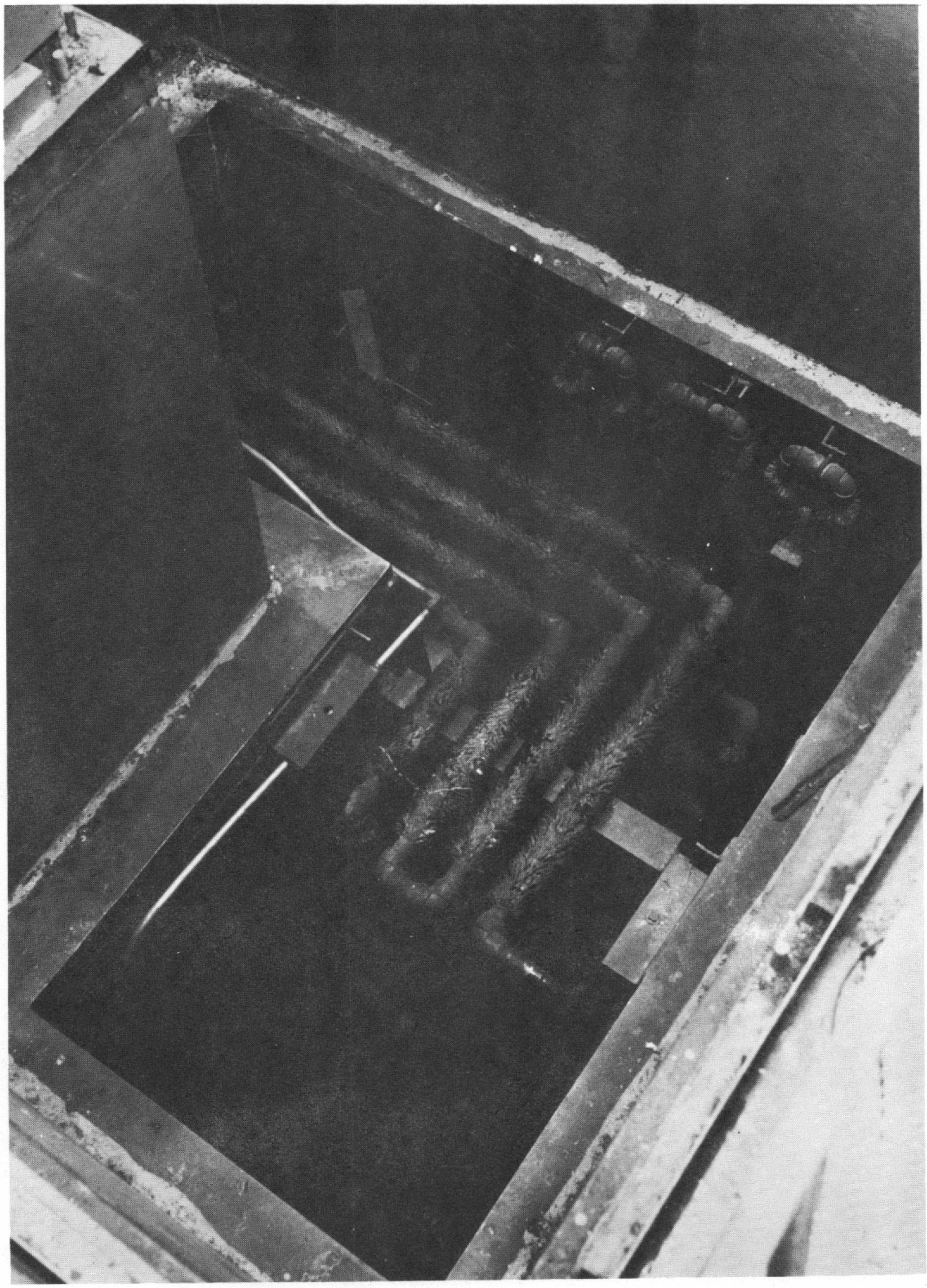
5/29/64 Miscellaneous support, wiring, and piping removed.



7599-5423

5/15/64 Demolition completed, construction started.

Figure 6. SRE Main Primary Demolition (Sheet 2 of 2)



7599-5406

4/10/64 Auxiliary primary pipe gallery at start of demolition.

Figure 7. SRE Auxiliary Primary Demolition (Sheet 1 of 2)

7599-5418

4/29/64 Auxiliary primary pipe gallery, demolition completed.

Figure 7. SRE Auxiliary Primary Demolition (Sheet 2 of 2)

3) Local shielding was applied to the areas having the highest radiation levels.

4) Signal and power leads were cut from the system and allowed to drop to the vault floor. No further work was done with these leads until the entire system had been removed. Thus, radiation exposure to the crews was minimized.

5) The location of cuts were identified with areas having the highest radiation levels receiving top priority.

6) Thermal insulation in the area of the cut was removed and temporarily stored. Following a survey for contamination, it was disposed of as either contaminated or normal waste.

7) The relative humidity was determined and if less than 50%, a fire standby was arranged and the demolition crews donned protective gear.

8) The pipe was cut at the locations indicated, and both ends were capped and sealed. When the pipe was cut, a ratio of high energy beta (sufficient to penetrate the plastic pipe caps) to gamma of about 8 to 1 was found. Thus, the maximum allowable personnel exposure (measured by pencil dosimeters) had to be reduced from 300 to 150 mrem per week, and film badges were processed weekly rather than monthly. Additionally, local shielding was applied to the open end of the system remaining in the vault.

9) The section was removed from the vault and the remaining thermal insulation removed. Each section was then stored in a building until the entire demolition was completed before disposal was started.

10) A new survey for radiation and contamination in the vault was made following each removal. If contamination levels exceeded 1000 dpm per 100 cm^2 smear (average level of about 300 dpm with areas directly beneath the cutting operation becoming as high as 19,000 dpm), spot decontamination was required.

11) The early removal of higher radiation pipe sections and the resulting decrease in radiation levels permitted the work to proceed rapidly.

12) Following complete removal of the system, the signal and power leads were identified in the pull boxes and removed from the vault floor.

13) A final survey for contamination was made, and the necessary decontamination performed.

IV. DISPOSAL OF THE HEAT TRANSFER SYSTEMS

Following completion of the demolition phase, all systems removed were cleaned free of sodium and disposed of as either salvageable material or radioactive waste. The method used to remove the sodium from the systems is described in the following paragraphs.

A. SECONDARY SYSTEMS

A preliminary cleaning operation was performed in which the system sections were immersed in a static 300°F oil bath. At this temperature, about 90% of the sodium melted and settled to the bottom of the oil tank. Following the oil bath, the sections were then steam cleaned to remove any remaining sodium. After the cleaning operation was completed, each section was surveyed for possible contamination or radiation (a precautionary measure only) and then disposed of as salvageable waste.

B. PRIMARY SYSTEMS

The primary system components underwent an identical preliminary cleaning, i.e., immersion in a static 300°F oil bath. To remove the remaining sodium, the system sections were placed in a bath of butyl-cellosolve which yielded a very slow reaction for safe removal of the remaining sodium. The solvent bath was followed by wrapping the components in plastic and placing them in disposal boxes for disposal as normal, dry, noncompressible radioactive waste.

It was interesting to note that the beta-gamma ratio in the piping increased from 8:1 to 15:1 after the sodium was removed. This anomaly was ascribed to a plating out of the fission products on the inner surfaces of the piping. Readings taken at the opening of a pipe prior to washing failed to yield a true measurement, since the sodium served to absorb the low energy beta emissions.

The use of butyl-cellosolve was discontinued as the surrounding area was being contaminated when the component was removed from the bath. A thin, contaminated coating was deposited on the external surfaces of the component as it was removed from the solvent; this film was easily dislodged during the wrapping operation, resulting in contamination of the surrounding work area. For this reason, cleaning of the primary sodium systems was terminated and the system was disposed of with the sodium remaining in the piping. This required that all components be cut into lengths (~30 in.) what would fit into a 55-gal disposal drum. Dry calcium carbonate was packed around the piping and a 6-in. layer was provided at the top and bottom of the drum.

V. CONCLUSIONS

Demolition of the SRE heat transfer systems was accomplished by 16 men over a seven-week period. The average radiation exposure for this period was 1000 mrem and the maximum exposure to one person was 1800 mrem (the maximum allowable for this period of time was 2100 mrem). Contributing to this low exposure was the ability to reassign personnel to the nonradioactive secondary systems. However, the primary reason was the order of removal employed with the radioactive systems, i.e., the component having the highest radiation level was removed first.

With the high beta to gamma ratio within the sodium, personnel protection from beta radiation (eye and gonad shielding, reduced maximum allowable radiation exposures, etc.) becomes a major consideration once the system is opened.

Finally, butyl-cellosolve is an excellent cleaning agent for sodium systems. However, if large quantities of radioactive sodium are to be removed, a definite contamination problem is encountered. Therefore at the SRE, use of butyl-cellosolve has been restricted to the cleaning of secondary sodium systems and small cleaning operations for primary component maintenance.

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