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CEND - 83
VOL. I & II

ABWR
QUARTERLY PROGRESS REPORT
SL-1 OPERATION, HEALTH & SAFETY

JANUARY 1, 1960 - MARCH 31, 1960

CONTRACT NUMBER AT (10-1)-967
U S ATOMIC ENERGY COMMISSION

NUCLEAR DIVISION
COMBUSTION ENGINEERING, INC.
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ABWR QUARTERLY PROGRESS REPORT

SL-1 OPERATION, HEALTH PHYSICS AND SAFETY
January 1 to March 31, 1960

May 25, 1960

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USAEC CONTRACT AT(10-1)-967

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PREFACE

ABWR QUARTERLY PROGRESS REPORT

This report presents the Army Boiling Water Reactor program progress during the third quarter of Fiscal Year 1960. This program includes the operation and test evaluation of the Stationary Low Power Reactor Number One (SL-1, formerly ALPR) and an associated design and development program with the objective of obtaining improved portable and modularized BWR plants in the low power range (PL plants).

Volume I discusses SL-1 plant operational experience, presents plant test activities and the power extrapolation program, summarizes the major maintenance and modifications performed, and reviews the technical administrative accomplishments during the report period.

Volume II summarizes the Health and Radiological Safety program in support of SL-1 operations. Included in the presentation are discussions on personnel and area monitoring, radiological test and evaluation, special problem analyses, health physics training, and industrial safety.

Volume III presents the current ABWR design and development status. Included in this volume are major sections covering PL-1 and PL-2 plant design, core analysis, and supporting research, including reactor theory development and health physics studies.

The work described in these volumes satisfies requirements established both by USAEC Contract AT(10-1)-967 and USA ERDL Contract DA-44-192-Eng. 11.

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VOLUME I

SL-1 OPERATIONS AND EVALUATION
January 1 to March 31, 1960

May 25, 1960

USAEC CONTRACT AT(10-1)-967

COMBUSTION ENGINEERING, INC.

Nuclear Division

Idaho Falls Idaho

302 007

HIGHLIGHT STATEMENT

The Stationary Low Power Reactor No. 1 is a three MW boiling water reactor designed to demonstrate the feasibility of a nuclear reactor to supply electrical power and space heat for remote sites. In addition to performance evaluation the facility provides training for military personnel.

This progress report is a description of the operational activities for the third quarter of Fiscal 1960. The plant was shut down during the month of January for an annual maintenance period. The details of the maintenance performed have been reported in IDO-19012, SL-1 Annual Operating Report.

The reactor was operated for 1159 hours during the quarter for a total core burnup of 20.3%. Power generation was 103.7 MWD for a total power accumulation of 466.9 MWD.

Eight malfunctions occurred during the quarter for a total unscheduled downtime of 40 hours 44 minutes. As a result of malfunctions, aluminum keys will be installed on the control rod drives, instrument well covers were removed, and an order has been placed for a station auxiliaries breaker with a higher temperature rating.

Data was taken on seven tests during the quarter. Four of these are expected to be completed during the next quarter.

All equipment items on order for the SL-1 power extrapolation expansion program are scheduled to be delivered before June 15, 1960. Although condenser dampers and damper controls, process instrumentation, equipment cabinets, and the radiation monitoring equipment have not yet been ordered, construction will not be delayed. The two tie-ins to the existing reactor piping which were required have been made.

The engineering and decontamination buildings are nearing completion and will be ready for occupancy in early May. An SL-1 operational cost analysis for March of electrical power generated, based on military personnel only, indicated a mil rate of 107.

I INTRODUCTION

A. HISTORICAL DATA

The Stationary Low Power Reactor No. 1 (SL-1) is a small natural circulation, direct cycle boiling water reactor designed for the generation of electrical power and space heat for remote arctic installations.

Design and construction of the facility was performed at the National Reactor Testing Station during 1957 and 1958. Criticality was initially achieved on August 11, 1958, and the plant was first operated at power on October 23, 1958. Prior to February 5, 1959, the plant was test operated by Argonne National Laboratory. Since then, the reactor plant has been operated by Combustion Engineering, Inc. as a test, demonstration, and training facility.

B. DESIGN DATA

Plant

Reactor heat output	3 MW(th)
Steam production	9020 lb/hr
Operating pressure	300 psig
Operating temperature	420 °F
Turbine generator output	300 KW(e)
Steam quality	Saturated
Space heating load	400 KW(th)
Ambient temperature	-60 to +60 °F
Air cooled condenser capacity	7.5×10^6 BTU/hr

Reactor Core

Cladding alloy for plates (Al - 1% Ni) ALCOA	X-8001
Length of active core	25.8 in.
Number of fuel elements	40
Total thickness of fuel plates (0.050" meat, 0.035" clad)	0.120 in.
No. of plates per element	9
Average water channel gap	0.310 in.
Fuel in 40 elements, U^{235}	14 Kg
Weight of U^{235} per element (approx.)	350 gm
Weight of B^{10} in B-Al strips Attached to 40 fuel elements	22.6 gm

Control Rods

Number of crosses	5
Size of crosses	14 1/4 in.
Length of cadmium section	32 in.
Thickness - cadmium	0.060 in.
Thickness - Al-1% Ni alloy clad	0.080 in.
Scram time	2 sec.
Withdrawal rate (approx. max.)	0.01% k/sec.

Nuclear Data

Core lifetime	3 years
Plant load factor	0.7
Average thermal flux	7.5×10^{12} n/cm^2/sec.
Average thermal lifetime	4 to 8 x 10^{-5} over range of core lifetime
Reactivity changes, % k	
Temperature effect	1.5 to 2
Steam voids	1.3 to 2
Xe + Sm	3
Xe override	1 to 1.5

Heat Transfer

Average power density in coolant	17.5 KW/l
Steam flow at 3 MW	9020 lb/hr
Average steam voids in heated channel	9%
Average steam voids in moderator	7%
Feedwater inlet temperature	175 ^{o}F
Average boiling length of core	20 in.
Total heat transfer area	475 ft^2
Average heat flux	21,500 BTU/hr (sq. ft.)

II PLANT OPERATION

The following section summarizes the operating limitations placed on the SL-1 plant and lists the operating history for this period.

A. OPERATING LIMITATIONS

The plant was operated at the maximum safe power possible during this quarter, except for periods of time when special tests required low steam flows. The design specifications for the SL-1 plant were based on arctic operations where the ambient temperature could vary from -60 to +60 °F. Under design conditions, the plant should be capable of producing 3 MW(th) power. However, the plant is unable to produce a continuous 3 MW(th) for the following reasons:

1. Main Air Cooled Condenser

The main condenser receives the expanded steam from the turbine. By maintaining a vacuum in the condenser more work can be obtained from the turbine. The ability of the condenser to dissipate the heat necessary to condense the steam and maintain design vacuum is dependent on the cooling air inlet temperature and flow. If the flow rate of the cooling air is considered relatively constant, the condenser capacity becomes dependent upon the cooling air inlet temperature. When the outside ambient temperature increases, condenser capacity decreases, resulting in a decrease in condenser vacuum unless the load is reduced.

2. Condenser Vacuum

Condensate from the hot well being returned to the reactor is first used for cooling the purification flow. The hot well water is also used for cooling the air ejector after-condenser, precooler, shield cooler and control rod seals. The performance of the above systems is adversely affected when hot well temperature becomes excessive. It becomes necessary to shut off purification flow to the mixed bed when the inlet temperature is above 175 °F and to the cation bed when the temperature exceeds 200 °F. To keep the hot well temperature from becoming excessive a minimum condenser vacuum of 10 in. Hg. based on operation at 5,000 feet was selected. The saturation temperature of the hot well water is 179 °F at a condenser vacuum of 10 in. Hg. When the outside ambient temperature increases the condenser capacity decreases and it becomes necessary to reduce the steam flow to the condenser in order not to reduce the vacuum below 10 in. Hg.

3. Condenser Fan Motor

The insulation on the condenser fan motor is designed for a maximum temperature of 194 °F. This motor is located on the fan floor on the exhaust side of the main air condenser where ambient temperatures exceed 150 °F. A thermocouple is installed through the motor housing and monitored to limit the fan motor temperature to 175 °F.

B. OPERATING HISTORY

1. Operational Data

The following is a summary of operational data for this report period:

	Current Quarter	Cummulative Plant Totals
Hours plant operated	1159	5560
Hours at power (2)	1032	4973
Reactor MWD(th) (3)	103.7	466.9
Turbine generator KWH(e) (4)	243,800	1,049,500
Simulated heat load KWH(th) (5)	311,900	1,729,400
Fuel burnup (grams) (6)	130.7	588.3
% core life used (7)	4.5	20.3

Notes: (1) Total time the plant was operated including checkout, startup and securing time.
(2) Total time the reactor was critical.
(3) Total of hourly reactor power calculations.
(4) From KWH meter.
(5) Total of hourly spare heat output calculations.
(6) For U^{235} only.
(7) Based on 2300 MWD design lifetime.

2. Operating Schedule

a. The plant was secured from January 1, 1960 through February 1 for an annual maintenance period.

b. On February 2, a pre-operational checkout was performed on all equipment following the extended maintenance.

c. The plant was operated on February 3 for checkout of equipment and adjustment of safety and relief valve operating pressures.

d. During the period February 4 through February 19, the plant was continuously operated to provide operational training time for Military and States Marine Steamship Co. personnel.

e. The plant was secured from February 20 to February 28 while the Military Cadre tested trainees.

f. From February 29 through March 31, the plant was operated continuously for core burnup and to provide information for the SL-1 test program.

3. Operating Personnel

The use of two-man crews during routine operations continued during this report period.

Eight Maritime personnel from the N. S. Savannah crew participated in reactor plant operations as part of their Army Nuclear Power Training course.

Three SL-1 Military personnel were qualified as Shift Supervisors and eight Military trainees were qualified as Reactor and Plant Operators.

4. Unscheduled Plant Shutdowns

The following list is composed of unscheduled shutdowns of the SL-1 plant during this report period. All have been previously reported in SL-1 Malfunction Reports and are mentioned in further detail in the Maintenance and Modification section of this report.

TABLE I

UNSCHEDULED DOWNTIME OF THE SL-1 PLANT
January 1 to March 31, 1960

SL-1 Malfunction Report No.	Description	Resultant Plant Downtime
15	Station auxiliary circuit breaker tripped from overload	1 hr. 15 min.
16	Shorted high voltage cable, Nuclear Channel No. II	10 hr. 45 min.
17	Operator error	3 hr. 0 min.
18	Failure of Control Rod Drive No. 7	5 hr. 40 min.
19	Shorted signal cable Nuclear Channel No. II	10 hr. 50 min.
20	Frozen air ejector vent line	7 hr. 18 min.
21	Station Auxiliary Circuit Breaker tripped from overload	0 hr. 41 min.
22	Improper adjustment of turbine governor control linkage	1 hr. 15 min.
		40 hr. 44 min.

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C. PLANS FOR NEXT QUARTER

1. The plant will be secured for the first week of the quarter to allow the removal of No. 9 Control Rod Drive for inspection and to provide one day of academic training for all Military personnel.

2. Continuous operation is planned for the period from April 9 through May 25, for core burnup and the SL-1 test program.

3. The reactor will be secured from May 25 through June 1 for maintenance and inspection.

4. After the scheduled maintenance period, the plant will be operated continuously for the remainder of the quarter.

III TEST AND EVALUATION

During the quarter work was continued to accomplish the objectives of the SL-1 Test Program, which are: The operational evaluation of the existing plant; development of experimental data to facilitate plant modifications with a goal of improving plant performance; and development of experimental data for use in PL plant design.

During the report period data for the following tests was taken:

a. Hydrogen Buildup During Startup (CM-2)
b. Measurement of Water Decomposition (CM-3)
c. Determination of System Decontamination Factors (CM-4)
d. Plant Water Analyses (CM-7)
e. Mixed Bed Ion Exchange Resin Evaluation (CM-9)
f. Steam Quality Measurements (MS-7)
g. Core Operational Data (PH-5)

Tests expected to be completed during the next quarter include: Measurement of Water Decomposition (CM-3), Determination of System Decontamination Factors (CM-4), Steam Quality Measurements (MS07), and Decay Heat Removal Test (RA-1). Collection of data for two tests, Hydrogen Buildup During Startup (CM-2) and Mixed Bed Ion Exchange Resin Evaluation (CM-9) will be continued.

Procurement of equipment for the SL-1 Power Extrapolation Program was continued during this quarter.

IV SL-1 POWER EXTRAPOLATION PROGRAM

The SL-1 plant expansion was continued during the report period to accomplish the objectives of evaluating the performance of the SL-1 core at elevated power levels while demonstrating a PL-2 type condenser module. The SL-1 plant, designed to produce three (3) megawatts thermal power, will be expanded to handle the additional steam produced up to 8.5 MW(t) reactor power during higher power operation.

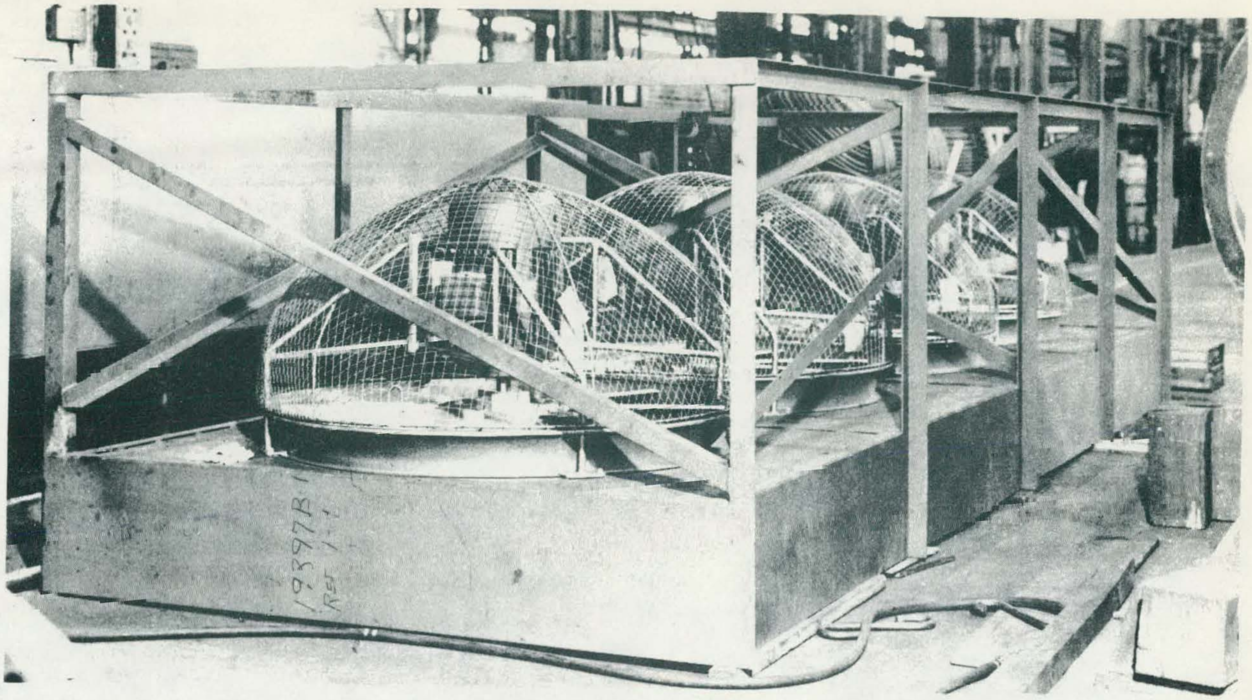
A description of the plant expansion systems is presented in Section IV of IDO 19009, ABWR Quarterly Progress Report, Volume I, SL-1 Operations and Evaluation, October 1 to December 31, 1959.

A. STATUS OF EQUIPMENT

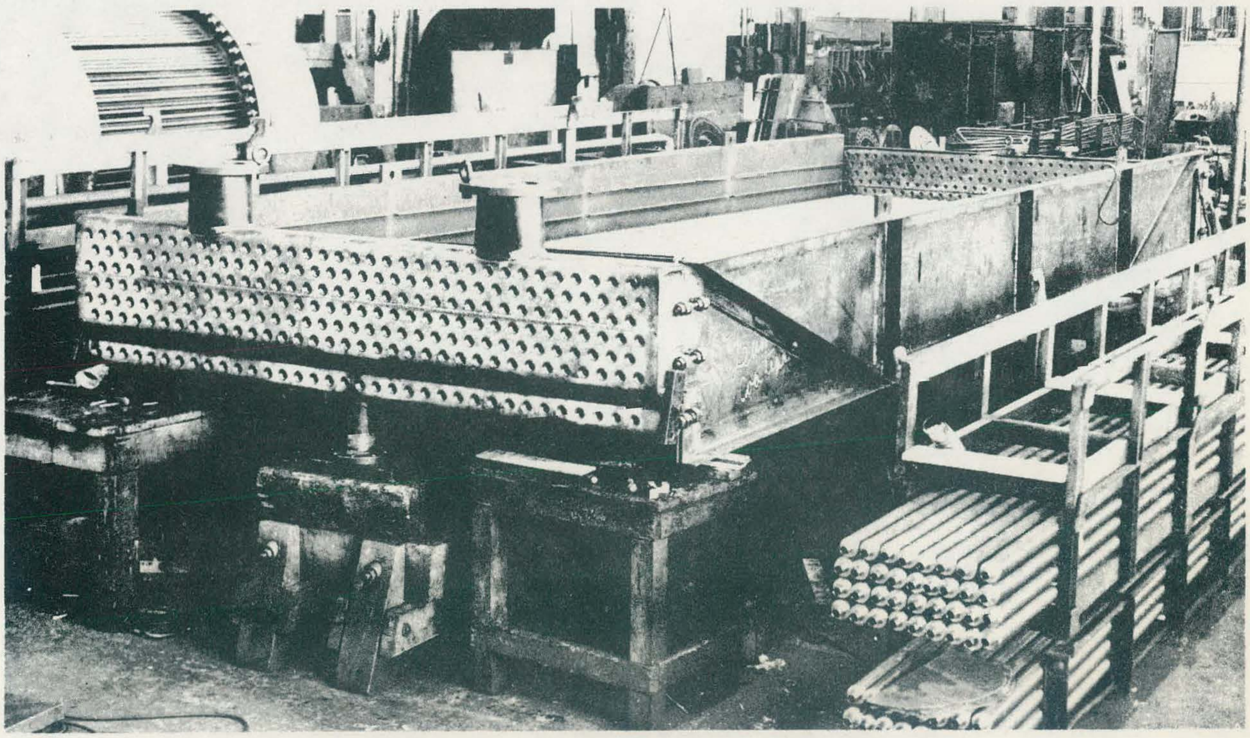
The main catagories of equipment for the plant expansion consists of the following:

1. Main condenser (air cooled PL type)
2. Main condenser dampers and damper controls
3. Main condenser subcooler level control
4. Air removal equipment
5. Special valves
6. Pumps
7. Special tanks
8. Process instrumentation
9. Process instrumentation equipment cabinets
10. Motor control equipment
11. Radiation monitoring equipment

The main condenser was released for purchase December 7, 1959. At the end of this report period the vendor indicated that fabrication was proceeding on schedule. Figure 1 contains two photographs of the PL condenser structure showing the condenser ready for tubing and the tube bundle support frame with the fans in place. All of the above items except the main condenser dampers and damper controls, process instrumentation equipment cabinets and the radiation monitoring equipment have been ordered. The condenser dampers and damper controls proposed by the various vendors were not compatible with the PL plant requirements; therefore, Combustion Engineering, Inc. has undertaken the job of designing a satisfactory unit. The equipment cabinets will not be ordered until all instrumentation sizes are available. Specifications for the radiation monitoring instruments were issued to various vendors for quotations. Equipment on order is scheduled to be delivered before June 15, 1960.



PL CONDENSER STRUCTURE WITH FANS



PL CONDENSER READY FOR TUBING

Figure 1

B. STATUS OF ARRANGEMENTS

A Butler Building, 20 ft. x 41 ft. 10 in., type 2014RF6 modified, was selected to house the expansion loop. Figure 2 shows the layout of major equipment and ducting in the building. The main condenser is centered with respect to the width of the building and is located near the equipment door. A pit under the condenser is provided for the system drain tank, the drain tank pump, and the feed booster pump. A partition is provided in the building to separate the main condenser from the equipment compartment. The air intake and exhaust ducts are located on, and supported by the building roof. Final arrangement drawings are being prepared by the architect-engineer.

C. CONSTRUCTION

Process connections to the existing SL-1 hot well and feed pumps have been made and are capped outside the reactor building. Connections to the main steam line and domestic water lines will complete the tie-ins to the SL-1 piping. It is estimated that construction can be completed approximately 30 days after receipt of the last major piece of equipment.

D. PLANS FOR NEXT QUARTER

1. Instrument cabinets and Radiation Monitoring Equipment will be ordered.

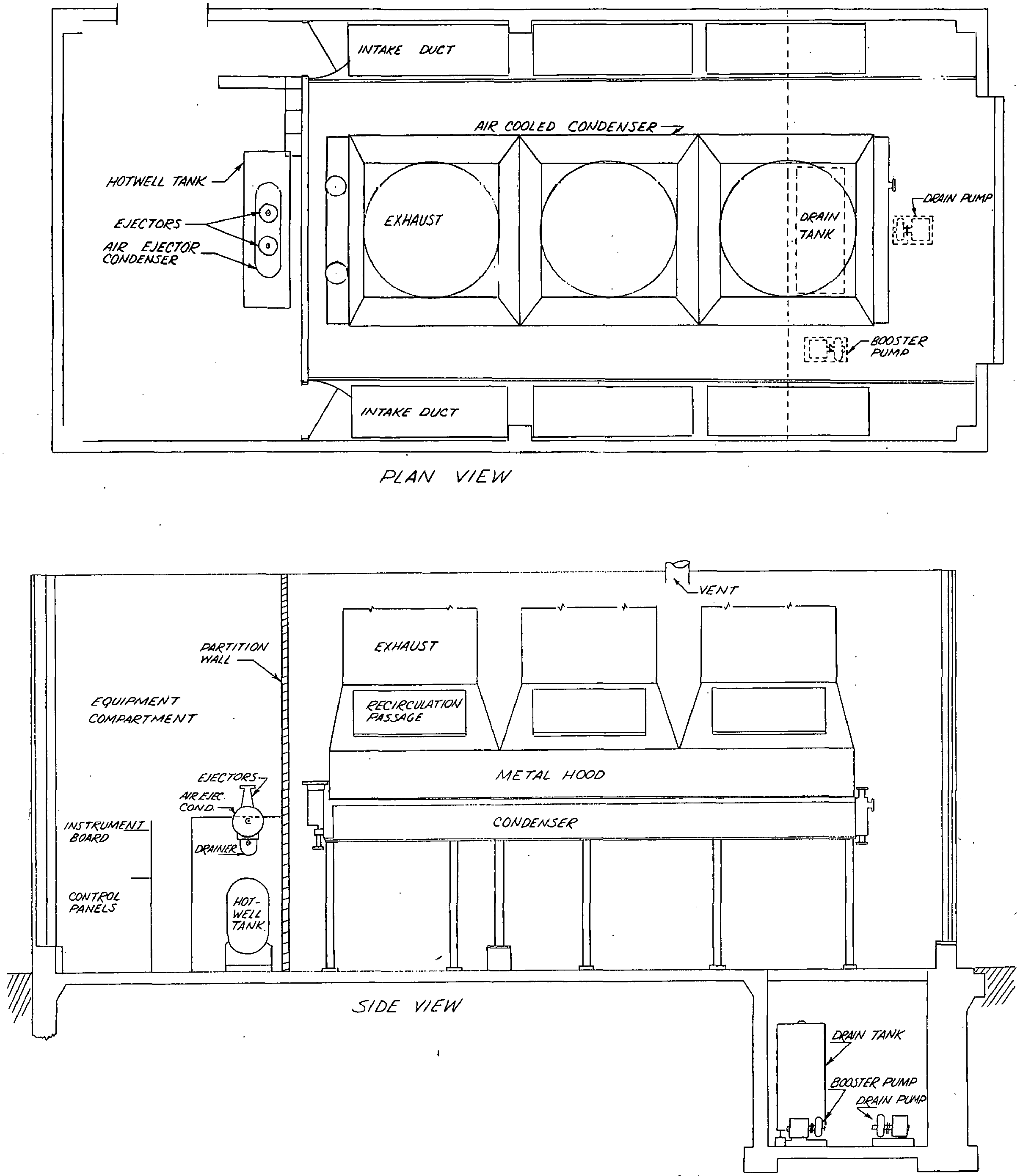
2. Receipt of all major pieces of equipment.

3. Completion of tie-in connections with SL-1 piping.

4. Final layout drawing will be prepared by architect engineer.

5. Final building and ducting drawings will be prepared by architect engineer.

6. Supplement to SL-1 hazards analyses will be prepared.



SL-1 POWER EXTRAPOLATION CONDENSER INSTALLATION
FIGURE 2

V PLANT MAINTENANCE AND MODIFICATIONS

Maintenance and modifications performed and completed during the annual maintenance period (December 24, 1959 through February 1, 1960) have been previously reported in the SL-1 Annual Operating Report, IDO-19012. This section describes the repairs to the SL-1 plant accomplished during February and March that were beyond the normal preventative maintenance common to any plant of this type and size. It also includes modifications in the plant that were found necessary for continued, or improved, operation. The extent of the items accomplished was determined by necessity, the operating schedule, and the availability of maintenance personnel.

A. REACTOR SYSTEMS

1. Control Rod Drive

The negator-spring on Control Rod No. 7 disengaged during a rod drop, causing minor damage to the rod drive mechanism. The negator-spring slipped off the rewind spool unnoticed during routine rod exercising. When the control rods were dropped by a scram caused by turbine trouble, the loose spring whiplashed, which uncoupled the gear-train for the position-indicating-selsyn and the rod control switches. Since the motor cut-off switches were not actuated, the drive motor continued to drive the rod into the positive stop, thus shearing the speed gear teeth and twisting the reduction gear drive shaft.

A spare drive-mechanism was installed and the damaged mechanism was repaired on the bench at SL-1.

Careful negator-spring installation and use of cast iron gear or aluminum key shear devices will prevent a recurrance of this type of malfunction.

2. Nuclear Instrument Cable

Local hot spots in the cable ducts for the nuclear chambers caused several cable failures. The upper sections of the nuclear chamber instrument wells and the cable duct near the vessel head are ventilated only by natural air convection. Radiant heat from the reactor causes local hot spots up to 200 °F. All of the polyethylene-dielectric cables used for signal and high voltage leads were replaced because of insulation failure; polyethylene insulation is temperature limited to 167 °F. To increase instrument well air circulation, the instrument well covers were removed. Subsequent hot-spot air temperatures were reduced to 150 °F although metal wall temperatures in the hot-spot regions remained above 170 °F.

The complete instrument ventillation system is currently being studied for revision. If the cable operating temperatures cannot be maintained below 167 °F, high temperature teflon-dielectric cables will have to be installed. Temporary thermocouple installations are presently monitoring hot spot temperatures, pending a permanent hook-up for indication on the control room 48-pt recorder.

B. MECHANICAL SYSTEMS

1. Vacuum Recorder

The turbine vacuum-recorder transducer was relocated to eliminate an error signal induced by a water leg in the transducer tap-off piping. Condenser steam accumulating in the "U" shaped tap-off piping caused the transducer recorder to read low by 2 to 4 in. Hg. The transducer is now located next to the vacuum tap-off on the turbine and positioned so that condensate will drain to the turbine exhaust trunk.

2. Turbine Horizontal Casing Seal

Following the inspection of the turbine internals during the annual maintenance period, the horizontally split turbine casing was reassembled. In accordance with the manufacturer's recommendations, the flange faces were completely cleaned and polished and a mixture of pure red lead and triple boiled linseed oil was applied. The prescribed bolting sequence was then employed.

The turbine was brought to temperature and speed following normal cold startup procedure. A steam leak developed at the casing point that could not be stopped by additional bolting and the turbine was secured.

The top half of the casing was removed and the joint regasketed with unbraided Johns Mansville asbestos rope parking and Permatex. After reassembling the casing, the unit was cycled from hot to cold. All bolts were tightened each cycle until a satisfactory joint was obtained.

3. Additional Sampling Tap in Main Steam Line

In order to allow adequate sampling of reactor steam, a tap was welded into the main steam piping approximately 20 feet downstream from the reactor near the original calorimeter tap. The second tap was provided to permit measurements of steam quality to be performed concurrently with other steam tests.

4. Adjustment of Governor Control Linkage

Following the annual maintenance period, the turbine generator governor control was adjusted to allow adequate steam flow to the turbine to provide 300 KW output when exhausting to a 15 in. Hg vacuum. This adjustment was later found to be inadequate for SL-1 operation and caused a reactor scram as reported in Malfunction Report No. 22. Therefore, the governor linkage was adjusted to hold the turbine control valve 83 per cent open when the generator is producing 300 KW and exhausting to 10 in. Hg vacuum.

C. ELECTRICAL

The station auxilaries circuit breaker was periodically tripping because of high environmental temperatures in the breaker cabinet. Previous breaker trips were attributed to faulty trip mechanisms; however, recent investigations revealed that the trouble is caused by adverse temperature effects on the trip mechanism capacity. The 60 KW breaker is rated for 400 amps at 25 °C. When the environmental temperature is increased to 45 °C the tripping current is reduced to 265 amps, which is the approximate operating condition at full power operation.

The problem will be rectified by installing a new trip mechanism designed to compensate for temperatures up to 50 °C. In the interim, the circuit breaker temperature is maintained below 40 °C to prevent unnecessary breaker trips.

VI PROJECT CONTROL AND ADMINISTRATION

This section summarizes the major technical administrative accomplishments during the second quarter Fiscal Year 1960.

A. FACILITY ADDITIONS

Work on both the engineering and decontamination buildings were approximately 80 per cent complete as of the close of this report period. Current estimates indicate that the facility will be ready for occupancy early in May, 1960. A plot plan of the location of the new additions may be seen in Figure 3.

B. PROPERTY CONTROL

The Argonne National Laboratory Final Cost Report was received during this report period. Plans were made for the establishment of property control procedures and detailed records based on the final cost information.

C. SL-1 OPERATIONAL COST PROGRAM

Collection of operational costs continued during the report period. The costs accumulated during March were based on sustained operations for the entire month. However, maintenance and test requirements precluded operations at full power during the period.

Using the March figures, a separate mil rate analysis was developed based on normal military labor, materials, service, fuel cycle, and depreciation charges, but excluding Combustion Engineering, Inc. labor costs. The results of this analysis are summarily presented in Table II.

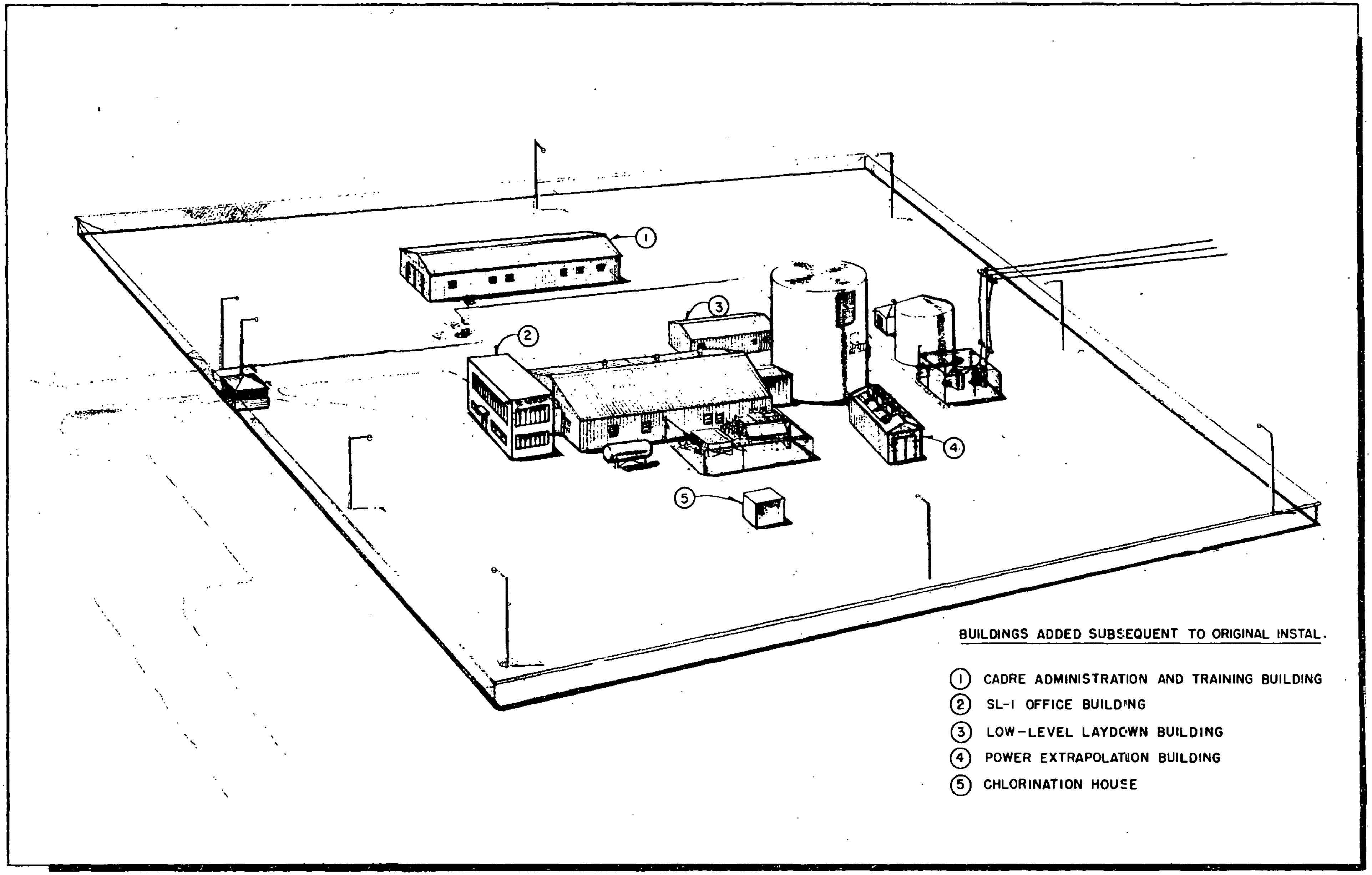


Fig. 3 - SL-1 SITE

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TABLE II

SL-1 OPERATIONAL COST ANALYSIS

Month of March, 1960

	Materials & Service	Military Labor	Government Total	Military Labor Hrs.	Mils
Operations	154.84	6,077.60	6,232.44	2,140	28.4
Fuel cycle costs	--	--	5,122.00	--	23.3
Maintenance	1,543.34	2,260.64	3,803.98	796	17.3
Depreciation	--	--	8,287.00	--	37.7
	1,698.18	8,338.24	23,445.42	2,936	106.7

Note: These figures are based on use of military personnel only.

From the table, a mil rate of 106.7 will be noted. This was calculated on a gross KW(e) production of 219,813. Assuming 176 hours equivalent to one man month, costs were based on an average of 16.7 personnel assigned to operations and maintenance during the month. The average cost in mils for each full man month of labor during March was 2.3 mils. If it is assumed that this identical facility was operated by a crew of six to eight men, the mil rate would then be between 82 and 87. The above analysis is hypothetical, however, it does give a conservative cost figure for SL-1 operations with a minimum of assigned personnel.

D. PLANS FOR NEXT QUARTER

1. Establish detailed property control procedures and records.

2. Revise the operational cost program to reflect depreciation rates based on the Argonne National Laboratory final cost report.

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VOLUME II

SL-1 HEALTH PHYSICS AND SAFETY
January 1, to March 31, 1960

May 25, 1960

USAEC CONTRACT AT(10-1)-967

COMBUSTION ENGINEERING, INC.

Nuclear Division

Idaho Falls Idaho

302 026

HIGHLIGHT STATEMENT

No exposures were received greater than limits established for military personnel in Technical Military Bulletin MED-254 nor in excess of the limits established in AEC Appendix 0524-02-F.

During the report period 41.5 curies of gaseous effluent was released to the atmosphere.

The total activity of liquid wastes released was .02 curies.

There have been no lost time injuries for a total of 44,908 man hours during this report period.

I HEALTH PHYSICS

In accordance with Commission requirements site telephone extension 2347 will be used for any incident described in Section 8 of Manual Chapter 0502. This assures the availability of extension 2424 for disaster notification.

Supplements issued this quarter which will be incorporated into the final revised Health Physics Manual are as follows:

Supplement No. 10 issued February 14, 1960, establishes new location procedures for ground deposition of SL-1 contaminated aquerous waste.

Supplement No. 11 issued March 17, 1960, establishes routine liquid storage tank sampling procedures.

A. PERSONNEL MONITORING

No exposures were received greater than limits established for military personnel in Technical Military Bulletin MED-254, nor in excess of the limits established in AEC Appendix 0524-02-F.

The highest accumulative weekly and thirteen consecutive weeks exposure (period ending 3/31/60) for personnel assigned to SL-1 was as follows:

	1st Quarter/60 mrem	4th Quarter/59 mrem	3rd Quarter/59 mrem
High Quarterly	245	210	100
High Weekly	205	120	100

The weekly accumulative dose, which has increased by a factor of two (2) over the previous quarter, was a planned exposure received during replacement of the activated coaxial cable for reactor instrumentation. However, this exposure was below the prescribed limit of 300 mrem/week.

The maximum quarterly exposure for this report period was 245 mrem as compared to the M.P.L. (maximum permissible limit for this period of 3 REM/quarter).

TABLE III

SL-1 EFFLUENT RELEASE ANALYSIS

Specific Activities DM/ML

Total Activity *d/m/ml	Kr 85 M (4.4 hr)	Kr 88 (2.8 hr)	Xe 133 (5.3 D)	Xe 135 (9.2 hr)	Xe 135 M (13.5 M)	Xe 138 (17 M)
4.50×10^4	1650	3135	332	3585	1238	3507
2.04×10^4	577	1447	106	1665	1688	8235
1.88×10^4	729	1320	133	1379	1056	8860
1.41×10^4	622	614	172	1109	1039	5889
3.05×10^4	823	1007	123	2050	2700	13500
1.50×10^4	286	380	112	1329	1903	4868

* Total activity as noted has been computed to Time = 0

B. RADIOACTIVE WASTE SUMMARY

The following is presented in summary for radioactive waste generated at the SL-1 during the period January 1, 1960, through March 31, 1960.

1. Stack Effluent Release - Samples collected from the air ejector vent line were analyzed for total activity at Time = 0. The specific activity of the gas released to atmosphere is presented in Table III. The following conclusions are presented in summary:

a. The stack effluent activity of approximately 10^4 c/m/ml remained constant as compared to the previous quarter.

b. Based upon a total of 103.7 MWD a release of 41.5 curies has been computed for this report period.

c. Stack effluent release to the environment has not precluded safe operation of the SL-1 plant during this report period.

2. Liquid Waste Release - A total of 9300 gallons of low activity water was disposed of during this report period. The monthly breakdown includes volume, total activity and principal isotope.

TABLE IV

LIQUID WASTE RELEASE

Month (1960)	Volume - (Gallons Of Liquid Waste)	Total Activity Microcuries	Principal Isotopes
January	2600	117.2	Na 24 (principal)
February	3100	1,865.3	Na 24 (94%) 5% I, 131, 133
March	3600	218.8	Na 24 - 60% Cd 115 20% I 131 10% In 115 8% Sr 90 .002%
Totals	9300	2,201.3	

Table 4 denotes the quantities of liquid waste discharged during the period January 1 and ending March 31, 1960. The total activity as listed is prior to dilutions to afford information as to the activity of the waste generated at the SL-1 plant.

3. Solid Waste Release - A total of 98 ft^3 of solid waste consisting of contaminated rags, papers, filters, and coaxial cable containing activated copper were released to the NRTS burial site during this report period. The following table represents a brief summary of volume, activity, and identification.

TABLE V

SOLID WASTE RELEASE

Month	Volume & Weight	Total Microcurie	Identification
January	84 ft^3 (275 #)	220	Fe 59, Fr 95, Nb 95 I 131, Na 24
February	None	None	None
March	14 ft^3 (44 #)	7005	Na 24 (85%) Cu (17%)
Totals	98 ft^3 (319 #)	7225	

C. MONITORING SUMMARY

Several minor steam leaks and other sources of aerosol radioactivity and residual surface radioactivity occurred during this report period. In most instances levels of activity were below the maximum permissible concentrations in air. However the levels above MPC are briefly reported.

A steam calorimeter leak development behind the purification panel caused air concentrations above MPC and surface contamination. Radioactivity evaluations were as follows:

Aerosol Activity ------------ 2.6×10^{-5} μc/cc Gross $\beta + \gamma$
Surface Activity ------------ 8.8×10^{2} d/m/100 cm^2 to
1×10^{3} Gross $\beta + \gamma$

Full protective clothing was worn to secure the leak. The parameters of the contamination were defined through smear test analyses and roped off. The area was controlled until all evidence of contamination was removed. No exposures were received by personnel.

Maintenance on the plant turbine caused air activity levels greater than MPC. A dry wire brushing technique was used.

Air Activity ---------------2×10^{-2} $\mu c/ml$ $\beta + \gamma$
Surface Activity -----------1×10^{2} to 10^{3} $d/m/100\ cm^2$

Problems of contamination were experienced. It is expected that the recently completed low level laydown room will help to avoid any future problems of this type.

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II SAFETY

Of a total of 44,908 man hours for this period including Windsor R & D personnel, Idaho assigned personnel, and military personnel, there have been no lost time injuries.