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TITLE

DESIGN CRITERIA-REACTOR PLANT MODIFICATIONS FOR INCREASED PRODUCTION AND 100-C AREA ALTERATIONS SECTIONS A AND B

CG-558

AUTHOR

M. H. RUSS

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VOLUME I

DESIGN CRITERIA
REACTOR PLANT MODIFICATIONS FOR INCREASED PRODUCTION
AND
100-C AREA ALTERATIONS

Reactor Design and Development Unit
Process Engineering Sub-Section
Design Section - Engineering Department
General Electric Company - Hanford Atomic Products Operation

Prepared by M. H. Russ

Date April 9, 1954

Approved by
Process Engineering Sub-Section

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DESIGN CRITERIA
REACTOR PLANT MODIFICATION - PROJECT CG-558
AND
100-C AREA ALTERATIONS - PROJECT CG-600

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DESIGN CRITERIA
REACTOR PLANT MODIFICATION - PROJECT CG-558
AND
100-C AREA ALTERATIONS - PROJECT CG-600

SECTION A
GENERAL

INTRODUCTION

This document defines the basic criteria to be used in the preparation of detailed design for Project CG-558, Reactor Plant Modification for Increased Production and for Project CG-600, 100-C Area Alterations. It has been determined that the most economical method of increasing plutonium production within the next five years is by the modernization and improvement of the 100-B, 100-C, 100-D, 100-DR, 100-F, and 100-H reactor plants. These reactors are currently incapable of operating at their maximum potential power levels because of a limited availability of process cooling water. As a result of this program, it is estimated that 1650-2350 megawatts of total additional production will be achieved.

An extensive engineering analysis of the methods by which the existing reactor plants could be modified in varying degrees was presented in Document HW-29419, "An Engineering and Economic Evaluation of Proposed Modifications to Existing Reactor Plants, RDS-10 and RDS-11", dated September 28, 1953. A summary of the more important alternates is presented in Document HW-29707, "Summary of Alternative Cases for Project CG-558", dated October 21, 1953. In a letter, W. E. Johnson to D. F. Shaw, "Alternative Capacity Increases for Project CG-558", dated October 21, 1953, the Commission was requested to appraise the alternate cases of production increases in the light of their anticipation of future plutonium demand. This request was answered in a letter, D. F. Shaw to W. E. Johnson of the same title (Document HAN-52827) dated November 27, 1953 in which they stated that the achievement of the maximum production potential represented by the proposed modifications (Case Seven) at the earliest possible date is of major importance to the Commission's program.

PURPOSE

The purpose of this document is to set forth the design basis for certain modifications and additions to Hanford reactors and their supporting facilities as required to obtain higher power levels and improve the safety of reactor operation.

The objective in making these changes to existing facilities is to raise the production level of the following reactors: 105-B, 105-C, 105-D, 105-DR, 105-F, and 105-H; to obtain more efficient utilization of power and filter plant capacity; and to add to the safety of reactor operation.

The bases for major decisions regarding the type of instrumentation, power transmission and distribution, choice of major equipment and other technical, economic, and safety considerations are contained in documents listed in the bibliography.

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ORGANIZATION OF DOCUMENT

The portion of this document following this Section A is divided into six major sections designated "B" through "F".

Sections B, C, D, and E define the modifications to be made to Areas 100-B, C; 100-D, DR; 100-H; and 100-F, respectively. Section F contains the codes and standards that must be observed in the design covered by this document, and the reference documents upon which these criteria are based.

Each succeeding section except Section F is divided into three parts. Part I defines the basic requirements that must be fulfilled in the redesign of the system. Part II defines the physical changes to the existing system which must be made in order to meet the requirements of operability and safety defined in Part I. Part III will be issued subsequently as a revision or addendum and will define in detailed and specific terms the nature of the alterations to system components such as piping and structures, and the nature of new equipment and processes.

All modifications that are to be made to 100-C Area will be under Project , 100-C Area Alterations, except that the secondary pressure monitoring system for 105-C will be part of Project CG-558, Reactor Plant Modifications.

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SECTION B
100-B, C AREA MODIFICATION

1. BASIC DESIGN REQUIREMENTS

1.000 Introduction

Part I of this section is intended to set forth flow and quality requirements of the water required to support the reactor power level objectives; establish required improvements for safety and reliability; and specify the means of effecting the savings in power cost that partially justify the prosecution of this program.

1.100 100-B Area

1.110 Reactor Coolant and Subsidiary Water Requirements

1.111 The basic continuous quantities of water to be provided are as follows:

To process	71,000 gpm
To export	18,000 gpm
Non-process to 105-B	4,000 gpm
Miscellaneous	1,500 gpm

The total amounts of raw and filtered water to be handled are derived under the description of the various component parts of the plant contained in Parts II and III of this document.

1.112 The quality of cooling water furnished to the reactor shall meet the following specifications:

Turbidity	0.20 ppm maximum
Iron	0.03 ppm maximum
Aluminum	0.50 ppm maximum
Chlorides	2.00 ppm maximum
pH	7.5 to 7.8
Sodium Dichromate	2 ± 1 ppm at any time 24 hour average 2 ± 0.2 ppm
Free Chlorine	0.2 ppm maximum

1.113 Under the condition of an emergency shutdown precipitated by the BPA power failure, water shall continue to be delivered to the reactor without interruption. It shall be delivered at a rate such that the top of riser pressure shall decay at a rate, with respect to time after power failure, not greater than that shown on Exhibit 1.1131. Conversely, under the condition of steam failure, water shall continue to be delivered to the reactor without interruption.

The process water pumping station shall be capable of furnishing the required shutdown flow for an indefinite period of time without recourse to BPA power.

The water requirement versus time after reactor tripout is shown on Exhibit 1.1132.

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VARIATION OF REQUIRED TORP AFTER BPA OUTAGE 105-B REACTOR

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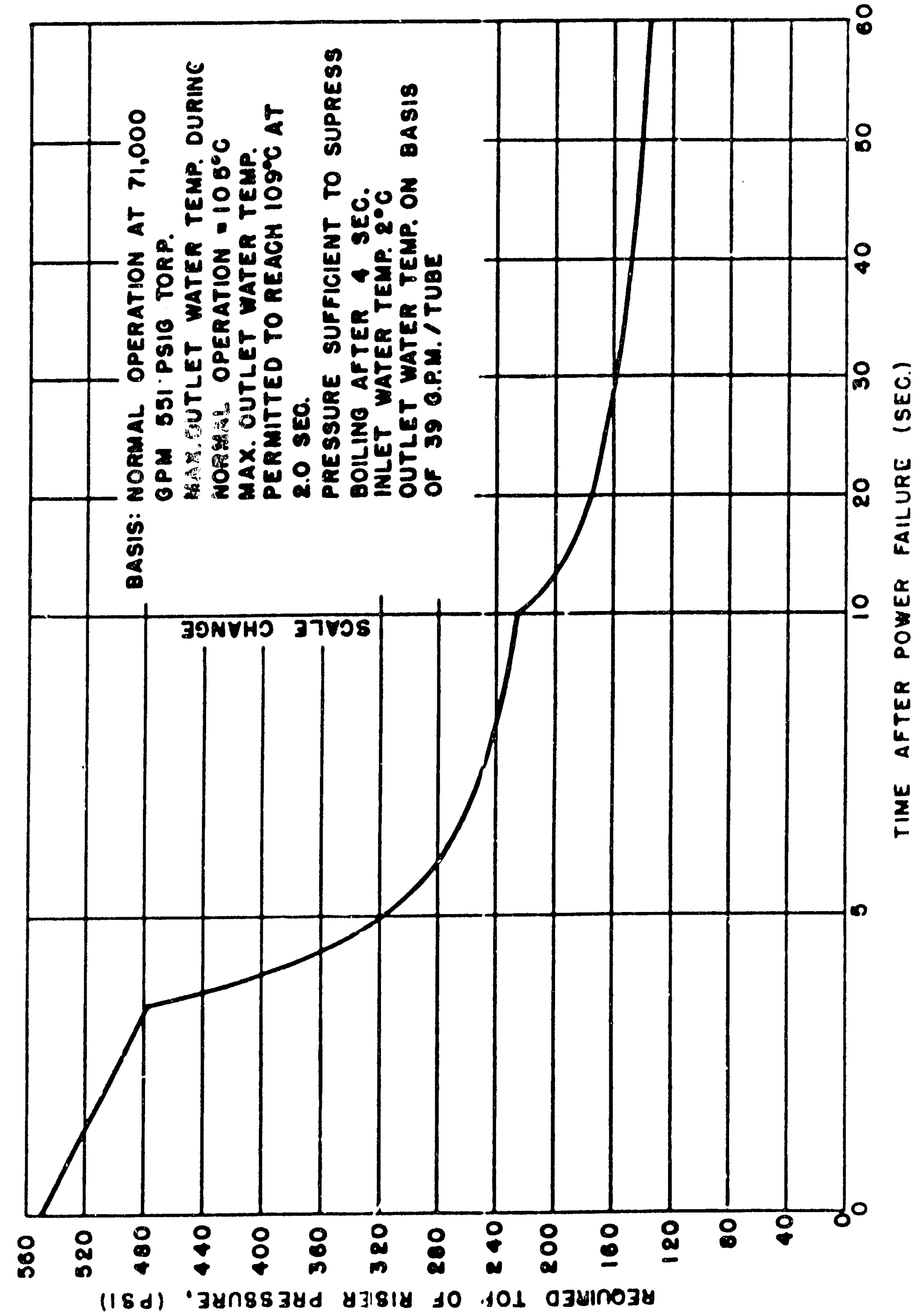

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EXHIBIT 1.1132

WATER REQUIREMENTS VERSUS TIME AFTER REACTOR "TRIP-OUT" 105-B

Time Hrs.	Time Min.	Time Sec.	Δ Time Minutes	Average Flow GPM	Flow During Period Gallons
0	30	0	30	71,000	2,130,000*
0	30	10	1/6	62,000	10,000
0	30	30	1/3	41,000	14,000
0	31	0	1/2	36,000	18,000
0	32	0	1	32,000	32,000
0	33	0	1	28,000	28,000
0	34	0	1	28,000	28,000
0	35	0	1	28,000	28,000
0	40	0	5	27,000	135,000
0	50	0	10	25,000	250,000
0	60	0	10	23,000	230,000
0					
1	30	0	30	21,000	630,000
2	30	0	60	18,500	1,110,000
3	30	0	60	13,400	804,000
4	30	0	60	8,800	528,000
5	30	0	60	5,700	342,000
6	30	0	60	3,600	216,000
30	30	0	1,440	2,880	4,147,000
				TOTAL	10,680,000

*Constant operating flow for 30 minutes prior to shutdown.

[redacted]

[redacted]

1.114 There shall be sufficient filtered water stored and available to the reactor, without replenishment from the raw water system, to provide 30 minutes of normal process flow, plus the volume required to satisfy the emergency transition from full flow to shutdown flow, plus 24 hours of shutdown flow.

1.120 <u>Conversion from Steam Power</u>

The present system of process water pumping, whereby approximately 40% of the total power required is furnished by steam turbines, shall be converted to an all electric system. Steam power shall continue to be available. It shall automatically assume the required pumping load in the event of electric power failure.

1.130 <u>Reactor Piping</u>

The pressure at the inlet of any process tube shall not exceed 450 psig.

The front face crossheaders shall be modified to provide a check valve at each end of each crossheader, as protection against the effects of earthquake or bomb blast.

1.140 <u>Disposal of Reactor Effluent</u>

The reactor effluent shall be retained for an average time of not less than one hour before being discharged into the Columbia River.

1.150 <u>Instrumentation and Control</u>

All instrumentation shall be of sufficient range and strength to perform its function under the conditions resulting from this program.

A primary system of reactor instrumentation shall be provided which will instigate a "scram" if boiling in any process tube becomes imminent.

A secondary system of reactor instrumentation shall be provided which will "backup" the primary system to the extent that the imminence of boiling in any process tube will be detected independently of the functioning of the primary system and a "scram" initiated.

A temperature monitoring system shall be provided to permit temperature determination in each layer of Masonite of the side and top biological shields as a measure of shield deterioration rate.

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A flow indicating system shall be provided to permit the positive flow determination through the thermal shield cooling system.

The main process water pump motors and their discharge pressures shall be controlled from a central control station in the 190-B Building.

The horizontal control rods, their thimbles, and test hole thimbles shall be modified or replaced to withstand the higher temperatures, and other conditions arising from this program that would be inimical to rod operation.

1.160 <u>Continuous Poison Column Charging</u>

Suitable mechanism shall be provided to enable certain process tubes to be charged or discharged with "poison" slugs without shutting down the reactor. Such mechanism shall not preclude the option of charging the same tubes with fuel slugs during shutdown.

1.170 <u>Spare Hydraulic Capacity</u>

One spare unit shall be provided at every pumping station furnishing water to the filter plant or to process.

1.180 <u>Architecture</u>

1.181 <u>General</u>

The guiding philosophy which shall be used to determine the architectural design shall be that the plant structures are to be designed on a functional basis with no architectural treatment for purposes of appearance.

1.182 <u>Structural Design</u>

All structures shall be designed to withstand the loads specified below without exceeding stresses or combinations of stresses as specified hereinafter or as provided in Section V of this document.

1.1821 <u>Soil Loading</u>

Design values for soil bearing shall be in accordance with the values given by the Uniform Building Code for compact fine sand. In no case shall the soil bearing pressure exceed 8000 pounds per square foot. Foundations placed adjacent to and above the level of the bottom of deep vertical walls shall be placed on a lean concrete backfill. In no case shall footings be placed on backfilled earth. Fill placed during the construction of the original plant shall not be considered as backfill.

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1.1822 Live Loads

Earthquake loads shall be of an intensity specified by Section 2312 of the Uniform Building Code for Seismic Probability, Zone No. 2.

Roof loads shall be taken as a uniformly distributed load of 25 pounds per square foot of roof area projected on a horizontal plane.

Floor and platform loads will be established by their usage and erection conditions.

Wind loads shall be taken as a uniformly distributed horizontal load of 20 pounds per square foot acting on the vertical projection of all areas.

1.1823 Concrete Design

Reinforced concrete design shall be in accordance with the requirements of the "Building Code Requirements for Reinforced Concrete" (ACI-318-51). Stresses used shall be those specified for structural concrete which will develop an ultimate 28 day strength of 3000 psi.

1.1824 Structural Steel Design

Structural steel design shall be in accordance with the requirements of the AISC "Specification for the Design, Fabrication, and Erection of Structural Steel for Buildings". In general, building frames shall be designed as continuous structures and structural continuity will be achieved by the use of welding or Dardelet bolts. No field riveting will be permitted.

1.183 Materials and Details of Construction

All buildings housing operating personnel and equipment shall be constructed with steel framing, sheathed with corrugated asbestos cement or corrosion resistant sheet metal siding. No burnable materials shall be used. This includes lumber and combustible insulating materials.

Reinforcing steel for reinforced concrete construction shall be intermediate grade and shall conform to the requirements of "Standard Specifications for Billet Steel Bars for Concrete Reinforcement" (ASTM designation A-15).

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Reinforcing bars shall be deformed in accordance with ASTM designation A-305.

All roofs shall be adequately sloped to provide drainage. Roof slabs shall be reinforced gypsum or poured in place lightweight concrete. A metal gravel stop shall be provided at all eaves. Metal gutters and downspouts shall be provided only where water would spill on lower roofs or over doorways and walks. All roofs shall be covered with a 20-year built up asphalt membrane covered with gravel.

Floors shall be reinforced concrete except steel grating will be used where required over valve pits, pipe galleries, etc.

Stairs shall be fabricated of (1) steel channel stringers with steel grating treads or concrete filled pan type treads or (2) poured reinforced concrete. Guard railings shall be steel of the "Nu-Rail" type, or its equivalent.

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No windows shall be provided in any exterior wall.

Interior doors shall be of the hollow metal type with steel frames.

Exterior doors for the passage of personnel shall be of the steel industrial type with channel frames. Exterior doors for the passage of large equipment shall be of the motor operated rolling steel type.

1.184 <u>Acoustical Treatment</u>

The noise level in structures modified under this program shall be suppressed to the practical minimum. The design of internal piping, interior finish and equipment foundations shall be upon this basis.

1.185 <u>Heating and Ventilation</u>

Heating, cooling and ventilation systems shall be provided for major buildings and annexes constructed under this program and where required because of additional head load. The systems shall be designed for the following conditions:

Summer		Winter	
Outside	Inside (5' above floor)	Outside	Inside
105° DB 68° WB	85° DB (All equipment operating)	-10° DB	70° DB (No equipment operating)

Temperatures are in degrees Fahrenheit.

The ventilation systems shall be capable of discharging air through the pipe tunnels to the 105 Buildings at a velocity of 75 feet per minute and shall be sufficient to prevent infiltration of dust into the buildings.

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1.200 100-C Area

1.210 Reactor Coolant and Subsidiary Water Requirements

1.211 The basic continuous quantities of water to be provided are as follows:

Discharge from 190-C Process Pumps	91,000 gpm
Non-Process to 105-C	4,000 gpm
Miscellaneous	1,500 gpm

The total amounts of raw and filtered water to be handled are derived under the description of the various component parts of the plant contained in Parts II and III of this document.

1.212 The quality of cooling water furnished to the reactor shall meet the following specifications:

Turbidity	0.20 ppm maximum
Iron	0.03 ppm maximum
Aluminum	0.5 ppm maximum
Chlorides	2.00 ppm maximum
pH	7.5 to 7.8
Free Chlorine	0.2 ppm maximum
Sodium Dichromate	2 ± 1 ppm at any time. 24 hour average 2 ± 0.2 ppm

1.213 Under the condition of an emergency shutdown precipitated by BPA power failure, water shall continue to be delivered to the reactor without interruption. It shall be delivered at a rate such that the top of riser pressure shall decay at a rate, with respect to time after power failure, not greater than that shown on exhibit 1.2131.

The process water pumping station shall be capable of furnishing the required shutdown flow for an indefinite period of time without recourse to BPA power.

The water requirement versus time after reactor trip-out is shown on exhibit 1.2132.

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VARIATION OF REQUIRED TORP
AFTER BPA OUTAGE
105-C REACTOR

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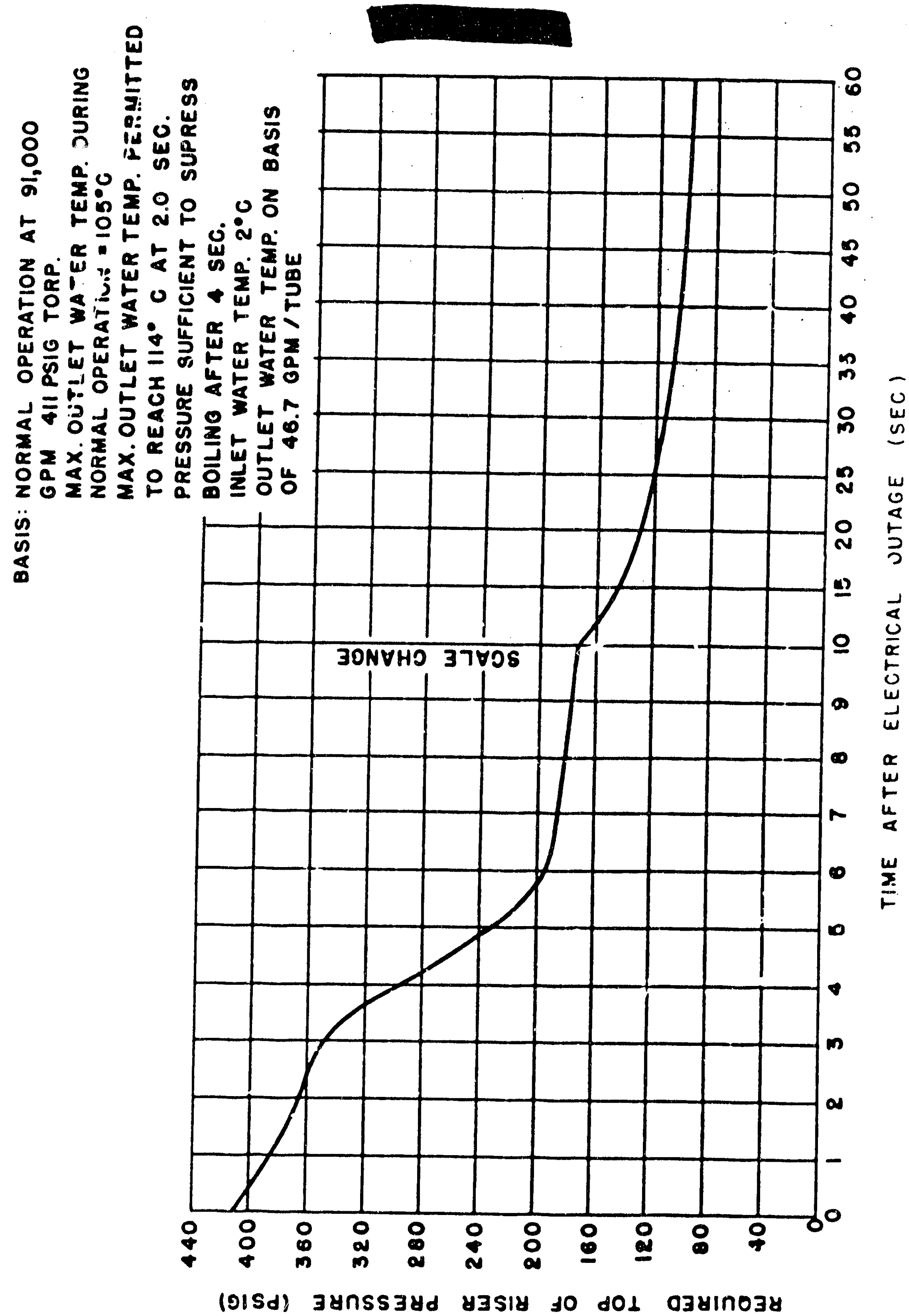

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EXHIBIT 1.2132

WATER REQUIREMENTS VERSUS TIME AFTER REACTOR "TRIP-OUT" 105-C

Time Hrs.	Time Min.	Time Sec.	Δ Time Minutes	Average Flow GPM	Flow During Period, Gallons
	30	0	30	91,000	2,730,000*
	30	10	1/6	80,000	13,000
	30	30	1/3	47,300	15,800
	31	0	1/2	40,000	20,000
	32	0	1	34,600	34,600
	33	0	1	30,500	30,500
	34	0	1	30,000	30,000
	35	0	1	29,600	29,600
	40	0	5	28,200	141,000
	50	0	10	25,900	259,000
	60	0	10	23,700	237,000
1	30	0	30	21,800	654,000
2	30	0	60	19,100	1,146,000
3	30	0	60	15,500	930,000
4	30	0	60	12,700	762,000
6	0	0	90	10,900	981,000
11	30	0	330	7,300	2,409,000
35	30	0	1440	4,500	6,480,000
				TOTAL	16,900,000

*Normal operation for 30 minutes prior to failure.

[redacted]

[redacted]

1.214 There shall be sufficient filtered water stored and available to the reactor, without replenishment from the raw water system, to provide 30 minutes of process flow at 91,000 gallons per minute plus the volume required to satisfy the emergency transition from full flow to shutdown flow, plus 24 hours of shutdown flow.

1.220 Reactor Piping

The reactor piping shall be modified in such a manner that 91,000 gpm can be pumped through the reactor by nine of the ten existing process pumps without overloading their drives by more than ten percent of their nameplate horsepower.

1.230 Disposal of Reactor Effluent

The reactor effluent shall be retained for an average time of not less than one hour before being discharged into the Columbia River.

1.240 Instrumentation and Control

All instrumentation shall be of sufficient range and strength to perform their function under the conditions resulting from this program.

A primary system of reactor instrumentation shall be provided which will instigate a "scram" if boiling in any process tube becomes imminent.

A secondary system of reactor instrumentation shall be provided which will "backup" the primary system to the extent that the imminence of boiling in any process tube will be detected independently of the functioning of the primary system and a "scram" initiated.

1.250 Continuous Poison Column Charging

Suitable mechanism shall be provided to enable certain process tubes to be charged, or discharged, with "poison" slugs without shutting down the reactor. Such mechanism shall not preclude the option of charging the same tubes with fuel slugs during shutdown.

1.260 Spare Hydraulic Capacity

One spare unit shall be provided at every pumping station furnishing water to the filter plant or to process.

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II. BASIC DESIGN PHILOSOPHY

2.000 Introduction

The following is intended to describe in a minimum of detail consistent with clarity what modifications to existing plant elements and what changes in operating philosophy will be made in order to enable the requirements specified in Part I to be realized. The water flow diagrams, as modified by this project, for the 100-B plant are shown in two parts in exhibits 2.010 and 2.020, and for the 100-C plant are shown in two parts in exhibits 2.030 and 2.040.

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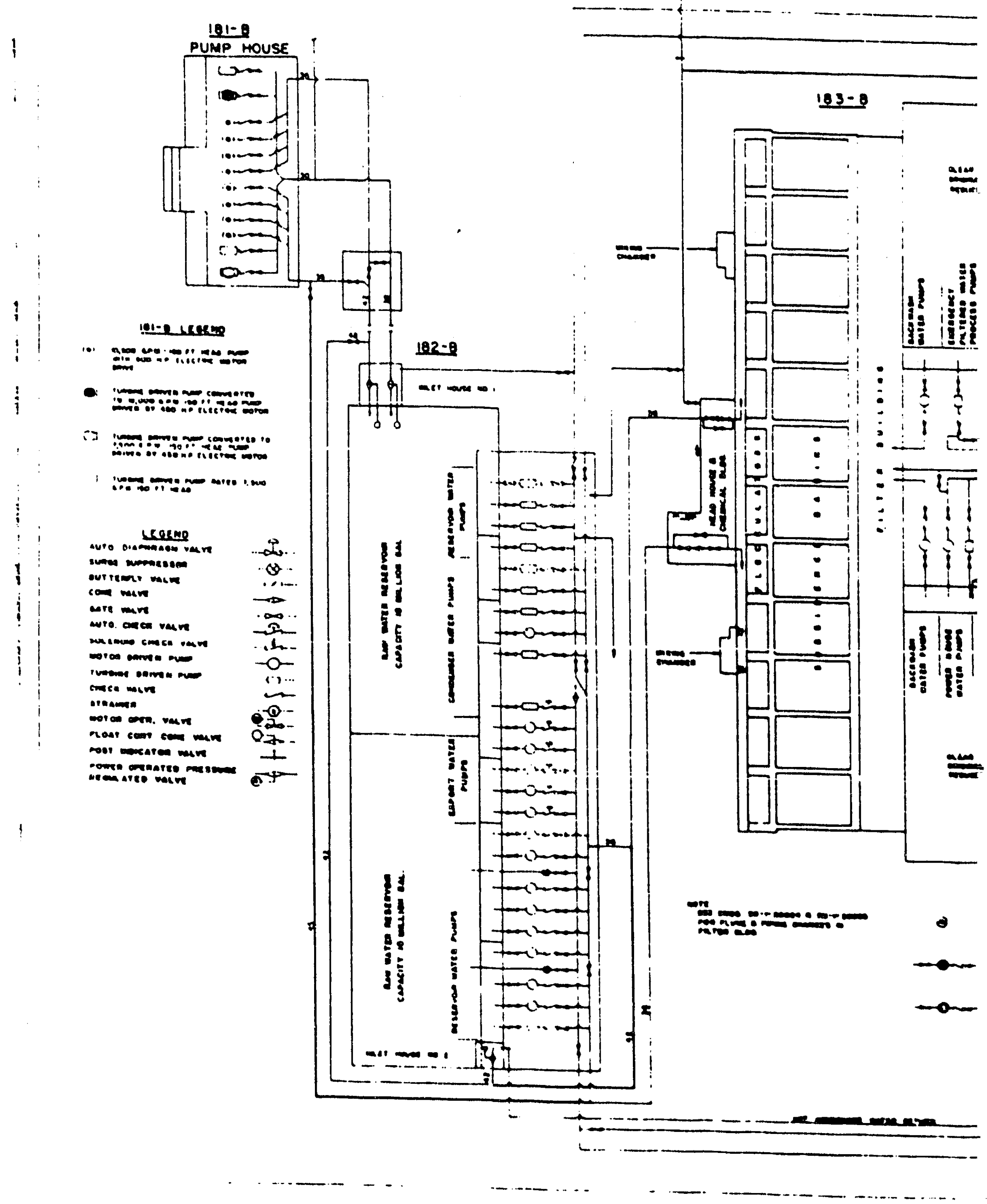

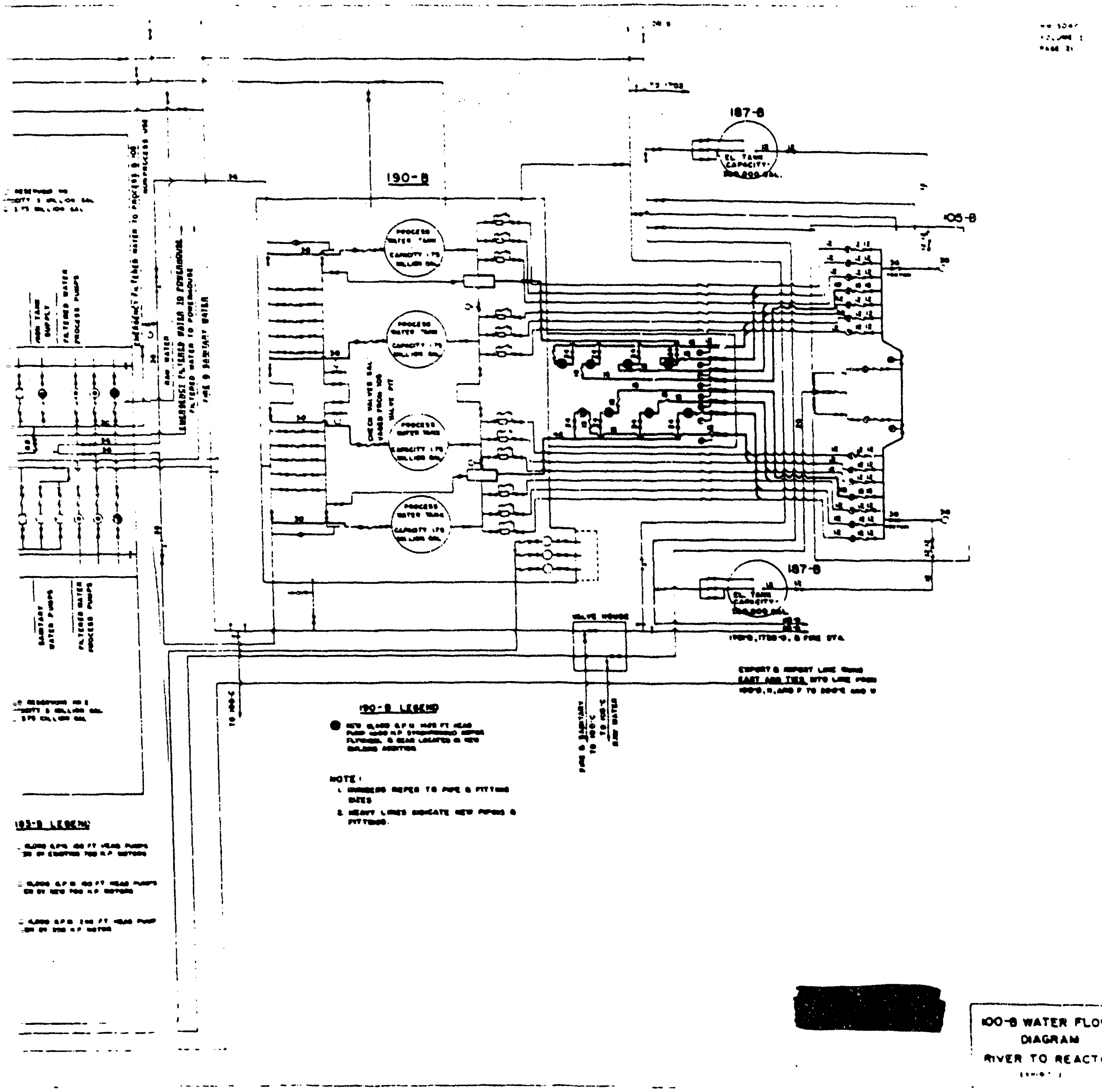

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100-B WATER FLOW DIAGRAM
RIVER TO REACTOR

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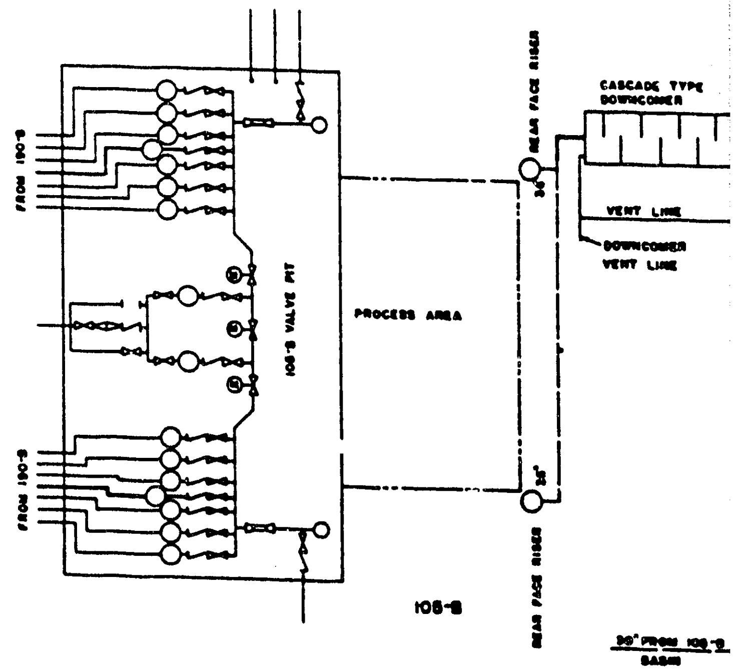
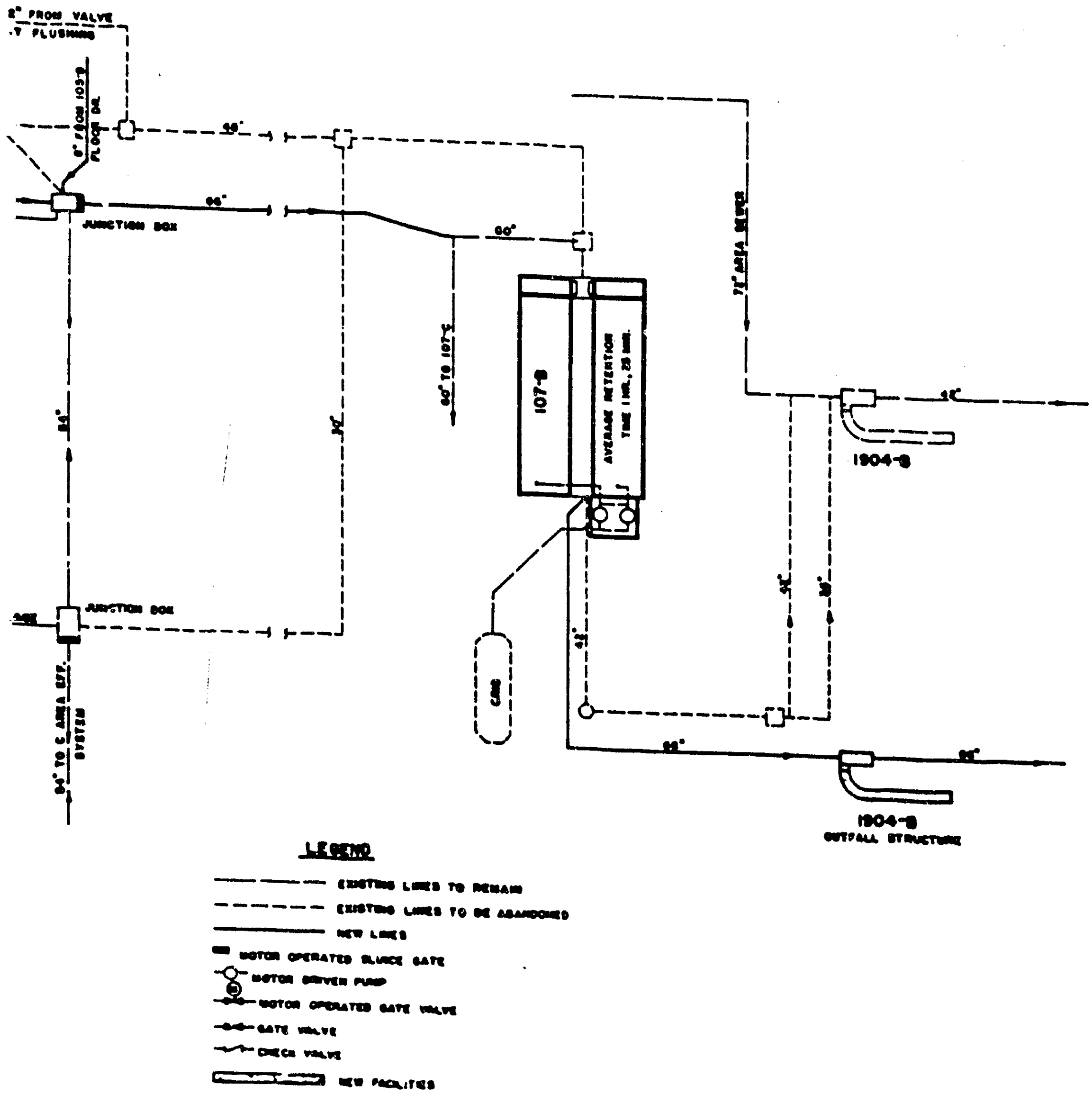

FROM 190-B
105-B VALVE PIT
PROCESS AREA
REAR FACE RISER
CASCADE TYPE DOWNCOMER
VENT LINE
DOWNCOMER VENT LINE
FROM 190-B
REAR FACE RISER
105-B



100-B WATER FLOW DIAGRAM
REACTOR TO RIVER

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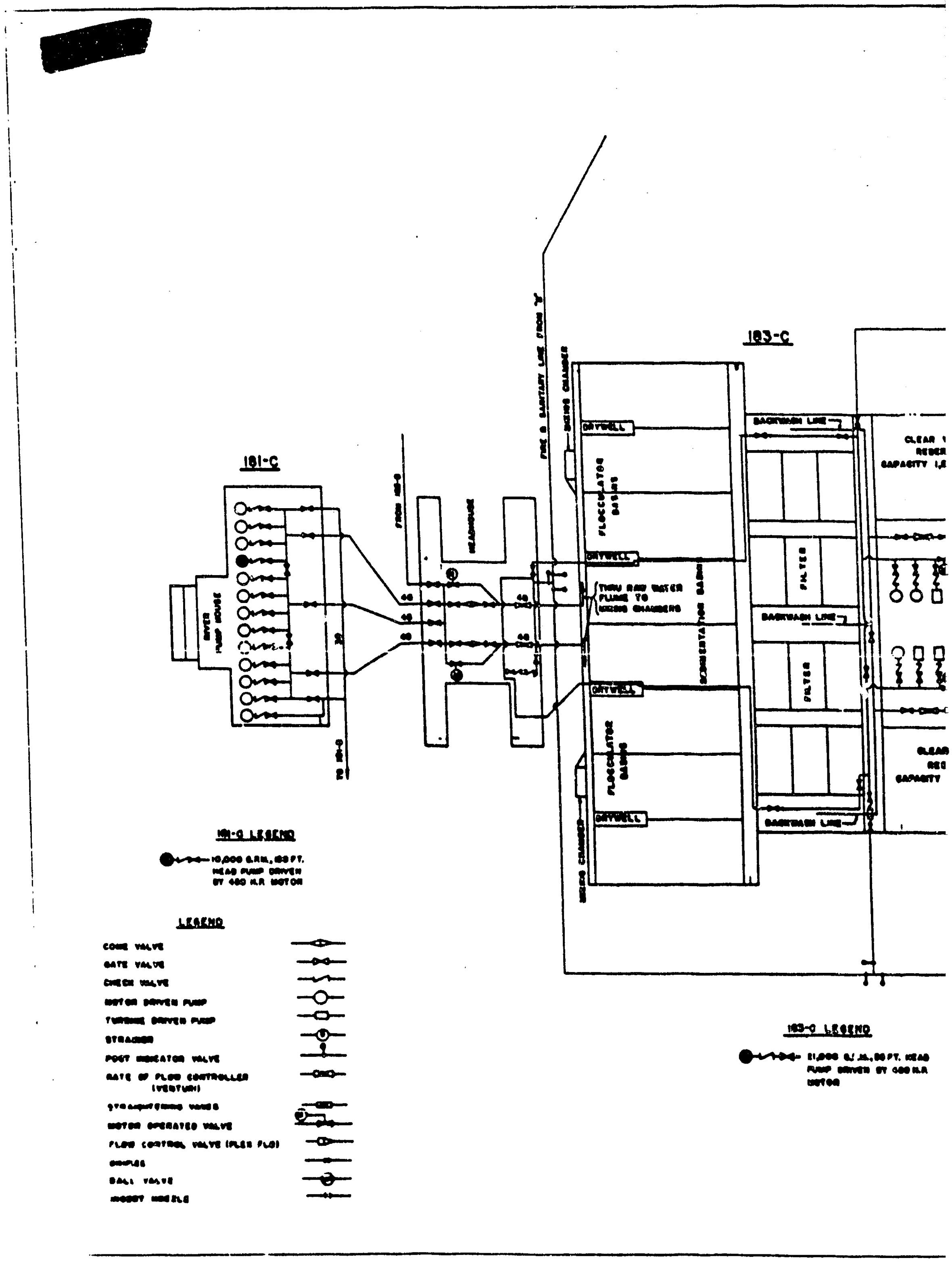

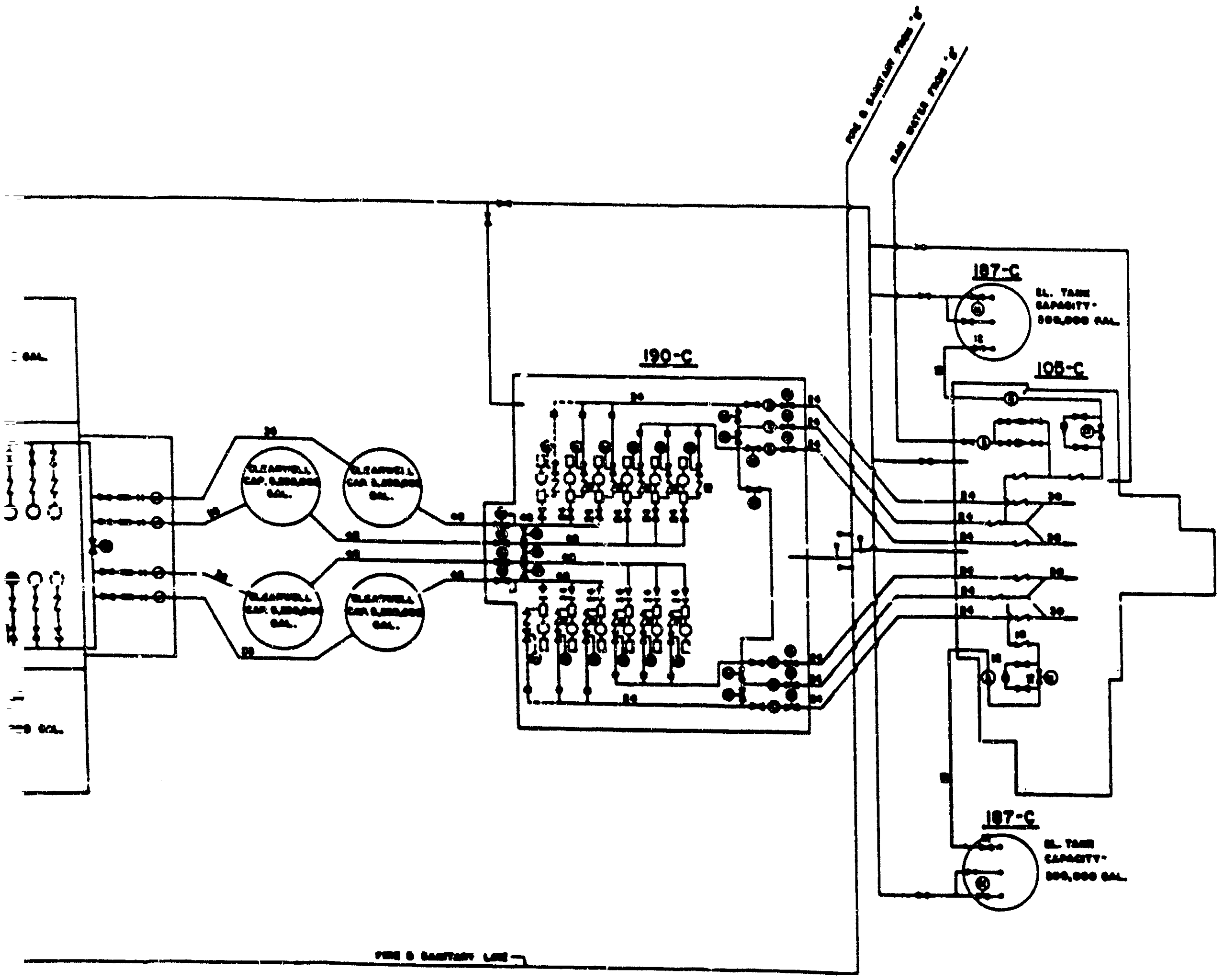

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100-C WATER FLOW
DIAGRAM
RIVER TO REACTO…

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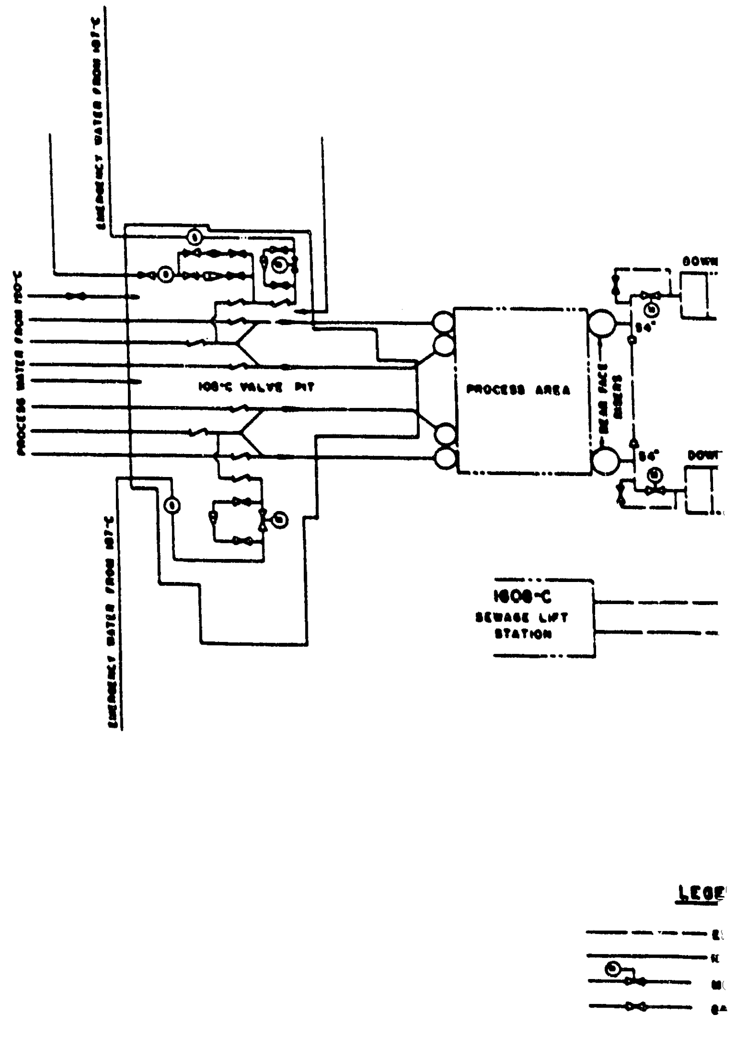

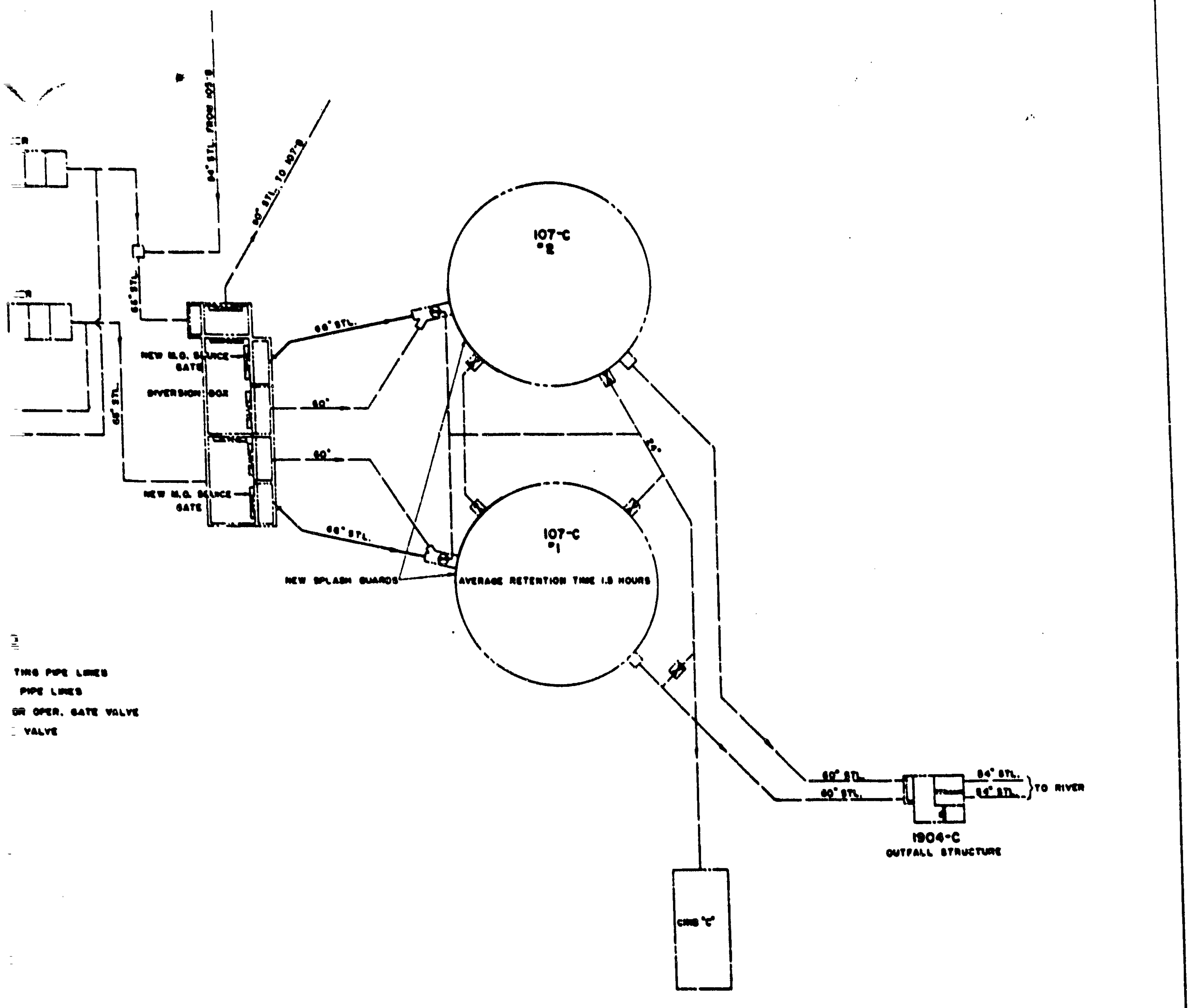

100-C WATER FLOW DIAGRAM
REACTOR TO RIVER

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2.100 100-B Area

2.110 Reactor Modifications

2.111 Front Face Piping

The increase in top of riser pressure, over that now in effect, will necessitate the replacement of the front face risers, including the base elbows.

Accordingly, the four existing stainless steel risers of 20 inch diameter will be replaced with two carbon steel risers of heavier wall thickness and 36 inch diameter. The two risers of greater diameter will be more efficient hydraulically than the four of smaller diameter and will be less expensive to install.

The existing four inch diameter strainers at each end of each crossheader will be replaced with five inch strainers of the type used in 105-K, in order to reduce head loss.

Five inch check valves will be installed at the end of each crossheader in order to protect against the possible effects of bomb blast or earthquake.

All front face nozzles and pigtails will be replaced with a type of greater hydraulic efficiency.

2.112 Instrumentation

2.1121 Tube Pressure Monitoring

The installation of new nozzles and pigtails requires that new venturi tubes in the central power zone and new orifices in the fringe power zone be installed to provide the optimum pressure and sensitivity of response of the Panellit gages in the pressure monitor system.

[redacted]

[redacted]

The existing Panellit gages will be replaced with new gages of a similar but improved type.

A new and complete Panellit pressure monitor system will be installed in parallel with the existing system for the purpose of gaining the safety that a dual system will afford. Facilities will be provided to calibrate and test the individual Panellit gages in their normal locations with the reactor in operation to provide increased system reliability.

2.1122 Biological Shield Temperature Monitoring

It is anticipated that the inner masonite layers of the biological shield will gradually deteriorate as a result of the heat generated by power levels produced by this program. In order to achieve a balance between maximum power levels and reasonable shield life it will be necessary to control the rate of shield deterioration. This control will be accomplished by the installation of a temperature monitoring system.

The temperature monitoring system will consist of a series of thermocouples located at selected positions in the shield. Thermocouple readings will be registered at a central control point. The temperature will be monitored at the following locations.

Far Shield: (1) Near the three coordinate centerlines of the shields in each layer of steel; (2) On the same horizontal axis as (1) but six to eight feet farther toward the rear of the reactor and in each layer of steel; (3) On the same vertical axis as (1) but eight feet higher in elevation, and in each layer of steel.

Top Shield: (1) Near the intersection of the three coordinate centerlines of this shield, equidistant from four central vertical rod plugs, and in each layer of steel.

2.1123 Thermal Shield Flow Monitoring

Rotating-vane, sight-glass flow indicators will be

[redacted]

installed between the thermal loop and each thermal shield cooling tube for the purpose of detecting flow through all tubes.

2.1124 Power Calculation

An automatic power calculator system will be provided.

2.1125 General

All existing instrumentation whose ranges are exceeded by the contemplated water flows, pressures, or operating power levels will be rehabilitated or replaced.

2.113 Poison Column Charging Mechanism

Twenty-four tubes will be equipped with ball valves on both the inlet and outlet nozzles for the purpose of charging or discharging poison pieces during reactor operation. The rear face ball valves will be remotely controlled by a hydraulic system of manually-operated valves in the control room. Special inlet connectors will be provided with integral valves to provide a high flow rate for flushing poison from the tube and a low flow rate for cooling purposes. The front face nozzles will be adaptable to the conventional fuel charging machine as well as to the poison charging machine.

The poison column charging machine will consist of a tube approximately three feet long into which the poison pieces will be placed with the inlet ball valve closed. After the tube is closed the ball valve will be opened and the pieces pushed into the tube with a hydraulic piston. Electrical lockouts will be provided for the "C" elevator, one to be located in the control room and the other on the charging machine, to prevent movement of the elevator during charging.

2.114 Horizontal Rods and Thimbles

Nine new horizontal rods, except for the rack sections, will be installed. The replacement rods will possess the same control ability as the existing rods but will have greater flexibility, and heat transfer capacity. They will be one piece aluminum extrusions which will operate through a silicone seal mounted on the side shield. This will make possible the removal of existing thimbles which will not function satisfactorily at the temperatures to be attained at the higher power levels.

The main shield gates over the rod openings will be removed and shield plugs used when a rod is removed from an opening.

[redacted]

These plugs will be stored in a shielding storage pit when not in use. A leak detection system utilizing existing shield gate control lines as sniffer lines will be provided for the detection of rod seal leaks.

2.115 Downcomers

The existing downcomer will be inadequate to carry the contemplated flows, without entrainment of air by the falling water and consequent vibration due to the introduction of sub-atmospheric pressures within the pipe column.

Further, the existing cushion chamber and junction box at the base of the downcomer will become pressurized with the increased flows, with consequent leakage and introduction of water and vapor into the 105-B Building proper.

These conditions will be alleviated by the removal of the existing downcomer and the installation of a "Cascade" type of downcomer similar to the ones presently installed in 105-DR, 105-H and 105-C. The base of the downcomer will rest in the present cushion chamber at the -20'0" elevation. A 66" effluent line will be brought out from the base of the downcomer through that portion of the cushion chamber at -20'0". The remainder of the cushion chamber will be abandoned.

2.120 Process Water System

2.121 Process Water Piping

The increase in water pressure over that now in effect will necessitate the replacement of the main headers in the valve pit. The mains connecting the process water pumps to the header and the piping connecting the export system will be adequate structurally. An analysis of the economics of pumping indicates that the process water piping between the front face risers and the main headers in the valve pit should be replaced with pipe of greater hydraulic capacity.

Accordingly, the four existing stainless steel pipes of 20 inch diameter connecting the main headers to the risers will be replaced with two 36 inch carbon steel lines with required valves and fittings. The two stainless steel 20 inch main headers will be replaced with a single 36 inch carbon steel header of heavier wall thickness.

Two new 18 inch diameter process water lines complete with valves and strainers would supplement the 12 existing lines connecting the process pumps to the main header in the valve pit.

[redacted]

[redacted]

2.122 Process Water Pumping

The presently installed process water pumping facilities consist of 12 pumping units. Each unit consists of two pumps in series, a steam driven primary, and an electrically driven secondary. Each pump set is rated at 3000 gpm against 915 feet total head, at the rated primary pump speed of 2100 rpm.

The modification will replace the existing 12 secondary process pumps with eight electrically driven main process pumps which will in themselves be capable of developing the required operating pressure. These pumps will be located in a new building addition to the present 190 Building. Each main process pump will deliver 10,400 gpm against 1360 feet TDH. Consequently, the contemplated flow of 71,000 gpm can be supported by seven of the eight main process pumps, thus providing one spare unit.

The existing steam driven primary pumps will be retained as emergency auxiliaries.

In order to effect safely the transition from normal to shutdown flow, the drive assembly of the main process pump will contain a flywheel. The inertia of the assembly will be such that in the event of a BPA power failure the speed of the main pumps will decay at a rate that will produce a rate of decay of top of riser pressure slower than the minimum requirement illustrated on item 1.1131 for a period of least 35 seconds.

At such time as the effect of the flywheels becomes insufficient to maintain a pressure, at the main pump discharges, higher than that at the auxiliary pump discharges, check valves will open allowing the auxiliary pumps to pump directly to the reactor bypassing the main pumps. Under these conditions the steam turbines driving the auxiliary pumps will have been accelerated to a constant speed that would cause ten or more of them to deliver flow in excess of the 35,000 gpm required.

The characteristic of the piping system through which the process pumps discharge will be slightly influenced by filming of the tubes and change in water temperature from summer to winter. The effect of this will necessitate some means of controlling Panellit pressure within the limits of the trip setting. This pressure control will be accomplished by installing a pressure regulating valve at each pump discharge.

2.123 Solids Feed System

The present solids feed system consists of mixing tanks, transfer pumps, injection pumps, and strainers for injecting a 5% diatomaceous earth slurry into the process water stream.

[redacted]

[redacted]

All existing equipment is located in the reactor valve pit, with the injection into the process water stream occuring in the process water lines connecting the valve pit with the front face of the reactor.

The existing pumps and piping are inadequate to supply the required amounts of diatomaceous earth slurry required under this program. All existing equipment, with the exception of the 11,500 gal. mixing tank, will be removed and replaced with a new system.

Two new pumps will be installed, taking their suction directly from the solids feed mixing tank, each capable of delivering 200 gpm of a 5% diatomaceous earth slurry at a rated head of 640 psi. One pump is capable of supplying the required amount of slurry for a purge of the reactor piping. A power operated self cleaning type of strainer will be provided in the suction line of each pump to provide for straining of the slurry. Provision for injection of the slurry shall be made in the valve pit piping.

The present solids feed system is also used as a source of high pressure filtered water for tube flushing. Provision will be made for the continuance of this water supply.

2.130 Filtered Water System

2.131 Water Treatment

Water quality of the required specification will be attained by treatment with alum and activated silica as presented in document HW-29542 which outlines the scope of Project CG-567 entitled Alum-Activated Silica Water Treatment Facility.

2.132 Filter Plant

The hydraulic capacity of the filter plant will be increased sufficiently to support the following demands:

To process	71,000 gpm
Non-process to 105-B	4,000 gpm
Miscellaneous	1,500 gpm
To 190-B (cooling)	1,500 gpm
Subtotal	78,000 gpm
Filter backwash	4,000 gpm
Total	82,000 gpm

The required increase in hydraulic capacity will be accomplished by means of alterations which will include the following:

2.1321 The openings from the flash mixing chambers to the distribution flume and between the compartments of the mixing chamber will be enlarged.

[redacted]

2.1322 The discharge capacity of the system conveying water from the subsidence basins to the filter beds will be increased by piercing the wall between the subsidence basin outlet flume and the filter influent flume with a series of holes two feet square.

2.1323 The present filter media of 10 inches of anthrafilt, 20 inches of sand, and 12 inches of gravel will be replaced with 27 inches of anthrafilt, 3 inches of sand, and 12 inches of gravel.

2.1324 The head losses through the filter effluent flume will be decreased by removing an orifice and baffle presently installed in the flume.

2.1325 The available head across the filter beds will be increased by lowering the clearwater reservoir surface by two feet.

2.1326 Filter flow controls will be redesigned to operate at a rate of 71,000 gpm to the reactor.

A system will be provided so that the effluent from each filter may be automatically sampled at the head house laboratory.

The system will consist of two sampling pumps, one for each half of the filter plant, located in the filter pipe gallery. The pump suction line will be a manifold into which copper tubing has been connected from each filter effluent line. Three-way solenoid operated valves will be located in each sampling line so that a continuous flow of water through the lines will be maintained at all times, either to waste or to the sampling pump suction. Controls for the pumps and valves will be located in the head house so that the filter to be sampled may be selected at that point.

The valve control will be arranged so that one sampling line to each pump may always be open, thus insuring constant flow of sample water. A discharge line from each pump will be run to a sampling sink located in the head house.

2.133 Filtered Water Pumping

Presently, filtered water for normal process requirements is pumped from the filter plant by electrically driven pumps. Normally connected to the process water loop are branches to the elevated tanks (187-B), thermal shield cooling, basin charging, and to the head house for miscellaneous services. Parallel to this system is an emergency system served by steam driven pumps.

Under this project will be installed an electrically driven pump of 4000 gpm capacity which will run continuously to

[redacted]

[redacted]

furnish thermal shield cooling water, water for miscellaneous filter plant services, and which could furnish a continuous flow through the elevated tanks and through the storage basin, if and when desired.

Relieved of the head requirements of the elevated tanks and thermal loop, the four presently installed filtered water pumps would be required to develop approximately 50% of the head now required. These pumps would then operate at or near their cut-off point and at a greatly reduced efficiency. Consequently, they will be replaced by pumps capable of delivering 15,000 gpm each. This discharge at the head required will not overload the existing driving motors, which will be retained.

The balance of the 72,500 gpm requirement, plus one spare unit, will be furnished by installing two new 15,000 gpm pumps.

2.134 Filtered Water Pipe Lines

Presently, filtered water is pumped to the clearwell tanks, in 190-B, through ten lines feeding from a loop. Each line contains a butterfly valve and orifice. The present system requires these energy dissipating devices because the filtered water pumps must develop a pressure much greater than that required to supply the clearwells.

The high pressure services will now be supplied by the separate high pressure pump. Consequently, the valves and orifices will be by-passed to provide a more efficient system.

2.135 Filtered Water Storage

Of the 10,907,000 gallons required to satisfy the criteria stated in paragraph 1.114 seven million gallons are available in the 190-B process water tanks. The balance may be drawn from the seven million gallon 183-B clearwell reservoirs.

2.140 Raw Water System

The raw water system will have electrically driven pumping capacity sufficient to meet the requirements specified hereinbefore.

To 183-B	82,000 gpm
To Export	18,000 gpm
Total	100,000 gpm

Requirements of 100-C Area will be furnished through a separate system and are described under "2.200 - 100-C Area".

In furnishing the required flows a departure will be made from the present mode of operation.

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The presently installed raw water system provides two parallel pumping systems between the river pump house (181-B_ and the raw water reservoir (182-B).

One system is served by six electrically driven pumps pumping into a 42 inch line to the reservoir. The other system is served by three steam driven pumps and two electrically driven pumps pumping into a 30 inch line to the reservoir. The two systems are cross-connected near the river pump house.

All water to the filter plant is presently pumped from the raw water reservoir (182-B) to the head house (183-B).

The changes contemplated under this program will provide one pumping and piping system for export, and other raw water demand, and another system for supplying water to the head house. This will involve enlarging and increasing the efficiency of the system presently furnishing water to the head house. Specifically:

Flow would be diverted around the raw water reservoir, through the existing system, directly into one side of the head house; a new 48 inch line would be installed from the river pump house directly into the opposite side of the head house.

All existing raw water lines would continue to be interconnected near the river pump house and would each be capable of pumping independently into the raw water reservoir.

At the river pump house, the six 10,000 gpm units presently furnishing water for filtration and for export will be replaced with six 10,5000 gpm units pumping directly to the head house. A seventh and eighth 10,500 gpm unit will be added to the system.

Water for export, and other raw water demand, will continue to be furnished to the raw water reservoir via the existing 30 inch pipe line.

To provide spare electrically driven capacity, one of the three steam driven pumps rated at 7500 gpm at 150 foot TDH would be converted to electric drive and would be fitted with a bowl and impeller assembly to increase its capacity to 10,000 gpm at 150 foot TDH. Thus, an outage of a single unit in the system furnishing water to the filter plant could be supported by pumping extra water to 182-B and thence to 183-B.

2.150 Electric Power Supply

A normal increment of 20,000 kva over the present demand of approximately 15,000 kva will be required by 100-B Area under this program.

[redacted]

[redacted]

This 35,000 kva will be drawn from the modified 230 kv transmission system via the 151-B substation as it now exists.

The 27,500 kva normally required by the process pump drives, in the 190-B Building, will be transmitted directly to the motors at 13.8 kv via new circuit breakers and underground cables.

An additional increment of 1300 kva will be required by the river pump drives and will be transmitted, as presently, at 13.8 kv. The added increment of power will necessitate a new 13.8/2.3 kv, 5000 kva substation at the pump house.

All other electrical power requirements will be satisfied as at present.

2.160 Steam Generation and Utilization

The effect of this program upon the steam demand of 100-B Area will be to greatly decrease the base load on the steam generators, and to greatly accelerate the rate of steam demand during the initial stage of an emergency BPA power outage.

This change in the steam utilization from that now in effect is due entirely to the change in operation of the 190-B process pumping station, as described under paragraph 2.122. Other requirements for emergency standby and miscellany will remain substantially the same as at present.

The present base steam demand of the turbines driving the 190-B primary process pumps is 120,000 pounds per hour and represents approximately 70 percent of the total steam generated exclusive of that for building heating. After the accomplishment of this program, the base steam demand of the turbines driving the auxiliary process pumps would be 20,000 pounds per hour or 28 percent of the total steam generated exclusive of that for building heating.

On the basis of summer conditions where no heating load is imposed, the base load on the boiler house would be approximately 70,000 pounds per hour. The four boilers installed in the 184-B Building are each rated at 100,000 pounds of steam per hour and would require a minimum load of not less than 20,000 pounds per hour per boiler in order to operate satisfactorily. Three boilers steaming would require a base load of at least 60,000 pounds per hour which will be exceeded by 10,000 pounds per hour. Winter conditions would necessitate the steaming of the fourth boiler in order to support the building heating demand.

[redacted]

In the event of BPA power failure, the steam supply to the turbine driving the auxiliary process pumps would be accelerated from 20,000 pounds per hour to 120,000 pounds per hour within 45 seconds. This degree of acceleration is within the capability of the boiler and turbine response when four minute delays are incorporated in the emergency switching to steam driven ventilating fans in the reactor and gas buildings. This delay in operation of the emergency ventilating system would not incur unreasonable risk in reactor operation since the possibility of the coincidence of an electric power failure with a reactor contamination is low.

The above stated emergency steam demand is predicated on an operating procedure under which no cooling water would be furnished the condensors serving the auxiliary process pump turbines. Operating non-condensing, the turbines would require about the same amount of steam under normal operating conditions as they would require if running condensing. Under emergency conditions, the instantaneous steam demand to the turbines would be 120,000 pounds per hour with non-condensing operation, as compared to an instantaneous turbine demand of 95,000 pounds per hour, plus a demand of 6500 pounds per hour to the condensor water pumps with process pump turbines operating condensing.

2.170 <u>Pile Effluent System</u>

2.171 Process Sewer System

The increase in the process water flow rate will necessitate replacement of the existing 48" RCP effluent line between 105-B and 107-B. The existing reinforced concrete pipe is not hydraulically capable of handling the water flows; and is in such a state of physical deterioration that it would be necessary to replace the lower portion of the line at the present process flows in the immediate future.

A diversion box will be provided in the vicinity of the 105-B Building to provide a cross connection with the 100-C effluent system and to collect the 105-B Building floor drainage.

[redacted]

[redacted]

2.172 107-B Retention Basin

The retention basins are of sufficient size to retain the reactor effluent for a period in excess of one hour.

The inlet sluiceways will be enlarged and provided with larger sluice gates.

The outlet weir will be lowered by one foot to prevent over-topping the basin.

No changes in crib piping, basin drainage system, or effluent monitoring systems are necessary.

2.173 Outfall System - 107-B to Mid-River Channel

The existing outfall system serves both the 107-B retention basin and the main area sewer system, as a means of disposing drainage to the river. Under the increased flow rates, the process sewer lines from 107-B to the outfall structure, the outfall structure (1904-B) and the 42" outfall line will be hydraulically inadequate.

It will be advantageous to construct a completely new outfall structure. It will be located downstream from the existing structure. It will be connected to 107-B by means of a new 66" line. A new 66 inch outfall line will convey the ffluent from the new 1904 Building to mid-river channel.

All process, and other retained drainage, will be discharged through the new outfall system. The existing outfall will continue to serve the area main sewer.

2.200 <u>100-C Area</u>

2.210 <u>Reactor Modifications</u>

2.211 Front Face Piping

All front face nozzles and pigtails will be replaced with a type of higher hydraulic efficiency.

[redacted]

[redacted]

2.212 Instrumentation

The installation of new nozzles and pigtails requires that existing venturis in the central power zone be replaced with new venturi tubes to provide the optimum pressure and sensitivity of response to the Panellit gages in the pressure monitor systems. By tapping the Panellit gages into the throat of the venturi and thus registering a pressure less than the tube inlet pressure, the existing Panellit gages will continue to be of adequate range. Moreover, the sensitivity of response of the Panellit system to small variations in pressure will be improved.

Where necessary, the existing orifices in the fringe power zone will be replaced with new orifices which will produce the optimum sensitivity within the range of the Panellit gages.

A new and complete Panellit system will be installed in parallel with that existing of the purpose of gaining the safety that a dual system will afford.

Facilities will be provided to calibrate and test the individual Panellit gages in their Panellit locations when the reactor is in operation thus providing increased reliability.

Existing instrumentation, including the automatic power calculator, the semi-automatic power calculator, and miscellaneous process water instrumentation, will be recalibrated or replaced where their ranges are exceeded by operating power levels, water flows, or pressures.

2.213 Poison Column Charging Mechanism

Twenty-four tubes will be equipped with ball valves on both the inlet and outlet nozzles for the purpose of charging or discharging poison pieces during reactor operation. The rear face ball valves will be remotely controlled by a hydraulic system of manually-operated valves in the control room. Special inlet connectors will be provided with integral valves to provide a high flow rate for flushing poison from the tube and a low flow rate for cooling purposes. The front face nozzles will be adaptable to the conventional fuel charging machine as well as to the poison charging machine.

The poison column charging machine will consist of a tube approximately three feet long into which the poison pieces will be placed with the inlet ball valve closed. After the tube is closed the ball valve will be opened and the pieces pushed into the tube with a hydraulic piston. Electrical lockouts will be provided for the "C" elevator, one to be located in the control room and the other on the charging machine, to prevent movement of the elevator during charging.

[redacted]

[redacted]

2.220 <u>Process Water System</u>

The capacity of the process water system will be increased to meet the requirements of this program by decreasing the resistance of the system as specified in 2.211, and by running nine of the ten pumps installed.

The philosophy of operation would remain the same as currently, except that the rated flow would be on the basis of one rather than two spare pumps.

On these bases the driving motors will draw current 3% - 10% in excess of that at which they are rated.

In the event of an emergency shutdown due to a BPA power failure, the minimum allowable rate of decay of the riser pressure will be that illustrated on exhibit 1.2131. The flywheel effect of the existing pump drive assemblies is sufficient to meet this requirement.

2.230 <u>Filtered Water System</u>

2.231 Water Treatment

Water quality of the required specification will be attained by treatment with alum and activated silica as presented in Document HW-29542.

2.232 Filter Plant

The filter plant will be required to support the following demand:

To 190-C Process Pumps	91,000 gpm
Non-Process to 105-C	4,000 gpm
Miscellaneous	1,500 gpm
Subtotal	96,500 gpm
Filter Backwash	4,500 gpm
Total	101,000 gpm

This demand will be satisfied with no modifications to the filter plant.

2.233 Filtered Water Pumping

The pumping capacity of filtered water to the process water clearwells and to backwash will be increased to meet the requirements of this program by adding one new vertical turbine-type pump in parallel with, and identical to, the five 21,000 gpm units presently installed.

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2.240 Raw Water System

The raw water supply to 100-C Area will, as at present, under normal operating conditions be pumped from the river pump house (181-B) directly to the 183-C head house.

In order to provide the required 101,000 gallons per minute of raw water, one new river pump will be installed in parallel with, and identical to, the ten units presently installed.

This installed capacity will provide, in addition to the pumps required to furnish 101,000 gpm to 183-C, a spare unit capable of pumping either into the 100-C raw water system or into the 100-B raw water system as described under paragraph 2.140.

2.250 Electric Power Supply

An increment of 800 kva over the present demand of approximately 34,000 kva will be required by 100-C Area under this program.

This 800 kva will be drawn from the modified 230 kv transmission system via the 151-B substation as it now exists.

No additional transformer or switchgear capacity will be required to serve additional power demand by 100-C plant.

2.260 Steam Generation and Utilization

This program will have no significant effect upon the steam demand of 100-C Area.

The capacity and capability of response of the existing boiler plant will be sufficient to provide the requirements of 100-C Area when combined with 100-B Area as described under paragraph 2.160.

2.270 Reactor Effluent System

2.271 Process Sewer System

The changes to this system are based upon a future possible process flow of 100,000 gpm attainable by installing process water pumps in the two vacant places in 190-C.

On this basis the following changes to the effluent system will be made:

In the diversion box, the "Knock-out Walls" between the main chamber and the outlet chambers would be removed and new motor operated sluice gates installed.

[redacted]

[redacted]

The two existing 66 inch pipe connections at the [illegible] box would be connected with 66 inch pipe to existing 66 inch connections at the 107-C basins, each box connecting to its respective basin.

2.272 107-C Retention Basin

A splash guard will be provided at the influent to the basin in order to prevent splashing over the basin walls.

[redacted]

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