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THREE REMAINING SMALLER REACTORS

by

L. B. Brinkman

June 9, 1964

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DESIGN CRITERIA FOR COOLANT BACKUP
THREE REMAINING SMALLER REACTORS

Prepared by L. B. Brinkman

Date June 9, 1964

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DESIGN CRITERIA FOR COOLANT BACKUP
THREE REMAINING SMALLER REACTORS

I. Introduction

This document defines the objectives, bases, and functional requirements that shall govern the preparation of design of the coolant backup system for the three remaining smaller reactors. This project will increase the reliability of the coolant backup facility at B Area by providing an independent last-ditch coolant system to B and C Reactors. The reliability of the last-ditch system for D Reactor will also be improved in that the present F and H leg of the export system will no longer be a part of the new export system.

II. Objective

The objective of this document is to define the operational and technical requirements of the new facility and to describe the functional requirements of the proposed coolant backup system for the purpose of design.

III. General Requirements

The equipment and piping for the coolant backup facilities shall be designed for operation consistent with the requirements for reactor coolant. Unless otherwise stated, the design, the materials used, and the work to be performed shall adhere to the requirements set forth in the latest edition of Hanford Works Standards and the applicable codes approved by these standards. All new pipe 16 inch or greater in diameter shall have certified low temperature properties as determined by Charpy V-notch test bars. The test specimens shall be able to absorb an energy of 15 foot-pounds at $\pm$ 10 F.

IV. Process and Functional Requirements

A. General

Upon completion of the deactivation program at Hanford, the three remaining smaller reactors must be provided with reliable last-ditch coolant backup system that will supply adequate coolant to a stricken reactor or reactors in the event of a normal electric power failure and a simultaneous loss of steam power in one of the two remaining areas. For the purpose of last-ditch consideration, it is assumed that electric power may be lost at both 100-B and 100-D Area with a simultaneous loss of steam power at either 100-B or 100-D Area but not at both areas.

The criteria⁽¹⁾ for reactor coolant backup states that the last-ditch cooling system must be independent of both the primary and secondary cooling systems, including piping to the reactor manifold.

(1) HW-66929 - Unclassified - "Performance Criteria For The Hanford Production Reactors", R. E. Trumble, September 1, 1960.

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It must be capable of providing shutdown flow indefinitely assuming instantaneous loss of power to the primary system and concurrent failure of the secondary system to provide its rated flow.

An independent system is defined as one with power sources and pumping systems, such that failure or cause of failure in one cannot induce failure of the alternate system. Adequate cooling is defined, as a minimum, as that required to maintain reactor components, including fuel elements, at a temperature below the melting point. Failure of any single component in a system shall not be capable of rendering that system inadequate. Certain piping and valves may be qualified as exceptions.

The foremost consideration of the last-ditch cooling system is its reliability. Cooling water must be available at the reactor from the last-ditch system if and when the primary and secondary systems have failed. Consequently, adequate pumping equipment must be available when needed. In order to assure that adequate pumping equipment will be available at all times and still allow one pump to be down for maintenance, one spare pumping unit shall be provided at each location supplying coolant backup to the reactors.

The last-ditch coolant backup requirements for the B, C, and D Reactors are the reactor flows required to provide a bulk outlet temperature of 90°C after an emergency whereby the reactor is scrammed. They are based on reactor operating flows of 98,000 gpm at B, 107,000 gpm at C, and 98,000 at D; bulk outlet temperature of 95°C; and coolant backup water temperature of 25°C. The last-ditch requirements are 4400 gpm for B Reactor, 5900 gpm for C Reactor, and 4600 gpm for D Reactors.

The 100-B Area last-ditch coolant backup system shall be an independent pumping system from 182-B to the B and C Reactors and the existing high tanks at the reactors. The 182-B pumping system shall be capable of supplying simultaneously reactor coolant requirements of 4400 gpm to B Reactor and 5900 gpm to C Reactor within 10 minutes after scram.

The 100-D Area last-ditch coolant backup system flow requirements shall continue to be met by the export system and the high tanks at D Reactor. All export system coolant backup to D Area will be supplied by steam turbine-driven pumps in 182-B Building. These steam turbine-driven pumps shall be able to supply the reactor coolant backup requirements of 4600 gpm to D Reactor within 10 minutes after scram and shall also be able to supply the combined requirements of 2000 gpm of coolant backup to 105-D and 3600 gpm to the 200 Areas 21 hours after loss of electric power.

Normal export water to the 200 Areas will continue to be supplied by the export pumping facilities at 182-B. The export pumping facilities at 182-D will continue to serve as a backup for export water to the 200 Areas and will also supply water to the 182-B

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Reservoir in the event that additional water is required at 182-B for last-ditch coolant to B and C Reactors. The steam turbine-driven export pumps at 182-D shall be able to supply the combined requirements of 2500 gpm to 182-B Reservoir and 3600 gpm to the 200 Areas.

During normal operation, the export system will continue to supply water to the Central Fire Station and limited backup to N Area. No water will be supplied to N Area during an emergency at B and D Areas. The export system leg to F and H Areas will be cut and separated from the export system as a part of the deactivation program. This revised export system is shown on SK-1-6703.

The following discussion is a description of a facility that will provide a last-ditch system with a degree of reliability and adequacy as is presently considered feasible and acceptable.

B. 100-B Area Reactor Coolant Backup System

1. System Pumping

The turbine drives of the three 4,000 gpm, 250-foot head emergency raw water pumps at the north end of the 182-B pump room shall be replaced with diesel units as shown on Drawing SK-1-6798 in order to provide the independent power source. A fourth pump and new diesel engine shall be installed in the available space adjacent to the three pumps. An emergency raw water pump is presently available in 182-F and may be relocated to 182-B to provide this fourth pump.

The diesel engines which will be coupled directly to the pumps shall be able to operate at a speed of 2300 RPM and shall have a horsepower rating of at least 25% above that required to drive the existing 4000 gpm, 250 ft head pumps at 2250 RPM. They shall be of a physical size to fit in the existing space available. Three of the pumping units shall be capable of supplying in excess of the present reactor coolant requirements to B and C Reactor. Thus, installation of four pumps will provide the required redundancy of equipment and allow one pump to be down for maintenance. Tests will be run on the existing pumps by the operating contractor as soon as possible to assure that three pumps will provide a combined flow of 11,500 gpm to assure adequate flow to the reactors.

All four engines shall start in case of a BPA power failure through actuation of existing power loss relays in 190-B and 190-C or they shall start in the event that the top of riser pressure (TORP) in either 105-B or 105-C

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drops 130 psi through actuation of an existing pressure switch in the 190-B Building and a new pressure switch to be installed for 105-C backup. The starting signals shall be fail safe and shall start the diesel in the event of a loss of control power in the remote signal system. The diesel engine and pumps will continue to run until they are manually shut off at which time the automatic starting feature would be reset. These automatic starters will be by-passed during normal reactor shutdown. Interlocking shall prevent startup without reset. In order to enhance the reliability of the equipment and to provide for unattended, continuous operation, a gravity-fed lubricating oil system shall be provided to each diesel unit with oil storage capacity for 21 days continuous service. Also, each diesel engine shall be supplied fuel oil by gravity flow directly from fuel oil storage tanks outside of the 182 pump room. The storage tank (s) shall be sized to contain fuel oil for at least three weeks of continuous operation on the basis of three pumps running for two days and two pumps running the remaining nineteen days.

2. Underground Lines - 182-B to 105 Buildings

Water will be transferred from the 182-B pump room to the B and C Reactors through existing and new lines. The new pipe in this piping system shall have a diameter which will ensure the required flows from 182-B to B and C Reactors. A welded steel line, minimum 24" diameter, shall be installed from the existing 30-inch emergency water line to the existing steel last-ditch line near 105-B as shown on SK-1-6705. The exterior of the pipe shall be suitably protected from corrosion. The 14-inch steel line to 105-B can continue to be used for supplying last-ditch coolant to 105-B. The 14-inch steel line to the 105-C Building, however, shall be replaced by a new 20-inch minimum diameter steel line which will tie-in to the existing last-ditch coolant backup system just outside of the 105-C valve pit. The two, 14-inch tie-ins to the 42-inch export line near the 105-C Building shall be blanked off and physically separated from the export system and B/C coolant backup system as shown on SK-1-6705.

The new pipeline shall be encased or protected at road crossings as specified in the Hanford Works Standards. The pipeline from 182 pump room will be filled with water at all times during normal reactor operation and the water pressure in the lines maintained at about 50 psi at the 105-C valve pit. Provisions shall be made to enable circulation of water through the underground lines so that the water in the lines may be maintained at a temperature not to exceed 25°C during the hot summer months. Provisions shall also be made to enable flushing the lines from 182-B to both

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105-B and 105-C with the maximum amount of water that the 182-B diesel pumps can supply or as limited by the drains in the 105 valve pits. Orifice plates in the coolant backup lines at both 105-B and 105-C valve pits must be sized so as to permit the required coolant flow to the reactors with the new pumping head.

The effects of corrosion on the new pipeline shall be considered in determining the required diameter of the lines. Pipe shall be sized so that the system will continue to deliver the present required coolant flow to the reactors for at least five years with the expected corrosion product buildup on the inside of the pipes. The design shall also include investigation of methods of inhibiting corrosion in the steel lines such as by use of chemical inhibitors and protective coatings or liners.

3. System Operation

The operation of the new last-ditch system at 100-B Area will be much the same as the present coolant backup system. It shall take over and supply water to the reactor or reactors only if both the primary and secondary systems have failed. In the event of a B Area electric failure, the coolant backup pumps at 182-B Building shall start automatically and pump against the normally closed automatic valves (Grove valves) in the backup lines. If the secondary system pumps come up to speed and the top of riser pressure (TORP) remains above that required to trip the last-ditch Grove valves, neither the high tanks nor the 182-B pumps would supply water to the reactor. In the event that the 190 Building steam turbine pumps fail to maintain the required TORP, the reactors will be supplied first from the high tanks, then from both the high tanks and 182-B pumps, and finally from the 182-B pumps alone when the high tank water becomes exhausted. At this time the 182-B coolant backup pumping system shall be able to supply 5900 gpm to C Reactor and 4400 to B Reactor. Pumps at 182-B will then be manually shut off as permitted by the decrease in the reactor coolant requirements. In the event that the primary or secondary system power in 181-B is not available before the 25,000,000 gallons of water in the 182-B Reservoir is exhausted, water will be pumped by a steam turbine-driven export pump in 182-D through the export system into the 182-B Reservoir.

4. System Testing

Suitable test procedures shall be provided and tests made to demonstrate the adequacy and operability of the new system. Tests shall simulate as nearly as practicable the actual operating conditions and suitable instrumentation shall be provided to fully evaluate system performance.

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C. Export System

1. Export System Pumping 182-B

Last-ditch export system coolant backup to D Reactor will be supplied from export pumping facilities at 182-B. In the event that D Area loses both primary and secondary system power sources, the reactor will be supplied first from the high tanks, then from the high tanks and export system, and finally from the export system alone when the high tank water supply is exhausted. At this time the export system shall be able to supply 4600 gpm from 182-B to 105-D Reactor.

If the loss of electric power at both areas and steam power at D Area lasts beyond 21 hours, a flow of 3600 gpm will be required to be pumped from 182-B to the 200 Areas. By this time the D Reactor demand will not exceed 2000 gpm. The total flow of 5600 gpm can be supplied by one export steam turbine-driven pump. Two steam turbine-driven export pumps must be available in 182-B Building, since one unit may be down for maintenance at any time. The existing unused reservoir water pumps No. 3 and No. 4 shall be removed, and a 6000 gpm steam turbine export pump shall be installed as shown on SK-1-70191. An existing export steam turbine-driven pump together with automatic starting equipment and discharge pipe consisting of Rotocheck valve, gate valve, and 14" pipe is presently located in 182-H and may be re-located to 182-B and tied to the export header. Both steam turbine-driven export pumps in 182-B shall be capable of automatic start. One pump shall be set on automatic to start on a low-pressure signal from the export system with the other pump on standby to be started manually. The export system low-pressure signal shall be fail safe which will start the steam turbine in the event of a loss of control power to the signal system.

2. Export System Pumping 182-D

If additional water is required at the 182-B Reservoir for cooling B and C Reactors, it will be supplied from the 182-D export pumping facilities through the export system. These 182-D export facilities shall also supply water to the 200 Areas within 21 hours after B Area has lost both primary and secondary power sources. If this condition occurs, one steam turbine-driven export pump in 182-D will be manually started to supply 3600 gpm of water to the 200 Areas. If and when additional water is required at 182-B Reservoir, the additional pumping capacity of the 6000 gpm export steam pump will be utilized to transfer water to the 182-B

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Reservoir. Two steam turbine-driven export pumps must be available in 182-D pump room since one unit may be down for maintenance at any time. One 6000 gpm steam turbine-driven export pump shall be installed in the vacant space at 182-D as shown on Drawing SK-1-70192. An existing export steam turbine-driven pump together with automatic starting equipment and discharge piping consisting of Rotocheck valve, gate valve, and 14" pipe is presently located in 182-F and may be relocated to 182-D and tied to the export header.

3. System Piping at 100-D Area

The existing underground export system backup piping in D Area will continue to be used. The valve in the 14" line to 105-DR, however, will be closed.

V. REFERENCES

1. HW-66929, Unclassified, "Performance Criteria For The Hanford Production Reactors", R. E. Trumble, September 1, 1960.
2. HW-81935, Secret, "Preliminary Engineering Report and Justification Coolant Backup - Three Remaining Reactors", L. B. Brinkman, April 30, 1964.
3. HW-81612, Secret, "Project Proposal Coolant Backup Modifications Required By Reactor Deactivation - Three Small Reactors", T. H. Lyons.
4. HW-74094, Vol. 1., Secret, Hazards Summary Report, June 21, 1963.

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