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14. KP Perkins 28. Yellow File

Richland, Washington
April 8, 1952

TO: Distribution
FROM: Harold S. Davis Room 2124, Bldg. 762
Subject: DESIGN CRITERIA FOR THE BIOLOGICAL SHIELD
RDA-DC-3 and Program "Y"

Enclosed is the comment issue for the design criteria of the biological shield for RDA-DC-3 and Program "Y". This document reflects comments received upon HDC-2463, "Preliminary Data on the Scope and Design of the Biological Shield for RDA-DC-3", issued January 24, 1952. Please forward your comments on the enclosed criteria, via your representative, to the author before April 18, 1952.

HS Davis:hr

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DESIGN CRITERIA - "I" REACTOR

Number: 1.212

Title: Biological Shield

100 Area Development
Process Engineering Unit
Design Section - Engineering Department
Hanford Works

Prepared by Harold S. Davis

Date April 3, 1952

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Revision No.: Original Issue

Date _____

1.212 BIOLOGICAL SHIELD

SUMMARY

A high-density concrete shield is proposed for the biological shield. Adequate shielding of personnel and equipment can be obtained for about two-fifths the cost of a laminated shield of steel and masonite. The proposed shield is expected to behave satisfactorily during the life of the Reactor Unit and, in addition, the shield will possess considerable resistance to earthquakes and blast loads. (See HDC-2463.)

DESIGN REQUIREMENTS

Technical (Shielding) Requirements: Adequate protection of personnel must be provided. Except for the discharge face, radiation levels at the outside faces of the shield shall be less than 1 milli-rem, or 1/6 tolerance. A neutron flux of 10^3 neutrons above the normal background may be tolerated in the discharge area. Corresponding to a power level of 2000 MW and an enrichment factor of 3, design values of radiation intensities shall be taken as:

- ① 1.2×10^7 m/hr gamma intensity
- ② 1.0×10^{10} n/cm²/sec. neutron flux

The above values are based upon the use of iron thermal shields ten inches thick, and are maximum intensities at inside faces of the B-shield.

Production Requirements: General arrangement, materials used, and shield thicknesses should be such as to facilitate production, maintenance, and experimental activity.

Engineering Requirements:

- (a) Structural: The shield shall be designed for (1) dead loads during construction and operation, including effects of thermal shields, gun barrels and VSR assemblies; (2) thermal effects during operation; (3) a live load of 300 psf on the top shield in lieu of dynamic forces produced by the VSR system; and (4) Zone 2 earthquake forces. Maximum deflection of the top shield under the above loads shall be less than 1/2 inch. Integrity of the shield shall be provided to obtain resistance to blast loads of 1000 psf.
- (b) Thermal Effects: Allowance shall be made in design for thermal effects associated with the construction and operation of the unit. Values of operating temperatures to be used in design are as follows: (1) Maximum water temperature in the process tube passing through the rear face--90°C; minimum screen temperature--0°C. (2) Maximum surface temperature on the innermost faces of the biological shield--100°C; maximum temperature

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differential between the inside and outside faces of the shield-- 20°C. A water cooling system shall be used if necessary to keep shield temperatures within the above values.

- (c) Operational: The shield shall be designed for a useful life of 20 years. Optimum thicknesses of shields shall be determined based upon operational requirements and economy. The unit shall be essentially gas-tight with seals provided along expansion joints. Holes are to be provided through the "B" shield for control rods, VSR's, test and monitoring facilities as well as process tubes. (See HDC-2524.)
- (d) General: Attention shall be given to construction requirements and scheduling in order to facilitate the construction and assembly of other components of the reactor unit along with the biological shield. Tolerances in the location of holes through the shield must be consistent with requirements for packing, process-tube assemblies and piping. Tolerances for the location of production holes in the inlet and outlet faces of the shield shall be less than $\pm 1/32$ inch with respect to a vertical axis through the center of each respective face, and less than $\pm 1/16$ inch with respect to a horizontal axis. Tolerance on the distance between adjacent tube holes shall be $\pm 1/64$ inch.

DESIGN DESCRIPTION OF "B" SHIELD

A high-density concrete shield is proposed for the biological shield of the reactor being scoped under RMA-DC-3 and Program I. Preliminary data on its scope and design are presented in HDC-2463, issued 1/24/52. A general description of this concrete shield is presented on page 3 of the above document. The engineering data and recommendations presented below are consistent with the design requirements outlined above.

Shield Thicknesses and General Dimensions: Based upon the use of high-density concrete similar to that used in the Brookhaven shield and the radiation intensities presented above, the recommended shield thicknesses are as follows:

Inlet Face	63 inches (includes 2-1 inch skin plates)
Outlet Face	45 inches (includes 2-1 inch skin plates)
Sides	63 inches (includes 1-3/4 inch and 1-1 inch plate)
Top	82 inches (includes 63 inches of iron-limonite concrete and about 17 inches of magnetite concrete)

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These shield thicknesses are in accordance with the general dimensions shown on drawing H-1-21403 and the requirements presented above. Gamma leakage through the discharge face of the B-shield is much less than gamma radiations from the effluent water. Radiation intensities in the discharge area will not produce induced activities in excess of 1 mr/hr. Data presented in HDC-2524, "Basic Design Specifications for X-Pile" by G. M. Roy has been used in scoping the B-shield.

General Description: Permanent forms for confining the high-density concrete will be fabricated from steel plates and rigidly braced. These plates will serve later as a covering for the unit and will aid in centering tube-sleeves, attaching the process-tube assembly, supporting the side thermal blocks, and providing a gas seal. The inlet and outlet faces of the B-shield will be constructed from crates 5 ft. high which extend the full width of the unit. For the top and side shields, a structural steel framework will support skin plates, embedded items and concrete fill. The sides and top will be designed to behave integrally as a monolithic structure. The inlet and outlet faces of the B-shield will be keyed into the sides and top of this rigid frame to provide for expansion. Reinforcing steel will be placed in the high-density concrete fill to provide continuity of structural action and to allow for temperature effects. Outer plates on the side and top shields will be welded to obtain a gas-tight structure; omega seals will be used along horizontal joints between crates and at expansion joints along the keys. Heavy welding of skin plates near the process-tube area will be kept to a minimum in order to eliminate welding distortion. The discharge face, sides and top of the B-shield will be water-cooled.

High-Density Concrete: High-density concrete similar to that used in the Brookhaven shield is required. Constituents of this high-density concrete are steel aggregate, limonite ore, portland cement, water and admixture. This concrete will have a dry density in excess of 265 pcf and an iron-hydrogen ratio of less than 135 in order to be compatible with the shield thicknesses given above. Mix proportions are given in HDC-2463.

It is recommended that the high density concrete be placed by the Prepack method. Use of this method will (a) assure a more uniform distribution of steel aggregate throughout the biological shield, (b) reduce the amount of void pockets and "honey comb", and (c) allow for a final alignment of through-sleeves and embedded items before the grout is pumped and the concrete hardens.

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