Document ID: EDF-6381
Revision ID: 1
Effective Date: 06/20/07

ENGINEERING DESIGN FILE

MATERIAL TEST REACTOR (MTR) COMPLEX ACTIVITY VS. DEPTH

Idaho Cleanup Project

CH2M◆WG Idaho, LLC is the Idaho Cleanup Project contractor for the U.S. Department of Energy

6m 6/20/07

EDF No.: EDF-~~7688~~ 6381 EDF Rev. No.: 1 Project File No.: 23415

1. Title: Material Test Reactor (MTR) Complex Activity vs. Depth

2. Index Codes:

   Building/Type NA SSC ID NA Site Area RTC

3. NPH Performance Category: ______ or ☒ N/A SCC Safety Category ______ or ☒ N/A

4. (a) Affects Safety Basis: ☐ Yes ☒ No (b) Affects a SNF Facility ☐ Yes ☒ No

5. Summary:

The purpose of this EDF is to estimate the source term of the Materials Test Reactor (MTR) complex above grade level, from grade level to 3 feet below grade, from grade level to 10 feet below grade, and the source term below grade level (to the bottom of the concrete slab of the lowest level for each building in the MTR complex).

Summary of changes in Revision 1: Added background information for facility; added source term determination information.

6. Review (R) and Approval (A) and Acceptance (Ac) Signatures:
(See instructions for definitions of terms and significance of signatures.)

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Reviewer	R	Scott Reno/CWI	Scott L. Reno	6-18-07
Reviewer	R	David P. Hutchison/CWI	Per e-mail	6/18/07
Independent Peer Reviewer (if applicable)	R	NA		
Design Authority (if applicable)	A	NA		
Nuclear Safety (only if 4(a) is Yes)	R	NA		
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Requestor (if applicable)	Ac			

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8. Does document contain sensitive unclassified information? ☐ Yes ☒ No

   If Yes, what category:

9. Will document be externally distributed? ☐ Yes ☒ No

10. NRC related? ☐ Yes ☒ No

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11. Registered Professional Engineer's Stamp (if required) ☒ N/A

Materials Test Reactor (MTR) Complex Activity vs. Depth

Introduction

The purpose of this EDF to estimate the source term of the MTR complex above grade level, from grade level to 3 feet below grade, from grade level to 10 feet below grade, and the source term below grade level (to the bottom of the concrete slab of the lowest level for each building in the MTR complex). The source term values relative to grade are developed to support the CERCLA risk assessment.

The required CERCLA risk assessment examines three exposure scenarios:

- The "no action scenario" which utilizes the above grade and below grade source terms.
- The "industrial scenario" which utilizes the grade to 3' below grade source term.
- .The "residential scenario" which utilizes the grade to 10' below grade source term.

Background

Reactor

Design work on a test reactor to provide a testing environment with high thermal and fast neutron fluxes began in the 1940's. The design evolved into a light water moderated beryllium reflected reactor using thin aluminum-clad fuel plates. The water moderator also provided the cooling for the reactor. The mock-up of the Materials Testing Reactor (MTR) using this design went critical in 1950.

The Materials Testing Reactor (MTR) itself was constructed at the INL Reactors Test Complex (RTC) between 1950 and 1952. First criticality was in March 1952 using 1666 g of U-235 in a slab configuration. The original design power was 30 MW_{th}, but it was subsequently found that MTR could be safely operated at 40 MW_{th}. It operated at that power between September 1955 and the end of its service in August 1970 except for special experimental runs. Table 1 contains a summary of the main phases of MTR operation.

Table 1. Summary of MTR operating history.

Period	Power (MW_{th})	Energy (MWd)	Description
May 1952 to May 1954	30	26,900	Initial operating mode, 93% U-235 fuel
May 1954 to September 1955	30		U-235 content increased from 130 to 168 to 200g per fuel element
September 1955 to November 1957	30	550	5,130 g 20% enriched U-235
	40	110	5,130 g 20% enriched U-235
November 1957			20% U-235, Cycle 95
November 1957 to August 1958			Routine operation
August 1958	≤30	262	3,270 g Pu fuel, Cycle 108
August 1958 to March 1960	40	71,323	Routine operation

March 1960 to July 1969	40	108,000	Routine operation
December 1969 to April 1970	30	923	Phoenix Pu core, new Be reflector
August 1970	40	83	Conventional core, 93% U-235
At shutdown (Aug 1970)		180,329	

Unlike many of the reactors built at the INL, the MTR's core is above ground. It is housed in a large shielding structure in Building TRA-603. Figures 1 through 9 show some aspects of its configuration. Several points should be made here regarding its configuration and function:

- The central core of the reactor, visible in Figures 7, 8, and 10, was water filled. The core internals were cooled by water circulating through 24 in. process water lines. Those lines ran to the Process Water Building (TRA-605) where the water was degassed in 3 identical flash evaporator units and subsequently cooled. That water was removed in 1979, and the ducts to the Process Water Building are dry.
- D tank, which immediately surrounds the core, and C tank, located just above it, are made of ASTM 209-46T Alloy A2 aluminum. D Tank is 1 in. thick except in the region where the beam hole thimbles penetrate the tank where it is 1.25 in. thick. E tank is lowermost tank and, like the A and B tanks, which comprise the top of the reactor vessel, is made of 304 ELC stainless steel. Like the A tank, the E tank was coated with tar and cast integrally into the concrete. A stainless steel A tank extension was added after the original construction to accommodate experiment nozzles that were required for experiment access directly into the core from above.
- The graphite balls in the reflector immediately surrounding the core tanks were cooled by room air drawn in through the vents on the four faces of the biological shield, towards the top, as shown in Figure 8 and visible in Figures 1 – 3 and 7. That air was then taken to the Fan House (TRA-610) by large blowers, which have since been removed.
- The elevations shown in Figures 7 and 10 are in relation to the reactor core. The reactor core horizontal centerline was arbitrarily chosen to be the 100 ft elevation. The buildings main floor is 3.5 ft below the reactor core centerline thus the elevation of the main floor is 96 ft 6 in.

Figure 1. MTR as seen from the southwest during its early operational days.

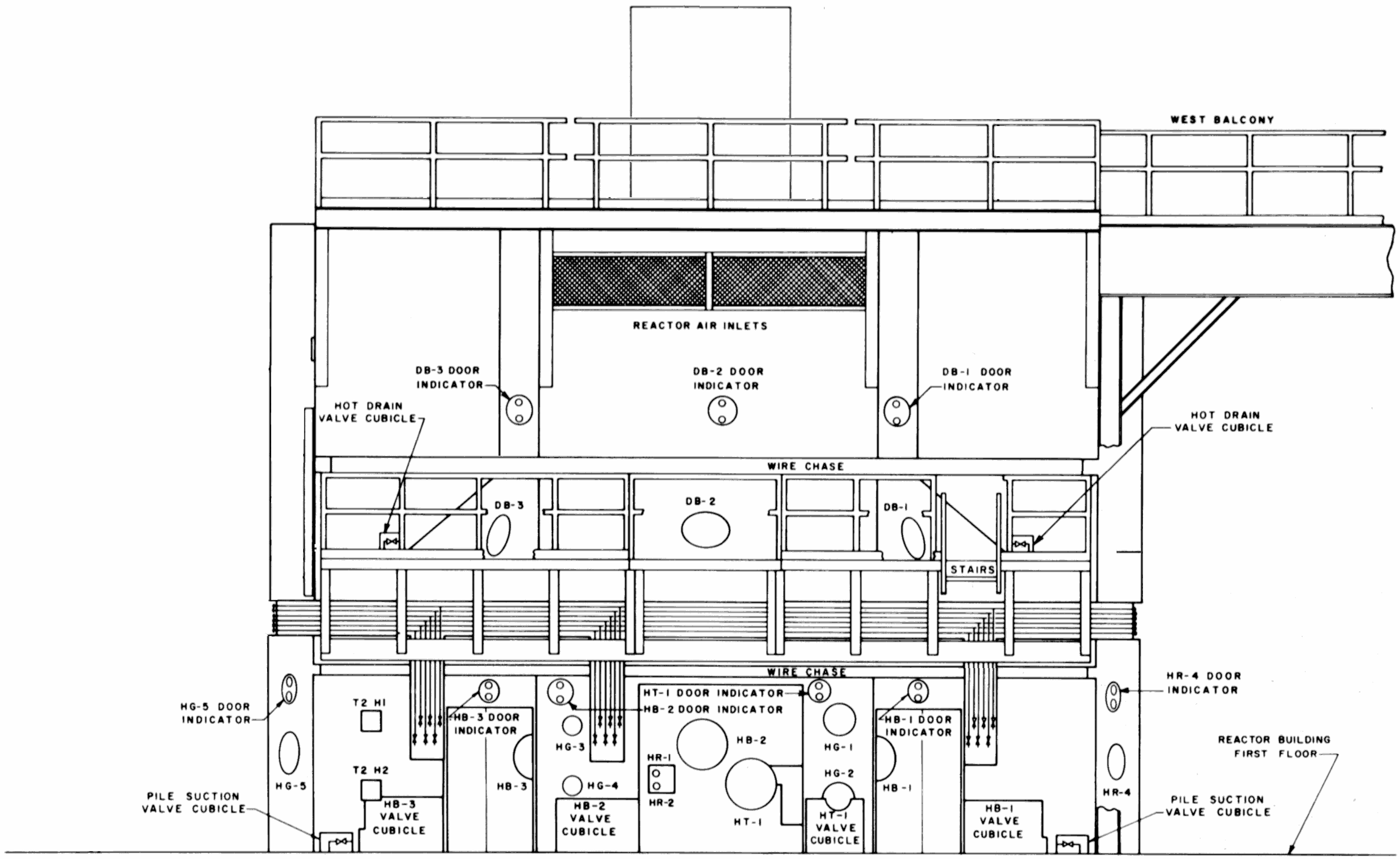

Figure 2. Profile of the MTR as seen from the north side in its present configuration.

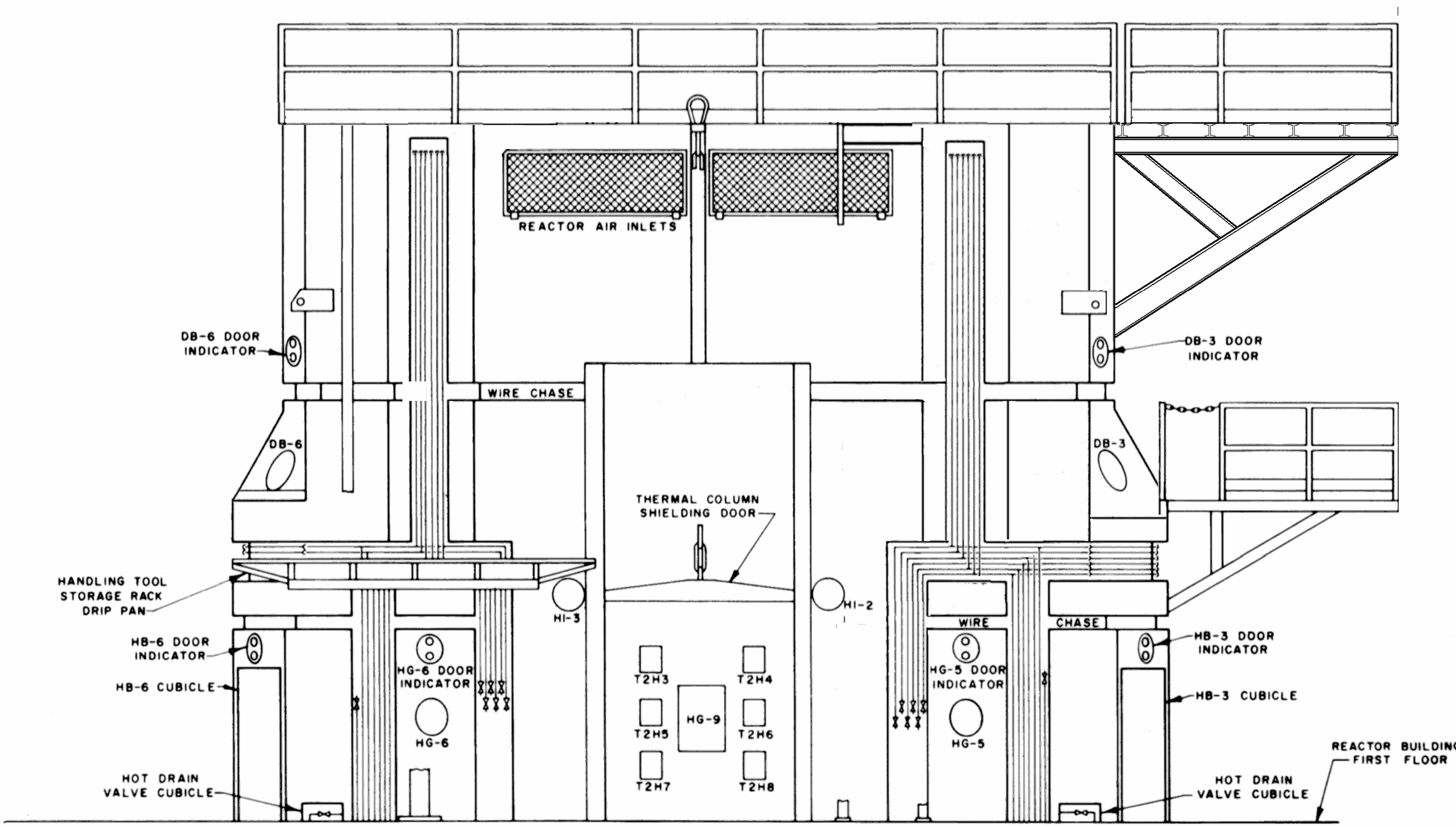

Figure 3. Profile of the MTR as seen from the east side in its present configuration.

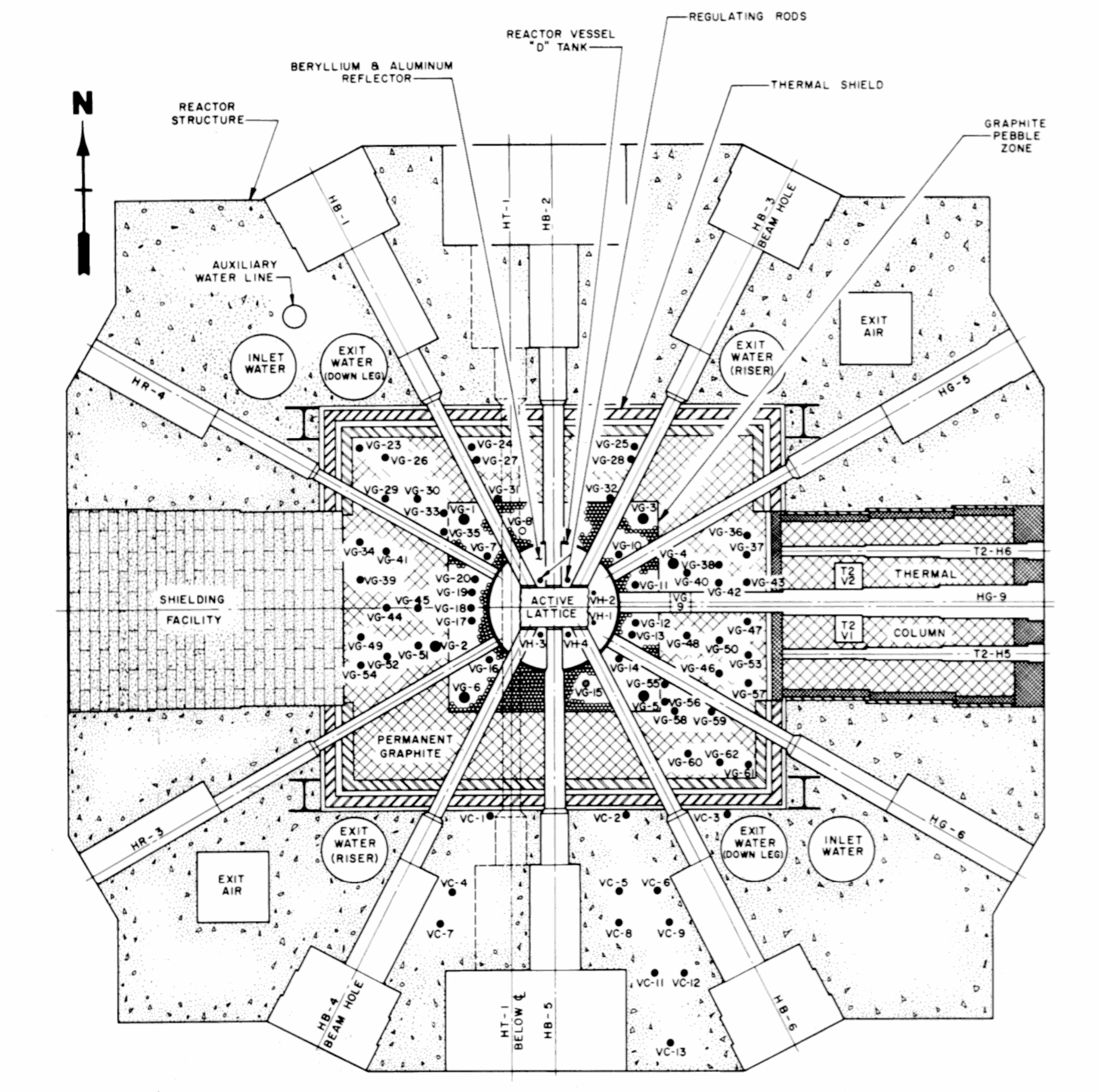

Figure 4. Horizontal cross section of the MTR reactor.

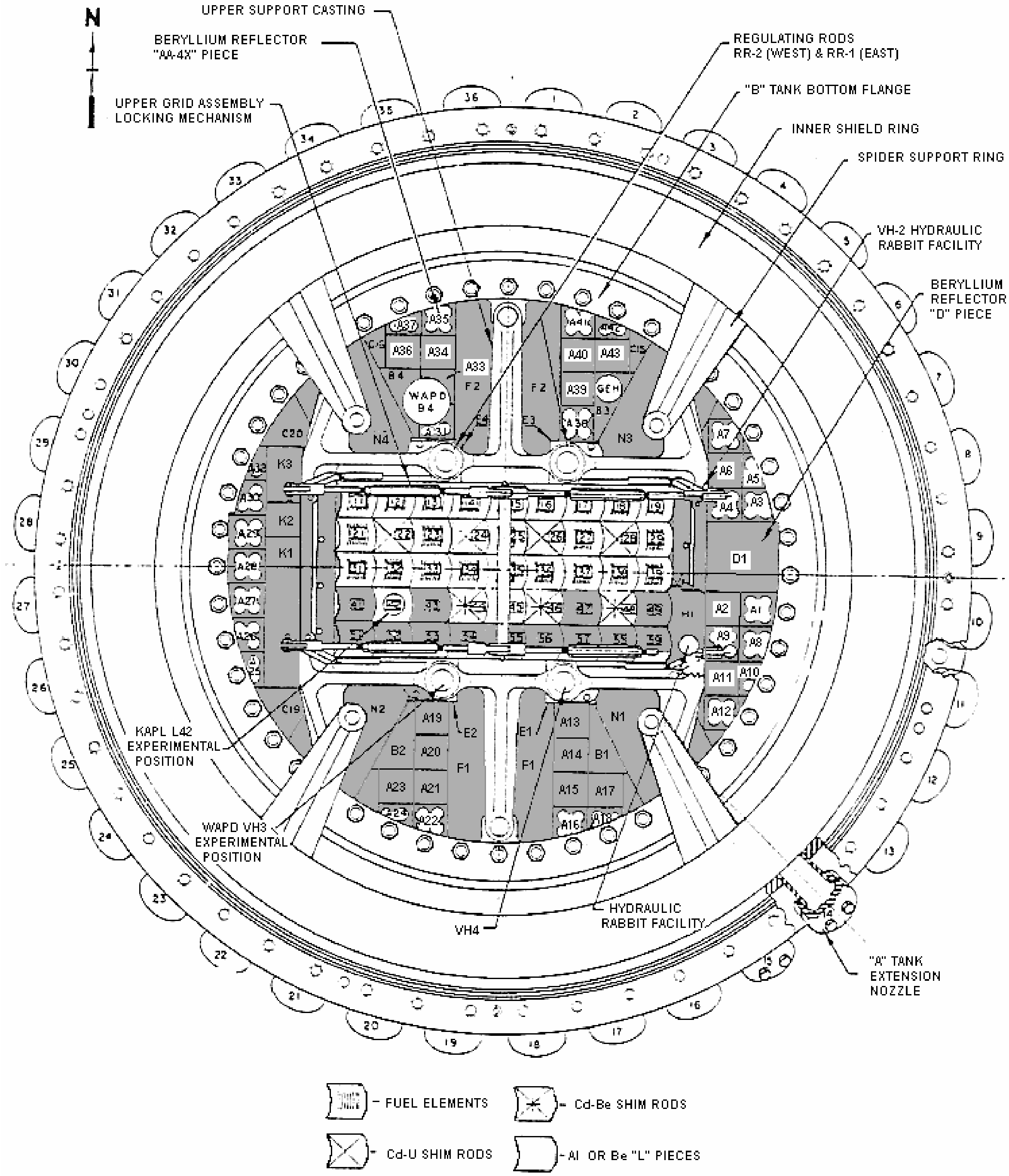

Figure 5. Details of MTR core configuration. Shaded areas are beryllium reflector.

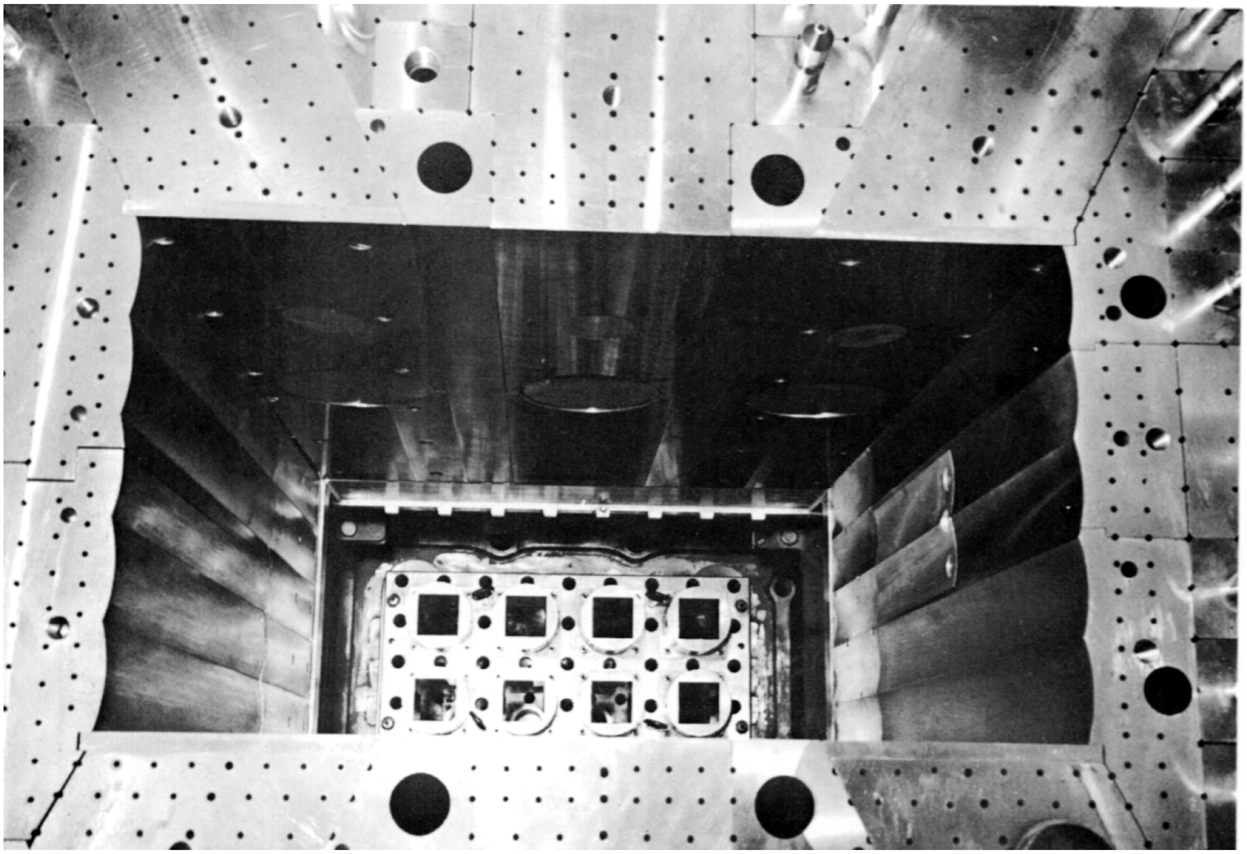

Figure 6. Photograph of the MTR reactor core volume before addition of fuel elements and “L” piece beryllium reflector sections.