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BULK SHIELD FACILITY IRRADIATION
ACCOMODATIONS AT THE
AIR FORCE NUCLEAR ENGINEERING TEST FACILITY

by
E. J. Vallish

AFIT TR 66-9

Wright-Patterson Air Force Base, Ohio

Technical Report

AFIT TR 66-9

BULK SHIELD FACILITY IRRADIATION ACCOMODATIONS AT THE AIR FORCE NUCLEAR ENGINEERING TEST FACILITY

by

E. J. Vallish

Nuclear Engineering Test Facility Department
School of Engineering
Air Force Institute of Technology
Air University

June 1966

Bulk Shield Facility
Irradiation Accommodations
At the Air Force Nuclear
Engineering Test Facility

This technical report has been written for the purpose of assisting experimentors in using the Bulk Shield Facility.

Reviewed By:

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Chief, EED

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J. R. Bohannon, Jr.
Col. USAF
Director, AFIT-NETF

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Section I

INTRODUCTION

This report describes the Bulk Shield Facility (BSF) located in the Air Force Nuclear Engineering Test Facility (AF NETF). The AF NETF has a 10-megawatt nuclear reactor and is located in Area B of Wright Patterson Air Force Base, Ohio.

This report is intended to assist engineers and scientists who may be contemplating research and development, engineering and applied testing, and technological applications in the following functional areas.

1. Metallurgy
2. Biomedical Research
3. Solid State Physics and Electronic Systems
4. Nuclear Engineering
5. Nuclear Physics
6. Radiochemistry
7. Activation Analysis
8. Other

Section II

DESCRIPTION OF THE BULK SHIELD FACILITY

The BSF contains high purity water which shields the south face of the reactor. Figure 1 (Drawing C-66-6) shows the location of the BSF within the reactor building. This floor plan also represents access to the building from the ground level, and depicts relative distances by the grid overlay.

Figure 2 (Drawing B-66-7) is of the reactor top elevation, and again has the grid overlay for distance reference. Access to this floor is available by stairs from the ground level. An overhead polar bridge crane is provided with a 20-ton and a 5-ton lift.

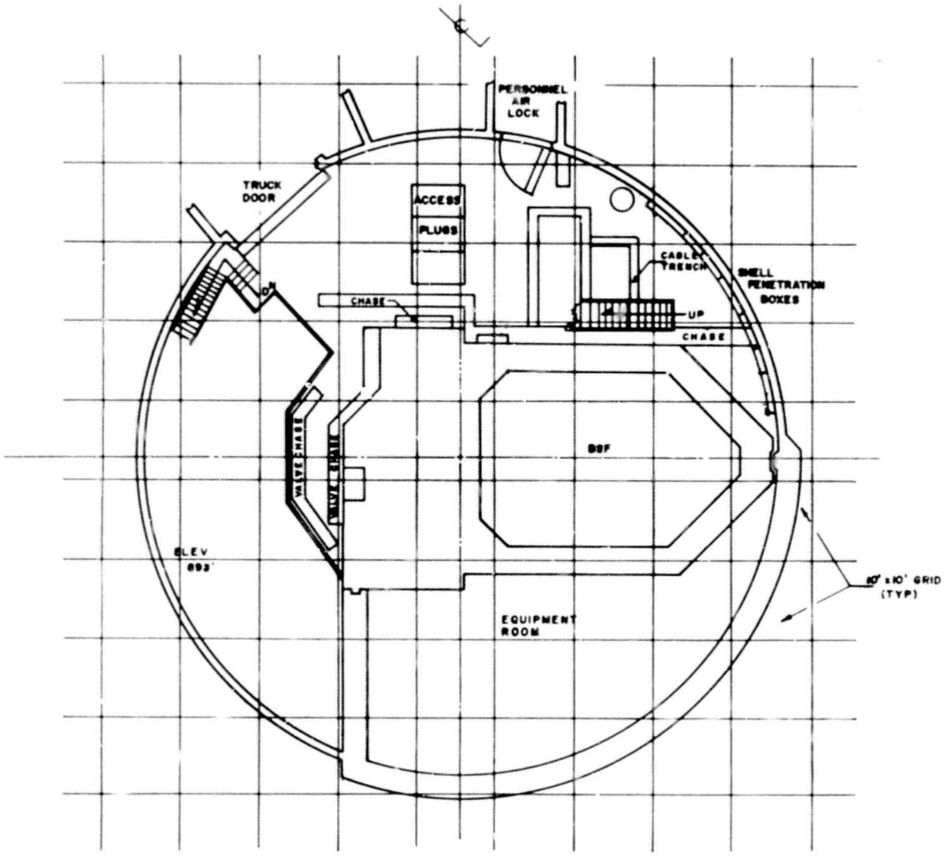
Figure 3 (Drawing D-66-8) shows the relative location of electrical and fluid process utilities supporting the BSF experiment needs. The BSF dolly is shown in the retracted position. Notice the gamma facility at the south end of the BSF, and the isotope tubes at the north end.

Figure 4 supplements the drawing and describes those utilities servicing the BSF.

Figure 5 (Drawing D-66-9) has the as-built dimensions of the various details and perimeter of the BSF. The N-8 channel is reactor control instrumentation. It is a spare start-up channel to the regular N-3 start-up channel. When the N-8 channel has to be used for reactor start-up, the BSF dolly must be retracted from the irradiation position until after start up. Then after N-8 is moved counter-clockwise out of the core area, the dolly may be driven forward into the irradiation position. Whether or not the N-8 channel is used would have to be resolved on the basis of the schedule at that time in consideration with the experiment to be irradiated.

The BSF interface window to the reactor core is also shown. Details of this window are presented later in this report. The window distance from the core east-west centerline is shown as 19.562 inches.

Figure 6 (Drawing D-66-10) depicts the minimum opening into the BSF at the level of the water overflow scuppers. The BSF liner is noticeable here. This liner is made of 1/4-inch thick, Type 5050 aluminum plate. This liner assists in maintaining the BSF water at about 1/2 megohm per cm resistivity. The water is constantly cleaned-up by circulating it through appropriate demineralizer beds and filters, then returning it to the BSF.



PARTIAL FIRST FLOOR PLAN

C-66-6

Figure 1

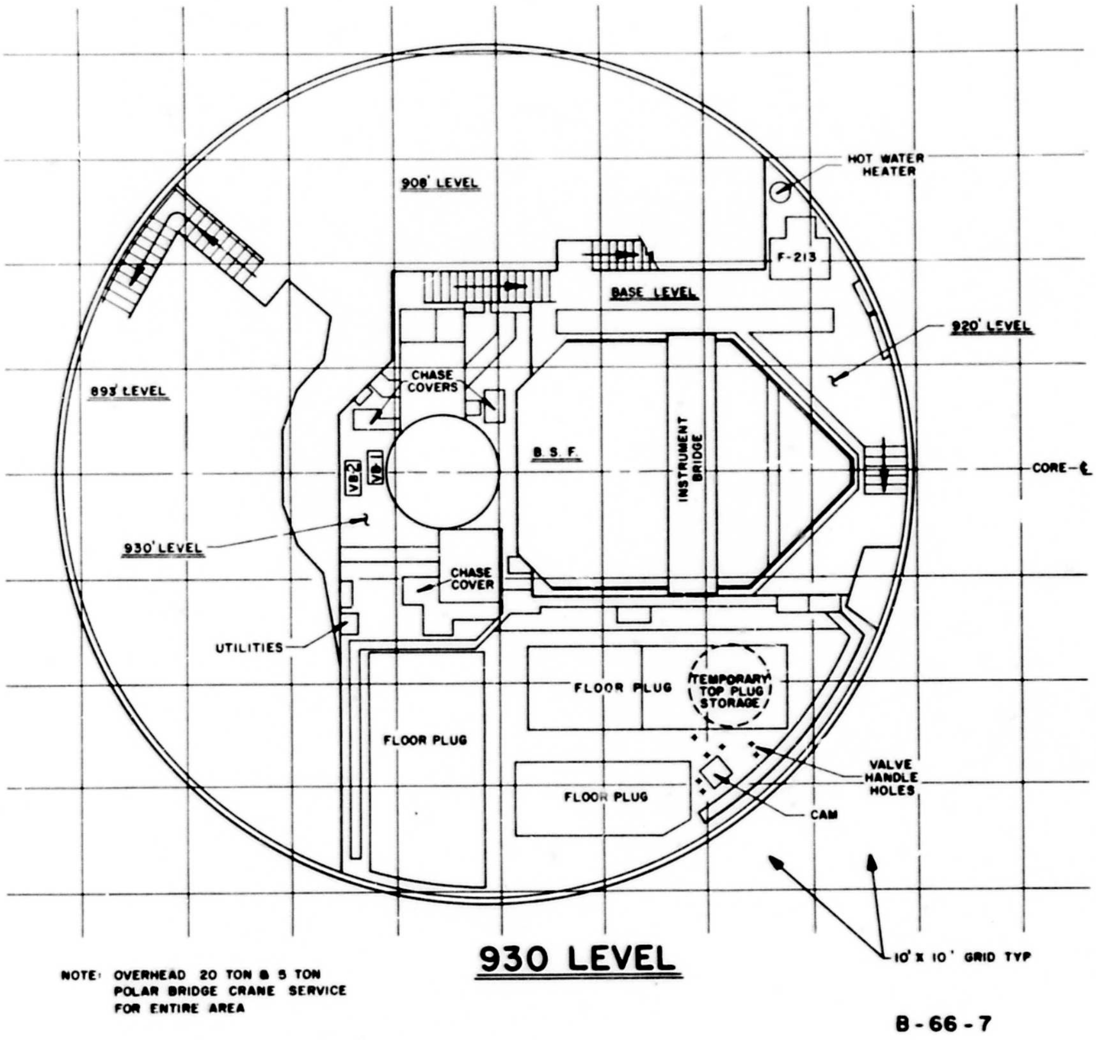
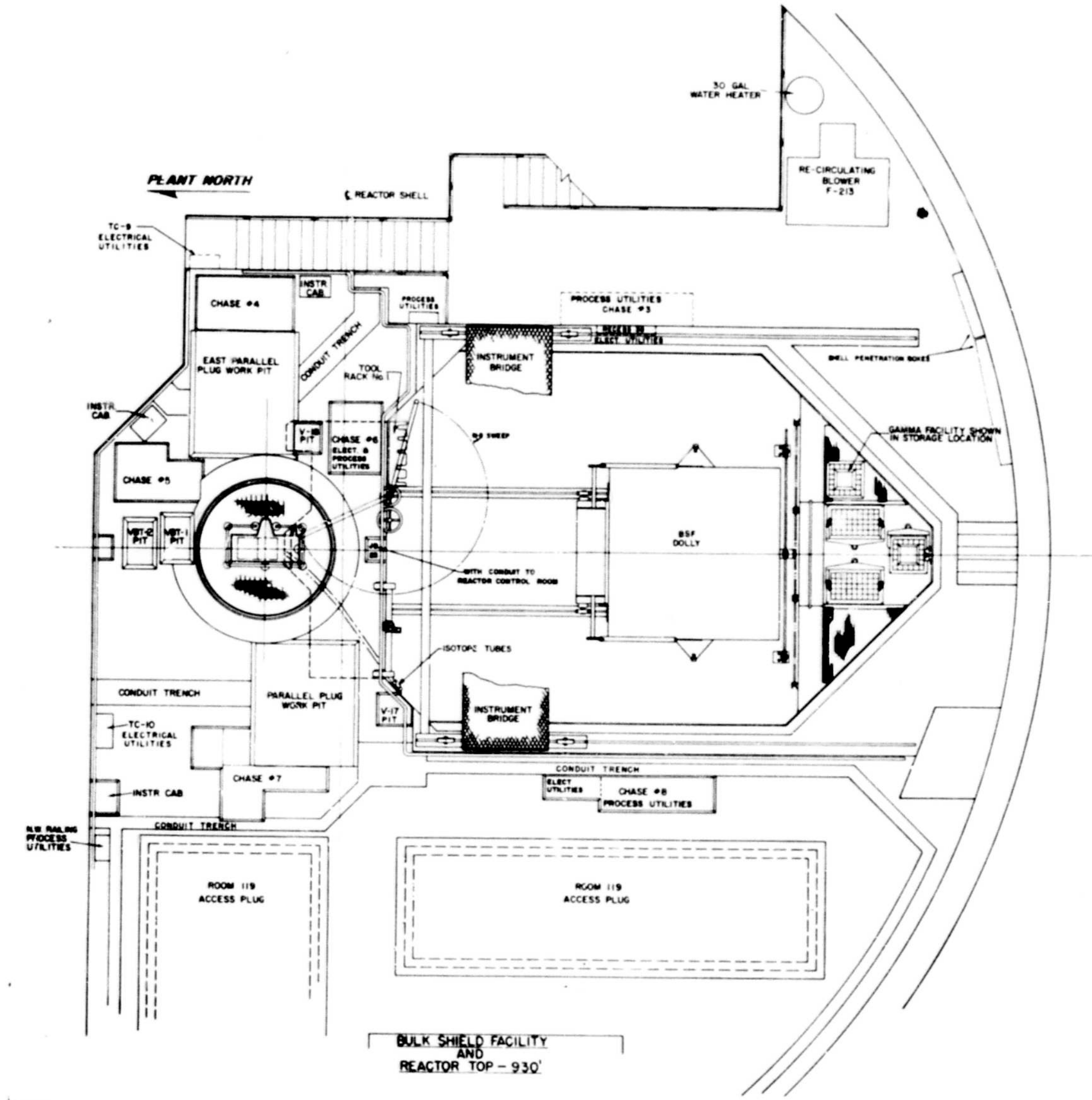

HOT WATER HEATER
908' LEVEL
F-213
BASE LEVEL
920' LEVEL
893' LEVEL
CHASE COVERS
B.S.F.
INSTRUMENT BRIDGE
VB 2
VB 1
CORE-℄
930' LEVEL
CHASE COVER
UTILITIES
FLOOR PLUG
TEMPORARY TOP PLUG STORAGE
FLOOR PLUG
VALVE HANDLE HOLES
FLOOR PLUG
CAM
930 LEVEL
10' X 10' GRID TYP
NOTE: OVERHEAD 20 TON & 5 TON POLAR BRIDGE CRANE SERVICE FOR ENTIRE AREA
B-66-7

Figure 2



PLANT NORTH
℄ REACTOR SHELL
30 GAL WATER HEATER
RE-CIRCULATING BLOWER F-213
TC-9 ELECTRICAL UTILITIES
CHASE #4
INSTR CAB
PROCESS UTILITIES
PROCESS UTILITIES CHASE #3
CONDUIT TRENCH
EAST PARALLEL PLUG WORK PIT
INSTRUMENT BRIDGE
SHELL PENETRATION BOXES
TOOL RACK No. 1
INSTR CAB
V-18 PIT
CHASE #6 ELECT & PROCESS UTILITIES
GAMMA FACILITY SHOWN IN STORAGE LOCATION
CHASE #5
MST-2 PIT
MST-1 PIT
BSF DOLLY
WITH CONDUIT TO REACTOR CONTROL ROOM
ISOTOPE TUBES
CONDUIT TRENCH
PARALLEL PLUG WORK PIT
INSTRUMENT BRIDGE
V-17 PIT
TC-10 ELECTRICAL UTILITIES
CONDUIT TRENCH
ELECT UTILITIES
CHASE #8 PROCESS UTILITIES
CHASE #7
INSTR CAB
PROCESS UTILITIES
CONDUIT TRENCH
ROOM 119 ACCESS PLUG
ROOM 119 ACCESS PLUG
BULK SHIELD FACILITY AND REACTOR TOP - 930'

Figure 3

UTILITIES SERVICING

	East Wall BSF - 908' Elev.	Chase #3 - 920' Elev.	Chase #6 - 930' Elev.	Chase #8 - 930' Elev.	TC-9 - 908' Elev.	TC-10 - 930' Elev.	Recess #38 - 920' Elev.	No. West Railing - 930' Elev.
Exhaust Air		X	X	X				
100 psig Air	X (1)	X (2)	X (2)	X (2)				X (1)
Vacuum, 24" Hg	X (1)	X (2)	X (2)	X (2)				X (1)
Spare Gas	X	X						X
Demin. Water	X (1)	X (2)	X (2)	X (2)				X (1)
Hot Ind. Water	X							X
Cold Ind. Water	X							X
Suspect Waste Drain	X	X	X	X				X
480 v 60 ~ 3 ϕ					50A	50A	30A	
240 v 60 ~ 3 ϕ					30A	30A		
208 v 400 ~ 3 ϕ				30A	20A	20A	30A	
120 v 60 ~ 1 ϕ			90A Splice	30A (1)	30A (2)	30A (2)	30A (1)	
120 v 60 ~ 1 ϕ Regulated			90A Splice	30A (1)	30A (2)	30A (2)	30A (1)	
Ground Plate	X		X		X	X		X

A

Figure 4

UTILITIES SERVICING BSF

[illegible]	TC-10 - 930' Elev.	Recess #38 - 920' Elev.	No. West Railing - 930' Elev.	Connector	Manufacturer
				1-1/2" NPT	
			X (1)	3/4" NPT (1) 1" NPT (2)	
			X (1)	3/4" NPT (1) 1" NPT (2)	
			X	3/4" NPT	
			X (1)	3/4" NPT (1) 1" NPT (2)	
			X	3/4" NPT	
			X	3/4" NPT	
			X	1-1/2" NPT	
A	50A	30A		JPD 116046-PR	Pyle National Company
A	30A			JPD 83046-PR	Pyle National Company
A	20A	30A		KPD-1410046 (20A)	Pyle National Company
A 2)	30A (2)	30A (1)		#5264 (3 wire) JPD-53036-PR	Hubbell or Equivalent (1) Pyle National Company (2)
A 2)	30A (2)	30A (1)		#5666 (3 wire) KPD-53336-PR	Bryant or Equivalent (1) Pyle National Company (2)
X	X		X	3/8 x 16 Thd.	

B

Figure 4

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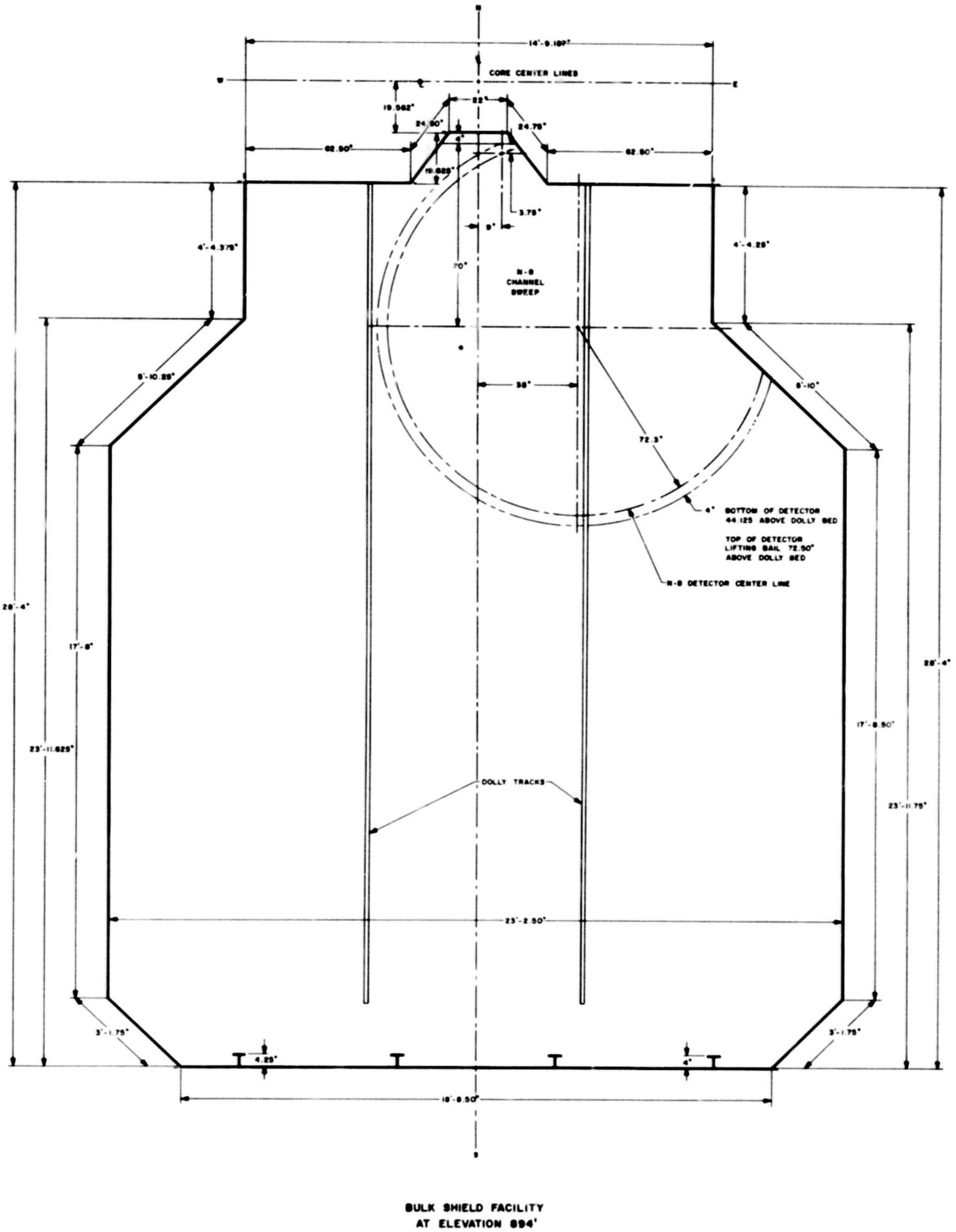
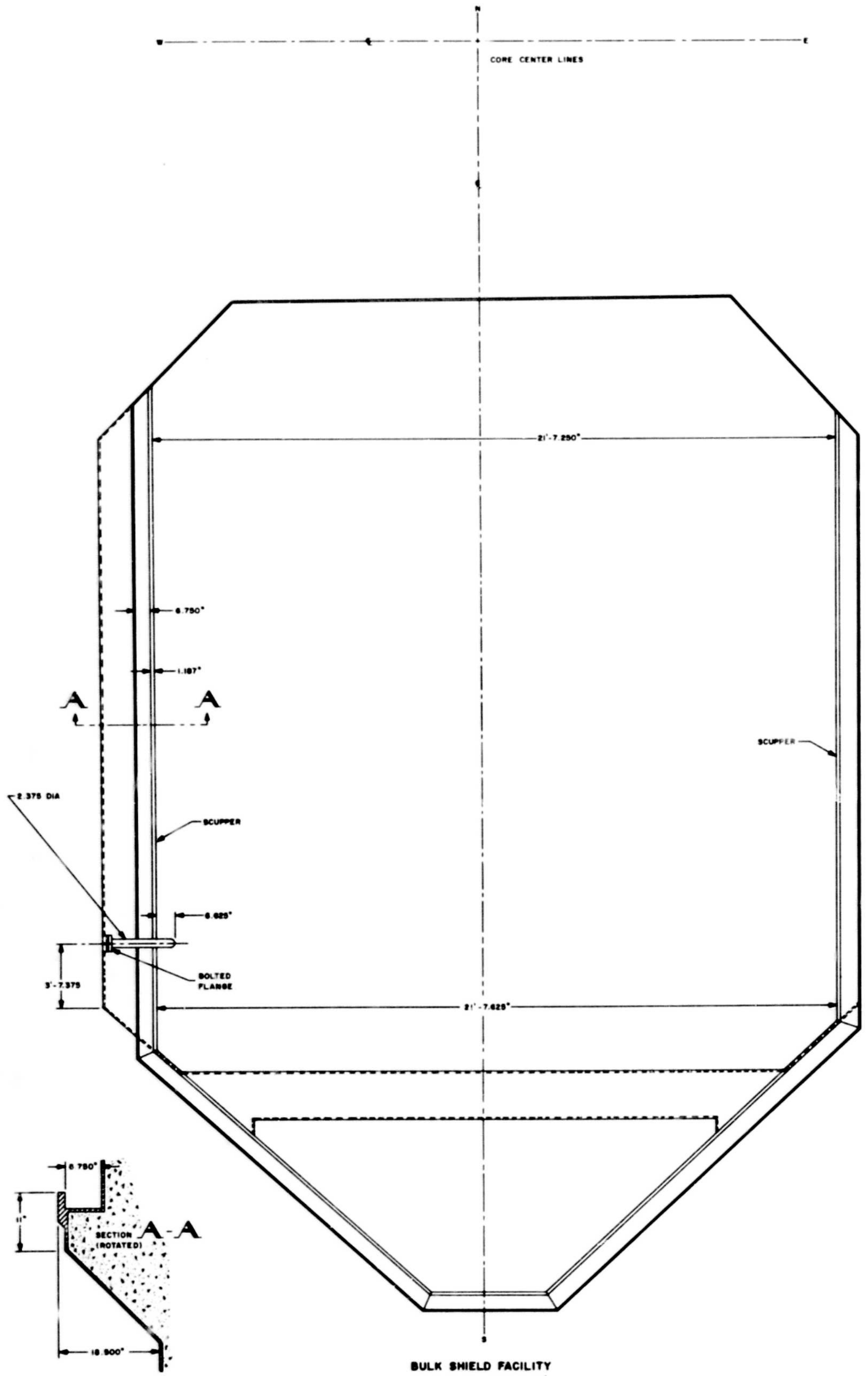


BULK SHIELD FACILITY
AT ELEVATION 894'

Figure 5



BULK SHIELD FACILITY
AT ELEVATION 924'

Figure 6

Figure 7 (Drawing D-66-11) shows the BSF dolly in the retracted position. This dolly is electric motor driven by remote control from atop the BSF. The experiment holder rack contains a removable plate on which experiments may be mounted and positioned in the desired flux from the reactor. The dolly is designed to support a 10-ton load.

Important vertical as-built dimensions are indicated on the drawing.

Figure 8 (Drawing D-66-12) displays additional as-built dimensions and picturization of the two isotope tubes.

The isotope tubes provide a very convenient means of irradiating small objects. A metal carrier contains the object and by means of an aluminum chain the carrier is lowered into the tube, to come to rest at the window. Figure 9 (Drawing C-66-17) is a diagram of the carrier.

These carriers are made from aluminum stock of short half-life element alloys.

Figure 10 (Drawing D-66-13) shows the details of the window interface between the reactor and the BSF. Here are also the as-built dimensions one would require to mount an experiment on the experiment holder. Details of the typical holder are shown. The experiment container should be designed to fit against the window, or in the recesses between the ribs for maximum flux. It should also be securely mounted on the experiment plate. The plate and its support tubes should be furnished such that the unit can be slipped into the 24-inch long spring-loaded tubes on the large plate that slips into the rack on the dolly. The entire assembly then, on the large plate, is lowered by crane into the water and down to the experiment holder rack on the dolly.

Figure 11 (Drawing D-66-4) shows the as-built geometry of the BSF window with respect to the reactor core and its core tank structure. The drawing also shows the dry irradiation facilities interface with the core and their proximities.

Figure 12 indicates the dimensions of the gamma facility. Twenty spent fuel elements are to be positioned around the perimeter of the central void. Pure gamma irradiation experiments would be lowered into this void. Figure 3 shows the location of this facility in the BSF.

Dimensions of the instrument bridge are shown in Figure 13. The bridge is designed to support a 75 PSF live load.

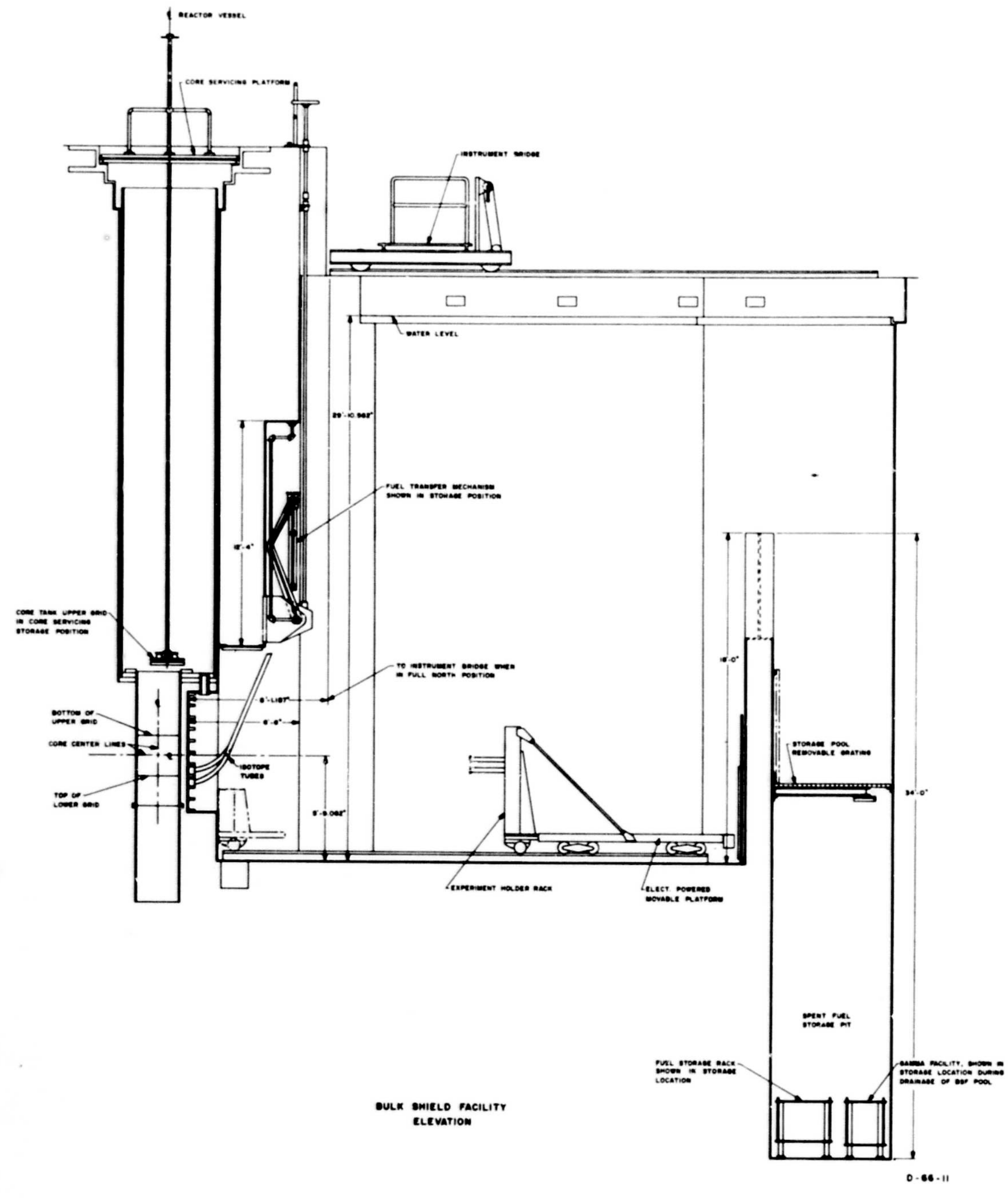
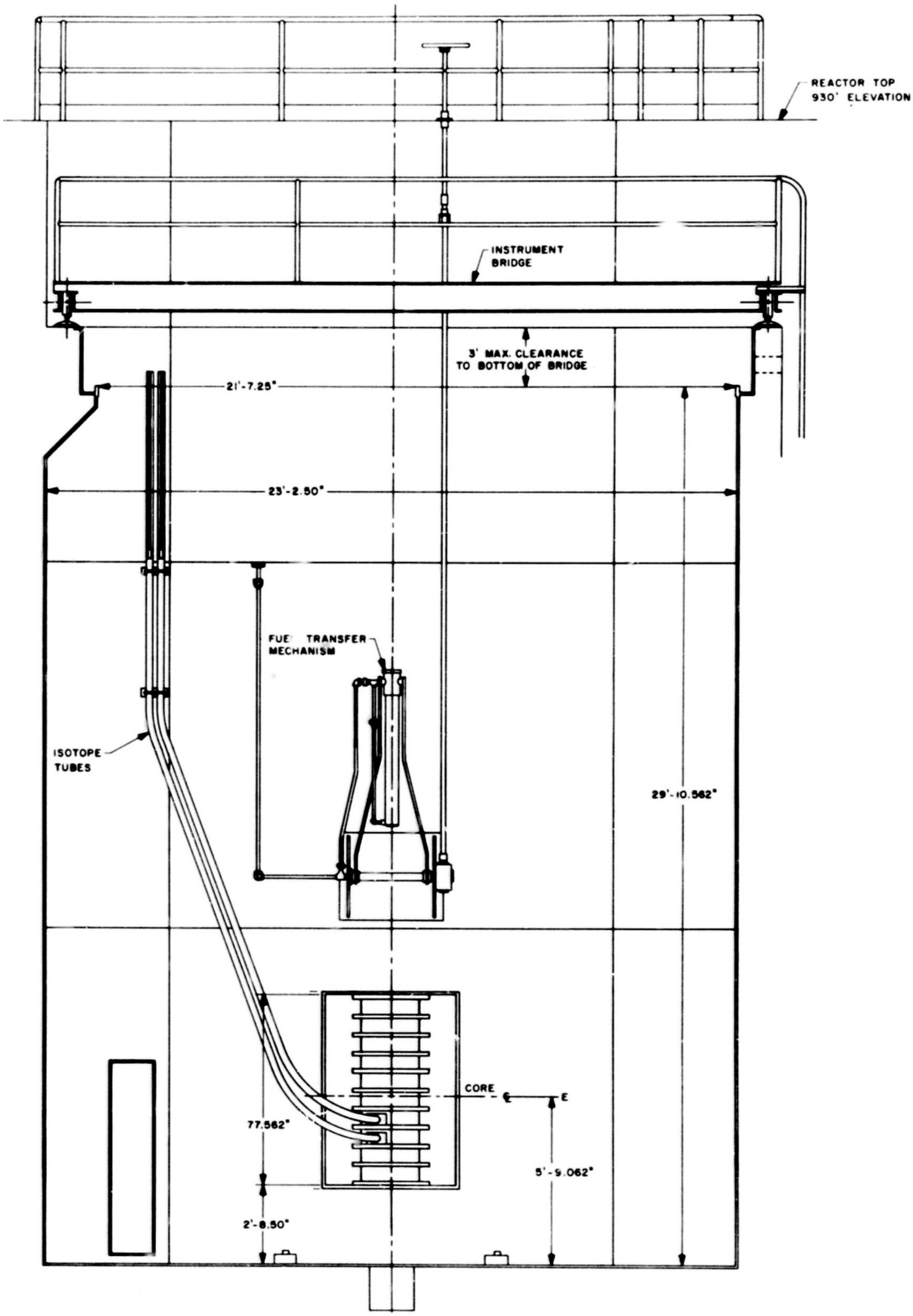
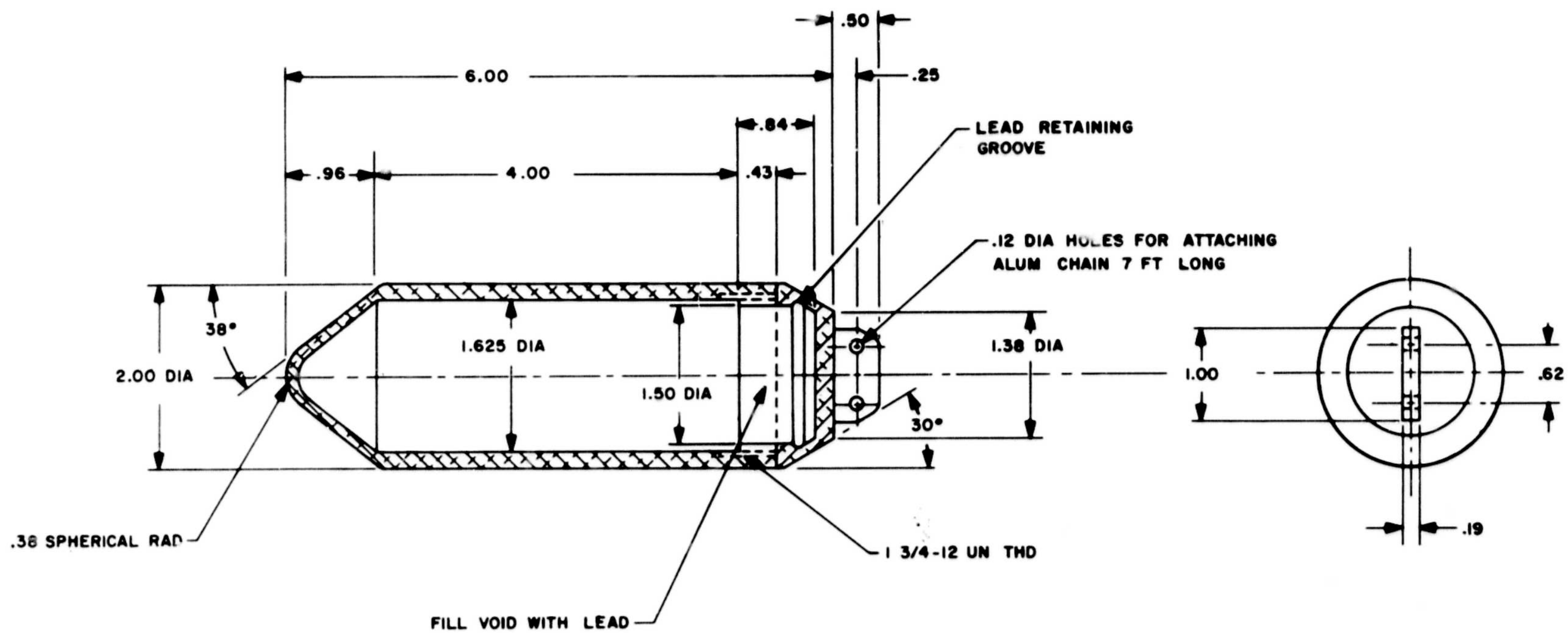

REACTOR VESSEL
CORE SERVICING PLATFORM
INSTRUMENT BRIDGE
WATER LEVEL
29'-10.962"
FUEL TRANSFER MECHANISM SHOWN IN STORAGE POSITION
12'-4"
CORE TANK UPPER GRID IN CORE SERVICING STORAGE POSITION
TO INSTRUMENT BRIDGE WHEN IN FULL NORTH POSITION
6'-1.187"
6'-6"
BOTTOM OF UPPER GRID
CORE CENTER LINES
ISOTOPE TUBES
TOP OF LOWER GRID
5'-9.062"
EXPERIMENT HOLDER RACK
ELECT. POWERED MOVABLE PLATFORM
16'-0"
STORAGE POOL REMOVABLE GRATING
34'-0"
SPENT FUEL STORAGE PIT
FUEL STORAGE RACK SHOWN IN STORAGE LOCATION
GAMMA FACILITY, SHOWN IN STORAGE LOCATION DURING DRAINAGE OF BSF POOL
BULK SHIELD FACILITY
ELEVATION
D-66-11

Figure 7



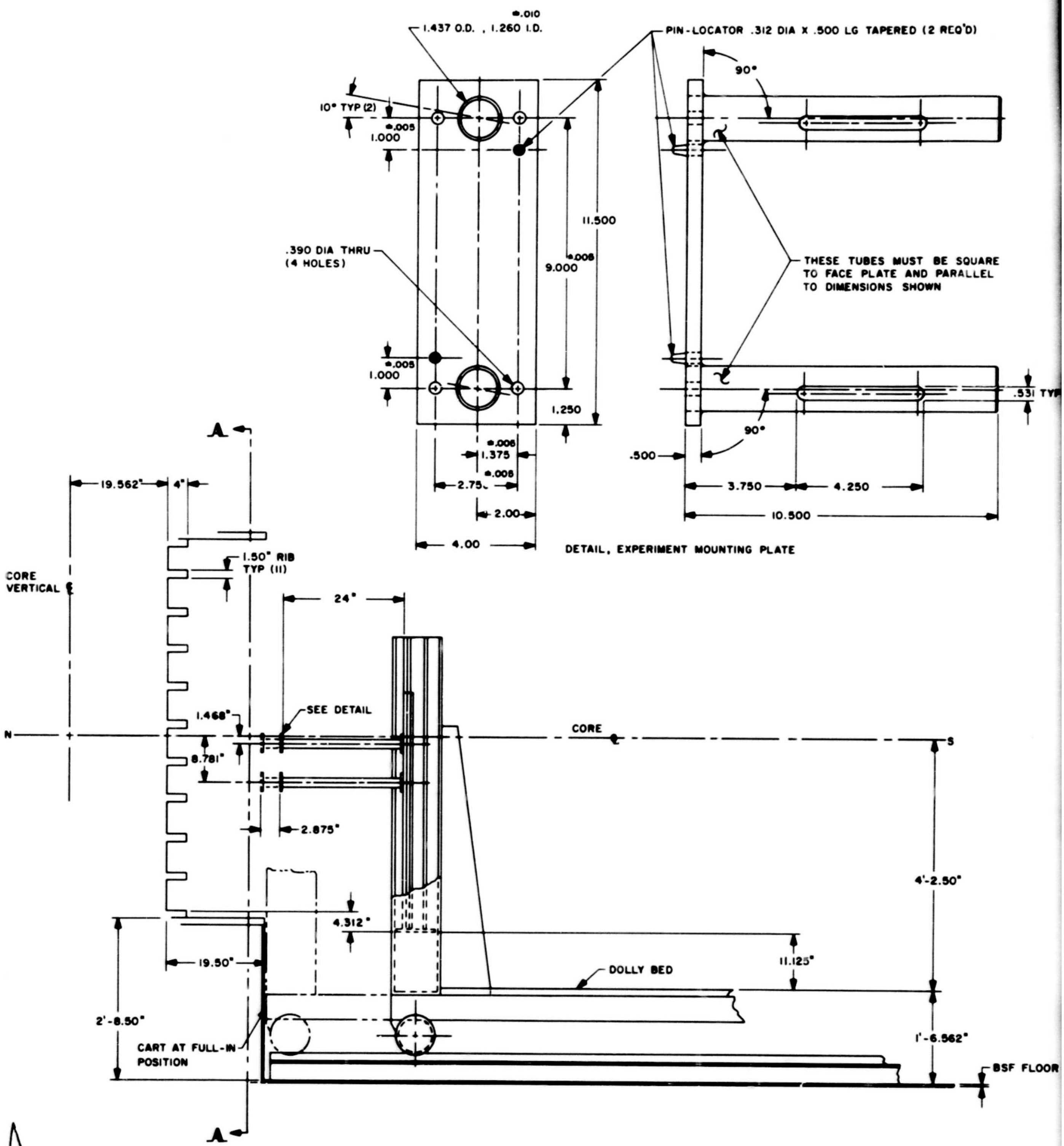
BULK SHIELD FACILITY
NORTH WALL

Figure 8



.50
6.00
.25
.84
LEAD RETAINING
GROOVE
.96
4.00
.43
.12 DIA HOLES FOR ATTACHING
ALUM CHAIN 7 FT LONG
38°
2.00 DIA
1.625 DIA
1.50 DIA
1.38 DIA
1.00
.62
30°
.19
.38 SPHERICAL RAD
1 3/4-12 UN THD
FILL VOID WITH LEAD

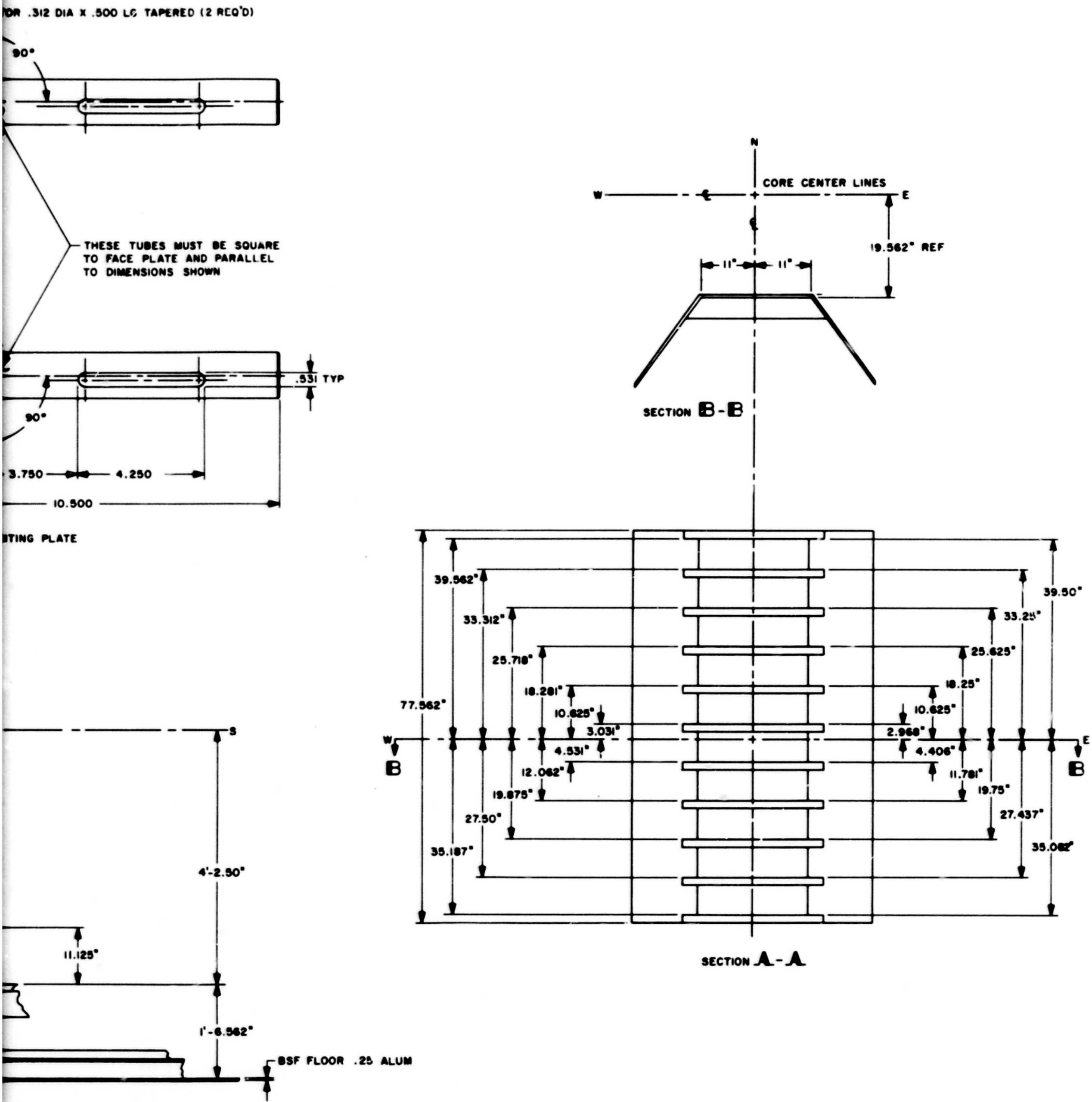
Figure 9



A

BSF WINDOW DETAILS
AND EXPERIMENT PLATE

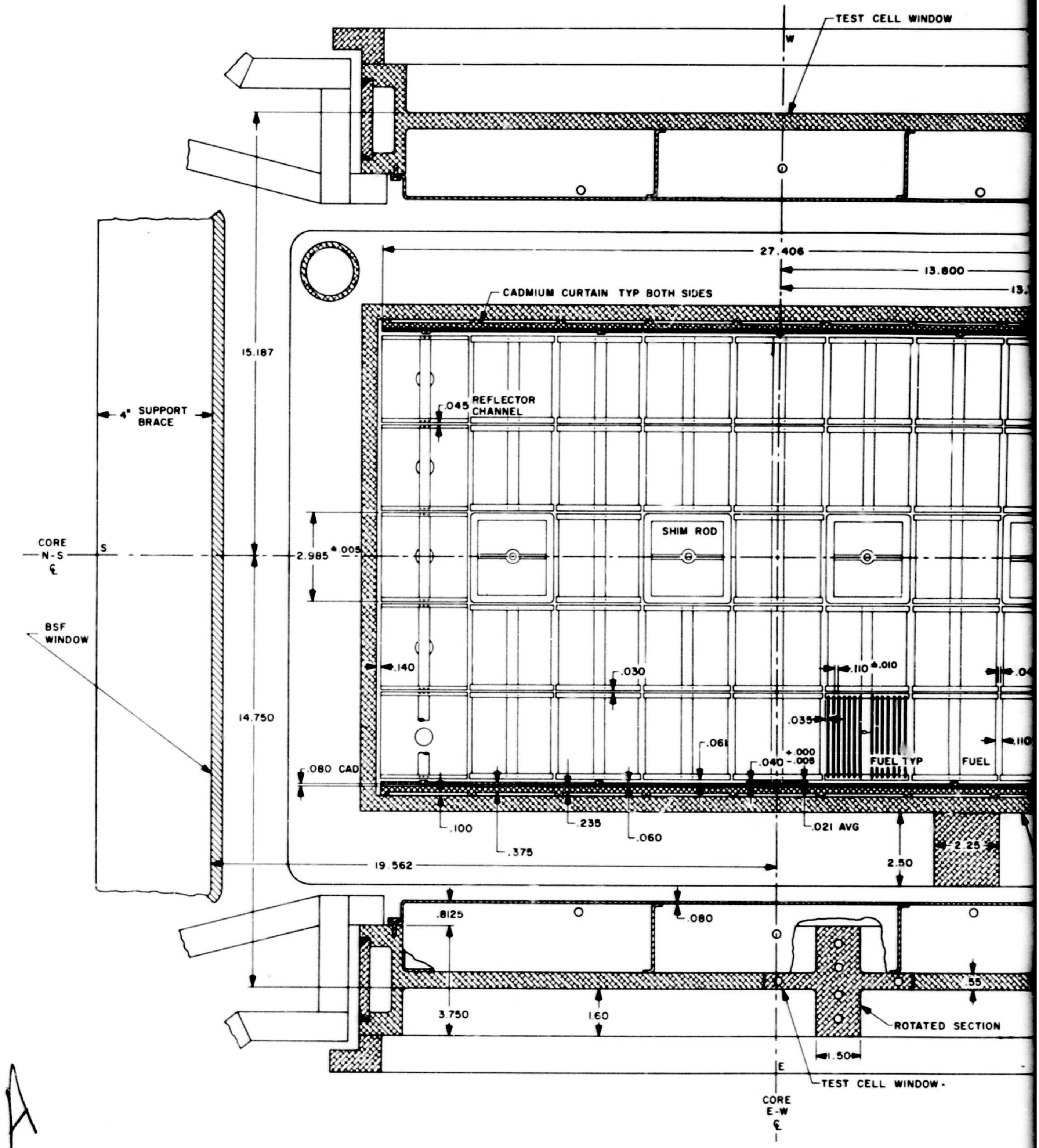
Figu



BSF WINDOW DETAILS
AND EXPERIMENT PLATE

Figure 10

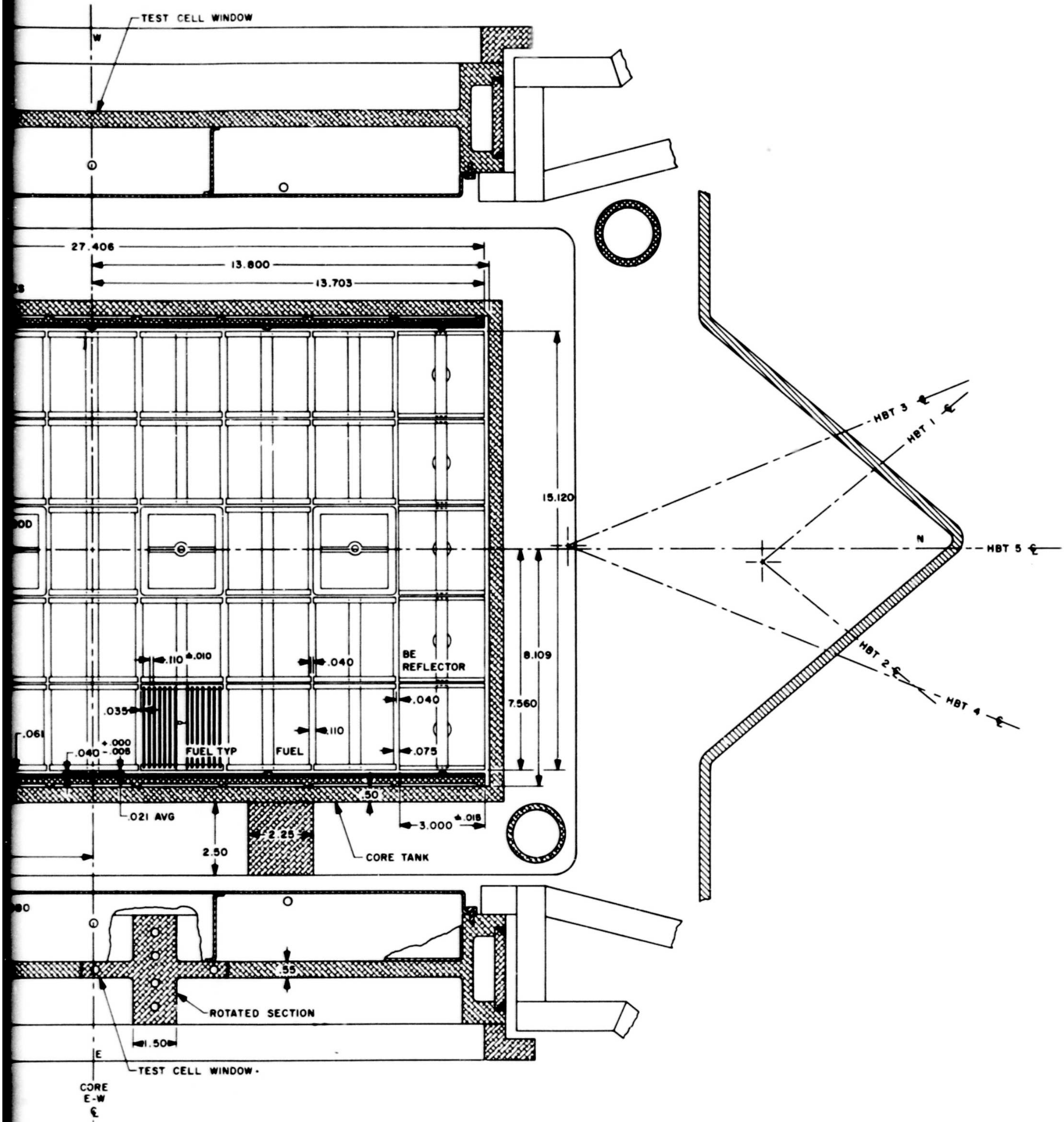
B



A

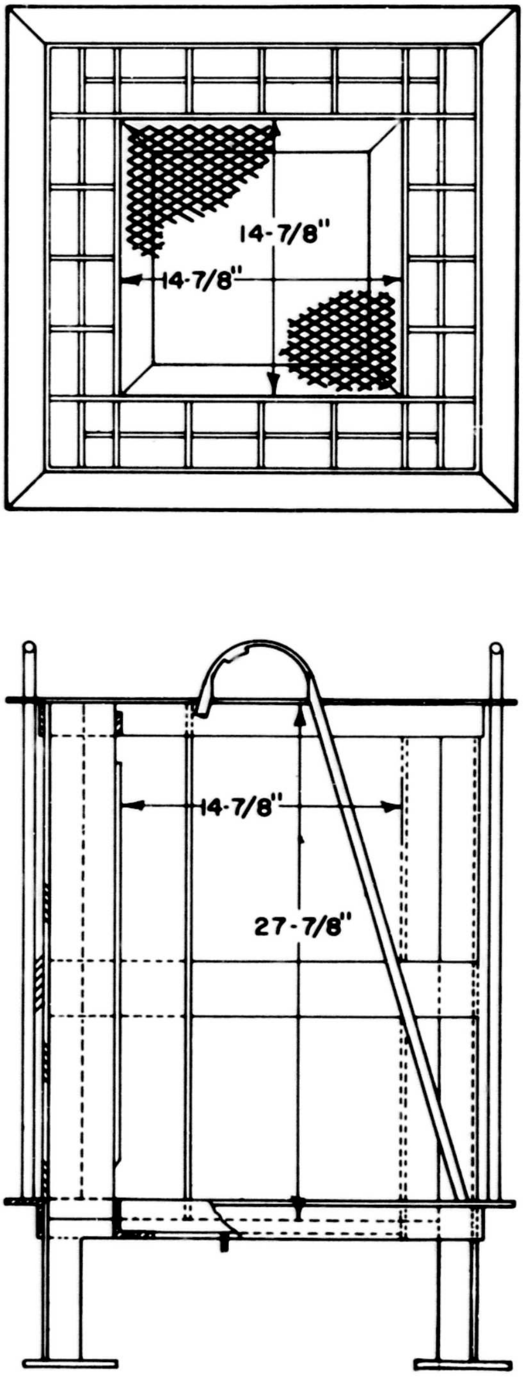
REACTOR CORE (SECTION)

Figure 11



ACTOR CORE (SECTION)

Figure 11



GAMMA FACILITY

FIG 12

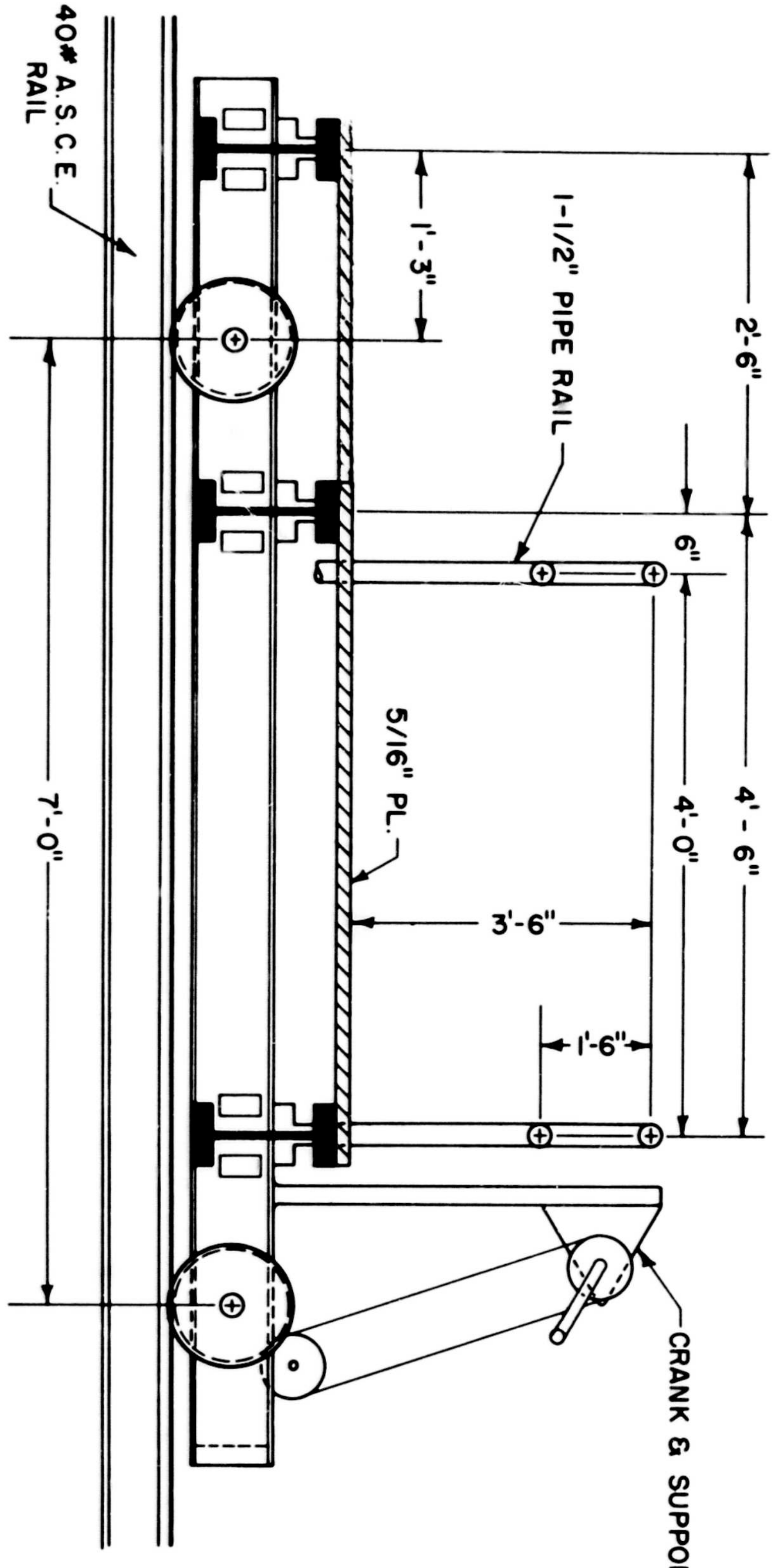


FIG 13

INSTRUMENT BRIDGE

Section III

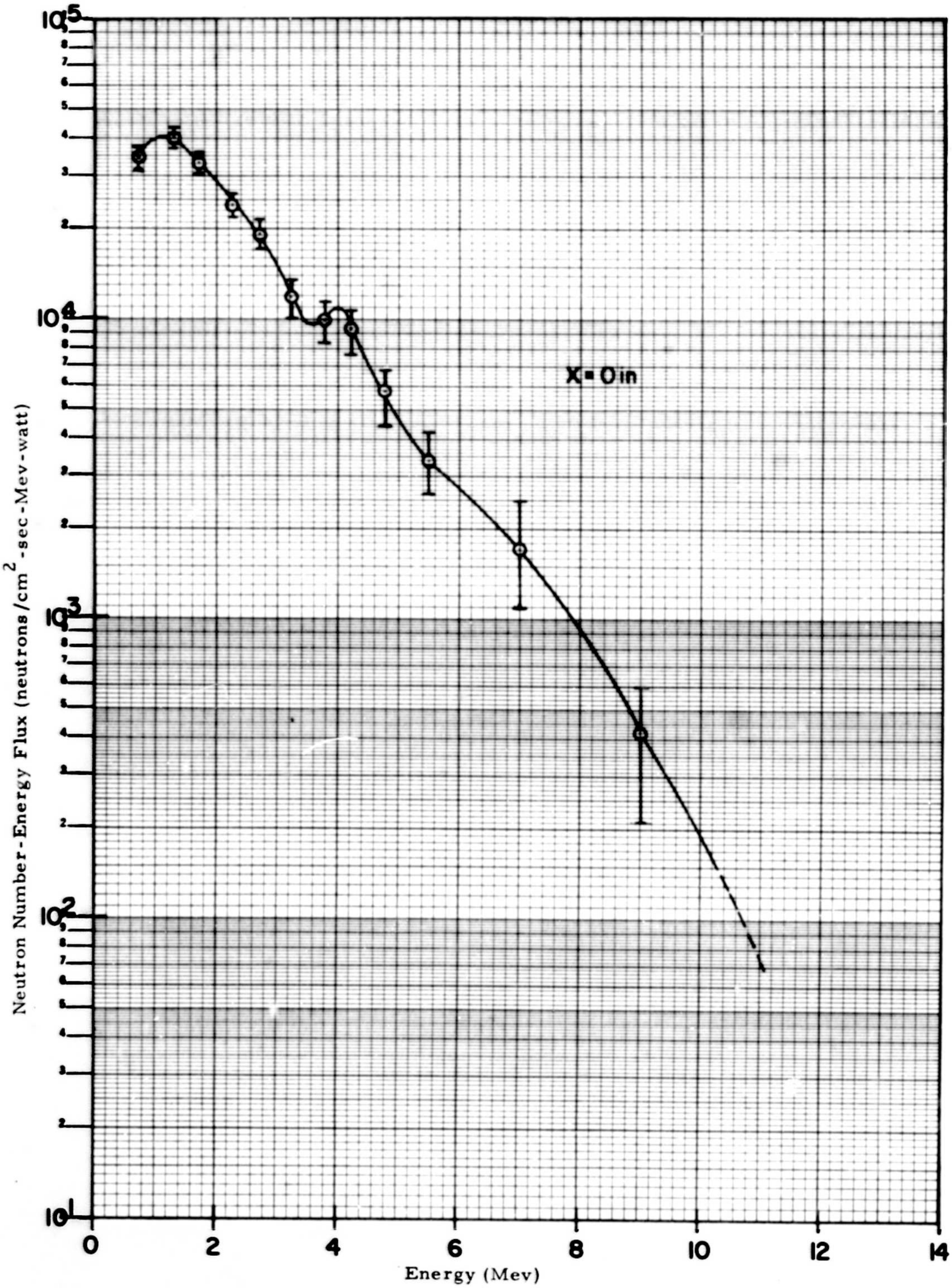
FLUXES AVAILABLE

The plot of the fast neutron spectrum is shown in Figure 14. The data for this plot was taken at distance (x=0) inches from the BSF window interface.

Figure 15 shows the neutron flux in the BSF as the x distance increases from the window interface. Three energy groups are plotted.

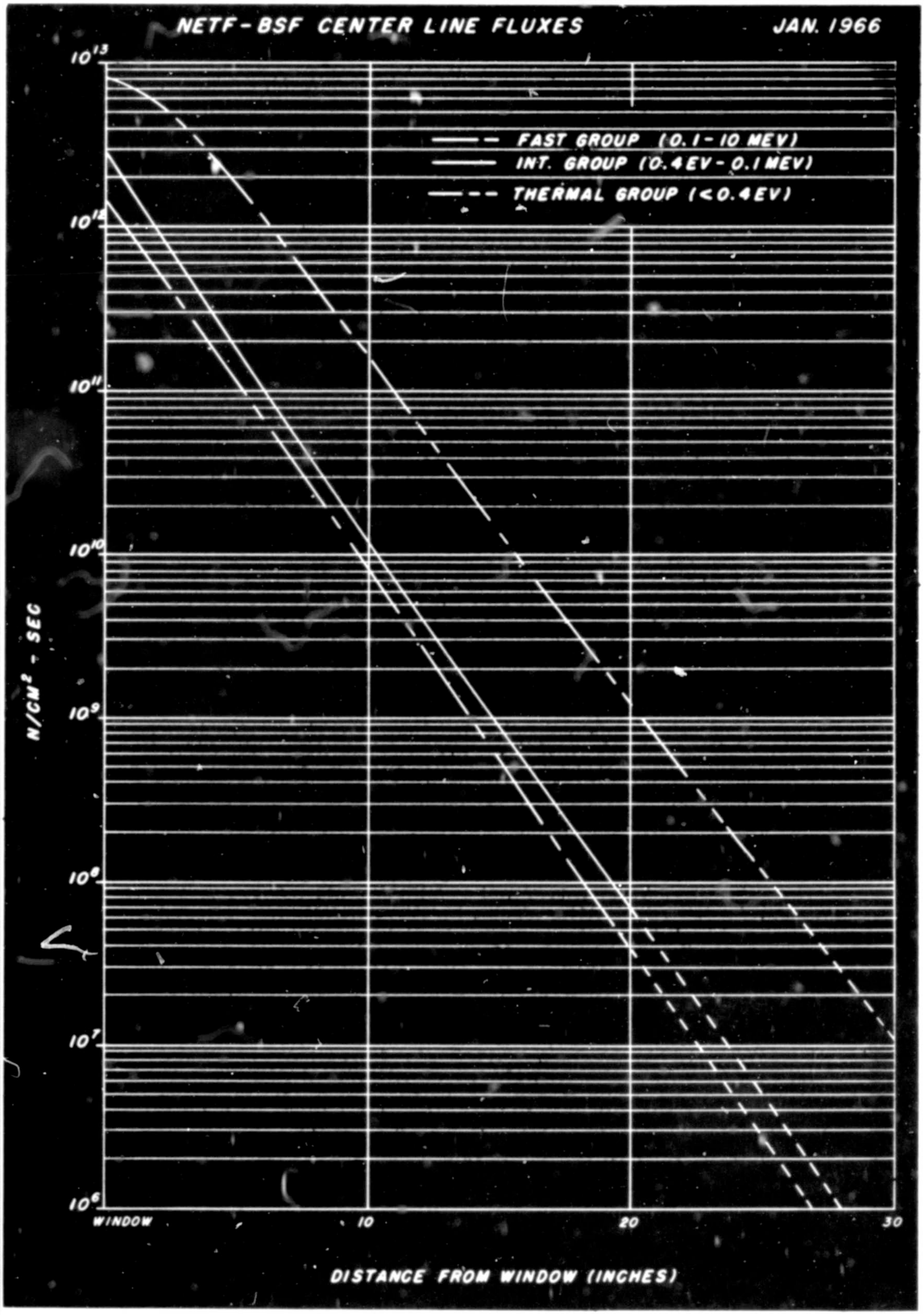
The gamma dose rate for the BSF is shown in Figure 16.

The gamma dose available in the Gamma Facility will be on the order of 10^7 ergs/gm-carbon per hour. Since this facility uses spent fuel elements as the gamma source, and as yet the reactor has not used sufficient fuel to make spent elements available, measured dose rates for this facility are unobtainable.



Spectrum of Fast Neutrons at the Window in the BSF

Figure 14



NETF-BSF CENTER LINE FLUXES
JAN. 1966
FAST GROUP (0.1-10 MEV)
INT. GROUP (0.4 EV-0.1 MEV)
THERMAL GROUP (<0.4 EV)
N/CM² - SEC
10¹³
10¹²
10¹¹
10¹⁰
10⁹
10⁸
10⁷
10⁶
WINDOW
10
20
30
DISTANCE FROM WINDOW (INCHES)

Figure 15

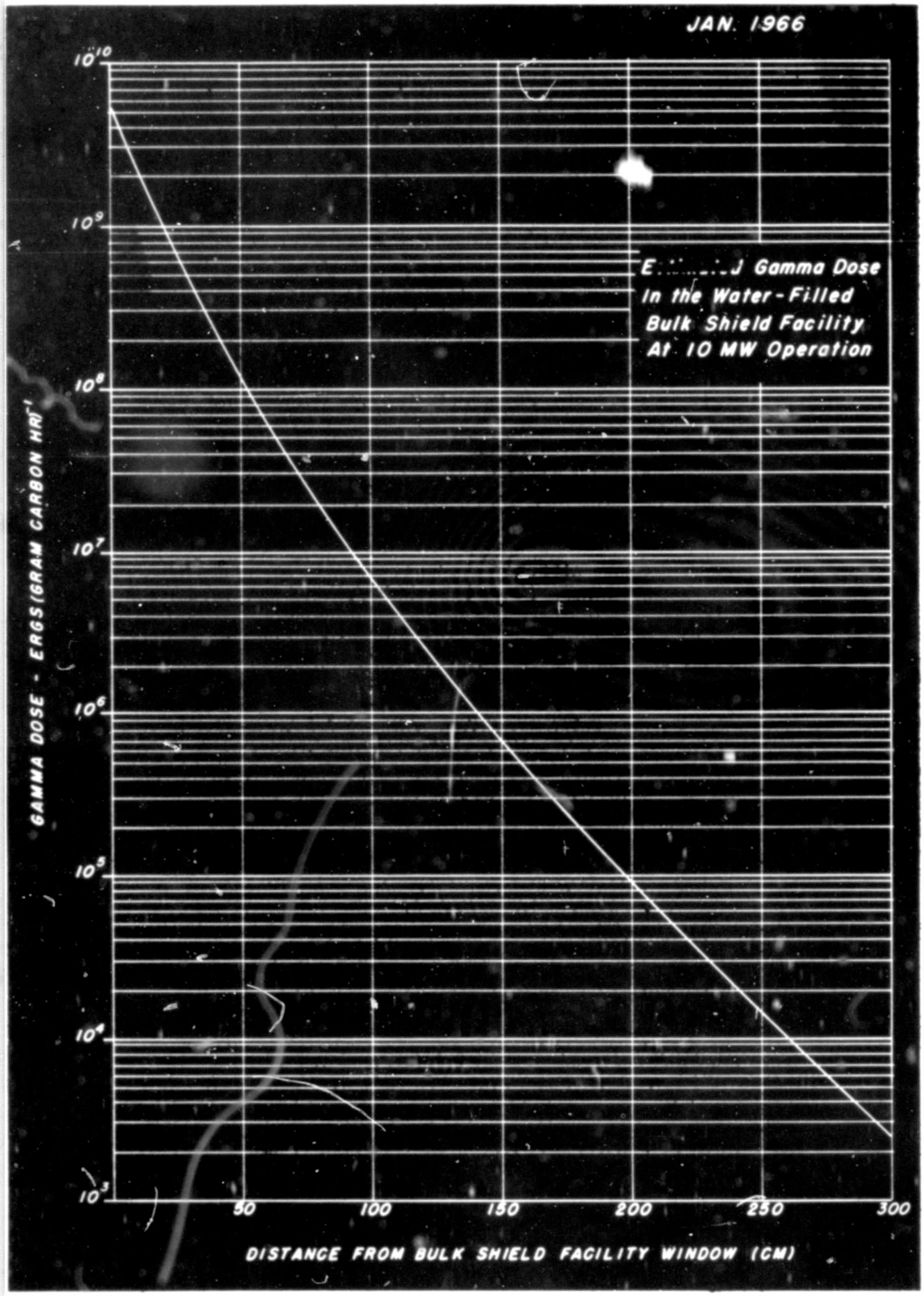

JAN. 1966
Gamma Dose
In the Water-Filled
Bulk Shield Facility
At 10 MW Operation
GAMMA DOSE - ERGS (GRAM CARBON HR)$^{-1}$
10^{10}
10^{9}
10^{8}
10^{7}
10^{6}
10^{5}
10^{4}
10^{3}
50
100
150
200
250
300
DISTANCE FROM BULK SHIELD FACILITY WINDOW (CM)

Figure 16

Section IV

BSF PHOTOGRAPHS

Figure 17 is an aerial view of the south-east quadrant inside the containment shell of the reactor building. The empty BSF is at the top of the picture and is spanned by the instrument bridge.

Figure 18 is a vertical view looking downward into the spent fuel element storage pit. The triangular shaped grating about half-way down is the level on which the gamma facility will be placed for irradiation use.

Notice at the upper left corner the empty gamma facility box.

The south-west quadrant of the reactor top level is shown in Figure 19. Here again, the instrument bridge is shown spanning the BSF.

An aerial view of the reactor top level and the BSF is shown in Figure 20. The top shielding plug is removed from the reactor core tank. This plug is in the upper right corner. When the reactor is operating, the plug is inserted over the core tank making that area floor level.

Figure 21 is the BSF floor and dolly. Notice the measuring rule at the right side of the dolly on the floor. This indexes the dolly distance from the reactor core east-west centerline. Another rule fixed to the dolly bed indexes the bed area from the rule on the floor. Using these indexes one can locate large experiments on the dolly and accurately position them with respect to the core and obtain the desired flux. The experiment holder rack is on the north end of the dolly.

The N-8 start-up channel arm is shown along with the arc in which it travels. The tube arrangement hanging down from the north wall is the fuel transfer mechanism. It is normally stored in the full vertical position, against the north wall.

At the south end of the BSF are stored the three neutron-gamma ratio curtains which can be used on the dolly.

Figure 22 is at floor level, clearly showing the dolly and the experiment holder rack in their closest approach to the BSF window.

The chain drive on the left side of the dolly has since been replaced by an electric motor drive for the rear wheels on the dolly. This new arrangement provides more accurate control of positioning an experiment in the desired flux.

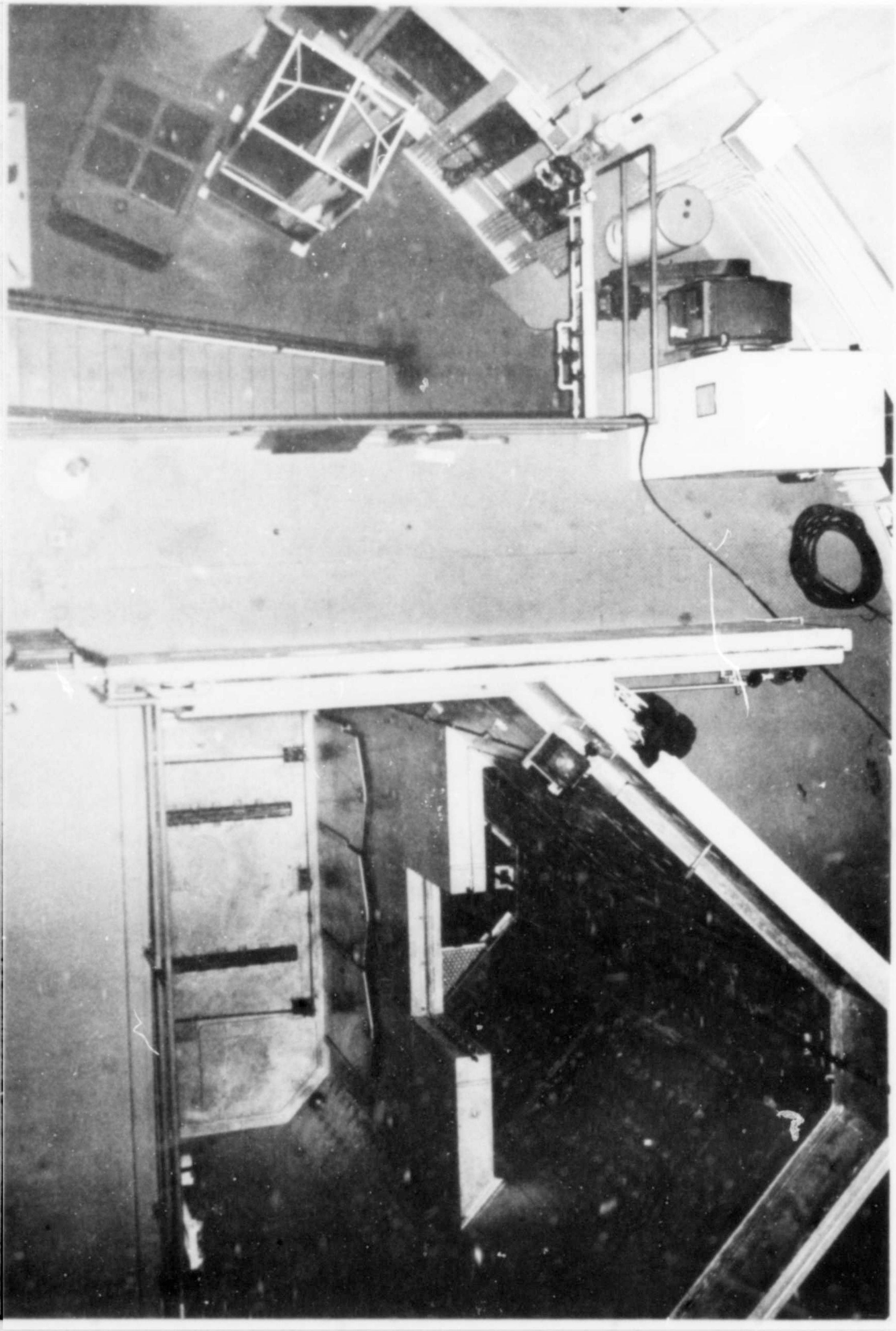


Figure 17

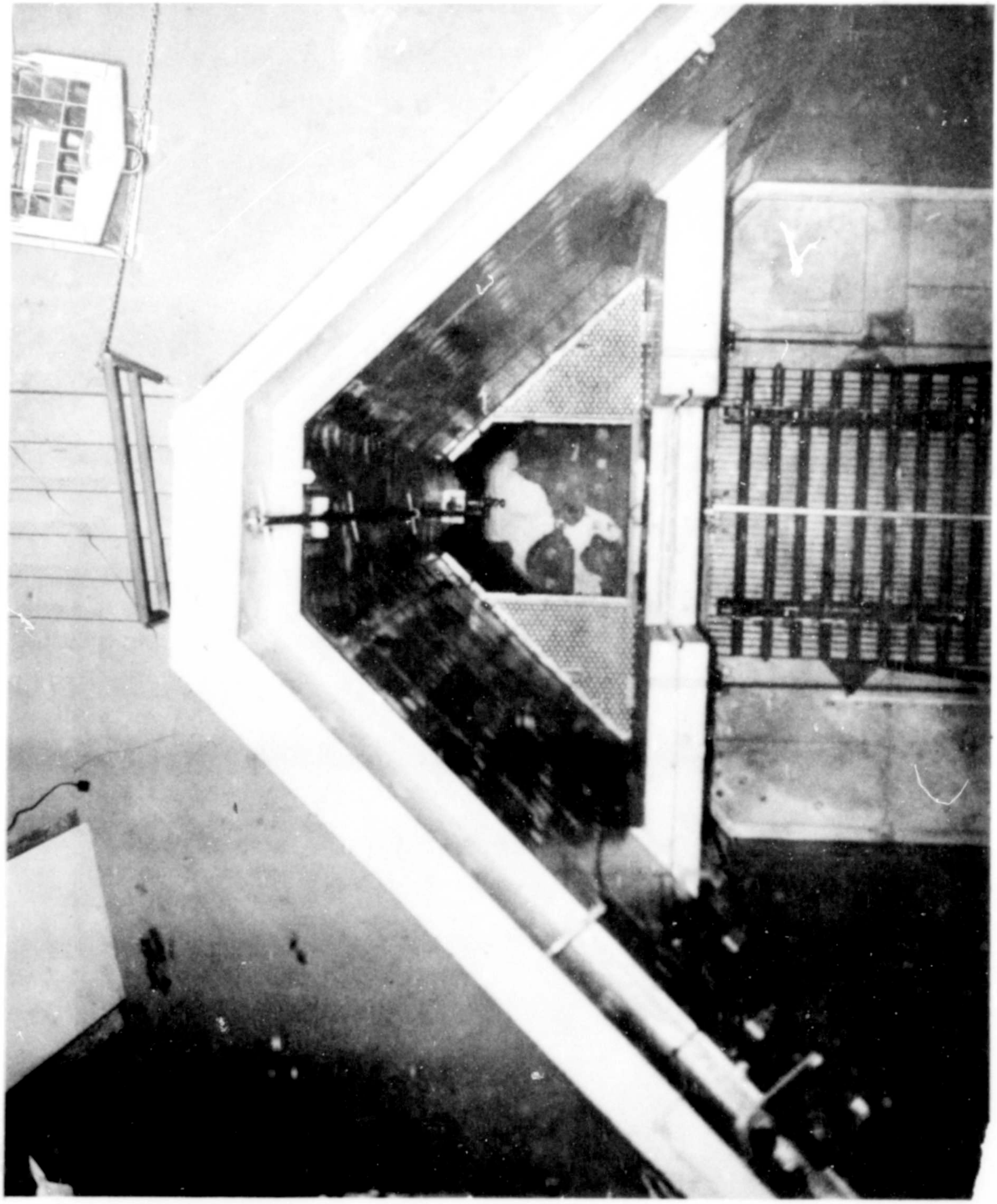


Figure 18

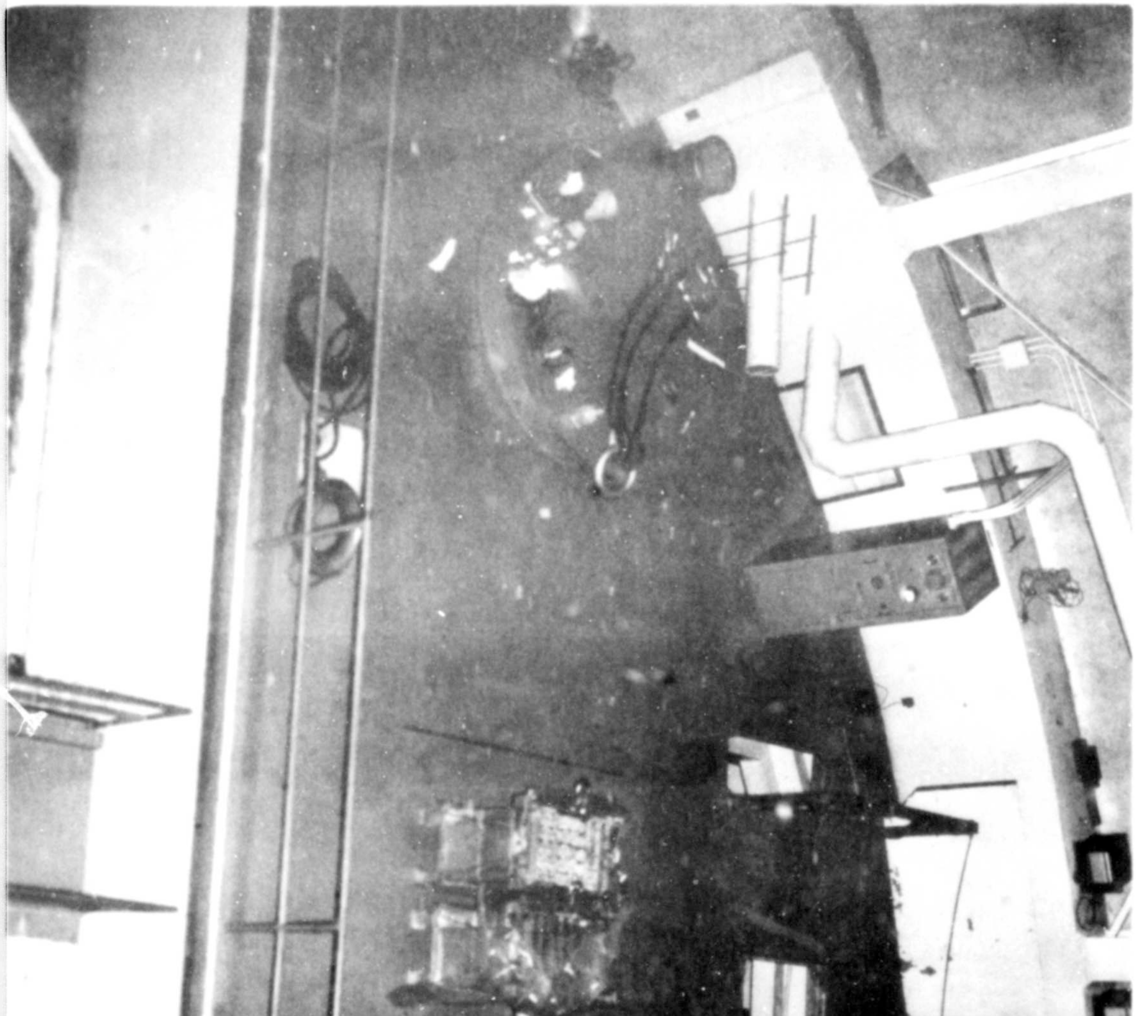


Figure 19

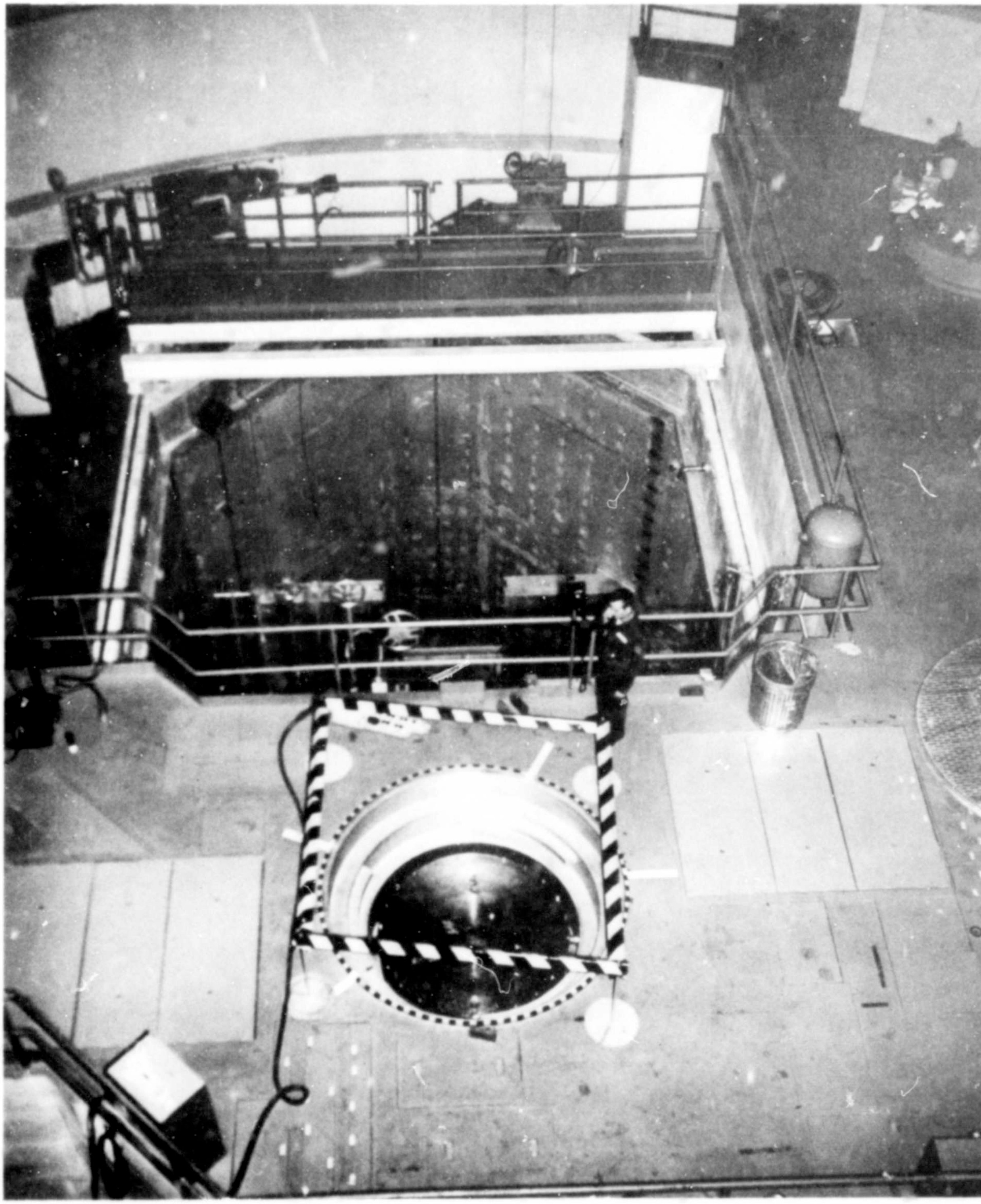


Figure 20

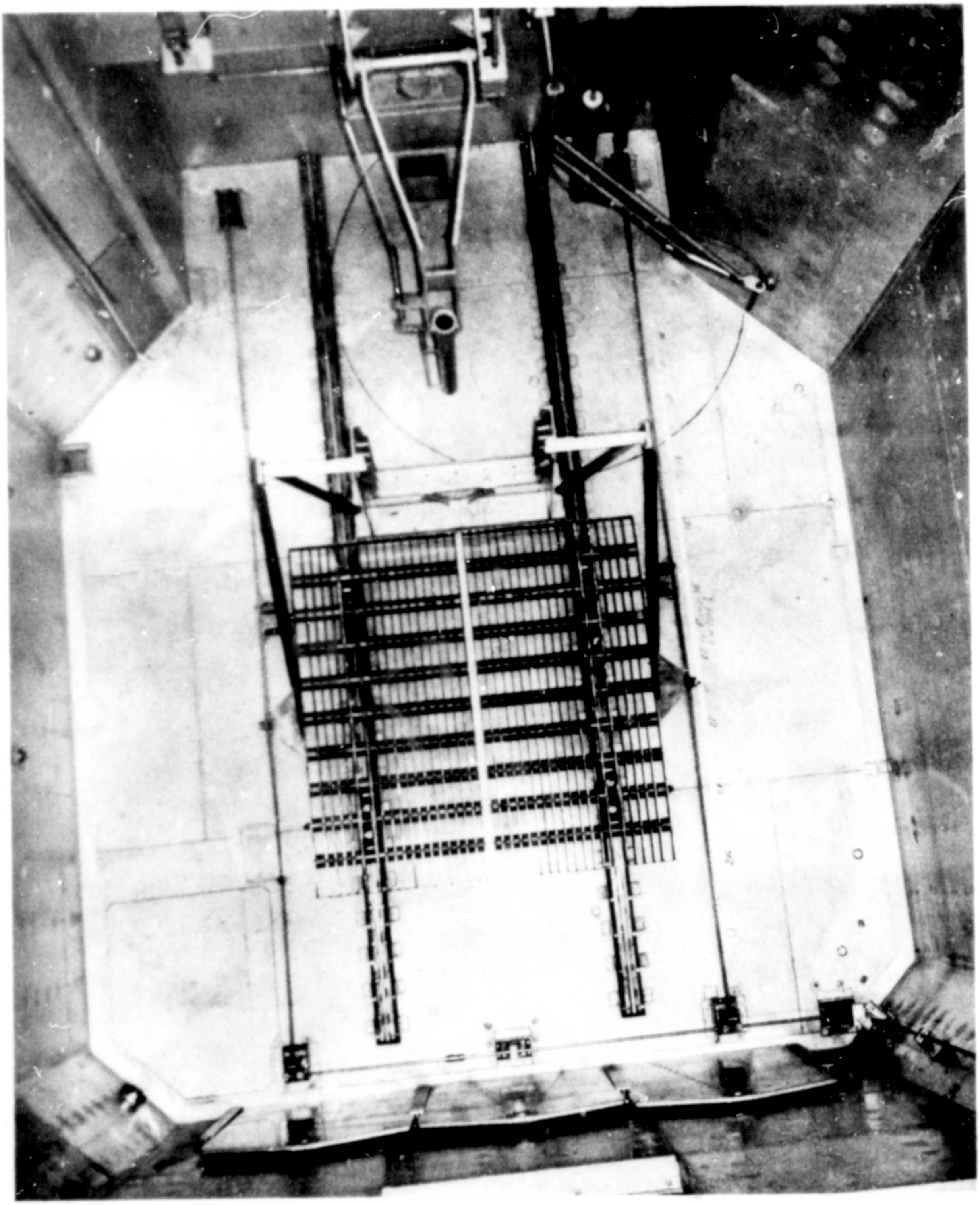
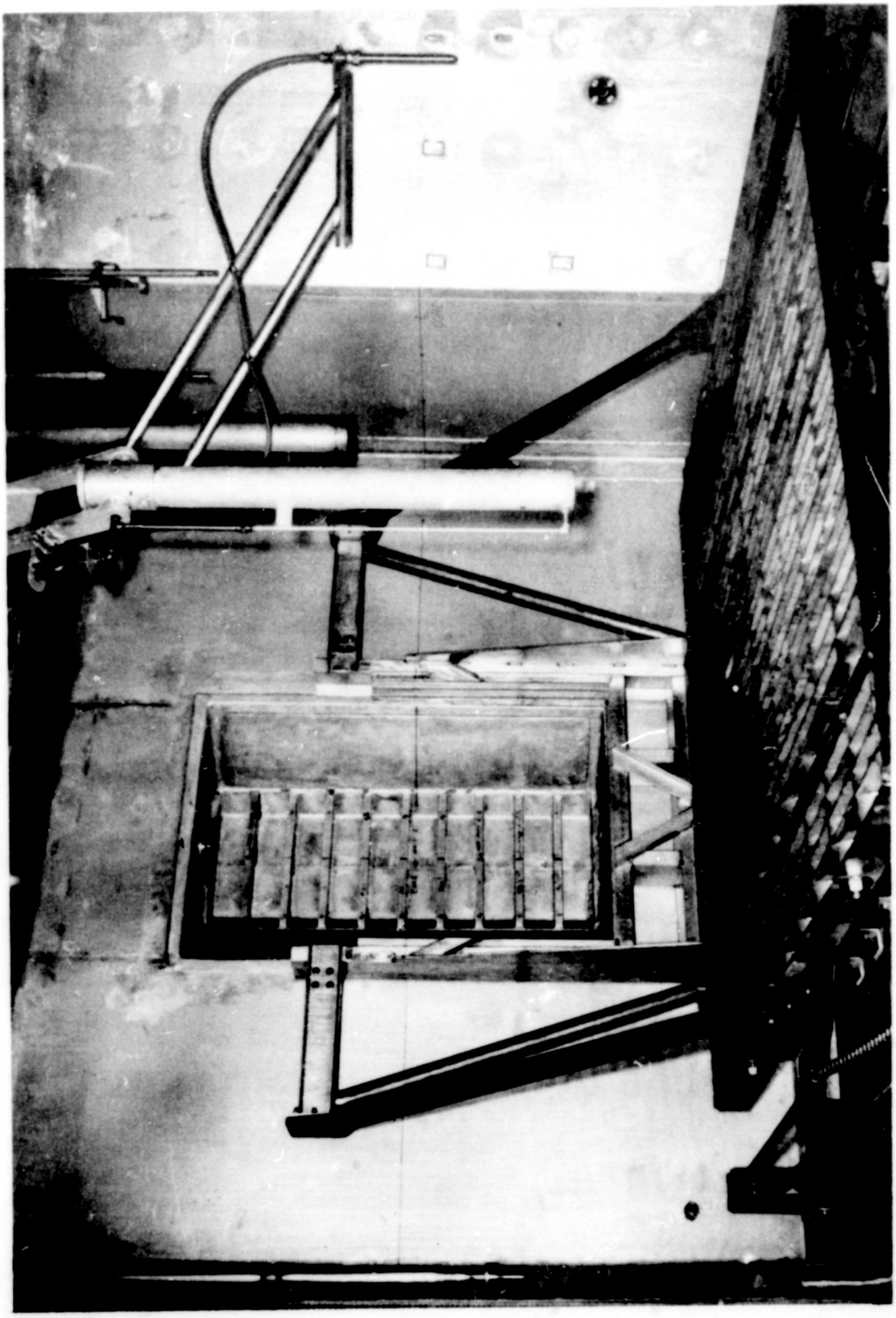


Figure 21



A close-up of the BSF window is Figure 23. Some of the as-built dimensions can be seen marked on the various surfaces.

Details of the experiment holder rack are also shown. This rack is also used to hold the neutron-gamma ratio curtains. These are inserted into the holder to selectively attenuate either the neutron or gamma flux such that variations in their ratios may be obtained. These curtains are only usable for experiments which would be mounted on the bed of the dolly.

Figure 24 is a close-up of the lower half of the BSF window showing details of the experiment holder rack interface with the window recess.

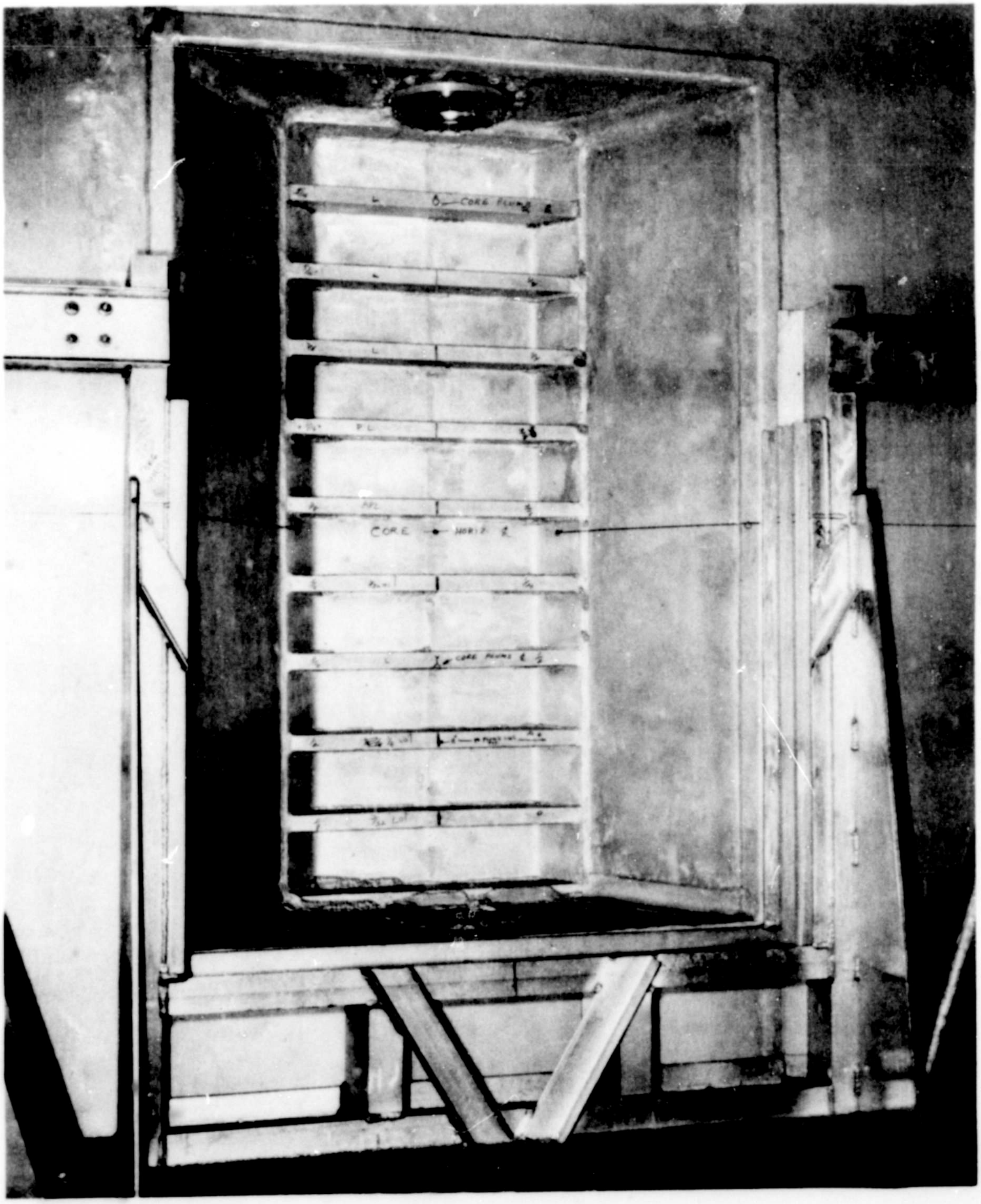


Figure 23

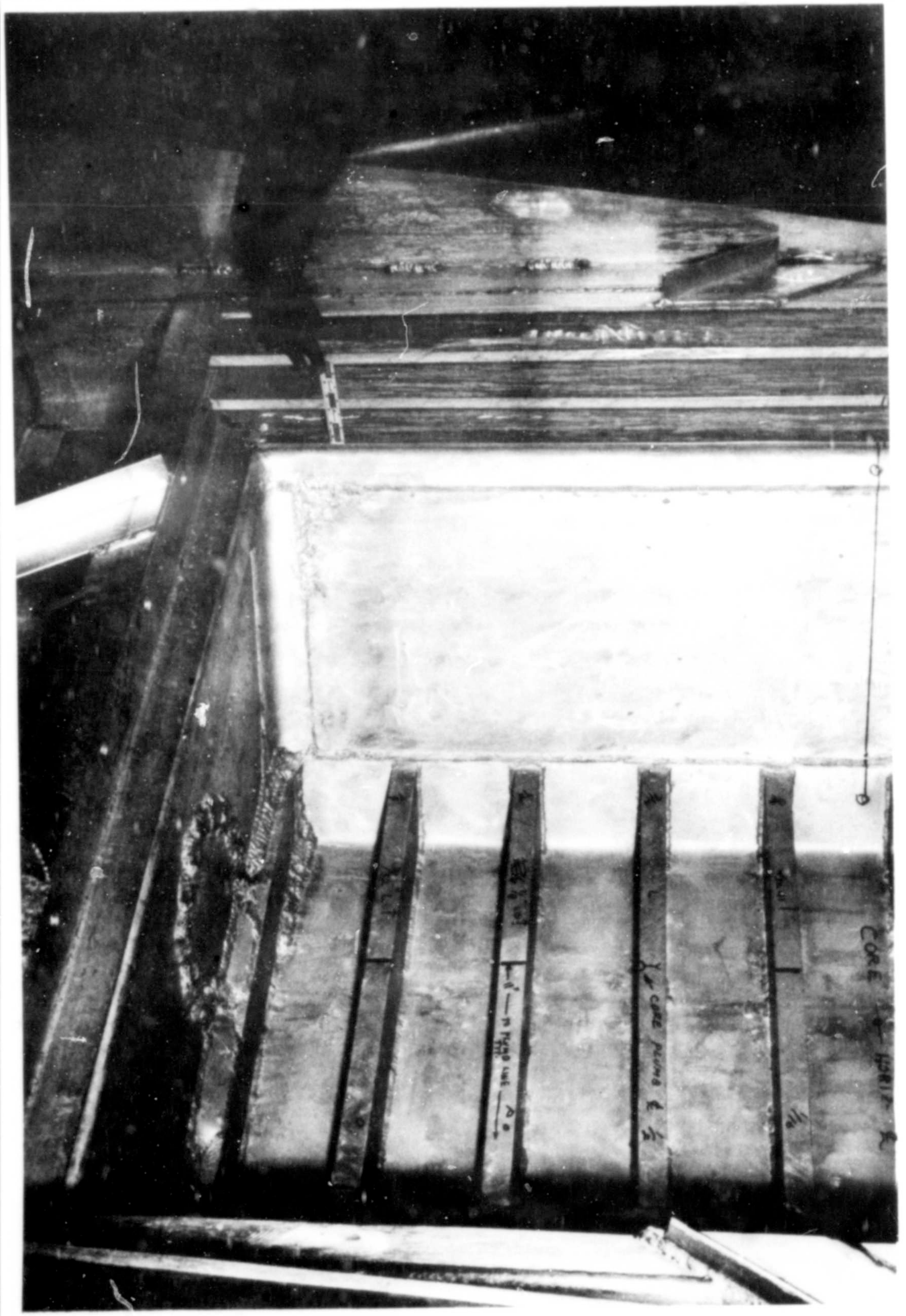


Figure 24

Section V

CONCLUSION

The close review of this report should be sufficient to gain an understanding of the capabilities and research applications offered by the bulk shield facility.

Additional information with regard to specific questions of usage is available upon request to: Director, AFIT-SEN (Det #11), Wright-Patterson Air Force Base, Ohio 45433. Attention: Engineering and Experimentation Division.

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13. ABSTRACT

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