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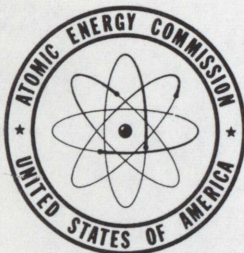
PHYSICS

UNITED STATES ATOMIC ENERGY COMMISSION

COST ESTIMATE FOR THE FOOD
IRRADIATION REACTOR

August 23, 1956

Internuclear Company
Clayton, Missouri



Technical Information Service Extension, Oak Ridge, Tenn.

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COST ESTIMATE
FOR THE
FOOD IRRADIATION REACTOR

Work Performed
for the
Schenectady Operations Office
U. S. Atomic Energy Commission

Contract No. AT(30-3)-252

Work Performed by

R. J. Jaffe
A. M. Larson, Jr.
C. F. Leyse
E. E. Mason
R. W. Sliger

INTERNUCLEAR COMPANY
Clayton, Missouri

August 23, 1956

1.0 Introduction

In April, 1956, the Schenectady Operations Office of the A.E.C. requested Internuclear Company to conduct studies, for the Army Reactors Branch, of reactors for the irradiation of food. The studies involved the selection of the most promising reactor type for the large scale production of gamma radiation for the food irradiation program of the Quartermaster Corps and a preliminary design of the system selected to the point where the major problems foreseen in the design, construction, and operation of the reactor-radiator complex could be ascertained. The following two reports covering the above work were submitted to the A.E.C. on July 1, 1956.

INTERNUC 2 - Selection of a Food Irradiation Reactor Type

INTERNUC 3 - Preliminary Design Study of a Food Irradiation Reactor

On July 30, 1956, the Schenectady Operations Office further requested Internuclear Company to prepare and submit to the A.E.C. on or before August 31, 1956 a cost estimate of the design and construction of the reactor and food irradiation facility, basing the estimate primarily on the design proposed in INTERNUC 3.

This report is the fulfillment of the above request.

2.0 Summary

A cost estimate summary, with a breakdown into the major categories, is given below. The summary is a condensation of the overall cost estimate given in Section 4.0.

Cost Estimate Summary

A. Construction (includes materials, equipment, fabrication, and installation)	\$ 1,733,000
B. Labor and weather allowance (10% of A)	174,000
C. Technical services (includes engineering and nuclear design, drawings, specifications, etc.)	225,000
D. Research and Development	415,000
E. Operating manual	25,000
F. Hazards Summary Report	25,000
G. Performance tests (including auxiliary equipment necessary for tests)	151,000

Sub-Total	\$ 2,748,000
Contingency (15%)	412,000

Total	\$ 3,160,000

3.0 Bases for Cost Estimate

The cost estimate outlined in Section 4.0 includes cost of all labor, equipment, and materials involved in the design and construction, the research and development, and the test operation of the FIR.

In general, the cost estimate is based on the reactor concept proposed in INTERNUC 3 and the Scope of Work (as enclosed in proposal invitations) covering the design, development, construction, and test operation of the FIR. However, the cost estimate is based on a more thorough consideration of the overall plant requirements than is evidenced in the preliminary study report (INTERNUC 3). In this regard, preliminary building layouts to show more completely the extent of space and structure required for the indium system equipment, control room, offices, health physics room, electrical switchgear, heating and ventilating equipment, and other equipment and functions directly associated with operation of the FIR, were prepared. These layouts, which are shown by Figures A, B, C, and D of Appendix A, served as additional bases for the cost estimate.

Wherever possible, estimated costs were obtained from commercial vendors for items which will be so supplied. In the absence of such information and for evaluating the many non-commercial components, discriminating comparison was made with other known reactor plant costs and experience data.

In compiling the cost figures a contingency factor is included to allow for inaccuracies normally expected in estimating work. Allowance for contingency in this case is based upon the degree of completion of designs and is taken as approximately 15 percent of estimated cost. It is not intended that the contingency be sufficient to cover work beyond the scope of the present conception.

To account for labor scales and productivity in various locations of the country and also to allow for climatic conditions, a value of 10 percent of the construction, fabrication, and installation cost is included. This labor and weather allowance may be high or low since it depends strongly on site location.

In addition to the above, costs of the following are also included: technical services, research and development, operating manual, hazards summary report, and performance tests.

Technical services cover design, drawings, specifications, liaison,

as well as nuclear calculations directly related to the design (not research and development) work.

The costs for the research and development program were taken directly from INTERNUC 5, "Research and Development for the Food Irradiation Reactor", a report recently submitted to the A.E.C. These costs cover both the theoretical and experimental work involved in the research and development.

Included in the performance test are: 1) specific tests of individual items, components and systems, 2) a 100 hour minimum non-critical test run, 3) a low and high power performance test, and 4) a 360 hour performance test, as outlined in the Scope of Work. In addition to the work as outlined in the Scope of Work, it appears to be desirable to obtain information on the following during the performance tests:

- a. neutron flux distributions in the reactor
- b. shielding survey of reactor-radiator system
- c. statistical weights in the reactor core
- d. reactivity effects of empty and water filled blanket

An allowance for the above, as well as similar tests, has been included in the cost of the 'low and high power test'. The cost of this particular test phase is therefore relatively high. Included in the costs for all performance tests are allowances for proper reporting of the information obtained, as well as the cost of test equipment such as dummy fuel elements, auxiliary heaters for the primary coolant, and miscellaneous test hardware.

4.0 Cost Estimate

A. Construction, Fabrication, and Installation		\$1,733,000
1. <u>Reactor Assembly</u>		\$ 82,000
Reactor tank	\$ 8,000	
Reactor internal assembly	8,000	
Fuel elements (one loading)	24,000	
Control rods	3,000	
Control mechanisms	27,000	
Blanket tank	4,000	
Thermal shield	8,000	
2. <u>Reactor Equipment</u>		52,000
Fuel coffin	35,000	
Fuel storage rack	1,000	
Misc. handling tools	2,000	
Fuel cut-off saw	8,000	
Shield pool tank	6,000	
3. <u>Reactor and Radiator Building Structure</u>		497,000
Reactor building en- closure	80,000	
Concrete (Barytes and common)	272,000	
Masonry and roofing	24,000	
Floor plugs	6,000	
Structural steel	95,000	
Insulation	20,000	
4. <u>Reactor and Radiator Building Equipment</u>		86,000
Cranes (20 ton, 5 ton, and utility)	38,000	
Service elevator	10,000	
Heating and ventilating	10,000	
Plumbing and domestic water and steam	9,000	
Electric outlet service	10,000	
Compressed air system	6,000	
Communications equipment	3,000	

5.	<u>Demineralizer and Pump Building</u>		\$ 15,000
6.	<u>Nuclear Instrumentation and Controls</u>		70,000
	Instruments and indicators	\$55,000	
	Control panels	8,000	
	Fission chamber drives	7,000	
7.	<u>Indium Loop Instrumentation and Controls</u>		63,000
	Instruments and indicators	56,000	
	Graphic panel	7,000	
8.	<u>Process Water Instruments and Controls</u>		64,000
	Instruments and indicators	59,000	
	Panels	5,000	
9.	<u>Electrical Distribution System</u>		60,000
	Transformers	22,000	
	Switchgear	26,000	
	Regulated power supply	12,000	
10.	<u>Indium Loop Equipment</u>		547,000
	Vessels	123,000	
	Indium sulfate	40,000	
	Pumps	6,000	
	Valves	33,000	
	Pipe	52,000	
	Pipe fittings	17,000	
	Condensers	12,000	
	Misc. equipment	4,000	
	Refrigeration and heating units	40,000	
	Lead shielding for pumps, etc.	65,000	
	Waste storage tank containment	23,000	

	Cubicle liners	\$ 19,000	
	Remote sampling and analytical facilities	50,000	
	Retention basin and equipment	21,000	
	Radiators	42,000	
11.	<u>Primary Reactor Cooling Circuit</u>		\$ 98,000
	Heat exchangers	57,000	
	Pipe and valves	15,000	
	Pumps	13,000	
	Pressurizer and heaters	3,000	
	Purification equipment	10,000	
12.	<u>Auxiliary Cooling Circuit</u>		20,000
	Heat exchanger	6,000	
	Pipe and valves	6,000	
	Pumps	8,000	
13.	<u>Secondary Cooling Circuit</u>		59,000
	Water cooling towers	24,000	
	Pumps	14,000	
	Pipe and fittings	10,000	
	Softener	10,000	
	Chemical feed equipment	1,000	
14.	<u>Deionized Water Supply</u>		20,000
	Storage tank	10,000	
	Deionizers	10,000	
	Sub Total All Items Under 'A'		<u>\$1,733,000</u>
B.	<u>Labor and Weather Allowance 10%</u>		174,000
C.	<u>Technical Services</u>		225,000

D.	<u>Research and Development</u>		\$ 415,000
	1. Nuclear Characteristics	\$113,000	
	2. Indium System	200,000	
	3. Gamma Radiators	78,000	
	4. Reactor Components	24,000	
E.	<u>Operating Manual</u>		25,000
F.	<u>Hazards Summary Report</u>		25,000
G.	<u>Performance Test (incl. auxiliary equipment for tests)</u>		151,000
	1. Site and Structure	10,000	
	2. System Components	10,000	
	3. System Integrity	17,000	
	4. Non Critical Test Run	15,000	
	5. Low and High Power Test	65,000	
	6. 360 Hr. Performance Test	20,000	
	7. Test Equipment	14,000	
	Dummy elements	\$ 6,000	
	External heat source	4,000	
	Misc. tools and parts	4,000	
	Sub Total		\$2,748,000
	Contingency 15%		412,000
	<u>Total Estimated Cost</u>		\$3,160,000

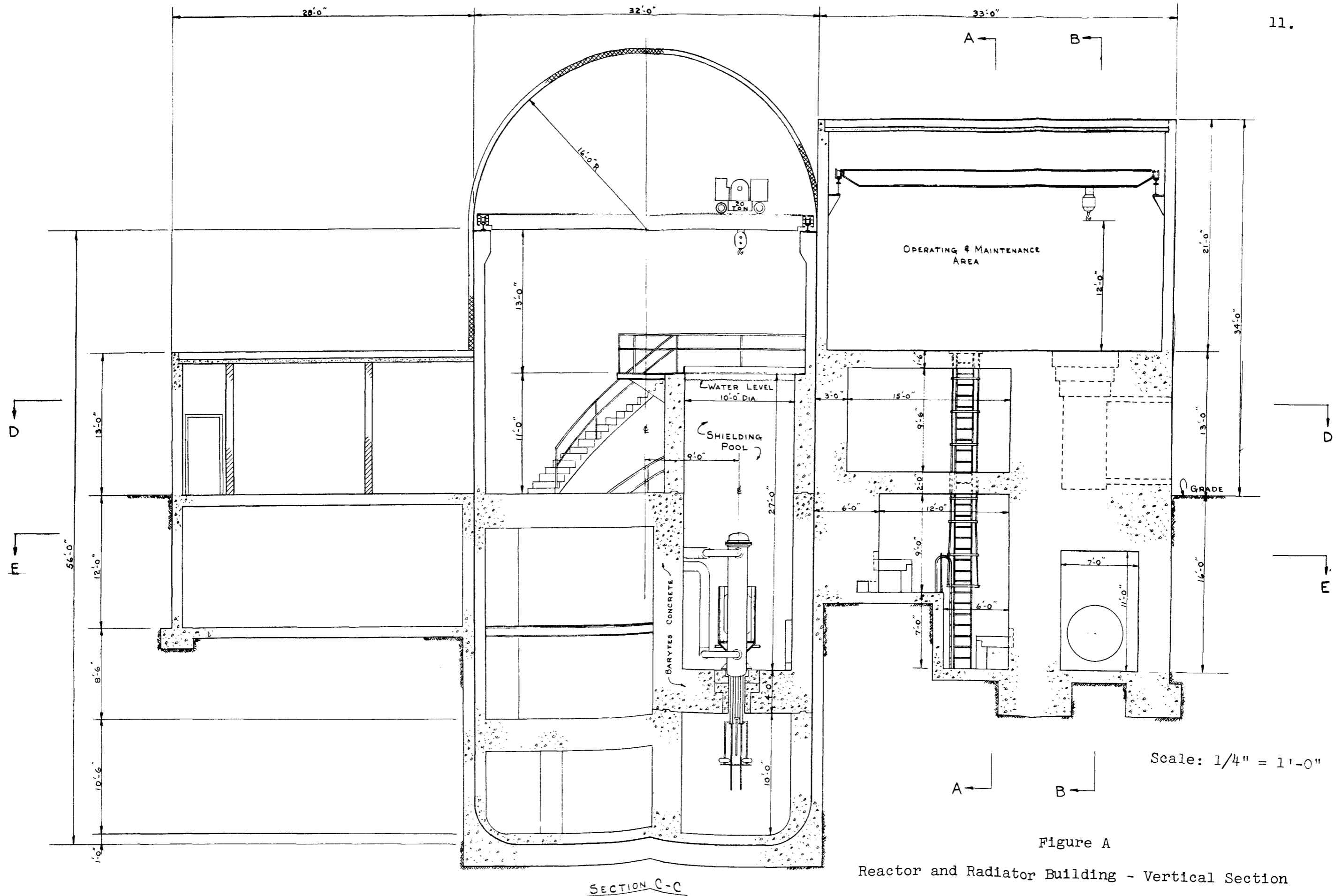
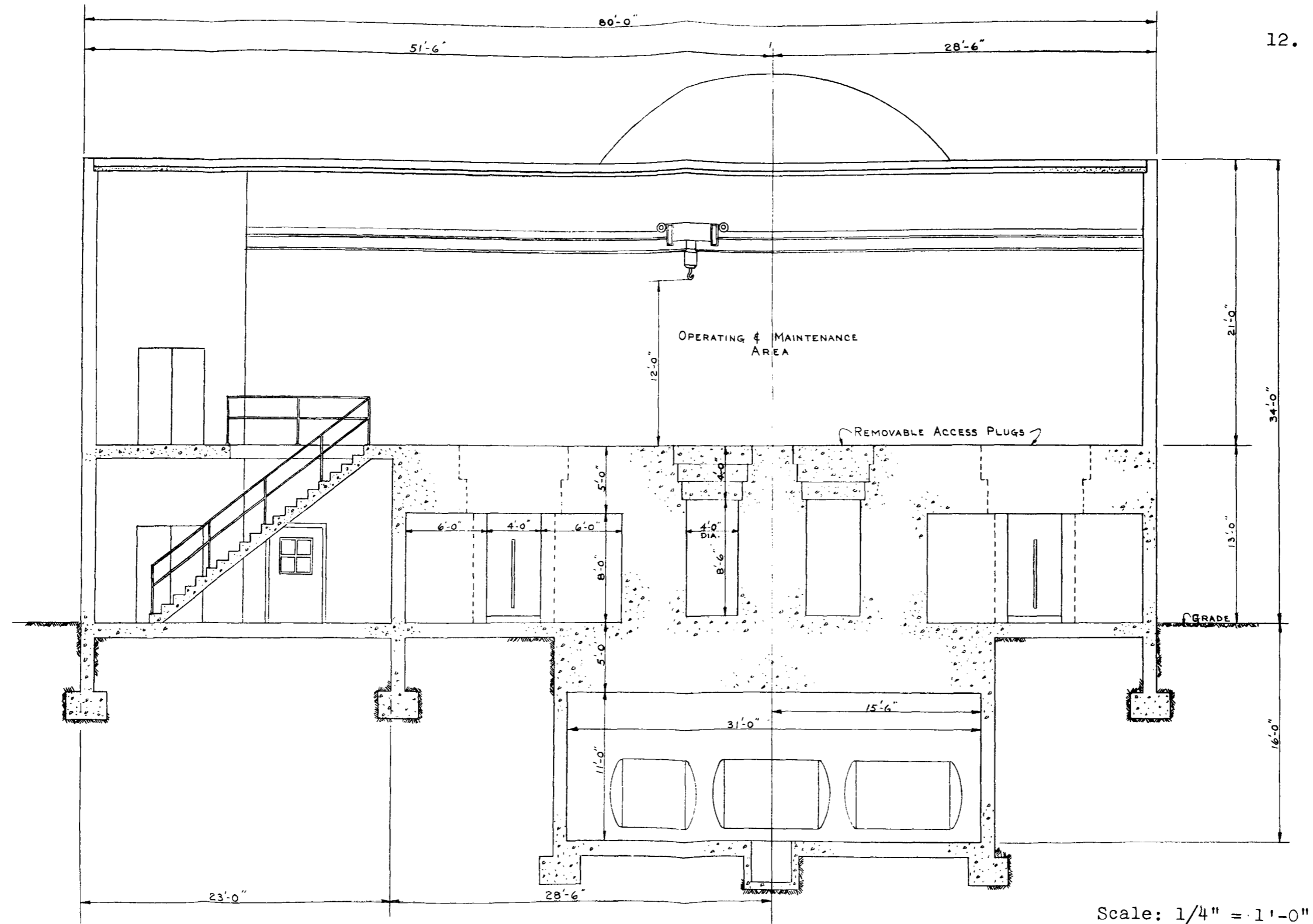


Figure A
Reactor and Radiator Building - Vertical Section



12.

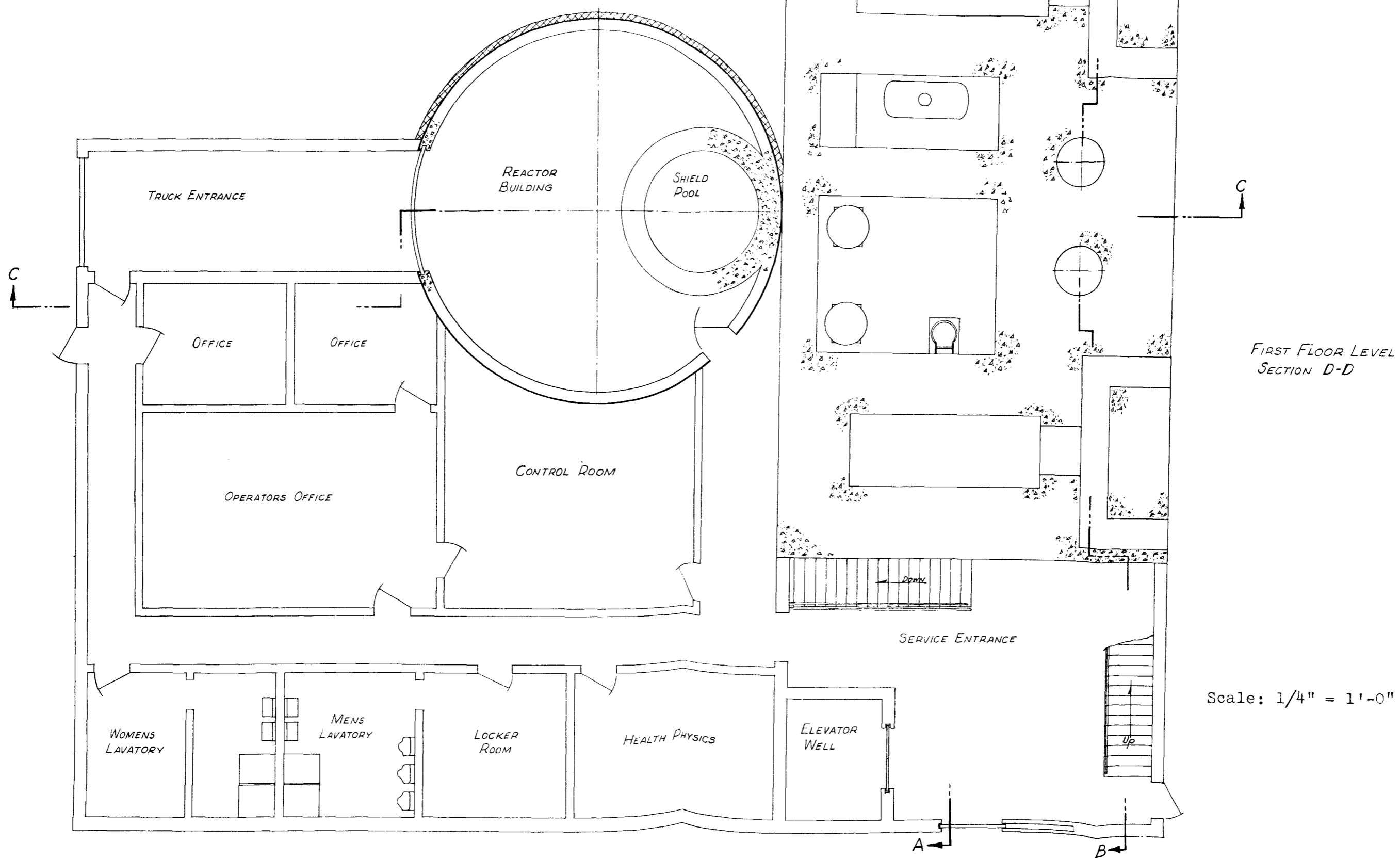
SECTION B-B

Figure B

Reactor and Radiator Building - Vertical Section

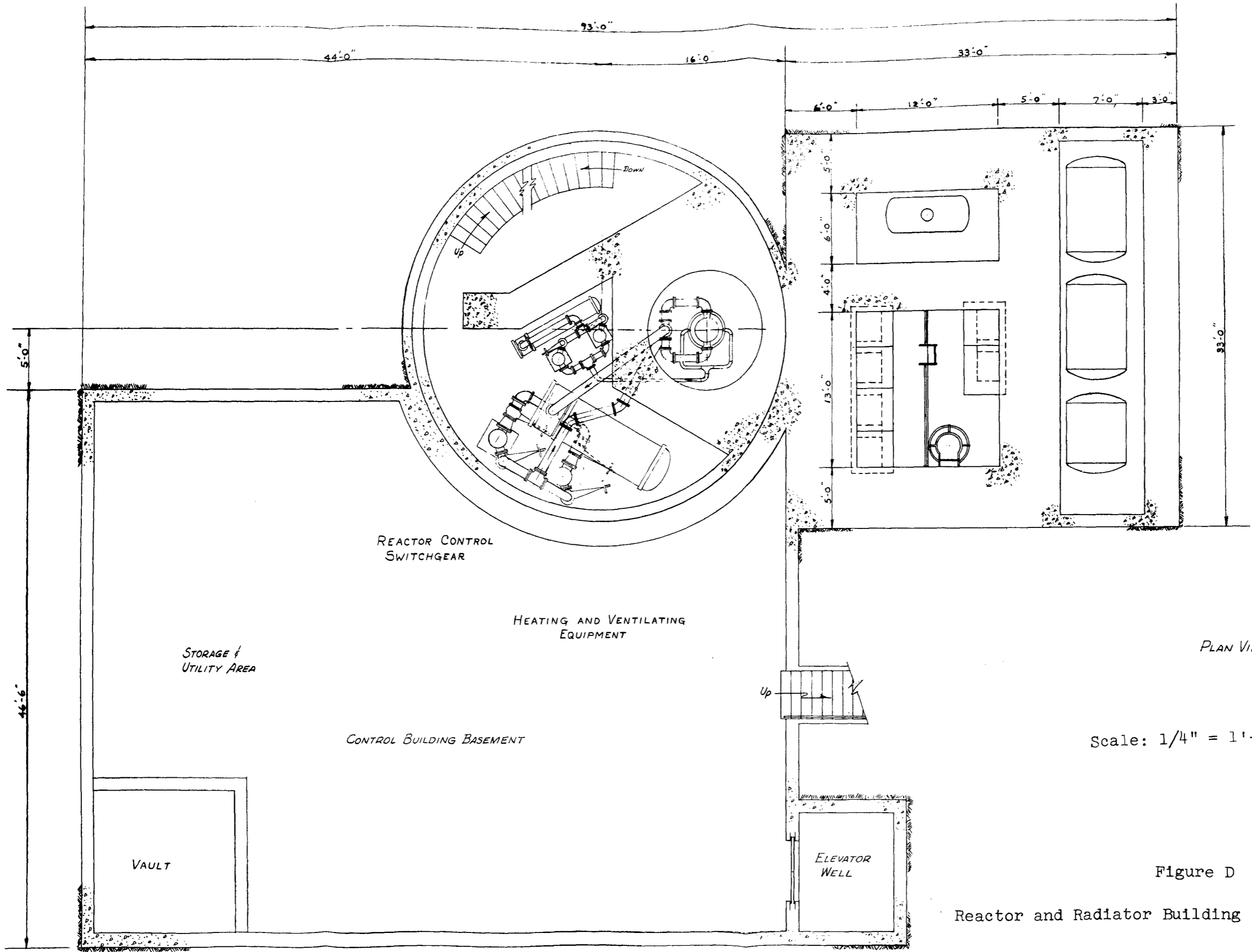
Figure C

Reactor and Radiator Building - Horizontal Section



FIRST FLOOR LEVEL
SECTION D-D

Scale: 1/4" = 1'-0"



PLAN VIEW 5FT. BELOW GRADE
SECTION E-E

Scale: 1/4" = 1'-0"

Figure D
Reactor and Radiator Building - Horizontal Section

