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AEC Hot Cells and Related Facilities

Technical Information Service Extension
Oak Ridge, Tennessee

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AEC Hot Cells and Related Facilities

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Division of Construction and Supply
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FOREWORD

The primary purpose of this report is to present an accumulation of basic information on the hot cells constructed to date by the United States Atomic Energy Commission.

The need, by both the Government and industry for information on hot cells constructed by the AEC, has been increasing as the atomic energy program in the United States has expanded. Hot cells are basic tools that are used in almost all phases of the atomic energy program for research, development, and operation in connection with irradiated materials.

To obtain the basic information needed for this report, the AEC Division of Construction and Supply prepared a questionnaire, with the advice and assistance of the Division of Reactor Development, which was sent by the Division of Reactor Development in December 1956 to each AEC operations office where hot cells are located. This report is a compilation of the data supplied in reply to these questionnaires; in addition, it includes information on unit construction costs and related matters.

Additional information is needed regarding the preferred type of biological shielding to be used, standardization of biological shielding, and shielding-window thickness and related matters. Further study of these matters should be undertaken, directed toward the establishment of design criteria for hot cells and the development of a standard specifications.

To facilitate comparison of the various cells, unless otherwise indicated, they are rated in terms of 1-Mev gamma sources.

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1 Introduction

Experiments and processes involving radioactivity frequently require remote handling inside a biological shield and viewing through shielding windows or optical devices. Such shielded enclosures, equipped with viewing devices and remote-handling equipment, are referred to as "hot cells."

Hot cells are used for a wide variety of purposes. For example, they may contain facilities for carrying on various chemical- and metallurgical-separations processes on irradiated reactor fuel elements; for machining operations and measurements on irradiated metal and related metallurgy and physics investigations; for preparation, examination, and testing of metallographic specimens; for repair and maintenance of radioactive components of experimental machines and equipment; for handling and packaging high-level Co^{60} and Ce^{137} sources designated for commercial purposes; and for processing I^{131} for medical and research institutions and other AEC installations.

A single-purpose hot cell used for a production or routine process does not need the versatility required in hot cells in which the nature of future experiments and equipment may vary widely and can be quite unpredictable at the time of construction. Hot cells designed for research and development work must have a wide degree of flexibility if they are to handle satisfactorily many different kinds of work without costly and time-consuming alterations. For this reason the cost of hot cells of the same size can vary widely, depending upon the maximum radiation level expected and the provisions for shielding windows and special equipment.

Hot cells reported upon herein are structures permanently located in laboratories. Portable and semiportable hot cells, shielded boxes, and very large cells, such as hot shops, have not been included in this report.

The preparation of this report, which to a considerable extent is based upon a compilation of data primarily of a nonoperating nature, emphasizes the need for additional studies and reports on hot cells directed toward better design, lower construction costs, and improved operation. In particular, studies are needed to:

1. Determine the optimum size of hot cell to construct
2. Standardize as many aspects of hot cells and related facilities as possible
3. Determine the best and lowest cost materials to use for biological shielding
4. Determine the best methods of operating hot cells to increase the amount of time they are used, increase the uses to which they are put, and develop improved methods of operation.

Some of these matters will require the assistance of suppliers, particularly in the development of certain standards.

Hot cell, as used in this report, includes the biological shield enclosing the working space in the hot cell, viewing devices, special ventilating equipment, and special equipment for use in the hot cells, such as manipulators, cranes, machine tools, and measuring devices. A hot cave is the same as a hot cell, and this term is used when so designated by the individual operations offices. A junior hot cave is a small-sized hot cave.

The hot cells described in this report are listed here according to use. Column 1 of this tabulation lists the operations office, column 2 gives the location and building number, and column 3 is a brief description of the hot cells. A number in parentheses following the cell description indicates more than one cell.

Chemical Research:

Chicago	Argonne National Laboratory, Bldg. 40	Chemical research, main cave
	Bldg. 40	Chemical research, junior cave
	Bldg. 200	Heavy-element chemical processing, junior cave
	Bldg. 211	Radioactive chemical processing, junior cave (2)
	Bldg. 205	Chemical engineering, junior cave
Hanford	Redox Analytical Laboratory, Bldg. 222-S	Multicurie cells (2)
Oak Ridge	Unit operations, Bldg. 4505	Chemical solvent experiment semiworks cells (6)
San Francisco	Canoga Park	Atomics International, hot cave
	Livermore Radiation Laboratory, Bldg. 121	Chemical operations cell 2

Fuel-element Service and Testing:

Chicago	Ames Laboratory	Fuel-element-process hot cell 1 Fuel-element-process hot cell 2
Idaho	Chemical Processing Plant, Bldg. 627	Multicurie cell
Oak Ridge	Chemical Processing Pilot Plant, Bldg. 3019	High-radiation-level analytical facilities (8); also one shielded tunnel
	High-level Radiochemical Laboratory, Bldg. 4501	Corrosion examination, machining station defilming station weighing station
San Francisco	Santa Susana	Sodium Reactor Experiment, primary cell secondary cell
Schenectady	West Milton, Fuel-element Service	Fuel-element service cell (2)

General Purpose:

Albuquerque	Mound Semiworks	Area 1A, cave
Oak Ridge	Solid State Laboratory, Bldg. 3025	General-purpose cells 3 and 6
San Francisco	Livermore Radiation Laboratory, Bldg. 121	General utility cell 1
Savannah River	Main Technical Laboratory, Bldg. 773-A	General purpose (3)
Schenectady	Knolls Atomic Power Laboratory, Irradiation Laboratory	Very high level double cells 3 and 4 Low-level utility cell 6

Isotope Research and Processing:

Oak Ridge	Unit Operations, Bldg. 4505	Isotope research (4)
	Remote-control Cell, Bldg. 3029	Multi-kilocurie loading cell Argonne type general-purpose cell
	Radioiodine separation, Bldg. 3028	I^{131} processing facility

Materials Testing and Radiometallurgy:

Chicago	Argonne National Laboratory, Bldg. 301	Machining measurements, etc., caves 1 and 2
	Bldg. 17	Metallurgy, junior cave
	Bettis Physics of Solids Laboratory	Original hot cells (5)
		Expanded hot cells (3)
	Lockland Radioactive Materials Laboratory	Hot cell (3)
	Aircraft Nuclear Propulsion Project, Bldg. 607	Special-services cubicle
Hanford	Radiometallurgy, Bldg. 327	Irradiated-material cell B
		Physical and mechanical testing cells D and E
		Decontamination cell
		Density-measurement cell
		Double-crystal X-ray diffraction cell
		High-temperature tensile-testing cell
		Room-temperature tensile-testing cell
Idaho	Materials Testing Reactor, Bldg. 632	Materials Testing Reactor hot cell
Oak Ridge	Solid State Laboratory, Bldg. 3025	Machine shop cell 1
		Corrosion examination cell 4
		Tensile testing cell 5A
		Impact station cell 5B
San Francisco	Livermore Radiation Laboratory, Bldg. 121	Hot machine shop cell 34 (2)
		Preparation cell 5
		Metallurgical examination cell 6
		Metallographic cave
Schenectady	Knolls Atomic Power Laboratory, Irradiation Laboratory	High-level double cells 1 and 2

Metallography:

Chicago	Argonne National Laboratory, Bldg. 301	Metallographic cave 3 (3)
Hanford	Radiometallurgy, Bldg. 327	Metallographic cell C
Oak Ridge	Solid State Laboratory, Bldg. 3025	Remote metallography cell 2
		Metallographic cell
Schenectady	Knolls Atomic Power Laboratory, Irradiation Laboratory	Remote metallography cell 5

The following list comprises the names of the contractors operating the AEC hot cells. Columnar listing includes: (1) the name of the contractor; (2) the operations office; (3) location; and (4) a brief description of the hot cell. Numbers in parentheses in the description column again indicate more than one cell.

Atomics International	San Francisco	Canoga Park	Atomics International hot cave
		Santa Susana	Sodium Reactor Experiment, primary cell
			Sodium Reactor Experiment, secondary cell

E. I. du Pont de Nemours & Co., Inc.	Savannah River	Main Technical Laboratory, Bldg. 773-A	General-purpose hot cells (3)
General Electric Company	Chicago	Aircraft Nuclear Propulsion Project, Bldg. 607	Special-services cubicle
	Hanford	Radiometallurgy, Bldg. 327	Irradiated material cell B
			Metallographic cell C
		Redox Analytical Laboratory, Bldg. 222-S	Multicurie cells (2)
	Schenectady	Knolls Atomic Power Laboratory	High-level double cells 1 and 2
		Irradiation Laboratory	Very high level double cells 3 and 4
			Remote metallographic cell 5
			Low-level utility cell 6
		West Milton, Fuel-element Service	Fuel-element service cell (2)
Monsanto Chemical Co.	Albuquerque	Mound Semiworks	Area 1A, cave
Phillips Petroleum Co.	Idaho	Lockland Radioactive Materials Laboratory	Hot cell (3)
		Chemical Processing Plant, Bldg. 627	Multicurie cell
		Materials Testing Reactor, Bldg. 632	Materials Testing Reactor, hot cell
Pratt & Whitney Aircraft Div.	San Francisco	Livermore Radiation Laboratory, Bldg. 121	General utility cell 1
			Chemical operations cell 2
			Hot machine shop cell 34
			Preparation cell 5
		Bldg. 211	Radioactive-chemical processing, junior cave (2)
		Bldg. 301	Machining, measurements, etc., caves 1 and 2
Union Carbide Nuclear Company	Oak Ridge	Chemical Processing Plant, Bldg. 3019	Metallurgical examination cell 6
			Metallographic cave
			High-radiation-level analytical facilities (8)
		Solid State Laboratory, Bldg. 3025	Machine shop cell 1
			Remote metallography cell 2

Union Carbide Nuclear Company (continued)	Oak Ridge	Solid State Laboratory, Bldg. 3025 (continued)	Corrosion examination cell 4
			General-purpose cell 3
			Tensile testing cell 5A
			Impact station cell 5B
			General-purpose cell 6
		Radioactive Separation, Bldg. 3028	I^{131} processing facility
		Remote Control Cell, Bldg. 3029	Argonne type general-purpose cell
			Multi-kilocurie loading cell
		High-level Radiochemical Laboratory, Bldg. 4501	Corrosion examination, machining station defilming station weighing station
		Unit Operations, Bldg. 4505	Isotope research (4)
			Chemical solvent experiment
			Semiworks cells (6)
University of Chicago	Chicago	Argonne National Laboratory, Bldg. 17	Metallurgy, junior cave
		Bldg. 40	Chemical processing, main cave junior cave
		Bldg. 200	Heavy-element chemical processing, junior cave
		Bldg. 205	Chemical engineering, junior cave
University of Iowa	Chicago	Ames Laboratory	Fuel-element-process hot cell 1
			Fuel-element-process hot cell 2
Westinghouse Electric Corporation	Chicago	Bettis Physics of Solids Laboratory	Original hot cells (5)
			Expanded hot cells (3)

General Characteristics of AEC Hot Cells

Photographs and design drawings for several typical hot cells that have been constructed by the AEC are shown in this report. Copies of the detailed design drawings for most of the AEC hot cells may be obtained from the Technical Information Service Extension, USAEC, P. O. Box 62, Oak Ridge, Tenn.

Summary of Hot-cell Data

A summary of pertinent data relating to hot cells in use at various installations of the AEC is given in Tables 1 to 10 inclusive. These data are for a total of 97 hot cells. The number of hot cells at each location is as follows:

Albuquerque	Mound Laboratory	1
Chicago	Ames Laboratory	2
	Bettis Plant	8
	Lockland Area	3
	Argonne National Laboratory	12
Hanford		11
Idaho		3
Oak Ridge		37*
San Francisco		10
Savannah River		3
Schenectady		8

*Includes one shielded tunnel.

The maximum source strength in curies for 1 Mev gamma from the radioactive material to be handled is given, when available, in the table for each hot cell. The year each hot cell was constructed and the construction costs are shown for major components to permit a comparison of these costs for various cells.

2 Construction Costs

The construction costs of certain AEC hot cells and related facilities may appear to be somewhat out of line, owing to the additional cost of new design and construction problems encountered, development work done in connection with new equipment, or fast construction schedules established because of an urgent need for the completed hot cell.

The construction costs of AEC hot cells and related facilities, including indirect costs and the cost of Government-owned materials or equipment, are:

Engineering, design, and inspection		$ 1,452,647
Site work	$ 124,131	
Building (excluding hot cells)	7,141,650	
Utilities	2,264,152	
Equipment	2,627,659	
Total for site work, buildings, utilities, and equipment		$12,157,592
Hot cells (excluding shielding windows and special equipment)	4,582,814	
Shielding windows	1,140,266	
Special equipment	4,096,146	
Total for hot cells		$ 9,819,226
Air filters and other special ventilating facilities		$ 251,149
Total		$23,680,614

These items of total construction cost apply as follows: (1) Engineering, design, and inspection applies to all items of construction cost. (2) Site work includes improvement to land (landscaping, roads, walks, paved areas, fences, etc.). (3) Building covers cost of building construction (excluding hot cells), including related mechanical work (plumbing, heating, electrical work, etc.) within buildings. (4) Utilities includes cost of utility work (water, gas, sewer, electrical service) beyond a point 5 ft outside building. (5) Equipment applies to functional items used in connection with process functions or operations that are carried on within the building, excluding special equipment subsequently referred to. (6) Hot cell includes the biological shield for the cell together with shielding doors, inserts in shield walls other than shielding window frames, cell utility and service connections, and lighting. (Excludes shielding windows and special equipment.) (7) Shielding window includes the shielding window completely assembled in the frame and in place in the shield wall together with fluid reservoir and breathing device, where required. (8) Special equipment includes the following equipment located at or in the cell, complete, in place, and with remote controls where needed: manipulators, cranes, machine tools, measuring devices, and other equipment. (9) Air filters and other special ventilating facilities include the equipment required to ventilate the hot cells.

Figure 1 shows the maximum, minimum, and mean percentages these elements bear to the total construction cost, exclusive of air filters and other special ventilating facilities, which are considered separately because of their special nature.

Laboratory Buildings

Various types of buildings are used to house the hot cells and their related facilities. The extent to which the laboratory building is used by the hot cells is often relatively small, the need for these buildings being created primarily by some other requirement.

The total cost for each laboratory building and its cost per cubic foot are shown in Tables 1 to 10. The unit cost varies from a minimum of $0.71 for the fuel-element service building at West Milton, New York, to a maximum of $4.55 for the remote analytical facility building of the Chemical Processing Plant at the National Reactor Testing Station in Idaho.

The West Milton building has a reinforced-concrete substructure supporting a structural-steel frame covered with insulated corrugated-asbestos siding. The NRTS building, on the other hand, is a complicated reinforced-concrete structure to house facilities used to analyze radioactive samples.

Biological Sheilding

The construction cost of biological shielding (hot cells, excluding shielding windows and special equipment) for the AEC hot cells constructed to date, totaling $4.6 million, is not, in many cases, directly related to the maximum radiation level specified. This is due, in part, to the fact that standards have not been established for determining the amount of shielding required for a given source strength because it is not always known exactly what the maximum source strength will be and because the amount of shielding required for a given source strength depends on whether the source is a point isotropic source, i.e., small with radiation in all directions, or some other type source.

Various materials with different densities have been used for biological shields. The most economical shield to use in each case can only be determined after considering the effect the various types of shield will have upon the cost of foundations, enclosing structures, shielding windows, etc. The relative thickness of shield required at 1-Mev density and the approximate costs per cubic foot of various kinds of shielding are as follows:

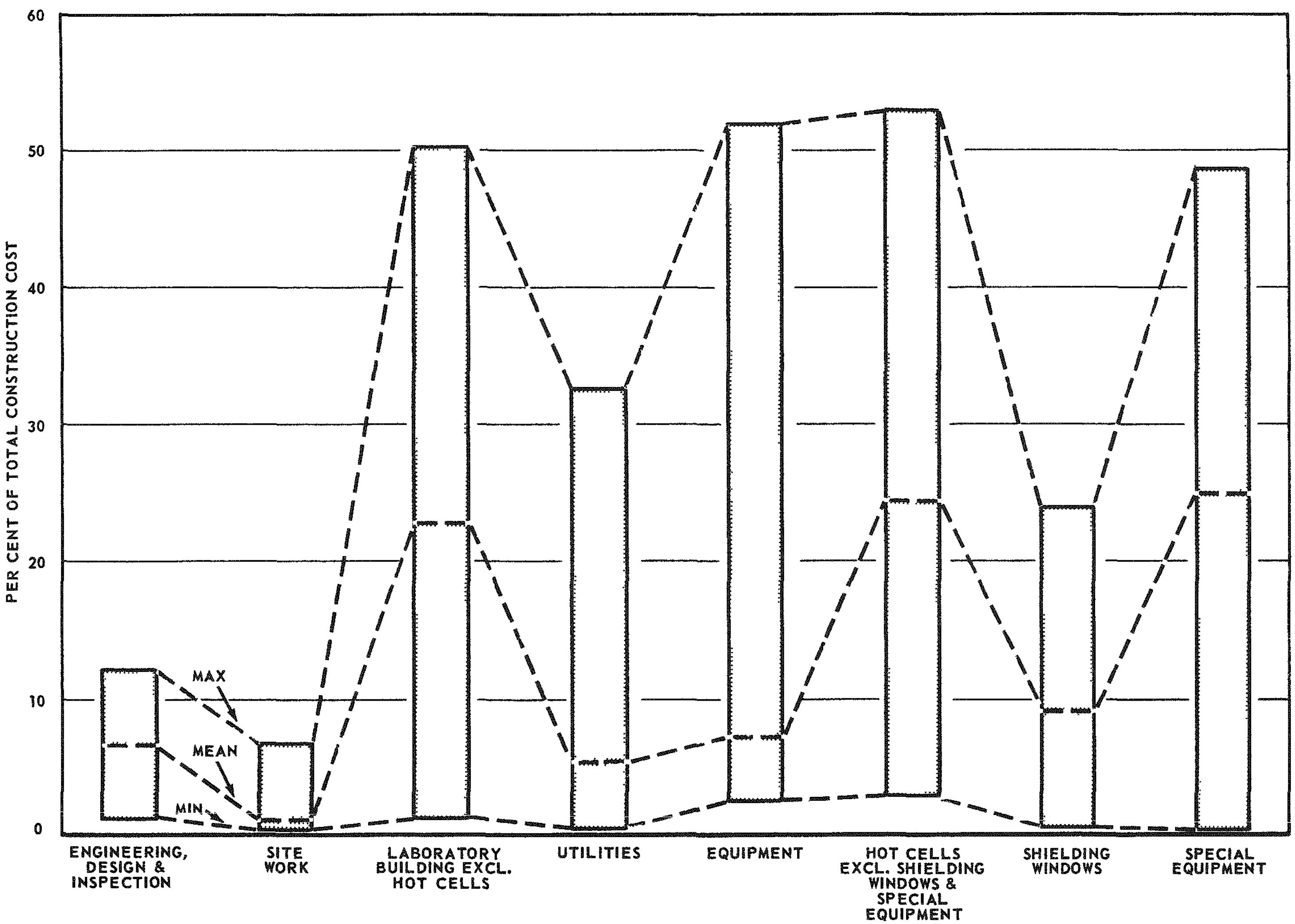

Fig. 1—Relation (in per cent) of construction and components.

Shielding material	Relative thickness required at 1 Mev	Lb/cu ft	Approximate cost installed/cu ft, dollars
Standard concrete	6.5	140	2.60
Barytes concrete	4.7	200–210	8.50–10.50
Magnetite concrete	4.7	200–240	8.15
Ferrophosphorus concrete	3.3	300	15.20
Magnetite and steel punchings concrete		310	26.00
Meehanite cast iron		437	260.00
Laminated steel	1.9	490	196.00
Lead brick	1.0	708	160.00

The amount of shielding required for a hot cell is that amount which will attenuate the gamma radiation given off by the radioactive substance to be handled. Neutrons are not normally present in hot cells, and alpha and beta particles are absorbed by the required gamma shielding. The thickness of concrete shielding walls used in the various AEC hot cells is $^3/_4$, 1, $1^1/_2$, 2, 3, 4, or 6 ft, depending upon the density of the concrete and the level of radiation to be attenuated. Meehanite cast-iron shielding $15^1/_4$ in. thick is used for one cell and $10^1/_2$ in. thick for three others. Lead shielding used varies from 4 to 6 in.; steel shielding is $^3/_4$, 1, 6, 8, and 9 in. thick. When there is a probability of corrosive and radioactive spills and vapor, the cells are lined with either carbon steel or stainless steel. In cells where dry type work is done, a stainless-steel floor is ordinarily used, and the walls are sometimes coated with a stripable plastic.

The best guide for estimating the cost of a hot-cell biological shield is the volume of concrete or tons of metal required, exclusive of shielding windows and equipment.

The thicknesses of the most commonly used shielding materials which would be required to attenuate gamma radiation of energies at 1 Mev, and also 2 Mev for certain assumed conditions, are shown in Fig. 2 to allow cost comparison. A 1-Mev gamma, in most cases, is about the maximum energy encountered in the materials handled in hot cells, including irradiated fuel elements that have been cooled. The required thickness of biological-shield material corresponding to a given density, as indicated by Fig. 2, is only approximate since the density of most shielding materials can vary over a considerable range.

A dosage rate of 300 mr/40-hr week, the maximum permissible, has been used in the calculations for Fig. 2. The distance r between the point isotropic source of radiation and the working plane for personnel has been taken as 8 ft in preparing the curves for Fig. 2. In order to use the curves in Fig. 2 for any other distance, r_2, it is necessary to multiply the curie level of the point isotropic source by $F = r^2/64$. These curves are not applicable when the source is other than a point isotropic source.

The additional amount of shielding, and hence the cost, required for high levels of radiation decreases rapidly as the curie level increases, as may be seen from the following shielding thickness for standard concrete under the conditions previously specified.

Curies at 1-Mev gamma	Thickness, ft	Increase, ft
10	1.70	
20	1.90	0.2
100,000	4.28	
200,000	4.48	0.2

The increase in the thickness needed for high levels of radiation is substantially less for materials of higher density than standard concrete.

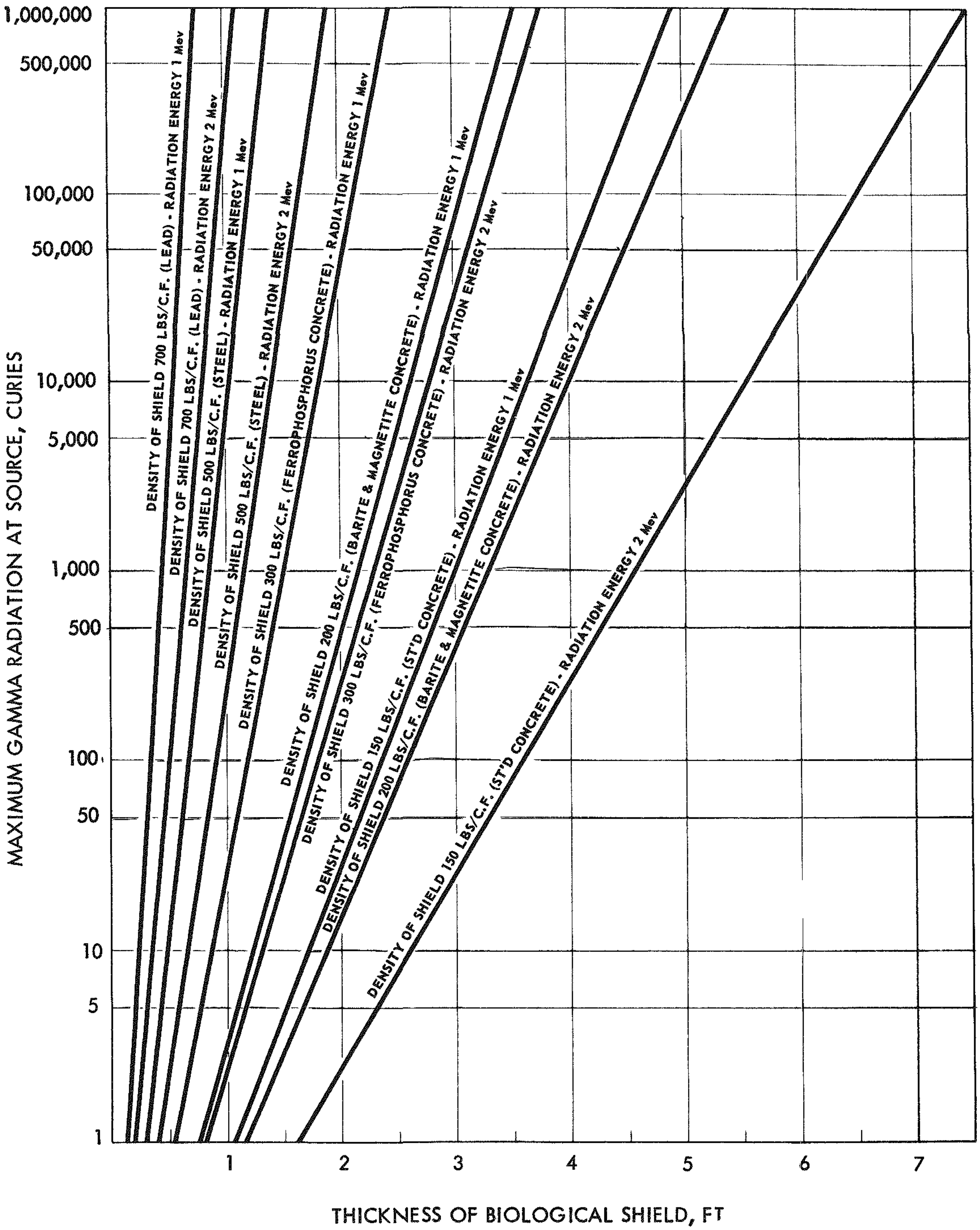

Fig. 2—Maximum source strength for different shielding materials. Calculations were based on an 8-ft distance from a point isotropic source to the working plane.

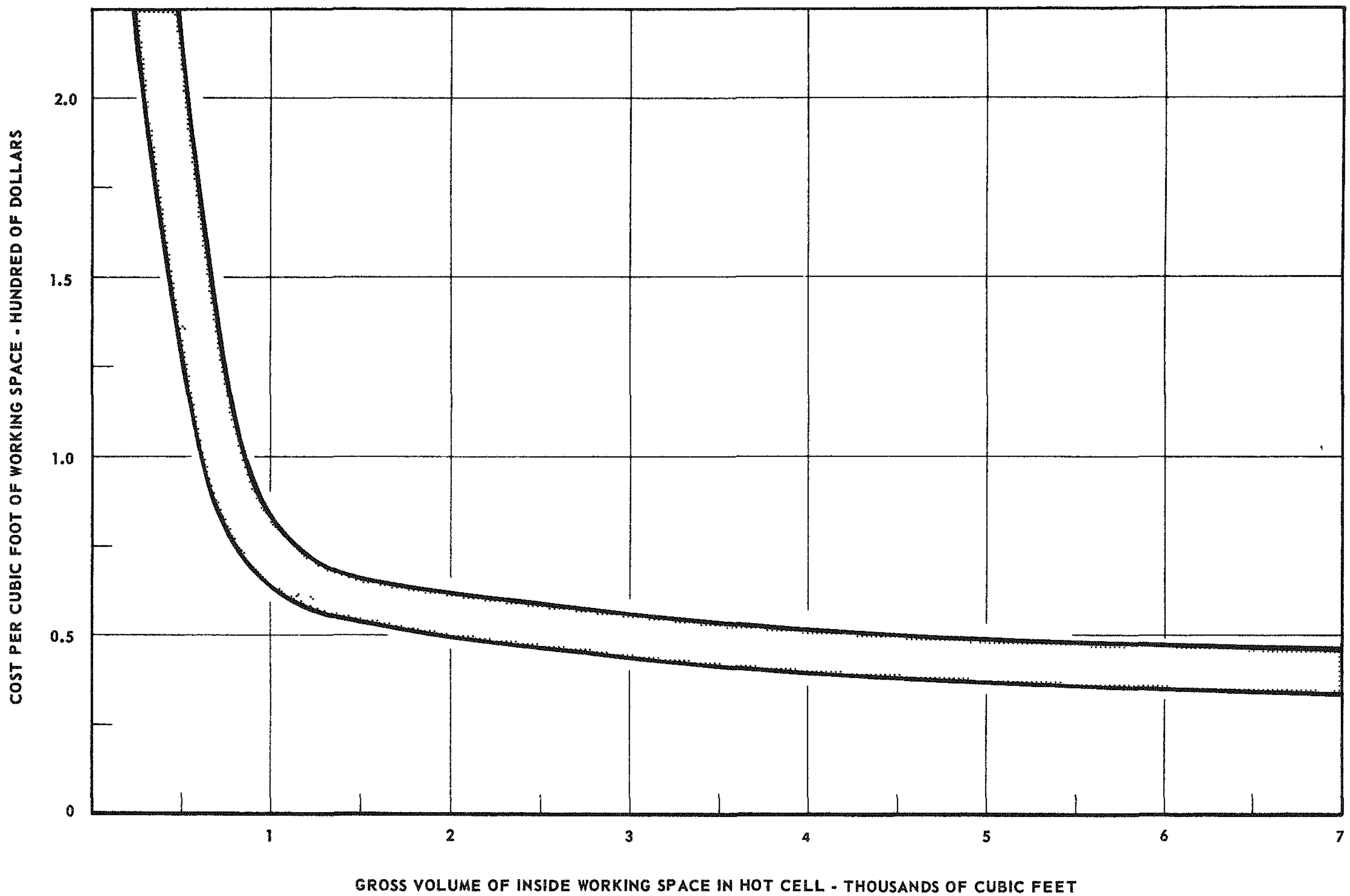

Fig. 3—Cost of hot cells, excluding shielding windows and special equipment, using concrete shielding. Costs (1957) at Argonne, Rocky Flats, and West Milton = 100.

The construction cost per gross cubic foot of volume inside totally enclosed hot cells (excluding shielding windows and special equipment) of various sizes using concrete shielding is shown in Fig. 3. As the size of this kind of hot cell increases, the cost per cubic foot decreases rapidly from a maximum of about $200 per cubic foot for small cells with a volume of 300 cu ft to about $75 per cubic foot for medium-sized cells with a volume of 1000 cu ft. The unit cost of larger cells decreases at a slower rate as the size increases above 1000 cu ft, becoming about $40 per cubic foot for a volume of 7000 cu ft.

The curve in Fig. 3 is based on construction costs that have been adjusted to the 1957 cost level and to a median cost level for AEC field offices. Variations in the construction costs of hot cells can result from differences in the size and number of openings for viewing devices, manipulators, remote-controlled special equipment, and shielding doors or from differences in the amount of shielding as well as from the usual causes or variations in construction costs.

The construction cost of hot-cell shielding can be reduced, when the use of dense concrete shielding is found desirable, by using dense concrete to a height of 7 or 8 ft and standard concrete above this height where circumstances will permit. A further saving can be achieved by using less shielding in the top of the hot cells than in the walls where conditions will permit.

The construction cost for hot cells is somewhat less for multiple-cell construction where common shielding walls serve two cells. Common shielding walls are usually made of the same material as the other walls of the cell, although sometimes the cost can be further reduced by making them thinner. In some cases the cost of common shielding walls can be reduced by extending them only part way to the top of the cells, in which case they are usually made of lead brick or concrete block so they can be removed in order to make a larger cell space available when desired. In other cases the common shielding wall between cells is a shielding door that can be moved out of the way when a larger cell space is wanted.

Viewing Devices

Observation of procedures involving radioactive materials inside the hot cells is permitted by openings left in the biological shields which are filled by transparent shielding windows having the same protective properties as the surrounding shield, or, in some cases, by optical devices such as periscopes and binoculars. The windows most commonly used have various types of glass, and in the thicker windows several laminations of two or more different kinds of glass are used. The inner and outer optical faces are parallel. The fluids used to fill spaces between lamination of glass in the hot-cell windows are either a water solution of zinc bromide ($ZnBr_2$) or oil.

Solid-glass shielding windows that are similar optically to laminated shielding windows may be necessary in some cases, e.g., when the shielding window is to be installed in a wall with thin biological shielding or when unusually high-density shielding is required for special operating conditions, such as in the presence of high temperatures.

A summary of pertinent data relating to 203 shielding windows installed in hot cells at various AEC facilities, costing $1.1 million, is shown in Table 11. The maximum radiation level, type of shielding window, size at the viewing end, thickness, and cost is given in each case.

The relation of the amount of shielding in viewing windows to the maximum radiation level, as in the case of hot-cell biological shielding, varies rather widely, although generally the windows are approximately the same thickness as the rest of the biological shield. High-intensity lighting is required in the hot cell to overcome the high attenuation of light through shielding windows.

The field of vision and maximum radiation level that can be attenuated are not necessarily directly related to the physical dimensions of a shielding window. Many windows are simple rectangular solids, with the dimension of the viewing face determined by the desired field of vision. A window, however, may be pyramidal if the area must be scanned from a more fixed vantage point owing to limited mobility of the operator, in which case the aperture at the inside face will be larger than the aperture at the outer face. A typical laminated glass pyramidal shielding window is shown in Fig. 4.

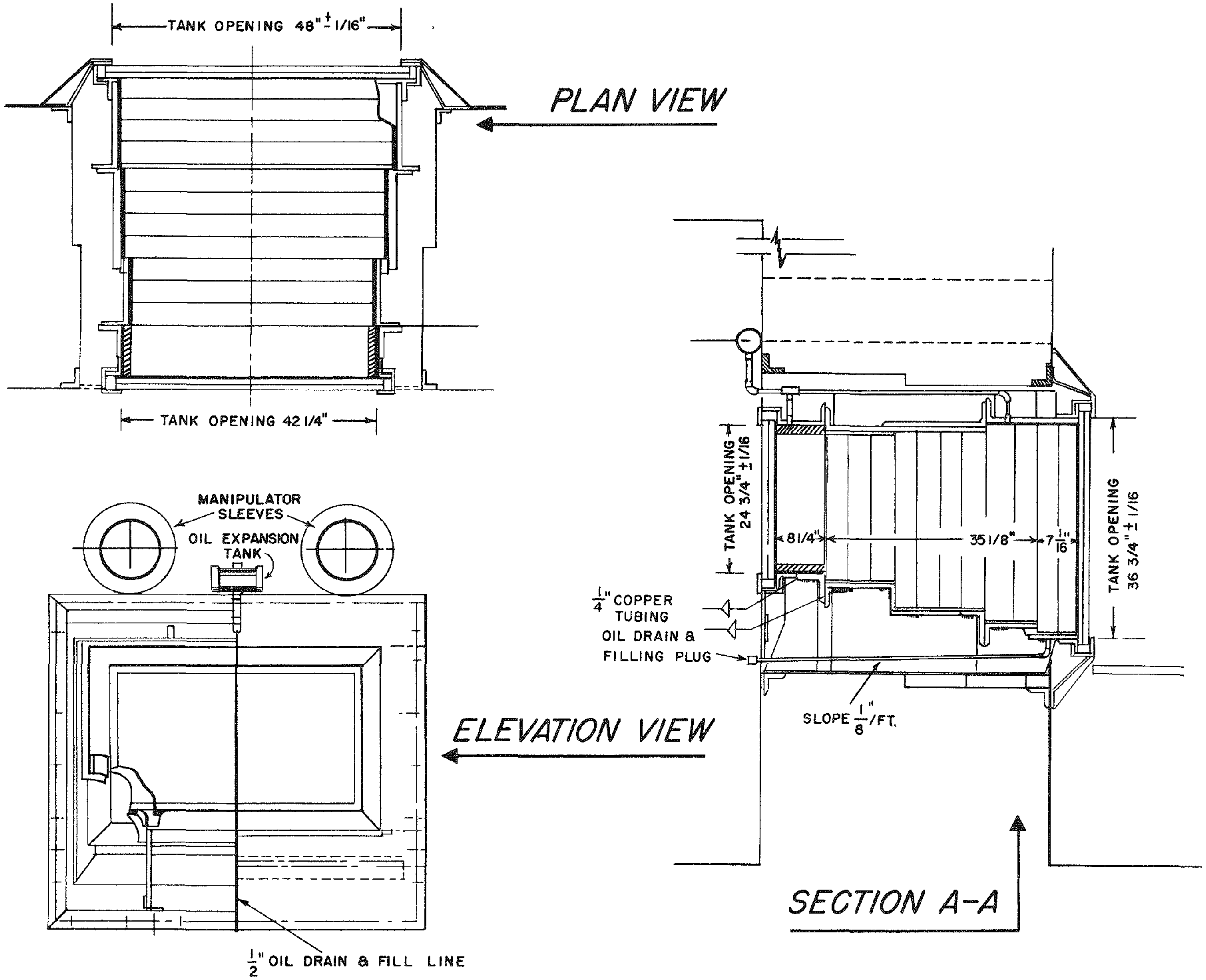

Fig. 4—Typical laminated glass pyramidal shielding window.

The thickness of a shielding window is generally determined by the thickness of the adjoining biological shield, and the density of glass used is selected accordingly. Commercial lime glass has a density of 95 lb/cu ft; nonbrowning lime glass, 168 lb/cu ft (comparable with standard concrete); X-ray lead glass, 305 lb/cu ft (comparable with ferrophosphorus concrete or magnetite concrete with steel punchings); and dense lead glass, 387 lb/cu ft (comparable with iron and steel shielding). Zinc bromide solution has a density of 157 lb/cu ft, comparable with standard concrete shielding.

Shielding-window construction cost varies widely for the reasons previously referred to but probably to an even greater extent because they have not been standardized. It appears, however, that the cost of lead-glass windows is somewhat higher than the cost of zinc bromide- or oil-filled windows of equivalent shielding and size.

Of the 203 shielding windows installed in AEC hot cells, 123, or 61 per cent, are laminated rectangular or pyramidal windows in 34 different sizes with a thickness of 24 in. or more. The windows in this group are of the size and shape most used in AEC hot cells, as may be seen in the following tabulation. One might expect reduced costs and expedited deliveries if a few standard sizes were made available.

Type of window	Windows		No. of sizes
	No.	Per cent of total	
Rectangular and pyramidal			
4 to 24 in. thick	23	11	11
24 to 60 in. thick	123	61	34
Porthole 6 in. dia.			
9 to 36 in. thick	57	28	1
Total	203	100	46

Rectangular and pyramidal laminated shielding windows of the following seven sizes, or modifications thereof, will, based upon the past experience of AEC, fill over 80 per cent of the needs for shielding windows in hot cells in which the biological shield is 24 in. or more in thickness.

Clear viewing area				Thickness, in.
Working (outside) face		Inside (hot) face		
Width, in.	Length, in.	Width, in.	Length, in.	
18	24	18	24	24
24	36	24	36	24
24	36	33	45	36
36	48	45	57	36
36	48	48	60	48
48	60	60	72	48
48	60	63	75	60

Special Ventilating Facilities

Ventilation of totally enclosed cells and filtering of the off-gas is usually provided with slight negative pressure maintained in the cell so that leakage is into the cell. This eliminates the possibility of exposing personnel to air-borne contamination. Filters suitable for use in hot-cell ventilation can be readily obtained from commercial sources.

Special Equipment

A description of the special equipment for each hot cell with a total cost of $4.1 million is given in Table 12. Special equipment for hot cells consists of manipulators, cranes, remote-controlled machine tools, measuring devices, and also other equipment of a specialized nature.

A manipulator is a tool or device for extending the operator's movements to a distance. It may be operated mechanically, electrically, or hydraulically and may vary from simple tongs to ball and socket type, pantograph manipulator, and electrically actuated manipulators with elaborate control consoles.

The number, type, capacity, and cost of each manipulator and crane are given in Table 12 in addition to the type and cost of the remote-controlled machine tools, measuring devices, and other special equipment. Additional information on special equipment will be found in the AEC publication "Hot Laboratory Equipment" (2d ed., in press).

Table 1—SUMMARY OF DATA FOR MOUND LABORATORY HOT CELL

(Maximum radiation level, 5 curies from radium source; constructed in 1950–1951.)

Item	Semiworks building Area 1A cave	
	Amount	Per cent of total
Construction costs:		
Engineering, design, and inspection	$ 8,475	11.0
Hot cell (one cell with a gross volume of 2088 cu ft), excluding shielding windows and special equipment	35,250*	46.0
Cost/cu ft	16.88	
Shielding windows (six windows with a total area of 41 sq ft	17,130	22.3
Cost/sq ft	481	
Special equipment	15,900	20.7
Subtotal	$76,755	100.0
Air filters and other special ventilating facilities	7,850	
Total	$84,605	

*Shielding is steel.

(Text continues on page 32.)

Table 2a—SUMMARY OF DATA FOR HOT CELLS AT AMES LABORATORY

Item	Hot cell No. 1	Hot cell No. 2	Total amount	Per cent of total
Maximum radiation level from a Co^{60} source, curies	*20*	*1000*		
Year constructed	1954	1956		
Construction costs:				
Engineering, design, and inspection	$6,000	$2,000	$8,000	4.7
*Building, excluding hot cells, amount**	$29,000	$8,245	$37,245	21.7
Gross vol., cu ft	25,000	4,250	29,250	
Cost/cu ft	$1.16	$1.94		
Hot cells, excluding shielding windows and special equipment, amount	$33,000†	$16,051‡	$49,051	28.5
No.	1	1	2	
Gross vol., cu ft	2,600	1,200	3,800	
Cost/cu ft	$12.69	$13.29	$12.99§	
Shielding windows, amount	$16,167	$9,711	$25,878	15.1
No.	5	2	7	
Type	Lead glass	Lead glass		
Total sq ft	20.25	11	31.25	
Cost/sq ft	$800	$883	$842	
Special equipment	$33,263	$18,159	$51,422	30.0
Subtotal	$117,430	$54,166	$171,596	100.0
Air filters and other special ventilating facilities	30,000	20,000	50,000	
Total	$147,430	$74,166	$221,596	

*Costs of adjoining areas not used by hot cell are included in the amounts shown.
†*Hot cell No. 1 is open at the top; shield walls are concrete, lead, and steel.*
‡Shielding is steel and earth.
§Average for both hot cells.

Table 2b—SUMMARY OF DATA FOR HOT CELLS AT LOCKLAND AREA, EVENDALE, OHIO

(Maximum radiation is 10,000 curies from a Co^{60} source; constructed in 1955–1956)

Item	Radioactive Materials Laboratory	
	Amount	Per cent of total
Construction costs:		
Site work	$ 1,500	0.3
Building, excluding hot cells	12,900*	2.7
Utilities	83,100	17.4
Hot cells (three cells with gross vol. of 4017 cu ft†), excluding shielding windows and special equipment	214,500	44.8
Cost/cu ft	55.40	
Shielding windows (four nonbrowning glass windows with a total area of 30 sq ft)	41,700	8.7
Cost/sq ft	1,390	
Special equipment	124,700	26.1
Subtotal	$478,400	100.0
Total	$478,400	

*Demolition in existing building.
†Average gross volume is 1399 cu ft.

Table 2c—SUMMARY OF DATA FOR HOT CELLS AT BETTIS PLANT, PITTSBURGH, PA.

Item	Physics of Solids Laboratory Original section	Expanded section	Total amount	Per cent of total
Maximum radiation level, curies	10,000	1,000,000		
Year constructed	1950	1955–1956		
Construction costs:				
Engineering, design, and inspection	$3,380	$9,000	$12,380	1 0
Building, excluding hot cells, amount	$112,414	$195,586	$308,000	24.0
Gross vol., cu ft	98,050	170,000	268,050	
Cost/cu ft	$1.15	$1.15	$1.15	
Utilities		$30,000	$30,000	2.3
Hot cells, excluding shielding windows and speical equipment, amount	$84,638	$183,000	$267,638	20.8
No.	5	3	8	
Gross vol., cu ft	5,065*	1,080†	6,145	
Cost/cu ft	$16.71	$169.44	$43.55	
Shielding windows, amount	$14,530	$35,499	$50,029	3.9
No.	5	3	8	
Type	Laminated glass-oil	Laminated glass-oil		
Total sq ft	90	27	117	
Cost/sq ft	$161	$1,315	$428	
Special equipment	$240,647	$376,000	$616,647	48 0
Subtotal	$455,609	$829,085	$1,284,694	100.0
Air filters and other special ventilating facilities			$8,000	
Total			$1,292,694	

*The five cells have an average gross volume of 1013 cu ft each; cell partitions are laminated steel doors 6 ft high.
†The three cells have an average gross volume of 360 cu ft each; cell partitions are steel doors.

Table 3a—SUMMARY OF DATA FOR ARGONNE NATIONAL LABORATORY HOT CELLS

(Physics and Metallurgy "Hot" Laboratory, Building 301, constructed in 1950–1954.)

Item	Cave 1	Cave 2	Metallographic cave	Total amount	Per cent of total
Maximum radiation level, curies	10,000	10,000			
Construction costs:					
Engineering, design, and inspection				$119,563	8.1
Site work				$21,186	1.4
Building, excluding hot cells, amount				$718,135	48.6
Gross vol., cu ft				435,167	
Cost/cu ft				$1.65	
Utilities				$200,204	13.5
Hot cells, excluding shielding windows and special equipment, amount	$71,292	$71,292	$97,120	$239,704	16.2
No.	1	1	3	5	
Gross vol., cu ft	750	750	1,575	3,075	
Cost/cu ft	$95.06	$95.06	$61.66	$77.95	
Shielding windows,(zinc bromide), amount	$6,336*	$6,336*	$16,671	$29,343	2.0
No.	4	4	5	13	
Total sq ft	22.8	22.8	36.3	81.9	
Cost/sq ft	278	278	459	358	
Special equipment	$38,575	$38,693	$73,702	$150,970	10.2
Subtotal	$116,203	$116,321	$187,493	$1,479,105	100.0
Air filters and other special ventilating facilities				$11,833	
Total				$1,490,938	

*Maximum radiation level is 500 curies.

Table 3b — SUMMARY OF DATA FOR ARGONNE NATIONAL LABORATORY HOT CELLS

(Chemistry Hot Laboratory, Building 40.)

Item	Main cave	Junior cave	Total amount	Per cent of total
Maximum radiation level, curies	1	0 03		
Year constructed*	1949	1950		
Construction costs				
Engineering, design, and inspection			$3,600	1.8
Site work			$10,000	5.1
Building, excluding hot cells, amount			$113,000	57.3
Gross vol , cu ft			41,000	
Cost/cu ft			2.76	
Hot cells, excluding shielding windows and special equipment, amount	$27,000†	$10,500†	$37,500	19.0
No	1	1	2	
Gross vol., cu ft	405	42	447	
Cost/cu ft	$66.67	$250 00	$83.89	
Shielding windows, amount	$12,000	$2,500	$14,500	7.4
No.	4	1	5	
Type	Plate glass-oil	Lead glass	Lead glass and plate glass-oil	
Total sq ft	24.0	6.0	30.0	
Cost/sq ft	$500	$417	$483	
Special equipment	$11,500	$7,000	$18,500	9.4
Subtotal	$50,500	$20,000	$197,100	100.0
Air filters and other special ventilating facilities			$19,500	
Total			$216,600	

*Building 40 reflects structural additions made in 1953 – 1954.
†Shielding is steel

Table 3c — SUMMARY OF DATA FOR ARGONNE NATIONAL LABORATORY JUNIOR CAVE

Item	Building 200 (Chemistry)	Building 211 (Cyclotron)	Building 205 (Chemical Engineering)	Building 17 (Metallurgy)
Maximum radiation level, curies	0 03	0 03	0 06	100
Year constructed	1952	1955	1955	1949
Construction costs:				
Hot cells, excluding shielding windows and special equipment, amount	$16,375*	$19,582*	$28,240†	$42,900†
No.	1	2	1	1
Gross vol., cu ft	42	33	105	176
Cost/cu ft	$389.88	$593 39	$268.95	$243.75
Shielding windows, amount	$1,057	$4,213	$3,850	$4,100
No.	1	2	1	3
Type	*Lead glass*	*Plate glass*	*Plate glass-cerium*	*Zinc bromide*
Total sq ft	5 6	13.4	8 8	11.5
Cost/sq ft	$189	$314	$438	$357
Special equipment	$7,000	$20,560	$8,850	$3,500
Total	$24,432	$44,355	$40,940	$50,500

*Shielding is steel.
†Shielding is concrete and steel.

Table 4 — SUMMARY OF DATA FOR HANFORD OPERATIONS OFFICE HOT CELLS

Item	327 Radiometallurgy building[a] Cell B	Cell C	Cell D	Cell E	Density cell	Double-crystal X-ray diffraction cell	High-temperature tensile testing cell	Room-temperature tensile testing cell	Decontamination cell	Total amount	Per cent of total	222-S building[b] multicurie cell Amount	Per cent of total
Maximum radiation level, curies	2000	100	100	100	100	100	100	100	0.100				
Construction costs:													
Engineering, design, and inspection										$160,000	9.5	$184,934	4.3
Building,[c] excluding hot cells, amount										451,738	26.7	1,909,952	44.9
Gross vol., cu ft										326,300		598,070	
Cost/cu ft										$1.38		$3.19	
Utilities										$168,719	10.0	$1,384,950	32.5
Equipment										$60,887	3.6	$649,371	15.3
Hot cells, excluding shielding windows, and special equipment, amount	$155,984[d]	$120,528[d]	$120,528[d]	$120,528[d]	$800[e]	$10,000[e]	$15,000[e]	$30,515[d]	$43,729[f]	$617,612	36.5	$111,820	2.6
No.	1	1	1	1	1	1	1	1	1	9		2	
Gross vol., cu ft	113	113	113	113		g	g	85				943	
Cost/cu ft	1,380	1,067	1,067	1,067		g	g	359				110	
Shielding windows,[h] amount	$6,400[i]	$4,200[i]	$4,200[i]	$4,200[i]	$400[i]	$800[i]	$1,200[i]	$5,500[i]	$9,153	$36,053	2.1	$8,640	0.2
No.	8	6	6	6	1	2	3	6	4	42		11	
Total sq ft	2.3	1.7	1.7	1.7	0.28	0.57	0.85	17.5	34.2	60.8		5.9	
Cost/sq ft	2,819	2,470	2,470	2,470	1,428	1,403	1,411	314	267	593		1,464	
Special equipment	19,515	49,384	19,751	23,517	278	23,000	32,449	28,116	600	196,610	11.6	10,084	0.2
Subtotal	$181,899	$174,112	$144,479	$148,245	$1,478	$33,800	$48,649	$64,131	$53,482	$1,691,619	100.0	$4,259,751	100.0
Total										$1,691,619		$4,259,751	

[a] 327 Radiometallurgy building was constructed 1951–1953.
[b] 222-S building has a maximum radiation level of 20 curies and was constructed 1950–1952.
[c] The costs for air filters and other special ventilating facilities for each building are included in these figures.
[d] Shielding is Meehanite cast iron 7.0 g/cc.
[e] Shielding is lead brick.
[f] Shielding is 1-in. steel
[g] Prototype cells made from lead brick in stock.
[h] All shielding windows are of lead glass.
[i] Estimated replacement value.

Table 5 — SUMMARY OF DATA FOR IDAHO OPERATIONS OFFICE HOT CELLS

Item	MTR building 632 hot cell*		ANP A&M building 607 special services cubicle†		CPP building 627 multicurie cell‡	
	Total amount	Per cent of total	Total amount	Per cent of total	Total amount	Per cent of total
Construction costs:						
Engineering, design, and inspection	$3,214	1.1	$43,700	6.7	$41,167	6.5
Site work	$2,233	0.8				
Building, excluding hot cells, amount	$76,697	26.6			$219,300	34.9
Gross vol., cu ft	60,000				48,180	
Cost/cu ft	$1.28				$4.55	
Utilities	$18,298	6.3				
Equipment	$7,418	2.6				
Hot cells, excluding shielding windows and special equipment, amount	$55,316	19.2	$209.866§	32.3	$220,203	35.0
No.	1		1		1	
Gross vol., cu ft	1213		7000		5925	
Cost/cu ft	$45.60		$29.98		$37.17	
Shielding windows, amount	$43,328	12.1	$155,000	23.8	$65,670	10.5
No.	4		5		3	
Type	Plate and lead glass-zinc bromide		Plate and lead glass-oil		Lead glass-oil	
Total sq ft	22.3		30		11.7	
Cost/sq ft	$1,943		$5,167		$5,613	
Special equipment	$81,476	31.3	$242,000	37.2	$82,441	13.1
Subtotal	$287,980	100.0	$650,566	100.0	$628,781	100.0
Air filters and other special ventilating facilities	$5,500		$4,300		$584	
Total	$293,480		$654,866		$629,365	

*MTR, building 632, has a maximum radiation level of 10,000 curies at 2 Mev; constructed in 1953.

†ANP, assembly and maintenance, building 607, has a maximum radiation level of 10^7 r/hr; constructed in 1954.

‡Chemical Processing Plant, building 627, has a maximum radiation level of 50,000 curies at 1.6 Mev; constructed in 1955.

§Partially lined with stainless steel.

Table 6a — SUMMARY OF DATA FOR OAK RIDGE OPERATIONS OFFICE HOT CELLS

Item	Building 3019[a] Total amount	Building 3019[a] Per cent of total	Building 4501[b] (North portion) Total amount	Building 4501[b] (North portion) Per cent of total	Building 4505[c] Isotope research cell block[d]	Building 4505[c] Semiworks cell block	Building 4505[c] Total amount	Building 4505[c] Per cent of total
Maximum radiation level, curies	250		25		10,000	1,000		
Construction costs:								
Engineering, design, and inspection	$45,600	12.1	$9,800	8.2			$390,000	10.2
Site work	$6,500	1.7					$70,000	1.8
Building, excluding hot cells, amount	$94,000	24.9					$1,500,000	39.3
Gross vol., cu ft	54,300		10,580				$1,852,000	
Cost/cu ft	$1.73						$0.81	
Utilities	$21,000	5.6	$3,600	3.0			$25,000	0.7
Equipment	$14,500	3.8					$930,000	24.4
Hot cells, excluding shielding windows and special equipment, amount	$45,000	11.9	$28,600	23.9	$521,000[e]	295,000	$816,000	21.4
No.	9		3		4	6	10	
Gross vol., cu ft	3,485[f]		1,020[g]		2,688[h]	11,440[i]	12,112	
Cost/cu ft	$12.91		$28.04		$193.82	$25.79	$67.37	
Shielding windows, amount	$30,000		$17,900		$8,000		$8,000	
	$12,000	11.1	$1,700	16.4	$36,000		$36,000	1 1
No.	7		2		8		8	
	1		2		8		8	
Type	Zinc bromide-cerium		Zinc bromide-lead glass		Zinc bromide-lead glass		Zinc bromide-lead glass	
Total sq ft	56		12		1 6		1 6	
	8		1.5		28		25	
Cost/sq ft	$ 536		$1,492		$5,000		$5,000	
	$1,500		$1,133		$1,286		$1,440	
Special equipment	$108,900	28.9	$57,900	48 5	$35,000	$5,000	$40,000	1 1
Subtotal	$377,500	100.0	$119,500	100.0	$600,000	$300,000	$3,815,000	100 0
Air filters and other special ventilating facilities	$7,000		$1,000				$35,000	
Total	$384,500		$120,500				$3,850,000	

[a] Building 3019 was constructed in 1954 – 1955.
[b] Building 4501 was constructed in 1954 – 1955.
[c] Building 4505 was constructed in 1950 – 1952.
[d] Construction costs for building 4501 are combined with those for building 4505.
[e] Lined with stainless steel.
[f] Seven hot cells, 1 storage cell, and 1 shielded tunnel adjoining; volume of one hot cell is 330 cu ft, average cost of $16 00/cu ft
[g] Machining station, 884 cu ft; defilming station, 46 cu ft; weighing station, 90 cu ft; average space per cell is 340 cu ft
[h] Each cell has 672 cu ft
[i] Four cells, 1716 cu ft each; 2 cells, 2288 cu ft each; average is 1907 cu ft/cell.

Table 6b — SUMMARY OF DATA FOR OAK RIDGE OPERATIONS OFFICE HOT CELLS
(Constructed in 1950 – 1952)

Item	Building 3025: General purpose hot cells	Building 3025: Metallographic cells	Total amount	Per cent of total
Maximum radiation level, curies	7000	1		
Construction costs				
Engineering, design, and inspection			$133,000	9.4
Site work			$5,000	0.4
Building, excluding hot cells, amount			$578,000	40.8
Gross vol , cu ft			218,000	
Cost/cu ft			$2.65	
Utilities			$4,000	0.3
Equipment			$30,000	2.1
Hot cells, excluding shielding windows and special equipment, amount	$181,100	$16,000*	$197,100	13.9
No	6	1	7	
Gross vol., cu ft	2,706†	110	2,726	
Cost/cu ft	$66.93	$145.45	$72 30	
Shielding windows, amount	$50,000	$2,000	$52,000	3.7
No.	10	2	12	
Type	Zinc bromide	Lead glass	Zinc bromide-lead glass	
Total sq ft	69	4	73	
Cost/sq ft	$725	$500	$712	
Special equipment	$397,700	$19,200	$416,900	29 4
Subtotal	$628,800	$37,200	$1,416,000	100
Air filters and other special ventilating facilities			$5,000	
Total			$1,421,000	

*Shielding is steel plate.
†Three cells, 720 cu ft each; 3 cells, 182 cu ft each; average is 300 cu ft/cell

Table 6c — SUMMARY OF DATA FOR OAK RIDGE OPERATIONS OFFICE HOT CELLS

Item	Building 3029: Multi-kilocurie loading cell*: Total amount	Per cent of total	Building 3029: Argonne type general-purpose cell†: Total amount	Per cent of total	Building 3028‡: Total amount	Per cent of total
Construction costs.						
Engineering, design, and inspection	$10,800	12.1	$3,200	10 1	$15,300	7.3
Site work	$1,000	1.1	2,100	6.6	$1,900	0.9
Building, excluding hot cells, amount	$1,000§	1.1	$800§	2.5	$35,000	16.7
Utilities	$3,800	4.3	$1,500	4.7	$500	0.2
Equipment					$26,000	12.4
Hot cells, excluding shielding windows and special equipment, amount	$47,300	52.9	$10,400	32 8	$44,400	21.1
No.	1		1		6	
Gross vol., cu ft	520		68		1,220¶	
Cost/cu ft	$90.96		$152 94		$36.39	
Shielding windows, amount	$8,300	9.3	$5,500	17.4	$600	0.3
No	1		1		1	
Type	Cerium		Lead glass		Lead glass	
Total sq ft	0.56		6		0.33	
Cost/sq ft	$14,821		$917		$1,818	
Special equipment	$17,200	19.2	$8,200	25.9	$86,300	41.1
Subtotal	$89,400	100	$31,700	100	$210,000	100
Air filters and other special ventilating facilities	$500		$800		$2,500	
Total	$89,900		$32,500		$212,500	

*Multi-kilocurie loading cell has a maximum radiation level of 10,000 curies; constructed in 1954 – 1955.
†Argonne type general-purpose cell has a maximum radiation level of 300 curies; constructed in 1952.
‡Building 3028 has a maximum radiation level of 100 curies; constructed in 1952 – 1954.
§Alternate to existing building; also used for other purposes.
¶Three cubicles, 40 cu ft each; 1 cell, 160 cu ft; 1 cell, 300 cu ft; 1 cell, 640 cu ft; average is 203 cu ft.

Table 7 — SUMMARY OF DATA FOR HOT CELLS AT SANTA SUSANA AND CANOGA PARK, CALIFORNIA

Item	Sodium Reactor Experiment* Santa Susana, Calif. Total amount	Per cent of total	Atomics International hot cave,† Canoga Park, Calif. Total amount	Per cent of total
Construction costs:				
Engineering, design, and inspection	$21,000	8.3	$10,343	13 7
Building, excluding hot cells, amount	$30,141	12.0		
Gross vol., cu ft	33,800			
Cost/cu ft	$0 89			
Utilities	$59,972	23.8	$1,653	2 2
Hot cells, excluding shielding windows and special equipment, amount	$59,869	23.8	$35,096‡	46.4
No.	2		2	
Gross vol., cu ft	2260		300	
Cost/cu ft	$26.49		$116.99	
Shielding windows, amount	$48,000	19 0	$10,000	13.2
No.	3		2	
Type	Lead glass		Zinc bromide	
Total sq ft	36			
Cost/sq ft	$1,333			
Special equipment	$33,000	13.1	$18,500	24.5
Subtotal	$251,982	100	$75,592	100
Air filters and other special ventilating facilities	$17,811		$444	
Total	$269,793		$76,036	

*SRE has a maximum radiation level of 1,000,000 curies, constructed in 1955 – 1956.
†Atomics International hot cave has a maximum radiation level of 400 curies, constructed in 1953 – 1954
‡Walls constructed of dense-concrete blocks, roof of cast-iron blocks.

Table 8 — SUMMARY OF DATA FOR LIVERMORE HOT CELLS

Item	Cell 1	Cell 2	Cell 34	Cell 5	Cell 6	Metallographic cave*	Total amount	Per cent of total
Maximum radiation level, curies	1000	1000	10,000	1000	500	50		
Construction costs:								
Engineering, design, and inspection							$10,500	2.4
Site work							†	
Building, excluding hot cells							†	
Utilities							$227,000	52.0
Hot cells, excluding shielding windows and special equipment, amount No.	1	1	2	1	1	1	7	
Gross vol., cu ft	588	672	1536	768	768	462	4,794	
Shielding windows, amount	$6,850	$6,850	$21,690	$2,150			$37,540	8.6
No.	1	1	3	2		1		
Type	Zinc bromide	Zinc bromide	Zinc bromide	Zinc bromide		Lead glass		
Total sq ft	8.1	8.1	33.9	6.0		0.5		
Cost/sq ft	$846	$846	$640	$358				
Special equipment	$21,347	$20,902	$56,759	$25,290	$37,340		$161,638	37.0
Air filters and other special ventilating facilities							†	
Total	$28,197	$27,752	$78,449	$27,440	$37,340		$436,678	100.0

*Constructed in 1956.
†Modified existing facilities (1955).

Table 9—SUMMARY OF DATA FOR SAVANNAH RIVER OPERATIONS OFFICE HOT CELLS

(Maximum radiation level is 5000 curies; constructed in 1951–1953.)

	Building 773-A, main technical laboratory	
Item	Total amount	Per cent of total
Constructions costs:		
Engineering, design, and inspection	$123,600	9.0
Building, excluding hot cells, amount	$263,000	19.1
Gross vol., cu ft	110,000	
Cost/cu ft	$2.39	
Equipment	$168,000	12.2
Hot cells, excluding shielding windows and special equipment, amount	$284,400	20.7
No.	3	
Gross vol., cu ft	3,315*	
Cost/cu ft	$85.79	
Shielding windows, amount	$123,000	12.8
No.	6	
Type	Nonbrowning glass-oil	
Special equipment	$361,300	26.2
Subtotal	$1,323,300	100
Air filters and other special ventilating facilities	$24,000	
Total	$1,347,300	

*Each cell contains 1105 cu ft; partitions are metal and metal-encased high-density concrete.

Table 10 — SUMMARY OF DATA FOR SCHENECTADY OPERATIONS OFFICE HOT CELLS

Item	Irradiation Laboratory (KAPL) High-level double cell 1 & 2	Very high level double cell 3 & 4	Remote metallography cell 5	Low-level utility cell 6	Total amount	Per cent of total	Fuel-element Service Building (West Milton) Total amount	Per cent of total
Maximum radiation level, curies	10,000	1,000,000	200	50			1,000,000	
Year constructed	1951	1953	1956	1951			1953 – 1954	
Construction costs:								
Engineering, design, and inspection					$46,103	2.3	$48,368	2.5
Site work					$2,712	0.1		
Building, excluding hot cells, amount					$316,083	15.9	$476,659	25.1
Gross vol., cu ft					174,548		671,526	
Cost/cu ft					$1.81		$0.71	
Utilities					$106,862	5.4	$150,994	7.9
Equipment					$514,483	25.9		
Hot cells, excluding shielding windows and special equipment, amount	$158,235	$231,409	$30,759*	$49,831†	$470,234	23.7	$378,858	20.0
No.	2	2	1	1	6		2	
Gross vol., cu ft	1,425‡	1,425‡	576	455	4,031		9,435§	
Cost/cu ft	$111.04	$162.39	$53.40	$109.52	$116.65		$40.15	
Shielding windows, amount	~$62,348	$62,348	$10,494	$4,205	$139,395	5.4	$109,840	5.8
No.	8	8	3	2	28		8	
Type	Zinc bromide	Zinc bromide	Lead glass	Zinc bromide			Zinc bromide	
Total sq ft	33.6	33.6	15	8.4	90.6		96	
Cost/sq ft	$1,850	$1,850	$700	$500	$1,530		$1,144	
Special equipment	$127,407	$238,014	$57,925		$423,346	21.3	$732,302	38.7
Subtotal	$315,068	$531,771	$99,178	$54,036	$2,019,218	100.0	$1,897,021	100.0
Air filters and other special ventilating facilities					$25,125		$24,402	
Total					$2,044,343		$1,921,423	

*Cell has steel walls.
†No shielding on top.
‡For two cells and radiation lock; volume for one cell, 536 cu ft.
§Average volume for one cell, 4700 cu ft.

Table 11 — SUMMARY OF DATA FOR SHIELDING WINDOWS

Operations office	Location	Hot cell	Maximum radiation level, curies at 1 Mev gamma	Shielding windows: No.	Type*	Viewing end: Size, in.	Sq ft (ea.)	Thickness, in.	Cost (ea.) installed, dollars
Albuquerque	Mound Laboratory	Semiworks Bldg. cave		6		26 x 38	6.9	25	2,855
Chicago	Ames Laboratory	Hot cell 1	20	4	Lead glass	36 × 18	4.5	8	16,300
		Hot cell 2	1,000	1	Penberthy glass	48 × 30	10	12	11,620
	Bettis, Physics of Solids Laboratory	Original	10,000	10	Laminated glass-oil	36 x 36	9	36	1,453
		Expanded	1,000,000	3	Laminated glass-oil	36 x 36	9	36	11,833
	Lockland	Radioactive Materials Lab.	10,000	4	NBG-oil	36 x 30	7.5		10,430
	Argonne:								
	Bldg. 301	Cave 1	500	2	NBG-$ZnBr_2$	30 × 34	7.1	36	2,915
				2	NBG-$ZnBr_2$	26 × 24	4.3	36	252†
		Cave 2	500	2	NBG-$ZnBr_2$	30 × 34	7.1	36	2,915
				2	NBG-$ZnBr_2$	26 × 24	4.3	36	252†
		Metallographic cave	50	3	NBG-$ZnBr_2$	30 × 58	12.1	28	5,557
	Bldg. 40	Main cave	1	4	Laminated glass-oil	24 × 36	6.0	20	3,000
		Junior cave	0.03	1	Laminated glass	26 × 33	6 0	9	2,500
	Bldg. 200	Junior cave	0.03	1	Laminated lead glass	20 × 40	5.6	4½	1,057
	Bldg. 211	Cyclotron junior cave	0.06	2	Laminated glass	20 × 48	6.7	9	2,106
	Bldg. 205	Junior cave	10	1	NBG-$ZnBr_2$	31 × 41	8.8	18	3,850
	Bldg. 17	Metallurgy junior cave	100	1	NBG-$ZnBr_2$	24 × 54	9.0	36	3,000
		Metallurgy junior cave	100	1	NBG-$ZnBr_2$	Porthole			250
		Metallurgy junior cave	100	1	NBG-$ZnBr_2$	18 × 18	7.3	36	850
Hanford	Bldg. 327	Cell B	2,000	8	Lead glass	5⅞ dia	0.20	15	800‡
		Cell C	100	6	Lead glass	5⅞ dia	0.20	10½	700‡
		Cell D	100	6	Lead glass	5⅞ dia	0.20	10½	700‡
		Cell E	100	6	Lead glass	5⅞ dia	0.20	10½	700‡
		Density cell	100	1	Lead glass	5⅞ dia	0.20	10½	400‡
		Double X-ray-diffraction cell	100	2	Lead glass	5⅞ dia	0.20	10½	400‡
		High-temperature tensile testing cell	100	3	Lead glass	5⅞ dia	0.20	10½	400‡
		Room-temperature tensile testing cell	100	6	Lead glass	5⅞ dia	0.20	10½	917‡
		Decontamination cell	0.100	4	Lead glass	5⅞ dia	0.20	10½	2,288‡
	Bldg. 222-S	Multicurie cell	20	6	Laminated lead glass	6 dia	0.20	9	
				4	Laminated lead glass	9 × 14	0.87	9	8,640‡
				1	Laminated lead glass	11 × 16	1.2	4	

Idaho	MTR Bldg. 632	Hot cell	10,000	1	NBG-$ZnBr_2$	$17\frac{3}{4} \times 17\frac{3}{4}$	3.4	48	7,772
			@ 2 Mev	3	NBG-$ZnBr_2$	$27\frac{1}{4} \times 33\frac{1}{4}$	6.3	48	11,582
	ANP A&M Bldg. 607	Special services cubicle	10^7 r/hr	5	NBG-oil	$22 \times 39\frac{1}{2}$	6.0	54	31,000
	CPP Bldg. 627	Multicurie cell	50,000	3	NBG-oil	$18 \times 31\frac{1}{2}$	3.9	60	21,890
			@ 1.6 Mev						
Oak Ridge	Bldg. 3019	Analytical cell	250	7	NBG-$ZnBr_2$	24 × 48	8.0	36	4,286
		Storage cell	250	1	Cerium glass	24 × 48	8.0	36	12,000
	Bldg. 4501	Corrosion examination facility	25	2	NBG-$ZnBr_2$	24 × 36	6.0	18	8,950
		Weighing station	25	2	Lead glass	9 × 12	0.75	4	850
		Isotopes research cell block	10,000	4	Lead glass	24 × 24	4.0	36	5,750
	Bldg. 4505	Unit operations	1,000	4	Lead glass	18 × 24	3.0	36	3,250
			1,000	8	Lead glass-$ZnBr_2$	6 dia	0.20	36	1,000
	Bldg. 3025	General purpose hot cells, 1,2,3	7,000	6	$ZnBr_2$	30 × 36	7.5	36	5,433
		5		2		24 × 24	4.0	36	2,750
		4, 6		2		24 × 48	8.0	36	6,000
		Metallographic cell	1	2	Lead glass	12 × 24	2.0	6	1,000
	Bldg. 3029	Multi-kilocurie loading cell	10,000	1	Nonbrowning cerium	4 × 20	0.56	36	8,300
		Argonne type cell	300	1	Lead glass	24 × 36	6.0	24	5,500
	Bldg. 3028	I^{131} processing facility	100	1	Lead glass	6 × 8	0.33	6	600
San Francisco	Canoga Park	Atomics International hot cave	400	2	Lead glass-$ZnBr_2$			27	5,000
	Santa Susana	SRE, primary	1,000,000	2	Lead glass	36 × 48	12.0	42	16,000
		Secondary	1,000,000	1	Lead glass	36 × 48	12.0	36	16,000
	Livermore	General utility cells 1, 2	1,000	2	NBG-$ZnBr_2$	26 × 45	8.1	39	6,580
		34	10,000	3	NBG-$ZnBr_2$	36 × 45	11.3	$43\frac{1}{2}$	7,230
		5	1,000	2	NBG-$ZnBr_2$	$25\frac{3}{4} \times 33\frac{1}{2}$	6.0	38	§
		6	500	2	NBG-$ZnBr_2$	30 × 36	7.5	36	¶
Savannah River	Bldg. 773-A	Main technical laboratory cells	5,000	6	NBG-oil	$25\frac{1}{2} \times 30$	5.3	36	20,500
Schenectady	KAPL	High-level double cell 1, 2	10,000	8	Lead glass; $ZnBr_2$	20 × 30	4.2	36	7,793
		Very high level double cell 3, 4	1,000,000	8	Lead glass; $ZnBr_2$	20 × 30	4.2	36	7,793
		Remote metallography cell 5	200	3	Lead glass	20 × 36	5.0	9	3,498
		Low-level utility cell 6	50	2	Glass-$ZnBr_2$	20 × 30	4.2	9	2,102
	West Milton	Fuel-element service cell	500,000 r/hr	8	Glass-$ZnBr_2$	36 × 48	12.0	60	13,730

*NBG, nonbrowing glass.
†Optical window.
‡Estimated replacement value.
§Existing window modified.
¶Existing windows.

Table 12 — SUMMARY OF DATA FOR SPECIAL EQUIPMENT IN HOT CELLS

	Manipulators				Cranes				Machine tools		Measuring devices		Other		
Operations office	No. of pairs	Type[a]	Capacity	Cost	No.	Type	Capacity, tons	Cost	Type	Cost	Type	Cost	Type	Cost	Total cost
Albuquerque															
Mound Laboratory Area 1A cave	1	Rectilinear electric	200 lb	$ 15,900											$ 15,900
Chicago															
Ames hot cell 1	2	CRL model 4	Master slave	31,150	2 1	Electric Electric bridge	1/4 2	$ 10,865	Slitting saw, remote wrenches, saws, etc.	$ 1,248	Radiation monitoring equipment, etc.	$ 1,723	SS slag jacket dissolver; TV viewer	$ 6,436	51,422
Ames hot cell 2	1	CRL model 8	Master slave		1	Hydraulic monorail	1½								
Bettis original section	4 2 1 1 1	CRL model 8 GM model E GM model C GM model D ANL model	Master slave	163,900	5 1	Electric jib Electric bridge	2 15	17,747	Milling machine, bench lathe, drill press, pipe cutter, shaper	7,500	Diamond utiliscope, tensile machine, Fulton hardness tester, X-ray equipment, balance	34,000	Steam, jenny, safes, telescopes, binoculars, grinding and polishing equipment, optical system, centrifuge and mixing kettle	17,500	240,647
Bettis expanded section	3 1	CRL model 8 GM model E	Master slave	77,000					16- × 28-in. lathe, 14-in. × 18-ft vertical milling machine, 8-in shaper, 18-in. drill press, 8-in. belt grinder, hand-saw, power lock saw	13,000	Tensile machine, impact testing machine, hardness testing machine, remote milling machine, central radiation monitoring	100,000	Metallographic cell, radiochemistry installation, dry-sample storage, waste disposal, etc.	186,000	376,000
Lockland Radioactive Materials Lab.	2 1	CRL model 8 GM model E	Master slave	14,600 33,100	1	Electric bridge	10	11,300	Remote slitting saw, remote shear, remote hacksaw, hydraulic moulding press, grinder tool, abrasive cutoff machine, hydraulic air pump, ultrasonic cleaning equipment	25,600	Hardness testing machine, analytical balancer, periscope, stereoviewer, stereomicroscope, camera, meter radiation devices, gauging unit	33,200	Radiation monitoring equipment, miscellaneous furniture	6,900	124,700
Argonne, Bldg. 301, cave 1	4	CRL model 8	Master slave	15,000	1	Special		3,200	Lathe, portable press, drill press, hacksaw, milling machine, screw-cutting lathe, electric hammer, guillotine cutter	2,059	Analytical balances, gauges, recorders, air meter, microscopes, stress-strain tester, fatigue testing machine, hardness tester	8,227	Binoculars, trolley hoists (portable), pumps, transfer pot, portable shields, pot dolly, 5-ton electric hoist, lift table, miscellaneous dollies	10,089	38,575
cave 2	4	CRL model 8	Master slave	15,118	1	Special		3,200		2,059		8,227		10,089	38,693
Metallographic cave	3	CRL model 8	Master slave	46,614				3,870	Polishing machine, mounting equipment, electric cutting machine	8,637	Optical and photographic equipment, special lenses, binocular microscope	11,545	Small tools, magnets, lamps and stands, motor-driven carbon arc, tilting table, photographic lights, ultrasonic washer	3,036	73,702
Bldg. 40, main cave	1	ANL model	Electric	11,500											11,500
junior cave	1	(?) Model 5	Master slave	7,000											7,000
Bldg. 200, junior cave	1	ANL model 7[b]	Master slave	7,000											7,000
Bldg. 211, junior cave	1	ANL model 7	Master slave	20,560[c]											20,560
Bldg. 205, junior cave	1	ANL model 7	Master slave	8,850											8,850
Bldg. 17, junior cave	1	ANL model 4	Master slave	3,500											3,500
Hanford, Bldg. 327,															
Cell B	1	Hanford	10 lb	5,000	1 1	Electric bridge Electric bridge	15 3[d]	11,767					Opton microscope sample positioner	2,748	19,515
Cell C	1	Hanford	10 lb	5,000	1 1	Electric bridge Electric bridge	15 3[d]	11,767					Sample mounting apparatus, sample polishing apparatus, cathodic etching apparatus, electrolytic etching apparatus, ultrasonic cleaner, metallograph	32,617	49,384
Cell D	1	Hanford	Master slave 10 lb	5,000	1 1	Electric bridge Electric bridge	15 3[d]	11,767			Rockwell hardness tester	2,848	Vacuum annealing furnace	136	19,751
Cell E	1	Hanford	Master slave 10 lb	5,000	1 1	Electric bridge Electric bridge	15 3[d]	11,767	Lathe	2,000	Electrical resistivity	4,500	Can opener and sealer, scintillation scanner	250	23,517
Density cell											Balance	278			278
Double crystal X-ray-diffraction cell											X-ray-diffraction unit and accessories	23,000			23,000

Table 12 — (Continued)

Operations office	Manipulators: No. of pairs	Manipulators: Type	Manipulators: Capacity	Manipulators: Cost	Cranes: No.	Cranes: Type	Cranes: Capacity, tons	Cranes: Cost	Machine tools: Type	Machine tools: Cost	Measuring devices: Type	Measuring devices: Cost	Other: Type	Other: Cost	Total cost
High-temperature tensile testing cell											Tensile tester, optical strain gauge	$ 20,449	Vacuum system	$ 12,000	$ 32,449
Room-temperature tensile testing cell	1	Hanford	10 lb	$ 2,500	1	Electric bridge	15	$ 11,767			Tensile tester	13,849			28,116
					1	Electric bridge	3^d								
Decontamination cell	3	Ball and socket		600											600
Bldg. 222-S, multicurie cell	5	Ball and socket		5,574	1	Remote air	2^e	4,510							10,084
	1	Hanford	Master slave												
Idaho, MTR, Bldg. 632, hot cell	1	GM model C-7	40–750 lb	41,480					Portable hacksaw, milling machines, drill press, lathe	$ 1,556			3 work tables, dolly, 3 work benches, steel storage drawers	2,274	81,476
	1	CRL model 6-B	7 lb	36,166											
ANP Bldg. 607, special services cubicle	1	GM model B-1		56,250	1	Jib crane	3	1,000	Elox cutting machines, specimen mounting press, special purpose cutting equipment	33,650	Hadley balance	19,000	1 Bausch & Lomb and 1 Kollmorgan periscope, track and dolly system, access conveyor	35,000	242,000
	1	GM model E-2		37,500											
	1	ANL model 6	Master slave	28,000											
	2	ANL model 8	Master slave	31,600											
CPP Bldg. 627, multicurie cell	1	ANL model 8	Master slave	58,167	1	Electric boom	1/18	1 543					No description	22,731	82,441
Oak Ridge, Bldg. 3019, analytical cells	7	(?) Model 8		70,000	1	Electric hoist	3/4	600					Expendable storage boxes, continuous conveyor	38,300	108,900
Storage cell	1	(?) Model 8													
Bldg. 4501 (North portion)	1	(?) Model 8		13,000	1	Jib boom		2,700	Air-driven abrasive saw, special vises, electroarc metal disintegrator	23,600	Speedigram balance	1,800	Coolant recirculating equipment, portable shielded containers, tray and tool racks, electrolytic defilming tank, wash tanks, electric drying oven and desiccator	16,800	57,900
	1	Flexible tongs													
Bldg. 4501, isotopes research cells					1	Jib boom							Cutting wheel, universal chuck, disk changer, vises, washing station	30,000	35,000
					1	Electric bridge	5	5,000							
Bldg. 4505, semiworks cell															5,000
Bldg. 3025, general purpose cell 1					1	Electric bridge	5	5,000	Machine lathe, milling machine				Dust collector		
Cell 2	1	GM model (?)			2	Jib	1	4,000					4 polishing wheels, lapping machines, 2 specimen cleaners, cutoff wheel mounting press		
Cell 3				138,500					Horizontal bandsaw	130,200				92,100	382,700
Bldg. 3026, general Cell 4	1	Model 4									Micro table		Periscope		
Cell 5	1	Model 4									Tensile machine, impact machine	17,900			
Cell 6	1	Model 4							Drill press, lathe						
Metallographic cell	1	Model 4		9,200							Stereomicroscope, metallograph	10,000			19,200
Equipment used in cells as needed									Slitting saw		Dimensional apparatus, analytical balances, stored-energy apparatus	8,000	Profile recorder, Hall effect apparatus, electric furnace	7,000	15,000
Bldg. 3029, multikilocurie loading cell	1	Model 8		14,700	1	Monorail hoist	1	2,500							17,200
ANL type general purpose cell	1	Model 4		8,200											8,200
Bldg. 3028, I^{131} cubicle 1 facility															
Cubicle 2													Slug charging chute and SS dissolver		
Cubicle 3													Slug charging chute and SS dissolver		
Cell 1					1	Monorail	1	6,000					Glass distillation equipment		
					1		3							80,300	86,300
Cell 2													Dissolver condensers, caustic scrubber, catch tank, bubble-cap column, still, distillate receiver, evaporator condenser, water plate scrubber, tantalum evaporators		

Table 12 — (Continued)

Operations office	Manipulators: No. of pairs	Manipulators: Type	Manipulators: Capacity	Manipulators: Cost	Cranes: No.	Cranes: Type	Cranes: Capacity, tons	Cranes: Cost	Machine tools: Type	Machine tools: Cost	Measuring devices: Type	Measuring devices: Cost	Other: Type	Other: Cost	Total cost
Cell 3 Control of operations in cells 1, 2, 3													Instrument panel board above cell 3 and instrument cubicle in front of cells 1, 2		
San Francisco, Canoga Park, A1 cell	2	ANL model 4		$ 17,000	1	Electric bridge	2	$ 1,500							$ 18,500
Santa Susana, SRE cell (primary)	2	ANL model 8		24,000	1	Electric bridge	1/8	3,000	Cutoff wheel, slitting device, lapping machine	$ 2,000	Hardness tester	$ 1,000	Ultrasonic cleaner, chemical, electrochemical, or cathodic etch, metallograph	$ 3,000	33,000
Livermore, Bldg. 121, cell 1	1	ANL model 8	Master slave	9,000	1	In-cell	1	2,745	Bandsaw	300			Transfer trays, vacuum cleaning system and pump	9,302	21,347
Cell 2	1	ANL model 8	Master slave	9,000	1	In-cell	1	9,390			Automatic chemical balance, automatic mortar and pestle	1,120	Vacuum cleaning system, high-vacuum producer, telescope	1,392	20,902
Cell 34	2	ANL model 8	Master slave	18,000	1	CM[f] Meteor hoist in cell	2	11,345	Milling machine	18,000	Jordan meter	200	Transfer trays, optical periscope, vacuum cleaning system, pipe cutter, vacuum equipment, mounting press, horizontal cut-off wheel	9,225	56,770
Cell 5	1	ANL model 8	Master slave	9,000	1	CM Lodestar in cell	1	9,390					J. Crane Lapmasters, precision mounting press, ultrasonic cleaning unit, vacuum cleaning system, Globar furnace, electrolytic etching apparatus	6,900	25,290
Cell 6	1	ANL model 8	Master slave	9,000	1	CM Lodestar in cell	1	9,390			Microhardness tester		Precision polishers, custom-built polishers, ultrasonic cleaning system, metallograph, vacuum cleaning system	18,950	37,340
Savannah River, Bldg. 773-A, caves 1, 2, 3	1	GM model C5		211,600	1	Remote-bridge	1	8,800					Lead-filled transfer casks	23,900	361,300
	1	Master slave		84,100	2	Jib	4	8,000							
					1	Bridge	10	24,900							
Schenectady, KAPL Irradiation Lab., cell 1, 2	4	GE Man–I Master slave		82,000	1	Electric hoist		2,454			Hardness tester, tensile tester, high-temperature tensile tester, optical comparator	64,724			214,378
	2	GM models C & E		47,500											
	1	ANL model 6B		17,700											
Cell 3, 4	7	GE Man–II		60,000	1	Hydraulic door hoist system		7,907			Manometers	169	Radiation detecting devices, waste disposal equipment, sample storage equipment	59,445	162,521
	2	GM models E-1, E-2		35,000											
Cell 5	3	ANL model 4	Master slave	20,000									Microscope, metallography and shield, microhardness tester, mounting, press, polishing wheels	36,175	56,175
Cell 6															
Fuel-element Service Bldg. fuel-element service cell	1	Farrel-bridge arm	100	157,363									Periscopes, radiation monitoring, rod transfer casks, rod clean and leak station, inspection and measuring station, rod dis-assembly station, shearing station, scanning station, tunnel dolly, etc.	523,414	732,302
	1	ANL model 6	1:1												
	1	ANL model 8	1:1	51,525											
Total				$1,904,017				$240,691		$271,409		$385,759		$1,304,009	$4,105,885

[a]CRL, Central Research Laboratory. GM, General Mills.
[b]Experimental model.
[c]Includes one spare.
[d]Serves five cells in Bldg. 327; cost allocated
[e]Two-ton capacity, 500-lb hoist being used.
[f]CM, Chisholm-Moore Hoist Div., McKinnon Chain Corp.

3 Albuquerque Operations Office

Mound Laboratory — Semiworks Building, Miamisburg, Ohio

Laboratory Building

The semiworks building is an L-shaped one-story brick building, 140 ft long, 60 ft wide, and 30 ft high. The main portion of the building is divided into three areas: area 1-A, which contains the cave, occupies one-sixth of the floor area and has a mezzanine; area 1-B, which occupies one-third of the total area; and area 1-C, which occupies one-half of the total area. The section between the main portion of the building and the research building contains a corridor connecting the semiworks and research buildings, a men's toilet room, a janitor room, and a mechanical equipment room. This portion of the building is $23\frac{1}{3}$ by $54\frac{3}{4}$ ft with a ceiling height of 18 ft in the mechanical equipment room.

Services are available as follows:

Steam, 100 psi	Propane gas	Heating and ventilating—tempered air with no recirculation, with booster unit heaters (building is not air-conditioned)
Condensate return	Oxygen	
Compressed air	Nitrogen	
Domestic water	Waste, sanitary and storm	
Fire-protection water	Power, 460-volt, 3 phase	
Hot water		

Area 1-A Cave. The program that was carried out in this cave has been completed, and much of the special equipment has been removed.

The cave is essentially a vault type structure, approximately 29 ft long, 6 ft wide, and 12 ft high, with doors and windows. It may be divided into three sections—base, body, and superstructure.

The base consists of structural-steel members (approximate total, 3 tons) encased in ordinary concrete.

The body is affixed to this base and consists of (1) The end and back sections, made up of fixed and hinged sections of mild-steel plate and built up to a thickness of 6 in. The largest section measures 50 by 27 in. The total steel is approximately 20 tons. (2) The front fixed sections are of light steel members and plate (approximately $2\frac{1}{2}$ tons), filled with special dense concrete, having a density of about 375 lb/cu ft and special barrier windows. The maximum dense concrete section measures 72 by 17 in. There are six identical shielding windows, each being approximately 38 in. long, 26 in. high, and 25 in. deep over-all.

The superstructure is made up of 16-gauge black soft steel light angles and includes hinged doors, fixed windows, and filter frames. Stainless steel, types 302 and 316, in the form of $\frac{1}{4}$-in. plate and 12- and 18-gauge sheets, totalling slightly under 1 ton, is used as a floor plate, drip shield, and for built-in ductwork. Miscellaneous items of hardware: mirrors, lead access plugs, etc., are included in the structure.

The cave is constructed with a gamma shielding effectiveness of 4 in. of lead; this reduces the transmitted radiation at a distance of 1 meter from the source to approximately 15 mr/hr for a 5-g batch.

No attempt is made to make the cave airtight, but it is maintained below room pressure (low-risk area) by a 3000 cu ft/min exhaust system. Air is supplied to the low-risk area, then it is fed to a high-risk area behind the cave, next it is fed through the cave, and finally, through a filter bank.

4 Chicago Operations Office

Ames Laboratory, Iowa State College, Ames, Iowa

Laboratory Building

The hot canyon is located in the research building, which is a part of the Ames Laboratory facilities. A section of this building—33 ft wide, 76 ft long, and 22 ft high (Fig. 5)—has been set aside for radioactive work. The research building houses several scientific research groups in the departments of Physics, Physical Chemistry, Chemical Engineering, Radiochemistry, Mechanical Engineering, etc.

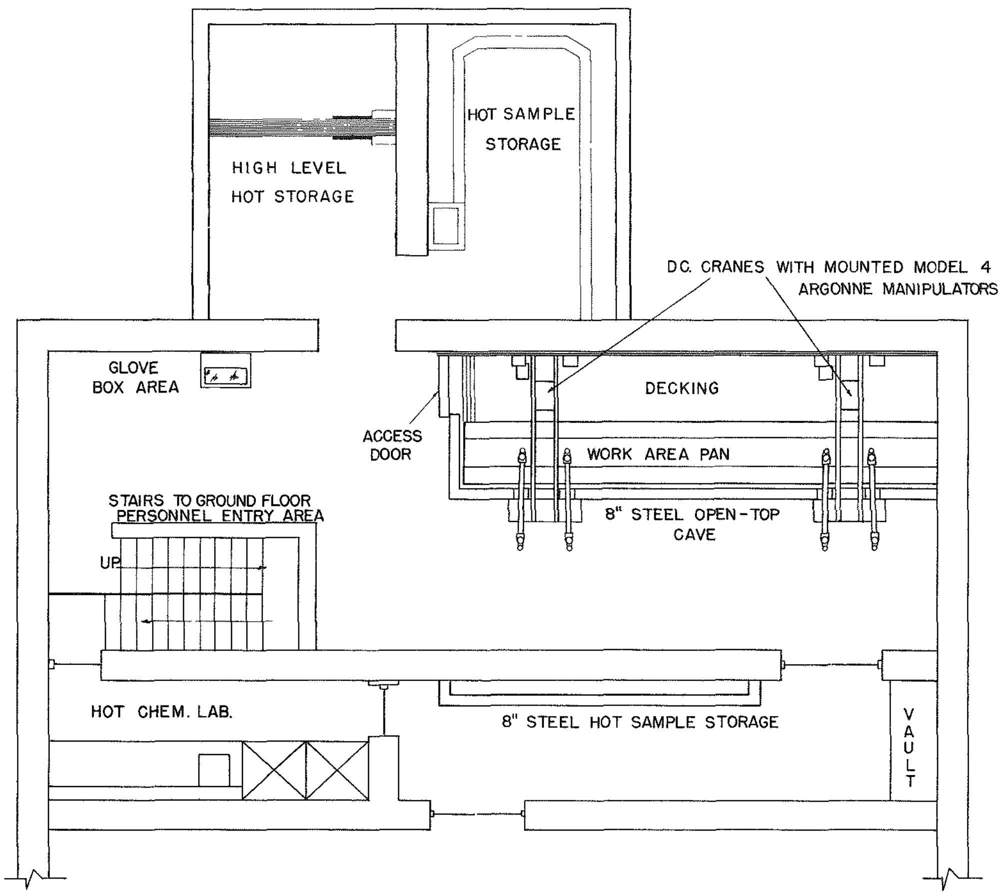

Fig. 5—Plan of hot cell No. 1, Ames Laboratory, Iowa State College.

The research building is a five-story reinforced-concrete structure 245 ft long, 100 ft wide, and 72 ft high; the exterior walls are brick with stone trim. Partitions are 4-in. glazed tile, except those in the offices, which are 4-in. tile and plaster. The floors, laboratories, and shops have concrete floors, and the offices and corridors are floored with asphalt tile.

The major portion of the building is air conditioned with the exception of the hot canyon and the Chemical Engineering section; these have special ventilation facilities.

The primary function of the two hot cells is to provide facilities for carrying out various chemical- and metallurgical-separations processes on hot reactor fuel elements.

Hot Cell 1. The "hot cave" occupies a 31- by 9-ft area including shielding walls. The shielding wall is 10 ft high and is designed of appropriate thickness and location to attenuate 20 curies of Co^{60} down to 15 mr/hr on the safe side of the shield. The cave is so designed that four experiments can be carried on simultaneously, with individual utilities, viewing windows, etc., provided for each of the four sections.

The shield wall consists of a reinforced-concrete base 3 ft high and 1 ft thick with an additional 2 in. of lead on the interior. Resting on this foundation is an 8-in. steel wall pierced for four 8-in.-thick lead-glass windows, each 3 ft long and 18 in. high (Fig. 6). Stepped plugs are provided for the introduction of various utilities required for experiments.

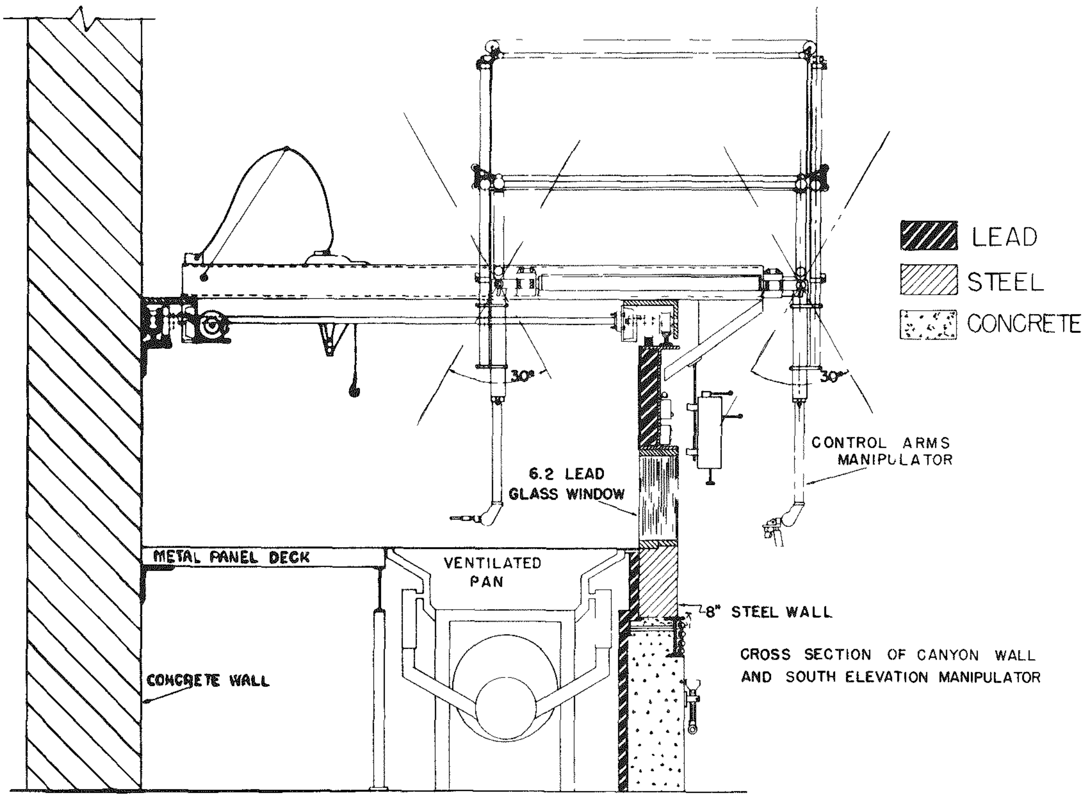

Fig. 6—Vertical section of hot cell No. 1, Ames Laboratory, Iowa State College.

This cave has an open top and, consequently, is not suitable for experiments involving plutonium or other programs involving the use of volatile radioactive material that might diffuse in the air stream.

Ventilation is accomplished by bringing in warm filtered air through a perforated ceiling and taking the air out through a stainless-steel manifold that serves as a combination working surface and waterproof trough.

The primary exhaust system maintains a negative pressure of 0.3 in. of water within the hot canyon area. Air is exhausted along the bottom of the cave and passes horizontally through a stainless-steel duct to a bank of filter-glass prefilters and then through another bank of filters. This, in turn, is followed by a bank of Farr filters, which serve as a safety device in case one of the CWS filters is ruptured. The air is discharged through a stack located on the exterior of the building and extending 12 ft above the parapet wall. The exhaust fan is protected by an automatic starting stand-by motor-generator set and a second blower fan that takes over automatically in case the primary blower fails.

The door of the hot cave is constructed of steel plate, 8 in. thick, 6 ft high, and 4 ft wide, installed in an overlapping manner. This door is opened manually by a chain-drive mechanism traveling on a rail embedded in the concrete floor.

Explosion-proof incandescent lights are located in the cave to provide a sustained lighting level of 100 foot-candles at bench height. Emergency lighting is also provided.

The four viewing windows are designed to give shielding protection equivalent to 8 in. of steel and are constructed of Penberthy 6.3 high-density glass.

Two 500-lb d-c cranes travel along the length of the cave. They carry the manipulators and aid in removing the covers from the shielding containers (Fig. 7). In addition, a 2-ton bridge crane runs along the entire canyon length to lift heavy containers or equipment into the cave proper. This bridge crane has a span of 17 ft with a maximum vertical lift of 19 ft. The crane is operated from the floor by means of push buttons. Figure 8 shows a pair of manipulator tongs in use.

Hot Cell 2. Hot cell 2 has an inside dimension of 8 by 12 ft and is located in a vault constructed outside the research building, connected to the hot canyon by a doorway. This vault is covered with 8 ft of earth that gives additional protection. The main shielding wall of the cell is steel, 12 ft wide, 12 ft high, and 12 in. thick, with a window 4 ft wide, $2\frac{1}{2}$ ft high, and 12 in. thick. The shield design is based on attenuating 1000 curies of Co^{60} down to 15 mr/hr on the safe side of the shield. The 12-in. window consists of three 4-in. thicknesses of high-density Penberthy glass.

The door serving this cell is 3 ft wide, 7 ft high, and 12 in. thick with a step edge to eliminate radiation leaks. A 12- by 12-in. Penberthy high-density glass window is used for viewing purposes. The door is electrically operated with safety features to prevent accidental openings. A hydraulic monorail crane, $1\frac{1}{2}$-ton capacity, is located along the back wall to transport the large shielded containers in this area. The air leaving this cell is prefiltered through a bank of fireproof filters and is then discharged into the general canyon ventilation system described above. A negative pressure of 1 in. of water is maintained within the cell when the door is closed.

Physics of Solids Laboratory, Bettis Plant, Pittsburgh, Pa.

Laboratory Building

The Physics of Solids Laboratory is constructed with reinforced-concrete footings and foundations, structural-steel framework, masonry exterior walls of concrete block faced with Speedtile tile and block interior partitions, metal roof deck with graveled surface, three-ply composition built-up roofing, metal flashing, metal commercial projected sash, plasterboard and fiberboard ceilings where the ceilings are finished, asphalt-tile floor, color-treated concrete floor in work areas, painted masonry walls, wood and metal doors, and metal stairways. Fluorescent lighting is furnished in the support areas and 1000-watt mercury-vapor lights, in the high-bay work area. Direct-radiation and unit-heater type heating is used. Exhaust ventilation, equipped with wet dust collectors, is used in the original portion of building. In the addition there are five separate exhaust systems comprised of five Roto-clones and five Precipitrons.

Services to the building consist of 110-, 220-, 440-volt, and d-c current, air, gas, and hot and cold water, including circulating water supply and return. Monitor, special monitor, and hot drains are installed and connected to existing plant facilities. An electrically operated overhead steel door provides access to the working area. The working area is serviced by a 15-ton overhead crane.

Original Five Hot Cells. Each of the five hot cells built in the original hot laboratory are of equal size and capacity (Fig. 9). Each cell is 6 ft wide and $11\frac{1}{4}$ ft long with a maximum height of 15 ft. An electrically operated $2\frac{1}{2}$- by $4\frac{1}{2}$-ft steel door provides access to the cell. The cells are separated by an 8-in.-thick laminated-steel intercell barrier, 6 by 6 ft. The cell walls are 3 ft thick on all sides with high-density concrete poured to a level of $8\frac{1}{2}$ ft and then extended upward to a height of 16 ft with regular concrete. Each cell has two viewing windows, 3 ft square

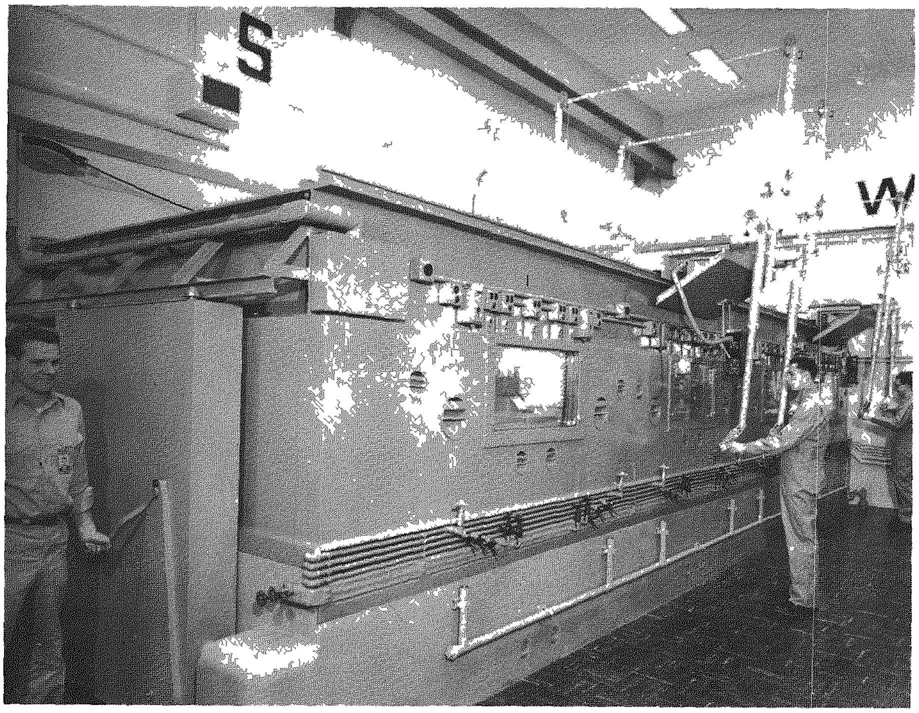

Fig. 7—Operating area for hot cell No. 1, Ames Laboratory, Iowa State College.

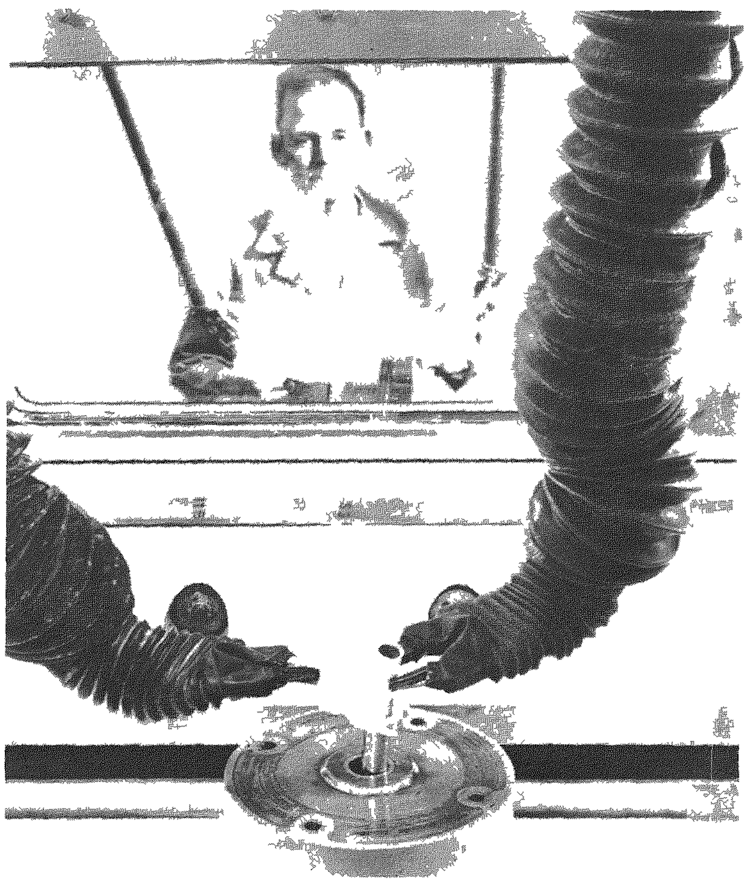

Fig. 8—Manipulator tongs for hot cell No. 1, Ames Laboratory, Iowa State College.

with oil-filled laminated glass 1 in. thick, spaced $^1/_{32}$ in. apart. The total depth of the viewing windows is 3 ft. The cells are designed for 10,000 curies maximum radiation. Each cell has a removable roof slab 1 ft thick. Two Roto-clones serve the five cells and provide 3000 cu ft/min exhaust capacity through two separate exhaust systems. In addition to the 15-ton overhead crane, each cell is serviced by an electrically operated 2-ton jib crane. Lighting within the cell is provided by two BL-80 fluorescent fixtures with two 40-watt lamps; in addition, each cell has 10 sodium-vapor lamps. These lamps are evenly spaced around the edge of the shielding window.

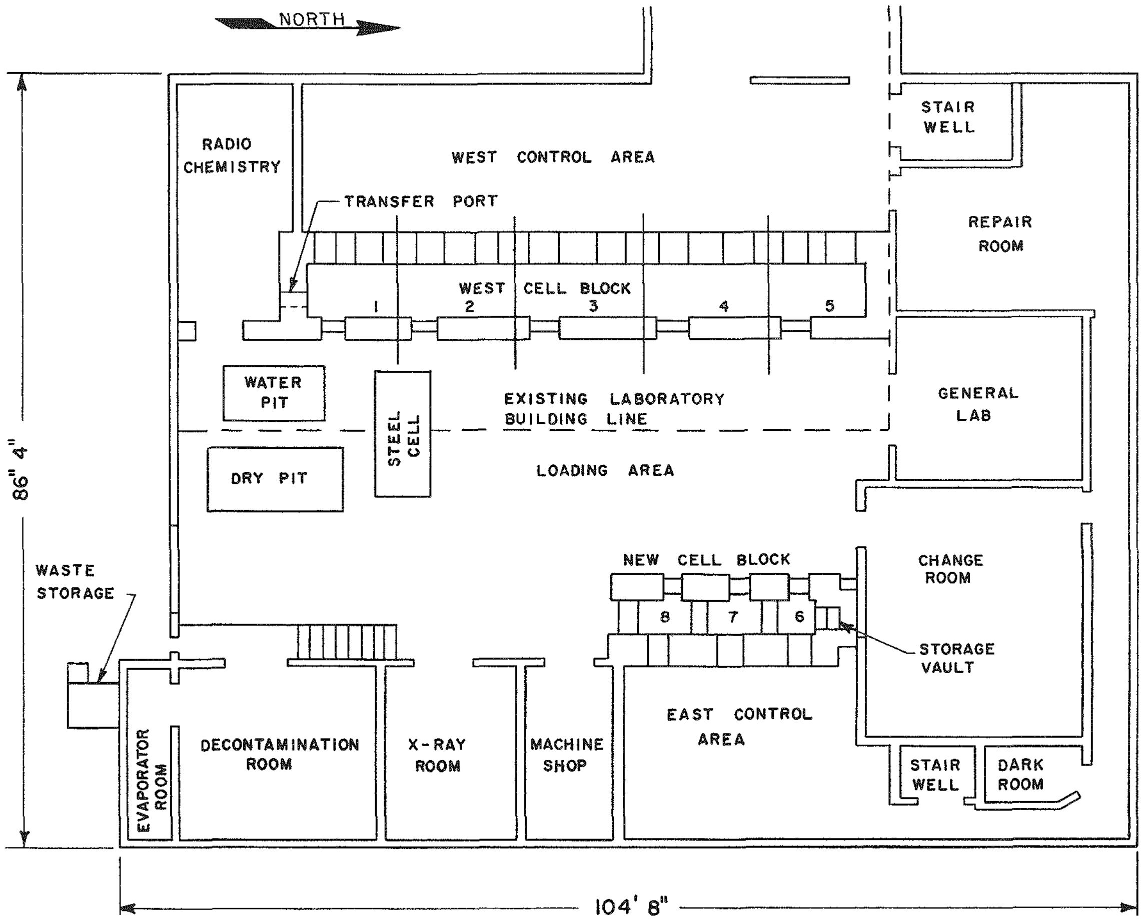

Fig. 9 — Plan of Physics of Solids Laboratory, Bettis Plant.

Additional Three Hot Cells. The addition to the facility consists of three cells 5 by 6 ft each, with a clear height of 12 ft. Access to each cell is by an air-operated steel door, $2^3/_4$ by $6^1/_2$ ft. The cells are separated by $1^1/_2$-ft-thick laminated steel intercell barrier doors. The cell walls are 3 ft thick on all sides with ferrophosphorous heavy concrete poured to a level of 7 ft on the viewing side and 13 ft on the work area side of the cells. Each cell has a viewing window 3 ft square with oil-filled laminated glass 6 in. thick, spaced $^3/_{16}$ in. apart (Fig. 10). The total shielding window thickness is 3 ft. The cells are designed for 1,000,000 curies of 1-Mev gamma radiation. Each cell has a precast removable roof slab 1 ft thick. Each cell has its own exhaust system composed of a 2500-cu ft/min Roto-clone, Precipitron and dry filter, fan, and motor. The remaining area is serviced by a 1900- and a 4000-cu ft/min Precipitron and dry filter, fan, and motor for the cell work area and associated work rooms. Lighting within the cells is provided by two 400-watt mercury lamps and four 40-watt fluorescent fixtures in each cell.

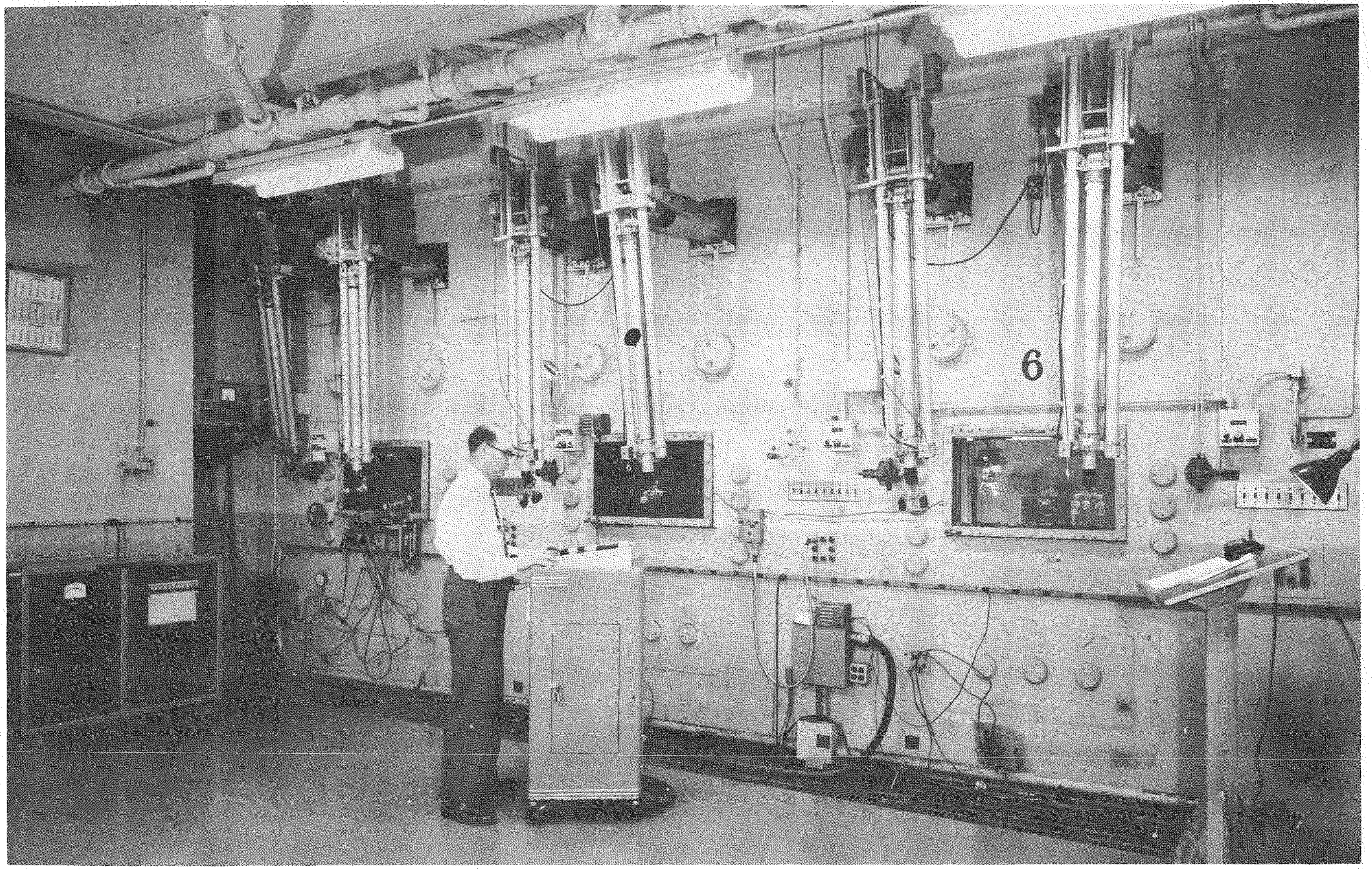

Fig. 10—Operating area for expanded section (three additional hot cells), Bettis Plant.

Lockheed Area, Evendale, Ohio

Radioactive Materials Laboratory, Building D

The Radioactive Materials Laboratory is at the Aircraft Nuclear Propulsion (ANP) Department in Evendale. It is located in an existing area (40 by 60 ft) in Building D. The building was formerly used as an aluminum foundry and now houses offices, laboratories, and manufacturing area for the ANP Department. Essentially, all services and utilities, such as water, steam, and electrical power, were available.

Hot Cells. The primary function of the three hot cells is to provide the facilities required for the developmental evaluation of reactor materials after exposure to radiation has rendered the test specimens unsuitable for test and examination by conventional methods.

The cell area is 14 by $37\frac{1}{3}$ ft (246 sq ft floor area and 524 sq ft over-all, including walls). Height inside the cells is $16\frac{1}{4}$ ft. Cells 1 and 2 are 8 ft 10 in. long by 8 ft wide. Cell 3 is 13 ft long by 8 ft wide. The three cells are designed to contain radioactive material and allow personnel to use the adjacent operating, loading, and storage areas at the same time. Intercell partitions are sufficiently thick to permit personnel to enter either Cell 1 or Cell 3, provided that Cell 2 does not, at the time of entry, contain high-level radioactivity.

Shielding walls are constructed of reinforced high-density concrete using barytes aggregate. The density of the concrete is a minimum of 210 lb/cu ft in place. Walls are approximately 3 ft thick at the viewing level. The thickness of the walls and viewing windows was based on attenuating 10,000 curies of Co^{60} down to 1 mr/hr on the safe side of the shield.

Heating and ventilating the cells will be accomplished by an exhaust system taking air from the loading and storage area through cell roof slots. A primary exhaust system will maintain a negative pressure within the cells of 2 to 3 in. of water. The exhaust is taken from the bottom of the cells and passed upward through stainless-steel ducts to a bank of prefilters followed by CWS filters. The air is then discharged through a 15-ft stack on the building roof.

Doors are the concrete plug type, $6\frac{1}{2}$ ft high by 3 ft wide and 3 ft thick, with steps and gaskets to provide radiation shielding equivalent to the cell wall. Movement of the doors is by chain-wheel-driven grooved wheels rolling on rails embedded in the concrete floor. A loading plug and sleeve is installed in each of the three doors. Fluorescent lighting is installed in the control room to maintain a sustained lighting level of 50 foot-candles at bench height. Lighting circuits are arranged to allow the lighting level to be reduced as required for cell viewing. Emergency lighting and life-guard units are provided. Lighting within the cells is provided by sodium-vapor lamps to give an apparent lighting level on the viewing side of 60 foot-candles.

Argonne National Laboratory, Lemont, Ill.

Physics and Metallurgy Hot Laboratory, Building 301

The Physics and Metallurgy Hot Laboratory is a one-story combination reinforced-concrete and structural-steel brick structure with a partial basement and partial subbasement, and a canopied loading dock 8 ft wide, having an over-all length of approximately 42 ft.

Construction consists of reinforced-concrete footings, piers, foundation walls, floor slabs on ground, and beams; structural-steel and reinforced-concrete columns; reinforced-concrete roof slabs supported by reinforced-concrete and structural-steel beams. All roof slabs are built up with filler, insulation, and roofing. Exterior walls are of red-face brick with common brick back-up; Hope's intermediate, industrial projected, and fixed steel sash; and hollow metal and rolling steel shutter exterior doors. Interior partitions are of brick, clay partition tile, Waylite block, solid concrete block, with wood, hollow metal, and steel doors. A plan view of the building is shown in Fig. 11.

Ventilation of the structure is by means of a forced tempered air intake and distribution system supplied at 11,040 cu ft/min and partial forced-air exhaust at 9000 cu ft/min.

Heating of the structure is by means of radiant panels (hot water), hot-water convection, steam convection, and forced tempered air by unit heaters.

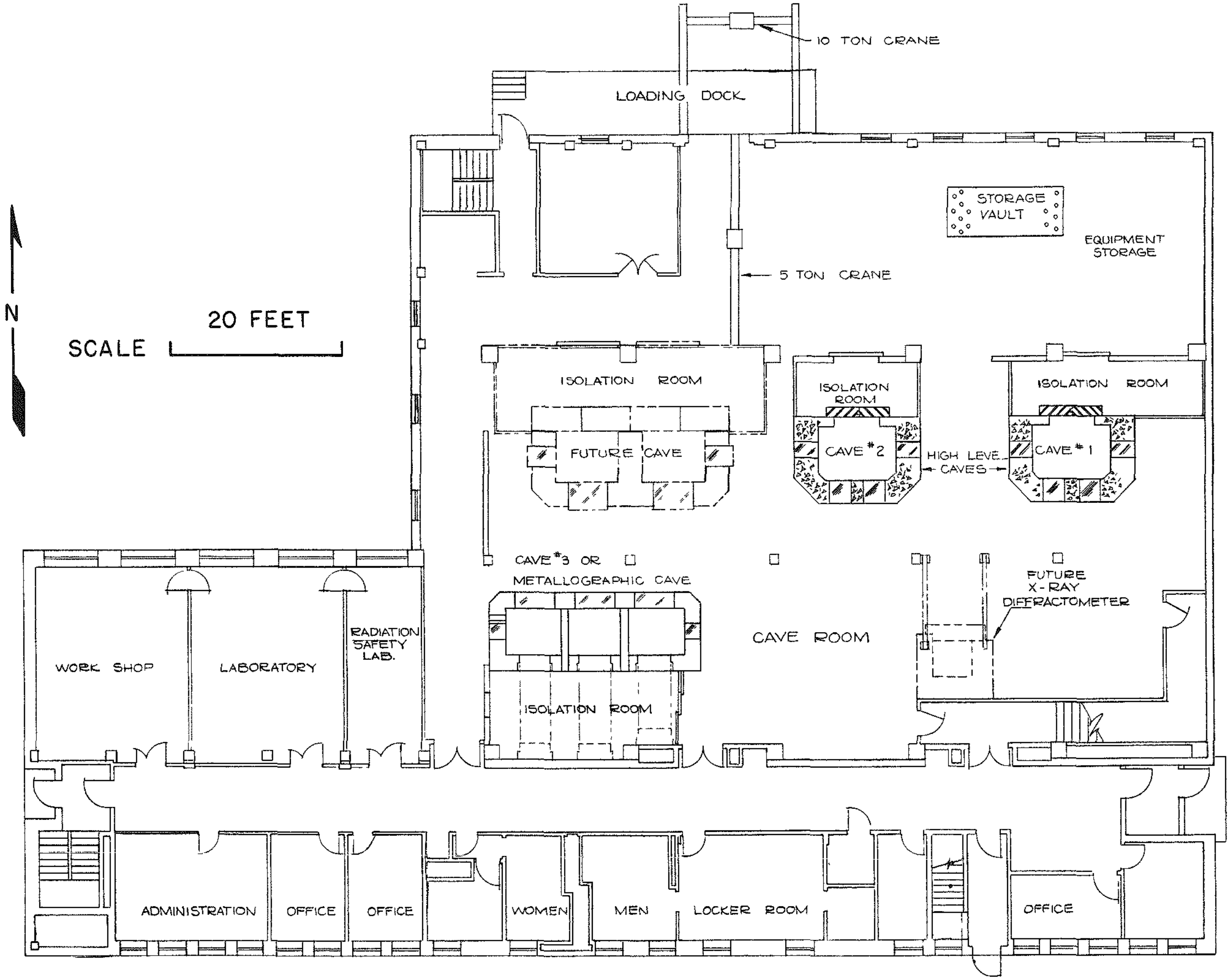

Fig. 11—Plan of physics and metallurgy hot laboratory, ANL, Bldg. 301.

In addition to the normal electric service, the building has been equipped with an independent distribution system that supplies electric current to vital motors and a number of strategically located lighting fixtures throughout the building.

Noncontaminated wastes and storm waters are discharged into the site storm-sewer system.

Removal of contaminated relief drainage from around the footings of the structure is provided by 6-in. vitrified tile and pumps which discharge into the site storm-sewer system. The removal of contaminated waste from the lavatories in the toilets, from the slop sink in the janitor's closet, from laboratory fixtures, from floor drains in the decontamination room, from capped openings in the cave room, and from exhaust fans in fan loft is provided by laboratory drains that discharge into the laboratory site drain. Bypass provisions have been made for the integration of this system with future laboratory waste tanks, permitting optional discharge of contaminated waste to trucks or site drain.

Compressed air service at 20 psi is supplied to the laboratories, the cave room, and equipment controls.

City gas service is metered at the service entry and discharged to the laboratories, cave room, and decontamination room at a maximum pressure of 3 psi.

Caves 1 and 2. These two caves are essentially identical; each cave has one cell, 6 by 10 by $12\frac{1}{2}$ ft high. The interior is lined with steel. They are used for machining operations and measurements on irradiated metal for determination of physical properties, irradiation damage studies, and related metallurgy and physics investigations. An isolation room behind each cave is used for decontamination of the equipment in order to limit spread of contamination.

Shielding consists of 3 ft of magnetite concrete. Maximum radiation level is approximately 10,000 curies at 1 Mev. This radiation level is based upon a maximum permissible level of 300 mr/week reaching an operator working at the front of the cave for 8 hr a day, five days a week.

Each cave has a special exhaust system with a blower motor. Sodium-vapor lights are installed in all the caves; fluorescent fixtures are provided for emergency lighting. Each cave has two front windows 30 by 34 by 36 in. thick and one window on each side approximately 26 by 24 by 36 in. thick. All windows are filled with zinc bromide solution. Nonbrowning glass is used as the inside plate of the window tanks. Maximum radiation level for these windows (which may be removed and replaced with more dense viewing material if required) is 500 curies.

Metallographic Caves. This facility is set up in a semipermanent arrangement for the preparation and examination of metallographic specimens. The first cell is used for mounting and rough grinding; the center cell is used for polishing and etching; and the third cell is used for optical inspection, hardness testing, and photographing.

The working space of each cell is 6 by 7 ft. A special exhaust system has been installed which is so balanced that the greatest volume of air is exhausted from the first cell and the least from the third cell in order to minimize contamination of the optical equipment. Provisions were made for passing specimens and equipment from one cell to another by providing sliding partitions for the transfer of larger items. Specimens are introduced through transfer holes, and general personnel access is through a rear door in each cell.

The cave consists of 2-ft-thick high-density concrete walls and an iron-ore-shielded roof. The dividing shield walls are of steel, and each cell has a zinc bromide window of nonbrowning glass on the operating side, 30 by 58 by 28 in. thick, and one window in each end. The shielding is designed for medium-level intensity radioactive work (approximately 50 curies). A shielded metallograph is attached to the examination cell. A view of the operating area is shown in Fig. 12.

Hot Laboratory Building No. 40

Building No. 40 is a one-story building of brick and concrete-block construction with a structural-steel reinforced roof of precast concrete slabs; it has concrete footings, foundations, and floor slabs on ground level. The interior partitions are concrete block and brick; Truscon commercial pivoted steel sash was installed together with Truscon steel exterior and interior doors and frames. The building has a steel exhaust stack.

The electric power system consists of a 230-volt three-wire three-phase power service distributed from a power panel located inside the building, including a 115–230-volt three-wire single-phase lighting service.

The heating system is composed of forced warm air unit blowers with supplemental radiation by steam unit radiators.

Domestic cold and hot water are distributed to various fixtures, and drainage of the fixtures is provided through connections to a sanitary sewer line discharging into the sewer main.

The present structure reflects major 1953-1954 improvements to the building consisting principally of structural additions, additional heating facilities, air-conditioning modifications, and two 1500-gal retention tanks.

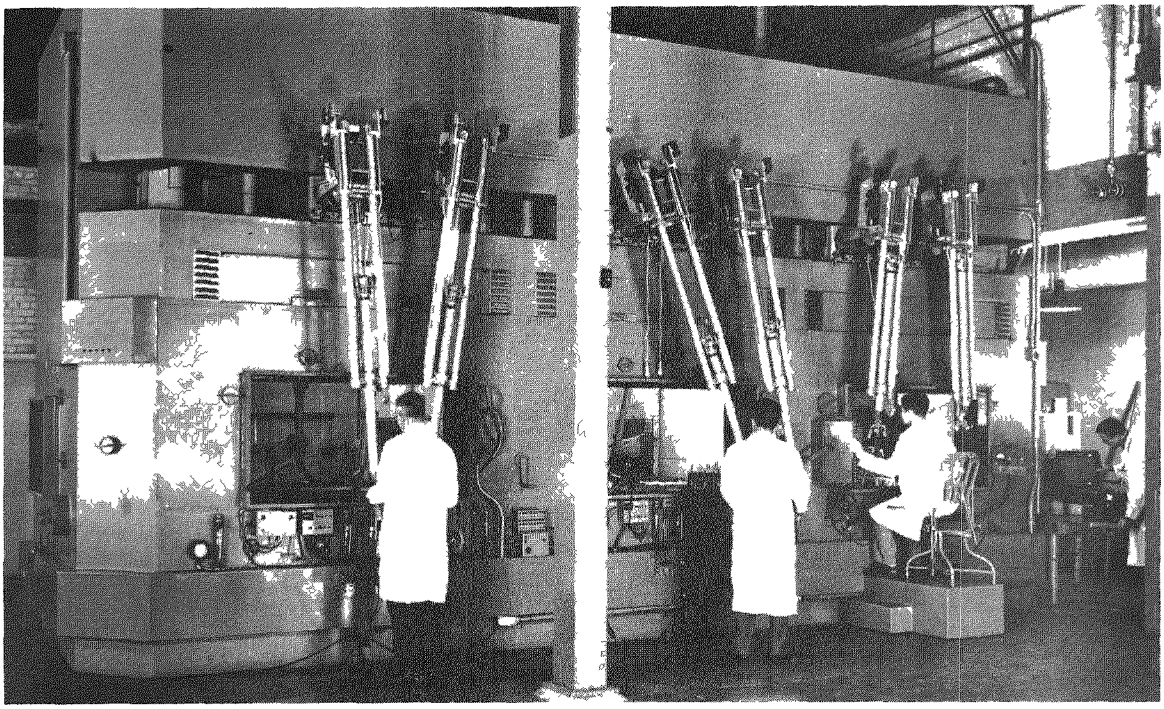

Fig. 12—Operating area of metallographic caves, ANL, Bldg. 301.

Main Cave. This cave consists of a single cell that provides a 3- by 18-ft working area. The cave is used for the chemical processing of research quantities of irradiated materials. The working area is shown in Fig. 13.

Shielding consists of 6 in. of steel. The maximum radiation level is 1 curie of 1-Mev gamma activity.

Junior Cave. This small cave has one cell with a $2\frac{1}{2}$- by 5-ft working area. It is used for chemical processing at intermediate levels of activity and supplements processing in the main cave. The working area for this cave is shown in Fig. 14.

Shielding consists of 3 in. of steel. The maximum radiation level is 0.03 curie of 1-Mev gamma activity.

Chemistry Building 200

Building 200 is a multiwing reinforced-concrete structural-steel and masonry structure with reinforced-concrete floors and roofs. The laboratory wings are connected at their opposite extremities to a corridor which, in turn, provides access to and from a spectroscopy wing and a stock wing.

Basically, the building is a one-story design, the exceptions being partial second floor fan lofts along the long axis of the laboratory wings and part of the spectroscopy wing, a partial

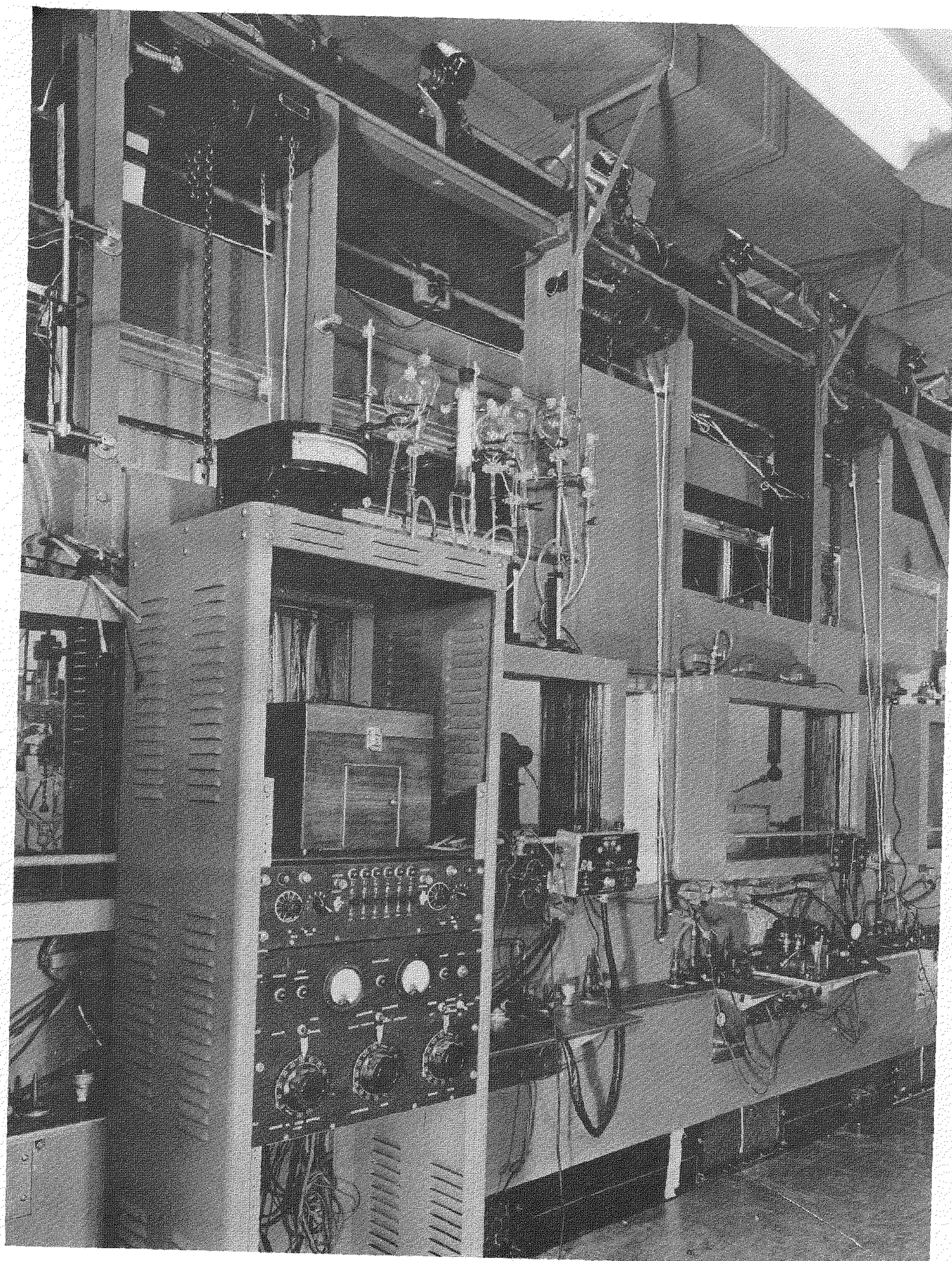

Fig. 13—Operating area for main cave, ANL, Bldg. 40.

second floor administration wing level, and a partial small-area second and third floor stock wing level. The laboratory wings have partial basements, and the stock wing has two sub-basement areas below the basement level.

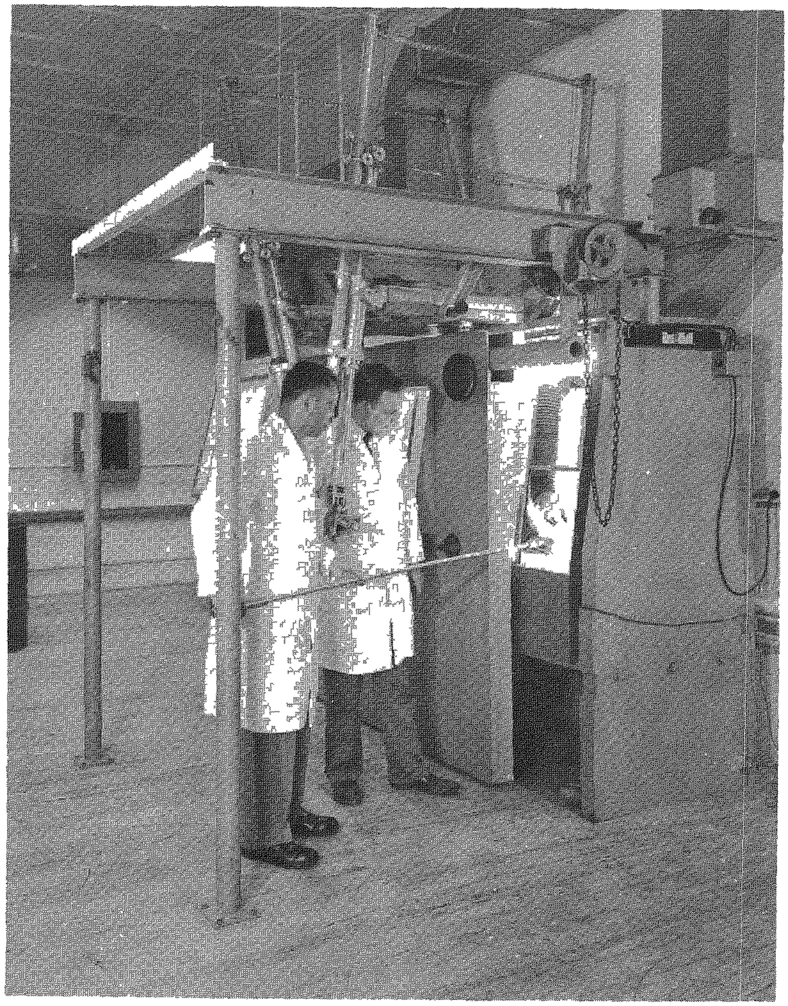

Fig. 14—Operating area for junior cave, ANL, Bldg. 40.

Junior Cave. This junior cave is used for the chemical processing of heavy elements that have been irradiated. The working space covers an area of $2\frac{1}{2}$ by 5 ft; shielding is provided by 3-in. steel plate. This cave can handle 0.03 curie of 1-Mev gamma activity.

Cyclotron Building 211

Building 211 is developed around a central reinforced-concrete vault and experimental tunnel; other than the vault and tunnel, with few minor exceptions, the shell construction consists basically of reinforced-concrete foundations, load-bearing exterior masonry walls, and structural-steel and masonry supported metal decked roof.

Junior Caves. These two junior caves and a senior cave (in process of completion) were planned as the hot laboratory serving the cyclotron. The junior caves are used for processing bombarded samples after some cooling and are also used for repair and maintenance of radioactive components from the cyclotron. Each cave has one cell with a working space 2 by 5 ft.

A view of the operating area for one of these caves is shown in Fig. 15. The shielding consists of 3 in. of steel (0.03 curie).

Chemical Engineering Building 205

Building 205 is a multiwing multilevel reinforced-concrete and masonry structure. Within the main mass are incorporated 50-, 25-, and 12-ft High-bay Engineering Laboratories with surmounting fan lofts, storage areas, and incidental shops and offices. Roof levels range from a high level of six stories to a one-story roof level. The main mass and the two laboratory wings have partial basements; the administration wing has a full basement.

The shell construction consists basically of reinforced-concrete footings, piers, and foundation walls, nonload-bearing exterior masonry walls, and rigid reinforced-concrete framing with reinforced-concrete floor and roof slabs.

Junior Cave. The Chemical Engineering junior cave was designed to handle gram quantities of alpha emitters together with activities up to 0.06 curie of 1-Mev gamma. The inside dimensions of the cave are 3 by 5 by 7 ft high. The cave, which weighs about 26 tons, was assembled from prefabricated sections and can be disassembled, moved, and reassembled.

Three of the walls are large concrete-filled pans. The pans are 14 in. deep, 7 ft high, and made of $\frac{1}{2}$-in.-thick hot-rolled steel plate. The pans were laid on their sides, reinforced with steel rod, and filled with magnetite concrete to which steel punchings were added, giving the concrete an approximate density of 210 lb/cu ft. The fourth wall, which closes the cave, is fabricated of steel and consists of a door frame and a series of doors. This wall is made airtight by the $\frac{3}{4}$-in.-thick steel sealing doors, which are equipped with standard refrigerator hardware and gaskets.

The top of the cave is 2-in.-thick steel plate with frame-cut circular holes to allow installation of the model 7 Argonne type manipulators. The manipulators are gasketed to the top with truncated cone-shaped Koroseal boots.

Air is drawn into the cave through air inlet ducts near the floor in the back wall. The cave regularly operates at a pressure of 0.10 to 0.25 in. of water negative with respect to the room. Approximately 250 cu ft/min is drawn from the room through bypass filters and is exhausted through a final filter system.

Field calibration showed an activity equivalent to 26 curies of approximately 1.2-Mev gamma. Experimental attenuation measurements showed factors of 100 to 125. The build-up factor was approximately 10.

Lighting is of the fluorescent-lamp type.

Building No. 17

The building that contains the metallurgy junior cave is of quonset construction made up of 16 bays, 20 by 31 ft, and eight bays, 20 by $20\frac{1}{2}$ ft. Ceiling heights range to a maximum of 23 ft at the top of the arches. Heights under the mezzanines are generally held at 10 ft, leaving an extreme height of 12 ft above.

All exterior walls, including curved partitions, are covered with corrugated metal, and all are insulated. The inside of all exterior walls, including curved roof sections, are finished with Flexboard. Steel windows are continuous along the sides of the buildings.

Junior Cave. The metallurgy junior cave was constructed for the development of experimental techniques in hot metallurgical testing. It is used for bench type tests, such as hardness, dimensioning, profiling, macrophotography, and electrical conductivity. It can also accommodate somewhat larger equipment, such as a small tensile machine, a weight and density balance, polishing wheels, and a small horizontal mill or drill press.

Working area of the cell is 3 by $6\frac{1}{2}$ ft. Shielding consists of $\frac{1}{4}$-in. steel liners and 3-ft Trap Rock concrete block of 2.3 density. Radiation level is about 100 curies of 1-Mev gamma activity.

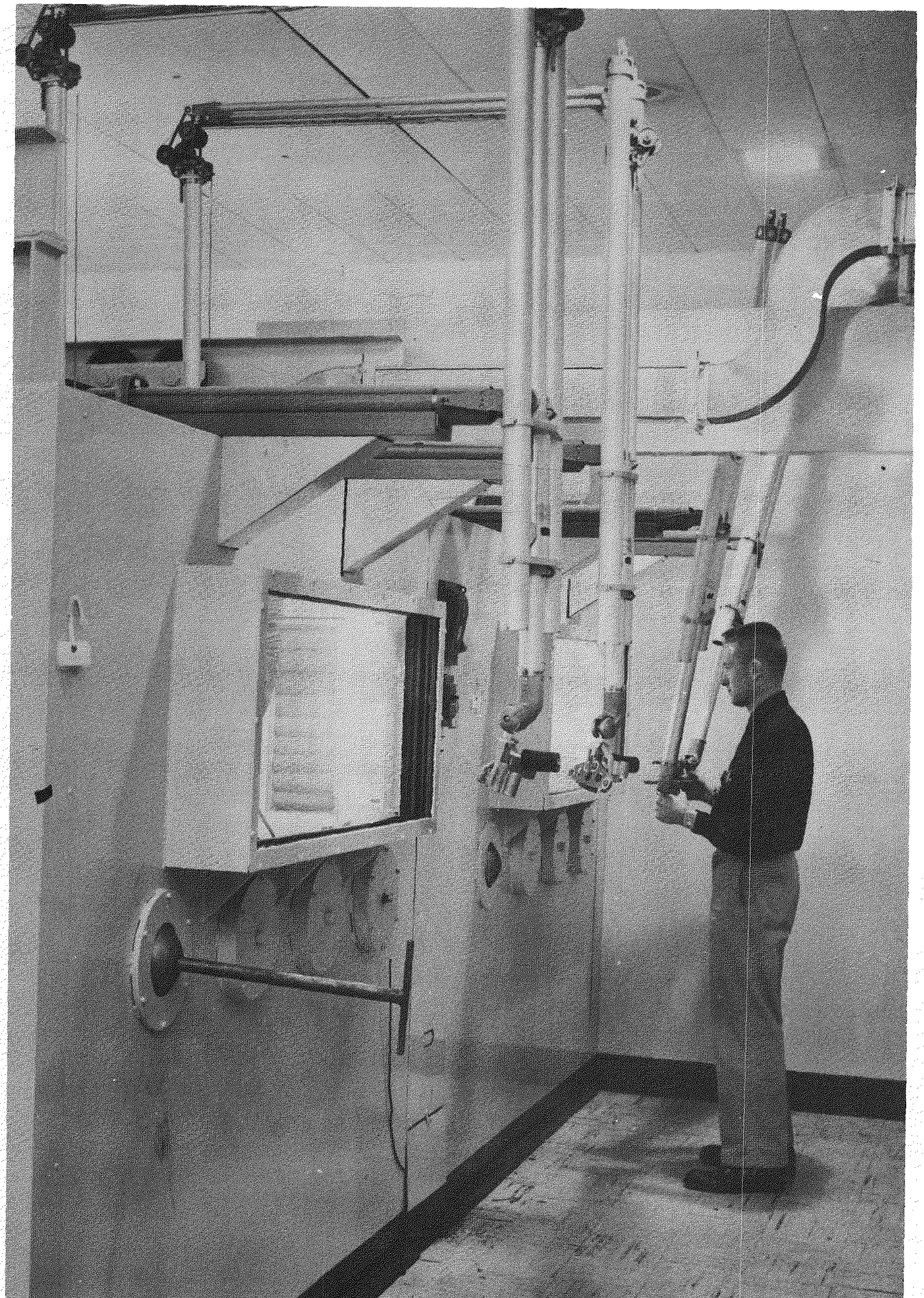

Fig. 15—Operating area for junior cave, ANL, Bldg. 211.

5 Hanford Operations Office

Radiometallurgy, Building 327

Laboratory Building

This cross-shaped building houses the cells in a large rectangular room called a canyon, which extends across the building and forms the major part of it. Offices, change rooms, and supporting facilities occupy the front bay of the building, and laboratory, decontamination, and storage facilities are at the rear. It is an extended one-story building with full basement. The basement floor, foundation walls, and canyon-area walls are of reinforced concrete. The building above the foundation consists of steel framing which supports the Robertson Q Panels, metal roof deck, siding, and canyon flooring. The first floor slab is concrete with vinyl-sheet floor covering on designated traffic areas. The roof is built-up asphalt with a gravel surface. The interior partitions and wall liners are insulated Martin-Parry panels. The ventilation system is single-pass integrated forced supply and forced exhaust. Air-pressure barriers are achieved by supplying air through the offices and exhausting it through the cells and laboratory hoods. The building is piped for water, vacuum, compressed air, argon, helium, and an individual spare line for each cell. A patch panel is provided to supply various electrical currents and instrumentation combinations to the cells: 120- and 240-volt a-c, single-phase; 480-volt a-c, three-phase; and 24- and 120-volt d-c are available. Two systems collect radioactive waste of different radiation levels throughout the building.

A dry storage cell is recessed in the canyon deck. It resembles a soft-drink vending machine in that its five perforated storage disks can be rotated to permit loading and unloading the samples. It is approximately $7\frac{1}{2}$ ft in diameter by 6 ft deep and can hold over 700 samples. A wet storage basin for storing and viewing irradiated samples under 10 ft of water is also built into the deck. Its concrete walls are 4 ft thick. In the north wing decontamination-cell facilities provide space for disassembling and decontaminating equipment.

High-level Multicurie Cell B. This cell is used for the examination of irradiated material. The walls are constructed of $15\frac{1}{2}$-in.-thick Meehanite cast iron, having a density of 7.0 g/cm^3. The cell weighs 60 tons. Its interior dimensions are 52 in. wide by 52 in. high by 72 in. deep. It has been partitioned with lead brick into 2 cells, 52 by 52 by 32 in. It has a 2000-curie capacity. There are 140 access holes spaced symmetrically about the sides, ends, and top. The only hole in the base is for the air exhaust duct. Two of the sides are provided with $7\frac{1}{4}$-in.-diameter access ports arranged in a lattice of 10-in. vertical and 12-in. horizontal spacing, as may be seen in Figs. 16 and 17. The other two sides have a 10-in. vertical and 10-in. horizontal spacing lattice. Under ordinary conditions most of the ports are filled with solid steel (7.8 g/cm^3) plugs. Viewing plugs and other special plugs may be located anywhere on the lattice. The viewing plugs are 6.2 g/cm^3 lead glass. The special plugs are used for utility and instrument access.

Air is admitted to the cell through labyrinth openings and is exhausted through filters into the building exhaust system to the atmosphere. Lighting is provided by incandescent lights in special plugs at the top of the cell. General access is provided through the ports, but the walls and top can be lifted away from the cell when major access is required. The cell is designed with stepped joints to prevent radiation leakage.

Intermediate-level Multicurie Cell C. This cell is used for metallographic examination. The walls are constructed of $10\frac{1}{2}$-in.-thick Meehanite cast iron, having a density of 7.0 g/cm^3. The cell weighs 38 tons and has the same interior dimensions and openings as described in the high-level cell (cell B).

Intermediate-level Multicure Cells D and E. These cells are used for physical and mechanical testing. They are exactly like cell C. The only difference is in the equipment.

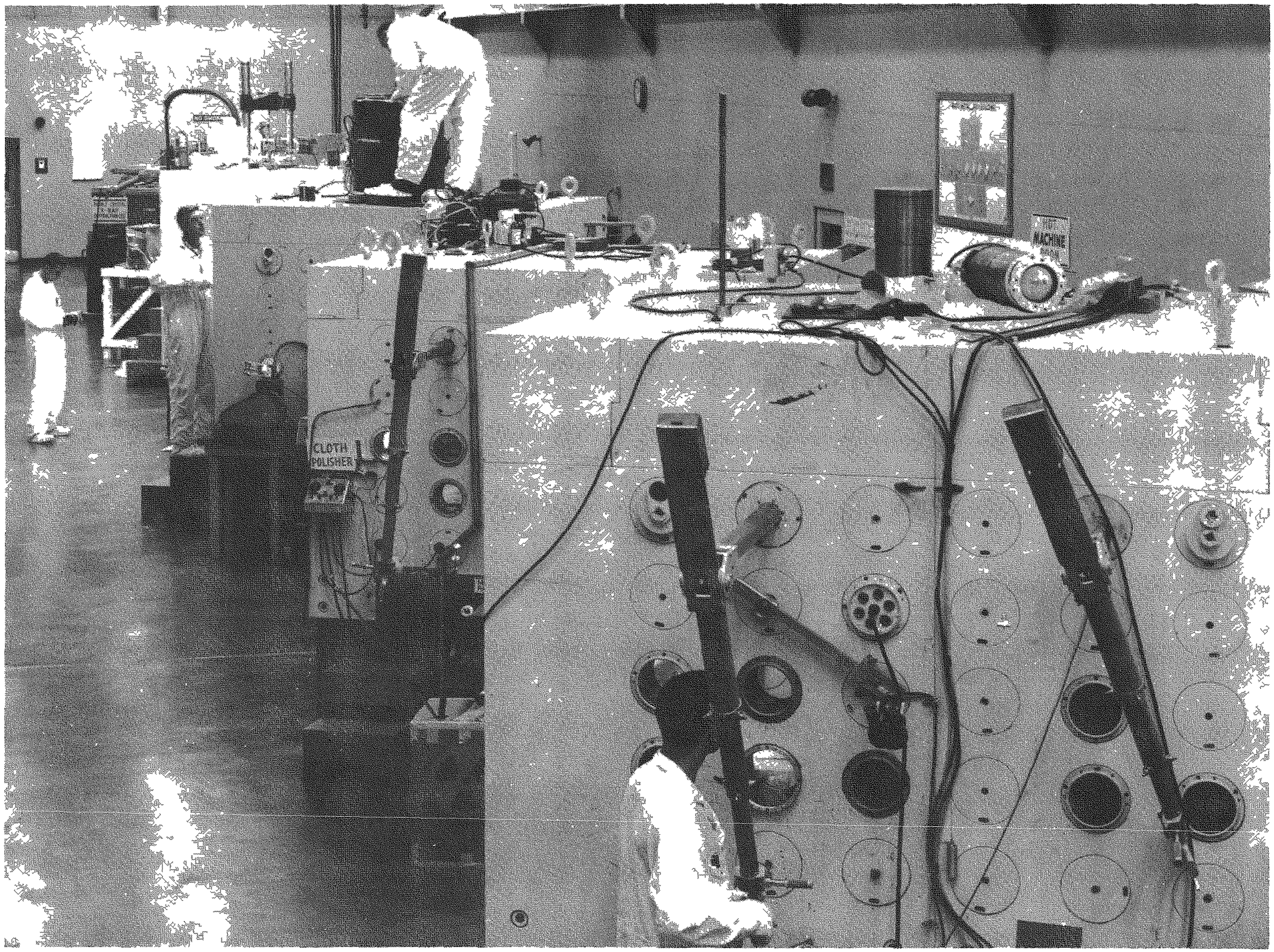

Fig. 16—High-level cell in foreground, intermediate-level cell in background, radiometallurgy building 327, Hanford.

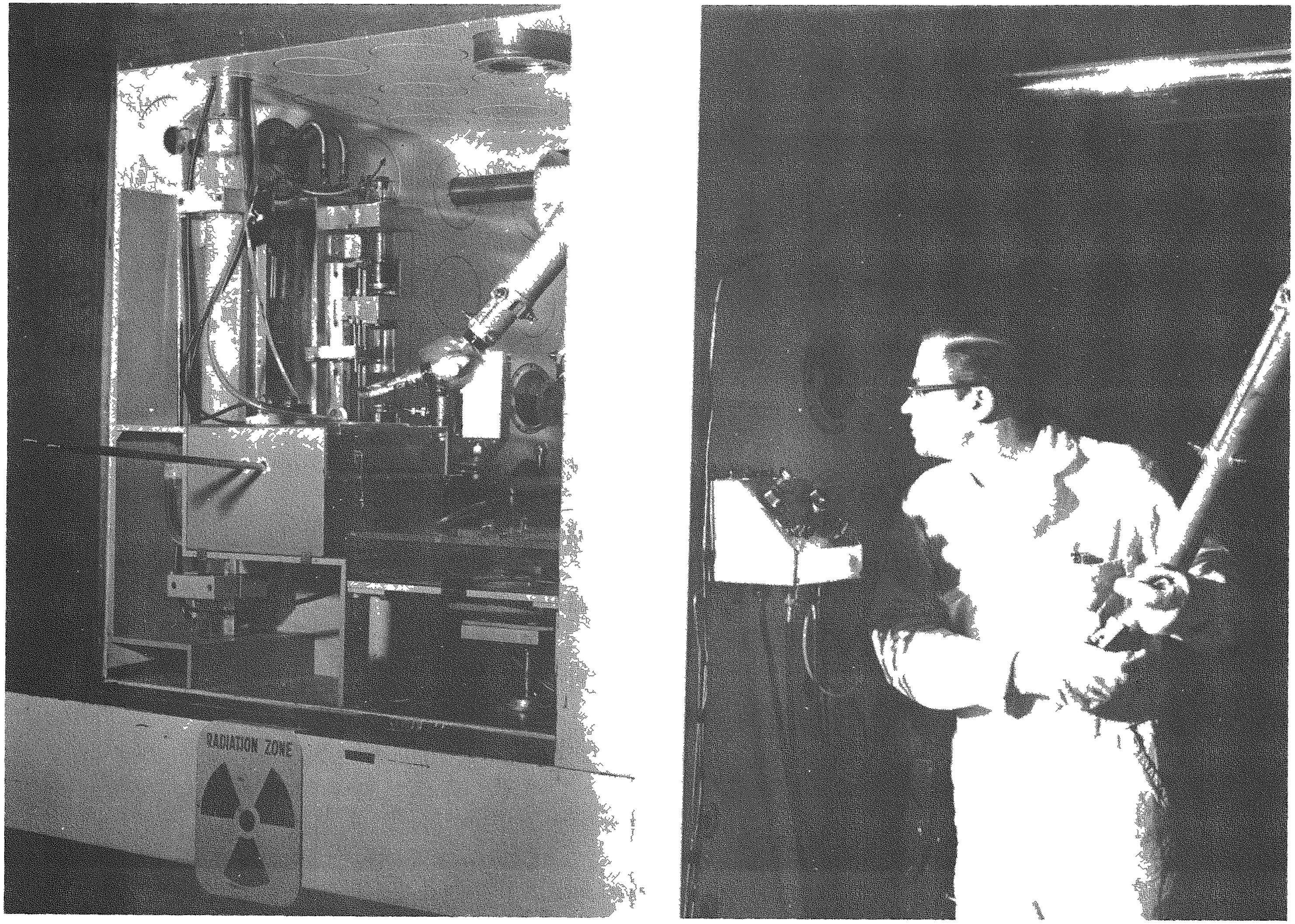

Fig. 17—View of high-level cell with side removed, radiometallurgy building 327, Hanford.

Density-measurement Cell. This is a simple lead-brick enclosure around a balance with 6-in.-thick walls. It has a 100-curie capacity.

Double Crystal X-ray Diffraction Cell. This cell consists of a 6-in.-thick lead-brick shield containing the double-diffraction X-ray equipment.

High-temperature Tensile-testing Cell. This 100-curie cell consists of a lead-brick shield containing a tensile tester having a 60,000-lb capacity and operating at temperatures to 800°C, with a vacuum of 2×10^{-5} mm. The system includes an optical strain gauge.

Room-temperature Tensile- and Bend-testing Cell. The walls are constructed of $10\frac{1}{2}$-in.-thick Meehanite cast iron, having a density of 7.0 g/cm^3. At the top of the cell is a 2-in. steel plate. The interior dimensions are 48 by 48 by 64 in. high. The front and back are each equipped with four $7\frac{1}{4}$-in.-diameter access ports, arranged to conform with critical locations of the tensile tester. Two 12-in.-square viewing windows are provided at the front wall in addition to a service door. Four $7\frac{1}{4}$-in.-diameter lead-glass windows are provided on other walls for viewing critical adjustments. Illumination is provided by fixtures suspended from plugs in the top.

Decontamination Cell. This cell has a 1-in.-thick steel wall in the form of one central cylinder flanked by two smaller connecting ones. Each cylinder contains a rotating steel disk that moves the equipment from one cleaning station to another.

Redox Analytical Laboratory

Building 222-S

This building is fire resistant with reinforced-concrete foundations and reinforced-concrete walls around the partial basement area. All floors are of reinforced-concrete slab construction. The area over the partial basement is supported by concrete beams, and the second floor is supported on structural steel. Partitions are reinforced concrete or removable steel Hauserman panels. The walls of the second floor consist of structural-steel framing and insulated steel panels. Roof construction consists of a structural-steel frame covered with steel roof deck, insulation, and built-up roofing. Ventilation is by a single-pass integrated forced supply and forced exhaust system. Air-pressure barriers are achieved by supplying air through the offices and exhausting it through the laboratory hoods and cells. Certain instrument rooms are supplied conditioned air by a refrigerated system. The building is piped for water, vacuum, compressed air, steam, nitrogen, and individual spare lines for each laboratory. Hydrogen, oxygen, methane, 90-lb air, and sulfuric and nitric acids are also provided at certain locations. Three radioactive-waste systems collect wastes of different radiation levels throughout the building.

Multicurie Cells. The two cells are located back-to-back and are constructed of removable interlocking modular blocks having a 14- by 24-in. front surface. The blocks are separated by 4-in.-high horizontal risers. The 9-in.-thick stepped blocks are designed to shield 20 curies. Air is admitted to the cell through Dust-Stop filtered openings and is exhausted by up-draft through filters into the building exhaust system. The lighting is provided by suspended incandescent lights that can be removed through plugs at the top of the cell. The stepped shielding windows are of laminated lead glass: six are 6 in. in diameter, four are 9 in. deep (9 by 14 in.), and one is 4 in. deep (11 by 16 in.). Standard laboratory utilities are built into the cubicle and are controlled by valves in a pipe trench just outside the front wall. Additional special series are introduced through lead plugs in blocks. No special manipulators are provided, manipulation being either by ball and socket manipulators or, remotely, by a small air-driven hoist. Liquid transfer is by vacuum or compressed air.

6 Idaho Operations Office: National Reactor Testing Station

Aircraft Nuclear Propulsion, Building 607

Laboratory Building

The laboratory building is located adjacent to the south wall of the hot shop in the east central portion of the assembly and maintenance building, ANP-607.

Special-services Cubicle. The primary function of the cubicle is the postradiation destructive and nondestructive examination of reactor components. The designed radiation level is 10^7 r/hr.

The special-services cubicle is constructed of high-density concrete on reinforced-concrete drilled pier footings. The walls are 4 ft thick, the floor is 1 ft thick, and the roof is $7\frac{3}{4}$ ft thick. The outside dimensions are 18 by 43 by $27\frac{3}{4}$ ft high, and the inside dimensions are 10 by 35 by 20 ft high. The interior of the cubicle is lined with 16-gauge stainless steel to a height of 12 ft. A 3- by 7-ft opening in the south wall of the cubicle is provided with a stainless-steel interior door and a 4-ft-thick high-density concrete sliding exterior door, mounted on a roll-race bearing assembly with manually operated chain and sprocket drive. A 4-ft-thick high-density concrete removable plug type door, mounted on a remote-controlled motor-driven dolly, is provided for a 4- by 8-ft opening in the wall between the cubicle and the hot shop.

The east wall contains 3 service plugs, 33 pipe plugs, 1 shielding window, and mounting sleeves for master-slave manipulators located above the shielding window. The west wall contains a fixed-objective periscope, 26 pipe plugs, 4 shielding windows, and mounting sleeves for master-slave manipulators located above each shielding window. Incandescent ceiling-mounted fixtures and wall-mounted sodium-vapor fixtures are provided for interior lighting. Figure 18 shows the control room, and Fig. 19 is an interior view of the special-services cubicle.

Exhaust air from the special-services cubicle is drawn through filter banks and stainless-steel ductwork to the building exhaust stack. Cubicle service piping consists of contaminated and sanitary drainage lines, mask air, vacuum sampling, instrument air, acid, industrial and demineralized water supply lines, balance air lines, and spare lines for future connections.

Chemical Processing Plant — Remote Analytical Facilities, Building 627

Laboratory Building

This is a 32-ft-wide by 75-ft-long room enclosed by reinforced-concrete walls, 12 in. thick. The floor slab is 8-in.-thick reinforced concrete with vinyl tile finish. The roof has a $2\frac{1}{2}$-in.-thick precast pumice concrete slab deck with 1-in.-thick rigid type insulation and 4-ply built-up roofing. A 12-ft-wide by 14-ft-high motor-operated metal door is provided in the west side of the room.

Space is provided within the room for the multicurie cell, a truck well, and a general work area.

Heating and ventilating for the cell room is provided by ductwork that delivers filtered and tempered air from a central system located in the laboratory building, CPP-602. The air is delivered through preheat coils and ducts to registers strategically located within the room. Air is exhausted from the room through ductwork to filters located in the building vent room and then to the atmosphere by motorized blowers.

Services provided within the room include service connections and facilities for vacuum air, treated water supply, 15-lb plant air, and low-pressure steam lines. A drainage system for process wastes is provided by 11 floor drains.

A 120–208-volt 3-phase 4-wire power supply provides electricity for lighting and equipment from existing facilities in the service building, CPP-606. Single-phase 3-wire 60-cycle

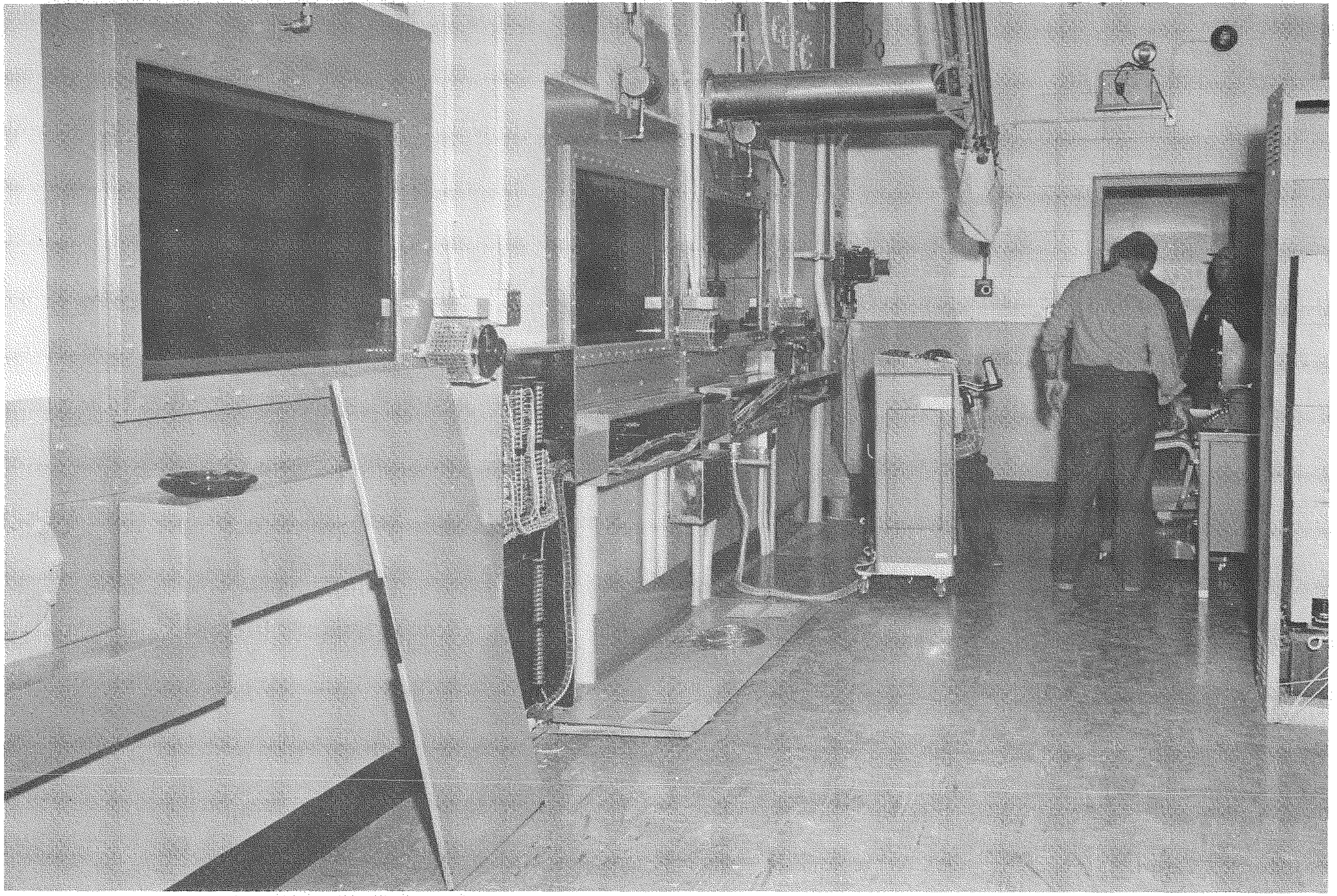

Fig. 18—Control room for special-services cubicle, ANP, Bldg. 607, Idaho.

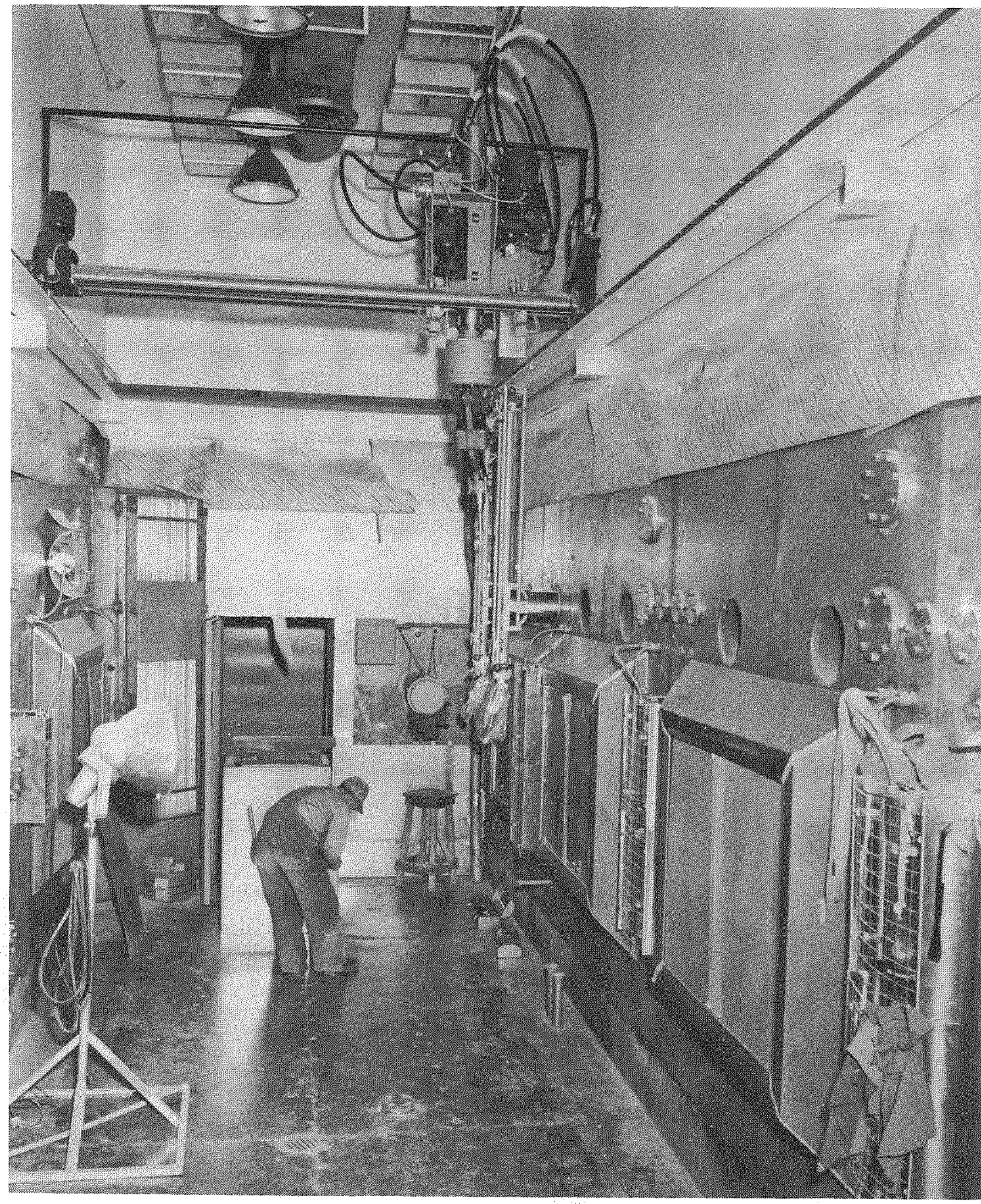

Fig. 19—Interior view of special-services cubicle, ANP, Bldg. 607, Idaho.

emergency power supply is provided by existing facilities in the process building, CPP-601. Fluorescent lighting is provided for the room.

Multicurie Cell. The multicurie cell provides a facility for development work involving large quantities of radioactive materials, including facilities for cutting fuel elements, dissolution studies of various fuels, development of separation processes, and process improvements.

The cell is 20 ft long, 15 ft wide, and $19\frac{3}{4}$ ft high. It is constructed of reinforced high-density concrete, 60 in. thick at the walls, 69 in. thick at the foundation floor slab, and 36 in. thick at the roof level, except for the first 7 ft at the west elevation, which is 81 in. thick. Access to the cell is provided by the cell door at the west end. Viewing windows are located in the north and east walls. The interior of the cell is lined with stainless steel and has a 3-ft-diameter by 15-ft-deep sump for mounting tall columns and for temporary storage of active materials. A view of the operating side of the cell is shown in Fig. 20, and the interior is shown in Fig. 21.

Services provided within the cell include 22 sodium-vapor lights around the viewing windows and 4 recessed incandescent lights in the ceiling, 50 stainless-steel-lined access plugs located in the wall areas, a line for venting gaseous fission products, and hot waste lines for returning active uranium-containing liquids to the process building for treatment. Vacuum air, treated water, 15-lb plant air, and low-pressure steam lines are also located inside the cell.

Heating and ventilating is provided by ductwork that delivers filtered and tempered air to the cell labyrinths. Air vented from the cell is exhausted to filters and then to the vent corridor of the process building, CPP-601.

The radiation level of the multicurie cell is 50,000 curies of 1.6-Mev gamma.

The 18-in.-thick cell door is constructed of laminated carbon steel, 8-in.-thick lead sheet center and $\frac{1}{2}$-in.-thick stainless-steel backplate. It is mounted on an overhead 16-ton trolley (Wright Hoist Division, American Chain & Cable Co.) and has a base-mounted 15 ft/min door travel hoist (Wright Hoist catalog No. WB 2S4) attached to dead ends of the cable and a 60-cycle 3-phase 440-volt reversible motor.

Materials Testing Laboratory, Building 632

Laboratory Building

This is a single-story structure 50 by 50 by 24 ft with reinforced-concrete footings, foundation, and floor slab, structural-steel framework with reinforced-concrete column footings, 12-in.-thick pumice block exterior walls, 8-in.-thick pumice block interior partitions and isolation walls, open-web steel roof joists, $2\frac{1}{2}$-in.-thick precast pumice slab roof deck with 1-in.-thick rigid type insulation and 4-ply built-up roofing, steel sash windows with clear glass, hollow metal doors, except for flush wood personnel doors in the shower and change areas, and plywood overhead equipment doors.

Space is provided on the main floor for the hot cell, shower and change rooms, storage, and working areas. Additional light storage space and a heating and ventilating equipment room are located on a 16-ft 10-in. by 25-ft 10-in. mezzanine floor above the shower and change rooms.

A forced-air supply system located in the heating and ventilating equipment room supplies warm filtered outside air through ductwork containing motorized volume-control dampers to the storage and working areas. The forced-air supply system is supplemented by steam-coil type unit heaters in the storage and working areas and by finned type wall convector heaters in the shower and change rooms. Steam for heating is supplied by the MTR area steam plant. Ventilation is provided by two roof-mounted power ventilators and two natural-flow roof exhausters. Storage and working areas have fluorescent lighting.

Building services consist of hot and cold soft-water systems, sanitary sewer, warm and cold process-waste drainage systems, high-pressure steam and condensate return systems, 440-volt 3-phase 60-cycle power system for electrical equipment, 110-volt single-phase 60-cycle electrical system for lighting and general use, and telephone communications system. A

Fig. 20—Operating side of multicurie cell, CPP, Bldg. 627, Idaho.

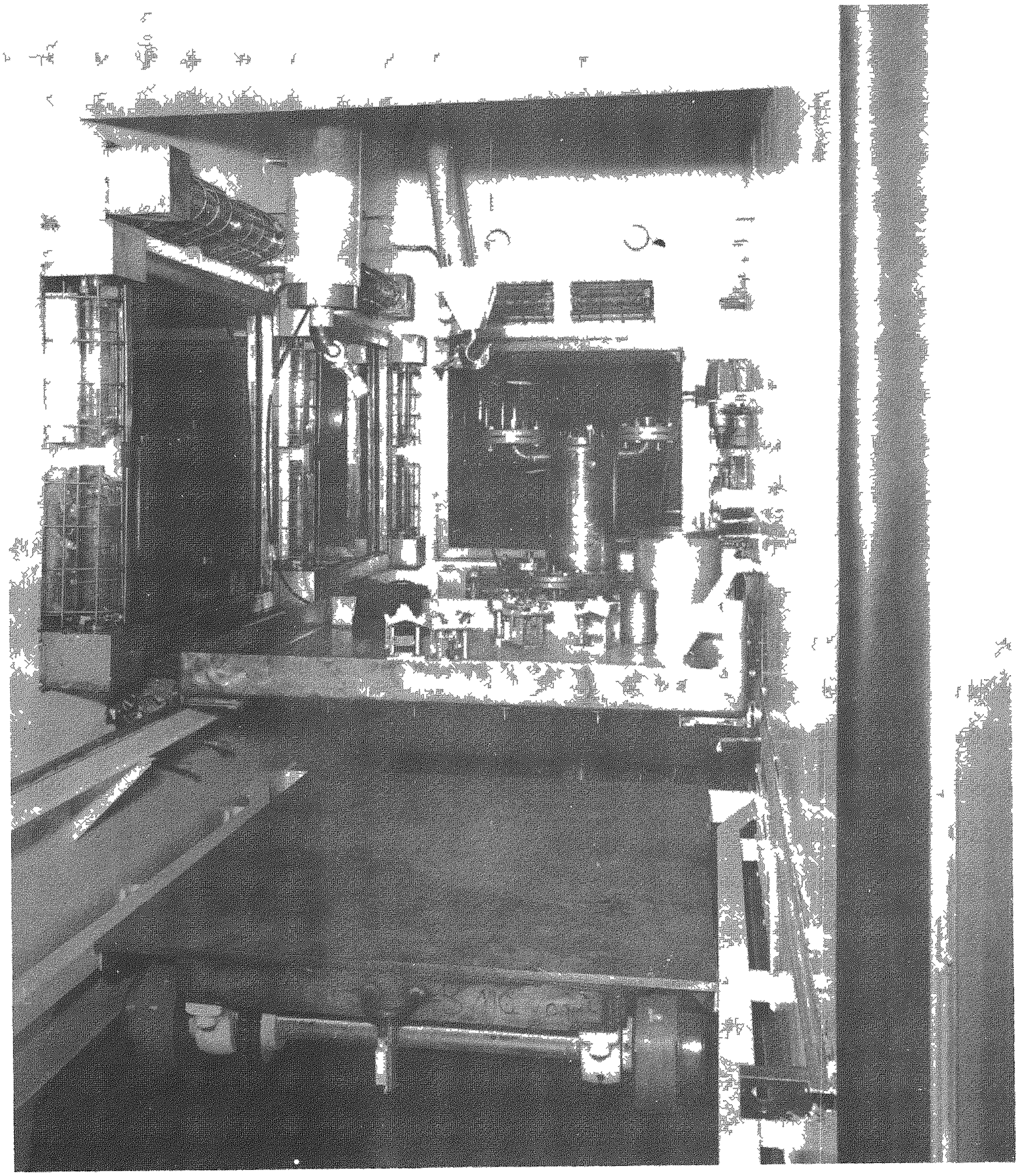

Fig. 21—Interior view of multicurie cell, CPP, Bldg. 627, Idaho.

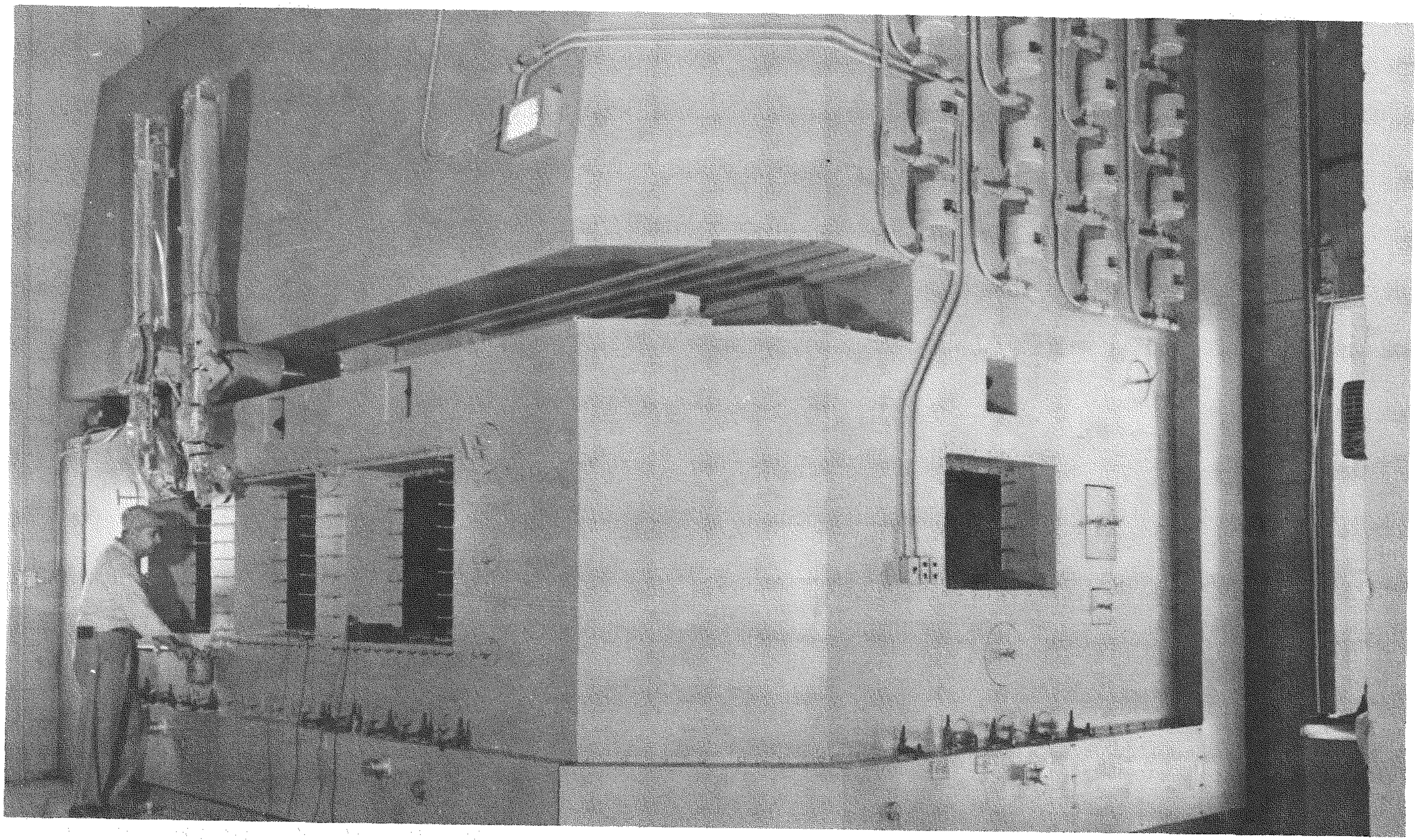

Fig. 22—Operating side of hot cell, MTR, Bldg. 632, Idaho.

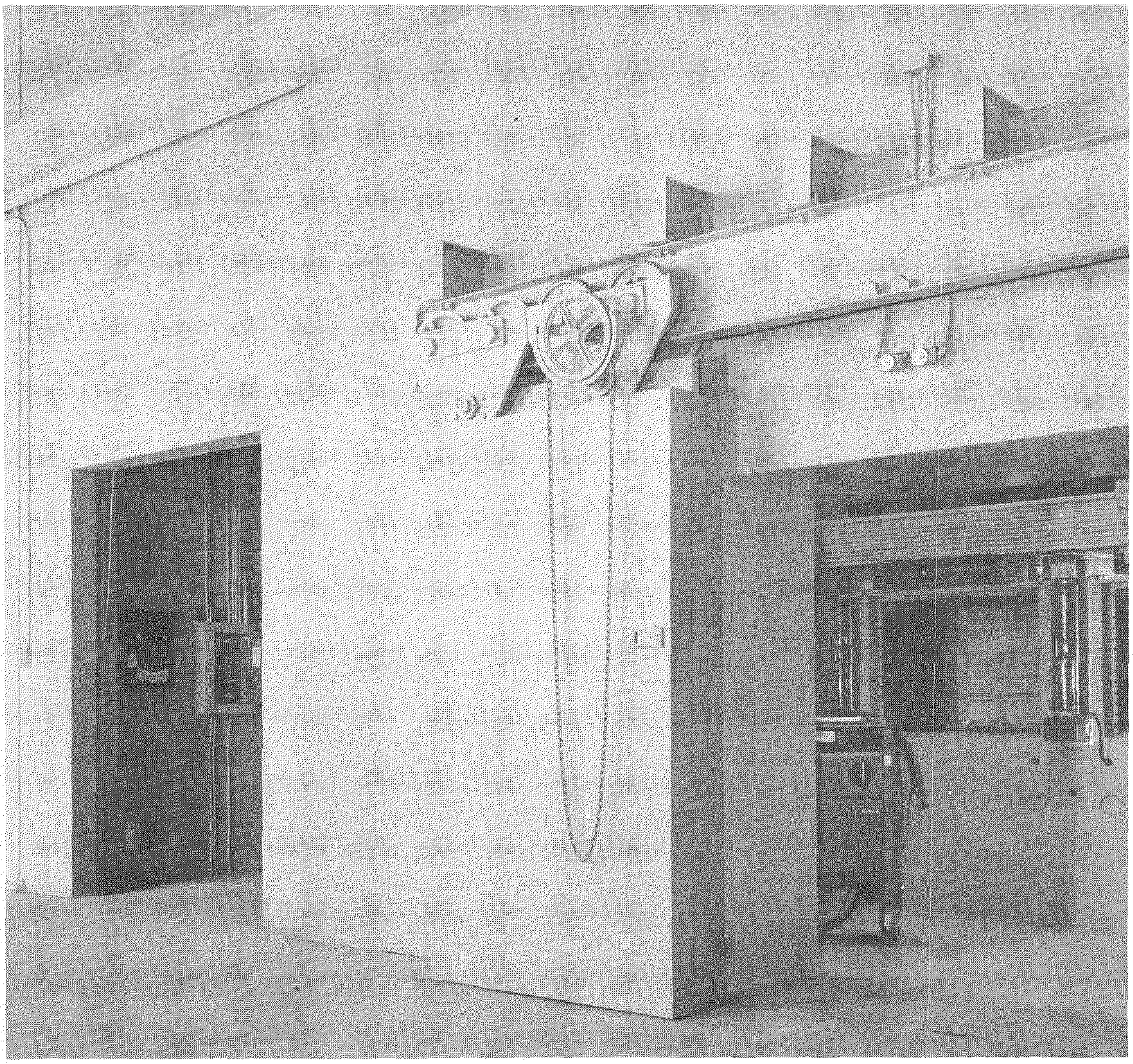

Fig. 23—Hot-cell shielding door, MTR, Bldg. 632, Idaho.

10-ton capacity manually operated chain-drive bridge crane and trolley with electrically driven hoist with pendant control is provided in the storage area for handling shielded containers and equipment outside the hot cell.

MTR Hot Cell. Located in the eastern portion of the hot-cell building, MTR-632, this cell provides facilities for visual examination, modification, adjustment, and repair of experimental equipment after irradiation in the MTR. The cell also permits removal and insertion of irradiated samples in experimental equipment and shipping containers and the transfer of complete experimental assemblies to shielded containers for further handling outside the cell. In addition, physical and mechanical properties of materials may be tested in the cell. The radiation level is 10,000 curies of 2-Mev gamma.

The hot cell is constructed of barytes concrete with 4-ft-thick walls and a $2\frac{1}{2}$-ft-thick roof. Outside dimensions are $14\frac{1}{2}$ ft by 22 ft by 18 ft 10 in. Inside dimensions are $6\frac{1}{2}$ by 14 by $13\frac{1}{3}$ ft. The operating side of the cell is shown in Fig. 22.

The interior of the cell is lined with $\frac{1}{4}$-in.-thick mild carbon steel. A $1\frac{1}{2}$-ft-thick laminated steel biparting door hung on roller-bearing trolleys and operated by chain pulleys is located at a 6- by 7-ft opening in the south wall of the cell. The left half of this door is shown in Fig. 23. The charging hole is located in the east cell wall and is accessible through a $2\frac{1}{4}$- by $2\frac{1}{4}$- by $\frac{1}{3}$-ft-thick laminated steel door hung on roller-bearing trolleys on the outside wall of the hot-cell building. A telescoping shield assembly, 23 steel-lined access holes, 3 observation windows, and a pair of manipulators are located in the north wall of the cell. One observation window and seven steel-lined access holes are located in the west wall of the cell. Lighting for the interior of the cell is provided by 6 recessed incandescent ceiling fixtures and 14 sodium-vapor lamps installed above, and at the sides of, the observation windows. Exhaust air is drawn through filter banks and ductwork to two 850 cu ft/min capacity blower units located in a filter and blower loft above the hot cell, where it is refiltered and discharged through a metal exhaust stack to the atmosphere.

Service piping consists of warm drainage and off-gas vent lines, bottled gas, demineralized water, 15-lb plant air, and 150-lb instrument air.

7 Oak Ridge Operations Office: Oak Ridge National Laboratory

Chemical Processing Pilot Plant, Building 3019

Laboratory Building

The building housing the cell bank is a concrete-block structure, 42 by 84 by $17\frac{1}{2}$ ft high, attached to the west end of the Chemical Processing Pilot Plant, building 3019. Footings, foundations, and floor slab are reinforced concrete; the roof is built-up tar and gravel on insulated metal roof decking. The floor in the office and in the operating area in front of the cell bank is covered with asphalt tile; the floor behind the cell bank is painted with Amercoat. Lighting in the office and in the operating area is fluorescent, and that for the area behind the cell bank is incandescent. Normal laboratory services—air, water, gas, etc.—and hot drains were installed. There are no exterior windows in the building. Personnel entrance is normally through building 3019; panic doors are installed on the south and north sides of the building. A service door and an unloading dock are installed in a central location on the west end of the building. Heating and ventilation in the area behind the cell bank are supplied by two 6620 cu ft/min unit heaters and two fin type radiant heaters. Exhaust for this area is provided by two manually controlled dampers located in the cell-block exhaust system. Temperature and humidity control in the operating area is supplied by a 32-ton capacity air-conditioning unit with a capacity of 54,000 cu ft/min air at $\frac{3}{4}$ in. water external static pressure.

The equipment utilized in conjunction with the operation of the cells consists of standard laboratory hoods, sinks, instrument benches, etc. A 2-ton capacity hoist is located behind the cell block for handling heavy carriers.

High-radiation-level Analytical Cells. The primary function of these cells is to provide facilities for the storage and handling of high-radiation-level samples from pilot-plant runs of short-cooled reactor fuel and from in-pile experiments in which reactor fuels, coolants, moderators, and blanket materials are irradiated in the highest possible neutron fluxes.

The over-all dimensions of the cell bank are $7\frac{1}{2}$ ft long by 11 ft wide by 13 ft high, providing space for seven analytical cells and one storage cell centrally located in the cell bank, as shown in Figs. 24 and 25. Maximum radiation level for the seven cells is 250 curies of fission-product activity.

The seven analytical cells are identical; each one is a unit designed for multiple operations. The cells are 6 ft wide by 5 ft deep by 11 ft high, shielded in the front with high-density (3.33) concrete up to the 6-ft level; standard concrete 3 ft thick forms the upper portion of the front, back (except for access doors), and end sections of the cell bank. The roof of the cells is standard concrete 2 ft thick. The cells are divided by a standard concrete partition 3 ft thick up to the 38-in. level and by high-density (3.33) concrete blocks to form a partition 2 ft thick to the ceiling. The optimum height of the working area in respect to the viewing window is 40 in. The access doors are solid concrete block, $6\frac{1}{2}$ ft high, stepped from 5 to 4 ft in width and 3 ft thick. Each door weighs approximately 18,000 lb and is mounted on a wheeled cart that rolls on rails embedded in the floor. A $\frac{3}{4}$-in. reversible ratchet wrench with an extension handle is used to open and close the doors. Electrical, air vacuum, hot off-gas, and process-water outlets are located inside each cell and are controlled from the cell face. Hot drains and salvage drains are located on the left side in each of the cells, away from the transfer drawer, to reduce the possibility of stray radiation leakage through the apertures around the drawer. The transfer drawer, one for each cell, is an 8-in. channel filled with 8 in. of high-density concrete. These are used to move small pieces of equipment into and out of the cell.

A 12- by 15-in. service chase runs the length of the cell to hold small electronic control instruments and a duplication of the cell services. Twenty-two access plugs are located in the chase at each cell. Cell ventilation is provided by a 3-in. opening in the front face of each cell through which controlled air is forced into the cell from the operating area. The air is exhausted through a 9- by 25-in. opening in the roof of the cell. Transition ducts extend to the cell-ventilation system. Lighting in each cell is provided by four 400-watt alternate-switched fluorescent type mercury-vapor lamps and two incandescent lamps. The interior cell surfaces are painted with white Amercoat 33. The viewing windows are zinc bromide filled, 4 by 2 by 3 ft, with a 1-in.-thick standard plate glass on the front face and a 1-in.-thick plate of nonbrowning glass on the back face.

The storage cell is $7\frac{1}{2}$ ft wide by $6\frac{3}{4}$ ft deep by $7\frac{1}{3}$ ft high, shielded on all sides by 3 ft of high-density (3.33) concrete; the top of the cell is $2\frac{1}{2}$ ft thick. The bottom section of the cell consists of a pad of standard concrete, 3 ft thick. The surface of this pad is used as the cell working surface. Cell operations are viewed through a cerium glass window, 3 ft long by 2 ft high by 3 ft thick, fabricated from nine pieces of nonbrowning glass 4 in. thick, with a 1-in.-thick standard plate glass on the front face and a 1-in.-thick plate of nonbrowning glass on the back face. A carrier tunnel constructed of standard concrete, $6\frac{1}{2}$ ft wide by 4 ft 7 in. deep by approximately 27 ft long, provides access for carriers to the interior of the cell. The sides of the tunnel are $1\frac{1}{2}$ ft thick; the roof and base of the tunnel are 12 in. thick. Carriers containing samples are lowered into the carrier tunnel onto a motorized cart either from the loading platform on the west end of the building or from the inside of the building. The carrier cart is actuated through the tunnel to a predetermined stop. A nonrotating automotive type hydraulic lift raises the carrier and cart into the storage cell. A 6-in. viewing plug, located in the cell face, provides a means for double checking the alignment of the cart and lift before the hydraulic lift is operated.

This cell is a nonaccess area; the insertion and removal of equipment is accomplished by utilizing the carrier-cart entrance or an opening in the roof of the cell, which is normally closed by a high-density concrete plug. Utility services are identical to those in the analytical

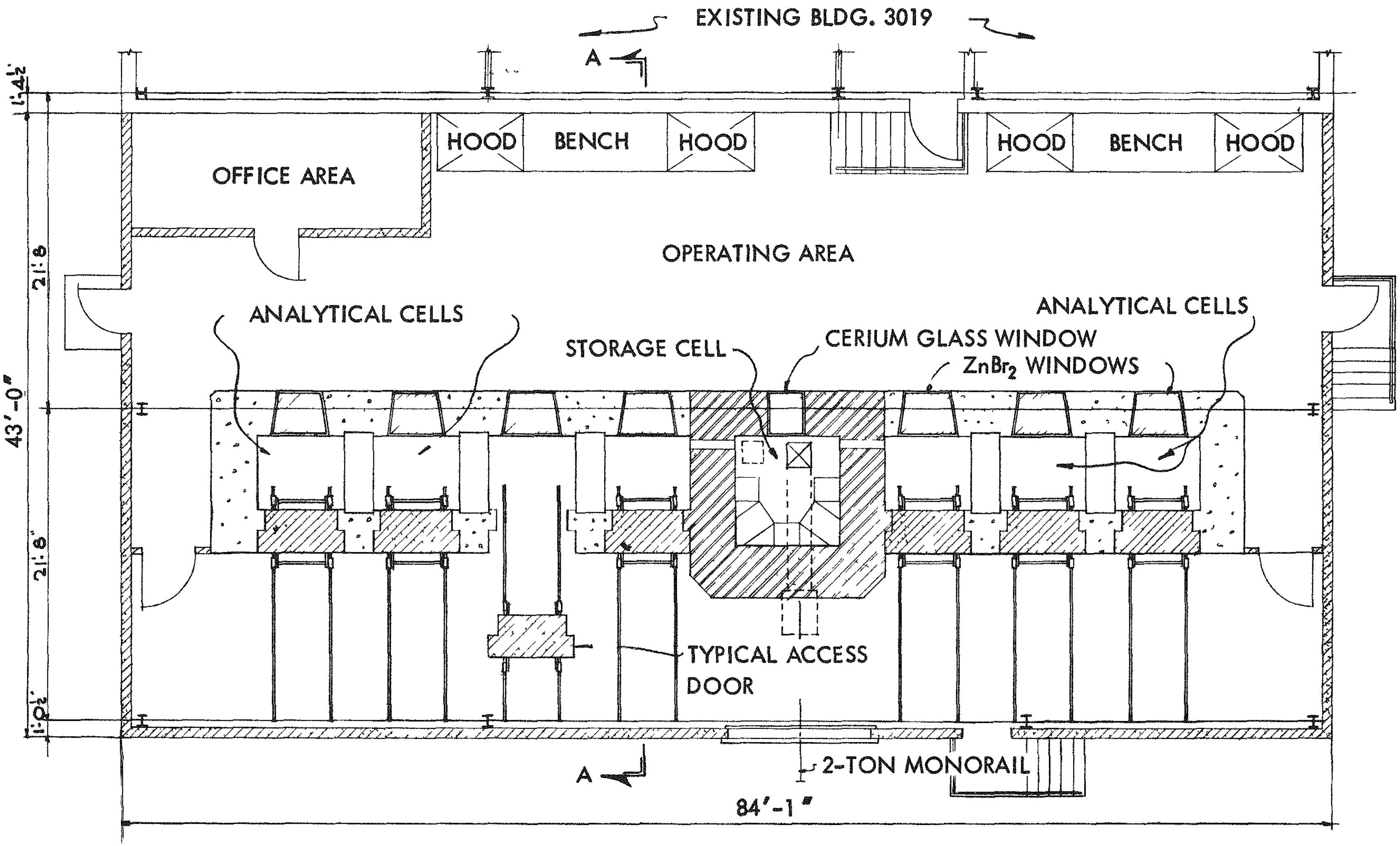

Fig. 24—Sectional plan of high-radiation-level analytical facility, Chemical Processing Pilot Plant, building 3019, Oak Ridge. [pattern], poured concrete (regular); [pattern], poured concrete (barytes); [pattern] concrete blocks (regular).

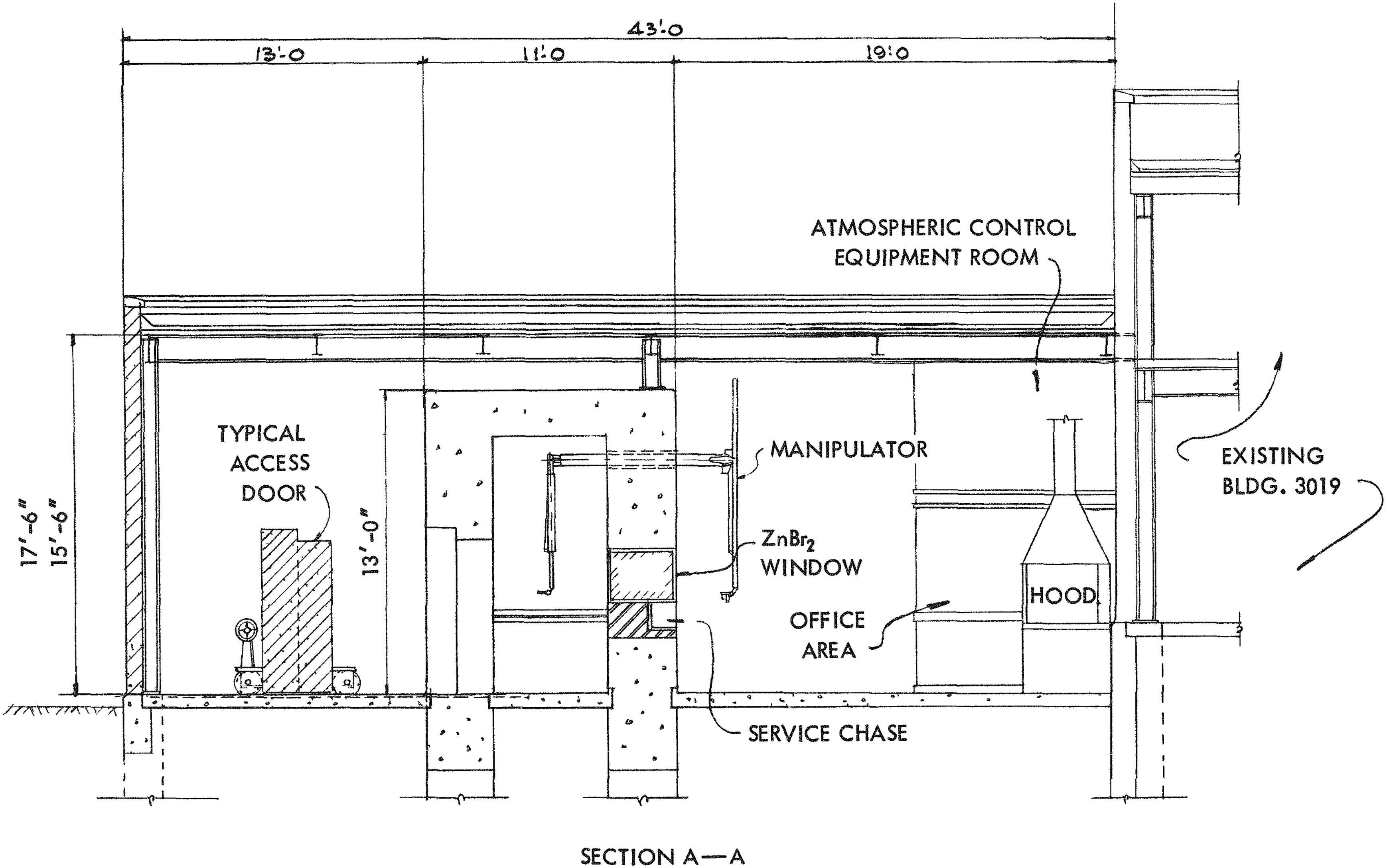

Fig. 25—Vertical section of high-radiation-level analytical facility, Chemical Processing Pilot Plant, building 3019, Oak Ridge.

cells. Lighting in this cell consists of two fluorescent type 400-watt mercury-vapor lamps mounted on removable wall plugs. The interior surface of the cell is painted with white Amercoat 33.

Intercell transfers are made on a continuous type conveyor common to the seven cells with controls located on the face of each cell. This arrangement permits the moving of samples from the storage cell to any other cell location. All the cells are equipped with stainless-steel pans to simplify decontamination.

A full-height concrete-block partition wall extending the length of the cell block along the front face separates the operating area from the hot area behind the cells (Fig. 26).

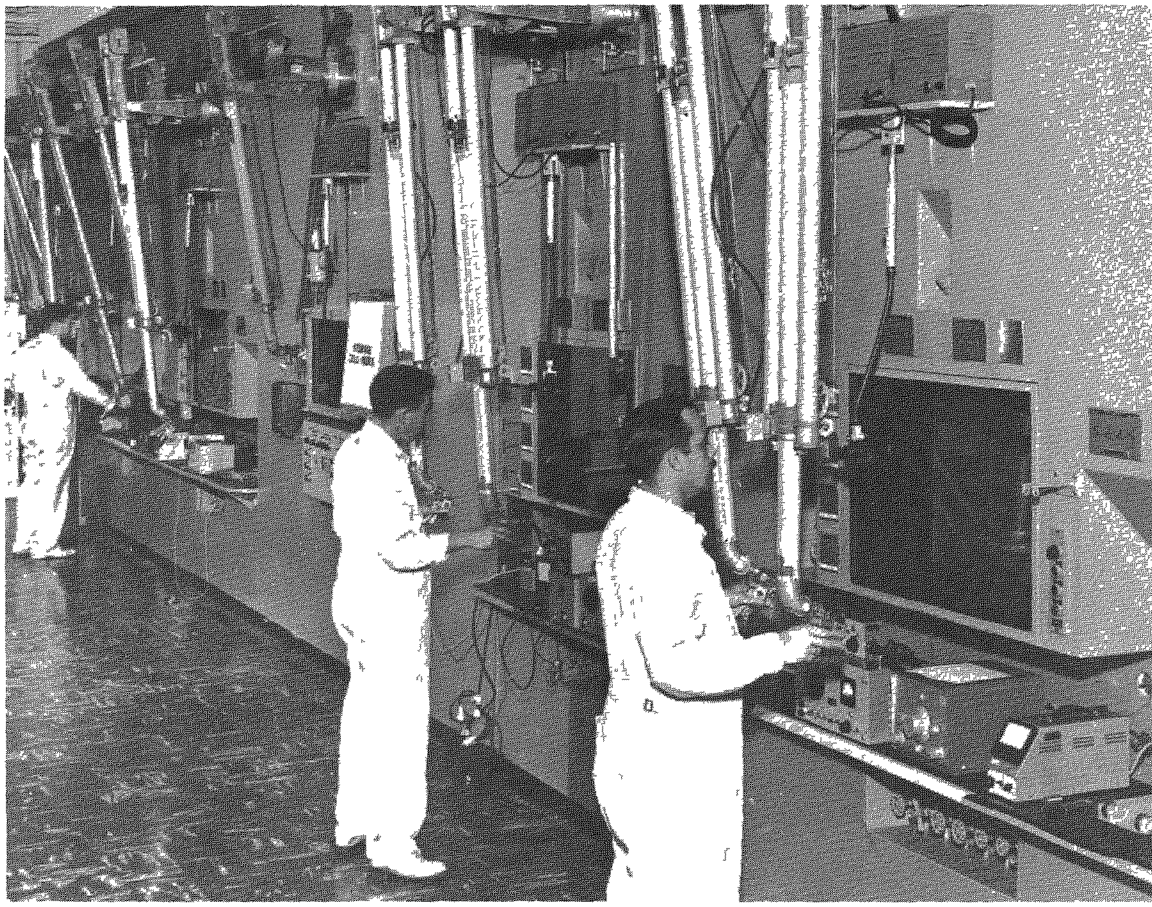

Fig. 26—Operating area of high-radiation-level analytical facility, Chemical Processing Pilot Plant, building 3019, Oak Ridge.

Ventilation for the analytical cells is provided by ducts leading from each cell to a common duct system located above the cell block. A 35- by 30-in. exhaust riser extends through the roof and connects with a 42-in.-diameter duct. The ventilation for the storage cell is exhausted through the same system; air entering this cell comes through the carrier tunnel. The 42-in.-diameter duct, approximately 50 ft long, connects to the exhaust system for building 3019. Ducts from the process hoods also connect to the 42-in.-diameter duct.

High-level Radiochemical Laboratory, Building 4501 (North Portion)

Laboratory Building

The hot cells are in a room 23 by 23 by 20 ft with 18-in. concrete walls that extend into building 4501. A bridge crane was installed as part of the original building construction.

Corrosion Examination Cells. These cells are designed for the removal of homogeneous reactor in-pile dynamic corrosion specimens from the loops, and defilming, weighing, and preparing the samples for detailed metallurgical examination.

They are located along the west wall of a shielded room on the first floor of the High-level Radiochemical Laboratory, building 4501. The north, south, and west faces of the cell are formed by the walls (18-in. concrete) of the room. The cell extends 8 ft into the room on the south end and approximately 5 ft 2 in. on the north end; the over-all length of the cell structure is 23 ft. It is divided into three compartments designated as the machining, defilming, and weighing stations (see Fig. 27). The height of the cell is 9 ft. The maximum radiation level is estimated at 25 curies from fission-product activity.

The machining station is 17 by 8 ft, which includes a receiving station approximately 6 by 6 ft. The space immediately under this area is standard concrete; the face of this part of the cell is high-density (3.33) concrete 18 in. thick for shielding, with the viewing-window frames and pipe sleeves poured in place. The viewing windows are zinc bromide filled, $\frac{1}{2}$ by 3 by 2 ft, with nonbrowning glass front and back. A stainless-steel coolant tank (20 cu ft capacity), located adjacent to the receiving space, provides for submerged cutting operations.

The entire area in this station is lined with stainless steel to facilitate decontamination. A lead-filled door (3 by 5 ft), located in the back wall of the structure, provides an access for sample carriers (Fig. 27). The roof over this station is $1\frac{1}{2}$-in.-thick steel plate with lifting lugs attached. Lighting in this station is incandescent.

The defilming station occupies a space 3 ft 2 in. by 2 ft 3 in. and is separated from the machining station by high-density concrete and lead-brick shielding. The working level of this station is 4 ft above the building floor; the inside area is stainless steel lined to a height of $\frac{1}{2}$ ft above the working level. The north wall is constructed of lead and lucite shielding; the front face, from the floor level to a height of $6\frac{1}{2}$ ft, is shielded with lead brick. Access between this compartment and the machining station is provided by a lead-shielded drawer that slides through the lead-brick shielding wall that separates the stations. The roof over this station is $\frac{1}{2}$-in.-thick lucite (Fig. 28); lighting is incandescent.

The weighing station occupies a 2-ft 8-in. by 5-ft 2-in. space and is separated from the defilming station by lead-brick and lucite shielding. The working level of this station is 3 ft 10 in. above the building floor. The front face of this compartment from the floor level to a height of $6\frac{1}{2}$ ft is shielded with lead brick with two lead-glass windows 9 by 12 by 4 in. thick installed for viewing (Fig. 29). The roof over this station is lucite; lighting is fluorescent.

Ventilation for the cell is provided by a short extension connecting with the existing building cell-ventilation system. Standard laboratory services—water, gas, compressed air, etc.,—were installed.

Isotope Research Cells. The primary function of these cells is laboratory-scale and pilot-plant-scale research in chemistry. The maximum radiation level is 10,000 curies of radioactive material.

The cell block is constructed of high-density (3.33) concrete with standard reinforced-concrete foundations and support walls. The over-all height of the cell-block structure from the underside of the footer pad to the top of the cell-block roof is 33 ft, 15 feet extending below the building first floor level; it is 22 ft wide and 25 ft long. The base of the cell block is standard concrete, 3 ft thick, supported on concrete walls. The north and south walls are 2 ft thick by 37 ft long, and the east-west walls (four sections) are 3 ft thick by $5\frac{1}{2}$ ft long. The cell block contains four cells with identical features (Figs. 30 and 31). Each cell is 6 by 8 by 14 ft high (inside dimensions) and completely lined with stainless steel and painted with Amercoat; the walls are 3 ft thick; the roof is 4 ft thick; the north-south partition wall is 3 ft thick, and the east-west wall, which contains the cell exhaust ducts, is 4 ft thick. Access to the cells is through roof plugs, lead-filled doors, located in the center top of each cell (Fig. 30) and through lead-filled doors located at the ends of each cell (Fig. 32).

Each cell contains two in-line (vertical) lead-glass viewing windows, 24 by 24 by 36 in. and 18 by 18 by 36 in., two 6-in.-diameter by 3-ft-long removable plug type zinc bromide viewing ports, and six periscopes (Fig. 33). Pipe sleeves for utilities and periscopes and the frames for the windows and doors are poured in place. The stainless-steel cell liners provided the

(Text continues on page 71.)

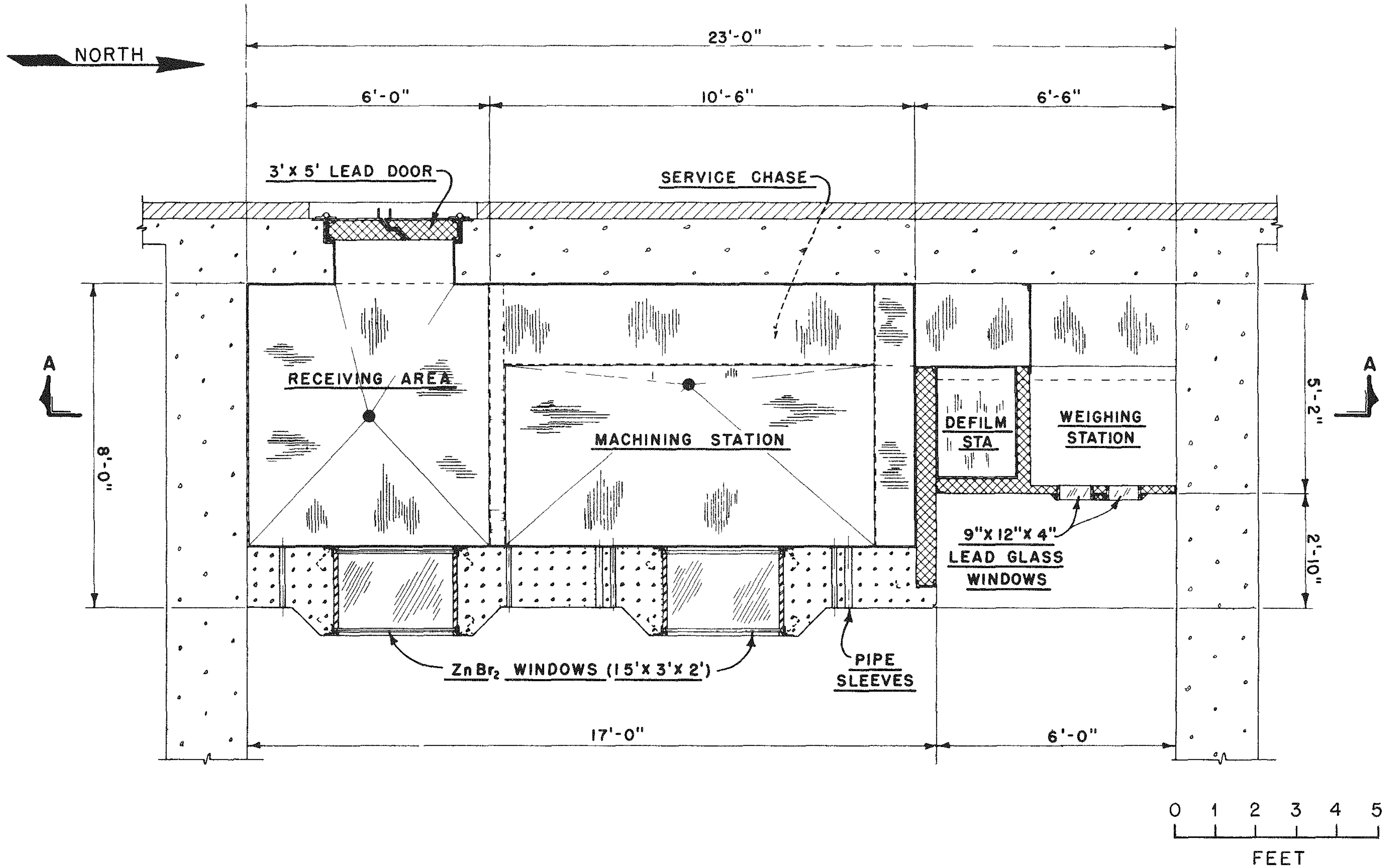

Fig. 27—Horizontal section of corrosion examination cells, High-level Radiochemical Laboratory, building 4501, Oak Ridge.

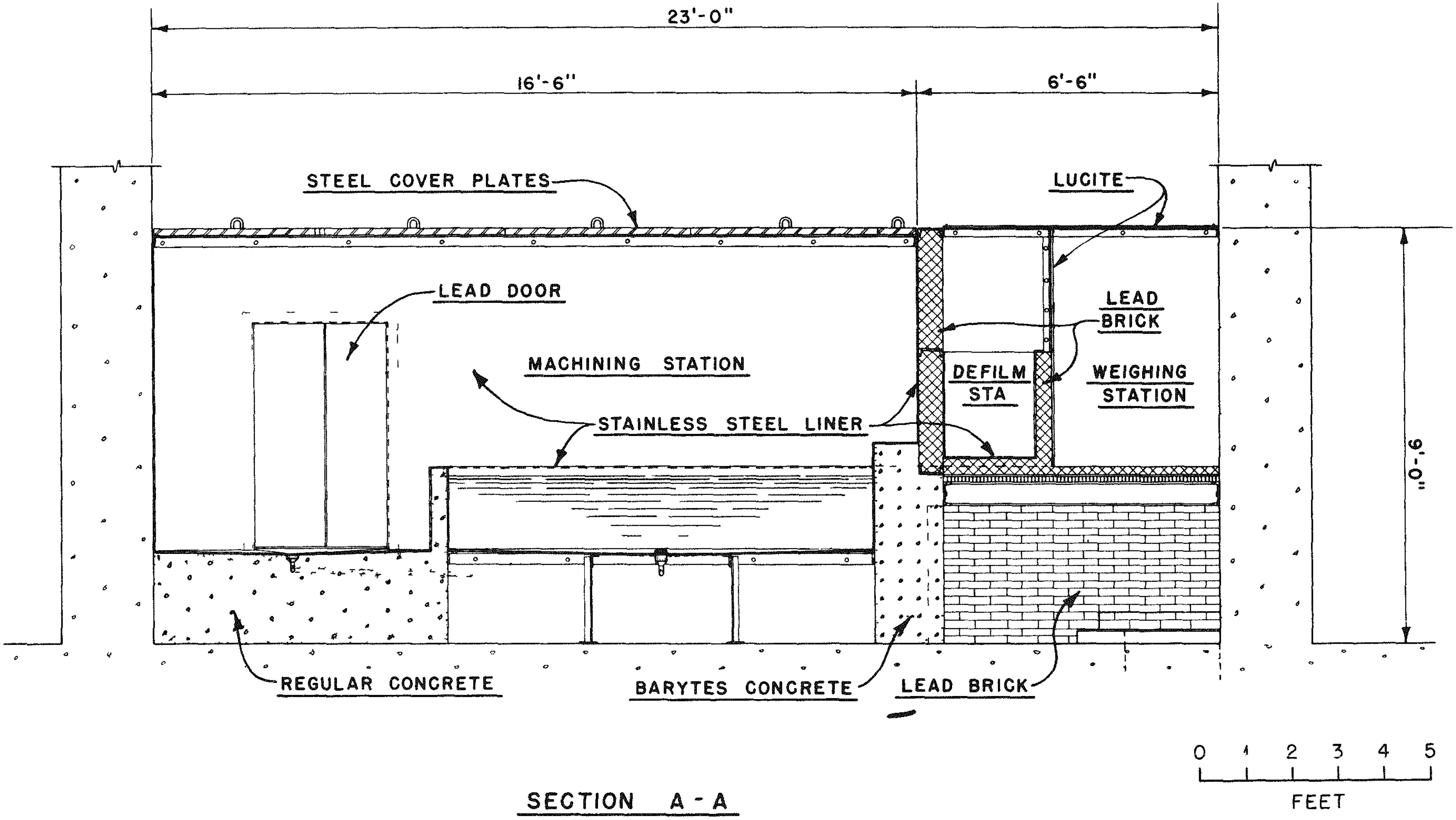

Fig 28—Vertical section of corrosion examination cells, High-level Radiochemical Laboratory, building 4501, Oak Ridge.

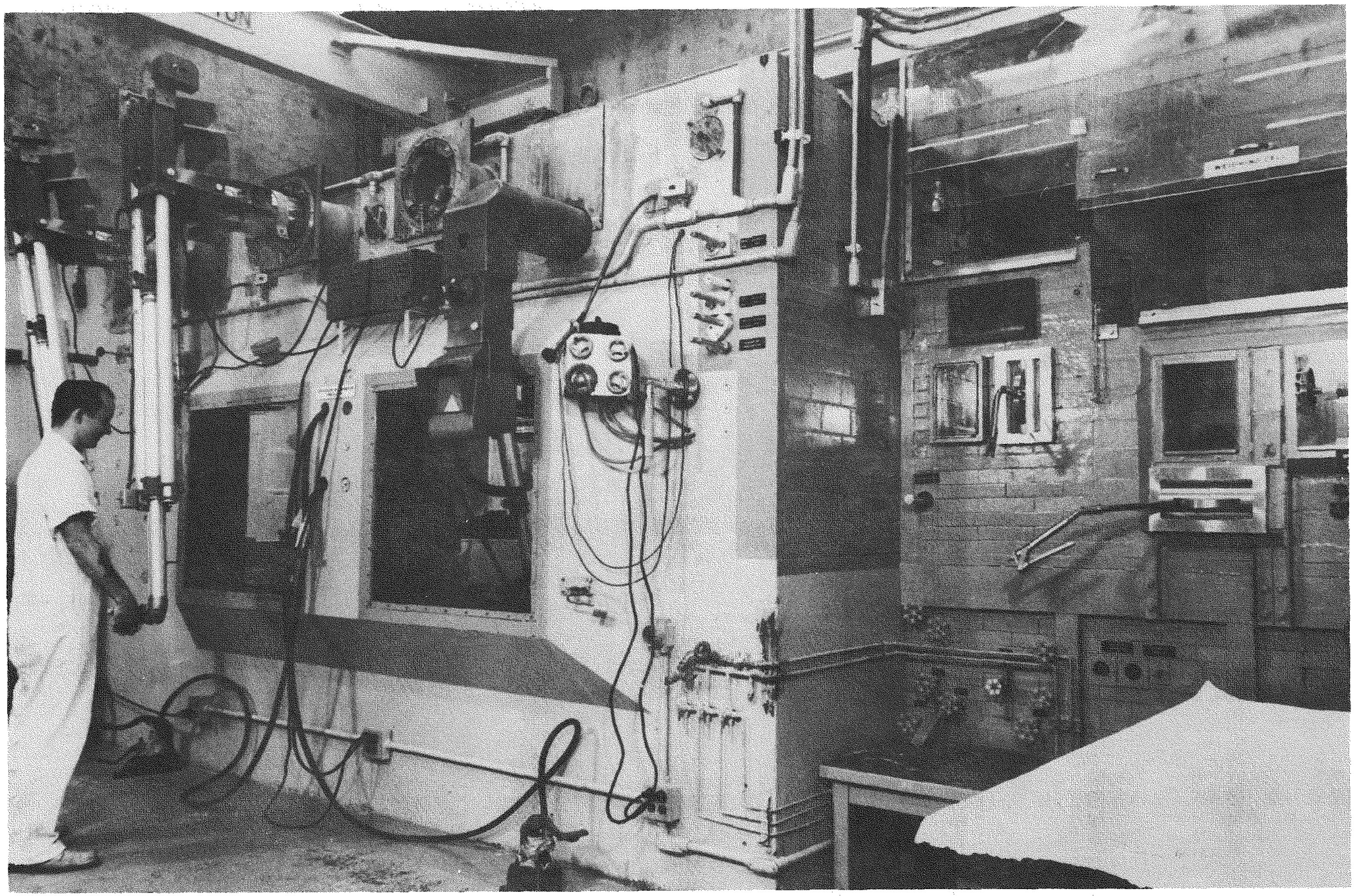

Fig. 29—Operating face of corrosion examination cells, High-level Radiochemical Laboratory, building 4501, Oak Ridge.

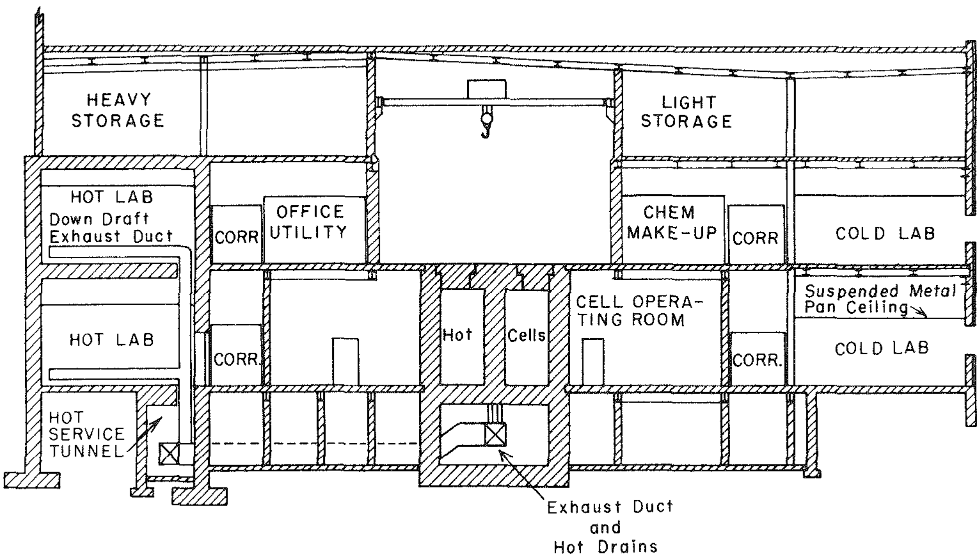

Fig. 30—Plan of isotope research facility, High-level Radiochemical Laboratory, building 4501, Oak Ridge.

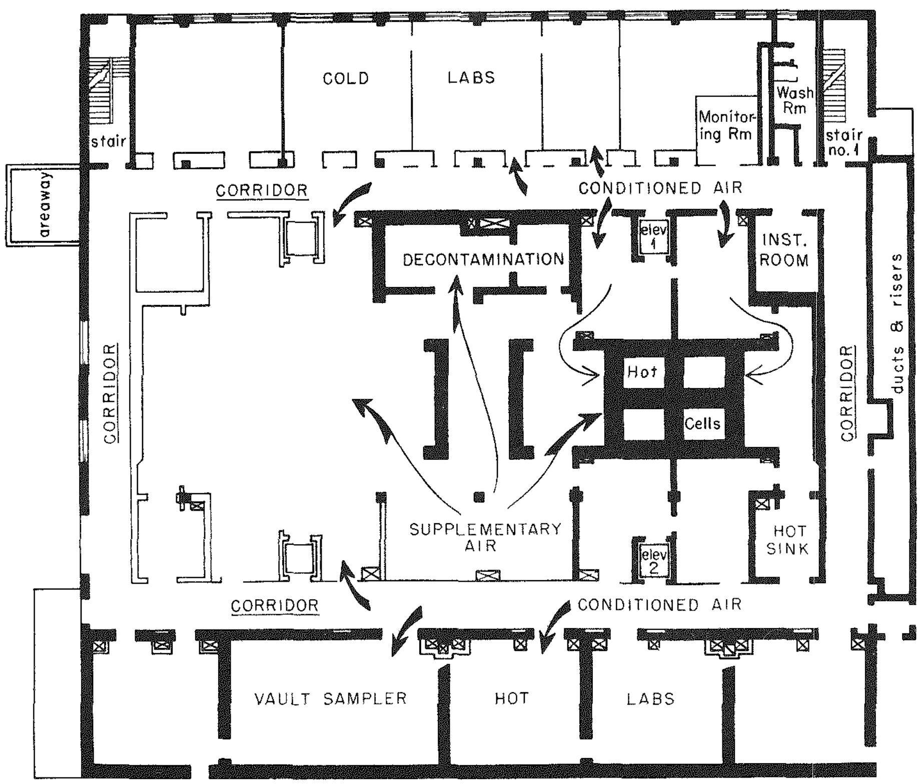

Fig. 31—Vertical section of isotope research facility, High-level Radiochemical Laboratory, building 4501, Oak Ridge.

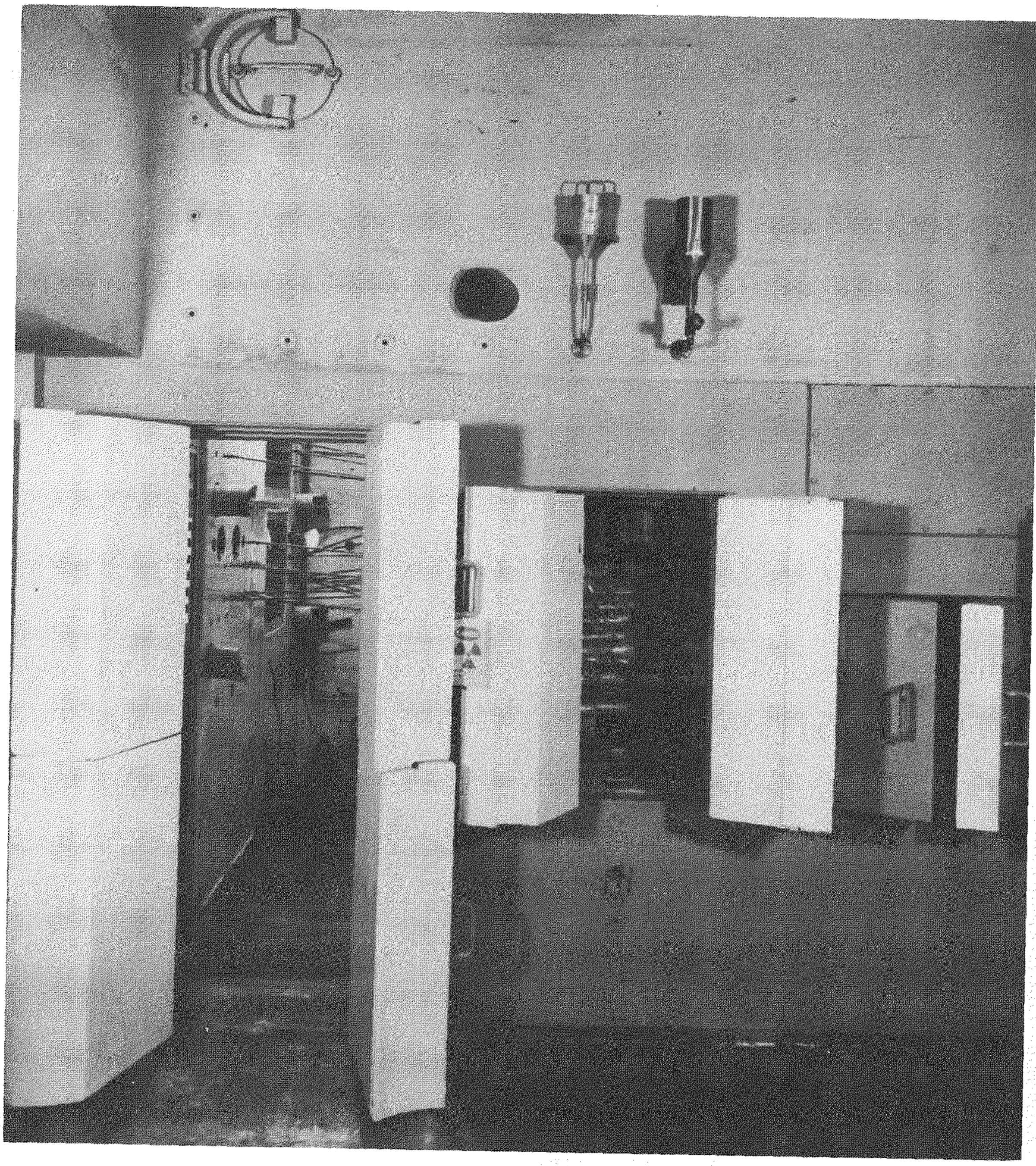

Fig. 32—Access doors to isotope research cell block, High-level Radiochemical Laboratory, building 4501, Oak Ridge.

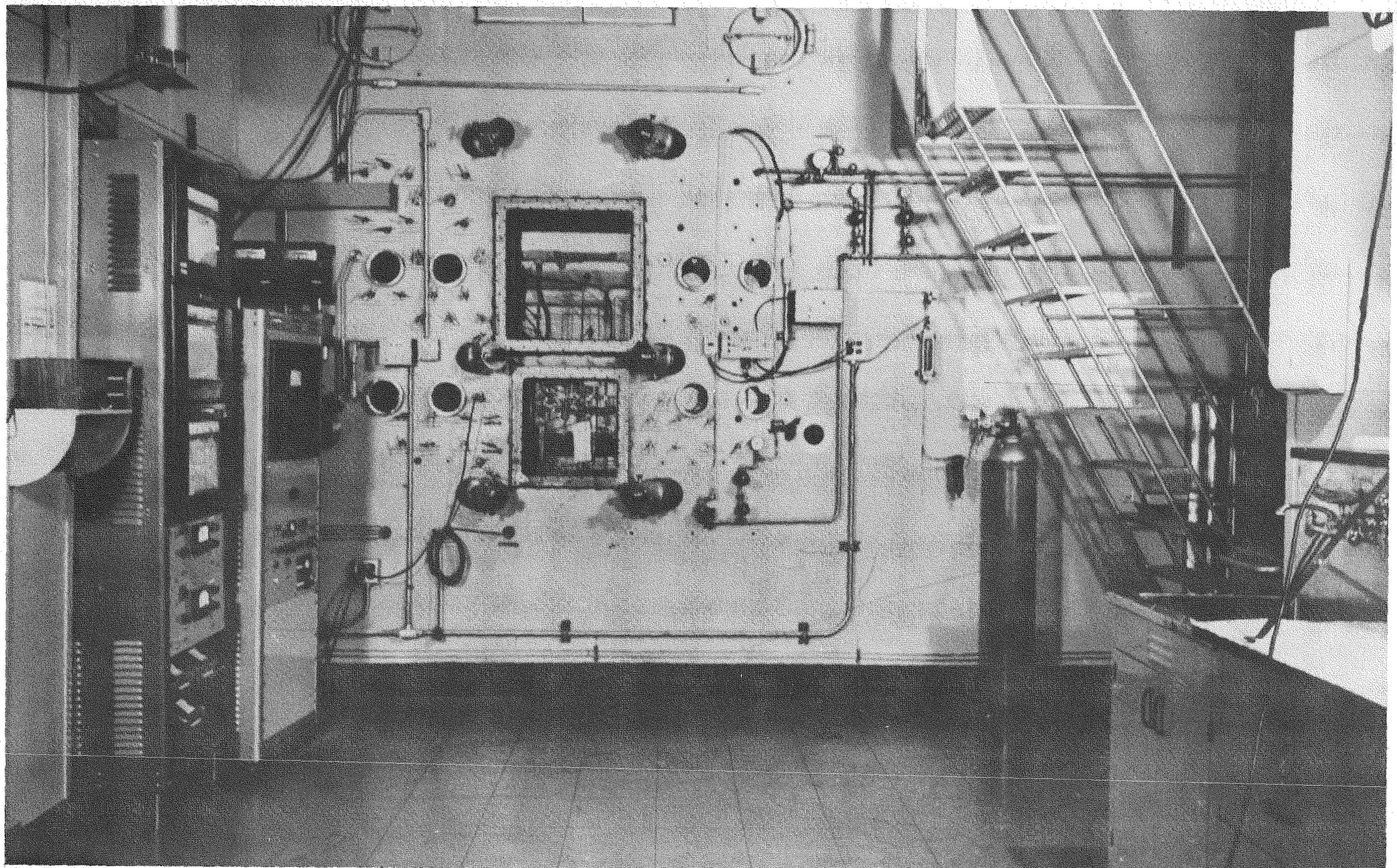

Fig. 33—Operating face of one isotope research cell, High-level Radiochemical Laboratory, building 4501, Oak Ridge.

forms for the interior cell dimensions. Ventilating ports and ducts are located in the east-west cell partition wall; the ports are situated in the top and lower portions in each cell; the ducts consist of 6 by 14 in. stainless steel, four ducts for each cell. The cell-ventilation system provides two conditions: (1) when the cells are closed and in operation and (2) when one or more cells are open. Under either condition the air is exhausted from within the cells through the hot tunnel to the isotope stack area. When the cells are closed, air enters the cells by infiltration through pipe and equipment openings in the walls. Since these cells were designed for various research purposes, there was no equipment installed in the original cell block. At the present time, however, one cell is being used exclusively for in-pile loop experiments.

Unit Operations, Building 4505

Laboratory Building

The building is a three-story and basement steel-framed brick-faced masonry-walled structure, 146 by 199 ft. It has concrete foundations and floors; the roof is 2-in. metal decking with 1-in. insulation and tar and gravel waterproofing. The building houses an isotope research cell block, a semiworks cell block, hot and cold laboratories, decontamination facilities, counting rooms, shops, offices, and operating and storage areas. The building is divided longitudinally by a continuous wall extending the full length of the building from the basement to the roof. From its foundation to the third floor this division wall is monolithic concrete 2 ft thick, and from the third floor to the roof it is concrete-block construction. The portion of the building north of the division wall houses the isotope research facilities, and the portion south of the wall houses the semiworks facilities. An enclosed passage connecting building 4505 to building 4500 is located at the southeast corner of building 4505. Partitions vary from metal to solid concrete-block construction as dictated by usage, i.e., in offices, cold laboratories, etc., the partitions are metal and in the hot work areas, hot laboratories, hot storage rooms, etc., the partitions are solid concrete block for shielding.

The floor covering in all areas, except in the basement, toilet rooms, and areas subject to possible radioactive spillage, including some corridors, is grease-proof asphalt tile; the floor covering in the decontamination room is acid-proof brick.

Ceilings are suspended metal pans in the hot and cold laboratories, assembly storage areas, solution-handling room, volatile-reagents room, parts subassembly room, and in all toilet and change rooms; perforated acoustic metal pan with a noncombustible sound absorbent pad is installed in all offices and health physics rooms, three work rooms, and in all the corridors and vestibules; mineral acoustic tile is used in all counting rooms; in the crane bay areas over the cell blocks, the ceilings are the underside of the metal roof decking. Interior doors are metal to match the metal partitions; exit doors are half-glazed hollow metal. Window sash is aluminum with satin aluminite finish.

Building services include the usual electric power and lights; emergency power system; water, gas, and steam; sanitary sewer; heating, ventilating, and air-conditioning systems; and fire-protection facilities.

Air conditioning is provided in all hot and cold laboratories, shop rooms, offices, certain work rooms on the first and second floor, solution-handling room, volatile-reagents room, and the parts subassembly room. Refrigeration for the air conditioning is supplied from equipment that also supplies the Research and Administration Building (4500). Spent air from the offices, shops, and other rooms without hood exhausts leaves via doors and other openings in adjacent areas; from the laboratories and other rooms having hoods, the air is exhausted through the hoods, each hood venting individually to the atmosphere through filters. Hot hoods exhaust air through the cell-ventilation system. All other areas are heated and ventilated by means of a tempered air system utilizing 100 per cent outside air, filtered. Spent air is exhausted via an exhaust duct system to atmosphere through filters.

In the isotope research area there are two 1-ton capacity electric lift type elevators with 4- by 6-ft cabs; one of the elevators provides service from the first to the second floor and the other from the basement to the second floor. In the semiworks area there is one elevator and one dumbwaiter. The elevator is an electric lift type with a 6- by 8-ft cab; it has a stainless-steel floor to catch any drippings or spillage from cargo. The elevator travels from the basement to the roof. The dumbwaiter is a 200-lb capacity electrically operated lift located in the southeast section of the building.

There are two truck loading platforms with steps to grade located on the west side of the building. A small metal house for the temporary storage of hot cans is located in the approximate center and on the outer portion of the platform which serves the isotope research section of the building. A truck-bed height platform 8 ft long by 6 ft wide is located on the south side of the building wall of the semiworks section opposite the center of the cell structure.

Monorails and hoists serving the building consist of three 5-ton capacity units and a 1-ton unit. A monorail track extending from the isotope research decontamination room to the vault room, with branch rails in the vault room, is equipped with two low headroom electric hoists of 5-ton capacity each. A monorail track with one 5-ton capacity low headroom electric hoist is installed for transporting loads from the outside loading platform (west side of the building) to a shielded storage room in the isotope research area. A monorail track with a 1-ton capacity low headroom electric hoist serves the semiworks decontamination room, hot storage room, and the area south of the cell structure. All hoists are floor operated from pendants.

Semiworks Cells. The primary function of the semiworks cells is for radioactive chemical-solvent experimental studies. Maximum radiation level is 1000 curies of radioactive material.

The cell block is constructed of high-density (3.33) concrete, standard concrete, solid concrete block, and lead. The cell block, extending from the basement level to the third floor level, is 12 by 54 by 40 ft high, measured from the basement floor to the top of the cell block. There are four cells designated as cell 1A and 1B, cell 2, cell 3, and cell 4A and 4B which provide three operating levels each. The interior of cells 1A and 1B and 4A and 4B are 8 by 6 ft; cells 2 and 3 are 8 by 8 ft. The height of the cells is $8^3/_4$ ft at the basement level and approximately $13^1/_2$ ft for the first- and second-floor levels. The foundation for the cell block is a reinforced standard-concrete slab to bed rock, 13 ft wide by 55 ft long by a minimum of $2^1/_4$ ft thick.

In general, the walls of the cell block are high-density concrete 2 ft thick; the exceptions are as follows: at the basement level a portion of the north and south faces of cells 1A and 1B and 4A and 4B, 6 by 10 ft and 4 by 10 ft, respectively, are solid concrete block dry-stacked to form a wall section 2 ft thick. This arrangement provides access for large tanks and vessels. The north and south faces, in the basement area, of cells 2 and 3 each have dry-stacked concrete-block sections 3 by 6 by 2 ft thick. Dry-stacked block is also utilized on the first- and second-floor level 6 ft high, around the lead-filled cell access doors in the south face of the cell block; there are six lead-filled doors on each level. The floors of cells 1A and 1B and 4A and 4B at the first-floor level are high-density concrete, 2 ft 3 in. thick, with a stainless-steel floor pan; steel grating is installed at the second-floor level. In cells 2 and 3 a half floor, 2 ft wide by 2 ft thick, is located at the first-floor level; the balance of the area at this level and at the second-floor level is provided with steel grating. Partition walls of high-density concrete, 2 ft thick by cell-block height (40 ft), separate cells 2 and 3 and form the west wall of cell 1B and the south wall of cell 4A.

Access to the cells is through the stacked concrete blocks, the lead access doors, and through removable concrete-slab roof plugs. Pipe sleeves for the entry of utility services, process lines, etc., are poured in place. Ventilation for the cells consists of two systems: (1) a hot exhaust system operates when the cells are closed and in operation and (2) a cold exhaust system exhausts air from the cells when they are open and after they have been decontaminated. When closed, the air enters the cells by infiltration and through small entrance ports and is exhausted through the hot tunnel to the isotope stack area. When the cells are open and free of radioactivity, the cells are vented through the building exhaust duct system to atmosphere through filters. The systems are dampered to provide for various combinations of open and closed cells at any one time. In the open condition room air is pulled into the cells as induced by dampered bypass manifold in the exhaust system, so that a part or all of the spent room air will pass through the cells.

A traveling crane is installed in the high-bay area over the cell block for handling heavy equipment and removing the cell block roof. This is an under-running motor-driven crane that is floor operated from a pendant and equipped with an electric hoist of 5-ton capacity.

The cell block does not have installed equipment or viewing windows.

Laboratory Building

The building housing the cells is a two-story steel-framed reinforced-concrete structure, 58 by 106 ft with insulated build-up roofing on metal roof decking, concrete-block exterior walls with brick facing, and concrete floors with asphalt and plastic tile, except in the cell loading area. The building is a high-bay and low-bay structure with heights above finished floor grade of 33 and 28 ft, respectively. Partitions and doors are hollow metal; windows are steel sash.

Laboratories, offices, working areas, and the cells are located on the main floor (see Fig. 34); laboratories and offices are on the ground floor. There are two mezzanines, one at each end of the high-bay area; the cell manipulator cable take-up reel is located on the west mezzanine and the east mezzanine is used for storage and access to the penthouse.

The penthouse situated over the low-bay section of the building houses the toxic laboratory ventilation equipment. The penthouse walls are insulated metal siding.

There is a 3-ton bridge crane and two 1-ton jib cranes located in the high-bay area (Fig. 35). The jib cranes serve cells 1, 2, and 3.

In addition to the air conditioning for the offices, laboratories, and operating areas in the building, there is a separate system for the toxic laboratory and for room 1 in laboratory 1. The heating system consists of steam unit heaters in the change rooms and work areas. Ventilation in the work areas is provided by exhaust fans.

Lighting consists of fluorescent fixtures in all laboratory, office, and work areas and incandescent fixtures in all storage, corridor, and toilet room areas.

General-purpose Hot Cells. The primary function of these cells is for the physical and metallurgical examination of high-level radioactive materials.

The cell block is constructed of high-density (3.33) concrete, standard concrete, solid high-density concrete block, stainless steel, and lead. The cell block contains seven in-line cells extending east and west in the building; cell 1 is located at the west end of the cell block.

Utility services, hot drains, etc., and sodium-vapor lighting are provided for all cells. Maximum radiation level for the facility is 7000 curies of fission-product activity.

The over-all dimensions of that portion of the cell block containing cells 1, 2, and 3 are 12 ft wide by $40\frac{1}{2}$ ft long by $15\frac{1}{2}$ ft high (from floor level). The base under these cells is standard concrete 2 ft thick; the roof consists of removable standard-concrete slabs 1 ft thick. A cross section through cells 1, 2, and 3 would show the front and back walls stepped; this allowed the installation of the manipulators. The walls of the cells 6 ft above the cell floor are high-density concrete 3 ft thick; from the 6-ft level to the $10\frac{1}{2}$-ft level, they are standard concrete, 2 ft thick; from the $10\frac{1}{2}$-foot level to the top of the cell (13 ft, inside), the walls are standard concrete, $1\frac{1}{3}$ ft thick. The west end of the cell block is high-density and standard concrete; the east end is solid high-density concrete block; the thickness of these walls is approximately the same as that for the front and back walls. The inside dimensions of these cells are approximately 6 ft wide by 10 ft long by 12 ft high to the underside of the cell roof slab.

Fixed and movable steel and lead-filled barriers separate cells 1 and 2 and cells 2 and 3. The bottom section is 8-in.-thick steel plate, $2\frac{1}{2}$ ft high; the center part consists of a 8-in.-thick fixed steel plate approximately 2 by 3 ft, a hollow lead-filled fixed barrier, which is the guide for the movable barrier, and a lead-filled movable barrier approximately 5 in. thick, 2 by 3 ft, mounted on rollers. The upper portion of the barrier is a movable 1-in.-thick steel plate extending from the top of the center section to the top of the cell. Barrier transfer and storage units are provided in all the intercell barriers so that samples may be transferred from one cell to another or stored when it is necessary for personnel to enter the cells. Access to these cells is through 6-in.-thick hinged lead-filled doors (one for each cell) that weigh approximately 3 tons each. The doors are located in the north cell face, as shown in Fig. 36.

The floors of the cells are covered with stainless steel; the balance of the interior is painted with Amercoat to facilitate decontamination. Pipe sleeves for utilities, instrument lines, etc., viewing window frames, and access door frames were poured in place in the cell block.

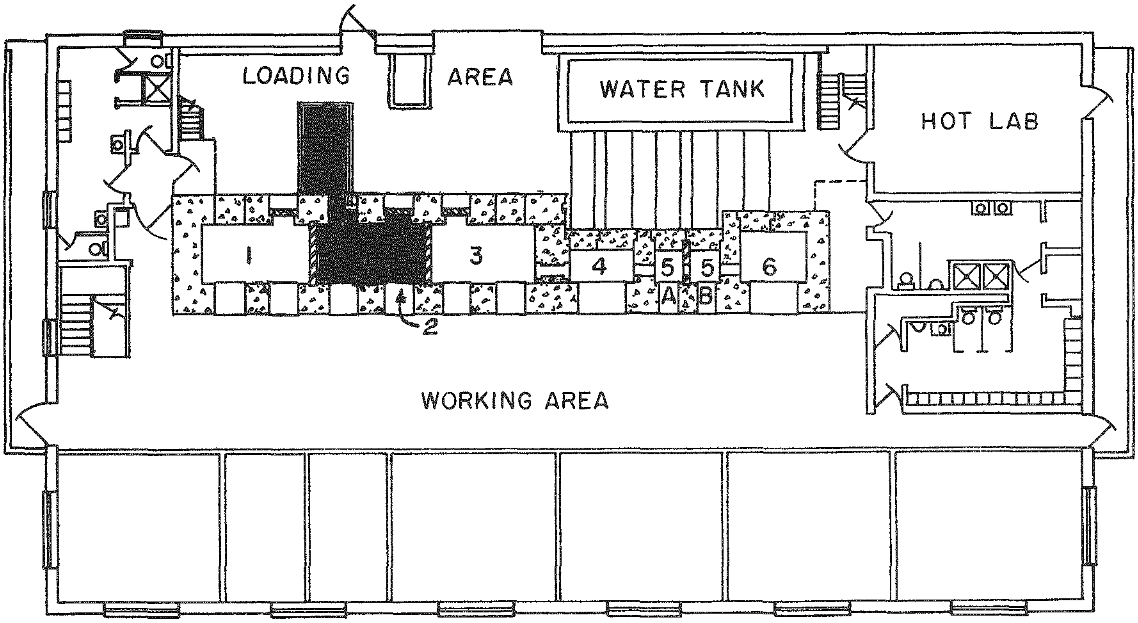

Fig. 34—Plan of general-purpose hot cells, Solid State Laboratory, building 3025, Oak Ridge.

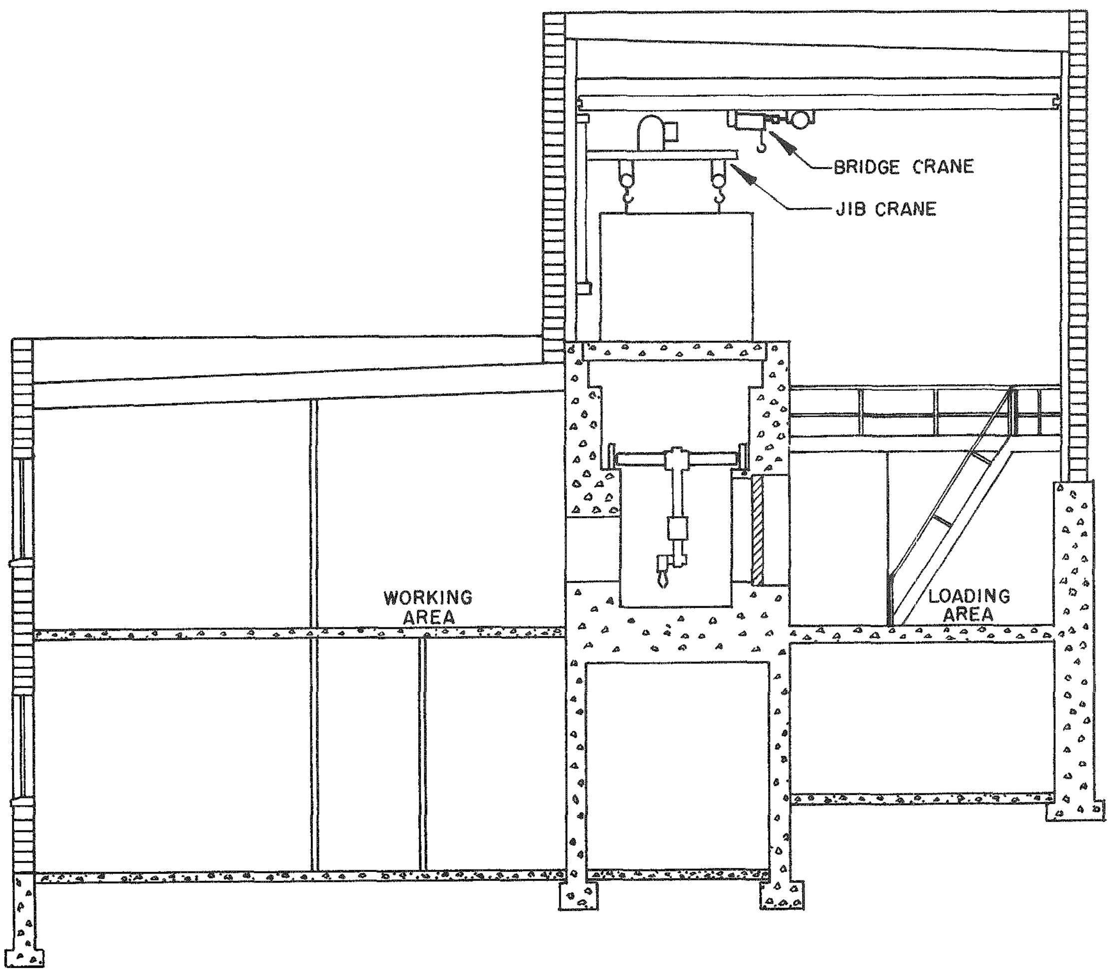

Fig. 35—Vertical section of general-purpose hot cells, Solid State Laboratory, building 3025, Oak Ridge.

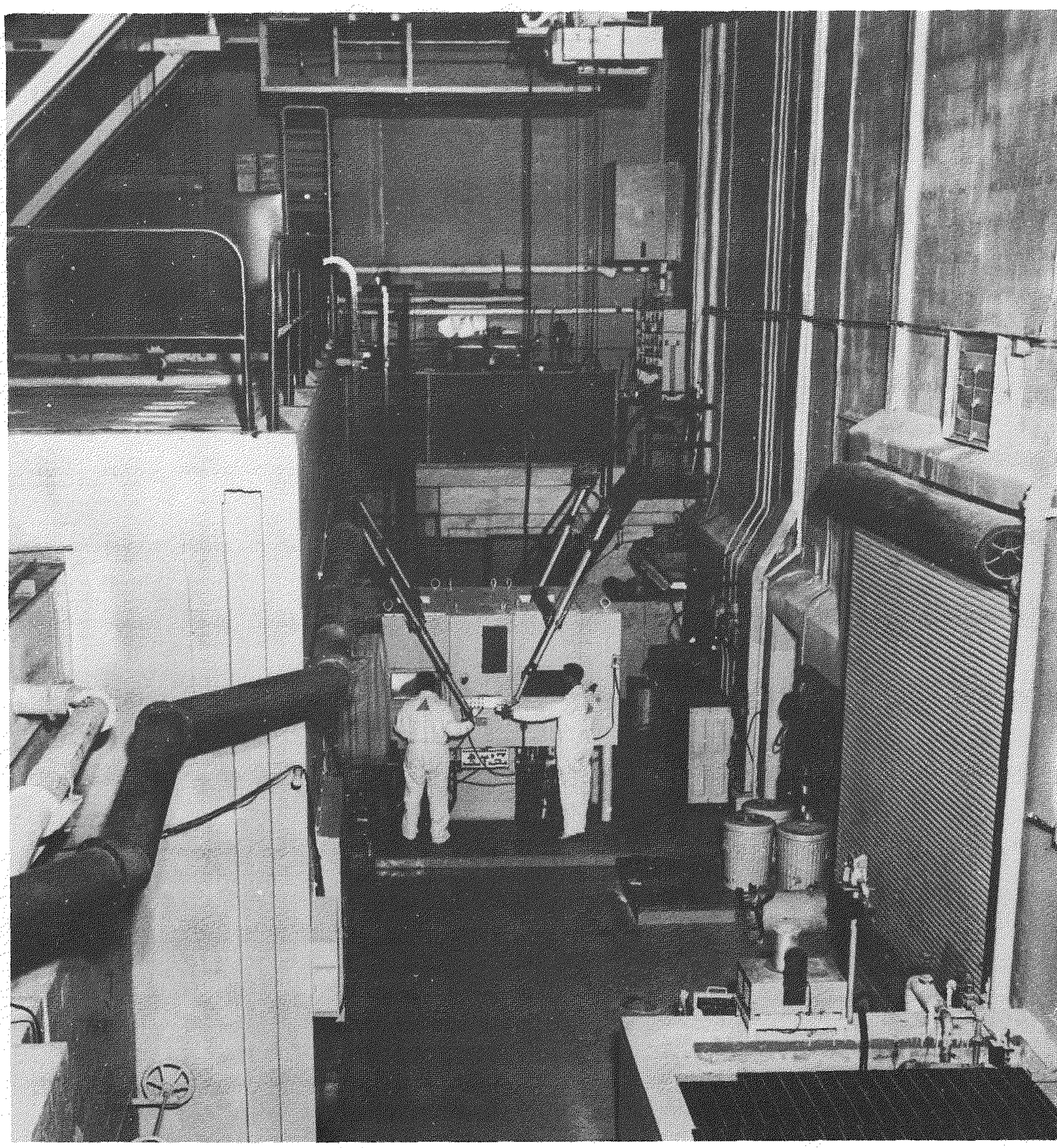

Fig. 36—Loading area of general-purpose hot cells, Solid State Laboratory, building 3025, Oak Ridge. (Note metallographic cell in background.)

Six zinc bromide-filled viewing windows, 36 by 30 by 36 in., are installed in the south face of the cell block—two windows for each cell (Fig. 37).

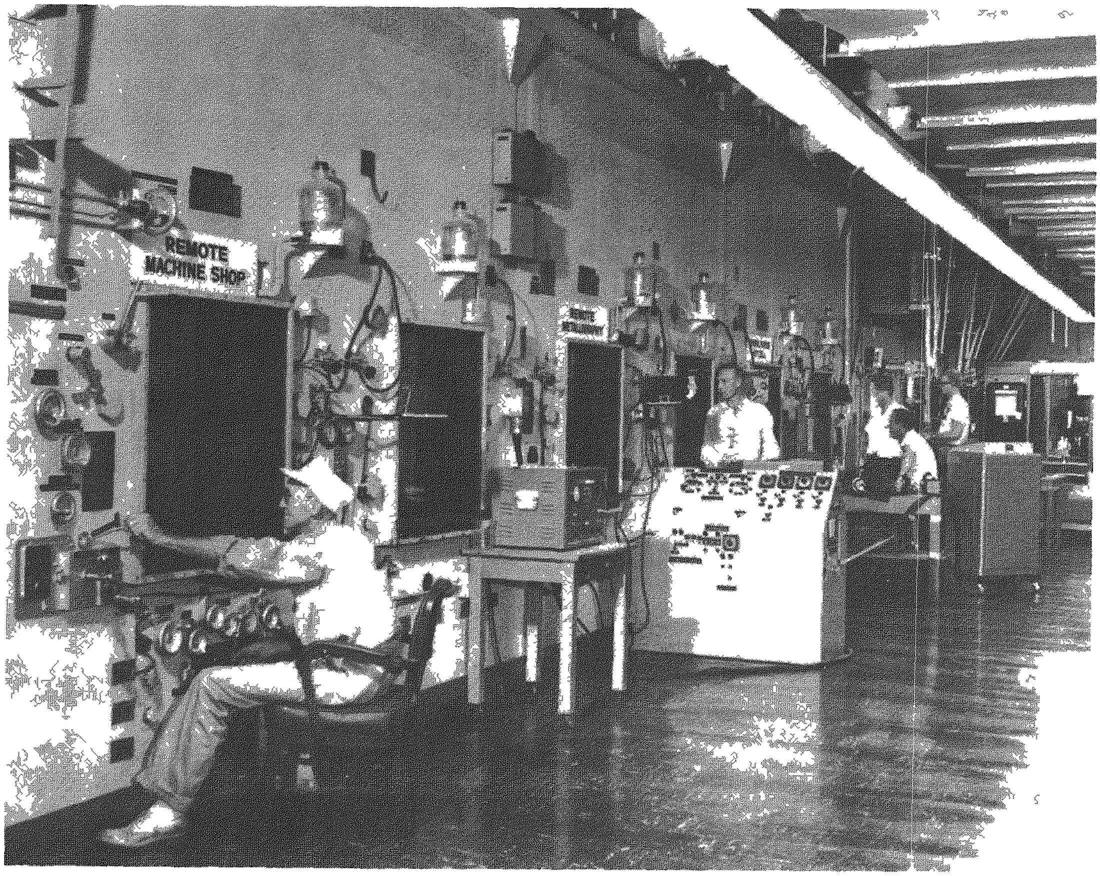

Fig. 37—Operating face of general-purpose hot cells, Solid State Laboratory, building 3025, Oak Ridge

Cell 1 is designated as the machine shop; cell 2 is the remote metallography station; and cell 3 is the general-purpose hot cell. Cells 4, 5, and 6, which comprise the east end of the cell block, are constructed of high-density concrete block, standard concrete, and steel. The base for these cells is a standard-concrete pad $3\frac{1}{2}$ in. thick placed on the existing building floor. The pad extends beyond the north wall, the width of the cells, and the water tank walls; 10 ASCE No. 2040 rails, 15 ft long, are embedded in this section of the pad. The west wall of this portion of the cell block is composed of the east wall of cell 3. The face of the cells (south wall) consists of solid high-density concrete blocks forming a wall 3 ft thick; the east wall, the north wall, and the partitions between the cells are each 2 ft thick. The working surface in the cells consists of a stainless-steel pan, 40 in. above the floor level. A high-density concrete curb 8 in. thick by 2 ft 5 in. high extends the full length and is integrated with the lower section of the south wall of the cells 4, 5, and 6.

Window head blocks and sill blocks are precast high-density concrete with pipe sleeves for services and manipulators; window jamb blocks are also precast high-density concrete. The roof over these cells is comprised of steel plates laminated to a thickness of $5\frac{3}{4}$ in.; the portion over cell 4 is movable. All interior surfaces are painted with Amercoat. Access to the cells is through solid concrete-block carriage-mounted doors located in the back wall of the cells.

Cell 4 is the corrosion examination cell. Cell 5 is divided into two compartments, each 3 ft 7 in. by 7 ft 5 in. high and separated by a high-density concrete-block barrier $3\frac{1}{2}$ ft high;

the upper portion of the barrier is a movable 6-in.-thick steel plate. Compartment 5A is designated the tensile-testing station; there is a zinc bromide-filled window, 24 by 24 by 36 in. located in the front face of the cell.

Cell 6 is 7 ft by 7 ft 5 in. high with one zinc bromide-filled viewing window, 24 by 48 by 36 in. This is a general-purpose cell.

Metallographic Cell. The metallographic cell is located adjacent to the north wall of cell 2. This structure, in general, is rectangular, having outside dimensions of 8 by 4 by 4 ft, with a structural-steel frame base approximately 3 ft high (Fig. 38). The interior of the cell is

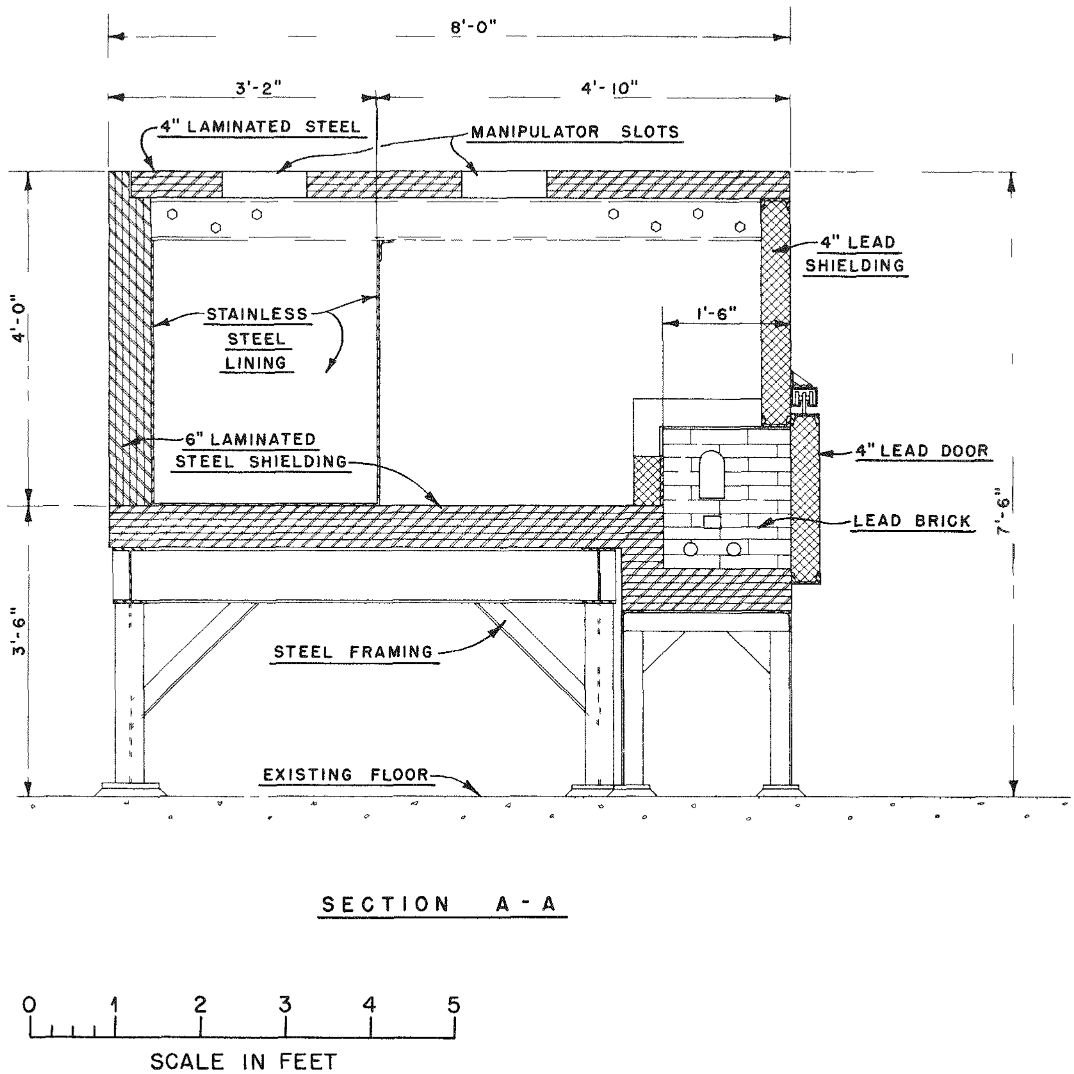

Fig. 38 — Vertical section of metallographic cell, Solid State Laboratory, building 3025, Oak Ridge.

divided and provides two separate areas that are designated the specimen-handling station and the examination station. These areas are separated by a stainless-steel plate that extends the full width and height of the structure. The cell is constructed of steel plates laminated to 6 in. thick for the floor, north and east walls, and the roof (Fig. 39). The west wall is lead shielding 4 in. thick, and the south wall is the north face of cell 2. The specimen-handling station is approximately $2\frac{2}{3}$ ft by 4 ft 2 in. by $3\frac{2}{3}$ ft, lined with stainless steel, except for the roof, one side of which provides the separating partition between the two sections. Material specimens are prepared for examination in this section. The examination station is irregular in shape with approximate interior dimensions of $4\frac{1}{2}$ ft by 4 ft 2 in. by $3\frac{2}{3}$ ft. Access to each station is through the manipulator slots in the roof. Two lead-glass viewing windows, 12 by 24 by 6 in., are located in the east face of the cell.

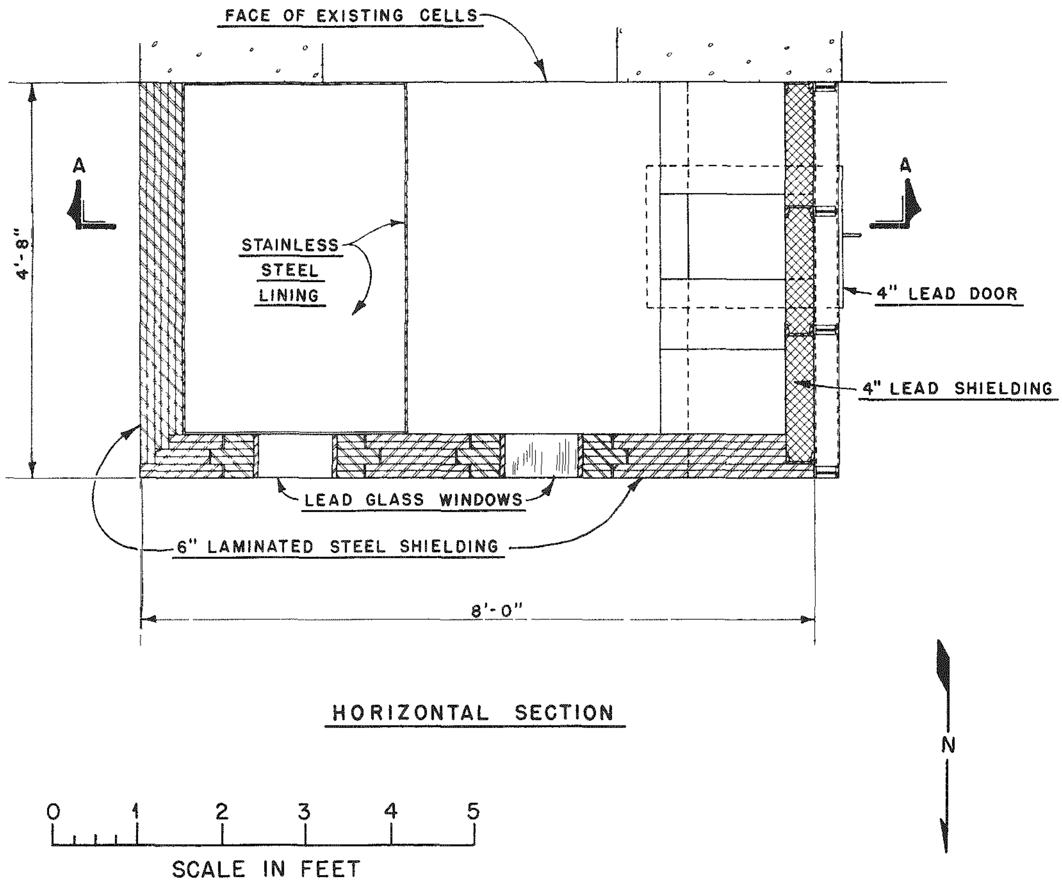

Fig. 39—Horizontal Section of metallographic cell, Solid State Laboratory, building 3025, Oak Ridge.

Electrical outlets, sodium-vapor lighting, compressed air, and water services are installed in the cell. Figure 40 shows the metallographic installation.

Ventilation for cells 1, 2, and 3 is provided by a connection to a 13-in.-diameter pipe cast in place in the top section on the front face of the cells. A 13-in.-diameter steel pipe for each cell extends through the roof and connects to a 26-in.-diameter header extended to the connection with the isotope area stack. Cells 4, 5, and 6 are ventilated by ducts connected to the cell-ventilation system.

Remote-control Cell, Building 3029

Laboratory Building

The multi-kilocurie loading cell is a self-contained structure requiring no building for housing.

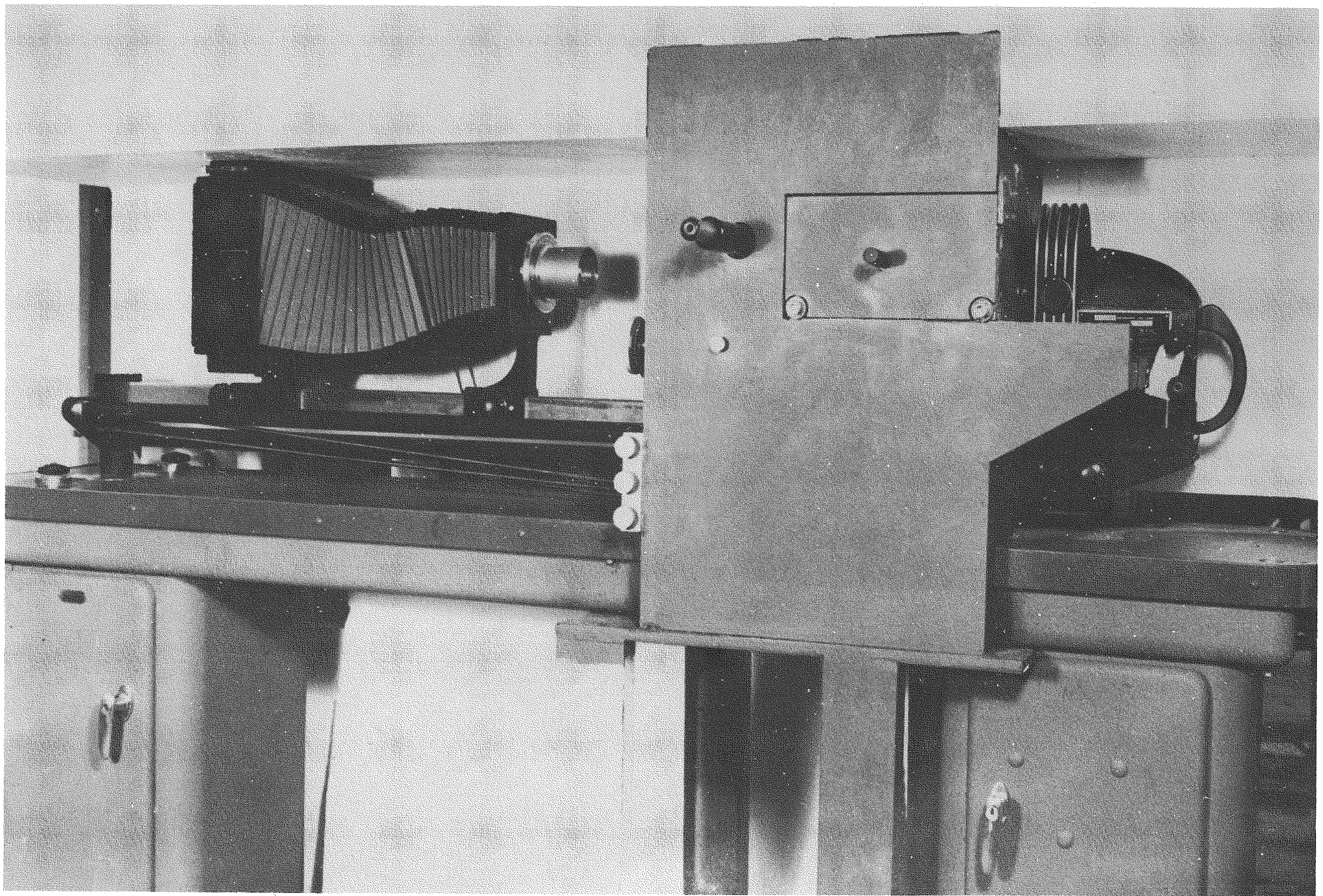

Fig. 40—Metallographic installation in metallographic cell, Solid State Laboratory, building 3025, Oak Ridge.

The building housing the Argonne type general-purpose cell is a one-story steel-framed structure, 27 by 32 by 19 ft, with concrete foundations and floor, corrugated insulated aluminum siding, insulated metal roof with tar and gravel waterproofing, normal building and laboratory services, hot drains, hot exhaust system, metal doors in the north and south elevation, no windows, and heating, provided by unit steam heaters. Standard laboratory equipment, hood, benches, sink, cabinets, etc., is installed in this building.

Multi-kilocurie Loading Cell. The primary function of this cell is to provide facilities for handling and packaging high-level Co^{60} and Cs^{137} sources designated for commercial purposes.

This facility is located adjacent to, and integrated with, the remote-control cell, building 3029. This arrangement provides the necessary operating area in front of the cell and effects economical installation of utility services that require only short extensions in order to connect with existing services available in this building.

The cell is constructed of high-density (3.33) concrete with walls 3 ft thick; the roof of the cell is $2\frac{1}{2}$ ft thick. Two high-density concrete doors, each 3 ft thick by 11 ft high by 5 ft $5\frac{1}{2}$ in. wide, compose the walls for the rear of the cell (Fig. 41). These doors, which provide access to the cell from the outside, are mounted on dollies designed especially for this application. The doors roll on 60# rails and are actuated through a geared arrangement by a $\frac{1}{4}$-hp 4-rpm reversible motor for each door. The exterior and interior dimensions of the cell are 11 by 14 by 15 ft 5 in. and 5 by 8 by 13 ft, respectively. The front of the cell contains a viewing window and portholes (see Fig. 42), which afford access into the cell for miscellaneous small tools and two model 8 manipulators. The viewing window consists of nine pieces of nonbrowning cerium viewing glass each 4 by 20 in. to form a window with a depth of 3 ft. The cell was designed to safely handle radioactivity equivalent to 10,000 curies of Co^{60}. Figure 43 shows the operating area, and Fig. 44 shows the loading area. The entire area on the inside of the cell is lined with stainless steel to facilitate decontamination. Lighting is incandescent. Cell ventilation is accomplished with a short extension connecting with the ventilation system for building 3029.

Argonne Type General-purpose Cell. This cell is utilized primarily for chemical processing of irradiated units and for charging and sealing capsules with sources of activity less than 300 curies.

The cell structure is situated in the west end of building 3029 with the west face (cell width, height, and wall thickness) integrated with the building wall (Fig. 45). The radiation level for the facility is equivalent to 300 curies of Co^{60}.

The cell is constructed of high-density (3.33) concrete with walls 2 ft thick on the north, east, and south sides and 1 ft thick on the west side. The roof consists of two $\frac{3}{4}$-in.-thick steel plates (removable) with slots for manipulator access. Concrete blocks are stacked on the roof, as required, for shielding. The base of the cell is the building floor slab. The lower portion of the cell (interior) is a standard-concrete slab lined with stainless steel to provide a working surface $3\frac{1}{2}$ ft high. Outside dimensions are 9 by $6\frac{1}{4}$ by $7\frac{3}{4}$ ft; interior dimensions are $3\frac{1}{4}$ by 5 by 4 ft 2 in. high, measured from the working surface to the underside of the roof plate. The cell contains one lead-glass viewing window 2 by 3 by 2 ft thick (Fig. 46).

Access for moving carriers into, and out of, the cell is through a pair of lead-filled doors in the west wall of the cell (see Fig. 47). A small lead-filled door located in the southeast corner of the cell at work-area height provides access for placing and removing chemicals and small equipment items. Lighting is incandescent.

Ventilation for the cell is provided by a short extension connecting with the ventilation system for building 3029.

Radioiodine Separation, Building 3028

Laboratory Building

Alterations to building 3028 were made to permit the installation of an 8- by 14-ft section of the cell block. The area includes the space in this building occupied by the cell block; the gross cubage includes only that portion of the facility housed in the extension to the building. The extension consists of a structural-steel-framed structure 20 by 25 by 18 ft with metal

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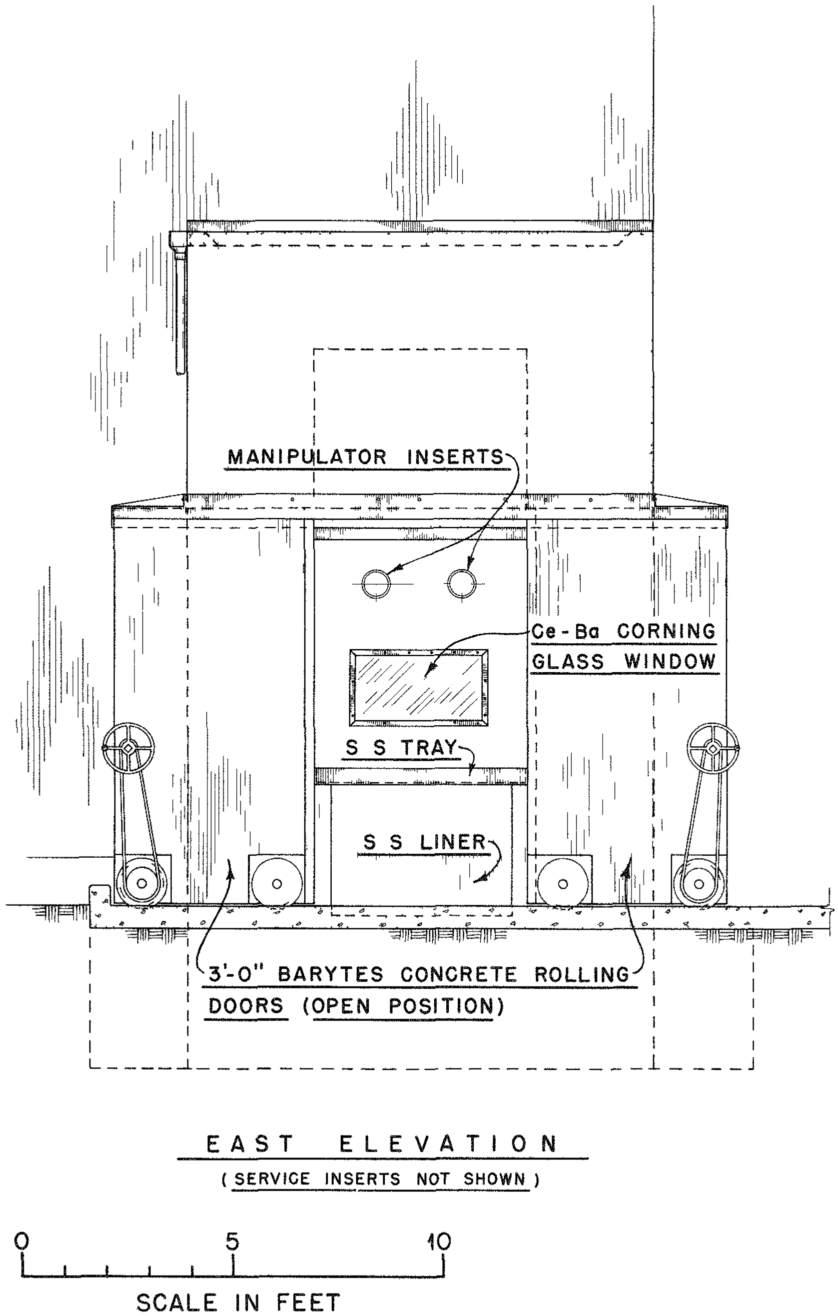

Fig. 41—Front view of multi-kilocurie loading cell, Remote-control Cell Building, 3029, Oak Ridge.

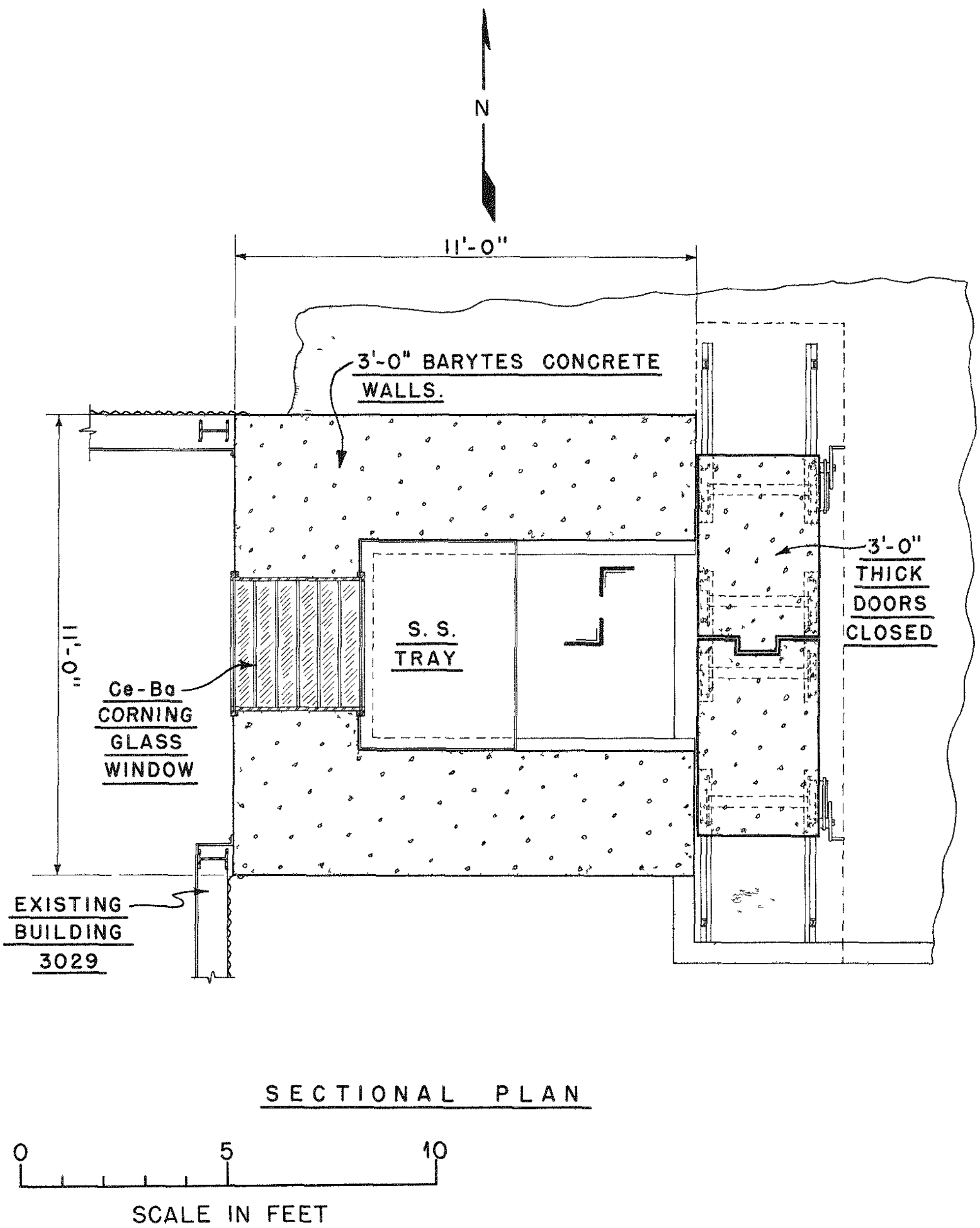

Fig. 42—Vertical section of multi-kilocurie loading cell, Remote-control Cell Building, 3029, Oak Ridge.

Fig. 43—Operating face of multi-kilocurie loading cell. Remote-control Cell Building, 3029, Oak Ridge.

Fig. 44—Loading area of multi-kilocurie loading cell, Remote-control Cell Building, 3029, Oak Ridge.

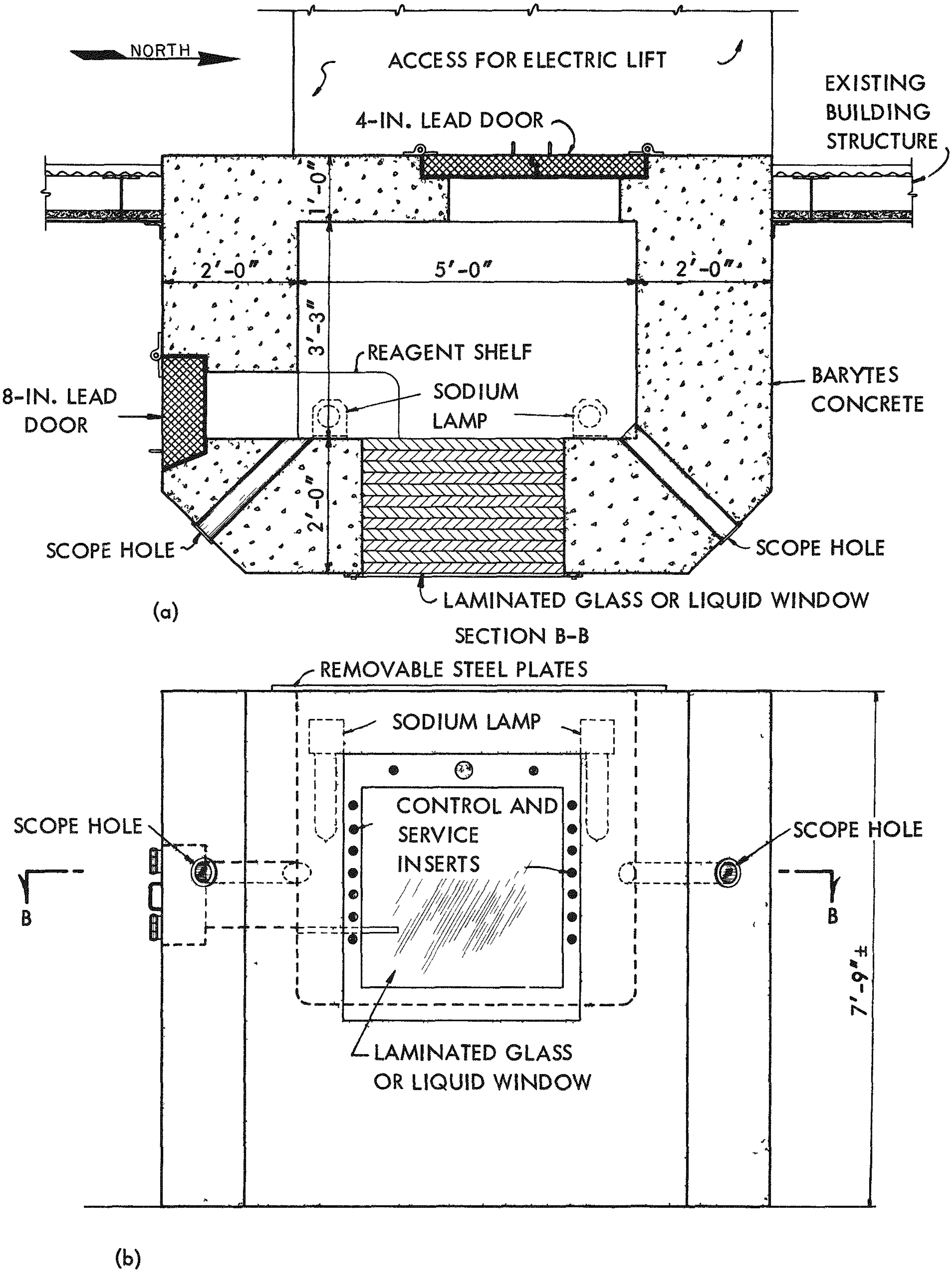

Fig. 45—(a) Section plan and (b) front elevation of Argonne general-purpose cell, Remote-control Cell Building, 3029, Oak Ridge.

Fig. 46—Operating face of Argonne general-purpose cell, Remote-control Cell Building, 3029, Oak Ridge.

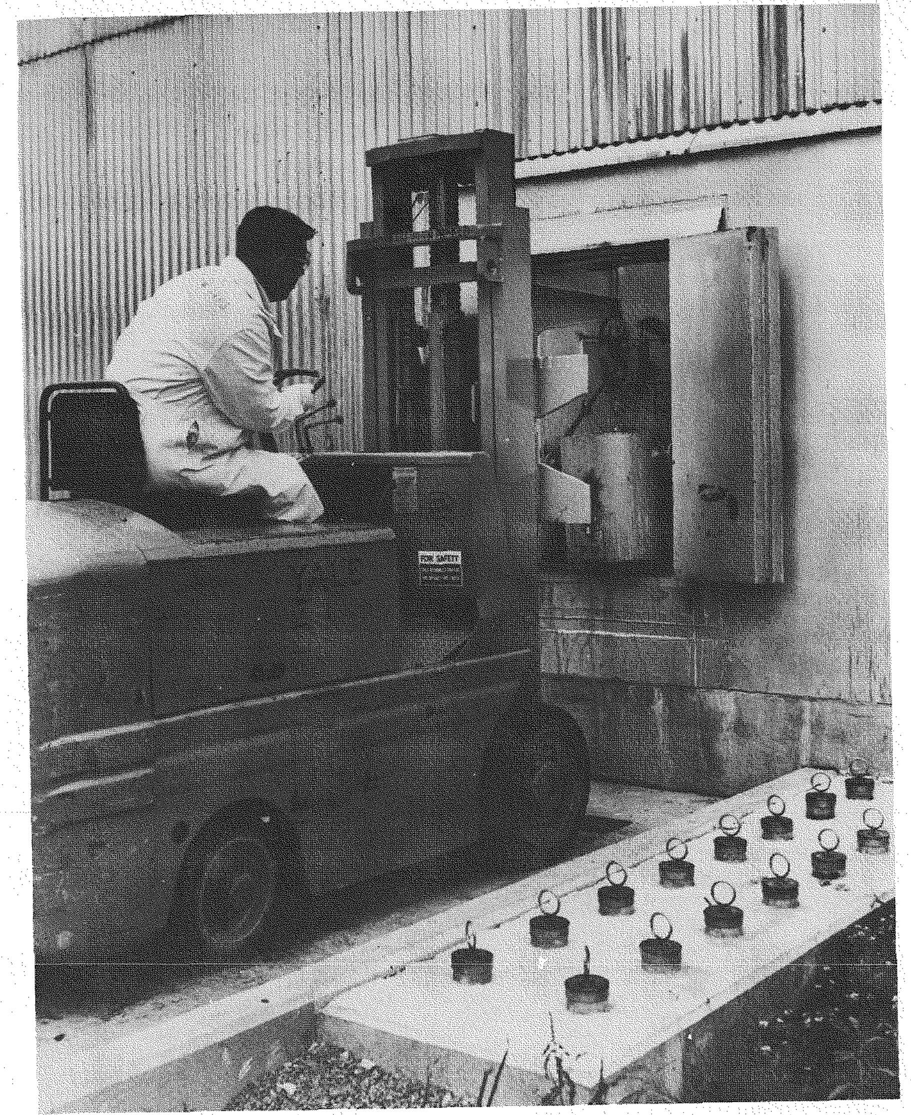

Fig. 47—Loading area of Argonne general-purpose cell, Remote-control Cell Building, 3029, Oak Ridge.

siding, normal building services, a pair of 8-ft-high metal doors in the west wall for the entrance of shielded slug carriers, and a pair of monorail tracks for 1- and 3-ton hoists which serve the cubicles and cells 1 and 2. A concrete drive extending from an existing street to the cell block provides access for trucks to the hoists. Steel stairs afford access to the roof over cells 1 and 2.

I^{131} Processing Cell. The facility was designed primarily for the processing of I^{131} for medical and research institutions and other AEC installations.

The cell block is constructed of high-density (3.33) concrete, standard concrete, solid standard-concrete block, and lead. The cell block contains three cells and three cubicles, as shown in Fig. 48. The floors of the cubicles and cells 1 and 2 are 12-in.-thick standard concrete; the floor in cell 3 is 6 in. thick. Maximum radiation for the facility is 100 curies I^{131}.

The three cubicles are arranged in line on the north side of the cell block. They are identical in size, 3 ft by 2 ft 11 in. by 4½ ft. lined with ¼-in.-thick stainless steel and have common utility services. The partitions between the cubicles and the wall separating the east cubicle from cell 3 are standard concrete, 2 ft thick; the wall of the west cubicle is standard concrete, 3 ft thick. The roof immediately over the cubicles is high-density concrete, 3 ft thick. Shielding on the exposed north face of the cubicles consists of stacked solid concrete blocks to form a shield 2¾ ft wide by 6 ft. The high-density concrete roof of the cubicles extends over this area. The walls between the cubicles and cells 1 and 2 are standard concrete, 2 ft thick.

Cell 1 is located in the southwest corner of the cell block. The cell is 6⅔ ft deep by 4 ft wide by 6 ft high, lined with stainless steel. The west wall of the cell is standard concrete, 2 ft thick; the roof is high-density concrete 1½ ft thick, and the partition between cells 1 and 2 is high-density concrete, 12 in. thick. Access to the cell is through a plug hatch in the roof. The face of the cell consists of 4-in.-thick lead, with a lead-glass viewing window 6 by 8 by 6 in.

Cell 2 is located in the center south side of the cell block. The cell is 5 ft deep by 10 ft long by 6 ft high, lined with stainless steel. The partition separating this cell from cell 3 is high-density concrete 12 in. thick; the roof is 1½ ft thick; the face of the cell is standard concrete, 2 ft thick. Access to the cell is through a plug hatch in the roof.

Cell 3 composes the entire east end of the cell block, the larger portion extending into building 3028. It is 9½ ft deep by 10⅔ ft long by 6⅓ ft high, lined with stainless steel. The north, east, and south walls of the cell are high-density concrete, 1½ ft thick. The west wall of the cell consists of the partitions, previously described, which separate this cell from the cubicles and cell 2. Access to this cell is through openings from within building 3028.

Pipe sleeves for ventilation and for the entrance of services and instrument lines were poured in place in the cells.

Ventilation for the cell block is provided by extensions connecting with the existing nearby cell-ventilation system.

The operating face of the cell is shown in Fig. 49, the equipment in cubicles adjoining the cell is shown in Fig. 50, and the cell instrument panel is shown in Fig. 51.

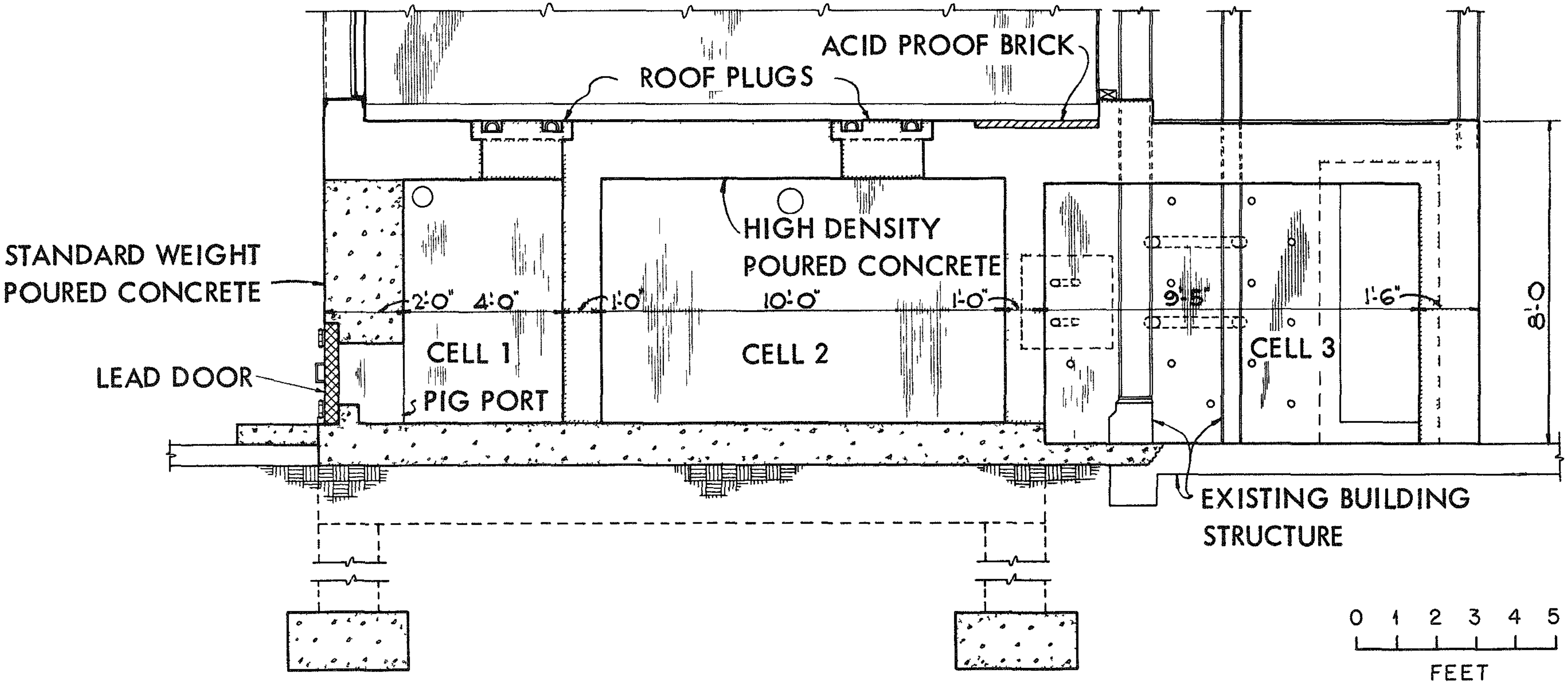

Fig. 48—Vertical section of I^{131} processing cell, Radioiodine Separation Building, 3028, Oak Ridge.

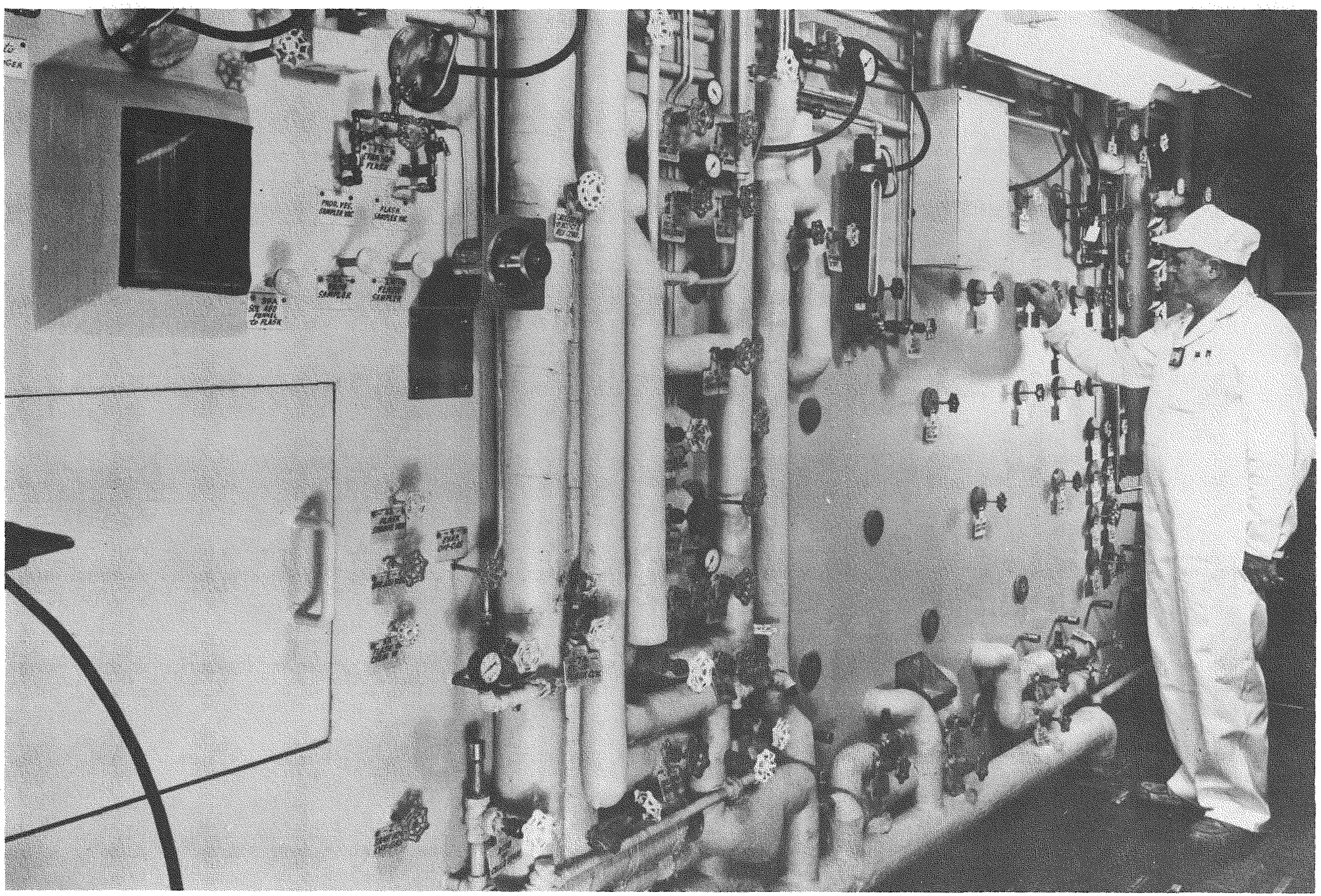

Fig. 49—Operating face of I^{131} processing cell, Radioiodine Separation Building, 3028, Oak Ridge.

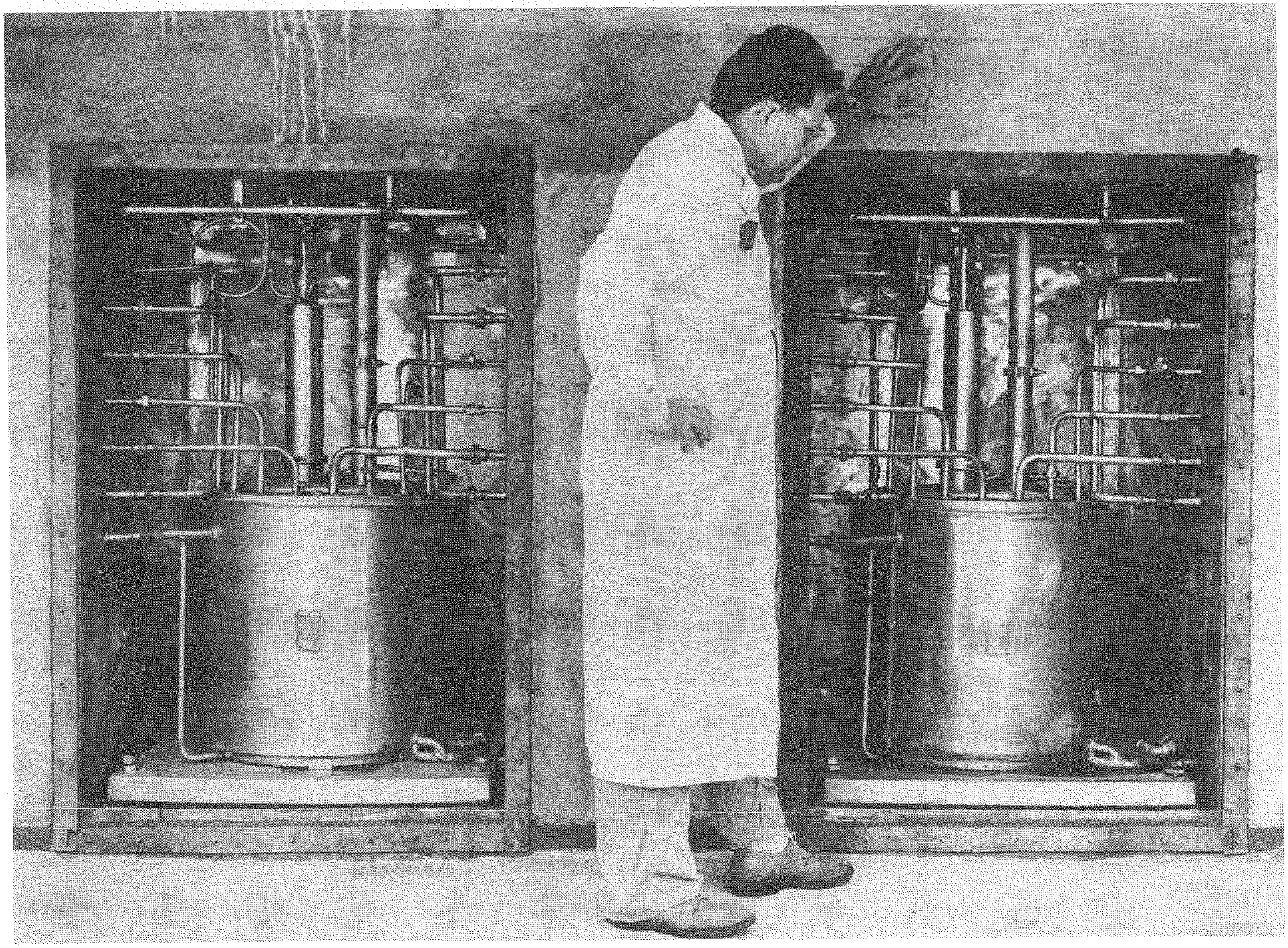

Fig. 50—Equipment in cubicle adjacent to I^{131} processing cell, Radioiodine Separation Building, 3028, Oak Ridge.

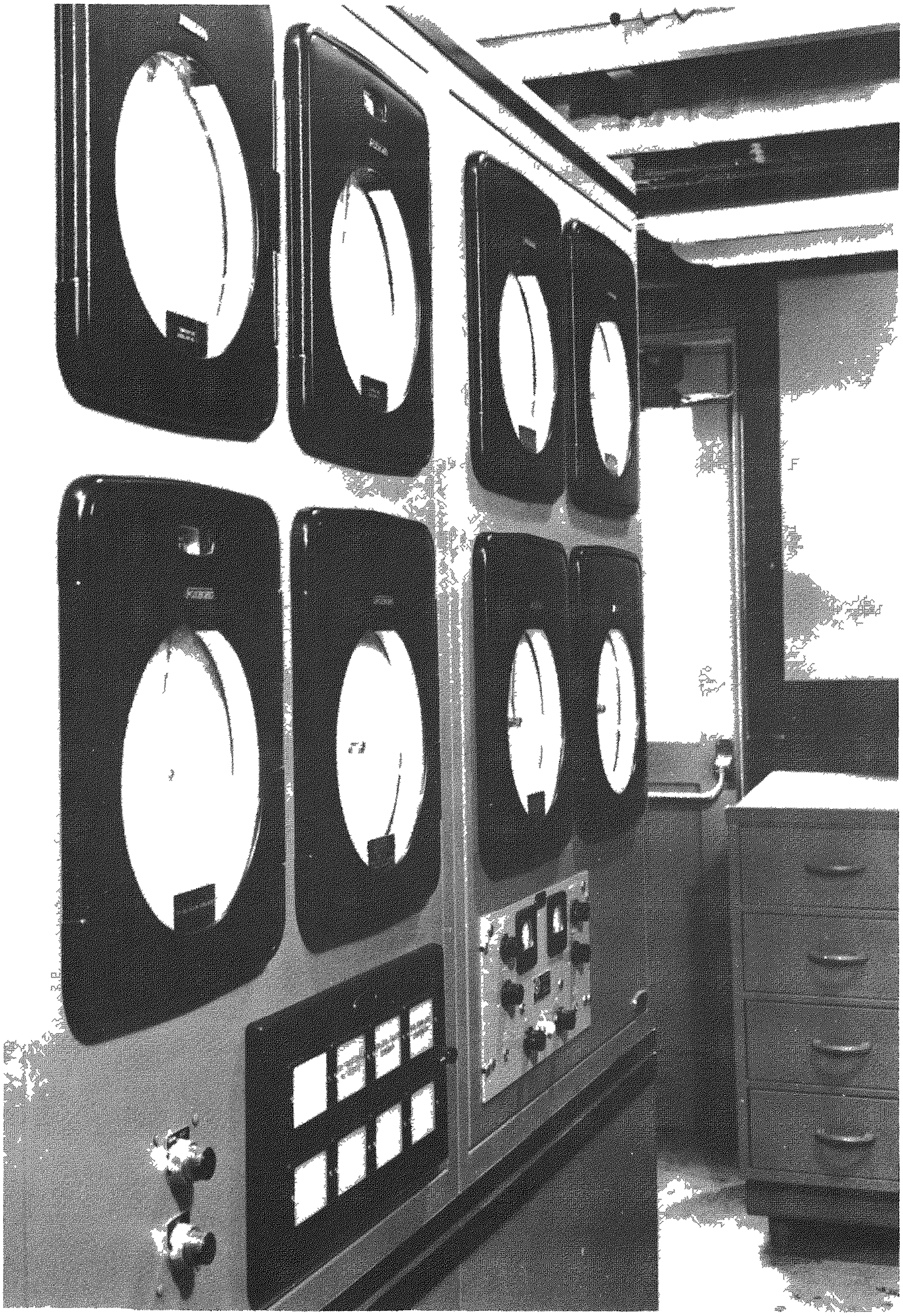

Fig. 51—Instrument panel for I^{131} processing cell, Radioiodine Separation Building, 3028, Oak Ridge.

8 San Francisco Operations Office

Atomics International, Canoga Park, Calif.

Laboratory Building

The Atomics International hot cave was built at Downey; then it was disassembled and moved to Canoga Park, where it was reassembled at the Atomics International Vanowen facility. No particular structure, as such, houses the hot cave.

Hot Cell. The function of this hot cave is to provide the facilities for conducting experiments on radioactive materials, processing reactor fuel samples, and measuring the physical properties of radioactive materials. It is made up of two cells joined at the ends; each cell is 72 in. long by 48 in. wide by 75 in. high inside. Concrete blocks, 27 in. thick, with a density of 3.6 were used for constructing the walls; the roof is made of cast-iron blocks. The cell floor is concrete, and it is 2 in. above the level of the room floor. It is covered with a stainless-steel pan, $1\frac{1}{2}$ in. thick.

The maximum radiation level is 400 curies.

A 12-in.-thick sliding door is provided at the end of the cell. It weighs 12 tons and is moved by means of an air cylinder.

The viewing window is constructed in two parts; the first part is $8\frac{3}{4}$ in. of dense lead glass, and the second is an 18-in.-thick aquarium filled with zinc bromide solution.

A negative-pressure ventilation system is included for contamination control. The air is drawn in through a dust filter and leaves through a roughing filter and an absolute filter. (Some leakage will occur around the door, but it will be into the cell.)

Lighting is provided by sodium-vapor lamps.

Sodium Reactor Experiment, Santa Susana, Calif.

Laboratory Building

The laboratory consists of a substructure, reinforced-concrete slab, walls, and roof, with a forced-air heating and ventilating system.

Hot Cell. The function of the SRE hot cell provides a facility for examining SRE fuel elements. It consists of two cells: (1) primary cell ($7\frac{1}{2}$ ft wide by 15 ft long by 16 ft high) and (2) secondary metallurgical cell (5 ft wide by 8 ft long by $11\frac{1}{2}$ ft high). Construction is reinforced-concrete slab, with walls and roof of reinforced heavy concrete (magnetite). Shielding is heavy concrete (magnetite), $3\frac{1}{2}$ ft thick on the primary cell and 3 ft thick on the secondary cell.

The maximum radiation level is 10^6 curies.

Doors are track roll type, made of magnetite concrete, with a steel shell. There are two doors weighing 8 tons each.

The viewing windows are made of high- and medium-density lead glass. They are of a dry type construction. There are three windows, with 3 by 4 ft interior dimensions. The thickness of the window in the primary cell is $3\frac{1}{2}$ ft, in the secondary cell, 3 ft.

The primary cell has two pairs of Argonne model 8 manipulators; the secondary cell has one pair of these manipulators.

Hot-cell lighting consists of mercury-vapor lamps in especially designed fixtures; the fixtures were designed and built for rapid removal and replacement. There are 26 fixtures installed so as to produce approximately 200 foot-candles in each cell. Lamps give forth yellow incandescence which is necessary in view of the lead-glass windows.

During normal operations, with the hot-cell doors closed, the cell atmosphere is changed 20 times per hour. When the cell doors are open, the cell-air change rate is governed by a flow of 100 ft/min air velocity across the cell door. Incoming air is filtered through 85 per cent efficient filters. Exhaust air is discharged to the atmosphere through a system of absolute filters, a 10 to 1 ratio dilution fan, and a stack two and one-half times the building height.

Pratt & Whitney Aircraft Division, Building 121, Livermore, Calif.

Laboratory Building

This building, originally used as an aircraft hangar, was converted for use as a hot laboratory by the California Research and Development Company. The building is of wood frame on flat-slab construction with an unfloored attic area of 18,000 sq ft.

Following the modification for use by Pratt & Whitney, the ground-floor area was divided into 13,230 sq ft of clean area and 7870 sq ft of dirty area, where radioactive materials were to be handled. An auxiliary clean area of 2000 sq ft and the unfloored attic area remained unchanged.

The dirty area contains the five hot cells, cell back service aisle, metallographic cave, warm chemistry laboratory, decontamination room, warm machine shop, high vacuum laboratory, warm X-ray diffraction laboratory, and change room, including shower facilities. The clean area contains the cold metallurgical laboratory, cell front service aisle, counting room, radiation-detection instrument room, cold chemistry laboratory, cold machine shop, engineering mock-up area, glass-blowing shop, and office area.

The building ventilation system introduces clean tempered air into both the clean and dirty areas. Air to the clean area amounts to about eight air changes per hour; it is exhausted to atmosphere by gravity or power ventilators. Air to the dirty area amounts to about six air changes per hour; it is exhausted through filters and a monitored duct to a 100-ft stack. A 25-hp 40,000 cu ft/min fan furnishes the fresh air. Air cleaning is accomplished by water-sprayed filters and tempering by steam coils. A 25-hp, 28,000 cu ft/min fan removes air from the dirty areas. The clean areas are separated from the dirty areas by double door air locks. In addition the ventilating system provides 600 cu ft/min of air flow through any cell, with the back door open.

The building services include low-pressure air (15 psig), high-pressure air (70 psig), hot and cold water, distilled water, and steam (70 psig saturated). Building electrical power is supplied by two power feeders. A 2400-volt feeder supplies a 150-kva 2400- to 120/208-volt transformer bank for normal light and emergency ventilation loads. A 13.8-kv feeder supplies a 1500-kva 13.8-kv/480-volt transformer bank, which has one feeder for 480-volt power loads and a second feeder for a 300-kva 480- to 120/208-volt transformer bank for main 120/208-volt power, normal ventilating, and emergency lighting loads.

In the event of failure of the 300- or 150-kva 120/208-volt power supplies, there is provision for transfer of lighting and ventilating loads from their normal power supply to an alternate power supply.

Hot-cell Block. The cell block consists of five cells described as general utility cell (No. 1), chemical operations cell (No. 2), hot machine shop (No. 34), metallurgical-specimen preparation cell (No. 5), and metallurgical examination cell (No. 6). The entire cell block is serviced by an overhead 5-ton bridge crane in addition to the crane located in each cell. In addition, there is a 20-ton A-frame monorail for unloading heavy coffins. This monorail extends from a loading port outside the building into a loading port at the back wall of the hot machine shop cell (Fig. 52). The roof of each cell is comprised of removable roof slabs. Exhaust air from each cell passes to filters, booster fan, collection duct, and a monitoring station to the area exhaust fan and 100-ft stack. A Spencer Turbine Co. high-vacuum producer with a $7\frac{1}{2}$-hp motor and associated in-cell ducting and Aerotec centrifugal dust separators with filters service the entire cell block for preliminary remote cleaning operations. Entry to each cell may be through either a back door or through the removable roof slabs.

General Utility Cell 1. The outer cell walls are 4-ft-thick standard-density concrete. The interior dimensions of the cell are 7 by 7 by 12 ft high, above the false operating floor. The false floor is 6 in. below the bottom of the window and 30 in. above the operating aisle. The

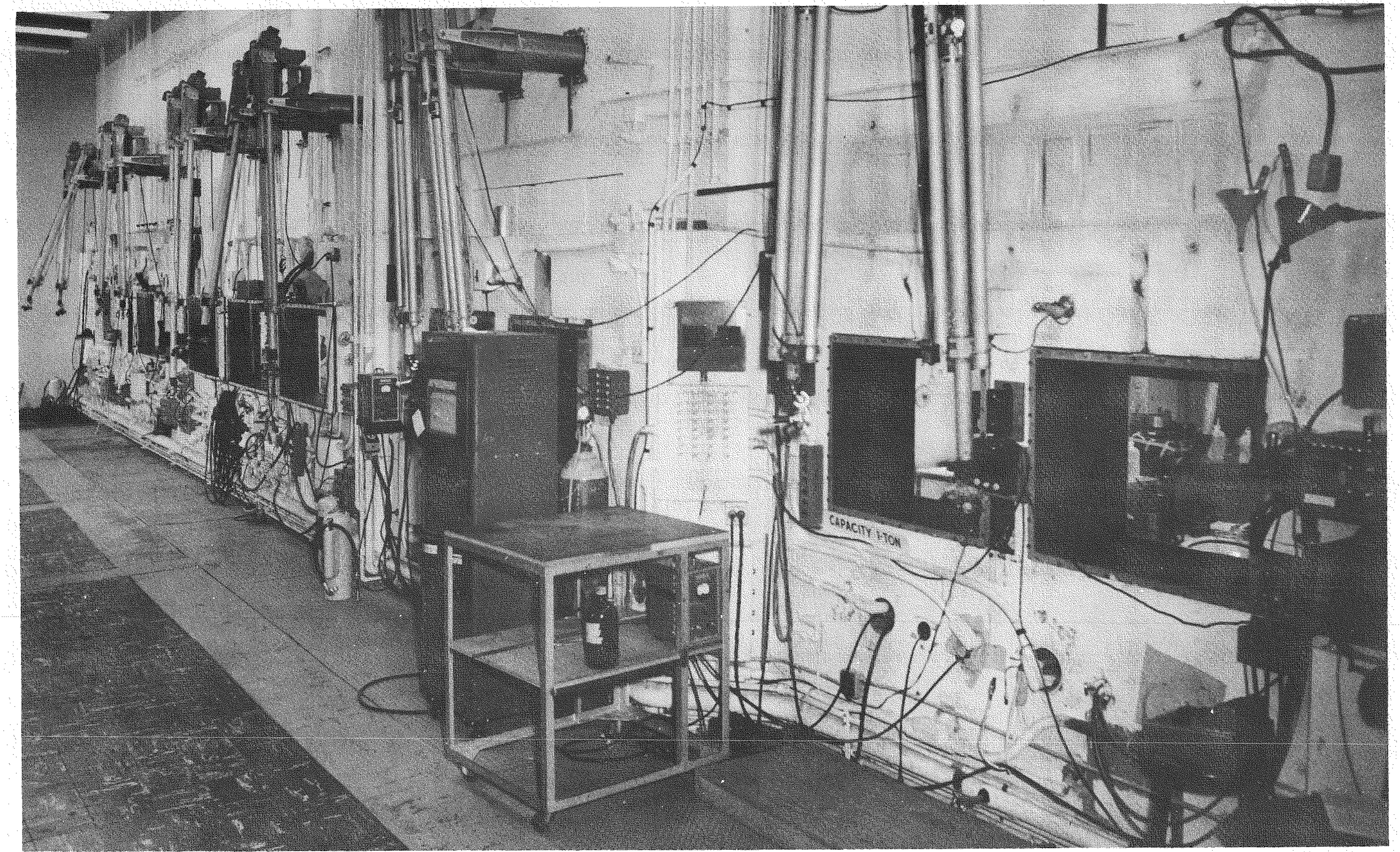

Fig. 52—Operating area for hot cells, Livermore, building 121.

depth of the pit below the false floor is 8 ft. Illumination is provided by six 11,000-lumen mercury-vapor lamps. Viewing is through a 26-in.-high by 45-in.-wide by 39-in.-deep zinc bromide window. Access to adjoining cell 2 is by means of a 12-in. tray lazy susan, the over-all dimensions of which are 32 in. long by 42 in. wide by 30 in. high. The shield thickness of the lazy susan is 12 in. of cast iron.

Chemical Operations Cell 2. The outer cell walls are 2-ft-thick standard-density concrete and an outer $1\frac{1}{2}$-ft-thick layer of class B concrete (230 lb/cu ft). Illumination is provided by six 10,000-lumen sodium-vapor lamps. Viewing is through a 26-in.-high by 45-in.-wide by 39-in.-deep zinc bromide window. This cell is used for the initial preparation of highly radioactive chemical samples. Final chemical determinations are obtained in the warm chemistry laboratory on low-level radioactive aliquot samples. Internal dimensions of this cell are 7 by 8 by 12 ft high, above the operating false floor. The false floor is 6-in. below the bottom of the window and 30 in. above the operating aisle. Depth of the pit below the false floor is 8 ft.

Hot Machine Shop Cell 34. This cell is essentially a remote machine shop. The internal dimensions of this cell are 16 by 8 by 12 ft high, above the operating false floor. The false floor is 6 in. below the bottom of the window and 30 in. above the operating aisle. Depth of pit below the false floor is 8 ft. The cell walls are 2-ft-thick standard-density concrete and an outer layer of $1\frac{1}{2}$-ft-thick class C concrete (300 lb/cu ft).

Illumination is provided by fourteen 10,000-lumen sodium-vapor lamps. Access to adjoining cells 2 and 5 is accomplished by means of 16-in. tray lazy susan, the over-all dimensions of which are 36 in. long by 42 in. wide by 30 in. high. Viewing is through three zinc bromide windows; each is 36 in. high by 45 in. wide by $43\frac{1}{2}$ in. deep.

Metallurgical-specimen Preparation Cell 5. This cell is used as a preliminary metallurgical-sample preparation area. Samples are received via the lazy susan from the hot machine shop cell mounted in bakelite and lapped flat on two John Crane lapping machines. Internal dimensions of this cell are 8 by 8 by 12 ft high from the false operating floor. The false floor is 6 in. below the bottom of the window and 30 in. above the operating aisle. The depth of the pit below the false floor is 3 ft. Illumination is provided by six 10,000-lumen sodium-vapor lamps. Viewing is through two windows; each is a $25\frac{3}{4}$-in.-high by $33\frac{1}{2}$-in.-wide by 38-in.-deep zinc bromide window. The cell is constructed of 2-ft-thick standard-density concrete with an outer $1\frac{1}{2}$-ft-thick layer of class B concrete (230 lb/cu ft). Access to the hot machine shop cell is by means of a lazy susan and access to the metallurgical examination cell is by means of a sliding transfer drawer. The inside dimensions of this drawer are 30 by 14 by 9 in. high.

Metallurgical Examination Cell 6. This cell is used for the final polishing operations of previously mounted and lapped specimens. This unit is located against the outer end wall of the cell block. Radiation protection is accomplished by a 6-in.-thick lead-filled mild-steel shell. Access to the stage of the metallograph is by means of a 6-in. tube through the end wall of the metallurgical examination cell. The metallograph shielding is sealed to the cell wall, and the exhaust air passes into the metallurgical examination cell. The interior dimensions of the cell are 8 by 8 by 12 ft high, above the operating false floor. The false floor is located 6 in. below the bottom of the window and 30 in. above the operating aisle. The depth of the pit below the false floor is 3 ft. Viewing is through two 30-in.-high by 36-in.-wide by 36-in.-deep zinc bromide windows. Illumination is provided by six 10,000-lumen sodium-vapor lamps. Cell walls are constructed of 3-ft-thick standard-density concrete (140 lb/cu ft).

Metallographic Cave. In addition to the five cells in the cell block, there is a metallographic cave adjacent thereto. This measures $5\frac{1}{2}$ by 7 ft.

9 Savannah River Operations Office

Main Technical Laboratory, Building 773-A

Laboratory Building

The high-level caves are housed in a wing on the left rear corner of the Main Technical Laboratory and connected to the main laboratory by a personnel corridor. This wing is of class III construction (structural-steel frame enclosed with flat asbestos panels on steel girts between columns) and is rectangular in shape, 53 ft wide by $80\frac{1}{2}$ ft long. The roof has three elevations: the distance from top of floor slab to top of roof slab is 38 ft 7 in. for a 24- by $56\frac{2}{3}$-ft area over the caves and cave loading area; $11\frac{1}{2}$ ft for a width of approximately 12 ft 10 in. along the entire north side of the wing; and 27 ft 2 in. for the balance of the wing. The interior of the exterior walls and interior partitions are cement asbestos panels on studs; ceilings are flat asbestos panels on furring strips; roofing is built-up on concrete slab; roof and exterior walls are insulated; and floors are bare concrete except for cave floors, which have vinyl paint.

In addition to the caves, the wing houses the following facilities: cave operating area, mock-up area, contamination control room, cave loading area, storage area, mechanical equipment room (over operating area), manipulator reel room (over mock-up area), and electric control room (over mock-up area).

Ventilation and air-conditioning units use no recirculated air, and the system is balanced to ensure air flow from clean to contaminated areas. An 11-ton 6000 cu ft/min air-conditioning unit with reheat coils supplies warm or refrigerated air to the operating area, loading area, mock-up area, contamination control room, and storage room. A 2315 cu ft/min ventilating unit supplies fresh or warmed fresh air to the electrical control and mechanical equipment rooms. Positive exhaust from these rooms is through a 2215 cu ft/min exhauster mounted on the roof.

Building exhaust, discharging through the roof, is accomplished by exhaust units, varying according to area: wet and dry storage pits in the loading area, a 620 cu ft/min unit; high-level drain system, a 26 cu ft/min unit; contamination and storage rooms, a 1200 cu ft/min unit; and the operating and mock-up areas, a 2230 cu ft/min unit. The fans exhausting the pits, high-level drain system, and contamination control and storage rooms are all preceded by AEC type filters for exhaust air from contaminated areas and, with the exception of the high-level drain unit, are installed in duplicate to ensure ventilation of contaminated areas against equipment failure.

Lighting is by fluorescent and incandescent fixtures with sodium-vapor units in the caves. Normal electrical lighting and power circuits are provided.

Normal hot and cold water supplies and clean drainage systems are provided. A special high-level drainage system is provided for the caves and other areas in which high-level contamination is present.

Hot Cells. Design of the caves is based on the installation at Westinghouse Atomic Power Division with modifications incorporating Westinghouse operating experience, isolation techniques developed at Knolls Atomic Power Laboratory, and local requirements. A perspective view of the cells is shown in Fig. 53.

Outside dimensions of the cave structures are 45 by 12 by $17\frac{1}{4}$ ft from operating floor to top of caves. Walls are high-density (200 lb/cu ft) barytes aggregate concrete with a thickness of 3 ft. This construction is based on a design criteria requiring 1 mr at the outside face of the cave from a 5000 curie/1-Mev source 1 ft from the inside face. The cave roof is composed of 10 high-density concrete slabs 1 ft thick with stepped joints and lifting eyes permitting removal of the slabs by the overhead crane (Fig. 54). The interior of the structure is divided into three $11\frac{1}{3}$- by 6-ft caves by means of removable barriers (Fig. 55). The lower portion of this barrier, to a maximum height of $8\frac{3}{4}$ ft is made of metal-encased high-density concrete blocks, 30 in. thick. A 2-ft-wide by 2-ft 5-in.-deep opening in these blocks at the rear of the cave provides for passage of the head of the manipulator. The intercave barrier, above the concrete blocks, is a 2½-in.-thick steel plate removable by jib cranes. A tongue made of ½-in. steel plates outside of a 1½-in.-thick lead plate and attached to the steel barrier closes the opening in the block wall.

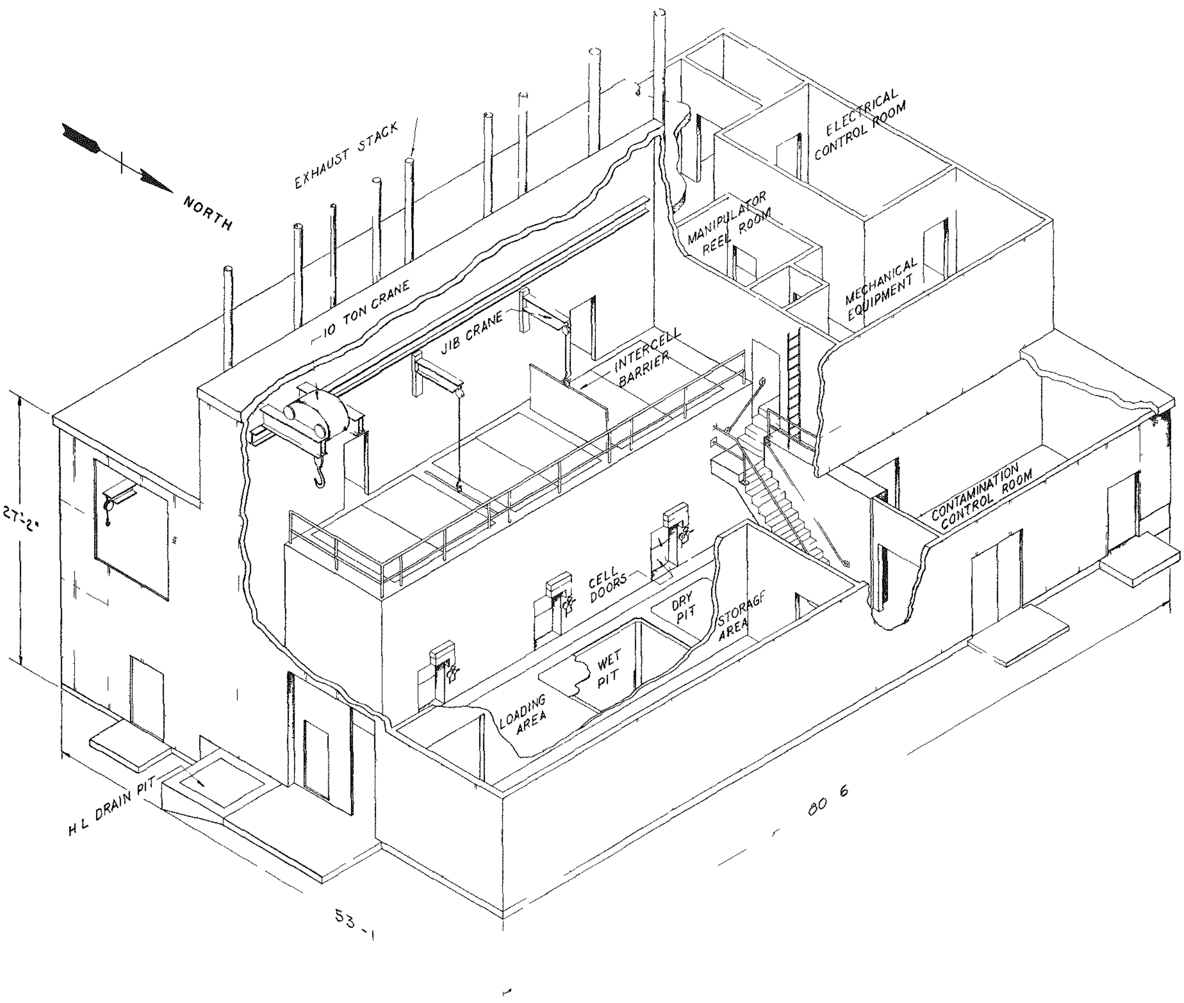

Fig. 53—Perspective of hot cells from loading area side, Main Technical Laboratory, building 773-A, Savannah River.

The elevation of the cave loading area is 2 ft 10 in. above the operating and cave structure floors, requiring a false floor within the caves. This floor is made up of four sections of ¼-in. smooth steel plate with a 2-in. angle lip around the perimeter and supported on steel horses.

Each cave is provided, in the loading area face, with a pneumatically operated vertical biparting door with a free opening, 36 by 60 in. Each leaf is 10-in.-thick steel. These access doors are operated from the loading area only, and, when closed, they are locked from the operating area. Indicating lights in both areas show the operating condition.

Below each window is a stepped steel high-density-concrete-filled breech block containing 28 holes for KAPL type control plugs (Fig. 56). Additionally, three KAPL type control plugs are provided beside each window and four in the space between the windows of each cave. A 10-in.-diameter hole with a stepped steel sleeve is provided beside the top of each cave window for the installation of optical equipment. A slot, 14 in. high by the length of the cave, is provided in the front wall of each cave for the installation of master-slave manipulators.

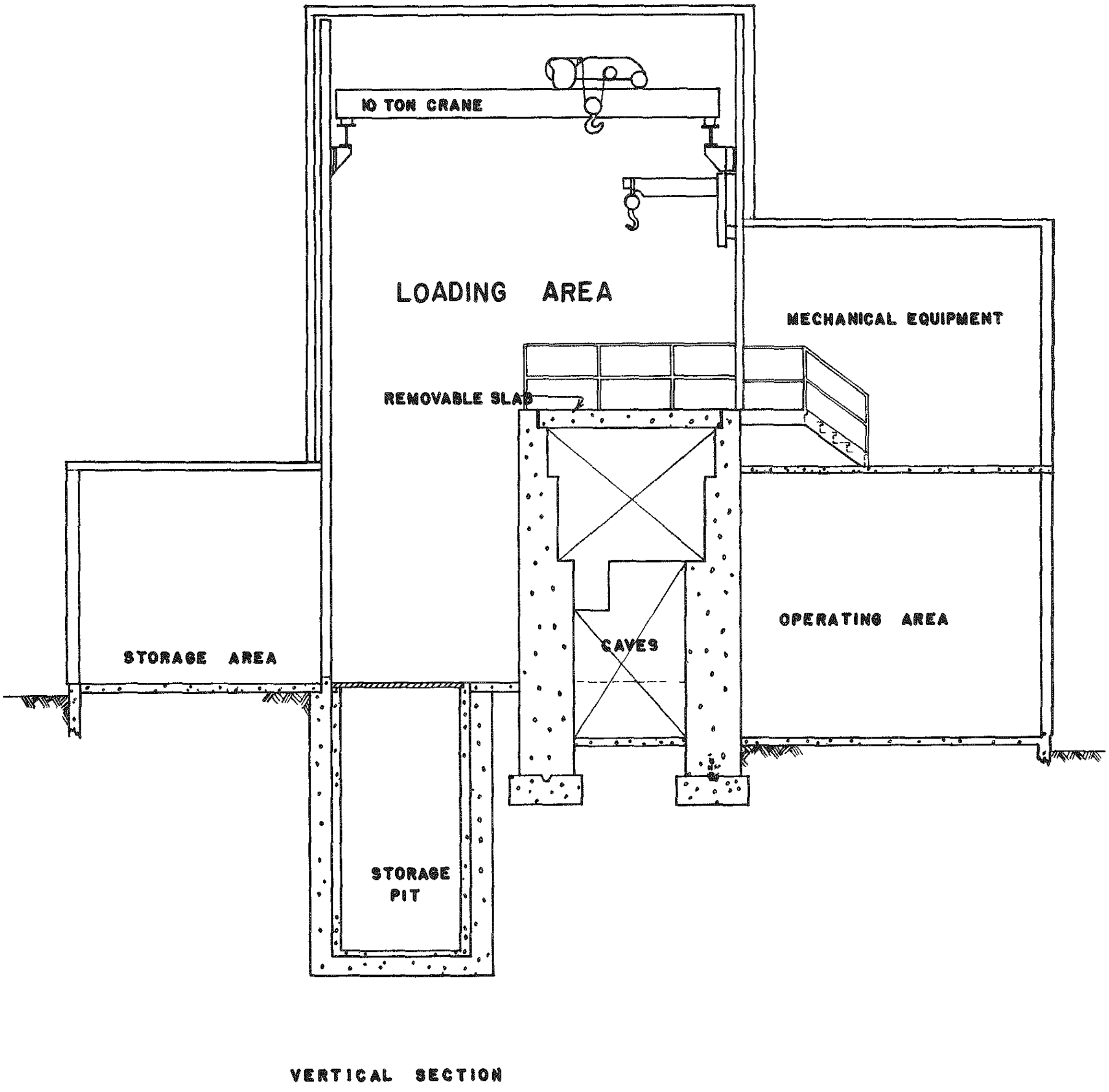

Fig. 54—Vertical section through hot-cell building, Main Technical Laboratory, building 773-A, Savannah River.

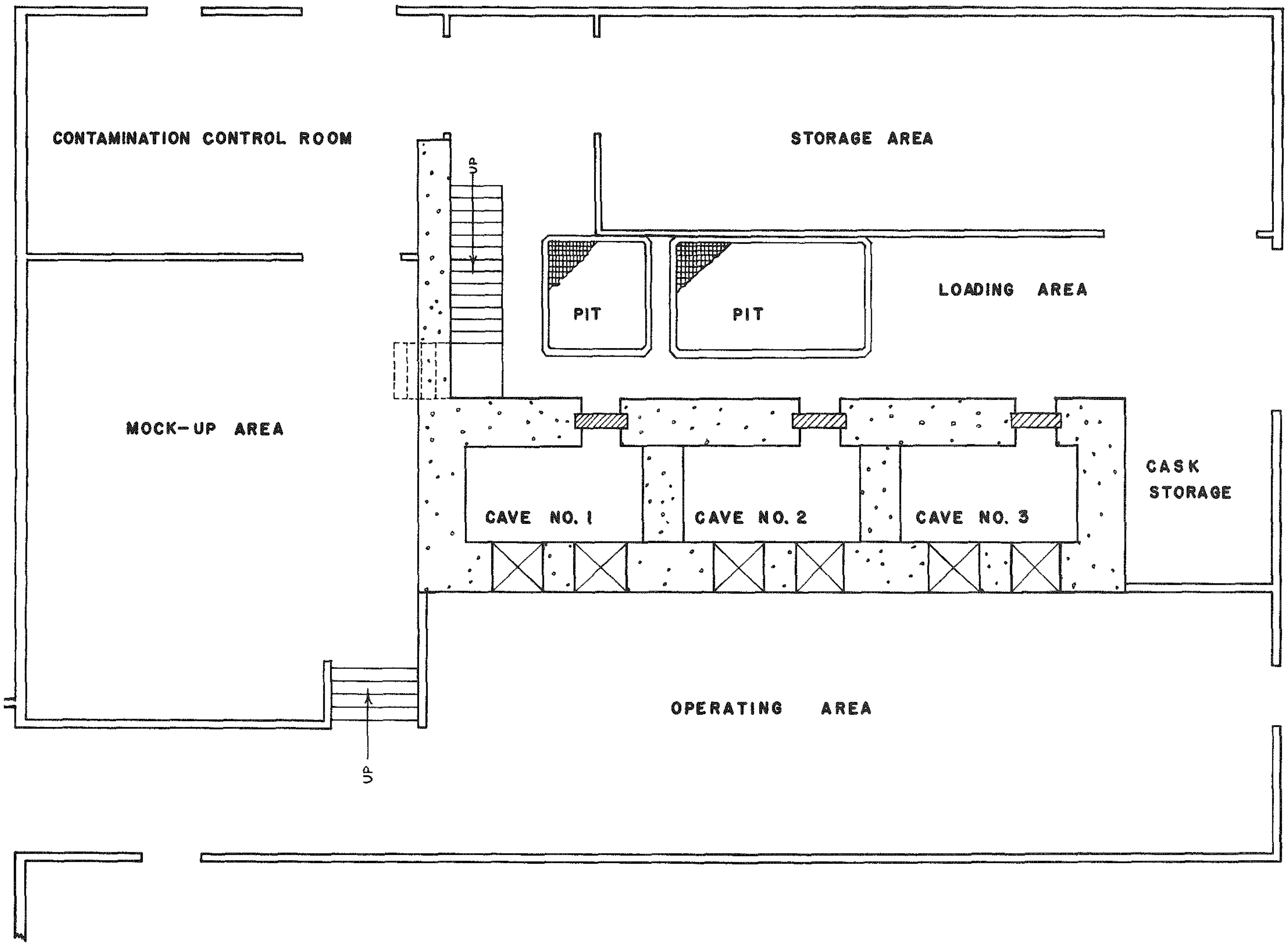

Fig. 55—First-floor plan of hot-cell building, Main Technical Laboratory, building 773-A, Savannah River.

The portion of the slot not occupied by the slave mounts is filled with removable concrete blocks encased in steel and having blocks with a 10-in.-diameter hole over each window and one in the center of the slot.

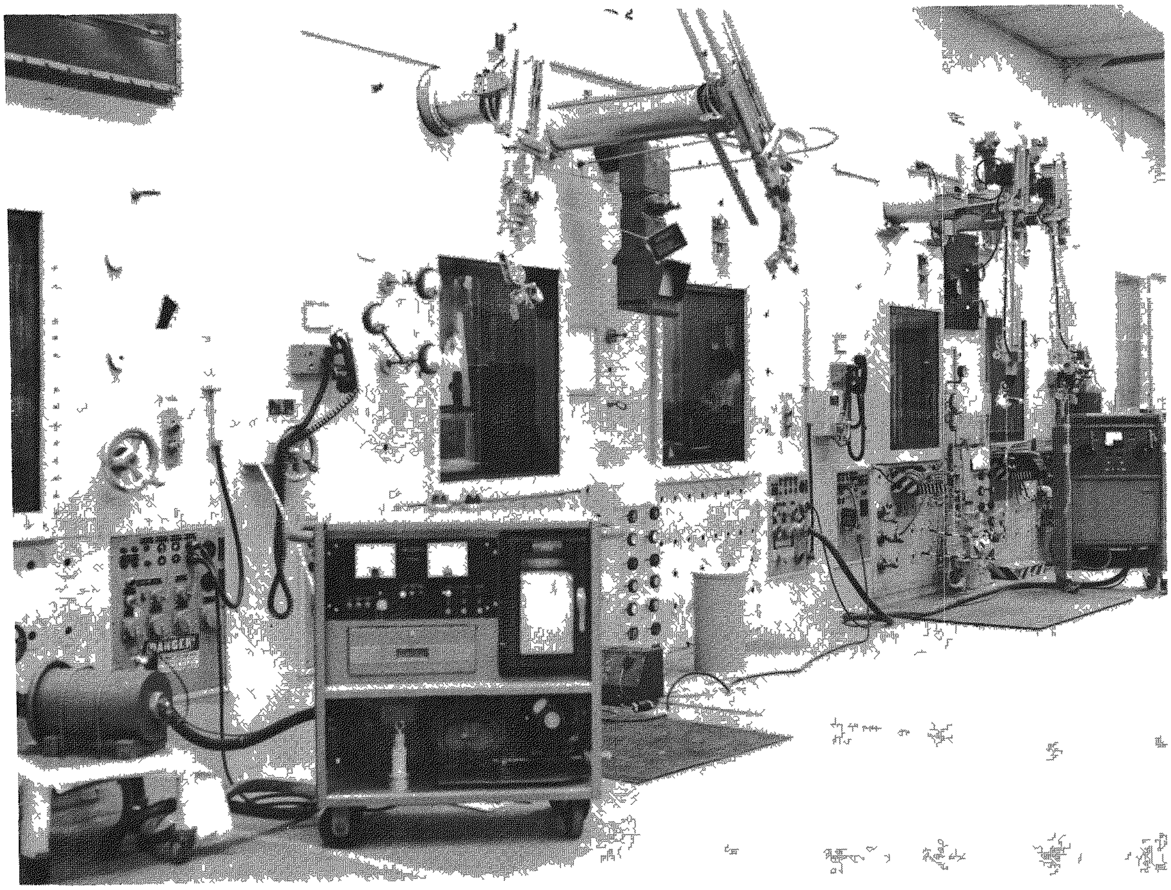

Fig. 56—Operating area for hot cells, Main Technical Laboratory, building 773-A, Savannah River.

The rear wall of each cave is provided with four KAPL plugs, two on each side of the steel doors. Additionally, an 11- to 10-in.-diameter tapered sample transfer port and a 12-in.-square port with a stepped steel frame are also provided in the rear wall.

A 4-ton jib crane is provided over each intercell steel barrier to withdraw these barriers. Clearance on these cranes is such that the barriers can be raised until the lowest point is at the level of the underside of the roof slabs.

A 10-ton bridge crane runs on rails above the caves and loading areas for handling sample casks, removing roof slabs, and introducing bulky or heavy equipment into the caves.

The caves are ventilated by means of independent downdraft systems. Two 500 cu ft/min fans exhaust the caves through filters and discharge through the roof. Only one unit per cave operates at any time, the spare unit being provided as insurance should the operating unit fail. Audible and visual alarms to signal equipment failure are provided in the operating area at the electrical control panels.

The following services are brought to the cave face for introduction into the caves through the KAPL plugs: clear water drain, process cold water, 15-lb compressed air, 90-lb compressed air, inert gas, burner gas, oxygen, steam, and electrical service—normal 120 volt, instrument 120 volt, 3-phase 208 volt, and instrument-control connectors.

10 Schenectady Operations Office: Knolls Atomic Power Laboratory

Irradiation Laboratory

Laboratory Building

The Irradiation Laboratory was built in two sections. The first section consists of reinforced-concrete footings, foundation walls, parapet walls, and floors, with framing of light industrial type structural steel. The siding is corrugated asbestos applied over $1\frac{1}{8}$-in. Cemesto insulation board. The roof deck is $2\frac{1}{2}$-in. precast concrete plank, insulated with 1-in. Cemesto board and covered with four-ply 15-lb felt. The exterior doors are mechanically operated 10- by 12-ft roll-up metal type and 3- by 7-ft steel panel. Windows are projection type industrial steel sash. The building dimensions are $59\frac{1}{3}$ ft wide, $73\frac{1}{2}$ ft long, and $21\frac{3}{4}$ ft high, single story, with a 22-ft 2-in. by $22\frac{1}{3}$-ft mezzanine floor supporting the ventilating equipment.

Building services consist of: (1) heating, steam from central plant circulated through unit heaters; (2) ventilating, heated fresh-air openings and equipment to supply 6000 cu ft/min and two exhaust systems with capacities of 4000 and 2000 cu ft/min through CWS filters; (3) lighting, industrial type fluorescent and incandescent; (4) fire protection, Gamewell automatic alarm system; and (5) other services, such as power, gases, water, compressed air, and sanitary and contaminated waste drains.

An extension was attached to the original building and completed in 1954. The dimensions are $79\frac{1}{3}$ ft long by 73 ft 1 in. wide by 24 ft 2 in. high, single story, with a mezzanine floor, $21\frac{2}{3}$ by 66 ft for supporting ventilating equipment. The type of construction and building services are the same as the original building.

High-level Double Cell 1 and 2. This cell is constructed of magnetite concrete (200 lb/cu ft), with walls 3 ft thick. It is a general-purpose high-level cell having two compartments separated by a wall and a movable 12-in. steel door. The work-area dimensions are 15 ft long, $6\frac{1}{2}$ ft wide, and 11 ft high, with a radiation lock, 6 ft long, $6\frac{1}{2}$ ft wide, and 11 ft high.

Very High Level Double Cell 3 and 4. This cell is constructed of 3-ft ferrophosphorus concrete walls (300 lb/cu ft) and has a two-compartment work area, 15 ft long, $6\frac{1}{2}$ ft wide, and 11 ft high. There is a radiation lock, 6 ft long, $6\frac{1}{2}$ ft wide, and 11 ft high for shielded access.

The work areas are separated by a wall and a 15-in. steel door that lowers into the floor on a hydraulic hoist.

Remote Metallography Cell 5. This cell has 9-in. steel walls and inside dimensions of 12 by 6 by 8 ft high. The internal working space of the cell is divided into three modules with $\frac{1}{4}$-in.-thick Plexiglass partitions with sliding doors (see Figs. 57 and 58).

Low-level Utility Cell 6. This cell is constructed of 9-in.-thick concrete and has inside dimensions of 10 ft long and 6 ft wide. There is no equipment permanently attached to this cell. Manipulators are attached as required and then removed for use in other cells. Direct viewing is provided through two zinc bromide windows.

Fuel-element Service Building, West Milton, N. Y.

Laboratory Building

The reactor servicing building, located at the KAPL West Milton, N. Y., site contains a hot cell referred to as the fuel-element service cell, which is used for processing the fuel elements used in the prototype of the power plant for the submarine *Seawolf.* The building structure consists of a reinforced-concrete substructure supporting a structural-steel frame with insulated corrugated asbestos siding. The building dimensions are 75 ft long, 69 ft wide and 45

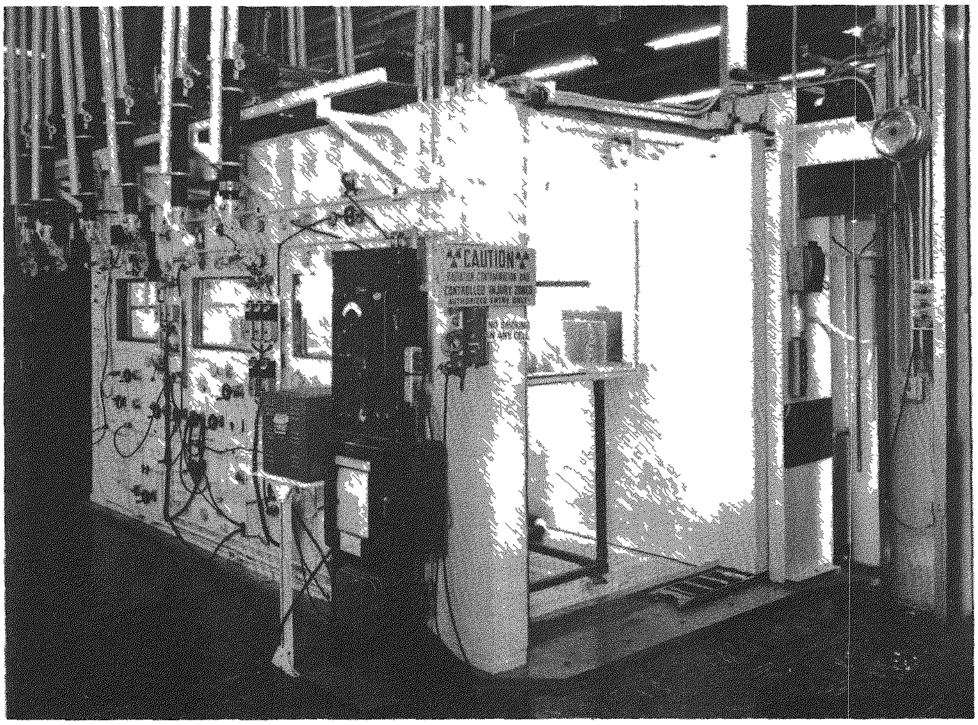

Fig. 57—Remote metallography cell No. 5, KAPL.

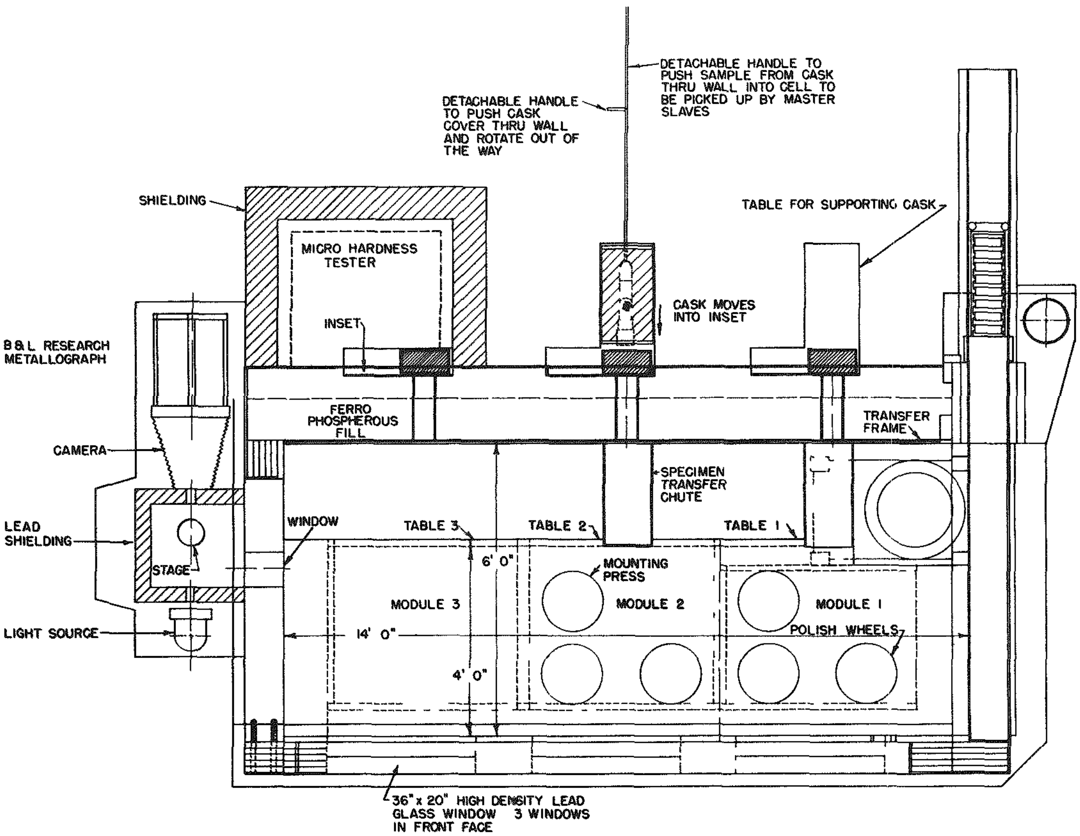

Fig. 58—Floor layout of remote metallography cell, KAPL.

ft high; the building consists of two basic sections, a basement work area and a main floor area housing the fuel-element service cell and supporting equipment.

The basement is divided by concrete walls into several areas: a general work area, a tunnel for underfloor access to the fuel-element service cell, a ventilation-equipment room, and a tank room for storage of radioactive liquids from the fuel-element service cell. The main floor contains the fuel-element service cell, an office area, a cleaning room, electrical-control panels, and a 30-ton bridge crane. Two 12- by 12-ft roll-up doors provide access for large equipment, and a pair of sliding doors provide access for the fuel transfer casts to the adjoining power plant building, housing the submarine prototype power plant. Building services consist of heat, light, power, water, compressed air and gases, and a ventilating and exhaust system.

Fuel-element Service Cell. The primary function of the fuel-element service cell is to service fuel assemblies of the S1G reactor (USS *Seawolf* prototype) and the S2G (USS *Seawolf*—SSN-575). This servicing consists in:

1. Removal of residual sodium by water or alcohol cleaning
2. Disassembly of fuel assemblies
3. Reassembly of fuel assemblies
4. Visual inspection of external surfaces, 80× magnification
5. Radiation distribution scanning
6. Leak detection
7. Radioactive-fuel storage and preparation for shipment

The maximum radiation level to be handled is 1,000,000 curies. The cell is U shaped. Walls are of 6-ft-thick high-density concrete, and the ceiling is 4-ft-thick high-density concrete. Cell internal dimensions are 15 ft wide, 17 ft high, and 37 ft long. The cell is divided into two sections known as the process cell and the decontamination cell. The process cell is 22 ft long and the decontamination cell is 15 ft long. The process cell contains the fuel-servicing equipment. The decontamination cell provides facilities for equipment decontamination plus storage for lighter (less than 8 ton) casks. Hydraulically operated shielding doors separate the process cell from the decontamination cell and separate the decontamination cell from the building proper.

Wall plugs provide for manipulator shifting and ceiling plugs provide for emergency grappling operations. Viewing into the cell is through eight zinc bromide windows and four periscopes in conjunction with a mirror system.

Floor drains are provided to drain decontaminating solutions to an underground tank. A hold-up tank in a basement cell receives high-level radioactive solutions from the fuel-assembly cleaning process.

A shielded tunnel underneath the cell provides for moving the heavy (12- to 30-ton) casks in which the radioactive fuel is transported. The tunnel also provides for storage of radioactive fuel in a storage tank.