AAEC/E 35

UNCLASSIFIED

AAEC/E 35
COPY NO.

AUSTRALIAN ATOMIC ENERGY COMMISSION

RESEARCH ESTABLISHMENT

LUCAS HEIGHTS

POST-IRRADIATION FACILITIES AT LUCAS HEIGHTS

by

D. R. EBELING

B. S. HICKMAN

Sydney, April, 1959.

UNCLASSIFIED

UNCLASSIFIED

AUSTRALIAN ATOMIC ENERGY COMMISSION

POST-IRRADIATION FACILITIES AT LUCAS HEIGHTS

by

D. R. Ebeling

and

B. S. Hickman

Abstract

The post irradiation facilities at present under construction at Lucas Heights are described, and the equipment which will be available; these facilities are discussed.

CONTENTS

1. INTRODUCTION

The utilisation of a high flux materials testing reactor such as HIFAR requires that adequate facilities be available for the post irradiation handling and examination of radioactive materials. This note describes the facilities which have been designed at Lucas Heights for this purpose and which are at present under construction. The facilities are intended to provide initially for carrying out all work likely to be encountered on the site involving activities greater than about 1–10 curies. Other work, particularly chemical and isotope handling below this level will be carried out in facilities elsewhere on the site.

Amongst operations which will have to be carried out in the facility are the following:–

(a) Dismantling and sectioning of in–pile loops and experimental assemblies, machining of test specimens, etc.

(b) Dispensing high activity isotopes.

(c) A wide variety of physical, metallurgical and chemical operations such as mechanical testing, metallography, fission product diffusion studies, etc.

The main requirements therefore were for a flexible design which could meet and keep pace with a constantly developing research programme and handle the high activities likely to be encountered. These facts dictated that the American practice of using concrete cells with large viewing windows and master slave manipulators must be followed. The alternative approach of lead shielded cells with tong and ball joint manipulators could not be considered as this approach is not suitable for development to high levels of activity and is rather inflexible in that the cells must be designed around fixed pieces of equipment.

2. GENERAL LAYOUT

The hot cells at Lucas Heights will be situated in an existing building adjacent to the reactor shell and connected to it by a vehicle air lock.

The general layout of the installation is shown in figure I. Initially an in–line arrangement of four cells is to be provided as follows:–

(1) A high level cell, fifteen feet by six feet, to handle up to 100,000 curies, for dismantling and sectioning in–pile loops and assemblies and for machining operations.

(2) A medium level cell, ten feet by six feet for physical and metallurgical testing.

(3) A medium level cell, eight feet by six feet for chemical work.

(4) A medium level cell for the preparation of metallographic specimens.

In addition, a small annexe is provided for a metallurgical microscope and an enclosed area is provided at the end of the line for servicing of the heavy duty manipulator.

The in–line arrangement was chosen for the following reasons:–

(a) It enables separation of the clean working face of the cells from the area at the rear of the cells which will become contaminated due to traffic of equipment into and out of the cells.

(b) By means of inter–cell doors a single heavy duty manipulator and crane can be used in all the cells.

(c) It is the most economical of space.

The area at the rear of the cells is completely enclosed and access to it is only obtained through the change rooms.

Some features of the design will now be considered in more detail.

3. DETAILS OF DESIGN

3.1 Shielding

Due to the lack of space in the building the cell walls had to be reduced in thickness to a minimum level compatable with cost. It was also considered desirable to have the walls as thin as possible in order to reduce the distance between the operator and his work. Both the cost of the concrete and the cost of shielding windows had to be considered together in this respect. Eventually a three feet thick wall of high density concrete using scrap steel punchings as aggregate was chosen. This concrete was developed in conjunction with Sydney University and has been discussed elsewhere. Densities of up to 350 lbs/cu.ft. have been obtained(1). The whole of the cell walls will be constructed of this material although initially the activities to be handled in the medium level cells will not require this amount of shielding. However, at a later date the cells could all be converted to high activities by simply changing the windows.

3.2 Windows

For the high level cell, all lead glass windows which match the shielding of the wall will be used. These will consist of two six inch thick blocks of 3.3 density stabilised glass on the inner side and four six inch thick blocks of 4.08 density glass.

In the medium level cells, combination lead glass zinc bromide windows will be used. These are cheaper than all lead glass windows and have better light transmission characteristics. They will consist of a four inch block of stabilised glass on the inner side, a bonded plastic tank with two glass sides containing the zinc bromide and a four inch block of 4.08 density on the outer side.

3.3 Manipulators

Most of the operations in the cells will be carried out with master slave manipulators. A pair of these will be associated with each window. A model developed from the Argonne type 8 will be used which has independent slave arm indexing parallel to and at right angles to the cell wall. Due to the limited capacity of these units they will be supplemented by a single heavy duty General Mills manipulator and a 3 ton crane. By means of intercell doors these can be moved from cell to cell as required.

3.4 Cell Access

The in–pile assemblies will be brought from the reactor in a shielded flask and lowered onto a trolley in a pit at the end of the cell block. The trolley is then run under the end wall into the first cell and then raised and placed on the working bench using a 2 ton hoist permanently situated at the end of the cell.

Equipment for use in the cells will generally be set up and tested on trolleys outside the cell and then run into cells through the rear access doors. These doors will also be used for personnel access for decontamination maintenance, etc. Posting ports are provided in these doors for transfer of small items into and out of the cells.

3.5 Ventilation

A total of approximately 6,000 c.f.m. of air is drawn through dust filters into the change rooms and dirty area and then through a second bank of dust filters into the top of the cells. The air is then extracted through a coarse filter under the cell windows through an absolute filter in the cell floor (designed for remote changing), through a bank of absolute filters in the fan room and finally discharged through a stack. A small propellor fan operated from batteries will maintain a reduced flow in the event of failure of the main fans.

The flow pattern and pressure drops are controlled to minimise the spread of contamination, i.e., the flow is from the clean to the dirty areas and the greatest reduced pressure (about 0.5 ins. w.g.) is in the cells themselves. This, together with the fact that most of the openings in the cell walls are sealed as well as possible, should prevent the escape of activity into the clean operating area. It is also hoped that large flow through the cells (about one air change per minute) will sweep radioactive dust into the filters as it is produced thus minimising contamination of the cell itself.

3.6 Services

The following services are provided in each cell terminating on the rear wall:-

(a) Three phase and single phase power.

(b) 100 p.s.i. air.

(c) 1500 p.s.i. hydraulics.

These are all controlled by valves and switches on the operating face.

Lighting is by banks of sodium vapour lights (1400 watts in the large cell and 800 watts in the others, supplemented by incandescent lighting in plugs in the cell roof).

High level radiation monitors are mounted above the cell doors for reading the general level of radiation. These are interlocked with the access doors to prevent inadvertent opening if the level is too high. A portable monitoring head on a flexible lead is provided to assist with cell decontamination.

Carbon dioxide fire fighting equipment is built into each cell. On pressing the fire alarm button the inlet dampers on the ventilation ducts automatically close and the cells are blanketed with CO_2 from nozzles in the roof.

Removable plugs are situated around each of the windows for installation of through wall drives to machines, etc., and provision of additional services should they be required.

Storage wells are provided in the floor of cells No. 1 and No. 3 for active storage of irradiated samples. A deep well is also provided in cell No. 1 for storage of a complete irradiation assembly.

3.7 Ancillary Buildings

As mentioned earlier, a change room block is to be built adjacent to the dirty area. This will contain a clean change area and two active change rooms for access to the rear of cell area. One of these active change rooms is for use with pressurised PVC suits. Three hose reels and a suitable oil free compressed air line are provided for use with these suits. The change room block also contains a small workshop for operations on contaminated equipment and an office from which the operation of the PVC suits can be controlled. This office also contains the main switchboards and monitor station for the cell area.

4. EQUIPMENT

In general due to the versatile nature of the facility it is intended that as far as possible standard equipment will be used in the cells with little modification. The practice will be to mount and test equipment on trolleys outside the cells. After use the equipment will be partially decontaminated and then removed and stored until required again. In some cases where equipment is in continuous use inside the cells, specially designed units may be used and installed semi-permanently. Wherever possible use will be made of pneumatics and hydraulics for operating machines, etc.

Amongst equipment which has been designed or purchased for the cells is the following:-

4.1 Cutting and Machining Equipment

For rough cutting operations such as separation of rigs from shielding plugs, cutting up scrap for disposal, etc., a mechanical saw which can be handled by the heavy duty manipulator will be used.

For semi-precise operations such as cutting open fuel cans, etc., a simple milling machine which can also be used as a lathe will be used.

At a later date it is intended to provide a small precision lathe for machining of test specimens.

A high speed liquid cooled slitting wheel will be used for cutting off specimens for metallographic examination.

Provision will be made for piercing and taking gas samples from fuel element cans.

4.2 Macro-Examination

A Bausch and Lomb through wall stereo-binocular microscope will be installed in Cell No. 2 for macro examination. This unit has been specially designed for hot cell work and will give magnifications of 0.5 to 30. Stabilised glass is used on the active side of the unit.

A closed circuit television unit with remote controlled focus and objective turret will be used to assist general viewing in the cells during such operations as machining, grinding and polishing, etc.

Standard 7 x 30 binoculars modified for close up viewing will be used to give magnified images through the cell windows.

4.3 Metrology

A unit is being designed using slip gauges and dial gauges for dimensional measurements to an accuracy of $\pm$0.0001''. A standard automatic single pan balance will be used for weight and density measurements.

4.4 Mechanical Testing

An Amsler hydraulic 1000 Kg. tensile and compression testing machine has been ordered. The pulling head will be inside the cells with the control unit, dynamometer, etc., and a second pulling head for control specimens outside the cells. An extensometer based on the use of differential transformers is being developed for use with this machine.

4.5 Physical Measurements

4.5.1 Stored Energy. A rig based on the Sykes method (2) is being developed for the measurements of stored energy of irradiated materials. This uses samples ¼" dia. and ¾" long.

4.5.2 Electrical Resistivity. An A.C. bridge circuit capable of measuring down to 10^{-9} microvolts is being constructed for electrical resistivity measurements.

4.5.3 Thermal Conductivity. Provision will be made for measurement of thermal conductivity.

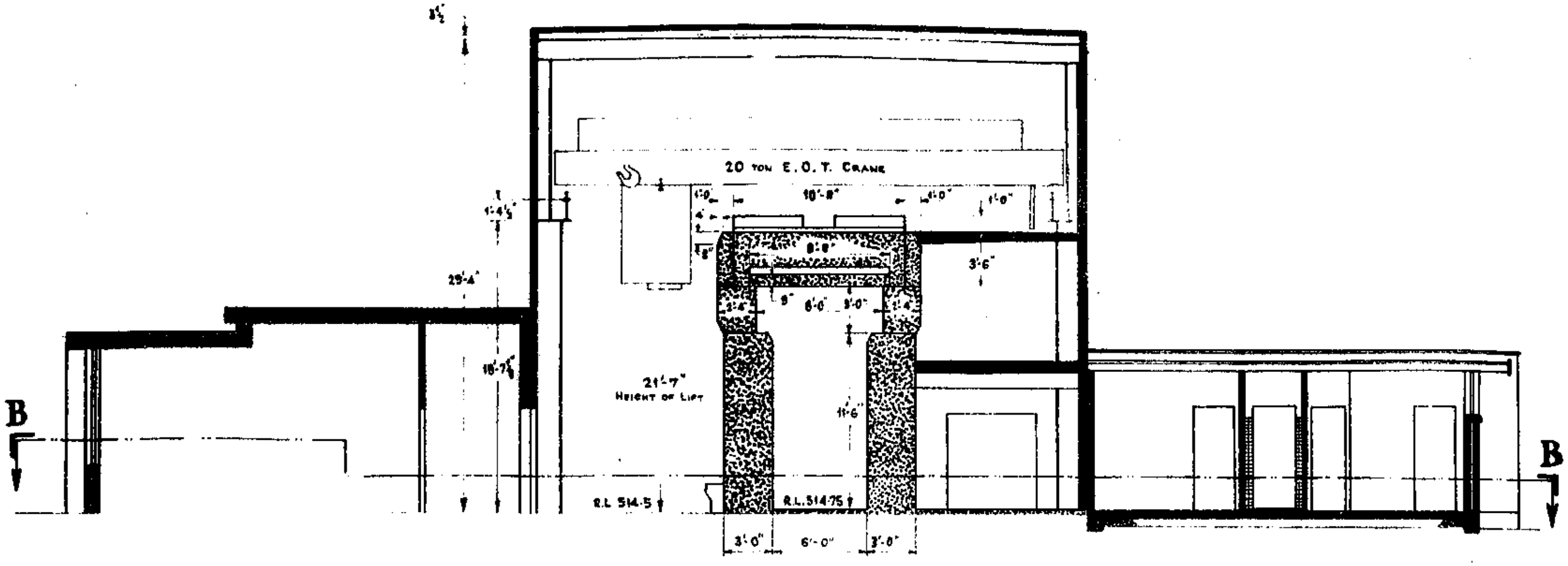
4.6 Metallography

Specimens will be mounted in a cold setting resin. Vibration polishing techniques (3) are being investigated using impregnated polythene for the grinding stages and impregnated wax laps for polishing. This technique is particularly suitable for hot cell work due to its simplicity. Vacuum cathodic etching as well as standard etching facilities will be available. An ultrasonic cleaning bath will be used for cleaning specimens during polishing and after etching.

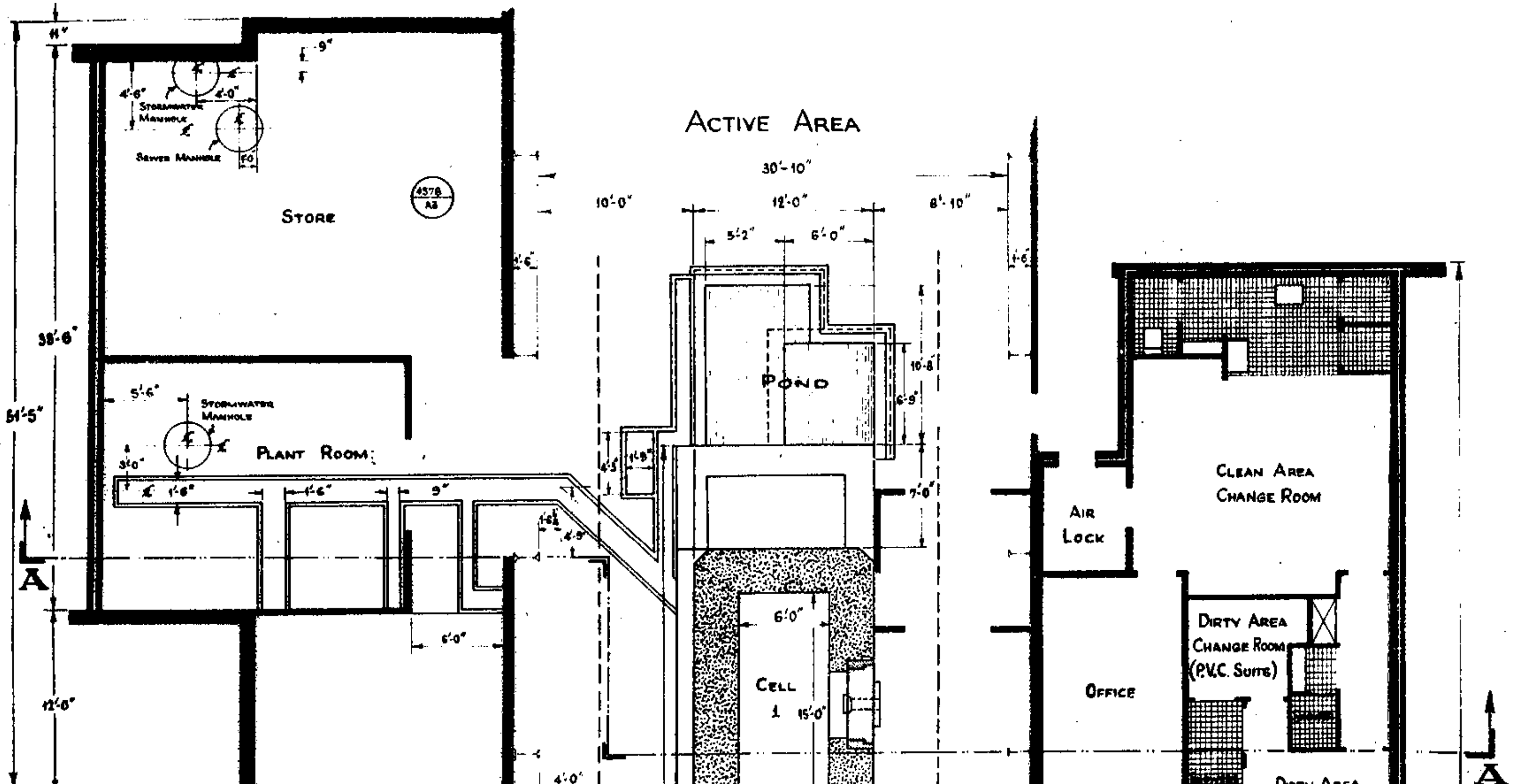
A Reichert inverted stage metallograph modified for remote operation will be used for final examination. This will be situated in a small lead shielded cell adjacent to cell No. 4. The light source and the eyepieces and photographic equipment are situated outside the shielded enclosure. Provision is made for remote operation of the stage movements, objective changing, filters, etc. The unit is fitted with polarised light, phase contrast and micro-hardness equipment. A limited range of stabilised objective lens in addition to the standard lens has been purchased for use with highly active samples.

5. REFERENCES

1. D.R. Ebeling, AAEC/E 11 (1958)
2. R.L. Carter, NAA-SR-288 (1953)
3. E.L. Long, R.J. Gray, ORNL.2494 (1958)


20 TON E.O.T. CRANE
21'-7"
HEIGHT OF LIFT
R.L. 514·5
R.L. 514·75
B
B

SECTION A A


ACTIVE AREA
STORE
SEWER MANHOLE
STORMWATER MANHOLE
PLANT ROOM
POND
CELL
AIR LOCK
OFFICE
CLEAN AREA CHANGE ROOM
DIRTY AREA CHANGE ROOM (P.V.C. SUITS)
30'-10"
12'-0"
10'-0"
8'-10"
39'-6"
51'-5"
12'-6"
A
A

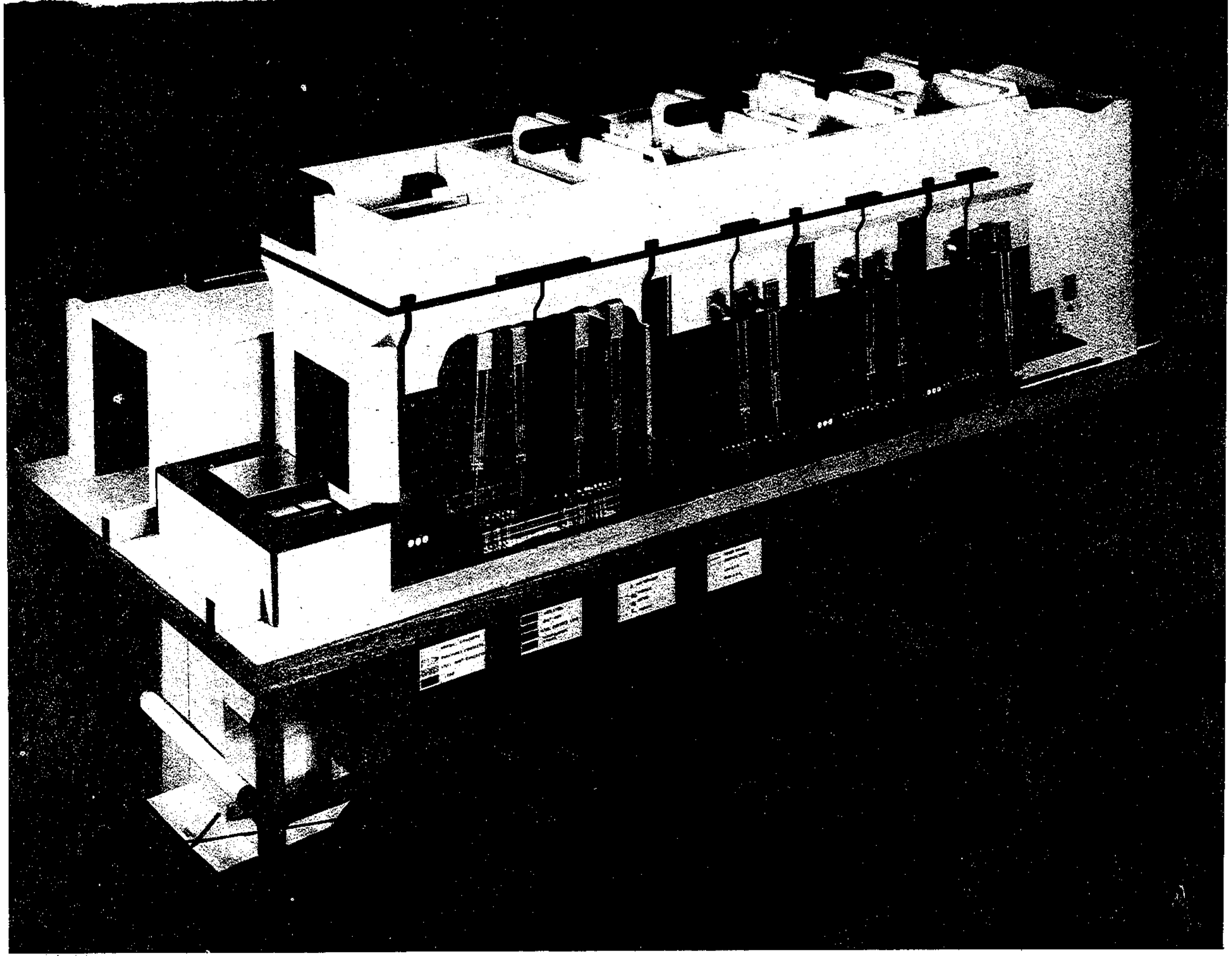


Figure 2. View of front face of model of cells.