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CAPABILITIES AND APPLICATION OF EXISTING  
HOT CELLS AT THE  
HANFORD ENGINEERING DEVELOPMENT LABORATORY

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ABSTRACT

The Hanford Engineering Development Laboratory operates two hot cell facilities, the Postirradiation Testing Laboratory, and the Shielded Materials Facility. The hot cell facilities provide a wide range of capabilities for postirradiation examination and testing of irradiated reactor fuels and structural materials to evaluate irradiation tests and determine failure mechanisms and effects of irradiation on physical and mechanical properties of reactor core components. Current functions performed include non-destructive examinations, destructive examinations, fabrication of test specimens from reactor core components, fabrication of reactor test assemblies containing irradiated fuel pins or structural material samples, and shipping and receiving radioactive materials.

INTRODUCTION

The Hanford Engineering Development Laboratory operates hot cell facilities in the Hanford 300 Area laboratory complex near Richland, Washington, which support primarily the U.S. fast breeder reactor fuels and materials development programs. The facilities offer a wide range of capabilities encompassing irradiated fuel pin nondestructive and destructive examinations, structural materials testing and remote machining, and fabrication of irradiation test assemblies containing irradiated components. These functions are distributed between two major facilities, the Postirradiation Testing Laboratory (PTL) in 327 Building, and the Shielded Materials Facility (SMF) in the 324 Building, based on separating operations that create particulate contamination from those that remain relatively clean. One other complex of small hot cells, the 325 Building B cells, is used primarily for chemical and analytical support to fuel examination and reactor flux dosimetry. These hot cells provide capability for burnup, fission gas, cladding, and other specialized chemical analyses.

POSTIRRADIATION TESTING LABORATORY, FIGURES 1 AND 2

The 327 Building PTL was activated in 1953 and expanded in 1955 and 1968 to provide a total of ten separate, alpha-qualified cells. Constructed of modular steel wall sections ranging from 27 cm to 46 cm in thickness, the smaller cells can accommodate approximately  $3 \times 10^3$  Ci and the larger cells  $5 \times 10^5$  Ci of mixed fission products and irradiated cladding or structural metals. The free standing hot cell configuration and cell access via removable interchangeable

plugs together with plug mounted equipment provide a high degree of versatility for adapting cell functions to changing program requirements. Successful adaptation of the facility from handling 25 cm (10 in.) long metal slug fuel forms to current capability to handle 2.44 m (8 ft.) long FFTF fuel pins attests to this versatility.

The size and current utilization of each of the cells in the PTL is as follows:

- A Cell - 6' x 10' x 8' high - Used for visual examination, sectioning and cutting, and packaging and accumulation of high level waste for transfer from the facility.
- B Cell - 4' x 6' x 5' high - Used for structural materials postirradiation testing including preliminary preparation for transmission electron microscopy; immersion density determination on cladding and structural samples.
- C Cell - 4' x 6' x 5' high - Used for fuel metallography, including preparation and examination on a remotized Bausch and Lomb metallograph and precision core sampling of fuel sections.
- D Cell - 4' x 6' x 5' high - Used for fuel cladding transient testing (FCTT), reflecting capability for rapid RF heating, gas pressurization, remote extensometry, in-cell welding, and macrophotography.
- E Cell - Identical in size and metallography capability to C cell.
- F Cell - 5' x 8' x 8' high - Used for precision sample forming, recovery of samples from test capsules, extraction of fuel from cladding reflecting application of remote lathe and milling machine operation. Procedures for controlled removal and disposal of NaK and Na from test capsules are employed.

- G Cell - 5' x 12' x 8' high - Used for complex experiments on response of irradiated fuel to rapid thermal transients. Equipment including special high temperature furnace, gas sampling system and on-line mass spectrometer can be serviced by walk-in personnel access when irradiated specimens have been removed.
- H and I Cells - both 4' x 6' x 5' high - Used for physical and mechanical properties testing of irradiated structural materials. H cell also contains equipment to assemble irradiated, pre-formed, structural materials test specimens in sodium-filled subcapsules and make capsule weld closures. Several subcapsules make up an irradiation test capsule which is assembled in the Shielded Materials Facility.
- SERF Cell - 6' x 12' x 8' high - Used for fuel pin precision sectioning (pin length capacity to 98"), fission gas collection, metallographic preparation and examination on a Leitz remote metallograph, and microhardness testing under inert nitrogen atmosphere.
- An auxiliary cell provides vacuum sputtering capability to prepare specimens for electron microprobe examination.

Water storage basins and dry storage facilities provide capacity for 445 sectioned breeder reactor fuel pins plus 7.1 kg fissile loading of small specimens with undefined geometry. Loading/unloading trucks for on-site transfers and in-facility transfers between hot cells and storage facilities are made in casks moved by either of two overhead bridge cranes in PTL.

SHIELDED MATERIALS FACILITY, FIGURES 3 AND 4

The Shielded Materials Facility (SMF), completed in 1966, was originally designed for remote fuel refabrication in conjunction with the Pu recycle demonstration program. Shielding consists of 1.22 m (4 ft.) thick concrete in a monolithic, interconnected configuration typical of most recently constructed hot cells. Currently the 4.88 m (16 ft.) x 6.1 m (20 ft.) x 5.49 m (18 ft.) high Airlock cell handles all loading/unloading of off-site shipping casks and containers, plus staging out transfers between the SMF and PTL facilities. It also connects the South and East cells which have shield doors to allow access to each operating cell from the airlock.

The East cell of SMF, 4.88 m (16 ft.) x 7 m (23 ft.) x 5.49 m (18 ft.) high is used for fuel pin nondestructive examination (NDE) and remote assembly and welding of irradiation test assemblies containing irradiated fuel pins or structural material samples. NDE systems are currently being upgraded to extend length capability to the 2.39 m (94 in.) FFTF pin. An in-cell storage facility with capacity for 100 breeder reactor fuel pins is located in East cell.

Modification of South cell in SMF, 4.88 m (16 ft.) x 15.24 m (50 ft.) x 5.49 m (18 ft.) high, was completed in 1977 to consolidate a wide range of structural materials testing capabilities at one location. Utilities and services that can accommodate several types of test units were installed at each operating station to provide maximum versatility as testing requirements vary. A removable section of shielding in the ceiling of South cell permits access for equipment items too large to pass through the Airlock and South cell access doors.

The ceiling access has been used to install/remove a 500,000 pound capacity materials test machine to obtain data from massive pressure vessel specimens.

SMF can store 145 intact breeder reactor fuel pins, and additional storage capacity for 300 pins will be in place in the near future.

#### CAPABILITIES

The current hot cell facilities efforts are primarily in support of Department of Energy Breeder Reactor and Reactor Safety programs and provide a wide range of postirradiation examination (PIE) and testing capabilities to provide data to assist scientists and engineers from many disciplines in evaluating reactor core components and structural materials. A major upgrading to meet the PIE requirements for initial Fast Flux Test Facility characterization, irradiation tests, and surveillance is nearly complete. It is expected that most of the effort for the next several years will be PIE of components irradiated in FFTF.

#### Nondestructive Examination

NDE covers gross and precision gamma scanning, profilometry using a contact (LVDT) measure head, full length plus rotational scanning, encircling coil and point coil eddy current scanning, and a nuclear periscope combined with a gridded photo board providing pin translation and rotation for visual examination and photography. NDE examination techniques provide a rapid and economical way to gather large quantities of data on irradiated material including gross external condition, bowing, changes in location and condition of

internal components, swelling, and fission product migration and distribution. A modification to the 300 Area TRIGA reactor facility currently under construction will provide neutron radiography capability for irradiated components from FFTF and enhance existing NDE capability.

#### Destructive Examination

Destructive examination (DE) capability includes fission product gas collection and analysis, sectioning, burnup analysis, metallography and ceramography, preparation of samples for electron microprobe analysis, replication for electron microscopy, and preparation of thin specimens for transmission electron microscopy. DE provides data to characterize microstructural changes induced by irradiation and/or testing, study fuel/cladding interactions, determine thermal performance for fuel and structural materials, characterize porosity, and locate fuel or fission product migration.

#### Remote Fabrication

Remote fabrication includes sample forming, fuel pin modification, assembly of components, Na and NaK filling, welding, inspection, and qualification. Structural material test specimens are formed from irradiated reactor core components, and irradiated fuel pins are modified for special tests and/or further irradiation. Fuel and structural irradiation tests containing irradiated specimens are assembled and qualified for in-reactor service/testing. Specimens are fabricated from irradiated fuel pin cladding for simulated reactor transient tests.

This capability permits interim examination, reassembly and further irradiation of internals and specimens from reactor test assemblies, and the ability to assemble irradiation tests containing irradiated components such as TREAT assemblies and preformed structural materials test specimens. Data is provided on physical and mechanical properties of reactor core components after service and continuity are maintained in data from long term tests requiring several reactor cycles.

#### Physical and Mechanical Properties Tests

Physical and mechanical properties testing capability includes density determination, tensile testing at ambient and elevated (to 1000°C) temperature, stress rupture, creep, and fracture mechanisms and failure propagation.

#### Shipping and Receiving Radioactive Materials

Radioactive materials are packaged for shipment, a file of shipping containers maintained, transportation arrangements are made, and procedures and certifications are maintained and upgraded to meet regulatory requirements to provide capability to transport irradiated/contaminated components between facilities on- and off-site for examination, testing, storage, or disposal. Other organizations are assisted in planning radioactive material shipments, and technical expertise is provided for planning shipping containers and packaging systems.

# POSTIRRADIATION TESTING LABORATORY

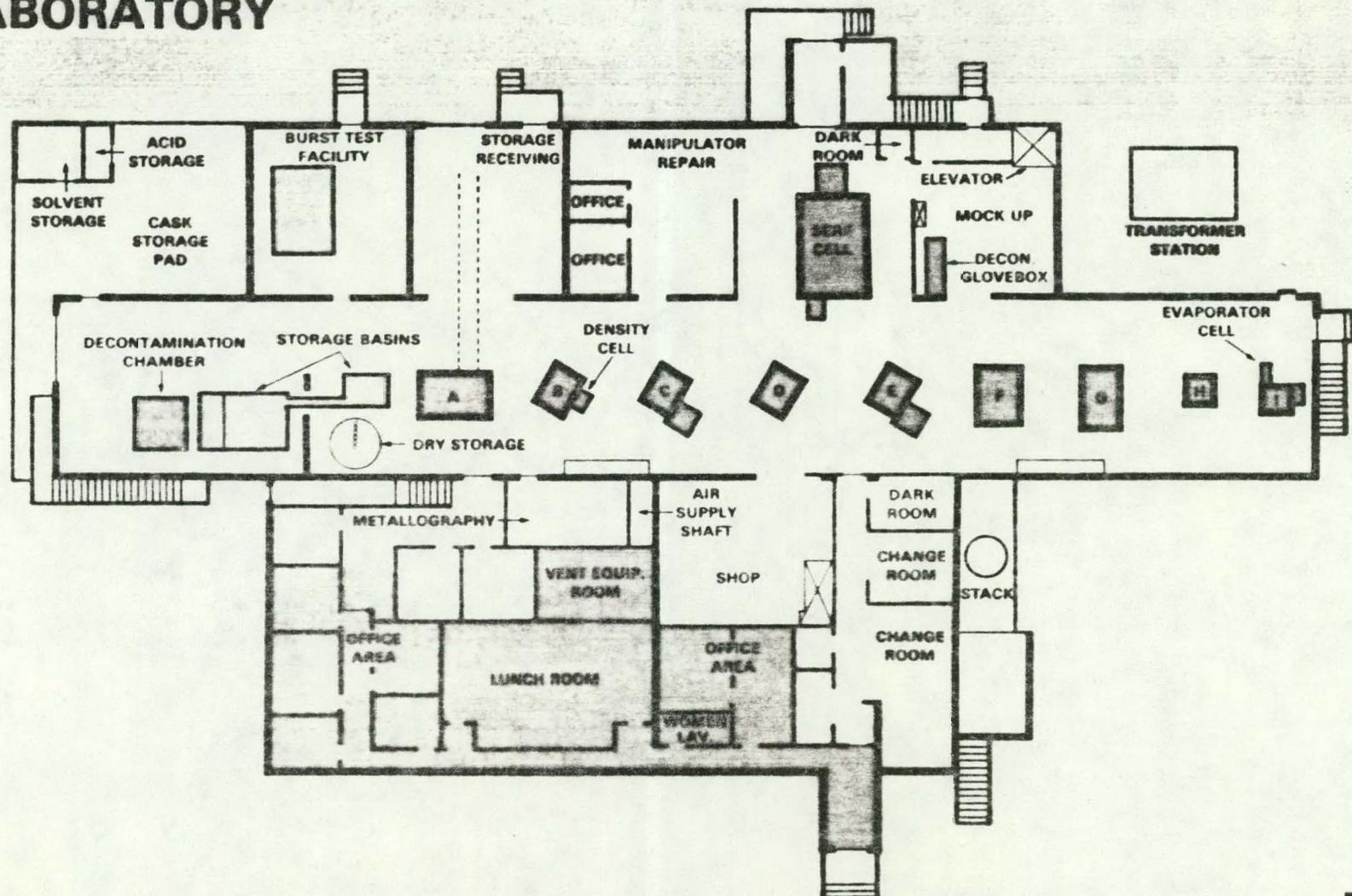


Figure I - POSTIRRADIATION TESTING LABORATORY FLOOR PLAN

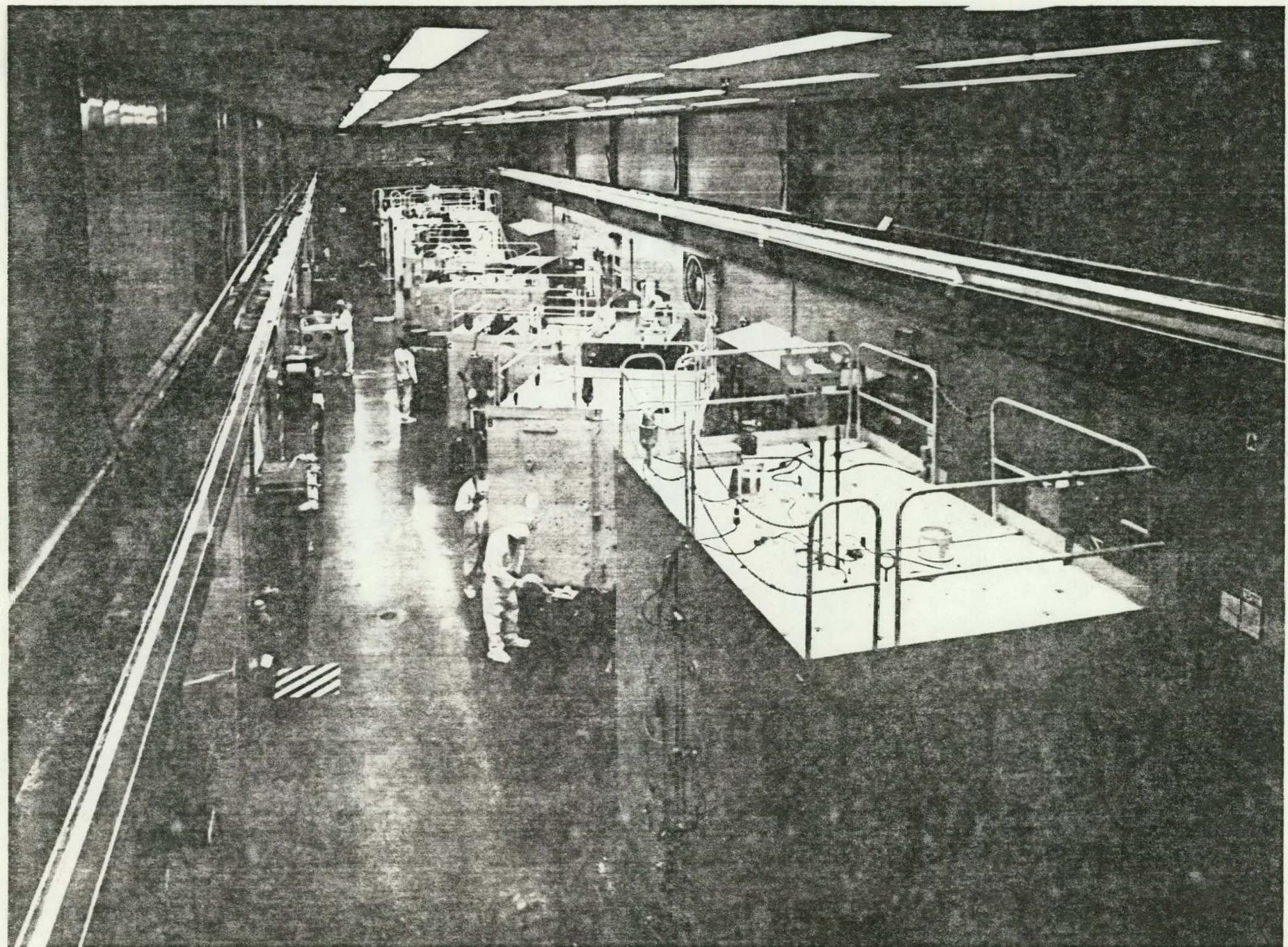
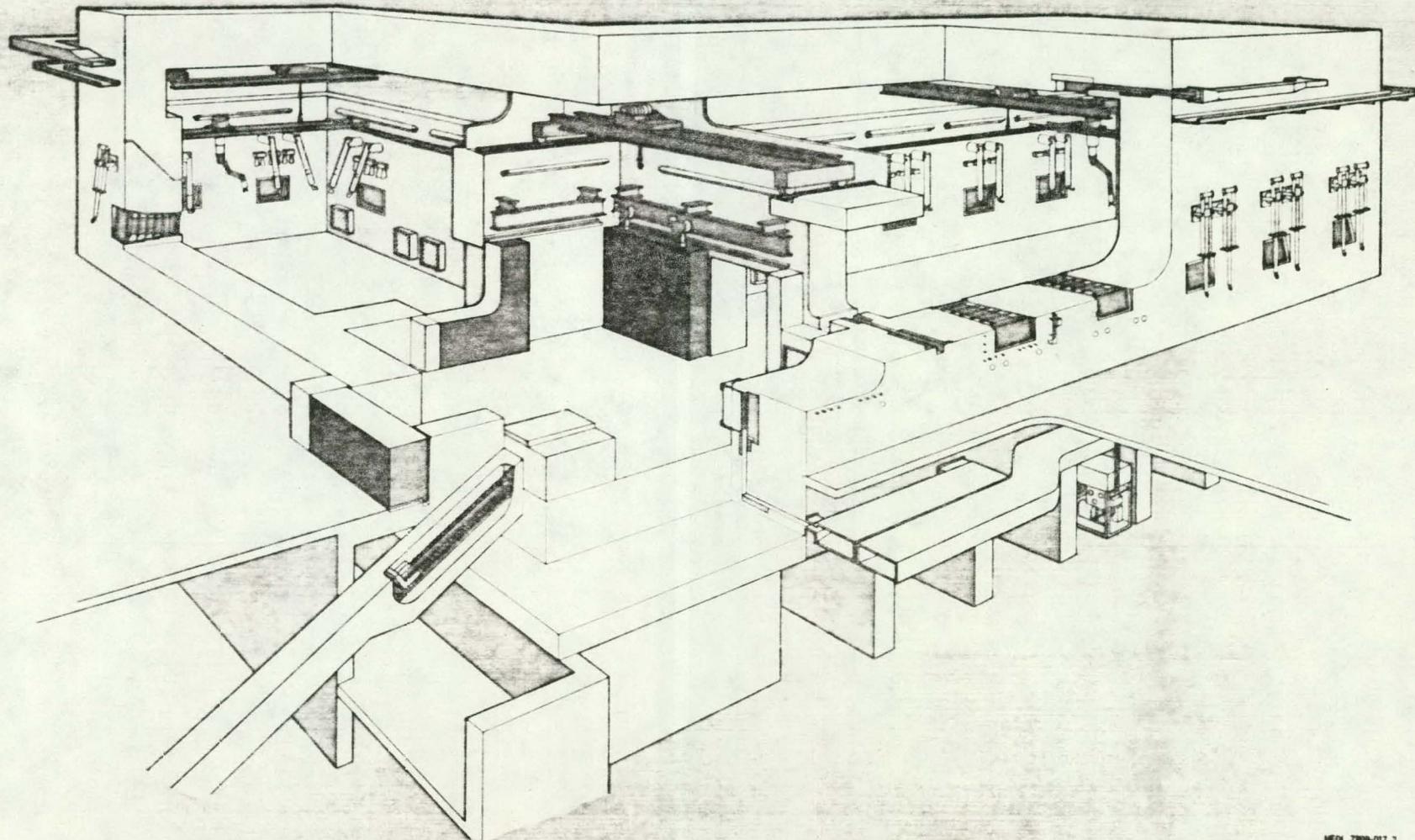


Figure II - POSTIRRADIATION TESTING HOT CELLS

## SHIELDED MATERIALS FACILITY



HEOL 7809-017.2

Figure III - SHIELDED MATERIALS FACILITY SCHEMATIC

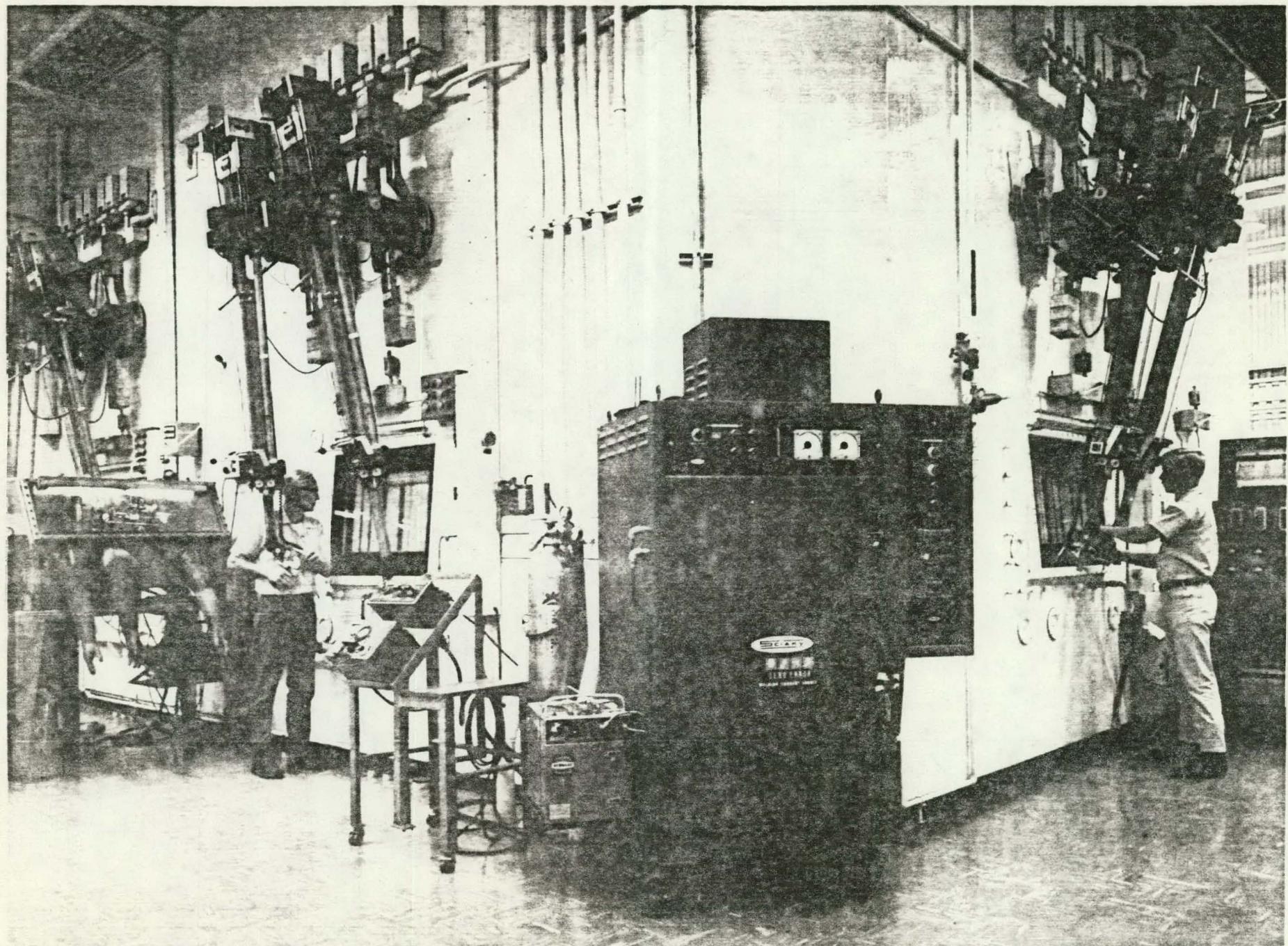


Figure IV - SHIELDED MATERIALS FACILITY EAST CELL