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A GENERAL PURPOSE ALPHA-GAMMA
HOT LABORATORY

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A GENERAL PURPOSE ALPHA-GAMMA HOT LABORATORY

Introduction

This design is based on the philosophy that cell areas can be entered after proper decontamination for maintenance and other purposes. The Oak Ridge National Laboratory has some research programs which indicate an alternate philosophy of no planned personnel entry and maximum containment of radioactive materials by limiting the doors and entrances to the cell area. This latter philosophy requires a higher degree of remote maintenance and design of equipment with easily removable component units.

The intent of this report is to design a general purpose hot cell bank that embodies the maximum permissible safety for operating personnel handling source material containing air-borne alpha-gamma emitters. This cell bank is to be designed to meet the following criteria and to be housed in a structure both economical to construct and maintain.

1. A negative pressure must be maintained at all times within the cell bank. This is normally a maximum of 2 1/2 inches of water.
2. Air leaks into and from the cell bank must be kept to an absolute minimum. Care must be taken to minimize air flow in manipulator and periscope sleeves.
3. An air lock must be maintained during material-equipment transfer into and out of the cell bank.
4. An air lock must be maintained during the entry and exit of personnel.
5. Decontamination must be a continuing operation each time a personnel door on the semi-hot side is opened, each time the manipulator is removed from its sleeve, and whenever source material, equipment, or waste is removed from the cell bank.
6. A method of safely maintaining a minimum of manipulation for clearing each cell of source material in case of an emergency must be provided.
7. Access must be provided into the air locked cell bank for source material contained in all types of carriers. These consist of top loading, side loading, and bottom loading types of various sizes and shapes.
8. A safe and economical method shall be provided for removing solid radioactive waste from the work cells in this cell bank.

Figure I shows the plan of a general purpose, self-contained Alpha-Gamma Hot Laboratory specifically designed for use as an in-pile loop segmenting and analytical facility. The central portion of this laboratory is composed of an in-line cell bank with its cold operating and semi-hot charging areas separated from each other by the cell bank and a concrete block partition wall. The cell bank consists of a 6' x 10' analytical cell, a 10' x 18' segmenting cell, a 12' x 20' cell for maintenance of inter-cell bridge cranes and/or G.M. electric arms, and an 18' x 18' dual purpose cell. This large cell is not only utilized for permanent dry storage of hot wastes but contains the all-important hot material and equipment access ports for introducing the in-pile loop and other large radioactive sources into the cell bank. In the designing of a high level alpha-gamma hot laboratory, there are two problems that must be recognized, faced and solved. The first of these is the problem of the safe introduction and removal of the alpha-gamma source; be it an in-pile loop in a side loading shielded coffin, reactor fuel elements in a top loading shielded carrier, or reactor slugs in a bottom loading shielded carrier. And, while introducing and removing this infinite variety of alpha-gamma sources, an air lock into the cell bank must be maintained. The second problem is that of positive maintenance of the minimum remotely-controlled manipulation necessary to handle the source material within each activated cell. For it is imperative at all times to be able to shield the source material so that personnel may enter the cell if necessary. And during this emergency maintenance of manipulation the air lock must be maintained and the maintenance crew must be shielded from all exposed radioactive sources.

In this particular facility the shielding walls of the cell bank are composed of three distinct materials. Everywhere possible the low cost limestone-sand Portland cement concrete is utilized. However, there are two places where good practice calls for other more expensive material to be used. The front or operating face of the analytical and segmenting cells is composed of barytes-Portland cement concrete preferably placed by the pressure grouting method. The area of the charging face, containing the hinged steel doors, is provided with a supplementary shield of steel plate to prevent gamma radiation from beaming around the sides and top of the personnel doors.

A. A Description of the Hot Laboratory Components

1. The Cell Bank

a. Analytical Cell A (Figures 1, 2, & 3)

Analytical Cell A is serviced by one 3.3 density lead glass viewing window; a pair of model 8 or 9 through-the-wall type master-slave manipulators; and a loading/unloading station above the inter-cell material-equipment access tunnel. (See description of Cell B for the common usage of a G.M. electric arm and a 2-ton bridge crane) In the wall between

analytical Cell A and segmenting Cell B is a material-equipment transfer port, with bi-parting doors that can be operated by the model 8 manipulators. This port may well be used for shielding the source material in case of an emergency in either cell. Personnel access to this cell is provided by a bi-parting steel door, 20" in thickness, through the 6' thick charging side shielding wall of regular, limestone-Portland cement concrete. Two supplementary pairs of bi-parting, gasketed SST doors are utilized, as shown in Fig. 1, to provide an air locked area within this cavity. The cell side pair of doors is equipped with glove ports and viewing windows of non-browning lime glass.

This manipulator cell is 6' x 10' x 14' high with an 11-gage Type 347 stainless steel wall liner and a 1/4" thick floor pan of the same material. The underside of the poured concrete roof slab shall be waterproofed by sacking with a thin grout and rubbed to a smooth finish with a carborundum stone, then given two coats of Amercoat 86 primer and two coats of Amercoat 33 HB. A 36 1/2" high work level of stainless steel sheet on grating on structural steel is provided in this cell. (See Fig. 3) Access to the inter-cell tunnel is provided between this work level and the inner wall air lock.

b. Segmenting Cell B (Figures 1, 2 & 3)

Segmenting Cell B is serviced by three 3.3 density lead glass viewing windows; three pairs of model 8 or 9 master-slave manipulators; one G.M. electric arm, as well as one 2-ton bridge crane (both on the same track system); a hinged, 20" thick bi-parting steel; personnel access door; and a large three-section loading/unloading station above the inter-cell material equipment access tunnel. Note: in Cell A and Cell B the charging side shield wall is of sufficient thickness to permit an air lock to be maintained between the two pairs of stainless steel bi-parting splash doors during the entry and exit of personnel into and from the cell. Of course, in this case the gamma source would either have been removed or shielded, the cell decontaminated, and the personnel masked against air-borne alpha emitters.

In the west wall of this cell is the material-equipment transfer port as mentioned under Cell A. This segmenting cell is 10' x 18' x 14' high with the same stainless steel liner, floor pan, under roof finish and stainless steel work level as described under Cell A.

Openings are provided in the top portion of the east and west walls of this cell to permit the G.M. electric arm and the 2-ton bridge crane to be used in Cell A and to be serviced in maintenance Cell C. These two wall openings are provided with 4" thick steel hydraulic lift doors. Limit switches on the bridge crane track may be used to activate an aqua spray system downward upon the crane or electric arm just as it enters these wall cavities, rinsing from them the dry alpha-gamma emitters before they can be spread from cell to cell. Of course, this spray system is used in conjunction with an elaborate filtered air ventilation layout.

c. Maintenance Cell C (Figures 1, 2 & 4)

Maintenance Cell C is serviced by one zinc bromide solution viewing window, a single model 8 master-slave manipulator and a 3-ton bridge crane (Fig. 2). An air lock is provided for this cell by a pair of sliding stainless steel doors between it and the personnel and equipment decontamination area.

Maintenance Cell C contains the terminals of the bridge crane tracks from both Cell B and Storage Cell D. These track extensions are hinged so as to hang on the cell walls when not in use. (Fig. 2) Cell C also contains the access hatch to the pipe and duct chase that is provided below the cells (Fig. 3) and a transfer station to and from the inter-cell tunnel (Fig. 2).

This maintenance cell is 12' x 20' x 25' high with the same stainless steel liner to the underside of the wall cavities for passing the bridge crane from Cell B and Cell D. These cavities are also lined with 11-gage Type 347 stainless steel and 1/4" thick floor pan as described under Cell A. In addition, the walls above the stainless steel liner shall receive the Amercoat treatment as described under Cell A.

A washdown spray system for the walls and floor pan is provided. And, in a space provided in the northwest corner of this cell is a tray area, with glove ports and plate glass viewing, for small equipment decontamination and maintenance. Within this cell a periscope providing visual inspection of the inter-cell tunnel is provided.

d. Hot Material Entry and Storage Cell D (Figures 1, 2 & 5)

Dual purpose Cell D is serviced by two, large zinc bromide solution, viewing windows, one 2-ton bridge crane mounted

on tracks located above the top of the liquid type window, two model 8 master-slave manipulators, a number of storage wells for dry radioactive waste, the terminus of the inter-cell material-equipment access tunnel and the large, through-and-beneath-the-wall material-equipment ports used for introducing the in-pile loop and other large size radioactive sources into the cell bank. These consist of a 40" square material access port for side loading carriers with a 20" thick steel vertical lift, hydraulically operated door, (Fig. 2) and a dry carrier transfer tunnel beneath the cell wall. This second facility is designed to accommodate up to a 48" diameter carrier weighing many tons on a mobile hydraulic lift table that receives the carrier through a roof hatch in the out cell air lock to the east of Cell D and shifts it to a position beneath Cell D. Here it can be raised into Cell D to any desired level pursuant to the easy removal of its radioactive contents. Hinged, gasketed covers are provided at both openings into the carrier transfer tunnel for top and bottom loading carriers and a lift type stainless steel door provided on the cell side of the material access port for side loading carriers. An 11-gauge Type 347 stainless steel liner is provided on the walls of Cell D to the bottom of the cavity through the west wall for maintaining the bridge crane in Cell C as well as throughout the cavity provided for the material access port for side loading carriers and the dry transfer tunnel for top and bottom loading carriers. The underside of the cell roof and that portion of the walls above the stainless steel liner shall receive the Amercoat treatment as noted under Cell A. The entire floor of this cell is lined with stainless steel as indicated under Cell A.

2. Supporting Facilities

a. Air Lock for Large Radioactive Material Entry (Figures 1 & 2)

To the east of Cell D is located a 12" thick solid concrete block walled structure for use as an air lock while an in-pile loop or other bulky radioactive object is introduced into Cell D. This structure contains a removable roof hatch permitting the introduction of a large carrier onto the material access port over the carrier transfer tunnel by the use of a mobile crane. The size of this air lock structure is 18' x 18' and countersunk into its heavy concrete floor slab are the tracks for the cart servicing the material transfer coffin or other side loading carriers (Fig. 2). A 1 1/2-ton monorail hoist is provided for raising the lift door in such carriers. The walls, floor, and underside of roof shall be given an Amercoat treatment as noted in Cell A. The gasketed bi-parting doors into this room are of Amercoated metal. This structure is provided with a washdown spray system for decontaminating it of air-borne radiation.

b. The Inter-Cell Access Tunnel (Figures 1 & 2)

This facility is the lifeline of the cell bank and extends from the west wall of Cell D to a maintenance pit for removing the tunnel cart on the extreme west end of the Hot Laboratory Building (Fig. 1). This pit, of poured concrete with removable roof slabs, contains the mechanical as well as the manual drive mechanism for the cart. Gasketed doors are provided in this tunnel below the cells and locker room to compartment contamination insofar as possible as well as to prevent the pit from becoming contaminated when servicing of the cart is necessary. The floor of the tunnel, including the tracks for the cart, are of Type 347 stainless steel and the walls and underside of its roof slab are given the Amercoat treatment as noted in Cell A. Lights in removable concrete plugs are provided when visual inspection of the tunnel becomes necessary. Periscopes for performing this inspection are provided in the charging wall at the west side of Cell A and the east end of Cell B. Hinged tunnel covers are provided in Cells A and B and a transfer station provided in Cell C. The track for the cart extends across the floor of Cell D to its east wall.

c. Personnel and Equipment Decontamination Areas (Figures 1 & 4)

Decontamination may be defined as the removal of radioactive by-products of nuclear fission from the parent substance. This definition should be enlarged to include the removal of radioactive by-products of nuclear fission from any surface where they might have been introduced by a chemical spill, by dust, by gas or by the spreading of contamination by tracking or localized explosion. All walls and floors subject to contamination should be finished in a nitric acid proof, impervious material to permit the decontamination of these surfaces. In addition to nitric acid, which is the strongest decontaminant short of sandblasting or grinding, many liquids, starting with warm water with detergent and continuing through acids and caustics of increasing strength to nitric acid are utilized, depending on the type and scope of the surface contamination.

In Fig. 1 we note that the personnel and equipment decontamination facility is separated into two parts. The personnel portion is located within the air lock separating maintenance Cell C from the equipment decontamination area. The floors of both of these decontamination areas are composed of a 3/8" thick floor pan of Type 347 stainless steel sheet with edge coved up 8" against all walls. This floor pan is to be seam welded to that within maintenance Cell C. In the shower area a stainless steel curb is provided to contain the water

until it drains off. The floor pan in the rest of the decontamination facility is sloped to conveniently located semi-hot floor drains. The interior surfaces of all walls within this facility are waterproofed by sacking with thin grout; then rubbed to a smooth finish with a carborundum stone; then with the ceiling given an impervious, nitric acid-proof coating composed of two coats of Amercoat 86 primer and two coats of Amercoat 33 HB in accordance with manufacturer's recommendations. Around the interior surfaces of this facility the coved edge of the floor pan is seam welded to a 1 1/2 x 1 1/2 x 3/16" stainless steel angle that has one leg embedded in the mortar joint of the concrete block walls. The personnel portion, in addition to the shower, contains a personnel-equipment monitoring facility. The equipment portion is provided with a 3-ton monorail hoist system that extends out over the concrete truck access pad, as well as an air locked entry into the semi-hot charging area.

d. The Semi-Hot Charging Area (Figure 1)

Since the charging area wall of Cells A and B contains the personnel-material access doors into these cells, the possibility of the charging area becoming contaminated is greater than that of the operating area. This is the reason for its designation as a semi-hot area where protective clothing is required. In an alpha-gamma hot laboratory this area is isolated from the cold, operating area by not only the cell bank itself, but a concrete block partition wall, to the sides of, as well as on top of the cell bank. In this case it is imperative to limit the access between these two areas to air locks as shown on Fig. 1.

The critical feature of any semi-hot area is its floors. This is true because of the continuing necessity to decontaminate spills as well as the contamination spread by the shoes and clothing of those who enter the cells, so as to maintain at all times as low an overall background radiation level as possible.

The floor of the semi-hot charging floor area, including the air lock into the decontamination area, is covered with vinyl plastic floor tile laid in large sheets or rolls to minimize cracks, and in conjunction with a vinyl plastic coved base around the interior surfaces of all walls as well as the cell bank except at drainage trench. The floor within this area shall be so constructed as to drain into a trench located along the face of Cells A and B (Fig. 1). The interior wall surfaces within this area shall be given the following surface treatment. Both the concrete block walls and concrete surface of the cell bank shall be waterproofed by sacking with thin grout, then rubbed to a smooth finish with a carborundum stone; then with the ceiling given a prime and a finish coat of any good washable paint.

e. The Locker, Change Room and Toilet Facility (Figure 1)

The floor covering within the locker, change room and toilet facility shall be vinyl plastic floor tile in large sheets or rolls used in conjunction with a coved base around the perimeter walls. This facility contains not only the toilet facilities and individual lockers for the operating personnel but fresh supplies of protective clothing and foot covers, a hand and foot counter, soiled clothing hamper, showers, gang-type hand washing facilities, etc. The walls in this change locker area should be waterproofed, then covered with any good washable paint--except the shower stalls and walls behind the lavatories, etc. which should be covered with wall tile or some comparative impervious material.

f. The Cold Operating Area

This area contains the viewing and manipulating facilities for the cells as well as hood and laboratory bench space for any cold lab analysis in connection with inner cell operation. The only possible cause of air-borne alpha contamination in the operating area is during the removal of the booted through-the-wall manipulators from their sleeves. Great care must be taken to prevent the spread of air-borne alpha or gamma contamination at this time.

The floor covering within this operating area should be vinyl plastic floor tile in large sheets or rolls used in conjunction with a coved base of the same material around the perimeter walls and cell block. The interior surface of all walls in this area should be waterproofed, then the ceiling covered with a good washable interior paint.

g. The Building Containing the Hot Laboratory (Figure 1)

This facility, in line with the Spartan simplicity demanded of such structures, is composed of 12" hollow concrete block walls, a built-up class one tar and gravel roof on 2" of rigid type insulation on metal decking on a framework of structural steel beams and columns. No windows are provided. On top of the cell bank are located the shielded inner cell air handling filters. The floor slab is of reinforced concrete.

LEGEND

- CONCRETE (REGULAR).
- CONCRETE (HIGH DENSITY).
- STEEL.
- CONCRETE BLOCK (CORED).
- LEAD.

SCALE IN FEET

828 810

FIG. 2 - SECTION "A - A"

870 011

FIG. 3 - SECTION "B-B" SHOWN
SECTION "C-C" SIMILAR

SCALE IN FEET

870 012

FIG. 4 - SECTION "D-D"

SCALE IN FEET

878 013

FIG. 5 - SECTION "E-E"

SCALE IN FEET

8720 014

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