ADVANCED MEDICAL SYSTEMS, INC.

ISP MANUAL

LONDON ROAD ISOTOPE FACILITY SAFETY AND PROCEDURES MANUAL

ISSUE DATE January, 1995

SECTION 1.6

Enclosed in its entirety are the company's Isotope Shop Procedures. These procedures represent Advanced Medical Systems' Radiation Safety Program. These procedures have been reviewed and rewritten to comply with current 10CFR regulations. The Isotope Shop Procedures have been numbered to be consecutive. Included in the ISP Manual is a cross reference to the prior ISP numbering system.

FOREWARD

IT IS THE INTENT OF THIS MANUAL TO PROVIDE ALL ADVANCED MEDICAL SYSTEM, INC. EMPLOYEES AND CONTRACTORS WITH THE INSTRUCTIONS AND OPERATIONAL PROCEDURES NECESSARY TO INSURE THAT RADIATION EXPOSURE IS KEPT AS LOW AS REASONABLY ACHIEVABLE (ALARA).

EVERY PERSON WORKING IN THE ISOTOPE FACILITY AT LONDON ROAD SHALL BE FAMILIAR WITH, AND ADHERE TO, THE INSTRUCTIONS AND PROCEDURES HEREIN.

REVISIONS AND ADDITIONS WILL BE MADE AS REQUIRED AND ALL PERSONNEL WILL RECEIVE NOTIFICATION OF THE CHANGES.

THIS MANUAL IS NOT INTENDED TO REPLACE THE NUCLEAR REGULATORY COMMISSION REGULATIONS AS PUBLISHED IN 10CFR AND SHOULD BE READ IN CONJUNCTION WITH 10CFR.

THIS MANUAL SUPERSEDES ALL PREVIOUS EDITIONS.

Robert Forsythe
APPROVAL

1-95
EFFECTIVE DATE

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CHAPTER 1 - DESCRIPTION OF THE ISOTOPE FACILITY

This chapter describes the physical aspects of the isotope facility, its construction, safety features and evaluation of shielding. It also presents floor plans of the facility as an aid in identifying specific areas that are referenced in later chapters of this manual.

INTRODUCTION

The design of the facilities follows the philosophy of containment of activity within small working areas. Health and safety considerations have been based on minimum hazard in Restricted Areas and zero hazard in Controlled and Unrestricted Areas, with confinement of emergency situations to the Isotope Shop Area (ISA).

The Isotope Facility is situated on 6.3 acres of land which lies on the boundary between industrial and residential areas. Because of the proximity to these areas, special care has been exercised in planning the safety program. The Isotope Shop Area is located in the south end of the building on the first floor. There are no windows in the ISA because windows were felt to be of questionable value for the following reasons:

1) Safety considerations and protection against unauthorized entry into the ISA.
2) The maintenance of proper air flow balance.
3) Uniform lighting is difficult to maintain.
4) The special procedures required for cleaning windows inside Restricted Areas and the possible radiation hazards of cleaning windows on the outside.
5) The noise transmission of windows from the adjacent railroad tracks.

The one story projection of the southwest corner of the building contains the stairwell to the basement and the Source Storage Garden. The door located in this stairwell is for emergency exit use only. It will set off an alarm upon opening.

Starting on page 16 are floor plans of the London Road Isotope Facility. The first floor of the facility contains the Isotope and Shielded Work Areas. The Restricted Areas are enclosed by the heavy dashed line. The location of the heavy shielding for the Shielded Work Room and the Cell provides an unbroken radiation barrier between the Isotope Areas and the high occupancy areas of the rest of the building.

The activity centers of the facility are the Hot Cell, the Shielded Storage Room, the Isotope Shop Area, Isotope Shop Warehouse, the Isotope Storage and Irradiation Facility (Garden) and the offices.

The areas in which radioisotopes are handled are accessed through a changing area located in the southeast corner of the building.

THE SHIELDED WORK ROOM

The Shielded Work Room has a minimum of three (3) feet of concrete shielding and a labyrinth entrance. The broad corridor through the labyrinth permits large objects to be moved into and out of the room.

This room may be used for development, manufacture and testing of equipment or storage of radioactive material.

HOT CELL

The Hot Cell was designed and equipped to encapsulate the largest sources used for medical therapy and industrial radiography. Advanced Medical Systems no longer encapsulates Cobalt into sources. With the exception of the shielding walls, virtually every item in the cell structure is removable to permit changes which the future may require.

The Hot Cell is six (6) feet square inside, five and a half (5 1/2) foot concrete walls and four (4) foot floor and ceiling. The floor pan is stainless steel and the inside walls are one quarter (1/4) inch steel plate up to a height of eleven (11) feet. The cell is closed at the rear by a forty two (42) ton hinged door which provides a full six (6) foot wide entrance to the cell when open. Two small access ports are available for insertion and withdrawal of items less than three (3) inches in diameter. These access ports are located between the Isotope Shop Area and the Hot Cell. Observation of cell operations is possible through a sixty (60) inch glass and zinc bromide window. Remote handling is accomplished with a pair of Model 8 Manipulators and a two (2) ton overhead crane.

All cell operating controls are located on the cell face so that normal operation does not require entry into the Contaminated Isotope Areas. The Isotope Areas may be observed from the Cell Control Area by a window through the southeast corner of the cell in line with mirrors placed against the south wall. The Isotope Areas are connected to the Cell Control Area by an intercom system.

The viewing window for the cell is removable from outside the cell. The viewing components consist of an eight (8) inch inside coverplate of non-browning glass, a two (2) inch plate glass, forty eight (48) inches of zinc bromide solution and a two (2) inch outside coverplate of laminated safety glass. This construction provides shielding equivalent to sixty six (66) inches of one hundred fifty (150) lb/ft^3 concrete with only two (2) glass/zinc

bromide interfaces. The entire metal structure in contact with the zinc bromide solution is coated to prevent introduction of impurities which might cloud the zinc bromide solution. The window was designed and constructed in 1984 by Hot Cell Services Corporation, Kent, Washington.

To reduce the potential of an electrostatic discharge of the Cell window, a grounding strap has been placed on the Hot Cell window at electrical ground. Therefore, any electrostatic charge on the window and frame will be shunted to ground.

The Model 8 Master Slave Manipulators are mounted above the window using the roller tube mounts. The roller tubes are positioned on twenty eight (28) inch centers in concrete within a twenty four (24) by fifty eight (58) inch steel-lined opening in the cell wall. This method of mounting in an oversized opening will permit installation of new types of manipulators as they become available or relocation of the present manipulators to a different centerline, if required by future operating conditions.

The cell door is located at the rear of the Hot Cell and opens into the Decontamination Room. The door is an internally braced steel tank filled with concrete. The upper and lower stub shafts are mounted on bearings which permit the door to rotate about a vertical line through one end without touching the floor or ceiling at any point. This construction permits a smooth unbroken level floor into the cell over which heavy shipping containers can be easily moved. The forty (40) ton door is removable in case of bearing failure, but due to the low rotational speed and infrequent operation, a long service life is anticipated. The turntable upon which the door rides contains a heavy duty bearing mounted on a hemispherical balljoint to permit alignment of the lower bearing with the upper bearing. The upper hinge has the bearing mounted in a block which can be moved by means of wedges and power screws to obtain the necessary alignment for a true axis of rotation. The stub shaft connecting the upper hinge to the door is removable through a nine (9) foot vertical tube to the second floor. The upper bearing is a sealed unit and should require no lubrication. The lower bearing, at floor level, may become dirty or contaminated even though a neoprene wiper rides the edge of the turntable. The lower bearing may be lubricated, or flushed and lubricated if dirty or contaminated, by means of a tube which runs beneath the floor to the service trench on the south side of the cell. The door is opened and closed electrically by means of a motor mechanism mounted on the outside of the door. An electrical interlock prevents the electric door drive from being actuated until the switch at the cell face and the drive motor switch are simultaneously operated. Release of either button stops the door from opening. This safety feature makes it impossible for the cell door to be opened without the knowledge and consent of the Cell Operator or for the cell to be opened by a person working alone.

The two (2) ton overhead crane inside the Hot Cell is electrically powered and controlled. In order to cover the six (6) foot square floor area of the cell with a minimum of travel, an electrically powered trolley was mounted on an I-beam rail which can be rotated 180^0 degrees. The crane assembly is mounted in a removable plug in the cell ceiling.

Storage facilities for isotopes within the cell are provided by two (2) containers inserted in steel sleeves in the floor.

Two (2) prefilters for the Hot Cell are mounted just above the viewing window.

As mentioned previously, the Hot Cell is shielded by five and a half (5-1/2) feet of concrete with one quarter (1/4) inch steel plate on the inside faces. The shielding thickness was chosen as sufficient to handle the largest sources currently available with complete safety and to provide adequate shielding for the larger sources the future may require. Calculations indicate that the shielding is adequate for 1.5 million Curies of Cobalt-60.

HOT CELL SUPPORTING FACILITIES

The facilities supporting the operation of the Hot Cell are primarily concerned with the safety considerations necessary when this type of facility is located in a populated area. Every effort has been made to eliminate possible exposure of the public to radiation or radioactive material.

The air handling system has received special attention due to the location of a residential area within a block of the facility. The facility has separate air conditioning systems for the isotope areas, first floor office control area, second floor office area, and the lobby and reception area. The Isotope Shop Area and Hot Cell have a once-through airflow system with carefully balanced flow gradient to the Hot Cell as the low pressure point of the system. The supply air to the isotope areas is filtered through prefilters before entering the building. The heavy burden of industrial air wastes, from neighboring plants and the railroad tracks, is removed at the point where filter changing is accomplished with the least difficulty. The supply air is distributed to the isotope areas by ventilation ducts containing manually adjustable dampers. The airflow pattern is adjusted initially by balancing the supply and exhaust systems to obtain the desired flow pattern and periodic checks of manometers are made to assure the desired pattern is maintained. The doors at either end of the change area are electrically interlocked to prevent simultaneous opening which might disturb the airflow pattern. The

doors at either end of the air lock, which are used to move shipping containers in and out of the isotope areas, are similarly interlocked. The exhaust system has two (2) centrifugal blowers which are located on the second floor directly above the Hot Cell. Both blowers exhaust through separate filters and a common high-velocity stack. The larger blower removes air from all isotope areas, except the Hot Cell, and requires a 2 x 2 array of absolute filters. The exhaust fan for the Hot Cell is independently operated and has a high temperature prefilter and a single absolute filter. The balanced air flow pattern is from the change areas through the Isotope Shop Area to the Decontamination Room and finally to the Hot Cell. The Hot Cell exhaust fan is driven by a two (2) speed motor which is controlled by the position of the double doors connecting the Decontamination Room with the Isotope Shop Area. With the doors closed the fan operates at low speed and the Decontamination Room receives its air supply through a duct at the south side of the doorway. When the door is opened the supply air is diverted from inside to outside the Decontamination Room by means of a switch which also increases the Hot Cell exhaust fan capacity by about 100%. This prevents reverse flow of the potentially contaminated air of the Decontamination Room into the lower level Isotope Shop Area.

The air handling system is under continuous control by a monitoring and safety system. The air sampling tube is mounted across a diameter of the air exhaust stack about eight (8) feet above roof level. An air monitor located in the Clean Equipment Room with monitoring instrumentation located in the Hot Cell Control Area draws a continuous sample of four (4) to five (5) cubic feet per minute (cfm) for analysis. Any increase of activity above the preset level immediately stops the exhaust fans and the supply fan. The control system also includes automatic shutdown of either exhaust fan if a sudden pressure drop occurs across its absolute filters, indicating a rupture to the filter media.

The Decontamination Room provides space for opening the cell door without disturbing the air flow through the cell.

The original design of the facility had all drains on the first floor of the Restricted Area, with the exception of the toilet drains, connected to stainless steel holding tanks located in the Shielded Waste Room in the basement of the facility. Circa 1986, these drains were modified to route water to a plastic holding tank in the front basement. This plastic holding tank does not drain and holds water for evaporation.

The original floor drains in the basement were connected to the municipal sanitary system. These drains are sealed with concrete.

The Shielded Waste Hold-Up Tank Room which is not used is curbed twenty four (24) inches high to prevent waste water from running into the sanitary sewer in the event of a leak in one of the holding tanks. The holding tanks had a total capacity of six hundred (600) gallons and the curbed floor area, which has no drain, has a capacity of approximately twenty four hundred (2,400) gallons. Circa 1988, this room was sealed with all services to and from the room disconnected.

The operation of the air handling equipment, the monitoring facilities and the liquid waste facilities is insured in the event of electrical power failure by a natural gas burning emergency generator with automatic rapid changeover. An emergency lighting system is also powered by this generator.

All safety and monitoring devices are connected to an alarm panel in the Cell Control Area. Separate lights for each controlled item are always lit on the panel so that faulty operation of the panel itself is indicated by no light. When a controlled item malfunctions, the alarm light increases in intensity and flashes on and off until an acknowledgement button is depressed. An audible alarm also sounds on the first and second floors until acknowledged. This type of alarm will therefore indicate the difficulty even though it has corrected itself before the operator has checked the panel and the alarm signal will be erased only when the acknowledgement button has been depressed.

Alarms for fan shutdown, excessive heat or cold are also transmitted to a local alarm monitoring company so that malfunctions during non-working hours are reported to a responsible person.

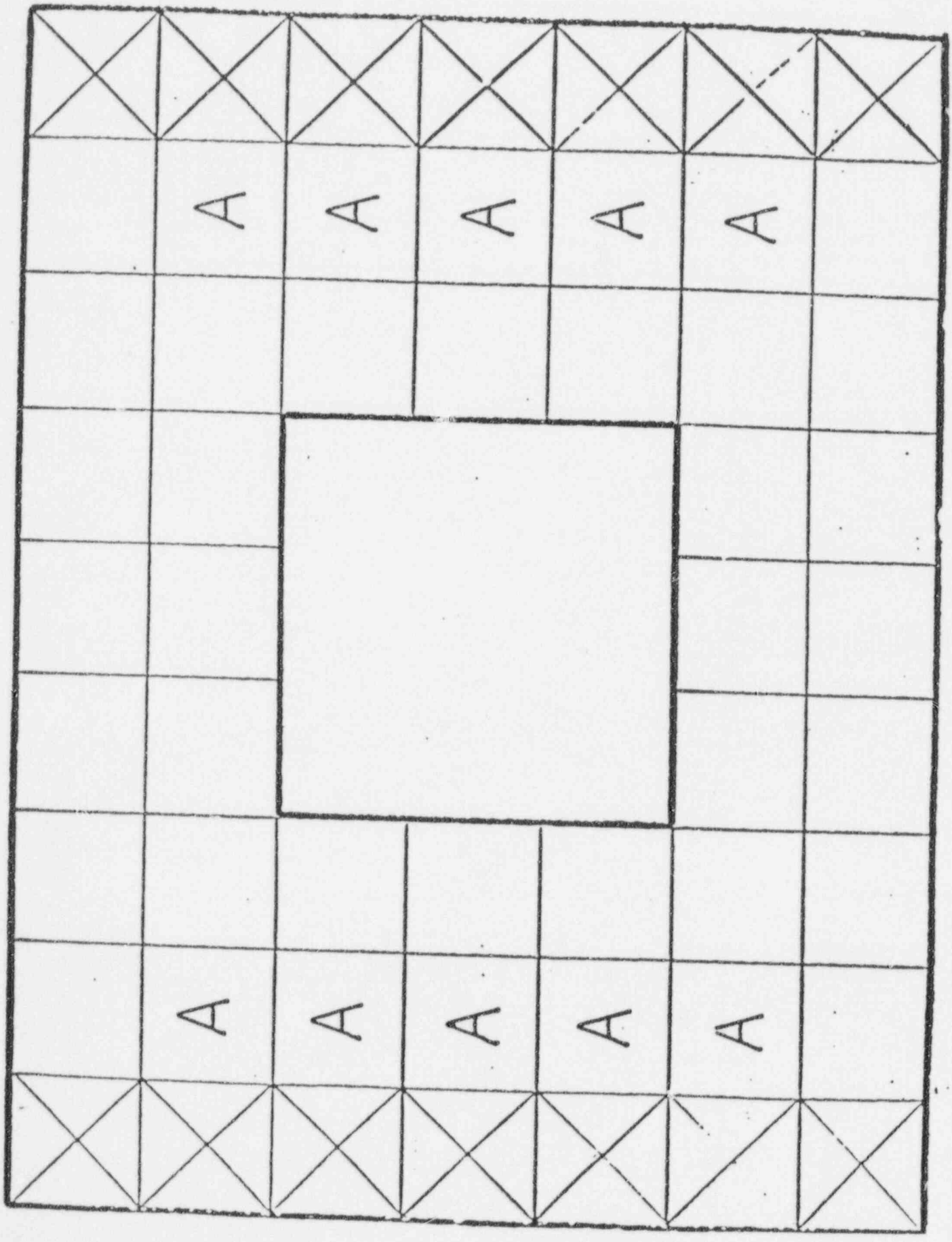
STORAGE GARDEN AND IRRADIATION FACILITY

The facility is located in the southwest corner of the building and contains vertical storage tubes in a six (6) foot square well extending from the first floor level to the basement floor level. An L-shaped shield around the well is provided by two (2) sand filled shield rooms that are accessible through manholes in the first floor. Coarse concrete sand with a bulk density of one hundred twenty seven (127) lb/ft^3 was used as the shielding material for a number of reasons. Immediate shielding requirements are easily handled by the use of sand, which can be replaced easily by a higher density material in the future, if desired. The rooms have been waterproofed and a well drilling point extends to the basement floor level beneath each manhole cover so that temporary additional shielding may be obtained by flooding the voids of the sand with water. Flooding increases the shield density by seven (7) lb/ft^3. If storage needs ever require it, the rooms can be emptied and filled with concrete, steel shot or other higher density material.

The Storage Garden is constructed with fifty four (54) vertical storage tubes in a rectangular array. The tubes are arranged in a 7 x 9 array with the center nine (9) spaces left open (see next page). The center space is fitted with an irradiation plug which can be used to irradiate objects up to eight and one half (8 1/2) inches square by twelve (12) inches high. Each of the tubes marked "A" can also be used for irradiation by placing sources in the four (4) tubes around each which have a common side. The two (2) outer rows of seven (7) tubes, marked by crosses, extend about two (2) feet below the bottom of the tubes in the central 7 x 7 array. This permitted installation of an irradiation facility beneath the garden with two (2) parallel rows of sources between which objects up to a seventeen (17) inch cube can be irradiated.

The source storage tubes terminate in a metal container through which cooling air is drawn from the room through the garden to the absolute filter exhaust system.

SOURCE STORAGE GARDEN ARRAY



PRELIMINARY EVALUATION OF CELL SHIELDING

On November 13, 1959, a shipping container containing 17,557 Curies in two (2) bulk capsules and 4550 Curies in three (3) therapy capsules (total 22,107 Curies) was opened inside the cell and the capsules placed on the cell table. A radiation survey of the areas around the cell was performed by a Victoreen Model 592 portable survey meter.

For the most part, there was no measurable increase in radiation levels with the exceptions noted below:

1) Cell Control Area (east wall of cell) - no measurable increase above background.

2) Shielded Work Room Corridor (north wall of cell) - no measurable increase above background.

3) Isotope Shop Area (south wall of cell) - no measurable increase above background.

4) Decontamination Room (west wall or door of cell) - primary leakage at surface of the door midway up on the door was negligible. Scatter leakage through the 1/8 to 1/4 inch clearance between the floor and the door was a maximum of 40mR/hr. Maximum leakage through a two (2) inch opening at top of cell door was 600mR/hr.

5) Cell Machinery Room (above cell) - maximum leakage of 5mR/hr at hoist support plug in the floor of the room.

6) Waste Storage Room (beneath cell) - no measurable increase.

To evaluate the adequacy of shielding in the floor storage plugs, the two (2) bulk capsules (17,557 Curies) were placed in the front plug and two (2) therapy sources (3,710 Curies) were placed in the rear plug. Measurements were made inside the cell and in the Waste Room below the cell.

1) Inside Cell - maximum leakage was 300mR/hr at the crack between the plug and floor. At floor level in the center of the port plug leakage was 22mR/hr. At waist height over the cell area maximum was 35mR/hr, minimum was 8mR/hr.

2) Waste Room - maximum leakage was 300mR/hr at the ceiling directly beneath the front plug. At head height maximum was 100mR/hr. At waist height maximum was 35mR/hr, minimum was 2mR/hr.

It should be pointed out that these high readings occur only in Restricted Areas that are not entered when the cell is in operation except for emergencies. These areas are the Decontamination Room, Cell Machinery Room and the Waste Storage Room.

PRESSURE GRADIENT BETWEEN CELL AND CONTROL AREA

The air handling system for the Isotope Shop Area has been carefully balanced to maintain the Cell at negative pressure relative to all other rooms in the building. The remainder of the Isotope Restricted Areas are at negative pressure relative to the Cell Control Area, but slightly above the pressure inside the Cell. These pressure gradients are maintained by supplying less air to the Isotope Shop Area than is removed by the exhaust system (slight negative pressure) and by supplying more air to the Cell Control Area than is removed by its exhaust system (slight positive pressure).

The pressure gradient between the Cell and Cell Control Area is indicated by the inclined tube manometer located directly over the cell window. Normal operation of the system provides a pressure differential of 0.2 to 0.4 inches of water absolute, the exact value depending upon whether fans are on high or low speed, cell door is open or closed, etc.

Experimentation has shown that the Cell pressure remains negative under virtually all abnormal operating conditions, even when all exhaust fans in the Isotope Shop Area are off. (The Cell Control Area is still pressurized by the independent system supplying this area).

In the event of fire or explosion inside the Cell, or in the other areas of the Isotope Shop Area, there may be a brief reversal of pressure gradient. This should cause little or no problem in the Cell Control Area, however, since virtually all of the normal air leakage into the Cell is through the transfer duct over the cell door and the air spaces around the cell door, any rapid pressure rise inside the Cell might be expected to relieve itself along these paths of least resistance.

Any resultant contamination problems would then be confined to Restricted Areas. Since the fans are well shielded from these areas by solid concrete, up to four (4) feet thick, and since the ductwork from the Cell to the fan runs a tortuous path through solid concrete, the exhaust ductwork should remain intact and the exhaust system continue operating.

EVALUATION OF CELL FILTERS IN FIRE OR EXPLOSIONS INSIDE THE CELL

The filters handling the exhaust from the Isotope Shop Area and Hot Cell are Cambridge Absolute Filters Type 1F-1000-2 (or equivalent) that are of fire-proof construction and rated for 800^{0}F continuous service and should remain in-service even during a fire.

In the event of fire or explosion damage inside the Hot Cell, the following events will occur automatically:

A. An in-line smoke/heat detector located in the exhaust trunk from the Hot Cell would secure the Hot Cell and the Isotope Shop exhaust fans and the Isotope Shop supply fan. The associated low leakage spring shut automatic dampers will shut. All forced and induced air flow within the Hot Cell and Isotope Shop Area will cease.

The filters are rigidly mounted in angle frames and most probably the filter media would be ruptured before the filters yield in their frames.

SAFETY FEATURES

I. Master Alarm System

Six (6) safety and monitor devices are connected to the Master Alarm Panel in the Cell Control Area and to the Remote Alarm Panel in the Isotope Shop Area. The separate red lights for each controlled item are always dimly lit on the panel so that faulty operation of the panel itself is indicated by no light. When a controlled item malfunctions, the alarm light is increased in intensity and flashes on and off. In addition, a loud buzzer sounds on and off in synchronism with the flashing lights. This will continue until the acknowledgement button is depressed causing the buzzer to stop and the flashing light corresponding to the malfunctioning item to change to a steady bright red. The alarm can be erased only by correcting the difficulty after depressing the acknowledgement button. In addition, two (2) other warning lights show on the Master Alarm Panel; one for the Equipment Room door and for the Cell Machinery Room door on the second floor, and the other for the basement door in the Isotope Shop Area. These will indicate steady bright red lights when the doors have been opened and indicate to the Hot Cell Operator that personnel are in this area. Evaluation tests indicated that no unusual hazards exist in these areas under normal Cell operating procedure, but the precautions should be taken nevertheless.

On five (5) of the six (6) major systems, any alarm is transmitted to the local alarm monitoring company so that malfunctions during non-working hours are reported to a responsible person. The emergency generator will not trip the other five (5) alarms if it restores power before the fans stop.

The following are the six safety and monitoring systems and the conditions which will cause the alarm:

A. Cell Exhaust Fan

1. Shut down from lack of power or switch turned off.
2. Sudden pressure drop across air filter indicating a ruptured filter.
3. Improper pressure across filter indicating broken belts, fan inoperative, plugged filter or in-line manual damper is shut.
4. Excessive radiation on the air monitor.

B. Isotope Shop Area Exhaust Fan

1. Shut down from lack of power or switch turned off.
2. Sudden pressure drop across air filters indicating a ruptured filter.
3. Improper pressure across filter indicating broken belts, fan inoperative, plugged filter or in-line manual damper is shut.
4. Excessive radiation on the air monitor.

C. Air Monitor

Excessive airborne particulate levels above setpoint as indicated on the effluent air monitor system or electronic malfunction of monitoring equipment.

D. Cell Temperature

Two (2) thermostats, one located in the Cell Control Area and the other located in the Decontamination Room immediately behind the Cell, are set to give an alarm signal for temperatures below 40^0F or above 85^0F.

E. Supply Fan Freeze Up

A thermostat in the intake system after the heaters will give an alarm signal for temperatures below 50^0F.

F. Emergency Generator

Signal given on power failure when generator starts.

II. Hot Cell Systems

A. Door Interlock

An electrical interlock secures the door in the closed position until two (2) switches, one on the outside of the door and one on the cell face in the Cell Control Area, are depressed simultaneously. This safety feature makes it impossible for the Cell door to be opened without the knowledge and consent of the Cell Operator or for the door to be opened by a person working alone.

B. Cell Probe

A high energy probe, Victoreen Model 550 Series (or equivalent) is used within the Cell to locate loose Cobalt-60 pellets and other high radiation levels. It is connected to a Victoreen Model 510 Rate meter (or equivalent) located on the Cell face in the Cell Control Area. The rate meter is auto-ranging up to 2000R/min.

C. Gamma Alarm

A Technical Operations Gamma Alarm Model 492C (or equivalent) is mounted opposite the Cell face in the Cell Control Area. Since it is connected to a loud buzzer, it gives both an audible and a visual alarm (flashing red light) continuously when radiation levels are in excess of the preset level of approximately 2mR/hr. The gamma alarm features fail safe circuitry to provide a signal at all times. Failure of any element either turns on the red lamp or turns off the green (safe) lamp, signalling improper operation.

III. Decontamination Room

A. The Hot Cell Exhaust fan is driven by a two speed motor which is controlled by the position of the double doors connecting the Decontamination Room with the Isotope Shop Area. With the doors closed the fan operates at low speed which is indicated by a red light on the locked switch control at the Cell face. With the doors opened the fan speed is increased for about 100% greater capacity. This prevents reverse flow of potentially contaminated air of the Decontamination Room into the Isotope Shop Area. High speed mode is indicated by a yellow light on the locked switch control at the Cell face.

IV. Isotope Shop Area

A. Gamma Alarm

A Technical Operations Gamma Alarm, Model 492D (or equivalent) is mounted on the west wall between the Storage Garden and the Decontamination Room adjacent to the source transfer operation. This will give a visible flashing red light when radiation exceeds the preset level of 5mR/hr.

B. Basement Door

When the basement door is opened, a steady red light turns on above the door Also, a steady red light shows on the Master Alarm Panel.

C. Air Locks

1. The doors at either end of the Change Area are electrically interlocked to prevent simultaneous opening which might disturb the air flow pattern. The entrance to the Change Area from the Cell Control Area is an air lock by itself. The first door is interlocked with the door on the opposite side of the Change Area leading into the Isotope Shop Area.

2. The air lock on the west side of the Isotope Shop Area has three (3) electrically interlocked doors. One set of doors leads to the Isotope Shop Area; one set leads to the Isotope Warehouse, and the last set on the north side of the air lock leads to the Restricted Area. When the Isotope Shop Area doors are open, the other two doors cannot be opened. When one of the other two doors is open, the Isotope Shop Area doors cannot be opened.

V. Equipment Room

A. This room is directly above the Shielded Work Room. This room contains the heating and intake air fan as well as the air conditioners. The floor is shielded with two (2) feet of concrete. A Technical Operations Gamma Alarm, Model 492B (or equivalent) set at approximately 2mR/hr is mounted in the center of the room. It remotely indicates a signal above the entrance to the room. No one is permitted to enter this room without permission of the Radiation Safety Officer (RSO) or designee. In addition, when the door is opened, a steady red light shows on the Master Alarm Panel.

CAUTION: Personnel are not permitted in this room when there is no signal white light or when there is a red light.

VI. Doors

A. Only authorized personnel have access to keys to any Restricted Areas. Doors to Restricted Areas are kept locked at all times. This includes the following:

1. Air lock from Cell Control Area to Change Area.

2. Doors from the Shop Area to the air lock.

3. Doors from the Warehouse to the above air lock.

4. Doors from the air lock to Isotope Shop Area.

5. Doors from the Warehouse to the Shop Area on the northeast side of the Warehouse.

6. Equipment Room on second floor.

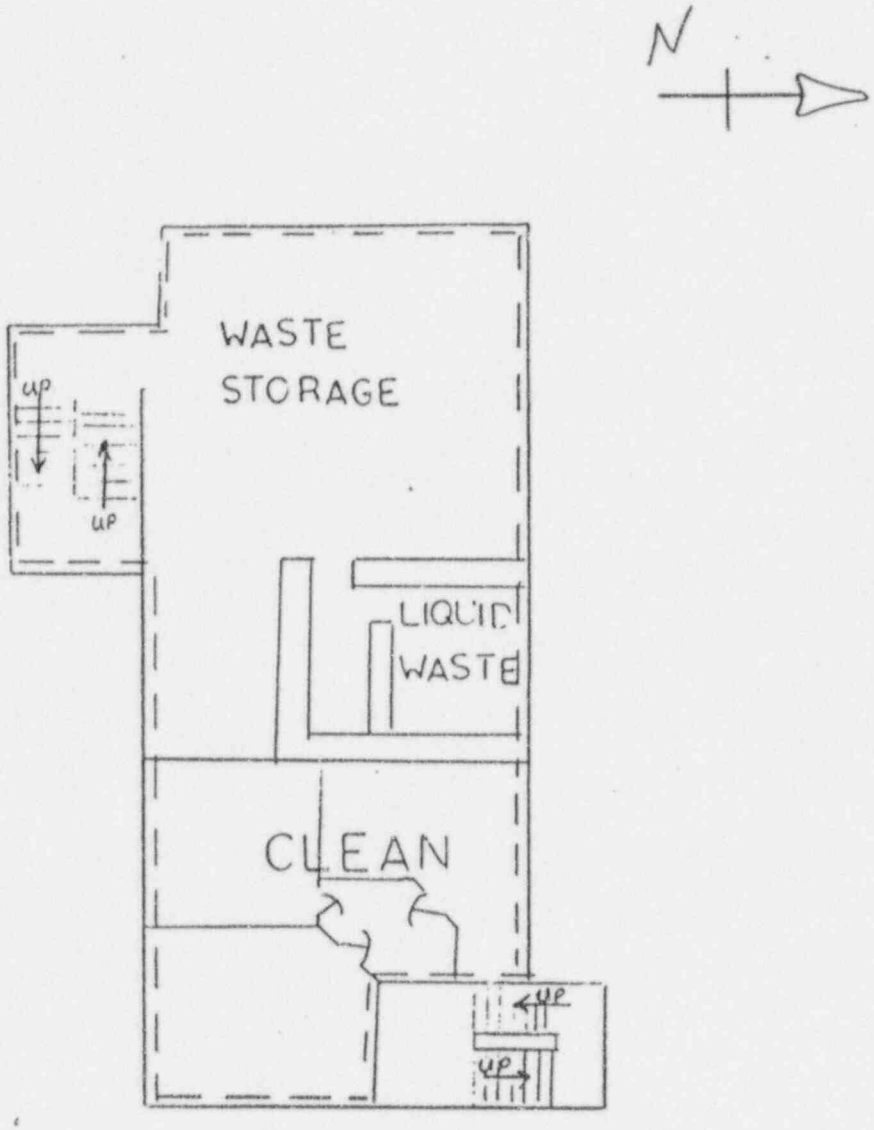
7. Cell Machinery Room on second floor.

8. Room adjacent to Cell Machinery Room.

9. Basement door opening to clean side of basement.

10. In addition to above, the perimeter of the entire facility is tied in with a local alarm monitoring company.

BASEMENT RESTRICTED AREA

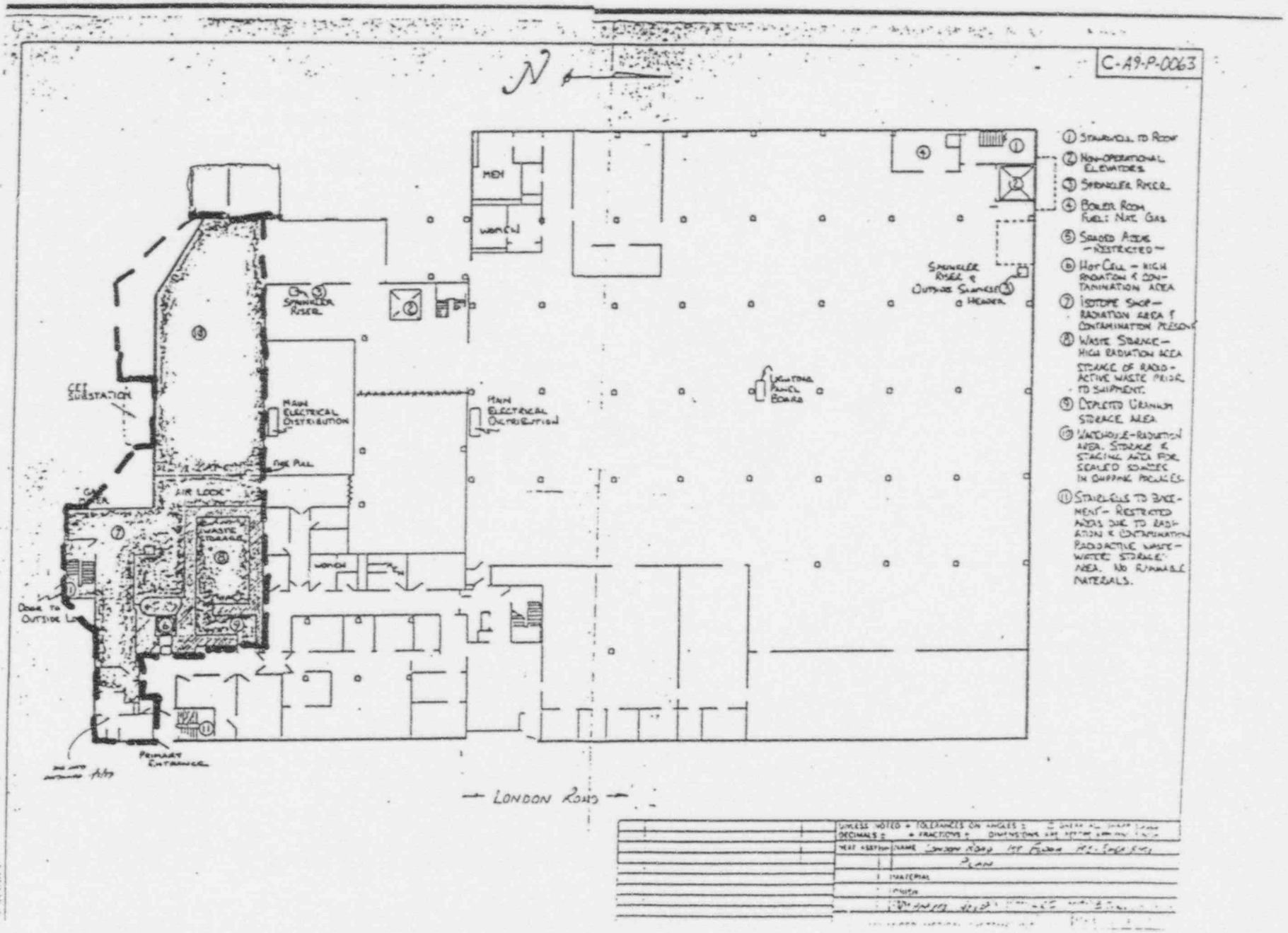


- - - -INDICATES RESTRICTED AREA
CONTROLLED ACCESS

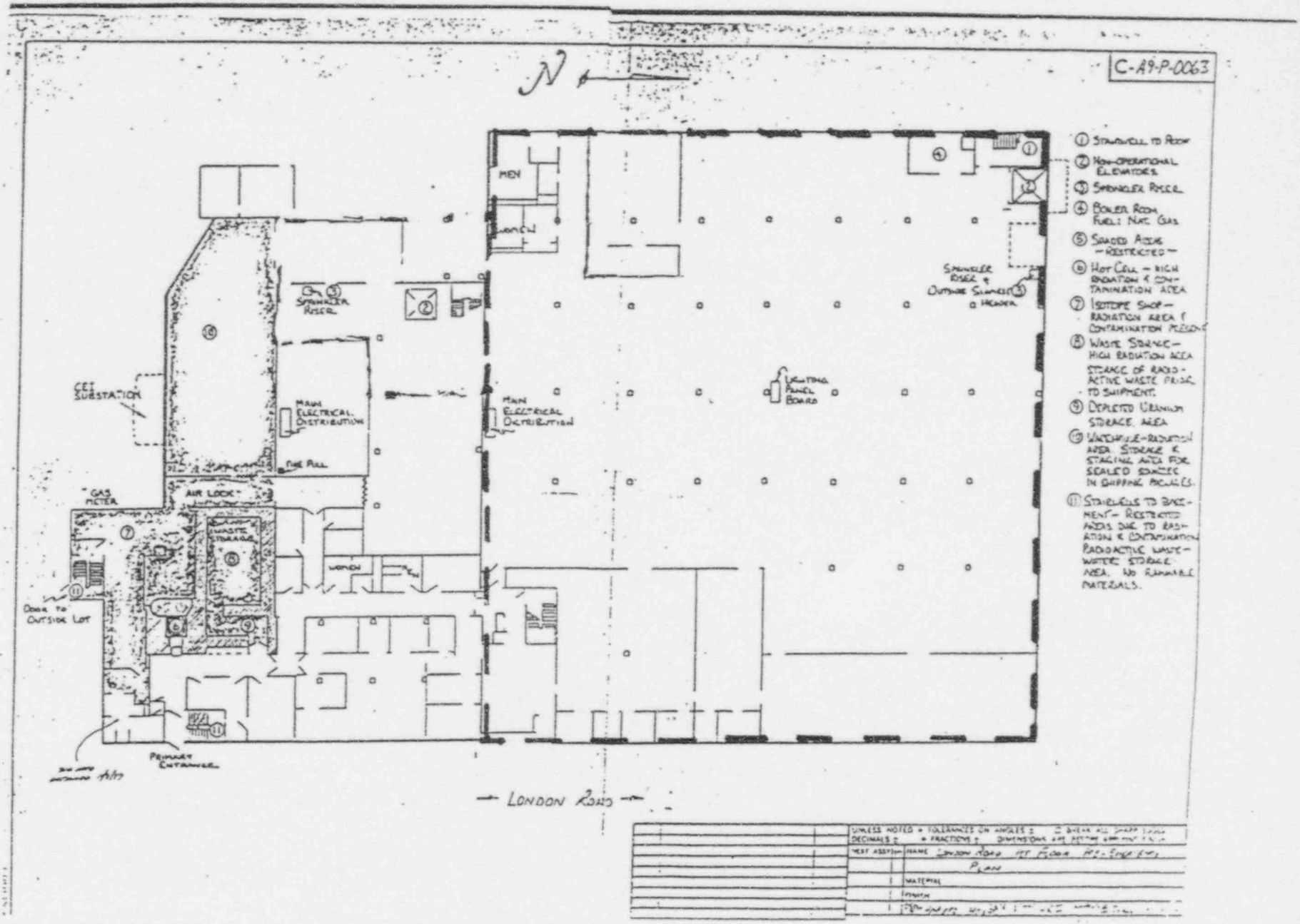
BASEMENT

SCALE 1/16"

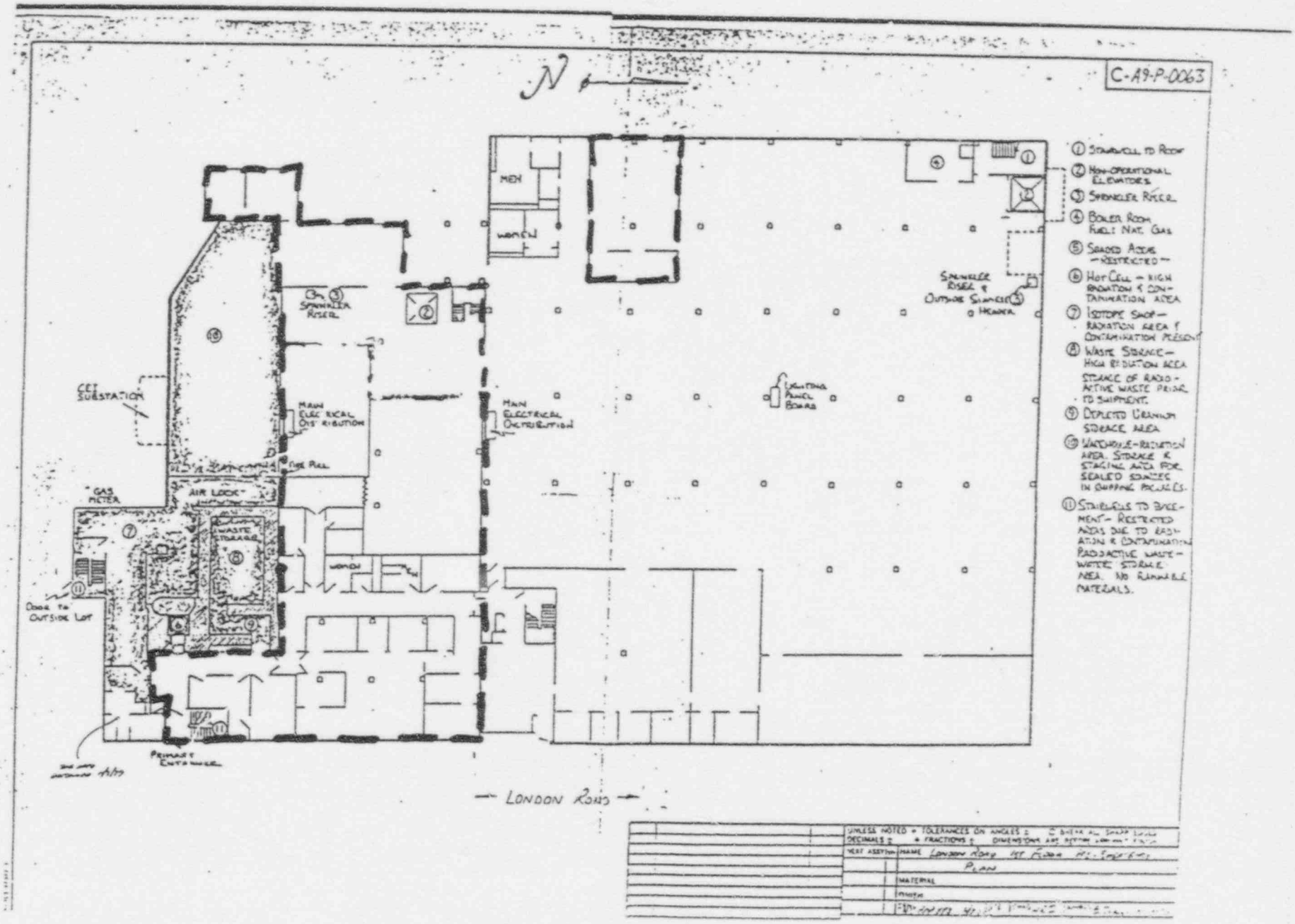
FIRST FLOOR RESTRICTED AREA



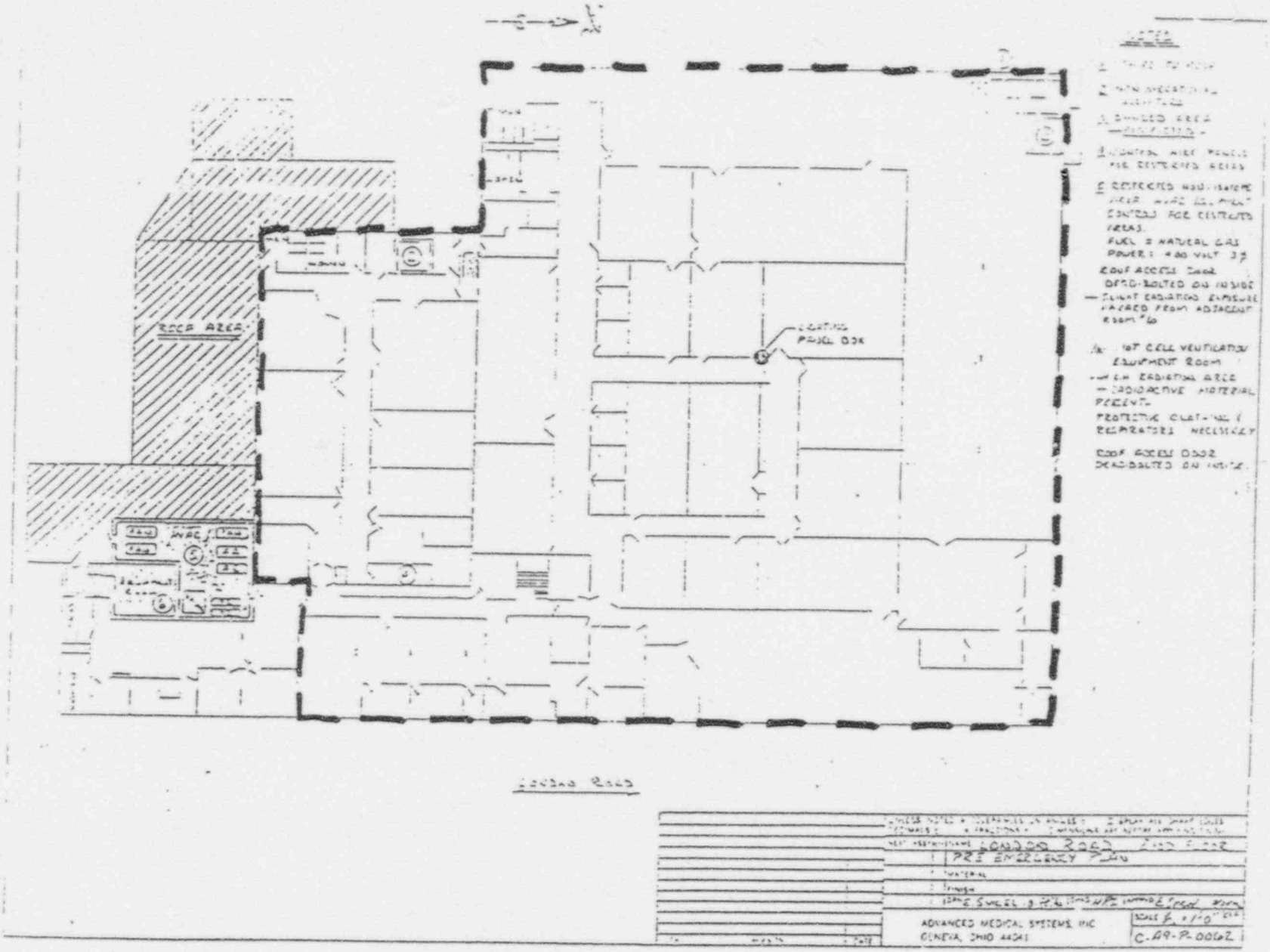
FIRST FLOOR UNRESTRICTED AREA



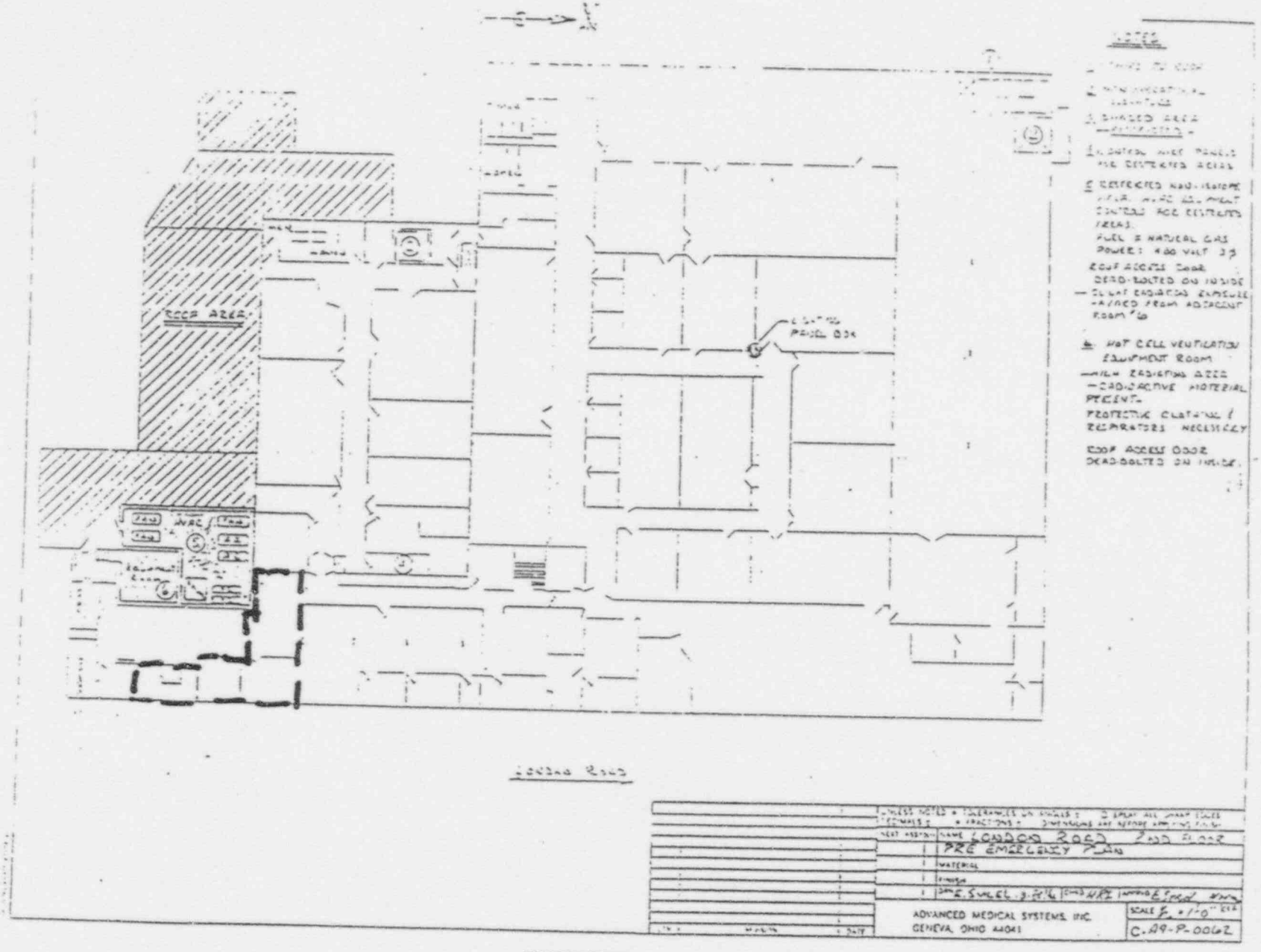
FIRST FLOOR CONTROLLED AREAS



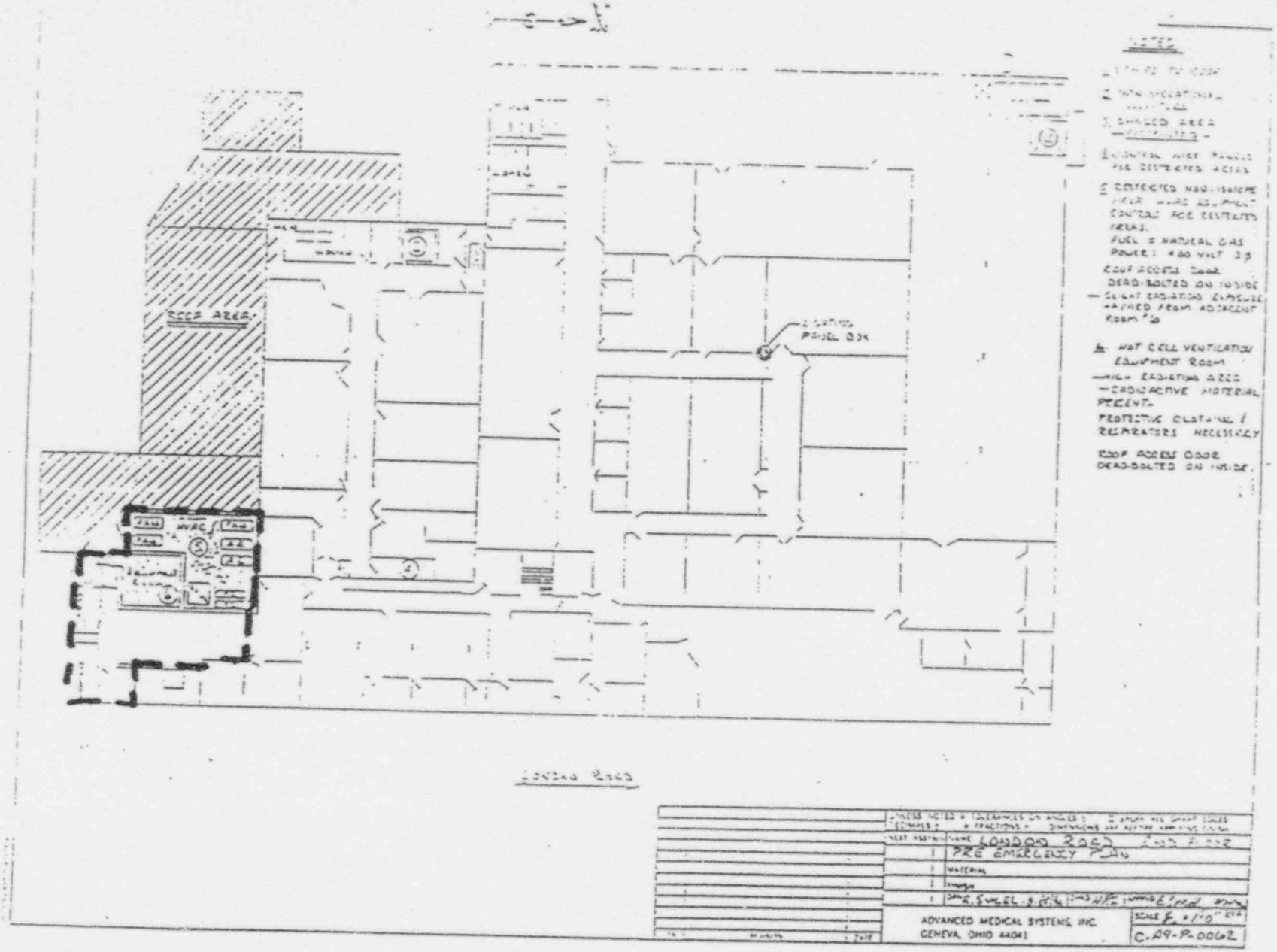
SECOND FLOOR UNRESTRICTED AREA



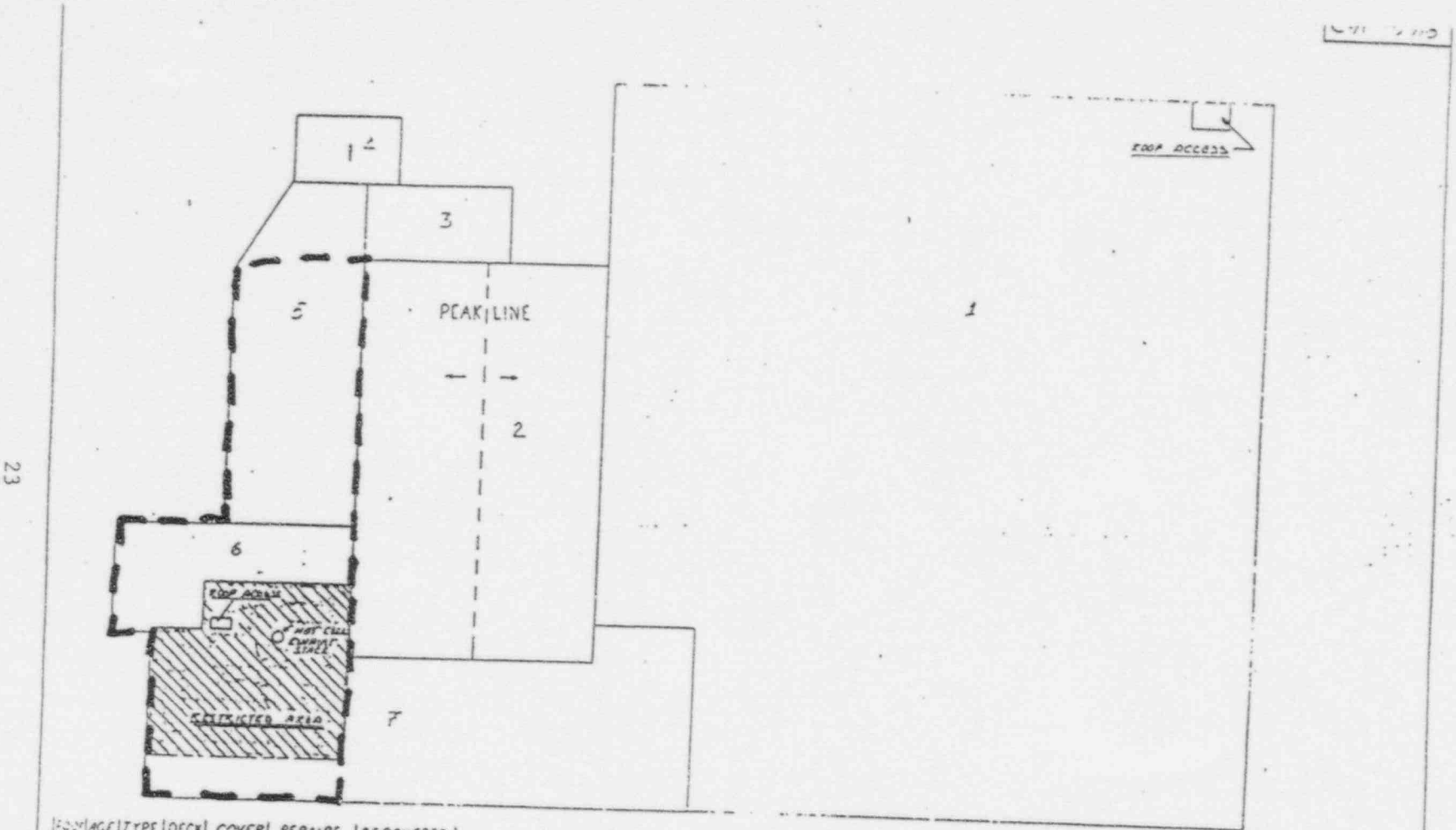
SECOND FLOOR CONTROLLED AREA



SECOND FLOOR RESTRICTED AREA



ROOF RESTRICTED AREA



ROOF	AGE	TYPE	DECK	COVER	REPAIRS	RECOVERED
1		FLAT	CONCRETE	ASPH / GRAVEL	1983	
2	1958	GABLE	WOOD	RI. ASPH.	1983	
3	1960	FLAT	STEEL	ASPHALT/GRAVEL		
4	1960	FLAT	STEEL	" "		
5	1970	FLAT	STEEL	ASPHALT/GRAVEL	1982	
6	1958	FLAT	STEEL	ASPH.		
7	1958	FLAT	CONCRETE	ASPH. GRAVEL		

A	ADDED AREA (TENT OVER)	STV/B	
LTR	REVISION	DATE	

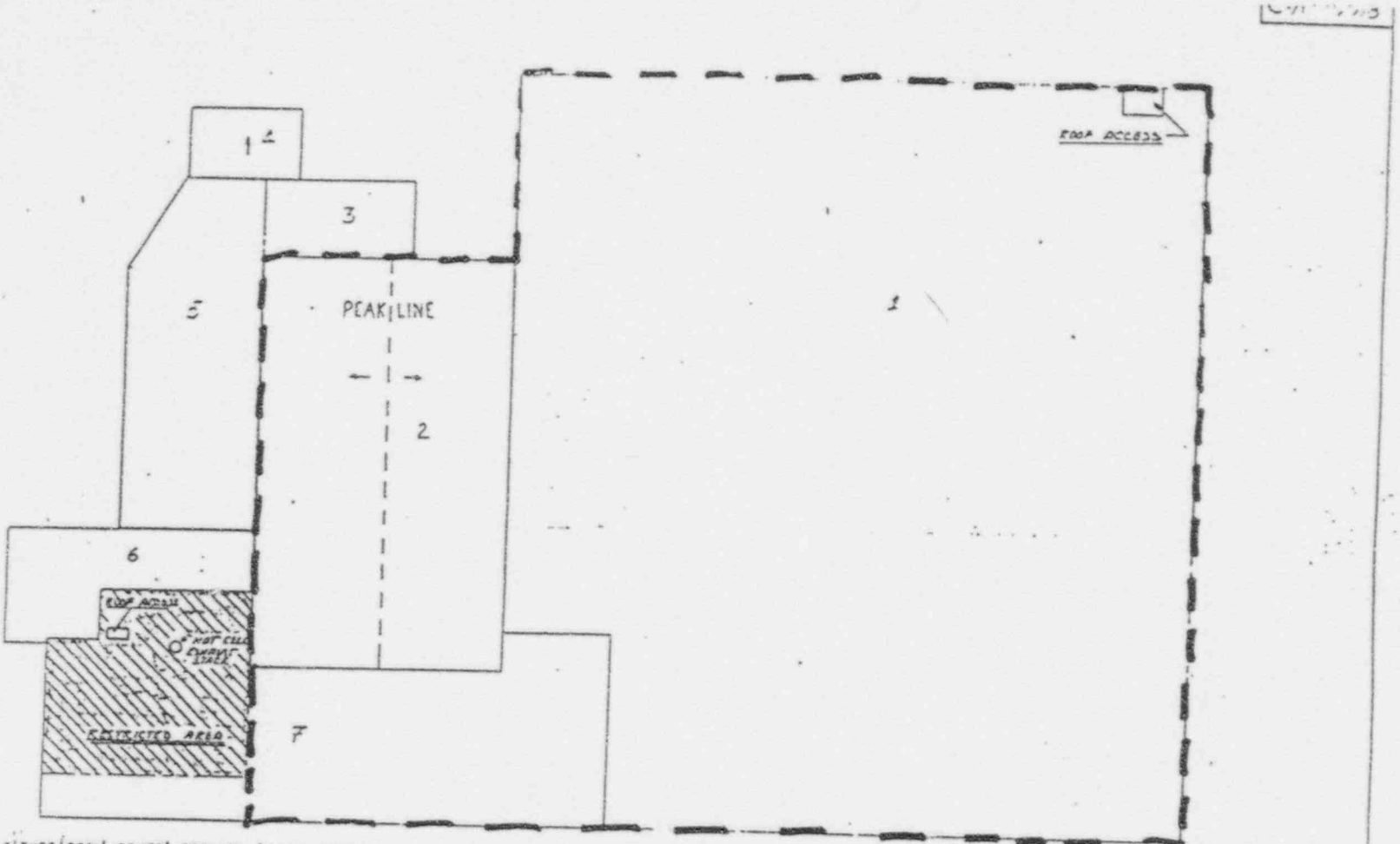
UNLESS NOTED ± TOLERANCES ON ANGLES ± ○ BREAK ALL SHARP EDGES
DECIMALS ± ± FRACTIONS ± DIMENSIONS ARE BEFORE APPLYING FINISH

NEXT ASSY | NAME LONDON ROAD FACILITY
ROOF LAYOUT
MATERIAL
FINISH
DRN | DATE | CHKD | APPROVED

ADVANCED MEDICAL SYSTEMS, INC.
GENEVA, OHIO 44041

SCALE 1/16 = 1'-0"
C-A9-R-7018

ROOF UNRESTRICTED AREA



ROOF	AGE	TYPE	DECK	COVER	REPAIRS	RECOVERED
1						
2						
3						
4						
5						
6						
7						

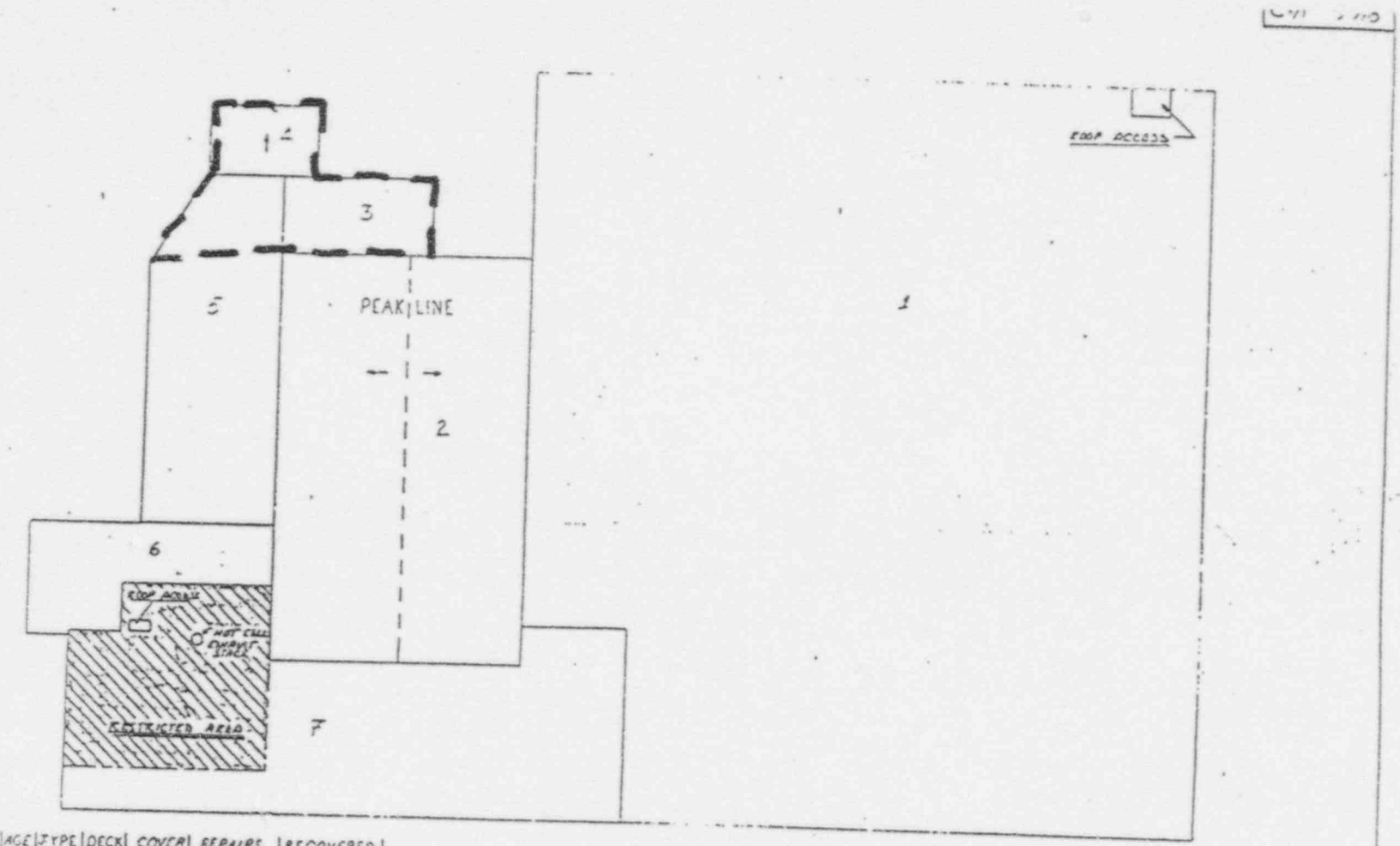
UNLESS NOTED ± TOLERANCES ON ANGLES ± ◊ BREAK ALL SHARP EDGES
DECIMALS ± & FRACTIONS ± DIMENSIONS ARE BEFORE APPLYING FINISH

NEXT ASSY | USED ON | NAME LONDON ROAD FACILITY
PCCE LAYOUT
MATERIAL
FINISH
DRN | APVD | DATE | WEIGHT | SHEET

ADVANCED MEDICAL SYSTEMS, INC.
GENEVA, OHIO 44041

SCALE 1/2" = 1'-0"
C-A9-R-3018

ROOF CONTROLLED AREA



ROOM	AGE	TYPE	DECK	COVER	REPAIRS	RECOVERED
1	NEW	FLAT	CONC	ASPH/ROCK	1983	
2	1954	GABLE	WOOD	BI ASPH	1983	
3	1980	FLAT	STEEL	ASPH/ROCK		
4	1960	FLAT	STEEL	" "		
5	1980	FLAT	STEEL	ASPH/ROCK	1981	
6	1958	FLAT	WOOD	ASPH		
7	1958	FLAT	CONC	ASPH/ROCK		

UNLESS NOTED ± TOLERANCES ON ANGLES ± ◎ BREAK ALL SHARP EDGES
DECIMALS ± ± FRACTIONS ± DIMENSIONS ARE BEFORE APPLYING FINISH

NEXT ASSY | USED ON | NAME: LONDON ROAD FACILITY
ROOF LAYOUT
MATERIAL
FINISH
DRN | DATE | CHKD | APPROVED | DATE

ADVANCED MEDICAL SYSTEMS, INC.
GENEVA, OHIO 44041

SCALE 1/8" = 1'-0"
C-A9-R-3015

SECTION 1.5 - FACILITIES AND EQUIPMENT

The attached facility description is included in Chapter 1 of the Isotope Shop Procedure Manual. For convenience, it is also included in Section 1.5 in its entirety.

The current equipment list of that equipment which is used by personnel in the performance of their surveys is as follows:

Isotope Handling Equipment
Portable GM Survey Meters
Portable Ion Chamber Survey Meters
Breathing Zone Air Samplers
Fixed Air Samplers
Counter/Scales
GM Rate Meters
HEPA/Ventilation and Vacuums
Miscellaneous Computer Support Programs
Overhead Hoists
Forklifts
Shop Tools (Hand and Electric)
Volt Meters
Operation of Hot Cell and Manipulators

CHAPTER 1 - DESCRIPTION OF THE ISOTOPE FACILITY

This chapter describes the physical aspects of the isotope facility, its construction, safety features and evaluation of shielding. It also presents floor plans of the facility as an aid in identifying specific areas that are referenced in later chapters of this manual.

INTRODUCTION

The design of the facilities follows the philosophy of containment of activity within small working areas. Health and safety considerations have been based on minimum hazard in Restricted Areas and zero hazard in Controlled and Unrestricted Areas, with confinement of emergency situations to the Isotope Shop Area (ISA).

The Isotope Facility is situated on 6.3 acres of land which lies on the boundary between industrial and residential areas. Because of the proximity to these areas, special care has been exercised in planning the safety program. The Isotope Shop Area is located in the south end of the building on the first floor. There are no windows in the ISA because windows were felt to be of questionable value for the following reasons:

1) Safety considerations and protection against unauthorized entry into the ISA.
2) The maintenance of proper air flow balance.
3) Uniform lighting is difficult to maintain.
4) The special procedures required for cleaning windows inside Restricted Areas and the possible radiation hazards of cleaning windows on the outside.
5) The noise transmission of windows from the adjacent railroad tracks.

The one story projection of the southwest corner of the building contains the stairwell to the basement and the Source Storage Garden. The door located in this stairwell is for emergency exit use only. It will set off an alarm upon opening.

Starting on page 16 are floor plans of the London Road Isotope Facility. The first floor of the facility contains the Isotope and Shielded Work Areas. The Restricted Areas are enclosed by the heavy dashed line. The location of the heavy shielding for the Shielded Work Room and the Cell provides an unbroken radiation barrier between the Isotope Areas and the high occupancy areas of the rest of the building.

The activity centers of the facility are the Hot Cell, the Shielded Storage Room, the Isotope Shop Area, Isotope Shop Warehouse, the Isotope Storage and Irradiation Facility (Garden) and the offices.

The areas in which radioisotopes are handled are accessed through a changing area located in the southeast corner of the building.

THE SHIELDED WORK ROOM

The Shielded Work Room has a minimum of three (3) feet of concrete shielding and a labyrinth entrance. The broad corridor through the labyrinth permits large objects to be moved into and out of the room.

This room may be used for development, manufacture and testing of equipment or storage of radioactive material.

HOT CELL

The Hot Cell was designed and equipped to encapsulate the largest sources used for medical therapy and industrial radiography. Advanced Medical Systems no longer encapsulates Cobalt into sources. With the exception of the shielding walls, virtually every item in the cell structure is removable to permit changes which the future may require.

The Hot Cell is six (6) feet square inside, five and a half (5 1/2) foot concrete walls and four (4) foot floor and ceiling. The floor pan is stainless steel and the inside walls are one quarter (1/4) inch steel plate up to a height of eleven (11) feet. The cell is closed at the rear by a forty two (42) ton hinged door which provides a full six (6) foot wide entrance to the cell when open. Two small access ports are available for insertion and withdrawal of items less than three (3) inches in diameter. These access ports are located between the Isotope Shop Area and the Hot Cell. Observation of cell operations is possible through a sixty (60) inch glass and zinc bromide window. Remote handling is accomplished with a pair of Model 8 Manipulators and a two (2) ton overhead crane.

All cell operating controls are located on the cell face so that normal operation does not require entry into the Contaminated Isotope Areas. The Isotope Areas may be observed from the Cell Control Area by a window through the southeast corner of the cell in line with mirrors placed against the south wall. The Isotope Areas are connected to the Cell Control Area by an intercom system.

The viewing window for the cell is removable from outside the cell. The viewing components consist of an eight (8) inch inside coverplate of non-browning glass, a two (2) inch plate glass, forty eight (48) inches of zinc bromide solution and a two (2) inch outside coverplate of laminated safety glass. This construction provides shielding equivalent to sixty six (66) inches of one hundred fifty (150) lb/ft^3 concrete with only two (2) glass/zinc

bromide interfaces. The entire metal structure in contact with the zinc bromide solution is coated to prevent introduction of impurities which might cloud the zinc bromide solution. The window was designed and constructed in 1984 by Hot Cell Services Corporation, Kent, Washington.

To reduce the potential of an electrostatic discharge of the Cell window, a grounding strap has been placed on the Hot Cell window at electrical ground. Therefore, any electrostatic charge on the window and frame will be shunted to ground.

The Model 8 Master Slave Manipulators are mounted above the window using the roller tube mounts. The roller tubes are positioned on twenty eight (28) inch centers in concrete within a twenty four (24) by fifty eight (58) inch steel-lined opening in the cell wall. This method of mounting in an oversized opening will permit installation of new types of manipulators as they become available or relocation of the present manipulators to a different centerline, if required by future operating conditions.

The cell door is located at the rear of the Hot Cell and opens into the Decontamination Room. The door is an internally braced steel tank filled with concrete. The upper and lower stub shafts are mounted on bearings which permit the door to rotate about a vertical line through one end without touching the floor or ceiling at any point. This construction permits a smooth unbroken level floor into the cell over which heavy shipping containers can be easily moved. The forty (40) ton door is removable in case of bearing failure, but due to the low rotational speed and infrequent operation, a long service life is anticipated. The turntable upon which the door rides contains a heavy duty bearing mounted on a hemispherical balljoint to permit alignment of the lower bearing with the upper bearing. The upper hinge has the bearing mounted in a block which can be moved by means of wedges and power screws to obtain the necessary alignment for a true axis of rotation. The stub shaft connecting the upper hinge to the door is removable through a nine (9) foot vertical tube to the second floor. The upper bearing is a sealed unit and should require no lubrication. The lower bearing, at floor level, may become dirty or contaminated even though a neoprene wiper rides the edge of the turntable. The lower bearing may be lubricated, or flushed and lubricated if dirty or contaminated, by means of a tube which runs beneath the floor to the service trench on the south side of the cell. The door is opened and closed electrically by means of a motor mechanism mounted on the outside of the door. An electrical interlock prevents the electric door drive from being actuated until the switch at the cell face and the drive motor switch are simultaneously operated. Release of either button stops the door from opening. This safety feature makes it impossible for the cell door to be opened without the knowledge and consent of the Cell Operator or for the cell to be opened by a person working alone.

The two (2) ton overhead crane inside the Hot Cell is electrically powered and controlled. In order to cover the six (6) foot square floor area of the cell with a minimum of travel, an electrically powered trolley was mounted on an I-beam rail which can be rotated 180^0 degrees. The crane assembly is mounted in a removable plug in the cell ceiling.

Storage facilities for isotopes within the cell are provided by two (2) containers inserted in steel sleeves in the floor.

Two (2) prefilters for the Hot Cell are mounted just above the viewing window.

As mentioned previously, the Hot Cell is shielded by five and a half (5-1/2) feet of concrete with one quarter (1/4) inch steel plate on the inside faces. The shielding thickness was chosen as sufficient to handle the largest sources currently available with complete safety and to provide adequate shielding for the larger sources the future may require. Calculations indicate that the shielding is adequate for 1.5 million Curies of Cobalt-60.

HOT CELL SUPPORTING FACILITIES

The facilities supporting the operation of the Hot Cell are primarily concerned with the safety considerations necessary when this type of facility is located in a populated area. Every effort has been made to eliminate possible exposure of the public to radiation or radioactive material.

The air handling system has received special attention due to the location of a residential area within a block of the facility. The facility has separate air conditioning systems for the isotope areas, first floor office control area, second floor office area, and the lobby and reception area. The Isotope Shop Area and Hot Cell have a once-through airflow system with carefully balanced flow gradient to the Hot Cell as the low pressure point of the system. The supply air to the isotope areas is filtered through prefilters before entering the building. The heavy burden of industrial air wastes, from neighboring plants and the railroad tracks, is removed at the point where filter changing is accomplished with the least difficulty. The supply air is distributed to the isotope areas by ventilation ducts containing manually adjustable dampers. The airflow pattern is adjusted initially by balancing the supply and exhaust systems to obtain the desired flow pattern and periodic checks of manometers are made to assure the desired pattern is maintained. The doors at either end of the change area are electrically interlocked to prevent simultaneous opening which might disturb the airflow pattern. The

doors at either end of the air lock, which are used to move shipping containers in and out of the isotope areas, are similarly interlocked. The exhaust system has two (2) centrifugal blowers which are located on the second floor directly above the Hot Cell. Both blowers exhaust through separate filters and a common high-velocity stack. The larger blower removes air from all isotope areas, except the Hot Cell, and requires a 2 x 2 array of absolute filters. The exhaust fan for the Hot Cell is independently operated and has a high temperature prefilter and a single absolute filter. The balanced air flow pattern is from the change areas through the Isotope Shop Area to the Decontamination Room and finally to the Hot Cell. The Hot Cell exhaust fan is driven by a two (2) speed motor which is controlled by the position of the double doors connecting the Decontamination Room with the Isotope Shop Area. With the doors closed the fan operates at low speed and the Decontamination Room receives its air supply through a duct at the south side of the doorway. When the door is opened the supply air is diverted from inside to outside the Decontamination Room by means of a switch which also increases the Hot Cell exhaust fan capacity by about 100%. This prevents reverse flow of the potentially contaminated air of the Decontamination Room into the lower level Isotope Shop Area.

The air handling system is under continuous control by a monitoring and safety system. The air sampling tube is mounted across a diameter of the air exhaust stack about eight (8) feet above roof level. An air monitor located in the Clean Equipment Room with monitoring instrumentation located in the Hot Cell Control Area draws a continuous sample of four (4) to five (5) cubic feet per minute (cfm) for analysis. Any increase of activity above the preset level immediately stops the exhaust fans and the supply fan. The control system also includes automatic shutdown of either exhaust fan if a sudden pressure drop occurs across its absolute filters, indicating a rupture to the filter media.

The Decontamination Room provides space for opening the cell door without disturbing the air flow through the cell.

The original design of the facility had all drains on the first floor of the Restricted Area, with the exception of the toilet drains, connected to stainless steel holding tanks located in the Shielded Waste Room in the basement of the facility. Circa 1986, these drains were modified to route water to a plastic holding tank in the front basement. This plastic holding tank does not drain and holds water for evaporation.

The original floor drains in the basement were connected to the municipal sanitary system. These drains are sealed with concrete.

The Shielded Waste Hold-Up Tank Room which is not used is curbed twenty four (24) inches high to prevent waste water from running into the sanitary sewer in the event of a leak in one of the holding tanks. The holding tanks had a total capacity of six hundred (600) gallons and the curbed floor area, which has no drain, has a capacity of approximately twenty four hundred (2,400) gallons. Circa 1988, this room was sealed with all services to and from the room disconnected.

The operation of the air handling equipment, the monitoring facilities and the liquid waste facilities is insured in the event of electrical power failure by a natural gas burning emergency generator with automatic rapid changeover. An emergency lighting system is also powered by this generator.

All safety and monitoring devices are connected to an alarm panel in the Cell Control Area. Separate lights for each controlled item are always lit on the panel so that faulty operation of the panel itself is indicated by no light. When a controlled item malfunctions, the alarm light increases in intensity and flashes on and off until an acknowledgement button is depressed. An audible alarm also sounds on the first and second floors until acknowledged. This type of alarm will therefore indicate the difficulty even though it has corrected itself before the operator has checked the panel and the alarm signal will be erased only when the acknowledgement button has been depressed.

Alarms for fan shutdown, excessive heat or cold are also transmitted to a local alarm monitoring company so that malfunctions during non-working hours are reported to a responsible person.

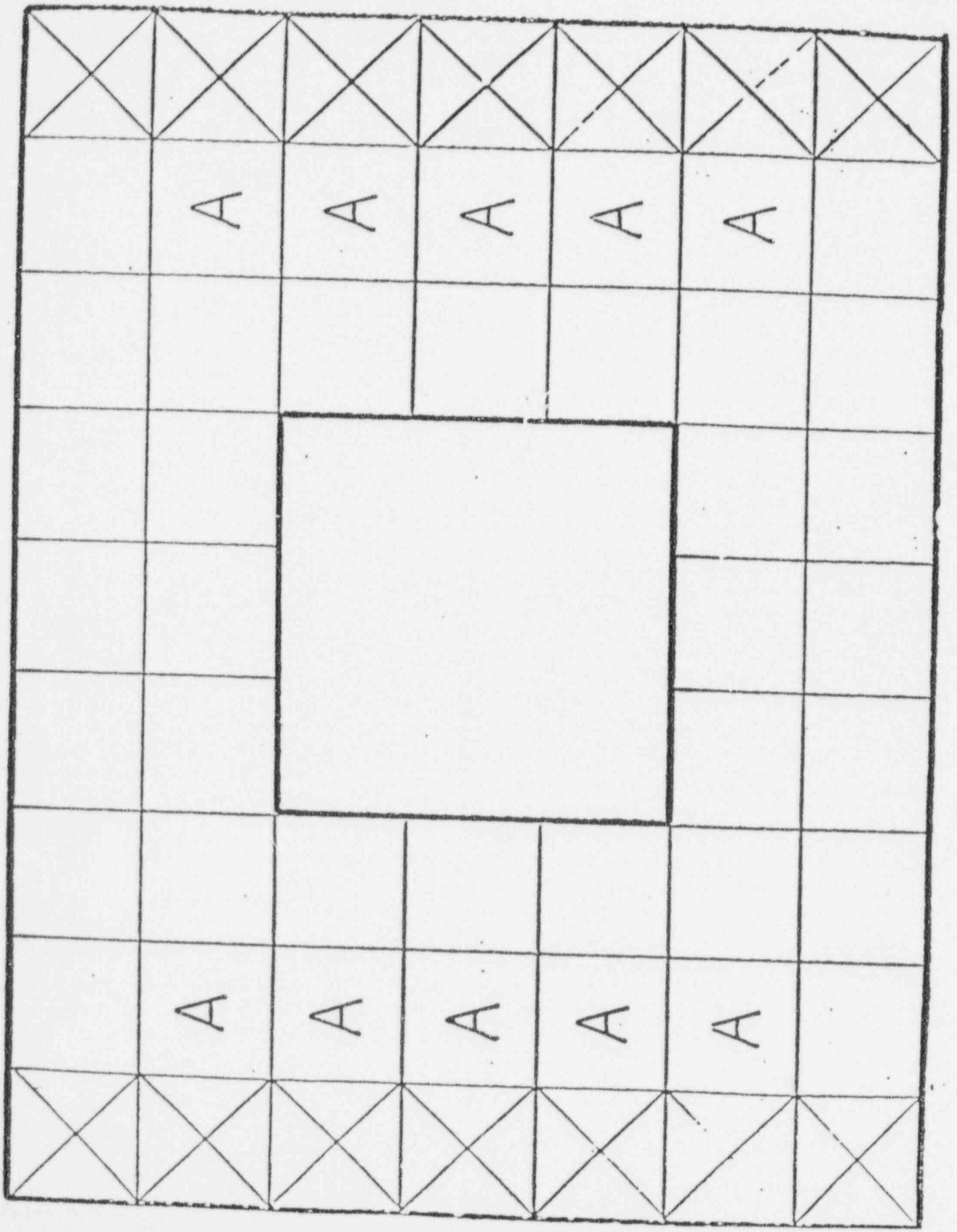
STORAGE GARDEN AND IRRADIATION FACILITY

The facility is located in the southwest corner of the building and contains vertical storage tubes in a six (6) foot square well extending from the first floor level to the basement floor level. An L-shaped shield around the well is provided by two (2) sand filled shield rooms that are accessible through manholes in the first floor. Coarse concrete sand with a bulk density of one hundred twenty seven (127) lb/ft^3 was used as the shielding material for a number of reasons. Immediate shielding requirements are easily handled by the use of sand, which can be replaced easily by a higher density material in the future, if desired. The rooms have been waterproofed and a well drilling point extends to the basement floor level beneath each manhole cover so that temporary additional shielding may be obtained by flooding the voids of the sand with water. Flooding increases the shield density by seven (7) lb/ft^3. If storage needs ever require it, the rooms can be emptied and filled with concrete, steel shot or other higher density material.

The Storage Garden is constructed with fifty four (54) vertical storage tubes in a rectangular array. The tubes are arranged in a 7 x 9 array with the center nine (9) spaces left open (see next page). The center space is fitted with an irradiation plug which can be used to irradiate objects up to eight and one half (8 1/2) inches square by twelve (12) inches high. Each of the tubes marked "A" can also be used for irradiation by placing sources in the four (4) tubes around each which have a common side. The two (2) outer rows of seven (7) tubes, marked by crosses, extend about two (2) feet below the bottom of the tubes in the central 7 x 7 array. This permitted installation of an irradiation facility beneath the garden with two (2) parallel rows of sources between which objects up to a seventeen (17) inch cube can be irradiated.

The source storage tubes terminate in a metal container through which cooling air is drawn from the room through the garden to the absolute filter exhaust system.

SOURCE STORAGE GARDEN ARRAY



PRELIMINARY EVALUATION OF CELL SHIELDING

On November 13, 1959, a shipping container containing 17,557 Curies in two (2) bulk capsules and 4550 Curies in three (3) therapy capsules (total 22,107 Curies) was opened inside the cell and the capsules placed on the cell table. A radiation survey of the areas around the cell was performed by a Victoreen Model 592 portable survey meter.

For the most part, there was no measurable increase in radiation levels with the exceptions noted below:

1) Cell Control Area (east wall of cell) - no measurable increase above background.

2) Shielded Work Room Corridor (north wall of cell) - no measurable increase above background.

3) Isotope Shop Area (south wall of cell) - no measurable increase above background.

4) Decontamination Room (west wall or door of cell) - primary leakage at surface of the door midway up on the door was negligible. Scatter leakage through the 1/8 to 1/4 inch clearance between the floor and the door was a maximum of 40mR/hr. Maximum leakage through a two (2) inch opening at top of cell door was 600mR/hr.

5) Cell Machinery Room (above cell) - maximum leakage of 5mR/hr at hoist support plug in the floor of the room.

6) Waste Storage Room (beneath cell) - no measurable increase.

To evaluate the adequacy of shielding in the floor storage plugs, the two (2) bulk capsules (17,557 Curies) were placed in the front plug and two (2) therapy sources (3,710 Curies) were placed in the rear plug. Measurements were made inside the cell and in the Waste Room below the cell.

1) Inside Cell - maximum leakage was 300mR/hr at the crack between the plug and floor. At floor level in the center of the port plug leakage was 22mR/hr. At waist height over the cell area maximum was 35mR/hr, minimum was 8mR/hr.

2) Waste Room - maximum leakage was 300mR/hr at the ceiling directly beneath the front plug. At head height maximum was 100mR/hr. At waist height maximum was 35mR/hr, minimum was 2mR/hr.

It should be pointed out that these high readings occur only in Restricted Areas that are not entered when the cell is in operation except for emergencies. These areas are the Decontamination Room, Cell Machinery Room and the Waste Storage Room.

PRESSURE GRADIENT BETWEEN CELL AND CONTROL AREA

The air handling system for the Isotope Shop Area has been carefully balanced to maintain the Cell at negative pressure relative to all other rooms in the building. The remainder of the Isotope Restricted Areas are at negative pressure relative to the Cell Control Area, but slightly above the pressure inside the Cell. These pressure gradients are maintained by supplying less air to the Isotope Shop Area than is removed by the exhaust system (slight negative pressure) and by supplying more air to the Cell Control Area than is removed by its exhaust system (slight positive pressure).

The pressure gradient between the Cell and Cell Control Area is indicated by the inclined tube manometer located directly over the cell window. Normal operation of the system provides a pressure differential of 0.2 to 0.4 inches of water absolute, the exact value depending upon whether fans are on high or low speed, cell door is open or closed, etc.

Experimentation has shown that the Cell pressure remains negative under virtually all abnormal operating conditions, even when all exhaust fans in the Isotope Shop Area are off. (The Cell Control Area is still pressurized by the independent system supplying this area).

In the event of fire or explosion inside the Cell, or in the other areas of the Isotope Shop Area, there may be a brief reversal of pressure gradient. This should cause little or no problem in the Cell Control Area, however, since virtually all of the normal air leakage into the Cell is through the transfer duct over the cell door and the air spaces around the cell door, any rapid pressure rise inside the Cell might be expected to relieve itself along these paths of least resistance.

Any resultant contamination problems would then be confined to Restricted Areas. Since the fans are well shielded from these areas by solid concrete, up to four (4) feet thick, and since the ductwork from the Cell to the fan runs a tortuous path through solid concrete, the exhaust ductwork should remain intact and the exhaust system continue operating.

EVALUATION OF CELL FILTERS IN FIRE OR EXPLOSIONS INSIDE THE CELL

The filters handling the exhaust from the Isotope Shop Area and Hot Cell are Cambridge Absolute Filters Type 1F-1000-2 (or equivalent) that are of fire-proof construction and rated for 800°F continuous service and should remain in-service even during a fire.

In the event of fire or explosion damage inside the Hot Cell, the following events will occur automatically:

A. An in-line smoke/heat detector located in the exhaust trunk from the Hot Cell would secure the Hot Cell and the Isotope Shop exhaust fans and the Isotope Shop supply fan. The associated low leakage spring shut automatic dampers will shut. All forced and induced air flow within the Hot Cell and Isotope Shop Area will cease.

The filters are rigidly mounted in angle frames and most probably the filter media would be ruptured before the filters yield in their frames.

SAFETY FEATURES

I. Master Alarm System

Six (6) safety and monitor devices are connected to the Master Alarm Panel in the Cell Control Area and to the Remote Alarm Panel in the Isotope Shop Area. The separate red lights for each controlled item are always dimly lit on the panel so that faulty operation of the panel itself is indicated by no light. When a controlled item malfunctions, the alarm light is increased in intensity and flashes on and off. In addition, a loud buzzer sounds on and off in synchronism with the flashing lights. This will continue until the acknowledgement button is depressed causing the buzzer to stop and the flashing light corresponding to the malfunctioning item to change to a steady bright red. The alarm can be erased only by correcting the difficulty after depressing the acknowledgement button. In addition, two (2) other warning lights show on the Master Alarm Panel; one for the Equipment Room door and for the Cell Machinery Room door on the second floor, and the other for the basement door in the Isotope Shop Area. These will indicate steady bright red lights when the doors have been opened and indicate to the Hot Cell Operator that personnel are in this area. Evaluation tests indicated that no unusual hazards exist in these areas under normal Cell operating procedure, but the precautions should be taken nevertheless.

On five (5) of the six (6) major systems, any alarm is transmitted to the local alarm monitoring company so that malfunctions during non-working hours are reported to a responsible person. The emergency generator will not trip the other five (5) alarms if it restores power before the fans stop.

The following are the six safety and monitoring systems and the conditions which will cause the alarm:

A. Cell Exhaust Fan

1. Shut down from lack of power or switch turned off.
2. Sudden pressure drop across air filter indicating a ruptured filter.
3. Improper pressure across filter indicating broken belts, fan inoperative, plugged filter or in-line manual damper is shut.
4. Excessive radiation on the air monitor.

B. Isotope Shop Area Exhaust Fan

1. Shut down from lack of power or switch turned off.
2. Sudden pressure drop across air filters indicating a ruptured filter.
3. Improper pressure across filter indicating broken belts, fan inoperative, plugged filter or in-line manual damper is shut.
4. Excessive radiation on the air monitor.

C. Air Monitor

Excessive airborne particulate levels above setpoint as indicated on the effluent air monitor system or electronic malfunction of monitoring equipment.

D. Cell Temperature

Two (2) thermostats, one located in the Cell Control Area and the other located in the Decontamination Room immediately behind the Cell, are set to give an alarm signal for temperatures below 40^0F or above 85^0F.

E. Supply Fan Freeze Up

A thermostat in the intake system after the heaters will give an alarm signal for temperatures below 50^0F.

F. Emergency Generator

Signal given on power failure when generator starts.

II. Hot Cell Systems

A. Door Interlock

An electrical interlock secures the door in the closed position until two (2) switches, one on the outside of the door and one on the cell face in the Cell Control Area, are depressed simultaneously. This safety feature makes it impossible for the Cell door to be opened without the knowledge and consent of the Cell Operator or for the door to be opened by a person working alone.

B. Cell Probe

A high energy probe, Victoreen Model 550 Series (or equivalent) is used within the Cell to locate loose Cobalt-60 pellets and other high radiation levels. It is connected to a Victoreen Model 510 Rate meter (or equivalent) located on the Cell face in the Cell Control Area. The rate meter is auto-ranging up to 2000R/min.

C. Gamma Alarm

A Technical Operations Gamma Alarm Model 492C (or equivalent) is mounted opposite the Cell face in the Cell Control Area. Since it is connected to a loud buzzer, it gives both an audible and a visual alarm (flashing red light) continuously when radiation levels are in excess of the preset level of approximately 2mR/hr. The gamma alarm features fail safe circuitry to provide a signal at all times. Failure of any element either turns on the red lamp or turns off the green (safe) lamp, signalling improper operation.

III. Decontamination Room

A. The Hot Cell Exhaust fan is driven by a two speed motor which is controlled by the position of the double doors connecting the Decontamination Room with the Isotope Shop Area. With the doors closed the fan operates at low speed which is indicated by a red light on the locked switch control at the Cell face. With the doors opened the fan speed is increased for about 100% greater capacity. This prevents reverse flow of potentially contaminated air of the Decontamination Room into the Isotope Shop Area. High speed mode is indicated by a yellow light on the locked switch control at the Cell face.

IV. Isotope Shop Area

A. Gamma Alarm

A Technical Operations Gamma Alarm, Model 492D (or equivalent) is mounted on the west wall between the Storage Garden and the Decontamination Room adjacent to the source transfer operation. This will give a visible flashing red light when radiation exceeds the preset level of 5mR/hr.

B. Basement Door

When the basement door is opened, a steady red light turns on above the door. Also, a steady red light shows on the Master Alarm Panel.

C. Air Locks

1. The doors at either end of the Change Area are electrically interlocked to prevent simultaneous opening which might disturb the air flow pattern. The entrance to the Change Area from the Cell Control Area is an air lock by itself. The first door is interlocked with the door on the opposite side of the Change Area leading into the Isotope Shop Area.

2. The air lock on the west side of the Isotope Shop Area has three (3) electrically interlocked doors. One set of doors leads to the Isotope Shop Area; one set leads to the Isotope Warehouse, and the last set on the north side of the air lock leads to the Restricted Area. When the Isotope Shop Area doors are open, the other two doors cannot be opened. When one of the other two doors is open, the Isotope Shop Area doors cannot be opened.

V. Equipment Room

A. This room is directly above the Shielded Work Room. This room contains the heating and intake air fan as well as the air conditioners. The floor is shielded with two (2) feet of concrete. A Technical Operations Gamma Alarm, Model 492B (or equivalent) set at approximately 2mR/hr is mounted in the center of the room. It remotely indicates a signal above the entrance to the room. No one is permitted to enter this room without permission of the Radiation Safety Officer (RSO) or designee. In addition, when the door is opened, a steady red light shows on the Master Alarm Panel.

CAUTION: Personnel are not permitted in this room when there is no signal white light or when there is a red light.

VI. Doors

A. Only authorized personnel have access to keys to any Restricted Areas. Doors to Restricted Areas are kept locked at all times. This includes the following:

1. Air lock from Cell Control Area to Change Area.

2. Doors from the Shop Area to the air lock.

3. Doors from the Warehouse to the above air lock.

4. Doors from the air lock to Isotope Shop Area.

5. Doors from the Warehouse to the Shop Area on the northeast side of the Warehouse.

6. Equipment Room on second floor.

7. Cell Machinery Room on second floor.

8. Room adjacent to Cell Machinery Room.

9. Basement door opening to clean side of basement.

10. In addition to above, the perimeter of the entire facility is tied in with a local alarm monitoring company.

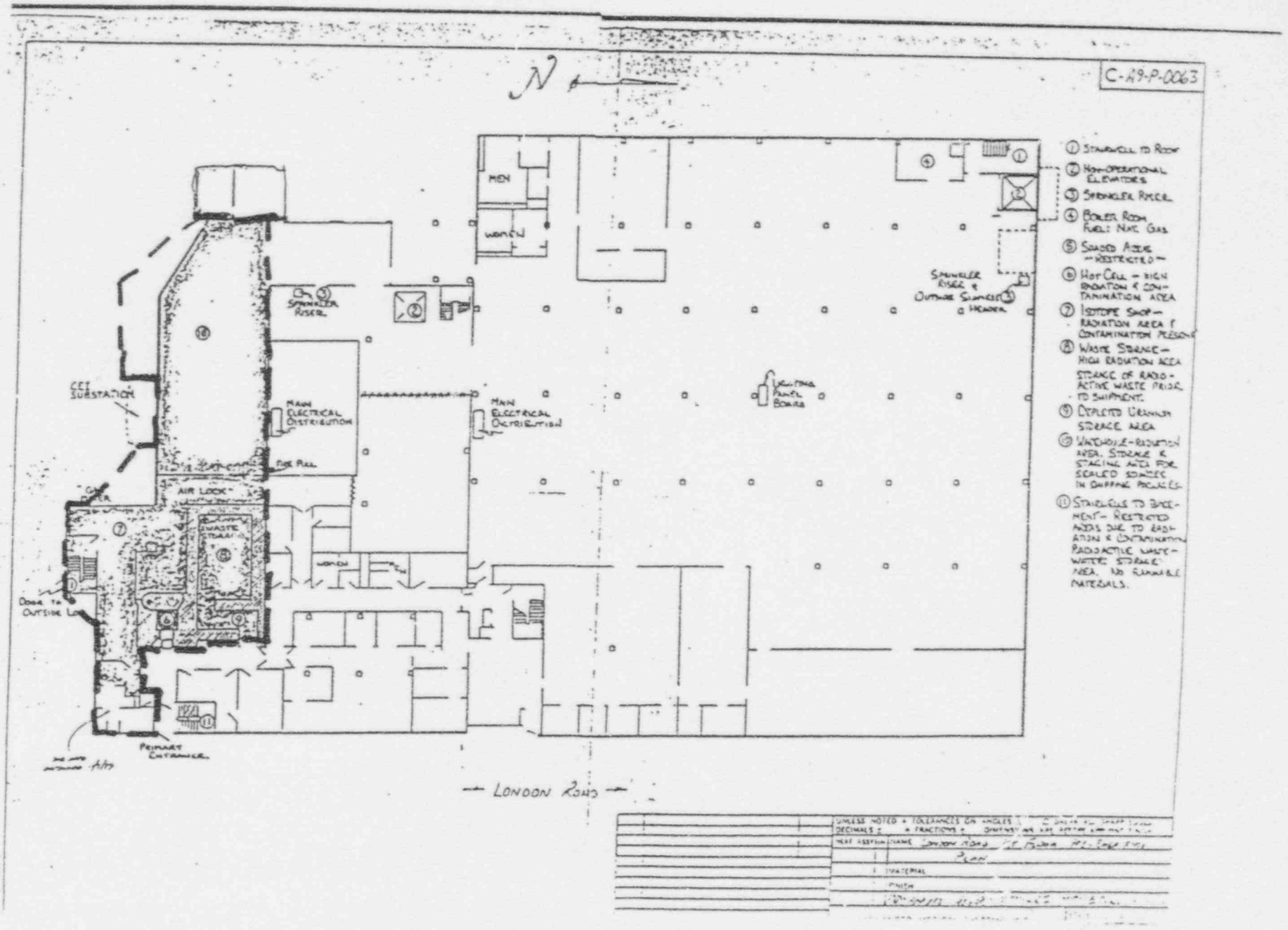
BASEMENT RESTRICTED AREA

---INDICATES RESTRICTED AREA
CONTROLLED ACCESS

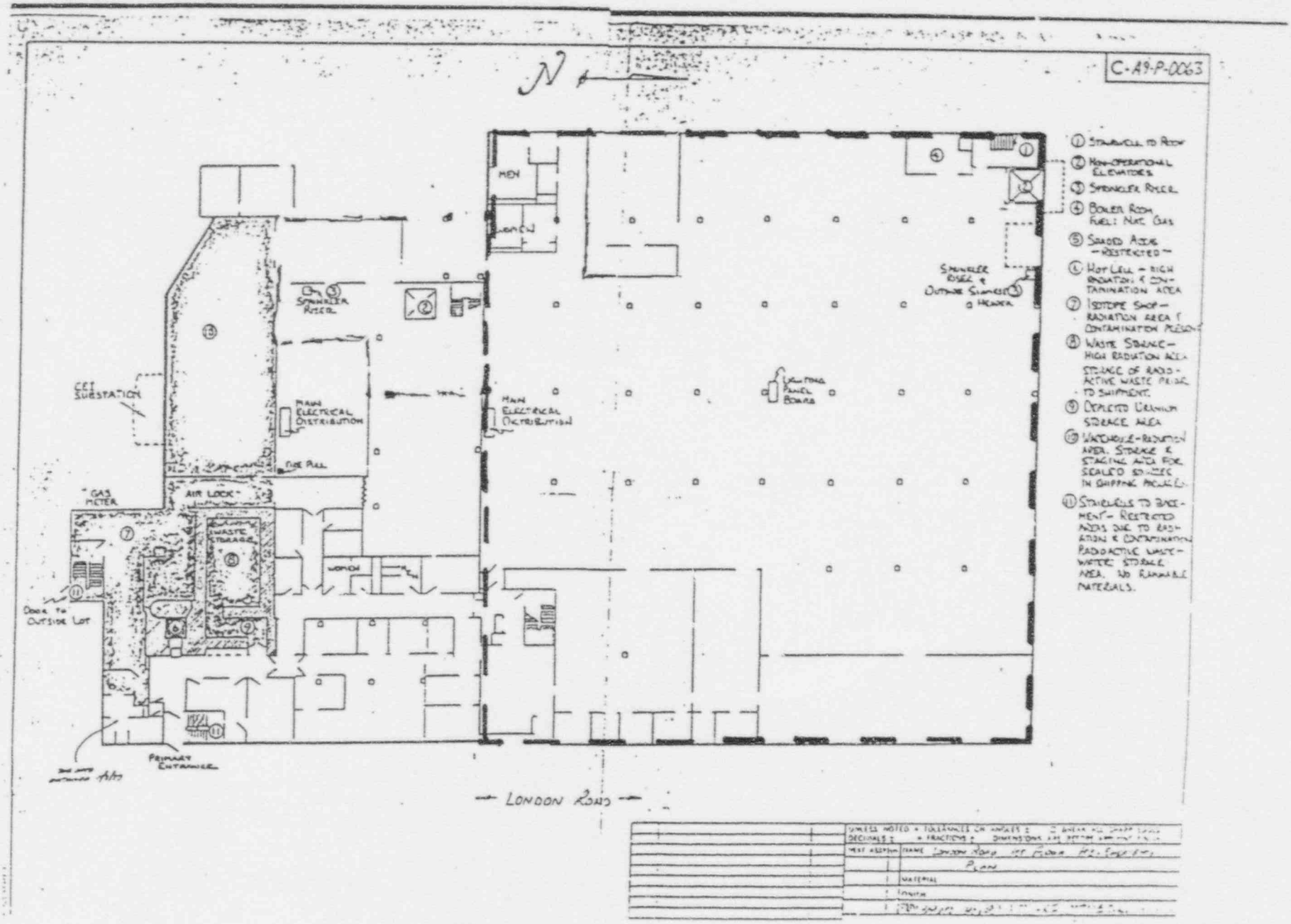
BASEMENT

SCALE 1/16"

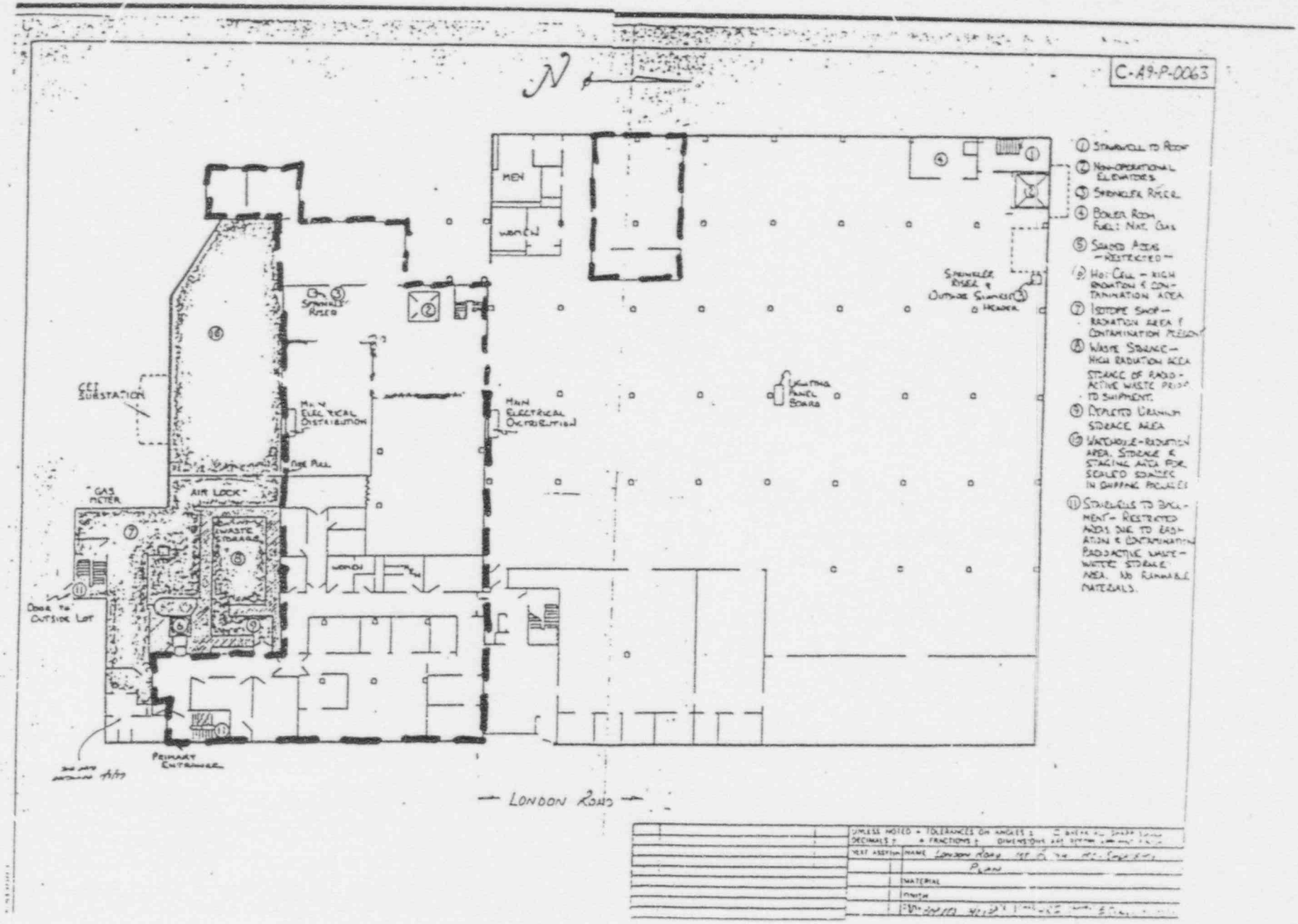
FIRST FLOOR RESTRICTED AREA



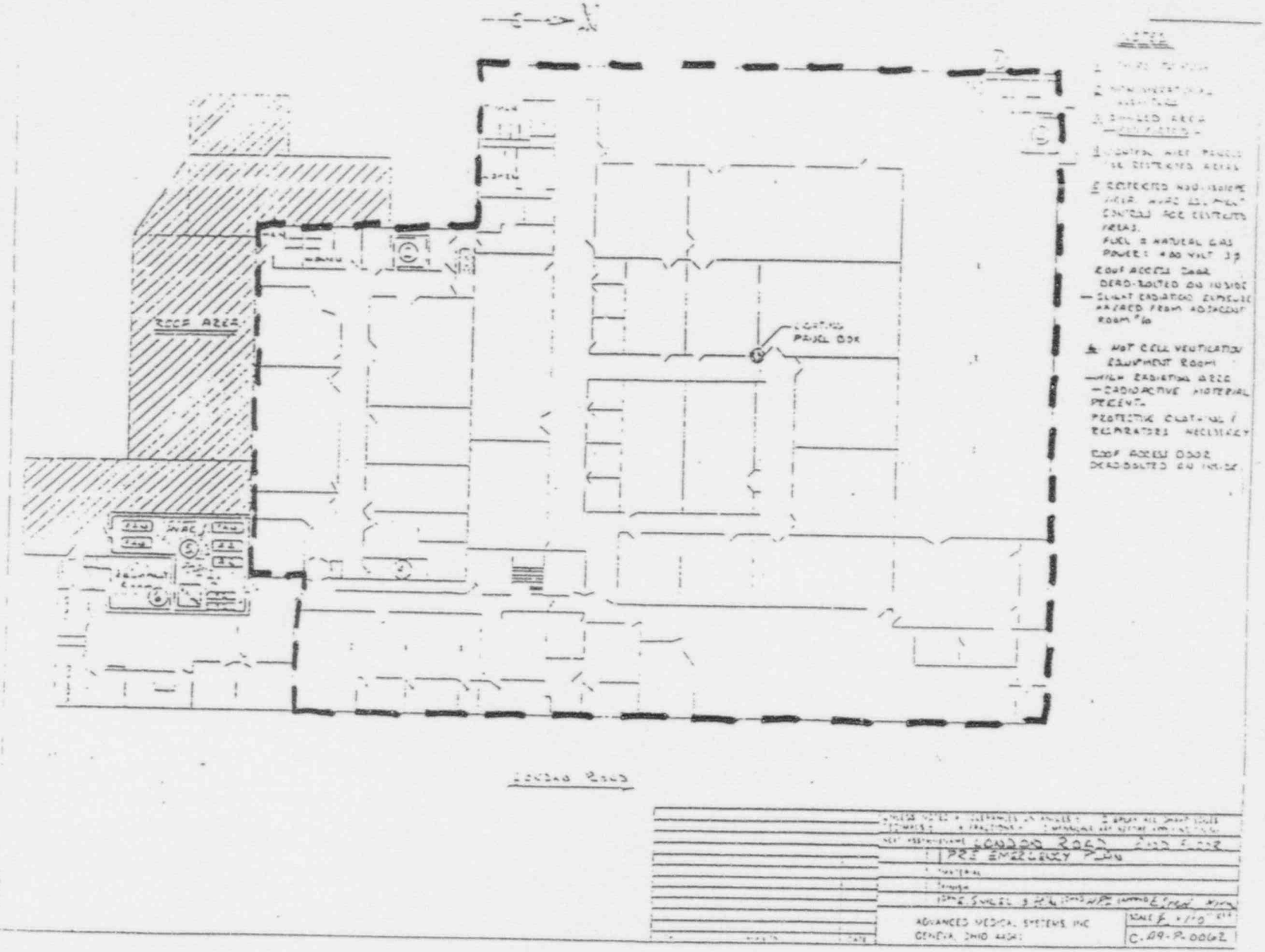
FIRST FLOOR UNRESTRICTED AREA



FIRST FLOOR CONTROLLED AREAS



SECOND FLOOR UNRESTRICTED AREA



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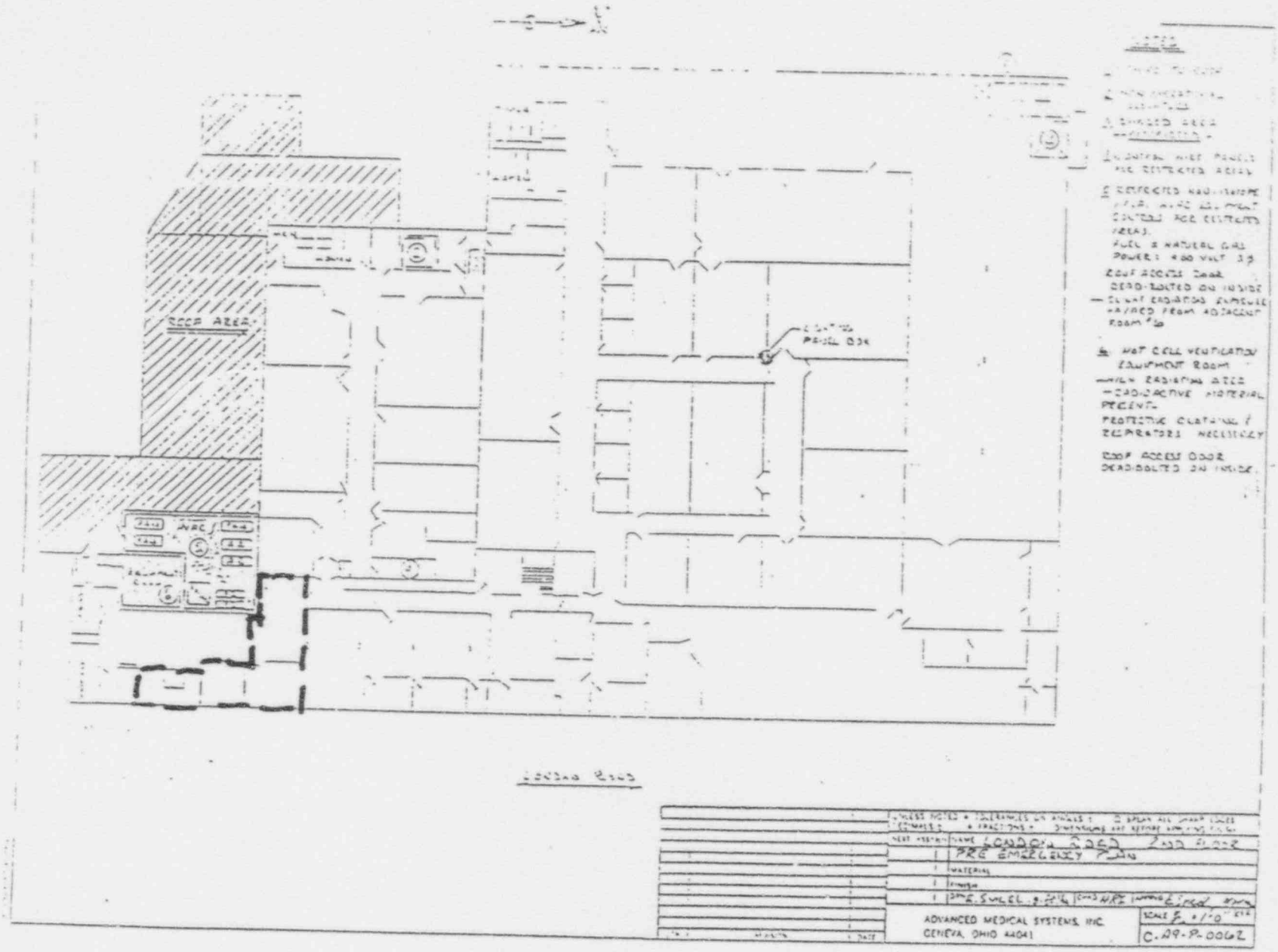

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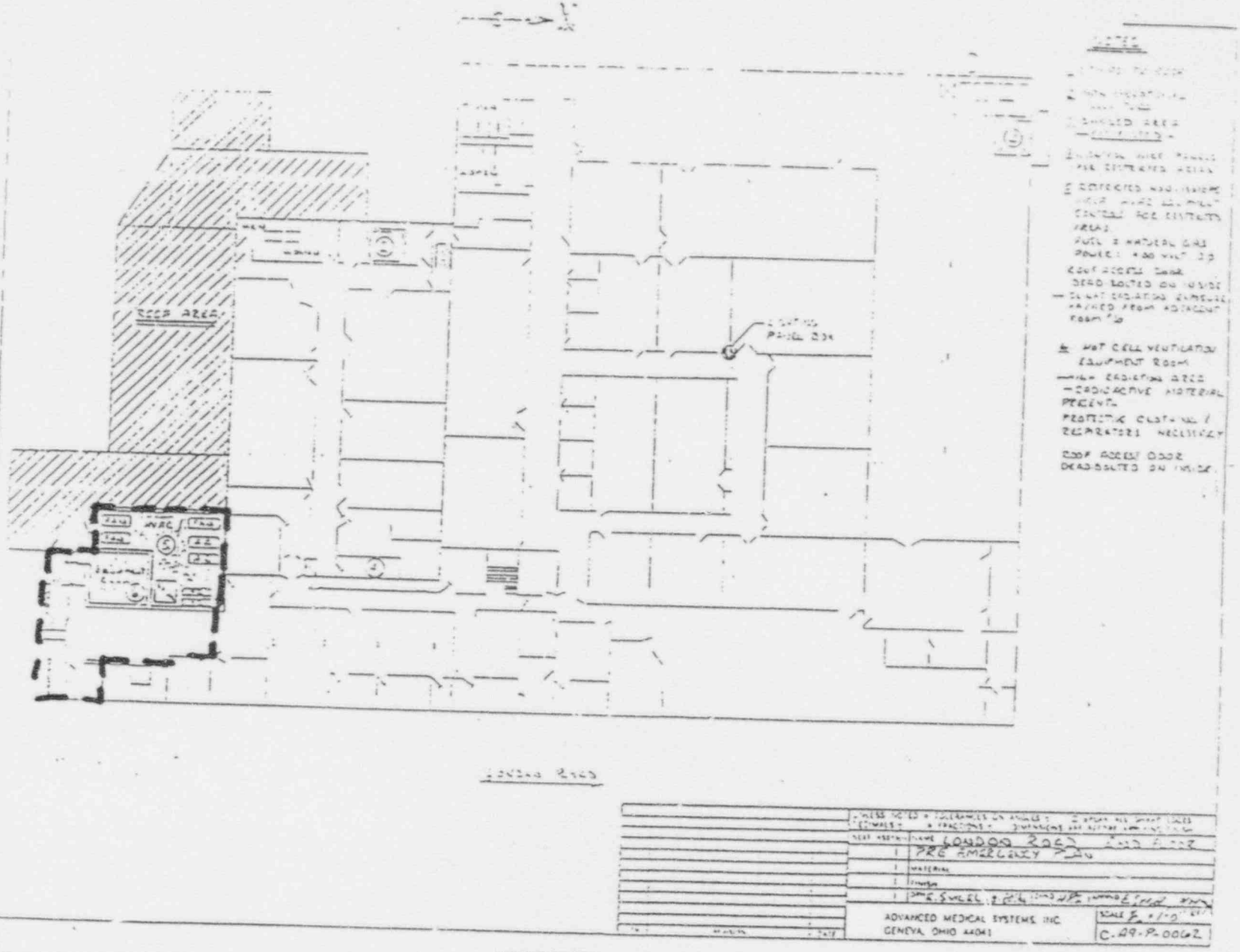

ROOF RES...D AREA

ROOF	AGE	TYPE	DECK	COVER	REPAIRS	RECOVERED
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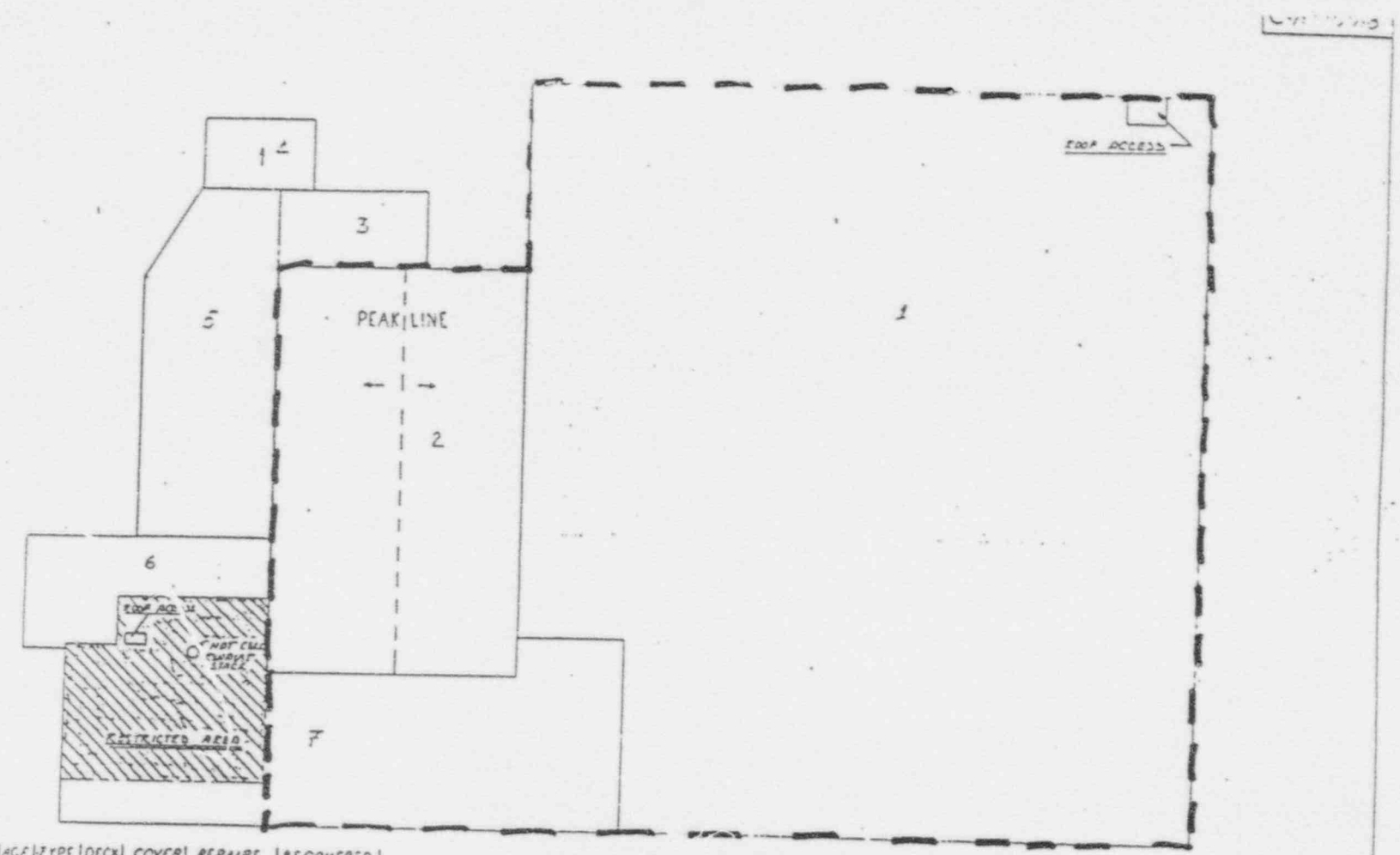
2	1958	GABLE	WOOD	RI. ASPH.	1983	
3	1960	FLAT	STEEL	ASPH/[illegible]		
4	1960	FLAT	STEEL	" "		
5	1958	FLAT	STEEL	ASPH/[illegible]	1981	
6	1958	FLAT	STEEL	ASPH.		
7	1958	FLAT	CONCRETE	ASPH [illegible]		

ROOF UNRESTRICTED AREA



FOOTAGE	TYPE	DECK	COVER	REPAIRS	RECOVERED
1	FLAT	CONCRETE	ASPH/GRAVEL	1983	
2	GABLE	WOOD	ASPH/GRAVEL	1983	
3	FLAT	STEEL	ASPH/GRAVEL		
4	FLAT	STEEL	" "		
5	FLAT	STEEL	ASPH/GRAVEL	1981	
6	FLAT	STEEL	ASPH		
7	FLAT	CONCRETE	ASPH/GRAVEL		

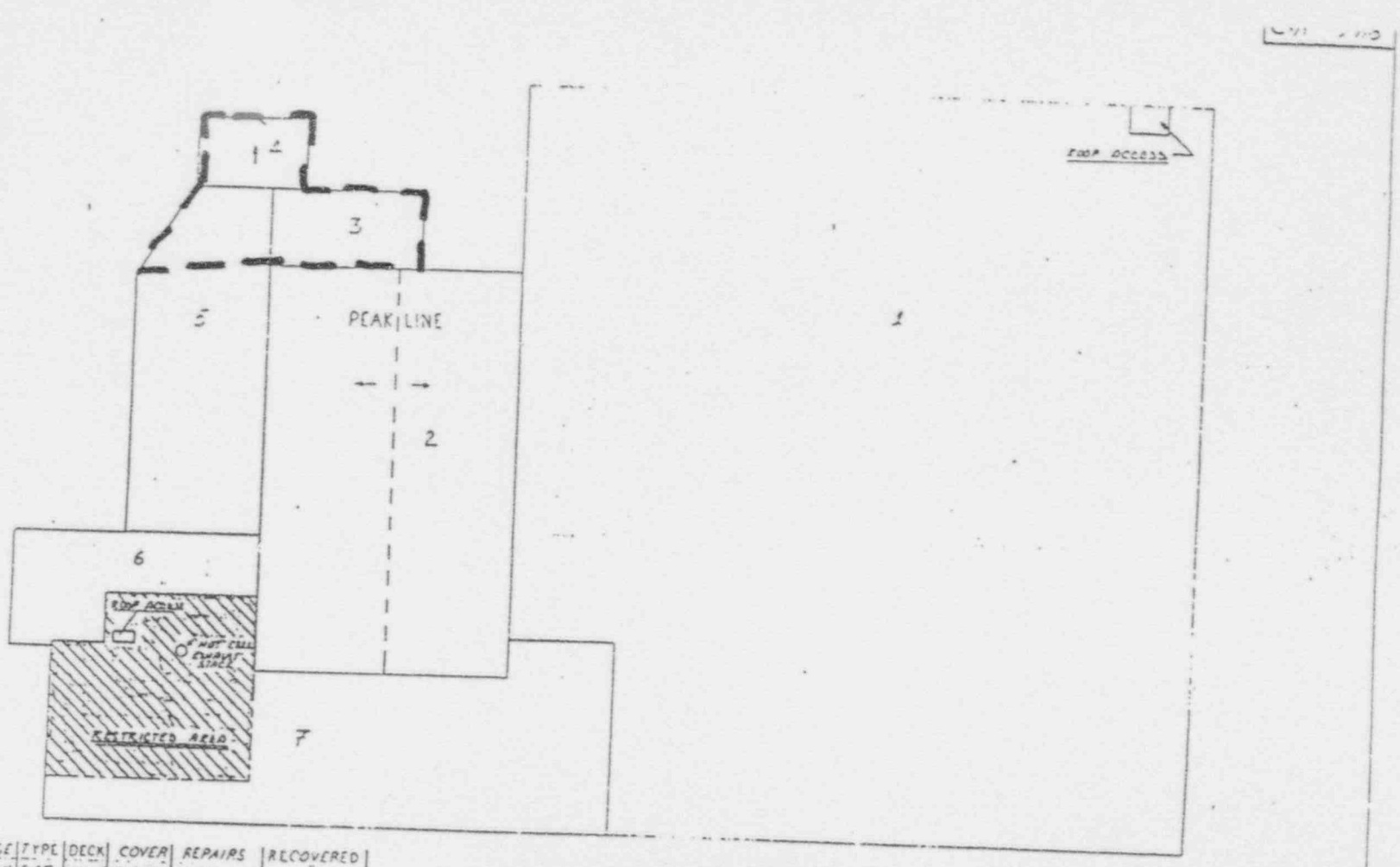
UNLESS NOTED ± TOLERANCES ON: ANGLES ± DECIMALS ± FRACTIONS ± DIMENSIONS ARE BEFORE APPLYING FINISH. BREAK ALL SHARP EDGES

NEXT ASSY | NAME: LONDON ROAD FACILITY ROOF LAYOUT | MATERIAL | FINISH | DRAWN | CHECKED | APPROVED | DATE

ADVANCED MEDICAL SYSTEMS, INC. GENEVA, OHIO 44041

SCALE 1/16" = 1'-0" | C-A9-R-3019

ROOF CONTROLLED AREA



ITEM	AGE	TYPE	DECK	COVER	REPAIRS	RECOVERED
1	[illegible]	FLAT	[illegible]	ASPH / [illegible]	1983	
3	1958	GABLE	WOOD	RI ASPH	1983	
4	1960	FLAT	STEEL	ASPH/[illegible]		
2	1960	FLAT	STEEL	" "		
5	1958	FLAT	STEEL	ASPH/[illegible]	1981	
6	1958	FLAT	STEEL	ASPH		
7	1958	FLAT	CONCRETE	ASPH [illegible]		

UNLESS NOTED ± TOLERANCES ON ANGLES ± DECIMALS ± ± FRACTIONS ± DIMENSIONS ARE BEFORE APPLYING FINISH. ☐ BREAK ALL SHARP EDGES

NEXT ASSY | NAME LONDON ROAD FACILITY
ROOF LAYOUT
MATERIAL
FINISH
DRAWN | DATE | APPROVED | DATE

ADVANCED MEDICAL SYSTEMS, INC.
GENEVA, OHIO 44041

SCALE 1" = 1'-0"
C-A9-A-5015

PERSONNEL EXPOSURE POLICY

It is the policy of Advanced Medical Systems, Inc. (AMS) that exposure of personnel to ionizing radiation be kept As Low As Reasonably Achievable (ALARA) and always within the limits of 10CFR20. This chapter outlines the limits and procedures to be used by all AMS employees to maintain exposure ALARA.

PERSONNEL EXPOSURE MONITORING

For monitoring personnel exposure, the following guidelines are in effect:

I. Self Reading Pocket Dosimeters (SRPD)

A. SRPDs are available in the following ranges: 200mR, 1R and 5R.

B. All personnel should wear a 200mR SRPD while at the Isotope Facility. At a minimum, it is to be read at the end of each working day.

C. The 1R and 5R SRPDs are for use in any instance where work is performed in areas or with materials which may cause a whole body exposure equal to or greater than 100mR in one hour. They may be worn in conjunction with a 200mR SRPD. SRPDs should be read at least once every fifteen (15) minutes during such work or more frequently depending on the type of work and exposure rates involved.

D. All SRPD readings are to be recorded on the Monthly Dosimeter or Visitors Log book at the end of each working day. This Log is used to keep track of personnel exposure on a continual basis and is reviewed by the Radiation Safety Officer (RSO) at least monthly.

II. Film Badges

A. Film badges are supplied by a commercial service. They shall be worn by any personnel working in a Radiation Area of the Restricted Area and are to be worn within an inch of a 200mR SRPD by all Isotope personnel.

B. Film badges are processed at least weekly.

C. Film badges are issued to non-AMS personnel when all of the following conditions are met:

1. They will perform work related to facility operations and the work is performed in a Restricted Area.

2. The individual is likely to receive more than 125mrem during the entire year from exposure to sources of radiation and radioactive material at the London Road facility.

3. Training has been conducted and signed by the individual and the RSO or designee.

III. Extremity Dosimetry - Thermo Luminescent Dosimeters (TLD)

A. Finger ring TLDs are worn by all Isotope personnel when handling radioactive materials.

B. Additional TLDs are available for extremity monitoring (i.e. head, feet, etc.)

C. Extremity TLDs are processed at least monthly.

D. All dosimetry reports are reviewed by the RSO and maintained as permanent record of personnel exposure.

IV. Audible Dosimetry or Alarming Dosimeters

A. These devices are to be worn by Isotope personnel when directed by the RSO. Typically these devices are used in activities that have high exposure potential (i.e. Cell entries, etc.).

PERSONNEL EXPOSURE LIMITS

The following limits for personnel exposure to ionizing radiation are in effect for AMS Isotope personnel. Members of the public allowed access to Restricted Areas of the facility are subject to the exposure limits of 10CFR20.1301.

I. Total Effective Dose Equivalent (TEDE)

A. An administrative Total Effective Dose Equivalent limit of four and a half (4.5) rem/year is in effect.

B. Personnel are responsible for tracking their exposure and maintaining their exposure within administrative limits.

C. The RSO shall periodically review individual exposure records and conditions under which the exposure was received.

II. Extremity Exposure

A. Extremity exposure shall be controlled within 90% of the limits of 10CFR20.1201.

B. Personnel are responsible for tracking their exposure and maintaining their exposure within the administrative limits.

C. The RSO shall periodically review individual exposure records and conditions under which the exposure was received.

III. Internal Exposure

A. Internal exposure is most likely to occur from work in areas of potential airborne contamination. This type of exposure shall be monitored by calculating DAC-hrs and intake for each individual working in any such area as follows:

$$\frac{\text{concentration of air sample}}{1.0 \times 10^{-8}} \times \text{time in area} = \text{DAC-hrs}$$

Time in area x 2 x 10^4 x concentration of sample = Intake

B. The administrative limit for Internal Exposure is 200 DAC-hrs/year. The sum of the External and Internal exposure should not exceed the administrative TEDE. In the event that these limits are exceeded, the RSO shall review all circumstances involved to determine any necessary actions.

C. Individuals are responsible for maintaining their exposure within these limits.

D. Internal exposure shall also be monitored by periodic Whole Body Counts performed by a commercial service.

IV. Exposure Control for Minors, Declared Pregnant Women and Members of the General Public

A. The annual occupational exposure for minors shall not exceed 10% of any annual dose limit for adults as specified in 10CFR20.1201.

B. The occupational exposure for a Declared Pregnant Woman shall not exceed 500mrem TEDE during the entire gestation period. It is the responsibility of the woman to declare pregnancy in writing to AMS.

C. The TEDE to members of the public shall not exceed 100mrem in one calendar year from external sources of radiation from the London Road facility. If a member of the public is given access to a Restricted Area, the limits for members of the public continue to apply to these individuals.

RADIATION AND CONTAMINATION SURVEY REQUIREMENTS

This section provides guidelines for survey frequencies and radiation and contamination action levels. Also described are uses and controls for Restricted and Controlled Areas within the Isotope Facility.

I. Controlled Area Action Levels

A. A Controlled Area is any area within the facility which requires minimal precautions for entry regarding radiation exposure or contamination levels. Radiation and contamination surveys are to be performed:

1. At least twice a month.
2. Immediately after any evolution which may raise exposure or contamination levels above the action levels.

B. Action Levels

1. 0.5mR/hr in occupied areas.
2. 1000 dpm/100cm^2 loose surface contamination.

C. If any of these levels are exceeded, notify the RSO as soon as possible and proceed with any or all of the following actions:

1. Restrict access to the area in accordance with survey results.

2. Determine and remove the source of radiation, if possible, and resurvey.

3. Determine the source of contamination, decontaminate and resurvey.

II. Restricted Area Action Levels

A. Radiation and contamination surveys are to be performed at least monthly or immediately after any evolution which may significantly change radiation or contamination levels. Restricted Areas within the Isotope Facility may fall under one or more of the following:

1. Contaminated Area - Any area where contamination levels are permitted above 1000 dpm/100cm^2.

2. Radiation Area - Any area, accessible to individuals, in which radiation levels could result in an individual receiving a dose equivalent in excess of 5mrem in one hour at 30 centimeters from the radiation source or from any surface that the radiation penetrates.

3. High Radiation Area - Any area, accessible to individuals, in which radiation levels could result in an individual receiving a dose equivalent of 100mrem in one hour at 30 centimeters from the radiation source or from any surface that the radiation penetrates.

4. Very High Radiation Area - Any area, accessible to individuals, in which radiation levels could result in an individual receiving an absorbed dose in excess of 500rads in one hour at one meter from a radiation source or from any surface that the radiation penetrates.

5. Airborne Radioactivity Area - Any area in which airborne radioactive materials, composed wholly or partly of licensed material, exist in concentrations-

   a. In excess of the Derived Air Concentrations (DACs) specified in Appendix B to 10CFR 20.1001-20.2401, or

   b. To such a degree that an individual present in the area without respiratory protective equipment could exceed, during the hours an individual is present in a week, an intake of 0.6 percent of the Annual Limit on Intake (ALI) or 12 DAC-hours.

6. All of these areas shall be posted in accordance with the requirements in 10CFR20.

B. Action Levels for Restricted Areas

1. Surface contamination - 40,000 dpm/100cm^2 (except Hot Cell). Contamination levels exceeding this amount should be decontaminated. A survey of the decontamination results shall be documented and forwarded to the RSO for review and filing.

2. Radiation levels - Areas shall be posted in accordance with the levels stated above (i.e. Radiation Area, High Radiation Area or Very High Radiation Area). Where practical, sources of radiation shall be moved or shielded to maintain personnel exposure ALARA.

3. Airborne levels - Posting is required for areas that could exceed the levels defined in the definition of an Airborne Area. Portable air samples are required for entry into these areas. Respiratory protection may be required for entry into these areas.

C. Hot Cell Entry and Action Levels

1. The Hot Cell is the only accessible potential Very High Radiation Area within the Isotope Facility. Each entry requires a job specific Radiation Work Permit (RWP) and specific permission of the RSO. It is preferred that the RSO be on-site for all Cell entries. If the RSO is not available, the Senior Isotope Handler may supervise the Cell entry with prior specific authorization of the RSO.

2. The Hot Cell is surveyed remotely with a Victoreen Model 500 Ratemeter (or equivalent). Monitoring is performed continuously during all phases of source production and remote decontamination operations. Although Hot Cell operations have been very limited since January 1988, recent experience indicates that levels of 1,000mR/minute or less should be maintainable during operations (source material in storage plugs).

3. Hot Cell entries shall be performed in accordance with ISP-14.

D. Schedule of Routine Safety Assurance Checks

The following is a schedule of minimum frequency requirements for all routine safety functions performed at the Isotope Facility.

1. Daily

   a. Read air monitor chart and time delay.
   b. Read Hot Cell and Isotope Lab pressure differential.
   c. Check alarm board for red lights.
   d. Check gamma alarm lights.
   e. Visual inspection and response check of survey instruments.
   f. Check source inventory.
   g. Read and record SRPD readings.

2. Weekly

   a. Whole body film badge change.

3. Semi-Monthly

   a. Emergency generator test.
   b. Controlled Area radiation and contamination surveys.
   c. Test emergency lighting.

4. Monthly

   a. Gamma alarm function test.
   b. Stack air monitor sample analysis.
   c. Emergency generator battery check.
   d. Area TLD change.
   e. Extremity TLD change.
   f. Restricted Area surveys.
   g. Waste Holdup Tank Room visual inspection.
   h. Conduct a fire and safety check of entire facility.

5. Quarterly

   a. Radiation survey of sanitary sewer.
   b. Stack Air Monitor check source response check.

6. Semi-Annually

   a. Calibration of portable survey instruments in use.
   b. Radiation and contamination survey of unused facility areas.
   c. Radiation and contamination survey of facility perimeter.
   d. Calibration source leak test.
   e. Isotope decay inventory.

7. Annually

   a. Submit required reports to the Nuclear Regulatory Commission (NRC).
   b. Radiation Safety Program review as per ISP-17.
   c. Respiratory Protection Program review as per ISP-39.
   d. Refresher training for isotope facility personnel.

8. Biennial

   a. Independent audit of AMS records and procedures.
   b. Emergency Plan drill.

9. 5-Year Scheduling

   a. Physical inventory of all isotopes at AMS London Road.
   b. Physical inspection of Hot Cell automatic damper seals.

10. Each Use

   a. Personnel monitoring for contamination upon leaving a Contaminated Area or after handling contaminated material.
   b. Surveys of areas where there has been a potential change in radiation, contamination or airborne levels.

CHAPTER 3 - PROCEDURES FOR HANDLING RADIOISOTOPES

HAZARDOUS QUALITIES OF ISOTOPES

All use of isotopes is to be considered hazardous and requires prior approval by the Isotope Committee. Special care must be exercised in handling isotopes.

The use of Cobalt-60 requires careful planning of operations since it is a penetrating gamma radiation emitter.

Depleted Uranium is used as shielding material in source head construction. This material is purchased in the final form. This material is nickel plated. No machining is done after receipt, therefore, a low hazard is presented.

The Cobalt-60 will be in the form of solid metal encapsulated in a source capsule.

AMS currently purchases Cobalt-60 in sealed source form only.

Unencapsulated Cobalt-60 is stored in screw-top capsules. The company posseses this type of Cobalt incident to transfer to a third party. Advanced Medical Systems no longer encapsulates Cobalt-60. The sealed sources are used or handled with loading equipment only in the Controlled Isotope Shop Area or the Shielded Work Room.

EXTERNAL HAZARDS

I. General Operation Procedures

When working with sources of penetrating radiation, the following steps will help maintain exposures ALARA:

A. Plan each step of the operation thoroughly in advance.

B. Keep as far away from the source as practical at all times.

C. Avoid getting radioactive material on the hands. Hands should be kept at a safe distance from the source, as even small sources will cause burns if the distance is close enough.

D. Interpose a proper shield between you and the source whenever practical.

E. Obtain actual exposure data with the proper monitoring instruments.

F. Know the properties of the material you are going to work with.

G. Attempt to positively identify the radioactive material and determine the activity.

H. Consult frequently with the Radiation Safety Officer.

II. Specific Procedures

A. Source Transfer Operations

In any operation involving movement of a source, from one container to another, there is a momentary period of higher radiation intensity as the source crosses the fine gap between containers. For this reason, the area around any transfer operation must be cleared of all personnel not required for the transfer and the operating personnel must observe appropriate procedures.

B. Entering the Liquid Waste Storage Room

The room is sealed and will not be unsealed until its radiation levels are low enough to permit decontamination.

C. Entering the Hot Cell - See ISP-14.

D. Entering the Equipment Room

This room is located directly above the Shielded Work Room and has adequate floor shielding for our operations. A gamma alarm in the Equipment Room gives a red signal if the radiation level exceeds 2mR/hr and remotely indicates the signal above the entrance to the room.

CAUTION: When there is no white signal light or there is a red light personnel are not permitted in this room until cleared by the RSO.

INTERNAL HAZARDS

Deposition of radioactive materials in the body may from ingestion, inhalation and absorption through the skin. It must be remembered that, apart from the accidental swallowing of a radioactive solid or solution, ingestion may take place quite unnoticed over long periods of time through contaminated food, cigarettes or other articles brought to the mouth. The presence of

radioactive dust or spray in a laboratory may lead to similar chronic intake through inhalation. The following procedures are designed to prevent these internal hazards:

I. General Operating Procedures

A. Do not eat, drink or smoke in any Restricted Area or when handling any radioactive source.

B. Personnel with open cuts or lesions shall obtain permission from the RSO prior to working in potentially Contaminated Areas.

C. Never handle radioactive material with bare hands. Forceps, rubber gloves or some other interposing device should always be used.

D. General air ventilation shall be maintained.

E. Local exhaust ventilation is mandatory.

F. All effluents from local exhaust systems and from Restricted Areas must be properly filtered before being discharged to the outside.

G. Know the properties of the material with which you are to work and attempt to identify and determine its activity.

H. Plan ahead each step of the operation prior to entry into the Restricted Area. This should include actions to be taken in the event of emergencies.

I. Frequent house cleaning and good personal hygiene practices are essential.

J. Isotope shop surfaces are designed to prevent the accumulation of dust and must be kept clean.

K. Consult frequently with the Radiation Safety Officer.

II. Specific Operating Procedures

A. Cell and Decontamination Room - Respirators and proper protective clothing must be worn in these areas.

B. Liquid Waste Storage and Processing Room

These rooms are sealed and will not be unsealed until their radiation levels are low enough to permit decontamination.

III. Accidents and Emergency Techniques

In the event of accidental leakage or spillage from potentially hazardous amounts of radioactive material, the following measures should be taken at once:

A. Stop the leak or spill taking care not to put yourself in a hazardous situation.

B. Where liquids or solids are involved, no immediate attempt should be made to clean up the area.

C. Local exhaust ventilation should be maintained where radioactive gases are involved. Ask the RSO whether the building ventilating system should remain on.

D. Everyone should leave the room and the doors should be closed and locked.

E. If powdered sources are involved, the doors and all the other openings leading into the room should be sealed with wide masking tape or other suitable material.

F. It shall be assumed that all personnel within the accident area have been contaminated until checked out with adequate monitoring equipment.

G. Entrance to the Contaminated Area is prohibited until the RSO can be called in and his advice followed.

PROTECTIVE CLOTHING

The company furnishes a complete change of clothing which must be worn by any personnel performing work in a Restricted Area where radioactive contamination is known to exist or is suspected.

CHAPTER 4 - STORAGE OF ISOTOPES

GENERAL STORAGE PROCEDURES

A. All radioactive isotopes must be stored in areas specifically designated for them by the RSO.

B. Storage facilities have been predicated on the type of emitter involved and the quantity being stored.

C. No solution is to be stored uncovered. Dry materials are to be placed in dust-tight containers.

D. Place glass containers in an unbreakable outer container large enough to contain the volume of material should the glass break.

E. If the storage area contains radioactive gases or materials which decay with the formation of such gases, make certain that the local exhaust ventilating system is in operation prior to opening.

F. Should temporary storage outside of permanent storage areas be necessary, consult first with the RSO. Proper posting is required.

POSTING

A. Posting requirements of current regulations must be observed.

B. Posting signs, tags and labels of the approved type must be used and are available from the RSO.

SPECIFIC STORAGE PROCEDURES

I. Storage Garden

Isotopes to be placed in the garden must be in a welded capsule.

CAUTION: The transfer cask must be used to remove storage rods, even when empty, since this operation otherwise opens an unshielded air path into the source region.

II. Liquid Waste Storage Room

This room is sealed and will not be unsealed until its radiation levels are low enough to permit decontamination.

III. Cell

The storage containers provided in the floor of the Cell may be used for radioisotope storage.

IV. Shipping Containers

Radioisotopes may be stored in shipping containers as long as labeling and safety requirements are met.

CHAPTER 5 - TRANSPORTATION OF ISOTOPES

Transferring or shipping of licensed quantities of isotopes outside the company itself, should be authorized only by the Isotope Committee. Transportation of these isotopes to other areas, or from one area in the building to another, for the purpose of research or development work is permissible when such transportation procedures have been covered by the RSO in the initial programming of the work.

GENERAL TRANSPORTATION PROCEDURES

A. All radioactive isotopes must be transported in containers that are suitably designed for use as temporary or permanent storage.

B. If isotopes are in glass containers, transportation containers must be large enough to contain the volume of material should the glass break. If gases are involved, containers must have a tight seal.

C. Material must never be left unattended during transportation between facilities.

D. Whenever practical, transport isotopes through the building at periods of least congestion and use the most direct route practicable.

E. All licensed by-product material being transported must be labelled as prescribed by current regulations.

SPECIFIC TRANSPORTATION PROCEDURES

A. Receiving of Isotopes - All incoming shipments of radioisotopes are to be received at the London Road facility. Radiation monitoring of the article is required before removing from the truck. Operating procedure ISP-16 specifies the actions to be performed when isotopes are received.

B. Shipment of Isotopes - Outgoing shipments of radioactive isotopes are to be prepared for transportation by individuals authorized under AMS's NRC licenses. All packages must comply with current NRC and Department of Transportation (DOT) regulations. Quality assurance procedure QA1014 specifies the actions to be performed when preparing a shipment. For depleted Uranium, refer to operating procedure ISP-28. Once properly packaged, any authorized AMS employee may release a radioactive shipment to the carrier.

C. Preparing Source Exchange Containers for Shipment.

1. Before loading with a radioisotope (if applicable), the accessible internal surfaces should be given a wet smear contamination check and cleaned, if necessary, to meet current Regulatory Standards.

2. The container mechanism (if any) will be checked for proper function and repaired if necessary.

3. The container and its mechanisms (if any) will be inspected for integrity and proper mechanical functions in accordance with manufacturer's drawings, descriptions, certificates and check lists. Repairs will be made when necessary.

CHAPTER 6 - MONITORING

AREA MONITORING

A. All area monitoring will be performed under the direction of the RSO, who will review the results.

B. A survey instrument compatible with the energy and intensity of the radiation anticipated must be used.

C. Written records of all surveys will be maintained indicating dose rate in mR/hr unless otherwise noted.

PERSONNEL MONITORING

A. All personnel entering Restricted Radiation Areas must wear approved film badges and self-reading pocket dosimeters (SRPD) with a range of 0 to 200 mR. An additional SRPD with a range of 0 to 1000 mR or greater may be required depending on the anticipated dose rate in the area to be entered.

B. If work is to be performed where there is a possibility that the hands and forearms may be exposed to a dose rate in excess of 100mR/hr, a thermoluminescent finger ring dosimeter must be worn.

C. Work in high dose areas will be proceeded by a survey with appropriate monitoring equipment and an estimated total accumulated exposure determined. The SRPD will be read at intervals consistent with the anticipated dose rate to determine that the actual exposure is not greater than the anticipated exposure.

D. Alarming dosimeters are also available to monitor personnel exposure in high dose rate areas.

E. Personnel monitoring equipment will be protected against contamination while being used in a high Contamination Area. Sealing in a plastic bag is usually sufficient.

F. Whole body contamination checks are mandatory before leaving a Contaminated Area. All personnel shall check themselves for possible contamination before redressing into street clothing. This check will be done by slowly scanning over the entire body with a GM type probe connected to a count rate meter. Listen to the audible clicks and observe the meter deflection while scanning, any reading greater than 100 cpm above background is <u>not</u> acceptable. Pay particular attention to the hair, neck, ears, nostrils, hands, fingernails, feet and ankles. If contamination is detected, decontaminate as per Chapter 7 of this manual.

CHAPTER 7 - CONTAMINATION CONTROL AND WASTE DISPOSAL

GENERAL

Radioactive contamination may be defined as radioactive material in places where it is not wanted. Because of the wide range in the magnitudes of radiation involved, the impossibility of neutralizing radiation, the invisibility of radiation and the difficulties inherent in cleaning up minute amounts of material, the job of decontamination is no simple matter.

DECONTAMINATION PROCEDURES

I. Action in the event of a spill

A. Where gross contamination from a spill or leak has occurred, proceed as outlined in Chapter 3 Section III. RSO has the authority to deviate from standard operating procedures if the situation warrants.

Accidents and Emergency Techniques

In the event of accidental leakage or spillage from potentially hazardous amounts of radioactive material, the following measures should be taken at once:

A. Stop the leak or spill taking care not to put yourself in a hazardous situation.

B. Where liquids or solids are involved, no immediate attempt should be made to clean up the area.

C. Local exhaust ventilation should be maintained where radioactive gases are involved. Ask the RSO whether the building ventilating system should remain on.

D. Everyone should leave the room and the doors should be closed and locked.

E. If powdered sources are involved, the doors and all the other openings leading into the room should be sealed with wide masking tape or other suitable material.

F. It shall be assumed that all personnel within the accident area have been contaminated until checked out with adequate monitoring equipment.

G. Entrance to the Contaminated Area is prohibited until the RSO can be called in and his advice followed.

PROTECTIVE CLOTHING

The company furnishes a complete change of clothing which must be worn by any personnel performing work in a Restricted Area where radioactive contamination is known to exist or is suspected.

II. Personnel Decontamination

A. Immediately remove all contaminated clothing and place in properly labeled plastic bags for subsequent evaluation by the RSO.

B. Notify the RSO who will prescribe the decontamination method.

III. Area Decontamination - Non Expendable Equipment

A. Any area or item from which a one hundred (100) cm^2 wipe indicates contamination of 40,000 dpm or more will be cleaned as soon as practical after the work causing the contamination is completed (with the exception of Very High Radiation Areas).

B. Appropriate decontamination methods as prescribed by the RSO will be used.

C. On porous surfaces, a HEPA vacuum cleaner may be used as prescribed by the RSO.

IV. Handling of Contaminated Expendable Material

A. Package for safe handling.

B. Properly label according to the hazard.

C. Treat as waste.

WASTE DISPOSAL

I. Liquid Radioactive Waste

No liquid radioactive wastes should be generated at the facility.

II. Solid Radioactive Wastes

Waste involving long-lived isotopes shall be packaged for safe handling and temporarily stored in special containers prior to shipment to a commercial waste disposal service.

LIQUID WASTE STORAGE SYSTEM

I. Description of Facility

Liquid radioactive waste is not generated in the normal operation in the Isotope Facility.

The original design of the facility had all drains on the first floor of the Restricted Area of the facility, with the exception of the toilet drains, connected to stainless steel holding tanks in the Shielded Waste Room in the basement of the facility. Circa 1986, these drains were modified to go to a plastic holding tank in the front basement.

The original floor drains in the basement were connected to the municipal sanitary system. These drains are plugged with concrete

The Shielded Waste Room, shielded by thirty (30) inches of high density concrete walls, is curbed twenty four (24) inches high to prevent waste water from running into the sanitary sewer in the event of a leak in one of the holding tanks. The holding tanks have a total capacity of six hundred (600) gallons and the curbed floor area, which has no drain, has a capacity of approximately twenty four hundred (2,400) gallons. Circa 1988, this room was sealed with all services to and from the room disconnected.

Any liquid radwaste that comes into the company's possession through abnormal circumstances will be controlled and managed on a case-by-case basis.