NRC Form 591
10 CFR 2.201

U.S. NUCLEAR REGULATORY COMMISSION

# SAFETY INSPECTION

| 1. LICENSEE | 2. REGIONAL OFFICE |
|---|---|
| Isomedix (Puerto Rico), Inc.<br>State Road 690 Km-1.7<br>Barrio Sabana Hoyos<br>PO Box 415<br>Vega Alta, PR 00762 | US NUCLEAR REGULATORY COMMISSION, REGION II<br>101 MARIETTA STREET, N.W., SUITE 2900<br>ATLANTA, GEORGIA 30323 |

| 3. DOCKET NUMBER(S) | 4. LICENSE NUMBER(S) | 5. DATE OF INSPECTION |
|---|---|---|
| 030-20206 | 52-23041-01 | 5/7/85 |

Licensee:

The inspection was an examination of the activities conducted under your license as they relate to radiation safety and to compliance with the Nuclear Regulatory Commission's (NRC) rules and regulations and the conditions of your license. The inspection consisted of selective examinations of procedures and representative records, interviews, with personnel, and observations by the inspector. The findings as a result of this inspection are as follows:

- [x] 1. Within the scope of this inspection, no violations were observed.
- [ ] 2. The inspector also verified the steps you have taken to correct the violations identified during the last inspection. We have no further questions on these actions at this time.
- [ ] 3. During this inspection certain of your activities, as checked below, were in violation of NRC requirements. **THIS IS A NOTICE OF VIOLATION** which is required to be posted in accordance with 10 CFR 19.11.

  - [ ] A. ______ was not properly posted to indicate the presence of a ______. 10 CFR 20.203(b), (c), (d), (e) or 34.42.
  - [ ] B. Containers located in ______ were not properly labeled to indicate the presence of radioactive material. 10 CFR 20.203(f)(1), or (f)(2).
  - [ ] C. ______ of sealed sources were not performed at the proper frequencies. 10 CFR ______ License Condition Number ______.
  - [ ] D. Records of ______ were not properly maintained. 10 CFR ______ or License Condition Number ______.
  - [ ] E. Documents were not properly posted or otherwise made available. 10 CFR 19.11
  - [ ] F. Reports or notifications of ______ were not made in accordance with 10 CFR ______ or License Condition Number ______.
  - [ ] H. ______
  - [ ] I. ______
  - [ ] J. ______
  - [ ] K. ______

I hereby state that within 30 days the actions described by me to the inspector will be taken to correct the violations identified in the items checked above. This statement of corrective actions is made in accordance with the requirements of 10 CFR 2.201. No further response will be submitted unless required by the NRC.

8507230007
X4

| SIGNATURE – LICENSEE | DATE | SIGNATURE – NRC INSPECTOR | DATE |
|---|---|---|---|
| | | L. C. Faulkner | 5/7/85 |

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USNRC, Region II
Atlanta, GA

MATERIALS INSPECTION
FIELD NOTES

Page 1 of ___

INSPECTION REPORT NO. 85-01

Attached

( ) Appendix A
( ) Appendix B
( ) Appendix C
( ) Memo *

Licensee: Isomedix (Puerto Rico), Inc
Street: State Road 690 Km 1.7, Barrio Sabana Hoyos
City, State: Vega Alta, PR

Licensee contact: Albert L DeCarlo    Telephone No.: ___

License No.: 52-23041-01    Last amendment and date: ___

Category: E3, and Priority: 1, as of last amendment.

Inspection date(s): 5/7/85    Type of inspection: routine unannounced

SUMMARY OF FINDINGS AND ACTION

(✓) No noncompliance, clear 591 issued
( ) Noncompliance, Appendix A*
( ) Action on previous noncompliance, Appendix B**
( ) Noncompliance 591 issued
( ) Regional action ___ action
( ) Supplemental info, Appendix C***

RECOMMENDATIONS

See Basis in Appendix C or attached memo.

( ) Change Category: ___    ( ) Change Priority to: ___

(✓) Next inspection date: 5/86

PERSONS CONTACTED

Albert DeCarlo, Gen'l Mgr.

Inspector: [signature]    5/7/85

Approved: [signature]

*Use current ROI 0915, Standard Forms
**Use for actions not documented in a prior licensee response
***Use for inspector evaluation or recommendations

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INSPECTION PLAN AND REPORT NUMBER: 85-01



Licensee: Inomedix

License No.: 52-23041-01

| Inspection Items | Scheduled for Inspection | Post-inspection status | Module No. | 766 Time Info |
|---|---|---|---|---|
| Management meeting - Entrance and Exit Interviews (Required) | | | 30703B | 0.5 |
| Initial Management Meeting | | | | |
| Program requirements, MC 28___ (Required) | | | 77710B | 20 |
| Licensee Event Followup | | | 92700B | |
| Followup on Inspector-identified problems | | | 92701B | |
| Followup on Noncompliance and Deviations | | | 92703B | |
| IE Bulletin/Immediate Action Letter Followup | | | 92703B | |
| Followup on Headquarters Requests | | | 92704B | |
| Followup on Regional Requests | | | 92705B | |
| Independent Inspection Effort (Required) | | | 92706B | 0.5 |
| Inspector Dispatched to Site | | | 93700B | |
| Followup on Significant Event Occurring During Inspection | | | 93701B | |

77710B - Industrial-Academic

AREAS INSPECTED AND FINDINGS

Licensee: Isomedix License No.: 52-22041-01 Amendment No.: ______

| INSPECTION ITEMS | CRITERIA | FINDING |
|---|---|---|
| 1. Organization | Lic Cond ______ | OK |

Management organization.

Radiation protection organization. No licensee change

Radiation Safety Committee

Authorized Users 9 New GM locally

NOTES:

Q.C. Inspectors added to structure.

| | | |
|---|---|---|
| 2. Licensee internal audits | Lic Cond ______ | OK |

Scope and frequency.

Management controls.

ALARA Audits

Radiation Safety Committee Meetings
Minutes Recorded

NOTES:

RSO out of Corporate Hdq's audits facility annually

Records maintained.

INSPECTION REPORT NUMBER: 25-01



77710B - Industrial-Academic

AREAS INSPECTED AND FINDINGS

Licensee: Isomedix License No.: 52-23041-01 Amendment No.: ______

| INSPECTION ITEMS | CRITERIA | FINDING |
|---|---|---|
| 3. Training and instructions to employees | Lic Cond ___ | OK |
| Training program, scope and frequency, retraining. Conducted by who? | Lic Cond ___ | |
| Required tests administered; scores satisfactory. | | |
| Instructions to workers. | §19.12<br>R.G. 8.13<br>R.G. 8.27<br>R.G. 8.29 | |

NOTES:

Examined training records including those for OM. Retraining conducted on a monthly basis for all aspects of safety including Rad. Safe

| | | |
|---|---|---|
| 4. Radiation protection procedures | Lic Cond ___ | OK |
| * Operating & emergency procedures implemented. yes | Lic Cond ___ | |
| Manufacturer's instructions for devices Used | | |
| Protective clothing used NA @ present | | |
| Contamination control procedures OK | | |
| Access control "High Radiation Area" OK | §20.203(c) | |
| Security excellent | §20.207 | |

NOTES:

* posted in control room

Received demonstration of alarm & interlock system. Entry to area as noted in procedures.

77710B - Industrial-Academic

AREAS INSPECTED AND FINDINGS

Licensee: Isomedix License No.: 52-23041-01 Amendment No.: ________

| INSPECTION ITEMS | CRITERIA | FINDING |
|---|---|---|
| 5. Materials, facilities, and instruments | | OK |
| Authorized uses and quantities. YES | Lic Cond _____ | |
| Restricted areas, posting requirements. OK | §20.203 | |
| Survey instruments & dosimeters; operable, properly calibrated. YES | Lic Cond _____ | |
| Fixed monitors (operable and calibrated) YES | | |

NOTES:

As of 4/1/85 1,267 Cis

Portable inst Calib by Ralzen in Tucker, Ga. ~~Changing to Tabsco Ltd.~~ Ontario Can

Examined records for inst Calib, all timely and in good order

| INSPECTION ITEMS | CRITERIA | FINDING |
|---|---|---|
| 6. Receipt and transfer of materials | | OK |
| Procedures implemented, adequate. Yes | §20.205, Lic Cond _____ | |
| Transfer of byproduct material. Never any transfers | §30.41 | |
| Labeling and packagining. | §71.5, (49CFR 170-189) | |
| Records of receipt, transfer, storage, survey, and monitoring OK | ¶30.51, Lic Cond _____ | |
| Procurement procedures OK | Lic Cond _____ | |
| Inventory control YES - performed, records | Lic Cond _____ | |

NOTES:

AREAS INSPECTED AND FINDINGS

Licensee: Isomedix License No.: 52-23041-01 Amendment No.: ___

| INSPECTION ITEMS | CRITERIA | FINDING |
|---|---|---|
| 7. Personnel protection - external | | OK |
| Personnel monitoring control; minimize exposures, control of accumulated dose OK | §20.101, §20.102, §20.202, §20.104 | |
| * Dosimetry supplier, frequency of exchange, type dosimeters (W. B. or extremity) | Lic Cond ___ | |
| Avg. exposures (W.B. and extr.) max exposures (W.B. and extr.) -0 both | | |
| Number of persons monitored 8 | | |
| Surveys conducted yes | §20.201, Lic Cond ___ | |
| Frequency, results, records OK | §20.401 | |
| Levels in "Unrestricted Areas" OK | §20.105 | |

NOTES & REMARKS:

* Monthly W.B Teledyne Isotopes Westwood N.J.

| INSPECTION ITEMS | CRITERIA | FINDING |
|---|---|---|
| 8. Personnel protection - internal | | OK |
| Airborne concentrations in "Restricted Areas." OK | §20.103 | |
| Exposure of minors. none | §20.104 | |
| Posting of airborne radioactivity areas, none | §20.203 | |
| Survey, monitoring requirements; records. yes | §20.201, §20.401 | |
| Ventilation systems OK | Lic Cond ___ | |
| Installation and Testing yes OK | | |
| Process or Engineering controls yes | §20.103(b)(1) | |

NOTES:

777108 - Industrial-Academic

AREAS INSPECTED AND FINDINGS

Licensee: Isomedix License No.: 52-23041-01 Amendment No.: ________

| INSPECTION ITEMS | CRITERIA | FINDING |
|---|---|---|
| 9. Leak tests | | OK |
| Performed by who? Licensee | Lic Cond ______ | |
| Test frequency, Records of results | | |

NOTES:

Six month frequency, all records timely.

| | | |
|---|---|---|
| 10. Effluent control, waste disposal | | OK |
| Release of effluents. NA | §20.106 | |
| Procedures, monitoring of effluents | §20.401, Lic Cond ______ | |
| Waste disposal | | |
| Transfer for final disposal | §20.311 | |
| Release into sanitary sewage | §20.303 | |
| Disposal by incineration | §20.305, Lic Cond _____ | |
| Disposal of specific waste | §20.306 | |
| Waste held for decay | Lic Cond _____ | |
| Labels obliterated | | |
| Surveys conducted | | |
| Other specific disposal method(s) | §20.302 | |
| Records of disposal | §30.51, §20.401(3) | |

NOTES:

No waste disposal since last inspection.

## AREAS INSPECTED AND FINDINGS

Licensee: Saemud... License No.: 52-23041-01 Amendment No.: ___

| INSPECTION ITEMS | CRITERIA | FINDING |
|---|---|---|
| 11. Shipping shipping incidents | | OK |
| Procedures for pickup, receipt, monitoring of packages. YES | §20.205(b) & (c) Lic Cond ___ | |
| Transporation of licensed material. None since last insp | §71.5, Lic Cond ___ | |
| Incidents, reports, corrective actions. None | 49CFR 170-199 | |
| Compliance with DOT Regulations. OK | 49CFR 170-199 | |
| QA Program (under General License) NA | §71.11 | |

NOTES:

| | | |
|---|---|---|
| 12. Notifications and reports | | OK |
| To individuals. YES | §19.13 | |
| Overexposures, excessive levels and concentrations incidents. none | §20.403, §20.405 | |
| Personnel exposures and monitoring, termination reports. OK | §20.407, §20.408 | |
| Theft or loss of licensed material. none | §20.402 | |

NOTES:

777108 - Industrial-Academic

AREAS INSPECTED AND FINDINGS

Licensee: Isomedix License No.: 52-23041-01 Amendment No.: ___

| INSPECTION ITEMS | CRITERIA | FINDING |
|---|---|---|
| 13. Posting of notices | | OK |
| Part 20, license and documents, procedures, notice of violations. Yes | §19.11(a) | |
| Form NRC-3. Yes | §19.11(c) | |
| NOTES: All postings are required | | |
| 14. Environmental monitoring program | Lic Cond ___ | OK |
| Implementation of program, scope and frequency as required. | | |
| Records maintained, reviewed by management. NA this license at this time | | |
| NOTES: | | |
| 15. Emergency preparedness | Lic Cond ___ | OK |
| Procedures available for incidents and accidents. Yes | | |
| Training for personnel; coordination with supporting groups and agencies. OK | | |
| NOTES: | | |

77710B - Industrial-Academic

AREAS INSPECTED AND FINDINGS

Licensee: Isomedix License No.: 52-23041-01 Amendment No.: ___

| INSPECTION ITEMS | CRITERIA | FINDING |
|---|---|---|

16. Other license conditions — Lic Cond ___ — ok

Reviewed with licensee representative

NOTES:
Reviewed license conditions and examined all records, maint., entry logs etc. committed to in the application. All records in order & timely

17. Confirmatory measurements — §20.105, §20.201 — ok

Licensee's surveys verified on sampling basis.

NOTES:

NA

Meter used
Calib. Date: ___
Serial #: ___

Diagrams of areas surveyed

18. Independent inspection effort — ok

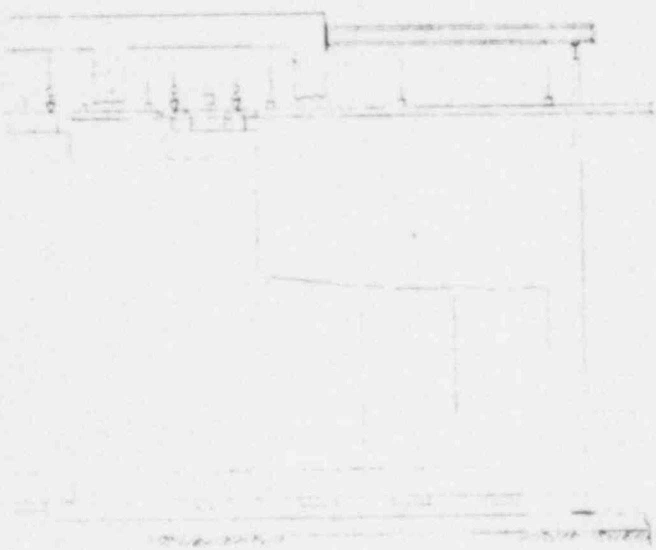
Scope of program

NOTES:

Made continuous survey during entry into fuel pool area
All areas < 0.1 mrem/hr

| B | A |
|---|---|

6



5

4

LIST FOR

| SHEET NO. | CONT. ON SHEET | DRAWING NUMBER | | |
|---|---|---|---|---|
| 2 | - | 3 1 1 0 7 0 1 | 0 0 2 | G |

| NUMBER | ASSY | No. REQD | DWG. SIZE | DESCRIPTION |
|---|---|---|---|---|
| | X | 2 | E | PERSONNEL SAFETY BARRIER ASSY. |
| | | 1 | | POOL WATER CHILLER - DUNHAM BUSH * PC0105 |
| | | 1 | | POOL WATER DEIONIZER - WATER REFINING * CODM-2 |
| | | 2 | | VENTILATION FAN - GEN. BLOWER & FORGE * BLVS-245E |
| | X | 2 | C | VENTILATION AIR FILTER ASSEMBLY |
| | | REF | C | IRRADIATION CHAMBER VENTILATION SYSTEM |
| | | 1 | | AIR COMPRESSOR |
| | X | 1 | C | TEMPORARY RAIL FOR SOURCE REPLENISHMENT |
| | X | 1 | D | LAY-IN DUCTWORK |

B-38

| | | | | |
|---|---|---|---|---|
| | | – | | [illegible] |
| | x | 2 | C | VENT [illegible] ASSEMBLY |
| | | REF | C | IRRADIATION [illegible] |
| | | 1 | | AIR COMPRESSOR |
| | x | 1 | C | TEMPORARY RAIL FOR SOURCE REPLENISHMENT |
| | X | 1 | D | LAY-IN DUCTWORK |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| CWN | | 1 | | RADIATION METER PACKAGE |
| CWN | | | I.D. | SPARES LIST |
| CWN | | – | E+ | ELEMENTARY WIRING |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | x | 88 | C | CARRIER WHEEL BRACKET |
| | | 352 | | HALF TROLLEY #PL754 (3 3/16 DROP) "MONOVEYOR" DEGREASED |
| 503 | | 354 | | 3/8"-16 x 1 1/4" LG. HEX. HD. CAPSCREW |
| 091 | | 352 | | 3/8-16 LOCKNUT - SPAE-NAUR # HN-127 |

... LIST FOR

DRAWING NUMBER: B 1 1 0 7 0 1 002 — ISSUE G

| NUMBER | ASSY | No REQ'D | DWG SIZE | DESCRIPTION |
|---|---|---|---|---|
| | x | 1 | E | SOURCE PASS MECHANISM ASSEMBLY |
| | x | 1 | E | CARRIER KEEL TRANSFER MECHANISM |
| | x | 1 | E | MAZE CONVEYOR ASSEMBLY |
| | x | 44 | E | PRODUCT CARRIER ASSEMBLY |
| | x | | D | MAZE KEEL GUIDE SYSTEM |
| | x | | E | INTERIM TRANSFER AREA ASSEMBLY |
| | x | 1 | E | STORAGE AREA CONVEYOR ARRANGEMENT |
| | x | 1 | E | PNEUMATIC SCHEMATIC - SOURCE PASS MECH. |
| | x | 1 | D | PNEUMATIC SCHEMATIC - STORAGE AREA |
| | x | 1 | E | SOURCE MECHANISM ASSEMBLY |
| WN | x | 1 | I.D. | SOURCE HANDLING TOOL KIT |
| | x | 1 | D | SOURCE HOIST SAFETY VALVE ASSEMBLY |
| 656 | x | 1 | C | POOL SKIMMER ASSEMBLY |
| 431 | x | 2 | C | WATER LEVEL SWITCH ASSEMBLY |
| | x | 1 | C | EMERGENCY STOP CABLE ASSEMBLY |
| 96 | x | 1 | D | MAZE ENTRANCE DOOR ASSEMBLY |
| | | 1 | | CONTROL CONSOLE ASSEMBLY |

| | DATE | BY | APP. |
|---|---|---|---|
| ...NAL LAYOUT | 24 NOV 80 | JH | |
| ...176 | APR 24/80 | FU | |
| DEIONIZER | MAR 3/80 | FU | |
| ...S #44 | DEC 23/79 | LO | |
| ... | 11 DEC 79 | JH | |
| ...QUOTED | NOV 21/79 | FU | |

ATOMIC ENERGY OF CANADA LIMITED
OTTAWA COMMERCIAL PRODUCTS CANADA

REQUIRED FOR

DRAFTSMAN: USHER — DATE: OCT 25/79 — DRAFTING APPR'L

MECH. ENG. | ELECT. ENG. | CIVIL ENG. | PHYSICS | ENG. APPR'L

MAT'L & SPEC. — | FINISH —

CODE NO. —

SCALE: 1/4" = 1'-0" — TOLERANCES: ± — FRACTION, ± — DECIMAL, ± — ANGULAR

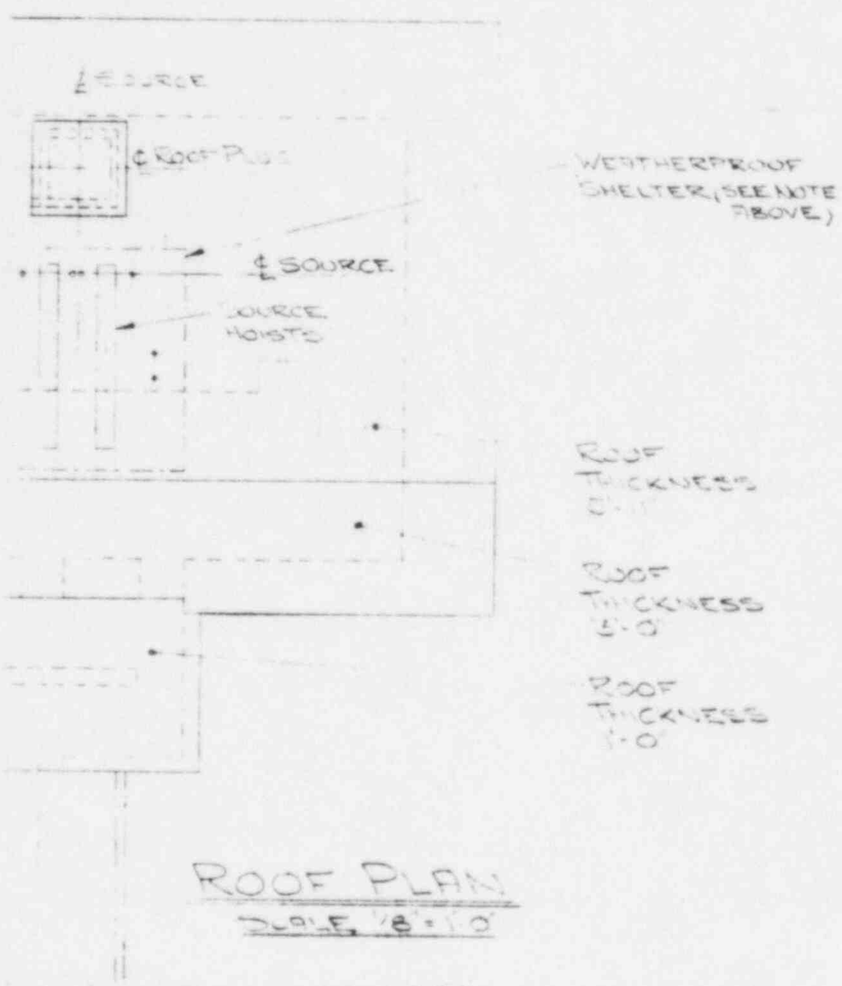
TITLE: CARRIER TYPE IRRADIATOR (ISOMEDIX PUERTO RICO)

DRAWING NUMBER: B 1 1 0 7 0 1 002 — ISSUE: G

D | C


## IDENTIFICATION

| | ITEM NO | DRAWING NUMBER | | STORES |
|---|---|---|---|---|
| | 18 | B110709 | [illegible] | |
| (CS) | 19 | | | |
| | 20 | | | |
| (CS) | 21 | | | |
| (CS) | 22 | B120002 | 004 | |
| (CS) | 23 | B112202 | 010 | |
| (CS) | 24 | | | |
| | 25 | B110709 | 039 | |
| | 26 | B110707 | 009 | |




ROOF PLAN

SCALE 1/8"=1'-0"

ACITY 4,000,000 CURIES COBALT 60.

OLOGICAL SHIELD, ALL SERVICES, MARKED (C.S.).

AT THE RATE OF 2200 C.F.M.

IS DESIGNED TO REDUCE THE EXTERNAL ELS WITH A 4,000,000 CURIE COBALT 60 VERAGE EXPOSURE RATE OF LESS THAN 0.25 PERSON FULL OCCUPANCY OF 40 HOURS PER E OF 500 MREM PER YEAR. EXPOSURE RATES E ALLOWABLE IN SMALL AREAS ADJACENT TO HESE CONTRIBUTIONS DO NOT RAISE THE OVER A SURFACE ABOVE 0.25 MR/HR.

WATER MUST BE LESS THAN 10.0 MICROMHOS.

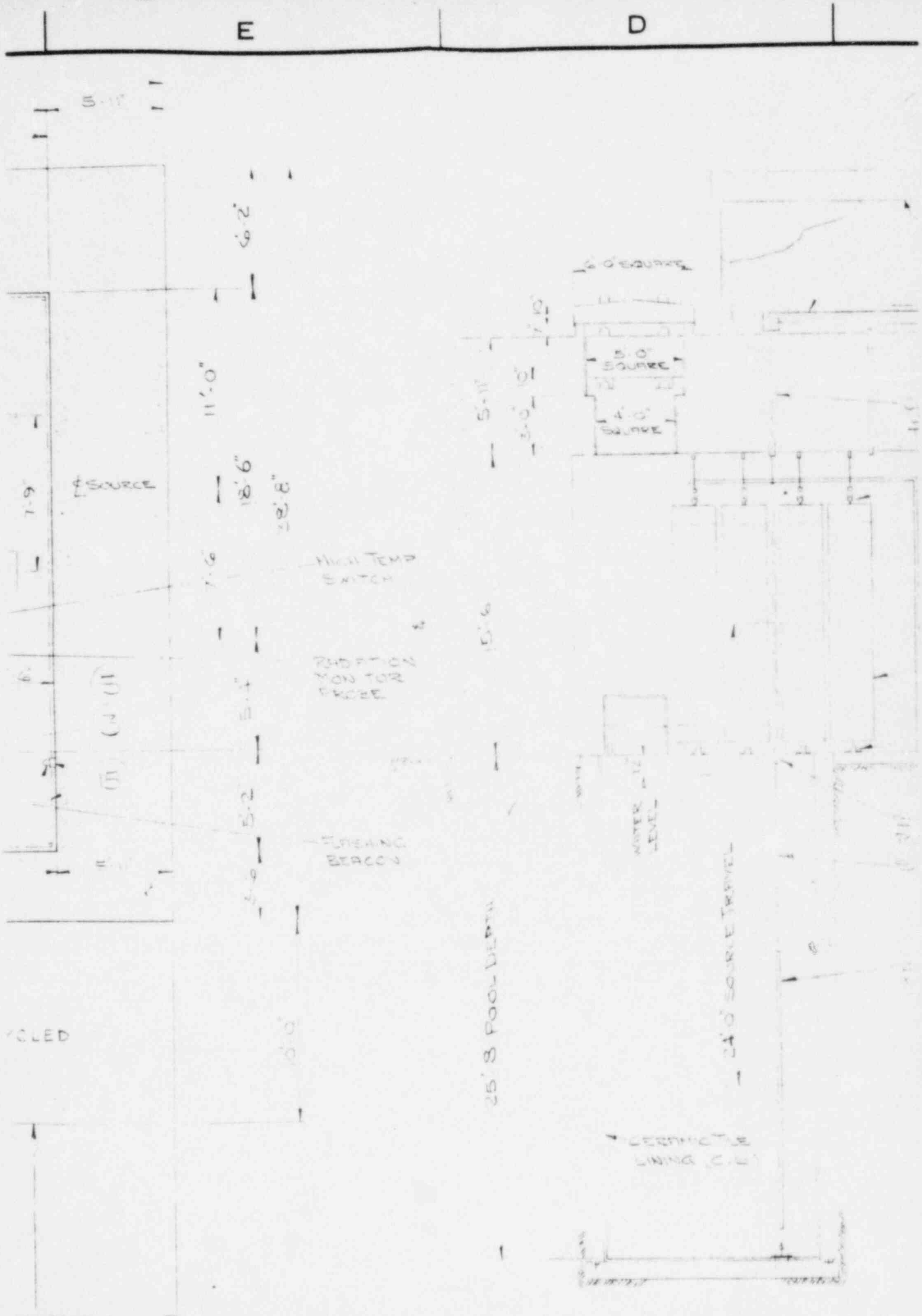
EF. # B110702/001,002,003,004,005,006,007,008,009

| | | | | |
|---|---|---|---|---|
| (C.S.) | 22 | B120002 | 00A | |
| (C.S.) | 23 | B 2202 | 010 | |
| (C.S.) | 24 | | | |
| | 25 | B110709 | 033 | |
| | 26 | B1 2707 | 009 | |
| | 27 | | | |
| | 28 | | | |
| | 29 | | | |
| | 30 | | | |
| | 31 | | | |
| | 32 | | | |
| | 33 | B120005 | 002 | NOTE |
| | 34 | B110701 | 003 | NOT S |
| | 35 | B110707 | 101 | NOT S |
| | 36 | | | |
| | 37 | | | |
| | 38 | | | |
| | 39 | | | |
| | 40 | B109709 | 013 | |
| | 41 | | | |
| | 42 | | | 5S073 |
| | 43 | | | 5N063 |
| | 44 | | | |

## IDENTIFICATION

| ITEM No | DRAWING NUMBER | | STORES N |
|---|---|---|---|
| 1 | B110709 | 001 | |
| 2 | B110709 | 002 | |
| 3 | B110709 | 003 | |
| 4 | B110709 | 004 | |
| 5 | B110709 | 036 | |
| 6 | B110709 | 040 | |
| 7 | B110709 | 101 | |
| 8 | B110707 | 001 | |
| 9 | B110707 | 201 | |
| 10 | B110704 | 001 | |
| 11 | B108906 | 001 | NOT S |
| 12 | B120007 | 005 | |
| 13 | A05885 | | 6D158 |
| 14 | A05843 | | 6D158 |
| 15 | B110707 | 050 | |
| 16 | B104207 | 017 | A065 |
| 17 | B110707 | 115 | |

| ISSUE | DESCRIPTION |
|---|---|
| G | REDRAWN TO SUIT CUSTOMERS |
| F | ITEMS # 41,42,43 QTY. WAS |
| E | DL-2 MONITOR ADDED TO |
| D | MOD. ITEM # 4, 40, 41, 42 |
| C | ITEM 26 ADDED |
| B | MAZE MONORAIL REV |
| A | ORIG. ISSUE |
| ISSUE TIC. # S1YA | DESCRIPTION |

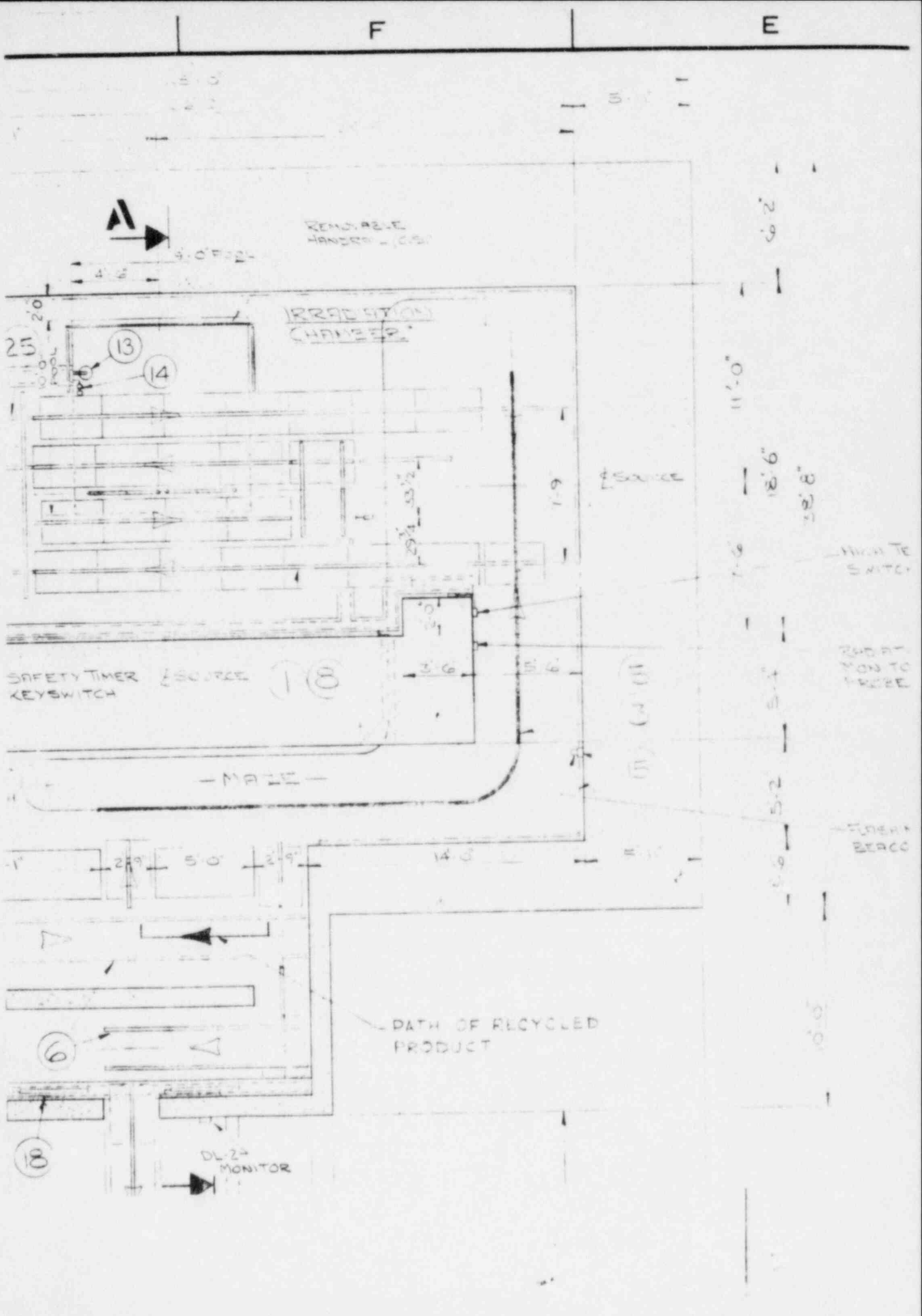

E
D
5'-11"
6'-2"
11'-0"
18'-6"
28'-8"
7'-9"
7'-6"
℄ SOURCE
HIGH TEMP SWITCH
RADIATION MONITOR PROBE
5'-2"
FLASHING BEACON
6'-0" SQUARE
5'-0" SQUARE
4'-0" SQUARE
5'-11"
3'-0"
15'-6"
25'-8" POOL DEPTH
WATER LEVEL
24'-0" SOURCE TRAVEL
CERAMIC TILE LINING (C.L.)
YCLED

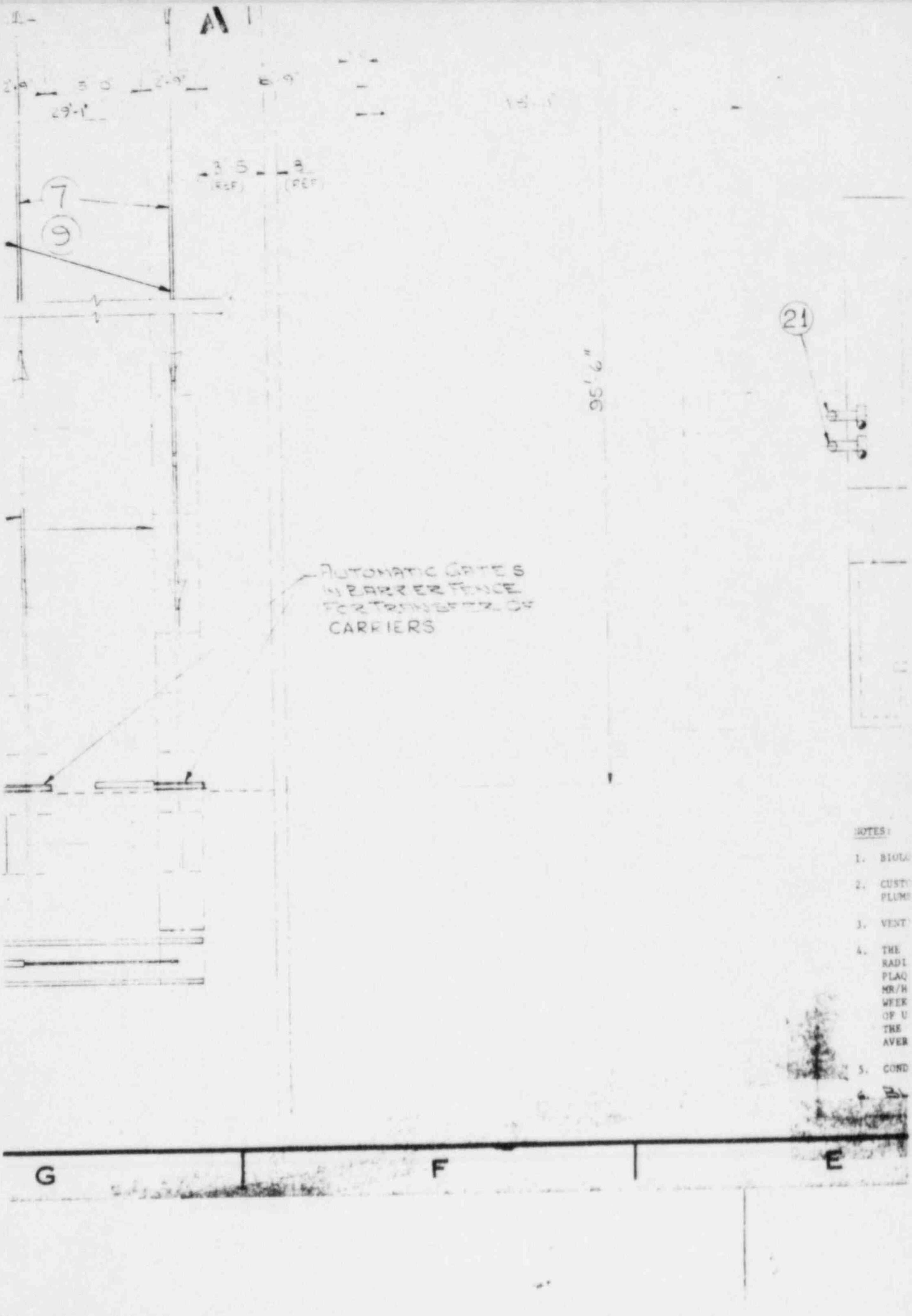

ROOF PLAN

SCALE 1/8" = 1'-0"

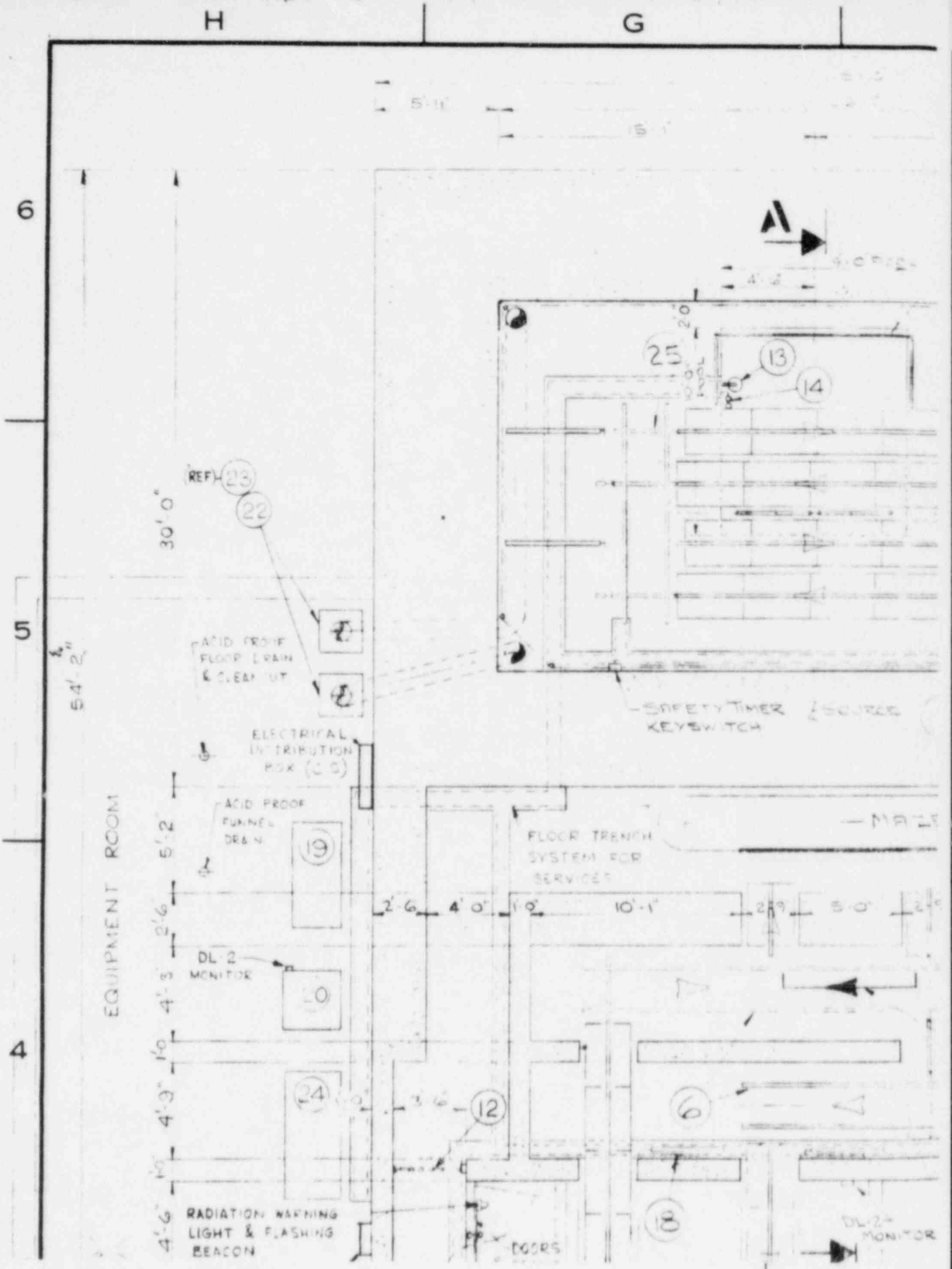
NOTES:

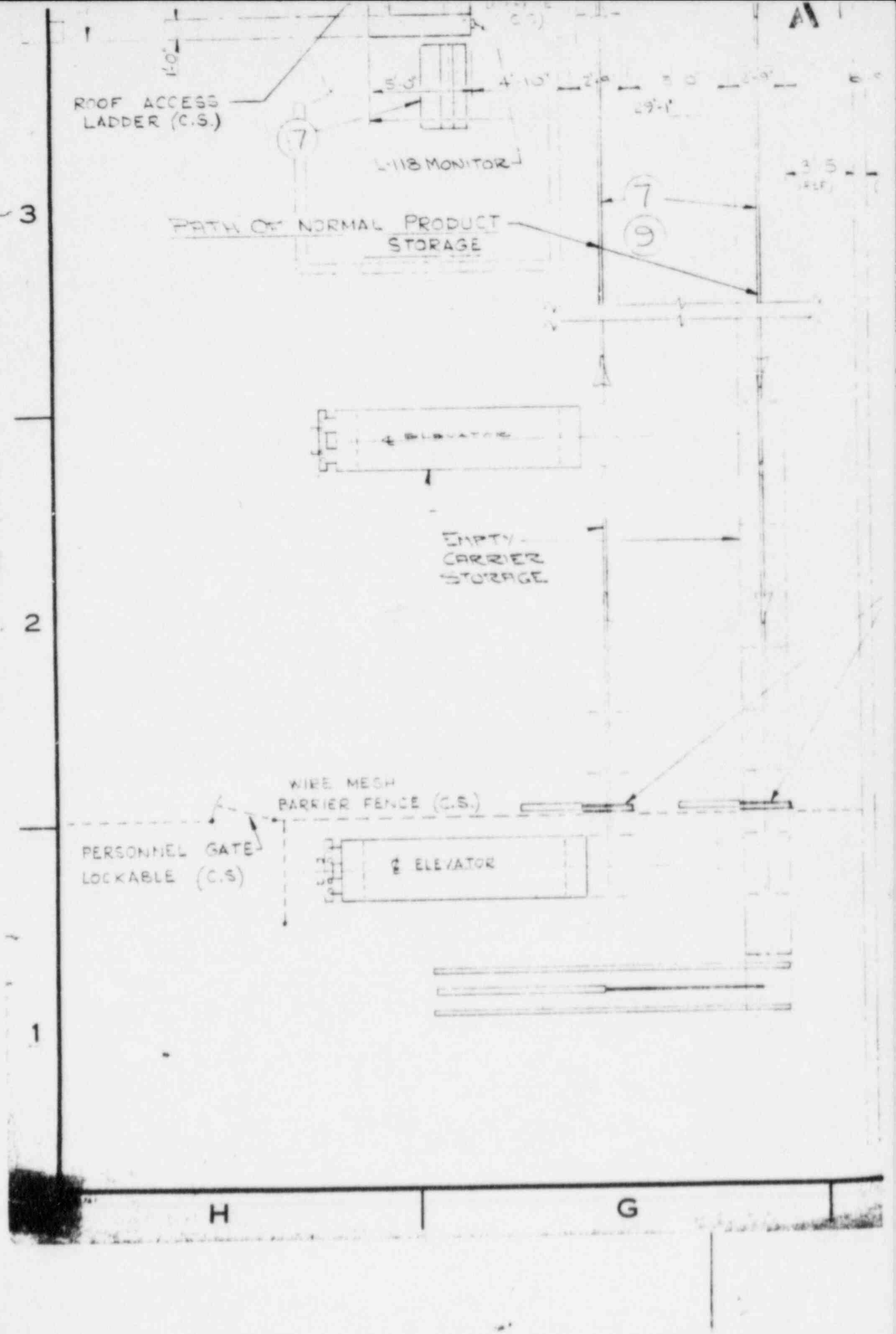
1. BIOLOGICAL SHIELD CAPACITY 4,000,000 CURIES COBALT 60.
2. CUSTOMER TO SUPPLY BIOLOGICAL SHIELD, ALL SERVICES, PLUMBING ETC. & ITEMS MARKED (C.S.).
3. VENTILATION REQUIRED AT THE RATE OF 2200 C.F.M.
4. THE BIOLOGICAL SHIELD IS DESIGNED TO REDUCE THE EXTERNAL RADIATION LEAKAGE LEVELS WITH A 4,000,000 CURIE COBALT 60 PLAQUE SOURCE TO AN AVERAGE EXPOSURE RATE OF LESS THAN 0.25 MR/HR. THIS ALLOWS A PERSON FULL OCCUPANCY OF 40 HOURS PER WEEK OR A MAXIMUM DOSE OF 500 MREM PER YEAR. EXPOSURE RATES OF UP TO 2.0 MR/HR ARE ALLOWABLE IN SMALL AREAS ADJACENT TO THE SHIELD PROVIDED THESE CONTRIBUTIONS DO NOT RAISE THE AVERAGE EXPOSURE RATE OVER A SURFACE ABOVE 0.25 MR/HR.
5. CONDUCTIVITY OF POOL WATER MUST BE LESS THAN 10.0 MICROMHOS.
6. BLDG. DWGS. REF. # B110702/001,002,003,004,005,006,007,008,009


F
E
A
REMOVABLE HANDRAIL
IRRADIATION CHAMBER
13
14
25
SAFETY TIMER KEYSWITCH
℄ SOURCE
18
℄ SOURCE
MAZE
14'-0"
5'-0"
2'-9"
6
18
PATH OF RECYCLED PRODUCT
DL-2A MONITOR
11'-0"
3'-6"
5'-6"



A
2'-9"
3'-0"
2'-9"
29'-1"
6'-9"
3'-5" (REF)
8" (REF)
7
9
95'-2"
21
AUTOMATIC GATES IN BARRER FENCE FOR TRANSFER OF CARRIERS
NOTES:
1. BIOLO
2. CUSTO PLUMB
3. VENT
4. THE RADI PLAQ MR/H WEEK OF U THE AVER
5. COND
G
F
E


H
G
6
5
4
A
4'-2"
2'-0"
25
13
14
(REF) 23
22
30'-0"
54'-2"
ACID PROOF FLOOR DRAIN & CLEANOUT
SAFETY TIMER KEYSWITCH
ELECTRICAL DISTRIBUTION BOX (C-3)
ACID PROOF FUNNEL DRAIN
EQUIPMENT ROOM
5'-2"
19
FLOOR TRENCH SYSTEM FOR SERVICES
2'-6
4'-0"
1'-0"
10'-1"
5'-0"
2'-6"
DL-2 MONITOR
4'-3"
20
1'-0"
24
4'-3"
3'-6"
12
6
18
RADIATION WARNING LIGHT & FLASHING BEACON
4'-6"
DOORS
DL-2 MONITOR


A
ROOF ACCESS
LADDER (C.S.)
1'-0"
5'-3"
4'-10"
29'-1"
7
L-118 MONITOR
3
7
9
PATH OF NORMAL PRODUCT
STORAGE
℄ ELEVATOR
EMPTY
CARRIER
STORAGE
2
WIRE MESH
BARRIER FENCE (C.S.)
PERSONNEL GATE
LOCKABLE (C.S)
℄ ELEVATOR
1
H
G

30-14214

C3510

FORM NRC-313 I (1-79) 10 CFR 30

U.S. NUCLEAR REGULATORY COMMISSION

# APPLICATION FOR BYPRODUCT MATERIAL LICENSE
## INDUSTRIAL

*See attached instructions for details.*

*Completed applications are filed in duplicate with the Division of Fuel Cycle and Material Safety, Office of Nuclear Material Safety, and Safeguards, U.S. Nuclear Regulatory Commission, Washington, DC 20555 or applications may be filed in person at the Commission's office at 1717 H Street, NW, Washington, D. C. or 7915 Eastern Avenue, Silver Spring, Maryland.*

1. APPLICATION FOR: *(Check and/or complete as appropriate)*

| | |
|---|---|
| X | a. NEW LICENSE |
| | b. AMENDMENT TO: ~~LICENSE NUMBER~~ |
| | c. RENEWAL OF: ~~LICENSE NUMBER~~ L+L 19769 |

**2. APPLICANT'S NAME** *(Institution, firm, person, etc.)*
Isomedix (Puerto Rico), Inc.
TELEPHONE NUMBER: AREA CODE – NUMBER EXTENSION
(201) 887-4700

**3. NAME OF PERSON TO BE CONTACTED REGARDING THIS APPLICATION**
George R. Dietz
TELEPHONE NUMBER: AREA CODE – NUMBER EXTENSION
(201) 887-4700

**4. APPLICANT'S MAILING ADDRESS** *(Include Zip Code)*
80 South Jefferson Road
Whippany, New Jersey 07981

**5. STREET ADDRESS WHERE LICENSED MATERIAL WILL BE USED** *(Include Zip Code)*
Macco Industrial Park
State Road 690 Km. 1.7
Vega Alta, Puerto Rico 00762

(IF MORE SPACE IS NEEDED FOR ANY ITEM, USE ADDITIONAL PROPERLY KEYED PAGES.)

**6. INDIVIDUAL(S) WHO WILL USE OR DIRECTLY SUPERVISE THE USE OF LICENSED MATERIAL**
*(See Items 16 and 17 for required training and experience of each individual named below)*

| | FULL NAME | TITLE |
|---|---|---|
| a. | George B. Baker | Group General Manager |
| b. | Luis E. Watlington | Plant Manager |
| c. | George R. Dietz, John Masefield, William M. Owens | Corporate Staff |

**7. RADIATION PROTECTION OFFICER**
Luis E. Watlington (on-site)
George R. Dietz (corporate)

*Attach a resume of person's training and experience as outlined in Items 16 and 17 and describe his responsibilities under Item 15.*
See Supplement, Parts 9 and 10

**8. LICENSED MATERIAL**

| LINE NO. | ELEMENT AND MASS NUMBER (A) | CHEMICAL AND/OR PHYSICAL FORM (B) | NAME OF MANUFACTURER AND MODEL NUMBER (If Sealed Source) (C) | MAXIMUM NUMBER OF MILLICURIES AND/OR SEALED SOURCES AND MAXIMUM ACTIVITY PER SOURCE WHICH WILL BE POSSESSED AT ANY ONE TIME (D) |
|---|---|---|---|---|
| (1) | See Part 1, Supplemental Information | | | |
| (2) | | | | |
| (3) | | | | |
| (4) | | | | |

| | DESCRIBE USE OF LICENSED MATERIAL (E) |
|---|---|
| (1) | See Part 1, Supplemental Information |
| (2) | |
| (3) | |
| (4) | |

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FORM NRC-313 I (1-79)

Copy sent to Region I and II CYC 5/28/82

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## 9. STORAGE OF SEALED SOURCES

| LINE NO. | CONTAINER AND/OR DEVICE IN WHICH EACH SEALED SOURCE WILL BE STORED OR USED. A. | NAME OF MANUFACTURER B. | MODEL NUMBER C. |
|---|---|---|---|
| (1) | AECL Standard Irradiator | Atomic Energy of Canada Limited | IR-107 |
| (2) | | | |
| (3) | See also Part 4 of Supplemental Information | | |
| (4) | | | |

## 10. RADIATION DETECTION INSTRUMENTS

| LINE NO. | TYPE OF INSTRUMENT A | MANUFACTURER'S NAME B | MODEL NUMBER C | NUMBER AVAILABLE D | RADIATION DETECTED (alpha, beta, gamma, neutron) E | SENSITIVITY RANGE (milliroentgens/hour or counts/minute) F |
|---|---|---|---|---|---|---|
| (1) | Geiger | Berthold | RATO/F ) | 3 | | |
| (2) | Geiger | Eberline | E-130G ) | | ) | |
| (3) | Geiger | AECL | L118 | | ) See also Part 2 ) to Supplement | |
| (4) | Geiger | AECL | L119 | | | |

## 11. CALIBRATION OF INSTRUMENTS LISTED IN ITEM 10

☐ a. CALIBRATED BY SERVICE COMPANY

NAME, ADDRESS, AND FREQUENCY

See Part 2 of Supplement

☐ b. CALIBRATED BY APPLICANT

*Attach a separate sheet describing method, frequency and standards used for calibrating instruments.*

## 12. PERSONNEL MONITORING DEVICES

| TYPE (Check and/or complete as appropriate.) A | SUPPLIER (Service Company) B | EXCHANGE FREQUENCY C |
|---|---|---|
| ☐ (1) FILM BADGE<br>☐ (2) THERMOLUMINESCENCE DOSIMETER *(TLD)*<br>☐ (3) OTHER *(Specify)*: ______ | See Part 3 to Supplement | ☐ MONTHLY<br>☐ QUARTERLY<br>☐ OTHER *(Specify)*: ______ |

## 13. FACILITIES AND EQUIPMENT (Check were appropriate and attach annotated sketch(es) and description(s).

☐ a. LABORATORY FACILITIES, PLANT FACILITIES, FUME HOODS *(Include filtration, if any)*, ETC.

☐ b. STORAGE FACILITIES, CONTAINERS, SPECIAL SHIELDING *(fixed and/or temporary)*, ETC.

☐ c. REMOTE HANDLING TOOLS OR EQUIPMENT, ETC. See Part 4 to Supplement

☐ d. RESPIRATORY PROTECTIVE EQUIPMENT, ETC.

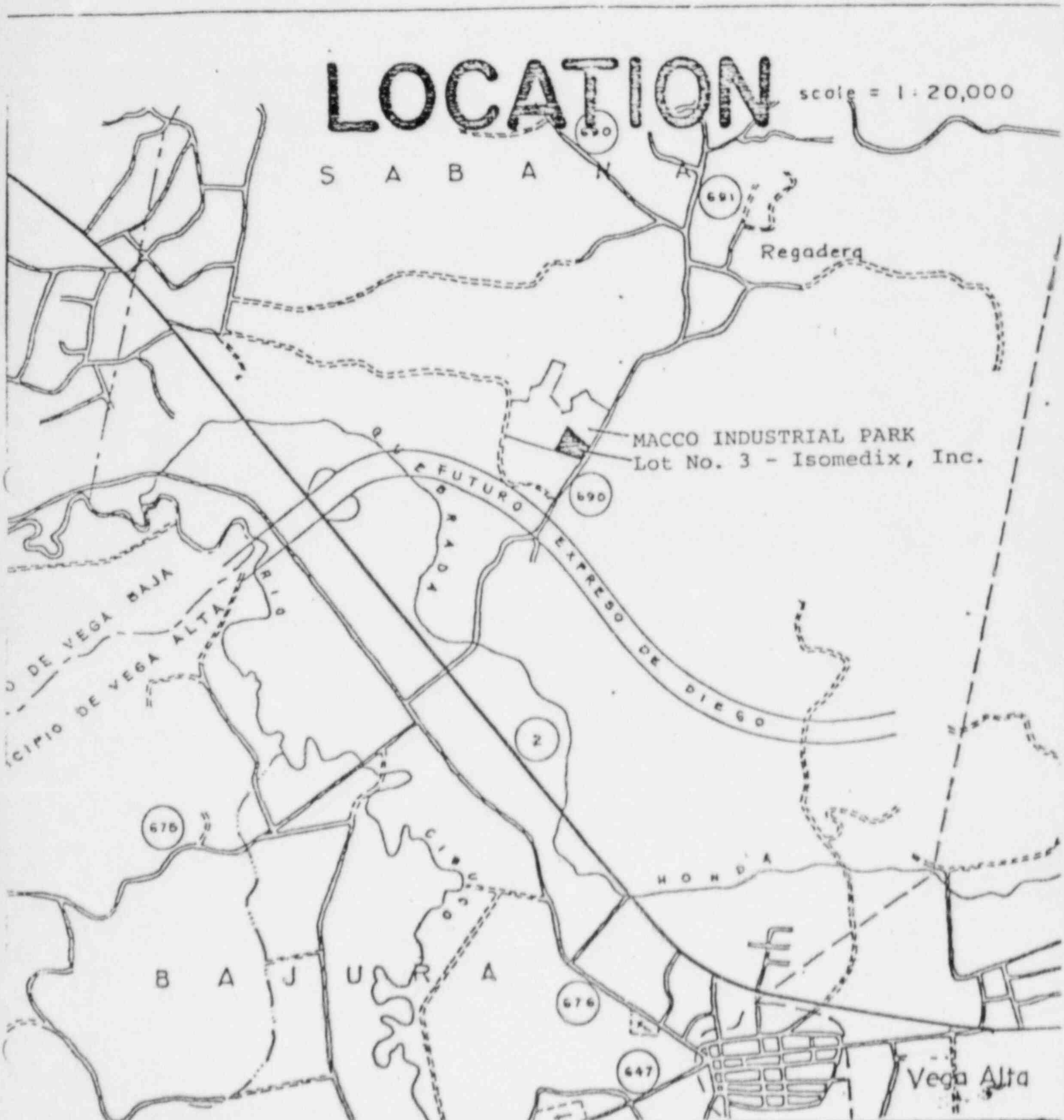
## 14. WASTE DISPOSAL

a. NAME OF COMMERCIAL WASTE DISPOSAL SERVICE EMPLOYED

Atomic Energy of Canada Limited - CP, See Part 5 to Supplement.

b. IF COMMERCIAL WASTE DISPOSAL SERVICE IS NOT EMPLOYED, SUBMIT A DETAILED DESCRIPTION OF METHODS WHICH WILL BE USED FOR DISPOSING OF RADIOACTIVE WASTES AND ESTIMATES OF THE TYPE AND AMOUNT OF ACTIVITY INVOLVED. IF THE APPLICATION IS FOR SEALED SOURCES AND DEVICES AND THEY WILL BE RETURNED TO THE MANUFACTURER, SO STATE.

4.1.3 MAP OF AREA

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NRC Form 782 (1-82)

U.S. NUCLEAR REGULATORY COMMISSION

# MATERIALS DATA INPUT – INDUSTRIAL, MEDICAL, SOURCE SPECIAL NUCLEAR

## A. TYPE OF ACTION AND IDENTIFICATION CODES

| | | | | | | |
|---|---|---|---|---|---|---|
| X NEW LICENSE | AMENDMENT TO RENEW LICENSE | AMENDMENT TO TERMINATE | VOID | DOCKET NUMBER | MAIL CONTROL NUMBER | CHANGE NAME ADDRESS (X box) |
| NEW LICENSE AND NEW LICENSEE | OTHER AMENDMENT | CLERICAL CHANGE NO AMENDMENT | 1 | 030-20206 | 50315 | X |

## B. INDICATIVE INFORMATION

INDIVIDUAL LICENSEES

NAME (Last, First, Middle)

52ML5267

ORGANIZATION LICENSEES

ORGANIZATION NAME (Alphabetic Sequence): Isomedix (Puerto Rico), Inc.

DEPARTMENT OR BUREAU:

| ADDRESS: BUILDING, STREET | CITY | STATE | ZIP CODE |
|---|---|---|---|
| State Road 690 Km. 1.7, P.O. Box 415 | Vega Alta | PR | 00762 |

| TYPE OF APPLICANT | | DATE REQUEST RECEIVED | INSTITUTION CODE | PENDING PROG. CODE | ACTUAL PROG. CODE |
|---|---|---|---|---|---|
| 333 | U.S. GOVERNMENT AGENCY / INDIVIDUAL LICENSEE / X ORGANIZATIONAL LICENSEE | 07/30/84 | 23041 | 03521 | 03521 |

SECONDARY PROGRAM CODES (As required): #1 #2 #3 #4 #5

| LICENSE NUMBER | DATE LICENSE ISSUED OR ACTION COMPLETED | EXPIRATION DATE |
|---|---|---|
| 52-23041-01 | | October 31, 1986 |

## C. STATISTICAL INFORMATION

MEDICAL CATEGORY: FOR HUMAN USE ONLY / FOR HUMAN AND NONHUMAN USE / X FOR NONHUMAN USE ONLY

POSSESSION OF THE MATERIAL IS AUTHORIZED IN ONE OF THE FOLLOWING AREAS

AND/OR IN THE STATE(S) TERRITORY(IES) COUNTRY CHECKED (At right)

X SAME AS STATE IN ADDRESS; ALL STATES; ALL NON-AGREEMENT STATES

| | | | | | |
|---|---|---|---|---|---|
| AL ALABAMA | GA GEORGIA | MD MARYLAND | NJ NEW JERSEY | SC SOUTH CAROLINA | WY WYOMING |
| AK ALASKA | HI HAWAII | MA MASSACHUSETTS | NM NEW MEXICO | SD SOUTH DAKOTA | |
| AZ ARIZONA | ID IDAHO | MI MICHIGAN | NY NEW YORK | TN TENNESSEE | AS AMERICAN SAMOA |
| AR ARKANSAS | IL ILLINOIS | MN MINNESOTA | NC NORTH CAROLINA | TX TEXAS | CZ CANAL ZONE |
| CA CALIFORNIA | IN INDIANA | MS MISSISSIPPI | ND NORTH DAKOTA | UT UTAH | GU GUAM |
| CO COLORADO | IA IOWA | MO MISSOURI | OH OHIO | VT VERMONT | PR PUERTO RICO |
| CT CONNECTICUT | KS KANSAS | MT MONTANA | OK OKLAHOMA | VA VIRGINIA | VI VIRGIN ISLANDS |
| DE DELAWARE | KY KENTUCKY | NB NEBRASKA | OR OREGON | WA WASHINGTON | |
| DC WASHINGTON DC | LA LOUISIANA | NV NEVADA | PA PENNSYLVANIA | WV WEST VIRGINIA | CN CANADA |
| FL FLORIDA | ME MAINE | NH NEW HAMPSHIRE | RI RHODE ISLAND | WI WISCONSIN | |

## D. POSSESSION LIMITS OF SOURCE AND SPECIAL NUCLEAR MATERIALS AND TRITIUM

SOURCE MATERIAL CEILING: G GRAMS / Kg KILOGRAMS — SNM CEILING: G GRAMS / Kg KILOGRAMS — FOR POWER REACTOR

| MATERIAL* | AMOUNT | UNIT | CONFIG | ENRICH | MATERIAL* | AMOUNT | UNIT | CONFIG | ENRICH |
|---|---|---|---|---|---|---|---|---|---|
| U5 U235 | | G / Kg | S / UNS | | | | G / Kg | S / UNS | |
| U3 U233 | | G / Kg | S / UNS | | | | G / Kg | S / UNS | |
| PU Plutonium | | G / Kg | S / UNS | | | | G / Kg | S / UNS | |
| UR Uranium | | G / Kg | S / UNS | | | | G / Kg | S / UNS | |
| TH Thorium | | G / Kg | S / UNS | | | | G / Kg | S / UNS | |
| | | G / Kg | S / UNS | | | | G / Kg | S / UNS | |
| | | G / Kg | S / UNS | | | | G / Kg | S / UNS | |

H3 Tritium: CURIES / MILLICURIES / MICROCURIES — RIS CODES

*Use two digit codes. S SEALED UNS UNSEALED

NRC Form 782

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I N D E X



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I N D E X

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# I N D E X

I N D E X

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# PART 1 - IRRADIATOR DESCRIPTION

## 1.1 INTRODUCTION

The IR-107 Irradiator as described herein is a standard model of medical supply irradiator, fabricated by Atomic Energy of Canada Limited. It consists of a large concrete biological shield which houses the cobalt-60 and a shuffle mechanism which transports product carriers past the source in a particular pattern. The unit is totally automated. Product is loaded into carriers in an outside unrestricted area, and carriers are then automatically sequenced into and out of the unit. The general layout of the facility is as shown on Drawing B110701 002G. (See Appendix A).

It is the intent of this presentation to describe the unit with special emphasis on the safety-related system and its operation. This will include detailed procedures applicable to the operation of the facility; however, it is not the intent to discuss the detailed operating procedures of the mechanical mechanism.

The mechanism is scheduled for installation into the concrete shielding in November 1981. Following installation of the mechanism and the total safety system, all aspects of the facility operation, again with special emphasis on the safety devices, will be checked to assure proper operation. Only after the safety system is intact and operationally correct, will source be loaded into the source rack.

Because of the logistics of installation and uncertain shipping times, it is possible that the source will arrive on-site prior to final checkout of the total safety system. If this occurs, the source will be held in the shipping casks, and unloaded into the pool for storage as soon as the pool-related safety system is functional (water circulation system, pool chiller, water level floats).

## 1.2 GENERAL FACILITY OPERATION

Drawing No. A-3 shows the general layout of the irradiator in relation to an associated 17,460 sq. ft. warehouse area which will support pre- and post-irradiation product storage and handling.

A conveying system located outside of the unit is available for the loading and storage of carriers scheduled for irradiation processing. The carriers are fed one at a time through a maze into the irradiation chamber. A tandem trolley system is utilized to take the carrier from the maze into the internal conveyor system. The tandem system will pick up a new carrier, transport it into the inner conveyor system and deposit the new carrier onto the inner system. Concurrently a finished carrier is put onto the second part of the tandem carrier for transport back through the maze to the exit side of the carrier system. The exit side is also physically blocked by carriers. As the exit carriers stack to a depth of 3 carriers, the unit on the end is forced out of position onto the post-irradiation external storage mechanism. In addition to the carriers acting as physical barriers, the inlet and outlet passages to the maze are obstructed by barriers when no product carriers are in the opening. The barriers are operated by pneumatic cylinders, and sequence their opening and closing with the passage of carriers into or out of the irradiator.

The total system is actually an incremental dose irradiator, where each transit by the source receives a unit of dose, say 1.0 Mrad. If the desired dose is 2.0 Mrad, the carrier is "recycled" for a second transit, and this occurs in the interior part of the irradiator where the notation "Path of Recycled Product" is made on Appendix A.

## 1.3 LICENSED MATERIAL

Line (1) A Cobalt-60

B Radioactive Cobalt-60 metal

C Manufactured by Atomic Energy of Canada Limited - Commercial Products. The cobalt-60 Model C-188 Type 1, 2, 3 or 4 are double encapsulated in 316 stainless steel. They have been designated as acceptable for licensing in the U.S.A.

D Maximum activity per C-188 source is 14,250 curies of cobalt-60. Maximum cobalt-60 source loading is 3,000,000 curies in 1344 positions. Initial source loading is probably about 1.2 Mci. The activity supplied in these sources will range from 6,000 to 12,000 curies of cobalt-60 per source.

E Commercial sterilization or processing of packaged medical products and other items, except those of an explosive or hazardous nature.

Line (2) A Cesium 137

B Anhydrous Cesium Chloride

C Nuclear Associates Incorporated, Westbury, New York Catalog Number 62-103

D Maximum activity per individual source is ten microcuries of Cesium 137. This is an exempt quantity.

E Instrument check source.

# PART 2 - RADIATION DETECTION INSTRUMENTS

2.1 Both portable and fixed monitors as described on the following pages will be utilized.

RATO/F or Eberline E-130G will be utilized as handheld units. Both types are currently in use in similar Isomedix operations, and both are acceptable units.

Highly sensitive small instrument for measuring dose rates of γ- and β-radiation as well as for detection of α-radiation.

Differentiation between γ- and β-radiation by adjustment of a built-in slide

| | | |
|---|---|---|
| Lowest value indicated | 10 μr/h | |
| Highest value indicated | 10 r/h | |
| Measuring ranges and time constants | 0– 1 mr/h | 10 s (RC values) |
| | 0– 10 mr/h | 10 s |
| | 0–100 mr/h | 1 s |
| | 0– 1 r/h | 1 s |
| | 0– 10 r/h | 1 s |

VERTRIEBS-GMBH FÜR MESSTECHNIK
der Firmen Frieseke & Hoepfner GmbH · Erlangen-Bruck
und Laboratorium Prof. Dr. Rudolf Berthold · Wildbad

**Acoustical indication**

In the lowest two measuring ranges, there is an additional acoustical indication as every pulse causes a click in the built-in loudspeaker.

**Scale division**

The scale is quasi-logarithmic whereby 1 % of the full deflection is still readable.

Since this quasi-logarithmic dial curve is produced by resistances and condensers only, high accuracy which is constant from one instrument to the next, is guaranteed.

As a further difference from the purely logarithmic division, the intensity value "0" is also indicated, and a high accuracy is obtained at small intensities combined with high zero-point-stability.

**Energy depence**

± 20 % in the range between 0.1 and 1.5 MeV γ-radiation.

**γ-Calibration**

with γ-radiation of radium (0.5 mm Pt-filter).

**Calibration accuracy** ± 10 %

**Recalibration**

Recalibration by a control source is not necessary in this instrument since high voltage as well as pulse size are stabilised, and since, furthermore, the counter tubes operate in the pulse mode.

Functional control is, moreover, provided by the acoustical and optical indication of background.

However, for demonstration and training purposes, a weak $Cs^{137}$ source, which is not subject to authorization, can be delivered.

**Counter tubes**

The instrument contains two counter tubes:

a) an end window halogen counter tube with a window of 63.5 $mm^2$ area, thickness 2–3 $mg/cm^2$. This counter tube is built into the base of the instrument. This arrangement facilitates the measurement of surface contaminations since the instrument can be held like a flat-iron.

b) a miniature halogen counter tube for the range of 0–10 *r/h*.

**Power supply**

The instrument has two built-in DEAC cells, type 500 DKZ. The working time with fully charged cells is 12 hours in continuous operation. A charging unit for connection to 220 volts A.C. (other voltages on request) is supplied for recharging the built-in cells. Charging time: 10 hours. If timely recharging was neglected, the instrument can also be powered by an external battery or, provisionally, from the mains by way of the charging unit. The stabilisation of the instrument is such that any type of battery between 1.25 and 3 volts can be used.

The voltage can be checked on the measuring instrument by turning the operation switch to the corresponding position.

**Temperature range**

– 30 ° to + 50 ° C

**Resistance against overload**

A dose rate of 1000 R/h does not cause a return of the pointer from full deflection in any measuring range.

**Stability against shocks and jolts**

approximately 10 g

**Case**

The instrument is incorporated in a plastic case which is insensitive to shocks and blows. It is splash-water-proof.

**Dimensions and weight**

190 x 90 x 80 mm 800 g

**Carrying case**

A carrying case of genuine cowhide is supplied with the instrument. The charging unit is also housed in this case.

**Other radiation protection measuring instruments**

For highly sensitive contamination measurements of α-, β- and γ-radiation, the contamination measuring instrument LB 1200 is recommended which, in addition to the built-in counter tube, makes the connection of numerous external probes possible (even for liquids and gases).

For wave-length-independent dose rate measurements of X-rays and gamma radiation, from 10 keV on, the portable apparatus TOL/E with a gas amplification chamber of plastic material is used (most sensitive range 0–300 μr/h, readable 10 μr/h).

## Taking into operation

Turn left hand switch to "Ein" ("on").
Adjust the right hand switch to the range desired.

## Measuring gamma-radiation

Push the slide at the reverse side of the instrument over the counter tube window.

## Measuring beta-radiation

Push the slide in opposite direction to the counter tube window.

## Voltage control

Turn the left hand switch to "K". The indication should now rise above the marking "K" in the upper scale. If it is below the marking "K", the DEAC cells in the instrument have to be recharged. For this purpose the plug of the charger is put into the socket at the side of the instrument and the charging instrument in the Schuko-socket. The charging time is about 13 - 15 hours. During that time the instrument must not be switched on.

# PORTABLE GAMMA RADIOGRAPHIC SURVEY METEI
# MODEL E-130(

MEETS U.S. AEC REGULATIONS
(10 CFR PART 34, PARA. 34.24)
FOR USE IN RADIOGRAPHIC INSTALLATIONS

UTILIZES INTEGRATED CIRCUITS

SMALL SIZE - LIGHT WEIGHT

LONG LIFE WITH TWO D-CELLS

STABLE OVER WIDE TEMPERATURES

EXCELLENT LINEARITY AND STABILITY

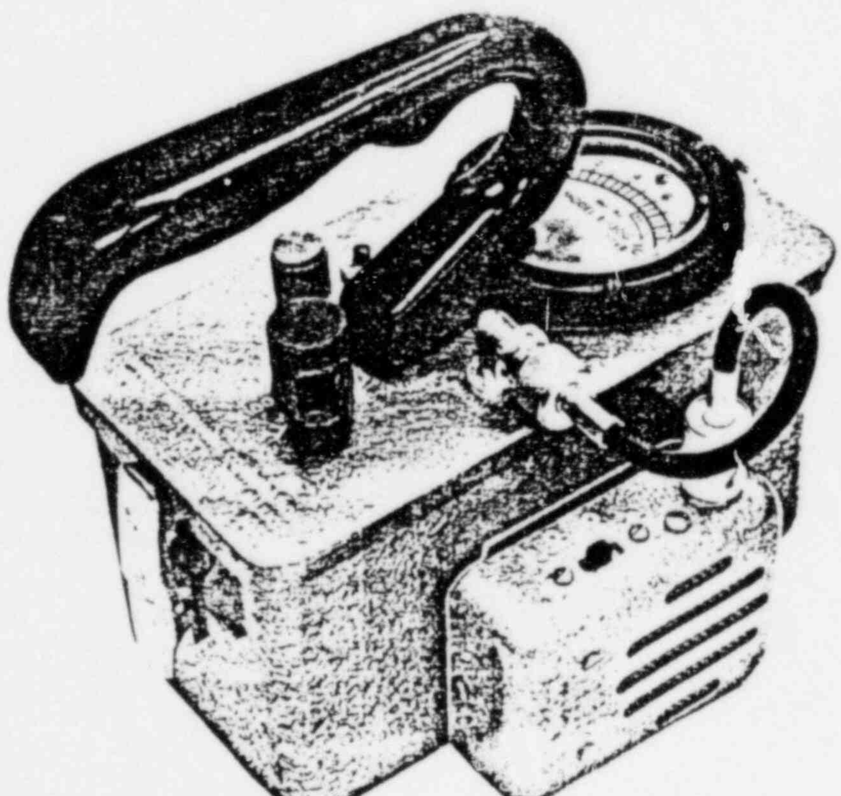
VARIABLE METER RESPONSE TIME

BATTERY CONDITION CHECK

3 RANGES - TO 1000 mR/hr

RUGGEDIZED METER

ENGRAVED SWITCH MARKING



SHOWN WITH SK-1 SPEAKER

# PORTABLE GAMMA RADIOGRAPHIC SURVEY METER
# MODEL E-130G

## GENERAL DESCRIPTION

The Model E-130G Portable Gamma Survey Meter combines the proven reliability of geiger detectors with new electronic circuits to provide an instrument with outstanding operational characteristics in a small, lightweight package at an economical price. The ruggedized meter provides exceptional linearity with continuously variable response time. Calibration stability results from temperature compensation and battery voltage regulation. High efficiency circuits extend the lifetime of the two D-cell batteries. A rotary switch combines the functions of power switch, battery check and selection of one of three sensitivity ranges. The amplifier-driven phone output may be used with headset, speaker assembly, or external pulse counter.

Design features include: voltage amplifier, monolithic integrated circuit trigger, meter driver with variable response time, phone driver, regulated and feedback controlled high voltage supply and individual calibration controls for each range. A single etched board holds and interconnects all components resulting in a minimum number of solder joints which enhances reliability. The etched board connects to the die cast aluminum cover, forming a completely operational instrument with controls and test points exposed for ease of calibration or maintenance. An aluminum can covers the assembly, sealing against an O-ring, forming a rugged, weather-proof housing.

Standard factory calibration is to mR/hr from $^{137}Cs$ sources having calibration traceable to the National Bureau of Standards. A cadmium shield surrounding the detector tube provides compensation for low energy gamma radiation. The instrument is furnished complete with C-Zn batteries, Calibration Certification, manual and carrying strap. Available accessories include headset and speaker assembly (SK-1).

## SPECIFICATIONS

I. READOUT
RANGES: 3 Linear Ranges, switch controlled, 10, 100, 1000 mR/hr $^{137}Cs$ full scale.
SCALE LENGTH: 1.76 inches (4.5 cm).
LINEARITY: Within ±5% of full scale, ±2% typical.
RESPONSE TIME: Variable by panel control from 10 sec. to 2 sec. to 90% of final value.
PHONE: One pulse for each event counted. Negative pulse approximately 2.5 volts amplitude, length determined by range switch.
SATURATION LEVEL: Exceeds 1000 R/hr.
VOLTAGE COEFFICIENT: Reading changes less than 10% with battery voltage from 3.0 to 2.0 volts (New batteries to end point.

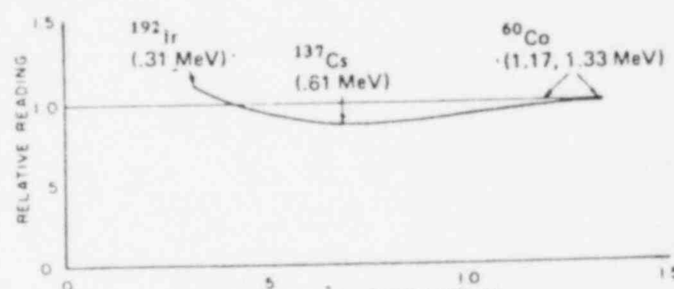
II. BATTERIES
Two "D" size cells held by internal captive holders.
VOLTAGE REQUIREMENT: 1.6 max. to 1.0 min. volts per cell.
LIFE: Variable depending on cell type, age, temperature, etc. Nominal life with new cells at room temperature for each type is:

| | |
|---|---|
| Carbon-Zinc | 300 hours |
| Alkaline | 500 hours |
| Mercury | 700 hours |
| Nickel-Cadmium (Single Charge) | 200 hours |

III. DETECTOR
GM TUBE: Small, rugged, halogen quenched.
Cadmium shield surrounding tube for low energy compensation.
SENSITIVITY: Approximately 100 CPM per mR/hr for $^{137}Cs$.

IV. MECHANICAL
DIMENSIONS: Approximately 6-3/4" L x 3-3/8" W x 3-5/8" + 2-3/8" handle H (17.1 x 8.6 x 9.2 + 6.0 cm).
WEIGHT: 3 lb. (1.4 Kg) with C-Zn batteries.

V. ENVIRONMENTAL
TEMPERATURE: Typical temperature coefficient of reading is -.15% per °F from -40° to +140°F (-.27% per °C from -40°C to +60°C). Maximum is -25% per °F (-.45% per °C).




TYPICAL ENERGY RESPONSE OF E-130G

EBERLINE INSTRUMENT CORPORATION
P.O. BOX 2108 SANTA FE, NEW MEXICO 87501
PHONE: (505) 471-3232 TWX: 910-985-0678

June 16, 1975

## FIXED RADIATION MONITORS

Three fixed monitors are provided. A Model L118 Wall Mounted Monitor is located adjacent to, and interlocked with the Personnel Access Door to the maze. The sensor is in the last leg of the maze leading to the irradiation room so that it prevents opening of the door unless the source is safely stored in the pool and there is no excessive radiation in the room.

A Model D/L2 No. L119 is mounted above the product exit barrier. One additional D/L2 No. L119 monitor is mounted on the deionizer unit. These continuously operating monitors are on separate circuits. They are individually interlocked with the machine operation. Should the radiation at the maze door or resin bed exceed a preset level, the product pass mechanism and conveyors will automatically shut down. These monitors are described in the following pages.

## RELIABILITY UNDER SERVICE CONDITIONS

### Response of Monitors in High Radiation Fields

a. Blank out of Model L118 monitor does not present a hazard. Interlocks prevent the Personnel Access door from being opened until monitor response has been tested each time the door is to be opened.

b. The D/L2 monitors or the Model L118 monitor will alarm well before radiation fields sufficiently high to cause blank out can occur.

DESCRIPTION, MODEL L118

DESCRIPTION, MODEL D/L 2, No. L119

SEE APPENDIX C

## 2.2 Calibration of Instruments

### 2.2.1 RATO/F and Eberline

These units will be calibrated at least semi-annually by an independent qualified laboratory. Units sent for repair will be calibrated as part of the repair procedure. The calibration lab has not yet been selected.

### 2.2.2 Model L118

This unit will be checked for proper functioning at quarterly intervals. The calibration procedure is outlined on Pages C-13 - C-15 of Appendix C.

### 2.2.3 Model L119

This unit will be tested for proper functioning once a month. The test procedure is outlined on Page C-33 of Appendix C.

# PART 3 - PERSONNEL MONITORING

## 3.1 Film Badges and Pocket Dosimeters

All Isomedix employees who enter the irradiator chamber or who work in or around the irradiator will wear film badges and pocket dosimeters.

Visitors with temporary restricted area access authorization will wear film badges and pocket dosimeters in the irradiation chamber. Badges are exchanged at intervals not exceeding one month and their issue and maintenance are supervised by the Radiation Protection Officer. Film badges and dosimeters are left in the facility in a rack near the entrance to the irradiator.

## 3.2 Procedural Restrictions

At the labyrinth entrance to the irradiator, there is a sign posted to inform personnel that certain radiation monitoring devices are required to be worn in the restricted area. Visitors will be accompanied by the Plant Manager or an authorized operator designated by the Plant Manager. Frequent visits to restricted areas by the Radiation Protection Officer and authorized users ensures that these procedures are followed. The procedures follow.

a. Obtain a film badge and pocket dosimeter from the film badge storage rack before entering any restricted area. Unless the monitoring devices are permanently assigned to individuals with regular restricted access, the name of the wearer must be identified with the identification number of the device, the date and time of issue and return, and the dosimeter reading.

b. Wear the monitoring device(s) at all times while in the restricted area.

c. Return the monitoring device(s) to the designated location upon leaving the restricted area or upon leaving the facility for the day. The time of return must be entered on the form provided.

d. Film badges are collected monthly and sent to the supplier for processing. Quartz-fiber dosimeters are read daily and the results recorded in a log. Film badge results are reported in record form and are transferred quarterly to Forms AEC-5 or equivalent.

e. The issuing, wearing and recording of film badges and dosimeters to employees or visitors is supervised by the Radiation Protection Officer or his designee.

## 3.3 Suppliers

Pocket dosimeters will be supplied by Dosimeter Corporation of America, or an equivalent supplier. The readable range of the pocket dosimeters will be 0-200 milliroentgens.

In other currently operating Isomedix irradiation facilities, both R. S. Landauer Co. and/or Teledyne-Isotopes badges are used. Although the supplier has not yet been selected, it will be one of the two aforemen ioned suppliers. Landauer provides film badges and Teledyne provides TLD devices.

# PART 4 - FACILITES AND EQUIPMENT

## 4.1 Site Location and Description

### 4.1.1 GENERAL INFORMATION

Isomedix (Puerto Rico), Inc. is a corporation registered under the provisions of the General Corporation Law of the State of Delaware and is duly registered and certified by the State Department of the Commonwealth of Puerto Rico to do business in Puerto Rico.

The Company's offices are temporarily located at:

223 Eleanor Roosevelt Street
Third Floor (Interior)
Hato Rey, Puerto Rico 00919
Telephone: (809) 753-7755

The proposed project facilities and offices will be located at:

Lot Number 3
Macco Industrial Park
State Road 690 Km. 1.7
Barrio Sabana Hoyos
Vega Alta, Puerto Rico 00762

## 4.1.2 PROJECT AREA

The site chosen for the project is Lot Number 3 of the Macco Industrial Park Development located at Km. 1.7 State Road 690, Barrio Sabana Hoyos; Vega Alta, Puerto Rico.

The lot is on the left front corner of the Park and adjacent to Route 690. The land area is of a square shape with 9,065 square meters of total capacity, (see map, Page 4-5).

At present, the lot is being developed as part of the Macco Industrial Park Development, in conformity with the conditions and recommendations outlined by the approved resolution of the Planning Board of the Commonwealth of Puerto Rico dated June 13, 1980.

The total land area of Lot Number 3 will be broken down as follows:

> Buildings, including warehouse and manufacturing areas, offices, equipment and maintenance room, employees' lounge and restrooms, will occupy approximately 21,000 square feet. The parking lot and trailer yard will use 27,000 square feet and the landscaping will take the remaining 50,000 square feet.

Topography

The topography of the lot is about 90% flat with an average elevation of 49.50 meters.

The adjacent areas follow the same pattern along the west and south side of the lot. The access road of the Park and Route 690 is located to the north and east sides of the lot, respectively .

Flora - Fauna

The vegetation of the area is one of minor fruit trees such as Avocado (Persea Americana), Mango (Mangifera Indica), Breadfruit (Artocapus Altilis), Lime (Citrus Aurantifolia), Grapefruit (Citrus Paradisi) and Orange (Citrus Sinensis). There are some common ornamental plants, such as Hibiscus, Anthurium and Allamanda Cathortica (Canario). A house and a garage were located on the central area of the Lot but the structures were demolished during the clearing and grading for the development and construction of the Park.

Geological Characteristics - Soil Quality

Seventy-five percent of the soils of the Park area are of the Bayamon Rock Outcrop and the rest is of the Tanama Rock Outcrop types.

Natural - Artificial Systems

There are no natural or artificial systems in the Park area.

## Surrounding Terrains - Description and Usage

The Park area is part of a small valley surrounded by low promontories (mogotes), which are very common along the northern coastal slope zone. The promontories are located to the north, west, and south areas of the Park and the terrains are not suitable for agriculture due to the difficulty to work them.

To the east, across State Road 690, is the Owens Illinois Industrial Glass Plant and the El Morro Corrugated Box Corporation. The nearest housing or community is located about 600 meters northeast of the Park and is known as Regadera Community.

There are three houses south of the Park, but they will be relocated to another area due to the widening of the road (Route 690), which is presently under construction.

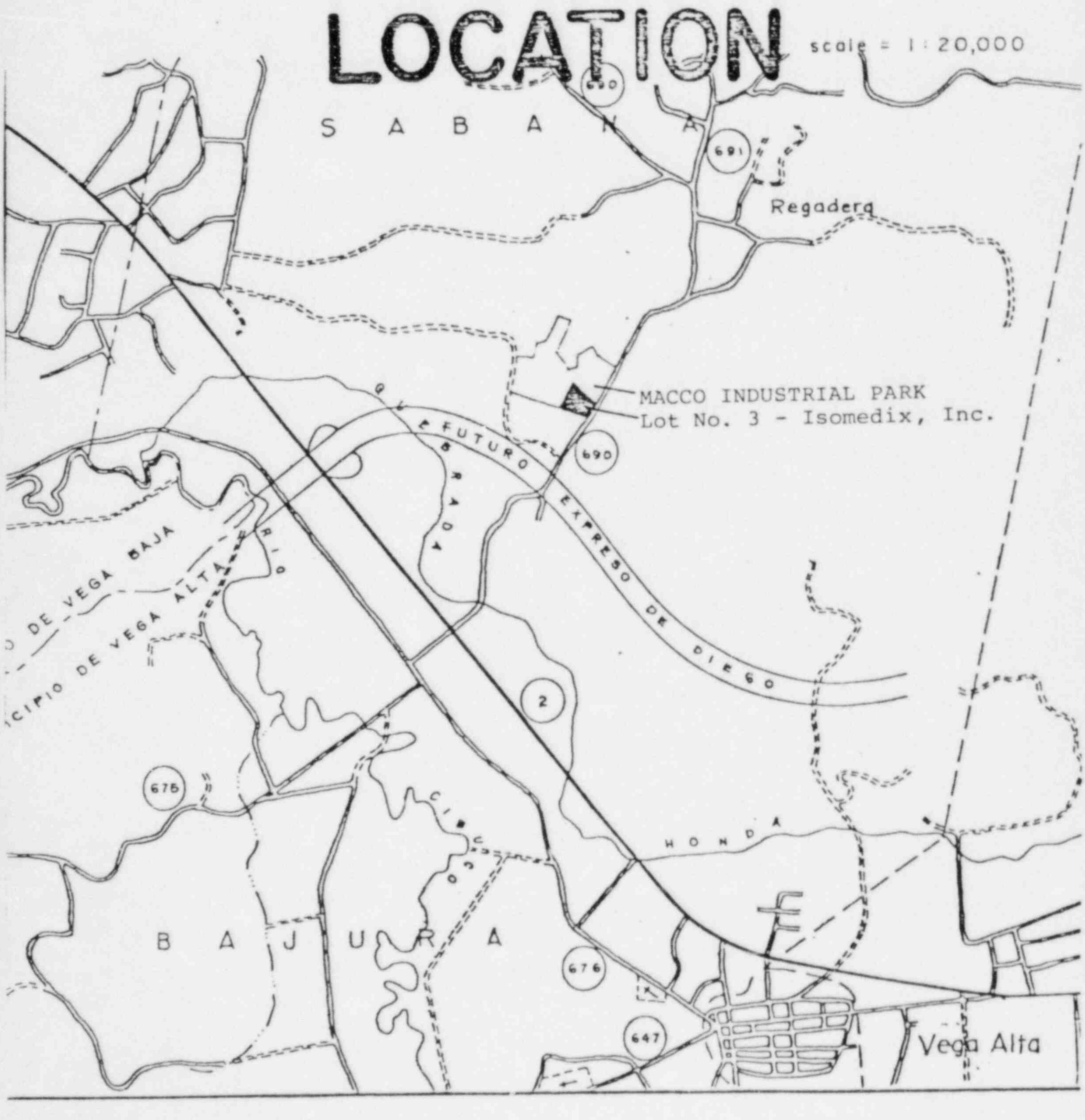
## Meteorology and Climatology

The prevailing climate is tropical and the temperature variations are minimum. The average annual rainfall for the area is about 60 inches. The winds are mostly from the east - northeast to the southeast with an average velocity of 12 to 14 miles per hour.

## Present Planning Board Zonification

The present zonification of the Macco Industrial Park is IL - 1 as per Resolution of the Planning Board dated June 13, 1980.

4.1.3 MAP OF AREA



## 4.1.4 SEISMIC HISTORY OF PUERTO RICO

(Source: U. S. Coast & Geodetic Survey)

The seismic history of Puerto Rico places it in the Zone 2 category, using the same criteria employed in the Uniform Building 2 Code, in designating seismic risk in the United States. This means that while a large part of the island may experience intensity VII and VIII earthquake disturbances (Modified Mercalli Intensity Scale of 1931), intensity IX, indicating major damage, is experienced at such infrequent intervals and over such limited areas that they modify the evaluation of risk over a long period of time. In recent years there has been a tendency to raise the MM intensities associated with the Uniform Building Code zones by one grade.

The maximum earthquake damage ever reported from Puerto Rico occurred on October 11, 1913, from a submarine earthquake (magnitude 7.5) in Mona Passage not far from the northwestern corner of Puerto Rico. In the nearby coastal area there was major damage from ground vibrations and additional damage from seismic sea waves. This shock struck closer to the shores of Puerto Rico than any other strong shock in its history.

The western half of Puerto Rico may expect moderate damage at relatively frequent intervals from submarine shocks which follow approximately the 67.10 meridian in the areas west and northwest of the island. Seismographic data reveal shocks of the following magnitude in the last 50 years in this area: 6.2, 6.5, 6.5, 6.8, 7.0, 7.5, and 7.8. They originated from 10 to 60 miles offshore.

In the eastern area a submarine shock in 1867 estimated of magnitude 7.5, appears to have originated within the triangle formed by the islands of St. Thomas, St. Croix, and Vieques. Although 75 miles off the eastern coast of Puerto Rico, damage was reported from all parts of the island, especially the eastern portion. Instrumental results indicate a smaller number of strong shocks in the eastern waters of Puerto Rico than in the waters to the west and northwest. No shocks of high magnitude have been recorded in the eastern area in the last 50 years.

Six or eight nondestructive shocks originating within historic time on the island itself have shaken areas seldom exceeding 25 miles in radius. They apparently all centered in the mountainous area halfway between San Juan and Ponce.

Possible Fault Line

Maps indicate that there is a possible fault line approximately 35-40 miles long, which generally parallels the north central coast of the island approximately 1-2 miles inland. The proposed facility will be located some 3-5 miles east and south of the eastern extremity of the possible fault.

Discussion

The structural portion of the facility has been designed to accommodate earth movements of the magnitudes indicated by past recorded experience.

The pool itself is constructed as an integral unit separate from the floor of the irradiator building and the foundation walls. The pool is free to move relative to the interior building, thus minimizing the stresses applied to walls and floor of the pool during any earth movement.

## 4.2 BUILDING LAYOUT

See Appendix B

## 4.3 MECHANISM OPERATION

### 4.3.1 Description

Refer to Drawing B- 110701-002 The source is raised from the fully shielded (safe) position in the pool to the "irradiate position by two stainless steel cables attached to the source rack. These cables run through the ceiling to a pneumatic hoist system. Return to the fully shielded (safe) position is by gravity when the air supply is shut off and the pneumatic hoists are vented. The source rack is guided by two taut stainless steel cables extending from the floor of the pool through the ceiling to the roof. The cables run through guides at each end of the source rack. The correct "irradiate" position of the source rack is sensed by the end of the rack activating a microswitch mounted on one of the guide cables. Each hoist cable passes over two sets of sheaves. One set of sheaves is fixed, the other is moved by the pneumatic cylinder so as to increase the separation between the two sets of sheaves thereby hoisting the rack. The hoisting distance is a function of the preset piston stroke and the number of sheaves in each set. The "irradiate" position of the source rack is adjusted to the full stroke of the pneumatic hoist.

Removing the air supply and venting the pneumatic hoists permits the weight of the source and rack to force the two sets of sheaves together. This extends the cable, lowering the source to the fully shielded (safe) position in the pool. The rate at which the source is lowered is governed by the rate at which air is allowed to exhaust from the pneumatic hoists. This normally takes about 25 seconds.

The hoists are located on the roof of the irradiation room where they can be serviced at any time. The only components of the source system within the radiation room are the source in its rack, guide cables, hoist cables and one microswitch. The rack, guide and hoist cables are not subject to radiation damage. Failure of the microswitch will return the source to the fully shielded (safe) position.

Each hoist cable is 3/16 inch (4.76mm) diameter preformed and prestressed stainless steel wire rope. The construction is 7 strands of 19 wires each and the breaking strength is rated at 3,700 pounds (1,678 kg). The weight of each of the two fully loaded source racks is approximately 600 lb (272 kg).

Separate guide cables for the rack are 5/16 inch (7.94 mm) diameter preformed and prestressed stainless steel wire rope.

The construction is 19 wires twisted into a single strand, and the breaking strength is rated at 9,000 poinds (4,090 kg).

The bottom of each guide cable is attached to a hook located at the end of an anchor assembly made from 2 stainless steel angles. This assembly is attached to the pool floor by threaded anchors embedded in the concrete. The tops of the guide cables pass through tubes installed in the concrete ceiling where they are held taut by tensioning devices on the roof. The source hoist and guide cables are visually inspected by AECL-CP at the time of each source replenishment and by the operator once a month during the routine preventive maintenance. If any broken strands or signs of wear are apparent, the source modules are removed from the rack by qualified AECL-CP personnel and stored at the bottom of the pool. The empty source rack is then raised and cables closely examined. If necessary, the damaged cable is replaced.

The guide cables can be removed from or replaced on the hooks on the anchor by use of underwater tools handled in areas above the pool surface where the radiation levels are low. There is no need to empty the pool for cable inspection or change.

### 4.3.2 Source Movement Procedure

To raise the source and start the machine, the operator must first rectify any faults indicated by the console lights. He must then use the MACHINE key to activate a time delay at the far end of the radiation room. This allows him to make a last inspection and ensures that no one is in the room. He then has a period of 90 seconds in which to engage the source hoist air interlock and close the maze door. The irradiation will start when the MACHINE key is turned to the START position. If the time delay runs out before he completes this sequence he must repeat the entire sequence.

The source hoist is controlled by fail-safe interlocks to prevent the source being raised if correct procedures are not followed or faults are indicated by safety devices. During the machine operation, the source will automatically return to the fully shielded (safe) position in the event of a power failure, a loss of air pressure or the actuation of a safety device.

A power failure when the source is up will de-energize all relays causing the air to exhaust from the source hoist system and lower the source. To prevent unnecessary shutdowns due to power failures of short duration, a pneumatic timer will restart the machine and raise the source if the power is off for less than ten seconds. Since the access door cannot be opened when the power is off, this feature does not present a radiation hazard to personnel.

The following unusual occurrences have been considered and the consequences are shown to not represent a radiation hazard. These are to be rectified by qualified AECL-CP personnel.

a) Source cable breaks. The rack would drop to the bottom of the pool under its own weight. The resistance of the water would prevent the rack from reaching sufficient speed to damage the source elements.

The rack in the fully up irradiate position actuates a microswitch secured to the guide cable. The microswitch must be actuated to indicate that the source is in the correct irradiate position. If the microswitch is de-actuated, the source moving alarm will sound. The air is exhausted from the hoist cylinder allowing the rack to return to the fully shielded (safe) position and the machine is shut down.

If the hoist cable breaks, the machine would shut down because of the de-actuation of the microswitch. The absence of weight pulling on the hoist would prevent the source down limit switch from being actuated. The source moving alarm will continue to sound, warning the operator of an abnormal occurrence.

To replace the hoist cable qualified AECL-CP personnel would remove the source modules from the rack. The modules and source pencils would be inspected underwater for any damage and stored at the bottom of the pool if no damage is apparent. The empty rack would then be lifted out of the water and inspected for any damage. The hoist cable would be replaced and the source modules would be reloaded into the rack.

b) Hoist cable jams in hoist. The hoist is located on the roof outside the radiation room and is readily accessible. It can be dismantled and the cable freed without any personnel exposure.

c) Source rack sticks on guide cable. The guide cable can be detached from the tensioning devices on the roof and lowered to the bottom of the pool.

d) Obstruction prevents source rack from lowering. Product is prevented from jamming against or under the rack by the metal carriers which are guided at the top and bottom.

e) Obstruction above the source rack. The lift capacity of the hoist is limited by controlling the air supply to it. An obstruction would prevent the rack from reaching the irradiate position within the preset time, causing it to automatically return to the fully stored safe position. The irradiator would be shut down.

Electrical Circuitry

All electrical circuits within the radiation room are low voltage, typically 24V, which is too low to result in an electrical shock hazard in the event of radiation damage to insulation or other components. The wiring is installed so that only the final 18 inches (45 cm) connecting to the pneumatic cylinders is ever flexed. Electrical malfunctions due to failed insulation will blow fuses and shut the plant down without creating a radiation hazard.

Personnel barriers at the product entry and exit openings are automatically controlled by the product. Product boxes which obstruct the openings must be present before the barrier doors open.

4.3.3 SPREAD OF RADIOACTIVITY DUE TO FORESEEABLE ACCIDENTS

Airborne Radioactivity

Tests have indicated that in the event of rupture of a source pencil containing cobalt-60, there will be no airborne release of radioactive material. As a precaution, a 97% absolute filter is placed in the ventilation system. There are no radioactive gases present.

In Source Storage Pool

The pool is a closed system so there will be no release of radioactivity from it to the environment.

It is assumed that a leaking source pencil could result in $10^{-5}$ µCi/ml in the pool. This has been discussed in "Radiation Levels Due to Foreseeable Accidents" part (C) Leaking Source Capsule (above). The disintegration of a source element is not considered possible. The lining of the pool is such that it can be cleaned by wiping and vacuuming without hazard if conducted by qualified personnel.

Source Movement Displays

Closing the maze door, after the interlocks within the radiation room have been properly made, lights a green MACHINE READY light on the control console.

Turning the MACHINE keyswitch to START causes the key, when released, to return to the ON position and yellow MACHINE ON indicator to light. The green SOURCE DOWN light is extinguished and the source travel alarm rings. When the source is fully raised, as signalled by the microswitch on the guide cable, the red SOURCE UP indicator lights and the source travel alarm stops ringing. Automatic operation of the conveyor system begins.

### 4.3.4 RADIATION LEVELS DUE TO FORESEEABLE ACCIDENTS

a) Source Activity Transported on a Product Carrier

The carriers will be stopped by the alarming of the D/L2 monitor when exterior radiation levels reach approximately 0.5 mR/h. The maximum activities which can escape undetected are:

i) activity detectable leaving product exit door ~7.0 mCi cobalt-60.

ii) activity detectable 10 feet (3.05m) before reaching end of maze - 80.0 mCi cobalt 60.

b) The Source Rack Sticks or Jams

There will be no external radiation field greater than that in normal operation.

c) Leaking Source Capsule

A maximum concentration of $10^{-5}$ µCi/ml is expected. This will deposit on the filter and resin bed of the water treatment plant and could accumulate to 0.5 mCi in a month. The radiation field at 1 metre from the treatment plant would therefore not exceed 0.6 mR/h. In any event the D/L2 monitors would alarm and shut down the irradiation facility when the preset alarm level or 0.5 mR/h is reached.

# 4.4 SHIELDING AND CALCULATIONS

## 4.4.1 . RADIATION ROOM SHIELDING

Permissible Radiation Levels

The shield is designed to attenuate radiation from the design capacity source to the level recommended by the International Commission on Radiological Protection. Shielding thicknesses are calculated so that under normal working conditions no person in the vicinity of the irradiator will receive more than 10 mrem/week or a maximum of 500 mrem/year.

The occupancy factor for areas adjacent to the irradiator shield is assumed to be 40 h/week.

Material Specifications

Concrete density = 2.35 $g/cm^3$ (147 $lb/ft^3$)

Lead = 11.35 $g/cm^3$

Shield Penetration

The ventilation duct from the radiation room passes below the floor and terminates in the equipment room at the filter assembly.

Piping serving the water treatment plant and the pool cooler, exits from the shielded area in a trench below the floor. Lead wool is used in the trench to reduce the radiation field to an acceptable level.

The source hoist and guide cables pass through the concrete ceiling in pipes which are just large enough to accommodate them. The pipes are located in the concrete with lead shot packing. In surveys of previous installations, the leakage along each of these paths has been acceptably low.

In any event, a complete survey of radiation fields in all accessible areas around the facility must be carried out when the source is first raised. Any deficiencies in shielding must be corrected before the plant is considered operational.

## 4.4.2 SHIELDING CALCULATIONS

Radiation Levels

The shield for the IR107 irradiator is shown on Drawing 8110701-002 The shield is designed to attenuate the radiation from a 4,000,000 curie cobalt-60 plaque source to sufficiently low levels so that under normal working conditions no person in the vicinity of the irradiator receives more than an average of 10 mrem per week or a maximum of 500 mrem per year. This is the exposure level recommended by the International Commission on Radiological Protection [(1)] for individual members of the public.

To allow full occupancy of 40 hours per week in all areas adjacent to the irradiator, the shield is designed to reduce the average exposure rate with a capacity source to less than 0.25 mR/h. Radiation levels up to 2.0 mR/h are allowed in small areas adjacent to the shield provided that these do not contribute significantly to the personnel dose. Some of the areas where exposure rates between 0.25 mR/h and 2.0 mR/h may be expected are at the edges of the personnel door, at the product opening, at the floor trench, at the edges of the roof plug and outside the primary shield at the source centreline.

When the source is in the fully shielded (safe) position, the average exposure rate inside the radiation room will be less than 0.25 mR/h.

Primary Shielding

The transmission of cobalt-60 gamma radiation in concrete is shown in Figures 5.1A and 5.1B, Pages 4-17 and 4-18. The exposure rate from a 1 curie point source of cobalt-60 is $1.3 \times 10^3$ mR/h at 1 metre and varies inversely with the square of the distance. Concrete thickness for the primary shielding was determined by calculating the maximum exposure rate outside the shielding wall for a point source and correcting for source geometry and absorption within the source plaque. Some sample calculations are given below:

a) Maximum field outside external wall parallel to source plaque.

Concrete thickness = 74 inches (1.88 m)

Transmission = $1.4 \times 10^{-9}$

Distance from source centre to exterior surface of wall = 16 feet 8 inches (5.08 m)

Exposure rate due to point source of 4,000,000 curies of cobalt-60 =

$$1.3 \times 10^3 \times 4.0 \times 10^6 \times \left(\frac{1.00}{5.08}\right)^2 \times 1.4 \times 10^{-9} = 0.28 \text{ mR/h}$$

Self absorption factor and geometry factor for transforming point source calculation to that for 13 foot (3.96m) high plaque source = 0.7

Maximum exposure rate = 0.20 mR/h

This is within the design average radiation level of 0.25 mR/h

b) Maximum field outside wall at end of source plaque.

Concrete thickness = 71 inches (1.80m).

Transmission = $3.3 \times 10^{-9}$

Assume point source at centre of source plaque.

Distance from source centre to exterior surface of wall = 21 feet, (6.40m).

Exposure rate due to point source of 4,000,000 curies of cobalt-60

$$1.3 \times 10^3 \times 4.0 \times 10^6 \left(\frac{1.00}{6.40}\right)^2 \times 3.3 \times 10^{-9} = 0.42 \text{ mR/h}$$

Self absorption and geometry factor at end of source plaque = 0.3

Maximum exposure rate = 0.13 mR/h

This is below the design average radiation level of 0.25 mR/h. Additional attenuation provided by oblique transmission through concrete will reduce the average radiation levels in the areas adjacent to the primary shielding to less than 0.25 mR/h with a capacity source of 4,000,000 curies of cobalt-60.

Maze Design

Accurate calculations of the exposure rate and energy spectrum at points along a concrete maze are difficult to perform. At present detailed calculations of the exposure rate attenuation in concrete mazes have been confined to two-legged concrete ducts[2]. The amount of work required for detailed calculations for mazes with more than one right-angle bend becomes prohibitive and maze designers must either rely on measurements to determine exposure rates at the entrance of a maze with several legs or must make order of magnitude estimates using purely empirical formulae.

Maze entrances for industrial irradiators designed by AECL-CP are based on both calculations and measurements. The radiations incident upon the maze walls due to singly-scattered radiation is calculated by dividing the scattering areas into small segments and calculating the amount of single-scattered radiation from each segment. The exposure rate from the small scattering area A (Figure 5.2, Page 4-19) is given by:

$$D = \frac{D_o \ \alpha \ (E_o, \ \theta_o, \ \theta, \ \phi) \ A \cos\theta}{r_1^{\ 2} \quad r_2^{\ 2}}$$

Where,

$\alpha \ (E_o, \theta_o, \theta, \phi)$ is the differential exposure albedo,

A is the area of the scattering surface,

$D_o$ is the exposure rate at one unit length from the source

$E_o$ is the initial energy of the gamma rays from the source

Values of the differential exposure albedo, $\alpha \ (E_o, \theta_o, \theta, \phi)$ have been calculated by Raso [3] using the Monte Carlo method. Using the Raso data, Chilton and Huddleston [4] developed the following semi-empirical equation for the differential exposure albedo,

$$\alpha \ (E_o, \theta_o, \theta, \phi) = \frac{C(E_o) \ K(\theta_s) \ 10^{26} + C^1(E_o)}{1 + \cos \theta_o / \cos \theta}$$

Where $C(E_o)$ and $C^1(E_o)$ are constants for a given energy $K(\theta_s)$ is the Klein-Nishina differential energy scattering coefficient,

$\theta_s$ is the angle through which the radiation is scattered and is given by:

$\cos \theta_s = \sin \theta_o \sin \theta \cos \phi - \cos \theta_o \cos \theta$

For cobalt-60 gamma rays, $E_o = 1.25$ MeV

$C(1.25 \text{ MeV}) = 0.0665$

$C^1(1.25 \text{ MeV}) = 0.107$

The calculated values of the differential exposure albedo for cobalt-60 gamma rays have been verified by measurements at AECL-CP.

The energy of the singly-scattered radiation is given by:

$$E = \frac{E_o}{1 + \frac{E_o}{0.511}(1-\cos\theta_s)}$$

The required thickness of the maze walls required to attenuate the singly-scattered radiation of energy, E, to below the design levels are calculated and corrections for lower energy multiply-scattered radiation are made using information obtained from measurements of the radiation fields in and around mazes built by AECL-CP.

For the maze walls where no singly-scattered radiation is incident and the maximum radiation energy is due to doubly-scattered radiation, an estimate of the incident doubly-scattered exposure rate is obtained by calculating the scatter from one wall surface to another surface and then to the maze wall. The energy of the gamma rays impinging on the second area is assumed to be the energy of a gamma ray having one Compton scatter at the centre of the first area and going to the centre of the second area. For the second scatter, the parameters"

$C(E_o)$ and $C^1(E_o)$ are approximated by

$C(E_o) = 0.0561\ E_o^{0.574}$ and $C^1(E_o) = 0.0122\ E_o^{-0.683}$

Again, corrections for lower energy multiply-scattered radiation are made from measurement data

Detailed measurements of radiation fields inside mazes have been performed by AECL-CP for two shielded room facilities in Ottawa, the irradiator at St. Hilaire, Quebec, and the Ethicon Medical Products Sterilizing Irradiator in Somerville, New Jersey. In addition, surveys of the exterior radiation fields are performed on every industrial irradiator built by AECL-CP. These extensive measurements confirm that the recommended maze shielding provides adequate protection.

References

1. "Recommendations of the International Commission on Radiological Protection", (adopted September 17, 1965), ICRP Publication 9, London;Pergammon Press 1966.

2. J.M. Chapman and C.M. Huddleston, "Dose Attenuation in Two-Legged Concrete Ducts for Various Gamma-Ray Energies", Nuclear Science and Engineering, 25, 66 (1966).

3. D.J. Raso, "Monte Carlo Calculations on the Reflection and Transmission of Scattered Gamma Rays", Nuclear Science and Engineering, 17, 411 (1963).

4. A.B. Chilton and C.M. Huddleston, "A Simi-Empirical Formula for Gamma Rays on Concrete", Nuclear Science and Engineering, 17, 419 (1963).

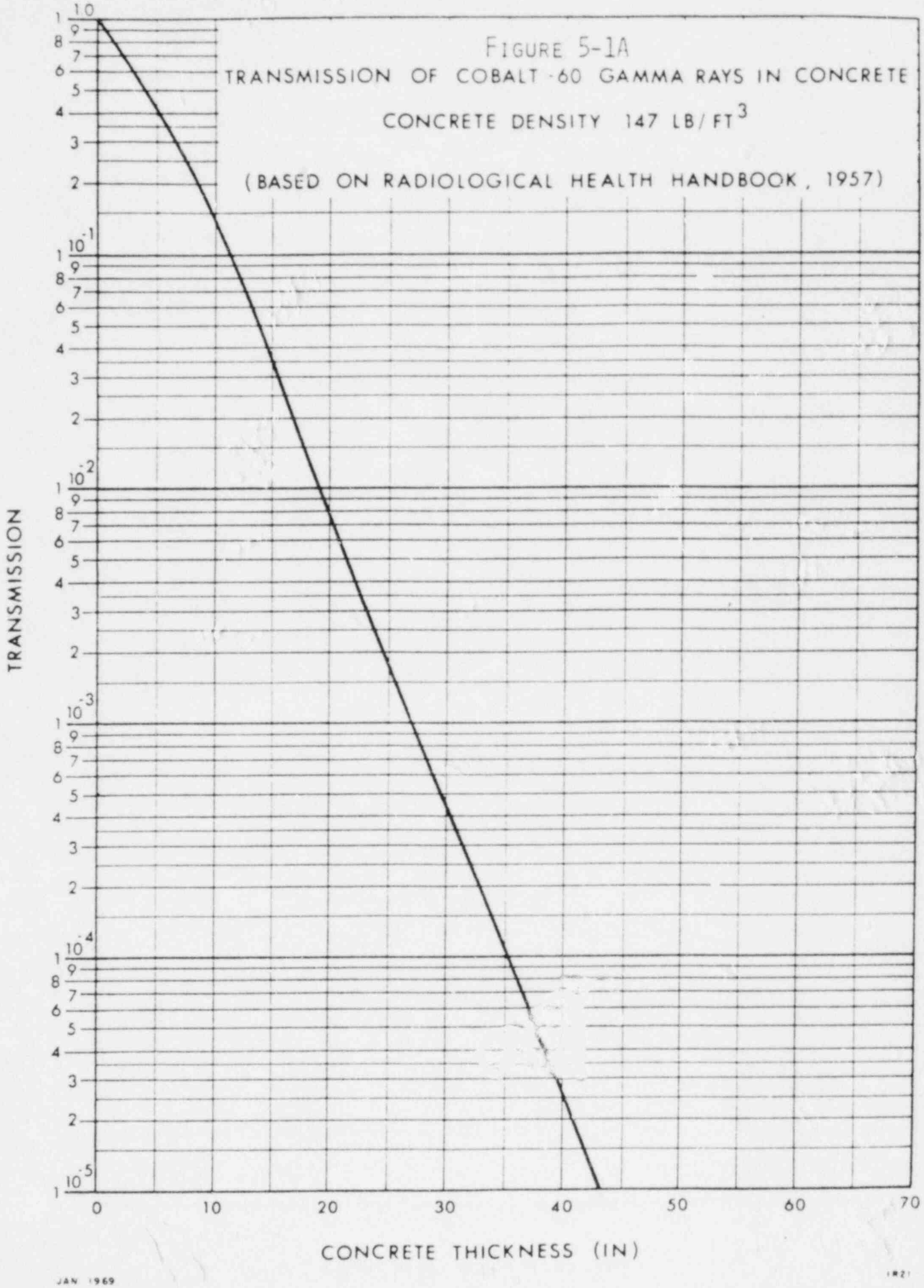


FIGURE 5-1A
TRANSMISSION OF COBALT-60 GAMMA RAYS IN CONCRETE
CONCRETE DENSITY 147 LB/FT$^3$
(BASED ON RADIOLOGICAL HEALTH HANDBOOK, 1957)
TRANSMISSION
1.0
$10^{-1}$
$10^{-2}$
$10^{-3}$
$10^{-4}$
$10^{-5}$
0
10
20
30
40
50
60
70
CONCRETE THICKNESS (IN)
JAN 1969

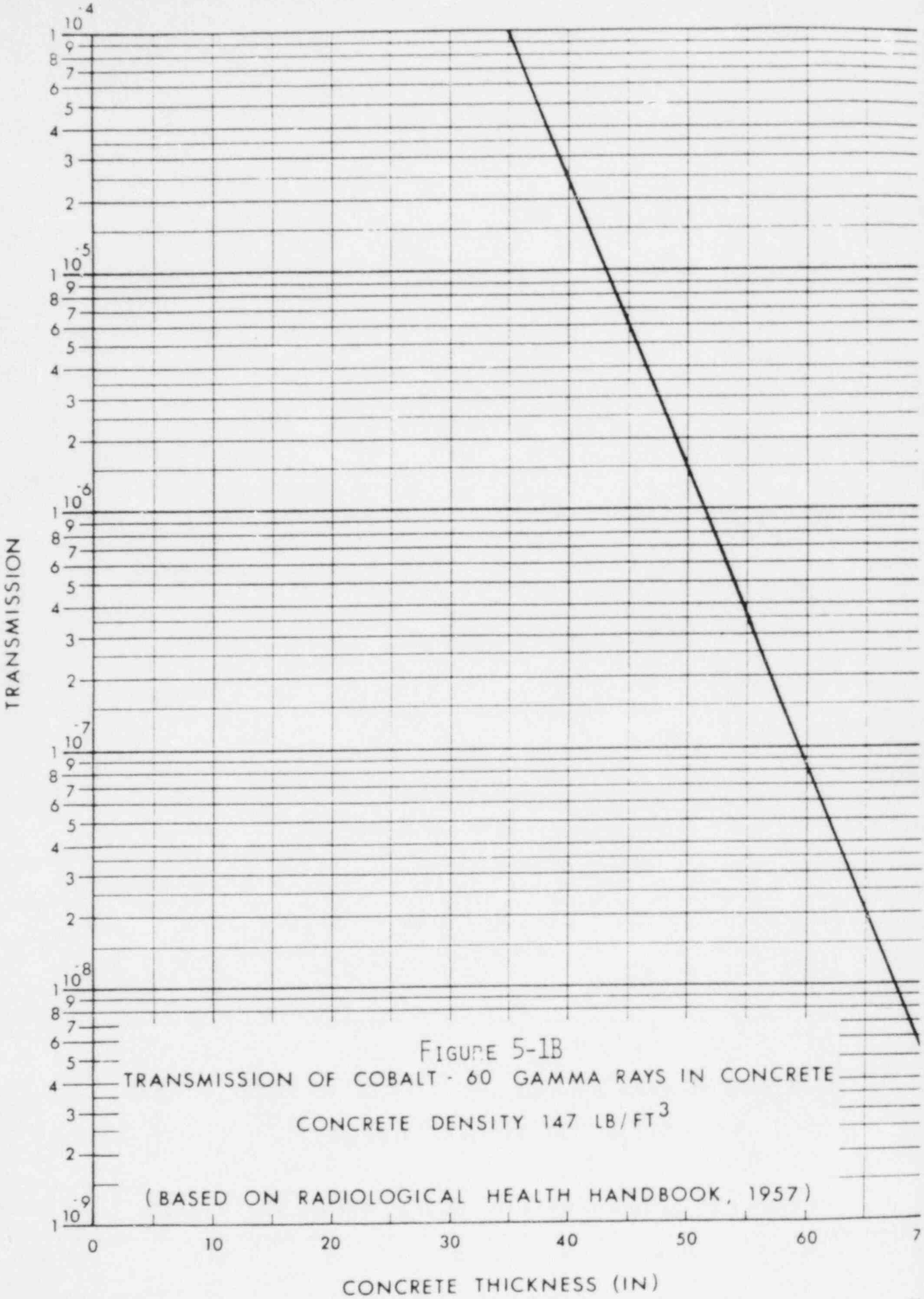



FIGURE 5-1B

TRANSMISSION OF COBALT - 60 GAMMA RAYS IN CONCRETE

CONCRETE DENSITY 147 LB/FT$^3$

(BASED ON RADIOLOGICAL HEALTH HANDBOOK, 1957)

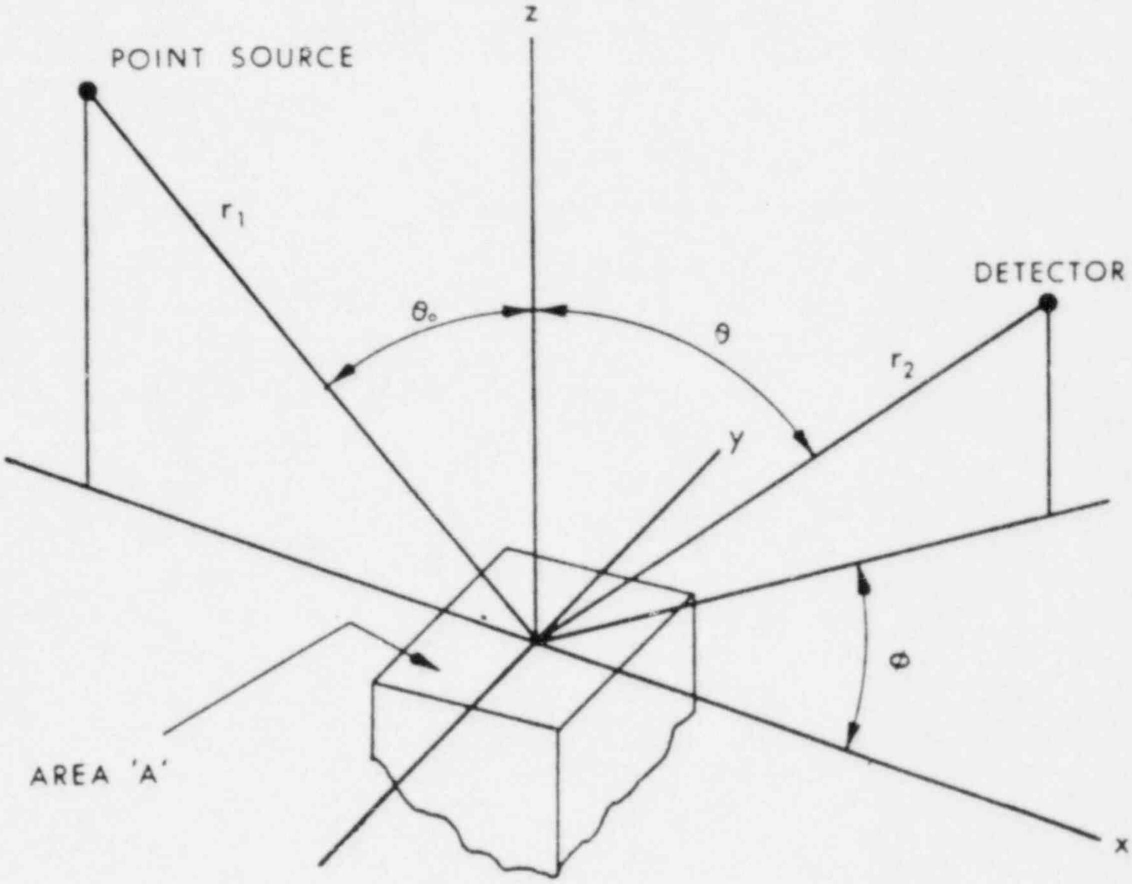



FIGURE 5-2
SCATTERING OF GAMMA RAYS
FROM SURFACE

# 4.5 POOL AND WATER TREATMENT SYSTEM

## 4.5.1 DETAILS OF POOL CONSTRUCTION

Pools used for the wet storage of source pencils in AECL-CP industrial irradiators are constructed of re-inforced concrete water-proofed by a continuous 4-ply membrane waterproofing applied to the exterior surface of the walls and floor. The specifications for membrane waterproofing and for Flintkote "Yellow Jacket" glass fibre membrane material are given in para. 4.5.2. The pool walls and floor are tested for leakage after the application of the membrane waterproofing and prior to backfilling.

The pool is constructed as an integral unit separate from the floor of the irradiator building and the foundation walls. The pool is free to move relative to the irradiator building, thus minimizing the stresses applied to walls and floor of the pool during any earth movement.

In the unlikely event that a crack should develop through the pool walls, the rate of water loss from the pool would be dependent on such factors as the permeability of the backfill and subsoil, and the distance above the water table. Water could be supplied at a rate greater than the rate of water loss by running hoses into the maze. The water level in the pool would be maintained at a sufficiently high level to permit underwater source handling operations. The source modules could then be removed from the source rack and the source pencils transferred from the source modules into shipping containers lowered to the bottom of the pool. The pool could then be drained and repaired.

The only foreseen condition that would require draining the pool and placing the sources into temporary storage is to repair a crack in the pool. All other operations including decontamination can be performed without emptying the pool. If it is ever necessary to drain the pool, sufficient shipping containers to temporarily store the entire source can be shipped from AECL-CP at short notice. For a source of 1,000,000 curies of Cobalt 60, three type F-168 source shipping containers, each capable of storing 400,000 curies of Cobalt 60 would be required. There is no personnel safety hazard during the period between the development of a crack in the pool and its repair. Depending on the rate of water loss, the irradiator can be shut down and personnel prevented from entering the radiation room or the water in the pool can be maintained at the proper level by installing temporary auxiliary supplies and irradiator operations can be continued until repairs are made.

The interior walls and bottom of the pool are lined with chemical resistant glazed ceramic tile which is corrosion resistant, impermeable to water and easily decontaminated. They are also resistant to radiation.

MONITORING

The carbon filter and resin beds are continuously monitored for radioactive contamination. Once a month the radiation levels are checked with the hand-held Berthold RATO/F and the results recorded. Any indication of a change in the amount of radiation present should be reported in accordance with the "Operating Regulations" to be supplied.

## 4.5.2 POOL WATERPROOFING SPECIFICATIONS

### A. EXAMINATION

1. Before the work of membrane waterproofing is commenced, the sub-contractor is to examine all walls and other surface to satisfy himself that all materials and finishes are in a proper condition for him to work over, and that all the proper waterproofing sleeves and flanges if any are installed for integration into the membrane, where pipes or ducts pass through.

2. All honeycombing, construction joints, form ties, etc. on the surfaces to be waterproofed shall be cut out to a depth of at least 1" and shall be patched with "Embeco".

3. The waterproofing sub-contractor will be held responsible for the final water-tightness unless he notifies the General Contractor and the Engineer in writing of defects, before commencing his work. Should this trade start the work without such notification, it shall be construed as an acceptance by him of all proceeding and connecting work and as a waiver of all claims or questions as to the suitability of such work for receiving his membrane waterproofing.

4. Concrete to receive waterproofing to have a maximum water content of 20% as ascertained by Inspector.

### B. MATERIALS

1. Asphalt primer - of the penetrating type meeting CGSB37-GP-9.

2. Glass Fibre Membrane - shall be an inorganic asphalt impregnated interwoven glass fibre cloth weighing not less than 1.8 oz. per square yard. Weave shall be 20 x 10 mesh or, shall be asphalt saturated cotton fabric weighing not less than 10 oz. per square yard and meeting C.S.A. Specification A123.15-1953.

3. Asphalt - types 1, 2 and 3 - C.S.A. A123.7.

4. Protective Board - 7/16" asphalt impregnated fibreboard.

5. Butyl Rubber - Mark II M.D.N. ASTM-D-412-61-T.

6. Butyl Rubber Adhesive - M.B.N. Asphalt or No. 90 M.B.N.

7. Joint Sealer - Igas Joint Sealer manufactured by Sika Chemical Corporation - or equal approved.

## C. PROTECTION

1. Where 1" - 0" widths or projecting membrane are exposed for lapping purposes at further application, the following protection will apply:

   After the projecting lap membranes have been laid and before any other traffic uses these areas, lay a complete temporary covering of building paper lapped 6" at joints, followed by a complete temporary covering of plywood or other non-flexible material. These shall only be removed just prior to the further application of the wall membrane.

2. 7/16" asphalt impregnated particle board shall be applied as per manufacturer's written specifications over all exposed membrane where waterproofing comes in contact with backfill to avoid damage to the finished membrane.

## D. APPLICATION

1. This work includes the furnishing of all labour, materials, tools, scaffolding, ladders, plant and other equipment required to complete the following hot process membrane waterproofing.

2. Surfaces over which waterproofing is to be applied shall be smooth and free from loose materials, grease, oil or any foreign matter. Wash off surface with water hose to assure freedom from deleterious substances, and allow surfaces to dry.

3. All concrete surfaces to be waterproofed shall be primed with undiluted Asphalt Primer at a rate of one gallon per square foot.

4. The application of all waterproofing membrane shall be a full mopping of each ply, three or more plies as specified of membrane, to the primed concrete surfaces, using not less than 20 pounds of hot asphalt per mopping per 100 square feet, plus top mopping. In no place shall dry membrane touch dry membrane.

All membrane shall be applied without wrinkles or buckles, making provision for ample lapping etc., as hereinafter specified, or indicated on the drawings.

5. A 3 Ply glass fibre membrane to be applied to exterior faces of all concrete pool walls.

6. At sump pits and other depressions below the floors, the membrane shall be 4 ply on walls and under slab, in accordance with above specifications, excepting that one additional ply of glass fibre and one additional mopping of hot asphalt shall be applied.

7. At all edges and angles, apply two extra plies of membrane in two additional moppings of hot asphalt. Additional plies of membrane shall be lapped not less than 6" all around.

8. Where vertical laps are left to be connected, they shall be temporarily protected with a 1/2" layer of cement mortar or treated wood plank. When connections with laps are made, laps shall be carefully cleaned and dried before proceeding with the work.

9. Provide extra plies carefully cut and fitted, and lapped onto pipe sleeves that pass through basement walls, trenches, sumps or pits. All gaps between pipes and sleeves shall be carefully caulked and made watertight.

10. Lay 1-1/2" insulation over waterproofing under arcade walk according to manufacturer's instructions for this type of application.

## E. DEFECTIVE WORK

Work which has been applied poorly or has become defective before backfilling or other covering, is to be either removed or is to have additional layers of material applied until acceptable.

## 4.5.3 WATER TREATMENT PLANT SPECIFICATIONS

TYPICAL RAW WATER ANALYSIS

| | |
|---|---|
| Alkalinity as $CaCo_3$ | Less than 100 ppm |
| Ion as Fe | Less then 1 ppm |
| Calcium as $CaCo_3$ | Less than 120 ppm |
| Free Chlorine as $Cl_2$ | Less than 1 ppm |
| Total Hardness as $CaCo_3$ | Less than 50 ppm |
| Turbidity | Less than 10 ppm |
| Dissolved Organic Material | Less than 1 ppm |
| Colour | Less than 15 ppm |
| Total Solids | Less than 150 ppm |
| Ph Factor | 6.5 to 8.0 |

*NOTE:*

*To determine the capacity of the water treatment plant, two (2) one-half pint water samples in clean containers should be sent to AECL for analysis*

WATER TREATMENT PLANT CHARACTERISTICS

1. Carbon Filter Bed - approximately 12 inches diameter.
2. Two Bed Demineralizer - exchange capacity greater than 1,000,000 milligrams as $CaCo_3$.

   Quality of effluent using raw water better than 10 micromhos/cm. Beds approximately 12 inches diameter.
3. Flow Rate - maximum 26 lpm (7.0 U.S. gpm).
4. Working Pressure - 3.5 Kg/cm$^2$ (50 psig)

   Maximum Pressure is 5.6 Kg/cm$^2$ (80 psig)

## WATER TREATMENT PLANT DESCRIPTION

1. Plant approximate dimensions are 1.1 m wide x 0.5 m deep x 1.5 m high (42 inches W x 19 inches D x 60 inches H).

2. Complete plant is skid mounted and completely assembled with all necessary water controls and flow meter. The raw water supply line, drain line, pool discharge line, recirculation line and all electrical wiring may be hooked up directly to the plant services. The drain system must be of acid resistant construction.

3. All valves and controls are located and accessible at the front of the plant.

4. An electrical control box containing a control relay, transformer, shut off switch and fuses is supplied and installed by AECL.

5. A pump motor starter is supplied and installed by AECL.

## CARBON AND RESIN SPECIFICATIONS

1. Carbon Bed - 2 cubic feet of high density large grain activated carbon.

2. Cation Resin - 2 cubic feet of DOWEX 50-8-W or equal.

3. Anion Resin - 2 cubic feet of DOWEX 21-K or equal.

# 4.6 VENTILATION SYSTEM

## 4.6.1 DESIGN BASIS

The system must:

a) maintain humidity at a low level,

b) prevent ozone from escaping down the maze,

c) maintain the ozone concentration within the radiation room low enough that the operator can safely enter the room as soon as the source has reached the fully shielded (safe) position.

The intakes, ducting and exhaust are laid out as described in Dwg. B110701-002 The location and height of the exhaust stack is such that the discharged air cannot be drawn into nearby ventilation intakes.

Proper operation of the irradiator ventilation system is monitored by a pitot tube in the 12 inch (304.8 mm) diameter ducting above the filter assembly and manometers at the pitot tube and across the pre-filter and the absolute filter. The air flow through the ventilation unit is adjusted by setting the damper to give an exhaust rate of 2200 $ft^3$/minute (62.3 $m^3$/minute). This corresponds to a linear velocity of 2800 ft/minute (854 m/minute) at the pitot tube equivalent to a pressure drop of 0.136 inch (3.45 mm) of water.

The pressure drop across the pre-filter and across the absolute filter can be checked routinely by reading the manometers installed across the filters. Clogging of the filters is indicated by an increase in the pressure drop. When the pressure drop exceeds 3 inches (76.2 mm), the filter is changed.

Proper operation of the ventilation fan is monitored by an air flow switch installed in the filter body. If no air flow is indicated, the source is returned to the fully shielded (safe) position and the machine is shut down.

The ventilation system is itself interlocked to a temperature sensor so that a high temperature condition in the radiation room will stop the ventilation system.

No auxiliary ventilation system is included.

## 4.6.2 NOXIOUS GAS PRODUCTION AND CONTROL

Allowable Concentration Versus Expected Production

| GAS | ALLOWABLE/WORKING DAY | EXPECTED WHEN SOURCE IS UP |
|---|---|---|
| Ozone | 0.1 ppm* | 0.6 ppm |
| $NO_2$ | 5. ppm* | 60 ppb |
| $H_2$ | <4% *** | zero |

* American Conference of Governmental Industrial Hygienists

** US OSHA

*** Lower Limit of flammability

The production of ozone is $1.2 \times 10^{-3}$ standard $m^3/h$ per million curies of Cobalt-60. Radiation room air is exhausted at 2200 $feet^3/min$ for approximately 4.6 minutes per complete air change. The concentration of ozone will therefore be adequately low by the time the operator can enter the radiation room.

The recombination rate of radiolytically produced $H_2$ is high enough that essentially no $H_2$ escapes from the water. The production of $NO_2$ is less than 60 ppb which does not represent a hazard.

## 4.6.3 CONTROL BY VENTILATION AND LOWERING OF SOURCE

Ozone and $NO_2$ production takes place when the source is exposed. As shown in preceding page, their levels will be controlled by operation of the ventilation system. In the event of this system failing the source is automatically lowered to fully shielded (safe) storage in the pool.

## 4.7 SAFETY DEVICES - SUMMARY

(REFER TO DRAWING B11C701002G)

The control system contains interlocks which will prevent start-up if correct procedure is not followed. Existing faults are annunciated at the control console. They must be rectified before start-up can take place. Similarly, faults which develop during operation, will automatically return the source to the SOURCE DOWN position and stop all conveyors. The problem may be diagnosed from the displays on the console.

### 4.7.1 MACHINE KEY

One key is used to operate all circuits as follows:

a) the POWER keyswitch

b) the MACHINE keyswitch

c) the MAINTENANCE keyswitch

d) the START-UP timer keyswitch

This key also unlocks the personnel door to the maze.

IMPORTANT - only one key should be used. This key must be attached permanently to a hand-held radiation monitor. Duplicate keys must be kept by the supervisor for emergency use only.

### 4.7.2 MAZE DOOR LOCK

The maze door can be opened from the outside only

a) with the MACHINE key

b) after POWER has been turned ON

c) when the source rack is in the "safe" position

d) when the cell monitor has been shown by test to be operating properly and no abnormal radiation field is present in the irradiation room.

This door may be opened from the inside at any time.

## 4.7.3 Source Hoist Valve

A safety chain across the maze just inside the door is mechanically interlocked with the source hoist air valve. Unless this chain is in place air can not be supplied to the source hoist to raise the source.

## 4.7.4 Emergency Stop Cable and Button

A pull-cable runs along the maze and three walls of the irradiation room. If pulled, all conveyors will stop and the source will be lowered automatically. An emergency STOP button on the console performs the same safety functions.

## 4.7.5 Fixed Radiation Monitors

A Model L118 Radiation Monitor is located alongside the Maze Door. Its radiation sensor is located in the irradiation room to sense radiation fields in the room when the source is down. The monitor circuit must be tested, by increasing the sensitivity to cause an alarm condition every time the door is to be opened. The monitor interlock prevents the door from being opened and sounds an alarm horn if there are abnormal radiation fields. There is an indicator light.

A Model D/L2 No. 119 monitor is mounted at the product exit door. Its sensor is located so as to monitor the radiation inside the maze door. Its purpose is to confine any radioactive material within the biological shield by stopping the conveyor. The source will also be lowered and a high pitched alarm sounded.

The carbon filter and resin beds are continuously monitored for radioactive contamination. Once a month the radiation levels are checked with the handheld Berthold RATO/F and the results recorded. Any indication of a change in the amount of radiation present should be reported in accordance with the "Operating Regulations" to be supplied.

### 4.7.6 Start-Up Timer

A 90 second timer which must be started with the MACHINE key is located at the far end of the irradiation room so that the operator ensures that the conveyors are correctly loaded and that no one remains in the room. If the start-up procedure is not completed within the time limit or any emergency device is actuated the start-up procedure must be repeated. The green MACHINE READY light is illuminated only after the maze door is closed. A warning bell rings during the timing period, and a light flashes in the irradiator.

### 4.7.7 Source Moving Alarm

When the source is either DOWN or UP its position is annunciated by console lights; while it is in transit a source moving alarm bell replaces those light signals. A "Radiation Warning" light adjacent to the maze door is illuminated when the source is not in its "safe" position.

### 4.7.8 Source Rack Guide Cables

If the source rack should jam, the tension on the guide cables can be relieved from outside the irradiation cell to permit the rack to be set free.

### 4.7.9 Pool Water Level

The water level in the pool is automatically maintained within pre-set levels by a switch controlling a water make-up line. The cell monitor will detect an increase in background radiation if the water level drops significantly while the source is in the down position.

A raw water meter measures and records the amount of make-up water being automatically introduced into the pool.

### 4.7.10 In-cell Temperature Sensor

A temperature sensor located in the radiation room will actuate if a rise in temperature of $40^{o}F$ ($22^{o}C$) above ambient occurs. Actuation of this sensor will cause the source to be lowered into the fully shielded (safe) position, stop the product pass system and shut down the room ventilation system.

The radiation room walls, ceiling and floor are constructed of concrete as shown on the drawing. The equipment inside the radiation room is mainly metal with a small amount of organic material such as insulation on wires, etc. This organic material will not sustain combustion when the ignition source is removed.

### 4.7.11 Security System

The irradiator system has been designed for total automation and hence unattended operation. The input accumulator conveyor can hold some 18 loaded carriers, ready for processing. These are fed into the irradiator in a controlled sequence, and completed carriers are directed into the output accumulator. Any malfunction--inside or outside of the irradiator--will automatically cause the source to return to the storage position.

We do plan to have unattended operation.

The security system planned includes the following:

(1) The property is surrounded by a 6' high chain-link mesh fence, topped with 1-foot high barbed wire (three strands, off-set).

(2) All doors and windows which give access to the warehouse area, which houses the irradiator, will be interlocked with a burglar alarm system. Any violation of the system automatically triggers a telephone system to call the plant manager or the licensed operator who is designated to be on standby and respond to abnormal operations for that period. The system also ties into the local police station, giving them notification of a possible unauthorized entry.

If unauthorized access is made into the warehouse, the security system relating to the irradiator itself will prevent entry into the unit while the source is exposed.

### 4.7.12 Roof Plug Interlock

An interlock on the roof plug senses when the plug is in the fully seated position. The source cannot be raised unless the plug is in its fully seated position.

# PART 5 - WASTE DISPOSAL

## 5.1 Collection, Storage and Disposal of Radioactive Wastes

### Contaminated Pool Water

This will be cleaned by passing it through a specially designed treatment plant. The radioactivity will accumulate in the filter and resin bed.

### Contaminated Solid Wastes

These will consist of filters and resins contaminated during the cleaning up of any spill. Other contaminated waste expected would be rags and styrofoam pads used for removing contamination from pool walls, source rack and other irradiator components.

These contaminated wastes would be stored in steel drums or shielded containers and disposed of as directed by the national regulatory bodies.

All radioactive source material to be returned to Atomic Energy of Canada Limited - Commercial Products, for disposal.

COMMENT - normal operation of the plant produces no radioactively contaminated wastes.

# PART 6 - RADIATION PROTECTION PROGRAM

## 6.1 INTRODUCTION

A basic Isomedix, Inc. philosophy is to limit radiation exposure of employees and the public to the lowest levels possible within the scope of all applicable regulations for protection against radiation. This philosophy is implemented in the following ways:

a. Design of operating procedures to minimize radiation safety hazards.

b. Continuous radiological surveillance of operational activities.

c. Establishment of effective administrative procedures, including emergency actions.

d. Utilization of competent, well-trained personnel.

e. Use of well-tested and reliable equipment.

## 6.2 ORGANIZATION

### 6.2.1 Operations

The chief operating officer of Isomedix (Puerto Rico), Inc. is the Plant Manager. He is responsible for the safe and continuous functioning of all aspects of the company's operations, including Radiation Safety. He reports to the Corporate Radiation Protection Officer (see organization chart, p. 6-7).

### 6.2.2 Radiation Protection

The on-site Radiation Protection Officer, if other than the Plant Manager, reports to the Corporate Radiation Protection Officer and as such, has direct authority to regulate operations when necessary to achieve adequate radiation protection control.

The responsibilities of the Corporate Radiation Protection Officer include:

a. Development of Isomedix's radiation protection program.

b. Surveillance of conditions affecting radiation protection, including source inventory and control, facility radiation monitoring, and personnel monitoring.

c. Training employees and the public in radiation protection principles and practices.

d. Coordination of emergency actions.

e. Maintenance of radiation protection records.

f. Licensing actions and liaison with the federal regulatory authorities. Periodic inspections of the Isomedix (Puerto Rico), Inc. Radiation Protection Officer's files and records will be made by George R. Dietz, John Masefield, William M. Owens and/or George B. Baker to assure compliance with license requirements and company standards.

6.2.3 <u>Maintenance of Safe Working Conditions</u>

6.2.3.1 <u>Source Inventory and Control</u>

6.2.3.2 <u>Procurement</u>

Each purchase order for radioactive material is approved by the Corporate Radiation Protection Officer to aid in determining that possession limits are not exceeded.

6.2.3.3 <u>Inventory</u>

Upon receipt or shipment of radioactive material, a copy of the receiving, shipping or transfer ticket is sent to the Radiation Protection Officer who enters the material into or removes it from inventory.

6.2.4 Contamination Detection Procedures

6.2.4.1 Source Wipe Testing

In the absence of a certificate from a transferror indicating that a test for leakage and/or contamination has been made within six months prior to a transfer to Isomedix, Inc., each source is leak tested upon arrival at Isomedix. Also, prior to removal or shipment, and in any case, at intervals not to exceed six months, sources are wipe tested. (Procedures are detailed in Section 8.2.5, p. 8-16).

6.2.4.2 Irradiator Wipe Test

Wipe testing of walls in the irradiator is accomplished on a monthly basis as follows:

a. Using a clean, dry, cotton swab or filter disc, thoroughly wipe several representative accessible surfaces of the irradiator and exhaust filter.

b. Place the sample in a clean plastic vial or envelope and remove from the irradiator.

c. Measure with a RATO/F or equivalent meter. If reading is over 2 millirad per hour, notify R.P.O. New Jersey. If below 1 millirad per hour, wrap and send samples to R.P.O. New Jersey for counting and determination of activity.

d. Procedure for counting is outlined in Section 8.2.5.4, p. 8-15.

6.2.4.3 Routine Checks

In addition to the constant checks of the safety devices and systems made by Operations personnel and the continuous display of area radiation monitoring, the Radiation Protection Officer makes the following checks;

a. Visual Inspection

Although inspections of the irradiator and discussions with operations personnel are made daily on an informal basis, regular inspections are conducted. These inspections consist of discussions with operations personnel about current and future work, observation of ventilation, monitoring, water and other controls, checking of the condition of irradiator equipment and confirmation that posted operating procedures are being followed.

b. Daily Operation Check

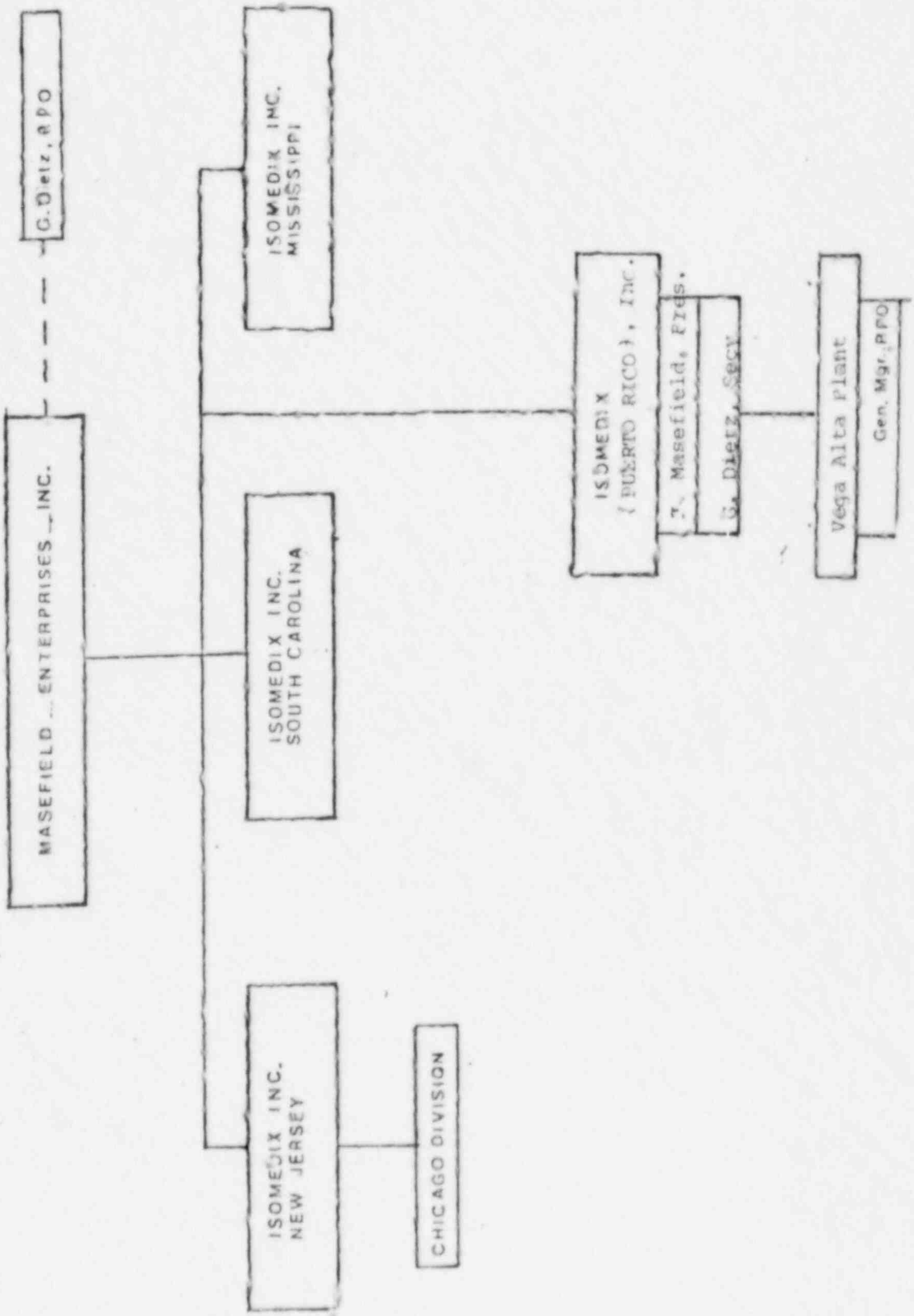
1. Visual checks by Operator to assure indicator lights are not burned out.
2. Determination that major systems are functioning during normal operations.

c. Other Periodic Inspections

Weekly, monthly, quarterly, semi-annual and annual checklists have also been developed to assure safe and uninterrupted operation of the irradiator.

Section 7 outlines the daily, weekly and monthly radiation safety checks. Quarterly, semi-annual and annual checks, which pertain to mechanical operation, have been omitted.

## 6.2.5 ORGANIZATIONAL CHART



# PART 7 - OPERATIONAL AND SAFETY CHECKS

## 7.1 IRRADIATOR ENTRY

Prior to each initial entry into the irradiator, the operator will complete the following "Irradiator Entry Safety Check".

(The Safety Check list follows the entry log.)

When the safety check is completed, the operator may enter the irradiator, carrying the hand-held meter.

# IRRADIATOR ENTRY SAFETY CHECK LOG - ISOMEDIX - SPARTANBURG

(To be performed prior to each entry into irradiator)

1. Control console "Source Down" light should be illuminated.
2. Flashing "Source Up" light should be off.
3. "Source moving" light and audible alarms should be off.
4. In-cell probe should indicate a radiation field of normal background only.
5. In-cell probe should be tested to confirm it is operational.
6. The portable survey instrument should be turned on and tested with the check source to be sure it is functional.
7. After opening the personnel entry door, the air coupling should be disconnected to cut off air supply to the source hoist mechanism.

When these safety checks are made and the safety system is determined to be functional, the irradiator may be entered using the approved irradiator entry procedure.

| DATE | TIME | SYSTEM FUNCTIONAL (Yes or No w/Comment) | OPERA[illegible] |
|---|---|---|---|
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## 7.2 SAFETY & MAINTENANCE RELATED CHECKS

It is self-evident that preventive maintenance on both the safety and mechanical systems of the irradiator will greatly assist in unit operation in the safest and most economical manner.

The following formalized Weekly and Monthly Operational Check-lists do not obviate the requirement that the operator exercise a continuous daily observance of operations and systems, and cause their repair or replacement on an as-needed basis.

# 7.2.1 WEEKLY SAFETY/MAINTENANCE CHECK

DATE ______________________

INSPECTOR ______________________

| ITEM | COMMENT (OK OR OTHER) |
|---|---|
| 1. Visually inspect control panel. All lights and indicators should be working correctly. | ____________ |
| 2. Attempt to open personnel door with key, with source up. Door should not open. | ____________ |
| 3. Source-up light should be flashing. | ____________ |
| 4. Press Emergency Stop Button. Source moving bell should alarm, "source up" light should extinguish, and "source moving" light should illuminite. | ____________ |
| 5. After source travel (approximately 30 seconds) "source moving" light should extinguish and "source down" light should illuminate. Flashing "source up" light should extinguish. | ____________ |
| 6. Attempt to open door without performing the radiation monitor check. Door should not unlock. | ____________ |
| 7. Perform monitor check and open door. Disconnect source hoist air line and inspect for damage, wear, etc. | ____________ |
| 8. Enter cell in approved manner, with monitor. Check radiation level over pool. Record reading at pool surface__________. | ____________ |
| 9. Depress pool water level control switch. Audible and visual alarms should sound at the control panel, the pump should stop, and makeup water should flow into the pool. | ____________ |
| 10. Inspect skimmer and remove debris as required. | ____________ |

WEEKLY SAFETY/MAINTENANCE CHECK

| ITEM | COMMENT (OK OR OTHER) |
|---|---|
| 11. Generally inspect the pool, source and mechanism for obvious faults. | ______ |
| 12. With the key, activate the startup delay timer. An audible alarm should sound, and the warning light should begin to flash. | ______ |
| 13. Exit the irradiator, hook up the air hose, and close the door. Allow the delay timer to time out and attempt to raise source. Source should not raise. | ______ |
| 14. Reenter the irradiator and start the delay timer. Exit, hook up the air hose, leave the door open and activate the "source up" switch. Source should not raise. | ______ |
| 15. Close door and activate source. Observe control panel lights for correct operation. Source moving alarm should sound. | ______ |
| 16. Inspect carrier door operation. They should sequence open and closed with carrier movement. | ______ |
| 17. Inspect air compressor for correct oil level in crankcase. Check for leaks. Clean air filter. Check V-belt for wear and tension. Check filter pressures. If above 3.0", filter must be changed. | ______ |
| 18. Check water treatment plant. Record incoming ________ and outgoing ________ water conductivity. Check for correct flow rate, no leaks, and general correct operation. | ______ |
| 19. Check air line lubricators and filters. Refill if necessary. Check for air and oil leaks. | ______ |
| 20. Visually inspect product carriers, storage conveyors and cylinders, and load/unload stations, for normal or routine operation. | ______ |

## 7.2.2 MONTHLY SAFETY/MAINTENANCE CHECK

DATE ____________________

INSPECTOR ____________________

| Item | COMMENT (OK or Other) |
|---|---|
| 1. Use the portable survey meter and check air filter banks and water filter and resin beds. Record readings. | AIR BANK ____________ <br> WATER BANK ____________ |
| 2. Lower source and enter irradiator. Attach a line to the emergency cable, and run line to outside. Start up irradiator in normal manner. After source begins to move, pull the line. The emergency cable action should cause the source to lower. | ____________ |
| 3. Check source hoist and guide cables for broken strands, fraying or signs of wear. (Report defects immediately.) | ____________ |
| 4. Check that the limit switch on the outlet conveyor shuts down the machine for a "fully loaded" condition. | ____________ |
| 5. With the source down, expose the irradiation room monitor probe to the test source. The alarm will sound. Close personnel door. Door should not be able to be opened from the outside. Door should be able to be opened from the inside. | ____________ |

MONTHLY SAFETY/MAINTENANCE CHECK

| Item | COMMENT (OK or Other) |
| --- | --- |
| 6. Expose the maze monitor to the test source. An alarm will sound. | |
| 7. Check ventilation system belts for wear and stretch. Lubricate moving parts. | |
| 8. Check the Monorail Drive unit motor for overheating. Inspect V-belt for wear and slipping. Check clutch for slipping. | |
| 9. Inspect source hoist motor, windup and cable for wear, broken strands. | |

## 8.1 NORMAL OPERATION

### 8.1.1 NORMAL START-UP

Normal start-up is defined as the commencement of operations not dictated by faulty or abnormal conditions.

To start the machine, the operator should proceed as follows:

In the Equipment Room

Turn on the main power supply to the control power transformer.

At the Control Console

1. Using the MACHINE key, turn the POWER keyswitch to the "RESET" position and release. The RESET/POWER TRIP indicator will briefly illuminate.

   NOTE: the radiation alarm may signal for a short period until the irradiation room monitor capacitors have fully charged.

2. Check the FAULT INDICATORS:

   a) SOURCE RACK/MONITOR

   b) LOW AIR/SAFETY STOP

   c) HIGH TEMP/EXHAUST FAN

   d) SAFETY TIMER/INTERN CONV

   e) LOAD/UNLOAD

   If any of these indicators are illuminated, a fault exists and must be rectified before proceeding (refer to "AUTOMATIC FAULT SHUT-DOWN").

3. Check that the irradiation room monitor, located at the maze door, is functioning as indicated by the flashing of the lamp and that the indicated radiation level is normal. If the radiation level is not normal,

or if an alarm condition is indicated, leave the facility immediately (refer to "CONTAMINATION DETECTION PROCEDURES" in this manual).

4. Check that the black hand on the MASTER CONTROL is set to its correct position. If the setting is incorrect, obtain the TIMER key from the facility supervisor and alter the time cycle accordingly.

5. Set the OVERDOSE CONTROL to a duration approximately 20% longer than that set on the MASTER CONTROL. The same TIMER key that is used to set the MASTER TIMER is used for this purpose.

6. Return the TIMER key to the facility supervisor.

7. Check that carriers are available on the inlet conveyor and that the outlet conveyor is clear.

8. Proceed as outlined in Figure 3.1 "ENTRY PROCEDURE".

NOTE: The maze door can not be opened if,

a) the monitor has not been tested, or

b) the radiation alarm is signalling, or

c) the source is not in the fully down position.

*IMPORTANT*

*When entering the maze:*

*If a noticeable increase in the audio output of the portable monitor is evident, leave and close the maze door, notify the facility supervisor immediately. The supervisor will check the radiation levels with the survey meter and will notify Atomic Energy of Canada Limited - Commercial Products of unusual conditions or incidents.*

*Do not enter the irradiation room.*

POST IN A PROMINENT POSITION CLOSE TO THE CONTROL CONSOLE AND AT THE MAZE ENTRANCE DOOR

# IMPORTANT

# DO NOT ENTER THE IRRADIATION CELL WITHOUT AN AUTHORIZED OPERATOR

## EMERGENCY CONDITIONS

IF RADIATION MONITOR ALARM SIGNALS (LOUD CLAXON)
OR SOURCE MOVEMENT BELL SOUNDS
TAKE THE FOLLOWING ACTION

(A) PERSONNEL IN MAZE OR IRRADIATION CELL

PULL SAFETY CABLE ON WALL AND LEAVE FACILITY IMMEDIATELY.
CLOSE MAZE DOOR BEHIND YOU.

(B) PERSONNEL IN THE CONTROL AREA

PUSH THE RED EMERGENCY STOP BUTTON ON THE CONTROL CONSOLE PANEL.

FOR EMERGENCY SERVICE, CONTACT

ATOMIC ENERGY OF CANADA LIMITED, COMMERCIAL PRODUCTS, OTTAWA, CANADA.
CABLE: NEMOTA TELEPHONE: (613) 592-2790 TELEX 053-4162

## COBALT 60 IRRADIATOR

In the Irradiation Room

1. Ensure that the pneumatic cylinders are in their normal start-up positions as indicated by green lights in the console display.

2. Ensure that the maze conveyor is in the start-up position.

3. Under normal conditions, there should be no personnel in the irradiation room. However, a check must be made to ensure that the room has been vacated.

   NOTE: The operator must lead all visitors when they are entering the cell and follow behind when they are leaving.

4. Actuate the SAFETY TIMER keyswitch using the MACHINE key. This will start the 90 second safety timer. An audible device will operate while the timer is running.

5. Leave the room (at a normal walking pace) making certain to engage the source hoist air interlock and to close the maze door on the way out. Closing the maze door will illuminate the MACHINE READY indicator on the control console provided the safety timer is still running.

   NOTE: If the safety timer runs out before the machine is started, the start-up procedure will have to be repeated.

Starting the Irradiator

1. Check that all green indicators are illuminated and that all red FAULT INDICATORS are extinguished. If either condition does not exist, the fault must be rectified before proceeding.

2. Turn the MACHINE keyswitch to the "Start" position and release. The key will return to the "On" position and the MACHINE ON indicator will illuminate.

The source will begin to rise as indicated by the ringing of the source travel alarm and the extinguishing of the SOURCE DOWN indicator. When the source is in the fully up position, the red SOURCE UP indicator will illuminate and the source travel alarm will stop ringing. Automatic operation of the machine will begin.

3. Make a complete entry in the Log Book. Entries should include the date, time of start-up, cycle time, box number, and other information required on sample log sheet.

### 8.1.2 NORMAL SHUT-DOWN

Normal shut-down is defined as the termination of operations not dictated by faulty or abnormal conditions.

To shut-down the machine, the operator must:

1. Turn the MACHINE keyswitch to the "Off" position when the machine has reached the end of a cycle. The MASTER CONTROL timer will reach zero and the source will begin to lower (the SOURCE UP indicator will extinguish) and the source travel alarm will signal.

2. When the source is in the fully down position (after the green SOURCE DOWN light illuminates and the source travel alarm stops ringing), remove the MACHINE key from the MACHINE keyswitch. The POWER keyswitch should be kept "On" at all times in order to keep the irradiation room monitor operating.

### 8.1.3 EMERGENCY SHUT-DOWN

a) Press the emergency STOP button on the control console, or

b) Turn "Off" the MAINTENANCE keyswitch (if being used), or

c) Turn "Off" the POWER keyswitch.

d) Pull the emergency PULL cable.

### 8.1.4 AUTOMATIC FAULT SHUT-DOWN

During operation, a number of fault conditions or abnormal occurrences may cause the irradiator to automatically shut-down. In this event, the cause will be indicated by the illumination of one or more of the FAULT INDICATORS on the control console.

*IMPORTANT*

*In the event of either a "Source Rack" or a "Monitor" shut-down, the operator must notify the facility supervisor immediately.*

*In the case of a "Monitor" shut-down, the supervisor will check the radiation levels with a survey meter and will notify Atomic Energy of Canada Limited-Commercial Products of unusual conditions or incidents.*

*For either shut-down, the resumption of normal operations is subject to the supervisor's approval.*

The indicator(s) will remain illuminated until the fault is rectified and the POWER keyswitch is turned to the "Reset" position and released.

If the irradiation room must be entered in order to rectify the fault, make certain that the "ENTRY PROCEDURE", Figure 3.1 is adhered to.

To correct the problem:

1. Rectify the fault.
2. "Reset" the POWER keyswitch.
3. Turn the MACHINE keyswitch to the "Start" position and release.

   The machine will resume normal operation.

# CELL ENTRY PROCEDURE

FIGURE 3-1

## 8.2 PROCEDURE FOR OTHER OPERATIONS

### 8.2.1 CHECK OUT PROCEDURE PRIOR TO COBALT-60 INSTALLATION.

As each facility component is installed it is checked for correct operation before proceeding with the next stage of assembly. These component checks include:

1. A full operation check out of the source rack (unloaded). Limit switch settings are adjusted to provide smooth operation and the rack is cycled at least 20 times.
2. The ventilation fan is checked for satisfactory operation and filters are installed.
3. Standby compressor operation. (If installed)
4. Water level float switch and water filtration unit.
5. The complete conveying system (using dummy product boxes) for smooth operation.
6. Interlock procedures and safety switches. The start-up procedures are simulated and machine functions are checked for satisfactory operation. All safety interlocks, emergency stops and alarms, are actuated to check for correct operation.
7. The monitor is checked using the test source.

## 8.2.2 CHECK OUT PROCEDURE <u>AFTER</u> INITIAL COBALT-60 INSTALLATION.

1. The operating area is monitored with an appropriate survey meter during and after source replenishment. The source pencils and associated components are wipe tested "in situ".

2. The first time that the radiation source is raised from the pool the following items must be checked:

   a) The correct interlock procedure is carried out and authorized persons only are in attendance during the test.

   b) The source is raised with the "Source" key-switch (without conveyor operation). The survey meter is checked for radiation readings.

   c) A complete radiation survey of the building is conducted with the source in the raised position.

3. The source rack is then lowered. The monitor is rechecked using the test source.

4. Final test of complete machine.

## 8.2.3 RECEIPT OF RADIOACTIVE MATERIAL IN CASKS

Cask unloading will require the physical presence of the RPO to supervise operations. Pocket dosimeters and film badges will be worn by participating personnel.

1. Survey the exterior of the cask while on the vehicle with a survey meter (RATO/F or equivalent type). Radiation level should not exceed 10 millirad at one meter from the cask's surface. If this rate is exceeded, the shipper will be notified to determine possible causes and courses of action.

2. Smear the cask surface and truck bed in five or more locations. Count with RATO/F.

3. If smears read more than 0.1 mrem source shipper will be notified to determine courses of action including rejection of shipment. Truck driver will be held until the problem is resolved.

4. If removable contamination limits (Item 3) and radiation levels (Item 2) are acceptable, unlash the cask. An overhead crane or mobile crane will be used as appropriate.

5. Move cask into designated area. If reading at cask surface is less than 2 millirad per hour, cask may be placed in unrestricted storage.

Place radioactive sign on cask. If surface dose rate is between 2 and 10 millirad per hour a rope barrier will be established at the 2 millirad distance and a radioactive sign will be hung from it.

### 8.2.4 PLACING THE CASK IN THE POOL IRRADIATOR AND UNLOADING SOURCE BASKET

This operation will require the physical presence of the RPO to supervise operations. RPO will use RATO/F meter to continually monitor radiation levels at pool surface.

1. Lower underwater light into pool or use high intensity dry lamp on surface.
2. Remove any conveying equipment on the irradiator floor directly beneath the stepped roof plug to permit easy access by the cask into the source storage pool.
3. Remove any obstructions from where cask will be placed in bottom of pool.
4. Utilizing a mobile crane, remove the roof plug from the irradiator roof.
5. Utilizing the mobile crane, lift the cask above the roof level, position it over the opening in the irradiator roof and from the roof of the building direct the crane operator as the cask is being lowered.
6. Cask is lowered to approximately floor level of the irradiation room.
7. From inside of the irradiator remove bolts securing the cask lid while cask is still suspended from the mobile crane.

8. Lower cask to bottom of pool.

9. Using long handled tools, disengage the crane hooks from the cask and secure them in the lifting lugs on the cask lid.

10. Advise crane operator to raise cask lid and set it to one side of the cask on the pool floor. Using long handled underwater tools, disengage crane hooks from cask lid.

11. Raise crane cables out of working area.

12. Using long handled tools, remove the basket holding the irradiation sources from the shipping cask. CAUTION: DO NOT RAISE THE HANDLING TOOL ABOVE THE POINT WHERE THE RED LINE AT THE 8' MARK IS LEVEL WITH THE SURFACE OF THE WATER.

13. Place the sources (in their basket) on the floor of the pool, well away from the shipping cask.

14. Advise crane operator to lower crane. Using long handled tools, hook the crane to the lid.

15. Replace lid on cask.

16. Using long handled tools, disengage crane hooks from lid and secure them in the lifting lugs on the source cask.

17. Guide the crane operator in removing the shipping cask from the pool, and through the roof. Monitor cask as it is raised.

18. Advise crane operator to place empty shipping cask on parking lot.

19. Replace stepped plug on top of irradiator.

## 8.2.5 SEALED SOURCE LEAK TEST PROCEDURES

General In the absence of a certificate from a transfer, or indication that a test for leakage and/or contamination has been made within six months prior to a transfer to Isomedix, each source will be leak tested upon arrival at Isomedix. After source receipt, leak tests will be performed on the source plaque at intervals not exceeding six months.

Specific Information

Name and Address of Individual Performing Leak Test

G. Baker or L. Watlington to take smears;
G. Dietz or designee to perform monitoring at Isomedix, Inc., 25 Eastmans Road, Parsippany, New Jersey 07054.

Leak Test Experience of Individuals

Nine years experience doing identical procedure for Isomedix, New Jersey, plant.

Type of Test

Wipe.

Radiation Detection Instruments Used

RATO/F (or equivalent)

Baird-Atomic Spectrometer, Model 530, with deep well counter (or equivalent), or Single Pulse Height Analyzer (Eberline or Ludlum).

# GENERAL DESCRIPTION OF PROCEDURE

(Note: The following procedure is currently being used under Isomedix Licenses 29-15364-01 and -02 in similar facilities in New Jersey, Chicago and Mississippi)

Wipe testing of the source in the pool is conducted as follows:

1. Attach a closed-cell pad (styrofoam, approximatel, 1 x 1 x 1/8" to the end of an underwater tool.
2. Rub the pad along the source, and on the accessible ends of the sources in a source module.
3. Remove the pad from the pool and check for radiation with a RATO/F or equivalent meter. Meter should read below 2mr/hr. If not, call RPO.
4. If reading in (3) is below lmr/hr, remove pad from tool, and allow to dry.
5. Repeat for each module of sources.
6. Send pads to Isomedix, New Jersey, for counting.

# PROCEDURE FOR COUNTING SMEARS AND DETERMINING CONTAMINATION LEVELS

Swipes are counted using a Baird-Atomic Spectrometer, Model 530, with deep well counter. Results are compared to counts from a standard .005uci cobalt-60 source, Item HP-1 from Tracerlab. Removable activity, in microcuries, is calculated as follows:

1. Take background count (BC).
2. Count standard swab (SS).
3. Then SS-BC = Standard Swab Count.
4. Count Leak Test Swab (LTS).
5. Then LTS-BC = Test Swab Count.
6. Then:

$$\frac{\text{Test Swab Count}}{\text{Standard Swab Count}} = \frac{x}{0.005 \text{ uci}}$$

7. And x = test results in microcuries.
8. Removable contamination should be less than $1 \times 10^{-5}$ microcuries.

## 8.3 - EMERGENCY PROCEDURES

### 8.3.1 GENERAL

Although plant facilities and equipment are designed to minimize radiation hazards and to facilitate their control, the possibility of an unforeseen accident cannot be overlooked. Radiation monitoring systems, through their meters and alarm features, provide warning and measurement of abnormal conditions to employees and the Radiation Protection Officer. Warning of a condition requiring emergency action might also come from an operator in his observation of such a condition. However, in virtually every conceivable instance, the radiation monitoring system would respond to the condition also.

### 8.3.2 RADIATION ALARM

If any unexplained audible alarm sounds, immediately lower source to bottom of pool. Call radiation protection officer. RPO will monitor surrounding area with a meter and attempt to determine the cause of the alarm .

If the alarm sounds and the cause can be immediately ascertained and controlled by the operator, he can first control the cause and then reset the alarm system. He will then notify the RPO or his designee of the situation and circumstances surrounding the incident.

If the alarm sounds and the cause cannot be immediately ascertained and controlled, personnel will proceed to their designated area. The RPO or his designee, determines the appropriate action based on a review of the monitoring system, ratemeters, and other available information. Appropriate action by a designee could be to keep people assembled or evacuate the area while calling for further assistance.

Emergency actions selected are based on limiting radiation exposures to employees with regular restricted area access authorization to 2.5 rem and other employees to .25 rem during the course of the emergency and its aftermath. Actions that are considered include: relocation of sources, erection of temporary barriers or shielding, area or building evacuation.

## 8.3.3 RADIATION OVEREXPOSURE

Copies of this procedure will be conspicuously posted near the irradiator entrance door, in the office area, or in any other conspicuous location determined by the Plant Manager.

The procedure was developed after consultation with the personnel, doctors and hospital listed.

The procedure is on the following page.

# RADIATION OVEREXPOSURE

## I. EXTREME OVEREXPOSURE - VICTIM UNCONSCIOUS

A. If a person is unconscious from an overexposure, immediately call the ambulance and tell the driver to take him to the Bayamon Regional Hospital. Call the Bayamon Hospital, explain the problem, and request that Dr. Manuel Martinez be notified and that he be requested to come to the hospital. Dr. Martinez can be reached at 787-5151.

B. Escort the victim to the hospital, either in the ambulance or in your car.

C. Following the above, immediately call one of the following:

| | Home | Work |
|---|---|---|
| Luis Watlington | (809) 763 9928 | (809) 753 7755 |
| George Baker | (609) 859 2753 | (201) 887 4700 |
| George Dietz | (201) 879 6066 | (201) 887 4700 |
| John Masefield | (201) 543 2814 | (201) 887 4700 |
| Bill Owens | (201) 625 9521 | (201) 887 4700 |

D. The person notified above in Item C will contact the NRC, Region II (404-221-4503), and explain the circumstances with a view toward obtaining the services of either Dr. Neil Ward or Dr. Thoma, both experts in overexposure, and both available to NRC on a consulting basis.

## II. MODERATE OR SUSPECTED OVEREXPOSURE - VICTIM CONSCIOUS

A. Immediately call one of the following:

Watlington, Baker, Dietz, Masefield or Owens (same as in I(C) above; if none of the above can be reached on the first try, call the hospital and take the victim there, and proceed as in I(A).

B. Take the actions directed from your contact of the above Isomedix people. Actions may include the following:

1. Taking the victim to the hospital (Bayamon Regional) in your own car.
2. Calling for the ambulance.
3. Notifying Bayamon Regional Hospital, and telling them to expect the victim, and to alert emergency.

C. If for some reason Isomedix personnel cannot be reached immediately and other action is taken, be sure to continue to try to contact Watlington, Baker, Dietz, Masefield or Owens until at least one has been notified.

## 8.3.4 EMERGENCY PROCEDURES FOR MALFUNCTIONS IN AUTOMATED IRRADIATOR

For any malfunction in the interior of the irradiator, personnel safety is maintained as long as personnel do not enter the chamber. In the event of product or carrier blockage of the source and the source cannot be returned to its normal storage position, the following corrective procedures can be conducted depending on the situation and source location, under the direction of the RPO. However, before other action is undertaken, the onsite RPO will take the following action:

1. Notify G. Dietz, W. Owens
   J. Masefield or G. Baker.
2. Notify AECL.

The following action may be authorized, but most likely will not be allowed until AECL representatives arrive on-site:

1. If source will not lower, raise source to the fully exposed position.
2. Attempt to lower source again in the normal manner.
3. If it is determined that a product is blocking the source from returning to its storage position, enter the irradiator roof and slacken the source rack guide cable tensioners located at the top of the irradiator roof

which in turn will permit the source rack to float within the constraints of the slackened cables.

5. Return to the control console and attempt to lower the source in the normal manner.
6. If this cannot be done, a less desirable procedure can also be followed. This involves the following:

   Allow source to remain in irradiation position. Several days may be required for the source to deteriorate the product to a point where it will crumble or virtually disintegrate. When this point has been reached, follow the procedures outlined above to attempt to lower source.

## 8.3.5 NOTIFICATION OF INCIDENTS

The Plant Manager or his authorized representative shall immediately notify

a. the pertinent licensing authority

b. Isomedix, New Jersey

c. Atomic Energy of Canada Limited, Ottawa, Ontario

by telephone or telegraph, of any incident involving any source of radiation possessed by him and which may have or threatens to cause a radiation hazard. In the event of an incident which endangers or threatens to endanger Plant Personnel or the Public, the licensing authority may take any steps necessary to remove the danger. Any further action to decontaminate the plant and return it to operating condition will be taken by AECL.

If for any reason AECL personnel cannot reach the plant in a reasonable time, further action may be taken by the licensee at the specific request of AECL.

## 8.3.6 DECONTAMINATION PROCEDURES

In the event of any indication of contamination by any of the monitors or from routine wipe tests, the licensee will immediately close down the facility, restrict entrance, and quarantine all products in the suspected area, and will notify Atomic Energy of Canada Limited by phone. The licensee will immediately advise the pertinent licensing authority that an incident is suspected and will effect the safety control measures as listed below:

1. No immediate attempt shall be made to clean up the contamination.

2. All windows shall be closed; fans, water filtration plant and air conditioners shall be shut off, and everyone shall leave the facility.

3. All doors shall be closed and locked.

4. All personnel who may have been contaminated shall be thoroughly tested for contamination and immediate steps taken to remove any radioactive contamination.

5. Entrance to the facility (or contaminated area) shall be prohibited except to authorized personnel requiring access in the performance of their special duties.

6. Under no circumstances shall any unauthorized or untrained persons attempt to examine or clean up any "spilled" radioactive material.

Fans or ventilating apparatus shall not be used in an attempt to disperse the radioactive material or its decay products. Such a maneuver will only disseminate the radioactive contamination throughout the area.

Atomic Energy of Canada Limited will dispatch qualified personnel to the site to assess the situation and confirm or deny the presence of contamination, and will report their findings to the pertinent licensing authority.

Atomic Energy of Canada Limited, or their Agent, have available, and will provide if necessary, emergency equipment as listed later in this manual.

If it is confirmed that contamination has been detected, Atomic Energy of Canada Limited will dispatch a Senior Radiation Protection Officer together with qualified personnel to institute corrective action.

## 8.3.7 EMERGENCY EQUIPMENT

Atomic Energy of Canada Limited, or their Agent, have available and will provide if necessary, the emergency equipment listed hereunder:

1. Personnel protective clothing, including plastic suits, special footwear, plastic hoods, gloves, etc.

2. Respiratory equipment, including demand air packs (MSA), canister type respirators, and supplied air respirators.

3. Decontamination supplies, including polyethelene sheeting, disposal bags and containers.

4. Approved radiation monitoring devices and personnel exposure dosimeters for all personnel involved.

5. Instruments of adequate sensitivity for the measurement of low level beta-gamma contamination.

6. Area radiation monitors with alarm.

7. General safety protective equipment, such as safety helmets, gloves, shoes, etc.

# EXAMINATION

# FOR

# OPERATOR QUALIFICATION



1. Name the three common types of radioactive decay emissions.

2. Of the three emissions from Question 1 above, cobalt-60 emits the highly penetrating ______________________________.

3. Cobalt-60 emits energy which (circle correct answer(s):

   (a) Can make other materials radioactive.
   (b) Can damage living tissues.
   (c) Can penetrate only the human skin.
   (d) Is identical to X rays, except for the mechanism by which they are "born".

4. Regulatory agencies allow limits of exposure for licensed, badged personnel working in radiation areas. The acceptable yearly level, if radiation history is unknown, is:

   (a) 12 rem.
   (b) 5 rem.
   (c) 25 rem.
   (d) 500 rem.

5. True or False (circle)

   It is far more detrimental to the body to receive a 3 rem dose over a two-hour period as opposed to over a three-year period.

6. The normally accepted dose of whole body radiation, over a short period, at which about 50% of the population would die, is ______ rem. Below ________ rem, there are no physical detectable effects.

7. A 30-year old worker joins the staff as an authorized worker around radiation. In his past work, he has received a total whole body exposure of 2 rem. Under the "banking" concept, how many rems should remain to his credit? _________

8. Can this worker use up all of his "credit" within the next three years? Yes _____ No _____

9. Define the term "rad".

10. High personnel exposures could cause genetic effects. What are genetic effects?

11. What are the three best means of protection from external exposure?

12. The dose rate at one foot from a source is 160,000 rads per hour. What is the dose rate at 4 feet?

13. How often should you zero your pocket dosimeter?

14. When are the pocket dosimeter and film badge worn?

15. You are on duty at night and the source automatically drops during the cycle. However, the access door to the irradiator will not open because the alert radiation light is lit. Perhaps the light has malfunctioned. Your correct course of action is to:

    (a) Unscrew the light and enter the cell normally.
    (b) Wait until the next shift arrives.
    (c) Call the Radiation Protection Officer.
    (d) Try to bypass the alarm and enter the chamber very carefully with a hand-held meter.

16. It is necessary to enter the irradiation chamber. You make a test check of the hand-held monitor, and find that you get no reading response. What action do you take?

17. A group of important looking visitors arrives unexpectedly at night and would like to go into the irradiation chamber to see the mechanism. The Radiation Protection Officer is temporarily absent and is expected to return in three hours. What do you do?

18. While you are working in the control room, you hear strange scraping sounds coming from the irradiation chamber. What is your first action?

19. Irradiation causes a toxic gas to be formed inside the irradiation chamber. What is it called?

    If you enter the irradiator and the odor is very noticeable, what is your action?

20. In <u>any</u> type of actual or suspected radiation emergency, what is your first action?

21. If a source were to leak or rupture, airborne or waterborne contamination could occur. Name at least two procedures which could give early warning of trouble.

22. In an actual personnel overexposure, where you are quite sure a person has received an overdose, who are the three persons or agencies to contact immediately?

23. An overexposed person will show physical signs which might give a clue to the dose he received. Match the following doses and symptoms:

| | |
|---|---|
| 25 rem | Nausea, fatigue |
| 100 rem | Unconscious, shock |
| 1000 rem | No detectable effect |

24. Can cobalt-60 irradiation of a person make him radioactive for a short time?

25. The Puerto Rico Irradiator is a production unit which is expected to operate on a continuous basis. Its primary and only function is to process. Only one consideration is more important. What is it?

## 9.4 ANSWERS TO SAMPLE EXAMINATION FOR OPERATOR QUALIFICATION

1. Alpha, Beta, Gamma

2. Gamma

3. b and d.

4. b.

5. True.

6. 500 and 25 respectively.

7. 58

8. No.

9. The absorption of 100 ergs per gram of energy.

10. Effects on future generations (such as mutations) which may be caused during or after conception, until birth.

11. Time, distance and shielding.

12. 10,000 rad/hr.

13. Whenever the reading exceeds 15 mrem at the beginning of the work tour.

14. At all times when on duty.

15. c.

16. Any of the following:

    a. Call Radiation Protection Officer.
       Do nothing until he advises.
    b. Take the spare meter.
    c. Replace batteries in the first meter; make sure it responds; then proceed.

17. Politely refuse entry of the visitors past the office/reception area.

18. Lower the source.

19. Ozone. Leave the cell for 2-3 minutes, then re-enter.

20. Call the Radiation Protection Officer.

(Answers to sample examination for Operator qualification - cont'd.)

21. Source wipe test.
    Monitoring of water treatment system.
    Smearing walls, floor, vent, in cell.

22. a. Hospital or emergency squad.
    b. Radiation Protection Officer.
    c. State Regulatory Authorities.

23.

| | |
|---|---|
| 25 rem | No detectable effect |
| 100 rem | Nausea, fatigue |
| 1000 rem | Unconscious, shock |

24. No

25. Safety

| DISTRIBUTION: PLANT MANAGERS | | SUBJECT: PERSONNEL TRAINING POLICY |
|---|---|---|
| EFFECTIVE DATE March 17, 1980 | PAGE NO. 1 OF 3 PAGES | FILE UNDER SECTION NO. |
| REVISION DATE | APPROVED BY George R Dietz | |

ALL REVISIONS ARE MARKED BY AN ASTERISK (*)

This policy covers the general training requirements applicable to warehouse personnel, operators, supervisors and production control managers, and plant managers. The program shall consist of both formal training requirements and on-the-job training administered by personnel deemed qualified by the Corporate Office and the Plant Managers.

A. Basic Training, All Personnel

1. Scope of activities of Isomedix.

2. Description of radiation operations.

3. Operational policies and procedures.

4. Need for general cleanliness and care in the handling and processing of medical devices and drugs.

5. General requirements of regulatory bodies, including the Nuclear Regulatory Commission and the Food and Drug Administration.

6. General requirements of FDA Good Manufacturing Practice guidelines.

7. NRC license requirements as they relate to the use and operation of cobalt-60 irradiators.

8. Other items which may be designated from time to time.

B. Operators, Supervisors, Production Control Managers, Plant Managers

In addition to (A) above, this category of personnel will receive additional training as follows.

1. Formal training course for qualification as Irradiator Operator (course as defined in NRC license).

2. General procedures for inspection and acceptance and/or rejection of good housekeeping conditions, including, but not limited to:

   a. Warehouse cleanliness.

| DISTRIBUTION: PLANT MANAGERS | | SUBJECT: PERSONNEL TRAINING POLICY |
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| REVISION DATE | APPROVED BY George R. Dietz | |

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b. Mechanism appearance/cleanliness.

c. Inspection of outgoing trailers for cleanliness, holes in body, dirt, strange odors, or other odd factors which might be sensitive to the shipment of finished medical devices.

d. General insect and rodent control on premises.

3. Irradiator operation and maintenance.

4. Processing procedures.

5. Dosimetry procedures and training.

6. Shipping/receiving procedures.

C. <u>Supervisors, Production Control Managers, Plant Managers</u>

This category of personnel shall, in addition to (A) and (B) above, receive additional training as follows:

1. Personnel administration.

2. Production control, including all factors related to scheduling, processing and administrative requirements related to processing.

3. Full indoctrination and training of all Isomedix policies and procedures as they relate to processing.

4. Other subjects as determined by the Plant Manager or Corporate Staff.

D. <u>Plant Managers</u>

In addition to all of the above, the Plant Manager shall receive additional training as determined appropriate by Corporate Staff, including administration, budgeting, personnel and quality control. The Plant Manager is also specifically charged with adherence to GMP procedures, and is responsible for quality control of his plant. Among other QC responsibilities the Plant Manager, in terms of

# ISOMEDIX POLICIES AND PROCEDURES

| DISTRIBUTION: PLANT MANAGERS | SUBJECT: PERSONNEL TRAINING POLICY | |
|---|---|---|
| EFFECTIVE DATE March 17, 1980 | PAGE NO. 3 OF 3 PAGES | FILE UNDER SECTION NO. |
| REVISION DATE | APPROVED BY George R Dietz | |

ALL REVISIONS ARE MARKED BY AN ASTERISK (*)

his Quality Assurance Program, will assure himself that he is capable of:

1. Identifying quality assurance problems.
2. Solving quality assurance problems.
3. Verifying implementation of solutions.
4. Determining that procedures are performed correctly.

This basic policy may be amended or added to from time to time either formally or informally as additional training requirements become obvious.

Refresher training, either on a formal or informal basis, should be conducted semiannually or earlier as the need arises.

# PART 9 - OPERATOR DESIGNATION AND TRAINING

## 9.1 General

It is proposed that Isomedix be authorized to appoint qualified personnel as operators, as is currently the case in its New Jersey, Chicago, Mississippi, and South Carolina irradiators. Such an appointment would be authorized when the trainee has:

a. Completed the required formal training.

b. Passed the written test with a minimum score of 75%.

c. Completed a minimum of 90 days of on-the-job training (exception can be made by Corporate RPO).

d. Been recommended for operator status by the Plant Manager to the Corporate RPO, wherein the trainee's qualifications are reviewed.

e. Been approved by the Corporate RPO.

The contents of the training program, together with the written test (and answers) follow.

The Isomedix policy for training of all personnel (including but not limited to irradiator operations) is shown on Pages 9-9, 9-10, and 9-11.

## 9.2 CONTENTS OF TRAINING PROGRAM — HOURS

1. The Hazards of Radiation — 1/2

   Unavoidable low level exposure

   Hazard evaluation

2. The Effects of External Radiation — 1

   a. Effects on the body.

   b. Units of measurement.

   c. Levels of injury.

   d. Long term exposures.

   e. The banking concept.

3. Protection from External Radiation — 1

   a. Time

   b. Distance

   c. Shielding materials

   d. Define curies and half value layers, dose rate curves in the Isomedix irradiator.

4. Radiation Physics — 1

   The nucleus-isotopes-radioactive decay

5. Internal Radiation Problems — 1

   a. How radioactive material enters the body.

   b. Effects on the body.

| | | HOURS |
|---|---|---|
| 6. | Contamination | 1 |
| | a. Hazards associated with contamination. | |
| | b. Prevention of spread. | |
| | c. Decontamination procedures. | |
| 7. | Instruments and Dosimetry | 1 |
| | a. Geiger counters. | |
| | b. Ionization chambers. | |
| | c. Scintillation counter. | |
| | d. Film badges. | |
| | e. Pocket Electroscopes. | |
| 8. | Review of Isomedix Facilities and Procedures | 2 |
| | a. Source interlock systems. | |
| | b. Operating procedures for routine irradiation. | |
| | c. Operating procedures for hot cell operations. | |
| 9. | Verbal Discussion on the Above Course | 1 |
| | Questions to determine understanding of all the topics. | |
| | TOTAL HOURS | 9½ |

The NRC publication, "Living with Radiation" is used as a basis for this training.

# PART 10 - TRAINING AND EXPERIENCE IN RADIATION SAFETY

## 10.1 OPERATIONAL PLAN

The Puerto Rico facility will be the sixth that Isomedix has started up. We have found it quite feasible to conduct initial operations with well experienced supervisory staff trained as operators, and during the first few months of operation to train additional qualified personnel to become operators.

We expect the following sequence to occur. (Training and experience resumes of specified individuals follow):

1. Installation of unit and final safety checkout to be performed by AECL-CP, with Baker and Watlington on-site 50% and 100% of their times, respectively, becoming intimately familiar with the electrical and mechanical aspects of the irradiator.

2. Cobalt loading by AECL.

3. Initial radiation surveys by AECL, Baker and Watlington.

4. Operational startup by AECL, Baker and Watlington.

5. Acceptance of unit by Isomedix.

6. Initial processing by Baker and Watlington.

7. Routine processing by Watlington.

8. Assistance by Baker, Dietz, Owens and Masefield as needed.

New plant personnel will begin to be hired and trained beginning the early stages of Item 1. Additional operators could be qualified some 10-12 weeks later, during Item 6.

## 10.2 Training and Experience Resumes

These are on the following pages.

APPLICATION FOR RADIOACTIVE MATERIAL LICENSE — GEORGE R. DIETZ

| TYPE OF TRAINING | WHERE TRAINED | DURATION OF TRAINING | ON THE JOB | FORMAL COURSE |
|---|---|---|---|---|
| a. Principles and practices of radiation protection. | Georgia Institute of Technology | 2 years | No | Yes |
| | U. S. Army Natick, Mass. Radiation Lab | 4 years | Yes | No |
| | Brookhaven National Lab. | 1 month | Yes | Yes |
| | Radiation International (Asst RSO) | 1½ years | Yes | No |
| b. Radioactive measurement standardization and monitoring techniques, and instrumentation. | Same as above. | | | |
| c. Math and calculations basic to the use and measurement of radioactivity. | Same as above. | | | |
| d. Biological effects of radiation. | Same as above. | | | |

EXPERIENCE WITH RADIATION

| Isotope | Max. Amount | Where Experience Was Gained | Duration | Type of Use |
|---|---|---|---|---|
| Co-60 | 500,000 curies | Brookhaven National Lab. | 1 month | Training |
| Co-60 | 600,000 curies | Radiation Machinery | 1-3/4 years | Irradiation Services |
| Co-60 | 350,000 curies | Radiation International | 2 years | Irradiation Services |
| Cs-137 | 250,000 | Isomedix | 9 years | Self-Contained Irradiators |
| Co-60 | 1,500,000 curies | Isomedix, N. J. | 9 years | Irradiation Services |

GEORGE R. DIETZ (continued)

Mr. George R. Dietz is President, and Radiation Protection Officer, of Isomedix, Inc.

In addition to handling the Corporate Radiation Protection functions (RPO) of Isomedix, he is a licensed operator for hot cell operations in New Jersey; of the 2,000,000 ci service irradiator in New Jersey; of the 300,000 ci Isomedix service irradiator in Chicago, Illinois; and the 1,500,000 ci service irradiator in Columbus, Mississippi.

APPLICATION FOR RADIOACTIVE MATERIAL LICENSE - GEORGE B. BAKER

| TYPE OF TRAINING | WHERE TRAINED | DURATION OF TRAINING | ON THE JOB | FORMAL COURSE |
|---|---|---|---|---|
| a. Principles and practices of radiation protection. | Isomedix, Inc. | 4 years | Yes | Yes |
| | U. S. Air Force | 6 months | Yes | Yes |
| b. Radioactive measurement standardization and monitoring techniques, and instrumentation. | | Same as above. | | |
| c. Math and calculations basic to the use and measurement of radioactivity. | | Same as above. | | |
| d. Biological effects of radiation. | | Same as above. | | |

EXPERIENCE WITH RADIATION

| Isotope | Max. Amount | Where Experience Was Gained | Duration | Type of Use |
|---|---|---|---|---|
| Co-60 | 1,500,000 ci | Isomedix, Inc. | 4 years | General radiation processing. |

Mr. Baker has undergone and successfully completed the Isomedix training program, and was designated as an operator of the New Jersey irradiator on January 30, 1978. In addition, he is familiar with and has participated in our routine safety program, including daily, weekly and monthly safety checks, source receipt, cask unloading, and source loading into modules, semiannual source wipe tests, and use of counting equipment.

Mr. Baker completed the following formal courses while assigned to the U. S. Air Force:

a. Disaster Preparedness Officer Course, Lowrey Technical Training Center, Lowrey AFB Colorado. Two-week course, completed in September 1970. Primary courses: Nuclear accident and attack training; personnel and equipment decontamination and contamination control; theory, operations and use of personnel and monitoring instrumentation; and biological effects of radiation.

b. Safety Officers Course, Aerospace Safety and Management Institute, University of Southern

California, Los Angeles. Three-month course, completed September 1971. The general purpose was to train students in developing administration safety programs, with emphasis on safety management. Radiation safety comprised a portion of the subject matter.

c. Safety Program Organization and Administration for the U. S. Air Force, New York University, New York. Seven-week course, completed November 1971. Course work was generally as outlined in (b) above.

d. Nuclear Safety Officer Course, Lowery Technical Training Center, Lowery AFB, Colorado. Three-week course included various aspects of nuclear safety, such as movement and storage of radioactive material, security, radiation protection, monitoring and instrumentation, and calculations pertinent to the measurement of radioactivity.

Mr. Baker served as Nuclear, Ground, Missile Safety Officer, 22nd Air Defense Missile Squadron (ADC), LangleyAFB, Virginia, from the period June 1971 - December 1972.

Mr. Baker served as the Plant Manager and on-site RPO for the Isomedix 3,000,000 curie Spartanburg Irradiator from its inception until February 1981 (3-plus years). He was recently assigned as a Group Manager at Corporate headquarters, where his primary function will be to supervise construction, startup and operation of new facilities, including the Puerto Rico unit.

He is a licensed operator also of the Spartanburg facility, which is currently loaded with over 2,000,000 curies of cobalt-60.

LUIS WATLINGTON

| TYPE OF TRAINING | WHERE TRAINED | DURATION OF TRAINING | ON THE JOB | FORMA COURS |
|---|---|---|---|---|
| a. Principles and practices of radiation protection. | Isomedix | 6 months | 6 months | Yes |
| b. Radioactive measurement standardization and monitoring techniques, and instrumentation. | Isomedix | 6 months | 6 months | Yes |
| c. Math and calculations basic to the use and measurement of radioactivity. | Isomedix | 6 months | 6 months | Yes |
| d. Biological effects of radiation. | Isomedix | 6 months | 6 mos. | Yes |

EXPERIENCE WITH RADIATION

| Isotope | Max. Amount | Where Experience Was Gained | Duration | Type of Use |
|---|---|---|---|---|
| Co-60 | 1,500,000 ci | Isomedix, Inc. Spartanburg, SC | 3 months | General processing, e.g., sterilization |

Mr. Watlington, through Mr. George R. Dietz, RPO, and Mr. George Baker, received on-the-job training in the use of shielding and time-distance relations in reducing radiation exposure; the use, maintenance and limitations of monitoring and surveying instruments; and protective, routine, and emergency procedures in effect at the Spartanburg facility. The on-the-job training was correlated with a formal course given by Mr. Dietz and Mr. Baker. (Contents of this training program are outlined elsewhere.)

Mr. Watlington successfully passed the course and became an operator at the Spartanburg plant. This plant was chosen as his on-the-job training site because of its close similarity and resemblance to the Puerto Rico plant. Both are carrier type plants with virtually identical radiation safety systems.

APPLICATION FOR RADIOACTIVE MATERIAL LICENSE

JOHN MASEFIELD

| TYPE OF TRAINING | WHERE TRAINED | DURATION OF TRAINING | ON THE JOB | FORMAL COURSE |
|---|---|---|---|---|
| a. Principles and practices of radiation protection. | Atomic Energy of Canada Limited | 7 years | Yes | Yes |
| | Radiation Int'l | 2 years | Yes | No |
| | Isomedix, Ltd | 4 years | Yes | No |
| | Isomedix, Inc. | 8 years | Yes | Yes |
| b. Radioactive measurement standardization and monitoring techniques, and instrumentation. | Same as above. | | | |
| c. Math and calculations basic to the use and measurement of radioactivity. | Same as above. | | | |
| d. Biological effects of radiation. | Same as above. | | | |

EXPERIENCE WITH RADIATION

| Isotope | Max. Amount | Where Experience Was Gained | Duration | Type of Use |
|---|---|---|---|---|
| Co-60 | 1,000,000 ci | AECL | 7 years | General processing, self-contained irradiators. |
| Co-60 | 300,000 ci | Radiation Int'l | 2 years | General processing. |
| Co-60 | 300,000 ci | Isomedix, Ltd. | 4 years | General Processing |
| Co-60 | 500,000 ci | Isomedix, Inc. | 8 years | General Processing |
| Co-60 | 100,000 ci | Newfield Products, Ltd. | 2 years | General Processing |
| Co-60 | 1,500,000 ci | Isomedix, Inc. | 8 years | General Processing |

During his seven years with AECL, Mr. Masefield was Head of Irradiator Design. In addition to supervising design and construction of self-contained irradiators, he supervised design and commissioning of large production irradiators, including the Ethicon units in Somerville, New Jersey, and San Angelo, Texas, as well as a production facility in Peterborough, Canada.

He was a licensed operator and RSO of the Newfield Products, Ltd. irradiator in Canada for two years. Mr. Masefield is a licensed operator for Isomedix' 2,000,000 ci service irradiator in New Jersey.

Mr. John Masefield is Chairman of the Board of the Isomedix Companies.

APPLICATION FOR RADIOACTIVE MATERIAL LICENSE

WILLIAM M. OWENS, JR.

| TYPE OF TRAINING | WHERE TRAINED | DURATION OF TRAINING | ON THE JOB | FORMAL COURSE |
|---|---|---|---|---|
| a. Principles and practices of radiation protection. | Isomedix | 8 years | Yes | Yes |
| b. Radioactive measurement standardization and monitoring techniques, and instrumentation. | Isomedix | 8 years | Yes | Yes |
| c. Math and calculations basic to the use and measurement of radioactivity. | Isomedix | 8 years | Yes | Yes |
| d. Biological effects of radiation. | Isomedix | 8 years | Yes | Yes |

EXPERIENCE WITH RADIATION

| Isotope | Max. Amount | Where Experience Was Gained | Duration | Type of Use |
|---|---|---|---|---|
| Co-60 | 300,000 ci | Isomedix | 4 Years | General Processing |
| Co-60 | 1,500,000 ci | Isomedix | 7 Years | Radiation Services |

Formal Education - Georgia Institute of Technology, 2 years, engineering studies toward BS in Mechanical Engineering.

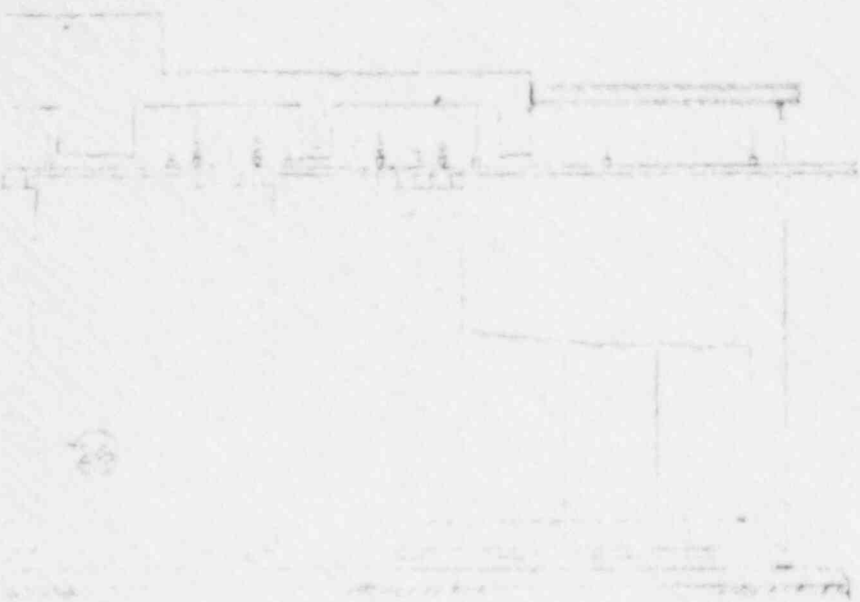
Mr. Owens, through Mr. George R. Dietz, RPO, and Mr. Austin Perrin, has received on-the-job training in the use of shielding and time-distance relations in reducing radiation exposure; the use, maintenance and limitations of monitoring and surveying instruments; and protective, routine, and emergency procedures in effect at the New Jersey facility. The on-the-job training was correlated with a formal course given by Mr. Dietz.

Mr. Owens is currently licensed as an operator at Isomedix' 2,000,000 ci service irradiator in New Jersey, the Spartanburg, South Carolina, facility (2,000,000 curies).

APPENDIX

A DRAWING B110701 002 G

DOOR & LOCK REQD.



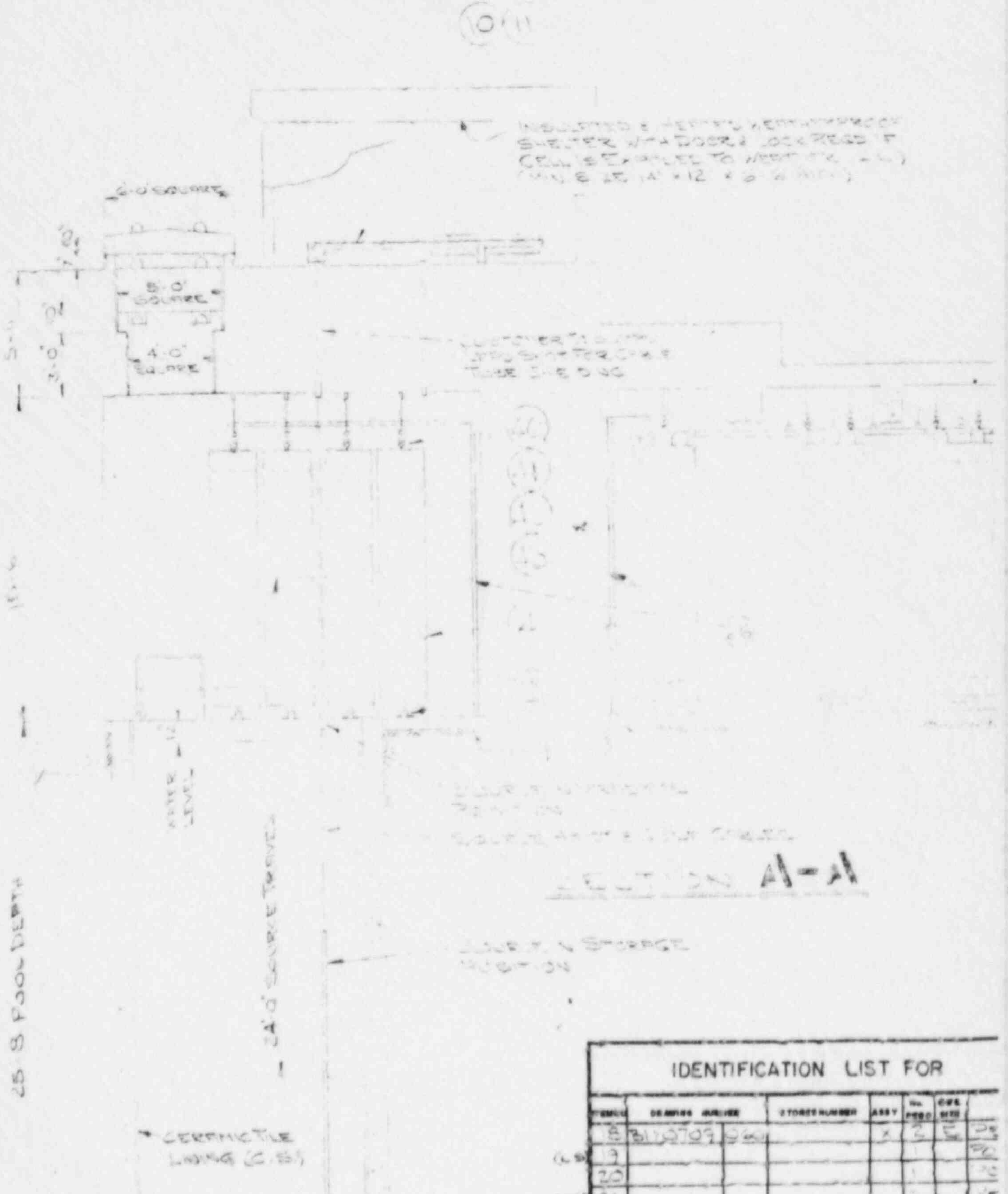
ON A-A

DENTIFICATION LIST FOR

| NUMBER | | STORES NUMBER | ASSY | NO. REQ'D | DWG. SIZE | DESCRIPTION |
|---|---|---|---|---|---|---|
| 99 | 060 | | x | 2 | E | PERSONNEL SAFETY BARRIER ASSY. |
| | | | | 1 | | POOL WATER CHILLER - DUNHAM BUSH *PC0105 |
| | | | | 1 | | POOL WATER DEIONIZER - WATER REFINING *CCDM.12 |
| | | | | 2 | | VENTILATION FAN - CEN. BLOWER & FORGE *BLVS. 2455 |
| 202 | 004 | | x | 2 | C | VENTILATION AIR FILTER ASSEMBLY |
| 02 | 010 | | | REF | C | IRRADIATION CHAMBER VENTILATION SYSTEM |
| | | | | 1 | | AIR COMPRESSOR |
| 09 | 039 | | x | 1 | C | TEMPORARY RAIL FOR SOURCE REPLENISHMENT |
| 07 | 009 | | | 1 | D | LAY-IN DUCTWORK |

SHEET NO. 2 | CONT. ON SHEET - | 2 1 0701 002 G

D | C

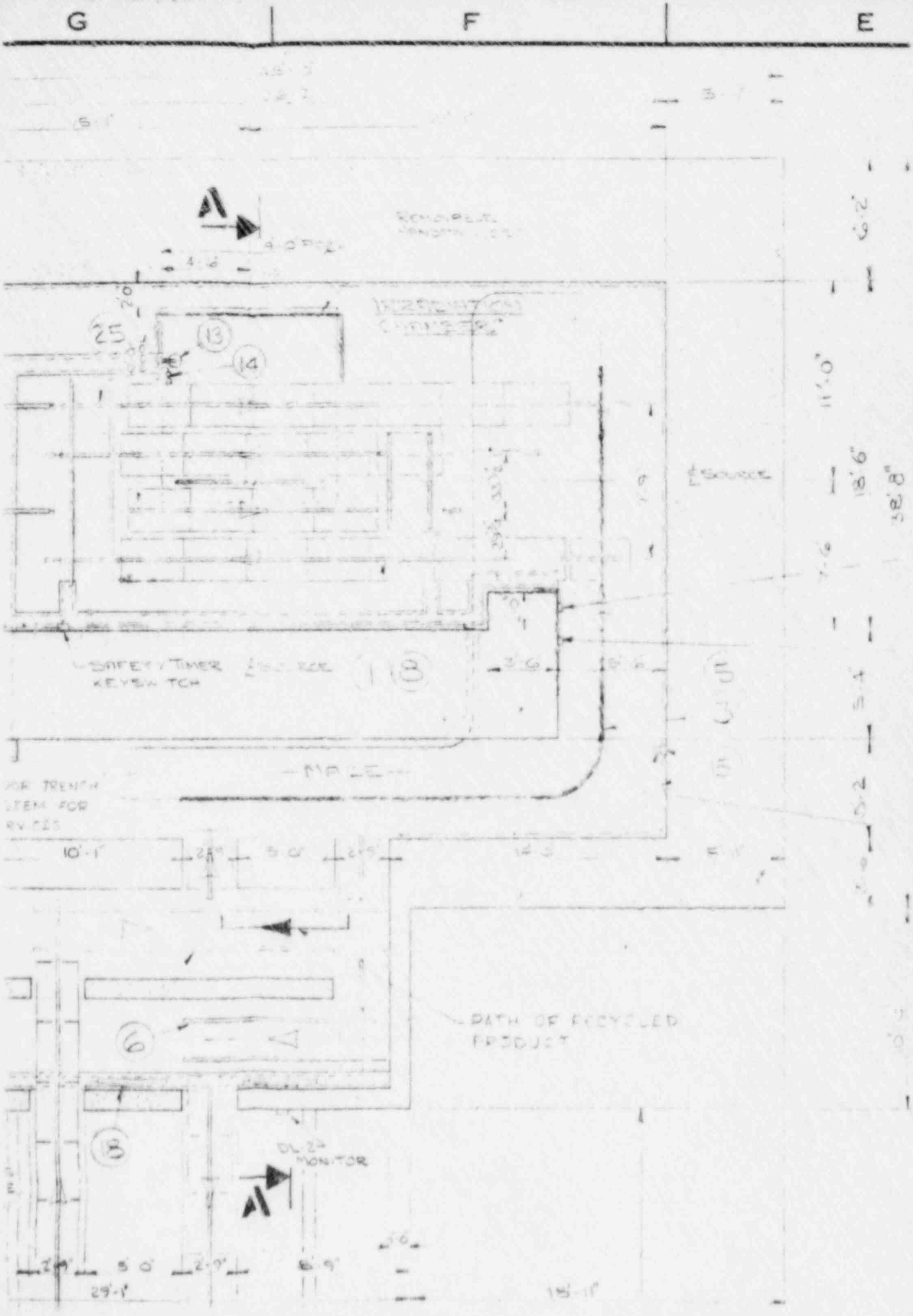



SECTION A-A

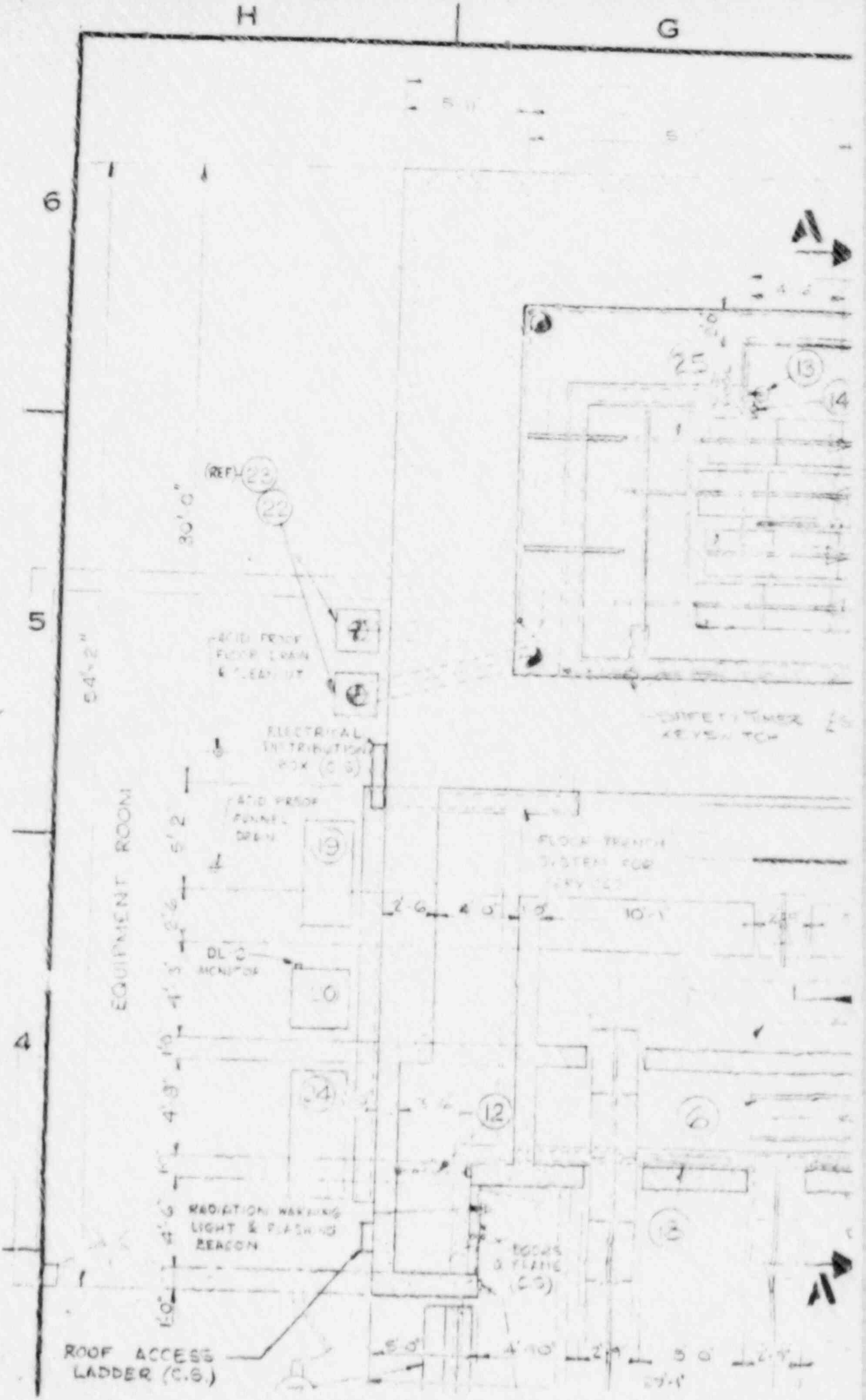
IDENTIFICATION LIST FOR

| ITEM | DRAWING NUMBER | | STORES NUMBER | ASSY | No. REQD | DWG SIZE | |
|---|---|---|---|---|---|---|---|
| 18 | B110709 | 960 | | X | 2 | E | [illegible] |
| 19 | | | | | 1 | | [illegible] |
| 20 | | | | | 1 | | [illegible] |
| 21 | | | | | 2 | | [illegible] |
| 22 | B120002 | 004 | | X | 2 | C | [illegible] |
| 23 | B112202 | 010 | | | REF | C | [illegible] |
| 24 | | | | | 1 | | [illegible] |
| 25 | B110709 | 939 | | X | 1 | C | [illegible] |
| 26 | B110709 | [illegible] | | X | 1 | D | [illegible] |

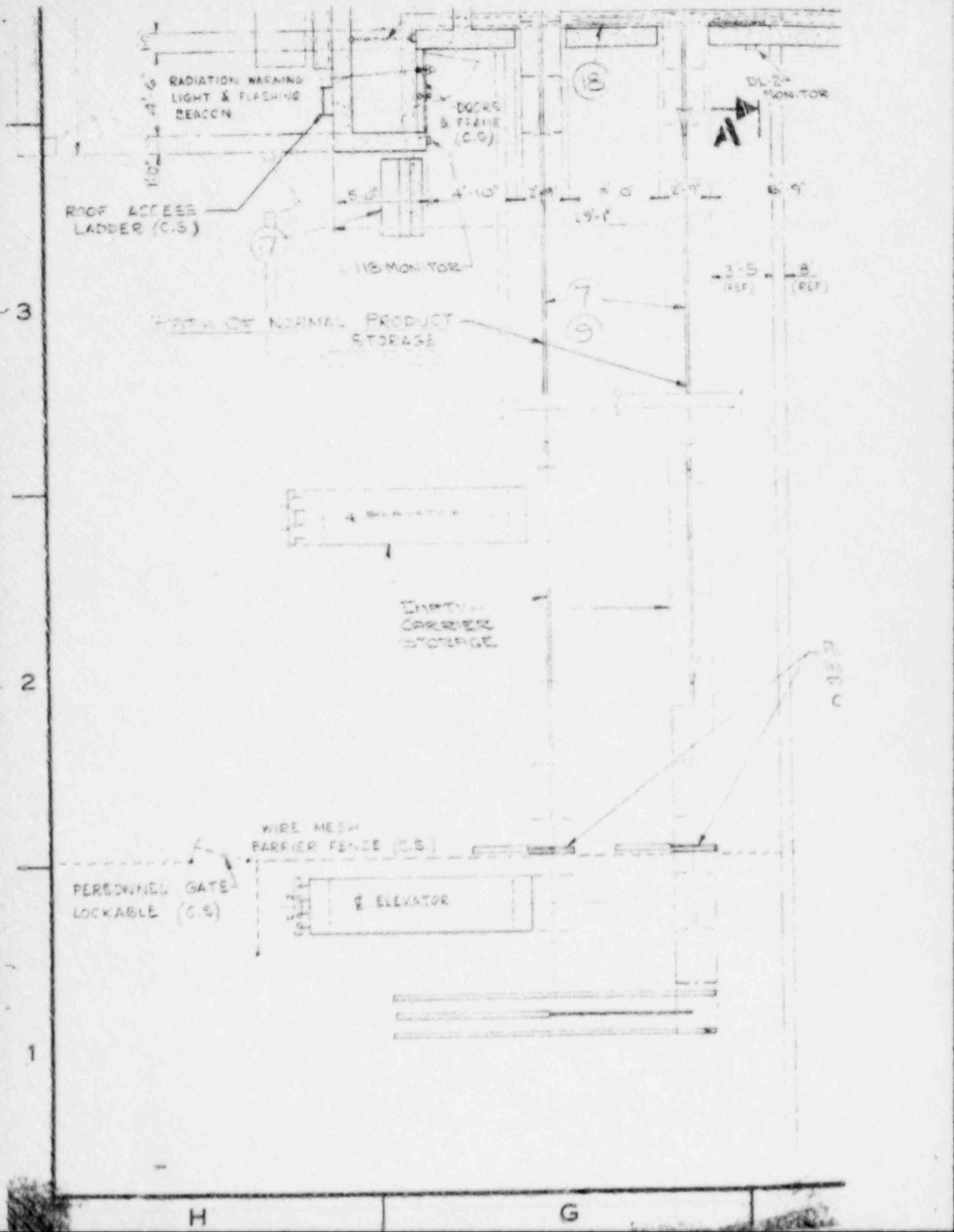
E
D
5'-1"
6'-2"
6'-0" SQUARE
1'-10"
5'-0" SQUARE
4'-0" SQUARE
11'-0"
5'-11"
3'-0"
18'-6"
32'-8"
℄ SOURCE
7'-9"
HIGH TEMP SWITCH
RADIATION MONITOR PROBE
3'-4"
3'-2"
FLASHING BEACON
25'-8" POOL DEPTH
24'-0" SOURCE TRAVEL
WATER LEVEL
OF RECYCLED DUCT
CERAMIC TILE LINING (C-22)

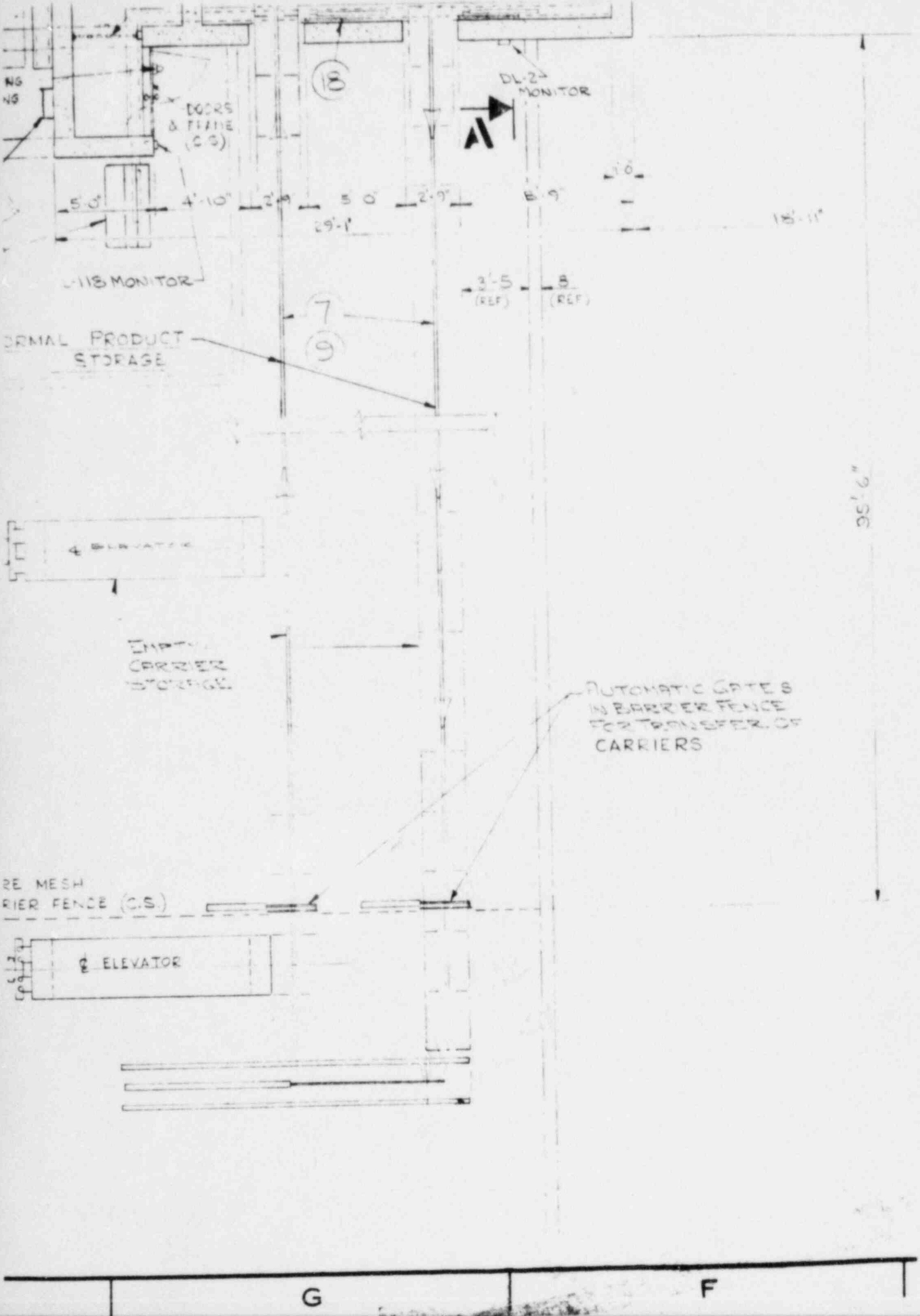


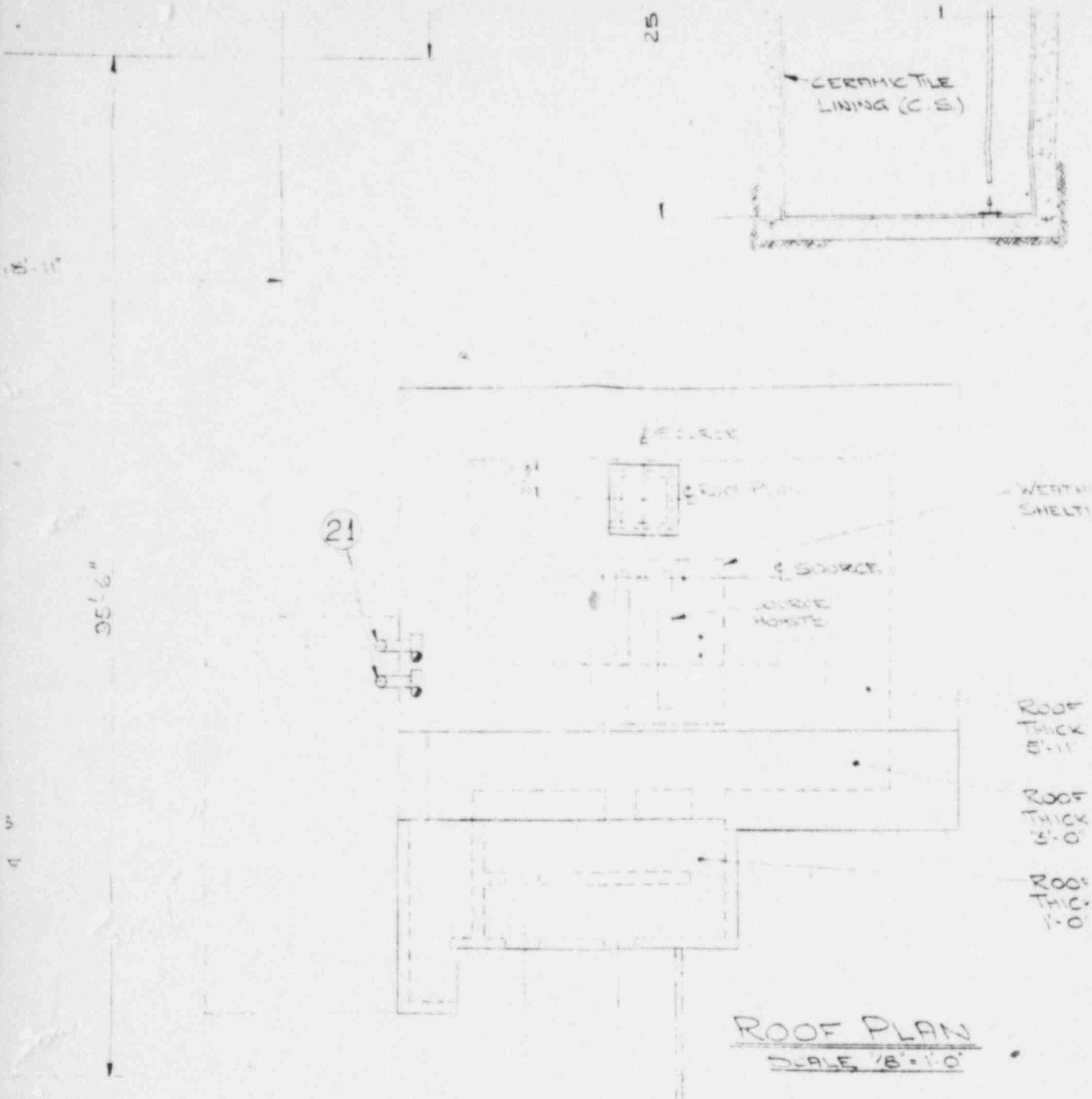
G
F
E
A
25
13
14
SAFETY TIMER KEYSWITCH
MAZE
10'-1"
3'-6"
14'-3"
11'-0"
18'-6"
38'-8"
7'-6"
6
PATH OF RECYCLED PRODUCT
18
DL-2 MONITOR
A
5'-0"
2'-9"
6'-9"
29'-1"
18'-11"



H
G
6
5
4
A
(REF) 23
22
30'-0"
54'-2"
ACID PROOF FLOOR DRAIN & CLEAN OUT
ELECTRICAL DISTRIBUTION BOX (C.G.)
ACID PROOF FUNNEL DRAIN
EQUIPMENT ROOM
19
DL-2 MONITOR
10
34
12
6
18
25
13
14
SAFETY TIMER KEYSWITCH
FLOOR TRENCH SYSTEM FOR SERVICES
RADIATION WARNING LIGHT & FLASHING BEACON
DOORS & FRAME (C.G.)
ROOF ACCESS LADDER (C.G.)
10'-1"


RADIATION WARNING LIGHT & FLASHING BEACON
DOORS & FRAME (C.S)
DL-24 MONITOR
ROOF ACCESS LADDER (C.S)
5'-0"
4'-10"
2'-9"
6'-9"
19'-1"
L-118 MONITOR
3'-5 (REF)
8" (REF)
PATH OF NORMAL PRODUCT STORAGE
ELEVATOR
EMPTY CARRIER STORAGE
WIRE MESH BARRIER FENCE (C.S)
PERSONNEL GATE LOCKABLE (C.S)
℄ ELEVATOR
H
G
3
2
1


18
DL-2 MONITOR
DOORS & FRAME (C.S)
A
1'6"
5'0"
4'-10"
2'-9"
5'0"
2'-9"
8'-9"
29'-1"
18'-11"
-118 MONITOR
3'-5 (REF)
8 (REF)
7
9
ORMAL PRODUCT STORAGE
35'-9"
℄ ELEVATOR
EMPTY CARRIER STORAGE
AUTOMATIC GATES IN BARRIER FENCE FOR TRANSFER OF CARRIERS
RE MESH
RIER FENCE (C.S.)
℄ ELEVATOR
G
F




NOTES:

1. BIOLOGICAL SHIELD CAPACITY 4,000,000 CURIES COBALT 60.

2. CUSTOMER TO SUPPLY BIOLOGICAL SHIELD, ALL SERVICES, PLUMBING ETC. & ITEMS MARKED (C.S.).

3. VENTILATION REQUIRED AT THE RATE OF 2200 C.F.M.

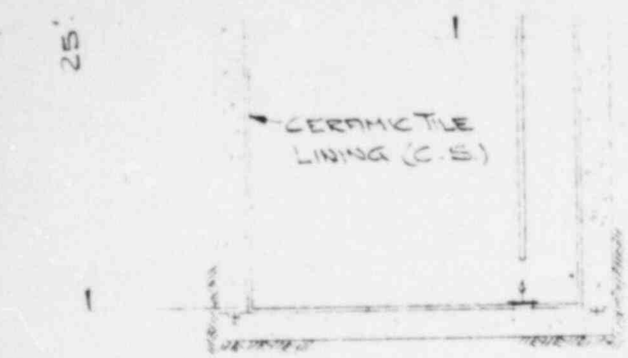
4. THE BIOLOGICAL SHIELD IS DESIGNED TO REDUCE THE EXTERNAL RADIATION LEAKAGE LEVELS WITH A 4,000,000 CURIE COBALT 60 PLAQUE SOURCE TO AN AVERAGE EXPOSURE RATE OF LESS THAN 0.25 MR/HR. THIS ALLOWS A PERSON FULL OCCUPANCY OF 40 HOURS PER WEEK OR A MAXIMUM DOSE OF 500 MREM PER YEAR. EXPOSURE RATES OF UP TO 2.0 MR/HR ARE ALLOWABLE IN SMALL AREAS ADJACENT TO THE SHIELD PROVIDED THESE CONTRIBUTIONS DO NOT RAISE THE AVERAGE EXPOSURE RATE OVER A SURFACE ABOVE 0.25 MR/HR.

5. CONDUCTIVITY OF POOL WATER MUST BE LESS THAN 10.0 MICROMHOS.

6. BLDG DWGS REF. # B110702/001,002,003,00[illegible],005,006,007,

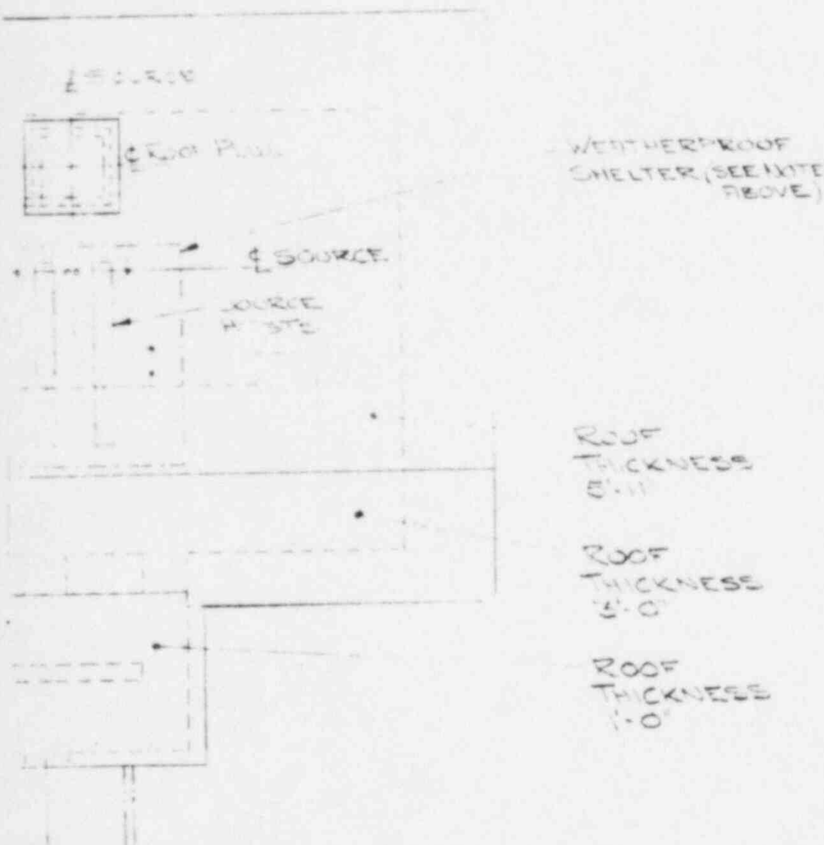
E D

25'




IDENTIFICATION LIST FOR

| ITEM No | DRAWING NUMBER | | STORES NUMBER | ASSY | No. REQD |
|---|---|---|---|---|---|
| 18 | B110709 | 060 | | × | 2 |
| (C.S) 19 | | | | | 1 |
| 20 | | | | | 1 |
| (C.S) 21 | | | | | 2 |
| (C.S) 22 | B120002 | 004 | | × | 2 |
| (C.S) 23 | B112202 | 010 | | | REF |
| (C.S) 24 | | | | | 1 |
| 25 | B110709 | 039 | | × | 1 |
| 26 | B110707 | 009 | | × | 1 |
| 27 | | | | | |
| 28 | | | | | |
| 29 | | | | | |
| 30 | | | | | |
| 31 | | | | | |
| 32 | | | | | |
| 33 | B120005 | 002 | NOT SHOWN | | 1 |
| 34 | B110701 | 003 | NOT SHOWN | | |
| 35 | B110707 | 101 | NOT SHOWN | | – |
| 36 | | | | | |
| 37 | | | | | |
| 38 | | | | | |
| 39 | | | | | |
| 40 | B109709 | 013 | | × | 88 |
| 41 | | | | | 352 |
| 42 | | | 55073503 | | 352 |
| 43 | | | 5N063091 | | 352 |
| 44 | | | | | |




ROOF PLAN
SCALE 1/8" = 1'-0"

IDENTIFICATION LIST FOR

| ITEM No | DRAWING NUMBER | | STORES NUMBER | ASSY | No. REQD |
|---|---|---|---|---|---|
| 1 | B110709 | 001 | | × | 1 |
| 2 | B110709 | 002 | | × | 1 |
| 3 | B110709 | 003 | | × | 1 |
| 4 | B110709 | 004 | | × | 44 |
| 5 | B110709 | 036 | | × | |
| 6 | B110709 | 040 | | × | 1 |
| 7 | B110709 | 101 | | × | 1 |
| 8 | B110707 | 001 | | × | 1 |
| 9 | B110707 | 201 | | × | 1 |
| 10 | B110704 | 001 | | × | 1 |
| 11 | B108906 | 001 | NOT SHOWN | × | 1 |
| 12 | B120007 | 005 | | × | 1 |
| 13 | A05865 | | 6D158856 | × | 1 |
| 14 | A05843 | | 6D156431 | × | 2 |
| 15 | B110707 | 050 | | × | 1 |
| 16 | B104207 | 017 | A06596 | × | 1 |
| 17 | B110707 | 115 | | | 1 |

| ISSUE | DESCRIPTION |
|---|---|
| G | REDRAWN TO SUIT CUSTOMERS FINAL LAYOUT |
| F | ITEMS 41 42 43 QTY WAS 176 |
| E | DL-2 MONITOR ADDED TO DEIONIZER |
| D | MOD. ITEM 4, 40, 41 42 43 44 |
| C | ITEM 26 ADDED |
| B | MAZE MONORAIL RELOCATED |
| A | ORIG. ISSUE |

TIC. 5.94

...ACITY 4,000,000 CURIES COBALT 60.

...OLOGICAL SHIELD, ALL SERVICES, MARKED (C.S.).

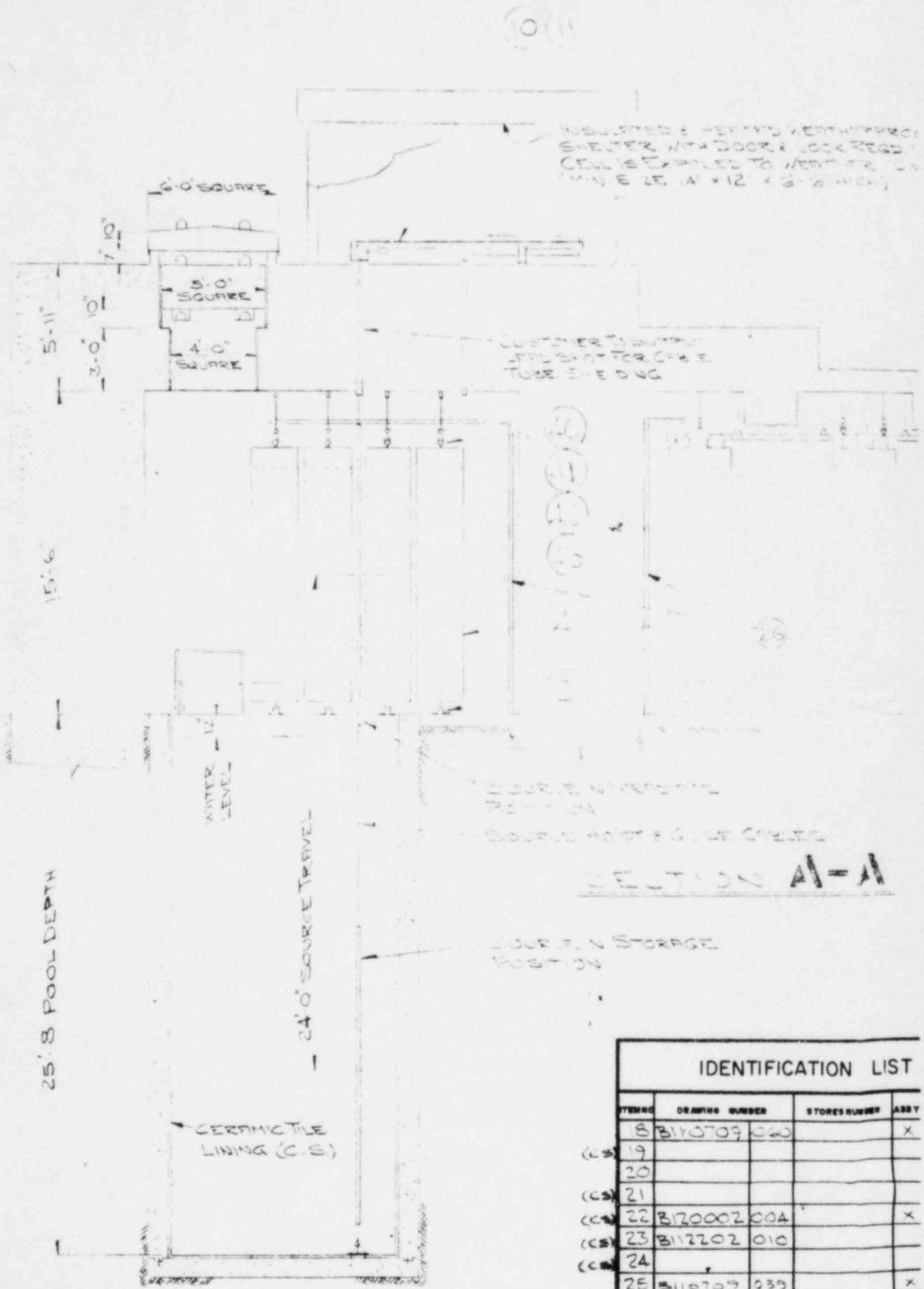
...AT THE RATE OF 2200 C.F.M.

... IS DESIGNED TO REDUCE THE EXTERNAL ...ELS WITH A 4,000,000 CURIE COBALT 60 ...VERAGE EXPOSURE RATE OF LESS THAN 0.25 ... PERSON FULL OCCUPANCY OF 40 HOURS PER ...E OF 500 MREM PER YEAR. EXPOSURE RATES ...E ALLOWABLE IN SMALL AREAS ADJACENT TO ...HESE CONTRIBUTIONS DO NOT RAISE THE ... OVER A SURFACE ABOVE 0.25 MR/HR.

... WATER MUST BE LESS THAN 10.0 MICROMHOS.

...EF. B110702/001, 002, 003, 004, 005, 006, 007, 008, 009

| D | C |
|---|---|




## IDENTIFICATION LIST

| | ITEM NO | DRAWING NUMBER | | STORES NUMBER | ASSY |
|---|---|---|---|---|---|
| | 18 | B110707 | 060 | | X |
| (CS) | 19 | | | | |
| | 20 | | | | |
| (CS) | 21 | | | | |
| (CS) | 22 | B120002 | 00A | | X |
| (CS) | 23 | B112202 | 010 | | |
| (CS) | 24 | | | | |
| | 25 | B110709 | 039 | | X |
| | 26 | B110707 | 009 | | X |

| | | | | |
|---|---|---|---|---|
| | | 2 | | VENTILATION FAN - CFN. BLOWER & FORGE * BLVS - 245E |
| | x | 2 | C | VENTILATION AIR FILTER ASSEMBLY |
| | | REF | C | IRRADIATION CHAMBER VENTILATION SYSTEM |
| | | 1 | | AIR COMPRESSOR |
| | x | 1 | C | TEMPORARY RAIL FOR SOURCE REPLENISHMENT |
| | X | 1 | D | LAY-IN DUCTWORK |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| OWN | | 1 | | RADIATION METER PACKAGE |
| OWN | | | 1.D. | SPARES LIST |
| OWN | | - | E+ | ELEMENTARY WIRING |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | x | 88 | C | CARRIER WHEEL BRACKET |
| | | 352 | | HALF TROLLEY * PL754 (3 3/16 DROP) "MONOVEYOR" DEGREASED |
| 503 | | 352 | | 3/8"-16 x 1 1/4" LG. HEX. HD. CAPSCREW |
| 091 | | 352 | | 3/8 - 16 LOCKNUT - SPAE-NAUR * HN-127 |

LIST FOR

DRAWING NUMBER: B 1 1 0 7 0 1 0 0 2 — ISSUE G

| NUMBER | ASSY | No. REQ'D | DWG SIZE | DESCRIPTION |
|---|---|---|---|---|
| | x | 1 | E | SOURCE PASS MECHANISM ASSEMBLY |
| | x | 1 | E | CARRIER KEEL TRANSFER MECHANISM |
| | x | 1 | E | MAZE CONVEYOR ASSEMBLY |
| | x | 44 | E | PRODUCT CARRIER ASSEMBLY |
| | x | | D | MAZE KEEL GUIDE SYSTEM |
| | x | 1 | E | INTERIM TRANSFER AREA ASSEMBLY |
| | x | 1 | E | STORAGE AREA CONVEYOR ARRANGEMENT |
| | x | 1 | E | PNEUMATIC SCHEMATIC - SOURCE PASS MECH. |
| | x | 1 | D | PNEUMATIC SCHEMATIC - STORAGE AREA |
| | x | 1 | E | SOURCE MECHANISM ASSEMBLY |
| OWN | x | 1 | D | SOURCE HANDLING TOOL KIT |
| | x | 1 | D | SOURCE HOIST SAFETY VALVE ASSEMBLY |
| 556 | x | 1 | C | POOL SKIMMER ASSEMBLY |
| 431 | x | 2 | C | WATER LEVEL SWITCH ASSEMBLY |
| | x | 1 | C | EMERGENCY STOP CABLE ASSEMBLY |
| 96 | x | 1 | D | MAZE ENTRANCE DOOR ASSEMBLY |
| | | 1 | | CONTROL CONSOLE ASSEMBLY |

| | DATE | BY | APP. |
|---|---|---|---|
| FINAL LAYOUT | 24 NOV 80 | JH | |
| 3176 | APR 24/80 | TU | |
| DEIONIZER | MAR 3/80 | TU | |
| ... #44 | ... | LO | |
| | 11 DEC 79 | JH | |
| ...TED | NOV 27/79 | | |

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**ATOMIC ENERGY OF CANADA LIMITED**
OTTAWA — COMMERCIAL PRODUCTS — CANADA

REQUIRED FOR

DRAFTSMAN: USHER — DATE: OCT 25/79 — DRAFTING APPR.

MECH. ENG. — ELECT. ENG. — CIVIL ENG. — PHYSICS — ENG. APPR.

MAT'L & SPEC. — FINISH —

CODE NO. —

SCALE: 1/4 = 1-0 — TOLERANCES: ± — FRACTION; ± — DECIMAL; ± — ANGULAR

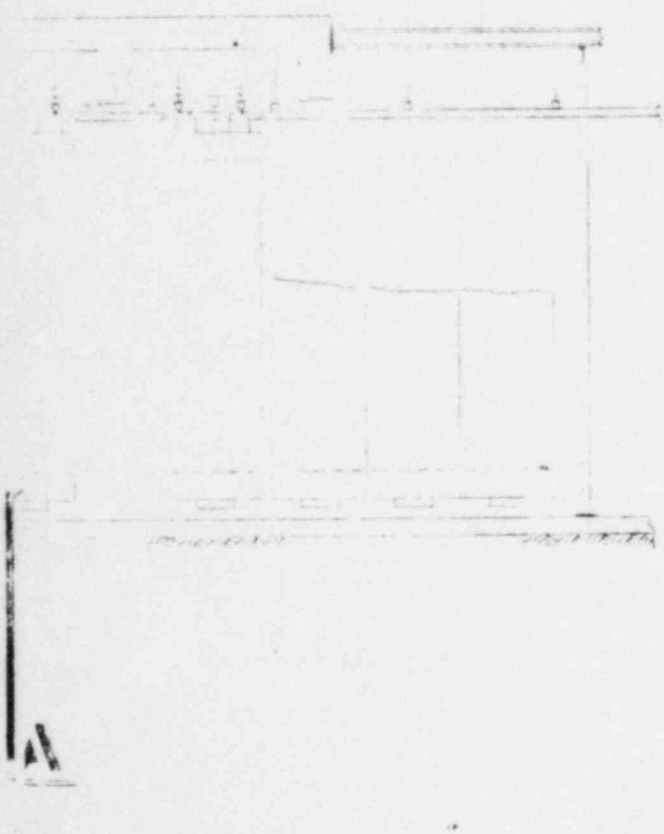
TITLE: CARRIER TYPE IRRADIATOR (ISOMEDIX - PUERTO RICO)

DRAWING NUMBER: B 1 1 0 7 0 1 0 0 2 — CODE — ISSUE G

Appendix A

B A

6



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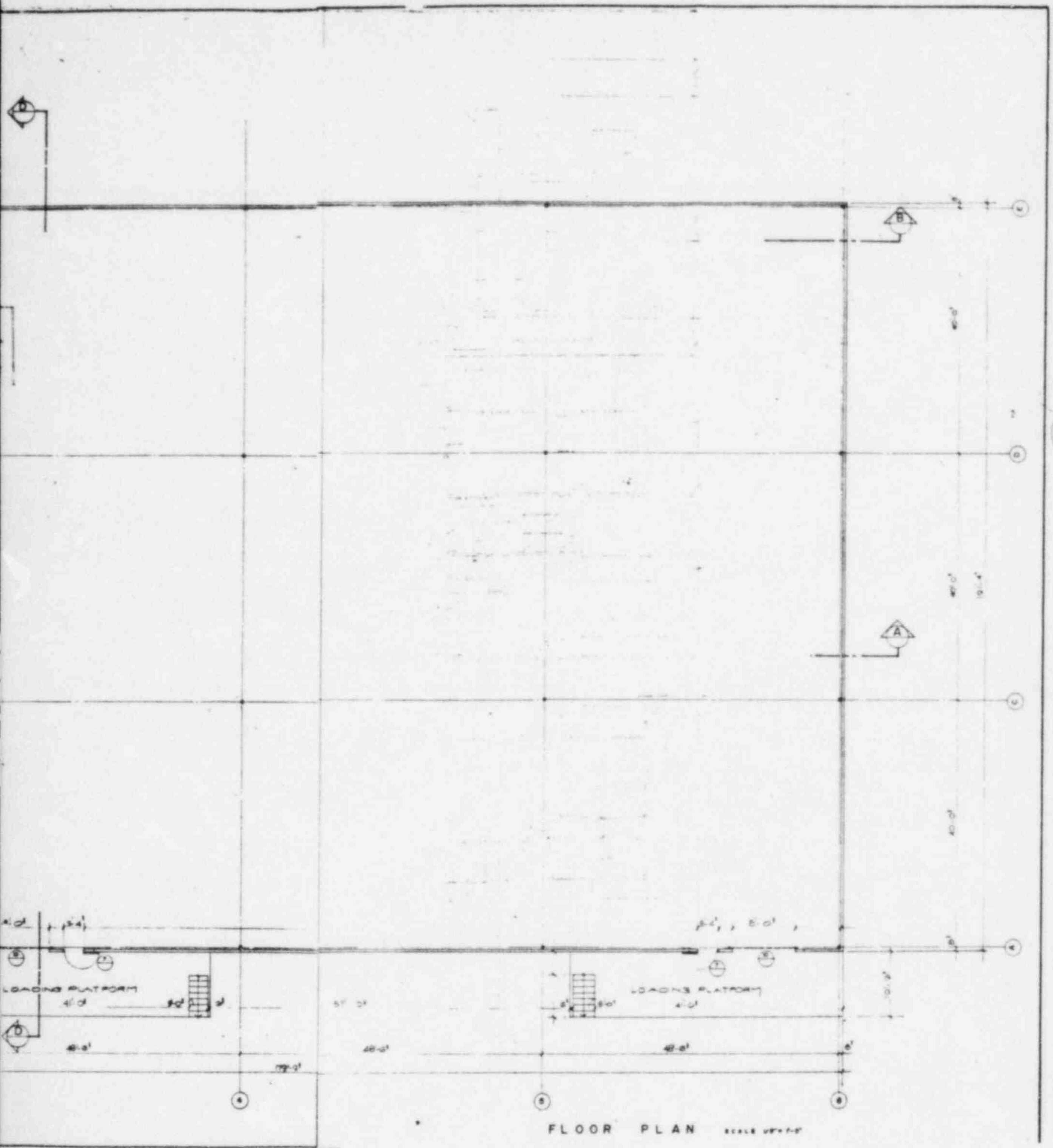
| LIST FOR | SHEET NO. | CONT ON SHEET | DRAWING NUMBER | REV |
|---|---|---|---|---|
| | 2 | - | 311070100 2 | G |

| NUMBER | ASSY | No. REQD | DWG. SIZE | DESCRIPTION |
|---|---|---|---|---|
| | X | 2 | E | PERSONNEL - SAFETY BARRIER ASSY. |
| | | | | POOL WATER [illegible] - DUNHAM BUSH # PC0105 |
| | | | | POOL WATER DE[illegible] - WATER REFINING # [illegible] |

APPENDIX

| | | |
|---|---|---|
| B | Drawing A-3 - | General Layout of Building |



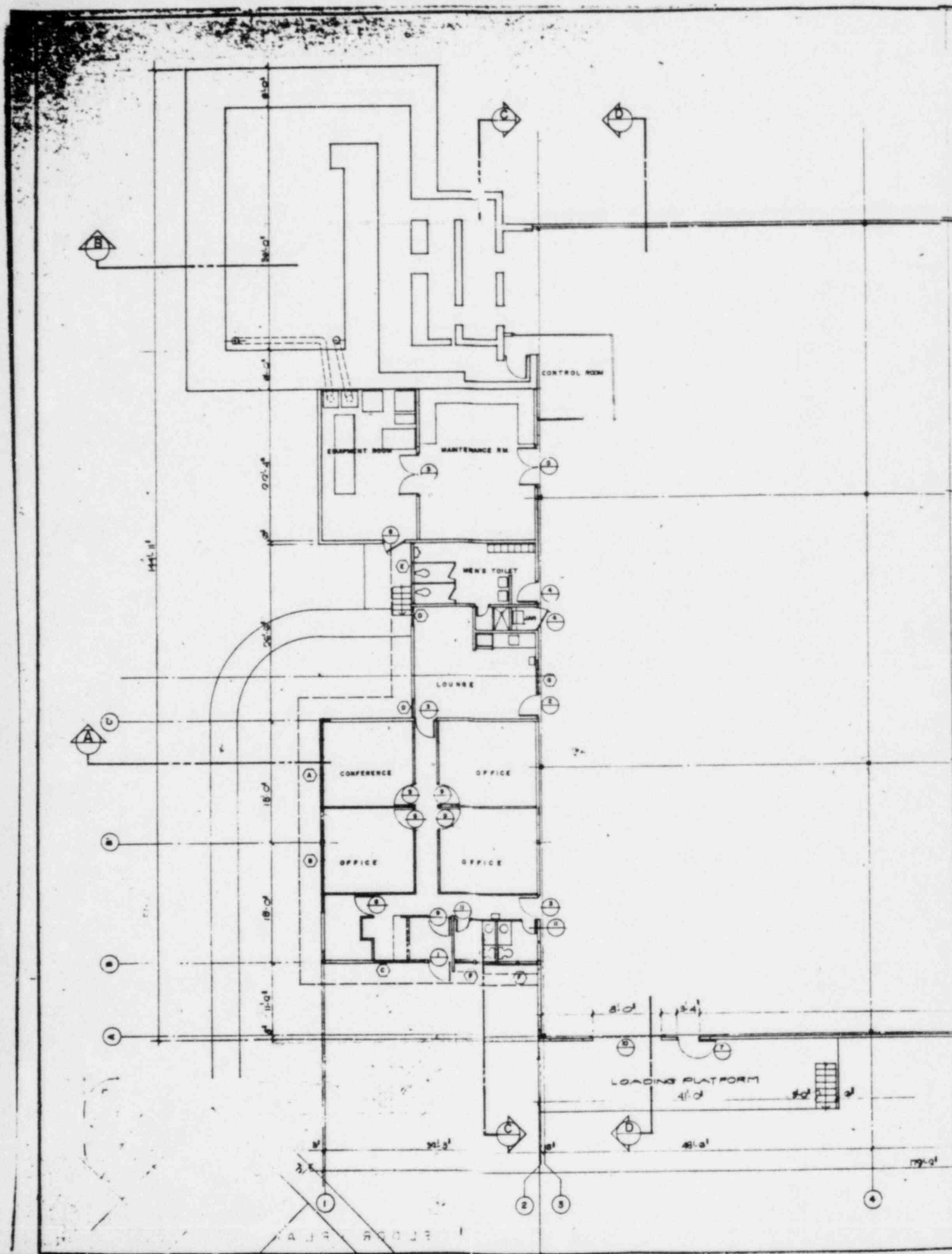

FLOOR PLAN

jose g barat-masini arquitecto

ISOMEDIX DE P.R.

VEGA ALTA, PUERTO RICO

A-3


CONTROL ROOM
EQUIPMENT ROOM
MAINTENANCE RM.
MEN'S TOILET
LOUNGE
CONFERENCE
OFFICE
OFFICE
OFFICE
LOADING PLATFORM
8'-0"
41'-0"
30'-0"
48'-0"

APPENDIX

C DESCRIPTIONS OF FIXED MONITORS

APPENDIX C

(No page numbers C-1, 2, 3 or 4)

# OPERATING INSTRUCTIONS

# SINGLE PROBE

# WALL MOUNTED MONITOR

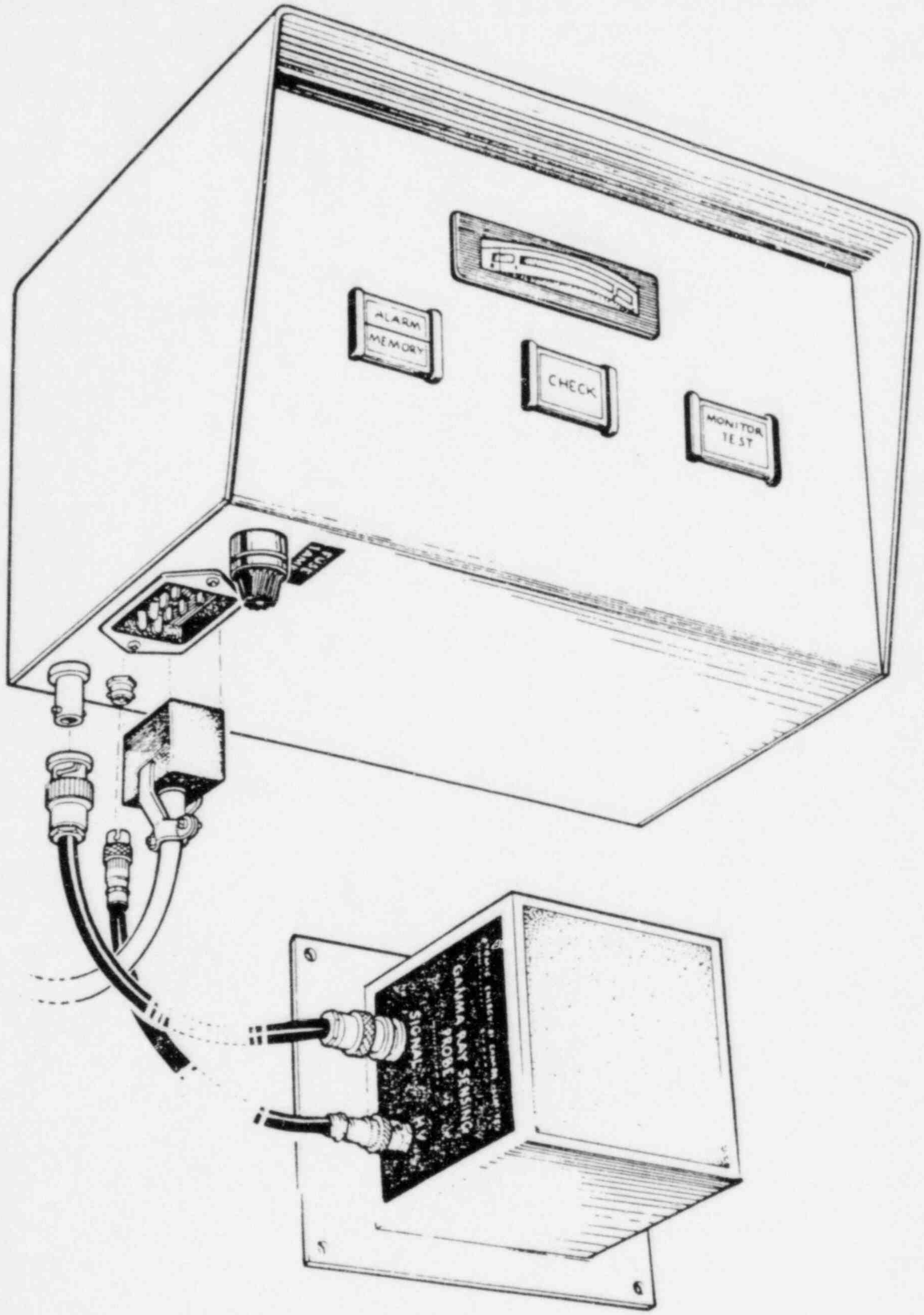
# CATALOGUE NO. L118

EDITION NO. 3, JULY 1975

ATOMIC ENERGY OF CANADA LIMITED,
COMMERCIAL PRODUCTS,
OTTAWA, CANADA.

# TABLE OF CONTENTS

# LIST OF ILLUSTRATIONS




REF H100312-007

WALL MOUNTED SINGLE PROBE
MONITOR SYSTEM

L118

FIGURE 1

5-72

# DESCRIPTION

## Introduction

The wall mounted monitor system is designed to warn and indicate that gamma radiation is present, and to monitor the radiation facility.

A Gamma Ray sensing probe is used with the radiation monitor system and is installed in the area to be monitored, and the detected radiation signal is then transmitted to the electronic assembly unit.

The electronic assembly will then transmit the detected signal to a visual and audio warning system. A visual indicator will also monitor the radiation level sensed by the probe.

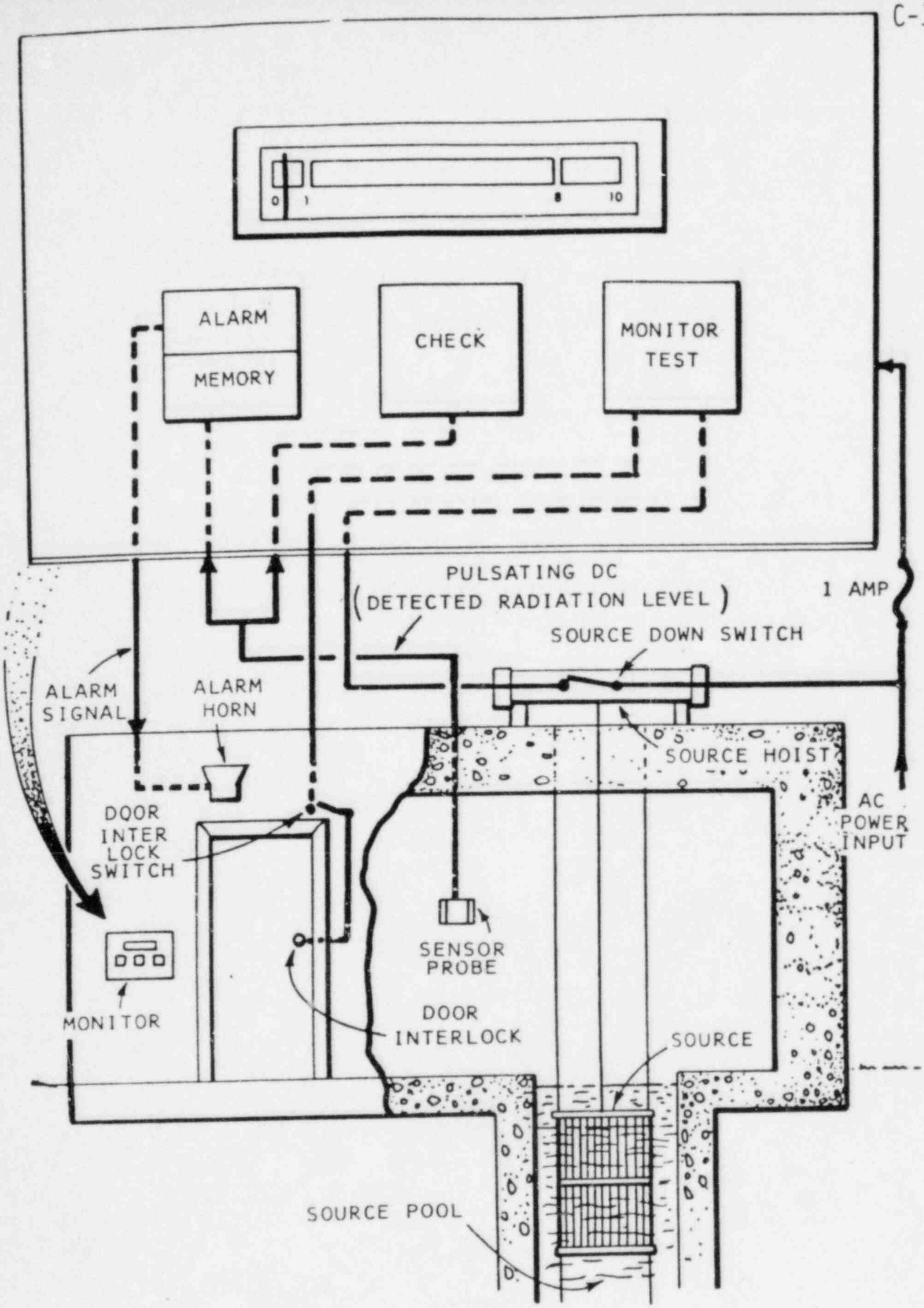
## General (Ref. Figure 1)

The Single Probe Monitor system consists of two assemblies. Reference AECL Drawing A12986.

a) A probe which contains the electronic radiation detectors.

b) The Ratemeter, Power Supply, associated relay and indicator circuits which are contained in the Monitor console. A radiation alarm horn is also an integral part of the system, which is mounted in the most advantageous position.

c) The Monitor System can be used with the following signal




MONITOR LOCATION
IRRADIATOR ROOM
FIGURE 2

inputs:

i) With an input from the Sensing Probe only; or

ii) A Sensing Probe signal input and an interlock system.

## Monitor Control Console (Ref. Figure 2)

The Monitor Control Console shall be located in a room where the electronic components are not exposed to a high radiation field.

The monitor console includes the following controls and indicators:

1. Check Lamp ... a flashing neon lamp which indicates that the ratemeter circuit is functioning properly.
2. Monitor Test ... an illuminated switch that is used in a safety interlock system and will simulate an alarm condition which will check that the Monitor system is functioning properly.
3. Alarm and Memory ... a split lens push switch; the alarm lens will illuminate in an alarm condition; the memory lens will remain ON after an alarm condition.

. Ratemeter ... a linear scale meter which indicates the level of radiation as sensed by the probe.

## Alarm Horn

The horn will sound under an alarm condition.

## Sensing Probe

When the detector in the sensing probe is exposed to a radiation field, it will generate a series of voltage pulses. The frequency of voltage pulses will be proportional to the radiation field strength, and is transmitted to the monitor ratemeter circuit for a visual indication of radiation level being sensed.

The Gamma Ray sensing probes contain Geiger-Meuller gas filled tubes, and are used with the radiation monitor system.

The sensing probe is installed in the location to be monitored, and is selected for use with a monitor system for a particular monitoring application.

The three types available are:

(a) Type L110A - Reference AECL Drawing A03364.

(b) Type L110B - Reference AECL Drawing A03367.

(c) Type L110C - Reference AECL Drawing A03366.

## Circuit Protection

The Monitor System has a 1 AMP fuse in the 115 VAC line side of the system.

## MONITOR CALIBRATION

### Ratemeters

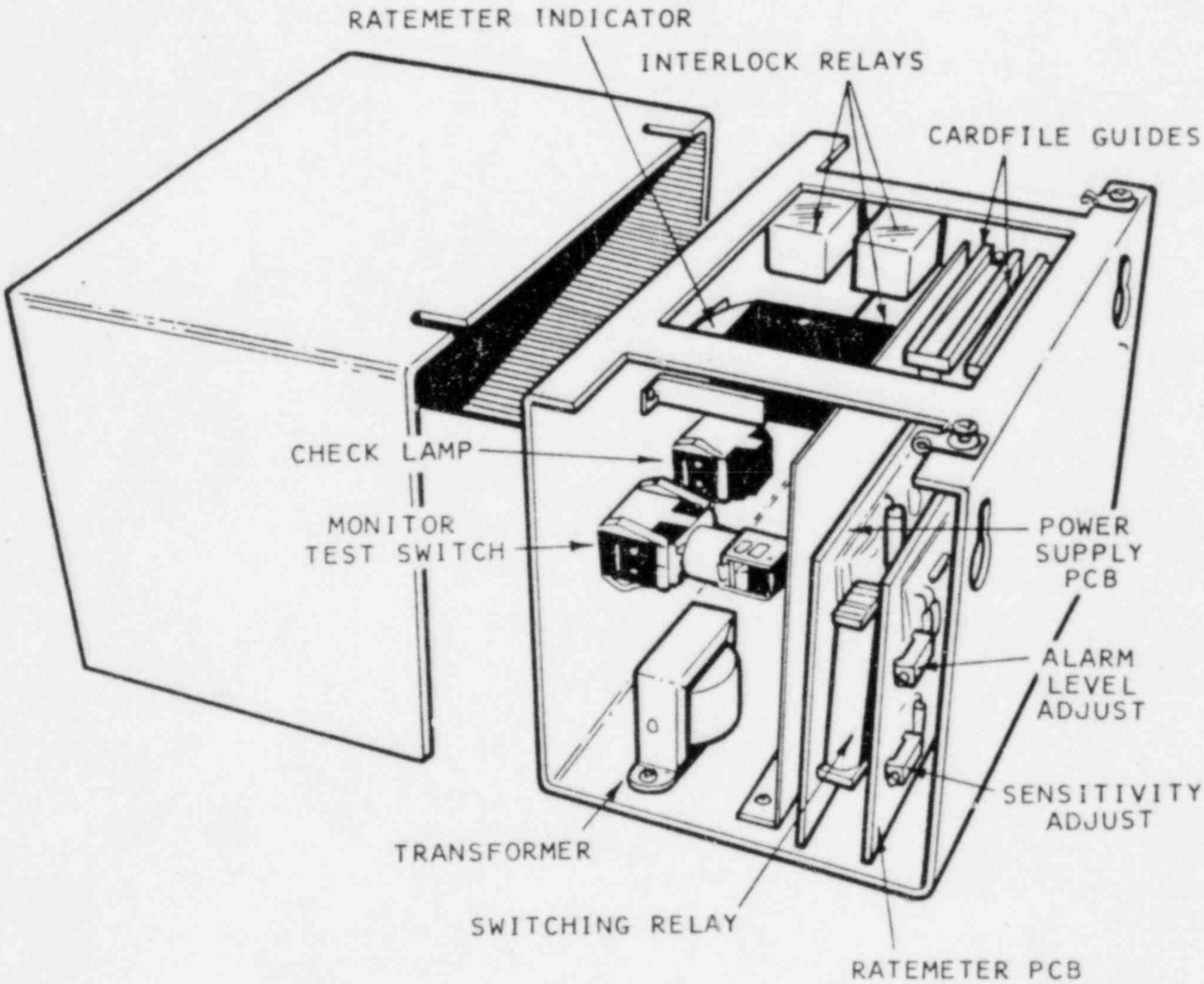
With the geiger probe located in a field of background strength, the sensitivity of the ratemeter can be adjusted by means of a trimpot mounted on the ratemeter board so that the meter registers at 10% of full scale (0-1 reading). The check lamp should be flashing in time with the pulses.

### Alarm Circuits

The critical level of the alarm circuit is adjustable by means of a trimpot located on the ratemeter board. This level should normally be set at 80% of the full scale meter deflection (a scale reading of 8).

The proper functioning of the alarm indicators, visual and audible, should be checked every 3 months by moving a calibration source close to the geiger probe. When the calibrator approaches the probe the irradiation system should sound the alarm horn and the "Alarm" and "Memory Alarm" lamps should illuminate.

Normal operating and alarm levels should be checked with the aid of a calibration source provided and adjusted every 6 months.




COMPONENT LOCATION
FIGURE 3

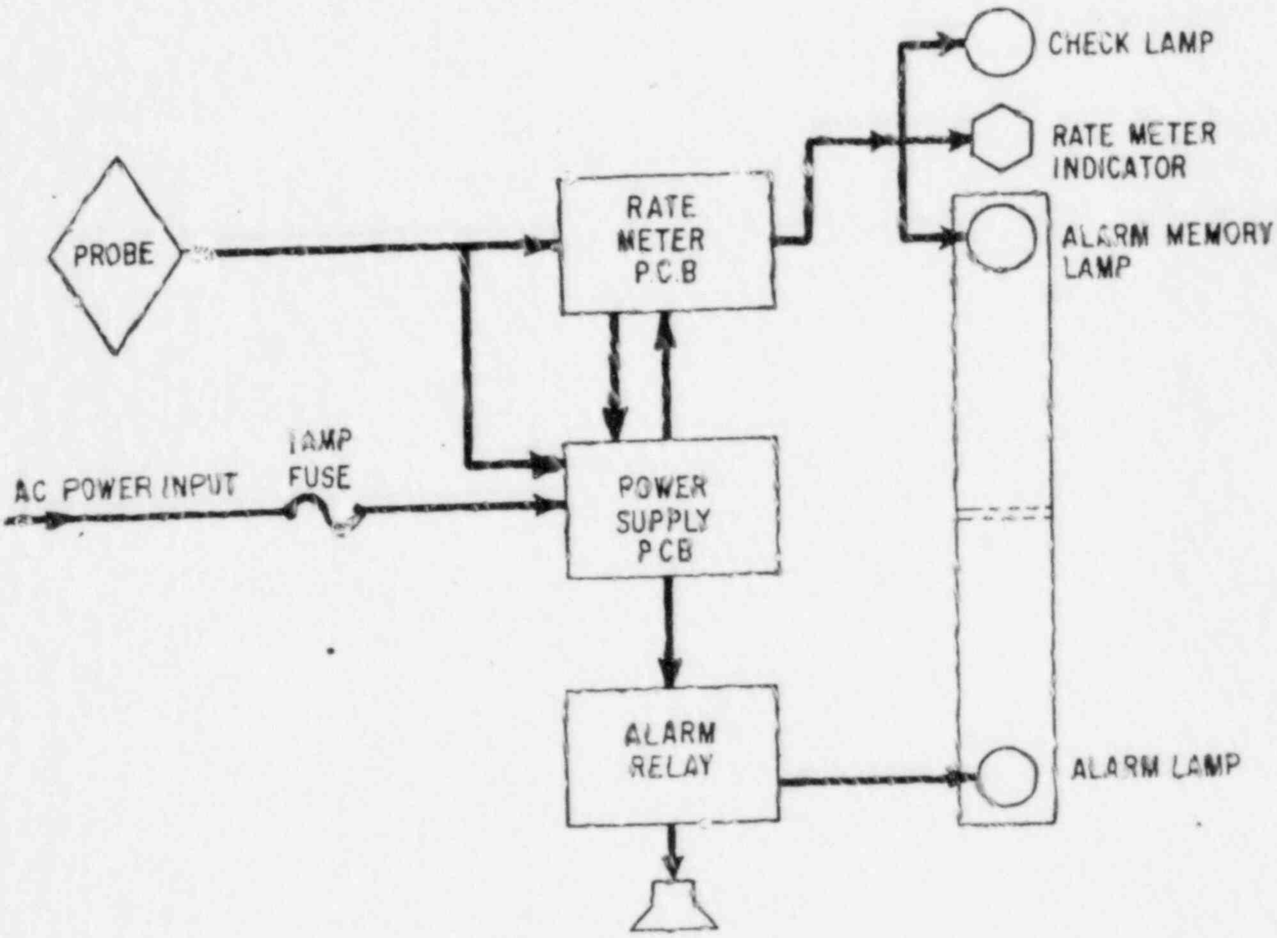
Calibration Procedure

(a) In areas "other than cell location", the calibration is conducted with the source in the raised or "On" position.

1. Using the signals from the Geiger Muller probe, preset the "Sensitivity Adjustment" settings on the ratemeter board for a scale reading of one (1).
2. Adjust the "Alarm Level" trimpot on the ratemeter board until the alarm signals. The ratemeter should give a scale reading of eight (8).
3. Reset the monitoring system at the "Alarm Memory" push button on the Monitor Control Panel.
4. If necessary, repeat step 1 and adjust the "Alarm Level Adjustment" until the alarm signal occurs within ± 10% of a scale reading of eight (8).
5. Reset the monitor system as in step 3. Note that the scale reading should decrease to one (1).

(b) In "cell locations", calibration is conducted with the source in the lowered or "Safe" position.

1. Repeat steps (a) 1 to 5 inclusive.




DATA FLOW DIAGRAM
CONTROL ROOM OPERATION
FIGURE 4

## USE AND OPERATION

Use

The L118 wal' mounted monitor system is designed to indicate the radiation level in an irradiation room when the source is in the "Safe" (stored) position.

It may also be used as a radiation detector in the control room.

CONTROL ROOM OPERATION (Ref. Figure 4)

Normal Operation

The sensing probe is located in the control room area where background radiation levels will be detected.

Voltage pulses proportional to the radiation field will be generated by the GM detector tube, and applied to the power supply and ratemeter printed circuit boards.

The signal to the power supply board is felt at the open contacts of the switching relay with no further circuit effect.

The monitor transformer which will be continuously operating applies 115 VAC through a rectifier, to the switching relay coil keeping it energized. With the transformer operating, 650 VDC from a rectifier circuit is also applied to the sensor probe necessary for system operation.

The detected signal is also applied to the ratemeter printed circuit board. The first stage to accept the signal is an emitter follower. From the follower, to a one-shot multivibrator which has an adjustable potentiometer in its integrator circuit. The potentiometer is used to adjust the pulse width of the signal pulses received. This determines the sensitivity of the meter indicator as described in the calibration procedures.

The one-shot output is fed to a driver, and the driver output is then fed to the check lamp and meter indicator.

The check lamp and meter will give a proportional indication of radiation detection.

The driver output signal is also felt at the next stage, the emitter follower.

The background radiation pulse has no further circuit effect as its frequency is below alarm level.

Alarm Operation

The circuit action to the meter indicator and check lamps will be as described in "Normal" operation.

However, the check lamps will flash at an increased rate at a frequency proportional to the radiation field, and the indicator meter needle will move into the alarm area as previously calibrated.

The alarm signal will now overcome the bias as set by the alarm level potentiometer, and the level detector stage will conduct.

The detector output is felt at the Schmitt trigger circuit, and its output will switch from a low to a high voltage level to the final emitter follower stage.

The final emitter stage of the ratemeter circuit will send an alarm signal to the trigger transistor. This high input is felt as a low at the SCR which will stop conducting. The alarm relay normally energized, will now de-energize.

The de-energized alarm relay will permit a DC Voltage to be felt at the "Alarm" lamp which will illuminate.

An AC Voltage will also be felt through the closed alarm relay contact which will sound the alarm horn.

## Alarm Condition Ceases

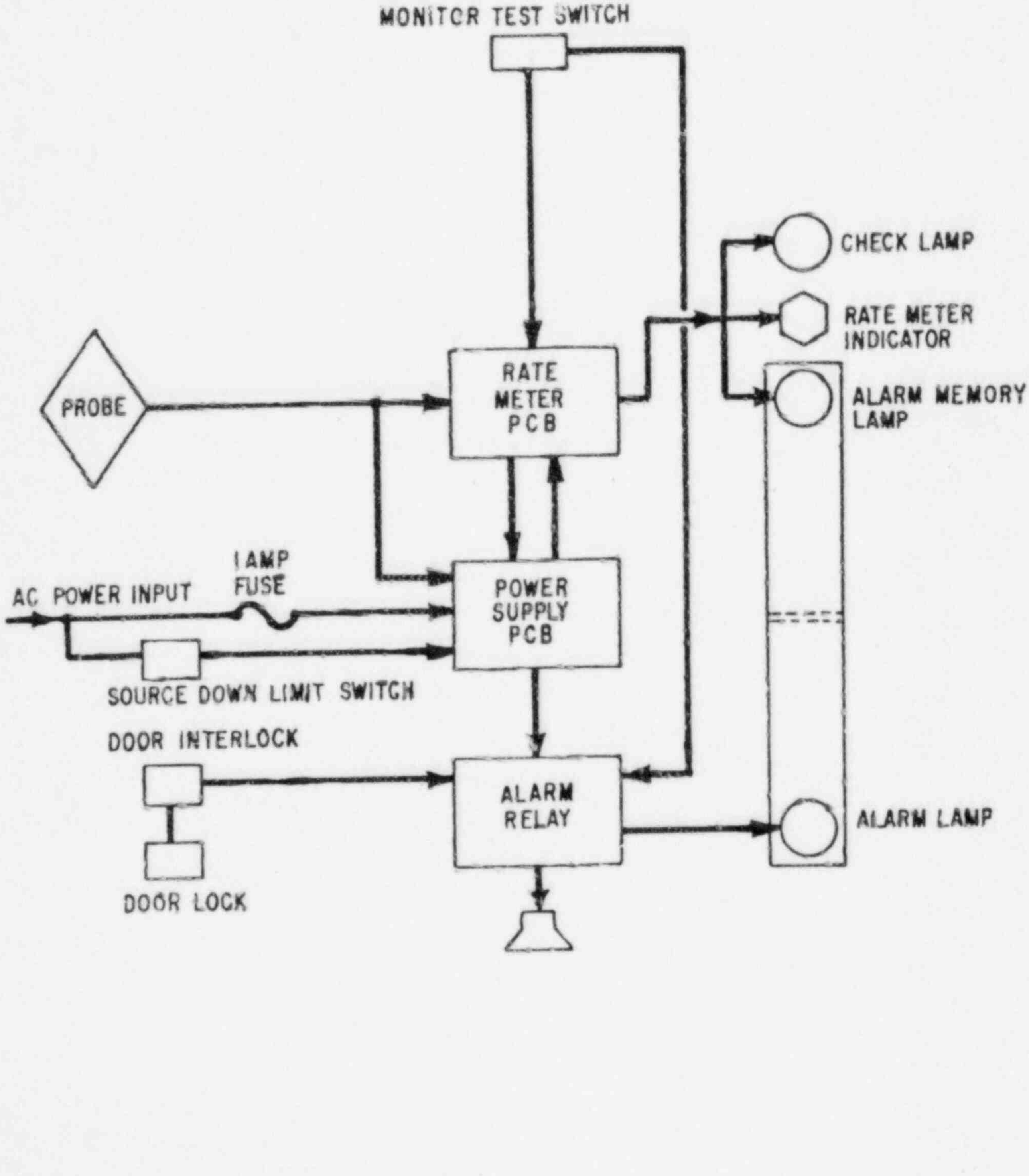
### Alarm Circuit

When the alarm condition ceases the red "Alarm" light will extinguish as the alarm relay will energize as in normal operation, breaking the 12.5 VDC circuit to the "Alarm" lamp.

The "Alarm Horn" will be silent as the 115 VAC line will be broken by the open contacts of the energized alarm relay.

### Memory Circuit

The "Memory Alarm" light will remain illuminated, as the SCR is still conducting, until the "Alarm Memory" lamp switch is depressed. Depressing the switch will cause the SCR to stop conducting, and open the circuit to the "Memory" lamp which will extinguish.




DATA FLOW DIAGRAM
IRRADIATOR ROOM OPERATION
FIGURE 5

IRRADIATION ROOM OPERATION (Ref. Figure 5)

The sensor probe is installed in the irradiation room where background radiation levels will be detected.

Feature

The following ancilliary circuits are used in an irradiation room operation:

(a) Electrical Interlock Circuit - This system has a microswitch which is actuated by the irradiation room door. The circuit is used as a "Safety" interlock in the irradiation room door lock mechanism, and will prevent the door from being inadvertantly opened while the source is in the exposed position.

(b) Electrical Source Safe/Exposed Circuit - This system will apply a high DC voltage to the sensor probe with the source in the "Safe" position; the DC voltage will be removed from the sensor probe with the source in the exposed position.

(c) Monitor Test Circuit - This system will test the monitor for correct operation before the operator enters the irradiation room. By depressing the "Monitor Test" switch two capacitors are paralleled which has the effect of increasing the alarm voltage level necessary for alarm operation. This will simulate an alarm condition in the monitor system.

Operation - Source Down

The sensing probe is located in the irradiation room. It will detect gamma ray radiation above the preset ambient level with the source in the "Safe" (stored) position. The sensor will not detect the radiation level when the source is in the "Exposed" position.

The Source Down Limit switch will close, making a high DC voltage available to the sensor probe for its operation. It also energizes a switching relay removing the ground from the signal line.

The monitor operation will be as previously described in CONTROL ROOM OPERATION in Normal, Alarm and Alarm Condition Ceases.

Ancilliary Circuits

The following will describe the function and use of the ancilliary circuits:

Monitor Test Switch

This switch is used by the operator to establish that the irradiation room monitor is functioning properly. The "Source" must be in the "Down" (stored) position. This check is performed preparatory to entering the irradiation room.

(a) Depress the Monitor Test switch and hold until the monitor indicates an alarm condition. The alarm relay will de-energize, 115 VAC will actuate the alarm horn and the meter indicator needle will move to full scale deflection.

The interlock relays will energize and 115 VAC will be fed to the contacts of the door interlock switch, when alarm condition ceases. The monitor test light, alarm and memory lights will illuminate.

(b) Release the monitor test switch, the alarm relay will energize and open its contacts to the alarm light which will extinguish.

The monitor test light and the memory light will remain "On".

(c) Press the memory switch to clear the circuit which will extinguish the memory lamp.

(d) The irradiation room door may now be unlocked, as the door key is turned it will complete the circuit to the door lock solenoid.

(e) Opening the door will now open the door switch and the interlock relay will de-energize extinguishing the monitor test lamp.

Operation - Source Up

The source down limit switch will open as the source rack begins to rise. This will remove the high DC voltage necessary for the sensor probe operation and grounds out the signal line.

## DETECTION OF MONITOR MALFUNCTIONS

With each L118 monitor, the following replacement parts are supplied:

1. Gamma Sensing Probe (FIGURE 1).
2. Power Supply PCB (FIGURE 3).
3. Ratemeter PCB (FIGURE 3).
4. Ratemeter Indicator (FIGURE 3).
5. Set of HV Test and Signal Cables (FIGURE 1).
6. Lamps, Fuses, etcetera (FIGURE 1).

In the event of a malfunction originating within the L118 Monitor System, proceed as follows:

1. Remove the monitor probe from the cell.
2. Using the supplied HV test cables, replace each component, one at a time, for which a replacement part has been provided, and using the test source located in the maze door keyswitch box, test the operation of the monitor.
3. When the fault has been located, replace the faulty component with its appropriate replacement part.

*NOTE:*

*Remember to immediately re-order any component which has been replaced.*

APPENDIX C

# OPERATING AND INSTALLATION INSTRUCTIONS

## D/L 2 MONITOR

## CATALOGUE NO. L119

EDITION NO. 2, AUGUST 1975

STORES CODE 2M002426

ATOMIC ENERGY OF CANADA LIMITED,
COMMERCIAL PRODUCTS,
OTTAWA, CANADA.

DESIGN CHANGE - EFFECTIVE JULY 1976.

D/L 2 MONITOR - OPERATING AND INSTALLATION INSTRUCTIONS

PAGE 11 - SCHEMATIC

Zener Diode CR8, BZY88 changed to SZ6.8A, 1 WATT.

# INDEX

# LIST OF ILLUSTRATIONS

INSTRUCTIONS

D/L 2 MONITOR

## GENERAL DESCRIPTION

The D/L 2 Monitor System is designed to warn and indicate that gamma radiation is present. A typical use is as an area monitor for an irradiator facility.

A clear light-emitting diode (LED) indicates that the detector is ON and a red LED "flickers" under normal background radiation.

If the gamma radiation reaches an unsafe level then an audible alarm signal is activiated and the red LED will remain illuminated. The D/L 2 Monitor also contains an auxiliary relay that closes a set of contacts when the audible alarm sounds. This facility can be used to control an associated system such as "shutting down" the irradiator facility.

## SPECIFICATIONS

1. Detection Sensitivity - Indicates background radiation below 0.05 mR/h.
2. Alarm Level - Can be set for 0.5 mR/h and higher.
3. Power Requirements - 100-130 VAC, 50/60 Hz.

*NOTE: A 1/4 AMP line fuse must be externally installed.*

4. Case Dimensions - 8-1/2 in long x 5-1/2 in wide x 4 in diameter, overall

5. Auxiliary Relay Contacts - 15 watts capacity.

COMPONENTS Refer to Figure 1

TRANSFORMER

1. Provides a 12 VAC supply.
2. Provides isolation from the 115 VAC line.

POWER LAMP

Indicates that the D/L 2 Monitor is ON.

ALARM LAMP

Provides a visua indica' n of gamma radiation.

GEIGER-MEULLER TUBE

Monitors the gamma radiation and produces output pulses at a frequency that is proportional to the radiation level.

ALARM HORN

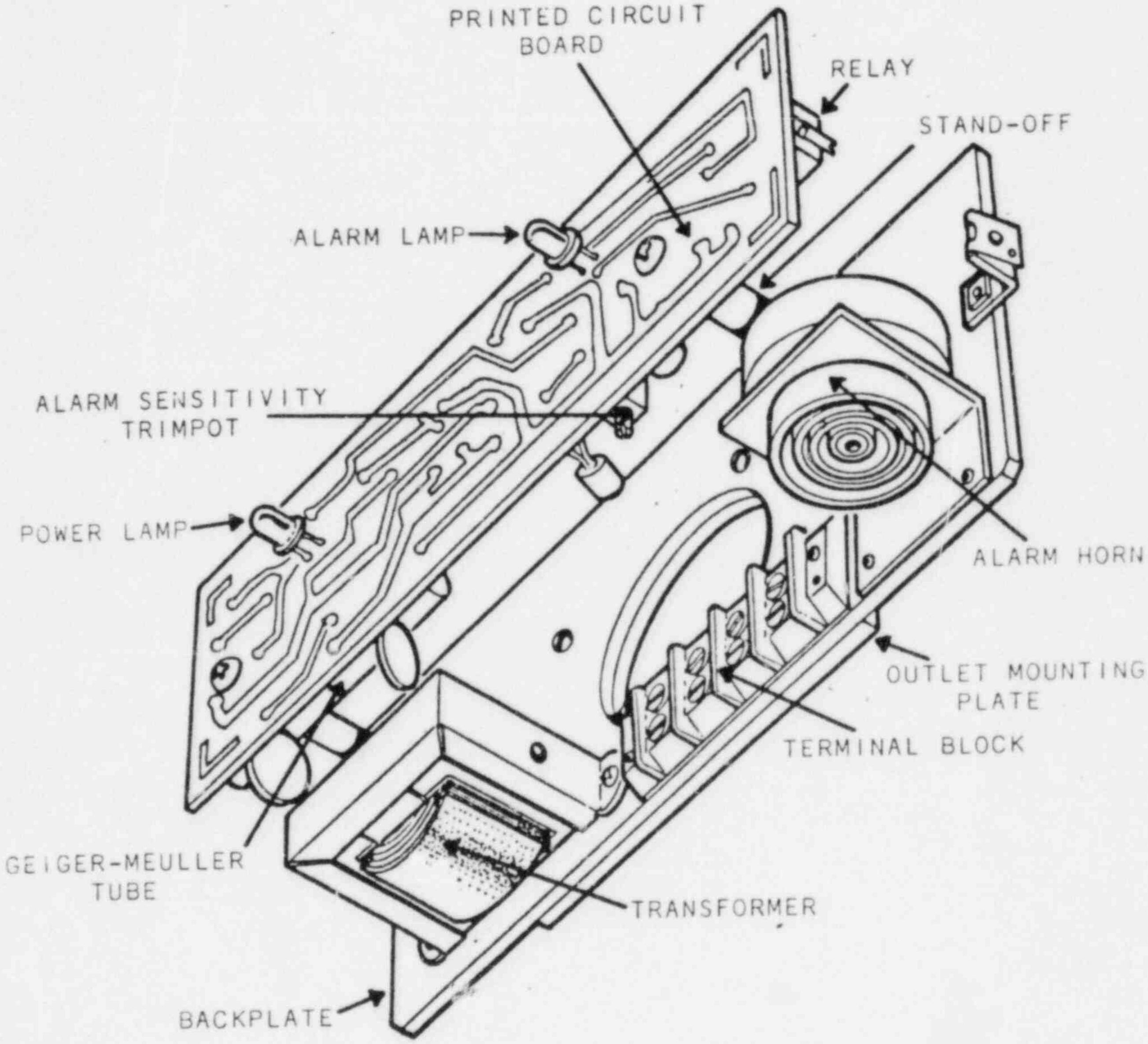
Produces a high-frequency "shrill" sound in the advent of unsafe gamma radiation.

RELAY

The relay contacts <u>close</u> in an alarm condition.

ALARM SENSITIVITY TRIMPOT

Provides a means of adjusting the sensitivity of the MONITOR to gamma radiation.




REF B105207-024/A

COMPONENT LOCATION

FIGURE 1

TERMINAL BLOCK

1. Provides for easy connection to 115 VAC.
2. Auxiliary relay contacts are also available at this terminal block.

THEORY OF OPERATION Refer to AECL Drawing A14233

The radiation level is monitored by a Geiger-Meuller tube which produces output pulses at a frequency proportional to the radiation level. These pulses are then processed by a Transducer Detector to produce a non-symmetrical square-wave output having an "on-time" proportional to the frequency of the pulses from the Geiger-Meuller tube.

The output of the transducer detector drives the red ALARM lamp (LED). This output also feeds an R-C integrator having a relatively "long" time constant. Therefore, the DC output voltage from the R-C integrator is consequently proportional to the radiation level.

The output of this R-C integrator goes to a COMPARATOR whose reference voltage is set by the ALARM SENSITIVITY trimpot.

If the radiation should increase to an unsafe level, then the COMPARATOR (along with transistor Q1) will "actuate" the audible alarm and thus de-energize the relay coil causing the relay contacts to close.

## SENSITIVITY ADJUSTMENT

The sensitivity of the D/L 2 Monitor should be adjusted with maximum background radiation (with the source in the raised or "ON" position).

1. Adjust the alarm sensitivity trimpot (Figure 1) until the alarm horn sounds.
2. With the alarm horn sounding, adjust the sensitivity until the horn just turns OFF. The SENSITIVITY is now set.

## TESTING THE SENSITIVITY OF THE MONITOR

With the source in the raised position (this provides maximum background radiation) bring a calibration source towards the D/L 2 Monitor until the alarm horn sounds.

If the alarm does not sound, then the SENSITIVITY should be re-adjusted as described above.

## PERIODIC CHECKING OF THE MONITOR

The D/L 2 Monitor should be checked once a month (minimum).

## CHECKING PROCEDURES

1. The POWER lamp should be ON (this can easily be inspected each day).
2. The red ALARM lamp should "flicker" for normal background radiation.
3. Check the SENSITIVITY as described above.

4. Check the operation of the relay contacts (perhaps the relay is used to turn on a light at a master control panel).

*NOTE:* *If the relay contacts are not used to control an associated system then there is no need to check these contacts since they, in no way affect the operation of the D/L 2 Monitor.*

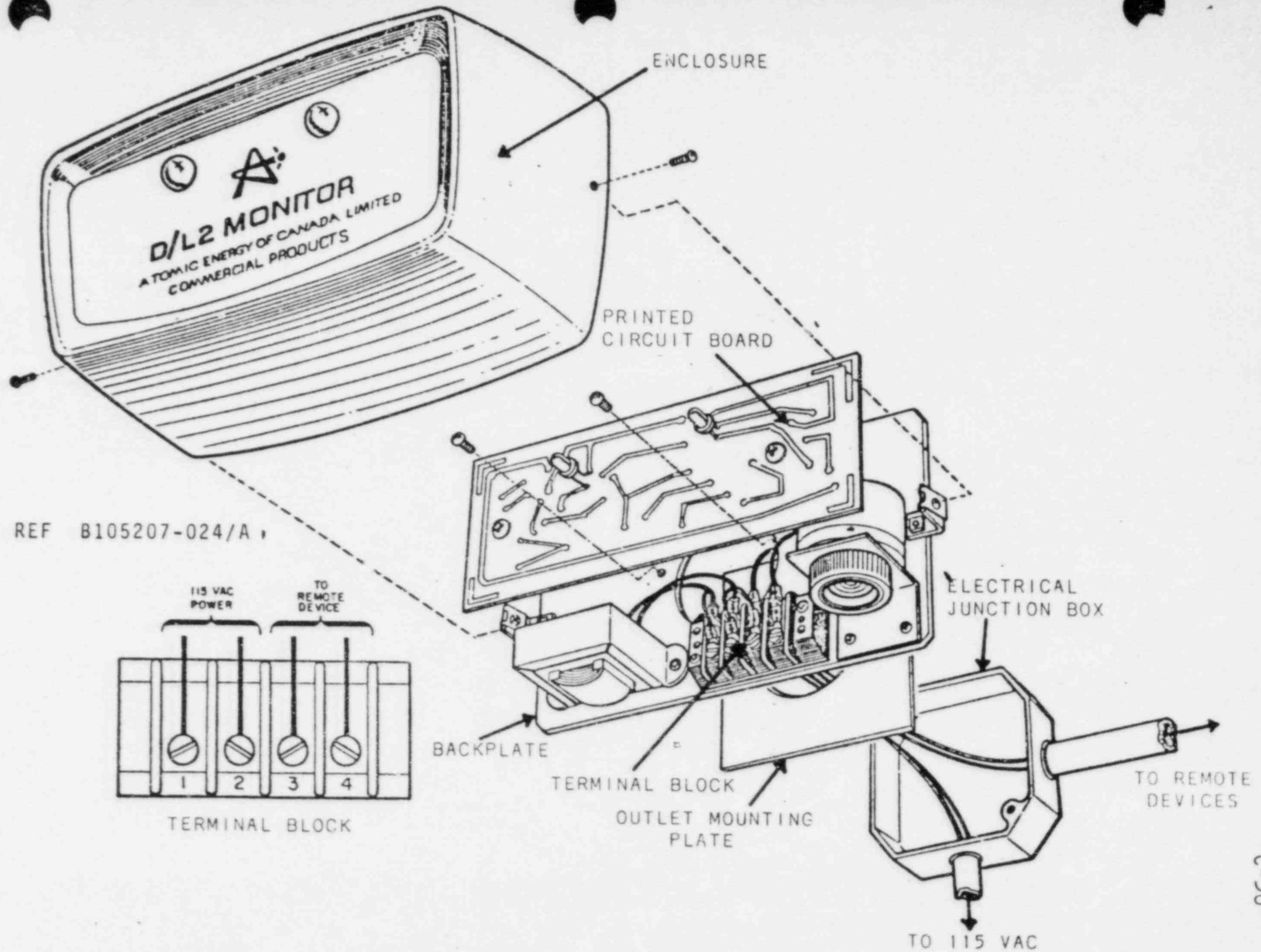
INSTALLATION INSTRUCTIONS Refer to Figure 2

The D/L 2 Monitor is designed for wall mounting and should only be located where the background radiation is relatively "low" otherwise the electronic components could be damaged.

MOUNTING

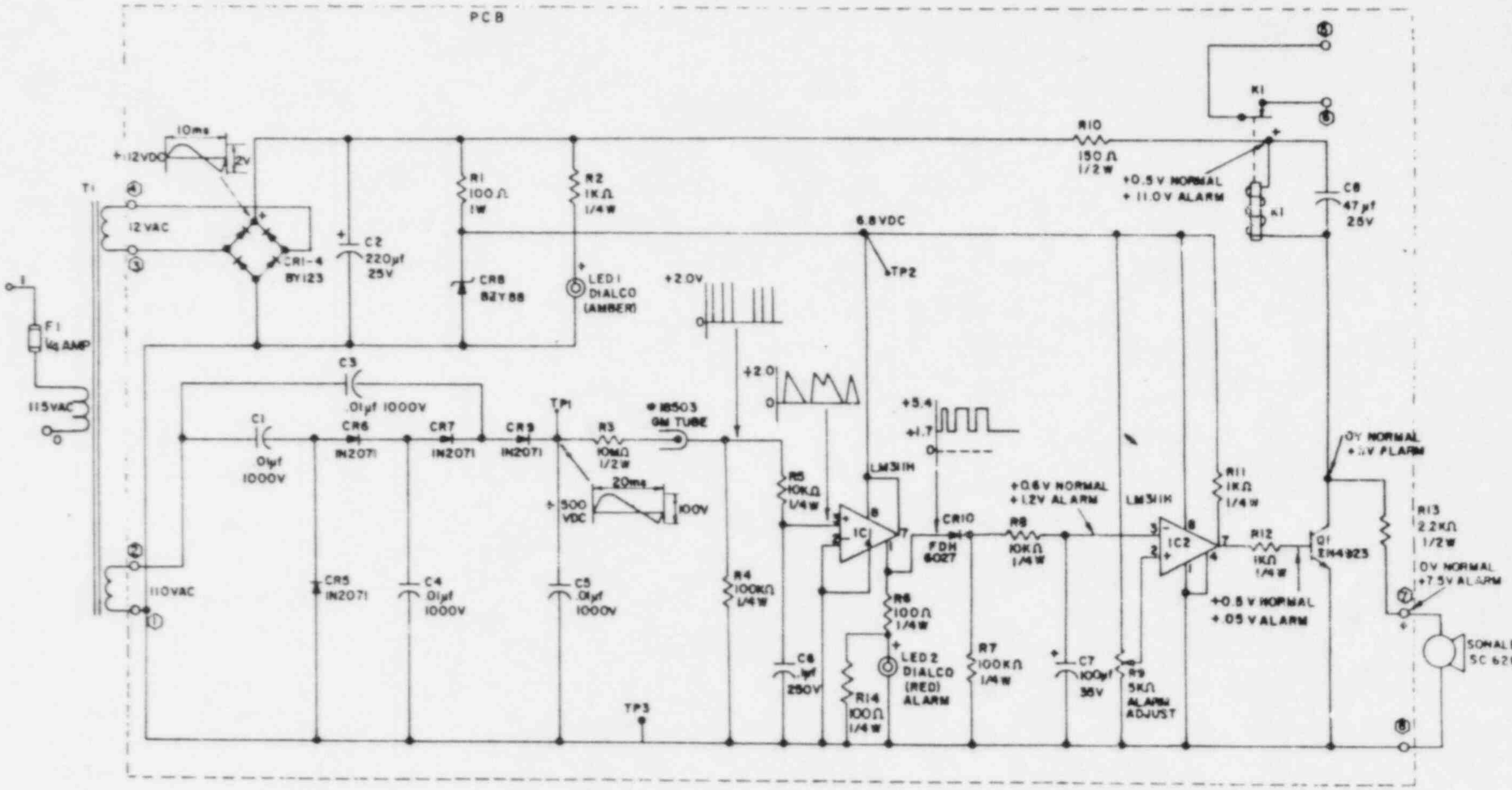
1. Remove enclosure from backplate.
2. Remove printed circuit board from stand-offs.
3. Remove outlet mounting plate.
4. Drill holes in the outlet mounting plate to align with mounting holes in the electrical junction box.
5. Bring wires through the access hole in the outlet mounting plate.
6. Mount the outlet mounting plate to the junction box.
7. Bring wires through the access hole in the backplate.
8. Mount backplate to outlet mounting plate.
9. Mount printed circuit board to the stand-offs.
10. Connect wires to terminal block (as shown in Figure 2).

11. Adjust the alarm sensitivity as described earlier in this section.
12. Mount enclosure to backplate.




MOUNTING DETAILS

FIGURE 2

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A14233 ISSUE E

D/L 2 MONITOR SCHEMATIC

FIGURE 3

-11-

C-37

08C13