30-09345

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

August 9, 1996

MEMORANDUM TO: Linda L. Howell, Chief
Nuclear Material Inspection and
Fuel Cycle/Decommissioning Branch
Division of Nuclear Material Safety
Region IV

FROM: Steven L. Baggett, Section Chief
Sealed Source Safety Section
Medical, Academic, & Commercial
Use Safety Branch
Division of Industrial and
Medical Nuclear Safety, NMSS

Thomas W. Rich, Acting Section Chief
Commercial Section
Medical, Academic, & Commercial
Use Safety Branch
Division of Industrial and
Medical Nuclear Safety, NMSS

SUBJECT: WHITE SANDS MISSILE RANGE (WSMR) INVESTIGATION OF TWO LEAKING COBALT-60 SOURCES. LICENSE NUMBER 30-02405-10

The following is a summary of the investigation of the leaking sources. The apparent cause of the failures was a design problem in the carrier-source configuration.

On July 30, 1996, the following individuals met to discuss and participate in the investigation of the leaking sources at Neutron Products Inc. (NPI) facility in Dickerson, MD:

Marvin Turkanis, NPI - VP
Jeff Williams, NPI- RSO
Richard Williams, WSMR
Roland Penny, WSMR
Douglas McDonald, WSMR
Allen Jacobenson, State of MD
Thomas Rich, NRC
Steven Baggett, NRC

030044

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SSD-6

9610150189 960809
PDR RC *
SSD PDR

WSMR personnel briefly described the irradiator facility, its uses, and general description of the operation of the facility.

NPI personnel provided a discussion about their fabrication method for the sources and how the sources are installed into WSMR supplied carriers. Dummy samples of the various products were made available for inspection. In addition, WSMR and NPI personnel discussed the various design changes, and reasons for the changes, that were made to the design since the 1970's. One of the major design changes, as indicated by NPI, was that they changed source fabrication from a single piece of rod stock to welding a piece of flat stock onto the rod stock and then matched the outer capsule to specifications. (Similar construction used for their teletherapy sources).

A possible issue is that neither NPI nor WSMR could clearly document why they started using belleville springs in the carrier. Also, in the early 80's, WSMR requested that NPI weld the threaded plug in place to further reduce the likelihood of leakage. Other facts of interest were presented by WSMR as follows: some corrosion problems have been identified in the exposure head of the device due to humidity in the compressed air system; it is not clear as to what the actual pressure applied to the carriers does to the location of the pressure valves; based on the last 2 years operational data, only one stuck source has occurred and it was moved using about 300 psi instead of the normal 10-20 psi; the radiography source movement system is designed to use 1500 psi nitrogen for stubborn stuck sources; heat treating of the carriers was done in the mid 80's, but the reason is not known and; WSMR staff are compiling historical use data to be used in its investigation of the event. WSMR appears to exercise flexibility in what the users of the irradiators can do without a conscious decision as to the cause and effect of the change on the entire system.

Attached is an outline of how the investigation was to proceed; however, the outline was modified due to a weld failure at the end cap and difficulty was experienced getting the second source out of its carrier. Also attached is a front view of the exposure head denoting the source port arrangement as provided by WSMR.

NPI performed swipe tests on the carriers. The test results identified levels of contamination above .005 microcurie. A helium bubble test conducted on both carriers had negative results; that is to say no bubbles were observed. The first capsule (SN 17591, from port number 5) was machined off at the carrier threaded end plug and the source was removed. The outer encapsulation of the source was deformed (the end cap was convex and showed signs of weld failure). An attempt was made to separate the outer and inner capsules, however, the end cap broke off (window end). The inner capsule weld failed at what appeared to be the end cap of the inner capsule. Examination of the belleville springs inside the capsules showed apparent deformation.

NPI staff machined off the threaded end plug of the carrier for the second capsule (SN 17594, from port number 8) but were not unable to get the source out of the carrier. Further attempts were halted because any further machining would have likely damaged the source and any useful information that might have been obtained.

NPI placed all components into seal welded canisters for later retrieval should WSMR deem necessary (i.e., metallurgical analysis may provide further insight into the failure of the capsules). NPI also took several photographs using a periscope. Copies will be forwarded to you when they are available.

Based on our analysis of the above data and the design of the carrier, the source failed because of design of the carrier source/configuration. This design did not appear to use good engineering principles to eliminate stress concentrations where possible, but rather concentrated them. As a result, we asked WSMR personnel to include a redesign of the carrier and design validation program in its response to Region IV verbal request for an investigation plan. Such a program must consider all factors the sources are exposed to during use, transport, storage, etc. The design change should consider, but not be limited to, the following issues: 1) elimination of the belleville springs, 2) redesign of the carrier, 3) possible source capsule redesign for this application and (4) a heat treatment (anneal) of the source capsule. We strongly suggested that WSMR do prototype testing of a dummy source to demonstrate the effectiveness of any design change.

We also suggested that WSMR provide a realistic schedule for design change and validation. This schedule should address the issue of replacing the sources, because it is very likely the sources currently in the system will be damaged and leak. We recognize that it is difficult to determine when it will leak, however, the sources should be replaced before the normal 5-year period, and as soon as a design change validation is completed and when the vendor can provide new sources.

We would suggest that WSMR and NRC personnel visit the site and review the equipment and possible affects to be considered in the validation program. Tom Rich is available to participate in such a meeting.

A copy of this memorandum was sent to the State of Maryland. If we can provide further assistance please contact me at (301) 415-7273 or Tom Rich at (301) 415-7893.

Distribution:
SSSS Staff SSSS r/f NE02-SSD-6

DOCUMENT NAME: H:\TRACI\WSMR.SLB *See previous concurrence
To receive a copy of this document, indicate in the box: "C" = Copy without attachment/enclosure "E" = Copy with attachment/enclosure "N" = No copy

OFFICE	IMAB* C	IMAB* C			
NAME	TRich	SBaggett			
DATE	8/ 9/96	8/9 /96			

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NAME	TRich ЯWR	SBaggett		
DATE	8/9/96	8/ /96		

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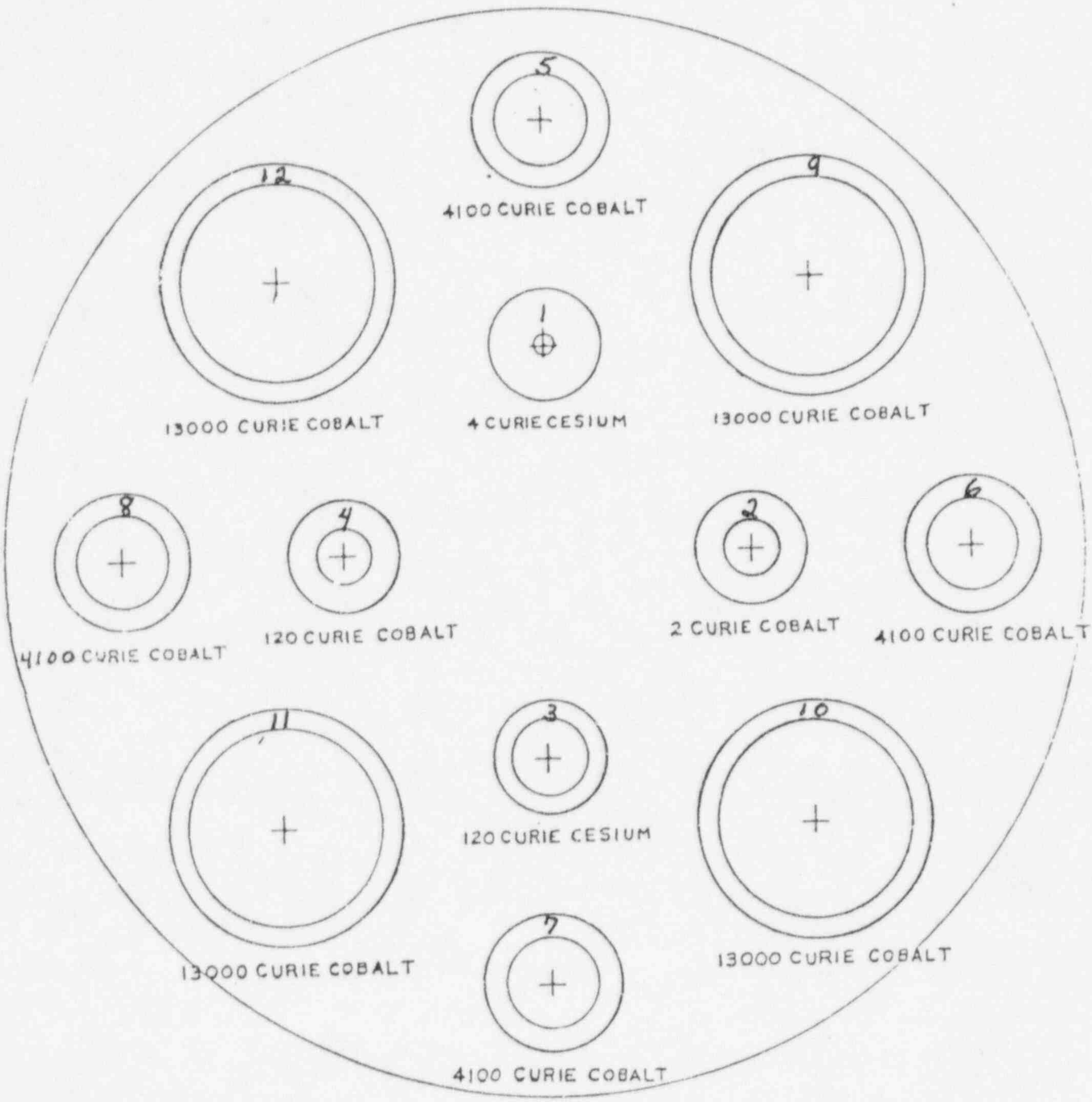
As provided by William 7/30



EXPOSURE ASSEMBLY SOURCE ARRANGEMENT
E-1-13

4 6 2277

PROGRAM FOR EVALUATION OF WSMR "LEAKERS"

PREPARATION (prior to July 30, 1996)

17501

17591

1. Setup hot cell to:

   - visually examine the capsule through the hot cell window with the periscope;

   - wipe test the carriers, outer capsules and inner capsules of both sources;

   - He bubble leak test the carriers, outer capsules and inner capsules of both sources;

   - photograph selected views;

   - weld slugs in storage capsules (in the event that both the inner and outer capsules have failed); and,

   - weld waste into waste capsules.

2. Grind weld off WR-1 encapsulation

3. Place WR-1 in the hot cell

4. Remove the two sources from WR-1 and place on hot cell table

EXAMINATION (July 30 and 31, if necessary)

1. Training course for WSMR and NRC, MD observers for entry into LAA

2. Examine carriers

3. Preview examination

75 - 90

8 - 92.4

CARRIERS

4. Confirm source identification

5. Visually examine carriers

6. Photograph

7. Wipe test carriers

8. Bubble test carriers

9. Remove carriers from each source

10. Photograph (optional)

OUTER CAPSULE

11. Visually examine outer capsules

12. Photograph (optional)

13. Wipe test outer capsules

14. Bubble test outer capsules

15. Remove outer capsules

16. Photograph (optional)

INNER CAPSULE (optional)

17. Visually examine inner capsules

18. Photograph (optional)

19. Wipe test inner capsules

20. Bubble test inner capsules

21. Remove inner capsules

STORE

22. Weld slugs in storage capsule
    Weld waste in waste capsule

REPORT

23. Write report of observation and recommendations, if any, to WSMR.

URGENT

NEUTRON PRODUCTS, INC.
22301 Mt. Ephraim Road
Dickerson, MD 20842
301-349-5001

FAX: 301-349-5007

FAX LEAD PAGE

DATE: July 15, 1996

TO: Mr. Richard Williams
Mail Code STEWS-DATTS-OP
White Sands Missile Range
WSMR, New Mexico 88002-5158

PAGES: 1

FAX: 505-678-7410

FROM: Marvin M. Turkanis

RE: Contract No. DAAD07-95-C-0141

This is to confirm that Neutron's inspection of the 2 leaking sources which were recently returned to Neutron per the terms of the referenced contract is scheduled for Tuesday, July 30, 1996. At this time, we expect that the inspection will take one or two days.

In addition to you and Mr. Douglas MCDonald from WSMR, we expect Mr. Tom Rich and Mr. Steve Baggett from NRC headquarters, and possibly Ms. Linda Howell from NRC Region IV to witness the inspection and participate in the evaluation. We have also notified the Maryland Department of the Environment, our regulator, of the inspection, but do not know if they will send a representative.

If you need any assistance in directions to our Dickerson facility or accommodations, please let us know.

Roland - Penny

CC: Mr. Douglas McDonald, WSMR, VIA FAX
Mr. Tom Rich, NRC, VIA FAX 301-415-5369
Ms. Linda Howell, NRC, VIA FAX 817-860-8188
Mr. Roland G. Fletcher, Maryland RHP, VIA FAX 410-631-3198 - Allen Jacobson 410 631-3300

mR Roland Penny WSMR

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Copy to Tum
Kim R- GAP

Draft

MEMORANDUM FOR: FILE

FROM: Robert A. Brown, Senior Radiation Specialist

SUBJECT: WSMR GAMMA RANGE- LEAKING SOURCES

LICENSEE: Department of the Army
White Sands Missile Range, New Mexico

LICENSE NO. 30-02405-10

DOCKET NO. 030-09345

The following is information concerning leaking cobalt-60 sources at the Department of the Army's White Sands Missile Range. These sources are used at the Gamma Range Facility (GRF) in a custom irradiator for the irradiation of components of various sizes to simulate the effects of nuclear weapons detonations. The GRF falls under the auspices of the Nuclear Effects Directorate. On April 24, 1996 the NRC Operations Center was notified by the Army that a 4000 Curie cobalt-60 was determined to be leaking. The highest smear reading was 0.1 about microcuries. This irradiator contains four cobalt-60 sources of approximately 4000 Curies each (initially) as well as other cobalt and cesium sources. The following chronology of events was obtained from a site visit on April 30 and May 1, 1996, review of the docket file and subsequent phone conversations with Army personnel.

• On October 6, 1982 the Army reported to the NRC (Attachment A) that a 4100 Curie cobalt-60 source was leaking above allowable limits. Measured activity was 0.096 microcuries. The source was located in port number 5 at the GRF. A visual inspection did not reveal any structural defects.

• On June 27, 1983 the Army reported to the NRC (Attachment B) that a 4100 Curie source located in port 8 of the GRF indicated contamination levels of 0.006 microcuries. Although this was below the allowable level of 0.05 microcuries the Army decided to shut down the GRF. A visual inspection indicated no structural defects. The Army surmised that the activity may have been due primarily to contamination of the source carrier.

• In a letter dated January 19, 1984 (Attachment C) the State of Maryland provided the results of their investigation of the June 27, 1983 leaking source to NRC State Agreements Program. They concluded that the contamination resulted from a rupture of the source encapsulation, although no evidence is provided to support this. This information was subsequently provided to the Region IV State Agreements Officer.

• On June 23, 1994 the Army reported to the NRC (Attachment D) that a 2000 Curie source (originally 4100 Curies) indicated leakage of 0.12 microcuries. This source was located in port 8 of the GRF.

• On April 29, 1996 the Army reported to the NRC (Attachment E) that a leak test of a 1830 Curie cobalt-60 source (originally 4100 Curies) indicated the presence of 0.1 microcuries of removable contamination.

• All of the above sources were manufactured by Neutron Products, Inc. of Dickerson, Maryland. They are identified as Model NPI-16-4000. The source is a standard double encapsulated teletherapy source which is placed in a source carrier supplied by the licensee. A threaded plug is welded in place to prevent the plug from "backing out" of the carrier (see Attachment F). NPI does not consider this weld to be a seal weld.

• GFR operators stated that ports 5 and 8 were used extensively. Frequent use for short duration irradiations indicates a high number of source cycles. An analysis of exact number of cycles these sources experienced has not been completed by the licensee as of May 16, 1996.

• During routine maintenance performed in December 1995, while replacing belleville springs, it was noted that the springs had been in place for 21 months. The licensees internal procedures require these springs be replaced every 12 months. These springs are located in the source storage area where the source comes to rest upon return. They are in place as a spacer and a cushion (see Attachment G). Examination of these springs indicted that the inner diameter opening was larger then what was specified. This diameter appeared to be equal to the diameter of the welded plug in the carrier. It was speculated that perhaps the spring abraded the weld allowing contamination on the inner capsule to escape. The correct size springs were installed during this maintenance period. However, during the source change and maintenance in May of 1996 it was discovered that the new belleville springs had not been heat treated as specifications required and had no "spring" left.

• The licensee has not contracted with NPI to analyze the failure mode for the two recent leaking sources. NPI has told the Army they will cut open the sources in their hot cell and check for structural damage. No timetable for this has been set.

MATERIALS LICENSE

Pursuant to the Atomic Energy Act of 1954, as amended, the Energy Reorganization Act of 1974 (Public Law 93-438), and Title 10, Code of Federal Regulations, Chapter I, Parts 30, 31, 32, 33, 34, 35, 39, 40 and 70, and in reliance on statements and representations heretofore made by the licensee, a license is hereby issued authorizing the licensee to receive, acquire, possess, and transfer byproduct, source, and special nuclear material designated below; to use such material for the purpose(s) and at the place(s) designated below; to deliver or transfer such material to persons authorized to receive it in accordance with the regulations of the applicable Part(s). This license shall be deemed to contain the conditions specified in Section 183 of the Atomic Energy Act of 1954, as amended, and is subject to all applicable rules, regulations and orders of the Nuclear Regulatory Commission now or hereafter in effect and to any conditions specified below.

Licensee	
1. Department of the Army Commander 2. White Sands Missile Range ATTN: STEWS-DES-R (RPO) White Sands Missile Range, New Mexico 88002-5048	In accordance with letter dated May 12, 1995 3. License number 30-02405-10 is amended in its entirety to read as follows:
	4. Expiration date August 31, 1995
	5. Docket or Reference No 030-09345

6. Byproduct, source, and/or special nuclear material	7. Chemical and/or physical form	8. Maximum amount that licensee may possess at any one time under this license
A. Cobalt-60	A. Sealed sources (Neutron Products - Custom Made)	A. Not to exceed 13,000 curies per source. Total 137,044 curies
B. Cesium-137	B. Sealed sources (ORNL Custom Made)	B. Not to exceed 3,525 curies per source. Total 14,224 curies
C. Cobalt-60	C. Sealed sources (AECL Model C-146 or C-151 or GE Company Dwgs. No. 106D3912)	C. 24,000 curies (2 sources of not more that 12,000 curies each)
D. Depleted uranium	D. Shielding	D. 999 kilograms

9. Authorized use

A. and B. For use in the U. S. Army Gamma Range Facility for radiation effects studies and the calibration of instruments.

C. One source to be stored only in an AECL Eldorado-78.

D. Shielding to be stored in AECL Eldorado-78 unit.

ML40

~~9507100029~~

MATERIALS LICENSE
SUPPLEMENTARY SHEET

License number: 30-02405-10
Docket or Reference number: 030-09345
Amendment No. 10

CONDITIONS

10. A. Licensed material identified in Items 7.A and 7.B shall be used only at the Gamma Range Facility, U.S. Army White Sands Missile Range, New Mexico.

B. Licensed material identified in Items 7.C and 7. D. shall be stored only at the Nuclear Effects Building 21225, Room 215, White Sands Missile Range, New Mexico.

11. A. Licensed material shall be used by, or under the supervision and in the physical presence of, individuals designated by the White Sands Missile Range Radiation Protection Committee.

B. The Radiation Safety Officer for this license is George R. Wenz.

12. A. Sealed sources and detector cells shall be tested for leakage and/or contamination at intervals not to exceed 6 months or at such other intervals as specified by the certificate of registration referred to in 10 CFR 32.210.

B. Notwithstanding Paragraph A of this Condition, sealed sources designed to emit alpha particles shall be tested for leakage and/or contamination at intervals not to exceed 3 months.

C. In the absence of a certificate from a transferor indicating that a leak test has been made within 6 months prior to the transfer, a sealed source or detector cell received from another person shall not be put into use until tested.

D. Sealed sources need not be leak tested if:

(i) they contain only hydrogen-3; or

(ii) they contain only a radioactive gas; or

(iii) the half-life of the isotope is 30 days or less; or

(iv) they contain not more than 100 microcuries of beta and/or gamma emitting material or not more than 10 microcuries of alpha emitting material; or

(v) they are not designed to emit alpha particles, are in storage, and are not being used. However, when they are removed from storage for use or transferred to another person, and have not been tested within the required leak test interval, they shall be tested before use or transfer. No sealed source or detector cell shall be stored for a period of more than 10 years without being tested for leakage and/or contamination.

NRC Form 374A (5-84) U.S [NUC]LEAR REGULATORY COMMISSION

PAGE 3 OF 4 PAGES

License number 30-02405-10

Docket or Reference number 030-09345

Amendment No. 10

MATERIALS LICENSE
SUPPLEMENTARY SHEET

12. (Continued)

E. The leak test shall be capable of detecting the presence of 0.005 microcurie of radioactive material on the test sample. If the test reveals the presence of 0.005 microcurie or more of removable contamination, a report shall be filed with the U.S. Nuclear Regulatory Commission in accordance with 10 CFR 30.50(b)(2), and the source shall be removed immediately from service and decontaminated, repaired, or disposed of in accordance with Commission regulations. The report shall be filed within 5 days of the date the leak test result is known with the U.S. Nuclear Regulatory Commission, Region IV, 611 Ryan Plaza Drive, Suite 400, Arlington, Texas 76011, ATTN: Director, Division of Radiation Safety and Safeguards. The report shall specify the source involved, the test results, and corrective action taken.

F. Tests for leakage and/or contamination shall be performed by the licensee or by other persons specifically licensed by the Commission or an Agreement State to Perform such services.

13. The procedures contained in application dated May 22, 1988, shall be followed and a copy of this application shall be made available to each person using or having responsibility for the use of the device identified in Items 7.A and 7.B.

14. The licensee shall not perform repairs or alterations of the AECL Eldorado-78 irradiator involving removal of shielding or access to the licensed material. Removal, replacement, and disposal of sealed sources in the irradiator shall be performed by a person specifically licensed by the Commission or an Agreement State to perform such services.

12a

MATERIALS LICENSE
SUPPLEMENTARY SHEET

License number
30-02405-10

Docket or Reference number
030-09345

Amendment No. 10

15. Except as specifically provided otherwise in this license, the licensee shall conduct its program in accordance with the statements, representations, and procedures contained in the documents, including any enclosures, listed below. The Nuclear Regulatory Commission's regulations shall govern unless the statements, representations, and procedures in the licensee's application and correspondence are more restrictive than the regulations.

A. Letter from AECL dated February 23, 1984
B. Application dated May 22, 1988
C. Application dated September 23, 1988
D. Letter dated January 18, 1989
E. Letter dated January 22, 1990
F. Letter dated March 7, 1990
G. Letter dated May 9, 1990
H. Letter dated January 17, 1991
I. Letter dated September 14, 1992
J. Letter received July 9, 1993
K. Facsimile dated July 23, 1993
L. Facsimile received August 30, 1993
M. Letter dated September 3, 1993
N. Letter received April 18, 1994
O. Letter dated July 1, 1994
P. Letter dated December 12, 1994
Q. Letter dated May 12, 1995

UNITED STATES NUCLEAR REGULATORY COMMISSION

FOR THE U.S. NUCLEAR REGULATORY COMMISSION

Date MAY 24 1995

By Original Signed By
Vivian H. Campbell
JB

Nuclear Materials Licensing Branch
Region IV
Arlington, Texas 76011

SUPPLEMENT A

SUBJECT: RADIOACTIVE MATERIAL
REFERENCE: NRC-313 - ITEM 5
COBALT-60, 20 SEALED SOURCES
8 EA @ 13,000 CURIES
8 EA @ 4,100 CURIES -
2 EA @ 120 CURIES
2 EA @ 2 CURIES

137,044 CURIES TOTAL

CESIUM-137, 6 SEALED SOURCES
4 EA @ 3,525 CURIES
1 EA @ 120 CURIES
1 EA @ 4 CURIES

14,224 CURIES TOTAL

COBALT-60 FORM: THE 2 CURIE AND 120 CURIE COBALT SOURCES ARE MADE FROM COILED COBALT WIRE. THE 4100 CURIE AND 13,000 CURIE SOURCES ARE: SOLID, COBALT METAL, NICKEL PLATED, CYLINDRICAL PIECES ALL MANUFACTURED BY: NEUTRON PRODUCTS, INC.

CESIUM-137 FORM: CESIUM CHLORIDE PRESSED POWDER PELLETS MANUFACTURED BY: ISOTOPES DEVELOPMENT-ORNL

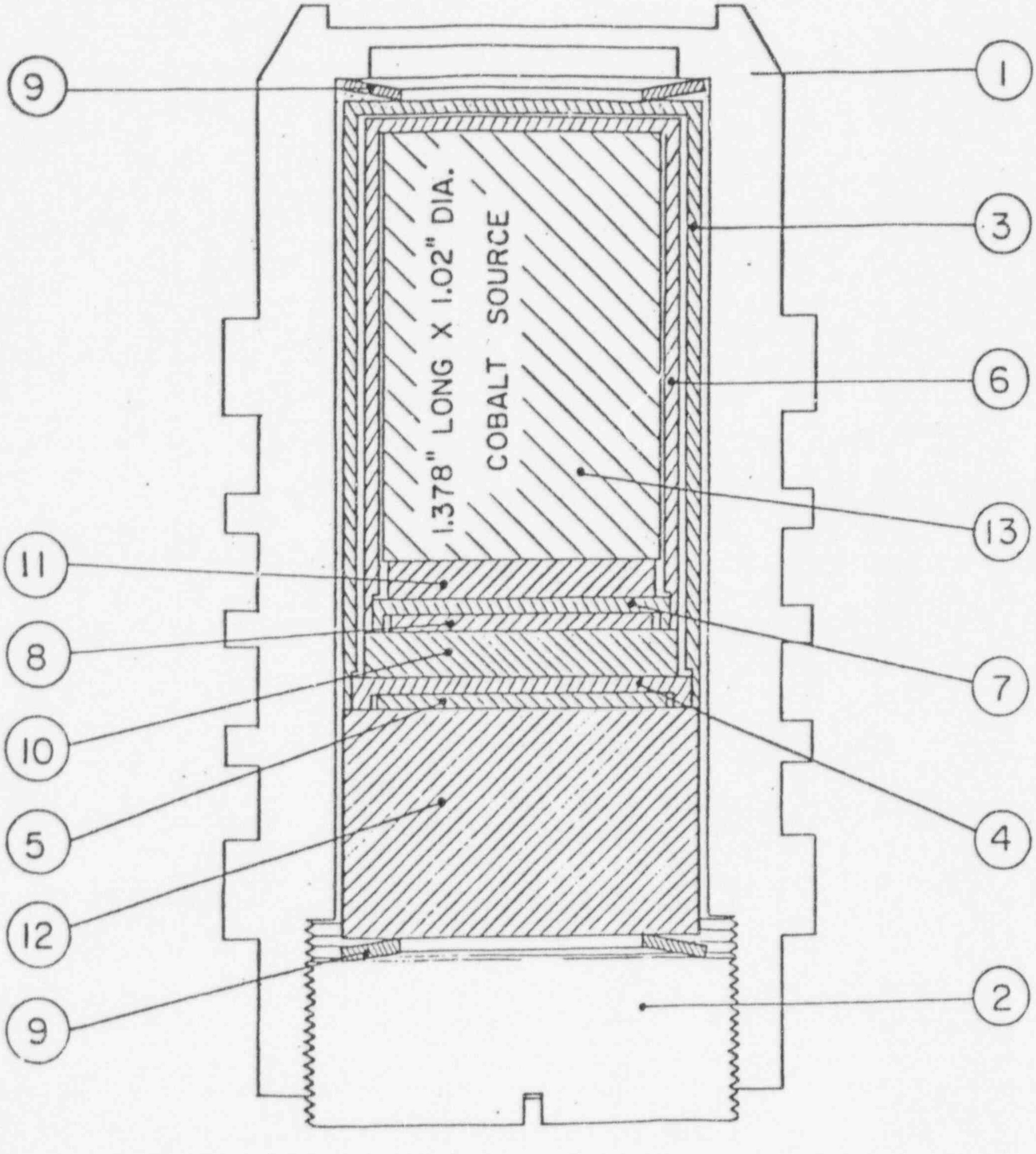
ALL SOURCES ARE TRIPLE ENCAPSULATED. SEE DRAWINGS ON FOLLOWING PAGES.

IT IS REQUESTED THAT TWENTY COBALT-60 SOURCES BE AUTHORIZED BY THIS LICENSE. ONLY TEN COBALT SOURCES WILL BE UTILIZED IN THE GAMMA RANGE SYSTEM AT A TIME BUT THE LICENSE FOR TWENTY SOURCES WILL ALLOW HAVING "OLD" SOURCES ON HAND DURING THE PURCHASE OF NEW SOURCES. THIS ALLOWS THE INCOMING SHIPPING CONTAINER TO BE USED FOR RETURNING "OLD" SOURCES TO THE VENDOR. THE VENDORS, DEPARTMENT OF TRANSPORTATION, APPROVED TYPE B, SHIPPING CONTAINERS AND ASSOCIATED QUALITY ASSURANCE PROGRAM WILL BE USED TO SHIP/RECEIVE SOURCES. IT IS ANTICIPATED THAT THE "OLD" SOURCES WILL BE SHIPPED OUT FOR DISPOSAL WITHIN ONE WEEK'S TIME OF ARRIVAL OF THE "NEW" SOURCES. ALTHOUGH A TOTAL OF 151,268 CURIES IS REQUESTED TO BE AUTHORIZED, THE MAXIMUM AMOUNT THAT CAN BE IN THE GAMMA RANGE SYSTEM AT ONE TIME IS EITHER:

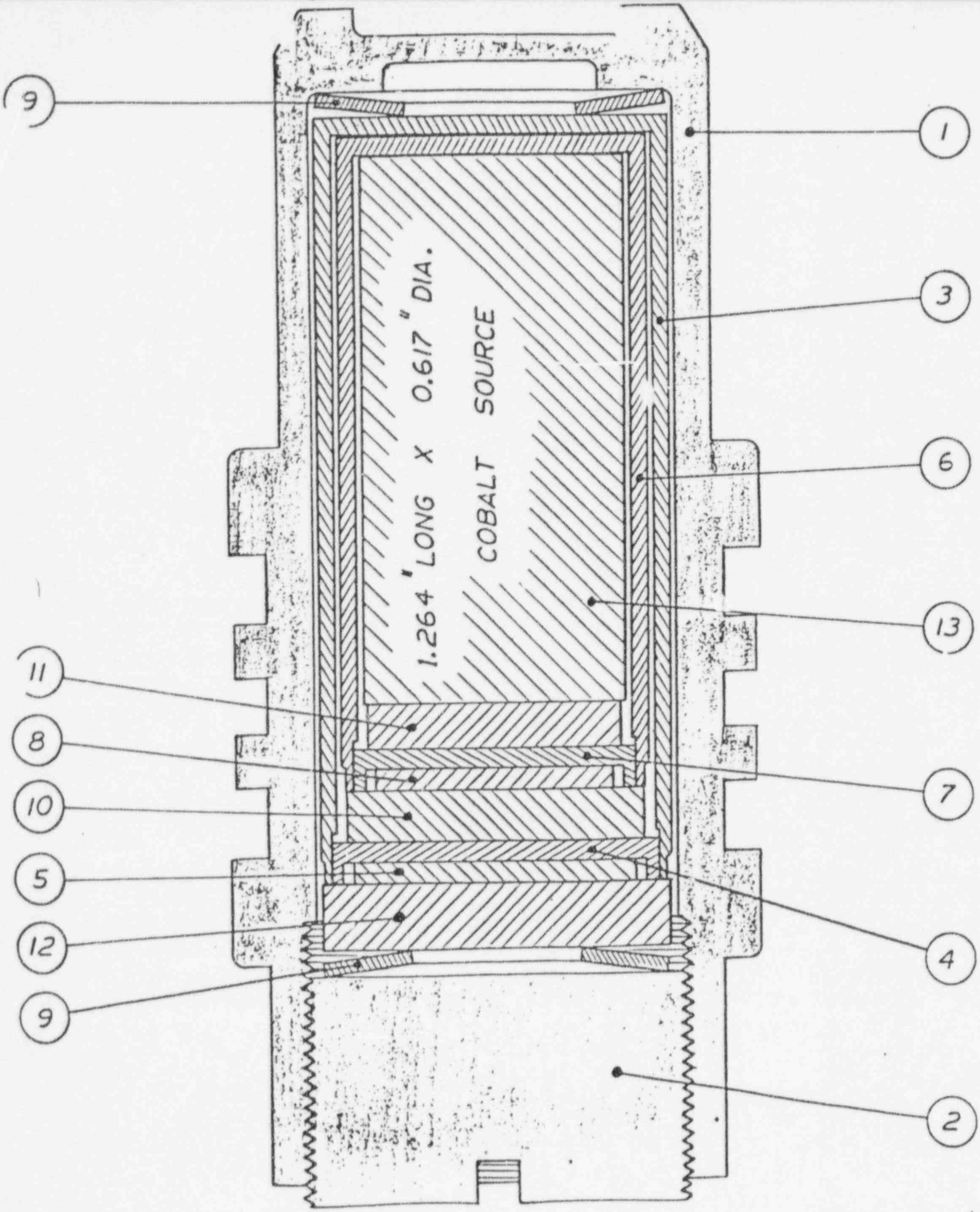
A. 14,224 CURIES OF CESIUM-137, PLUS 16,400 CURIES OF COBALT-60.

B. 68,522 CURIES OF COBALT-60

462277



13000 CURIE COBALT CARRIER ASSEMBLY
MODEL NPI-25-13000



4100 CURIE COBALT CARRIER ASSEMBLY
MODEL NPI-16-4000

LEGEND

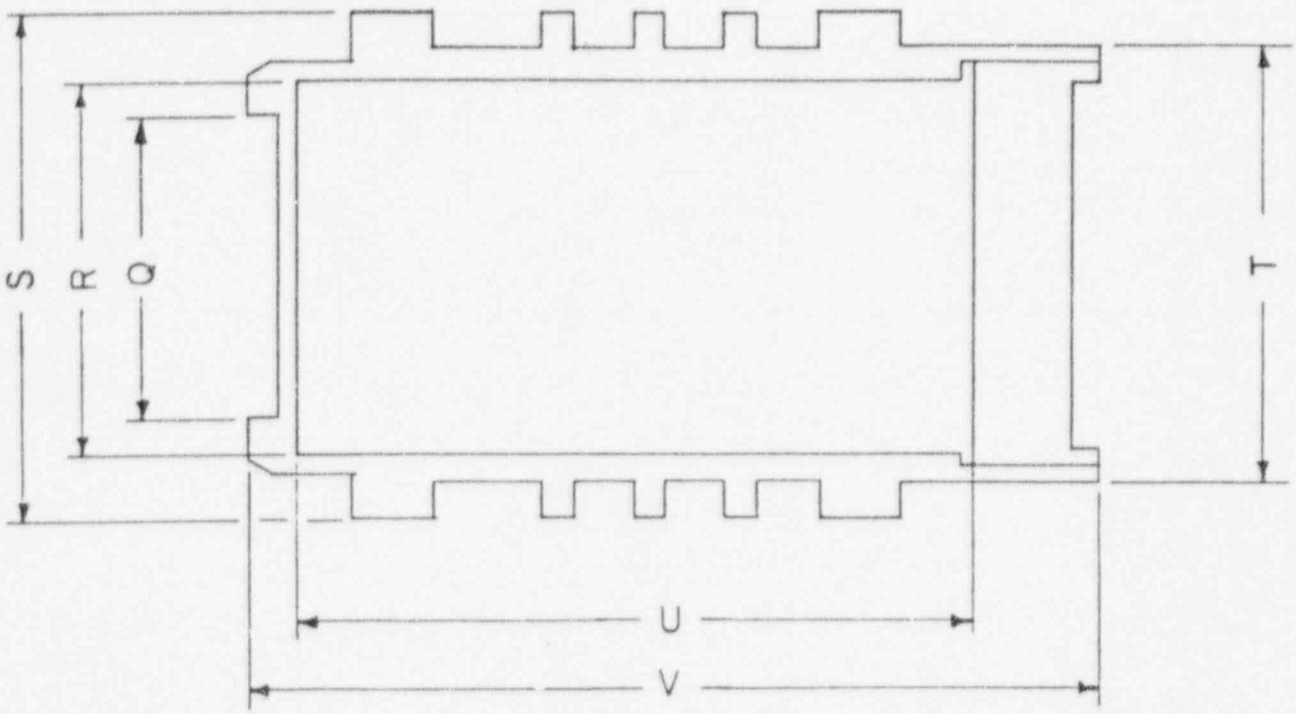
FOR

COBALT CARRIER ASSEMBLY

1. Source Carrier Body
2. Source Carrier Plug
3. Secondary Encapsulation Container
4. Secondary Capsule Lid
5. Secondary Capsule Lid Spacer
6. Primary Encapsulation Container
7. Primary Capsule Lid
8. Primary Capsule Lid Spacer
9. Belleville Spring BS 20-10.2-9.8
10. Secondary Capsule Spacer
11. Primary Capsule Spacer
12. Carrier Spacer
13. Cobalt Source

NOTE:

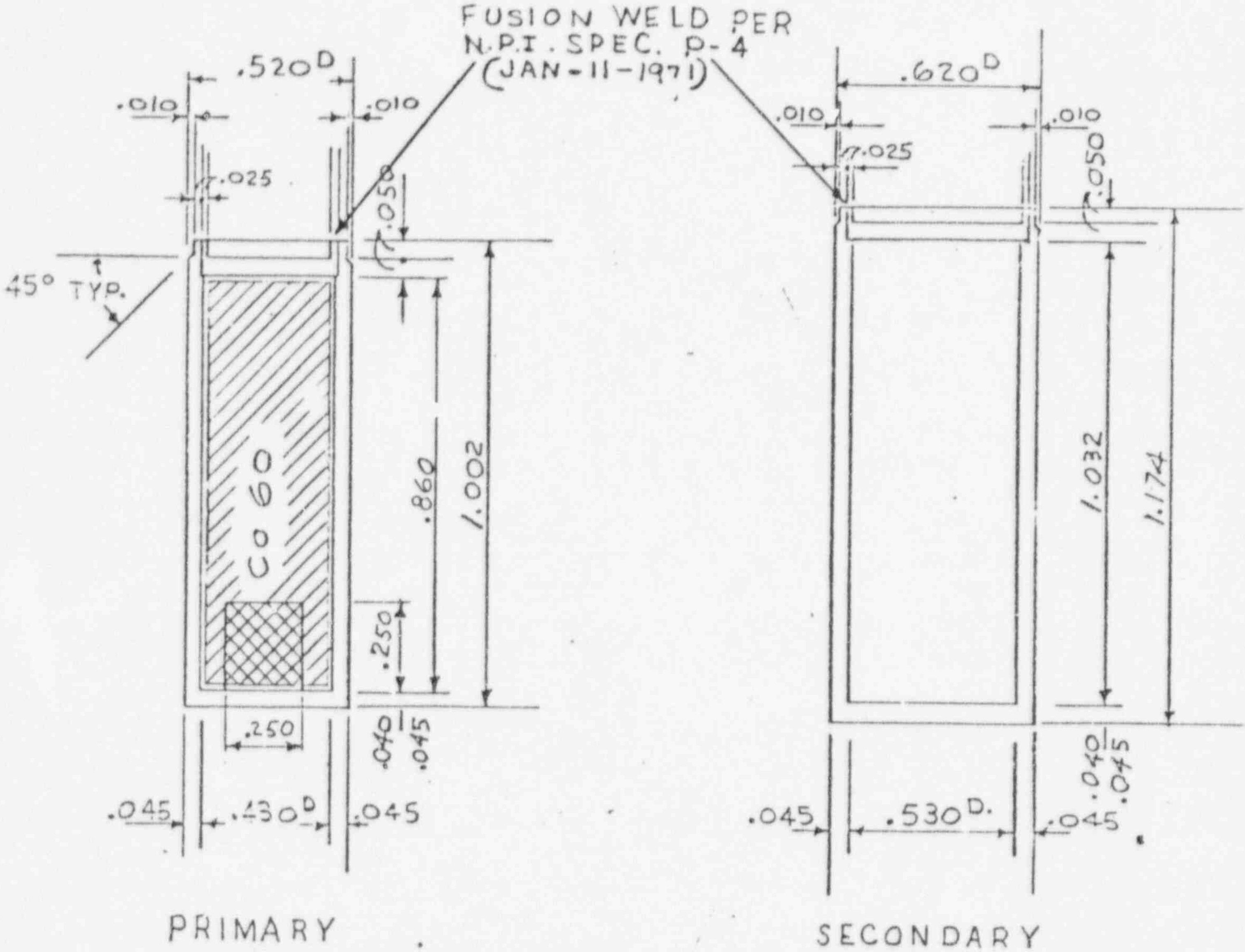
1. Belleville spring part numbers are Bearing Engineers, Inc., and are listed for size information only.
2. Model 176 source carrier is designed for a 1.264" long by 0.617" outside diameter cobalt source. Other source sizes will require other spacer sizes.
3. Belleville springs are shown uncompressed to show orientation which is critical for the front spring.
4. Approximately 15 feet-lb of torque on the carrier plug is required to compress the belleville springs. [illegible]



SOURCE	Q	R	S	T	U	V
SMALL COBALT	0.430	0.640	0.976	0.826	1.200	2.350
SMALL CESIUM	0.517	0.637	0.976	0.826	1.160	2.350
4100 COBALT	0.625	0.827	1.221	1.050	1.938	2.688
13000 COBALT	1.280	1.230	1.950	1.710	2.740	3.500

ALL DIMENSIONS MEASURED IN INCHES

SOURCE CARRIER DIMENSIONS



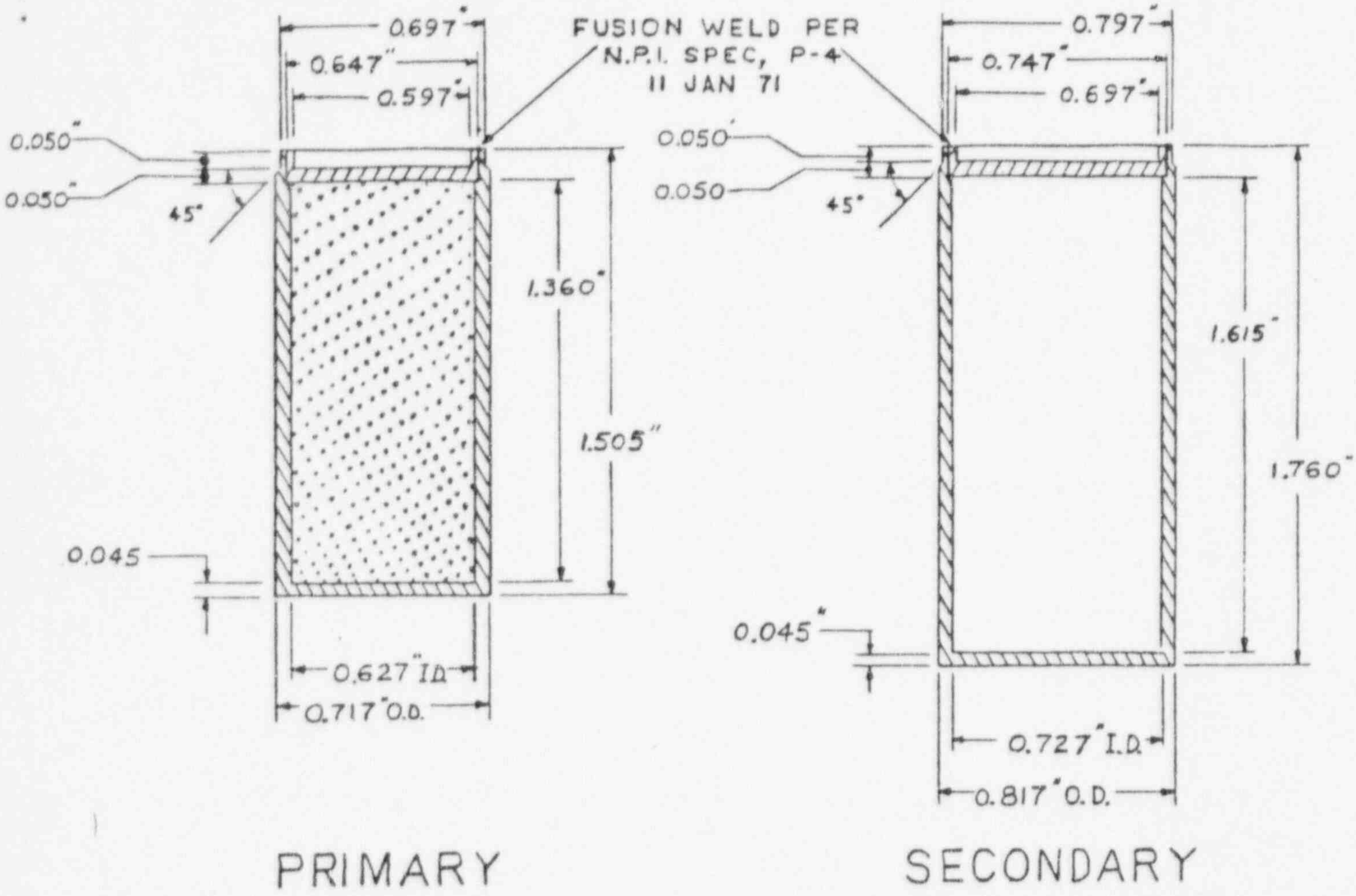
CAPSULE MATERIAL 304L STAINLESS STEEL
TOL. ± .002

= ACTIVE VOLUME 120 CURIES Co60
= ACTIVE VOLUME 1 CURIE Co60

CATALOG NUMBER NPI 11-0001
AND NPI 11-0120

COPY OF
NEUTRON PRODUCTS INC
DRAWING NO. A 200096

ENCAPSULATION CONTAINER
2 Ci and 120 Ci Cobalt Sources

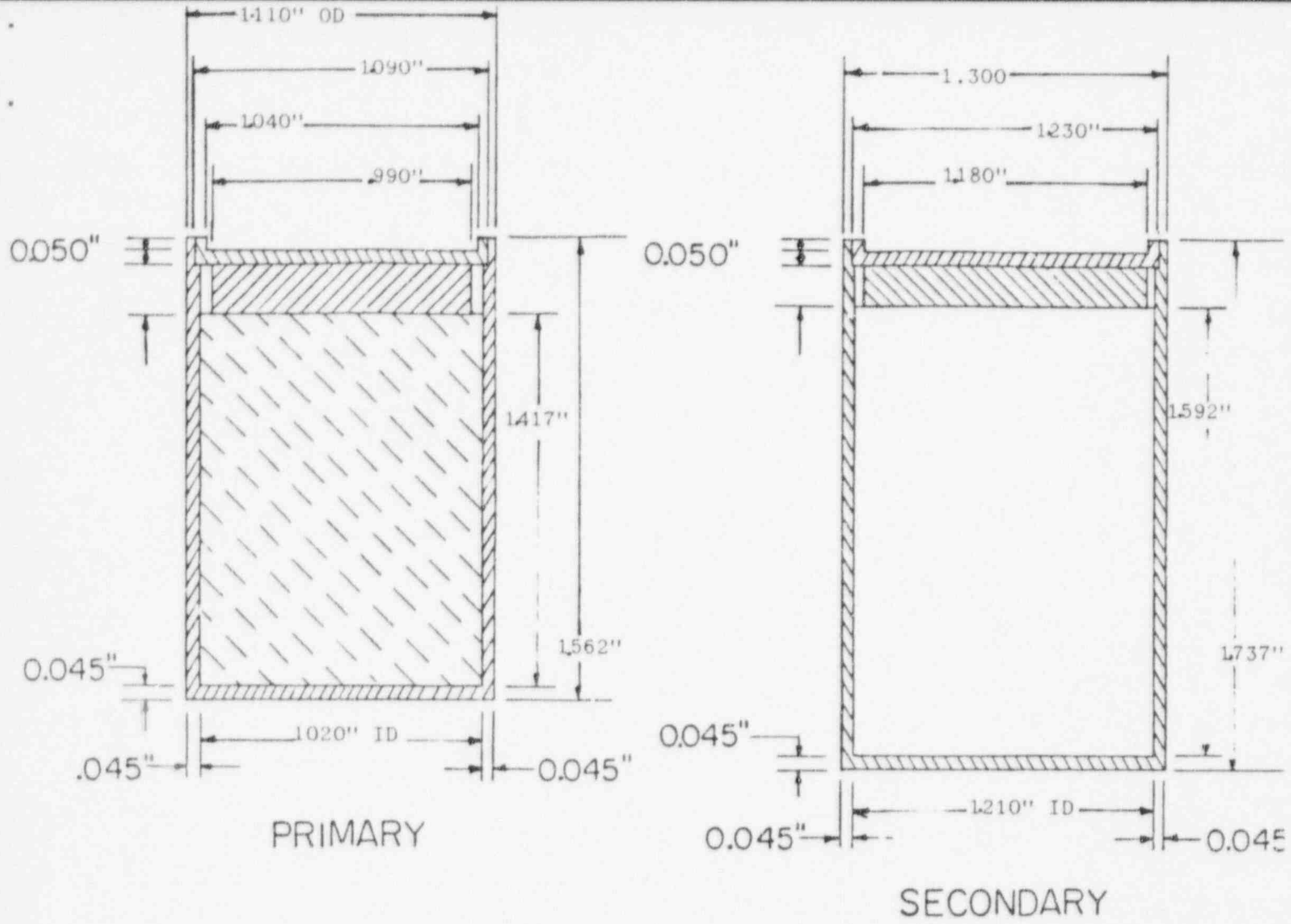


MATERIAL TO BE 304L S.S.
TOLERANCE TO BE ±0.002"

NEUTRON PRODUCTS, INC.
CAT. NO. NPI-16-4000
DRAWING NO. A 200095

ACTIVE VOLUME OF Co_{60}

ENCAPSULATION CONTAINER
4100 Ci Cobalt Sources



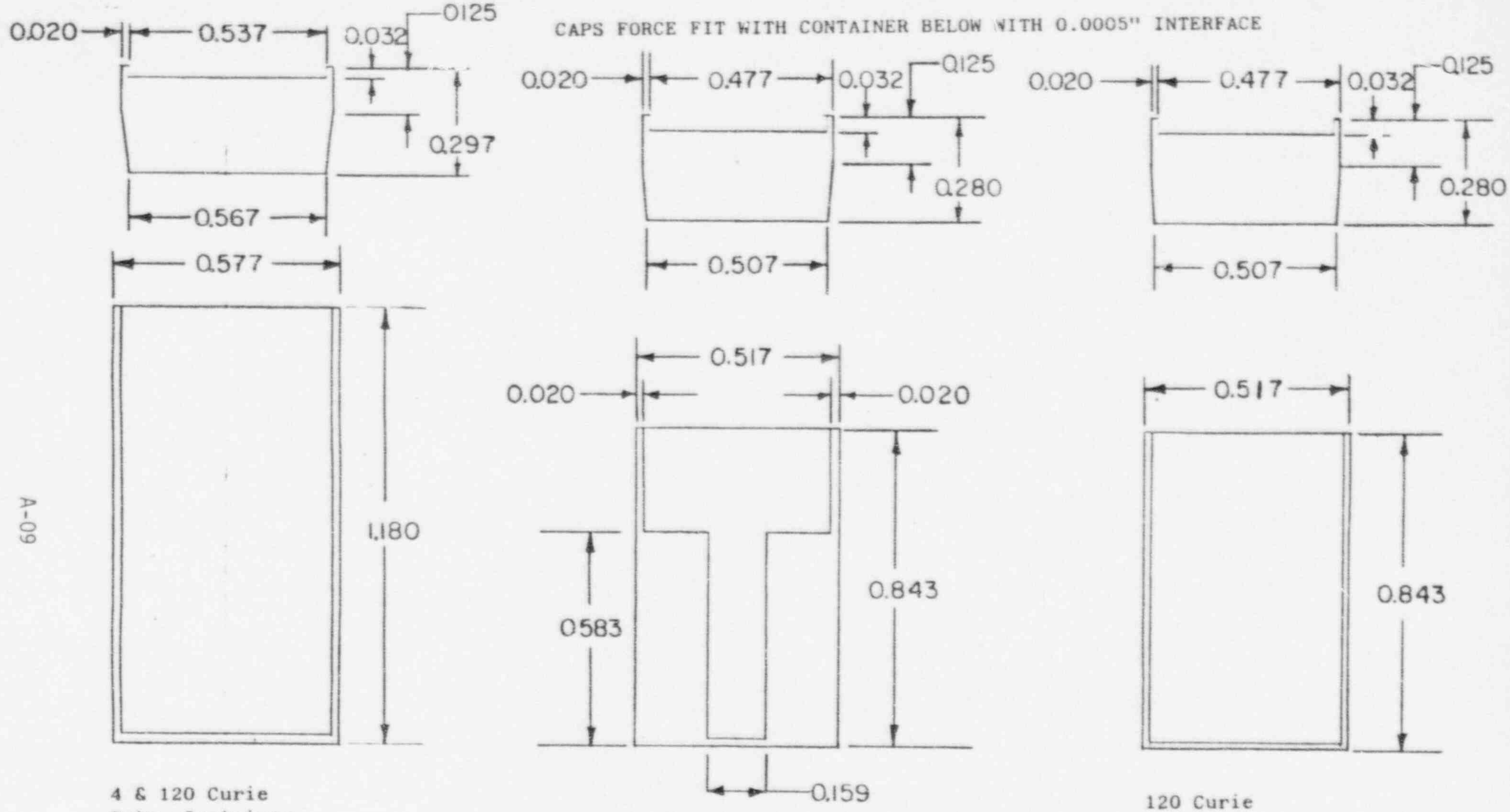
MATERIAL TO BE 304L S.S.

TOLERANCE TO BE 0.0002"

NEUTRON PRODUCTS, INC.
CAT. NO. NPI-25-13000
DRAWING NO. A200056

ACTIVE VOLUME OF Co_{60}

ENCAPSULATION CONTAINER
13000 Ci Cobalt Sources



4 & 120 Curie
Outer Container

4 Curie
Inner Container

120 Curie
Inner Container

MATERIAL - 316L S.S. ALL WALL THICKNESS ARE 0.02", UNLESS NOTED

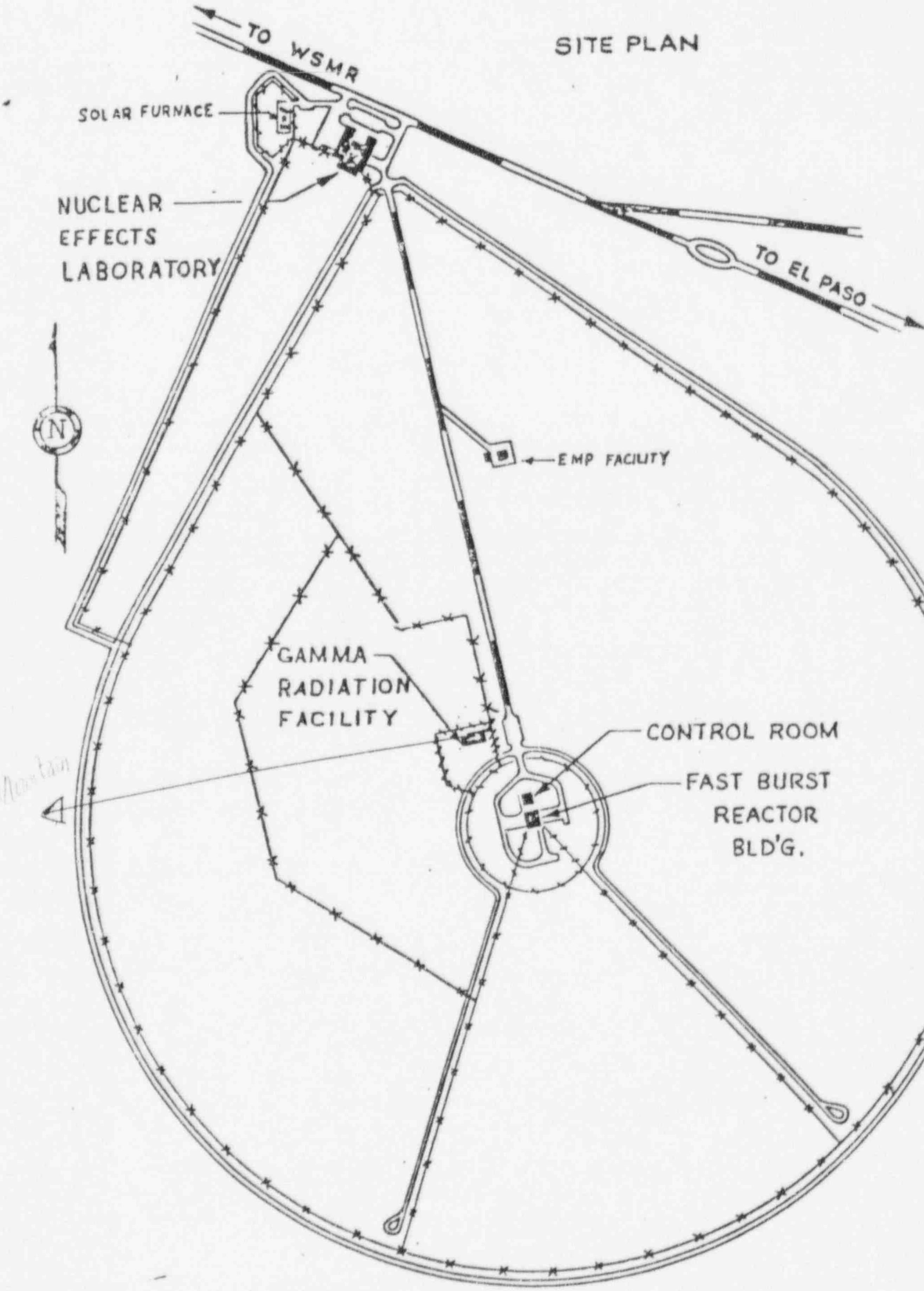
CESIUM SOURCES

ENCAPSULATION CONTAINERS

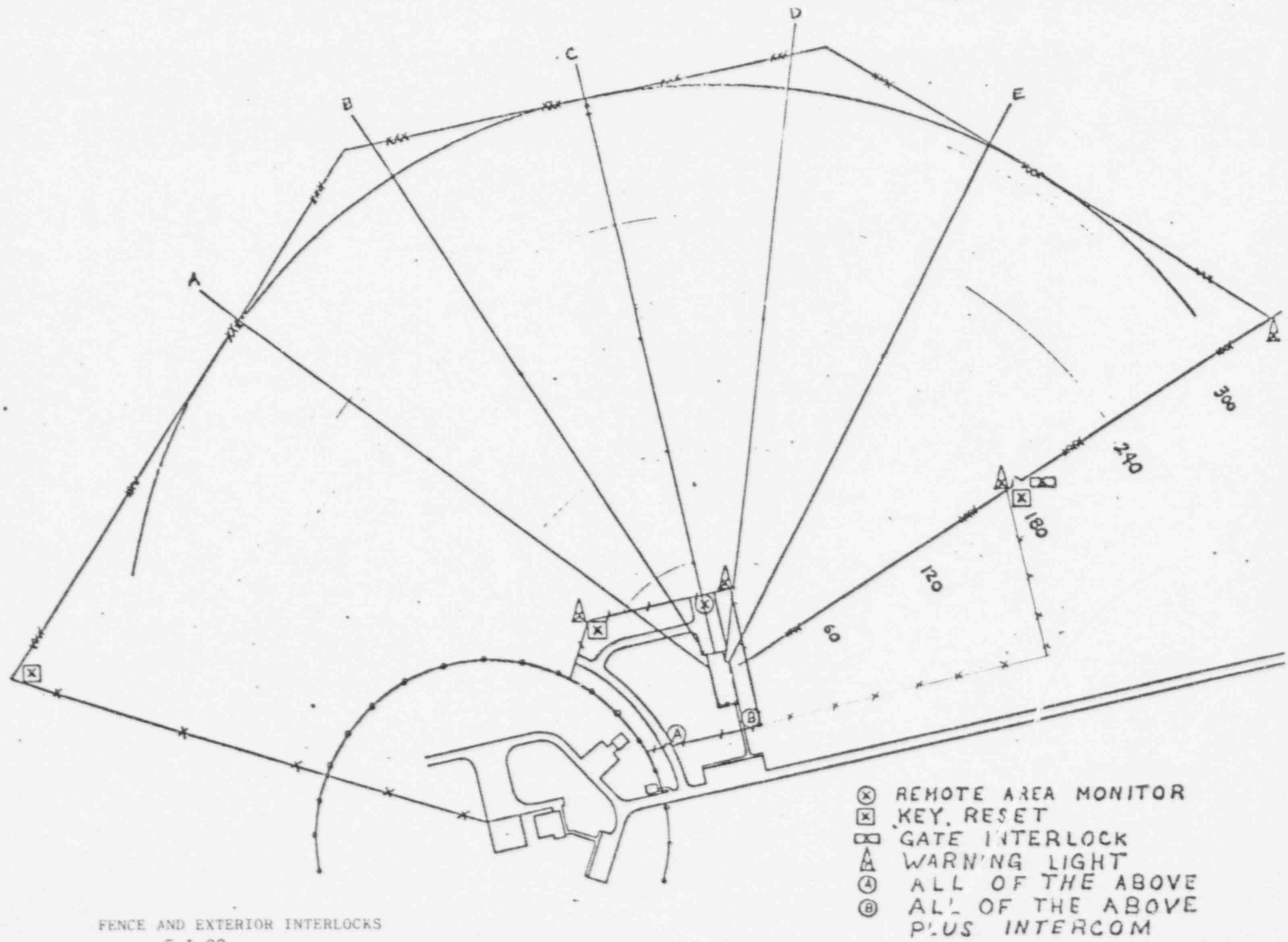
HEAT GENERATED WITHIN SOURCES

Source Material	Activity in Curies	Dose Rate, R/hr at 1 meter	Heat Generated within Source, watts
	2	1.2	Negligible
	120	120	< 1
Cobalt-60	4100	3500	27
	13000	10500	100
Cesium-137	4	1.2	Negligible
	120	30	< 1
	3525	500	10

[illegible] problem?

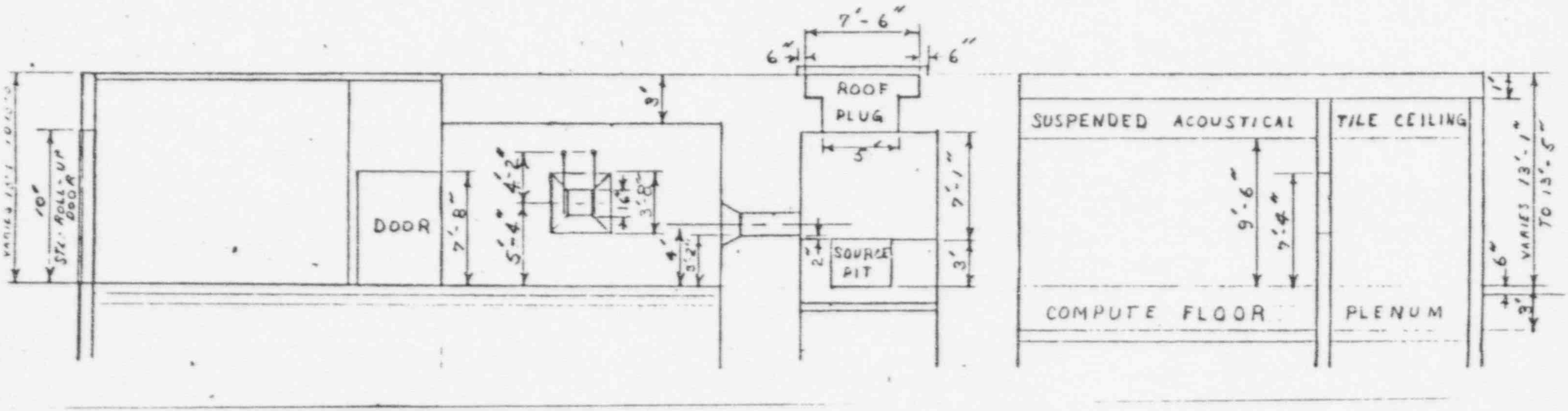


GAMMA RADIATION FACILITY
E-1-01 - SITE PLAN



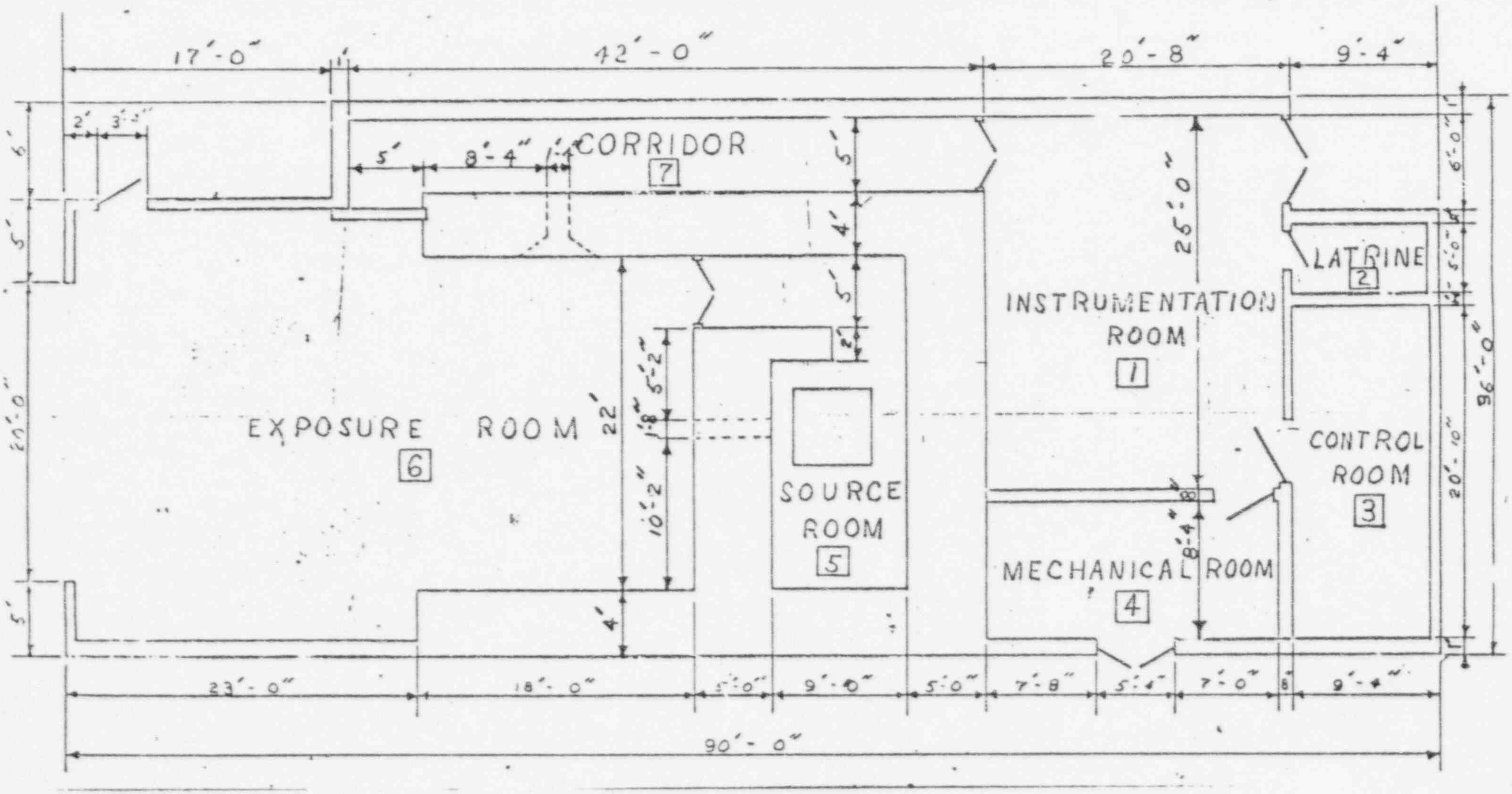
FENCE AND EXTERIOR INTERLOCKS

E-1-02



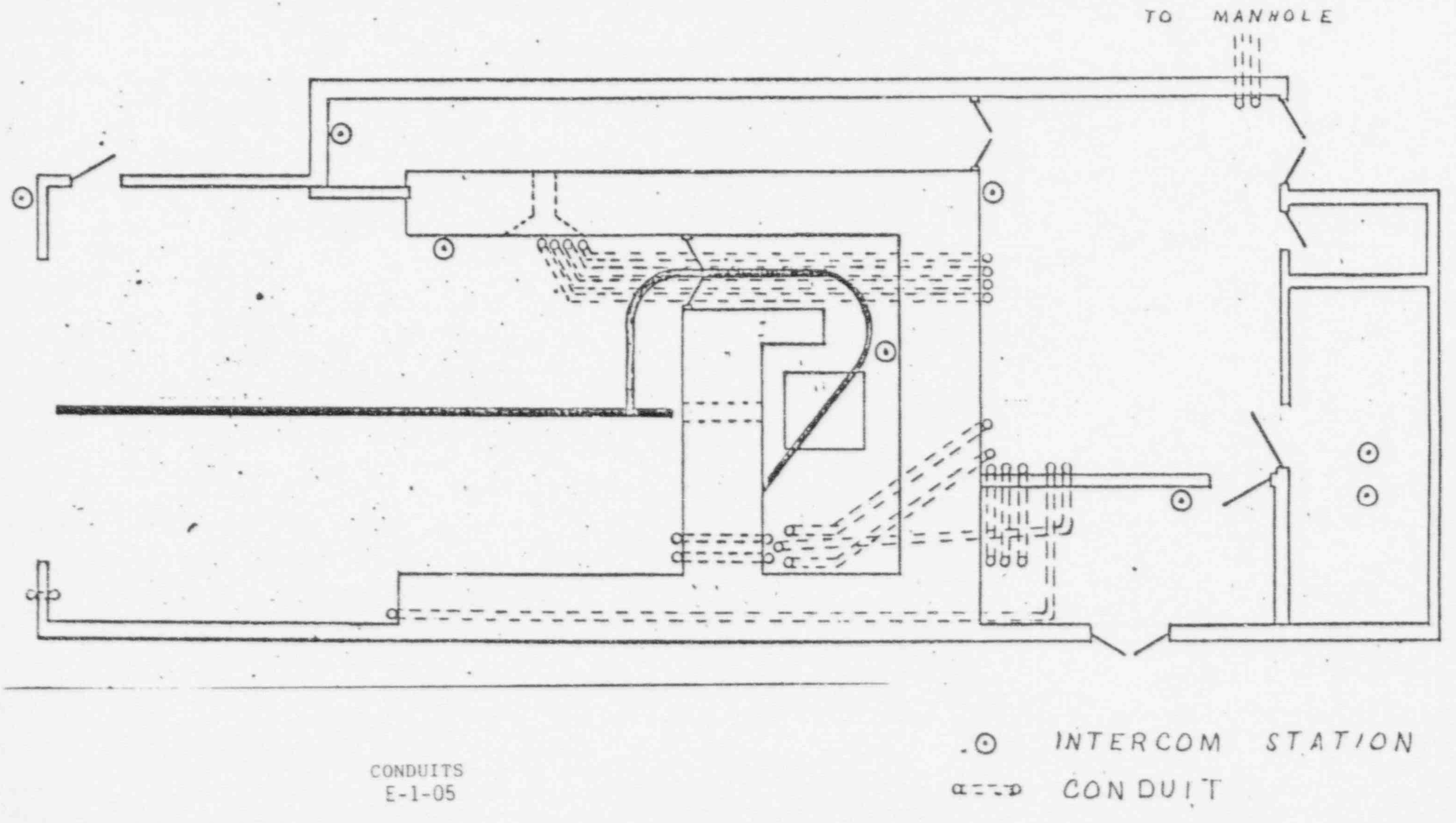
ELEVATION

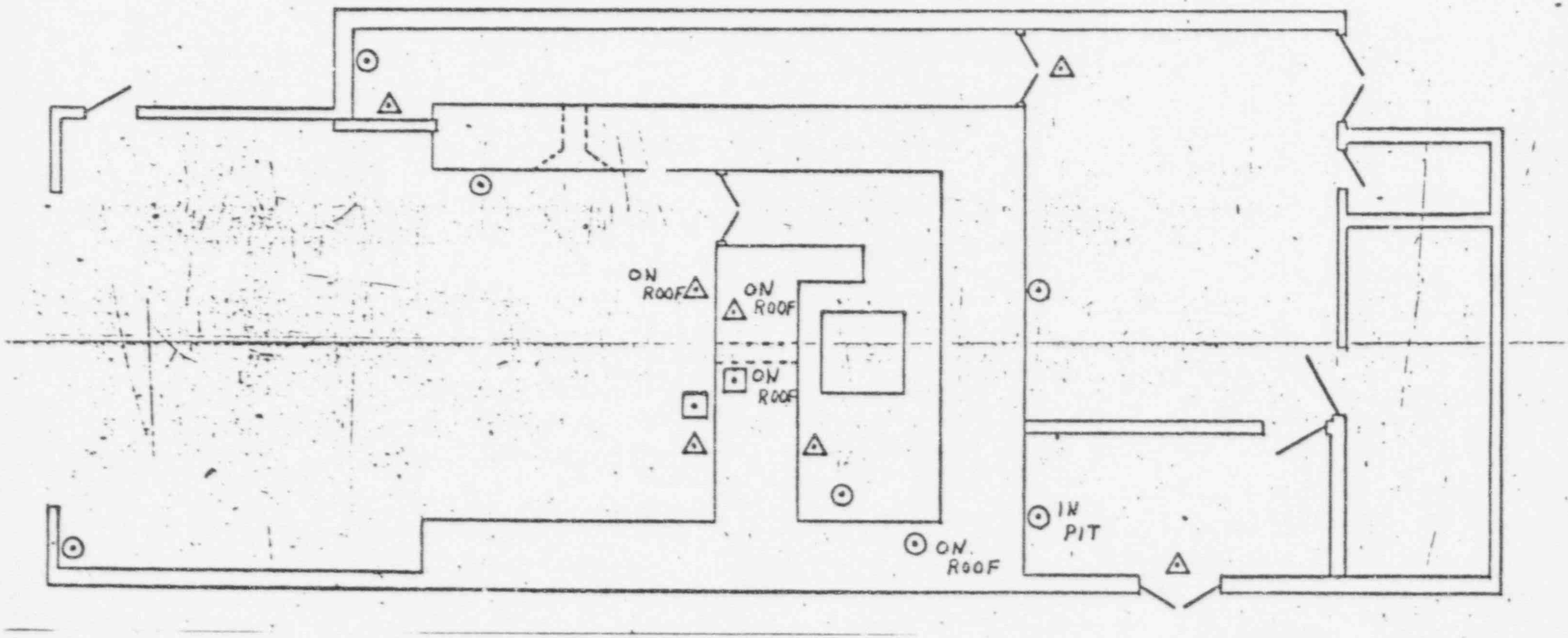
E-1-03



FLOOR PLAN

E-1-04


TO MANHOLE
INTERCOM STATION
CONDUIT
OVERHEAD CRANE RAIL
CONDUITS
E-1-05

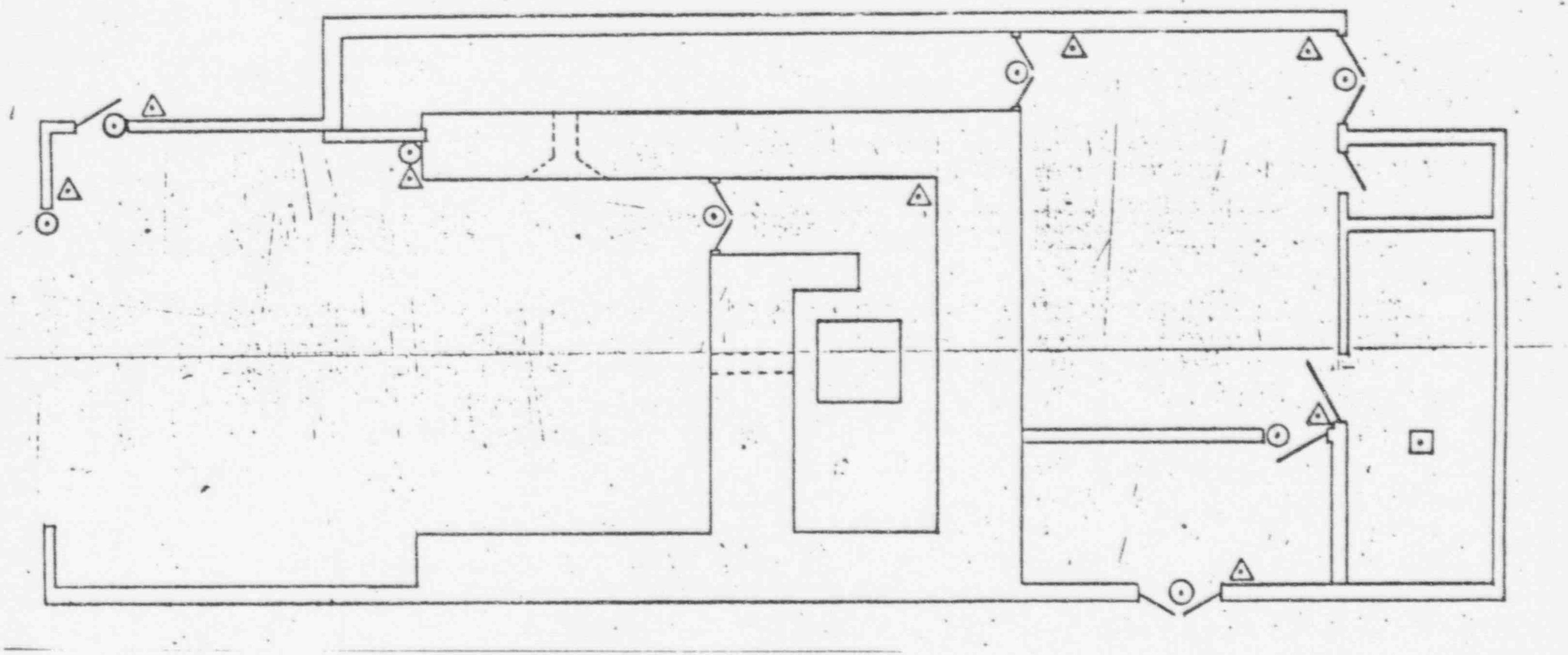


WARNING DEVICES
E-1-06

⊙ REMOTE AREA MONITOR

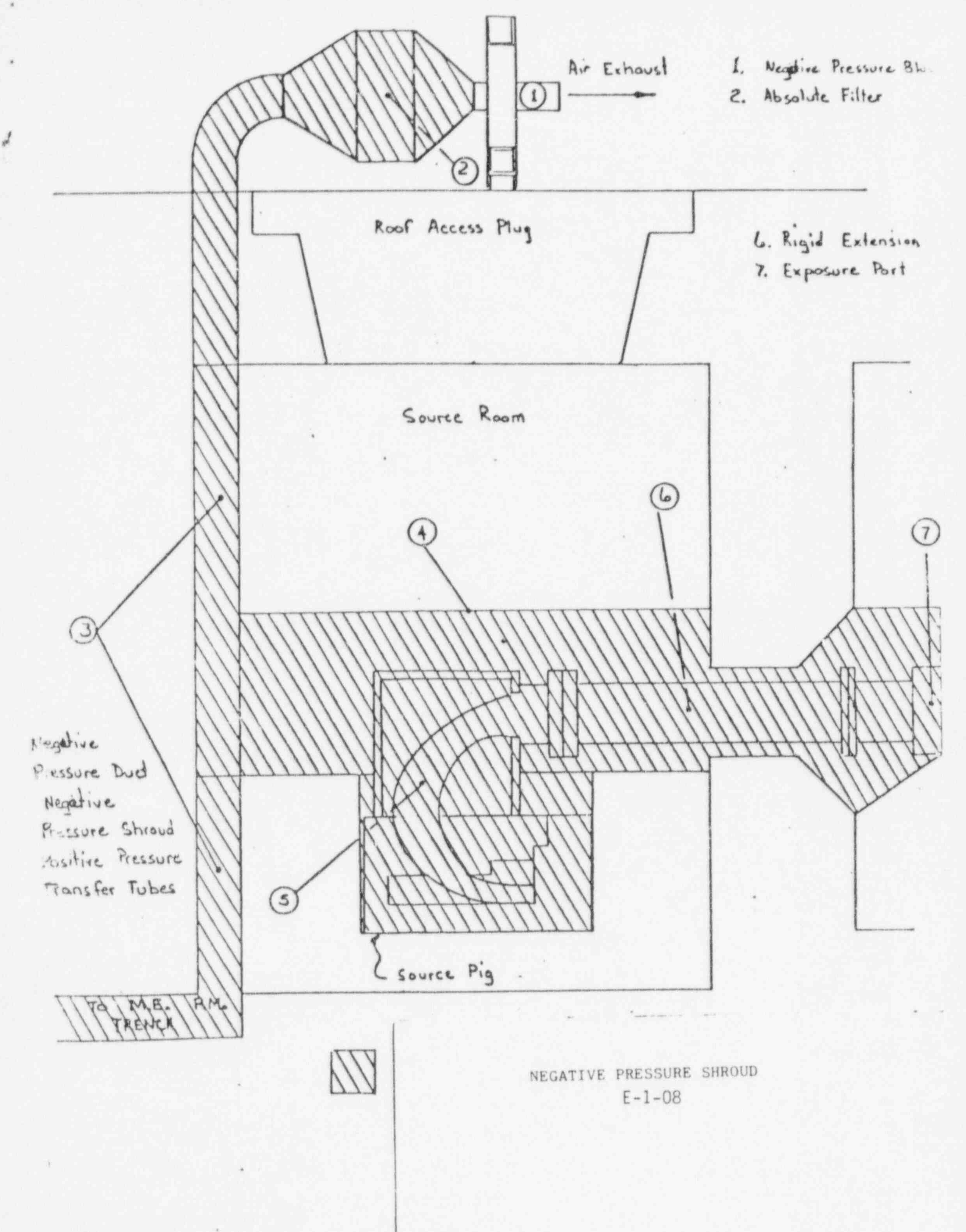
△ WARNING LIGHT

⊡ AIR HORN



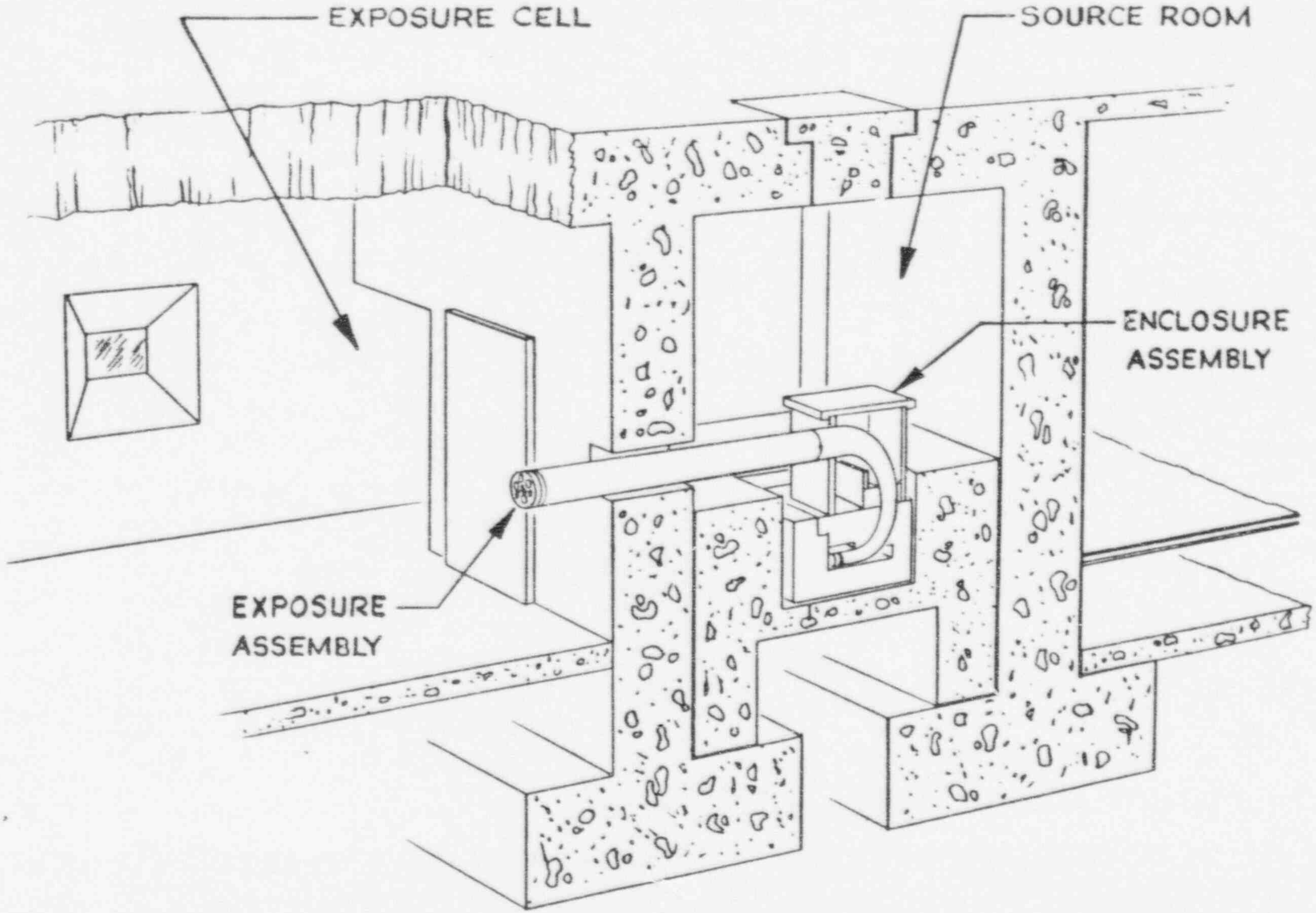
BUILDING INTERLOCKS
E-1-07

⊙ DOOR INTERLOCK
△ KEY RESET
⊡ KEY INTERLOCK



NEGATIVE PRESSURE SHROUD

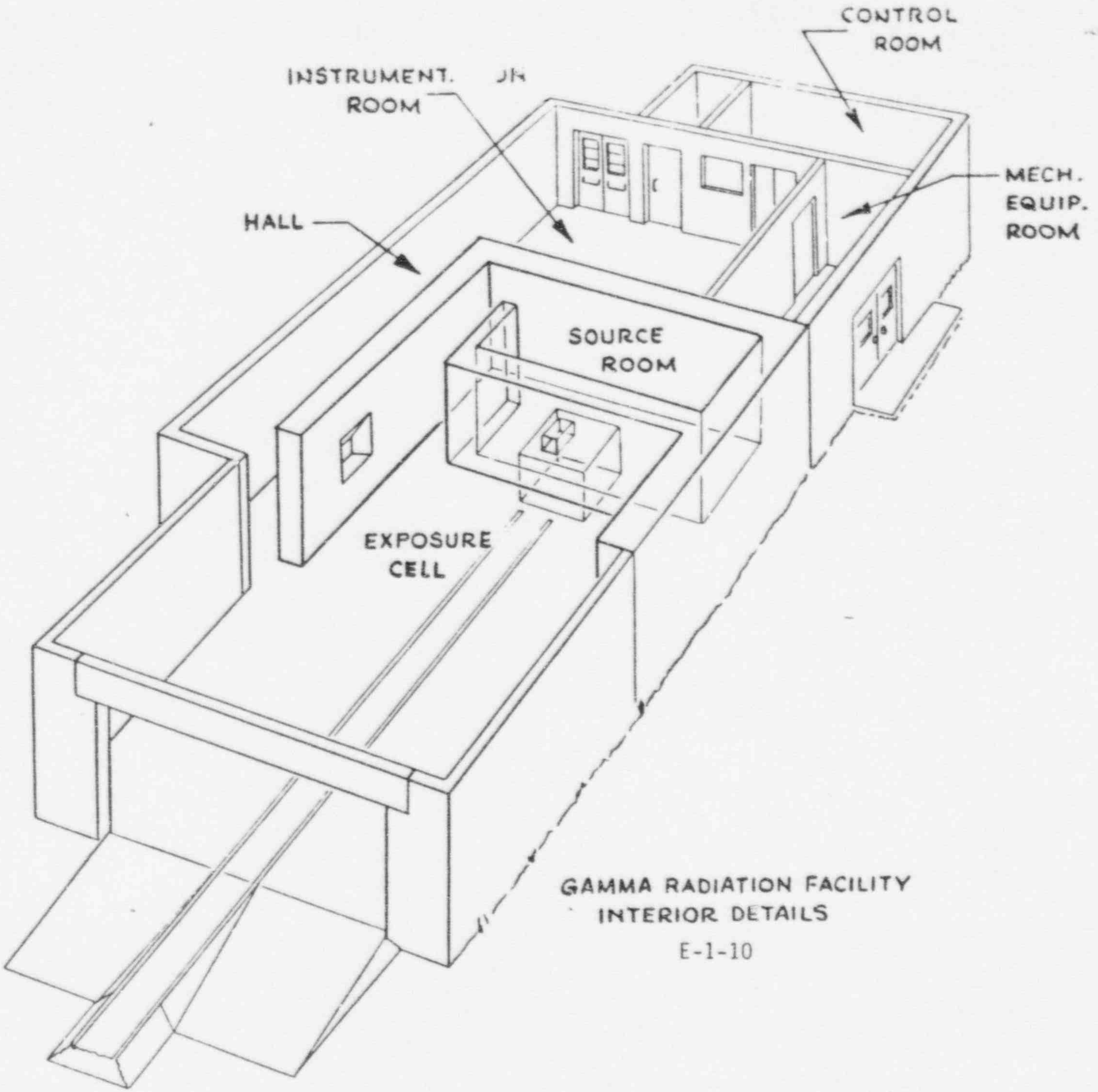
E-1-08



GAMMA RADIATION FACILITY CONCEPTIONAL SOURCE CELL LAYOUT

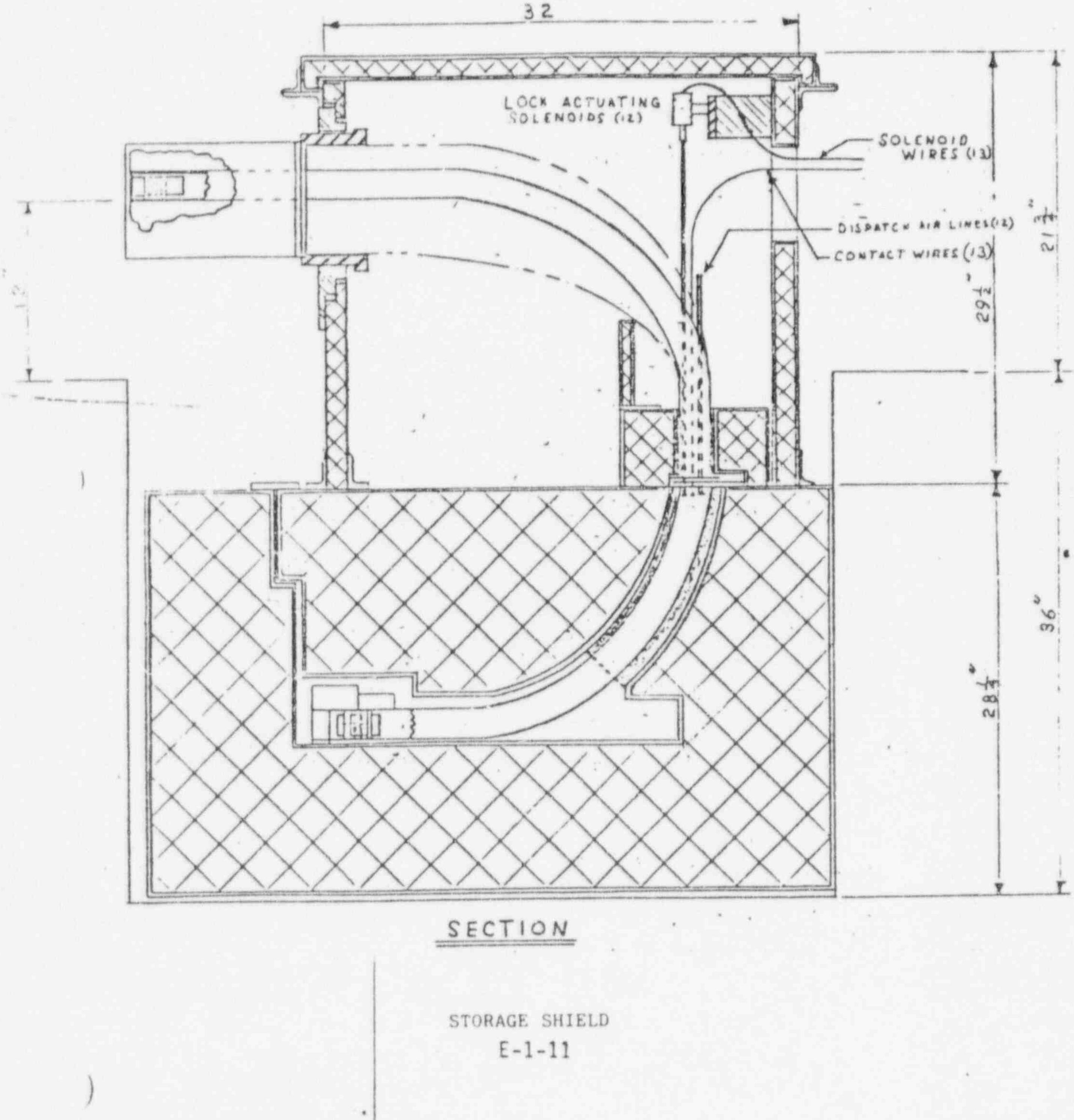
E-1-09

Do we have actual Dwg/Dims [illegible]
~~[illegible]~~ exposure Assembly



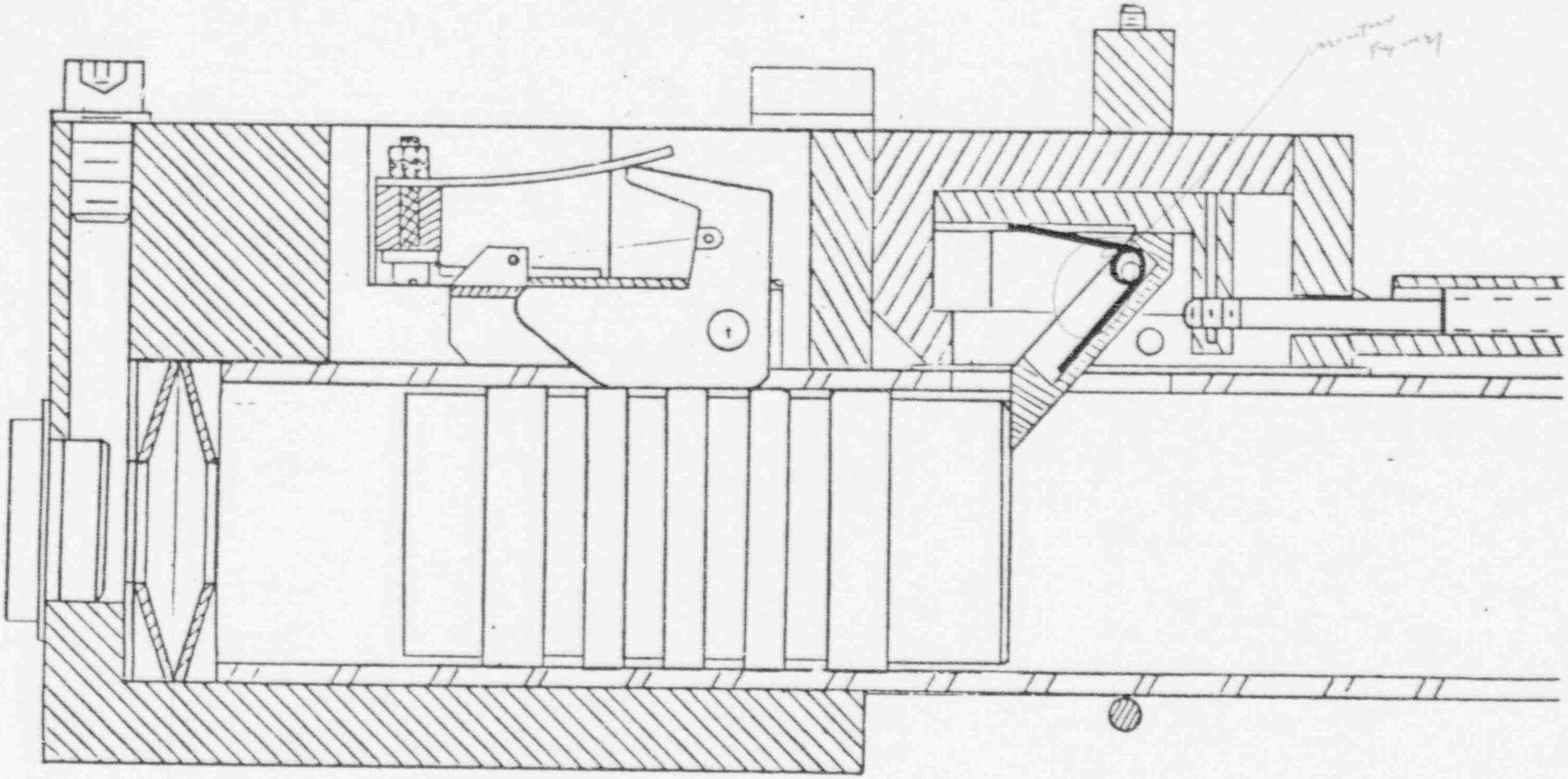
GAMMA RADIATION FACILITY
INTERIOR DETAILS

E-1-10



SECTION

STORAGE SHIELD
E-1-11



SOURCE STORAGE LOCATION AND LOCK BLOCK ASSEMBLY

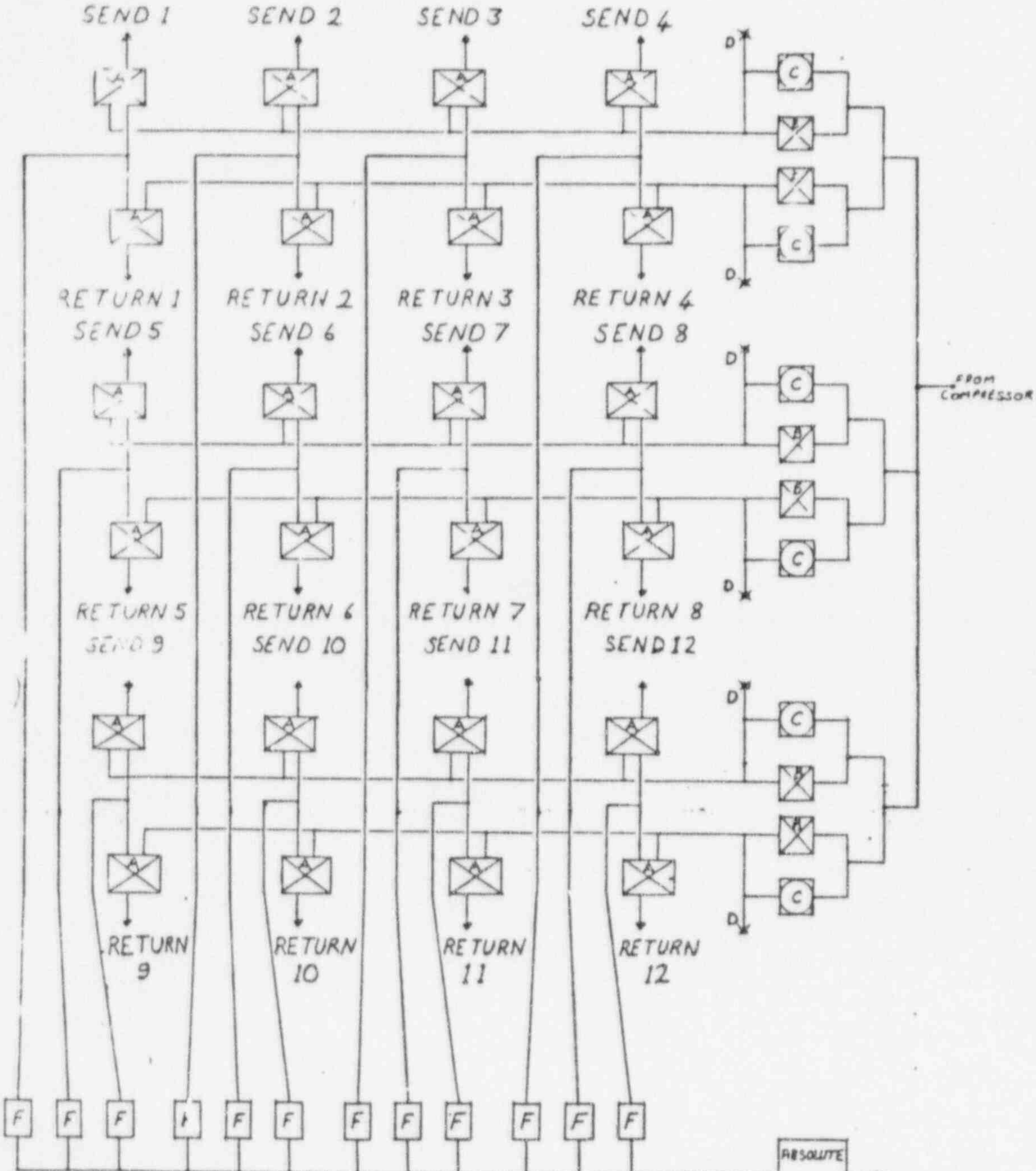
E-1-12

SUPPLE. ENT E

SUBJECT: FACILITIES & EQUIPMENT

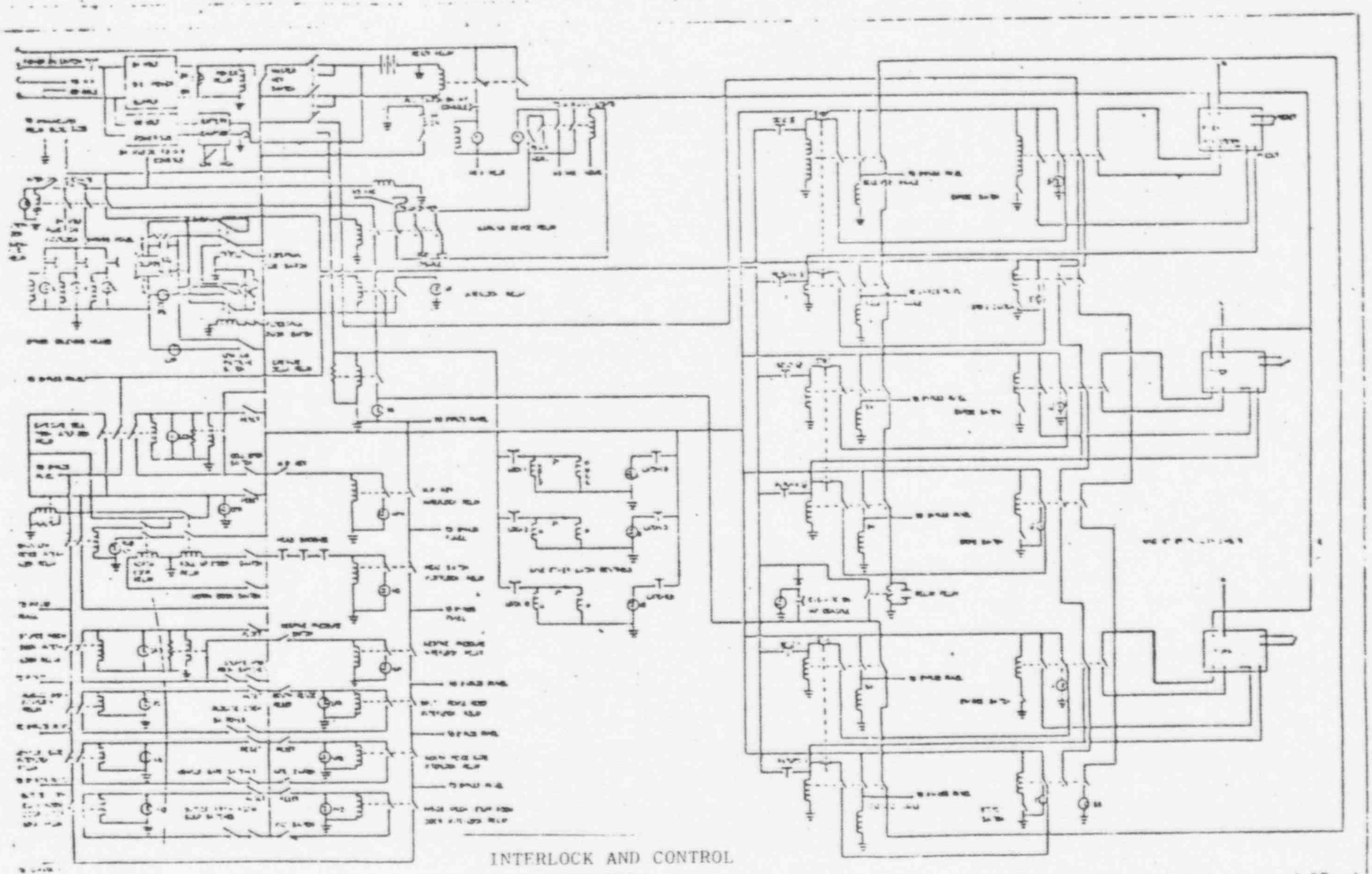
REFERENCE: NRC-313 - ITEM 9

462271

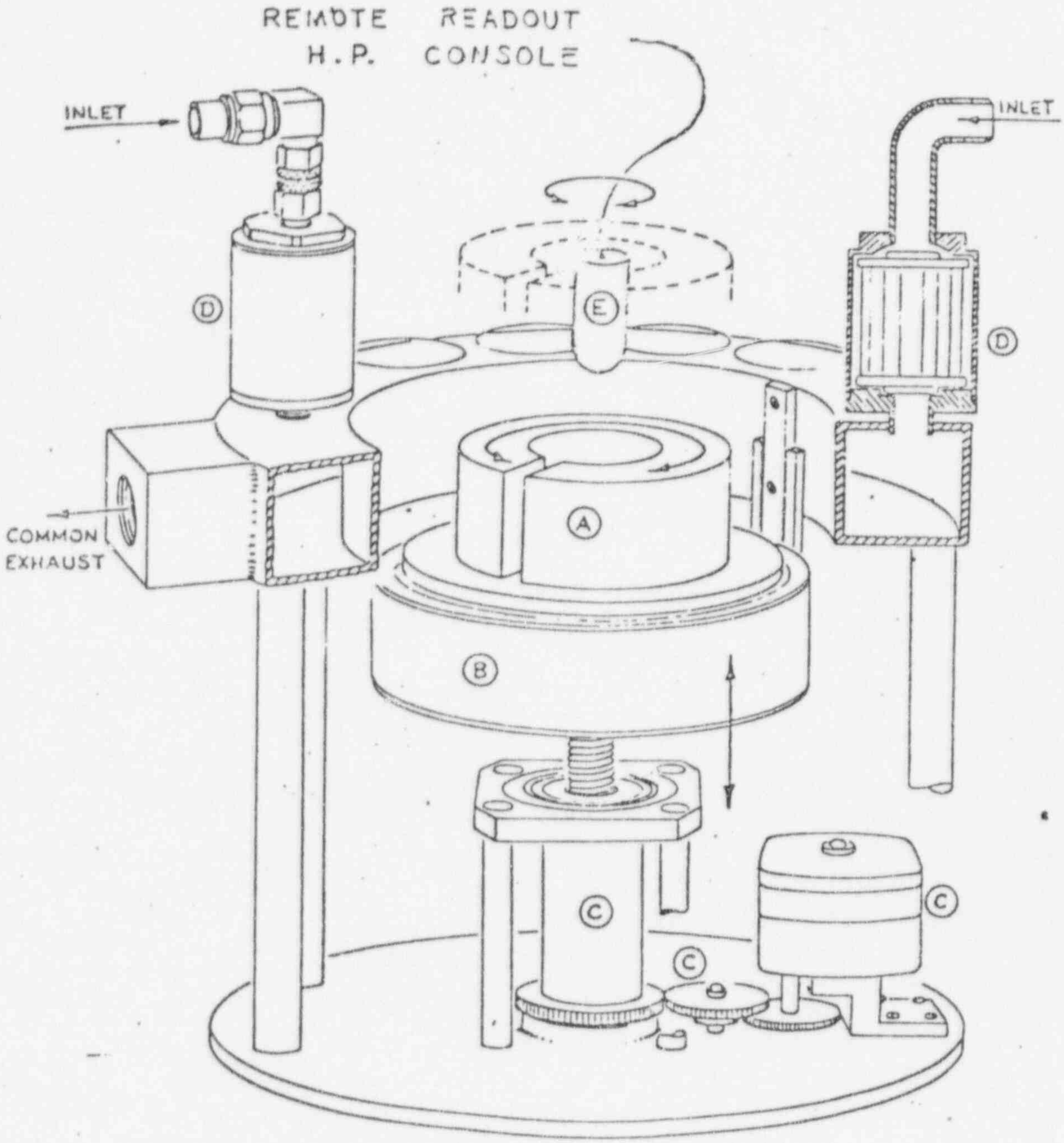


A : THREE WAY SOLENOID VALVES
B : TWO WAY SOLENOID VALVES
C : PRESSURE REGULATORS
D : QUICK DISCONNECTS
F : PIT FILTERS

PNEUMATIC SYSTEM SCHEMATIC
E-1-14



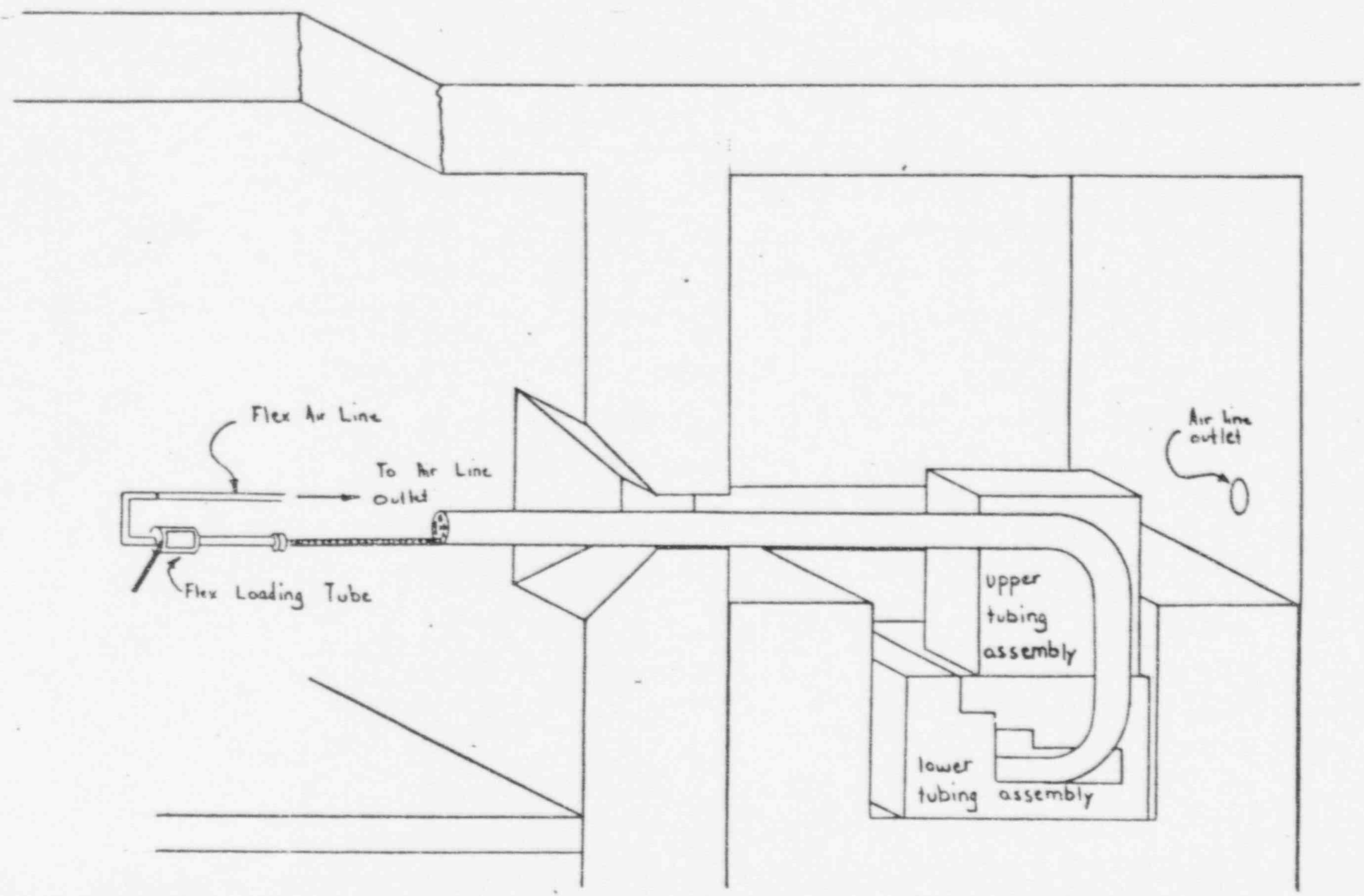
INTERLOCK AND CONTROL
SCHEMATIC
E-1-15



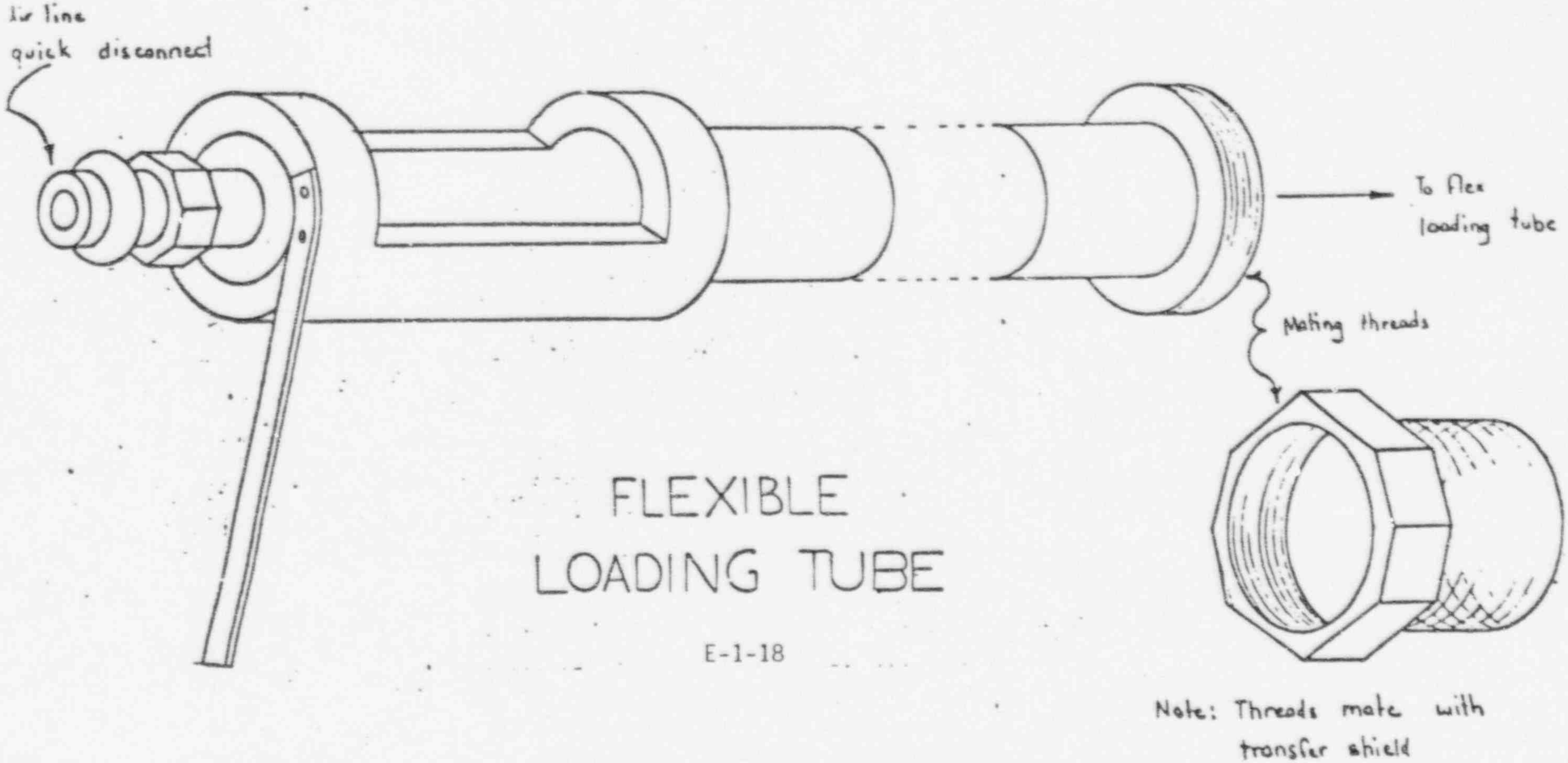
(A) SLOTTED LEAD SHIELD
(B) SHIELD ROTATING & POSITION SENSING MECHANISM
(C) SHIELD ELEVATING & LOWERING MECHANISM
(D) FILTER ASSEMBLIES (12)
(E) ION CHAMBER

PIT FILTER SECTION

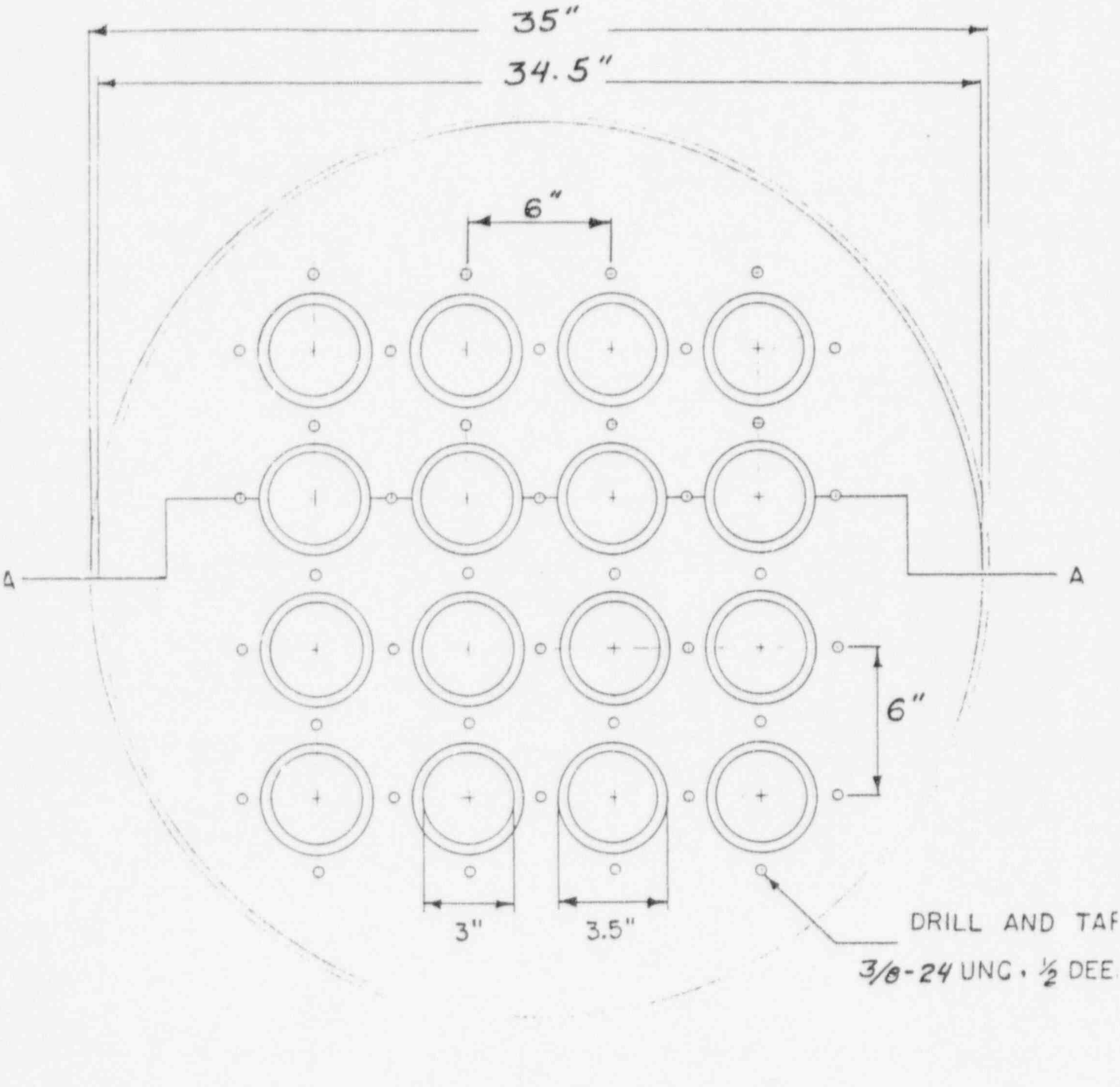
E-1-16



LOADING ASSEMBLY

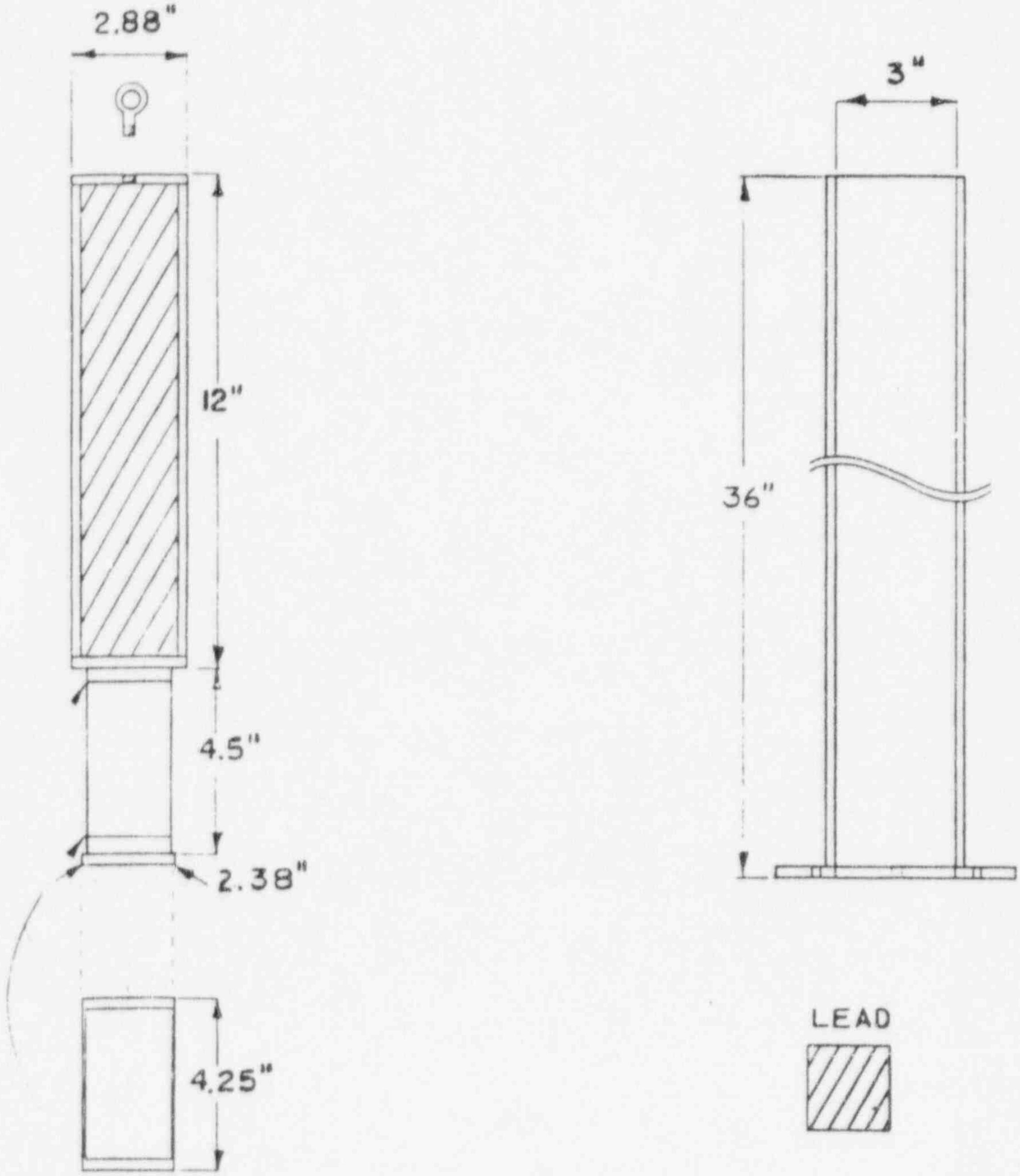


FLEXIBLE
LOADING TUBE



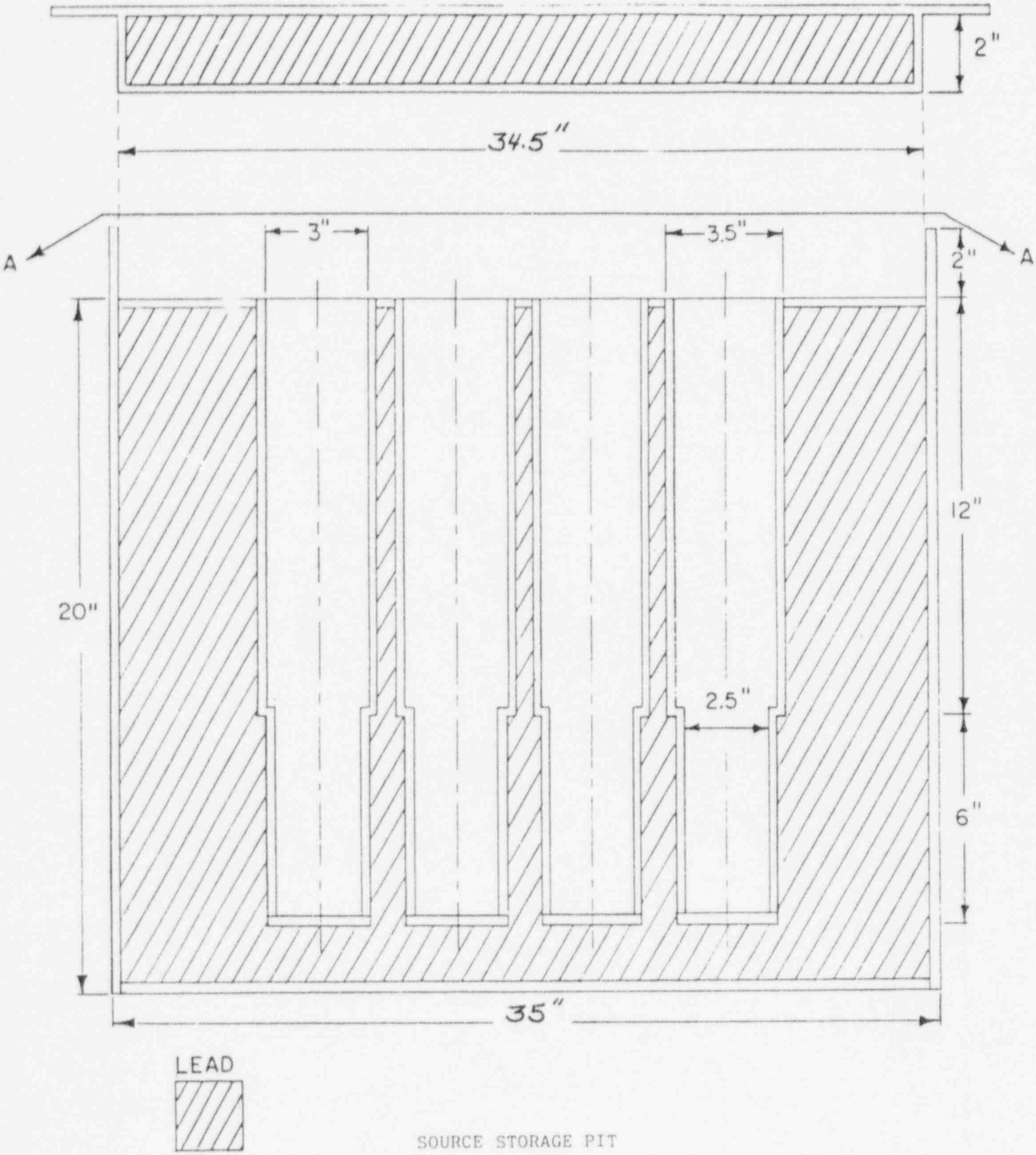
SOURCE STORAGE PIT
TOP VIEW

E-1-19



SOURCE STORAGE PIT
SHIELD PLUGS

E-1-20



SOURCE STORAGE PIT
SIDE VIEW

E-1-21

INTRODUCTORY AND SUMMARY (E-2)

This report provides a technical description of the Gamma Radiation Facility now at White Sands Missile Range, and the pertinent operating procedures.

The Gamma Source Irradiation System shown provides for the individual or combined use of any of 12 gamma sources. The doubly encapsulated cylindrical sources, contain either cobalt-60 or cesium-137 isotopes of sufficient strength to provide dose rates ranging from 0.4 to 95,000 R/hr at one meter from the face of the exposure head.

The complete source system consists of:

1. The 12 Gamma Source Carriers.

2. The Gamma Source Storage Shield.

3. The Transfer and Positioning Mechanism for independent transfer of any source from its storage position to an exposure position. Transfer is achieved by pneumatic means.

4. An Exposure Assembly which can be positioned two feet from the center of the Storage Shield and one foot above the floor level in the source room. The Exposure Assembly has provision for accepting the sources individually, or in any combination up to the total of 12.

5. A Control Console containing all controls and interlocks required for safe operation of the source system.

6. A Rigid Extension, 11 feet long, which permits locating the Exposure Assembly 13 feet from the center of the Storage Shield and four feet above floor level in the exposure room.

The Transfer and Positioning Mechanism consists of a Lower Tubing Assembly (contained within the Storage Shield), an Upper Tubing Assembly (contained within an Enclosure Assembly mounted on the Storage Shield), and the required pneumatic supply, electrical, and lock-actuating lines.

The Upper Tubing Assembly terminates at its lower end in a coupling plate which mates with and connects to the upper terminal plate of the Lower Tubing Assembly. At its upper end the Upper Tubing Assembly terminates in a coupling plate which mates with and connects to either the Exposure Assembly or the Rigid Extension. The Rigid Extension terminates in a coupling plate which mates with and connects to the Exposure Assembly, thus the Exposure Assembly can be connected directly to the Upper Tubing Assembly or to the Rigid Extension. When

– Ask personnel
positioning
– Inspect air spring
& inspect
measure if
spring fail

these connections are made, a continuous pneumatic transfer path is formed for each source from the source storage position to the exposure position. Together with the Control Console, the Transfer and Positioning Mechanism provides the means to transport the source capsules from the Storage Shield to the Exposure Assembly and back again.

The system has been designed using standard components and pneumatic techniques throughout. A complete checkout of the system utilizing non-radioactive dummy source capsules was made prior to initial installation of the sources. Safe operation is obtained through the use of interlocks which inhibit system operation until the storage cell, exposure room, and area outside the facility building have been inspected, the personnel and vehicle access gates have been closed, proper system air pressure is available, and the Exposure Assembly is properly connected in place. In addition, the control system returns all sources to storage in the event of an electrical or pneumatic failure. System air pressure is normally limited to approximately 20 psi by pressure reducing valves. All system components can withstand a static internal pressure of 450 psi.

The remainder of this Supplement is divided into sections. They present a description of the sources and their carriers. The chemical and physical form of the sources, source manufacturer, and capsule design information are given. The Storage Shield, Transfer and Positioning Mechanism, Exposure Assembly, Control Console and Rigid Extension are described. In the description of the Control Console, details of the function and operation of the pneumatic system, the electrical interlock and source transfer controls are presented. An itemization of the safety and reliability features of the systems is given. Finally the Supplement contains detailed procedures for handling, storage and disposal of the sources. These include installation, normal operating procedures, dismantling and disposal, and procedures for a variety of abnormal or emergency conditions.

DESCRIPTION OF SOURCES AND CARRIERS (E-3)

The 12 sources in the system may consist of ten Cobalt-60 and two Cesium-137 gamma sources, or six Cobalt-60 and six Cesium-137 sources. The remaining sources will be stored in the source storage pit located in the floor in the exposure cell.

Each source assembly consists of a doubly encapsulated source securely held within a pneumatic carrier made of magnetic (400 series) stainless steel. The outside of each carrier is marked to identify its radioactive source. The markings are distinguishable when viewed close-up through a black and white television monitoring system, or through the three foot thick lead glass window.

Each source is encapsulated in a cylindrical stainless steel container, which is then sealed by a plug welded in position, and then by inserting this container in a second cylindrical stainless steel container which is sealed in a similar manner.

The containers for the Cobalt sources are of an approved design, manufactured and loaded by Neutron Products, Inc., of Dickerson, Maryland. The 2 Curie source is model number NPI 11-0001. The 120 Curie source is model number NPI 11-0120. The 4,100 Curie sources are model number NPI 16-4000. (See Supplement A-07). The 13,000 Curie sources are model number NPI-25-13,000 (See Supplement A-08). The 4,100 and the 13,000 Curie sources have belleville springs between the outer encapsulation container and the pneumatic carrier for additional shock absorbers (See Supplement A-02).

The container for the Cesium sources are shown in (Supplement A-09). They were loaded by Isotopes Development, at Oak Ridge National Laboratories, Tennessee.

Prior to shipment a leak test of the hermatic seal will be performed on each source assembly as detailed in (Supplement F-04). The doubly encapsulated assembly is then inserted into the pneumatic carrier where it is held in place by a threaded plug which is welded to prevent unthreading. A smear(s) for external contamination on the carrier should be made at this time and decontamination performed if necessary.

The pneumatic carrier for all source types is similar in shape to the carrier shown in (Supplement A-02). Each carrier has raised rings to facilitate its pneumatic transfer. The carriers are fabricated from magnetic 4110 stainless steel. Carrier dimensions for each source type are given in (Supplement A-05). The carriers are machined to fit the supplier's containers.

No special provisions for cooling the sources or surrounding lead (when soures are in cask) are required. Adequate contact area is present in both the storage and exposure positions to conduct heat from the sources and limit the maximum source temperature to below 400° F. This temperature is well within the operating temperature range of the source and container materials. The amount of heat generated within each capsule is given in (Supplement A-10).

The maximum stress in a capsule is generated at the container end plates of the heaviest capsule during impact in the Exposure Assembly. This stress of 30,000 psi is less than the fatigue limits of 45,000 psi for the end plates, 30,000 psi for 316 L stainless, and 65,000 psi for fully heat treated 410 stainless. These sources may be either the large ^{60}Co (13,000Ci) or the large ^{137}Cs (3,525Ci) depending upon which sources are installed in the transfer system.

The under floor storage has been designed so that any or all sources from the system can be stored there. It has been designed so that access to the sources can be made using the remote manipulators and the crane. The maximum dose rate at the floor with all the sources in place is designed to be less than 25 mR/hr.

The under floor storage consists of sixteen 3 1/2 inch diameter tubes set in the floor on six inch centers. The 3 1/2 inch tubes are twelve inches deep, and below each of them is a three inch diameter extension tube, six inches deep. All these tubes are recessed two inches below floor level, and are covered by a steel shrouded lead filled lid, two inches thick and thirty eight inches in diameter (See Supplement E-1-21).

The plugs for these tubes are steel shrouded lead filled plugs, 3 1/2 inches in diameter and twelve inches long. Under each plug a stainless steel cage is be mounted, in which the sources can be placed using the manipulators. Any of the sixteen tubes will accept any size source. (See Supplement E-1-20).

For installation and removal of sources from these tubes, a stainless steel tube can be mounted on the floor plate above any tube, centered on that tube. The plug with the source on the bottom of it can be lifted up the tube with the crane. The top of the tube will be above the table top. When the plug is raised high enough the source cage will be at table level and the source can be installed or removed with the manipulator. Lowering the cage and plug assembly down the tube will ensure that it slides into the under floor tube into storage. (See Supplement E-1-20).

The whole assembly of tubes is enclosed in a 36 inch diameter cylinder, 22 inches deep which is filled with lead.

STORAGE SHIELD (E-4)

The Storage Shield is a fitted shield cask which contains the Lower Tubing Assembly. Construction is of lead with a 1/4 inch carbon steel plate exterior cladding. The cask dimensions are 47 inches long, 45 inches wide, 28 1/4 inches high, and it weighs approximately 24,000 pounds.

The Enclosure Assembly is mounted on top of the Storage Shield and is constructed of lead sheet, clad on both sides with 1/8 inch carbon steel plate. This assembly bolts directly to the top of the Storage Shield and houses, in addition to the transfer tubing and air lines, a lead collar made up of two bars 33 1/2 inches long, 5 1/4 inches high, and 3 3/4 inches thick, which extends the shielding around the capsule transfer tubes directly above the Source Storage

Assembly end plate. A lead baffle 5 1/4 inches high, 1 1/4 inch thick and 26 1/4 inches long, extends from the top of one side of the collar to the underside of the transfer tubes. The maximum dose rate at any exposed surface is 15mR/hr when all 12 Gamma Sources are in their storage positions.

The Lower Tubing Assembly, constituting a portion of the Transfer and positioning Mechanism, is nested in the Storage Shield. Radiation streaming from the stored sources through the empty transfer and air tubes is minimized by the shape of the cavity in the Storage Shield. A removable stepped shield cover is provided for access to the Lower Tubing Assembly (See Supplement E-1-11).

TRANSFER AND POSITIONING MECHANISM (E-5)

The Transfer and Positioning Mechanism consists of: A Lower Tubing Assembly (contained within the Storage Shield), an Upper Tubing Assembly (contained within an Enclosure Assembly mounted on the Storage Shield), and the required pneumatic supply, electrical, and lock actuation lines. With the Enclosure Assembly mounted and the Upper Tubing Assembly connected at the upper end through circular coupling plates to either the Rigid Extension or the Exposure Assembly, and at the lower end through rectangular coupling plates to the Lower Tubing Assembly a continuous pneumatic transfer path is formed for each source. The use of dissimilar materials for the carriers (Type 410 stainless) and the transfer tubes (300 series stainless) eliminates galling between the carriers and tubes during source transfer.

The Lower Tubing Assembly is an integral unit which is placed within the Storage Shield. The unit consists of 12 stainless steel transfer tubes and 12 air lines partially housed within a steel enclosure. There are four 2 inch ID, four 1 1/4 inch ID, and four 1 inch ID transfer tubes. The 12 air lines are all 1/2 inches in diameter. All voids in the enclosure are filled with lead.

All tubing terminates at the upper end in an end plate which, when installed, is mated to the lower terminal plate of the Upper Tubing Assembly. The other end of the transfer tubing of the Lower Tubing Assembly terminates in the Lock Block. The Lock Block provides the storage location for the sources (Supplement E-1-12). Each storage location has a mechanical lock and shock absorbing belleville spring assembly. When in storage, a source is securely locked in place and cannot be dispatched with system air pressure alone. The locks are driven by flexible cables, powered by solenoids mounted in the Enclosure Assembly. The solenoids are controlled from the control room. The belleville springs limit the impact load generated by a returning source. The Lock Block also contains electrical contacts which are actuated when a source is in its storage position.

The Upper Tubing Assembly terminates at its upper end in a vertically oriented circular coupling plate. The coupling plate is machined to accept steel positioning inserts to insure accurate alignment and mating with the Rigid Extension or the Exposure Assembly. At the other end of the Rigid Extension, a similar coupling plate is equipped with identical steel positioning inserts to insure accurate alignment and mating with the Exposure Assembly. Nine bolts are provided to clamp the Rigid Extension and/or Exposure Assembly securely in place.

In addition to the transfer tubing in the Upper Tubing Assembly, there are 12 dispatch air lines. The dispatch air lines are all 1/2 inch inside diameter and are connected at their lower end to the lower terminal plate and at their upper end to corresponding lines from the solenoids in the pit.

EXPOSURE ASSEMBLY (E-6)

What are actually [illegible]

The Exposure Assembly, shown in (Supplement E-1-13), consists of a two piece stainless steel end plate which serves as the termination for the 12 stainless steel transfer tubes. Shock absorbers in each transfer tube, consisting of several belleville springs made of fully heat-treated steel, are used to reduce impact loads. The maximum impact load, which is generated by arrival of the heaviest capsule, is 1000 pounds for the capsule design velocity of 10 ft/sec. The belleville springs are designed to bottom out at a stress of 100,000 psi, well below the allowable material stress of 150,000 psi. The maximum shear stress in the source seat due to impact is less than 1000 psi, well within the allowable stress for stainless steel. Even if the full air supply pressure of 150 psi is applied in the dispatch of a source, the Exposure Assembly end plate will not rupture and the source will be contained within the Exposure Assembly.

A source arriving at the Exposure Assembly thus comes to rest against the shock absorber and is held in place by a ring type permanent magnet located behind the source seat. When in place, the source capsule nose activates a contact which signals its arrival to the control console. Return air pressure to transfer a source back to storage is applied through individual air lines connected to the source magnet cavity. The Exposure Assembly terminates in a coupling plate which mates to the terminal plate of the Rigid Extension or the Upper Tubing Assembly.

CONTROL CONSOLE (E-7)

The Control Console houses all of the electrical controls required to program the transfer of source capsules to and from the Storage Shield.

Appropriate interlock controls are provided, and panel indicator lights are supplied to identify the location of all sources at all times. Preset elapsed-time exposure clocks are provided for each source to indicate the total time spent by a source in the Exposure Assembly for an experiment. Pneumatic controls to move the sources are all contained in a shielded pit under the Mechanical Equipment Room floor. Mechanical controls for the Lock Block are in the Enclosure Assembly.

The Control Console contains a key operated, three position Main Power switch (Off, Ready, Operate), a key operated Override Switch, and a push button Power Switch. Actuating the Power Switch brings power to the Control Console and activates the interlock circuits. Placing the Main Power Switch in the Ready position energized the elapsed-time clocks and the Exhaust Fan. Source Transfer cannot be accomplished until one minute after the Main Power Switch has been moved to Operate. In the event that any interlock is broken, or a power failure occurs during an operation, automatic sequential return of all sources at the Exposure Head will be initiated.

Timers are installed in the source transfer circuits that shut off the air blown to the tubes after a variable preset interval. The preset time for each source is set so that the source will drift into the Exposure Head, or Storage position, as gently as possible, while still ensuring that the sources arrive reliably.

PNEUMATIC SYSTEM (E-8)

The schematic diagram of the pneumatic system is given in (Supplement E-1-14). The pneumatic system in the Mechanical Equipment Room Pit provides air pressure through a series of pressure regulators and valves to each end of the transfer tubes. Air pressure at the Storage Shield is delivered through 12 individual ports in the Storage Shield. Air pressure at the Exposure Assembly is delivered via 12 external lines connecting to each source seat in the Exposure Assembly. The pneumatic system has been designed to give a maximum terminal velocity to any carrier of 10 ft/sec. The design pressure is estimated to be 10-15 psi, depending upon the weight of the capsule and the tube diameter.

Bypass valves are provided for emergency use. These are controlled from the console, and bypass the regulators and put accumulator pressure on the system.

INTERLOCK CONTROLS (E-9)

A schematic of the interlock system is shown in (Supplement E-1-15). Interlocks are provided to assure that the Exposure Head is properly connected

in place and to assure that negative air pressure is in the shroud. In addition, interlock controls are provided for the following locations, each with a key reset:

a. South Fence - Must be reset by Health Physics Monitor after checking outer exclusion area.

b. North Fence Gate - Must be locked.

c. Vehicle Gate - Must be locked.

d. Inside Mechanical Equipment Room Door - Must be closed.

e. Outside Mechanical Equipment Room Door - Must be closed.

f. Chain Link Fence - Must be reset by operator after checking inner exclusion area.

g. Source Room Door - Must be reset by operator after inspecting source room.

h. Exposure Cell Door - Must be reset by operator or Health Physics person after inspecting and clearing exposure room.

i. Passage Door - Must be reset by operator or Health Physics person.

Source transfer controls to dispatch the sources cannot be activated unless all interlocks have been set or reset. Visual indication of the status of the interlocks is provided at the Control Console. When all of the above interlock conditions have been met, a closed circuit through the interlocks will have been completed. This will activate the Interlock Relay, which, when the Master Switch is in Operate, completes the power circuit to the Solenoid circuits. Source transfer to return sources can be activated at any time the system is on.

The key-operated Override Switch is provided in the Control Console to permit the operator to override a breached interlock, energize the bypass valves, or power the emergency solenoid panel. In the event an interlock is breached, the Interlock Relay supplies a voltage at its contacts to automatically return all sources to the Storage Shield (See Special Operating Procedures, Supplement E-22).

SOURCE TRANSFER CONTROLS (E-10)

One minute after the Master Switch has been switched to Operate, the source transfer electrical controls which control the pneumatic valves can be operated.

All the pneumatic valves can be manually operated in the event of a power failure. Access to the valves is obtained by opening the pit in the Mechanical Equipment Room. There is a separate Send and Return push button switch for each of the 12 sources. Each switch is capable of transferring a source from the storage position to the exposure position or vice-versa as applicable.

Depression of one of the Send or Return switches for a particular source activates an electrical interlock which prevents the other 11 sources being moved. The other push button switches cannot be activated until the source has reached the exposure or storage position. At either position, the contact signal automatically releases the interlock, and another transfer can be initiated. This guarantees that only one source can be transferred at a time.

RIGID EXTENSION (E-11)

The Rigid Extension, 11 feet long, consists of two circular coupling plates connected by 12 tubes held in place by welded end fittings. The extension at one end to the coupling plate of the Upper Tubing Assembly and at the other end to the Exposure Assembly or the Flexible Loading Tubes.

SAFETY AND RELIABILITY FEATURES OF THE SYSTEMS (E-12)

Safe and reliable system performance is achieved by the following:

1. The use of doubly encapsulated sources which afford a double barrier against activity leakage. The capsules are further contained within pneumatic carriers with the entire assembly designed to handle the repeated impact loading without failure.

2. A complete checkout of the system was made utilizing non-radioactive dummy source capsules prior to shipment of sources to White Sands Missile Range.

Maybe should no

3. The Storage Shield is designed to hold molten lead, so that a fire involving the Cask will not produce a potential radiological hazard. It is also designed, that should irreparable damage be done in a fire, it is possible that it could be used with an over pack to transport the sources to a disposal site (Note: Current applicable DOT Regulations apply).

4. The dose rate at any accessible surface of the assembled system, with all sources in their storage location, is 15mR/hr.

5. All routine source transfers are performed remotely from the Control Console.

6. There is positive locking of the source capsule assembly at either end of the transfer tubing. A source cannot be released from the Storage Shield solely under air pressure; and a loss of air pressure, when the capsule is in the Exposure Assembly will not affect the position of the capsule. A source capsule cannot be permanently locked in its exposure position since the positive lock is by magnetic action which can be overridden by air pressure.

7. Interlock controls are provided at all facility entry locations. All gates into the exclusion areas are interlocked, and warning lights are located at each one. All doors in the building giving access to areas of possible high radiation are interlocked. Other doors have controlled access to insure personnel safety. To prevent personnel entry dui ng an experiment, all interlocks must be set or reset before the source transfer portion of the Console can be activated. Visual indication of the status of each interlock location is provided at the Control Console.

8. In the event that any interlock is broken, or a power failure occurs durng an operation, automatic sequential return of all sources at the exposure head is initiated (See Supplement E-22-2). Indicator lights on the Control show the position of the sources at all times. Interlocks, air pressure, door and gate conditions are also displayed at the console. Remote Area Monitors (RAM) in several rooms and outside areas continuously monitor for radiation.

9. Personnel alert systems are provided to assure evacuation prior to an experiment (i.e., alarm, flashing lights, loudspeaker system, plus visual scan of all critical areas). All gate and door interlocks are key resettable, the power switch and safety switches on the console are also key actuated. A key is needed for access to the emergency bypass panel located in the bottom of the console.

10. Two personnel will be present in the facility during all operations. One will be a certified Operator in accordance with WSMR Reg 40-8. The other will be a Health Physics Monitor. A certified member of the Health Physics Section or Gamma Facility Operations staff will be present in the Gamma Facility building anytime anyone is working the facility unless access doors to control areas are locked. The member present is expected to be informed concerning the nature of the work to be done and/or the experiments which are being planned. This enables him to recognize any conditions or experimental setups which differ from original proposals and which could constitute a safety hazard.

11. The shroud surrounding the entire transfer and storage system is maintained at a negative pressure by a blower located on the roof, exhausting through absolute filters. This negative pressure is also a part of the interlock chain (Supplement E-1-08).

12. When the facility is operational a RAM can monitor the exhaust air filters from all 12 systems. In the event that a high reading indicates the possibility of a leaking source, a remotely operated lead shield can be moved into place, and the RAM can then be used to check each air filter separately, to facilitate a determination of which source is leaking (See Supplement E-1-16).

13. The system contains a fail-safe control system. In case of any electrical or pneumatic malfunction the source(s) can be safely returned to the Storage Shield by instituting the proper emergency procedures at the Control Console. Even in the case of a lodged source, procedures have been devised to dislodge the source and return it to storage. There are three permanently available methods to use to free a source should it become lodged in the tube during transfer. None of them expose personnel to a radiation hazard. If all three fail to dislodge it, the Health Physicist will initiate other procedures (See Supplement E-22-4).

PROCEDURE FOR INSTALLATION, OPERATION AND EMERGENCIES

INSTALLATION PROCEDURES (E-13)

Lower the Storage Shield into position in the pit in the storage cell. Prior to installation of the Lower Tubing Assembly in the Storage Shield, the electrical contacts and the locks should be installed in the Lock Block.

Lock-Block Source Contact Installation (E-14)

The Lock Block source contact assemblies are shown in (Supplement E-1-12). Each assembly is attached to the Lock Block by means of two screws. The terminal at each contact is connected to the individual source indicating circuit load. One common ground lead serves to complete the circuit for all Lock Block contacts. All connecting wires are housed in ceramic utility fish-spine beads, then gathered and drawn through the central sleeve in the lead shot enclosure. Each contact assembly should be inspected once a year for insulator damage.

Latch Installation (E-15)

The latch assembly is shown in (Supplement E-1-12). Each assembly is attached to its corresponding tube and to the Lock Block as shown.

Installation of Flexible Lock-Actuating Cables at Lock Block (E-16)

Bolt the Upper Tubing Assembly to the Lower Tubing Assembly prior to inserting the flexible cables through their respective holes in the coupling plates. The flexible cables are then attached on their latch assemblies, with the latches disassembled, by the following procedures:

Pull the cable actuating solenoid fully out so that the free cable end is extended to its maximum distance beyond the cable shealth, and insert the cable through the end plate. Then thread the slide on the cable end and pin against rotation. Assemble the latch and bolt to the Lock Block. Check the alignment of cable and slide to allow for free movement of the slide, clamp, and the rigid shealth end of the cable. Attach the latch assembly to the tube using U-bolts.

After the Lock Block has been prepared for operation, the Lower Tubing Assembly is installed in the Storage Shield. After installation unbolt the Upper Tubing Assembly from the Lower Tubing Assembly and tilt it back prior to putting the Storage Shield plug in place. Care should be taken so that the flexible cables are not kinked when the Upper Tubing Assembly is moved. The connecting wires from the Lock Block should be nested between the transfer tubes so that they will not be damaged when the Storage Shield plug is installed.

Setting Air Pressures (E-17)

Settings, should be made on the pressure regulators in the pit for each operating setup. The pressure will be maintained as low as possible while still ensuring reliability of transfer.

LOADING PROCEDURES FOR GAMMA RADIATION FACILITY SORUCES (E-18)

1. A Proposed Plan of Experiment (Supplement F-10), will be submitted to the NED Test Planning Committee for approval of all proposed loading procedures prior to initiating any source loading.

2. A Health Physicist and the Gamma Radiation Facility Technical Specialist will be present during all loading and unloading operations.

3. A Radiation Work Permit will be required for all loading and unloading operations.

4. The sources will be received in a Shipping Container. This will be positioned in the Exposure Cell in view of the lead glass window where it can be reached by the remote manipulators.

5. The Source Loading Table will be positioned over the shipping container so that the lid of the container protrudes into the table, and vertically beneath the lifting sheave in the ceiling.

6. Remote controlled televisions and mirrors will be positioned so that all areas of the table can be clearly seen, both through the window and on the TV monitors.

7. Connect the flexible loading tube to the end of the Rigid Extension, and the air line to the appropriate tube. Sources will normally be loaded in ascending order of activity and unloaded in reverse order. (See Supplement E-1-18)

8. Three interlocks will be bypassed during loading and unloading operations and this fact will be noted on the Radiation Work Permit. The interlocks to be bypassed are: (1) Passage Door (personnel in the passage at the manipulators, etc.); (2) Head Switch (Exposure Head is removed); and (3) Negative Pressure (Negative Pressure Shield is removed). The air horn in the Exposure Cell will also be shut off due to extreme noise in the passage.

9. Clear the Exposure Cell and shut the cell door. Turn the Main Power Key Switch to Operate in order to actuate the warning horn and lights, and to lock the Exposure Cell door. After receiving Health Physics approval to proceed with the loading, raise the lid of the Cask and using the manipulators, remove the appropriate source from the Cask. Replace the Cask lid. As each source is brought out of the Cask it will be smeared, using the manipulators, to check for contamination. The identification number will also be visually checked to insure that it is the desired source before inserting it in the Flexible Loading Tube. Before the Tube is closed, the Technical Specialist will insure that the source is loaded correctly.

10. When the tube is closed, the operator will transfer the source into storage and lock it in storage.

11. When the source is in Storage, turn the Main Power Key Switch to Off and open the cell door. The Health Physicist will monitor for any unexpectedly high levels of radiation before personnel re-enter the cell. If none is found, the Flexible Loading Tube will be transferred to the next port on the Rigid Extension and the air line moved appropriately.

12. The procedure will then be repeated with each successive source until all have been loaded.

13. When all sources are latched in Storage, Health Physics personnel will enter the Source Room and Cell and monitor the whole area carefully. Wipes will be taken of the Flexible Loading Tubes and Rigid Extension to double check for contamination.

14. After all loading has been completed, install the Exposure Head and reconnect the air lines. Insure that the Head Switch Interlock is made. Replace the Negative Pressure Shield.

15. The system is now ready for normal operation.

Unloading Procedures for Gamma Radiation Facility Sources (E-19)

The unloading procedure is effectively the reverse of the loading. The Flexible Loading Tubes will be set so that when they are opened the source will drop into a padded recepticle.

Pre-Operational Tests and Inspections (E-20)

1. To assure that the Gamma Radiation Facility is continuously maintained in proper operating condiiton it is necessary that operating personnel perform routine tests and inspections of items critical to the performance of the Facility. Under normal operating conditions, such tests and inspections are performed at the start of each scheduled operating day and on a regular weekly, monthly, quarterly, and annual basis.

2. Tests and inspections are conducted by a certified Gamma Radiation Facility Operator and/or Health Physics Monitor.

a. Daily (when operational):

(1) Response check of all Remote Area Monitors (RAMS).

(2) Check interlocks by insuring that the lights come on as each interlock is reset.

(3) Check source position lights. Source Stored Lights should be on until a source is dispatched to the exposure head, at which time the expose light should come on.

b. Weekly (when operational):

(1) Check that all warning devices, horns, lights, and beacons are operating correctly.

(2) Run the pit filter shield up and rotate through a full 360° to insure it is operating correctly.

c. Quarterly:

(1) All RAMS and portable Health Physics instrumentation to be calibrated.

(2) Timers will be calibrated on request if there is any indication of inaccuracy. Accuracy will be spot-checked by Operator as convenient.

d. Annually:

Check and replace, if necessary, all pit filters, absolute filters, and air line filters.

NORMAL OPERATING PROCEDURES (E-21)

The operation of the system permits one capsule at a time to be withdrawn from the Storage Shield and positioned in the Exposure Assembly. Similarly, one capsule at a time is returned from the Exposure Assembly to the Storage Shield.

The sequence of operations is as follows (normally all power is Off, and the sources are locked in storage):

1. Press the Power Switch to turn on the 24 volts DC.

a. All indicating circuits on the console will be energized.

b. All interlock circuits will be activated, allowing them to be reset.

c. Observe the Interlock status and Source Position lights. All Storage and Latched lights will be on, indicating that all sources are locked in storage. If the Exposure Assembly is in place, the Head Switch interlock light will be on.

2. The Operator and/or Monitor then proceeds to the various gate and door interlocks to reset them, and clear the areas of all personnel, carefully checking all areas outside the building and inside the exclusion fence. His

partner will remain at the console to check that the interlocks are reset. The interlocks to be reset at this time are, in sequence, the South Fence Reset, the North Fence Gate, the Source Room Door, the Chain Link Fence Reset, (if the Roll-up Door is down), the Vehicle Gate and the Outside and Inside Mechanical Equipment Room doors. If the Roll-up Door is to be open during the operation, the Chain Link Fence Reset will be reset just before the Exposure Cell Door. The Exposure Cell Door and the Passage Door can be reset at this time if the experimenter is ready, otherwise they will be left until he requests the doors be shut.

3. As each interlock is reset, the applicable Interlock light will come on. The Roll-up door and the North Personnel Door will both be shut at this time, unless the Roll-up door needs to be open for experimental reasons. If either is opened during the day a visual indication will go out at the console, and the Chain Link Fence Reset interlock will drop out.

4. If the Roll-up door is open during operations, then the Chain Link Fence Reset interlock will drop out every time the Exposure Cell door is opened. Therefore, before resetting the Exposure Cell door interlock, the Monitor will have to go outside to reset the Chain Link Fence Reset, and again check that the inner exclusion areas are clear of personnel.

5. Turn the Main Power Key Switch to Ready.

a. The Roof Exhaust Fan will start when the Monitor presses the Fan switch, and as it does the Fan On light will come on. After a few seconds to allow the fan to build up a suction, the Negative Pressure interlock light will come on.

b. The Timers will be energized. Reset all the Timers.

6. Check that all Indication lights are normal; i.e., no low air pressure, personnel gate and entry door shut.

7. When the experimenter is ready and the cell clear of personnel, the Exposure Cell and Passage Door interlocks will be reset, and these lights will come on. The Monitor will insure that all Health Physics circuits are operating, and then turn the Health Physics key switch to On. The Health Physics Interlock light will come on. This will complete the interlock chain and the Interlock Relay light will come on.

8. Switch to Operate. All warning lights and horns will come on. After a one-minute time delay, the transfer circuits will be energized, the Transfer Ready light will come on, the transfer can be initiated.

9. Determine which sources are to be used, and how long each will need to be at the exposure head, Enter this information in the log, and set the times at the appropriate timers.

10. Press the Latch switches for those sources. This will raise the latch and the "Latched" lights will go out. The sources are then ready for transfer.

11. Press the first Send switch. The Storage light will go out and, when the transfer is complete the Expose light will come on, indicating that the source has reached the Exposure Head. The appropriate timer will start counting at the same time. The Health Physicist verifies that a source reached the exposure head by monitoring the RAMS on his console.

12. As soon as the Expose light has come on, the next Send switch can be pressed and so on in sequence until all sources to be used are at the exposure head, and the Expose lights are on and the timers running.

13. At the termination of each preset time, the timer circuit will energize the Return relay. The Expose light will go out as the source leaves the Exposure Head. When the source reaches the storage position, the Storage light will come on. When the storage light is on, press the Latch switch and the latch will be released. If it drops the "Latched" light will come on.

14. If the "Latched" light does not come on, the source is probably not completely in the storage position. Press the Return switch, and when the "Latched" light comes on, press the Stop switch.

15. After each exposure is completed, turn the Main Power key switch to Ready. this will de-energize the transfer circuits, preventing accidental transfer or any source. The warning lights and horn go off at this time.

16. If access is needed to the Exposure Cell or any other secured area, and the Operator can remain in the Control Room, the Master switch can be left at Ready and the timers and exhaust fan will stay on. If both the Operator and Monitor must leave, the Operator turns the Master switch Off and removes the key at which time the Timers and the exhaust fan will stop. The Negative Pressure interlock will, therefore, drop out. All indicator and interlock circuits will remain energized, and all interlocks will remain engaged unless they are broken by personnel access.

17. Prior to gaining cell entry after an operation the Health Physics monitor will remove the interlock key from the safety console and check the RAMS for an indication that the sources have returned to storage. (Health Physics monitoring procedures at the Gamma Range are listed in (Supplement F-06 and Supplement F-03 pages 23 thru 25). He will then proceed in to the exposure cell

with a portable survey meter and monitor the radiation level at contact with the Exposure Head. When he is satisfied that the sources are in storage he will permit operations and contractor personnel to enter the cell.

18. At the end of the day's operations, the operator will check that all Latched lights are on. When they are, press the Power Switch. This turns off the 24 volts DC and all resettable interlocks will drop out.

SPECIAL OPERATING PROCEDURES (E-22)

Any source(s) can be returned to the storage container prior to completion of the preset time by activating the Return switch. The Expose light will go out and the timer(s) will stop when the source leaves the Exposure Head. The timer(s) will now indicate the elapsed time of exposure. When the source(s) is(are) in storage and the store light comes on, the source(s) can be latched.

A source in transit can be stopped by pressing the Stop switch which shuts off the air flow. Pressing either the Send or the Return switch will start the source again in the desired direction.

Solenoid Failure (E-22-1)

If a solenoid valve fails to operate it can be manually actuated with a screwdriver. Solenoid valves are located in a trench in the mechanical equipment room.

Failure of a solenoid relay to operate through normal circuitry can be corrected in the following manner:

a. Place the Interlock Override switch in the override position. This puts 24 volts DC on the power jack in the bypass panel located on the lower front of the operations console.

b. Connect a jumper between the 24 volt jack and the appropriate solenoid valve jack. This applies power directly to the valve. Once the valve has operated remove the jumper, turn the override switch off and remove the key.

NOTE: The Interlock Override switch key is the Health Physics console interlock key and must be obtained from, and returned to, the Health Physics person monitoring the operation.

Interlocks (E-22-2)

If an interlock is broken during an operation, the interlock relay drops out which automatically initiates the sequential return of all sources from the Exposure Head. As each source leaves the elapsed time of Exposure Head the Expose Light goes out and the timer stops indicating the elapsed time of exposure. When the source returns to the Storage Shield and the Store Light comes on transfer of the next source automatically begins. Each source can be latched as soon as the Store Light is on.

In the event an emergency occurs, the interlock(s) can be bypassed ONE TIME ONLY by using the Interlock Override switch and the appropriate jumper(s) and jack(s) in the bypass panel.

Any other time the need to bypass an interlock arises written permission must be obtained from both the NED Health Physicist and the Gamma Range Technical Specialist prior to proceeding with the bypass. Both the above individuals will be notified as soon as the system is returned to the normal mode of operation.

Power Failure (E-22-3)

If 115vAC power fails, batteries will take over to power the indicator circuits.

a. The interlock relay will drop out, and this will initiate automatic sequential return of the sources, as in (Supplement E-22-2).

b. All resettable interlocks will drop out. The exhaust fan will stop, and therefore, the Negative Pressure interlock will drop out.

c. The Send transfer switches, are inoperative until regular 115vAC power is restored, unless the Interlock Override key switch is activated. Return switches remain operable under battery power.

d. The timers will stop when power fails, the reading they show will be the elapsed time until the moment of power failure. They will not take into account the few seconds until the source's transfer is initiated.

Stuck Source (E-22-4)

Evidence that a source is stuck in its transfer tube would be confirmed by the fact that neither the Store nor the Expose Light is on, and that one or more RAM shows an abnormal reading,. This reading would also give an approximation of the source's location. The operator should sequentially press the Send, Stop, Return and Stop switches in an attempt to dislodge the source. If this does not release the source then actuate the Interlock Override switch which will put power to the Bypass Solenoid Circuit. Full air compressor pressure will now be applied to the solenoid valves by pressing the appropriate Bypass switch as determined by the size of the stuck source. Again press the Send, Stop, Return and Stop switches in sequence as in the initial attenpt.

If at this time the Health Physics person monitoring the operation has not notified the NED Health Physicist and the Chief, NED and the WSMR Radiation Protection Officer (678-3210), he shall do so and no further action will be taken until instructions from either of the above persons are received. The operator will also notify the Technical Specialist at this time.

A third attempt can be made by connecting bottled nitrogen gas to the appropriate source tube in the mechanical equipment room trench. Increasing pressure can be applied as long as necessary.

Air Failure (E-22-5)

If the air compressor fails, this will be indicated by the Low Air Pressure visual and audible warning. There is sufficient supply of air in the accumulator tank to return all sources to the storage position when this is determined to be necessary.

Source Leak (E-22-6)

In the event that the RAM in the Mechanical Equipment Room pit indicates an excessive level of radiation, it will be required to determine if this is due to a leaking source. The controls for the leak checking equipment are on the Health Physics console. (The system will have been checked weekly under weekly maintenance.) The Monitor will go through the checking routine. (See Drawing in Supplement E-1-16)

a. Press the Power Switch. This applies voltage to the motors, meter and potentiometer. The Power Light will come on.

b. Press the Up switch. This will start the motor raising the lead shield. After about two minutes the Up light will come on, indicating the shield is fully raised.

c. The digital meter will indicate the position of the slit. Filters are positioned every 30°. Therefore, when the meter reads a multiple of 30 the slit is directly facing a filter.

d. Press either the Clockwise or Counterclockwise switch to rotate the shield. These switches must be held in to continue rotation. While the motor is rotating, the appropriate light will be on.

e. Continue to rotate the shield until a maximum reading is recorded on the RAM. The direction shown on the meter will indicate from which source the radiation is leaking. The Health Physicist can then be informed that source # (?) is leaking.

f. To lower the shield press the Up switch. The Up light wwll go out and the motor will drive the shield down. When the shield is fully down the Down light will come on.

g. Press the Power switch to remove power from the system. The Power light will go out.

Procedure in Case of Fire (E-22-7)

In the event of a fire "Nuclear Effects Facility Emergency Plan" (FOUO) will be put into operation. Following is a summary of the responsibilities and actions required by the SOP.

a. The Facility Operator takes charge and directs all procedures necessary to protect personnel and equipment in the area. He reports the fire to the Fire Department by dialing 117. Then he informs the Technical Specialist by telephone. The Facility Operator announces special information and instructions over the intercom.

b. The Health Physics Monitor turns his Interlock key to Off. This breaks the interlock chain and returns all sources to storage automatically. He then informs the Health Physicist by intercom, that there is a fire.

c. The Health Physics Monitor determines and informs the Facility Operator of the location of the fire. He sets up necessary exclusion areas as required.

The Health Physics Monitor accompanies the fire fighters and advises them of radiation levels and hazards.

d. All other personnel will evacuate the area when directed by the Facility Operator.

Special Procedure for Vertical Beam Operation (E-22-8)

Prior to vertical b‹ 1m operaiton, the Post Radiation Protection Officer and others that may be affected will be contacted for concurrence.

It is required to provide a radiation field for airborne radiation monitors. To do this operations will be required with the roof plug (shown in Supplement E-1-03) removed, and the top plate of the Enclosure Assembly also removed (Supplement E-4).

what happens here

Should an interlock be broken with sources in the Upper Tubing Assembly, the sources will still be automatically returned sequentially to storage by the normal scram system.

Prior to any operations in this configuration, a Health Physics survey will be made. This will cover the points used in the initial radiation survey of the facility that were inside the building, and various locations around the FBR, used in the quarterly surveys.

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