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TELETHERAPY FACILITY SURVEY
VETERANS ADMINISTRATION HOSPITAL
EAST ORANGE, NEW JERSEY

K. David Steidley
K. David Steidley, Ph.D., C.H.P.

and

Rene Craig, M.S.

8/18/85

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29-04481-02 PDR

"OFFICIAL RECORD COPY"

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Diplomate American Board of Radiology; Certified Health Physicist

OCT 17 1985

I. GENERAL

Upon installation on August 14, 1985 of the new Cobalt 60 source, various measurements were made to determine the protection afforded by the structural shielding and the Cobalt 60 head itself. A five-year inspection and preventative maintenance routine was conducted on August 14 and 15, 1985, and the unit was deemed safe to operate by Advanced Medical System, Inc.*

The new source contained 5444 curies on August 1, 1985. A Certificate of Measurement is enclosed. The old source was transferred to Advanced Medical System, Inc. The teletherapy unit itself is a Picker C/9, head: catalog number 590E, serial number 116; collimator: catalog number 3706E, serial number 101; stand: catalog number 1385D, serial number 112.

A measurement made on August 17, 1985, at 80 cm SSD, revealed the dose rate to be 8,289 R/hr for a 25 x 25 cm field. That is equivalent to 5,318 R/hr, at one meter, versus Advanced Medical System's value of 5,494 (~3% difference).

A wipe test (enclosed) revealed no removable contamination above 0.005 microcuries.

*Report enclosed

II. MISCELLANEOUS SAFETY CHECKS

The various warning lights (at control panel, over the door, at the inside wall, on the therapy head) for the source "ON" condition were tested and found to function properly. When the door was opened with the source "ON", the source returned to the "OFF" position and could not be turned "ON" again until the door was closed and the system reset at the control panel.

The treatment timer was tested against a stopwatch for periods of 1, 2, and 3 minutes, and found to be accurate to ± 1 second. The timer was found to return the source to the "OFF" position when the preset time elapsed.

Posted at the teletherapy treatment door are the signs "CAUTION--HIGH RADIATION AREA" and "CAUTION--RADIOACTIVE MATERIAL." Emergency procedures for source "hangup" are also posted and understood by the technicians. All conditions of licensure (NRC license number 29-04481-02 and 10-CFR-20), seem to be complied with by this facility.

Electrical stops that have been installed to limit the orientation of the teletherapy head with the source "ON" were tested and found to function properly. The head may be rotated off the beam stopper in the plane of rotation such that it is angled 8 degrees away from the vertical toward the east wall or 95 degrees away from the vertical toward the west wall (see Figure 1a). The head is so limited that it can rotate off the beam stop from 0 degrees to 65 degrees from the plane of rotation toward the north wall (see Figure 1b).

The "Emergency Off" bar on the control panel was tested and found to return the source to the "OFF" position. Similarly, either turning the "Main" power supply switch to "OFF," or throwing the wall mounted circuit breaker to "OFF" also caused the source to return to its "OFF" position.

Both the mirror system and the closed circuit television unit works properly and patients may be closely monitored during treatment. The audio link between patient and control panel was tested and found to be adequate.

Personnel dosimetry records for the technicians, physicists, nurses, and physicians routinely working in this area, reveal an average yearly exposure of about 200 mR during the last year. No quarterly or yearly overexposures are seen. The present method of personnel dosimetry is deemed adequate.

III. TELETHERAPY HEAD SURVEY

With the source in the "OFF" position, a survey of the teletherapy head was made at a distance of one meter from the source. The head survey was performed with a Victoreen Model 491, serial number 1572. The meter was calibrated on May 7, 1985. The enclosed sheet shows twenty-six (26) positions and their dose rates. The average was 1.4 mR/hr with a maximum of 8.5 mR/hr. These are well below the license limits (Item 18, A, (i)) of 2 and 10, respectively. The distance from the surface to one meter was determined from the manufacturer's drawings. In each instance the probe was moved about the point in question to find the maximum value which was then recorded.

IV. STRAY RADIATION MEASUREMENTS ABOUT THE COBALT ROOM

Inspection of Figures 2, 3, 4, 5, and 6 show the layout of the teletherapy room. The survey of radiation levels about the facility was made at various locations along each wall and the roof by scanning carefully with a Keithley (Model 36100, serial number 12174) portable ionization (calibration--July 1985) instrument for any "hot" spots.

A. Beam Orientation

Six principle orientations were used for the survey. The primary beam was positioned toward the floor, the ceiling, the east wall and the west wall in turn. The beam stop was in position in each of these instances. With the primary beam directed off the beam stop, the beam was directed at the north wall and also at the west wall. In every case, a CT phantom of circular cross-section was placed at 80 cm SSD. The radiation field size was 25 cm x 25 cm.

B. Radiation Levels

Radiation levels in the six (6) orientations were measured as less than 0.2 mR/hr with the following exceptions:

1. Roof

Beam toward ceiling, 1.3 mR/hr at center of beam

2. Machine Room

Southwest corner--no beam stop, 0.6 mR/hr

3. Viewing Window

None

4. Door

None

5. Control Panel Wall

None

6. Electrical Junction Box

Beam toward floor, 0.4 mR/hr

Beam toward east wall, 0.4 mR/hr

7. East Wall

None

8. West Wall

None

9. North Wall

None

10. Northwest Corner

With beam toward northwest corner--no beam stop:

215 mR/hr at ground level at ~4" from wall

60 mR/hr at waist level at ~1 meter from wall

23 mR/hr at waist level at edge of bushes

11. Chief of Staff's Office, Assistant Chief of Staff's Office

None (0.1 mR/hr or less)

C. PREDICTED VALUES VERSUS MEASURED VALUES

Previously instantaneous dose rates had been calculated for a variety of points about the facility (see Appendix A). None of these values were approached in practice and the calculations seem to be very conservative.

D. COMPARISON OF MEASURED DOSE LEVELS WITH PERMISSIBLE LEVELS

NRC Rules and Regulations, 10 CFR-20, requires permissible doses of ≤ 1.25 rems per calendar quarter for individuals in restricted areas (20.101) and ≤ 0.5 rem per year for individuals in unrestricted areas (20.105). In addition Section 20.105(b) requires that if the radiation level in an unrestricted area exceeds 2 mR/hr, then an individual continuously present in the area should receive ≤ 2 mRem in any hour or ≤ 100 mRem in any seven consecutive days.

Quarterly doses may be calculated from instantaneous hourly dose rates by multiplying the dose rate by the number of hours worked in the quarter, the duty cycle fraction, the occupancy factor, and the use factor of the unit.

The duty cycle is the hourly workload divided by the source output, i.e.,

$$\frac{40,000 \text{ R/week at one meter}}{40 \text{ hours/week} \times 5,400 \text{ R/hr at one meter}} = 0.19.$$

Table I lists the results of such a calculation.

All values are well below the <500 mRem/year requirement without invoking the use factor of the unit.

In the case of the 60 mR/hr dose rate, it should be noted that this would only be used for whole body irradiations of ~20 given rads, a clinical situation of some rarity (about once a year). The dose rate at 3 meters would be about 9.8 R/min and two minutes of time would be necessary. Thus, the dose to this point would be 2/60 of 60 mR/hr or 2 mR. This complies with 20.105(b).

TABLE I

POSITION	MAXIMUM DOSE RATE	U	T	DUTY CYCLE	HOURS IN QUARTER OR YEAR	mR/QUARTER (RESTRICTED)	mR/YEAR (UNRESTRICTED)
Most Areas	0.2	1	1/16	0.19	2080		5 or <1% MPD
Most Areas	0.2	1	1	0.19	520	20 or 4% MPD	
A*	0.4	1	1	0.19	520	40 or 8% MPD	
B*	1.3	1/16	1/16	0.19	2080		5 or <1% MPD
C*	0.6	1/16	1/16	0.19	2080		1 or <1% MPD
D*	.1	1	1	0.19	2080		40 or <8% MPD
E*	60	1	1/16	0.19	520	23 or 4% MPD	

A = electrical junction box below control panel

B = area on roof

C = southwest corner--no beam stop

D = Chief of Staff's office

E = northeast corner

*Keyed to Figures 2-6 (notation A, B, etc.)

V. SUMMARY AND CONCLUSIONS

The teletherapy facility is in compliance with all pertinent regulations and, indeed, exceeds most requirements. The radiation dose levels in both restricted and unrestricted areas are essentially one decade below Federal requirements.

APPENDIX A

Instantaneous dose rates are desired to compare with measured values in connection with a radiation protection survey. Knowing the barrier thickness, and assuming a source strength of 6,000 RHM, one may calculate these rates for points A, C, E, and F for the case of 90 degrees scatter (i.e., beam pointed down) and for point B in the case of 45 degrees scatter (i.e., beam directed east). Primary irradiation to points B and F will also be considered.

ASSUME

$$P_1 = B_{1g} WT/1000 (dsec)^2$$

and with $W = 100$ R/min @ 1 meter, and $T = 1$ for the survey meter, then

$$P_1 = 0.1 B_{1g}/(dsec)^2.$$

B_{1g} is found from $S/2.45''$ and NCRP-34, Figure B-3.

Eq. (7) may be rewritten as

$$P_s = \frac{aWT B_{sg}}{.49(dsec)^2}$$

with $W = 100$ R/min @ 1 meter, $T = 1$, then

$$P_s = 204 a B_{sg}/(dsec)^2.$$

The mR/hr for the various points is now calculated in the following table:

Points	S Inches Concrete	n (HVL)	B _{lg}	B _{sg}	θ	dsec Meter	P ₁ R/min ₅ x 10 ⁻⁵	P _s R/min ₅ x 10 ⁻⁵	P ₁ + P _s R/min ₅ x 10 ⁻⁵	P Total mR/hr
A	21	8.6	.0026	3.5 x 10 ⁻⁴	90°	2.67	3.65	0.9	4.6	2.8
C	36	4.4 = TVL	.0001	10 ⁻⁵	90°	6.36	.025	.0045	.03	.02
E	36	4.4 = TVL	.0001	10 ⁻⁵	90°	7.3	.0188	.0034	.022	.01
F	21	8.6	.0026	3.5 x 10 ⁻⁴	90°	4.45	1.31	.325	1.64	1
B	24	9.8	.001	8 x 10 ⁻⁴	45°	3.51	.813	4.78	5.59	3.4

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Primary radiation may be calculated as:

$$P = WUT \text{ Bug}/(\text{dpri})^2,$$

Where W = 100 R/min @ 1 meter, U = T = 1, or

$$P = 100 \text{ Bug}/(\text{dpri})^2.$$

Thus, point F at 4.45 meters has a Bug = .005, and $P = 100 \times .005/(4.45)^2 = 0.25 \times 10^{-3} \text{ R/min} = 15 \text{ mR/hr}$.

For point H at 3.00 meters, the 46" wall has a Bug < 10⁻⁵ or $P < 100 \times 10^{-5}/(3.00)^2 < 6.7 \text{ mR/hr} \approx 6 \text{ mR/hr}$.

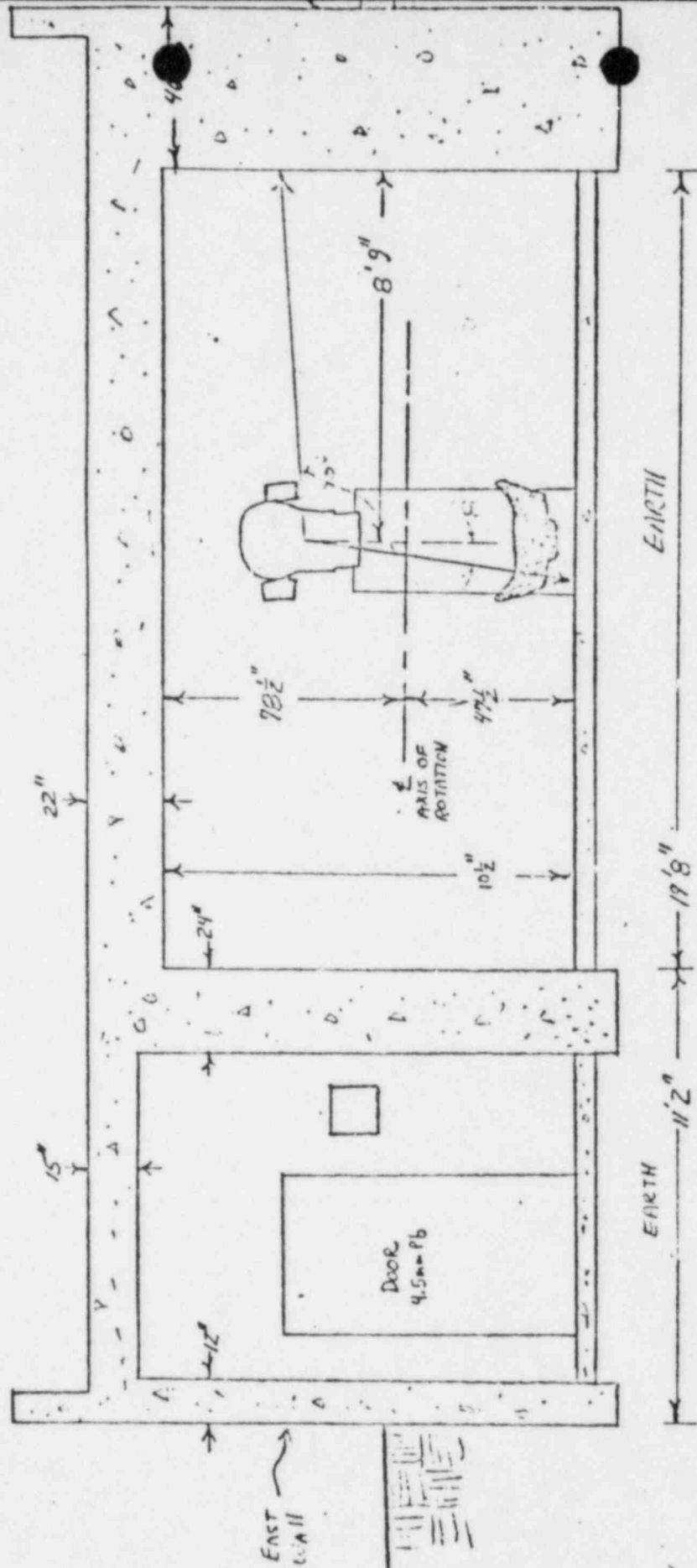


FIG. 1a
Scale 1/4" = 1'

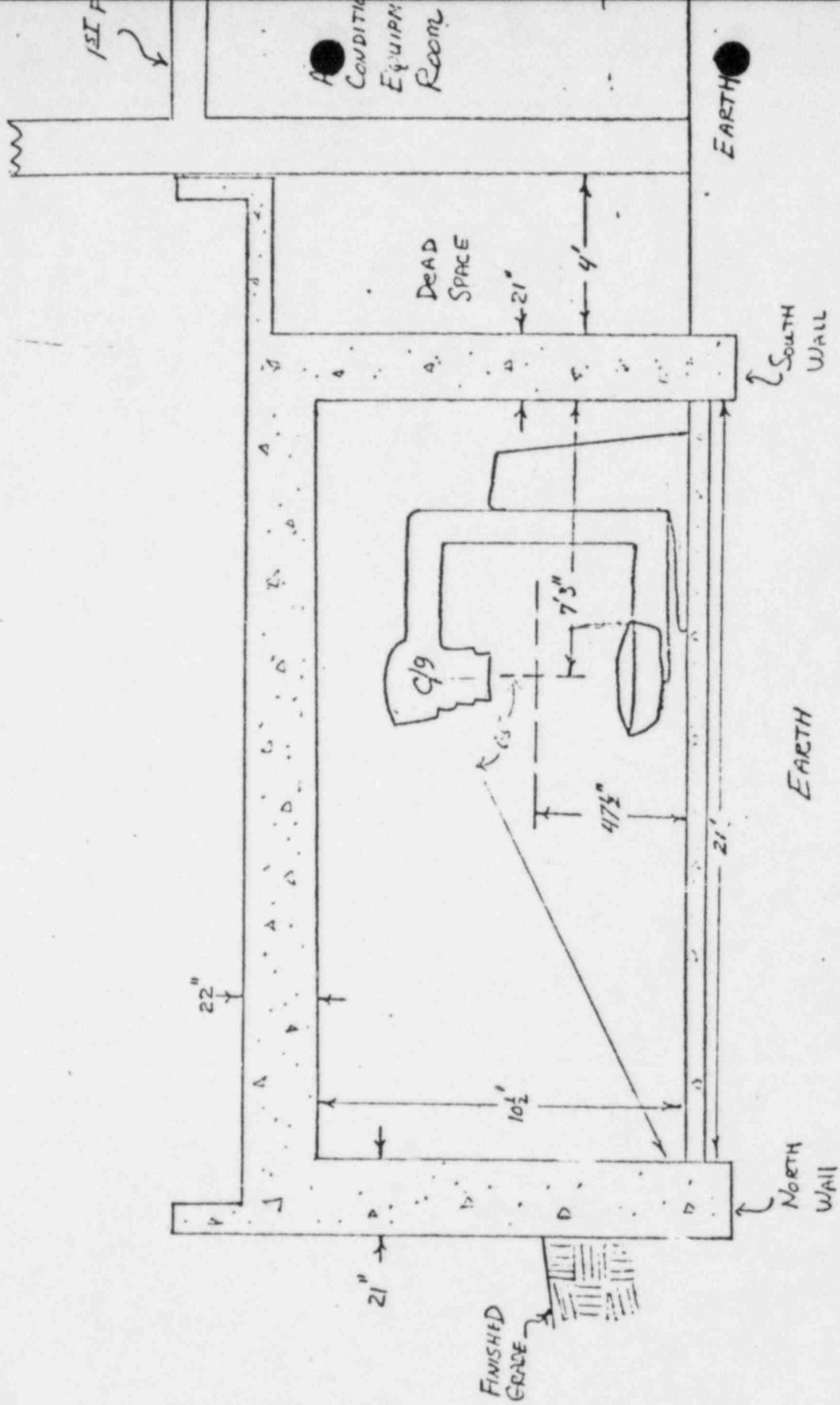
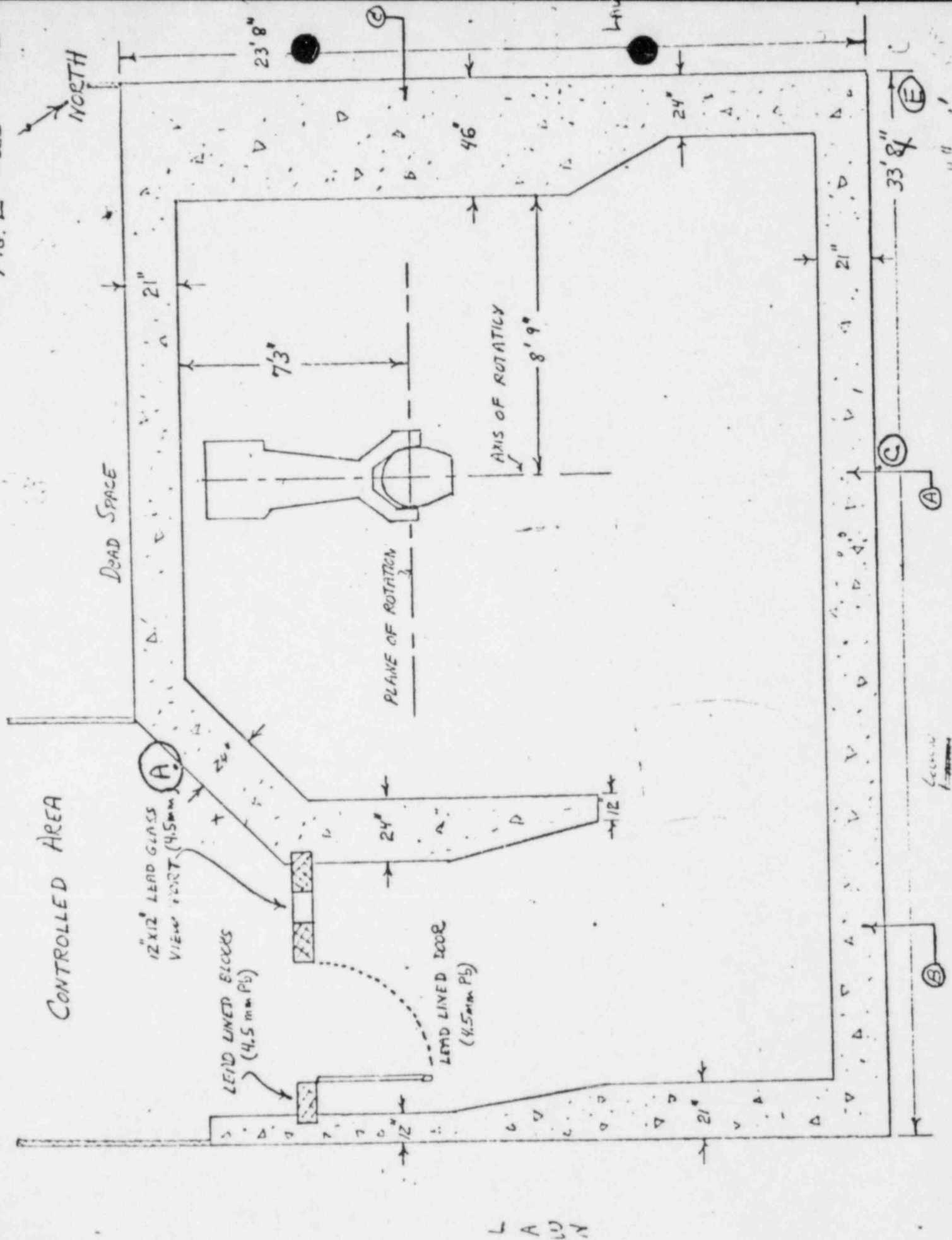


Fig. 1b.
 SCALE $\frac{1}{4}'' = 1'$

Fig. 2 - See Notes



NOTES ON FIGURE 2

Room A-108H, adapted from drawing 1A-1 of Cobalt Therapy Unit No 1A.

Concrete walls shown are ordinary concrete of nominal density 147 pounds per cubic feet.

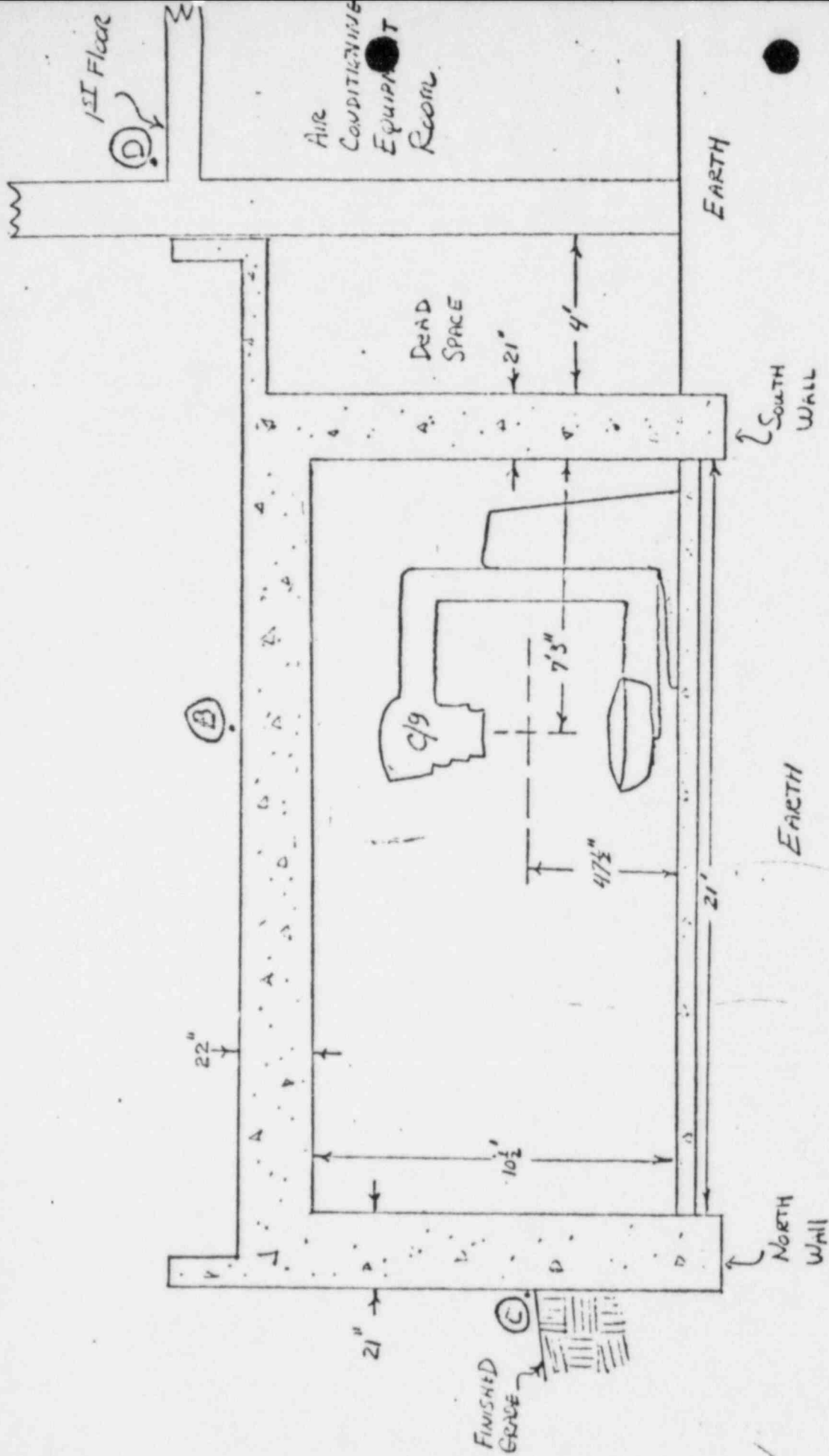
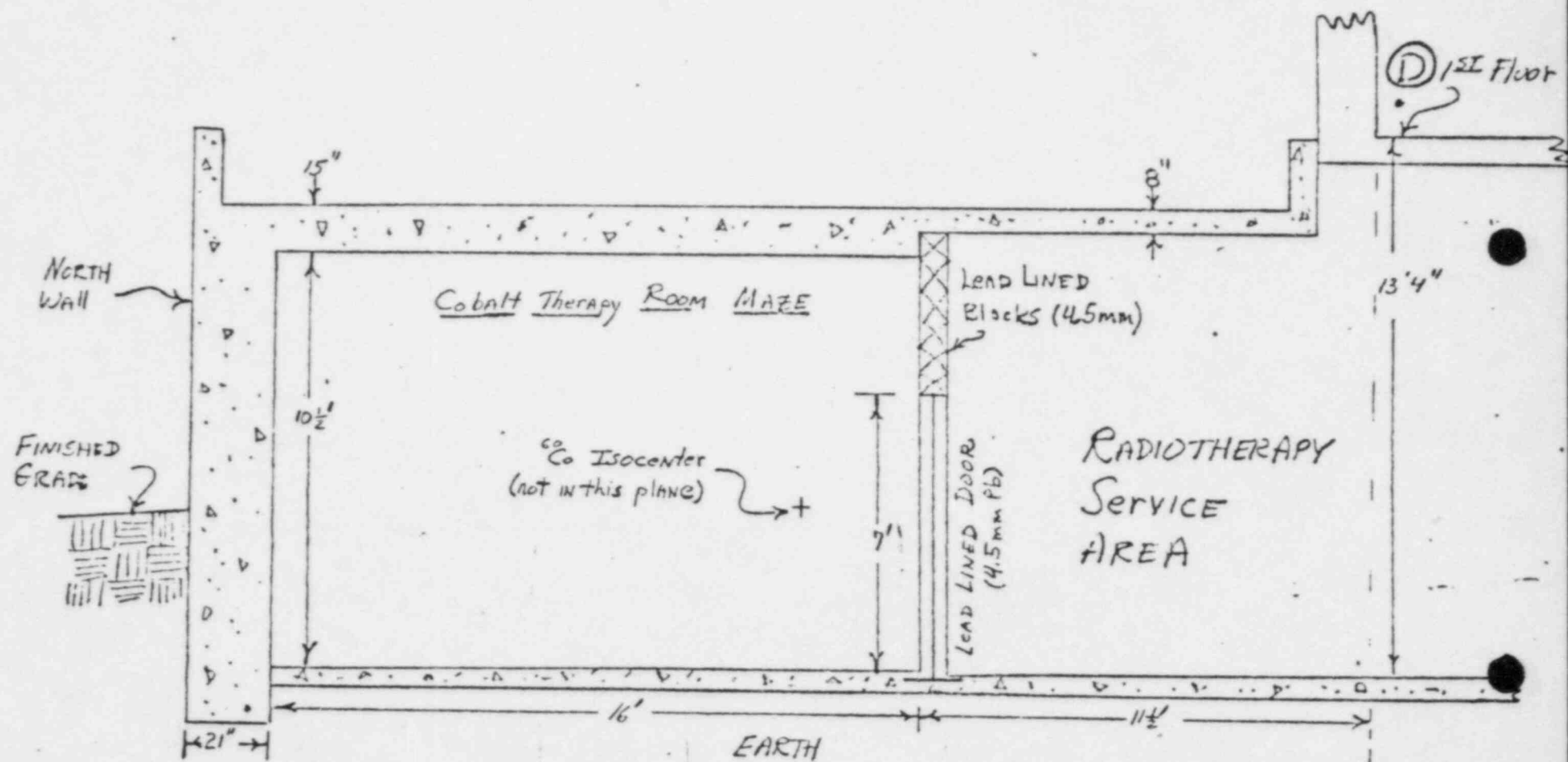


FIG. 3. SECTION A
SCALE 1/4" = 1'



SECTION B
 SCALE $\frac{1}{4}" = 1'$
 FIG. 4

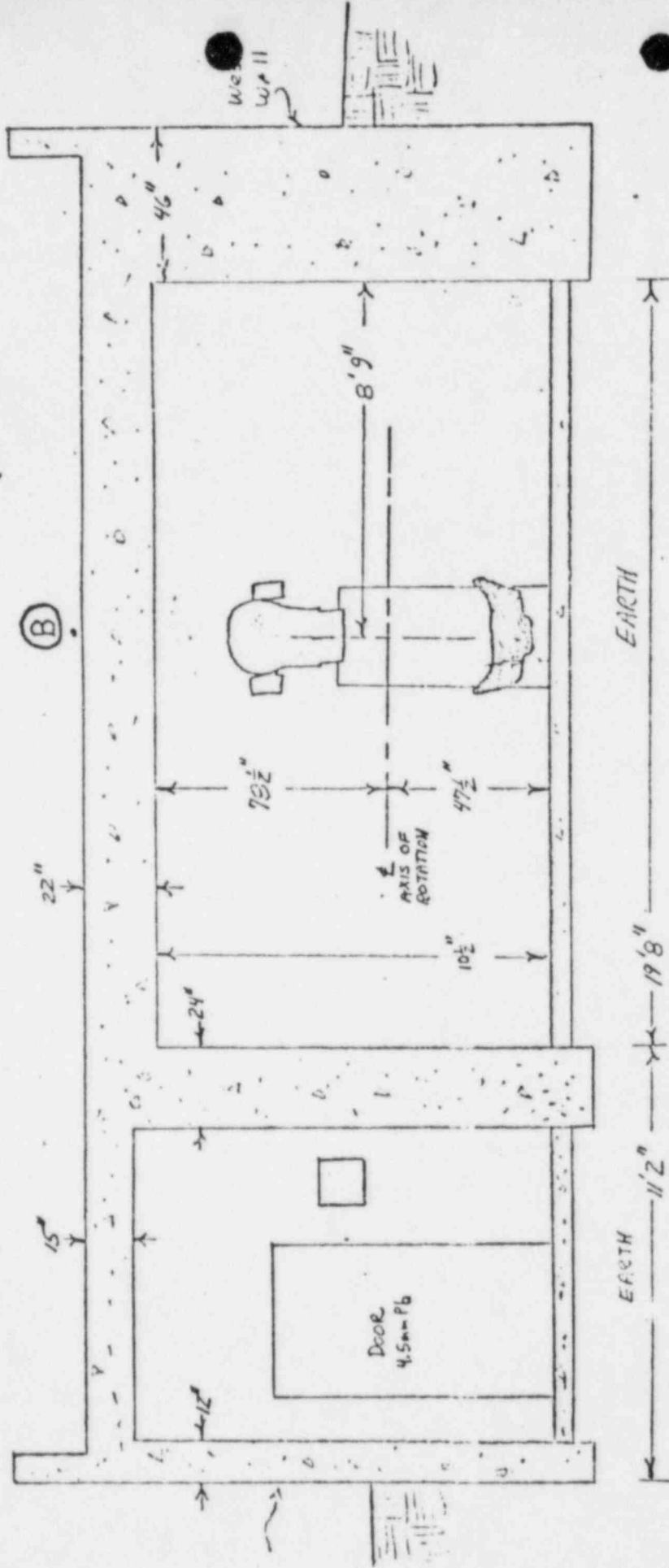


Fig. 5 Section C
Scale $\frac{1}{4} = 1'$

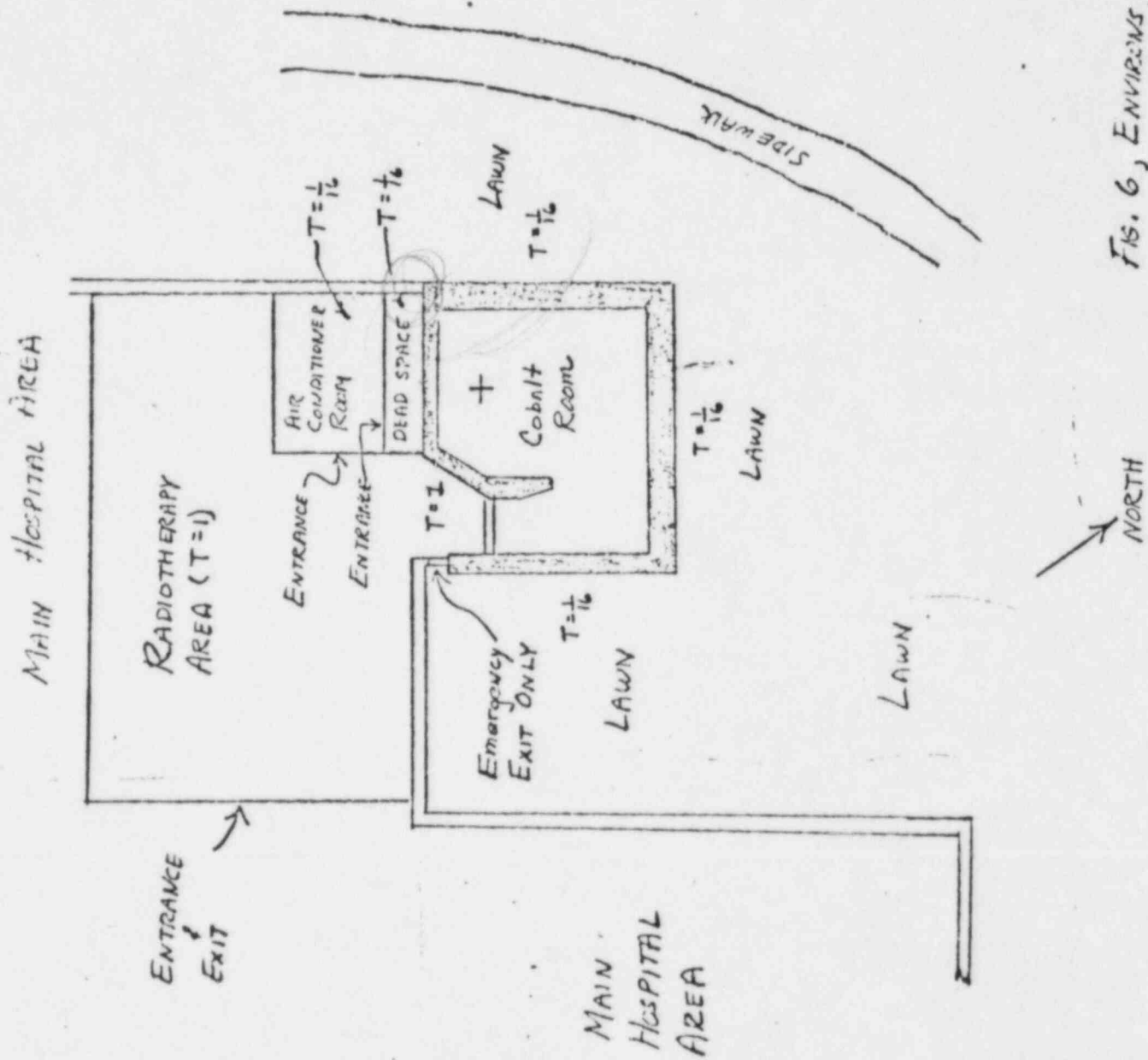
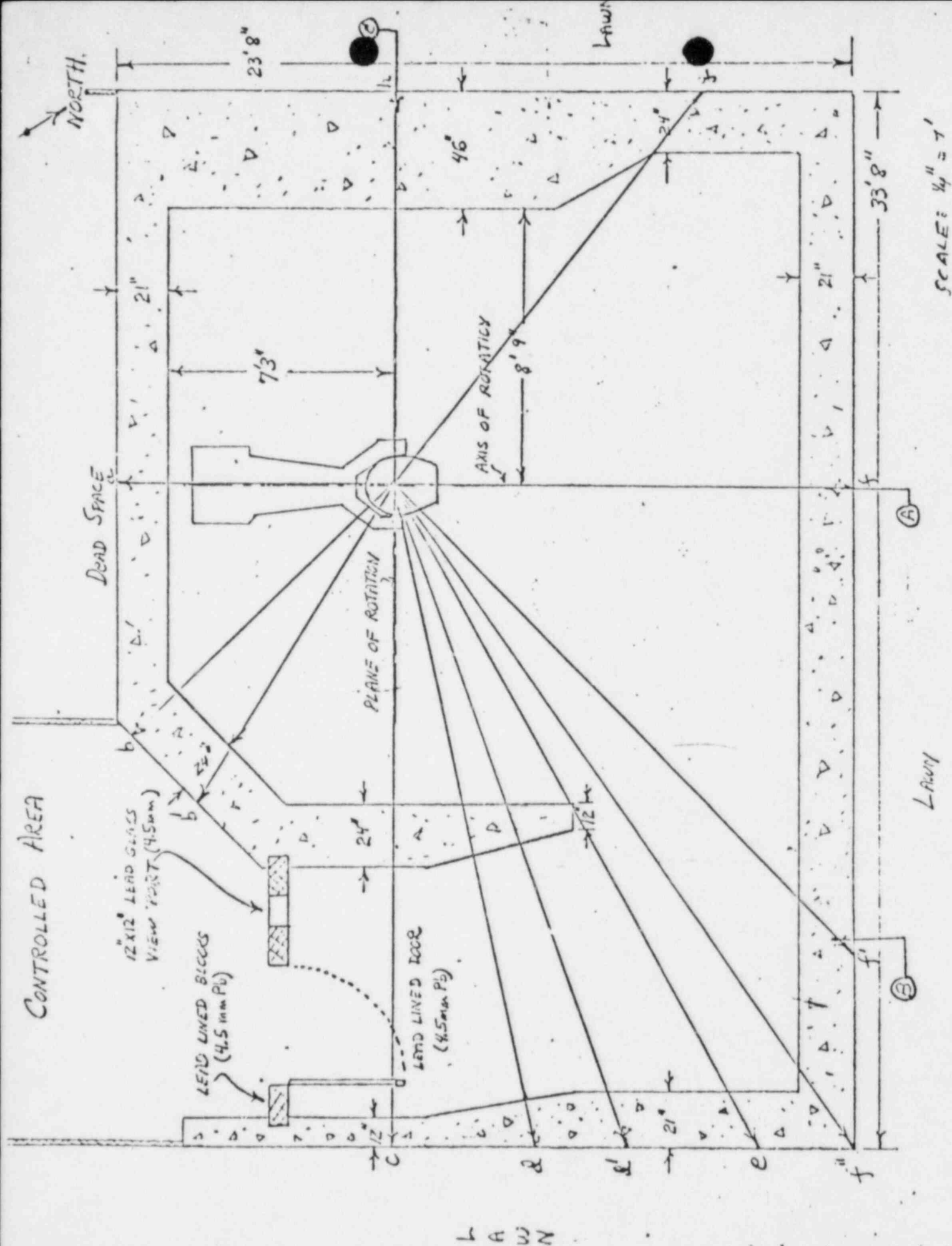
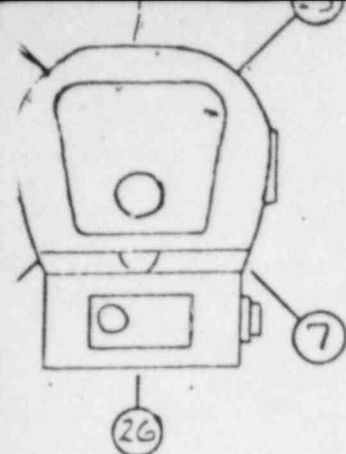


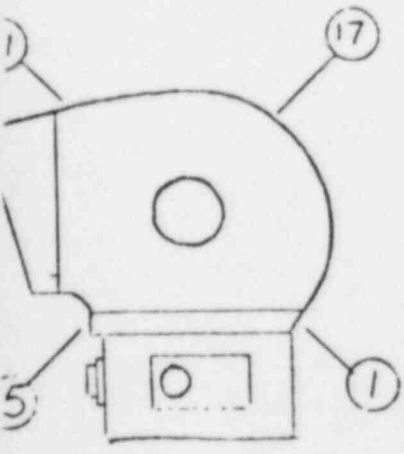
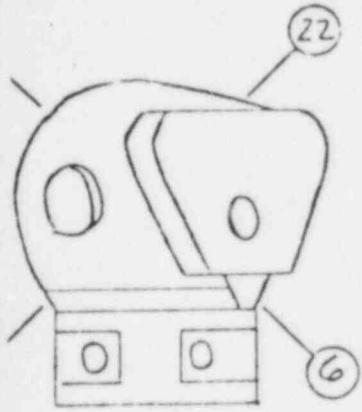
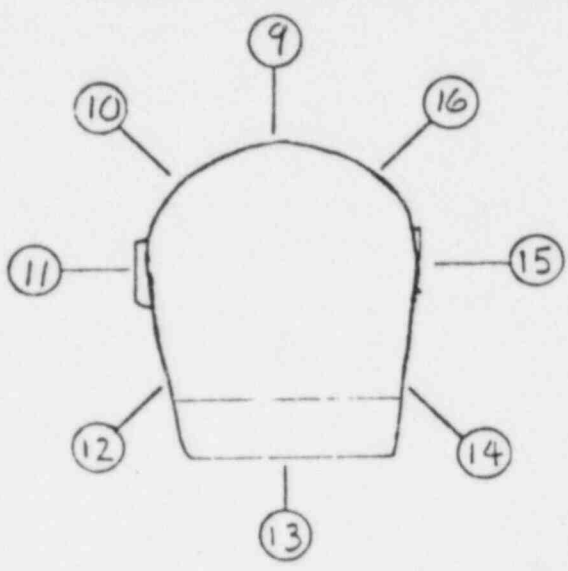
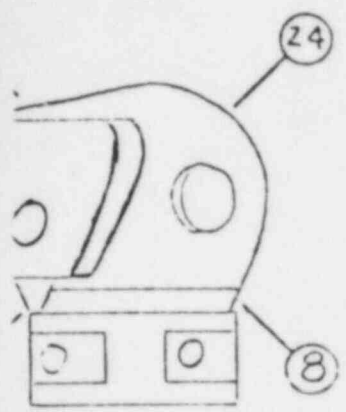
FIG. 6, ENVIRONS OF THERAPY ROOM
 SCALE: ROUGHLY 1"=20'
 T = OCCUPANCY FACTOR





HEAD #590- E SERIAL No. 116
 SOURCE, CAT. AMS-3801/1.5 cm. DIA.
 Rim 5494 on 7/30/85
 CURIES 5444 on 8/1/85
 COBALT HEIGHT 2.75 CAP TYPE SOLID
 SURVEY DATE 8/14/85 ENGR. VS/DM
 METER USED MFG. Victoreen MODEL 491 SER.# 1572
 METER CALIBRATION DATE 5-7-85

FOR: VA Medical Center/East Orange, N.J.
 INV. NO. S 85-08



No.	Dist.	Read	True	No.	Dist.	Read	True
1.	70cm.	1.2	+	14.	67cm.	1.1	+
2.	70	1.6	+	15.	73	0.4	+
3.	70	1.6	+	16.	73	0.6	+
4.	70	2.5	+	17.	73	0.6	+
5.	67	1.8	+	18.	73	1.1	+
6.	70	2.8	+	19.	73	0.8	N
7.	70	2.0	N	20.	71	0.4	E
8.	70	1.9	E	21.	69	0.5	A
9.	73	0.2	A	22.	71	0.4	R
10.	73	0.6	+	23.	73	1.0	R
11.	73	0.5	R	24.	73	0.6	+
12.	67	0.7	+	25.	76	1.6	+
13.	63	0.8	+	26.*	41	8.5	+

Note: * On test stand multiply true by .74

TOTAL 26 POINTS
 AVERAGE 26 POINTS
 3/2.9
 1.4

1020 London Road
Cleveland, Ohio 44110
(216) 692-3268

TELETHERAPY UNIT
FIVE YEAR INSPECTION & PREVENTATIVE MAINTENANCE REPORT

CUSTOMER: V. A. Medical Center/Tremont Ave & S. Centre ST./ East Orange, NJ. 07019
(HOSPITAL OR DOCTOR) (LOCATION)
TYPE OF UNIT: CAT. NO. 6296 HEAD 590-E SERIAL NO. 116
DATE OF INSPECTION: 8/14-15/35 LICENSED ENGINEER Darwin Murray

=====

The following items have been inspected and the listed action taken or recommended as indicated. None of the recommended items require that the source be removed for their correction.

I. SOURCE HEAD

- A. Check for significant radioactive contamination
 - (☒) None Detected
 - () See Notes
- B. Shutter Rotor Bearings
 - 1. Inboard
 - () Lubricated () N/A
 - (☒) Replaced
 - 2. OutBoard
 - () Lubricated () N/A
 - (☒) Replaced
- C. Shutter Rotor
 - (☒) Cleaned
 - () Other - See Notes
- D. Shutter Rotor Cavity
 - (☒) Cleaned
 - () Other - See Notes
- E. Shutter Rotor Return Spring
 - (☒) Replaced
- F. Shutter Rotor Stops
 - "ON" Position (☒) OK () Adjusted () Replaced
 - "OFF" Position () OK (☒) Adjusted () Replaced
- G. Shutter Rotor Drive Mechanism
 - (☒) Lubricated (☒) Voltage (71 Volts)
 - () Deficiency See Notes (☒) V Belt Replaced
- H. Head Leakage Survey (26 Points at 1 meter from source)
 - Average Leakage 1.4 mrhm
 - Highest Point Reading 8.5 mrhm

II. COLLIMATING DEVICE

A. General Condition: Good

FIVE YEAR INSPECTION AND PREVENTATIVE MAINTENANCE REPORT

B. Field Size Indicators - Calibration

1. Distance at which calibrated

() 55cm. () 60cm. () 75cm. (☒) 80cm. () 95cm.

2. Test Size

Dials Indicated

Light Field

4cm. x 4cm.

4 x 4

4 x 4

10cm. x 10cm.

10 x 10

9.9 x 10

18cm. x 18cm.

18 x 18

17.9 x 17.9

25cm. x 25cm.

25 x 25

24.9 x 24.8

C. Distance Localizer Calibration

Setting

Indicates

40cm.

55cm.

60cm.

75cm.

80cm.

80

95cm.

D. X-Ray film taken 80 cm. from source with actual field size of

10 x 10

Lines scribed on film indicate edges of light field.

E. Collimator accessories

1. Front Pointer () OK () Needs Repair - See Notes
2. Back Pointer () OK () Needs Repair - See Notes
3. Pin and Arc () OK () Needs Repair - See Notes
4. Wedge Filters (☒) OK () Needs Repair - See Notes
5. Breast Cone () OK () Needs Repair - See Notes
6. Beam Shaping Block Holder (☒) OK () Needs Repair - See Notes
7. Extenders (Trimmers) () OK () Needs Repair - See Notes
8. Other _____ () OK () Needs Repair - See Notes

III. UNIT IN GENERAL

A. Good

- B. Isocenter - The true isocenter has been determined to be at a distance of 36.3 cm. from the end of the collimator. The isocentric accuracy of the center of the beam was determined to be + or - 2 mm.

() see Notes and Recommendations which may improve accuracy.

C. Safety Modifications

- (☒) All modifications recommended by Picker and AMS, Inc. have been made.
 () The following safety modifications to this unit are recommended by Picker and AMS, Inc. but have not yet been completed. Your local AMS service representative will contact you regarding the following:

1. _____
2. _____
3. _____
4. _____

FIVE YEAR INSPECTION AND PREVENTATIVE MAINTENANCE REPORT

D. Treatment Timer Operation

Timer Set for:

30 Seconds

60 Seconds

120 Seconds

Actual Time:

30

60

120

() See Notes and Recommendations

E. Source Transit Time

On 2 Sec.

Off 2 Sec.

F. Operational Tests

1. Shutter opens and completely closes at 0,90,180, and 270 or at maximum angles in both directions allowable for this particular installation.

(X) OK

() See Notes

2. Where applicable that shutter will not open beyond allowable angles for this particular installation (X) OK () See Notes

3. Timer switch properly closes the shutter. (X) OK () See Notes

4. "Shutter Closes" or "Emergency" button properly closes the shutter (X) OK () See Notes

5. Shutter closes when main power is turned off and does not reopen when power is restored. (X) OK () See Notes

6. Shutter closes when room door is opened and the shutter does not reopen when the door is reclosed. (X) OK () See Notes

7. Where applicable, back pointer, collimator and localizer lights function properly and are calibrated properly. (X) OK () See Notes

8. Control panel and room warning lights works properly. (X) OK () Repaired () See Notes

9. All control functions work properly (Rotation, Skip Scan, etc.).

G. Mechanical Inspection

1. Structural Defects

(X) None Noted

() Repairs Needed-See Notes

2. Bolts

(X) All Correctly tightened

() Adjustments made

() Defective - See Notes

H. Electrical Inspection

Wiring (X) OK () Replaced - See Notes

Components (X) OK () Replaced - See Notes

I. Six (6) Rocker Switches replaced on VG8 Control (Rotational units)

(X) Replaced

() Not Applicable



FIVE YEAR INSPECTION AND PREVENTATIVE MAINTENANCE REPORT

J. General Safety

☒ Unit is safe to operate, however, whether or not the unit is accurate enough for treatment purposes is a determination which must be made by the radiotherapist.

() Unit UNSAFE to operate or treat - see below for recommendations:

IV. Table

A. Locks

1. Transverse

(☒) OK () Repaired () See Notes

2. Longitudinal

(☒) OK () Repaired () See Notes

3. Floor

(☒) OK () Repaired

() N/A () See Notes

B. Vertical Drive Clutch or Motor Mount

(☒) OK () Repaired () See Notes

C. Chain Tension & Condition

() OK (☒) Adjusted () See Notes

D. General

(☒) 1. Hardware Tightened

(☒) 2. Lubricated as Necessary

(☒) 3. Checked for signs of Binding and Unusual Wear.

E. Safety Service Notes

() (☒) Performed () See Notes

V. NOTES AND RECOMMENDATIONS

DATE INSPECTION COMPLETED: 15 Aug 1985

BY ADVANCED MEDICAL SYSTEMS, INC. LICENSED ENGINEER:

R. Murray

REPORT EXPLAINED TO AND COPY RECEIVED BY:

John P. Craig

NOTE: N/A - NOT APPLICABLE

1020 London Road
Cleveland, OH 44110
(216) 692-3268

V.A. Medical Center
Tremont Ave & S. Centre Street
East Orange, NJ 07019

CERTIFICATE OF WIPE TESTING OF RADIOISOTOPE SOURCE

This is to certify that the radioisotope source identified as ADVANCED MEDICAL SYSTEMS, INC., Catalog No. AMS-3801, Serial No. AMS-2541 Cobalt-60 Therapy Source and to be installed in Picker Model No. 590-E, Serial No. 116 Therapy Unit, was wipe tested on 25th July, 1985 and found to have .00170 microcurie of removable contamination, as determined by comparison of the wipe with a standard Cobalt-60 source of .0592 microcurie in a Picker Model 2804 Welltype Scintillation Detector and a Picker Model 628433 Spectroscaler.

Signed: Josephine S. Powell

Dated:

Josephine S. Powell
August 7th, 1985

1020 London Road
Cleveland, OH 44110
(216) 692-3268

V.A. Medical Center
Tremont Ave. & S. Centre Street
East Orange, NJ. 07019

CERTIFICATE OF MEASUREMENT
COBALT-60 SOURCES

CATALOG NO. AMS-3801
SERIAL NO. AMS-2541

This is to certify that the radioisotope source as identified above was measured at the Advanced Medical Systems, Inc., 1020 London Road Cleveland, Ohio, U.S.A., in such a fashion that the measurement is equivalent to that obtained when the source is installed in a Picker Corporation Catalog Number 6296 60-Cobalt Beam Therapy Treatment equipment with Catalog Number 3706 beam defining device of 25 cm by 25 cm aperture at a distance of 80 cm.

Under these conditions this source was found to have a radiation output in free air of 5494 roentgens per hour at one meter on 30th July 1985.

The attached decay table for this radioisotope will be useful in estimating the activity at future dates.

This source contained 5444 curies on August 1st, 1985

Signed: Josephine S. Powell

Josephine S. Powell
Dated: August 7th, 1985

The measurement reported is for invoicing purposes only and A.M.S. Inc, assumes no responsibility for results of exposures computed with this value.