



DEPARTMENT OF THE ARMY
MADIGAN ARMY MEDICAL CENTER
TACOMA, WASHINGTON 98431-5000

REPLY TO
ATTENTION OF

June 29, 1987

RECEIVED
NRC
1987 JUL -6 P 12:55
REGION V

Radiation Protection Office

United States Nuclear Regulatory Commission (NRC), Region V
ATTN: Chief, Nuclear Materials Safety and Safeguards Branch
1450 Maria Lane, Suite 210
Walnut Creek, CA 94596

Dear Sir:

The radioactive Cobalt-60 source contained in this medical center's single radiation therapy unit licensed by your organization was exchanged on June 19, 1987. As required by Condition 18 of our NRC Byproduct Material License No. 46-02645-05, a radiation survey of this unit was performed on 20 and 21 June 1987. A copy of this survey is enclosed.

Sincerely,

[Signature]
for Darryl H. Powell, M.D.
Brigadier General, U.S. Army
Commanding

Enclosure

8804120194 BB0323
REG5 LIC30
46-02645-05 PDR

~~70604~~

RADIATION SURVEY

Cobalt-60 Teletherapy Source Replacement

1. Name, Address, License Number, and Telephone Number:

Commander
Madigan Army Medical Center
ATTN: Radiation Protection Office, Box 2458
Tacoma, WA 98431-5000

NRC BML No. 46-02645-05, expiration date 31 Aug 87

Phone: (206)-967-7973

2. Name and Address of Each Person Conducting the Survey:

Major David W. Lee, Radiation Protection Officer, address as above

Captain Joseph P. Hellman, Medical Physicist, address as above except substitute "ATTN:
Radiation Therapy Clinic, Box 419 Phone: (206)-967-6696

3. Reason for Survey: Source Change

4. Date of Source Change: 19 June 1987. NOTE: Source exchange was accomplished by AECL on 19 Jun 87; however, the maintenance/refurbishment of the Cobalt-60 unit was not completed by the AECL NRC-certified source handler until 20 Jun 87.

5. Date Radiation Survey Performed: 20 & 21 June 1987

6. Radiation Measurement Instrumentation Used:

a. Radiation Therapy Instruments Used to Measure the Absolute Radiation Output

Manufacturer: Victoreen and PTW

Model: Victoreen, Model 500 Electrometer; PTW, Model 23333 Chamber

Serial Number: 231 (Electrometer); 486 (Chamber)

Date Last Calibrated: 4 March 1987

Calibration Standards/Methods Used: K & S Associates, an Accredited Dosimetry Calibration Laboratory accredited by the American Association of Physicists in Medicine. This laboratory provided TG-21 calibration factors for a Cobalt-60 source obtained by intercomparison with instruments calibrated by or directly traceable to the National Bureau of Standards. The Cobalt-60 unit was calibrated using the TG-21 protocol (Medical Physics, Vol. 10, No. 6, 1983, pp. 741-771).

b. Radiation Protection Office Instruments

Manufacturer: Victoreen

Model: 470A (Panoramic)

Serial Number: 3569

Date Last Calibrated: 17 July 1986

Calibration Standards/Methods Used: Calibrated by the U.S. Army Calibration and Repair Center, ATTN: AMXTM-CW-SA, Sacramento Army Depot, Sacramento, CA 95813-5035. This center has been licensed by the NRC under BML 4-4279-01 and SNM-507 to perform RADIAC instrument calibration/repair using procedures acceptable to the NRC. A copy of the general RADIAC calibration procedures used by this activity is in the possession of the NRC in the application for renewal of this medical center's Cobalt-60 teletherapy license. This renewal application was transmitted by this medical center on 12 May 87. Receipt of this application was acknowledged by the NRC in a letter dated 9 Jun 87, Docket No. 030-08074, Control No. 70579.

7. Cobalt-60 Unit Name, Model, and Serial Number:

Atomic Energy of Canada Limited (AECL)

Theratron 80

Serial No. 329

8. Cobalt-60 Source Manufacturer and Model

AECL, Type C-146, Source S-4003, 2-centimeter active diameter, leak tested by AECL on 3 Jun 87.

9. New Source Activity and Assay Date

a. Activity: 6168 Curies, assayed by AECL on 22 May 87; 117.5 Rmm +/- 5%

b. Decayed Value as of 20 Jun 87: 6103.83 Ci on the day the absolute radiation output was measured assuming 5.2610 years half-life and 365.242 days/year.

10. Intensity of Primary Beam

Date Measurement: 20 Jun 87

Field Size: 10 cm X 10 cm

Measurement Distance: 80 centimeters source-to-phantom distance. Intensity was measured in water at D_{max} , i.e. at 80.5 centimeters source-to-chamber distance in water.

Results: 168.8 rads/min @ D_{max} , (168.8 cGy/min)

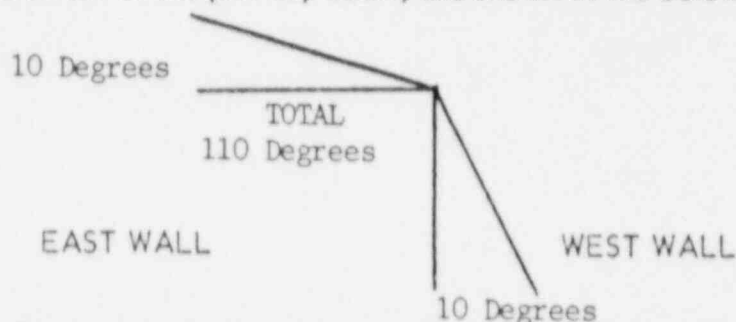
11. Maximum and Average Radiation Exposure Rate One Meter From the Source

See Figure F-1, Teletherapy Head Survey Attached

12. Limits of Beam Orientation -- See Attached Room Sketch

a. Gantry direction is East-West, with head swivel in the North-South direction mechanically prevented. The Theratron 80 has an integral beam absorber directly opposing the source head. For the primary beam directed toward the integral beam absorber, electrical interlocks are set so that the primary beam must be centered (within plus or minus 5 degrees) on the integral beam absorber, and, in that configuration, may be rotated 360 degrees pointing toward the floor, East wall, ceiling, and West wall. Even using the largest collimator field of $33 \times 33 \text{ cm}^2$, the plus or minus 5 degrees interlock has all of the primary beam attenuated by the beam absorber with no portion of the primary beam not absorbed by the integral beam absorber.

b. For the primary beam to be directed away from the integral beam absorber, mercury switches permit the unattenuated primary beam to be directed in a 110 degree arc from 10 degrees toward the West wall to vertically down toward the floor to 100 degrees toward the East wall. These angle limits, which allow the source to enter the "ON" position without the beam absorber in the primary beam, are shown in the below en-face drawing.



13. Radiation Scatter Measurement Results -- See the Attached Room Sketch and Results Sheet

14. Room Plan -- See Attached Room Sketch

15a. Primary beam directed toward the integral beam absorber. Rotational position causing maximum radiation level in each area adjacent to the treatment room, to include above the ceiling.

Phantom Used: MDH Model 8101 Mark I SCRAD Calibration Phantom, 25 cm X 25 cm X 23 cm dimensions. The maximum field size obtainable from the Cobalt-60 unit of 33 cm X 33 cm was used in all of the radiation scatter measurements. The source-to-top of phantom distance was 80 cm.

Instrument Used: Victoreen, Model 740A (Panoramic), Serial No. 3569

15b. Primary beam directed away from the integral beam absorber. Maximum radiation levels were measured within the arc specified in paragraph 12b, above, when no phantom was in the primary beam as indicated in measurement points 8, 9, and 10. Orientation of the primary beam is specified for each measurement on the attached radiation scatter measurements results sheet.

Phantom Used: None

Instrument Used: Same as in 15a, above

16. Compliance:

a. Assume a "worst case" workload on the Cobalt-60 unit of 20 patient treatments/work day, 4 minutes beam "on" time/treatment, and 5 treatment days/work week; then $(20) \times (4) \times (5)$ divided by 60 minutes/hr = 6.7 beam "on" hours/work week. Further, assume 100% occupancy and use of the presently unused attic area above the ceiling and of the unrestricted office space adjacent to the West wall of the Cobalt-60 room, i.e. $T = 1$ and $U = 1$ with a quality factor for gamma radiation of 1, i.e. $QF = 1$ rem/rad and taking Roentgens as being essentially equivalent to rads; then the integrated dose equivalent were a non-radiation worker to occupy these areas continuously for one work hour would be estimated by:

$$\frac{(\text{Radiation Exp Rate} - \text{mR/beam "on" hr}) \times (6.7 \text{ beam "on" hours/work wk}) \times (T=1) \times (U=1) \times (QF=1)}{(40 \text{ work hours/work week})}$$

b. Substituting the 5.8 mR/beam "on" hour measured in the unrestricted office space adjacent to the West wall of the Cobalt-60 treatment room and 4.8 mR/beam "on" hour measured in the attic space above the ceiling yields 0.97 mrem, and 0.80 mrem in any one work hour, respectively. Assuming 8 hours/work day yields 7.7 mrem and 6.4 mrem in any one work day, respectively. Assuming 5 work days/work week, yields 38.5 mrem and 32 mrem in any one work week, respectively. if the Cobalt-60 unit was utilized for 7 consecutive work days, the total beam "on" time would be 9.33 beam "on" hours/week. In this case, the maximum weekly unrestricted office space and above-ceiling attic space radiation dose equivalent to a non-radiation worker occupying these areas 100% of the time would be 54 mrem and 45 mrem in any 7 consecutive days, respectively.

c. Since the integrated scatter radiation dose equivalents to non-radiation workers occupying the unrestricted office space and the above-ceiling attic space are less than 2 mrem in any one hour and less than 100 mrem in any seven consecutive days, the NRC "unrestricted" area criteria for these areas which are adjacent to the Cobalt-60 room are fulfilled.

17. Safety System Tests and Results:

a. Teletherapy treatment door interlock: With the beam "on" as indicated by the control panel lights, the red illuminated light on the unit gantry, and the room radiation monitor adjacent to the control panel, the room entrance door was opened. Opening the entrance door caused the alarm at the control console to sound and the source to return to the "off" position, to turn off. The door was then reclosed and the beam control time turned back on again. The

beam did not come back on. For the beam to come on, the door must be closed, the timer must be manually turned off, and the reset button depressed which causes the reset button on the control console to go off. Opening the room entrance door also caused the source to retract into the "safe," "source off" position as evidenced by:

- (1) The source indicator rod retracting into the head.
- (2) The room radiation monitor returning to the normal, background radiation condition.
- (3) The illumination light on the gantry, console, and door glowed green.

b. Teletherapy "on-off" indicators:

- (1) Beam "On" -- With the beam "on" as indicated by the room radiation monitor:
 - (a) The source indicator rod protruded from the head.
 - (b) The room radiation monitor analog needle pegged to maximum.
 - (c) The gantry, door, and console warning lights glowed red.
- (2) Beam "Off" -- With the beam "off" as indicated by the room radiation monitor:
 - (a) The source indicator rod was fully retracted into the head.
 - (b) The room radiation monitor indicator needle returned to the background radiation position.
 - (c) The gantry, door, and console warning lights glowed green.

c. Stops installed to limit use of primary beam: With the beam absorber rotated out of the primary beam and the head positioned at the angles indicated in paragraph 12, above, the unit was activated at the control console. For angles greater than those specified, above, the source did not come to the "on" position as indicated by the zero reading on the room radiation monitor and by the green illumination of the gantry, console, and door interlock source condition lights.

d. Teletherapy treatment timing device:

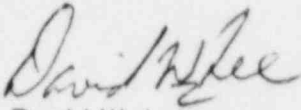
- (1) The accuracy of the timer was checked using a stop watch and a Veri-Timer for times between 0.5 and 5 minutes. The timer was found to be accurate to within plus or minus 0.02 minutes.
- (2) When the timer terminated the radiation exposure, the source fully retracted into the head.
- (3) The source did not come to the "on" position until the console reset button was depressed and the timer reset.

18. Source Removal -- (See attached removal certificate)

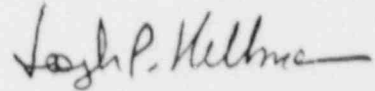
Date of Removal: 19 June 1987

Remover: AECL, Commercial Products, Ottawa, Ontario, Canada, License #54-00300-04

19. Recommended Changes to Source Change Report Format or Content -- No changes recommended.



David W. Lee
Major, U.S. Army
Radiation Protection Officer



Joseph P. Hellman
Captain, U.S. Army
Medical Physicist

RADIATION SCATTER MEASUREMENT RESULTS

1. Measurement Conditions:

a. When the head was directed directly toward the floor, this head position was considered to be the 0 degree position. When the head was rotated clockwise as viewed through the viewing window until the primary beam pointed directly toward the East wall, this head position was considered to be 90 degrees. When the head was rotated to the upside down position with the beam/beam absorber pointing directly toward the ceiling, this position was considered to be the 180 degree position. When the head was rotated toward the West wall with the beam/beam absorber pointing directly toward the West wall, this position was considered to be the 270 degree position.

b. The maximum field size obtainable from the Cobalt-60 unit was used, i.e. 33 cm X 33 cm.

c. An MDH, Model 8101 Mark I SCRAD calibration phantom was used whose dimensions were 25 cm X 25 cm X 23 cm. This top surface of the phantom was placed 80 cm from the source. Since the field size used was greater in area than the phantom, some primary beam photons were not intercepted by the phantom. These unattenuated primary photons were intercepted by the beam absorber. For measurements #8, #9, and #10, the beam absorber was rotated out of the primary beam and the head directed 90 degrees clockwise toward the East wall (primary barrier) without a phantom since this configuration produced the greatest (worst case) radiation exposure rate. Given these measurement conditions, the radiation scatter measurement results are considered to be "worst case."

2. Radiation Measurement Results:

<u>Measurement Point</u>	<u>Exposure Rate (mR/hr)</u>	<u>Head Position</u>
#1	0.0	Zero degrees with phantom/beam absorber
#2	0.0	Zero degrees with phantom/beam absorber
#3	2.0	245 degrees with phantom/beam absorber
#4	5.8	245 degrees with phantom/beam absorber
#5	0.2	245 degrees with phantom/beam absorber
#6	0.2	245 degrees with phantom/beam absorber
#7	0.0	Zero degrees with phantom/beam absorber

<u>Measurement Point</u>	<u>Exposure Rate (mR/hr)</u>	<u>Head Position</u>
#8	0.4	90 degrees--No phantom or beam absorber
#9	0.0	90 degrees--No phantom or beam absorber
#10	0.0	90 degrees--No phantom or beam absorber
#11	0.0	Zero degrees with phantom/beam absorber
#12	0.0	Zero degrees with phantom/beam absorber
#14	0.0	Zero degrees with phantom/beam absorber
#15	0.0	Zero degrees with phantom/beam absorber
#16 (Attic)	4.8	205 degrees with phantom/beam absorber

RADIATION SURVEY		DEPARTMENT Radiation Therapy Clinic		DATE																																																													
		LOCATION Bldg 9909C																																																															
PRINCIPAL USER Dr. Kull		TYPE OF SURVEY Stripes		SURVEYOR																																																													
SURVEY INSTRUMENT	SERIAL NUMBER	CALIBRATION DUE		QC CHECK OK? Y N																																																													
ROOM SKETCH		<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="text-align: left;">VISUAL INSPECTION/REMARKS</th> <th>Y</th> <th>N</th> <th>NA</th> </tr> </thead> <tbody> <tr><td>NRC Form 3 Posted</td><td></td><td></td><td></td></tr> <tr><td>Rad Warning Signs Properly Posted</td><td></td><td></td><td></td></tr> <tr><td>Dosimeters Being Worn</td><td></td><td></td><td></td></tr> <tr><td>Adequate Isotope Storage</td><td></td><td></td><td></td></tr> <tr><td>Adequate Rad Waste Storage</td><td></td><td></td><td></td></tr> <tr><td>No Eating/Smoking in Radiation Area</td><td></td><td></td><td></td></tr> <tr><td>No Food in Radiation Refrigerator</td><td></td><td></td><td></td></tr> <tr><td>Daily Survey Being Performed</td><td></td><td></td><td></td></tr> <tr><td>SOP Posted/Available</td><td></td><td></td><td></td></tr> <tr><td>KENALERT Logs Being Maintained</td><td></td><td></td><td></td></tr> <tr><td>Sink Logs Being Maintained Properly</td><td></td><td></td><td></td></tr> <tr><td> </td><td></td><td></td><td></td></tr> <tr><td> </td><td></td><td></td><td></td></tr> <tr><td>Clean-up & Resurvey Necessary</td><td></td><td></td><td></td></tr> </tbody> </table>				VISUAL INSPECTION/REMARKS	Y	N	NA	NRC Form 3 Posted				Rad Warning Signs Properly Posted				Dosimeters Being Worn				Adequate Isotope Storage				Adequate Rad Waste Storage				No Eating/Smoking in Radiation Area				No Food in Radiation Refrigerator				Daily Survey Being Performed				SOP Posted/Available				KENALERT Logs Being Maintained				Sink Logs Being Maintained Properly												Clean-up & Resurvey Necessary			
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		SUSPECT ISOTOPES <div style="text-align: center; font-size: 1.1em;">Cobalt-60</div>																																																															
		COUNTING INSTRUMENT Autogamma		COUNTING TIME (MIN) 1.0 min																																																													
		BACKGROUND CPM See Below	MDA ($\sqrt{\text{BKG}/\text{TIME}}$)																																																														
		DECIMAL EFF 0.52	FOR Co-60	MIN SENSITIVITY (DPM)																																																													
		ANALYSIS BY SFC Robinson		RPO REVIEW <i>[Signature]</i>																																																													
ITEM/LOCATION	CPM mR/Hr	NET DPM $\pm 2\sigma$	ITEM/LOCATION	CPM mR/Hr	NET DPM $\pm 2\sigma$																																																												
1. Outside of New Source Container (Fire Shield)			16.																																																														
2. Background = 313 cpm (601 dpm) 19 Jun 87			17.																																																														
3. Top	Less than Background		18.																																																														
4. Right Side	Less than Background		19.																																																														
5. Back	2.6×10^{-5} microcuries		20.																																																														
6. Left Side	4.3×10^{-6} microcuries		21.																																																														
7. Front	Less than background		22.																																																														
8.			23.																																																														
9. Source Leak Test--21 Jun 87			24.																																																														
10. Background = 307 cpm (590 dpm), eff = 0.52			25.																																																														
11. Upper Collimator--Less than background			26.																																																														
12. Source Traverse Tube-- 4.85×10^{-5} microCi			27.																																																														
13.			28.																																																														
14.			29.																																																														
15.			30.																																																														
NOTIFICATIONS			LEGEND																																																														
A. $2100\text{DPM}/100\text{cm}^2$ BUT $4500\text{DPM}/100\text{cm}^2$ No Resurvey NAME _____ DATE _____ TIME _____			B. $2500\text{DPM}/100\text{cm}^2$ Resurvey Required NAME _____ DATE _____ TIME _____																																																														
			$\text{NET DPM} = (\text{CPM} - \text{BKG})/\text{EFF}$ $2\sigma = 2(\sqrt{(\text{CPM} + \text{BKG})/\text{TIME}})/\text{EFF}$																																																														

Figure F-1 TELETHERAPY HEAD SURVEY

(Source in "OFF" position.
Measurements taken one meter
from source)

Top View-Showing
orientation
of Views A through D

Position No.	Radiation Level (mR/hr)
View A	
1	1.9
2	0.4
3	4.4
4	2.5

View B	
5	2.7
6	2.4
7	1.0
8	0.0

View C	
9	2.0
10	2.5

View D	
11	0.2
12	0.5
13	2.8
14	1.4

Average value 1.76 (Sum 1-14/14)

Maximum value 9.5 (Pt 4)

Date of survey 20 & 21 Jun 87

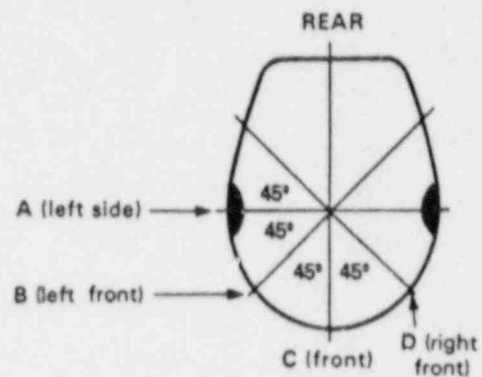
Instrument used Vict. Mod 470A
SN 3569

Manufacturer's
name & model number AECL, Type C-146
S-4003

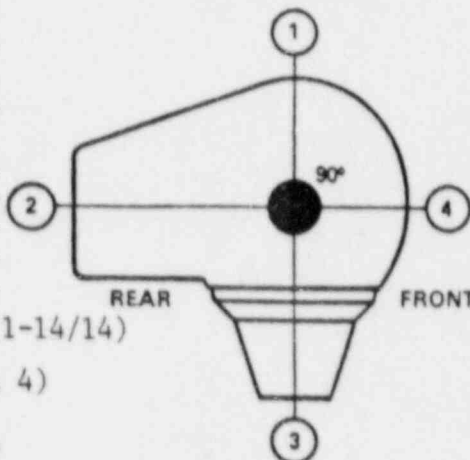
Date of installation 19 Jun 87

OUTPUT 117.5 ☐ RHM
☒ RMM

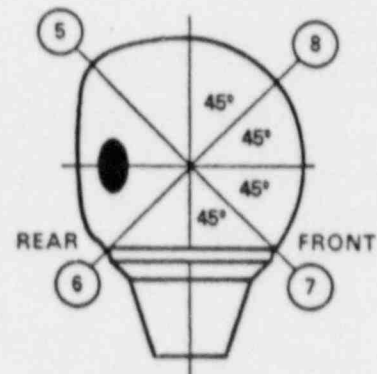
Date of output
measurement 22 May 87 by AECL



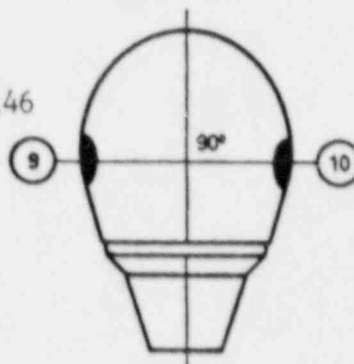
View A-Vertical
from left side



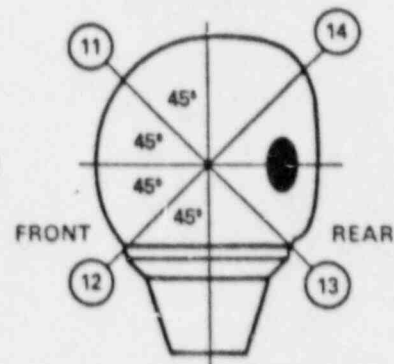
View B-Vertical
from left front



View C-Vertical
from front

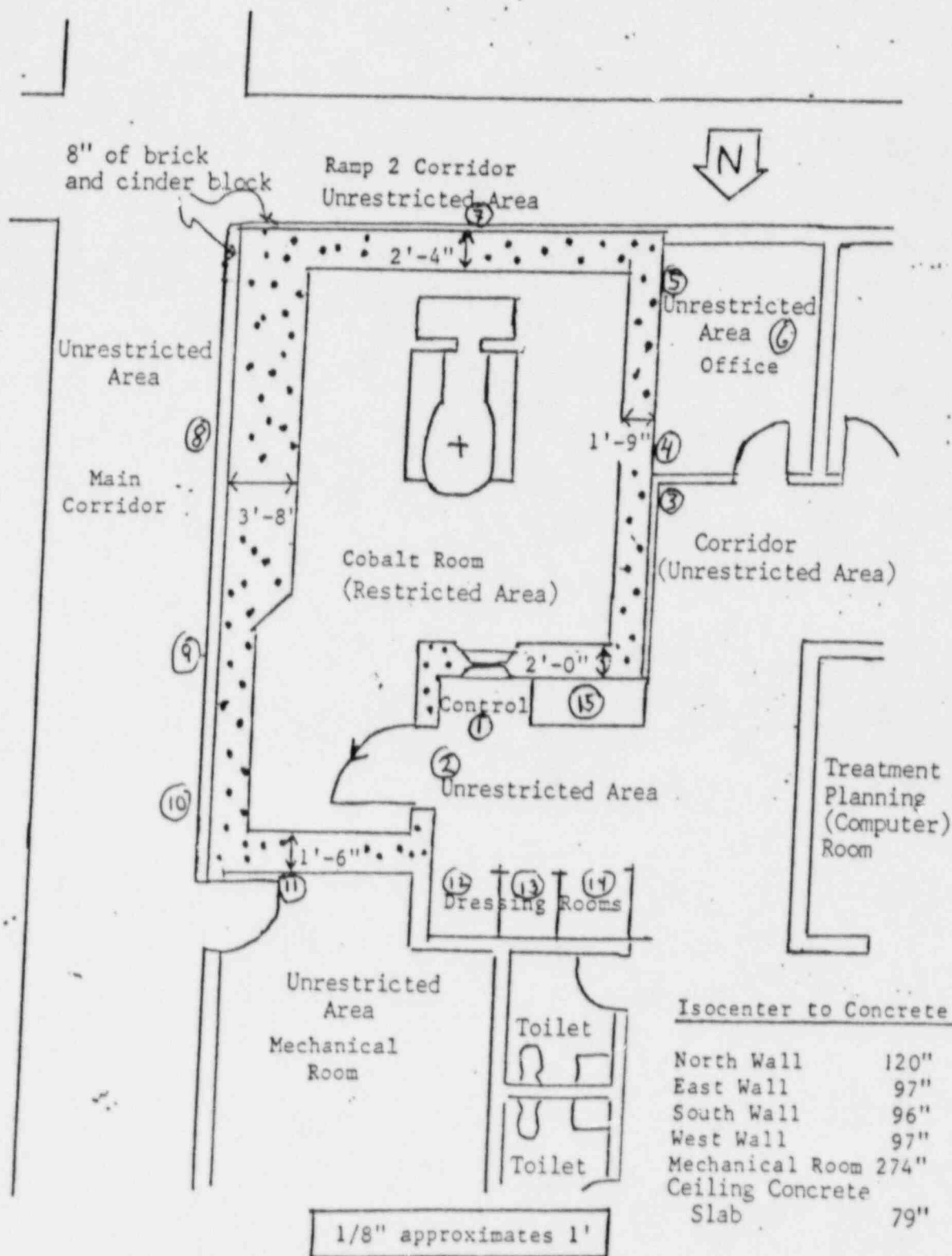


View D-Vertical
from right front



NOTE: Installed Absolute Radiation Output: 168.8 cGy/minute @ 80.5 cm (D_{max})
in water measured by the medical physicist on 20 Jun 87

Cobalt-60 Treatment Room
Building 9909
Madigan Army Medical Center



Floor = Concrete slab on fill, no basement

Ceiling = 24-inch concrete slab with secured crawl space above slab

Plane of Rotation = East-West

Concrete (Assumed to be 2.35 g/cm^3) per NCRP Report No. 35

NOTE: Radiation Scatter measurement #16 = Ceiling

Below Floor = No Occupancy



Atomic Energy of Canada Limited

SOURCE DISPOSAL CERTIFICATE

TO WHOM IT MAY CONCERN:

This is to certify that the following source has been removed from the unit described herein, and returned to Atomic Energy of Canada Limited, Commercial Products, Ottawa, Ontario, Canada for disposal:

COBALT 60 OR CAESIUM 137 SEALED SOURCE Co 60	SERIAL NO. S-3490	DEPLETED URANIUM lb	UNIT THERATRON 80	UNIT SERIAL NO. 329
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LOCATION OF UNIT

MADIGAN ARMY MEDICAL CENTER

TACOMA, WASHINGTON

Date: 20 June 1987

Signed:

A.E.C.L. Service Representative