m2

DEPARTMENT OF THE ARMY
FITZSIMONS ARMY MEDICAL CENTER
AURORA, COLORADO 80045

0888

HSF-X 30 April 1981

SUBJECT: Additional Information Requested Regarding Teletherapy Facility Survey

RECEIVED MAY 8 AM 10 16

THRU: HQDA
DASG-PSP-R/COL Wangemann
Washington, D.C. 20310

Wangemann 4 May 81
ROBERT T. WANGEMANN
Colonel, MSC
Radiological Hygiene Consultant

TO: US Nuclear Regulatory Commission
Material Licensing Branch
Division of Fuel Cycle and Materials Safety
Washington, D.C. 20555

1. Reference is made to NRC Control No. 06613.

2. Head leakage measurements with the source in the OFF position are attached as Inclosure 1.

3. a. Inclosure 2 is a diagram of the facility indicating locations at which environmental radiation measurements were taken, as well as the use of each area adjacent to the treatment room. Radiation levels were measured with the primary beam directed toward the integral beam absorber, the collimators fully open, and a phantom in the beam. The teletherapy unit was operated in the rotational mode with the source on. The maximum exposure levels and corresponding gantry angles were as follows:

Measurement Point	Location	Maximum Exposure Rate (mR/hr)	Gantry Angle
		TPCF = 1.2	
A	Control Panel	0.3	160°
B	Treatment Room Window	4.1	150°
C	Treatment Room Door	4.0	95°
D	Generator Room (South)	0.1	All angles
E	Storage Room (South)	13.0	50°
F	Transformer Room (South)	0.1	All angles
G	Crawl Space (West)	0.6	330°
H	Crawl Space (North)	1.0	275°
I	Examination Room (East)	0.2	0°
J	Storage Room (Above)	5.0	150°

COPIES SENT TO OFF. OF INSPECTION AND ENFORCEMENT

b. The highest exposure level occurred in the storage area south of the treatment room where 13 milliroentgens per hour was measured in a small volume next to the wall. Compressed gas bottles are stored in this room. In making the calculations to show compliance with Section 20.105(b), (1) and (2) of 10 CFR, Part 20, the following data were used and assumptions made. We are currently treating 13 patients with a mean of 2.2 fields per patient per day (28 total fields per day ÷ 13 patients) and a mean beam "on-time" of 1.01 minutes per field (28.4 minutes ÷ 28 fields). The patient load over the past 12 months has been approximately 20 patients treated per day, therefore it was assumed that the patient load would be 20 per day in the forseeable future. Multiplying the patients per day by the average number of fields treated per day per patient by the average "beam-on" time per field yields a total daily on-time of 44.4 minutes (20 x 2.2 x 1.01 = 44.4). To incorporate a conservative estimate of patient increases in the future, the total daily beam-on time was assumed to be 60 minutes. Utilizing a beam-on time of 1 hour per day over an 8-hour period results in an average of 7.5 minutes of beam-on time per hour (60 minutes ÷ 8 hours). Additional assumptions made were that the occupancy factor and use factor were unity. These assumptions led to the calculation that the maximum exposure which could be received by an individual in any one hour in the storage room was 1.6 milliroentgens.

Recap: Beam-On time = 7.5 minutes per hour
Maximum exposure rate = 13 milliroentgens per hour
Use factor = 1
Occupancy factor = 1

$$\frac{13\text{mR}}{60\text{min}} \times \frac{7.5 \text{ min (on time)}}{\text{hr}} \times 1 \times 1 = 1.6\text{mR in any one hour}$$

Cognizance must also be taken of the fact that this measurement represented an isolated "hot spot" in the storage room and the exposure rates around the general area of approximately one square meter were less than 5 milliroentgens per hour; therefore, the 1.6mR exposure calculated above would not constitute a whole body exposure. Further, the storage room is locked at all times when not occupied and the probability of a person occupying the actual location of the measurement, approximately 1 foot from the wall, is so small due to gas containers being secured to the wall in that area, that any exposure received by personnel in the room would be extremely small. However, in order to document the actual exposure received in the storage room, two film badge dosimeters have been placed in the vicinity of the "hot spot" and will be exchanged, read, and recorded monthly for the next six months.

c. The area above the teletherapy unit is used by the Food Service Division for storage of food. The exposure rate of 5 milliroentgens per hour was located over a pallet on which canned goods were stored and again was found to exist in only a very small volume. Utilizing the same assumptions as above, the maximum

exposure that a person could receive would be 0.6 milliroentgens in any one hour. Thus, it is not possible for an individual to receive more than 2 milliroentgens in any one hour or more than 100mR in seven consecutive days at the present time nor in the foreseeable future. It is also important to note that the gantry angle of 150° required to produce this maximum reading is totally impractical for actual radiation treatment since the primary beam must pass through the table before reaching the patient. The stretcher is not designed for treatment from below the patient, and the radiotherapist would never prescribe such an angle due to the loss of the skin-sparing effect and attenuation and scatter of the primary beam. The only rotational therapy prescribed on this teletherapy unit consists of lateral arcs which do not include treatment through the table-top. However, two film badge dosimeters have been placed in the food storage area to record and produce a record of actual exposure received in the area. They will be exchanged monthly for the next six months to clearly establish the environmental radiation level.

d. The exposure rates measured near the treatment room door and window are in a controlled area and thus occupancy is only by occupationally exposed individuals. Although it is possible to produce a geometry in which the exposure rate exceeds 2 milliroengtens per hour through the leaded window in the treatment room door, the gantry angle required to produce this was 150°, which was the same as that which resulted in the maximum reading in the food storage area above the teletherapy unit and was discussed in the previous paragraph. It is a totally impractical orientation of the beam for a therapy treatment with this machine.

e. The gantry angle orientation of 95° which produced an exposure rate of 4.0 milliroentgens per hour through the left side of the treatment room door is one likely to be used in routine therapy setups. However, a historical record of exposure through the door and window has been established by the personnel dosimetry exposure records of the technologists. They are 100% faithful in wearing their badges and yet their monthly exposures are consistently less than 25 millirem. This exposure, of course, also includes their time spent in the vicinity of the machine setting up patients for treatment, an environment much more likely to contribute the majority of their film badge dosimeter readings. Based upon the exposure histories of the technologists, the maximum exposure levels measured at the door, and the assumed beam-on time of 60 minutes per day, it is not conceivable that a person could exceed the radiation level requirements for an unrestricted area as specified in Section 20.105(b), (1) and (2) of 10 CFR 20. To further document the environmental radiation exposure, one film badge dosimeter has been placed on the door, also one on the window, and monthly results will be accumulated over the next 6 months to establish the actual radiation level existing outside the treatment room door.

HSF-X

SUBJECT: Additional Information Requested Regarding Teletherapy Facility Survey

4. a. Radiation exposure levels were also measured with the primary beam directed away from the integral beam absorber. Electrical interlocks prohibit the operation of the source drawer whenever the primary beam is directed away from the integral beam absorber except in the arc defined by the axis of the beam from 2° toward the south wall to 83° towards the north wall as measured from an imaginary vertical line between the source and the treatment room floor. The exposure levels were taken with the collimators opened to their fullest extent and the primary beam oriented as shown in Inclosure 3. A phantom was in the primary beam for all measurements.

EXPOSURE RATES (mR/hr)

	Angle of Central Axis							
Measurement Point	-2°	0°	15°	30°	45°	60°	75°	83°
A-Control Panel	0.1	0.2	0.1	0.1	0.1	0.1	0.1	0.1
B-Treatment Room Window	0.9	0.9	0.3	0.2	0.1	0.1	0.1	0.1
C-Treatment Room Door	1.8	1.5	0.7	0.2	0.2	0.1	0.1	0.1
D-Transformer Room (South)	0.1	*	*	*	*	*	*	*
E-Storage Area (South)	0.5	0.5	0.2	0.2	0.1	0.1	0.1	0.1
F-Generator Room (South)	0.1	*	*	*	*	*	*	*
G-Crawl Space (West)	0.1	0.1	0.3	0.4	0.1	0.2	0.1	0.1
H-Crawl Space (North)	0.1	0.1	0.2	3.5	0.2	0.2	0.3	1.0
I-Examination Room (East)	0.2	0.2	0.3	0.3	0.4	0.3	0.2	0.2
J-Storage Area (Above)	0.2	0.1	0.1	0.1	0.1	0.1	0.2	0.2

* Not measured due to the realtive position of these areas with respect to the plane of source rotation and the fact that exposure rates in these rooms while the unit was in the rotational mode were less than 0.1 milliroentgen per hour for all angles. Also considered was the fact that the radiation levels in these areas measured less than 0.1 milliroentgen per hour when the primary beam was directed away from the integral beam absorber and the source head swiveled 2° toward the south wall. All other beam orientations directed the primary radiation and scattered radiation away from these areas.

b. Only one beam angulation (30°) resulted in an exposure rate greater than 2 milliroentgens per hour in any of the areas adjacent to the teletherapy room when the primary beam was directed away from the intergral beam absorber.

On top of the dirt revetment in the drawl space north of the teletherapy unit an exposure level of 3.5 milliroentgens per hour was measured. Calculations based upon the assumptions in paragraph 3 clearly show that it would not be possible for an individual to receive an exposure in excess of 2 milliroentgens in one hour or 100 milliroentgens in 7 consecutive days. Further, in the past 2 years, no treatments have been given in which the primary beam was directed away from the integral beam absorber. To document the cumulative exposure received at this point, 2 film badge dosimeters have been placed in the area; they will be exchanged monthly and a record maintained for future inspections.

5. The interlock system on the treatment room door was tested for proper operation by first clearing the teletherapy room of all personnel, leaving the door slightly ajar, depressing the RESET button on the control panel, setting one minute on the timer and turning the timer switch to the "on" position. The teletherapy unit did not go on nor did the timer begin to run. It was observed that the RESET button was still illuminated. The RESET button was depressed several times but still remainedli. and the switch on the timer did not cause the source drawer to move on the cobalt unit. It was not possible to turn the teletherapy unit on with the door open. Only ofter closing the door securely and depressing the RESET button would the light behind the RESET button go off, indicating that the interlock circuit was complete. The timer switch was then turned on and the source moved to the EXPOSE position. The door was then eased slightly ajar to open the interlock switch and the source to the "off" position. The door was then closed securely to close the interlock and the source did not re-expose. Attempts to expose the source without first turning the timer switch to OFF, pressing the RESET button, and then turning the timer switch back on were futile.

6. a. The teletherapy source ON-OFF indicators were tested by observing the following indicators while the source was in the "off" position.

1. Control console: "Beam off" green light illuminated.

2. Over treatment room door: Green light illuminated.

3. Lights on gantry: Green light illuminated.

4. Rod on end of source drawer: Could not be seen (beam off condition).

5. Radiation monitor in treatment room (Nuclear Associates Primalert-10): Red light not flashing.

b. The room was then clearedof all personnel, the door closed securely, the RESET button on the control console was depressed, one minute was set on the timer, and the timer switch was turned to ON. The following observations were made from outside the treatment room via the closed circuit television system, window in the treatment room doo., and parabolic mirror mounted inside the room:

1. A distinct sound of the pneumatic cylinder pushing the source drawer into the ON position was heard.

2. The "Beam off" light on the control console went off and the red "beam on" light illuminated.

3. The green light over the treatment room door went off and the red light came on.

4. The green light on the gantry went out and the red light illuminated.

5. The red painted rod on the front of the source drawer was observed extending out the front of the teletherapy head indicating the source drawer was positioned fully forward.

6. The bright red light was flashing on the radiation monitor in the treatment room.

c. Additionally, a radiation survey meter was turned on its lowest scale, held up to the treatment room door, and an increase in the radiation level was noted outside the room.

d. After the one minute elapsed on the timer, the switch returned to the OFF position and all indicators reverted to the original observations noted above.

e. The operation of the radiation room monitor had previously been tested by holding a low activity radioactive check source near it and observing that the red light would flash whenever the source was positioned nearby.

7. Electrical interlocks installed for the purpose of limiting use of the primary beam of radiation were tested for proper operation as follows. The head of the teletherapy unit was rotated so that the collimator assembly and central ray pointed toward the south wall at an angle of 2^{o} from vertical, while the gantry was in the 0^{o} or vertical orientation. The room was cleared of all personnel and the door was closed securely. The RESET button was pushed, one minute was set on the timer, and the timer switch turned on. The source moved to the EXPOSE position as indicated by all the appropriate electrical and mechanical indicators. The timer was then turned off and the source returned to the OFF position. Then the head was swiveled to 3^{o} toward the south wall and the procedure repeated. The door was tightly closed, the RESET button depressed, one minute was set on the timer, and the timer switch turned ON, however, the source failed to be moved to the "on" position. All attempts to cause the source to move to the ON position were futile. Next the gantry was tilted to the 357^{o} position, with the net result that the central ray was again vertical, the procedure repeated, and it was observed that the source drawer could again be moved into the "source on" position. Various combinations of head swivel angles and gantry rotation angles, with the integral beam absorber

well out of the radiation field, verified that the source would not come "on" if the central axis of the primary beam was angled greater than 2° southward from a vertical line through the source and the treatment room floor. To test the electrical interlock for the opposite extent of permissible beam orientation, the gantry was returned to the vertical, or 0°, position. The head was then rotated to an indicated angle of 83° on the bezel. The usual procedures for activating the source drawer were accomplished and it was observed that the source was placed in the "on" position. The timer switch was turned off and the head was swiveled to 85°. The procedures were followed to expose the source, however, when the timer switch was turned on, the source drawer did not move. All usual attempts to expose the source were futile. The door was securely closed, the RESET button had been depressed and was no longer illuminated, and time still remained on the timer. Again, by rotating the gantry and adjusting the angle of the head so that the net angle between the central ray and the vertical line through the source to the floor did not exceed $83^{\circ} \pm 1^{\circ}$, the source drawer never failed to move to the "on" position, but if the angle exceeded $83^{\circ} \pm 1^{\circ}$ it was not possible to turn the beam "on" by the normal procedures.

8. The teletherapy treatment timing device was tested for accuracy by clearing the treatment room of all personnel, closing the door securely, depressing the RESET button and setting one minute on the timer. A verification timer has also been installed in the circuit which is automatically set to zero each time the RESET button is depressed. Utilizing a quartz digital stopwatch, both the stopwatch and timer switch were turned on simultaneously and the source was observed to move to the EXPOSE position. The time on the treatment timer was allowed to elapse and the stopwatch was stopped coincidentally. The source was observed to return to the "off" position by all the source position indicators. The stopwatch and verification timer were in agreement to within 0.02 minute of the time set on the treatment timer. This procedure was repeated for 0.4, 0.8, 1.25, 1.75, 2.00, 2.5, and 3.0 minute intervals set on the treatment timer and each time, the stopwatch and verification timer corroborated the time set on the treatment timer within 0.02 minute. After the time elapsed on the timer and the indicators pointed at 0.00 minutes remaining, the timer knob was again turned to the "on" position. The switch is spring-loaded and would immediately return to the "off" position unless forcibly held on. If the switch were forcibly held on, the source was observed to move to the "beam on" position; however, it would not remain on when the switch was released. The only way to cause the source to remain on was to set some time other than 0.00 minutes on the treatment timer so that the timer would remain on.

HSF-X
SUBJECT: Additional Information Requested Regarding Teletherapy Facility Survey

9. Due to the short suspense, the Radiological Hygiene Staff Office, HSC, directed that this correspondence be mailed directly to OTSG.

FOR THE COMMANDER:

Incl 3
as

George H. Touchard
GEORGE H. TOUCHARD, JR.
Major, MSC
Adjutant General

CF:
Cdr, USAHSC
ATTN: HSPA-P/COL Pitchford
Ft Sam Houston, TX 78234

Source in OFF position.
Measurements taken one
meter from source.

Position No.		Radiation Level (mR/hr)
View A	1	3.0
	2	2.2
	3	1.1
	4	2.8
	5	3.2
	6	0.2
	7	4.0
	8	0.1
View B	9	1.7
	10	2.4
	11	1.3
	12	0.4
View C	13	2.5
	14	2.0
	15	2.0
	16	2.5
	17	0.8
	18	0.7
View D	19	0.3
	20	0.9
	21	2.2
	22	2.6
Top View	23	1.7
	24	0.1
	25	0.1
	26	1.9

µR 70
1.64
x1.2
(1.97?)

TPCF = 1.2

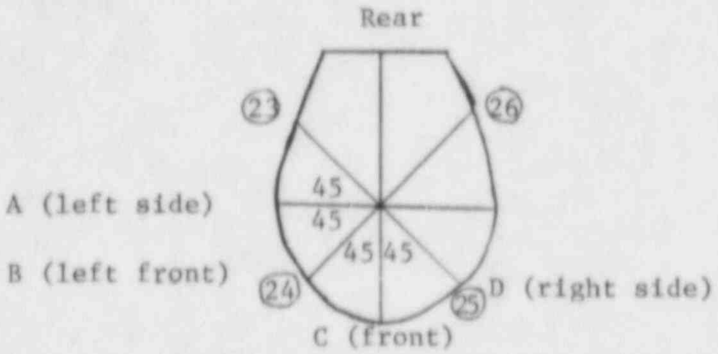
Average Value = 1.9mR/hr

Maximum Value = 4.8mR/hr

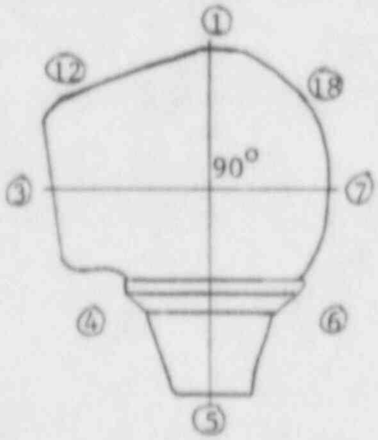
Instrument Used:
Victoreen 440

Calibrated: 6 Jan 1981

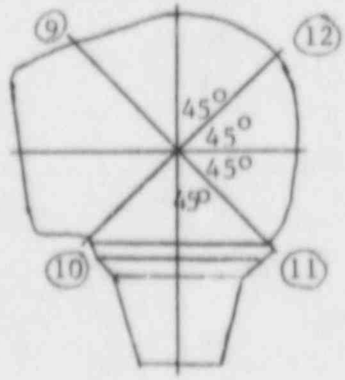
Top View - showing orientation
of Views A through D



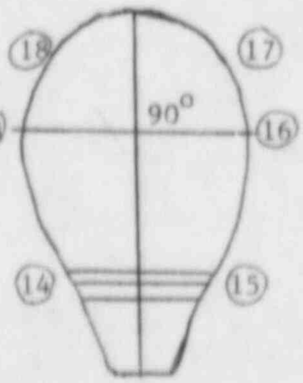
View A - Vertical from left side



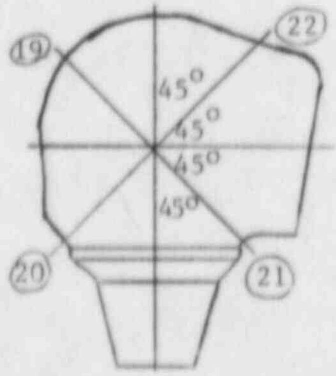
View B - Vertical
from left front



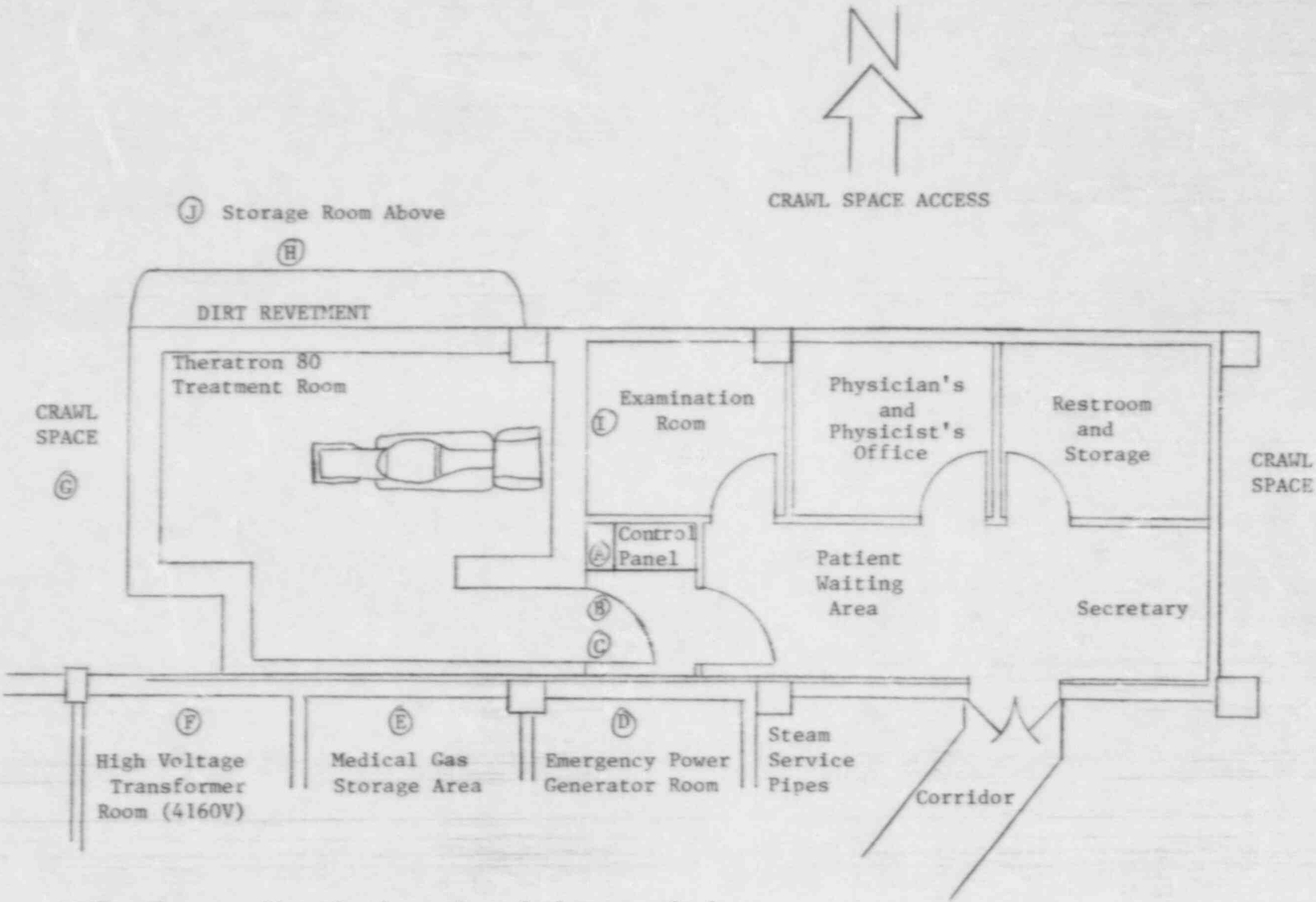
View C - Vertical from front



View C - Vertical
from right front

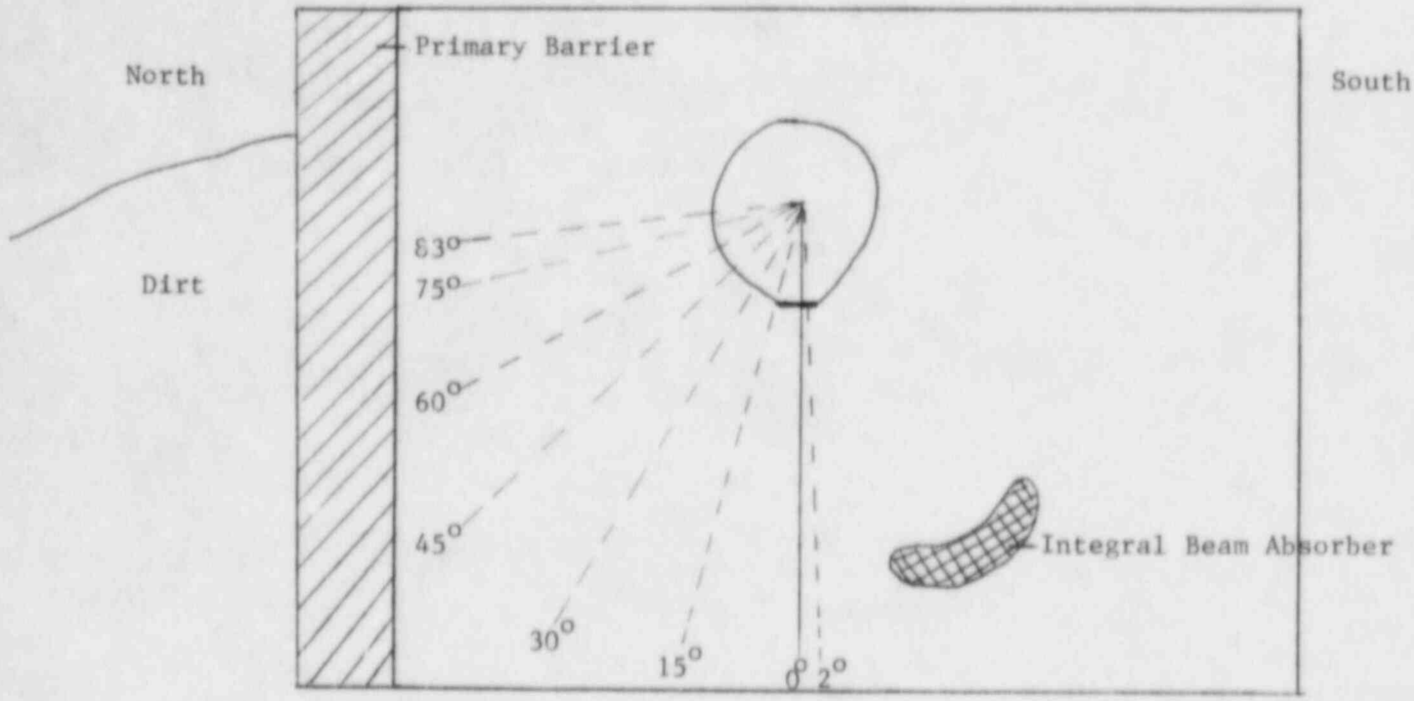


Inclosure 1



NOTE: The area directly above the teletherapy unit is a food storage area. The Theratron 80 is located in the basement therefore access below the unit is not possible.

Inclosure 2



View From West Wall Towards Machine

Inclosure 3