LEONARD S. ROSEN, M.D., F.A.C.R.
DANIEL S. CUKIER, M.D., M.A.C.R.
DAVID N. BRAMWIT, M.D., M.A.C.R.
FRANK GINGERELLI, M.D., M.A.C.R.
STEPHEN Z. KAUFMAN, M.D., M.A.C.R., D.A.B.N.M.
JAE N. KIM, M.D., PH.D., M.A.C.R., D.A.B.N.M.

HERBERT S. SHARLIN, M.D., F.A.C.R.
CONSULTANT

DIAGNOSTIC RADIOLOGY
XERORADIOGRAPHY
THERAPEUTIC RADIOLOGY
LINEAR ACCELERATOR
COBALT TELETHERAPY
NUCLEAR MEDICINE

SHARLIN RADIOLOGICAL ASSOCIATES, P.A.
35 PANGBORN PLACE
HACKENSACK, N. J. 07601

TELEPHONE (201) 342-7558

30-14993

September 20, 1985

United States Nuclear Regulatory Commission
Region I
631 Park Avenue
King of Prussia, PA 19406

Attn: John Glenn, Ph.D.

Dear Dr. Glenn:

Please find the enclosed radiation protection survey performed on our Cobalt-60 Teletherapy unit following replacement of the source. This report is submitted as a requirement by condition 18 of our license (29-16796-02). In accordance with Section 20.201 of 10 CFR Part 20.

Should you require further information, please do not hesitate to contact me.

Sincerely,

Frank Gingerelli, M.D.
Sharlin Radiological Assoc., P.A.
35 Pangborn Place
Hackensack, N.J. 07601

FG/mm

enclosure

cc: U.S.N.R.C.
c/o Document Management Branch
Washington, D.C. 20555

IE07
1/1

SHARLIN RADIOLOGICAL ASSOCIATES, P.A.
35 Pangborn Place
Hackensack, New Jersey 07601

RADIATION SAFETY SURVEY

NRC License # 29-16796-02

THERATRON 80

Source Manufacturer:		Neutron Products, Inc.
Model Number	:	NPI-20-6000W
Serial Number	:	T-788
Source Installed	:	September 13, 1985
Curie Content	:	6410 curies on September 13, 1985
Date of Survey	:	September 16, 1985

I. Beam Output Calibration

The exposure rate was measured on September 16, 1985 for the range of field sizes and for the range of distances used in treatment in compliance with 10 CFR 35.21. A Capintec model 192 electrometer with .6cc probe was used for the calibration. The Capintec Electrometer was last calibrated on March 9, 1984 at K & S Associates, Inc., 1854 Airlane Drive, Nashville, Tennessee. A copy of the calibration report is also appended.

II. Teletherapy HEAD Survey - Beam "Off"

The head survey was made with the beam in the "off" position at 1 meter from the source. A Victoreen Survey Model # 471A, Serial # 319, was used to perform this survey. Please see attached calibration certificate specifying calibration method and date. Table I specifies the maximum and average radiation levels surrounding the head. The head is in compliance with NCRP Report # 33, since the average exposure rate at 1 meter does not exceed 2.0 mR/hr., and the maximum exposure rate at 1 meter does not exceed 10.0 mR/hr..

III. Limits of BEAM ORIENTATION

Electrical and mechanical interlocks are installed so that the primary beam can not be directed off the beam absorber. The limit the primary beam is permitted away from the center line of the integral beam stopper is less than 5 degrees + or -.

Conversion from rads/min to RHM (Roetgens per hour at 1 meter) for a 10 x 10 field and 20 x 20 field at 80cm SAD.

1) 10cm x 10cm field at 80.0cm SAD = 163.7 rads/min.

$$\frac{163.7 \text{ rads/min} \times \left(\frac{80}{100}\right)^2 \times 60 \text{ min/hr}}{(.967)(.989)} = 6573 \text{ RHM}$$

where .967 = F (rads/R) water
.989 = Aeg

2) 20cm x 20cm field at 80.0cm SAD = 170.6 rads/min.

$$\frac{170.6 \text{ rads/min} \times \left(\frac{80}{100}\right)^2 \times 60 \text{ min/hr}}{(.967)(.989)} = 6850 \text{ RHM}$$

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

Position No.		Radiation Level (mR/hr)
View A	1	3.2
	2	1.1
	3	3.6
	4	1.0 (shield installed)
View B	5	1.3
	6	2.2
	7	0.5
	8	0.2
View C	9	1.5
	10	1.7
View D	11	0.2
	12	0.4
	13	2.3
	14	3.6

Average value 1.6

Maximum value 3.6

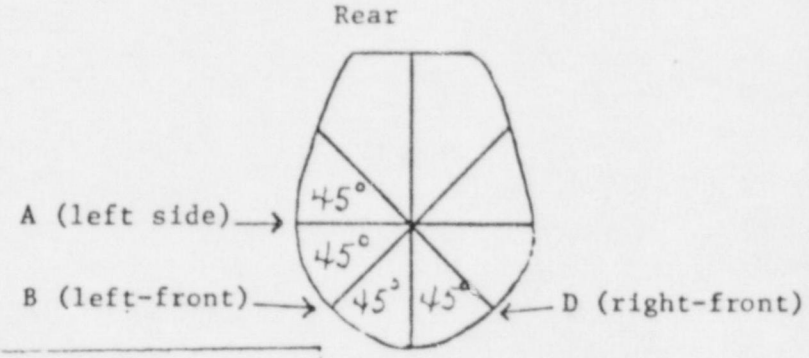
Instrument used

Victoreen 471A

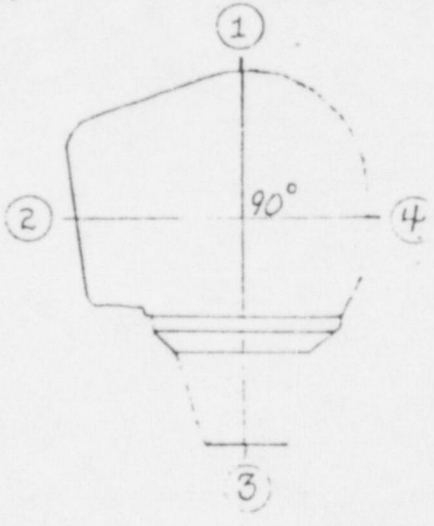
Curies & Date 6410, 9/13/85

Manufacturer's name & model # of teletherapy unit AECL Theratron 80

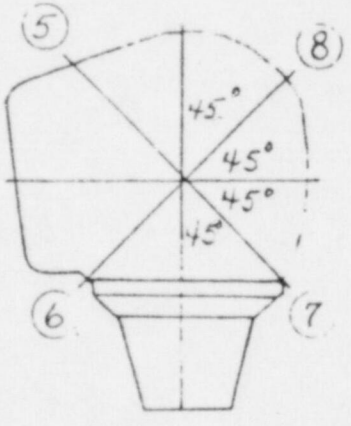
Top View - Showing orientation of Views A through D



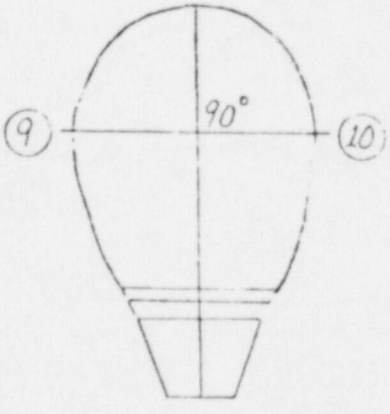
View A - Vertical from left side



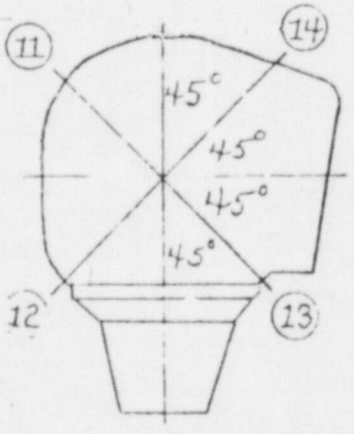
View B - Vertical from left-front



View C - Vertical from front



View D- Vertical from right-front



IV. Room Protection Survey

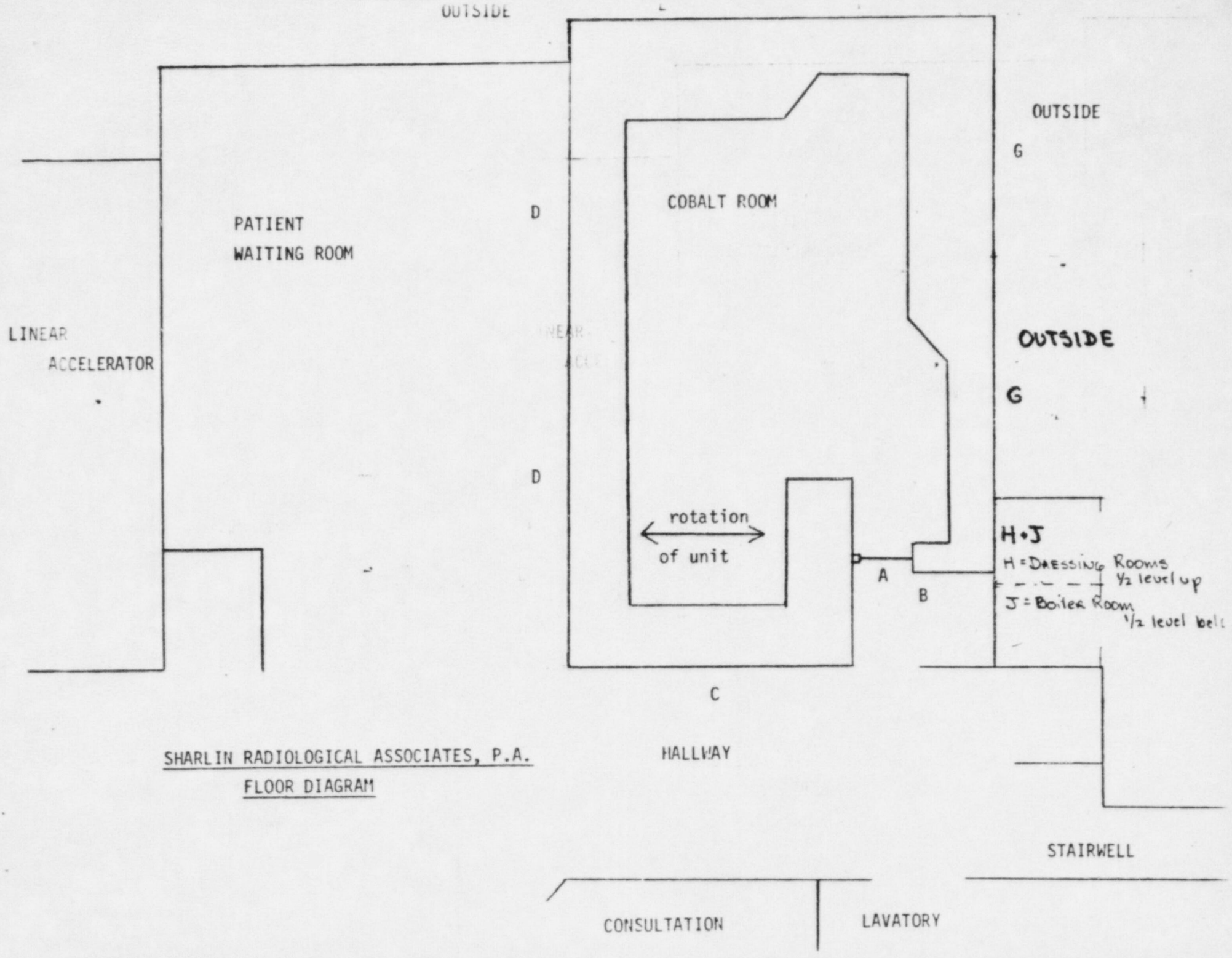
The room protection survey was made with a Victoreen Model 471A Survey Meter as described in Part II. The beam was directed against a lucite phantom with a 20cm x 20cm field size at 80.0cm SAD, 70.0cm SSD.

Each barrier was surveyed at 30^{o} increments of the gantry angle with the beam intercepted by the beam absorber. Figure II illustrates the gantry angle with respect to the room. For example, when the gantry angle is set on 90^{o}, the beam will be directed towards Barrier D (intercepted by the beam absorber).

Table II specifies the maximum readings and corresponding orientation of the beam. The dose rates were measured one foot from side barriers, and one foot on the roof.

Location	Description
A	Treatment room door
B	Control area
C	Hallway
D	Patient waiting room
E	Outside
F	Outside
G	Outside
H	Patient dressing rooms (1/2 level up)
I	Roof (fenced in area)
J	Boiler room (1/2 level down)
K	Roof (unfenced area)

Note: Room is located on ground level, no basement.



SHARLIN RADIOLOGICAL ASSOCIATES, P.A.

FLOOR DIAGRAM

FIGURE II

Beam Interlock Diagram

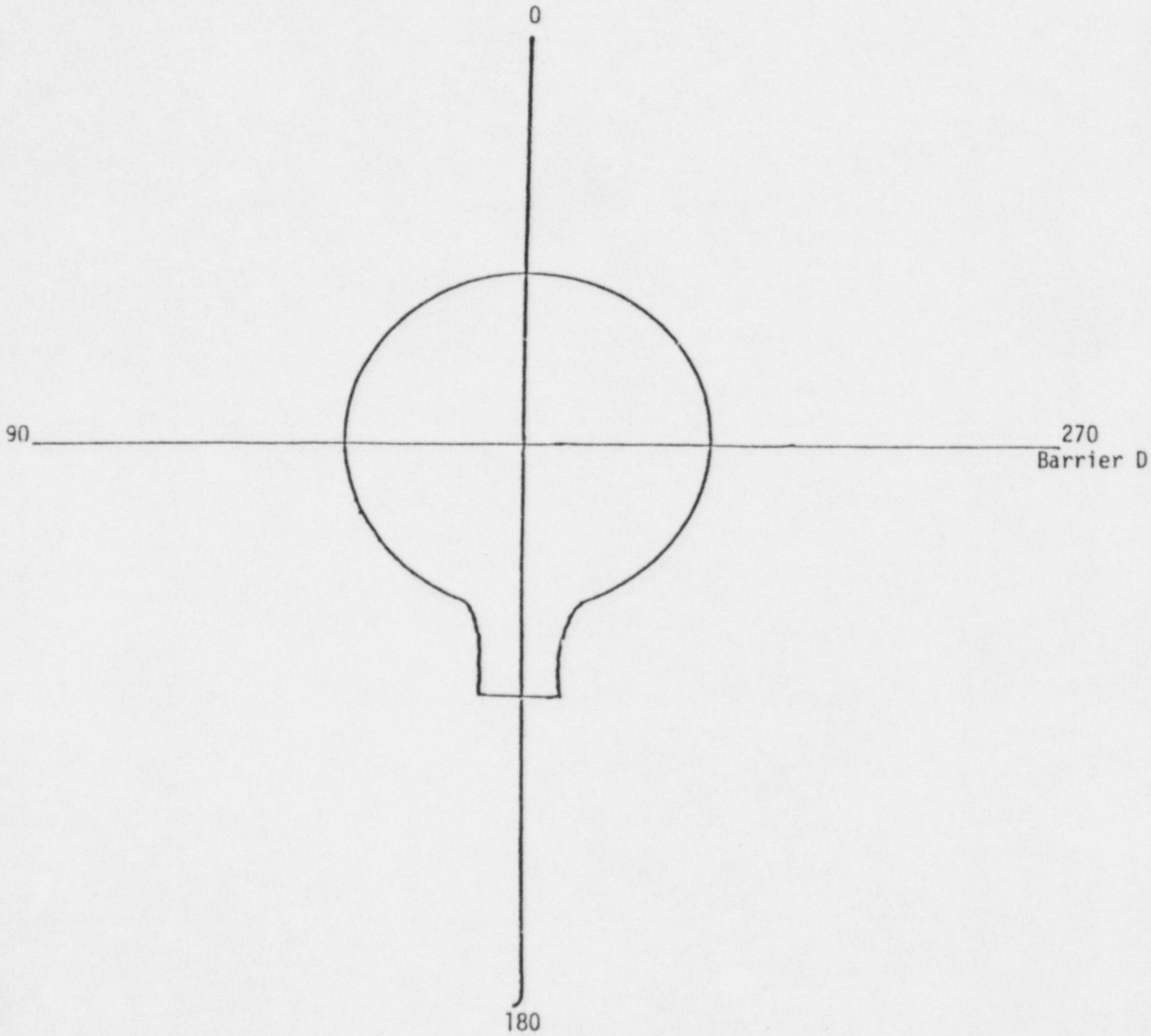


TABLE II

MAXIMUM DOSE RATES

Location	Area	Beam Orientation	mR/hr.
A	Restricted	240^{o}	2.7
B	Restricted	300^{o}	1.6
C	Non-Restricted	*	<0.5
D	Non-Restricted	90^{o}	1.2
E	Non-Restricted	*	<0.5
F	Non-Restricted	*	<0.5
G	Non-Restricted	240^{o} & 300^{o}	9.2
H	Non-Restricted	*	<0.5
I	Restricted	150^{o}	25.0
J	Non-Restricted	*	<0.5
K	Non-Restricted	150^{o}	4.0

*Detectable level less than 0.5 mR/hr in any orientation.

Beam orientation specifies the gantry angle (as illustrated in Figure II), with beam directed against the beam absorber.

In order for the room to comply with 10 CFR 20.105 (b), the average dose rate in one hour shall not exceed 2 mR/hr. in unrestricted areas. NCRP Report # 33 recommends that weekly permissible doses should be less than 100 mR/week in restricted areas and 10 mR/week in unrestricted areas. Refer to Table III for average dose rates and maximum weekly doses at each barrier. The average dose rate was calculated based on using fractional beam "on" times.

No more than 5 patients are treated in any one hour, therefore the amount of time the beam would be on in any given hour is 11 minutes. (See assumptions and calculations below.) The average hourly dose rate would then be 18% of the instantaneous maximum dose rate found in Table II. The maximum dose per week at each barrier is calculated employing a workload of 5.4 hours/week of beam "on" time. (See assumptions and calculations below.)

30 patients per day are treated
5 days per week, 200 rads average per patient
Average treatment time per patient
= 200 rads delivered to a depth of
10cm (Field Size 10 x 10) 80 SSD
Output = 167.5 rads/min., DD% = 55.6

$$\frac{200}{(167.5)(55.6)} = 2.15 \text{ min. per treatment (Avg. patient)}$$

The results listed in Table III show that the teletherapy room is in compliance with 10 CFR 20.105 (b) and NCRP Report # 33.

TABLE III

LOCATION	MAXIMUM mR/hour	OCCUPANCY FACTOR	AVERAGE mR/hour	MAXIMUM mR/week	MPD mR/week
A	2.7	1	0.5	14.6	100
B	1.6	1	0.3	8.6	100
C	<0.5	1	<0.1	<0.6	10
D	1.2	1	0.2	6.5	10
E	<0.5	1/16	<0.1	<0.2	10
F	<0.5	1/16	<0.1	<0.2	10
G	9.2	1/16	1.7	3.1	10
H	<0.5	1	<0.1	<0.5	10
I	25	$<<1/16$	4.6	<8.5	100
J	<0.5	1/16	<0.1	<0.2	10
K	4.0	$<<1/16$	0.7	<1.4	10

*Note: All areas become unrestricted and measure less than 0.5 mR/hr with beam in off position.

V. Timer Accuracy

The timer on the control panel of the teletherapy unit in the control area was tested against a calibrated stop watch and found to be accurate within two-tenths of a second for a trial of 60 seconds.

VI. Electrical and Mechanical Interlocks

The door to the teletherapy room was opened slightly when the machine was operating in the beam "on" mode and the interlock was found to be operational in that the source immediately moved to the "off" position. The emergency stop bar on the control panel was also activated in the beam "on" mode and the source returned to the beam "off" position. In both cases, door opened and emergency stop bar activated, the unit would not operate in the beam "on" position unless the control panel was reset. The "on" and "off" positions of the source were cross checked with the Primalert 10 radiation monitor which is tested daily with a test source provided by the manufacturer.

When the timer was switched "off" while the beam was in the "on" position, the source returned to the "off" position. (cross-checked with Primalert 10)

Electrical and mechanical beam stops were tested and found to restrict the operation of the unit to only be directed at the beam absorber as specified in Section III.

VII. Warning Signs, Indicator Lights, and NRC Posting Requirements

Beam "on-off" indicator lights on the control panel, in the treatment room (2 locations), and above the treatment door function correctly in both the beam "on" and the beam "off" modes. (cross-checked with Primalert 10) Appropriate warning signs are posted on the treatment room door. NRC-3 and emergency instructions with phone numbers to reach radiologists, physicists and repair technicians are posted as well. Also, posted are instuctions where N.R.C. license and regulations are kept.

The roof area that is restricted above the treatment room has a chain link fence around it on three sides and a stone wall on the fourth side. The fence is approximately six feet high and the stone wall is approximately seven feet high. There is no way to get onto any area of the roof of the entire building without either using a ladder or going out a window. Two signs stating "Caution Radiation Area", including the radiation symbol are attached to the fence at eye level. These two signs are approximately 8" x 12" in size and are located on the only two sides that one can climb from the other areas of the roof.

Also, there are two other signs located next to the above signs stating "CAUTION, DO NOT ENTER AREA, CHECK WITH COBALT TECHNICIAN TO REQUEST PERMISSION TO ENTER". These signs measure 16" x 12". No one is to be within the fenced area while the Cobalt 60 machine is "on". All personnel involved are aware of this.

VIII. Radiation Monitor

A Nuclear Associates Model 05-433 "Primalert 10" radiation monitor with Model 05-440 "Primapak" battery back-up unit has been installed within the teletherapy room, is checked daily, and in good working order.

Surveyors: Bruce D. Bucher
Bruce D. Bucher

Robert A. Sasso
Robert A. Sasso, M.S.

SHARLIN RADIOLOGICAL ASSOCIATES, P.A.
35 PANGBORN PLACE
HACKENSACK, N. J. 07601
TELEPHONE (201) 342-7558

COBALT - 60 OUTPUTS

MONTH OF: September, 1985

FIELD SIZE	80 SSD*	80 SAD
4 X 4	-	-
5 X 5	158.2	157.5
6 X 6	160.5	159.1
7 X 7	162.8	160.8
8 X 8	163.9	161.2
9 X 9	166.0	162.7
10 X 10	167.5	163.7
11 X 11	168.8	164.4
12 X 12	170.0	165.0
13 X 13	171.5	166.0
14 X 14	173.0	167.0
15 X 15	174.1	167.5
16 X 16	175.2	168.1
17 X 17	176.6	169.1
18 X 18	178.0	170.2
19 X 19	178.6	170.4
20 X 20	179.1	170.6
21 X 21	179.8	170.9
22 X 22	180.5	171.2
23 X 23	181.2	171.6
24 X 24	182.0	172.1
25 X 25	182.7	172.4
26 X 26	183.4	172.7
27 X 27	183.7	172.7
28 X 28	183.9	172.7
29 X 29	184.0	172.7
30 X 30	184.2	172.7

*NOTE: SSD Outputs include backscatter factor
Lucite Tray Factor=1.03
Calibration = 163.7 Rads/Min. at 80.0cm for 10X10 Field
for 9/16/85

Robert A. Sasso

Model No.	Serial No.	Date Calibrated	Calibration Technique	Recommended Date For Recalibration
471A	319	3-20-85	137 Cs	3-20-86

FREQUENCY OF RECALIBRATION MAY VARY DEPENDING ON LOCAL, STATE OR FEDERAL REQUIREMENTS.

Register No. REP 2193 Tom Krow Calibration Lab.

VICTOREEN, INC.
10101 Woodland, Avenue. Cleveland, Ohio 44104
A Sheller-Globe Corporation Subsidiary

8713178

K & S Associates, Inc.

Radiological Consultants

Medical - Industrial

ACCREDITED DOSIMETRY CALIBRATION LABORATORY

Calibration Report

Institution/Facility: Sharlin Radiological Associates, P.A.
35 Pangborn Place
Hackensack, New Jersey 07601

Date: March 26, 1984

Report: 283

Instrument: Capintec 192, SN 60F318
Capintec PR06C, SN CII0.6799

Test No.: 84043

The responsibility for calibration results provided by K & S Associates, Inc. and its employees extends only to the time the instruments leave the K & S laboratory facility. Constancy tests are highly recommended. It is the responsibility of the instrument user to assure himself that his interpretation of the information contained herein is consistent with the interpretation intended.

1834 Airlane Drive / Nashville, Tennessee 37210 / (615) 883-9760

CALIBRATION FACTORS:

R/RDG: Roentgen/reading calibration factors apply to the chamber-electrometer-readout system as a unit, with scales, switch settings and output mode specified. To obtain the exposure in roentgens at the reference point*, in the absence of the chamber, the calibration factor is applied directly to the instrument reading corrected for temperature and pressure:

Exposure = RDG x R/RDG x TPC
where TPC = temperature-pressure correction

R/C: Roentgen/coulomb calibration factors apply to the ion chamber alone. To obtain the exposure in roentgens at the reference point*, in the absence of the chamber, an appropriately calibrated (coulomb/reading) electrometer must be used.

Exposure = RDG x R/C x C/RDG x TPC
where C/RDG = calibration factor of electrometer
TPC = temperature-pressure correction

TEMPERATURE-PRESSURE CORRECTION FACTOR:

For chambers open to the atmosphere, the instrument readings were normalized to 760 millimeters of mercury and 22 degrees Celsius. Use of the chamber at other pressures and temperatures requires correction by the following multiplicative factor:

$$\frac{T + 273.15}{295.15} \times \frac{760}{P}$$

where T is the temperature in degrees Celsius, and P is the chamber pressure in millimeters of mercury.

No corrections were made for air humidity.

CALIBRATION CONDITIONS:

Unless otherwise indicated, the calibration field size is 10 cm x 10 cm for Co-60 and 10 cm diameter circle for x-rays. Stem effect was not investigated; the calibration factor applies only to the field size stated.

During calibration the chamber was centered in the beam with the stem perpendicular to the beam direction, except for end-window chambers which are calibrated with the stem parallel to the beam direction.

*The exposure reference point is at the geometrical center of the chamber volume, except when stated otherwise in the calibration report.

The exposure rate at the calibration position was measured with a transfer-quality ionization chamber which has a calibration that is directly traceable to the National Bureau of Standards.

BEAM QUALITY:

X-ray beam quality is described in terms of the first half-value thickness in millimeters of aluminum or copper. The ratio of the first to the second half-value thickness (homogeneity coefficient-H.C.) and the kilovoltage are also given.

The half-value thicknesses were determined under "good geometry" narrow beam conditions with high purity certified aluminum or copper attenuators. The focus-attenuator distance was approximately 50 cm, and the focus-chamber distance was approximately 100 cm.

ATMOSPHERIC COMMUNICATION:

All chambers are tested for communication to the atmosphere prior to calibration.

CALIBRATION ACCURACY CLASSIFICATION:

The accuracy of the calibration factors stated in this report are described in terms of classifications and represent the maximum deviation from the national dosimetry standard.

The classifications assigned by the ADCL are based on the precision of the laboratory and on the precision, accuracy, and reproducibility of the instrument or system submitted for calibration.

	Cobalt-60	Cesium-137	X-rays
CLASS I	+/- 0.5 %	+/- 0.5 %	+/- 1.0 %
CLASS II	+/- 0.5 %	+/- 0.5 %	+/- 2.0 %
CLASS III	+/- 1.0 %	+/- 1.0 %	+/- 2.0 %
CLASS III A	+/- 2.0 %	+/- 2.0 %	+/- 2.0 %
CLASS IV	-	+/- 5.0 %	+/- 5.0 %
CLASS V	-	+/- 10.0 %	+/- 10.0 %

ION COLLECTION EFFICIENCY:

The ion collection efficiency (A_{ion})[1] stated in this report is based on measurements of the currents (or charges) produced in a Cobalt-60 beam with the stated exposure rate and polarizing potential and has been calculated using the two voltage method of Boag[2] and Greening[3] for continuous radiation.

$$A_{ion} = \frac{((V_1/V_2)^2 - \text{Ratio})}{((V_1/V_2)^2 - 1)}$$

where V_1 = full polarizing potential

V_2 = reduced polarizing potential

Ratio = the current (or charge) at V_1 divided by the current (or charge) at V_2

REFERENCES

1. Task Group 21, Radiation Therapy Committee, American Association of Physicists in Medicine, "A protocol for the determination of absorbed dose from high-energy photon and electron beams" Med. Phys., Vol. 10, p. 742 (1983).

2. Boag, J. W., Radiation Dosimetry, 2nd ed., edited by F. Attix and W. Roesch (Academic, New York, 1966), Vol. II.

3. Greening, J. R., Phys. Med. Biol., Vol. 9, p. 143 (1964).

DOSIMETER SYSTEM CALIBRATION

3-9-84

ELECTROMETER:
Mfgr: Capintec
Model No. 192
Serial No. 60F318

SUBMITTED BY:
Sharlin Radiological Associates
Hackensack, New Jersey

CHAMBER:
Mfgr: Capintec
Model No. PR06C
Serial No. CIIO. 6799

ORIENTATION: "C" in serial no. toward source

SCALES, SWITCH POSITIONS, CONDITIONS:
COMPENSATION FACTOR: 1.00; PROBE SELECTOR: B;
METER RANGE: NORMAL or EXTENDED; EXPOSURE LEVEL: MEDIUM;
MODE: TOTAL

POLARIZING POTENTIAL -300 V SYSTEM LEAKAGE: 1×10^{-14} A

Beam Quality HVT (mm)	H.C.	kVp	Exposure Rate (R/min)	SCD (cm)	CALIBRATION FACTOR	Class
5.10 Al	0.76	100	13.4	50	1.005 R/ RDG	II
*Co-60	-	-	58.4	74	1.057 R/RDG	II

Discharge Test Reading (refer to instruction manual) NA % of full scale
COMMENTS: * with polystyrene buildup cap

Reviewed by: Thomas G Slaney
Title: Director

Checked by: R.F

Log C-4 Page(s) 125
Log T-4 Page(s) 117
Log ____ Page(s) ____
Log ____ Page(s) ____

IONIZATION CHAMBER CALIBRATION

3-9-84

CHAMBER:

Mfgr: Capintec

Model No. PR06C (0.6 ml, AE plastic)

Serial No. CIIC.6799

SUBMITTED BY:

Sharlin Radiological Associates

Hackensack, New Jersey

ORIENTATION/CONDITIONS: "C" in serial number toward source

ION COLLECTION EFFICIENCY (A_{ion}): 0.999

POLARIZING POTENTIAL: -314 V

CHAMBER LEAKAGE: -1×10^{-14} A

Beam Quality HVT (mm)	H.C.	kVp	Exposure Rate (R/min)	SCD (cm)	CALIBRATION FACTOR	Class
5.10 Al	0.76	100	13.4	50	4.650×10^{9} R/C	II
*Co-60	-	-	58.4	74	4.887×10^{9} R/C	II

COMMENTS: * with polystyrene buildup cap

Reviewed by: Robert A. Hagg
Title: Associate Director

Checked by: HWS

Log C-4 Page(s) 125
Log T-4 Page(s) 117
Log _____ Page(s) _____
Log _____ Page(s) _____

ELECTROMETER CALIBRATION

CALIBRATION FACTORS:

C/RDG: This factor is given in coulomb/unit of reading of the electrometer on the indicated switch settings and scales. To obtain the corrected charge in coulomb, the calibration factor is applied directly to the instrument reading of the appropriate scale:

Coulomb = TRUE RDG x C/RDG

POLARIZING POTENTIAL:

Polarizing potential was measured using a calibrated digital voltmeter and is reported as the potential of the thimble with respect to the circuit low or guard.

ELECTROMETER LEAKAGE:

Electrometer leakage is indicated in ampere for the indicated setting, and is the net charge in coulomb divided by the time interval in seconds.

LINEARITY:

Linearity is specified as a percentage of the full scale. If the electrometer is nonlinear on a portion of the scale, a linearity correction factor is given. To correct for nonlinearity, the linearity correction factor is applied to the reading as follows:

TRUE RDG = RDG x Linearity Correction Factor

Test No. 84043

ELECTROMETER CALIBRATION REPORT

3-9-84
DATE

INSTRUMENT:

Mfgr: Capintec
Model No. 192
Serial No. 60F318

SUBMITTED BY:

Sharlin Radiological
Associates
Hackensack, New Jersey

SCALES, SWITCH POSITIONS, CONDITIONS:

COMPENSATION FACTOR: 1.00; PROBE SELECTOR: (see below);
METER RANGE: NORMAL OR EXTENDED; EXPOSURE LEVEL: (see below);
MODE: TOTAL

POLARIZING POTENTIAL: -300 V (indicates + 0301 V)

LEAKAGE: + 3.3×10^{-14} A

LINEARITY: within +/- 0.1% of full scale or the precision of the reading, whichever is greater

CHARGE CALIBRATION FACTOR:

PROBE SELECTOR	EXPOSURE LEVEL	FACTOR (C/unit of reading)
B	MEDIUM	2.162×10^{-10} C/RDG
B	HIGH	2.159×10^{-10} C/RDG
ELECTROMETER	MEDIUM	0.990 C/RDG
ELECTROMETER	HIGH	0.988 C/RDG

COMMENTS:

Reviewed by: Robert A. Hagg — Log: E-2 Page(s) 204
Title: Associate Director — Log: _____ Page(s) _____
Checked by: TWS — Log _____ Page(s) _____