VETERANS ADMINISTRATION
HOSPITAL
2002 HOLCOMBE BOULEVARD
HOUSTON, TEXAS 77031

IN REPLY
REFER TO:

January 7, 1975

United States Atomic Energy Commission
Washington, D.C., 20545

Gentlemen:

Patients undergoing radiotherapy treatment at the Houston Veterans Administration Hospital facility will be continuously surveyed by means of a closed circuit television system. In the event of failure of the system, treatment will be discontinued immediately and will not be resumed until it is determined the system is functioning properly.

John W. Claiborne, Jr.

John W. Claiborne, M.D.
Director

Copies furnished:
Chief, Radiotherapy Department
Phillip H. Cooper, Ph.D.
Ann E. Wright, Ph.D.

Show veteran's full name, VA file number, and social security number on all correspondence.

Item 14.6
March, 1985

RADIATION PROTECTION SURVEY

OCTOBER 28, 1983

LOCATION: Veterans Administration Medical Center
Radiotherapy Department
2002 Holcombe Boulevard
Houston, Texas 77211

TYPE UNIT: A.E.C.L. Standard Theratron-780 Teletherapy Unit (Rotating, with beam stopper counter-weight), Serial No. 109.

SOURCE: A.E.C.L. Cobalt-60. Serial No. S-3539, 2.0 cm diameter capsule. Type C146, containing Cobalt pellets. Activity: 6767 curies on August 30, 1983.

DATE RECEIVED: October 21, 1983

DATE INSTALLATION COMPLETED: October 28, 1983

EXPOSURE RATE: 109.5 Roentgens per minute at the one meter position on the A.E.C.L. Calibration cell on August 30, 1983.

DATE PATIENT TREATMENT STARTED: October 31, 1983

INSTRUMENTATION: Measurements were made with the following instrument: Model 12 Ludlum measurements, Inc. survey meter. Serial #550.

This instrument has been recently calibrated: August 3, 1983.

SOURCE HOUSING: With the source in the "off" position, measurements were made at one meter from the source. The results are shown in Figure 12. The maximum exposure rate was 3.0 mR/hr. The average of 18 independent readings was .65 mR/hr.

ELECTRICAL INTERLOCKS: The treatment room has only one entrance. The door of this entrance is equipped with an electrical interlock which immediately turns the primary radiation beam off if the door is opened while the source is in the "on" position. The unit will remain in the "off" position until the door is closed and the unit reset and turned on from the control panel. The door was opened with the beam on and the interlock switch was found to be functioning properly.

ELECTRICAL STOPS: Electrical and/or mechanical stops installed to limit the orientation of the teletherapy head with the source "ON" were tested and found to function properly. The limitations are:

A direction in which either: 1) the entire beam in centered on the beam stopper, 2) the beam is directed not more than 15° off the perpendicular to the floor, 3) the beam is directed not more than 5° above the perpendicular to wall C, or 4) the beam is directed along an are connecting 2) and 3) above (See Figure 3).

Item 15, 16
March, 1985

BEAM "ON-OFF" INDICATORS: The teletherapy source "ON-OFF" indicators, both at the source housing and on the teletherapy machine control panel, were tested and found to function properly.

A visible alarm is installed in the maze of the treatment room. If at the end of a treatment the source fails to retract, the visible alarm remains flashing. The alarm was tested and is functioning properly.

TREATMENT TIMING DEVICE: The automatic timing device which retracts the source to the "off" position at the end of a treatment period was checked repeatedly and was found to be functioning properly.

AREAS ADJACENT TO TELETHERAPY ROOM: The exposure rate in adjacent areas was measured with the source in the "on" position and collimators at maximum opening. When measuring beyond secondary walls, a 30x30x30 cm^3 phantom was placed in the beam with the surface at 80 cm source-surface distance. The general layout, details of shielding, and measurement results are shown in Figures 1-12. As shown in Figure 6, directing the beam off the beam stopper results in an area where the radiation is greater than 2 mR/hr. This area has a diamenter of about two feet. Beam use in this fashion is for very unusual cases, such as relief of vena cava obstruction on an emergency basis, and occurs very infrequently. For example, an exposure time of two minutes during any one hour, and possibly twice during any one week, occurs prehaps ten times per year.

Figures 8, 9, and 10 show areas of the roof to be greater than 2 mR/hr when the gantry is in orientations representative of rotational treatments. The use factor for the machine in this mode is only one fourth of the treatment time, thereby reducing the average to less than 1 mR/hr.

With an assumed workload of 60,000 R/week at one meter, the measurements of all adjacent areas indicate that as a result of the operation of this unit, no individual continuously present in such areas could receive in excess of 2 millirems in one hour or 100 millirems in seven consecutive days. Operation of this installation is therefore in compliance with National Council on Radiation Protection Report No. 49 and Section 20.101 of 10CFR20.

Philip Cooper, Ph.D., RSO

L. David Gager, M.S.

David M. Bellezza, M.S.

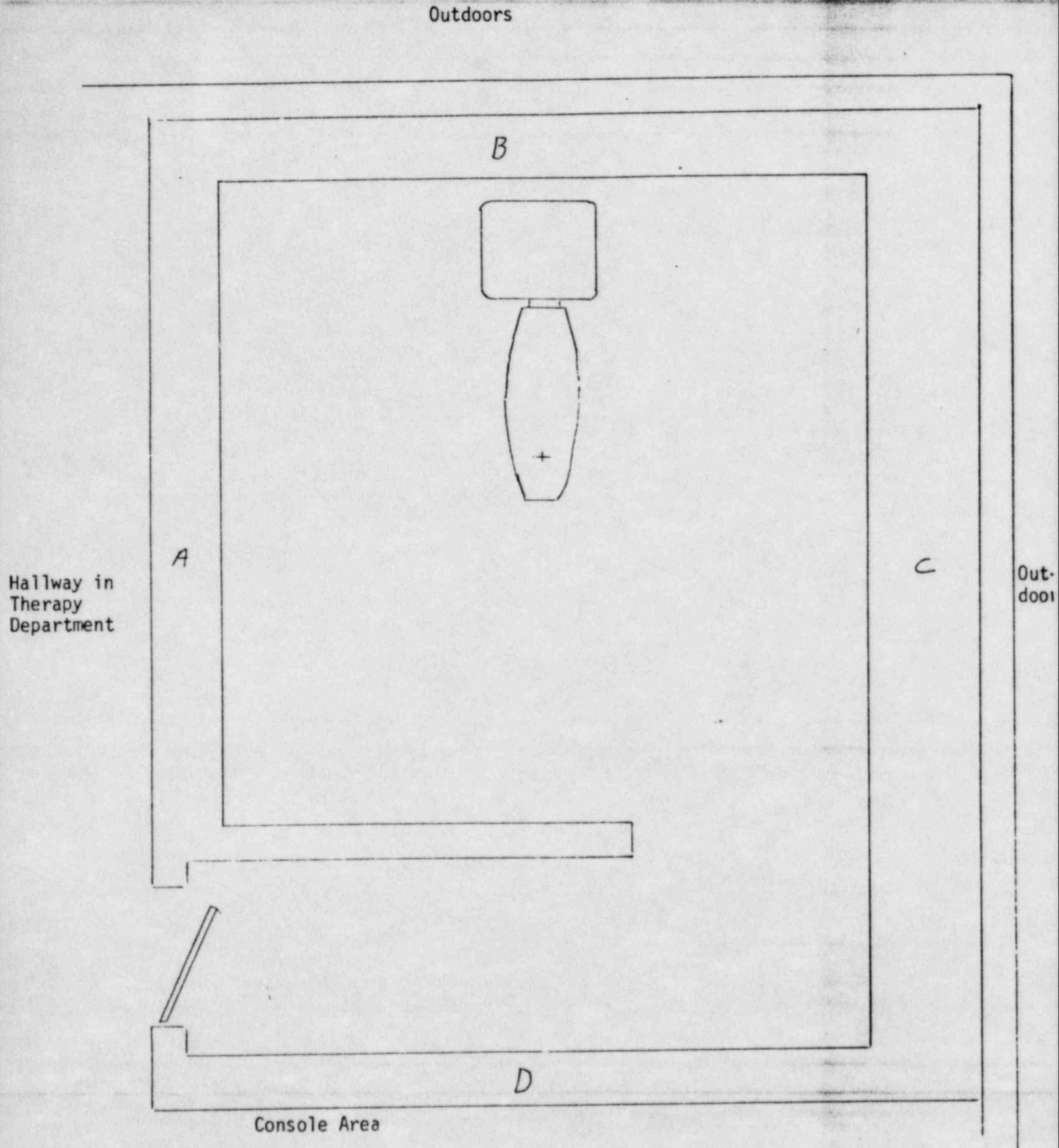


Figure 1 - Layout of Treatment Room

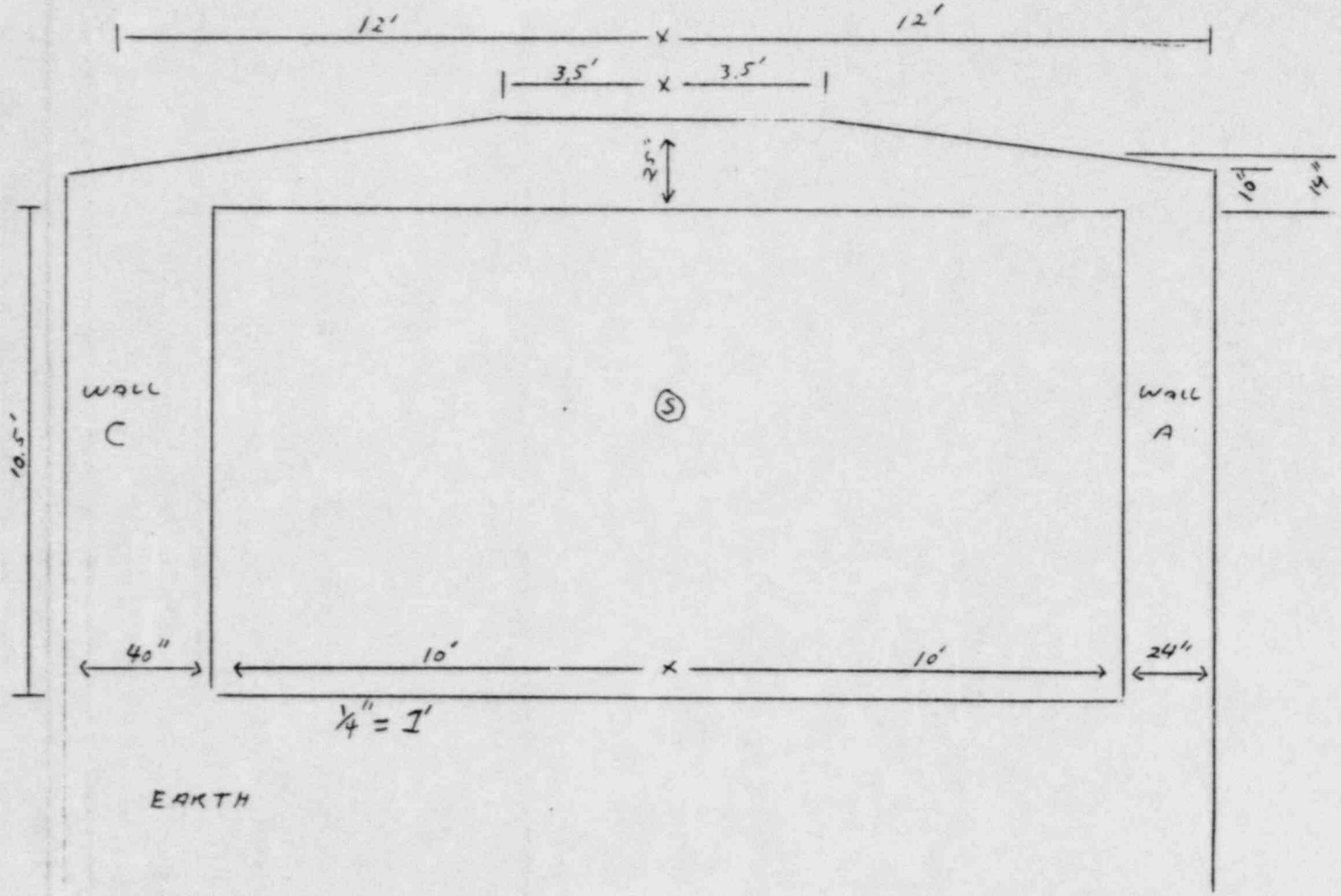


Figure 2 - Radiation Barriers

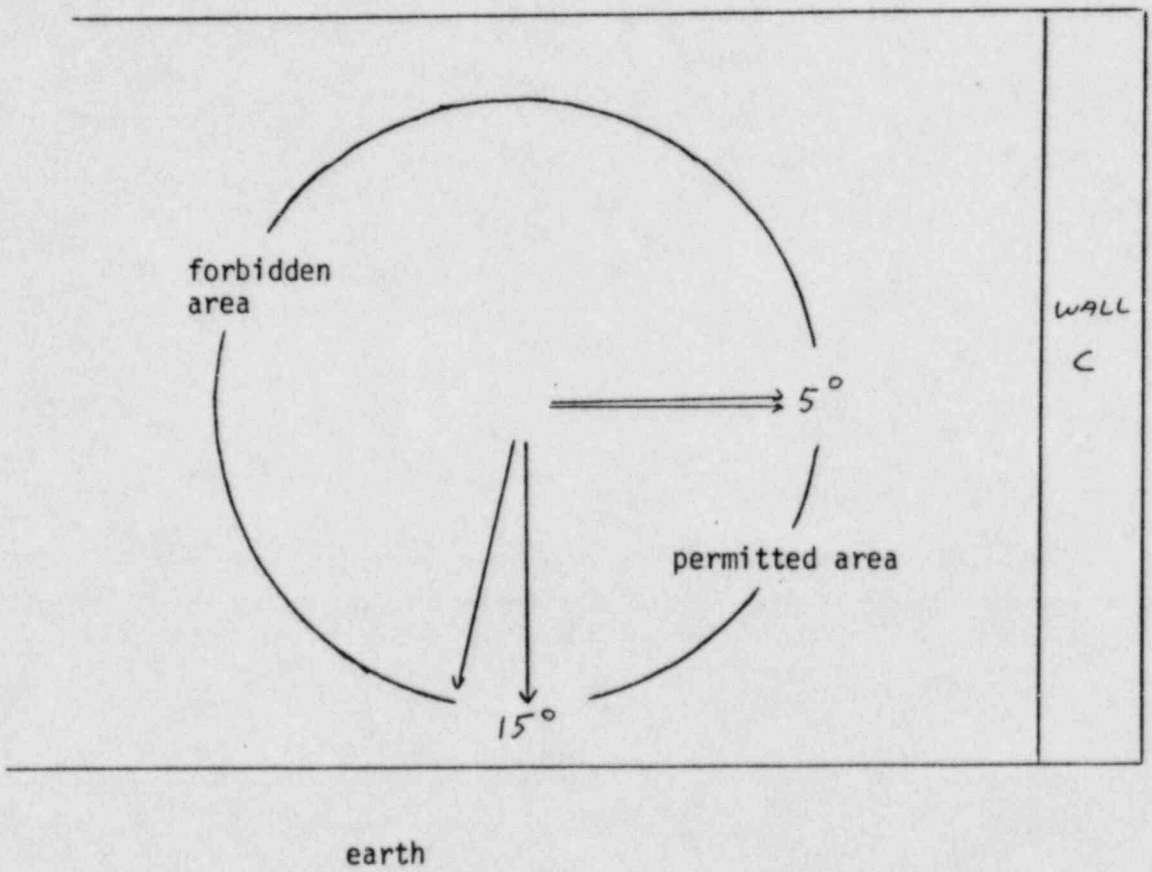
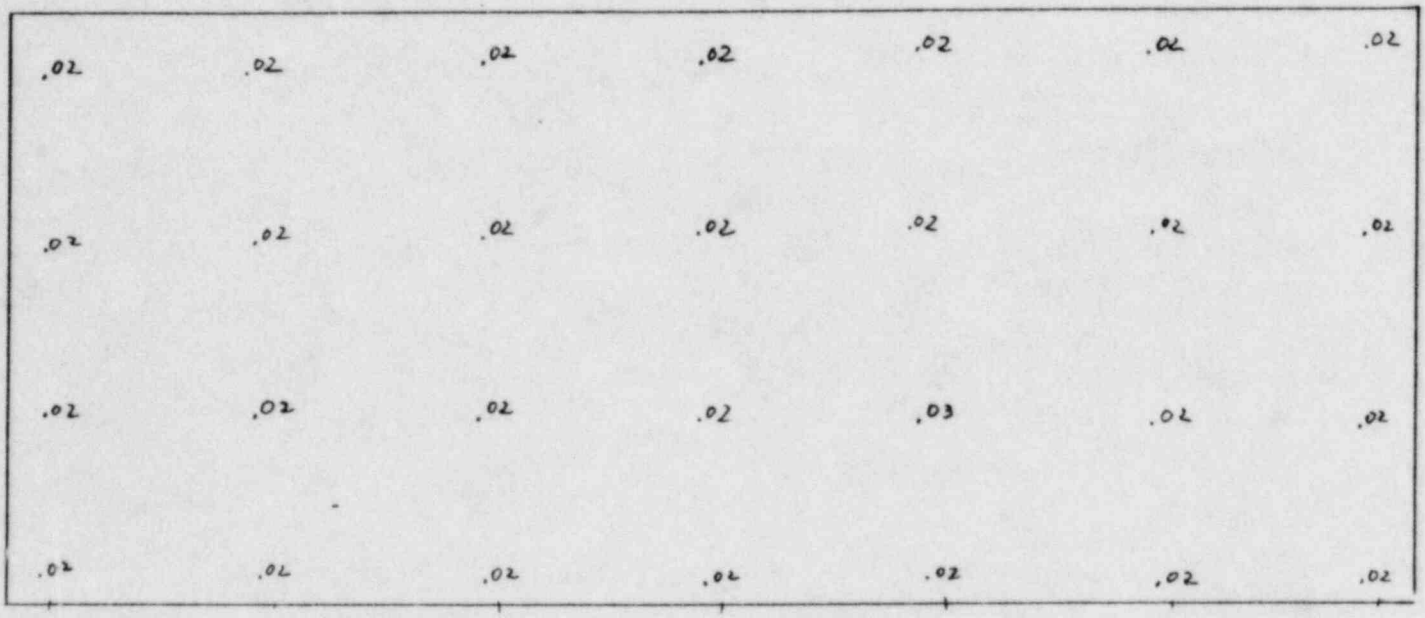
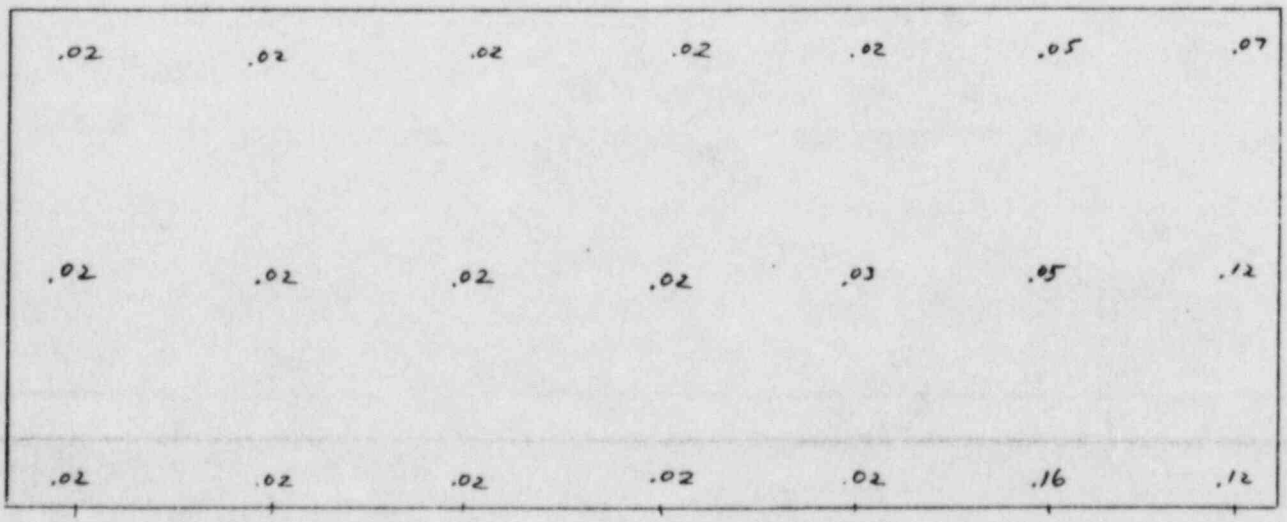


Figure 3 - Limitations on Orientation of Teletherapy Head with Source "On"

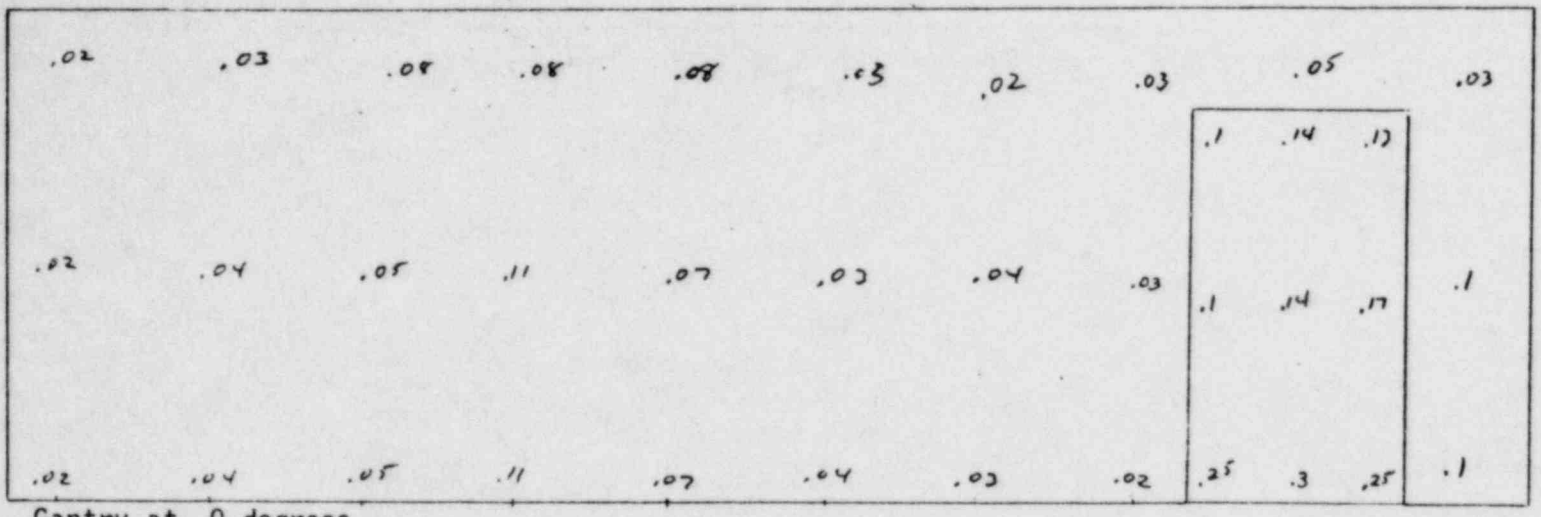


Wall "B" Gantry at 0 degrees

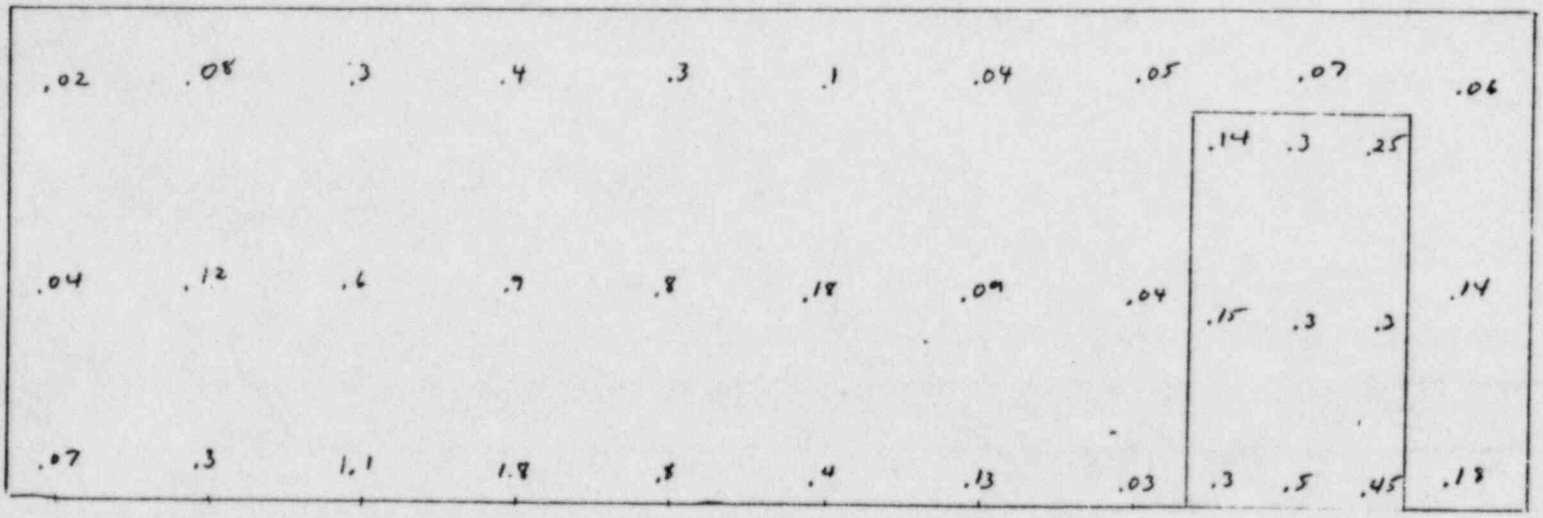


Wall "D" Gantry at 0 degrees

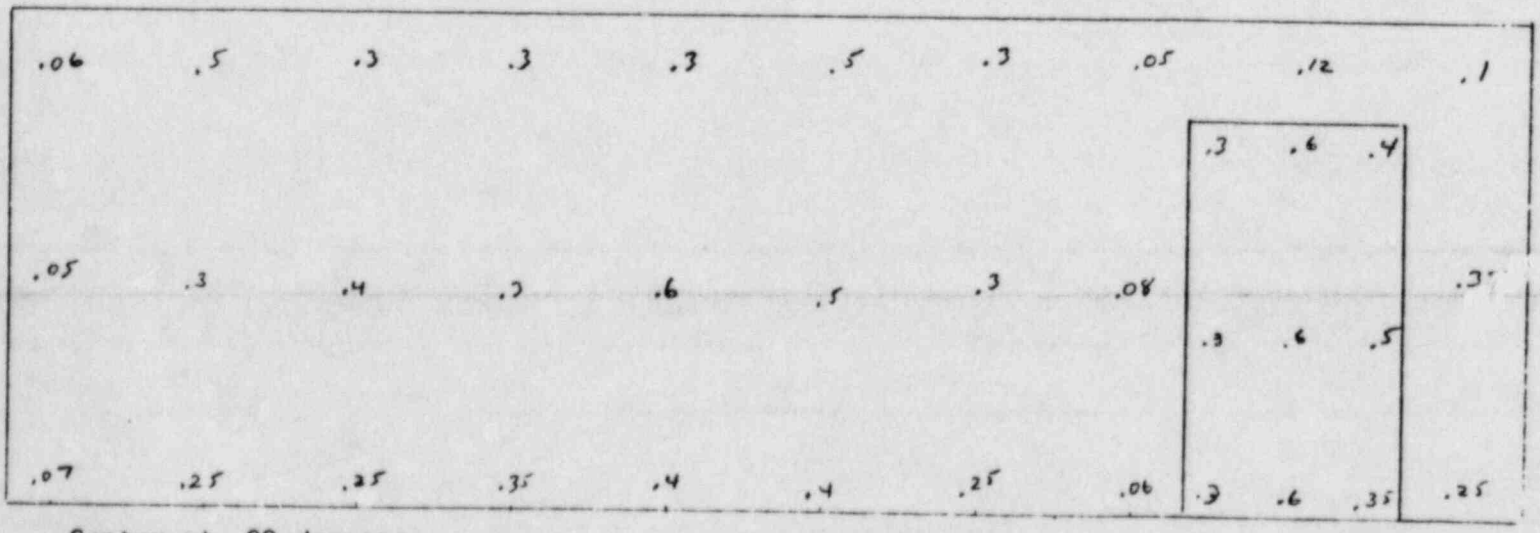
Figure 4 (Readings in mr/hr)



Gantry at 0 degrees

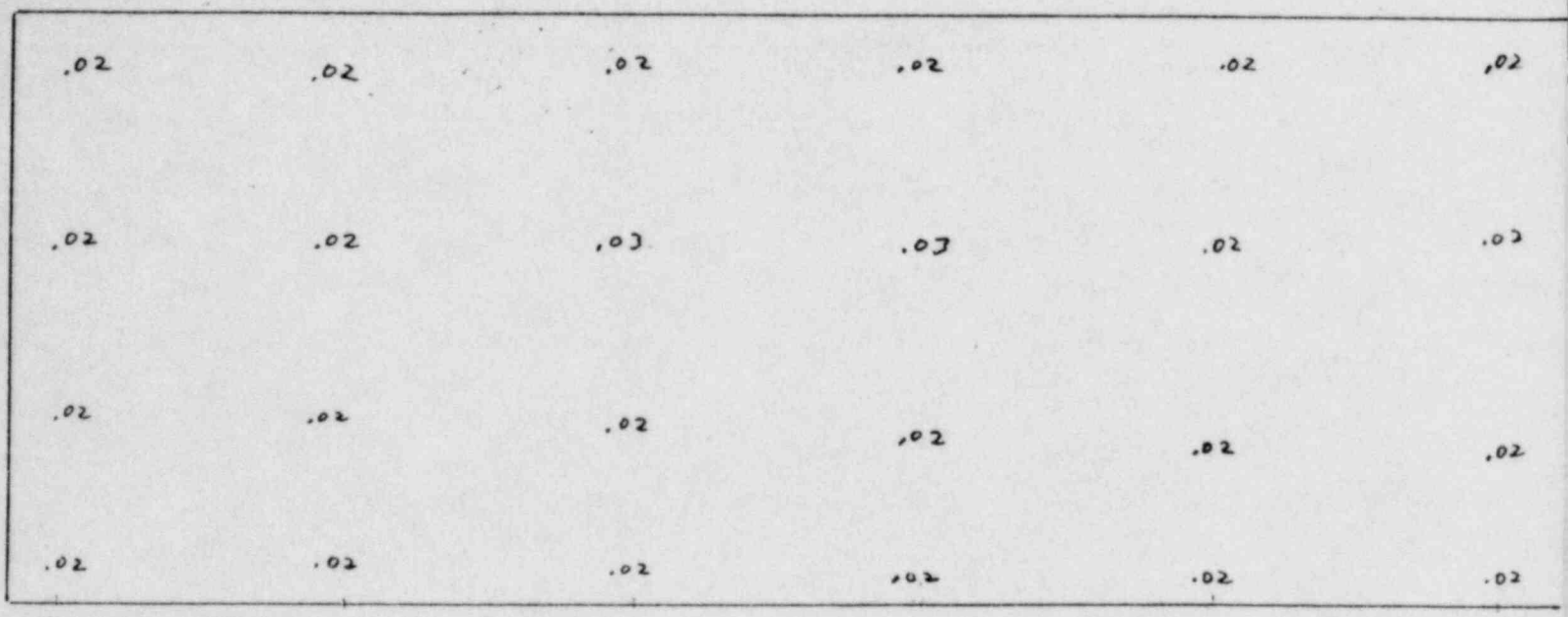


Gantry at 45 degrees

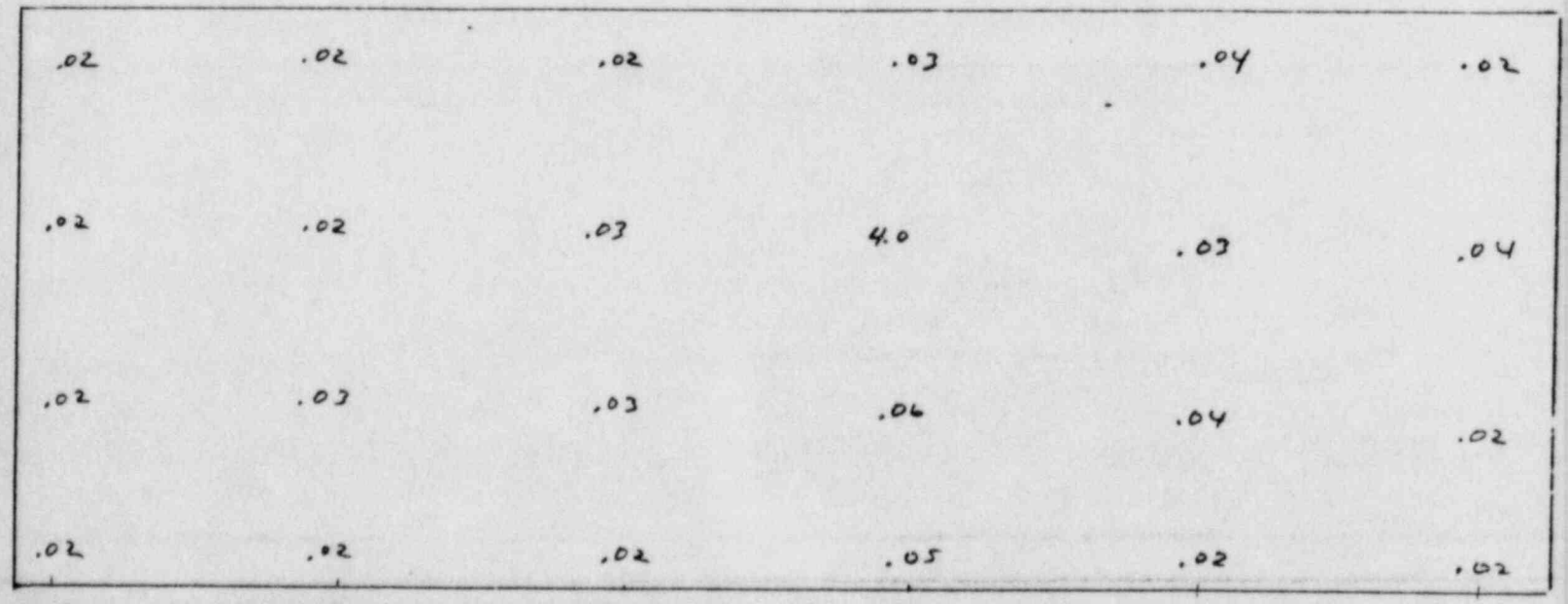


Gantry at 90 degrees

Figure 5 - Wall "A" (Readings in (mr/hr)



Gantry at 0 degrees



Gantry at 0 degrees - Head off Beam Stopper 90 degrees, pointed towards wall

Figure 6 - Wall "C" (Readings in mr/hr)

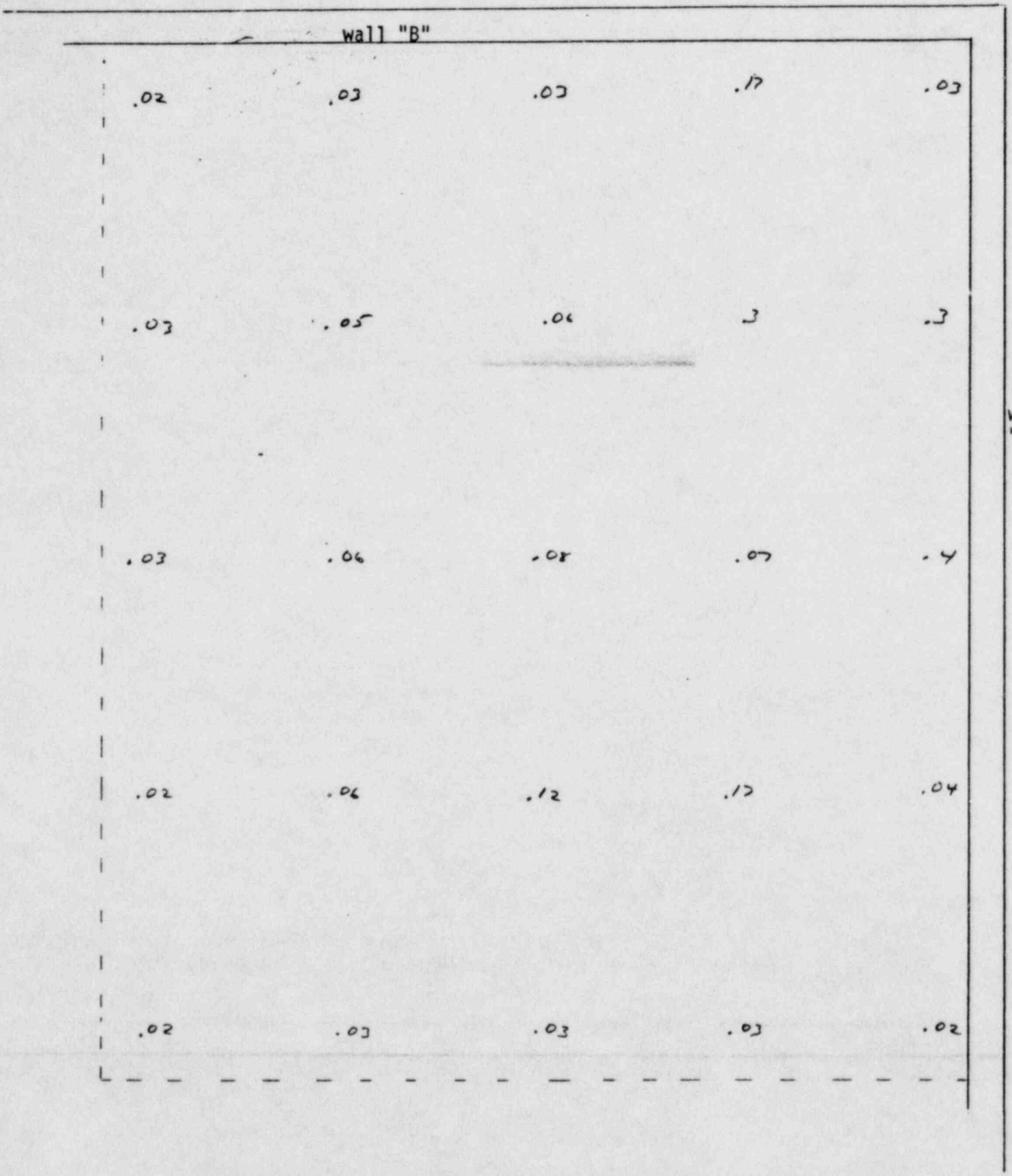


Figure 7 - Roof - Gantry 0 degrees (Readings in mr/hr)

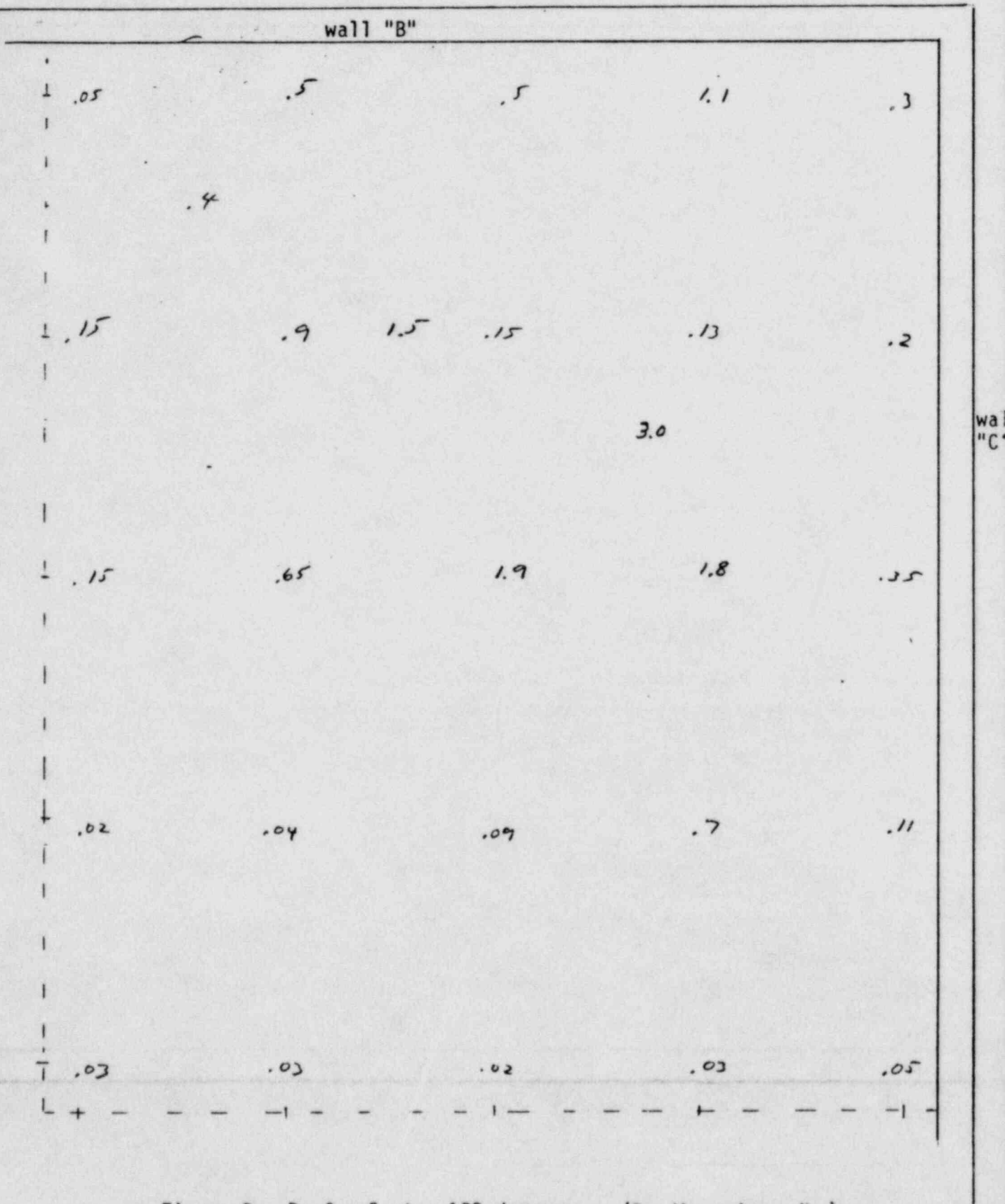


Figure 8 - Roof - Gantry 180 degrees (Readings in mr/hr)

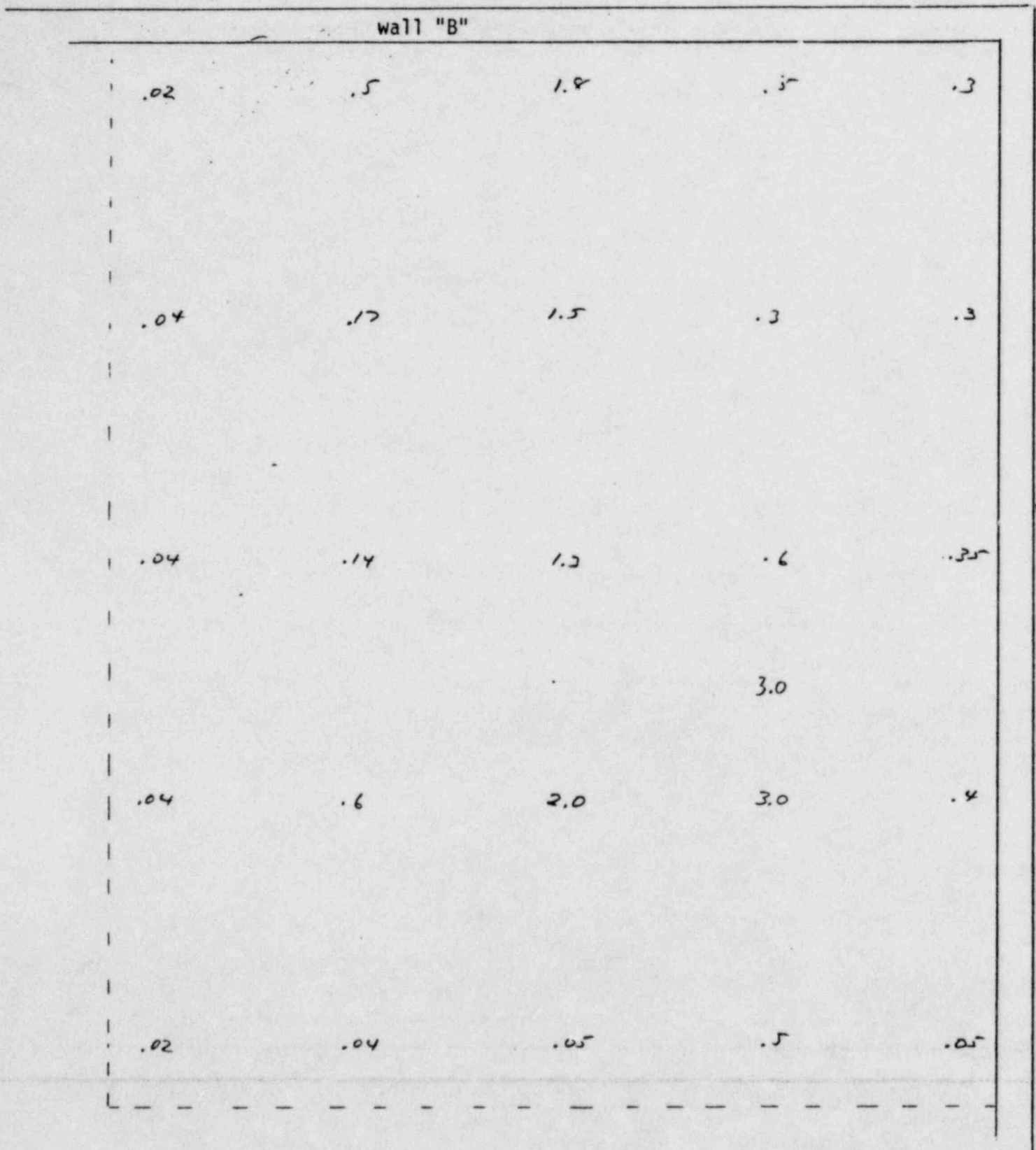


Figure 9 - Roof - Gantry 225 degrees (Readings in mr/hr)

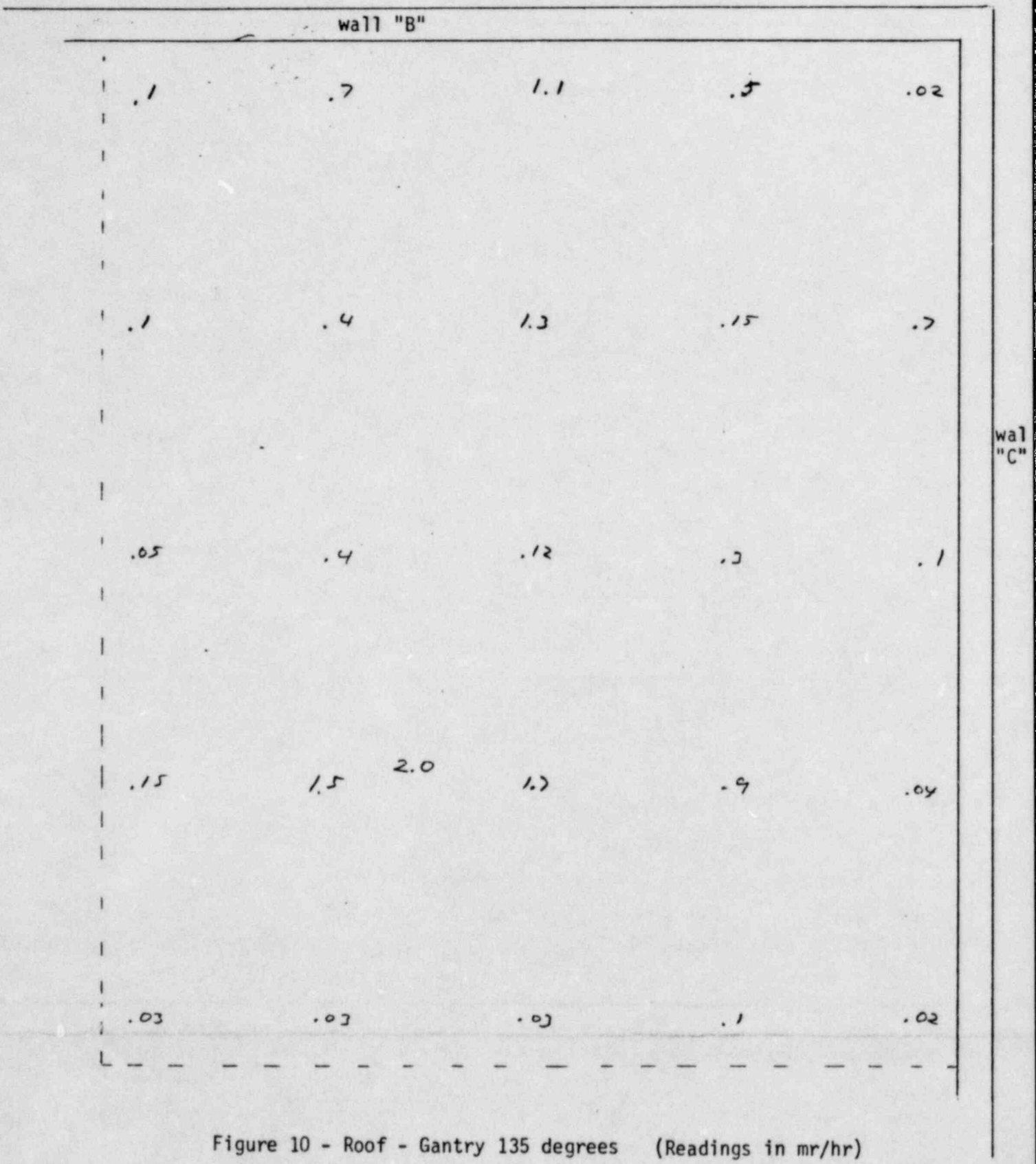


Figure 10 - Roof - Gantry 135 degrees (Readings in mr/hr)

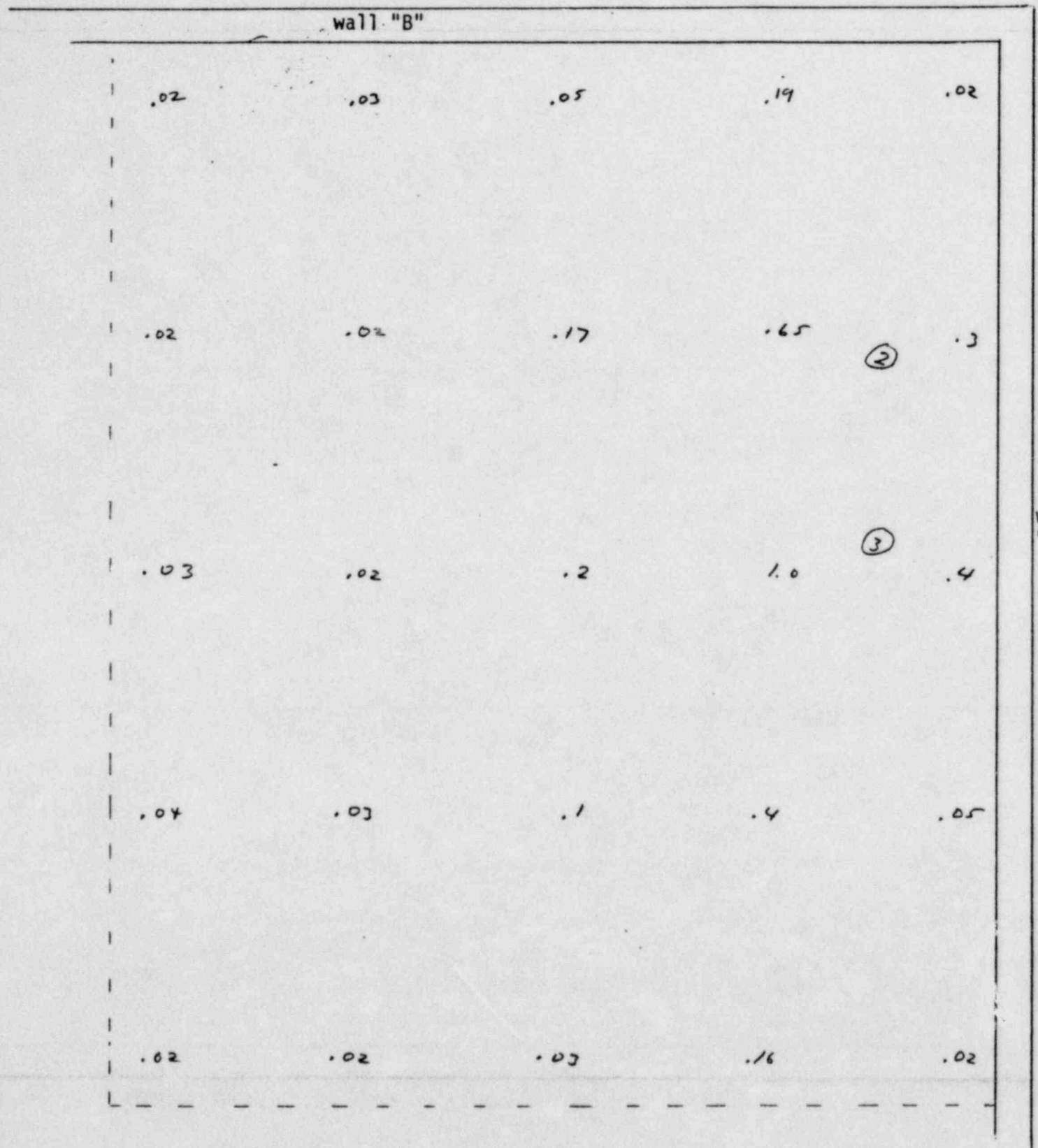


Figure 11 - Roof - Gantry 0 degrees - Head off Beam Stopper, pointed at wall (Readings in mr/hr)

ATOMIC ENERGY OF CANADA LIMITED

RADIATION SURVEY REPORT

Teletherapy Head - Beam Off

P&S 42941

Customer Chief Supply Service, V.A. Medical Center,

Location VAMC/580 - A38493RP, 2411 O.S.I, Houston, Texas.

Model Theratron 780 Serial Number 109

SOURCE DATA

Serial No. S-3539 Diameter 2.0 cm Curies 6767 Cobalt 60

Measured Output 109.5 (±3%) Rmm(ICRU) Measurement Date 30 August 1983

Maximum Unit Output 125.3 (±5%) Rmm Rated Capacity 318 Rmm(ICRU)

Survey Meter Ludlum Measurements Inc. Model 12

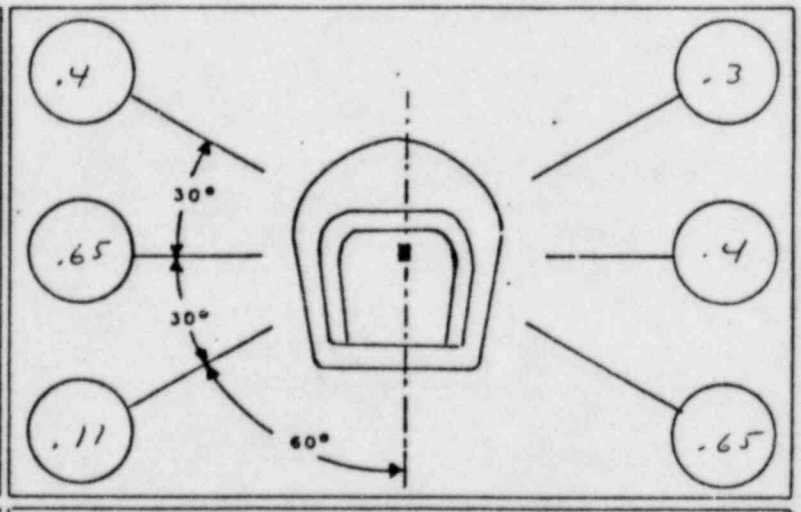
Serial No. 550 Calibration Date Aug 3, 83

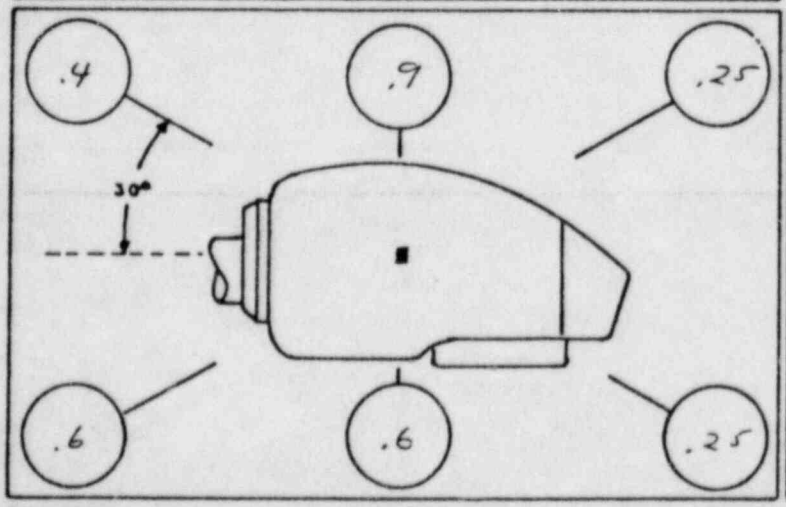
Supplementary Shielding: Donut ☐ Air Cylinder End ☐ Other ☐

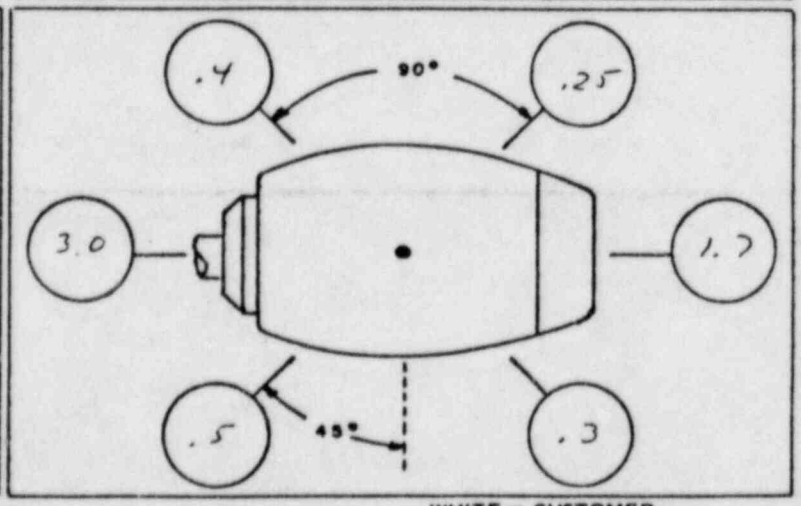
HEAD SURVEY PERFORMED BY Philip Cooper & David Bellezza Date 10/28/83

NOTES

1. Values at each point are averaged over a 100 square centimetre area in accord with recommendations NCRP Report 33.
2. Values are in mR/h at 1 metre from the source.
3. This report is based on values measured at 18 points and is it is for compliance verification only. Report is not to be used as a substitute for comprehensive 26 point survey originally performed under controlled conditions at the factory in accord with recommendations NCRP Report 33.
4. Average of values at all 26 points is equal to, or less than, 2 mR/h.
5. No measured value exceeds 10 mR/h.







VETERANS ADMINISTRATION

MEDICAL CENTER

RADIOTHERAPY

RADIATION SAFETY PROCEDURES

INTRODUCTION

Each person working with sources of radiation or caring for patients who have received radioisotope therapy has a responsibility in the maintenance of radiation safety in the VA Radiotherapy Section. Radiation Safety Precautions are designed to protect all individuals, patients, employees, visitors, etc., from receiving unnecessary radiation exposures as described in the N.R.C. Regulations for Control of Radiation.

PURPOSE:

This section describes the policy, organization, procedures and requirements for radiological health and safety in the VA Radiotherapy Service.

RADIOTHERAPY DEPARTMENT POLICY:

It is the policy in Radiotherapy to: (1) assure that exposure of personnel to ionizing radiation from radioactive materials or radiation-producing equipment is kept to a minimum; (2) assure that compliance with applicable regulations is maintained; (3) hold each supervisor responsible for training employees who are to use ionizing radiation and to see that all work is in compliance with applicable regulations.

APPLICABILITY:

It should be noted that regulations quoted are Federal statutes imposed on the VA under terms of its licenses with the N.R.C. Questions concerning details of current regulations or the applicability of regulations should be referred to the Radiation Therapy Physics Office.

GENERAL CONSIDERATIONS:

The principle objective of radiation protection is to insure that the dose received by an individual (other than the patient) is as low as reasonably achievable according to the VA Medical Center's ALARA Program.

Radiation workers are those occupationally exposed persons who spend their entire working period in controlled areas (i.e., radiotherapists, physicists, technicians, etc.) A controlled area is defined as one that required control of access, occuparcy and working conditions for radiation protection purposes. In our department, it is the area beyond the warning sign immediately surrounding the treatment machines.

Personnel monitoring is performed in controlled areas for each occupationally exposed individual. The monitoring device used here is the TLD and normally should be worn on chest or abdomen. It is convenient for determining the total dose of beta, gamma or X radiation accumulated over a set period.

The objective or protection is achieved by any one of combination of the following methods:

1. Providing sufficient distance between the individual and source of radiation. There is rapid attenuation of beam intensity with increasing distance from the source.

2. Limiting the time of exposure to the source.

3. Interposing a protective barrier between the individual and source of radiation.

For medical X and gamma ray equipment, shielding and distance are the factors most readily controlled. Protective shielding includes that incorporated into the equipment, mobile devices; e.g., lead screens or permanent barriers such as walls containing lead, concrete or other materials. These must be of thickness sufficient to provide the required degree of attenuation.

THE VA MEDICAL CENTER RADIOTHERAPY SECTION

In this department, there are machines producing X-rays; and teletherapy machines containing the nuclide Co^{60} producing gamma rays:

a. The AECL Simulator machine operated at approximately 60 to 100 KV_p and is used for taking X-rays for localization procedures.

b. The Phillips Superficial orthovoltage Unit at a potential of 100 KV_p to 250 KV_p

c. Co^{60} at 1.25 MeV.

Access to the treatment room is through shielded lead doors and no visitor should receive more than 100 mR in such areas.

SURVEY METERS

All radiation detection instruments shall be calibrated and records maintained.

1. Two types of survey meters are required:

a. An ionization-chamber-type survey instrument having multiple range from 0 to not more than 5 mR/h full scale to 0 to 50 mR/h full scale. This need may be met by one single instrument or by a combination of several having linear or logarithmic scales.

Instrumentation with the capability of measuring exposure as well as exposure rate is useful for measurement of leakage radiation around the X-ray head. The construction should be such that the calibration factors do not change more than 5% with orientation or for a change in photon energy from ^{137}Cs to ^{60}CO gamma radiation.

b. A rapid response Geiger or scintillation-type survey meter whose purpose is to search for anomalous leaks of radiation into occupiable space. Such leaks may be due to structural defects, unbacked junction boxes in the walls, inadequate caulking of lead glass windows, defects in overlaps between lead doors and leaded jambs, etc..

2. Instrument Calibration - Both types of survey meters shall be calibrated against a certified cesium, cobalt, or radium source within three months prior to use for purposes of survey. Portable instruments shall be calibrated every twelve months while in use. The calibration procedure requires exposure to known radiation fields with at least two points in each range checked. Generally, the calibration checks will be made in the regions of 10 - 30% and 70 - 90% of full scale. In the event it is not possible to obtain a calibration check for a particular range, that range will be considered uncalibrated. Should all calibration check readings fall within $\pm$ ten (10)%, no change will be made in the instrument settings. When the calibration shows the instrument response to exceed the above tolerance, a calibration adjustment will be made according to the manufacturers specifications. If the instruments response exceeds $\pm$ twenty (20)% for reasons other than rate or energy dependence and cannot be corrected by adjustment, the instrument will require repair.

RADIATION DOSE LIMITS

Radiation dose limits at the VA are based upon limits specified by the NRC regulations. It should be recognized that these limits are established as maximum values and, in all cases, personnel exposure should be maintained as far below the limits specified in this part as practical. A particular effort should be made to keep the radiation exposure of an embryo or fetus to the very lowest practicable level during the entire gestation period as recommended by the National Council on Radiation Protection and Measurements. (See Appendix III, NRC Regulatory Guide 8.13),

1. Dose Limits for Controlled Areas - Personnel shall not be exposed routinely to radiation or radioactive material in such a manner that the following limits are exceeded.

	Rem/Calendar Quarter
Whole body; head and trunk; active blood forming organs; lens of eyes; or gonads	1.25
Hands and forearms; feet and ankles	18.75
Skin of whole body	7.50

In exceptional cases an individual may be permitted to receive a quarterly, whole body dose greater than 1.25 rem provided:

a. During any calendar quarter the dose to the whole body shall not exceed 3 rem and;

b. The dose to the whole body, when added to the accumulated occupational dose to the whole body, shall not exceed 5(N-18) rem where N equals the individual's age in years at his last birthday and;

c. The individual's prior accumulated exposure has been determined.

2. Dose Limits for Minors - An individual under the age of 18 years shall not be permitted to enter or be employed in controlled areas such that he will receive doses of radiation in amounts exceeding 10% of the limits in 3.8, a. Exposures shall be averaged over periods not exceeding one calendar quarter.

3. Dose limits for Pregnant Personnel - The radiation exposure to pregnant personnel working in restricted areas shall be limited to less than 0.5 rem during the period of gestation. Supervisors should instruct female personnel of child bearing potential that they are to notify their supervisor upon learing they are pregnant. To insure compliance with this part supervisors should notify the Chief of the Radiotherapy Department and the radiotherapy physics group of all such pregnancies.

4. Dose Limits in Uncontrolled Areas - Radiation Dose Limits in uncontrolled areas shall be such that an individual will not receive a dose to the whole body in excess of 0.5 rem in any calendar year. Furthermore, radiation levels shall be such that if an individual was continuously present in the area, he would not receive a dose in excell of 100 millirem in any seven days.

PERSONNEL, MONITORING

1. Personnel monitoring is required for all individuals working in restricted areas. Personnel monitoring is not required for individuals who occasionally enter restricted areas for brief periods of time, provided the radiation levels are less than 5 mR/hr and that no individual is likely to receive a dose in any calendar quarter in excess of 25% of the applicable values in section 3.8 and that no individual under 18 years of age is likely to receive a dose in any calendar quarter in excess of 5% of the values in section 3.8. Specifically, the following are exempt from badging requirements.

Patients under radiation therapy.

Housekeeping personnel entering restricted areas to empty trash or sweep floors.

Secretaries entering restricted areas for less than 10 minutes per day.

Infrequent or one time visitors to restricted areas.

Individuals delivering packages to the department.

Maintenance personnel working on department equipment or making minor repairs or inspections after the department supervisor has inspected the area to assure a safe condition.

Housekeeping personnel entering radiographic or radiotherapy rooms to empty trash or sweep floors provided the radiation sources are off and locked, and the supervisor has inspected the area to assure safe condition.

Patient relatives required to be in the room during a radiographic procedure. Otherwise, the usual precautions are taken.

2. Personnel monitoring is required for each individual who regularly enters a high radiation area.

3. Personnel monitoring is required for all individuals operating any source of ionizing radiation.

4. Personnel handling mCi amounts of gamma emitting radioactive material on a routine basis will be provided with finger dosimeters.

5. The Radiation Safety Office shall maintain a permanent record of all radiation safety monitoring reports. If a report indicates an over-exposure, an investigation shall be initiated to determine cause and to suggest remedial action.

6. Individuals determined to require radiation monitoring shall be advised annually of the worker's exposure to radiation or radioactive material.

NOTICES AND CAUTION SIGNS

The following required signs and notices can be obtained from the Radiation Safety Office.

1. Notice to Employees: This notice is to be posted in all places where licensed radioactive materials or registered sources of radiation are used. This notice contains information pertaining to:

a. The responsibility of the employer.

b. The responsibility of the employee.

c. The subjects covered in the regulations set forth by the NRC.

d. Reports on radiation exposure histories.

e. Inspections.

f. Inquiries.

2. Document Location Notice

Information concerning the regulations, registration and licensing information, and safety procedures is available to all employees.

The documents may be examined in the Radiation Safety Office.

These documents include:

a. Operating and Safety Procedures

b. Registration Certificate/Radioactive Material License

c. Notice of Violations

d. Correspondence with the NRC.

3. "Caution - Radioactive Material" signs must be present on all containers in which radioactive materials are greater than license exempt quantities that are transported, stored or used. This sign must also be posted in each area or room in which radioactive materials are used or stored in an amount exceeding 100 times the license exempt quantity. This sign is to inform the individual of the presence of radioactive materials so that proper precaution will be taken in handling of such material. This sign does not indicate a dangerously high level of radiation.

4. "Caution - Radiation Area" sign is posted in all areas where an individual could receive a radiation dose of 5 millirem in any one hour or 100 millirem in any five consecutive days. When posted on the door of a room containing an X-ray machine or fluoroscope, it means that these levels of radiation are present only when the machine is operating. Individuals entering areas posted with this sign are required to wear radiation badges except as described in section 3.9.

"High Radiation Area" sign is posted in all areas where an individual could receive a radiation dose of 100 millirem or moer per hour. These areas should be entered only by authorized personnel and the individual entering the area must wear a radiation badge. These regulations do not apply to patients receiving X-ray therapy.

PROCEDURES FOR MINIMIZING EXPOSURE AND CONTAMINATION

Areas where in an exposure level or more than 2 mRem/hr can be expected should be clearly marked by radiation caution signs.

Drinking or eating in rooms which radioactive materials are stores or used is not permitted.

Items such as purses, combs, cosmetics, etc., should not be used where radioactive materials are used.

Radioactive sources shall not be manipulated with the fingers. Forceps of suitable length shall be used.

Radioactive materials and samples shall be conspicuously labeled as to the chemical content, the amount of radioactivity and the activity which the radionuclide was assayed.

Radioactive materials and samples shall be returned to the storage areas when not in use.

Discharge of radioactive materials into sewers without the approval of the Radiation Safety Officer is prohibited. A record of all radioactive materials, received, stored and disposed of shall be kept at all times.

Radioactive material shall never be disposed of in ordinary trash.

Sources of radiation must be secured against unauthorized removal from storage, for example, by locking the area when personnel are not present.

Individuals using radioactive materials will comply with all regulations made by the Radiation Safety Officer for records or safety reasons.

It is the responsibility of each individual using radioactive material to become familiar with the Radiation Safety Manual for the VA and the regulations for Control of Radiation and to strictly adhere to these regulations contained in these documents.

PROCUREMENT, STORAGE AND TRANSFER OF RADIATION SOURCES

1. Requisitions ordering radionuclides must be signed by the Radiation Safety Officer.

2. Receipt - Packages are to be delivered directly to the Radiation Safety Officer.

3. Storage - All storage areas for radioactive material shall be approved by the radiotherapy physics group. All such storage areas shall be so constructed that only authorized users have access to the material.

4. Transfer

a. A change in the location where radioactive material is used must have prior approval of the R.S.O.

b. Radioactive material cannot be transported from one floor to anotehr or from one building to another except in a manner approved by the R.S.O.

c. All off-site shipments of radioactive material from the VA Radiotherapy must be approved by the radiotherapy physics group. Each shipment shall be made in accordance with the applicable Federal, State and local transportation regulations.

4. Receipt During Off-Duty Hours

a. Radioactive packages, not damaged in shipment, shall be stored in the designated area in the receiving department and secured against unauthorized removal. The date, time and isotope should be recorded.

b. Packages which appear severely damaged or crushed must be reported to the R.S.O immediately.

SECURITY OF AREAS USING RADIOACTIVE MATERIALS

As required by the Regulations for Control of Radiation, all areas within the department in which radioactive materials are used or stored will be conspicuously labeled with a "Caution Radioactive Materials" sign. All areas of the department in which radioactive materials are stored will be locked at all times other than when under the direct supervision of department personnel.

LEAK TESTS

1. Requirements: Each sealed source of radioactive material, other than gold-198 grains, shall be periodically tested for leakage and/or contamination as prescribed in this section. Records of these tests shall be maintained and made available for inspection.

2. Method of Testing: Tests for leakage and/or contamination shall be performed by the RSO staff as authorized by NRC to perform such services. The test sample shall be taken from the surface of the source or from the surface of the device in which the source is stored or mounted and on which one might expect contamination to accumulate. The test sample shall be analyzed for radioactive contamination and the analysis shall be capable of detecting the presence of 0.005 microcurie of radioactivity on the test sample. The results of the test shall be kept in units of microcuries and maintained for inspection by the agency.

3. Interval of Testing: Each sealed source of radioactive material shall be tested at intervals not to exceed six (6) months. In the absence of a certificate from a transfer indicating that a test has been made prior to the transfer, the sealed source shall not be put into use until tested.

Door interlocks and warning signals are used to prevent access to the treatment rooms during exposures. Each door is provided with a fail safe interlock system so if the door is opened while the machine is "ON", the interlocal will cause the irradiation to be terminated.

RADIATION SURVEYS

INITIAL RADIATION SURVEYS

Prior to the use of radioactive material or the operation of radiation producing machines, an initial radiation survey shall be performed by the radiotherapy physics group. Based on this survey, general procedures for safe handling and use will be recommended while leaving as much latitude as is safe and feasible.

PERIODIC RADIATION SURVEYS

The radiotherapy physics group will schedule periodic inspections and radiation surveys. Any unsafe practice will be called to the attention of the Chief of the Radiotherapy Department.

RADIATION SURVEY METHODS

1. Radiation Level Surveys - A survey meter capable of measuring levels as low as 0.1 mr/hr is used and the results recorded on a standard form showing location, date, perfon performing survey, instrument used, exposure levels, and corrective action taken, if any. A sketch of the area is used to make an easily prepared and easily understood survey record when annotated with this information.

2. Contamination Leak Survey - A series of wipes using filter paper or swatches of cloth taken from those surfaces where contamination could be expected to exist or where radiation levels are fairly high. (Areas where incoming packages are received, radium and gold sources prepared, etc., are areas that may be contaminated.) The wipes should be numbered or labeled and the location where they are taken shown on the sketch records as described above the radiation survey. The wipes will be counted using a gamma or liquid scintillation well counter. A standard comparable to the predominant activity employed in the area will be counted for purposes of converting the dpm.

ACCEPTABLE LIMITS

Radiation Limits - In no areas that are unrestricted (uncontrolled) should radiation levels exist, such that a person could receive 2 mR in any one hour, 100 mR in any seven consecutive days, or 500 mR in any one year. If such areas are found action should be taken to eliminate the excessive exposure levels. Additional shielding or relocation of radioactive material may be required. In restricted areas the exposure limits do not apply as personnel are monitored to determine their exposure. However, levels should be reduced to minimum where practicable to reduce exposure.

RADIATION SAFETY PROCEDURES

FOR

COBALT-60 TELETHERAPY UNIT

1. The departmental radiation safety officer for radiotherapy (L. David Gager) is the chief physicist. He is responsible for implementing the radiation safety program policies and procedures, and for insuring that all occupationally exposed personnel are aware of the "Safety Procedures for Personnel" and their duties regarding these procedures. He maintains copies of all associated records. He supervises; operation, calibration, and maintenance of the radiation producing equipment. He has authority to enforce radiation safety policy, to suspend activities deemed unsafe and to require remedial action when necessary.

   The departmental radiation safety officer will report to the state health department agency all incidents of possible personnel overexposure. The radiation safety officer will inspect the radiotherapy section approximately every six months to insure general compliance with license regulations. The radiation safety officer will submit and obtain the approval from the agency for all procedures which involve a change in the institutional license, and will act as the point of contact with the state health department.

2. The radiation therapy physicians, graduate degreed medical physicist, and radiation therapy technologists are the only individuals authorized to operate the treatment unit for treatment of human beings. Treatment of human beings with this unit is performed only under the supervision of a qualified radiation therapy physician who will remain in the facility during the treatment procedure.

   Only qualified medical physicists and engineer service technicians knowledgeable in the operation of this unit and the associated radiaiton safety procedures, are allowed to perform calibration, research and maintenance duties. These various duties are performed only with the approval of the chief physicist.

   The machine is powered down with the source in a safe "off" position and the key to the controls removed whenever there is no knowledgeable person present.

3. Personnel monitoring for exposure to radiation is by personnel monitor badge to be worn by every occupationally exposed employee when on duty. The monitor badge program is administered by the chief technician who keeps all records and periodically sends reports to the chief radiotherapy physicist (departmental R.S.O.) who reviews the personnel monitoring program quarterly. These reports are posted on the employee notice board.

4. Under the supervision of hte chief physicist, the Co-60 treatment units and all other sealed sources (except gold seeds) stored in the department are lead tested every six (6) months by wiping surfaces of the unit and source drawer housing where contamination might be found for the Cobalt-60 units and the source surfaces for the brachy therapy sources, with alcoholsoaked wipes. The wipes are then analized by a firm approved by the state health department to perform leak tests on sealed sources. The results are reported in uCi and the records are kept by the chief physicist. If the tests were to indicate more than 0.005 uCi of activity the source would be considered to be leaking.

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5. Radiation survey instruments are calibrated every year by a Texas firm licensed to calibrate survey instruments.

6. The teletherapy unit ispowered down with the source verified to be in the safe off position, the electrical power disconnect breaker is turned off, and the key to the keywsitch, by which the machine is energized, is removed to another location where the unit is left unattended.

7. Instructions in case of the teletherapy equipment system malfunction are posted at the unit control console. Please see the copy of emergency instructions included.

8. A. A full "in phantom" calibration of the teletherapy unit is performed yearly, and immediately following installation of a new teletherapy source. This calibration includes verification of the radiation dose rate at the treatment distances from the source, verification of selected field dependence, and depth dose points, light field/x-ray field coincidnece, timer delay function study, beam uniformity, nad verification of other physical parameters consistent with the proper and safe use of the unit for the treatment of humans. The various protective and safety interlocks and devices are also checked for proper function. The results of all of these procedures are logged in the permanent machine log book.

In addition, monthly radiation output checks, and verification of proper function of the safety and interlocks and devices is performed with the results recorded in the permanent machine log books.

B. At periodic intervals not exceeding 5 years or immediately following installation of a new teletherapy source and prior to initiation of treatment, a radiation source survey shall be made of:

1. The teletherapy source housing with the source in the "off" position to insure that radiation levels at one meter from the source do not exceed a maximum of 10 mR/hr or an average of 2 mR/hr around imaginary planes passing through the source.

2. All areas adjacent to the treatment room, with the source in the "on" position. The survey will be performed with the phamtom in the primary beam of radiation for all areas adjacent to secondary and primary barriers and with full beam, no phantom for primary barriers.

These surveys will establish that radiation levels in restricted areas are ot likely to cause personnel exposure in excess of the limits specified in TRCR 21.101, and in unrestricted areas will not exceed the limits specified in TRCR 21.105.

C. Function of devices for limiting the direction of the primary beam of radiation as well as other interlocks and devices used to insure safe and proper operation of hte unit are checked monthly by a qualified service technician and the status of the devices noted in the machine maintenance log book.

Function of electrical interlocks on entrance doors, source on/off indicators, room radiation, monitors, emergency off devices and patient monitoring

systems are checked and the conditions recorded by the therapy technologist each morning prior to beginning the daily treatment schedule.

EMERGENCY PLAN OF ACTION FOR COBALT-60 UNITS

If the beam does not turn off when treatment time is completed,

1. Press emergency bar on control and hold down.
2. If beam does not turn off,
   A. Remove patient from room quickly. CAUTION: Stay out of direct beam. Do not stay in room longer than necessary.
   B. Leave room, lock door, or post guard to prevent unauthorized entry.
   C. Call the Radiotherapist and L. David Gager.
3. If patient cannot be removed from room and beam will shut off,
   A. Take T-bar from console area and place over indicating rood on front of machine. Push drawer to off position.
   B. Leave room, close and lock door, and post guard to prevent unauthorized entry and call the Radiotherapist and L. David Gager.

L. David Gager
HOME PHONE: 496-1523
OFFICE PHONE: 799-4411

DAILY MACHINE CHECK LIST

MACHINE: ELDORADO AND THERATRON

BEFORE TREATING PATIENTS EACH DAY, THE TECHNOLOGISTS WILL PLEASE CHECK THE FOLLOWING:

1. **OPTICAL DISTANCE**

   Use the distance indicator to compare with the optical pointer.

2. **DOOR INTERLOCK**

   Turn the machine on, open the door to check if the machine will shut off.

3. **EMERGENCY "OFF" SWITCH**

   Turn the machine on, push the "EMERGENCY" button to check if it will turn the machine off.

4. **OUTSIDE DOOR LIGHT**

   Turn the machine on and check whether the "RED" light above the door is working correctly.

5. **ROOM RADIATION MONITOR**

   Turn the machine on and check if the radiation monitor is blinking.

6. **INTERCOM AND TV MONITORS**

   Make sure they are both working correctly.

IF ANY OTHERS ARE NOT WORKING CORRECTLY, PLEASE CONTACT ONE OF THE SUPERVISORY STAFF.

N O T I C E

IN CASE OF SOURCE BEING STUCK IN THE "ON" POSITION

1. If the patient is ambulatory, instruct him to get off the table and leave the room.

2. If patient is not ambulatory:

   a) If patient can be removed from the room, enter the room and, avoiding exposure to the useful beam, pull the treatment table as far away from the useful beam as possible, transfer the patient to a stretcher and remove him from the toom.

   b) If the patient carnot be removed from the room, operate the unit from the console and direct the primary beam away from the patient toward a safe barrier. If the primary beam cannot be moved off the patient, enter the room, locate the device for manually turning off the primary beam (T-bar) and turn the unit off.

3. Close the door and secure the room against unauthorized entry.

4. Notify one or all of the following for remedial action:

   Dr. John H. Liem, ext. 3977 or
   home 980-6524

   Dr. Philip Cooper, ext. 3141 or
   beeper: 44-416
   home 772-9214

   L. David Gager, M.D., 799-4411
   home 496-1523

The physicists mentioned above will perform the semi-annual leak testing of the teletherapy source. Leak test samples are taken by rubbing a test area with a slightly moist cotton-tipped swab and counting the swab for removeable activity. The instrumentation used in the analysis and the sample test areas surveyed are listed on the attachment "Report of Leak Test" enclosed.

REPORT OF LEAK TEST

DATE: 11/9/84

Identification of Sealed Source:

Veterans Administration Medical Center
AECL Theratron-780 Cobalt 60 Unit
Serial No. 109 Source No. _____, Installed _____

Samples counted on a dual channel Packard Model 5230 Autogamma Scintillation Spectrometer PM 6630-5338 NXRN11538, with a 0.0077 uCi Co-60 standard for reference.

Count time was 10 minutes.

Sample Identification:

1) Inside source drawer cavity.
2) Inside of collimators, and all accessible areas of field defining system.
3) Trimmer bars.
4) Treatment couch top.

Results (CPM):

Standard 1770
Background 13.0
Sample 1) 14.0
Sample 2) 12.6
Sample 3) 15.1
Sample 4) 15.0

Signed: Philip H. Cooper

L. DAVID GAGER, M. S., PHYSICIST
Radiotherapy Service
Veterans Administration Medical Center

Program for Maintaining Occupational
Radiation Exposures at Medical Institutions ALARA

HOUSTON VETERANS ADMINISTRATION MEDICAL CENTER

August 15, 1980

I. Management Commitment

a. We, the management of this Medical Center are committed to the program described in this paper for keeping exposures (individual and collective) as low as reasonably achievable (ALARA). In accord with this commitment, we hereby describe an administrative organization for radiation safety and will develop the necessary written policy, procedures and instructions to foster the ALARA concept within our institution. The organization will include a Radiation Safety Committee (RSC), and a Radiation Safety Officer (RSO).

b. We will perform a formal annual review of the radiation safety program including ALARA considerations. This shall include reviews of operating procedures and past exposure records, inspections, etc., and consultations with the radiation safety staff or outside consultants.

c. Modification to operating and maintenance procedures and to equipment and facilities will be made where they will reduce exposures unless the cost, in our judgement, is considered to be unjustified. We will be able to demonstrate, if necessary, that improvements have been sought, that modifications have been considered, and that they have been implemented where reasonable. Where modifications have been recommended but not implemented, we will be prepared to describe the reasons for not implementing them.

d. In addition to maintaining doses to individuals as far below the limits as is reasonably achievable, the sum of the doses received by all exposed individuals will also be maintained at the lowest practicable level. It would not be desirable, for example, to hold the highest doses to individuals to some fraction of the applicable limit if this involved exposing additional people and involved significantly increasing the sum of radiation doses received by all involved individuals.

II. Radiation Safety Committee (RSC)[1]

a. Review of Proposed Users and Uses

1. The RSC will thoroughly review the qualifications of each applicant with respect to the types and quantities of materials and uses for which he has applied to assure that the applicant will be able to take appropriate measures to maintain exposure ALARA.

2. When considering a new use of byproduct material, the RSC will review the efforts of the applicant to maintain exposure ALARA. The user should have systematized procedures to ensure ALARA, and shall have incorporated the use of special equipment such as syringe shields, rubber gloves, etc., in his proposed area.

3. The RSC will ensure that the user justifies his procedures and that dose will be ALARA (individual and collective).

b. Delegation of Authority

(The judicious delegation of RSC authority is essential to the enforcement of an ALARA program.)

1. The RSC will delegate authority to the RSO for enforcement of the ALARA concept.

2. The RSC will support the RSO in those instances where it is necessary for the RSO to assert his authority. Where the RSO has been overruled, the Committee will record the basis for its action in the minutes of the Committee's quarterly meeting.

c. Review of ALARA Program

1. The RSC will encourage all users to review current procedures and develop new procedures as appropriate to implement the ALARA concept.

2. The RSC will perform a quarterly review of occupational radiation exposure with particular attention to instances where Investigational Levels in Table I below are exceeded. The principle purpose of this review is to assess trends in occupational exposure as an index of the ALARA program quality and to decide if action is warranted when Investigational Levels are exceeded (see paragraph VI)[1]

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[1] The NRC has emphasized that the Investigational Levels in this program are not new dose limits but, as noted in ICRP Report 26, "Recommendations of the International Commission on Radiological Protection", serve as check points above which the results are considered sufficiently important to justify further investigations.

3. The RSC will evaluate our institution's overall efforts for maintaining exposures ALARA on an annual basis. This review will include the efforts of the RSO, authorized users, and workers as well as those of management.

III. Radiation Safety Officer (RSO)

a. Annual and Quarterly Review

1. Annual review of the Radiation Safety Program. The RSO will perform an annual review of the Radiation Safety Program for adherence to ALARA concepts. Reviews of specific procedures may be conducted on a more frequent basis.

2. Quarterly review of Occupational Exposures. The RSO will review at least quarterly the external radiation exposures of authorized users and workers to determine that their exposures are ALARA in accordance with the provisions of paragraph VI of this program.

3. Quarterly review of records of Radiation Level Surveys. The RSO will review radiation levels in unrestricted and restricted areas to determine that they were at ALARA levels during the previous quarter.

b. Education Responsibilities for an ALARA Program

1. The RSO will schedule briefings and educational sessions to inform workers of ALARA program efforts.

2. The RSO will assure that authorized users, workers and ancillary personnel who may be exposed to radiation will be instructed in the ALARA philosophy and informed that management, the RSC and the RSO are committed to implementing the ALARA program.

c. Cooperative Efforts for Development of ALARA Procedures

Radiation workers will be given opportunities to participate in the formulation of the procedures that they will be required to follow.

1. The RSO will be in close contact with all users and workers in order to develop ALARA procedures for working with radioactive materials.

2. The RSO will establish procedures for receiving and evaluating the suggestions of individual workers for improving health physics practices and encourage the use of those procedures.

d. Reviewing instances of Deviation from Good ALARA Practices

The RSO will investigate all known instances of deviation from good ALARA practices; and, if possible, determine the causes. When the cause is known, the RSO will require changes in the program to maintain exposures ALARA.

IV. Authorized Users

a. New Procedures involving Potential Radiation Exposures

1. The authorized user will consult with, and receive the approval of, the RSO and/or RSC during the planning stage before using radioactive materials for a new procedure.

2. The authorized user will evaluate all procedures before using radioactive materials to ensure that exposures will be kept ALARA. This may be enhanced through the application of trial runs.

b. Responsibility of the Authorized User to Those He Supervises

1. The authorized user will explain the ALARA concept and his commitment to maintain exposures ALARA to all of those he supervises.

2. The authorized user will ensure that those under his supervision who are subject to occupational radiation exposure are trained and educated in good health physics practices and in maintaining exposures ALARA.

V. Persons Who Receive Occupational Radiation Exposure

a. The worker will be instructed in the ALARA concept and its relationship to his working procedures and work conditions.

b. The worker will know what recourses are available if he feels that ALARA is not being promoted on the job.

VI. Establishment of Investigational Levels In Order to Monitor Individual Occupational External Radiation Exposures

This institution hereby establishes Investigational Levels for occupational external radiation exposure which, when exceeded, will initiate review or investigation by the Radiation Safety Committee and/or the Radiation Safety Officer. The Investigational Levels that we have adopted are listed in Table 1 below. These levels apply to the exposure of individual workers.

Table 1

		Investigational Levels - (mrems per calendar quarter)	
		LEVEL I	LEVEL II
1.	Whole body, head and trunk, active blood-forming organs, lens of eyes, or gonads	125	375
2.	Hands and forearms, feet and ankles	1875	5625
3.	Skin of whole body*	750	2250

* Not normally applicable to nuclear medicine operations except those using significant quantities of beta emitting isotopes.

The Radiation Safety Officer will review and record on Form NRC-5, Current Occupational External Radiation Exposures, or an equivalent form (e.g. dosimeter processor's report), results of personnel monitoring, not less than once in any calendar quarter, as is required by 10 CFR 20, 20.401. The following actions will be taken at the Investigational Levels as stated in Table 1:

a. Quarterly exposure of individuals to less than Investigational Level 1.

Except when deemed appropriate by the RSO, no further action will be taken in those cases where an individual's exposure is less than Table 1 values for the Investigational Level 1.

b. Personnel exposures equal to or greater than Investigational Level 1, but less than Investigational Level II.

The RSO will review the exposure of each individual whose quarterly exposures equal or exceed Investigational Level I. He will report the results of his reviews at the first RSC meeting following the quarter when the exposure was recorded. If the exposure does not equal or exceed Investigational Level II, no action related specifically to the exposure is required unless deemed appropriate by the Committee. The Committee will, however, consider each such exposure in comparison with those of others performing similar tasks as an index of ALARA program quality and will record the review in the Committee minutes.

c. Exposure equal to or greater than Investigational Level II.

The RSO will investigate in a timely manner the cause(s) of all personnel exposures equaling or exceeding Investigational Level II and, if warranted, take action. A report of the investigation, the actions taken, if any, and a copy of the individual's Form NRC-5 or its equivalent will be presented to the RSC at the first RSC meeting following completion of the investigation. The details of these reports will be recorded in the Committee minutes. Committee minutes will be sent to the management of this institution for review. The minutes, containing details of the investigation, will be made available to NRC inspectors for review at the time of the next inspection.

d. Re-establishment of an Individual Occupational Worker's Investigational Level II Above That Listed in Table I.

In cases where a worker's or a group of worker's exposures need to exceed Investigational Level II, a new, higher Investigational Level II may be established on the basis that it is consistent with good ALARA practices for that individual or group. Justification for a new Investigational Level II will be documented.

The Radiation Safety Committee will review the justification for, and will approve, all revisions of Investigational Levels II. In such cases, when the exposure equals or exceeds the newly established Investigational Level II, those actions listed in paragraph c above will be followed.

VII. Signature of Certifying Official

I hereby certify that this institution has implemented the ALARA Program set forth above.

JOHN V. SHEEHAN
Director

QUALITY ASSURANCE TEST PROCEDURES FOR THE A.E.C.L. THERATRON-80 COBALT-60 TREATMENT UNIT

OUTLINE

I. Introduction

II. Instrumentation

III. Initial commissioning of Unit for patient treatment

IV. 5 year inspection by qualified source handler

V. Annual Complete calibration in Phantom

VI. Semi-annual tests

VII. Monthly calibration and tests

VIII. Daily start-up tests

IX. Recording data and documentation

I. Introduction

The successful treatment of cancer by radiation incorporates a skillful balance between the maximum probability of cure and the minimum probability of radiation-induced complications. It is now well documented that precisely administered radiation treatments are a requisite to achieving that balance and, therefore, are essential for radiation therapy with curative intent.

The use of megavoltage radiation in external beam therapy is one major step toward this goal of precision. However, the use of megavoltage radiation does remove or greatly modify many of the visible biological indicators previously used by the radiation therapist to evaluate the progress of the treatment and to avoid complications. Therefore, the radiation therapist must obtain a precise knowledge of the radiation dose distributed throughout the irradiated volume of the patient prior to initiating treatments. This knowledge must not only include the dose to the tumor itself but also the dose to normal organs or radiation-sensitive structures in the irradiated volume. This knowledge is based on physical information regarding the radiation beam to be used, on how this beam is altered as it passes through the various tissues of the body, and, finally, on how several beams are to be utilized to achieve the desired dose distribution in the patient. This information is all at a much higher level of sophistication than that practiced for ortho-voltage therapy. If the advantages of megavoltage radiation therapy are to be realized, then the decision to purchase must be accompanied by the decision to carry out the required physical measurements (Appendix I) with the assistance of a qualified radiological physicist (Appendix II). This radiological physicist shall plan and survey the installation in order that it comply with the various State and Federal laws as well as the recommendations of such bodies as the Federal Radiation Council and the National Council on Radiation Protection. The physicist shall certify that the therapy equipment is performing according to specifications after it is installed, generate the data necessary for the practice of high-quality radiation therapy, and outline a procedure to be used daily to determine that the machine is operating under the conditions for which the data were obtained. It must be emphasized that the practices of output calibrations once a year and dose distributions measured on other equipment are totally inadequate and not accepted as good practice.

It is necessary that the qualified radiological physicist have the appropriate equipment and instrumentation to perform the required measurements. It is also highly desirable that he have access to computer facilities so that meaningful physical evaluation of complex treatment plans proposed by the radiologist may be rapidly performed prior to the initiation of therapy.

In summary, the decision to provide a community with megavoltage radiation therapy facilities not only involves a decision to enlist the services of a radiation oncologist, purchase and house the therapy equipment, and arrange for its continued maintenance, but also to provide for the support of the qualified radiological physicist who has access to the appropriate equipment and facility.

II. Instrumentation

A. Survey Meters

Two types of survey meters are required:

An ionization-chamber type survey instrument having multiple ranges from 0 to not more than 5 mR/h full scale to 0 to 50 R/h full scale. This need may be met by one single instrument or by a combination of several having linear or logarithmic scales. Instrumentation with the capability of measuring exposure as well as exposure rate is useful for measurement of leakage radiation around the x-ray head. The construction should be such that the calibration factors do not change more than 5% with orientation or for a change in photon energy from ^{137}Cs to ^{60}Co gamma radiation.

A rapid response Geiger or scintillation-type survey meter whose purpose is to search for anomalous leaks of radiation into occupiable space. Such leaks may be due to structural defects, unbacked junction boxes in the walls, inadequate caulking of lead glass windows, defects in overlaps between lead doors and leaded jambs, etc.

Both types of survey meters shall be calibrated against a certified cesium, cobalt, or radium source within three months prior to use for purposes of survey.

B. Calibration dosimeters

The primary calibration of megavoltage therapy equipment should be made with an ionization chamber bearing calibrations for ^{60}Co gamma rays traceable to the National Bureau of Standards (NBS) through no more than one exchange. Alternatively, it may be calibrated by a Regional Calibration Laboratory (RCL). A calibration certificate should be obtained which includes chamber calibration factors, a specification of the voltage sensitivity, linearity of response, electrical leakage, size of irradiation field at calibration, stem leakage effects, and presence of openings to the atmosphere. Measurements should be made at 5-cm depth in a primary tissue-equivalent phantom (Sec. V.C) and corrected for spectral differences by use of the appropriate $C\lambda$ factor.[1] Check measurement which are normalized to such a primary calibration may be made under more varied conditions suitable to the phenomena under study (e.g., "in air" for study of variations in output with angle of gantry, "in a finite size" phantom for daily checks, etc.).

The changes in instrument calibration produced by the trauma of frequent use and transportation dictate that at least two ionometric dosimeters should be available together with an isotopic calibration source. One dosimeter should be of a design suitable for a local standard. Ideally, it would be reserved solely for that role. Under certain circumstances it may be used for the relatively infrequent initial, primary, reference calibration of a machine; otherwise, a third instrument similar to this first must be available for this purpose. The second ionometric dosimeter may be of less restrictive design and may be used as the field instrument for ongoing calibration of equipment subsequent to the initial reference calibration. It should be subject to frequent calibration checks against the local standard.

1. *Dosimeter suitable for a local standard and for initial or reference calibrations*

A direct-reading, integrating dosimeter is preferred as a local standard. If multirange, the instrument should be calibrated on all ranges. The linearity of response between indicated instrument reading and ^{60}Co gamma-ray exposure should be within ± 1%. The design should be such that it is inherently capable of being calibrated to within ± 0.5% of a national standard for ^{60}Co gamma radiation after correction for linearity of indicated response. The full-scale deflection should be in the range of therapy exposures. The ion-chamber wall should be of sufficient thickness, either inherently or by means of an added plastic cap, to provide electronic equilibrium for ^{60}Co gamma rays. If fitted with a cap, that cap must be considered an integral part of the instrument for all measurements utilizing the ^{60}Co gamma-ray calibration factor. The collection efficiency of the chamber should be determined for conditions of instrument intercomparison. If the intercomparison with field instruments is performed in a ^{60}Co gamma-ray beam, the collection efficiency should be determined under conditions of maximum dose rate to be used in standardization. If the beam is of a pulsing nature, the collection efficiency should be determined under conditions of maximum dose-rate and dose per pulse. If the design of the instrument permits controlled variation of the collection voltage on the ionization chamber, the saturation current or quantity of charge collected per unit time should be determined for positive and negative polarity and the mean value taken. The saturation current may be obtained by placing the collecting voltage at +50, +100, +150, +250, +500 V, or any other increment suitable to the chamber and recording the observed ionization current for each voltage with a constant exposure rate. The resulting data may be plotted against the reciprocal of the square of the voltage. Extrapolation of this curve to 0 on the $1/V^2$ axis yields the true saturation current as the intercept on the current axis. The design of the instrument may not permit controlled variation of the collection voltage for experimental determination of collection efficiency. The collection efficiency under the conditions of use outlined above may be computed using the method of Boag.[2] Limited information on the values of the constants entering the calculation make it advisable to operate the chamber under conditions where 99% collection efficiency may be expected from such calculations so that the correction is small. The interval between return to an RCL for recalibration should not exceed two years if the dosimeter is dedicated as a local standard and routinely compared to an isotopic standard. The instrument stability should be such that changes in calibration factor in excess of 1% are not observed between calibrations by an RCL.

If an isotopic source suitable for constancy check is available, one instrument may be used for primary calibrations in addition to its use as a local standard for comparison with other dosimeters. If no suitable source is available, one instrument should be used solely for comparison with other dosimeters and a second equivalent calibrated dosimeter should be obtained for initial primary reference calibrations.

To be useful for primary calibration, the ion chamber internal diameter should not exceed 1 cm nor the length 2 cm since displacement and field uniformity corrections will be excessive.[3] The collection efficiency of the chamber under conditions of maximum dose rate and dose per pulse should exceed 99% as determined above.

Stem effects should be minimized (e.g., by a guarded signal conductor design) and should be quantitatively known. The effects of rf interference should be minimized by external earthed sheaths and modifications to the electrometer circuits where appropriate. If the chambers are not heremetically sealed, the reading must be corrected for deviation of ambient temperature and pressure from those pertaining to the calibration. If the chambers are to be subject to sudden changes in either parameter, the rate of equilibration, and therefore the time to reach the room temperature and pressure, should be known.

To make these corrections, it is desirable that a thermometer and high quality aneroid barometer calibrated against a standard mercury barometer be available to measure the atmospheric temperature and pressure relevant to the calibration conditions. If an aneroid barometer is transported by air, the calibration may be lost by the pointer being driven against the stops and the calibration should be checked against the elevation barometric pressure as recorded at the airport before leaving for the therapy installation which may be at a different altitude. If the instrument is to be transported between treatment centers for initial reference calibrations, it should be hand-carried and placed on the floor of an automobile or in the passenger cabin space in an aircraft. This practice will minimize possible modifications to the calibration factor caused by mechanical changes and by significant temperature and pressure variations. It may be shipped to an RCL for calibration but should be returned by courier after calibration.

The instrument, if widely transported, should be submitted for recalibration by an RCL annually when all features of the certification will be reviewed. Instruments used locally and compared with isotopic standards routinely need only be returned to an RCL every two years for recertification.

2. Routine field instrument used for ongoing calibrations of equipment subsequent to the initial reference calibration

This instrument will be of maximum use if it is multirange and multipurpose so that large and small doses and dose rates can be conveniently measured in one to two minutes. If an integrating survey meter is not available (Sec. II.A) then an auxillary ion chamber large enough to serve the same purpose for exposures as low as one thousandth of primary beam intensity should be available. The considerations of chamber size, low collection efficiency, stem effects, and rf pickup, enumerated under Sec. II.B.1, are relevant. Linearity of response should be $\pm$ 1% over the working range. The spread of repeated readings in a ^{60}Co gamma-ray beam should not exceed $\pm$ 1.5% and the long-term calibration stability should be such that changes in calibration factors do not exceed $\pm$ 2% between comparisons with the local standard. Field instruments should be calibrated by an RCL at purchase and immediately compared to the local standard. If an isotopic source is available for local intercomparisons, the instruments do not need to be returned to an RCL until a deviation in calibration factor in excess of 2% is observed. If no isotopic source is available they should be returned to an RCL at least every two years.

C. Care and maintenance

Instructions given in the manufacture's handbook should be followed. In the event of defective performance, do not attempt local repairs. When not in use, the instrument should be kept in an appropriately sealed carrying case,

glass jar, or polyethylene bag. In moist environments these should contain dessicants, which should be maintained in active condition. It is recommended that the dosimeter be assessed for constancy of performance on a routine basis by comparison with a local isotope standard with reproducible geometry. Such standards are usually available from the manufacturer of the instrument.

III. The Initial Commissioning of the Unit for Patient Treatment

A. The initial commissioning of the unit for patient treatment is comprised of series of tests performed by the medical physicist to (1) verify that the unit meets manufacture's and regulatory agency specifications, (2) taking of original parameters and physical data for the clinical use of the unit, and (3) the initial in phantom calibration of radiation output of the unit.

These tests include:

1. Radiation protection survey of areas surrounding the treatment room
2. Radiation protection survey of head leakage
3. Verification of proper function of warning lights, door interlocks, emergency off buttons, patient monitoring devices, and safety systems.
4. Mechanical alignment of the collimator jaws
   a. rotational axis
   b. symetry
5. Coincidence of the mechanical axis of collimator assembly by beam defining light and radiation beam.
6. Coincidence of beam defining light with the useful x-ray beam
7. Determinization of radiation beam isocenter
8. Determinization of Timer Error
9. Verification of beam flatness
10. Radiation absorbed dose output calibration of the machine
    a. in phantom
    b. in air
11. Determination of Radiation Beam Parameters
    a. central axis depth dose data
    b. field size dependence factors
    c. backscatter factors
    d. wedge factors
    e. shadow tray attenuation
    f. normalization factors
    g. tissue air ratios (TMR)
    h. off axis data

If when all of the above data has been analyzed, it is found to be within satisfactory bounds and meet required specifications, the unit is accepted and approved for use in treating patients. The data necessary for clinical use of the unit is compiled, verified and posted. All of the data acquired and the evidence of processing of this data is recorded in the log book and file for this unit and kept for future evidence and reference.

PERSONNEL EDUCATION PROGRAM
FOR RADIATION SAFETY

A scheduled inservice lecture and demonstration will be provided by the physics group yearly to all radiotherapy personnel as a refresher course in radiation safety procedures and techniques. A similar discussion will be provided to new departmental employees as a part of their orientation procedure.

Topics covered in these discussions will include:

1. Brief history of medical use of radiation.

2. Potential hazards associated with radiation exposure.

3. Rules and regulations regarding radiation exposure and handling of radioactive sources.

4. Proper safety procedures to minimize personal exposure and exposure to others.

5. Procedures for reporting unsafe use of radiation producing equipment.

6. Proper response to emergency situations:
   a) Location of posted procedures.
   b) Location of emergency equipment.
   c) Practice drills.
   d) Personal awareness and responses.

7. Location of posted copies of:

   Licences
   Correspondence
   Notices
   Personnel monitoring reports
   Procedures

In addition, physics personnel will be available to all employees for discussion and counceling on matters of radiation safety.