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INTERIM REPORT

NRC Research and Technical Assistance Report

PERFORMANCE TESTING OF PERSONNEL DOSIMETRY SERVICES

U.S. Nuclear Regulatory Commission
Contract Number NRC-01-77-180

PROCEDURES MANUAL

submitted by

The Department of Environmental and Industrial Health
School of Public Health
The University of Michigan
Ann Arbor, Michigan 48109

August 14, 1979

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I. INTRODUCTION

From October, 1977 to September, 1979, The University of Michigan conducted a pilot study of the Health Physics Society Standards Committee (HPSSC) Standard titled CRITERIA FOR TESTING PERSONNEL DOSIMETRY PERFORMANCE. The Standard was given tentative approval by the American National Standards Institute as ANSI N13.11. Table 1 summarizes the radiation categories and statistical criteria required by the Standard.

During the two-year pilot study, 59 dosimetry processors volunteered to send us dosimeters for irradiation according to the requirements and restraints described in the HPSSC Standard. Once a processor evaluated their dosimeters, they reported their estimates of the delivered dose equivalents to us. We then determined if the processor passed or failed the Standard and sent the processor a computer printout of their results.

Each processor was permitted to be tested twice during the pilot study. For each test, a processor could choose to be tested in any or all of the eight radiation categories defined in the Standard. The average processor participated in six categories. During the two-year pilot study, we administered a total of 700 category tests among all the processors. These tests required the irradiation of approximately 21,000 dosimeters.

In addition to the open tests, we blind-tested seven of the large commercial processors. The blind testing program involved a total of 70 category tests and 1,680 dosimeters.

Table 1. Summary of HPSSC Standard prepared by The University of Michigan

	Radiation Category	Interval	Test Range	Number of Dosimeters Per Test	Tolerance Level (L) (see footnotes) Shallow (7 mg/cm^2)	Deep (1000 mg/cm^2)
I.	Gamma (Co-60)	1 Accident:	10-800 rad	10	no test	a
		2 Protection:	30-100 mrem	10	no test	b
		3	101-300 mrem	10	no test	b
		4	301-10,000 mrem	10	no test	b
II.	X Ray (30-300 keV)	1 Accident:	10-800 rad	10	no test	a
		2 Protection:	30-100 mrem	10	c	c
		3	101-300 mrem	10	c	c
		4	301-10,000 mrem	10	c	c
III.	X Ray (15-30 keV)	Accident:	no test			
		1 Protection:	150-300 mrem	10	c	c
		2	301-10,000 mrem	10	c	c
IV.	Beta (Sr-90)	Accident:	no test			
		1 Protection:	150-300 mrem	10	c	no test
		2	301-10,000 mrem	10	c	no test
V.	Neutrons (Cf-252)	Accident:	no test			
		1 Protection:	100-300 mrem	10	no test	c
		2	301-5,000 mrem	10	no test	c
VI.	Photon Mixtures (Cat. I & II)	Accident:	no test			
		1 Protection:	50-100 mrem	10	c	c
		2	101-300 mrem	10	c	c
		3	301-10,000 mrem	10	c	c
VII.	Photon and Beta Mixtures (Cat. I or II & IV)	Accident:	no test			
		1 Protection:	200-300 mrem	10	c	c
		2	301-10,000 mrem	10	c	c
VIII.	Photon and Neutron Mixtures (Cat. I & V)	Accident:	no test			
		1 Protection:	150-300 mrem	10	no test	c
		2	301-5,000 mrem	10	no test	c

For each dosimeter, a performance index is calculated by:

$$P = \frac{H' - H}{H}$$ where: H = delivered quantity, H' = reported quantity

For each depth of each interval, an average performance index, $\bar{P}$, and its standard deviation, S, are calculated.

A processor passes a category if, for each depth of each interval:

$$|\bar{P}| + 2S \leq L$$

where:

a: $L = 0.3$

b: $L = 0.3$ or $6/\sqrt{H}$ whichever is larger

c: $L = 0.5$ or $15/\sqrt{H}$ whichever is larger

The objective of this Procedures Manual is to describe the operational conditions of the pilot study in sufficient detail to permit another laboratory to duplicate our procedures. The Manual describes our source calibrations, irradiation geometries, quality control, record keeping, data analysis, and method of receiving, handling, and returning large numbers of dosimeters.

This Procedures Manual was prepared prior to the preparation of the Final Report on the pilot study, which will contain our recommendations for changes in the HPSSC Standard. Other interested groups are also expected to recommend changes in the Standard after the Final Report is issued. Thus, the reader of this Procedures Manual is cautioned that the HPSSC Standard will undoubtedly have changed between the time this Manual was prepared and the time it will first be used.

II. SOURCES, CALIBRATIONS, EQUIPMENT, AND INSTRUMENTS

A. General

Table 2 summarizes the six radiation sources that were used for each interval of the five radiation categories that require a single source. The remaining three categories involved appropriate combinations of the sources used for the first five categories.

All calibrations were done with ionization chambers placed free in air, but all dosimeters were irradiated while mounted on a phantom. Six phantoms were constructed for convenience, so one phantom could be left with each of the six radiation sources throughout the pilot study. Each phantom is a plexiglas box, 30 x 30 cm by 15 cm deep, filled with water. Six dosimeters, one from each of six different processors, were attached to a phantom and irradiated at the same time to the same quantity of radiation. The six irradiation positions on the front face of each phantom are shown in Figure 1. Calibration of each radiation source involved exposure (or absorbed dose) rate me surements at each of the six positions at which dosimeters were placed on a phantom. The irradiation geometry for dosimeters attached to a phantom is illustrated in Figure 1.

At each source, a phantom was placed on a permanent stand. The height of each stand was fixed in order to keep the phantom in the center of the radiation beam. A platform was mounted on top of each stand, and a phantom was placed on the platform. Each platform had the same surface dimensions

Table 2. Summary of radiation sources and irradiation conditions for the five categories that require a single source.

Radiation Category	Interval	Radiation Source	NBS Technique	Irradiation Conditions		$\bar{C}_x$ air (d)		$\bar{E}$ (e)
				Dist. (cm)	Approx. Rate	Shallow	Deep	(keV)
I. Gamma	10-200 rad (a)	Co-60, teletherapy		200	15 R/min	1.01	1.01	1250
	201-800 rad (a)	" "		100	60 R/min	"	"	"
	30-100 mrem	Co-60, Irradiator		200	25 mR/min	"	"	"
	101-300 mrem	" "		100	100 mR/min	"	"	"
	301-10,000 mrem	" "		100	100 mR/min	"	"	"
II. X-Ray (30-300 keV)	10-800 rad	X-ray machine (b)	MFK, 20mA	100	10 R/min	1.34	1.34	91
	30-100 mrem	" "	HFK, 5mA	100	15 mR/min	1.26	1.26	204
	101-300 mrem	" "	HFG, 10mA	100	50 mR/min	1.35	1.35	118
	301-10,000 mrem	" "	MFG, 5mA	100	750 mR/min	1.28	1.23	54
III. X-Ray (15-30 keV)	150-300 mrem	X-ray machine (c)	L-G, 1mA	200	100 mR/min	0.81	0.26	20
	301-10,000 mrem	" "	L-G, 4mA	200	300 mR/min	"	"	"
IV. Beta	150-300 mrem	Sr-90 irradiator		35	150 mrad/min			
	301-10,000 mrem	" "		35	150 mrad/min			
V. Neutron	100-300 mrem	Cf-252 irradiator		100	25 mrem/min			
	301-5,000 mrem	" "		50	100 mrem/min			

(a) The single interval from 10 to 800 rad was subdivided for ease of irradiation at two distances.

(b) A General Electric Maxitron 300 X-ray machine was used for all intervals of Category II.

(c) A General Electric XRD-5 X-ray machine was used for both intervals of Category III.

(d) Values of C_x are given in Table 2 of the HPSSC Standard. They are used to convert from exposure to dose equivalent index at shallow (7 mg/cm^2) and deep (1000 mg/cm^2) depths in tissue.

(e) Values of $\bar{E}$, the average energy of a photon spectrum, were measured by GSF in Neuherberg, Germany.

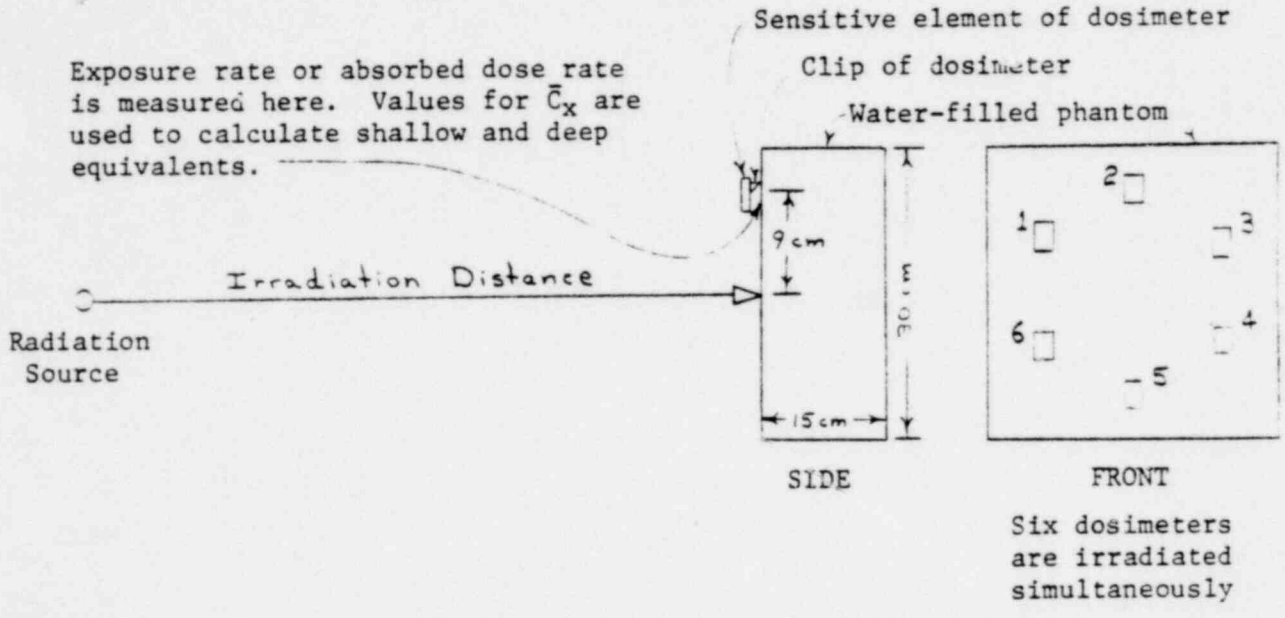

Figure . Irradiation geometry for dosimeters attached to a water-filled phantom.

as the bottom of a phantom, 30 cm x 15 cm. The front of the phantom was aligned with the front of the platform for dosimeter irradiations. The phantom was pushed back a distance equal to the radius of an ionization chamber for calibrations so the ionization chamber could be properly positioned before the phantom was removed.

Two methods were used to determine the proper alignment of a phantom in a radiation beam. First, for all photon sources, ionization chamber measurements were made repetitively at the six irradiation positions on the face of a phantom. The phantom was moved vertically or horizontally until the mean exposure rates among the six positions differed by less than 1%. Second, for every source including the californium-252 source, a piece of chest-size X-ray film was placed on the face of the phantom and irradiated. A Welch densitometer was used to examine the uniformity of the radiation beam among the six irradiation positions.

Once a phantom was properly aligned in a radiation beam, plumb bobs were suspended from permanent mountings in the ceiling to align with markings on the top of the phantom. Measurements were made relative to the phantom from the walls, the floor, and the source and were recorded on a schematic drawing of each room. A schematic drawing was posted at each source to make alignment quality control checks simple and consistent. Levels were placed on the phantom to be sure the face of the phantom was always perpendicular to the radiation beam. A rigid bar was cut for each source so the distance from the source to the phantom would be measured exactly

the same each time. Each measuring bar was labeled beta source, gamma source, etc., to provide each source with the same bar each time.

All of the radiation sources, except the neutron source, were calibrated with an electrometer, and a Leeds and Northrup Student Potentiometer. When operated in the capacitance mode, the electrometer was used with a $10{,}381.3 \times 10^{-12}$ farad capacitor calibrated by the National Bureau of Standards (NBS).

The X-ray and cobalt-60 sources were calibrated with either a 3 cm^3 or a 100 cm^3 Shonka-Wyckoff ionization chamber manufactured by Exradin, Inc. Both chambers were calibrated by NBS for specific NBS X-ray techniques and for cobalt-60.

The strontium-90 source was calibrated first by NBS and then with The University of Michigan's extrapolation chamber.

The californium-252 source was calibrated by NBS.

Throughout the pilot study, close ties were maintained between the testing laboratory and NBS. Before Test #1 began, NBS calibrated the two ionization chambers that were to be used to calibrate all the photon sources required for the pilot study. At the conclusion of Test #2, the ionization chambers were again calibrated by NBS. A team of five people from NBS visited the testing laboratory before Test #1 began to review

all calibration and irradiation procedures. This close cooperation with NBS was essential to insure that the delivered exposures and absorbed doses were as accurate as possible.

The following parts of Section II describe the procedures developed to calibrate and use the six radiation sources required for the pilot study. Floor plans of the irradiation facilities and specific calibration data are given in the Preliminary Phase Report prepared in April, 1978.

B. Cobalt-60 Irradiator

A 5-curie cobalt-60 irradiator with a 30° beam port was purchased from J.L. Shephard and Associates. Irradiation distances of 1 and 2 meters were chosen for the protection intervals of Category I. At each distance, a plexiglas phantom was placed on a stand and aligned in the center of the beam. Once the correct alignment was determined, two permanent plumb bobs (110 g each) were hung from the ceiling with nylon lines so the alignment of the phantom could be reproduced. Also, a plumb bob was hung from the ceiling above the source so that any movement could be detected. The beam extended approximately 50 cm beyond the edges of the front face of the phantom. Rigid bars 1 and 2 meters long were fabricated to assure reproducible distance measurements. The 3 cm^3 ionization chamber with a plastic buildup cap was used for calibration.

The following procedures were used for calibration. Four different measuring systems were used to determine which ones would be most accurate and to determine the agreement among the systems. The systems were: Keithley model 610B electrometer, Keithley electrometer with Leeds and Northrup Potentiometer, Cary model 31 electrometer, and Cary electrometer with Leeds and Northrup Potentiometer. At a later time, a Keithley model 616 electrometer was also used. It was determined that the Cary model 31 and the Keithley model 616 systems were the most accurate and reliable. However, there was fair agreement when the Keithley model 610B electrometer was used together with the potentiometer. It is felt that using different techniques enabled the testing laboratory to have some redundancy in the measurement systems.

Calibration measurements were made repeatedly at each of the six phantom positions at the 1 meter distance. The variation in the average exposure rates among all six phantom positions was no larger than the variations in individual readings at any one position. Therefore, the exposure rate was computed from a mean among all six phantom positions. At the 2 meter distance, only three phantom positions (#2, #3, and #5) were calibrated as above. The exposure rate was again computed from a mean rate among the three positions.

Personnel at NBS calculated that back-scatter from the walls of the room was less than 0.1%. The electronics were removed as far as possible from the direct and scattered radiation. Two line frequency timers, two barometers, two thermometers, low-noise cables, and proper connectors were used to insure accuracy of the measurements.

The calibrations were carried out independently of source-shutter (source-raising-and-lowering) functions. To check the effect of source-shutter functions, the source was raised and lowered several times with the timer, which is activated when the source is in the irradiation position, used to record the total source-on time. The actual irradiation time, computed form the steady-state ionization current determined in earlier measurements, was compared to the time on the irradiator's timer. The difference, if any, in the times was corrected for in the calibration.

Since the irradiator was manually operated, all the personnel involved in the pilot study were used to determine the shutter time. This was done several times and an average time was calculated. It was determined that, for the shortest times (on the order of 1 minute) used to irradiate dosimeters, an error of about 0.2% could result. Thus, it was concluded that shutter time errors were insignificant.

The linearity of the exposure rate was also checked by measuring the exposure rate as a function of exposure time. It was determined that the exposure rate was constant for times greater than 0.5 minute.

Leakage current of the electrometer system was measured after each set of six measurements. The leakage current averaged about 1×10^{-14} amperes and was corrected for in the calibration measurements.

C. Cobalt-60 Teletherapy Unit

The University of Michigan Hospital's 1500-curie cobalt-60 teletherapy unit was used to deliver the high absorbed doses required for the accident interval of Category I. Irradiation distances of 100 cm and 200 cm were chosen for convenience. At each distance, the phantom was placed on a stand and aligned in the center of the gamma-ray beam with the aid of the internal light source in the head of the teletherapy unit. The aperture of the source was adjusted so the beam extended beyond the phantom by a few centimeters. The phantom was then pushed back on the platform a distance equal to the radius of the 3 cm^3 ionization chamber. The chamber with a plastic buildup cap was placed at Position 1 (see Figure 1). The phantom was then removed, and the exposure rate was measured with the Cary electrometer, or its equivalent, operated in the null mode. The procedure was repeated for each of the other five positions on the phantom. The average exposure rate among the six positions was then calculated.

D. High-Energy X-Ray Machine

A General Electric Maxitron 300 X-ray machine was used to irradiate dosimeters for Category II. The machine has an inherent filtration of 4.75 mm Be. Four NBS X-ray techniques were used for Category II, one for each of the four intervals. The filtration and kilovoltage used for these four techniques are shown in Table 3.

A plexiglas phantom was mounted on a stand and aligned in the center of the X-ray beam. Two commercial plumb bobs were permanently suspended with nylon line from the ceiling so the alignment of the phantom could

Table 3. X-ray techniques used for the University of Michigan dosimetry performance pilot study.

X-Ray Machine	Category	Interval	kVp	Filtration (mm)					NBS Technique	GSF Measured $\bar{E}$ (keV)	UM Calculated $\bar{E}$ (keV)	UM Calculated Avg.	
				Be	Al	Cu	Sn	Pb				C_x-shallow	C_x-deep
G.E. XRD-5	III	1 and 2	30	0.25	0.37				L-G	19.7	19.0	0.813	0.259
G.E. Maxitron 300	II	4	100	4.75	6.31				MFG	53.9	57.5	1.283	1.233
G.E. Maxitron 300	II	3	150	4.75	4.00	4.00	1.46		HFG	117.5	118.5	1.349	1.349
G.E. Maxitron 300	II	1	200	4.75	4.85	5.00			MFK	91.1	107.5	1.342	1.338
G.E. Maxitron 300	II	2	250	4.75	3.97	0.60	1.03	2.65	HFK	204.2	205.3	1.262	1.262

*GSF: Gesellschaft für Strahlen-und Umweltforschung mbH, Neuherberg, Germany.

be reproduced. The beam was collimated with lead so that it extended beyond the edges of the phantom by approximately 5 cm. A rigid aluminum bar was cut to a length of 1 meter so that measurements from the X-ray tube head to the phantom face were reproducible for all irradiations. Two elapsed timers, driven by power line frequency, were used to time all irradiations.

Calibrations at the six positions on the face of the phantom were made with the 100 cm^3 ionization chamber. The Cary electrometer was used with the Leeds and Northrup Student Potentiometer in the null mode to measure exposure rates for each NBS technique. The Cary electrometer was also used in the capacitance mode to measure exposure rates, and these measurements were compared to exposure rates obtained with the potentiometer. The Keithley model 616 was also used as a redundant check. Redundant calibration measurements made with several different systems were made at only one of the dosimeter positions. The exposure rates measured among the systems differed by about 0.5%.

The exposure rates were then determined repeatedly (5 to 6 measurements) at each phantom position. It was concluded that the variations in the average rates for all six phantom positions were no larger than the variations in the individual measurements at any one position.

When dosimeters were to be irradiated, the following procedure was followed. The ionization chamber was placed at one of the six phantom

positions, and the phantom was removed. The ionization chamber was placed so that the center of the spherical chamber was in the same plane as the front face of the phantom would be when the phantom was returned to the stand for dosimeter irradiations. Five measurements of exposure rate were then made. The ionization chamber was then removed and the phantom placed on the stand. Dosimeters were irradiated during the working day with a beam monitor in continuous operation. The output of the beam monitor was recorded on a strip chart recorder. At the end of the day, the beam was calibrated again with the ionization chamber.

If the initial and final calibrations differed by less than 2%, and if the beam monitor showed no changes in the output of the X-ray machine during the day, then the initial and final exposure rates were averaged. The average exposure rate was combined with the recorded irradiation times for the dosimeters to calculate the exposure to each dosimeter.

If the initial and final calibrations differed by 2% to 4%, the assumption was made that the output of the X-ray machine had changed linearly during the day. Since the time of day was recorded for each dosimeter irradiated, the exposure rate could be calculated for each dosimeter, depending on when during the day it was irradiated.

If the initial and final calibrations differed by more than 4%, all dosimeters irradiated during the day were voided.

At no time during the pilot study did the initial and final calibrations differ by more than 2%. Thus, no corrections were required, and no dosimeters were voided due to exposure rate variations.

The electronic equipment was placed in a small room next to the X-ray room with a cable leading through a lead-covered opening in the wall. This eliminated scattered radiation from affecting the electronics. Low noise cable, automatic timing, a Data Precision and a Keithley digital voltmeter, two thermometers, and two barometers were used for the measurements.

The quality of the beams was determined by measuring the first half value layer (HVL_1) and the homogeneity coefficient (h) defined as the ratio of the first and second half value layers. Type 1100 aluminum filters were used for these measurements. The quality of the beam was determined to be acceptable only if the measured value for HVL_1 was within 5% of the HVL_1 measured by NBS, and if the measured value for h was within 10% of the h measured by NBS.

Timing errors were examined by measuring exposure rates for irradiation times that varied from 0.1 minute to 10.0 minutes. It was determined that there was no significant difference in the exposure rate for 1.0 minute to 10 minutes irradiations. Therefore, the minimum time used to irradiate dosimeters was 1.0 minute.

The leakage current of each system was monitored periodically during the calibrations, and corrections were made for leakage. The leakage current averaged about 1×10^{-14} amperes.

The rem/roentgen conversion factor ($\bar{C}_x$) for each X-ray technique was computed by weighing the factors given in Table 2 of the HPSSC Standard by the approximate exposure spectrum of each technique. The spectra were obtained by Kramers' calculational method. Energy absorption coefficients required for the calculations were obtained from the Radiological Health Handbook. Calculated values for $\bar{C}_x$ at shallow and deep depths in tissue are shown in Table 3.

An upper estimate of room scatter was made by shielding the ionization chamber from the primary beam. This experimental measurement showed that the maximum room scatter was approximately 1.6%.

E. Low-Energy X-Ray Machine

A General Electric XRD-5 X-ray machine was used to irradiate dosimeters for Category III. The machine has an inherent filtration of approximately 0.25 mm Be. A single NBS technique, L-G, with different tube currents, was used for the two intervals of Category III. The filtration and kilovoltage required for the L-G technique are shown in Table 3.

A plexiglas phantom was mounted on a stand and aligned in the X-ray beam. Two commercial plumb bobs were permanently suspended with nylon line from the ceiling so the alignment of the phantom could be reproduced. The beam was collimated with lead so that it extended beyond the edges of the phantom by approximately 5 cm. A rigid aluminum bar was cut to the appropriate length so that the measurement from the X-ray tube head to the phantom was reproducible for all irradiations.

The same calibration and irradiation procedures were used for the XRD-5 X-ray machine as were used for the Maxitron 300. These procedures and the equipment used are described in Section II D above.

An upper estimate of room scatter was made in the same manner described for the high-energy X-ray machine and found to be 1.2% at 200 cm. The quality of the beam was determined by measuring the first half value layer (HVL_1) and the homogeneity coefficient (h).

F. Strontium-90 Irradiator

The HPSSC Standard requires a sealed $^{90}Sr/^{90}Y$ beta-particle source equipped with a 100 mg/cm^2 filter of low atomic number. A 40-mCi strontium-90 source was lent to The University of Michigan by NBS for the pilot study. The active portion of the source is a disk, 1.3 cm in diameter by 0.6 cm thick. The source was mounted in a custom-made irradiator constructed of 1.3 cm thick plexiglas surrounded by 0.3 cm lead. The irradiator, shown in Figure 2, was equipped with a solenoid-activated shutter controlled by a precision digital timer.

The source was encapsulated in 60 mg/cm^2 stainless steel. It was calibrated by NBS at a distance of 35 cm and found to produce 189.0 mrad/min in tissue (water). However, the HPSSC Standard requires an encapsulation of 100 mg/cm^2. Therefore, when the source arrived at The University of Michigan, it was first calibrated with the University's extrapolation chamber at 35 cm with the original 60 mg/cm^2 encapsulation. An absorbed

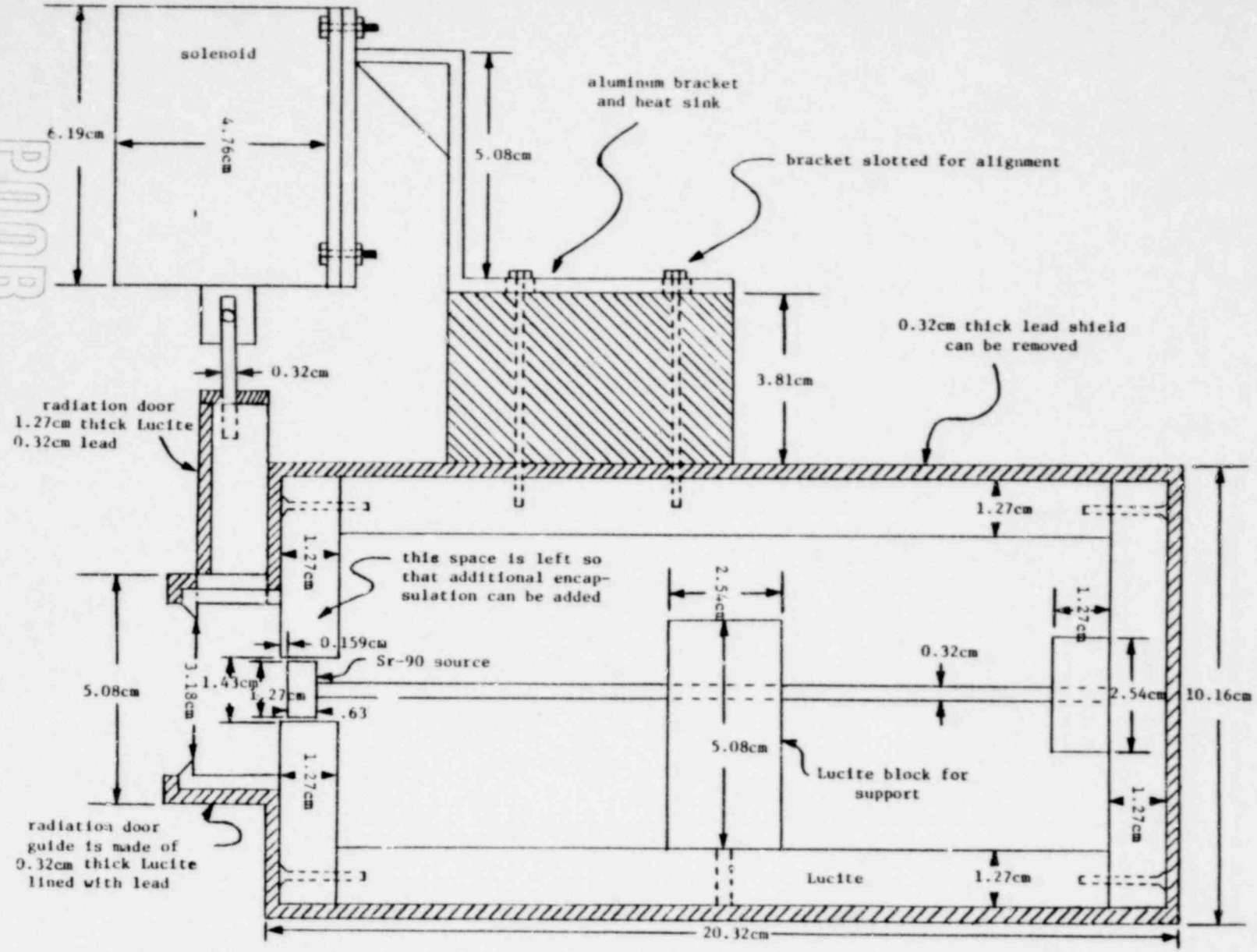

Figure 2. Strontium-90 irradiator used for Categories IV and VII.

dose rate of 188.9 mrad/min in tissue (water) was measured. This result compared favorably with the beta-particle measurements made by NBS. Finally, an additional 40 mg/cm^2 Mylar were added to the encapsulation of the source.

An extensive investigation of the beam showed that although beta particles were emerging from the source at nearly a 2π solid angle, the beam was not uniform. At a distance of 35 cm from the source, an area of only 3 cm in radius at the center of the beam showed uniform absorbed dose rates. At 5 cm from the center of the beam, the absorbed dose rate was 2% less than at the center. Therefore, only one dosimeter at a time could be irradiated with the strontium-90 source, instead of the six dosimeters which could be irradiated simultaneously with the other five sources.

The extrapolation chamber was positioned 35 cm from the source (the closest irradiation distance permitted by the HPSSC Standard) and the absorbed dose rate was measured. Additional layers of Mylar were then added to the source to determine the absorbed dose rate at a depth of 7 mg/cm^2 from a source encapsulated in 100 cm/cm^2. A difference of 3.35% was found between absorbed dose rate measurements made at 100 and 107 mg/cm^2.

G. Californium-252 Irradiator

The HPSSC Standard requires a californium-252 neutron source with such an activity that the required irradiations can be performed at a distance of not less than 35 cm. A 0.7 mg californium-252 source was lent to The University of Michigan by NBS for the pilot study. The source

had a fluence of 1.56×10^9 n/sec on March 4, 1978 as measured by NBS. It has a height and diameter of approximately 0.8 cm.

The source was stored and used in the University's Willow Run Laboratory, located approximately 24 km from the School of Public Health. The building is a moderately sized storage room with a floor space of approximately 7.5 x 33 meters and a height of 6 meters. When not in use, the source was stored in the same 91 cm diameter, 91 cm deep shipping cask used to deliver the source. The cask was placed in a 122 cm diameter, 122 cm deep pit in the floor. The source was screwed into a hollow aluminum wand 0.9 cm in diameter and 46 cm long. The hollow wand was attached to a solid aluminum shaft 1.3 cm in diameter and 168 cm long. The solid shaft slid inside two hollow aluminum guide tubes, one mounted to the floor above the cask and one mounted to the ceiling. There was an air space of about 130 cm between the ends of the two guide tubes.

The source was raised from the cask for use, and moved up through the lower guide tube to a reproducible point midway between the two guide tubes. The reproducibility of positioning was checked using a high-power telescope and a mirror so that a movement of 0.5 mm could be observed. Binoculars were also used to monitor the source on the wand.

A steel cable attached to the top of the solid aluminum shaft permitted the source to be raised and lowered manually from the control room located about 23 meters from the storage pit. The pit was covered

so that if the source should drop off the wand it would not fall into the pit. Proper handling devices and survey meters were in the building at all times. Figure 3 shows the guide tubes used to position the californium-252 source for the required irradiations.

A sample calculation of the neutron dose equivalent rate produced by this source at 100 cm is:

$$\frac{1.56 \times 10^{9}\ \frac{n}{sec} \quad 3.4 \times 10^{-5}\ \frac{mrem\text{-}cm^{2}}{n} \quad 60\ sec}{4\pi(100\ cm)^{2} \quad min} = 25.38\ mrem/min$$

The factor 3.4×10^{-5} is sometimes called the $4\pi r^{2}D(r)$ factor. The $4\pi r^{2}D(r)$ factor was obtained from Californium-252 Shielding Guide by Stoddard and Hooten (TID-4500, UC-41). The gamma-ray exposure rate was estimated by NBS to be 7.033% of the neutron dose equivalent rate. This gamma-ray exposure rate was accounted for in Category VIII.

When the source was used, a phantom was mounted on a stand and positioned at either 50 cm or 100 cm from the source, depending on the dose equivalent rate desired. Radiographic film exposed to gamma rays emitted from the source was used to determine proper alignment of the phantom. Permanent plumb bobs and reference distances were used as described for the other radiation sources to insure that phantom alignments were reproducible. The phantoms remained in their fixed position throughout the pilot study. The operator mounted a ladder to place and remove the dosimeters.

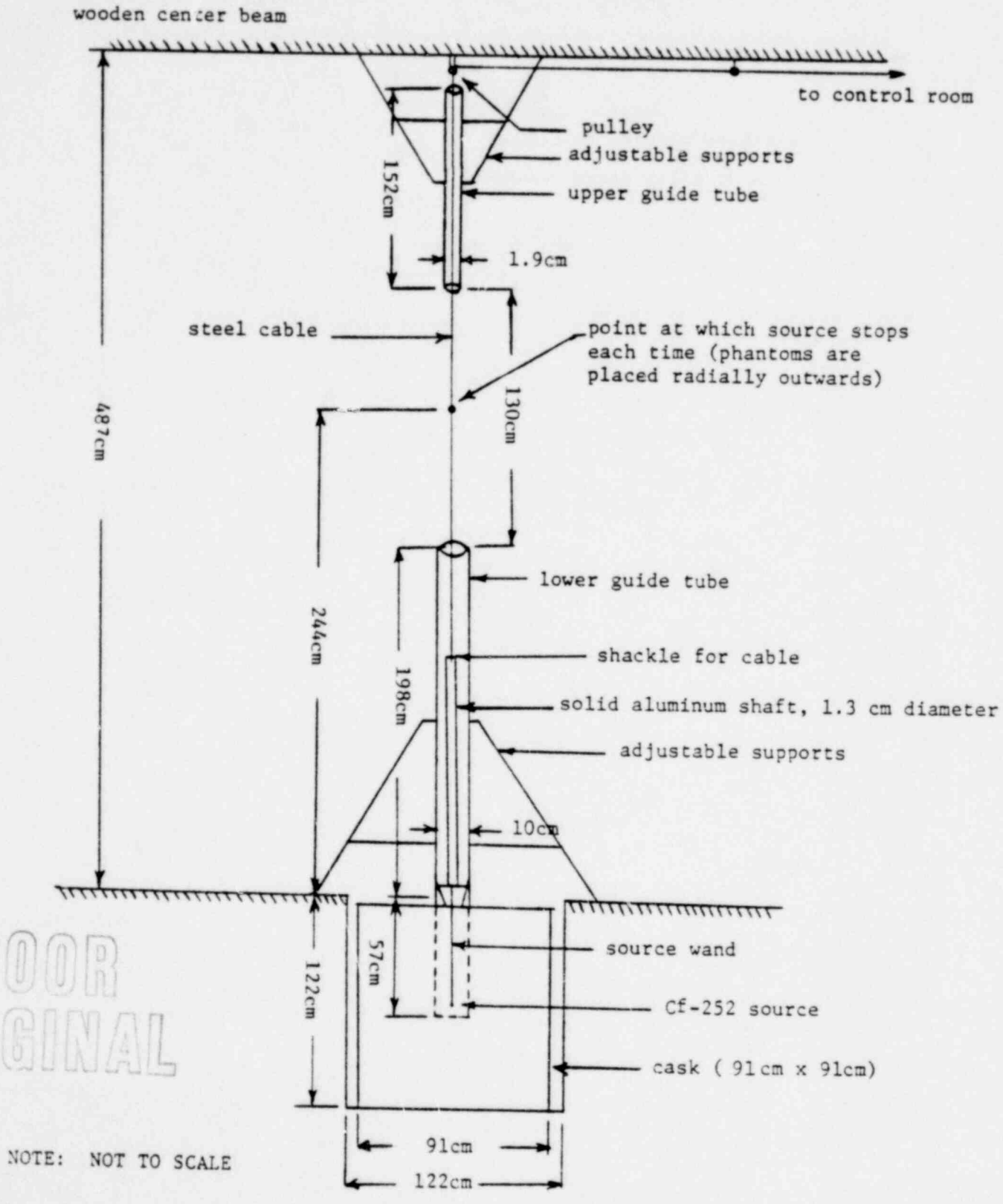

Figure 3. Guide tubes used to position the californium-252 source.

A concrete-block wall 19.3 cm thick and a shielded area for dosimeter storage, of the same thickness, were built in the control room to protect the operator and dosimeters. Shielding information was obtained from the Californium-252 Shielding Guide.

For dosimeters irradiated at 100 cm from the source, NBS computed that room scatter would cause non-albedo (e.g., NTA film) dosimeters to over-respond by about 6%. For the same position, it was computed that the scattered neutrons would cause an albedo-neutron dosimeter to over-respond by about 17%. At a distance of 50 cm, non-albedo dosimeters would over-respond by about 1.5%, and albedo-neutron dosimeters would over-respond by about 4%. The calculated delivered dose equivalent was increased by 1.060 and 1.015 for non-albedo dosimeters irradiated at 100 cm and 50 cm, respectively. The calculated delivered dose equivalent was increased by 1.170 and 1.040 for albedo-neutron dosimeters irradiated at 100 cm and 50 cm, respectively. An effort was made to irradiate albedo-neutron dosimeters only at 50 cm in order to minimize the effect of room-scattered neutrons.

III. CALCULATION OF DOSE EQUIVALENTS

A. Photon Sources

The two X-ray machines and the two cobalt-60 sources were calibrated with the ionization chambers positioned free in air. The dose equivalent delivered to a given dosimeter was calculated by:

$$H = \bar{C}_{x_{air}} \dot{X}_{air} t$$

where:

H = delivered dose equivalent at either the shallow or deep depth (mrem)

$\bar{C}_{x_{air}}$ = average conversion factor for either the shallow or deep depth calculated from the HPSSC Standard (mrem/mR)

$\dot{X}_{air}$ = exposure rate measured free in air and corrected for temperature and pressure (mR/min)

t = irradiation time (min)

B. Beta Source

As discussed in Section II F of this report, the dose equivalent at 7 mg/cm^2 delivered to a dosimeter was calculated by:

$$H = 0.9665 \cdot \dot{D}_{tissue} \cdot Q \cdot t$$

where:

H = delivered dose equivalent at 7 mg/cm^2 (mrem)

$\dot{D}_{tissue}$ = absorbed dose rate measured at the surface of a tissue equivalent material (mrad/min)

Q = quality factor for beta particles, assumed to be unity (mrem/mrad)

t = irradiation time (min)

C. Neutron Source

As discussed in Section II G of this report, the neutron dose equivalent rate produced by this source at 100 cm is calculated as:

$$H = \frac{3.4 \times 10^{-5} \cdot N \cdot RS \cdot t \cdot 60}{4\pi x^2}$$

where:

H = delivered dose equivalent produced by neutrons (mrem)

N = neutron emission rate at the time of irradiation as determined by NBS based on a half life of 2.65 years (n/sec)

RS = room scatter correction factor as determined by NBS

t = irradiation time (min)

x = irradiation distance (cm)

3.4×10^{-5} = dose equivalent conversion factor given in the HPSSC Standard (mrem-cm^2/n)

60 = time conversion factor (sec/min)

The gamma-ray dose equivalent rate was calculated as:

$$H_i = \frac{3.4 \times 10^{-5} \cdot N \cdot t \cdot 60 \cdot 0.0703}{4\pi x^2}$$

IV. OUTLINE OF PROCEDURES

A. Scheduling Test Irradiations

On the average, each processor submitted 150 dosimeters for each of the two tests, plus a few extra dosimeters for controls and in case some irradiations were voided by errors made by the testing laboratory. One-third of these dosimeters were mailed to the testing laboratory once per month for three months for each test. Each processor had three months between Test #1 and Test #2 to make any adjustments in their procedures they believed to be necessary as a result of their performance in the first test.

Each of the two tests was completed in six calendar months. The 59 participating processors were divided into two groups for convenience. One group participated in the first three months and the other group participated in the second three months of a testing period.

Great care was taken to insure confidentiality between the testing laboratory and each processor. A randomly chosen code number was assigned to each processor. If a processor submitted more than one type of dosimeter, each type was assigned a different code number. With the code numbers, a processor's results could be discussed with the NRC and other interested groups without revealing the identity of the processor.

B. Receiving and Cataloging Dosimeters

When the dosimeters were received, the arrival date, processor name, code number, and extra dosimeter numbers were recorded in the Administrative Log Book. Appendix A shows sample pages from this log book. The arrival of a monthly shipment was also noted on a list of expected participants. If the dosimeters were not received by the arrival deadline (the fifth day of the month), telephone calls were made to the processor regarding the status of the shipment.

The shipping container in which the dosimeters arrived was labeled with the processor's code number. The dosimeters were placed in envelopes labeled with the processor name, code number, category number and interval number. There were ten lines on the envelope numbered 1 to 10. The dosimeter numbers were recorded on these lines as they were placed in the envelopes. These lines corresponded to the numbered lines on the data sheets (see Appendix B) kept in the Irradiation Log Books for each interval of each category. The dosimeter number on line 1 of an envelope also appeared on line 1 of the corresponding data sheet. Dosimeter numbers were limited to five digits; no dashes or letters were recorded. These and other restrictions were adopted to enable the testing laboratory to use a computer code to evaluate the processors' performance.

When an envelope was filled with the dosimeters to be irradiated, it was placed in the appropriate storage box. Eight storage boxes were kept in a low-background room, one box for each of the eight radiation

categories. Each storage box was divided into sections, one section for each interval within a category. The storage boxes made it convenient to carry the dosimeters to the appropriate radiation source.

When a processor's dosimeters were irradiated sometime during the month, the irradiation date was recorded next to the dosimeter number on the envelope. This system of a box for each category, a section within a box for each interval, and individual envelopes that were dated at the time of irradiation, make it easy to determine the number of irradiations still to be done at any time during the month.

Irradiations were evenly distributed over the three months of a test. For each interval, four dosimeters were usually irradiated during the first month, three dosimeters during the second month, and three dosimeters during the third month.

Controls were left in the shipping box, and their numbers were not recorded. Shipping boxes were placed in numerical order on storage shelves located in the low-background room with the storage boxes. Letters of special instruction accompanying the dosimeters and shipping receipts were placed in a folder labeled by month.

C. Irradiations

Dose equivalents to be delivered were chosen before the start of each test. A random number table was used to select the delivered dose equi-

valents according to the specifications of the HPSSC Standard. The procedures followed on the day of irradiation were:

1. The radiation source room to be used was necked with a survey meter to determine if any radiation sources had been left out in the room.

2. Processor envelopes were selected six at a time.

3. Actual dosimeter numbers were checked against dosimeter numbers written on the envelopes.

4. Dosimeter numbers were recorded on data pages of the Irradiation Log Book shown in Appendix B in the same order as they appeared on an envelope.

5. As irradiations were completed, irradiation date, time of day, irradiation time, etc., were recorded on the data page, and the dosimeters were returned to their envelope.

6. The date of irradiation was recorded on the envelope. For mixed categories, there were two columns on each envelope for the date, one column for each source.

7. In mixed categories both data pages were checked to assure correct numerical order of dosimeter numbers. Numbers were written on both pages of a mixed category when the first irradiations were made for the month.

8. All data were pr ted, large and neat, in black or blue ink with no erasures.

9. Daily exposure rates were listed in the back of the Irradiation Log Books kept for each radionuclide source.

10. Quality control data and exposure rates for the X-ray machines were recorded in the back of the Irradiation Log Books kept for each X-ray machine.

11. Misirradiated or lost dosimeters were recorded in the Administrative Log Book, together with dosimeter number, processor number, error committed, and replacement dosimeter number. If a dosimeter was lost, the processor was notified. If a misirradiation demanded extra dosimeters from a processor, the processor was notified by phone as soon as possible.

D. Returning Dosimeters

Approximately two man-days were required at the end of each month to prepare the dosimeters for return to the processors. The procedures followed at this time were:

1. Dosimeters were removed from the envelopes and placed in the correct shipping box.
2. The envelopes were checked for irradiation dates and correct number of dosimeters.
3. A list of dosimeters irradiated in the accident intervals was enclosed in the shipping box with the dosimeters.
4. After all the shipping boxes were filled, they were sealed, labeled and stamped first class.
5. Special instructions for mailing were checked at this time.

E. Evaluating and Reporting Test Irradiation Results

When a processor sent all of the reported dose equivalents to the testing laboratory, a computer program was run for each category in which the processor participated. A copy of the printout was placed in the processor's file, and a second copy was sent to the processor.

Use of the computer program made evaluation quick, neat, and accurate. A copy of the program in Fortran and a sample output are included in Appendix C.

F. Maintaining Documented Records

A separate Irradiation Log Book was kept for each radiation category. One section of each notebook was devoted to calibration procedures and results for the particular radiation source, and a second section was devoted to quality control checks of the source. A third section contained the actual irradiation data for the test dosimeters. In this third section, a separate data page as shown in Appendix B was assigned to each processor who chose to be tested in that category. The Administrative Log Book contained the following lists:

1. processor names in alphabetical order to provide a quick reference for code numbers.
2. addresses, telephone numbers and contact persons for each processor.
3. processors by code number, the categories in which they participate, type of dosimeter, number of dosimeters required each month, and testing schedule.
4. shipping data including arrival date, processor name, code number, and a comment column for remarks regarding holders, controls, and mailing problems.
5. extra badge numbers each month for each processor.
6. daily environmental checks such as room temperature, atmospheric pressure and relative humidity.

Also included in the Administrative Log Book was a section where daily items were recorded such as phone calls to processors, problems with shipping, mistakes and corrections made, equipment failures, lost dosimeters or envelopes, changes in status of processors, and any other item of possible consequence.

A file folder for each processor was also maintained. Each file contained correspondence, copies of results, and data pages at the completion of a test.

G. Quality Controls

The most powerful quality control procedure was the simultaneous irradiation of dosimeters from six different processors. Any dosimeter with a reported dose equivalent that differed significantly from the delivered quantity could be compared to five other simultaneously irradiated dosimeters from five other processors. If the testing laboratory made a mistake in the positioning of the phantom relative to the radiation source, in the timing of the irradiations, etc., all or most of the six dosimeters should reflect the error. Because the time of day and date of irradiation were recorded for each dosimeter, and a list of participating processors was available for each category, it was a simple procedure to trace a dosimeter in question.

This procedure worked extremely well for questions by processors of the dose equivalents delivered. However, a problem resulted when some of the other five processors had not reported their results and a comparison could be made only with the few processors which had reported. Bad or erratic performance by another processor involved also weakens this procedure. However, it proved to be helpful because the check was provided by the processors and not just the testing laboratory.

Once the radionuclide sources (strontium-90, californium-252, and two cobalt-60 sources) were calibrated, their output remained constant throughout the pilot study except for radioactive decay, for which corrections were made.

The two X-ray machines were expected to show slight daily variations in their output. Calibrations were performed before and after irradiations on the day of irradiation as discussed in Sections II D and II E.

V. BLIND TESTING

Seven commercial processors were blind-tested during the pilot study. A utility company was asked to subscribe to each of the seven processors ostensibly to use the dosimeters in and around their nuclear power plant. The utility company then shipped the dosimeters they received to the testing laboratory to be irradiated with the same procedures applied to the open tests. At the end of the month, the dosimeters were returned to the utility company which mailed them to the seven commercial processors. All questions, problems, and answers regarding dosimetry, results, and radiation sources were relayed through the utility company to preserve the blind tests. The utility company was not shown the pass/fail results of the processors. The seven processors were blind-tested during the same months in which they were tested openly. Although this method was effective for blind testing large commercial processors, it would not work to blind test small or in-house processors.

VI. RECOMMENDATIONS

The two-year pilot study represented the first attempt to conduct a dosimetry testing program according to the requirements of the HPSSC Standard. Some of the methods and procedures that seemed reasonable when the pilot study began were later found to be less than satisfactory. The following are recommendations to improve the general operation of a future testing program. These recommendations do not include suggested changes in the Standard since those recommendations will be discussed in the Final Report of the pilot study.

1. Phantoms. The use of water-filled phantoms occasionally proved to be troublesome. Some of the phantoms leaked, distilled water had to be used since tap water discolored the plexiglas boxes and promoted algal growth, and when one phantom was accidently dropped, it virtually exploded. Solid slabs of acrylic and other plastics are no more expensive than the labor required to build a plexiglas box that can be filled with water.

2. Shipping Containers. Only a few processors ship dosimeters regularly through the mail. Many processors shipped dosimeters in weak containers, such as shoe boxes, and they continued to use the containers until they literally fell apart. Consequently, some dosimeters were lost during shipment. The testing laboratory should replace substandard shipping containers with sturdy containers.

3. Time Limit for Receiving Dosimeters. Throughout the pilot study, a great effort was made to complete all irradiations required during a given month at least two days before the end of that month so the last days could be used for packaging and mailing the dosimeters. Since an average of 2,000 dosimeters were irradiated each month, it was imperative that all the dosimeters arrive at the testing laboratory at or before the beginning of the month. During the early part of Test #1, several processors were very casual about shipping their dosimeters; some dosimeters did not arrive at the testing laboratory until the 15th or 20th of the month. We adopted a rule that any dosimeters arriving after the 5th of the month would be returned unirradiated. This solved the problem except for an occasional oversight by a processor.

4. Beam Monitors. A beam monitor connected to a strip chart recorder was used to monitor the output of each of the two X-ray machines while dosimeters were being irradiated. The irradiation date and time of day were recorded for each dosimeter. Thus, if a processor challenged the delivered dose to a particular dosimeter irradiated with X rays, the calibration and irradiation information could be checked including the actual irradiation time recorded on strip-chart paper. Some method should be available for the radioisotope sources to verify that the irradiation time recorded was, in fact, the true irradiation time. Perhaps beam monitors and strip chart recorders should be used with all radiation sources.

APPENDIX A

Format of data pages kept in
Administrative Log Book.

ARRIVAL DATE	PROCESSOR	CODE NO.	NO. OF DOSIMETERS	SHIPPING DATE	COMMENTS

EXTRA DOSIMETERS

MONTH	PROCESSOR	NUMBER

DAILY ENVIRONMENTAL CHECK

DATE	BAROMETRIC PRESSURE	% HUMIDITY	TEMPERATURE

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APPENDIX B

Format of data pages kept in the Irradiation Log Book. Processor's name and code number have been omitted. Computer printout for this processor is shown in Appendix C.

CATEGORY: 1, Gamma

INTERVAL: 1, 10-800 rad

Source: Cobalt-60 teletherapy

Irradiation Distance: shown below

Processor Name: NAME & NUMBER OMITTED

Processor Code No.:

Type of Dosimeter: FILM

Line	Dosimeter Number	Date Irra.	Exposure Rate (R/min)	Irra. Time (min)	Phantom Position	Irra. Dist.(cm)	Reference Time	Reported Dose (rad) Deep
1	34	022079	54.54	3.82	4	100	1740	195.
2	11	022079	54.54	9.86	4	100	1750	550.
3	52	022079	54.54	13.81	4	100	1800	600.
4	2	022079	54.54	12.91	4	100	1810	650.
5	154	032079	53.99	11.83	3	100	1830	620.
6	182	032079	53.99	10.40	3	100	1840	600.
7	170	032079	53.99	1.95	3	100	1850	130.
8	304	041879	53.43	3.57	3	100	1200	255.
9	342	041879	53.43	6.15	3	100	1210	800.
10	322	041879	53.43	8.45	3	100	1220	600.

CATEGORY: 1, Gamma

INTERVAL: 2, 30-100 mrem

Source: Cobalt-60 irradiator

Irradiation Distance: 200 cm

Processor Name: NAME & NUMBER

Processor Code No.: OMITTED

Type of Dosimeter: FILM

Line	Dosimeter Number	Date Irra.	Exposure Rate (mR/min)	Irra. Time (sec)	Phantom Position	Reference Time	Reported Dose (mrem) Deep
1	4	021579	22.49	140.5	2	1010	70.
2	33	021579	22.49	252.5	2	1014	100.
3	51	021579	22.49	196.5	2	1020	90.
4	163	032679	22.18	214.6	2	1200	97.
5	137	032679	22.18	259.6	2	1210	122.
6	194	032679	22.18	90.0	2	1215	38.
7	171	032679	22.18	103.8	2	1220	45.
8	305	042079	21.98	233.6	2	1200	107.
9	321	042079	21.98	117.2	2	1201	60.
10	340	042079	21.98	225.6	2	1202	107.

CATEGORY: 1, Gamma

INTERVAL: 3, 101-300 mrem

Source: Cobalt-60 irradiator

Irradiation Distance: 100 cm

Processor Name: NAME & NUMBER

Processor Code No.: OMITTED

Type of Dosimeter: FILM

Line	Dosimeter Number	Date Irra.	Exposure Rate (mR/min)	Irra. Time (sec)	Phantom Position	Reference Time	Reported Dose (mrem) Deep
1	35	022679	88.73	163.5	2	1325	290.
2	3	022679	88.73	99.4	2	1328	165.
3	27	022679	88.73	160.5	2	1331	270.
4	172	032279	87.97	115.3	3	1015	186.
5	162	032279	87.97	121.2	3	1016	200.
6	138	032279	87.97	103.3	3	1017	187.
7	192	032279	87.97	141.2	3	1018	240.
8	308	041879	87.11	148.2	6	1000	260.
9	349	041879	87.11	93.5	6	1001	135.
10	323	041879	87.11	72.6	6	1002	135.

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CATEGORY: 1, Gamma

INTERVAL: 4, 301-10,000 mrem

Source: Cobalt-60 irradiator

Irradiation Distance: 100 cm

Processor Name: NAME & NUMBER

Processor Code No.: OMITTED

Type of Dosimeter: FILM

Line	Dosimeter Number	Date Irra.	Exposure Rate (mR/min)	Irra. Time (sec)	Phantom Position	Reference Time	Reported Dose (mrem) Deep
1	25	022079	88.92	4258.	3	0832.	7400.
2	53	022079	88.92	631.5	3	0945	1100.
3	36	022079	88.92	694.3	3	0956	1100.
4	5	022079	88.92	477.2	3	1007	760.
5	195	032779	87.81	3426.	3	1500	5100.
6	141	032779	87.81	599.8	3	1600	1000.
7	174	032779	87.81	473.5	3	1610	750.
8	352	040879	87.43	3261.	3	1700	6300.
9	334	040879	87.43	360.0	3	1800	600.
10	306	040879	87.43	6160.	3	1900	10000.

CATEGORY: 2, X Ray

INTERVAL: 1, 10-800 rad

NBS Technique: MFK

Machine Settings: 200 kV, 20 mA

Added Filtration: 4.85 mm Al, 0.5 mm Cu

Irradiation Distance: 100 cm

Processor Name: NAME & NUMBER

Processor Code No.: OMITTED

Type of Dosimeter: FILM

Line	Dosimeter Number	Date Irra.	Exposure Rate (R/min)	Irra. Time (min)	Phantom Position	Reference Time	Reported Dose (rad) Deep
1	37	022379	8.83	46.58	2	1200	675.
2	55	022379	8.83	20.09	2	1230	385.
3	6	022379	8.83	3.83	2	1300	27.
4	26	022379	8.83	50.41	2	1330	613.
5	166	032679	10.83	48.10	1	1200	675.
6	161	032679	10.83	7.14	1	1300	79.
7	193	032679	10.83	52.33	1	1310	625.
8	360	042579	10.54	32.66	3	1301	750.
9	345	042579	10.54	25.26	3	1302	610.
10	311	042579	10.54	11.71	3	1303	355.

CATEGORY: 2, X Ray

INTERVAL: 2, 30-100 mrem

NBS Technique: HFK

Machine Settings: 250 kV, 5 mA

Added Filtration: 3.97 mm Al, 0.60 mm Cu, 1.03 mm Sn, 2.65 mm Pb

Irradiation Distance: 100 cm

Processor Name: NAME & NUMBER

Processor Code No.: OMITTED

Type of Dosimeter: FILM

Line	Dosimeter Number	Date Irra.	Exposure Rate (mR/min)	Irra. Time (min)	Phantom Position	Reference Time	Reported Dose (mrem) Shallow	Deep
1	24	022179	20.44	1.69	2	1215	60.	60.
2	38	022179	20.44	2.225	2	1220	75.	75.
3	7	022179	20.44	3.395	2	1225	116.	116.
4	191	032379	20.46	3.19	1	1120	106.	106.
5	167	032379	20.46	3.815	1	1125	120.	120.
6	160	032379	20.46	1.81	1	1130	60.	60.
7	140	032379	20.46	1.23	1	1135	50.	50.
8	303	042579	21.30	2.44	3	1301	105.	105.
9	313	042579	21.30	2.71	3	1303	107.	107.
10	351	042579	21.30	3.10	3	1303	110.	110.

CATEGORY: 2, X Ray

INTERVAL: 3, 101-300 mrem

NBS Technique: HFG

Machine Settings: 150 kV, 10 mA

Added Filtration: 4.00 mm Al, 4.00 mm Cu, 1.46 mm Sn

Irradiation Distance: 100 cm

Processor Name: NAME & NUMBER

Processor Code No.: OMITTED

Type of Dosimeter: FILM

Line	Dosimeter Number	Date Irra.	Exposure Rate (mR/min)	Irra. Time (min)	Phantom Position	Reference Time	Reported Dose (mrem) Shallow	Deep
1	39	022079	62.55	1.87	1	1215	170.	170.
2	23	022079	62.55	1.305	1	1220	121.	121.
3	56	022079	62.55	2.95	1	1225	248.	248.
4	190	032179	65.6	3.04	1	1930	256.	256.
5	168	032179	65.6	1.52	1	1935	165.	165.
6	180	032179	65.6	1.97	1	1940	197.	197.
7	142	032179	65.6	2.31	1	1950	263.	263.
8	335	042479	66.13	2.41	3	1301	225.	225.
9	316	042479	66.13	3.28	3	1302	337.	337.
10	359	042479	66.13	1.79	3	1303	170.	170.

CATEGORY: 2, X Ray

INTERVAL: 4, 301-10,000 mrem

NBS Technique: MFG

Machine Settings: 100 kV, current shown below

Added Filtration: 6.31 mm Al

Irradiation Distance: 100 cm

Processor Name: NAME & NUMBER

Processor Code No.: OMITTED

Type of Dosimeter: [illegible]

Line	Dosimeter Number	Date Irra.	Current (A)	Exposure Rate (mR/min)	Irra. Time (min)	Phantom Position	Reference Time	Reported Dose (mrem) Shallow	Deep
1	22	021479	5	877.2	5.085	2	1115	6400.	6150.
2	40	021379	1	105.2	3.11	2	1215	490.	480.
3	57	021479	5	877.2	3.34	2	1120	3000.	2900.
4	8	021379	1	105.2	3.49	2	1220	524.	504.
5	59	032179	5	860.3	6.30	1	1215	7425.	7135.
6	143	032179	5	860.3	5.93	1	1220	6900.	6550.
7	175	031979	1	102.9	5.685	1	1225	640.	615.
8	317	042479	5	896.3	3.69	3	1008	4095.	3936.
9	331	042479	1	73.21	3.92	3	1009	400.	384.
10	356	042479	1	73.21	6.67	3	1010	595.	572.

CATEGORY: 3, X Ray

INTERVAL: 1, 150-300 mrem

NBS Technique: L-G

Machine Settings: 30 kV, 1 mA

Added Filtration: 0.37 mm Al

Irradiation Distance: 200 cm

Processor Name: NAME & NUMBER

Processor Code No.: OMITTED

Type of Dosimeter: FILM

Line	Dosimeter Number	Date Irra.	Exposure Rate (mR/min)	Irra. Time (min)	Phantom Position	Reference Time	Reported Dose (mrem) Shallow	Deep
1	41	022679	114.5	1.89	4	1100	190.	59.
2	58	022679	114.5	2.92	4	1105	348.	108.
3	9	022679	114.5	2.26	4	1110	210.	65.
4	21	022679	114.5	1.78	4	1115	184.	55.
5	176	031379	116.8	2.66	1	1600	284.	88.
6	189	031379	116.8	2.71	1	1605	340.	105.
7	144	031379	116.8	3.01	1	1610	315.	97.
8	353	042879	116.0	2.51	4	1100	320.	100.
9	338	042879	116.0	1.88	4	1101	205.	65.
10	325	042879	116.0	1.93	4	1102	230.	71.

CATEGORY: 3, X Ray

INTERVAL: 2, 301-10,000 mrem

NBS Technique: L-G
Machine Settings: 30 kV, 4 mA
Added Filtration: 0.37 mm Al
Irradiation Distance: 200 cm

Processor Name: NAME & NUMBER
Processor Code No.: OMITTED
Type of Dosimeter: FILM

Line	Dosimeter Number	Date Irra.	Exposure Rate (mR/min)	Irra. Time (min)	Phantom Position	Reference Time	Reported Dose (mrem) Shallow	Deep
1	42	022679	286.4	18.15	6	1530	2835.	875.
2	59	022679	286.4	37.41	6	1600	7500.	2300.
3	28	022679	286.4	2.98	6	1630	830.	220.
4	10	022679	286.4	15.92	6	1700	2750.	850.
5	177	031479	288.6	1.66	1	1700	405.	125.
6	145	031479	288.6	11.84	1	1705	2700.	750.
7	157	031479	288.6	1.88	1	1710	526.	162.
8	357	042979	288.8	29.90	4	1350	6975.	2150.
9	336	042979	288.8	3.61	4	1400	1377.	425.
10	310	042979	288.8	1.77	4	1410	508.	157.

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ORIGINAL PAGE

CATEGORY: 4, Beta

INTERVAL: 1, 150-300 mrem

Source: Strontium-90

Irradiation Distance: 35 cm

Processor Name: NAME & NUMBER

Processor Code No.: OMITTED

Type of Dosimeter: FILM

Line	Dosimeter Number	Date Irra.	Absorbed Dose Rate (mrad/min)	Irra. Time (min)	Reported Dose (mrem) Shallow
1	43	021879	152.3	1.86	320.
2	60	021879	152.3	1.08	207.
3	12	021879	152.3	1.58	260.
4	29	021879	152.3	1.78	300.
5	156	030979	152.0	1.70	275.
6	188	030979	152.0	1.29	213.
7	149	030979	152.0	1.32	208.
8	502	051079 ~~042~~	151.3	1.67	275.
9	503	051079	151.3	1.22	215.
10	504	051079	151.3	1.90	310.

CATEGORY: 4, Beta

INTERVAL: 2, 301-10,000 mrem

Source: Strontium-90

Irradiation Distance: 35 cm

Processor Name: NAME & NUMBER

Processor Code No.: OMITTED

Type of Dosimeter: FILM

Line	Dosimeter Number	Date Irra.	Absorbed Dose Rate (mrad/min)	Irra. Time (min)	Reported Dose (mrem) Shallow
1	44	020679	152.3	46.80	6700.
2	13	020679	152.3	4.85	850.
3	30	020679	152.3	12.19	2575.
4	183	032179	152.0	3.71	680.
5	152	032179	152.0	17.66	2960.
6	169	032179	152.0	6.74	875.
7	139	032179	152.0	9.22	1600.
8	354	042379	151.6	3.54	740.
9	314	042379	151.6	53.60	8536.
10	327	042379	151.6	5.69	975.

CATEGORY: 5, Neutron

INTERVAL: 1, 100-300 mrem

Source: Californium-252

Irradiation Distance: shown below

Processor Name: NAME & NUMBER

Processor Code No.: OMITTED

Type of Dosimeter: FILM

Line	Dosimeter Number	Date Irra.	Dose Eq. Rate (mrem/min)	Irra. Time (min)	Phantom Position	Irra. Dist.(cm)	Reference Time	Reported Dose (mrem) Deep
1	75	022179	78.45	1.336	2	050	1900	150.
2	64	022179	78.45	2.543	2	050	1901	275.
3	72	022179	78.45	3.733	2	050	1902	358.
4	62	022179	78.45	2.383	2	050	1903	235.
5	208	031379	77.33	2.335	1	050	1700	142.
6	199	031379	77.33	3.600	1	050	1701	380.
7	205	031379	77.33	3.446	1	050	1702	290.
8	374	042679	74.93	2.223	3	050	1500	436.
9	368	042679	74.93	1.530	3	050	1501	310.
10	363	042679	74.93	2.339	3	050	1502	356.

CATEGORY: 5, Neutron

INTERVAL: 2, 301-5,000 mrem

Source: Californium-252

Irradiation Distance: shown below

Processor Name: NAME & NUMBER

Processor Code No.: OMITTED

Type of Dosimeter: [illegible]

Line	Dosimeter Number	Date Irra.	Dose Eq. Rate (mrem/min)	Irra. Time (min)	Phantom Position	Irra. Dist.(cm)	Reference Time	Reported Dose (mrem) Deep
1	70	022579	78.22	49.66	2	050	1700	5050
2	63	022579	78.22	4.445	2	050	1701	510
3	65	022579	78.22	23.55	2	050	1702	2215
4	74	022579	78.22	11.69	2	050	1703	1240
5	201	031579	77.22	57.50	1	050	1000	5020
6	198	031579	77.22	10.32	1	050	1001	1000
7	203	031579	77.22	39.50	1	050	1002	3480
8	365	040479	75.36	11.40	3	050	1700	1065
9	369	040479	75.36	32.00	3	050	1701	3180
10	373	040479	75.36	6.636	3	050	1702	590

1029 0200

CATEGORY: 6, Gamma component of gamma plus X ray

INTERVAL: 1, 50-100 mrem

Source: Cobalt-60 irradiator

Irradiation Distance: 200 cm

Processor Name: NAME & NUMBER OMITTED

Processor Code No.:

Type of Dosimeter: TLD

Line	Dosimeter Number	Date Irra.	Exposure Rate (mR/min)	Irra. Time (sec)	Phantom Position	Reference Time
1	45	021379	22.51	169.3	6	1900
2	14	021379	22.51	63.2	6	1901
3	19	021379	22.51	124.4	6	1902
4	173	031479	22.27	38.5	3	1300
5	151	031479	22.27	138.5	3	1301
6	187	031479	22.27	45.6	3	1302
7	158	031479	22.27	213.4	3	1303
8	350	040179	22.13	55.6	2	1200
9	332	040179	22.13	104.7	2	1203
10	302	040179	22.13	39.8	2	1208

CATEGORY: 6, X ray component of gamma plus X ray

INTERVAL: 1, 50-100 mrem

NBS Technique: HFK

Machine Settings: 250 kV, 5 mA

Added Filtration: 3.7 mm Al, 0.63 mm Cu, 1.03 mm Sn, 2.65 mm Pb

Irradiation Distance: 100 cm

Processor Name: NAME & NUMBER

Processor Code No.: OMITTED

Type of Dosimeter: FILM

Line	Dosimeter Number	Date Irra.	Exposure Rate (mR/min)	Irra. Time (min)	Phantom Position	Reference Time	Reported Dose (mrem) Shallow	Deep
1	45	022179	20.44	.98	1	1115	125.	125.
2	14	022179	20.44	2.62	1	1120	110.	110.
3	19	022179	20.44	.73	1	1125	90.	90.
4	173	032379	20.46	1.54	4	1000	65.	65.
5	151	032379	20.46	.78	4	1001	98.	98.
6	187	032379	20.46	.81	4	1002	38.	38.
7	158	032379	20.46	1.04	4	1003	130.	130.
8	350	042579	21.30	2.11	1	1301	45.	45.
9	332	042579	21.30	.67	1	1302	115.	115.
10	302	042579	21.30	1.67	1	1303	80.	80.

CATEGORY: 6, Gamma component of gamma plus X ray

INTERVAL: 2, 101-300 mrem

Source: Cobalt-60 irradiator

Irradiation Distance: 100 cm

Processor Name: NAME & NUMBER

Processor Code No.: OMITTED

Type of Dosimeter: [illegible]

Line	Dosimeter Number	Date Irra.	Exposure Rate (mR/min)	Irra. Time (sec)	Phantom Position	Reference Time
1	54	021379	22.51	156.4	4	1800
2	15	021379	22.51	318.4	4	1801
3	46	021379	22.51	421.6	4	1802
4	178	031479	22.27	281.4	5	1700
5	186	031479	22.27	203.7	5	1701
6	147	031479	22.27	209.4	5	1702
7	153	031479	22.27	289.0	5	1703
8	315	040179	22.13	135.6	2	1230
9	324	040179	22.13	241.7	2	1235
10	346	040179	22.13	151.3	2	1240

CATEGORY: 6, X ray component of gamma plus X ray

INTERVAL: 2, 101-300 mrem

NBS Technique: HFG

Machine Settings: 150 kV, 10 mA

Added Filtration: 4.00 mm Al, 4.00 mm Cu, 1.46 mm Sn

Irradiation Distance: 100 cm

Processor Name: NAME & NUMBER

Processor Code No.: OMITTED

Type of Dosimeter: FILM

Line	Dosimeter Number	Date Irra.	Exposure Rate (mR/min)	Irra. Time (min)	Phantom Position	Reference Time	Reported Dose (mrem) Shallow	Deep
1	57	022079	62.55	1.78	1	1045	194.	194.
2	15	022079	62.55	.95	1	1050	153.	153.
3	46	022079	62.55	1.185	1	1055	162.	162.
4	178	032179	65.6	.48	2	1700	81.	81.
5	186	032179	65.6	221	2	1701	529.	529.
6	147	032179	65.6	.42	2	1702	170.	170.
7	153	032179	65.6	.48	2	1703	235.	235.
8	315	042479	66.13	1.40	1	1900	185.	185.
9	324	042479	66.13	.41	1	1901	81.	81.
10	346	042479	66.13	illegible	1	1902	195.	195.

CATEGORY: 6, Gamma component of gamma plus X ray

INTERVAL: 3, 301-10,000 mrem

Source: Cobalt-60 irradiator

Irradiation Distance: 100 cm

Processor Name: NAME & NUMBER

Processor Code No.: OMITTED

Type of Dosimeter: FILM

Line	Dosimeter Number	Date Irra.	Exposure Rate (mR/min)	Irra. Time (sec)	Phantom Position	Reference Time
1	50	020679	89.37	97.5	2	1200
2	16	020679	89.37	338.7	2	1201
3	18	020679	89.37	92.7	2	1300
4	32	020679	89.37	314.7	2	1301
5	155	031379	88.25	253.2	5	1300
6	179	031379	88.25	362.4	5	1305
7	148	031379	88.25	176.6	5	1310
8	10	040279	87.65	1179.	2	1500
9	49	040279	87.65	73.9	2.	1600
10	24	040179	87.68	277.1	2	1200

CATEGORY: 6, X ray component of gamma plus X ray

INTERVAL: 3, 301-10,000 mrem

NBS Technique: MFG

Machine Settings: 100 kV, current shown below

Added Filtration: 6.31 mm Al

Irradiation Distance: 100 cm

Processor Name: NAME & NUMBER

Processor Code No.: OMITTED

Type of Dosimeter: FILM

Line	Dosimeter Number	Date Irra.	Current (A)	Exposure Rate (mR/min)	Irra. Time (min)	Phantom Position	Reference Time	Reported Dose (mrem) Shallow	Deep
1	50	021379	1	105.2	2.695	1	11[illegible]	500	485
2	16	021479	5	877.2	1.785	1	1215	8000	7900
3	18	021379	1	105.2	2.42	1	1[illegible]	371	357
4	32	021479	5	877.2	1.55	1	1220	7140	7100
5	155	031979	1	102.9	1.13	4	1100	418	418
6	179	032179	5	860.3	1.23	4	1105	1472	1415
7	148	031979	1	102.9	5.015	4	1110	705	675
8	9[illegible]10	042479	5	860.3	3.82	1	1130	not reported	
9	9[illegible]49	042479	1	73.27	2.78	1	1131	not reported	
10	[illegible]24	042479	5	860.3	1.405	1	1132	not reported	

CATEGORY: 7, Gamma component of beta plus gamma

INTERVAL: 1, 200-300 mrem

Source: Cobalt-60

Irradiation Distance: 100 cm

Processor Name: NAME & NUMBER

Processor Code No.: OMITTED

Type of Dosimeter: Film

Line	Dosimeter Number	Date Irra.	Exposure Rate (mR/min)	Irra. Time (sec)	Phantom Position	Reference Time
1	31	020679	89.37	48.75	2	0925
2	17	020679	89.37	115.2	2	0930
3	48	020679	89.37	41.5	2	0933
4	181	031079	88.35	135.4	1	1106
5	150	031079	88.35	49.7	1	1108
6	165	031079	88.35	129.3	1	1110
7	146	031079	88.35	121.8	1	1112
8	347	040179	87.65	42.2	2	1400
9	309	040179	87.65	49.3	2	1405
10	320	040179	87.65	126.6	2	1410

CATEGORY: 7, Beta component of beta plus gamma

INTERVAL: 1, 200-300 mrem

Source: Strontium-90

Irradiation Distance: 35 cm

Processor Name: NAME & NUMBER

Processor Code No.: OMITTED

Type of Dosimeter: [illegible]

Line	Dosimeter Number	Date Irra.	Absorbed Dose Rate (mrad/min)	Irra. Time (min)	Reported Dose (mrem) Shallow	Deep
1	31	022679	152.3	1.18	282.	92.
2	17	022679	152.3	.42	240.	240.
3	48	022679	152.3	1.01	241.	84.
4	181	031379	152.0	.53	310.	210.
5	150	031379	152.0	1.20	263.	70.
6	165	031379	152.0	.51	372.	197.
7	146	031379	152.0	.47	350.	230.
8	347	041679	151.6	1.03	250.	80.
9	309	041679	151.6	1.12	275.	95.
10	320	041679	151.6	.49	365.	190.

CATEGORY: 7, Gamma component of beta plus gamma

INTERVAL: 2, 301-10,000 mrem

Source: Cobalt-60 irradiator

Irradiation Distance: 100 cm

Processor Name: NAME & NUMBER

Processor Code No.: OMITTED

Type of Dosimeter: FILM

Line	Dosimeter Number	Date Irra.	Exposure Rate (mR/min)	Irra. Time (sec)	Phantom Position	Reference Time
1	47	020679	89.37	1036.	3	1107
2	20	020679	89.37	99.5	3	1126
3	49	020679	89.37	935.3	3	1337
4	185	031379	88.25	178.2	2	1910
5	184	031379	88.25	1128.	2	1930
6	164	031379	88.25	416.2	2	1945
7	344	040179	87.65	993.3	2	1590
8	358	040179	87.65	100.4	2	1600
9	312	040179	87.65	670.6	2	1610
10	333	040179	87.65	170.3	2	1620

CATEGORY: 7, Beta component of beta plus gamma

INTERVAL: 2, 301-10,000 mrem

Source: Strontium-90

Irradiation Distance: 35 cm

Processor Name: NAME & NUMBER

Processor Code No.: OMITTED

Type of Dosimeter: FILM

Line	Dosimeter Number	Date Irra.	Absorbed Dose Rate (mrad/min)	Irra. Time (min)	Reported Dose (mrem) Shallow	Deep
1	47	022479	152.3	25.53	3270.	2220.
2	20	022479	152.3	2.44	530.	258.
3	49	022479	152.3	3.63	1900.	1700.
4	185	031479	152.0	.75	428.	318.
5	184	031479	152.0	27.77	3350.	2000.
6	164	031479	152.0	1.58	680.	680.
7	344	040279	151.6	3.88	1980.	1700.
8	358	040279	151.6	2.51	595.	165.
9	312	040279	151.6	16.66	2300.	1300.
10	333	040279	151.6	.68	415.	295.

CATEGORY: 8, Gamma component of gamma plus neutron

INTERVAL: 1, 150-300 mrem

Source: Cobalt-60 irradiator

Irradiation Distance: 100 cm

Processor Name: NAME & NUMBER

Processor Code No.: OMITTED

Type of Dosimeter: FILM

Line	Dosimeter Number	Date Irra.	Exposure Rate (mR/min)	Irra. Time (sec)	Phantom Position	Reference Time
1	66	020679	89.37	42.5	3	1730
2	90068	020679	89.37	82.2	3	1731
3	71	020679	89.37	55.3	3	1732
4	209	031079	88.35	113.2	1	0930
5	204	031079	88.35	43.1	1	0932
6	197	031079	88.35	79.9	1	0934
7	201	031079	88.35	52.9	1	0936
8	375	041079	87.37	94.6	4	1100
9	371	041079	87.37	36.7	4	1101
10	362	041079	87.37	119.1	4	1102

CATEGORY: 8, Neutron component of gamma plus neutron

INTERVAL: 1, 150-300 mrem

Source: Californium-252

Irradiation Distance: shown below

Processor Name: NAME & NUMBER

Processor Code No.: OMITTED

Type of Dosimeter: FILM

Line	Dosimeter Number	Date Irra.	Dose Eq. Rate (mrem/min)	Irra. Time (min)	Phantom Position	Irra. Dist.(cm)	Reference Time	Reported Dose (mrem) Deep
1	66	022379	18.34	2.000	1	050	1829	300
2	90068							
3	71	022579	18.22	2.613	1	050	1547	349
4	209	032279	19.25	3.482	1	100	1700	255
5	204	032279	76.83	2.070	1	050	1701	344
6	197	032279	19.25	2.443	1	100	1702	225
7	201	032279	76.83	2.536	1	050	1703	385
8	375	042679	18.73	2.930	1	100	1715	210
9	371	042679	74.93	1.810	1	050	1716	284
10	362	042679	18.73	3.739	1	100	1717	263

CATEGORY: 8, Gamma component of gamma plus neutron

INTERVAL: 2, 301-5,000 mrem

Source: Cobalt-60 irradiator

Irradiation Distance: 100 cm

Processor Name: NAME & NUMBER

Processor Code No.: OMITTED

Type of Dosimeter: FILM

Line	Dosimeter Number	Date Irra.	Exposure Rate (mR/min)	Irra. Time (sec)	Phantom Position	Reference Time
1	67	020879	89.31	905.5	2	1510
2	73	020879	89.31	150.7	2	1525
3	69	020879	89.31	1653.	2	1530
4	200	031279	88.28	428.3	1	1328
5	202	031279	88.28	777.3	1	1338
6	206	031279	88.28	66.1	1	1355
7	210	031279	88.28	739.5	1	1400
8	364	040979	87.4	204.2	5	1200
9	372	040979	87.4	790.4	5	1205
10	367	040979	87.4	162.4	5	1215

CATEGORY: 8, Neutron component of gamma plus neutron

INTERVAL: 2, 301-5,000 mrem

Source: Californium-252

Irradiation Distance: shown below

Processor Name: NAME & NUMBER

Processor Code No.: OMITTED

Type of Dosimeter: FILM

Line	Dosimeter Number	Date Irra.	Dose Eq. Rate (mrem/min)	Irra. Time (min)	Phantom Position	Irra. Dist.(cm)	Reference Time	Reported Dose (mrem) Deep
1	67	022479	78.28	41.38	1	050	1729	3186
2	73	022479	78.28	7.15	1	050	1815	970
3	69	022479	78.28	12.55	1	050	1826	4210
4	200	032779	76.56	3.320	1	050	1635	990
5	202	032779	76.56	37.98	1	050	1636	4465
6	206	032779	76.56	2.9100	1	050	1637	475
7	210	032779	76.56	36.15	1	050	1638	4460
8	364	041979	75.36	1.601	1	050	1445	469
9	372	041979	7536	9.485	1	050	1446	2180
10	367	041979	7536	9.485	1	050	1447	1035

APPENDIX C

Computer program used to evaluate processor performance and a sample report. Processor's name and code number have been omitted. Raw data for this processor are shown in Appendix B.

```
      COMMON TYPE,NCAT,REF(10),FINISH,CODE(10)
      COMMON RATE(10),TIME(10),EXPOS(10),P(10),CX,RESULT,PBAR,HBAR,S
      COMMON NUMBER(10),IMONTH(10),IDAY(10),IYEAR(10),IPOS(10),IDIST(10)
      DIMENSION RSHAL(10),DSHAL(10),RDEEP(10),DDEEP(10),STATE(10),NUMX(1
     10),DSHALX(10),DDEEPX(10),RAT(10),TIM(10),JMONTH(10),JDAY(10),JYEAR
     2(10),JPOS(10),CLO(10),J(10),FIN(10),K(10),M(10),PP(10)
      REAL *8 PRO,CESSOR,TYPE,PR,CE,TY,OK8/'          '/
      DATA PASS/'PASS'/,FAIL/'FAIL'/,VOID/'VOID'/,OK/'    '/
      DATA STAR/'*   '/,STARR/'**  '/
      READ (5,300) NAME
  300 FORMAT (I1)
      READ (5,20) NCAT,INTER,PRO,CESSOR,NUM,TYPE
      NC = NCAT
      IN = INTER
      PR = PRO
      CE = CESSOR
      NU = NUM
      TY = TYPE
      WRITE (6,200)
  200 FORMAT (1H1///////19X,'PERSONAL DOSIMETRY PERFORMANCE TESTING'//33
     1X,'A PILOT STUDY'/////32X,'SPONSORED BY :'/22X,'U.S. NUCLEAR REGUL
     2ATORY COMMISSION'/////32X,'CONDUCTED BY :'/17X,'DEPT. OF ENVIRONME
     3NTAL AND INDUSTRIAL HEALTH'/28X,'SCHOOL OF PUBLIC HEALTH'/28X,'UNI
     4VERSITY OF MICHIGAN'/30X,'ANN ARBOR, MICHIGAN'/////18X,'**********
     4  RESULTS OF TEST #2  **********'/////)
      IF (NAME.EQ.1) PRO=OK8
      IF (NAME.EQ.1) CESSOR=OK8
      WRITE (6,201) PRO,CESSOR,NUM,TYPE
  201 FORMAT (23X,'PROCESSOR NAME : ',A8,A7//23X,'PROCESSOR CODE NO. : '
     1,I2//23X,'TYPE OF DOSIMETER : ',A8)
      WRITE (6,202)
  202 FORMAT (1H1///////3X,'FOR EACH DOSIMETER, A PERFORMANCE INDEX IS C
     1ALCULATED BY :',////32X,'P = (H* - H)/H*',///4X,'WHERE :  H = DELIV
     2ERED QUANTITY'/13X,'H* = REPORTED QUANTITY'////4X,'FOR EACH DEPTH
     3OF EACH INTERVAL OF A CATEGORY, AN AVERAGE PERFORMANCE'//4X,'INDEX
     4, (P AVERAGE), AND ITS STANDARD DEVIATION, S, ARE CALCULATED.'////
     54X,'A PROCESSOR PASSES A CATEGORY IF, FOR EACH DEPTH OF EACH INTER
     6VAL,'//4X,'THE ABSOLUTE VALUE OF (P AVERAGE) PLUS 2S IS LESS THAN
     7OR EQUAL TO'//4X,'THE TOLERANCE LIMIT, L.'////)
      WRITE (6,207)
  207 FORMAT (4X,'FOR CATEGORY I, INTERVAL 1, AND FOR CATEGORY II, INTER
     1VAL 1, L = 0.3.  FOR'//4X,'CATEGORY I, INTERVALS 2, 3, AND 4, L =
     20.3 OR 6/SQRT(H AVERAGE), WHICHEVER'//4X,'IS LARGER.  FOR ALL OTHE
     3R CATEGORIES, L = 0.5 OR 15/SQRT(H AVERAGE), WHICHEVER'//4X,'IS LA
     4RGER.')
      WRITE (6,226)
  226 FORMAT (////4X,'IF A DOSIMETER IS LOST, NOT REPORTED BY THE PROCES
     1SOR, IRRADIATED IMPROPERLY,'//4X,'ETC., THE WORD VOID APPEARS NEXT
     2 TO THE DOSIMETER NUMBER.  VOIDED DOSIMETERS'//4X,'ARE NOT INCLUDE
     3D IN THE PASS/FAIL CALCULATIONS.')
      DO 174 I = 1,8
      K(I) = 0
  174 J(I) = 0
      M(1) = 4
      M(2) = 7
      M(3) = 4
      M(4) = 2
      M(5) = 2
      M(6) = 6
      M(7) = 4
      M(8) = 2
      GO TO 152
  100 READ (5,20) NCAT,INTER,PRO,CESSOR,NUM,TYPE
   20 FORMAT (2I5,A8,A7,I5,A8)
```

```
      DO 500 I = 1,10
  500 CODE(I) = 0.0
      IF (NCAT.NE.0) GO TO 152
      DO 204 I = 1,8
      IF (K(I).GT.0) FIN(I)=STAR
      IF (J(I).EQ.M(I)) FIN(I)=PASS
      IF (J(I).LT.M(I).AND.K(I).EQ.M(I)) FIN(I)=FAIL
  204 IF (J(I).EQ.0.AND.K(I).EQ.0) FIN(I)=STARR
      WRITE (6,205)
  205 FORMAT (1HI///////17X,'********** SUMMARY OF RESULTS **********'
     1//////)
      IF (NAME.EQ.1) PR=OK8
      IF (NAME.EQ.1) CE=OK8
      WRITE (6,201) PR,CE,NU,TY
      WRITE (6,206) (FIN(I), I = 1,8)
  206 FORMAT (//////17X,'CATEGORY I,    GAMMA',24X,': ',A4,//17X,'CATEGOR
     1Y II,   HIGH-ENERGY X RAY',12X,': ',A4//17X,'CATEGORY III,  LOW-EN
     2ERGY X RAY',13X,': ',A4//17X,'CATEGORY IV,   BETA',25X,': ',A4//17
     3X,'CATEGORY V,    NEUTRON',22X,': ',A4//17X,'CATEGORY VI,   GAMMA
     4PLUS HIGH-ENERGY X RAY : ',A4//17X,'CATEGORY VII,  GAMMA PLUS BETA
     5',14X,': ',A4//17X,'CATEGORY VIII, GAMMA PLUS NEUTRON',11X,': ',A4
     6////)
      LL = 0
      MM = 0
      DO 221 I = 1,8
      IF (FIN(I).EQ.STAR) LL=1
      IF (FIN(I).EQ.STARR) MM=1
  221 CONTINUE
      IF (LL.EQ.0) GO TO 222
      WRITE (6,220)
  220 FORMAT (17X,'*  = RESULTS ARE INCOMPLETE FOR THIS CATEGORY'///)
  222 IF (MM.EQ.0) GO TO 224
      WRITE (6,223)
  223 FORMAT (17X,'** = PROCESSOR DID NOT PARTICIPATE IN THIS CATEGORY')
  224 WRITE (6,225)
  225 FORMAT (1HI)
      GO TO 100
  152 GO TO (1,2,3,4,5,6,7,8), NCAT
    1 GO TO (9,10,10,10), INTER
    9 READ (5,21) (NUMBER(I),IMONTH(I),IDAY(I),IYEAR(I),RATE(I),TIME(I),
     1IPOS(I),IDIST(I),REF(I),RDEEP(I), I = 1,10)
   21 FORMAT (I5,3I2,2F5.0,I1,I3,F4.0,F10.0)
      DO 502 I = 1,10
      IF (NUMBER(I).LT.90000) GO TO 502
      CODE(I) = 9.0
      NUMBER(I) = NUMBER(I) - 90000
  502 CONTINUE
      CX = 1.01
      CALL TEST (RDEEP,DDEEP)
      WRITE (6,22)
   22 FORMAT (1H1,9X,'CATEGORY I, GAMMA'//10X,'INTERVAL 1, 10 - 600 RAD'
     1)
   10 IF (NAME.EQ.1) PRO=OK8
      IF (NAME.EQ.1) CESSOR=OK8
      WRITE (6,23) PRO, CESSOR, NUM, TYPE
   23 FORMAT (47X,'PROCESSOR NAME : ',A8,A7//47X,'PROCESSOR CODE NO. : '
     1,I2,//47X,'TYPE OF DOSIMETER : ',A8)
      WRITE (6,24)
   24 FORMAT (10X,'SOURCE : COBALT-60 IRRADIATOR'//10X,'IRRADIATION DIST
     1ANCE : SHOWN BELOW'////)
      IF (INTER.GT.1) GO TO 29
      TOLER = 0.3
      WRITE (6,25) CX
   25 FORMAT (23X,'EXPOS.  IRRA. ',10X,'IRRA.  DEEP ABSORBED DOSE, CX =
     1',F4.2)
      WRITE (6,62)
```

```
 62  FORMAT (1X,'DOSIMETER',4X,'DATE',6X,'RATE',3X,'TIME   EXPOSURE DIS
    1T.   DELIV.   REPORT.')
     WRITE (6,63)
 63  FORMAT (2X,'NUMBER   IRRADIATED (R/MIN)  (MIN)    (R)    (CM)    (
    1RAD)    (RAD)    P=(H*-H)/H'//)
     GO TO 31
 29  TOLER = 6.0/SQRT(HBAR)
     IF (TOLER.LT.0.3) TOLER=0.3
     WRITE (6,30) CX
 30  FORMAT (23X,'EXPOS.  IRRA. ',10X,'IRRA.  DEEP DOSE EQUIVALENT, CX=
    1',F4.2)
     WRITE (6,62)
     WRITE (6,32)
 32  FORMAT (2X,'NUMBER   IRRADIATED (MR/MIN) (MIN)    (MR)    (CM)    (
    1MREM)   (MREM)   P=(H*-H)/H'//)
 31  DO 33 I = 1,10
     STATE(I) = OK
     IF (CODE(I).EQ.9.0) STATE(I)=VOID
     GO TO (33,43,44,44), INTER
 43  IDIST(I) = 200
     GO TO 33
 44  IDIST(I) = 100
 33  CONTINUE
     IF (INTER.GT.1) GO TO 400
     WRITE (6,26) (NUMBER(I),STATE(I),IMONTH(I),IDAY(I),IYEAR(I),RATE(I
    1),TIME(I),EXPOS(I),IDIST(I),DDEEP(I),RDEEP(I),P(I), I = 1,10)
 26  FORMAT (1X,I5,1X,A4,1X,I2,'-',I2,'-',I2,2X,F6.2,F8.3,F9.2,3X,I3,F9
    1.0,F10.3,3X,F9.4/)
     GO TO 401
400  WRITE (6,82) (NUMBER(I),STATE(I),IMONTH(I),IDAY(I),IYEAR(I),RATE(I
    1),TIME(I),EXPOS(I),IDIST(I),DDEEP(I),RDEEP(I),P(I), I = 1,10)
 82  FORMAT (1X,I5,1X,A4,1X,I2,'-',I2,'-',I2,2X,F6.2,F8.3,F9.2,3X,I3,2F
    19.0,4X,F9.4/)
401  WRITE (6,27) PBAR, S, HBAR, RESULT, TOLER
 27  FORMAT    (//62X,'P AVERAGE = ',F8.4//70X,'S = ',F8.4//62X,'H AVER
    1AGE = ',F8.1//52X,'ABS(P AVERAGE) + 2S = ',F8.4//70X,'L = ',F8.4//
    2/)
     FINISH = PASS
     IF (RESULT.GT.TOLER) FINISH=FAIL
     WRITE (6,28) FINISH
 28  FORMAT (52X,'**********  ',A4,'  **********')
     K(I) = K(I) + 1
     IF (FINISH.EQ.PASS) J(1)=J(1)+1
     GO TO 100
 10  READ (5,34) (NUMBER(I),IMONTH(I),IDAY(I),IYEAR(I),RATE(I),TIME(I),
    1,POS(I),REF(I),RDEEP(I), I = 1,10)
 34  FORMAT (I5,3I2,2F5.0,I1,F4.0,F10.0)
     DO 521 I = 1,10
     IF (NUMBER(I).LT.90000) GO TO 521
     CODE(I) = 9.0
     NUMBER(I) = NUMBER(I) - 90000
521  CONTINUE
     DO 725 I = 1,10
725  TIME(I) = TIME(I)/60.0
     CX = 1.01
     CALL TEST (RDEEP,DDEEP)
     WRITE (6,35)
 35  FORMAT (1HI,9X,'CATEGORY I, GAMMA'/)
     IF (INTER - 3) 36, 37, 38
 36  WRITE (6,39)
 39  FORMAT (10X,'INTERVAL 2, 30 - 100 MREM')
     GO TO 40
 37  WRITE (6,41)
 41  FORMAT (10X,'INTERVAL 3, 101 - 300 MREM')
     GO TO 40
 38  WRITE (6,42)
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```
 42  FORMAT (10X,'INTERVAL 4, 301 - 10,000 MREM')
     GO TO 40
  2  IF (INTER.GT.1) GO TO 46
     READ (5,34) (NUMBER(I),IMONTH(I),IDAY(I),IYEAR(I),RATE(I),TIME(I),
    1IPOS(I),REF(I),RDEEP(I), I = 1,10)
     DO 503 I = 1,10
     IF (NUMBER(I).LT.90000) GO TO 503
     CODE(I) = 9.0
     NUMBER(I) = NUMBER(I) - 90000
503  CONTINUE
     CX = 1.33
     CALL TEST (RDEEP,DDEEP)
     WRITE (6,47)
 47  FORMAT (1HI,9X,'CATEGORY II, HIGH-ENERGY X RAY'//10X,'INTERVAL 1,
    110 - 800 RAD')
     IF (NAME.EQ.1) PRO=OK8
     IF (NAME.EQ.1) CESSOR=OK8
     WRITE (6,23) PRO,CESSOR,NUM,TYPE
     WRITE (6,48)
 48  FORMAT (10X,'NBS TECHNIQUE : MFK'//10X,'IRRADIATION DISTANCE : 100
    1 CM'////)
     WRITE (6,49) CX
 49  FORMAT (23X,'IRRA.   IRRA. ',11X,'DEEP ABSORBED DOSE, Cx = ',F4.2)
     CALL ANSWER (RDEEP,DDEEP,1)
     K(2) = K(2) + 1
     IF (FINISH.EQ.PASS) J(2)=J(2)+1
     GO TO 100
 46  READ (5,58) (NUMBER(I),IMONTH(I),IDAY(I),IYEAR(I),RATE I),TIME(I),
    1IPOS(I),REF(I),RSHAL(I),RDEEP(I), I = 1,10)
 58  FORMAT (I5,3I2,2F5.0,I1,F4.0,2F10.0)
     DO 520 I = 1,10
     IF (NUMBER(I).LT.90000) GO TO 520
     CODE(I) = 9.0
     NUMBER(I) = NUMBER(I) - 90000
520  CONTINUE
     GO TO (59,59,60,61), INTER
 59  CX = 1.26
     CALL TEST (RSHAL,DSHAL)
     WRITE (6,50)
 60  FORMAT (1HI,9X,'CATEGORY II, HIGH-ENERGY X RAY'//10X,'INTERVAL 2,
    130 - 100 MREM')
     IF (NAME.EQ.1) PRO=OK8
     IF (NAME.EQ.1) CESSOR=OK8
     WRITE (6,23) PRO,CESSOR,NUM,TYPE
     WRITE (6,52)
 52  FORMAT (10X,'NBS TECHNIQUE : MFK'//10X,'IRRADIATION DISTANCE : 100
    1 CM'////)
     WRITE (6,54) CX
 54  FORMAT (23X,'IRRA.   IRRA. ',11X,'SMALLOW DOSE EQUIV., CX=',F5.3)
     CALL ANSWER (RSHAL,DSHAL,2)
     K(2) = K(2) + 1
     IF (FINISH.EQ.PASS) J(2)=J(2)+1
     CALL TEST(RDEEP,DDEEP)
     WRITE (6,50)
     IF (NAME.EQ.1) PRO=OK8
     IF (NAME.EQ.1) CESSOR=OK8
     WRITE (6,23) PRO,CESSOR,NUM,TYPE
     WRITE (6,52)
     WRITE (6,55) CX
 55  FORMAT (23X,'IRRA.   IRRA. ',11X,'DEEP DOSE EQUIVALENT, CX=',F5.3)
     CALL ANSWER (RDEEP,DDEEP,2)
     K(2) = K(2) + 1
     IF (FINISH.EQ.PASS) J(2)=J(2)+1
     GO TO 100
 60  CX = 1.35
     CALL TEST (RSHAL,DSHAL)
```

```
      WRITE (6,56)
   56 FORMAT (1HI,9X,'CATEGORY II, HIGH-ENERGY X RAY'//10X,'INTERVAL 3,
     1101 - 300 MREM')
      IF (NAME.EQ.1) PRO=OK8
      IF (NAME.EQ.1) CESSOR=OK8
      WRITE (6,23) PRO,CESSOR,NUM,TYPE
      WRITE (6,57)
   57 FORMAT (10X,'NBS TECHNIQUE : MFG'//10X,'IRRADIATION DISTANCE : 100
     1 CM'////)
      WRITE (6,54) CX
      CALL ANSWER (RSHAL,DSHAL,2)
      K(2) = K(2) + 1
      IF (FINISH.EQ.PASS) J(2)=J(2)+1
      CALL TEST (RDEEP,DDEEP)
      WRITE (6,56)
      IF (NAME.EQ.1) PRO=OK8
      IF (NAME.EQ.1) CESSOR=OK8
      WRITE (6,23) PRO,CESSOR,NUM,TYPE
      WRITE (6,57)
      WRITE (6,55) CX
      CALL ANSWER (RDEEP,DDEEP,2)
      K(2) = K(2) + 1
      IF (FINISH.EQ.PASS) J(2)=J(2)+1
      GO TO 100
   61 CX = 1.28
      CALL TEST (RSHAL,DSHAL)
      WRITE (6,65)
   65 FORMAT (1HI,9X,'CATEGORY II, HIGH-ENERGY X RAY'//10X,'INTERVAL 4,
     1301 - 10,000 MREM')
      IF (NAME.EQ.1) PRO=OK8
      IF (NAME.EQ.1) CESSOR=OK8
      WRITE (6,23) PRO,CESSOR,NUM,TYPE
      WRITE (6,66)
   66 FORMAT (10X,'NBS TECHNIQUE : MFG'//10X,'IRRADIATION DISTANCE : 100
     1 CM'////)
      WRITE (6,54) CX
      CALL ANSWER (RSHAL,DSHAL,2)
      K(2) = K(2) + 1
      IF (FINISH.EQ.PASS) J(2)=J(2)+1
      CX = 1.23
      CALL TEST (RDEEP,DDEEP)
      WRITE (6,65)
      IF (NAME.EQ.1) PRO=OK8
      IF (NAME.EQ.1) CESSOR=OK8
      WRITE (6,23) PRO,CESSOR,NUM,TYPE
      WRITE (6,66)
      WRITE (6,55) CX
      CALL ANSWER (RDEEP,DDEEP,2)
      K(2) = K(2) + 1
      IF (FINISH.EQ.PASS) J(2)=J(2)+1
      GO TO 100
    3 READ (5,58) (NUMBER(I),IMONTH(I),IDAY(I),IYEAR(I),RATE(I),TIME(I),
     1IPOS(I),REF(I),RSHAL(I),RDEEP(I), I = 1,10)
      DO 504 I = 1,10
      IF (NUMBER(I).LT.90000) GO TO 504
      CODE(I) = 9.0
      NUMBER(I) = NUMBER(I) - 90000
  504 CONTINUE
      IF (INTER.GT.1) GO TO 68
      CX = 0.81
      CALL TEST (RSHAL,DSHAL)
      WRITE (6,67)
   67 FORMAT (1HI,9X,'CATEGORY III, LOW-ENERGY X RAY'//10X,'INTERVAL 1,
     1150 - 300 MREM')
      IF (NAME.EQ.1) PRO=OK8
      IF (NAME.EQ.1) CESSOR=OK8
```

```
      WRITE (6,23) PRO,CESSOR,NUM,TYPE
      WRITE (6,69)
   69 FORMAT (10X,'NRS TECHNIQUE : L-G'//10X,'IRRADIATION DISTANCE : 200
     I CM'////)
      WRITE (6,54) CX
      CALL ANSWER (RSHAL,DSHAL,2)
      K(3) = K(3) + 1
      IF (FINISH.EQ.PASS) J(3)=J(3)+1
      CX = 0.25
      CALL TEST (RDEEP,DDEEP)
      WRITE (6,67)
      IF (NAME.EQ.1) PRO=OK8
      IF (NAME.EQ.1) CESSOR=OK8
      WRITE (6,23) PRO,CESSOR,NUM,TYPE
      WRITE (6,69)
      WRITE (6,55) CX
      CALL ANSWER (RDEEP,DDEEP,2)
      K(3) = K(3) + 1
      IF (FINISH.EQ.PASS) J(3)=J(3)+1
      GO TO 100
   68 CX = 0.81
      CALL TEST (RSHAL,DSHAL)
      WRITE (6,70)
   70 FORMAT (1HI,9X,'CATEGORY III, LOW-ENERGY X RAY'//10X,'INTERVAL 2,
     1301 - 10,000 MREM')
      IF (NAME.EQ.1) PRO=OK8
      IF (NAME.EQ.1) CESSOR=OK8
      WRITE (6,23) PRO,CESSOR,NUM,TYPE
      WRITE (6,69)
      WRITE (6,54) CX
      CALL ANSWER (RSHAL,DSHAL,2)
      K(3) = K(3) + 1
      IF (FINISH.EQ.PASS) J(3)=J(3)+1
      CX = 0.25
      CALL TEST (RDEEP,DDEEP)
      WRITE (6,70)
      IF (NAME.EQ.1) PRO=OK8
      IF (NAME.EQ.1) CESSOR=OK8
      WRITE (6,23) PRO,CESSOR,NUM,TYPE
      WRITE (6,69)
      WRITE (6,55) CX
      CALL ANSWER (RDEEP,DDEEP,2)
      K(3) = K(3) + 1
      IF (FINISH.EQ.PASS) J(3)=J(3)+1
      GO TO 100
    4 READ (5,11) (NUMBER(I),IMONTH(I),IDAY(I),IYEAR(I),RATE(I),TIME(I),
     1RSHAL(I), I = 1,10)
   11 FORMAT (I5,3I2,2F5.0,F10.0)
      DO 505 I = 1,10
      IF (NUMBER(I).LT.90000) GO TO 505
      CODE(I) = 9.0
      NUMBER(I) = NUMBER(I) - 90000
  505 CONTINUE
      CX = 0.966
      CALL TEST (RSHAL,DSHAL)
      IF (INTER.GT.1) GO TO 72
      WRITE (6,71)
   71 FORMAT (1HI,9X,'CATEGORY IV, BETA'//10X,'INTERVAL 1, 150 - 300 MRE
     1M')
      GO TO 75
   72 WRITE (6,74)
   74 FORMAT (1HI,9X,'CATEGORY IV, BETA'//10X,'INTERVAL 2, 301 - 10,000
     1MREM')
   75 IF (NAME.EQ.1) PRO=OK8
      IF (NAME.EQ.1) CESSOR=OK8
      WRITE (6,23) PRO,CESSOR,NUM,TYPE
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```
      WRITE (6,73)
   73 FORMAT (10X,'SOURCE : STRONTIUM-90'//10X,'IRRADIATION DISTANCE : 3
     1S CM'////)
      WRITE (6,54) CX
      CALL ANSWER (RSHAL,DSHAL,2)
      K(4) = K(4) + 1
      IF (FINISH.EQ.PASS) J(4)=J(4)+1
      GO TO 100
    5 READ (5,21) (NUMBER(I),IMONTH(I),IDAY(I),IYEAR(I),RATE(I),TIME(I),
     1IPOS(I),IDIST(I),REF(I),RDEEP(I), I = 1,10)
      DO 506 I = 1,10
      IF (NUMBER(I).LT.90000) GO TO 506
      CODE(I) = 9.0
      NUMBER(I) = NUMBER(I) - 90000
  506 CONTINUE
      CALL TEST (RDEEP,DDEEP)
      IF (INTER.GT.1) GO TO 99
      WRITE (6,77)
   77 FORMAT (1H1,9X,'CATEGORY V, NEUTRON'//10X,'INTERVAL 1, 100 - 300 M
     1REM')
      GO TO 78
   99 WRITE (6,80)
   80 FORMAT (1H1,9X,'CATEGORY V, NEUTRON'//10X,'INTERVAL 2, 301 - 5,000
     1 MREM')
   78 IF (NAME.EQ.1) PRO=OK8
      IF (NAME.EQ.1) CESSOR=OK8
      WRITE (6,23) PRO,CESSOR,NUM,TYPE
      WRITE (6,79)
   79 FORMAT (10X,'SOURCE : CALIFORNIUM-252'//10X,'IRRADIATION DISTANCE
     1: SHOWN BELOW'//)
      WRITE (6,81)
   81 FORMAT (10X,'NOTE : DELIVERED DOSE EQUIVALENT INCLUDES THE'/17X,'R
     1OOM RETURN (SCATTER) CORRECTION FACTOR'/17X,'SHOWN BELOW'///)
      WRITE (6,83)
   83 FORMAT (23X,'DOSE EQ.  IRRA. IRRA.',15X,'DEEP DOSE EQUIVALENT')
      WRITE (6,84)
   84 FORMAT (1X,'DOSIMETER    DATE',7X,'RATE    TIME  DIST. SCATTER   D
     1ELIV.   REPORT.')
      WRITE (6,85)
   85 FORMAT (2X,'NUMBER   IRRADIATED (MREM/MIN) (MIN) (CM)   C.F.      (
     1MREM)    (MREM)    P=(H*-H)/H'//)
      DO 86 I = 1,10
      STATE(I) = OK
      IF (CODE(I).EQ.9.0) STATE(I)=VOID
   86 CONTINUE
      WRITE (6,87) (NUMBER(I),STATE(I),IMONTH(I),IDAY(I),IYEAR(I),RATE(I
     1),TIME(I),IDIST(I),EXPOS(I),DDEEP(I),RDEEP(I),P(I), I = 1,10)
   87 FORMAT (1X,I5,1X,A4,1X,I2,'-',I2,'-',I2,3X,F6.2,F9.3,I5,F8.3,2F9.0
     1,4X,F9.4/)
      TOLER = 15.0/SQRT(HBAR)
      IF (TOLER.LT.0.5) TOLER=0.5
      WRITE (6,27) PBAR,S,HBAR,RESULT,TOLER
      FINISH = PASS
      IF (RESULT.GT.TOLER) FINISH=FAIL
      WRITE (6,28) FINISH
      K(5) = K(5) + 1
      IF (FINISH.EQ.PASS) J(5)=J(5)+1
      GO TO 100
    6 READ (5,88) (NUMBER(I),IMONTH(I),IDAY(I),IYEAR(I),RATE(I),TIME(I),
     1IPOS(I),REF(I), I = 1,10)
   88 FORMAT (I5,3I2,2F5.0,I1,F4.0)
      READ (5,20) NCAT,INTER,PRO,CESSOR,NUM,TYPE
      READ (5,58) (NUMX(I),JMONTH(I),JDAY(I),JYEAR(I),RAT(I),TIM(I),JPOS
     1(I),CLO(I),RSHAL(I),RDEEP(I), I = 1,10)
      DO 507 I = 1,1
      IF (NUMBER(I).LT.90000) GO TO 508
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      CODE(I) = 9.0
      NUMBER(I) = NUMBER(I) - 90000
  508 IF (NUMX(I).LT.90000) GO TO 507
      CODE(I) = 9.0
      NUMX(I) = NUMX(I) - 90000
  507 CONTINUE
      DO 726 I = 1,10
  726 TIME(I) = TIME(I)/60.0
      CX = 1.01
      CALL TEST (RDEEP,DDEEP)
      WRITE (6,94)
   94 FORMAT (1HI,9X,'CATEGORY VI, GAMMA COMPONENT',32X,'PAGE 1 OF 3'/23
     1X,'OF GAMMA PLUS HIGH-ENERGY X RAY'/)
      GO TO (91,92,93), INTER
   91 WRITE (6,95)
   95 FORMAT (10X,'INTERVAL 1: 50 - 100 MREM')
      GO TO 110
   92 WRITE (6,111)
  111 FORMAT (10X,'INTERVAL 2, 101 - 300 MREM')
      GO TO 110
   93 WRITE (6,112)
  112 FORMAT (10X,'INTERVAL 3, 301 - 10,000 MREM')
  110 IF (NAME.EQ.1) PRO=OK8
      IF (NAME.EQ.1) CESSOR=OK8
      WRITE (6,23) PRO,CESSOR,NUM,TYPE
      WRITE (6,96)
   96 FORMAT (10X,'SOURCE : COBALT-60 IRRADIATOR'//)
      GO TO (124,125,125), INTER
  124 WRITE (6,127)
  127 FORMAT (10X,'IRRADIATION DISTANCE : 200 CM'////)
      GO TO 126
  125 WRITE (6,128)
  128 FORMAT (10X,'IRRADIATION DISTANCE : 100 CM'////)
  126 WRITE (6,97)
   97 FORMAT (57X,'DELIVERED DOSE EQUIVALENT',/28X,'IRRA.    IRRA.',20X,
     1'SHALLOW',6X,'DEEP')
      WRITE (6,98) CX, CX
   98 FORMAT (1X,'DOSIMETER    DATE',9X,'RATE    TIME    EXPOSURE',9X,
     1'CX=',F4.2,'    CX=',F4.2)
      WRITE (6,101)
  101 FORMAT (2X,'NUMBER    IRRADIATED    (MR/MIN)    (MIN)    (MR)',12X
     1,'(MREM)    (MREM)'//)
      DO 102 I = 1,10
      STATE(I) = OK
      IF (CODE(I).EQ.9.0) STATE(I)=VOID
  102 CONTINUE
      WRITE (6,103) (NUMBER(I),STATE(I),IMONTH(I),IDAY(I),IYEAR(I),RATE(
     1I),TIME(I),EXPOS(I),DDEEP(I),DDEEP(I), I = 1,10)
  103 FORMAT (1X,I5,1X,A4,2X,I2,'-',I2,'-',I2,4X,F8.2,F10.3,F10.2,8X,F8.
     1 0,4X,F7.0/)
      WRITE (6,107)
  107 FORMAT (1HI,9X,'CATEGORY VI, X RAY COMPONENT',33X,'PAGE 2 OF 3'/23
     1X,'OF GAMMA PLUS HIGH-ENERGY X RAY'/)
      GO TO (104,105,106), INTER
  104 WRITE (6,95)
      CXSHAL = 1.26
      CXDEEP = 1.26
      GO TO 113
  105 WRITE (6,111)
      CXSHAL = 1.35
      CXDEEP = 1.35
      GO TO 113
  106 WRITE (6,112)
      CXSHAL = 1.28
      CXDEEP = 1.23
  113 CX = CXSHAL
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      DO 109 I = 1,10
      RATE(I) = RAT(I)
      TIME(I) = TIM(I)
      STATE(I) = OK
      IF (CODE(I).EQ.9.0) STATE(I)=VOID
  109 CONTINUE
      CALL TEST (RSHAL,DSHALX)
      CX = CXDEEP
      CALL TEST (RDEEP,DDEEPX)
      IF (NAME.EQ.1) PRO=OKB
      IF (NAME.EQ.1) CESSOR=OKB
      WRITE (6,23) PRO,CESSOR,NUM,TYPE
      GO TO (129,130,131), INTER
  129 WRITE (6,132)
  132 FORMAT (10X,'NBS TECHNIQUE : MFK'//)
      GO TO 108
  130 WRITE (6,133)
  133 FORMAT (10X,'NBS TECHNIQUE : MFG'//)
      GO TO 108
  131 WRITE (6,134)
  134 FORMAT (10X,'NBS TECHNIQUE : MFG'//)
  108 WRITE (6,135)
  135 FORMAT (10X,'IRRADIATION DISTANCE : 100 CM'////)
      WRITE (6,97)
      WRITE (6,98) CXSHAL, CXDEEP
      WRITE (6,101)
      WRITE (6,103)    (NUMX(I),STATE(I),JMONTH(I),JDAY(I),JYEAR(I),RATE(
     II),TIME(I),EXPOS(I),DSHALX(I),DDEEPX(I), I = 1,10)
      DO 89 I = 1,10
      DSHAL(I) = DDEEP(I) + DSHALX(I)
      DDEEP(I) = DDEEP(I) + DDEEPX(I)
      IF (NUMBER(I).EQ.NUMX(I)) GO TO 89
      WRITE (6,90) NCAT, INTER
   90 FORMAT (1H1,4X,'WARNING *** DOSIMETER NUMBERS IN CATEGORY ',I1,' I
     NTERVAL ',I1//17X,'DO NOT MATCH BETWEEN THE TWO RADIATION SOURCES
     USED')
      GO TO 100
   89 CONTINUE
      CX = 6.0
      CALL TEST (RSHAL,DSHAL)
      TOLER = 15.0/SQRT(HBAR)
      IF (TOLER.LT.0.5) TOLER=0.5
      DO 114 I = 1,10
      TIME(I) = DSHAL(I)
      EXPOS(I) = RSHAL(I)
  114 REF(I) = P(I)
      RAVG = PBAR
      SAVG = S
      HAVG = HBAR
      GAMRES = RESULT
      GAMTOL = TOLER
      GAMFIN = PASS
      IF (RESULT.GT.TOLER) GAMFIN=FAIL
      CX = 6.0
      CALL TEST (RDEEP,DDEEP)
      TOLER = 15.0/SQRT(HBAR)
      IF (TOLER.LT.0.5) TOLER=0.5
      FINISH = PASS
      IF (RESULT.GT.TOLER) FINISH=FAIL
      WRITE (6,115)
  115 FORMAT (1H1,9X,'CATEGORY VI, TOTAL OF GAMMA PLUS X RAY',22X,'PAGE
     13 OF 31'//)
      GO TO (116,117,118), INTER
  116 WRITE (6,95)
      GO TO 119
  117 WRITE (6,111)
```

```
      GO TO 119
  118 WRITE (6,112)
  119 IF (NAME.EQ.1) PRO=OK8
      IF (NAME.EQ.1) CESSOR=OK8
      WRITE (6,23) PRO,CESSOR,NUM,TYPE
      WRITE (6,120)
  120 FORMAT (////18X,'TOTAL SHALLOW DOSE EQUIVALENT',7X,'TOTAL DEEP DOS
     1E EQUIVALENT'/3X,'DOSIMETER',6X,'DELIVERED REPORTED',10X,'DELIVERE
     2D REPORTED'/4X,'NUMBER',10X,'(MREM)    (MREM)   P=(H*-H)/H',7X,'(MRE
     3M)    (MREM) P=(H*-H)/H'///)
      WRITE (6,121) (NUMBER(I),STATE(I),TIME(I),EXPOS(I),REF(I),DDEEP(I)
     1,RDEEP(I),P(I), I = 1,10)
  121 FORMAT (4X,I5,1X,A4,5X,F7.0,2X,F7.0,2X,F9.4,7X,F7.0,2X,F7.0,2X,F9.
     14/)
      WRITE (6,122) PAVG,PBAR,SAVG,S,HAVG,HBAR,GAMRES,RESULT,GAMTOL,TOLE
     1R
  122 FORMAT (///28X,'P AVERAGE =',F8.4,12X,'P AVERAGE =',F8.4//36X,'S =
     1',F8.4,20X,'S =',F8.4//28X,'M AVERAGE =',F8.1,12X,'M AVERAGE =',F8
     2.1//18X,'ABS(P AVERAGE) * 2S =',F8.4,2X,'ABS(P AVERAGE) * 2S =',F8
     3.4//36X,'L =',F8.4,20X,'L =',F8.4///)
      WRITE (6,123) GAMFIN, FINISH
  123 FORMAT (18X,'********** ',A4,' **********',2X,'********** ',A4
     1,' **********')
      K(6) = K(6) + 2
      IF (FINISH.EQ.PASS) J(6)=J(6)+1
      IF (GAMFIN.EQ.PASS) J(6)=J(6)+1
      GO TO 100
    7 READ (5,88) (NUMBER(I),IMONTH(I),IDAY(I),IYEAR(I),RATE(I),TIME(I),
     1IPOS(I),REF(I), I = 1,10)
      READ (5,20) NCAT,INTER,PRO,CESSOR,NUM,TYPE
      READ (5,141) (NUMX(I),JMONTH(I),JDAY(I),JYEAR(I),RAT(I),TIM(I),RSH
     1AL(I),RDEEP(I), I = 1,10)
  141 FORMAT (I5,3I2,2F5.0,2F10.0)
      DO 509 I = 1,10
      IF (NUMBER(I).LT.90000) GO TO 510
      CODE(I) = 9.0
      NUMBER(I) = NUMBER(I) - 90000
  510 IF (NUMX(I).LT.90000) GO TO 509
      CODE(I) = 9.0
      NUMX(I) = NUMX(I) - 90000
  509 CONTINUE
      DO 727 I = 1,10
  727 TIME(I) = TIME(I)/60.0
      CX = 1.01
      CALL TEST (RDEEP,DDEEP)
      TOLER = 15.0/SQRT(HBAR)
      IF (TOLER.LT.0.5) TOLER=0.5
      PAVG = PBAR
      SAVG = S
      HAVG = HBAR
      GAMRES = RESULT
      GAMTOL = TOLER
      GAMFIN = PASS
      IF (RESULT.GT.TOLER) GAMFIN=FAIL
      WRITE (6,136)
  136 FORMAT (1HI,9X,'CATEGORY VII, GAMMA COMPONENT',32X,'PAGE 1 OF 3'/2
     14X,'OF BETA PLUS GAMMA'/)
      IF (INTER.GT.1) GO TO 139
      WRITE (6,137)
  137 FORMAT (10X,'INTERVAL 1, 200 - 300 MREM')
      GO TO 138
  139 WRITE (6,140)
  140 FORMAT (10X,'INTERVAL 2, 301 - 10,000 MREM')
  138 IF (NAME.EQ.1) PRO=OK8
      IF (NAME.EQ.1) CESSOR=OK8
      WRITE (6,23) PRO,CESSOR,NUM,TYPE
```

```
      WRITE (6,96)
      WRITE (6,128)
      IF (NCAT.NE.8) GO TO 197
      WRITE (6,175)
  175 FORMAT (10X,'NOTE : DELIVERED DOSE EQUIVALENT INCLUDES A GAMMA-RAY
     1'/17X,'CONTRIBUTION FROM THE CF-252 SOURCE EQUAL TO'/17X,'7.033 PE
     2RCENT OF THE NEUTRON DOSE EQUIVALENT'///)
  197 WRITE (6,97)
      WRITE (6,98) CX, CX
      WRITE (6,101)
      DO 154 I = 1,10
      PP(I) = P(I)
      STATE(I) = OK
      IF (CODE(I).EQ.9.0) STATE(I)=VOID
  154 CONTINUE
      WRITE (6,103) (NUMBER(I),STATE(I),IMONTH(I),IDAY(I),IYEAR(I),RATE(
     1I),TIME(I),EXPOS(I),DDEEP(I),DDEEP(I), I = 1,10)
      IF (NCAT.EQ.8) GO TO 165
      WRITE (6,142)
  142 FORMAT (1H1,9X,'CATEGORY VII, BETA COMPONENT',32X,'PAGE 2 OF 3'/24
     1X,'OF BETA PLUS GAMMA'/)
      IF (INTER.GT.1) GO TO 143
      WRITE (6,137)
      GO TO 144
  143 WRITE (6,140)
  144 IF (NAME.EQ.1) PRO=OK8
      IF (NAME.EQ.1) CESSOR=OK8
      WRITE (6,23) PRO,CESSOR,NUM,TYPE
      WRITE (6,73)
      CX = 0.9665
      DO 147 I = 1,10
      RATE(I) = RAT(I)
      TIME(I) = TIM(I)
      REF(I) = 0.0
      STATE(I) = OK
      IF (CODE(I).EQ.9.0) STATE(I)=VOID
  147 CONTINUE
      CALL TEST (RSHAL,DSHAL)
      WRITE (6,97)
      WRITE (6,146)
  146 FORMAT (1X,'DOSIMETER',5X,'DATE',8X,'RATE',7X,'TIME',3X,'ABS. DOSE
     1',9X,'CX=.9665',4X,'CX=0.00'/2X,'NUMBER',4X,'IRRADIATED',3X,'(MRAD
     2/MIN)',3X,'(MIN)',4X,'(MRAD)',11X,'(MREM)',5X,'(MREM)'//)
      WRITE (6,103)   (NUMX(I),STATE(I),JMONTH(I),JDAY(I),JYEAR(I),RATE(
     1I),TIME(I),EXPOS(I),DSHAL(I),REF(I), I = 1,10)
      DO 148 I = 1,10
      DSHAL(I) = DSHAL(I) + DDEEP(I)
      IF (NUMBER(I).EQ.NUMX(I)) GO TO 148
      WRITE (6,90) NCAT INTER
      GO TO 100
  148 CONTINUE
      CX = 6.0
      CALL TEST (RSHAL,DSHAL)
      TOLER = 15.0/SQRT(HBAR)
      IF (TOLER.LT.0.5) TOLER=0.5
      FINISH = PASS
      IF (RESULT.GT.TOLER) FINISH=FAIL
      WRITE (6,149)
  149 FORMAT (1H1,9X,'CATEGORY VII, TOTAL OF BETA PLUS GAMMA',23X,'PAGE
     1 3 OF 3'//)
      IF (INTER.GT.1) GO TO 150
      WRITE (6,137)
      GO TO 151
  150 WRITE (6,140)
  151 IF (NAME.EQ.1) PRO=OK8
      IF (NAME.EQ.1) CESSOR=OK8
```

```
      WRITE (6,23) PRO,CESSOR,NUM,TYPE
      WRITE (6,120)
      WRITE (6,121) (NUMBER(I),STATE(I),DSHAL(I),RSHAL(I),P(I),DDEEP(I),
     1RDEEP(I),PP(I), I = 1,10)
      WRITE (6,122) PBAR,PAVG,S,SAVG,MBAR,MAVG,RESULT,GAMRES,TOLER,GAMTO
     1L
      WRITE (6,123) FINISH, GAMFIN
      K(7) = K(7) + 2
      IF (FINISH.EQ.PASS) J(7)=J(7)+1
      IF (GAMFIN.EQ.PASS) J(7)=J(7)+1
      GO TO 100
    8 READ (5,88) (NUMBER(I),IMONTH(I),IDAY(I),IYEAR(I),RATE(I),TIME(I),
     1IPOS(I),REF(I), I = 1,10)
      READ (5,20) NCAT,INTER,PRO,CESSOR,NUM,TYPE
      READ (5,21) (NUMX(I),JMONTH(I),JDAY(I),JYEAR(I),RAT(I),TIM(I),JPOS
     1(I),IDIST(I),CLO(I),RDEEP(I), I = 1,10)
      DO 511 I = 1,10
      IF (NUMBER(I).LT.90000) GO TO 512
      CODE(I) = 9.0
      NUMBER(I) = NUMBER(I) - 90000
  512 IF (NUMX(I).LT.90000) GO TO 511
      CODE(I) = 9.0
      NUMX(I) = NUMX(I) - 90000
  511 CONTINUE
      CX = 1.01
      DO 160 I = 1,10
      TIME(I) = TIME(I)/60.0
      EXPOS(I) = RATE(I)*TIME(I)
      DDEEP(I) = EXPOS(I)*CX + 0.07033*RAT(I)*TIM(I)
      IDEL = DDEEP(I)
      XDEL = IDEL
      DIFF = DDEEP(I) - XDEL
      IF (DIFF.GT.0.5) GO TO 173
      DDEEP(I) = XDEL
      GO TO 160
  173 DDEEP(I) = XDEL + 1.0
  160 CONTINUE
      WRITE (6,161)
  161 FORMAT (1H1,9X,'CATEGORY VIII, GAMMA COMPONENT',32X,'PAGE 1 OF 3'/
     125X,'OF NEUTRON PLUS GAMMA'/)
      IF (INTER.GT.1) GO TO 162
      WRITE (6,163)
  163 FORMAT (10X,'INTERVAL 1, 180 - 300 MREM')
      GO TO 138
  162 WRITE (6,164)
  164 FORMAT (10X,'INTERVAL 2, 301 - 5,000 MREM')
      GO TO 138
  165 WRITE (6,166)
  166 FORMAT (1H1,9X,'CATEGORY VIII, NEUTRON COMPONENT',30X,'PAGE 2 OF 3
     1'/25X,'OF NEUTRON PLUS GAMMA'/)
      IF (INTER.GT.1) GO TO 167
      WRITE (6,163)
      GO TO 168
  167 WRITE (6,164)
  168 IF (NAME.EQ.1) PRO=OKB
      IF (NAME.EQ.1) CESSOR=OKB
      WRITE (6,23) PRO,CESSOR,NUM,TYPE
      WRITE (6,79)
      WRITE (6,81)
      DO 191 I = 1,10
      RATE(I) = RAT(I)
      TIME(I) = TIM(I)
      STATE(I) = OK
      IF (CODE(I).EQ.9.0) STATE(I)=VOID
  191 CONTINUE
      CX = 8.0
```

```
      CALL TEST (RDEEP,DDEEPX)
      WRITE (6,169)
  169 FORMAT (23X,'DOSE EQ.  IRRA. IRRA.',14X,'DELIVERED DOSE EQUIVALENT
     1'/1X,'DOSIMETER    DATE',7X,'RATE    TIME  DIST. SCATTER',9X,'SHAL
     2LOW   DEEP')
      WRITE (6,170)
  170 FORMAT (2X,'NUMBER   IRRADIATED (MREM/MIN) (MIN) (CM)   C.F.',12X,
     1'(MREM)  (MREM)'//)
      WRITE (6,172)   (NUMX(I),STATE(I),JMONTH(I),JDAY(I),JYEAR(I),RAT(I
     1),TIM(I),IDIST(I),EXPOS(I),DDEEPX(I),DDEEPX(I), I = 1,10)
  172 FORMAT (1X,I5,1X,A4,1X,I2,'-',I2,'-',I2,3X,F6.2,F9.3,F5.3,F8.3,8X,2F
     18.0/)
      DO 183 I = 1,10
      DDEEP(I) = DDEEP(I) + DDEEPX(I)
      IF (NUMBER(I).EQ.NUMX(I)) GO TO 183
      WRITE (6,90) NCAT,INTER
      GO TO 190
  183 CONTINUE
      CX = 6.0
      CALL TEST (RDEEP,DDEEP)
      TOLER = 15.0/SQRT(HBAR)
      IF (TOLER.LT.0.5) TOLER=0.5
      FINISH = PASS
      IF (RESULT.GT.TOLER) FINISH = FAIL
      WRITE (6,184)
  184 FORMAT (1H1,9X,'CATEGORY VIII, NEUTRON PLUS GAMMA',29X,'PAGE 3 OF
     13'//)
      IF (INTER.GT.1) GO TO 176
      WRITE (6,163)
      GO TO 177
  176 WRITE (6,164)
  177 WRITE (6,178)
  178 FORMAT (///)
      IF (NAME.EQ.1) PRO=OKB
      IF (NAME.EQ.1) CESSOR=OKB
      WRITE (6,23) PRO,CESSOR,NUM,TYPE
      WRITE (6,179)
  179 FORMAT (///29X,'TOTAL DEEP DOSE EQUIVALENT'/10X,'DOSIMETER',8X,'DE
     1LIVERED REPORTED'/11X,'NUMBER',12X,'(MREM)    (MREM) P=(H*-H)/H'//)
      WRITE (6,180) (NUMBER(I),STATE(I),DDEEP(I),RDEEP(I),P(I), I=1,10)
  180 FORMAT (11X,I5,1X,A4,6X,F7.0,2X,F7.0,2X,F9.4/)
      WRITE (6,181) PBAR,S,HBAR,RESULT,TOLER
  181 FORMAT (///36X,'P AVERAGE =',F8.4//44X,'S =',F8.4//36X,'H AVERAGE
     1=',F8.1//26X,'ABS(P AVERAGE) * 2S =',F8.4//44X,'L =',F8.4//
      WRITE (6,182) FINISH
  182 FORMAT (26X,'**********  ',A4,'  **********')
      K(8) = K(8) + 1
      IF (FINISH.EQ.PASS) J(8)=J(8)+1
      GO TO 100
      END
```

```
      SUBROUTINE TEST (REP,DE.)
      COMMON TYPE,NCAT,REF(10),FINISH,CODE(10)
      COMMON RATE(10),TIME(10),EXPOS(10),P(10),CX,RESULT,PBAR,HBAR,S
      COMMON NUMBER(10),IMONTH(10),IDAY(10),IYEAR(10),IPOS(10),IDIST(10)
      DIMENSION REP(10),DEL(10)
      REAL *8 ALBEDO,TYPE
      DATA ALBEDO/'ALBEDO  '/
      TDEL = 0.0
      TP = 0.0
      DENOM = 10.0
      IF (CX.EQ.6.0) GO TO 50
      IF (CX.EQ.8.0) GO TO 24
      DO 22 I = 1,10
      EXPOS(I) = RATE(I)*TIME(I)
   22 DEL(I) = EXPOS(I)*CX
      IF (NCAT.NE.5) GO TO 50
   24 IF (TYPE.EQ.ALBEDO) GO TO 51
      CF50 = 1.015
      CF100 = 1.06
      GO TO 52
   51 CF50 = 1.04
      CF100 = 1.17
   52 DO 53 I = 1,10
      IF (IDIST(I).EQ.100) GO TO 54
      EXPOS(I) = CF50
      DEL(I) = RATE(I)*TIME(I)*CF50
      GO TO 53
   54 DEL(I) = RATE(I)*TIME(I)*CF100
      EXPOS(I) = CF100
   53 CONTINUE
   50 DO 34 I = 1,10
      P(I) = 0.0
      IDEL = DEL(I)
      XDEL = IDEL
      DIFF = DEL(I) - XDEL
      IF (DIFF - 0.5) 30, 30, 31
   30 DEL(I) = XDEL
      GO TO 32
   31 DEL(I) = XDEL + 1.0
   32 IF (DEL(I).EQ.0.0) GO TO 70
      P(I) = (REP(I) - DEL(I))/DEL(I)
   70 IF (CODE(I).LT.9.0) GO TO 33
      DENOM = DENOM - 1.0
      GO TO 34
   33 TDEL = TDEL + DEL(I)
      TP = TP + P(I)
   34 CONTINUE
      PBAR = TP/DENOM
      HBAR = TDEL/DENOM
      HOLD = 0.0
      DO 23 I = 1,10
      IF (CODE(I).EQ.9.0) GO TO 23
      HOLD = HOLD + (P(I) - PBAR)**2
   23 CONTINUE
      S = SQRT(HOLD/(DENOM - 1.0))
      RESULT = ABS(PBAR) + 2.0*S
      RETURN
      END
```

```
      SUBROUTINE ANSWER (REP,DEL,N)
      COMMON TYPE,NCAT,REF(10),FINISH,CODE(10)
      COMMON RATE(10),TIME(10),EXPOS(10),P(10),CX,RESULT,PBAR,HBAR,S
      COMMON NUMBER(10),IMONTH(10),IDAY(10),IYEAR(10),IPOS(10),IDIST(10)
      DIMENSION DEL(10),REP(10),STATE(10)
      REAL *8 TYPE
      DATA PASS/'PASS'/,FAIL/'FAIL'/,VOID/'VOID'/,OK/'    '/
      IF (NCAT.NE.4) GO TO 22
      WRITE (6,52)
   52 FORMAT (1X,'DOSIMETER',4X,'DATE',6X,'RATE',3X,'TIME',5X,'DOSE',5X,
     1'DELIV.',3X,'REPORT.')
      WRITE (6,53)
   53 FORMAT (2X,'NUMBER   IRRADIATED (MRAD/M) (MIN)',3X,'(MREM)     (MRE
     1M)   (MREM)   P=(H*-H)/H'//)
      TOLER = 15.0/SQRT(HBAR)
      IF (TOLER.LT.0.5) TOLER=0.5
      GO TO 23
   22 WRITE (6,51)
   51 FORMAT (1X,'DOSIMETER',4X,'DATE',6X,'RATE',3X,'TIME   EXPOSURE',3X
     1,'DELIV.   REPORT.')
      GO TO (20,21), N
   20 TOLER = 0.3
      WRITE (6,64)
   64 FORMAT (2X,'NUMBER   IRRADIATED (R/MIN)  (MIN)     (R)',6X,'(RAD)
     1   (RAD)    P=(H*-H)/H'//)
      GO TO 23
   21 TOLER = 15.0/SQRT(HBAR)
      IF (TOLER.LT.0.5) TOLER=0.5
      WRITE (6,65)
   65 FORMAT (2X,'NUMBER   IRRADIATED (MR/MIN) (MIN)     (MR)',5X,'(MREM)
     1    (MREM)    P=(H*-H)/H'//)
   23 DO 10 I = 1,10
      STATE(I) = OK
      IF (CODE(I).EQ.9.0) STATE(I)=VOID
   10 CONTINUE
      GO TO (30,31), N
   30 WRITE (6,13) (NUMBER(I),STATE(I),IMONTH(I),IDAY(I),IYEAR(I),RATE(I
     1),TIME(I),EXPOS(I),DEL(I),REP(I),P(I), I = 1,10)
   13 FORMAT (1X,I5,1X,A4,1X,I2,'-',I2,'-',I2,1X,F7.2,F8.3,F9.2,F9.0,F10
     1.3,3X,F9.4/)
      GO TO 32
   31 WRITE (6,11) (NUMBER(I),STATE(I),IMONTH(I),IDAY(I),IYEAR(I),RATE(I
     1),TIME(I),EXPOS(I),DEL(I),REP(I),P(I), I = 1,10)
   11 FORMAT (1X,I5,1X,A4,1X,I2,'-',I2,'-',I2,1X,F7.2,F8.3,F9.2,2F9.0,4X
     1,F9.4/)
   32 WRITE (6,12) PBAR,S,HBAR,RESULT,TOLER
   12 FORMAT (///56X,'P AVERAGE = ',F8.4//64X,'S = ',F8.4//56X,'H AVERAG
     1E = ',F8.1//46X,'ABS(P AVERAGE) + 2S = ',F8.4//64X,'L = ',F8.4//)
      FINISH = PASS
      IF (RESULT.GT.TOLER) FINISH=FAIL
      WRITE (6,57) FINISH
   57 FORMAT (47X,'**********  ',A4,'  **********')
      RETURN
      END
```

PERSONAL DOSIMETRY PERFORMANCE TESTING

A PILOT STUDY

SPONSORED BY :
U.S. NUCLEAR REGULATORY COMMISSION

CONDUCTED BY :
DEPT. OF ENVIRONMENTAL AND INDUSTRIAL HEALTH
SCHOOL OF PUBLIC HEALTH
UNIVERSITY OF MICHIGAN
ANN ARBOR, MICHIGAN

********** RESULTS OF TEST #2 **********

PROCESSOR NAME : NAME & NUMBER OMITTED

PROCESSOR CODE NO. :

TYPE OF DOSIMETER : FILM

FOR EACH DOSIMETER, A PERFORMANCE INDEX IS CALCULATED BY :

$$P = (H^* - H)/H$$

WHERE : H = DELIVERED QUANTITY
H* = REPORTED QUANTITY

FOR EACH DEPTH OF EACH INTERVAL OF A CATEGORY, AN AVERAGE PERFORMANCE INDEX, (P AVERAGE), AND ITS STANDARD DEVIATION, S, ARE CALCULATED.

A PROCESSOR PASSES A CATEGORY IF, FOR EACH DEPTH OF EACH INTERVAL, THE ABSOLUTE VALUE OF (P AVERAGE) PLUS 2S IS LESS THAN OR EQUAL TO THE TOLERANCE LIMIT, L.

FOR CATEGORY I, INTERVAL 1, AND FOR CATEGORY II, INTERVAL 1, L = 0.3. FOR CATEGORY I, INTERVALS 2, 3, AND 4, L = 0.3 OR 6/SQRT(H AVERAGE), WHICHEVER IS LARGER. FOR ALL OTHER CATEGORIES, L = 0.5 OR 15/SQRT(H AVERAGE), WHICHEVER IS LARGER.

IF A DOSIMETER IS LOST, NOT REPORTED BY THE PROCESSOR, IRRADIATED IMPROPERLY, ETC., THE WORD VOID APPEARS NEXT TO THE DOSIMETER NUMBER. VOIDED DOSIMETERS ARE NOT INCLUDED IN THE PASS/FAIL CALCULATIONS.

CATEGORY I, GAMMA

INTERVAL 1, 10 - 800 RAD

PROCESSOR NAME : NAME & NUMBER OMITTED

PROCESSOR CODE NO. :

TYPE OF DOSIMETER : FILM

SOURCE : COBALT-60 IRRADIATOR

IRRADIATION DISTANCE : SHOWN BELOW

DOSIMETER NUMBER	DATE IRRADIATED	EXPOS. RATE (R/MIN)	IRRA. TIME (MIN)	EXPOSURE (R)	IRRA. DIST. (CM)	DEEP ABSORBED DOSE, Cx = 1.01 DELIV. (RAD)	REPORT. (RAD)	P=(H*-H)/H
34	2-20-79	54.54	3.820	208.34	100	210.	195.000	-0.0714
11	2-20-79	54.54	9.860	537.76	100	543.	550.000	0.0129
52	2-20-79	54.54	13.810	753.20	100	761.	600.000	-0.2116
2	2-20-79	54.54	12.910	704.11	100	711.	650.000	-0.0858
154	3-20-79	53.99	11.830	638.70	100	645.	620.000	-0.0388
182	3-20-79	53.99	10.400	561.50	100	567.	600.000	0.0582
170	3-20-79	53.99	1.950	105.28	100	106.	130.000	0.2264
304	4-18-79	53.43	3.570	190.75	100	193.	255.000	0.3212
342	4-18-79	53.43	6.150	328.59	100	332.	800.000	1.4096
322	4-18-79	53.43	8.450	451.48	100	456.	600.000	0.3158

P AVERAGE = 0.1937

S = 0.4629

H AVERAGE = 452.4

ABS(P AVERAGE) + 2S = 1.1195

L = 0.3000

********* FAIL **********

CATEGORY I, GAMMA

INTERVAL 2, 30 - 100 MREM

PROCESSOR NAME : NAME & NUMBER

PROCESSOR CODE NO. : OMITTED

TYPE OF DOSIMETER : FILM

SOURCE : COBALT-60 IRRADIATOR

IRRADIATION DISTANCE : SHOWN BELOW

DOSIMETER NUMBER	DATE IRRADIATED	EXPOS. RATE (MR/MIN)	IRRA. TIME (MIN)	EXPOSURE (MR)	IRRA. DIST. (CM)	DEEP DOSE EQUIVALENT, CX=1.01 DELIV. (MREM)	REPORT. (MREM)	P=(H*-H)/H
4	2-15-79	22.49	2.342	52.66	200	53.	70.	0.3208
33	2-15-79	22.49	4.208	94.65	200	96.	100.	0.0417
51	2-15-79	22.49	3.275	73.65	200	74.	90.	0.2162
163	3-26-79	22.18	3.577	79.33	200	80.	97.	0.2125
137	3-26-79	22.18	4.327	95.97	200	97.	122.	0.2577
194	3-26-79	22.18	1.500	33.27	200	34.	38.	0.1176
171	3-26-79	22.18	1.730	38.37	200	39.	45.	0.1538
305	4-20-79	21.98	3.893	85.58	200	86.	107.	0.2442
321	4-20-79	21.98	1.953	42.93	200	43.	60.	0.3953
340	4-20-79	21.98	3.760	82.64	200	83.	107.	0.2892

P AVERAGE = 0.2249

S = 0.1023

H AVERAGE = 68.5

ABS(P AVERAGE) + 2S = 0.4295

L = 0.7249

********** PASS **********

CATEGORY I, GAMMA

INTERVAL 3, 101 - 300 MREM

PROCESSOR NAME : NAME & NUMBER

PROCESSOR CODE NO. : OMITTED

TYPE OF DOSIMETER : FILM

SOURCE : COBALT-60 IRRADIATOR

IRRADIATION DISTANCE : SHOWN BELOW

DOSIMETER NUMBER	DATE IRRADIATED	EXPOS. RATE (MR/MIN)	IRRA. TIME (MIN)	EXPOSURE (MR)	IRRA. DIST. (CM)	DEEP DOSE DELTV. (MR H)	EQUIVALENT, REPORT. (MREM)	CX=1.0; P=(H*-H)/r
35	2-26-79	88.73	2.725	241.79	100	244.	290.	0.1885
3	2-26-79	88.73	1.657	147.00	100	148.	165.	0.1149
27	2-26-79	88.73	2.675	237.35	100	240.	270.	0.1250
172	3-22-79	87.97	1.922	169.05	100	171.	186.	0.0877
162	3-22-79	87.97	2.020	177.70	100	179.	200.	0.1173
138	3-22-79	87.97	1.722	151.45	100	153.	187.	0.2222
192	3-22-79	87.97	2.353	207.02	100	209.	240.	0.1483
308	4-18-79	87.11	2.470	215.16	100	217.	260.	0.1982
349	4-18-79	87.11	1.558	135.75	100	137.	135.	-0.0146
323	4-18-79	87.11	1.210	105.40	100	106.	135.	0.2736

P AVERAGE = 0.1461

S = 0.0803

H AVERAGE = 180.4

ABS(P AVERAGE) + 2S = 0.3067

L = 0.4467

********* PASS **********

CATEGORY I, GAMMA

INTERVAL 4, 301 - 10,000 MREM

PROCESSOR NAME : NAME & NUMBER

PROCESSOR CODE NO. : OMITTED

TYPE OF DOSIMETER : FILM

SOURCE : COBALT-60 IRRADIATOR

IRRADIATION DISTANCE : SHOWN BELOW

DOSIMETER NUMBER	DATE IRRADIATED	EXPOS. RATE (MR/MIN)	IRRA. TIME (MIN)	EXPOSURE (MR)	IRRA. DIST. (CM)	DEEP DOSE DELIV. (MREM)	EQUIVALENT, CX=1.01 REPORT. (MREM)	P=(H*-H)/H
25	2-20-79	88.92	70.967	6310.35	100	6373.	7400.	0.1611
53	2-20-79	88.92	10.525	935.88	100	945.	1100.	0.1640
36	2-20-79	88.92	11.572	1028.95	100	1039.	1100.	0.0587
5	2-20-79	88.92	7.953	707.21	100	714.	760.	0.0644
195	3-27-79	87.81	57.100	5013.95	100	5064.	5100.	0.0071
141	3-27-79	87.81	9.997	877.81	100	887.	1000.	0.1274
174	3-27-79	87.81	7.892	692.97	100	700.	750.	0.0714
352	4- 8-79	87.43	54.350	4751.82	100	4799.	6300.	0.3128
334	4- 8-79	87.43	6.000	524.58	100	530.	600.	0.1321
306	4- 8-79	87.43	102.667	8976.14	100	9066.	10000.	0.1030

P AVERAGE = 0.1202

S = 0.0838

H AVERAGE = 3011.7

ABS(P AVERAGE) + 2S = 0.2878

L = 0.3000

********** PASS **********

CATEGORY II. HIGH-ENERGY X RAY

INTERVAL 1. 10 - 800 RAD

PROCESSOR NAME : NAME & NUMBER

PROCESSOR CODE NO. : OMITTED

TYPE OF DOSIMETER : FILM

NRS TECHNIQUE : MFX

IRRADIATION DISTANCE : 100 CM

DOSIMETER NUMBER	DATE IRRADIATED	IRRA. RATE (R/MIN)	IRRA. TIME (MIN)	EXPOSURE (R)	DEEP ABSORBED DOSE, CX = 1.33 DELIV. (RAD)	REPORT. (RAD)	P=(H*-H)/H
37	2-23-79	8.83	46.580	411.30	547.	675.000	0.2340
55	2-23-79	8.83	20.090	177.39	236.	385.000	0.6314
6	2-23-79	8.83	3.830	33.82	45.	27.000	-0.4000
26	2-23-79	8.83	50.410	445.12	592.	613.000	0.0355
166	3-26-79	10.83	48.100	520.92	693.	675.000	-0.0260
161	3-26-79	10.83	7.140	77.33	103.	79.000	-0.2330
193	3-26-79	10.83	52.330	566.73	754.	625.000	-0.1711
360	4-25-79	10.54	32.660	344.24	458.	750.000	0.6376
345	4-25-79	10.54	25.260	266.24	354.	610.000	0.7232
311	4-25-79	10.54	11.710	123.42	164.	355.000	1.1646

P AVERAGE = 0.2596

S = 0.5067

H AVERAGE = 394.6

ABS(P AVERAGE) + 2S = 1.2730

L = 0.3000

********** FAIL **********

CATEGORY II, HIGH-ENERGY X RAY

INTERVAL 2, 30 - 100 MREM

PROCESSOR NAME : NAME & NUMBER

PROCESSOR CODE NO. : OMITTED

TYPE OF DOSIMETER : FILM

NBS TECHNIQUE : HFK

IRRADIATION DISTANCE : 100 CM

DOSIMETER NUMBER	DATE IRRADIATED	IRRA. RATE (MR/MIN)	IRRA. TIME (MIN)	EXPOSURE (MR)	SHALLOW DOSE EQUIV.* CX=1.260 DELIV. (MREM)	REPORT. (MREM)	P=(H*-H)/H
24	2-21-79	20.44	1.690	34.54	44.	60.	0.3636
38	2-21-79	20.44	2.225	45.48	57.	75.	0.3158
7	2-21-79	20.44	3.395	69.39	87.	116.	0.3333
191	3-23-79	20.46	3.190	65.27	82.	106.	0.2927
167	3-23-79	20.46	3.815	78.05	98.	120.	0.2245
160	3-23-79	20.46	1.810	37.03	47.	60.	0.2766
140	3-23-79	20.46	1.230	25.17	32.	50.	0.5625
303	4-25-79	21.30	2.440	51.97	65.	105.	0.6154
313	4-25-79	21.30	2.710	57.72	73.	107.	0.4658
351	4-25-79	21.30	3.100	66.03	83.	110.	0.3253

P AVERAGE = 0.3775

S = 0.1283

H AVERAGE = 66.8

ABS(P AVERAGE) + 2S = 0.6341

L = 1.8353

********** PASS **********

CATEGORY II. HIGH-ENERGY X RAY

INTERVAL 2. 30 - 100 MREM

PROCESSOR NAME : NAME & NUMBER

PROCESSOR CODE NO. : OMITTED

TYPE OF DOSIMETER : FILM

NBS TECHNIQUE : HFK

IRRADIATION DISTANCE : 100 CM

DOSIMETER NUMBER	DATE IRRADIATED	IRRA. RATE (MR/MIN)	IRRA. TIME (MIN)	EXPOSURE (MR)	DEEP DOSE EQUIVALENT, CX=1.260 DELIV. (MREM)	REPORT. (MREM)	P=(H*-H)/H
24	2-21-79	20.44	1.690	34.54	44.	60.	0.3636
38	2-21-79	20.44	2.225	45.48	57.	75.	0.3158
7	2-21-79	20.44	3.395	69.39	87.	110.	0.3333
191	3-23-79	20.46	3.190	65.27	82.	100.	0.2927
167	3-23-79	20.46	3.815	78.05	98.	120.	0.2245
160	3-23-79	20.46	1.810	37.03	47.	60.	0.2766
140	3-23-79	20.46	1.230	25.17	32.	50.	0.5625
303	4-25-79	21.30	2.440	51.97	65.	105.	0.6154
313	4-25-79	21.30	2.710	57.72	73.	107.	0.4658
351	4-25-79	21.30	3.100	66.03	83.	110.	0.3253

P AVERAGE = 0.3775

S = 0.1283

H AVERAGE = 66.8

ABS(P AVERAGE) + 2S = 0.6341

L = 1.8353

********** PASS **********

CATEGORY II, HIGH-ENERGY X RAY

INTERVAL 3, 101 - 300 MREM

PROCESSOR NAME : NAME & NUMBER

PROCESSOR CODE NO. : OMITTED

TYPE OF DOSIMETER : FILM

NBS TECHNIQUE : HFG

IRRADIATION DISTANCE : 100 CM

DOSIMETER NUMBER	DATE IRRADIATED	IRRA. RATE (MR/MIN)	IRRA. TIME (MIN)	EXPOSURE (MR)	SHALLOW DOSE EQUIV., CX=1.350 DELIV. (MREM)	REPORT. (MREM)	P=(H*-H)/H
39	2-20-79	62.55	1.870	116.97	158.	170.	0.0759
23	2-20-79	62.55	1.305	81.63	110.	121.	0.1000
56	2-20-79	62.55	2.950	184.52	249.	248.	-0.0040
190	3-21-79	65.60	3.040	199.42	269.	256.	-0.0483
168	3-21-79	65.60	1.520	99.71	135.	165.	0.2222
180	3-21-79	65.60	1.970	129.23	174.	197.	0.1322
142	3-21-79	65.60	2.310	151.54	205.	263.	0.2829
335	4-24-79	66.13	2.410	159.37	215.	225.	0.0465
316	4-24-79	66.13	3.280	216.91	293.	337.	0.1502
359	4-24-79	66.13	1.790	118.37	160.	170.	0.0625

P AVERAGE = 0.1020

S = 0.0998

H AVERAGE = 196.8

ABS(P AVERAGE) + 2S = 0.3015

L = 1.0692

********** PASS **********

CATEGORY II. HIGH-ENERGY X RAY

INTERVAL 3. 101 - 300 MREM

PROCESSOR NAME : NAME & NUMBER

PROCESSOR CODE NO. : OMITTED

TYPE OF DOSIMETER : FILM

NBS TECHNIQUE : HFG

IRRADIATION DISTANCE : 100 CM

DOSIMETER NUMBER	DATE IRRADIATED	IRRA. RATE (MR/MIN)	IRRA. TIME (MIN)	EXPOSURE (MR)	DEEP DOSE EQUIVALENT, CX=1.350 DELIV. (MREM)	REPORT. (MREM)	P=(H*-H)/H
39	2-20-79	62.55	1.870	116.97	158.	170.	0.0759
23	2-20-79	62.55	1.305	81.63	110.	121.	0.1000
56	2-20-79	62.55	2.950	184.52	249.	248.	-0.0040
190	3-21-79	65.60	3.040	199.42	269.	256.	-0.0483
168	3-21-79	65.60	1.520	99.71	135.	165.	0.2222
180	3-21-79	65.60	1.970	129.23	174.	197.	0.1322
142	3-21-79	65.60	2.310	151.54	205.	263.	0.2829
335	4-24-79	66.13	2.410	159.37	215.	225.	0.0465
316	4-24-79	66.13	3.280	216.91	293.	337.	0.1502
359	4-24-79	66.13	1.790	118.37	160.	170.	0.0625

P AVERAGE = 0.1020

S = 0.0998

H AVERAGE = 196.8

ABS(P AVERAGE) + 2S = 0.3015

L = 1.0692

********** PASS **********

CATEGORY II, HIGH-ENERGY X RAY

INTERVAL 4, 301 - 10,000 MREM

PROCESSOR NAME : NAME & NUMBER

PROCESSOR CODE NO. : OMITTED

TYPE OF DOSIMETER : FILM

NBS TECHNIQUE : MFG

IRRADIATION DISTANCE : 100 CM

DOSIMETER NUMBER	DATE IRRADIATED	IRRA. RATE (MR/MIN)	IRRA. TIME (MIN)	EXPOSURE (MR)	SHALLOW DOSE EQUIV., CX=1.280 DELIV. (MREM)	REPORT. (MREM)	P=(H*-H)/H
22	2-14-79	877.20	5.085	4460.56	5710.	6400.	0.1208
40	2-13-79	105.20	3.110	327.17	419.	490.	0.1695
57	2-14-79	877.20	2.340	2052.65	2627.	3000.	0.1420
8	2-13-79	105.20	3.490	367.15	470.	524.	0.1149
150	3-21-79	860.30	6.300	5419.89	6937.	7425.	0.0703
143	3-21-79	860.30	5.930	5101.58	6530.	6900.	0.0567
175	3-19-79	102.90	5.685	584.99	749.	640.	-0.1455
317	4-24-79	896.30	3.690	3307.35	4233.	4095.	-0.0326
331	4-24-79	73.27	3.820	279.89	358.	400.	0.1173
356	4-24-79	73.27	6.670	488.71	626.	595.	-0.0495

P AVERAGE = 0.0564

S = 0.1008

H AVERAGE = 2865.9

ABS(P AVERAGE) + 2S = 0.2580

L = 0.5000

********** PASS **********

CATEGORY II. HIGH-ENERGY X RAY

INTERVAL 4. 301 - 10,000 MREM

PROCESSOR NAME : NAME & NUMBER

PROCESSOR CODE NO. : OMITTED

TYPE OF DOSIMETER : FILM

NBS TECHNIQUE : MFG

IRRADIATION DISTANCE : 100 CM

DOSIMETER NUMBER	DATE IRRADIATED	IRRA. RATE (MR/MIN)	IRRA. TIME (MIN)	EXPOSURE (MR)	DEEP DOSE EQUIVALENT, Cx=1.230 DELIV. (MREM)	REPORT. (MREM)	P=(H*-H)/H
22	2-14-79	877.20	5.085	4460.56	5486.	6150.	0.1210
40	2-13-79	105.20	3.110	327.17	402.	480.	0.1940
57	2-14-79	877.20	2.340	2052.65	2525.	2900.	0.1485
8	2-13-79	105.20	3.490	367.15	452.	504.	0.1150
159	3-21-79	860.30	6.300	5419.89	6666.	7130.	0.0704
143	3-21-79	860.30	5.930	5101.58	6275.	6550.	0.0438
175	3-19-79	102.90	5.685	584.99	720.	610.	-0.1458
317	4-24-79	896.30	3.690	3307.35	4068.	3930.	-0.0324
331	4-24-79	73.27	3.820	279.89	344.	384.	0.1163
356	4-24-79	73.27	6.670	488.71	601.	572.	-0.0483

P AVERAGE = 0.0583

S = 0.1047

H AVERAGE = 2753.9

ABS(P AVERAGE) + 2S = 0.2677

L = 0.5000

********** PASS **********

CATEGORY III, LOW-ENERGY X RAY

INTERVAL 1, 150 - 300 MREM

PROCESSOR NAME : NAME & NUMBER

PROCESSOR CODE NO. : OMITTED

TYPE OF DOSIMETER : FILM

NBS TECHNIQUE : L-G

IRRADIATION DISTANCE : 200 CM

DOSIMETER NUMBER	DATE IRRADIATED	IRRA. RATE (MR/MIN)	IRRA. TIME (MIN)	EXPOSURE (MR)	SHALLOW DOSE EQUIV., Cx=0.810 DELIV. (MREM)	REPORT. (MREM)	P=(H*-H)/H
41	2-26-79	114.50	1.890	216.41	175.	190.	0.0857
58	2-26-79	114.50	2.920	334.34	271.	340.	0.2841
9	2-26-79	114.50	2.260	258.77	210.	210.	0.0
21	2-26-79	114.50	1.780	203.81	165.	184.	0.1152
176	3-13-79	116.80	2.660	310.69	252.	284.	0.1270
189	3-13-79	116.80	2.770	323.54	262.	340.	0.2977
144	3-13-79	116.80	3.010	351.57	285.	315.	0.1053
353	4-28-79	116.00	2.510	291.16	236.	320.	0.3559
338	4-28-79	116.00	1.880	218.08	177.	205.	0.1582
325	4-28-79	116.00	1.930	223.88	181.	230.	0.2707

P AVERAGE = 0.1800

S = 0.1146

H AVERAGE = 221.4

ABS(P AVERAGE) + 2S = 0.4092

L = 1.0081

********** PASS **********

CATEGORY III, LOW-ENERGY X RAY

INTERVAL 1, 150 - 300 MREM

PROCESSOR NAME : NAME & NUMBER OMITTED

PROCESSOR CODE NO. :

TYPE OF DOSIMETER : FILM

NBS TECHNIQUE : L-G

IRRADIATION DISTANCE : 200 CM

DOSIMETER NUMBER	DATE IRRADIATED	IRRA. RATE (MR/MIN)	IRRA. TIME (MIN)	EXPOSURE (MR)	DEEP DOSE EQUIVALENT, Cx=0.250 DELIV. (MREM)	REPORT. (MREM)	P=(H*-H)/H
41	2-26-79	114.50	1.890	216.41	54.	59.	0.0926
58	2-26-79	114.50	2.920	334.34	84.	108.	0.2857
9	2-26-79	114.50	2.260	258.77	65.	65.	0.0
21	2-26-79	114.50	1.780	203.81	51.	55.	0.0784
176	3-13-79	116.80	2.660	310.69	78.	88.	0.1282
189	3-13-79	116.80	2.770	323.54	81.	105.	0.2963
144	3-13-79	116.80	3.010	351.57	88.	97.	0.1023
353	4-28-79	116.00	2.510	291.16	73.	100.	0.3699
33A	4-28-79	116.00	1.880	218.08	55.	65.	0.1818
325	4-28-79	116.00	1.930	223.88	56.	71.	0.2679

P AVERAGE = 0.1803

S = 0.1190

H AVERAGE = 68.5

ABS(P AVERAGE) + 2S = 0.4184

L = 1.8124

********** PASS **********

CATEGORY III. LOW-ENERGY X RAY

INTERVAL 2, 301 - 10,000 MREM

PROCESSOR NAME : NAME & NUMBER OMITTED

PROCESSOR CODE NO. :

TYPE OF DOSIMETER : FILM

NBS TECHNIQUE : L-G

IRRADIATION DISTANCE : 200 CM

DOSIMETER NUMBER	DATE IRRADIATED	IRRA. RATE (MR/MIN)	IRRA. TIME (MIN)	EXPOSURE (MR)	SHALLOW DOSE EQUIV.. CX=0.810 DELIV. (MREM)	REPORT. (MREM)	P=(H*-H)/H
42	2-26-79	286.40	18.150	5198.16	4211.	2835.	-0.3268
59	2-26-79	286.40	37.460	10728.54	8690.	7500.	-0.1369
28	2-26-79	286.40	2.980	853.47	691.	830.	0.2012
10	2-26-79	286.40	15.920	4559.48	3693.	2750.	-0.2553
177	3-14-79	288.60	1.660	479.08	388.	405.	0.0438
145	3-14-79	288.60	11.840	3417.03	2768.	2700.	-0.0246
157	3-14-79	288.60	1.880	542.57	439.	520.	0.1982
357	4-29-79	288.80	29.900	8635.12	6994.	6975.	-0.0027
336	4-29-79	288.80	3.610	1042.57	844.	1377.	0.6315
310	4-29-79	288.80	1.770	511.18	414.	506.	0.2271

P AVERAGE = 0.0555

S = 0.2774

H AVERAGE = 2913.2

ABS(P AVERAGE) + 2S = 0.6103

L = 0.5000

********** FAIL **********

CATEGORY III, LOW-ENERGY X RAY

INTERVAL 2, 301 - 10,000 MREM

PROCESSOR NAME : NAME & NUMBER

PROCESSOR CODE NO. : OMITTED

TYPE OF DOSIMETER : FILM

NBS TECHNIQUE : L-G

IRRADIATION DISTANCE : 200 CM

DOSIMETER NUMBER	DATE IRRADIATED	IRRA. RATE (MR/MIN)	IRRA. TIME (MIN)	EXPOSURE (MR)	DEEP DOSE EQUIVALENT, Cx=0.250 DELIV. (MREM)	REPORT. (MREM)	P=(H*-H)/H
42	2-26-79	286.40	18.150	5198.16	1300.	875.	-0.3269
59	2-26-79	286.40	37.460	10728.54	2682.	2300.	-0.1424
28	2-26-79	286.40	2.980	853.47	213.	220.	0.0329
10	2-26-79	286.40	15.920	4559.48	1140.	850.	-0.2544
177	3-14-79	288.60	1.660	479.08	120.	125.	0.0417
145	3-14-79	288.60	11.840	3417.03	854.	750.	-0.1218
157	3-14-79	288.60	1.880	542.57	136.	162.	0.1912
357	4-29-79	288.80	29.900	8635.12	2159.	2150.	-0.0042
336	4-29-79	288.80	3.610	1042.57	261.	425.	0.6284
310	4-29-79	288.80	1.770	511.18	128.	157.	0.2266

P AVERAGE = 0.0271

S = 0.2759

H AVERAGE = 899.3

ABS(P AVERAGE) + 2S = 0.5788

L = 0.5002

********** FAIL **********

CATEGORY IV, BETA

INTERVAL 1, 150 - 300 MREM

PROCESSOR NAME : NAME & NUMBER

PROCESSOR CODE NO. : OMITTED

TYPE OF DOSIMETER : FILM

SOURCE : STRONTIUM-90

IRRADIATION DISTANCE : 35 CM

DOSIMETER NUMBER	DATE IRRADIATED	IRRA. RATE (MRAD/M)	IRRA. TIME (MIN)	DOSE (MREM)	SHALLOW DOSE EQUIV., CX=0.966 DELIV. (MREM)	REPORT. (MREM)	P=(H*-H)/H
43	2-18-79	152.30	1.860	283.28	274.	320.	0.1679
[illegible]	2-18-79	152.30	1.080	164.48	159.	207.	0.3019
12	2-18-79	152.30	1.580	240.63	233.	260.	0.1159
29	2-18-79	152.30	1.780	271.09	262.	300.	0.1450
156	3- 9-79	152.00	1.700	258.40	250.	275.	0.1000
188	3- 9-79	152.00	1.290	196.08	190.	215.	0.1211
149	3- 9-79	152.00	1.320	200.64	194.	208.	0.0722
502	5-10-79	151.30	1.670	252.67	244.	275.	0.1270
503	5-10-79	151.30	1.220	184.59	178.	215.	0.2079
504	5-10-79	151.30	1.900	287.47	278.	310.	0.1151

P AVERAGE = 0.1474

S = 0.0658

H AVERAGE = 226.2

ABS(P AVERAGE) + 2S = 0.2790

L = 0.9973

********** PASS **********

CATEGORY IV. BETA

INTERVAL 2. 301 - 10,000 MREM

PROCESSOR NAME : NAME & NUMBER

PROCESSOR CODE NO. : OMITTED

TYPE OF DOSIMETER : FILM

SOURCE : STRONTIUM-90

IRRADIATION DISTANCE : 35 CM

DOSIMETER NUMBER	DATE IRRADIATED	IRRA. RATE (MRAD/M)	IRRA. TIME (MIN)	DOSE (MREM)	SHALLOW DOSE EQUIV., CX=0.966 DELIV. (MREM)	REPORT. (MREM)	P=(H*-H)/H
44	2- 6-79	152.30	46.800	7127.64	6889.	6700.	-0.0274
13	2- 6-79	152.30	4.890	744.75	720.	850.	0.1806
30	2- 6-79	152.30	12.190	1856.54	1794.	2570.	0.4353
183	3-21-79	152.00	3.710	563.92	545.	680.	0.2477
152	3-21-79	152.00	17.660	2684.32	2594.	2960.	0.1411
169	3-21-79	152.00	6.740	1024.48	990.	870.	-0.1162
139	3-21-79	152.00	9.220	1401.44	1354.	1600.	0.1817
354	4-23-79	151.60	3.540	536.66	519.	740.	0.4258
314	4-23-79	151.60	53.600	8125.76	7854.	8530.	0.0868
327	4-23-79	151.60	5.690	862.60	834.	970.	0.1691

P AVERAGE = 0.1725

S = 0.1734

H AVERAGE = 2409.3

ABS(P AVERAGE) + 2S = 0.5193

L = 0.5000

********** FAIL **********

CATEGORY V. NEUTRON

INTERVAL 1. 100 - 300 MREM

PROCESSOR NAME : NAME & NUMBER OMITTED

PROCESSOR CODE NO. :

TYPE OF DOSIMETER : FILM

SOURCE : CALIFORNIUM-252

IRRADIATION DISTANCE : SHOWN BELOW

NOTE : DELIVERED DOSE EQUIVALENT INCLUDES THE ROOM RETURN (SCATTER) CORRECTION FACTOR SHOWN BELOW

DOSIMETER NUMBER	DATE IRRADIATED	DOSE EQ. RATE (MREM/MIN)	IRRA. TIME (MIN)	IRRA. DIST. (CM)	SCATTER C.F.	DEEP DOSE EQUIVALENT DELIV. (MREM)	REPORT. (MREM)	P=(H*-H)/H
75	2-21-79	78.45	1.336	50	1.015	106.	150.	0.4151
64	2-21-79	78.45	2.543	50	1.015	202.	275.	0.3614
72	2-21-79	78.45	3.733	50	1.015	297.	358.	0.2054
62	2-21-79	78.45	2.383	50	1.015	190.	235.	0.2368
208	3-13-79	77.33	2.335	50	1.015	183.	142.	-0.2240
199	3-13-79	77.33	3.600	50	1.015	283.	380.	0.3428
205	3-13-79	77.33	3.446	50	1.015	270.	290.	0.0741
374	4-26-79	74.93	2.223	50	1.015	169.	436.	1.5799
368	4-26-79	74.93	1.530	50	1.015	116.	310.	1.6724
363	4-26-79	74.93	2.339	50	1.015	178.	356.	1.0000

P AVERAGE = 0.5664

S = 0.6377

H AVERAGE = 199.4

ABS(P AVERAGE) + 2S = 1.8417

L = 1.0623

********** FAIL **********

CATEGORY V, NEUTRON

INTERVAL 2, 301 - 5,000 MREM

PROCESSOR NAME : NAME & NUMBER OMITTED

PROCESSOR CODE NO. :

TYPE OF DOSIMETER : FILM

SOURCE : CALIFORNIUM-252

IRRADIATION DISTANCE : SHOWN BELOW

NOTE : DELIVERED DOSE EQUIVALENT INCLUDES THE ROOM RETURN (SCATTER) CORRECTION FACTOR SHOWN BELOW

DOSIMETER NUMBER	DATE IRRADIATED	DOSE EQ. RATE (MREM/MIN)	IRRA. TIME (MIN)	IRRA. DIST. (CM)	SCATTER C.F.	DEEP DOSE EQUIVALENT DELIV. (MREM)	DEEP DOSE EQUIVALENT REPORT. (MREM)	P=(H*-H)/H
70	2-25-79	78.22	49.660	50	1.015	3943.	5050.	0.2808
63	2-25-79	78.22	4.443	50	1.015	353.	510.	0.4448
65	2-25-79	78.22	23.550	50	1.015	1870.	2215.	0.1845
74	2-25-79	78.22	11.690	50	1.015	928.	1240.	0.3362
207	3-15-79	77.22	57.500	50	1.015	4507.	5020.	0.1138
198	3-15-79	77.22	10.320	50	1.015	809.	1000.	0.2361
203	3-15-79	77.22	39.500	50	1.015	3096.	3480.	0.1240
365	4-18-79	75.36	11.400	50	1.015	872.	1065.	0.2213
369	4-18-79	75.36	32.000	50	1.015	2448.	3180.	0.2990
373	4-18-79	75.36	6.636	50	1.015	508.	590.	0.1614

P AVERAGE = 0.2402

S = 0.1029

H AVERAGE = 1933.4

ABS(P AVERAGE) + 2S = 0.4460

L = 0.5000

********* PASS **********

CATEGORY VI. GAMMA COMPONENT
OF GAMMA PLUS HIGH-ENERGY X RAY

INTERVAL 1, 50 - 100 MREM

PROCESSOR NAME : NAME & NUMBER

PROCESSOR CODE NO. : OMITTED

TYPE OF DOSIMETER : FILM

SOURCE : COBALT-60 IRRADIATOR

IRRADIATION DISTANCE : 200 CM

OSIMETER NUMBER	DATE IRRADIATED	IRRA. RATE (MR/MIN)	IRRA. TIME (MIN)	EXPOSURE (MR)	DELIVERED DOSE EQUIVALENT SHALLOW Cx=1.01 (MREM)	DEEP Cx=1.01 (MREM)
45	2-13-79	22.51	2.822	63.52	64.	64.
14	2-13-79	22.51	1.053	23.71	24.	24.
19	2-13-79	22.51	2.073	46.67	47.	47.
173	3-14-79	22.27	0.642	14.29	14.	14.
151	3-14-79	22.27	2.308	51.41	52.	52.
187	3-14-79	22.27	0.760	16.93	17.	17.
158	3-14-79	22.27	3.560	79.28	80.	80.
350	4- 1-79	22.13	0.927	20.51	21.	21.
332	4- 1-79	22.13	1.745	38.62	39.	39.
302	4- 1-79	22.13	0.663	14.68	15.	15.

CATEGORY VI. X RAY COMPONENT
OF GAMMA PLUS HIGH-ENERGY X RAY

INTERVAL 1. 50 - 100 MREM

PROCESSOR NAME : NAME & NUMBER

PROCESSOR CODE NO. : OMITTED

TYPE OF DOSIMETER : FILM

NBS TECHNIQUE : HFK

IRRADIATION DISTANCE : 100 CM

OSIMETER NUMBER	DATE IRRADIATED	IRRA. RATE (MR/MIN)	IRRA. TIME (MIN)	EXPOSURE (MR)	DELIVERED DOSE EQUIVALENT SHALLOW CX=1.26 (MREM)	DEEP CX=1.26 (MREM)
45	2-21-79	20.44	0.980	20.03	25.	25.
14	2-21-79	20.44	2.620	53.55	67.	67.
19	2-21-79	20.44	0.730	14.92	19.	19.
173	3-23-79	20.46	1.540	31.51	40.	40.
151	3-23-79	20.46	0.780	15.96	20.	20.
187	3-23-79	20.46	0.810	16.57	21.	21.
158	3-23-79	20.46	1.040	21.28	27.	27.
350	4-25-79	21.30	2.110	44.94	57.	57.
332	4-25-79	21.30	0.670	14.27	18.	18.
302	4-25-79	21.30	1.670	35.57	45.	45.

INTERVAL 1, 50 - 100 MREM

PROCESSOR NAME : NAME & NUMBER OMITTED

PROCESSOR CODE NO. :

TYPE OF DOSIMETER : FILM

DOSIMETER NUMBER	TOTAL SHALLOW DOSE EQUIVALENT DELIVERED (MREM)	REPORTED (MREM)	P=(H*-H)/H	TOTAL DEEP DOSE EQUIVALENT DELIVERED (MREM)	REPORTED (MREM)	P=(H*-H)/H
45	89.	125.	0.4045	89.	125.	0.4045
14	91.	110.	0.2088	91.	110.	0.2088
19	66.	90.	0.3636	66.	90.	0.3636
173	54.	65.	0.2037	54.	65.	0.2037
151	72.	98.	0.3611	72.	98.	0.3611
187	38.	38.	0.0	38.	38.	0.0
158	107.	130.	0.2150	107.	130.	0.2150
350	78.	45.	-0.4231	78.	45.	-0.4231
332	57.	115.	1.0175	57.	115.	1.0175
302	60.	80.	0.3333	60.	80.	0.3333

P AVERAGE =	0.2684	P AVERAGE =	0.2684
S =	0.3594	S =	0.3594
H AVERAGE =	71.2	H AVERAGE =	71.2
ABS(P AVERAGE) + 2S =	0.9872	ABS(P AVERAGE) + 2S =	0.9872
L =	1.7777	L =	1.7777
********** PASS **********		********** PASS **********	

CATEGORY VI, GAMMA COMPONENT
OF GAMMA PLUS HIGH-ENERGY X RAY

INTERVAL 2, 101 - 300 MREM

PROCESSOR NAME : NAME & NUMBER

PROCESSOR CODE NO. : OMITTED

TYPE OF DOSIMETER : FILM

SOURCE : COBALT-60 IRRADIATOR

IRRADIATION DISTANCE : 100 CM

DOSIMETER NUMBER	DATE IRRADIATED	IRRA. RATE (MR/MIN)	IRRA. TIME (MIN)	EXPOSURE (MR)	DELIVERED DOSE EQUIVALENT SHALLOW CX=1.01 (MREM)	DEEP CX=1.01 (MREM)
54	2-13-79	22.51	2.607	58.68	59.	59.
15	2-13-79	22.51	5.307	119.45	121.	121.
46	2-13-79	22.51	7.027	158.17	160.	160.
178	3-14-79	22.27	4.690	104.45	105.	105.
186	3-14-79	22.27	3.395	75.61	76.	76.
147	3-14-79	22.27	3.490	77.72	78.	78.
153	3-14-79	22.27	4.817	107.27	108.	108.
315	4- 1-79	22.13	2.260	50.01	51.	51.
324	4- 1-79	22.13	4.028	89.15	90.	90.
346	4- 1-79	22.13	2.522	55.80	56.	56.

CATEGORY .I. X RAY COMPONENT
OF GAMMA PLUS HIGH-ENERGY X RAY

INTERVAL 2, 101 - 300 MREM

PROCESSOR NAME : NAME & NUMBER

PROCESSOR CODE NO. : OMITTED

TYPE OF DOSIMETER : FILM

NBS TECHNIQUE : HFG

IRRADIATION DISTANCE : 100 CM

OSIMETER NUMBER	DATE IRRADIATED	IRRA. RATE (MR/MIN)	IRRA. TIME (MIN)	EXPOSURE (MR)	DELIVERED DOSE EQUIVALENT SHALLOW CX=1.35 (MREM)	DEEP CX=1.35 (MREM)
54	2-20-79	62.55	1.780	111.34	150.	150.
15	2-20-79	62.55	0.950	59.42	80.	80.
46	2-20-79	62.55	1.185	74.12	100.	100.
178	3-21-79	65.60	0.480	31.49	43.	43.
186	3-21-79	65.60	2.210	144.98	196.	196.
147	3-21-79	65.60	0.420	27.55	37.	37.
153	3-21-79	65.60	0.480	31.49	43.	43.
315	4-24-79	66.13	1.400	92.58	125.	125.
324	4-24-79	66.13	0.410	27.11	37.	37.
346	4-24-79	66.13	1.590	105.15	142.	142.

INTERVAL 2. 101 - 300 MREM

PROCESSOR NAME : NAME & NUMBER
PROCESSOR CODE NO. : OMITTED
TYPE OF DOSIMETER : FILM

DOSIMETER NUMBER	TOTAL SHALLOW DOSE EQUIVALENT DELIVERED (MREM)	REPORTED (MREM)	P=(H*-H)/H	TOTAL DEEP DOSE EQUIVALENT DELIVERED (MREM)	REPORTED (MREM)	P=(H*-H)/H
54	209.	194.	-0.0718	209.	194.	-0.0718
15	201.	153.	-0.2388	201.	153.	-0.2388
46	260.	162.	-0.3769	260.	162.	-0.3769
178	148.	81.	-0.4527	148.	81.	-0.4527
186	272.	529.	0.9449	272.	529.	0.9449
147	115.	170.	0.4783	115.	170.	0.4783
153	151.	235.	0.5563	151.	235.	0.5563
315	176.	185.	0.0511	176.	185.	0.0511
324	127.	81.	-0.3622	127.	81.	-0.3622
346	198.	195.	-0.0152	198.	195.	-0.0152

P AVERAGE =	0.0513	P AVERAGE =	0.0513
S =	0.4652	S =	0.4652
H AVERAGE =	185.7	H AVERAGE =	185.7
ABS(P AVERAGE) + 2S =	0.9817	ABS(P AVERAGE) + 2S =	0.9817
L =	1.1007	L =	1.1007
********** PASS **********		********** PASS **********	

CATEGORY VI. GAMMA COMPONENT
OF GAMMA PLUS HIGH-ENERGY X RAY

INTERVAL 3. 301 - 10.000 MREM

PROCESSOR NAME : NAME & NUMBER

PROCESSOR CODE NO. : OMITTED

TYPE OF DOSIMETER : FILM

SOURCE : COBALT-60 IRRADIATOR

IRRADIATION DISTANCE : 100 CM

OSIMETER NUMBER	DATE IRRADIATED	IRRA. RATE (MR/MIN)	IRRA. TIME (MIN)	EXPOSURE (MR)	DELIVERED DOSE EQUIVALENT SHALLOW Cx=1.01 (MREM)	DEEP Cx=1.01 (MREM)
50	2- 6-79	89.37	1.625	145.23	147.	147.
16	2- 6-79	89.37	56.450	5044.93	5095.	5095.
18	2- 6-79	89.37	1.545	138.08	139.	139.
32	2- 6-79	89.37	52.450	4687.45	4734.	4734.
155	3-13-79	88.25	4.220	372.41	376.	376.
179	3-13-79	88.25	6.040	533.03	538.	538.
148	3-13-79	88.25	2.977	262.69	265.	265.
10 VOID	4- 2-79	87.65	19.650	1722.32	1740.	1740.
49 VOID	4- 2-79	87.65	1.232	107.96	109.	109.
24 VOID	4- 1-79	87.68	46.183	4049.35	4090.	4090.

CATEGORY VI, X RAY COMPONENT
OF GAMMA PLUS HIGH-ENERGY X RAY

INTERVAL 3, 301 - 10,000 MREM

PROCESSOR NAME : NAME & NUMBER OMITTED

PROCESSOR CODE NO. :

TYPE OF DOSIMETER : FILM

NBS TECHNIQUE : MFG

IRRADIATION DISTANCE : 100 CM

DOSIMETER NUMBER	DATE IRRADIATED	IRRA. RATE (MR/MIN)	IRRA. TIME (MIN)	EXPOSURE (MR)	DELIVERED DOSE EQUIVALENT SHALLOW Cx=1.28 (MREM)	DEEP Cx=1.23 (MREM)
50	2-13-79	105.20	2.695	283.51	363.	349.
16	2-14-79	877.20	1.785	1565.80	2004.	1926.
18	2-13-79	105.20	2.420	254.58	326.	313.
32	2-14-79	877.20	1.550	1359.66	1740.	1672.
155	3-19-79	102.90	1.130	116.28	149.	143.
179	3-21-79	860.30	1.230	1058.17	1354.	1302.
148	3-19-79	102.90	5.015	516.04	661.	635.
10 VOID	4-24-79	896.30	3.820	3423.87	4383.	4211.
49 VOID	4-24-79	73.27	2.780	203.69	261.	251.
24 VOID	4-24-79	896.30	1.405	1259.30	1612.	1549.

INTERVAL 3, 301 - 10,000 MREM

PROCESSOR NAME : NAME & NUMBER OMITTED

PROCESSOR CODE NO. :

TYPE OF DOSIMETER : FILM

DOSIMETER NUMBER	TOTAL SHALLOW DOSE EQUIVALENT DELIVERED (MREM)	REPORTED (MREM)	P=(H*-H)/H	TOTAL DEEP DOSE EQUIVALENT DELIVERED (MREM)	REPORTED (MREM)	P=(H*-H)/H
50	510.	500.	-0.0196	496.	485.	-0.0222
16	7099.	8000.	0.1269	7021.	7900.	0.1252
18	465.	371.	-0.2022	452.	357.	-0.2102
32	6474.	7140.	0.1029	6406.	7100.	0.1083
155	525.	418.	-0.2038	519.	418.	-0.1946
179	1892.	1472.	-0.2220	1840.	1415.	-0.2310
148	926.	705.	-0.2387	900.	675.	-0.2500
10 VOID	6123.	0.	-1.0000	5951.	0.	-1.0000
49 VOID	370.	0.	-1.0000	360.	0.	-1.0000
24 VOID	5702.	0.	-1.0000	5639.	0.	-1.0000

P AVERAGE =	-0.0938	-0.0963
S =	0.1603	0.1637
H AVERAGE =	2555.9	2519.1
ABS(P AVERAGE) + 2S =	0.4144	0.4238
L =	0.5000	0.5000
	********** PASS **********	********** PASS **********

CATEGORY VII, GAMMA COMPONENT
OF BETA PLUS GAMMA

INTERVAL 1, 200 - 300 MREM

PROCESSOR NAME : NAME & NUMBER

PROCESSOR CODE NO. : OMITTED

TYPE OF DOSIMETER : FILM

SOURCE : COBALT-60 IRRADIATOR

IRRADIATION DISTANCE : 100 CM

OSIMETER NUMBER	DATE IRRADIATED	IRRA. RATE (MR/MIN)	IRRA. TIME (MIN)	EXPOSURE (MR)	DELIVERED DOSE EQUIVALENT SHALLOW CX=1.01 (MREM)	DEEP CX=1.01 (MREM)
31	2- 6-79	89.37	0.813	72.61	73.	73.
17	2- 6-79	89.37	1.920	171.59	173.	173.
48	2- 6-79	89.37	0.692	61.81	62.	62.
181	3-10-79	88.35	2.257	199.38	201.	201.
150	3-10-79	88.35	0.828	73.18	74.	74.
165	3-10-79	88.35	2.155	190.39	192.	192.
146	3-10-79	88.35	2.030	179.35	181.	181.
347	4- 1-79	87.65	0.703	61.65	62.	62.
309	4- 1-79	87.65	0.822	72.02	73.	73.
320	4- 1-79	87.65	2.110	184.94	187.	187.

CATEGORY VII, BETA COMPONENT
OF BETA PLUS GAMMA

INTERVAL 1, 200 - 300 MREM

PROCESSOR NAME : NAME & NUMBER OMITTED

PROCESSOR CODE NO. :

TYPE OF DOSIMETER : FILM

SOURCE : STRONTIUM-90

IRRADIATION DISTANCE : 35 CM

DOSIMETER NUMBER	DATE IRRADIATED	IRRA. RATE (MRAD/MIN)	IRRA. TIME (MIN)	ABS. DOSE (MRAD)	DELIVERED DOSE EQUIVALENT SHALLOW CX=.9665 (MREM)	DEEP CX=0.00 (MREM)
31	2-26-79	152.30	1.180	179.71	174.	0.
17	2-26-79	152.30	0.420	63.97	62.	0.
48	2-26-79	152.30	1.010	153.82	149.	0.
181	3-13-79	152.00	0.530	80.56	78.	0.
150	3-13-79	152.00	1.200	182.40	176.	0.
165	3-13-79	152.00	0.510	77.52	75.	0.
146	3-13-79	152.00	0.470	71.44	69.	0.
347	4-16-79	151.60	1.030	156.15	151.	0.
309	4-16-79	151.60	1.120	169.79	164.	0.
320	4-16-79	151.60	0.490	74.28	72.	0.

INTERVAL 1, 200 - 300 MREM

PROCESSOR NAME : NAME & NUMBER
PROCESSOR CODE NO. : OMITTED
TYPE OF DOSIMETER : FILM

DOSIMETER NUMBER	TOTAL SHALLOW DOSE EQUIVALENT DELIVERED (MREM)	REPORTED (MREM)	P=(H*-H)/H	TOTAL DEEP DOSE EQUIVALENT DELIVERED (MREM)	REPORTED (MREM)	P=(H*-H)/H
31	247.	282.	0.1417	73.	92.	0.2603
17	235.	240.	0.0213	173.	240.	0.3873
48	211.	241.	0.1422	62.	84.	0.3548
181	279.	310.	0.1111	201.	210.	0.0448
150	250.	263.	0.0520	74.	70.	-0.0541
165	267.	372.	0.3933	192.	197.	0.0260
146	250.	350.	0.4000	181.	230.	0.2707
347	213.	250.	0.1737	62.	80.	0.2903
309	237.	275.	0.1603	73.	95.	0.3014
320	259.	365.	0.4093	187.	190.	0.0160

P AVERAGE =	0.2005	P AVERAGE =	0.1898
S =	0.1460	S =	0.1626
H AVERAGE =	244.8	H AVERAGE =	127.8
ABS(P AVERAGE) + 2S =	0.4925	ABS(P AVERAGE) + 2S =	0.5149
L =	0.9587	L =	1.3269
********** PASS **********		********** PASS **********	

CATEGORY VII, GAMMA COMPONENT
OF BETA PLUS GAMMA

INTERVAL 2, 301 - 10,000 MREM

PROCESSOR NAME : NAME & NUMBER

PROCESSOR CODE NO. : OMITTED

TYPE OF DOSIMETER : FILM

SOURCE : COBALT-60 IRRADIATOR

IRRADIATION DISTANCE : 100 CM

DOSIMETER NUMBER	DATE IRRADIATED	IRRA. RATE (MR/MIN)	IRRA. TIME (MIN)	EXPOSURE (MR)	DELIVERED DOSE EQUIVALENT SHALLOW (Cx=1.01 MREM)	DEEP Cx=1.01 (MREM)
47	2- 6-79	89.37	17.267	1543.12	1559.	1559.
20	2- 6-79	89.37	1.658	148.21	150.	150.
49	2- 6-79	89.37	15.588	1393.13	1407.	1407.
185	3-13-79	88.25	3.137	276.81	280.	280.
184	3-13-79	88.25	18.800	1659.10	1676.	1676.
164	3-13-79	88.25	6.770	597.45	603.	603.
344	4- 1-79	87.65	16.555	1451.04	1466.	1466.
358	4- 1-79	87.65	1.673	146.67	148.	148.
312	4- 1-79	87.65	11.177	979.63	989.	989.
333	4- 1-79	87.65	2.838	248.78	251.	251.

CATEGORY VII. BETA COMPONENT
OF BETA PLUS GAMMA

INTERVAL 2, 301 - 10,000 MREM

PROCESSOR NAME : NAME & NUMBER OMITTED

PROCESSOR CODE NO. :

TYPE OF DOSIMETER : FILM

SOURCE : STRONTIUM-90

IRRADIATION DISTANCE : 35 CM

DOSIMETER NUMBER	DATE IRRADIATED	IRRA. RATE (MRAD/MIN)	IRRA. TIME (MIN)	ABS. DOSE (MRAD)	DELIVERED DOSE EQUIVALENT SHALLOW CX=.9665 (MREM)	DEEP CX=0.00 (MREM)
47	2-24-79	152.30	25.530	3888.22	3758.	0.
20	2-24-79	152.30	2.440	371.61	359.	0.
49	2-24-79	152.30	3.630	552.85	534.	0.
185	3-14-79	152.00	0.750	114.00	110.	0.
184	3-14-79	152.00	27.770	4221.04	4080.	0.
164	3-14-79	152.00	1.580	240.16	232.	0.
344	4- 2-79	151.60	3.880	588.21	569.	0.
358	4- 2-79	151.60	2.510	380.52	368.	0.
312	4- 2-79	151.60	16.660	2525.66	2441.	0.
333	4- 2-79	151.60	0.680	103.09	100.	0.

INTERVAL 2. 301 - 10,000 MREM

PROCESSOR NAME : NAME & NUMBER OMITTED

PROCESSOR CODE NO. :

TYPE OF DOSIMETER : FILM

DOSIMETER NUMBER	TOTAL SHALLOW DOSE EQUIVALENT DELIVERED (MREM)	REPORTED (MREM)	P=(H*-H)/H	TOTAL DEEP DOSE EQUIVALENT DELIVERED (MREM)	REPORTED (MREM)	P=(H*-H)/H
47	5317.	3270.	-0.3850	1559.	2220.	0.4240
20	509.	530.	0.0413	150.	258.	0.7200
49	1941.	1900.	-0.0211	1407.	1700.	0.2082
185	390.	428.	0.0974	280.	318.	0.1357
184	5756.	3350.	-0.4180	1676.	2000.	0.1933
164	835.	680.	-0.1856	603.	680.	0.1277
344	2035.	1980.	-0.0270	1466.	1700.	0.1596
358	516.	595.	0.1531	148.	165.	0.1149
312	3430.	2300.	-0.3294	989.	1300.	0.3145
333	351.	415.	0.1823	251.	295.	0.1753

P AVERAGE =	-0.0892	P AVERAGE =	0.2573
S =	0.2249	S =	0.1885
H AVERAGE =	2108.0	H AVERAGE =	852.9
ABS(P AVERAGE) + 2S =	0.5391	ABS(P AVERAGE) + 2S =	0.6343
L =	0.5000	L =	0.5136
********** FAIL **********		********** FAIL **********	

CATEGORY VIII, GAMMA COMPONENT
OF NEUTRON PLUS GAMMA

INTERVAL 1, 150 - 300 MREM

PROCESSOR NAME : NAME & NUMBER OMITTED

PROCESSOR CODE NO. :

TYPE OF DOSIMETER : FILM

SOURCE : COBALT-60 IRRADIATOR

IRRADIATION DISTANCE : 100 CM

NOTE : DELIVERED DOSE EQUIVALENT INCLUDES A GAMMA-RAY CONTRIBUTION FROM THE CF-252 SOURCE EQUAL TO 7.033 PERCENT OF THE NEUTRON DOSE EQUIVALENT

DOSIMETER NUMBER	DATE IRRADIATED	IRRA. RATE (MR/MIN)	IRRA. TIME (MIN)	EXPOSURE (MR)	DELIVERED DOSE EQUIVALENT SHALLOW Cx=1.01 (MREM)	DELIVERED DOSE EQUIVALENT DEEP Cx=1.01 (MREM)
66	2- 6-79	89.37	0.708	63.30	75.	75.
68 VOID	2- 6-79	89.37	1.370	122.44	124.	124.
71	2- 6-79	89.37	0.922	82.37	98.	98.
209	3-10-79	88.35	1.887	166.69	173.	173.
204	3-10-79	88.35	0.718	63.46	75.	75.
197	3-10-79	88.35	1.332	117.65	122.	122.
201	3-10-79	88.35	0.882	77.90	92.	92.
375	4-10-79	87.37	1.577	137.75	143.	143.
371	4-10-79	87.37	0.612	53.44	64.	64.
362	4-10-79	87.37	1.985	173.43	180.	180.

CATEGORY VIII, NEUTRON COMPONENT
OF NEUTRON PLUS GAMMA

INTERVAL 1, 150 - 300 MREM

PROCESSOR NAME : NAME & NUMBER OMITTED

PROCESSOR CODE NO. :

TYPE OF DOSIMETER : FILM

SOURCE : CALIFORNIUM-252

IRRADIATION DISTANCE : SHOWN BELOW

NOTE : DELIVERED DOSE EQUIVALENT INCLUDES THE ROOM RETURN (SCATTER) CORRECTION FACTOR SHOWN BELOW

DOSIMETER NUMBER	DATE IRRADIATED	DOSE EQ. RATE (MREM/MIN)	IRRA. TIME (MIN)	IRRA. DIST. (CM)	SCATTER C.F.	DELIVERED DOSE EQUIVALENT SHALLOW (MREM)	DEEP (MREM)
66	2-23-79	78.34	2.000	50	1.015	159.	159.
68 VOID	0- 0- 0	0.0	0.0	0	1.015	0.	0.
71	2-25-79	78.22	2.613	50	1.015	207.	207.
209	3-22-79	19.25	3.482	100	1.060	71.	71.
204	3-22-79	76.83	2.070	50	1.015	161.	161.
197	3-22-79	19.25	2.443	100	1.060	50.	50.
201	3-22-79	76.83	2.536	50	1.015	198.	198.
375	4-26-79	18.73	2.930	100	1.060	58.	58.
371	4-26-79	74.93	1.810	50	1.015	138.	138.
362	4-26-79	18.73	3.739	100	1.060	74.	74.

INTERVAL 1. 150 - 300 MREM

PROCESSOR NAME : NAME & NUMBER OMITTED

PROCESSOR CODE NO. :

TYPE OF DOSIMETER : FILM

DOSIMETER NUMBER	TOTAL DEEP DOSE EQUIVALENT DELIVERED (MREM)	REPORTED (MREM)	P=(H*-H)/H
66	234.	300.	0.2821
68 VOID	124.	0.	-1.0000
71	305.	349.	0.1443
209	244.	255.	0.0451
204	236.	344.	0.4576
197	172.	225.	0.3081
201	290.	385.	0.3276
375	201.	210.	0.0448
371	202.	284.	0.4059
362	254.	263.	0.0354

P AVERAGE = 0.2279

S = 0.1639

H AVERAGE = 237.6

ABS(P AVERAGE) + 2S = 0.5556

L = 0.9732

********** PASS **********

CATEGORY VIII. GAMMA COMPONENT
OF NEUTRON PLUS GAMMA

INTERVAL 2.301 - 5.000 MREM

PROCESSOR NAME : NAME & NUMBER
OMITTED

PROCESSOR CODE NO. :

TYPE OF DOSIMETER : FILM

SOURCE : COBALT-60 IRRADIATOR

IRRADIATION DISTANCE : 100 CM

NOTE : DELIVERED DOSE EQUIVALENT INCLUDES A GAMMA-RAY CONTRIBUTION FROM THE CF-252 SOURCE EQUAL TO 7.033 PERCENT OF THE NEUTRON DOSE EQUIVALENT

DOSIMETER NUMBER	DATE IRRADIATED	IRRA. RATE (MR/MIN)	IRRA. TIME (MIN)	EXPOSURE (MR)	DELIVERED DOSE EQUIVALENT SHALLOW CX=1.01 (MREM)	DEEP CX=1.01 (MREM)
67	2- 8-79	89.31	15.092	1347.84	1589.	1589.
73	2- 8-79	89.31	2.512	224.32	266.	266.
69	2- 8-79	89.31	27.550	2460.49	2554.	2554.
200	3-12-79	88.28	7.138	630.17	654.	654.
202	3-12-79	88.28	12.955	1143.67	1360.	1360.
206	3-12-79	88.28	1.102	97.26	114.	114.
210	3-12-79	88.28	12.325	1088.05	1294.	1294.
364	4- 9-79	87.40	3.403	297.45	309.	309.
372	4- 9-79	87.40	13.173	1151.35	1213.	1213.
367	4- 9-79	87.40	2.707	236.56	284.	284.

CATEGORY VIII, NEUTRON COMPONENT OF NEUTRON PLUS GAMMA

INTERVAL 2. 301 - 5,000 MREM

PROCESSOR NAME : NAME & NUMBER

PROCESSOR CODE NO. : OMITTED

TYPE OF DOSIMETER : FILM

SOURCE : CALIFORNIUM-252

IRRADIATION DISTANCE : SHOWN BELOW

NOTE : DELIVERED DOSE EQUIVALENT INCLUDES THE ROOM RETURN (SCATTER) CORRECTION FACTOR SHOWN BELOW

DOSIMETER NUMBER	DATE IRRADIATED	DOSE EQ. RATE (MREM/MIN)	IRRA. TIME (MIN)	IRRA. DIST. (CM)	SCATTER C.F.	DELIVERED DOSE EQUIVALENT SHALLOW (MREM)	DEEP (MREM)
67	2-24-79	78.28	41.380	50	1.015	3288.	3288.
73	2-24-79	78.28	7.150	50	1.015	568.	568.
69	2-24-79	78.28	12.550	50	1.015	997.	997.
200	3-27-79	76.56	3.320	50	1.015	258.	258.
202	3-27-79	76.56	37.980	50	1.015	2951.	2951.
206	3-27-79	76.56	2.910	50	1.015	226.	226.
210	3-27-79	76.56	36.150	50	1.015	2809.	2809.
364	4-19-79	75.36	1.601	50	1.015	122.	122.
372	4-19-79	75.36	9.485	50	1.015	726.	726.
367	4-19-79	75.36	8.485	50	1.015	649.	649.

INTERVAL 2, 301 - 5,000 MREM

PROCESSOR NAME : NAME & NUMBER

PROCESSOR CODE NO. : OMITTED

TYPE OF DOSIMETER : FILM

DOSIMETER NUMBER	TOTAL DEEP DOSE EQUIVALENT DELIVERED (MREM)	REPORTED (MREM)	P=(H*-H)/H
67	4877.	3186.	-0.3467
73	834.	970.	0.1631
69	3551.	4210.	0.1856
200	912.	990.	0.0855
202	4311.	4465.	0.0357
206	340.	475.	0.3971
210	4103.	4460.	0.0870
364	431.	469.	0.0882
372	1939.	2180.	0.1243
367	933.	1035.	0.1093

P AVERAGE = 0.0929

S = 0.1838

H AVERAGE = 2223.1

ABS(P AVERAGE) + 2S = 0.4604

L = 0.5000

********** PASS **********

********** SUMMARY OF RESULTS **********

PROCESSOR NAME : NAME & NUMBER

PROCESSOR CODE NO. : OMITTED

TYPE OF DOSIMETER : FILM

CATEGORY I,	GAMMA	: FAIL
CATEGORY II,	HIGH-ENERGY X RAY	: FAIL
CATEGORY III,	LOW-ENERGY X RAY	: FAIL
CATEGORY IV,	BETA	: FAIL
CATEGORY V,	NEUTRON	: FAIL
CATEGORY VI,	GAMMA PLUS HIGH-ENERGY X RAY	: PASS
CATEGORY VII,	GAMMA PLUS BETA	: FAIL
CATEGORY VIII,	GAMMA PLUS NEUTRON	: PASS