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PRE-DECONTAMINATION GAMMA-RAY SURFACE SCANS IN TMI-2 CONTAINMENT BUILDING 305' ELEVATION

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Section 1

SUMMARY

On December 16, 1981 entry was made into the TMI-2 containment building to perform gamma-ray scans on surfaces of the 305' level. Five areas were selected for these measurements: two of them were of surfaces of walls, two were of floor surfaces under the reactor core flood tanks, and the remaining was of a floor surface in an area that had been receiving a great deal of personnel traffic. The results showed contamination levels of less than 1 $\mu Ci/cm^2$ for all of the surfaces, considerably less than was observed at the locations of previous scans. Two of the areas showed no net activity and minimum detectable limits are listed that are less than 0.3 $\mu Ci/cm^2$.

Section 2

MEASUREMENT TECHNIQUES AND DETECTOR CALIBRATION

The SAI collimated gamma-ray spectrometer ("gamma-ray camera") that was used in the measurements was designed specifically for scanning reactor piping and components to determine quantitatively the activity concentrations in these items. It is used with a method of analysis and calibration that was also developed (1,2) by SAI for use with sources of abnormal or extended geometry. This or similar collimators have been used (3-12) in previous scans of reactor system components.

A sketch of the collimated detector assembly is shown in Figure 1. Removable stepped plugs can be inserted into the open end of the collimator. Plugs used in the present measurements consist of one having a 1-cm diameter hole and a solid plug used for "background measurements". Figure 2 shows a cross-sectional view of the shielding. The assembly can be rotated to point at any angle from 0° to 180° with respect to a perpendicular to the floor. The frame is mounted on eight-inch wheels for easy movement. An 8% efficient (relative to 3"x3" NaI(Tl)) hyperpure germanium detector was used in the assembly. The nitrogen retention time of the detector dewar is about eight hours. The detector preamplifier is a portion of the detector assembly. The detector bias supply, amplifier, and system low-voltage power supply are mounted on the collimator cart. Multichannel analyzer (MCA) and input-output devices (printer and magnetic tape unit) are placed separately from the cart; and as much as 500 feet of signal cable can connect the MCA with the amplifier.

Calibration of the detector-collimator system used the techniques discussed in References 1 and 2. A certified mixed-isotope point-source standard was used to measure both on-axis and off-axis detector response. Energies and intensities of the gamma-rays emitted by this standard are listed in Table 1. Measurements were made at several distances along the symmetry axis of the detector and at several distances off axis at a fixed distance along the detector. The values of these distances are given in Table 2.

Figure 1

ISOMETRIC SKETCH OF DETECTOR COLLIMATOR ASSEMBLY
Not shown in the sketch are the 8" diameter wheels.

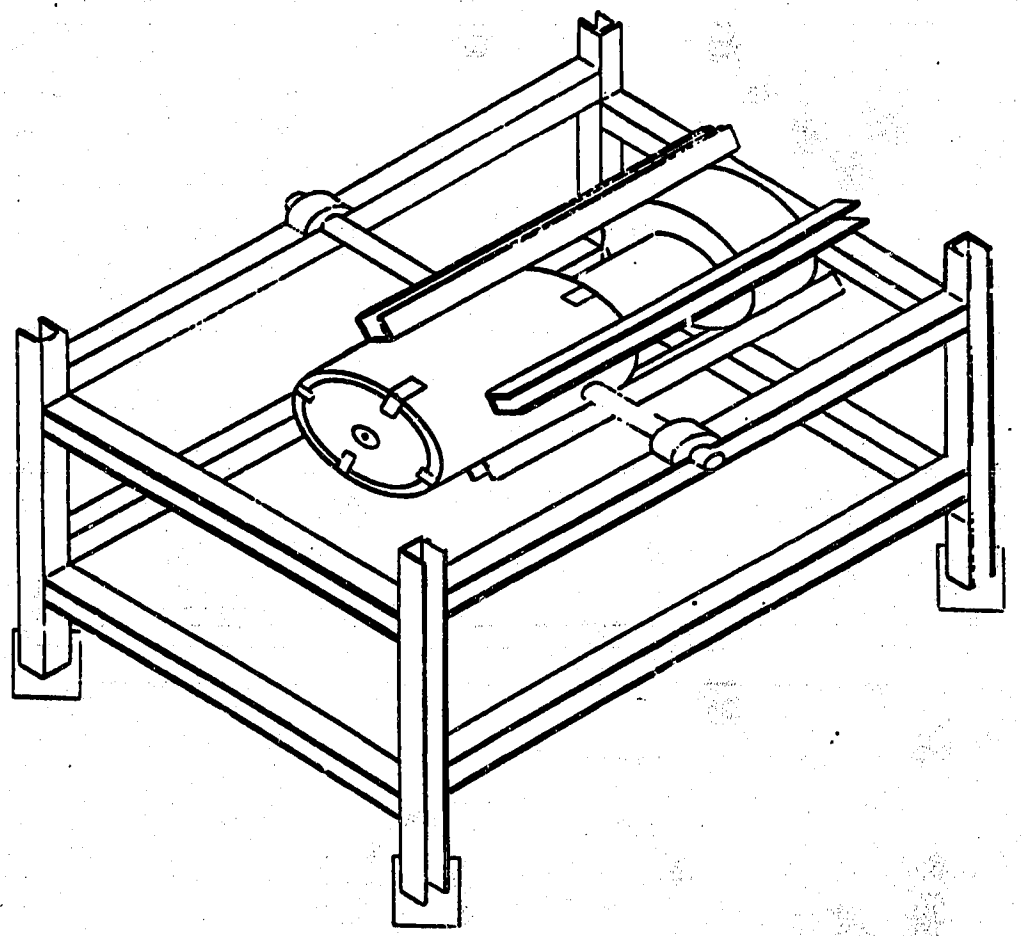


Figure 2

SKETCH OF COLLIMATOR SHIELDING

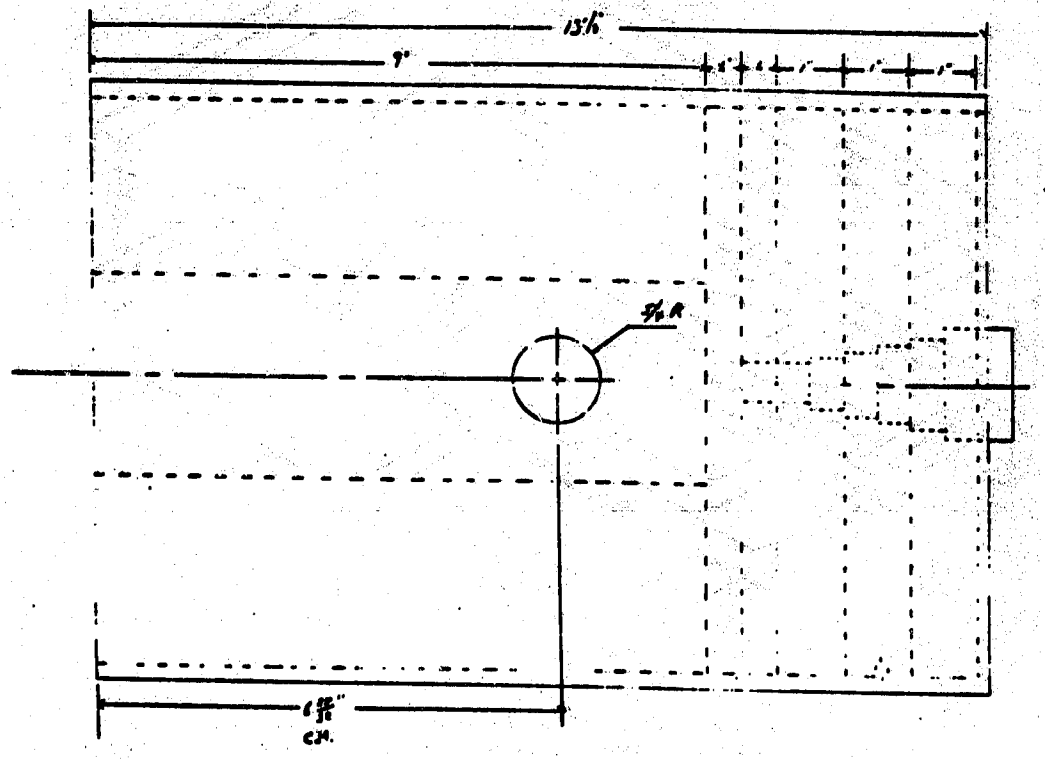


Table 1

GAMMA-RAY ENERGIES AND SOURCE INTENSITIES
FOR DETECTOR CALIBRATION STANDARD

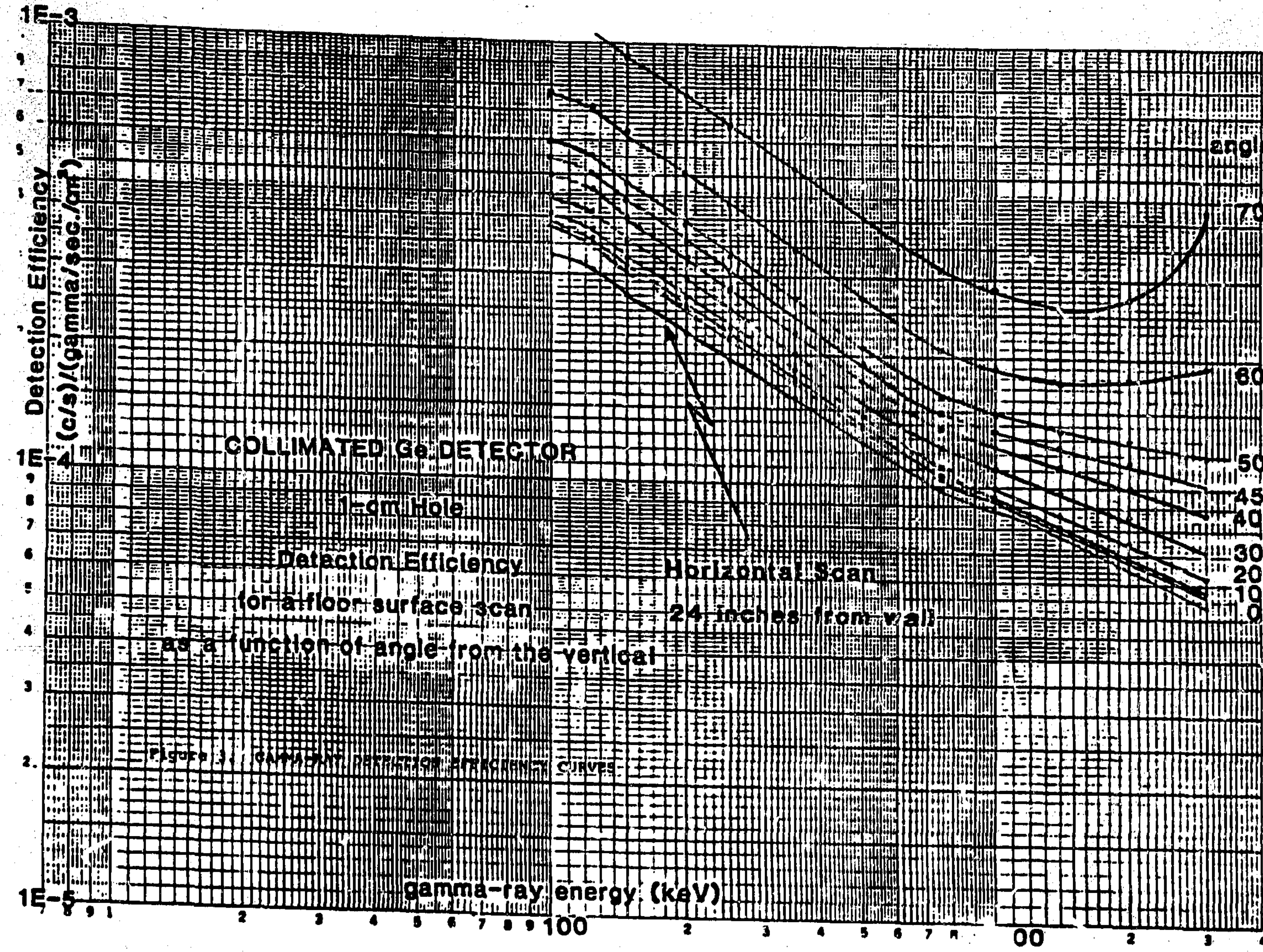
Gamma-Ray Energy (keV)	Intensity Gamma-Rays per Second
88	1345
122	1034
166	1001
279	2453
392	2919
514	5146
662	7817
898	8597
1173	9547
1332	9559
1836	9165

Table 2

ON-AXIS AND OFF-AXIS DISTANCES AT WHICH CALIBRATION MEASUREMENTS WERE MADE

Distance Along Detector Symmetry Axis (cm)	Distance Off Detector Symmetry Axis (cm)
12.76	0
"	0.1
"	0.2
"	0.3
"	0.4
"	0.6
"	0.7
"	0.8
"	1.0
17.26	0
22.76	0
30.96	0

Distances along the detector symmetry axis are measured from the cap of the detector cryostat. The distance of 12.76-cm is the distance to the outside of the collimator. Since the diameter of the hole in the collimator is 1-cm, it can be seen that measurements were made that extended to two diameters of the collimator hole. Data from the calibration measurements were fit to obtain the values for the parameters describing the detector response (as in the detector model of Reference 2). These values were then used to calculate detection efficiencies. Figure 3 shows the calculated detection efficiencies for the configuration as a function of collimator angle and of gamma-ray energy.


COLLIMATED Ge DETECTOR
1-cm Hole
Detection Efficiency
for a floor surface scan
as a function of angle from the vertical
Horizontal Scan
24 inches from wall
Detection Efficiency (c/s)/(gamma/sec./cm²)
gamma-ray energy (keV)
angle
70
60
50
45
40
30
20
10
0
1E-3
1E-4
1E-5
100

Section 3

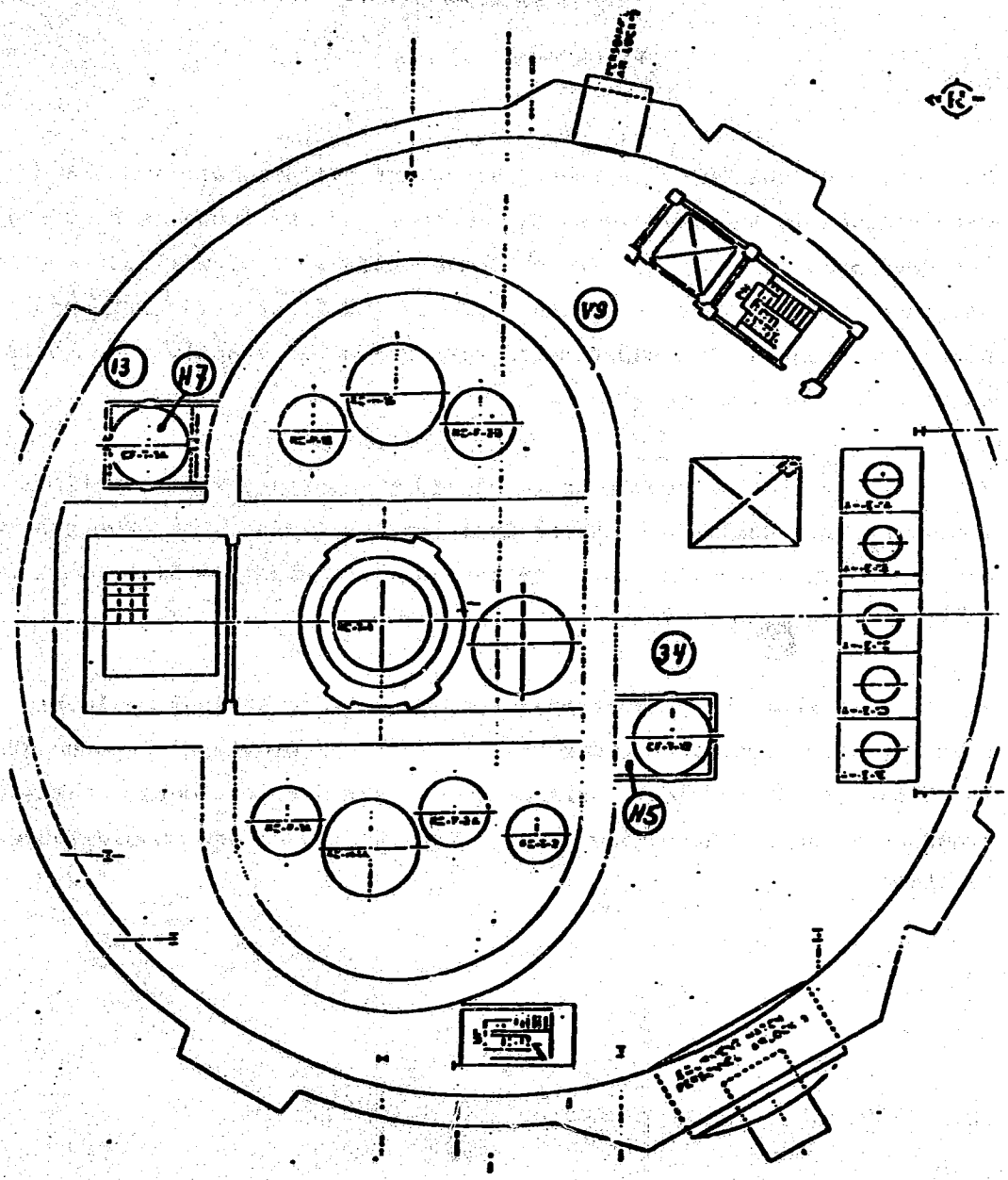
MEASUREMENTS AND RESULTS

Five areas of the TMI-2 reactor containment building elevation 305' were scanned in the measurements. These areas are shown in Figure 4 and described in Table 3. Two of these areas were of wall surfaces and three were of floor surfaces. Two of the floor areas were under core-flood tanks. The experiments were conducted exactly as discussed in Reference 10.

Table 4 shows the net counting rates and the surface contaminations resulting from analyses of these data for the five areas. The results are for ^{137}Cs contamination. The analysis technique is also identical to that of Reference 10.

The results from the present measurements show contamination levels substantially lower than those seen[10,11] in our previous measurements. The areas are of vertical surfaces which were not previously scanned, floor areas under tanks, and a floor area that had seen considerable traffic.

FLOOR PLAN OF TMI-2 REACTOR BUILDING 305' ELEVATION
SHOWING MEASUREMENT LOCATIONS



PLAN EL. 305'-0"

Figure 4

Table 3

LISTING OF AREAS OF TMI-2 CONTAINMENT, ELEVATION 305' FOR WHICH MEASUREMENTS WERE MADE BY GAMMA-RAY SCANNING OF THE SURFACE CONTAMINATION IN THE ENTRY OF DECEMBER 16, 1981

Area Designation	Description of Area
13	Area of containment wall, approximately two feet above the floor. Northeast corner near "A" core-flood-tank.
H7	Floor area under core-flood-tank "A".
V9	Surface of "D-ring" wall near #2 stairwell.
34	Area of floor near "B" core-flood-tank and six feet out from edge of "D-ring".
H7	Floor area under core-flood-tank "B".

Table 4

NET ^{137}Cs COUNTING RATES AND SURFACE CONTAMINATION LEVELS FOR THE FIVE SCANS OF THE ENTRY OF DECEMBER 16, 1981

Area Designation	Net ^{137}Cs Counting Rate (c/s)	^{137}Cs Surface Contamination ($\mu Ci/cm^2$)
13	<0.6	<0.2
H7	4.5±0.5	0.96±0.10
V9	1.7±0.9	0.5±0.3
34	4.1±0.8	0.9±0.2
H5	<1.5	<0.3

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