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RECIP.NAME RECIPIENT AFFILIATION
EISENHUT,D.G. Division of Licensing

SUBJECT: Forwards bases for using containment high range radiation monitor to estimate offsite doses during emergency,in response to Div of Emergency Preparedness request.

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FLORIDA POWER & LIGHT COMPANY

August 10, 1982
L-82-344

Office of Nuclear Reactor Regulation
Attention: Mr. Darrell G. Eisenhut, Director
Division of Licensing
U. S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Mr. Eisenhut:

Re: St. Lucie Units 1 and 2
Docket Nos. 50-335 and 50-389
Offsite Dose Calculations

The Division of Emergency Preparedness has requested Florida Power and Light Company to provide supplemental information to the St. Lucie Plant Radiological Emergency Plan. The bases for using the Containment High Range Radiation Monitor (CHRRM) to estimate offsite doses, during an emergency, is enclosed.

These bases address the Unit 1 CHRRM's and this design is directly applicable to Unit 2 (Unit 2 uses the identical monitors as Unit 1).

Please contact this office if any further information regarding these bases is required.

Very truly yours,

Jack E. Vasey for

Robert E. Uhrig
Vice President
Advanced Systems & Technology

REU/JJM/cab

Attachments

cc: Harold F. Reis, Esquire
Brian K. Grimes, DEP
J. P. O'Reilly, Region II

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PDR ADOCK 05000335
F PDR

ATTACHMENT

Re: St. Lucie Units 1 & 2
Docket Nos. 50-335 and 50-389
OFFSITE DOSE CALCULATIONS

BASES FOR USING THE CONTAINMENT HIGH RANGE RADIATION MONITOR TO ESTIMATE OFFSITE DOSES.

To compute the dose rate at the detector location, the containment was modeled as an air filled cylinder of 2.5×10^6 cubic feet volume. The cylinder was 70' in radius and 162' high. The detector (dose point) was placed 72' from one end to correspond to the actual detector location. The dose point was placed 2 cm outside the cylinder because the code does not allow the dose point inside the source volume. The radioactive isotopes were assumed to be uniformally distributed within the free volume.

All photons below 0.06 MEV and all beta radiation were neglected. The detector has an internal check source that produces a constant 1 R/hr reading. Thus 1 R/hr was added to all calculated dose rates. The monitor has a readout in the control room in units of R/hr.

Calculated dose rates for the various accident conditions are shown in the attached Table 1 and Figure 1.

The concentration/dose rate conversion factor ((uCi/cc)/(R/HR) = (Ci/M^3)/(R/HR)) was obtained by dividing the total radionuclide inventories by the containment free volume and the corresponding monitor reading. The resultant conversion factors are presented in attached Table 2 and Figure 2. The rapid drop-off in the conversion factor for coolant activity is due to the constant reading from the check source.

In addition to the releases considered above, containment monitor readings and conversion factors were calculated for containment activities corresponding to the example initiating condition No. 13.a, for Site Area Emergency, and initiating condition No. 1.a, for General Emergency, in Appendix 1 to NUREG-0654/FEMA-REP-1, Revision 1, November 1980. These readings can be used for emergency classification. The source term was assumed to consist of a gas gap mix of noble gases corresponding to, respectively, 50 MR/HR, 500 MR/HR and 1 R/HR whole body at the site boundary given containment design basis leakage of 0.5% day and 5%-ile atmospheric dilution factor (EAB) of 1.80×10^{-4} sec/m^3. The results, which were obtained by the dose-calculational methodology described in FSAR Section 15.4, are presented in Table 3.

For actual leakage rate and meteorological conditions, the corresponding monitor readings can be determined from the following equation:

$$R = R_o \frac{L_o}{L} \frac{X/Q_o}{X/Q}$$

where R = Monitor Reading (R/HR)

R_o = Monitor Reading in Table 2 (R/HR)

L = Actual Containment Leak Rate (%/Day)

L_o = Design Basis Containment Leak Rate (0.5%/Day)

X/Q_o = 5%-ile EAB X/Q (1.80×10^{-4} sec/m^3)

X/Q = Actual EAB X/Q (sec/m^3)

The actual containment leak rate can be estimated from the containment pressure.

St. Lucie Unit 1 has two high range containment monitors. The detectors are located inside the containment and are mounted on the primary containment structure at elevation 90'. The two detectors are located 180° apart and they view the bulk of the containment free volume.

The detector is ionization type manufactured by General Atomic of San Diego, California, and is identified as model RD23. These detectors are capable of detecting photons with an energy range of 80 KEV to 3 MEV with an energy response of ± 20%. The detector is sensitive to 60 KEV photons but with an energy response of approximately - 40%. Response falls off rapidly for photons below this energy. The detector is relatively insensitive to beta particles because of its steel jacket.

The response of the detector was considered for the following releases into the containment:

1. 100% Coolant Activity (CA)

2. 100% Gas Gap (GG)

3. 100% CA + 100% GG + 1% Core Inventory

4. 100% CA + 100% GG + 10% Core Inventory

Isotopic inventories as a function of time were calculated based on initial inventories given in the St. Lucie 1 FSAR. The coolant inventory was obtained by multiplying the design basis concentrations in Table 11.1-1 by the primary coolant volume given in Table 11.1-2. The gas gap and core inventory were taken from Table 15.4.1-1.

In addition to radiological decay, credit was taken for iodine scrubbing by containment sprays according to the model in FSAR Section 15.4. This reflects the judgement that, given release into the containment, the sprays are likely to operate. Without credit for spray operation, use of containment monitor reading would result in a slight underestimate of the activity initially released into the containment and, thus, the degree of core damage. However, since the noble gases are not affected by sprays, this effect would not be significant.

The isotopic sources were converted to photon source strength for 20 different energy groups by the code GROUP. This code is an Ebasco program that generates multigroup photon source strengths based on photon energies and probabilities of each isotope. These multigroup sources are inputed into the code DEVISOSHLD which computes the dose rate at the detector location. DEVISOSHLD is an Ebasco moidifed version of the RSIC code ISOSHLD[1/]. This code is a point kernal integration code that utilizes buildup factors and mass attenuation coefficients for various standard geometries.

1/ ISOSHLD, Code Package CCC-79, Radiation Shielding Information Center, Oak Ridge National Laboratories, Oak Ridge, Tn.

ST. LUCIE 1

HIGH RANGE CONTAINMENT MONITOR

Expected Monitor Reading (R/HR) and Conversion Factor ((uCi/cc)/(R/HR)) for

1. 100% Coolant Activity (CA)
2. 100% Gas Gap (GG)
3. 100% CA + 100% GG + 1% Core Inventory
4. 100% CA + 100% GG + 10% Core Inventory

TABLE 1

CONTAINMENT HIGH RANGE RADIATION MONITOR

ACCIDENT CASE	MONITOR READING (R/HR)*					
	0 HR	2 HR	8 HR	1 DAY	4 DAYS	30 DAYS
100% Coolant Activity (CA)	1.16E1**	4.96	3.48	2.52	1.84	1.03
100% Gas Gap (GG)	4.28E4	5.42E3	3.20E3	1.72E3	7.46E2	4.54E1
100% CA + 100% GG + 1% Core	6.32E4	8.31E3	4.42E3	2.19E3	8.98E2	4.94E1
100% CA + 100% GG + 10% Core	2.47E5	3.43E4	1.54E4	6.39E3	2.27E3	9.42E1

*Includes check source reading of 1R/HR

**Read as 1.16×10^1

TABLE 2

CONTAINMENT HIGH RANGE RADIATION MONITOR

Conversion Factor (uCi/cc per R/HR)

ACCIDENT CASE	0 HR	2 HR	8 HR	1 DAY	4 DAYS	30 DAYS
100% Coolant Activity (CA)	7.00E-2*	1.49E-1	2.01E-1	2.48E-1	2.26E-1	1.63E-2
100% Gas Gap (GG)	1.35E-2	4.20E-2	6.09E-2	9.12E-2	1.28E-1	1.35E-1
100% CA + 100% GG + 1% Core	1.20E-2	3.44E-2	5.30E-2	8.34E-2	1.22E-1	1.36E-1
100% CA + 100% GG + 10% Core	9.67E-3	2.34E-2	3.79E-2	6.42E-2	1.04E-1	1.24E-1

*Read as 7.00×10^{-2}

TABLE 3

CONTAINMENT HIGH RANGE RADIATION MONITOR

MONITOR READING FOR EMERGENCY CLASSIFICATION

ACCIDENT CASE*	R/HR
50 MR/HR Offsite	7.34E3**
500 MR/HR Offsite	7.34E4
1R/HR Offsite	1.47E5

*Whole body dose rate at EAB given a 5%-ile, 2 HR, dilution factor of 1.80×10^{-4} sec/m^3 and design basis containment leak rate of 0.5% per day.

**Read as 7.34×10^3

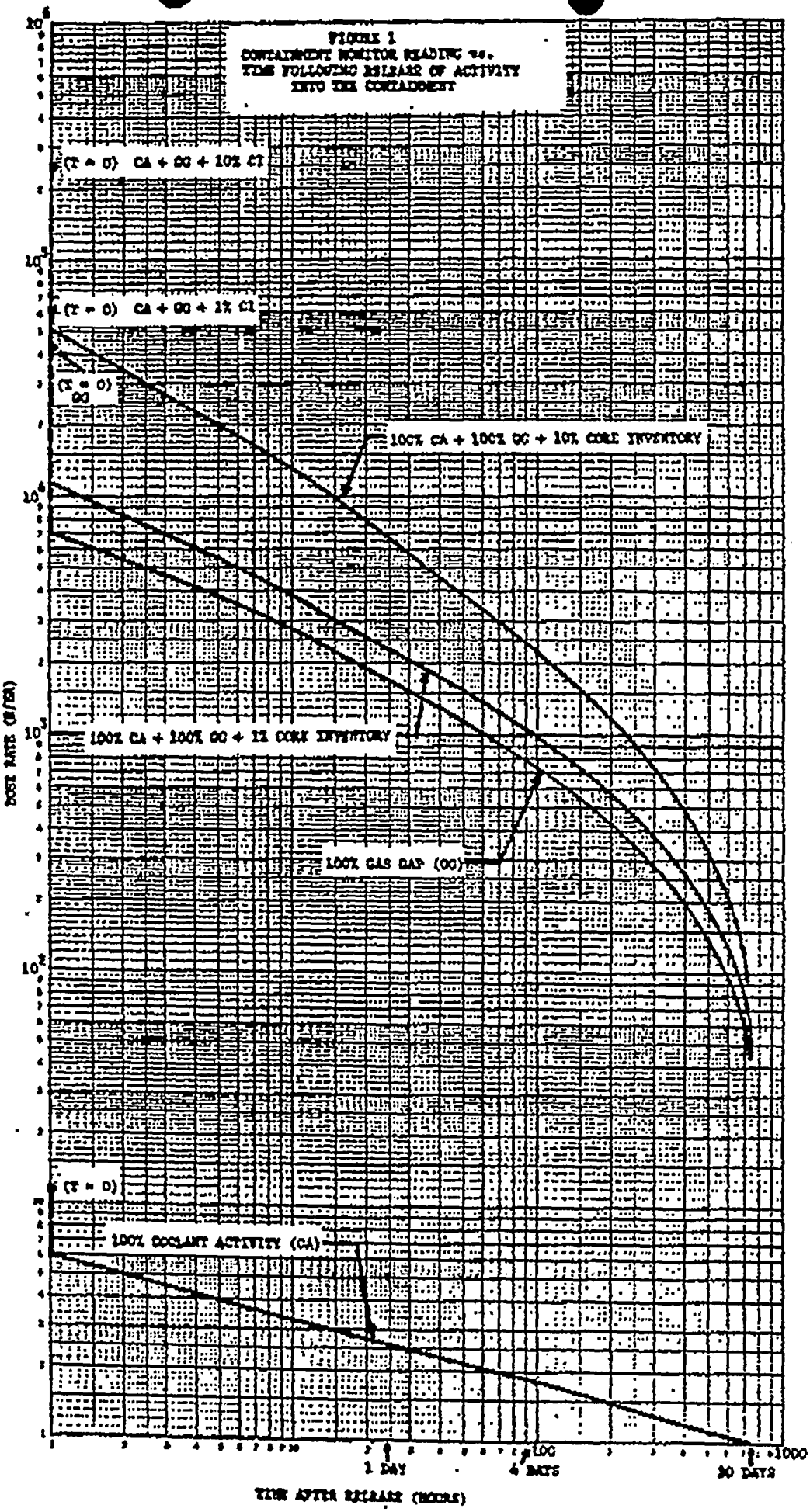
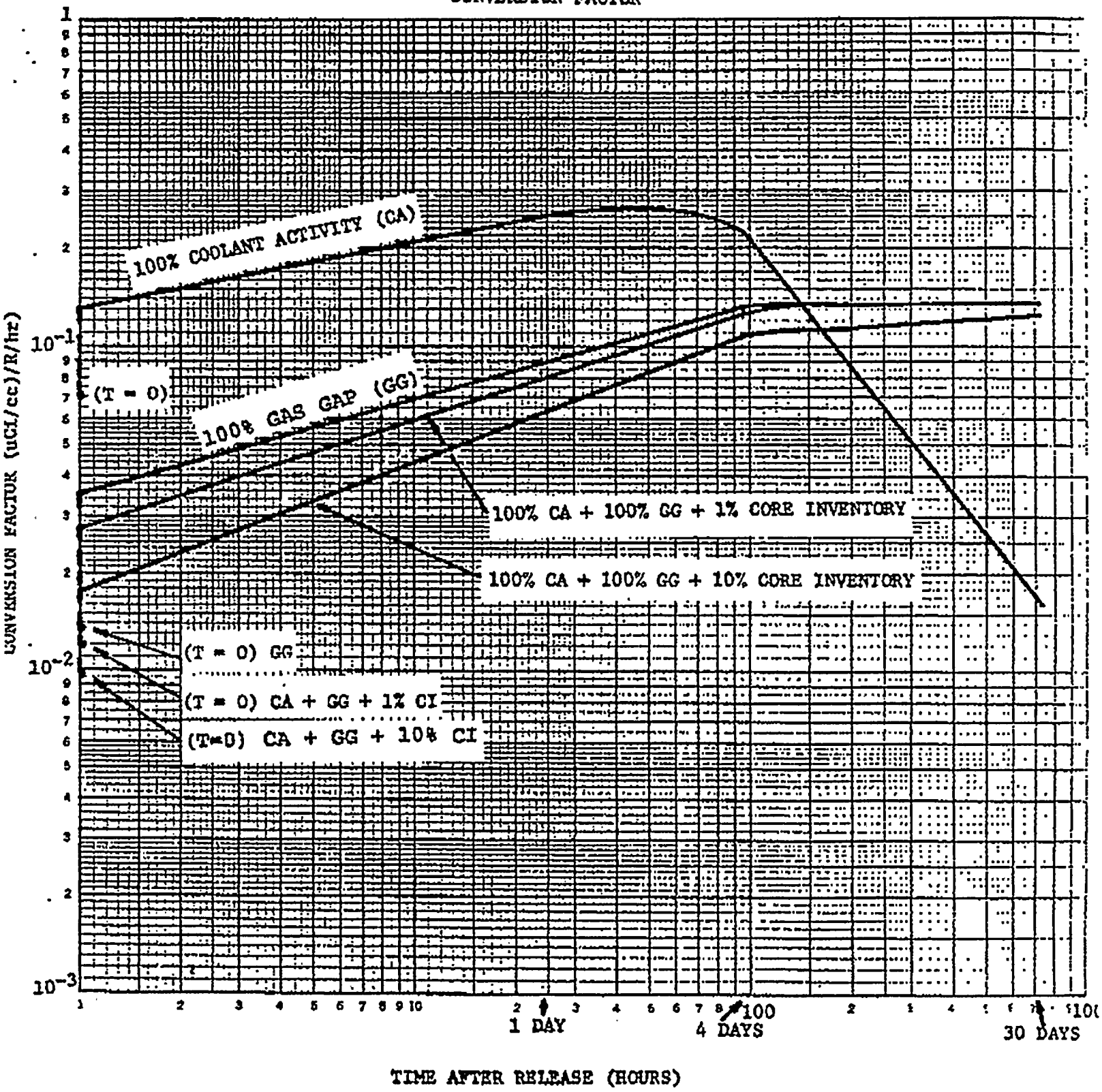


FIGURE 1
CONTAINMENT MONITOR READING vs.
TIME FOLLOWING RELEASE OF ACTIVITY
INTO THE CONTAINMENT

FIGURE 2

CONTAINMENT MONITOR
CONCENTRATION/DOSE RATE
CONVERSION FACTOR



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1/ ISOSHLD, Code Package CCC-79, Radiation Shielding Information Center, Oak Ridge National Laboratories, Oak Ridge, Tn.

ST. LUCIE 1

HIGH RANGE CONTAINMENT MONITOR

Expected Monitor Reading (R/HR) and Conversion Factor ((uCi/cc)/(R/HR)) for

1. 100% Coolant Activity (CA)
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TABLE 1

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ACCIDENT CASE	MONITOR READING (R/HR)*					
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100% Gas Gap (GG)	4.28E4	5.42E3	3.20E3	1.72E3	7.46E2	4.54E1
100% CA + 100% GG + 1% Core	6.32E4	8.31E3	4.42E3	2.19E3	8.98E2	4.94E1
100% CA + 100% GG + 10% Core	2.47E5	3.43E4	1.54E4	6.39E3	2.27E3	9.42E1

*Includes check source reading of 1R/HR

**Read as 1.16×10^1

TABLE 2

CONTAINMENT HIGH RANGE RADIATION MONITOR

Conversion Factor (uCi/cc per R/HR)

ACCIDENT CASE	0 HR	2 HR	8 HR	1 DAY	4 DAYS	30 DAYS
100% Coolant Activity (CA)	7.00E-2*	1.49E-1	2.01E-1	2.48E-1	2.26E-1	1.63E-2
100% Gas Gap (GG)	1.35E-2	4.20E-2	6.09E-2	9.12E-2	1.28E-1	1.35E-1
100% CA + 100% GG + 1% Core	1.20E-2	3.44E-2	5.30E-2	8.34E-2	1.22E-1	1.36E-1
100% CA + 100% GG + 10% Core	9.67E-3	2.34E-2	3.79E-2	6.42E-2	1.04E-1	1.24E-1

*Read as 7.00×10^{-2}

TABLE 3

CONTAINMENT HIGH RANGE RADIATION MONITOR

MONITOR READING FOR EMERGENCY CLASSIFICATION

ACCIDENT CASE*	R/HR
50 MR/HR Offsite	7.34E3**
500 MR/HR Offsite	7.34E4
1R/HR Offsite	1.47E5

*Whole body dose rate at EAB given a 5%-ile, 2 HR, dilution factor of 1.80×10^{-4} sec/m^3 and design basis containment leak rate of 0.5% per day.

**Read as 7.34×10^3

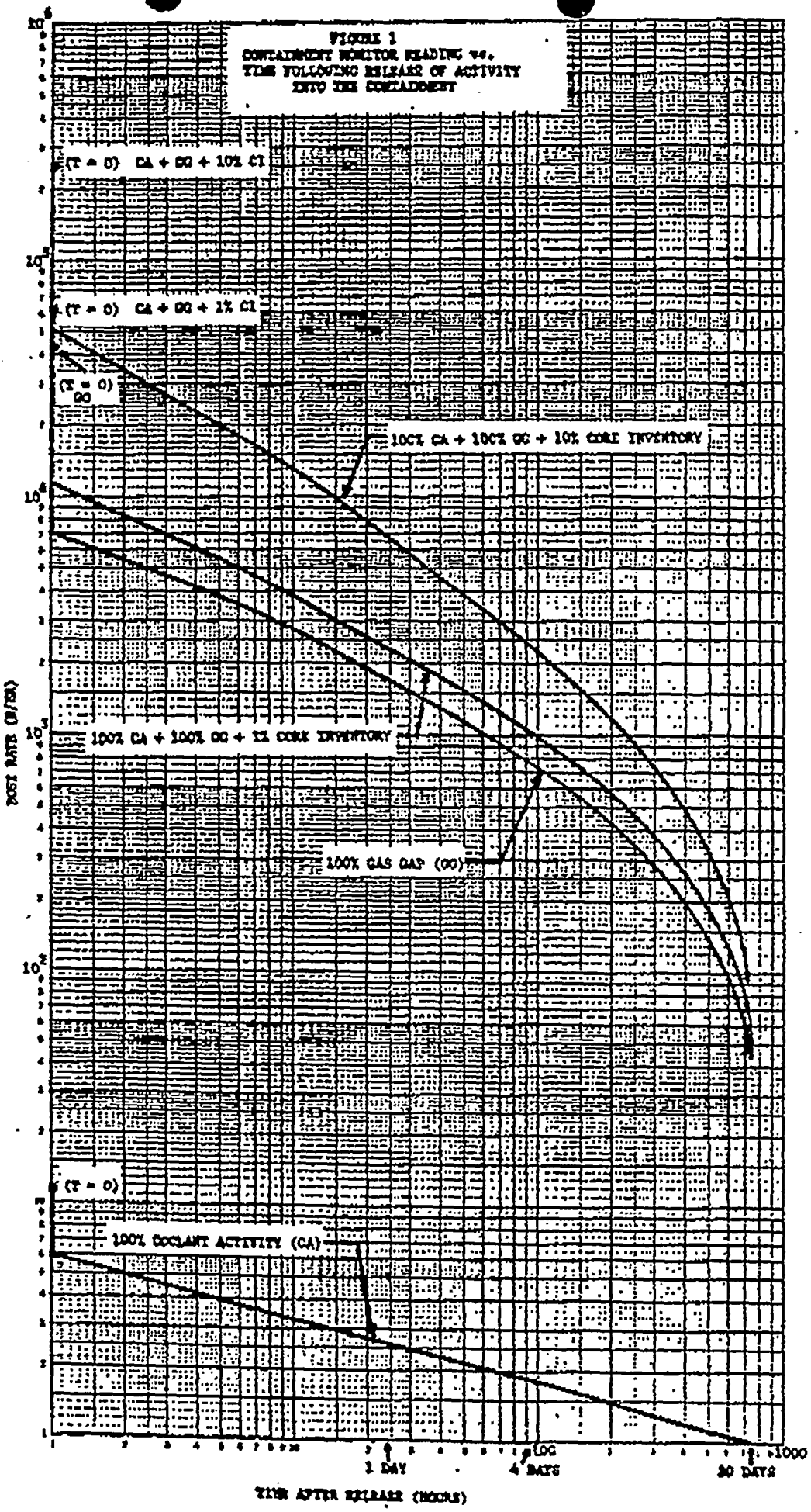
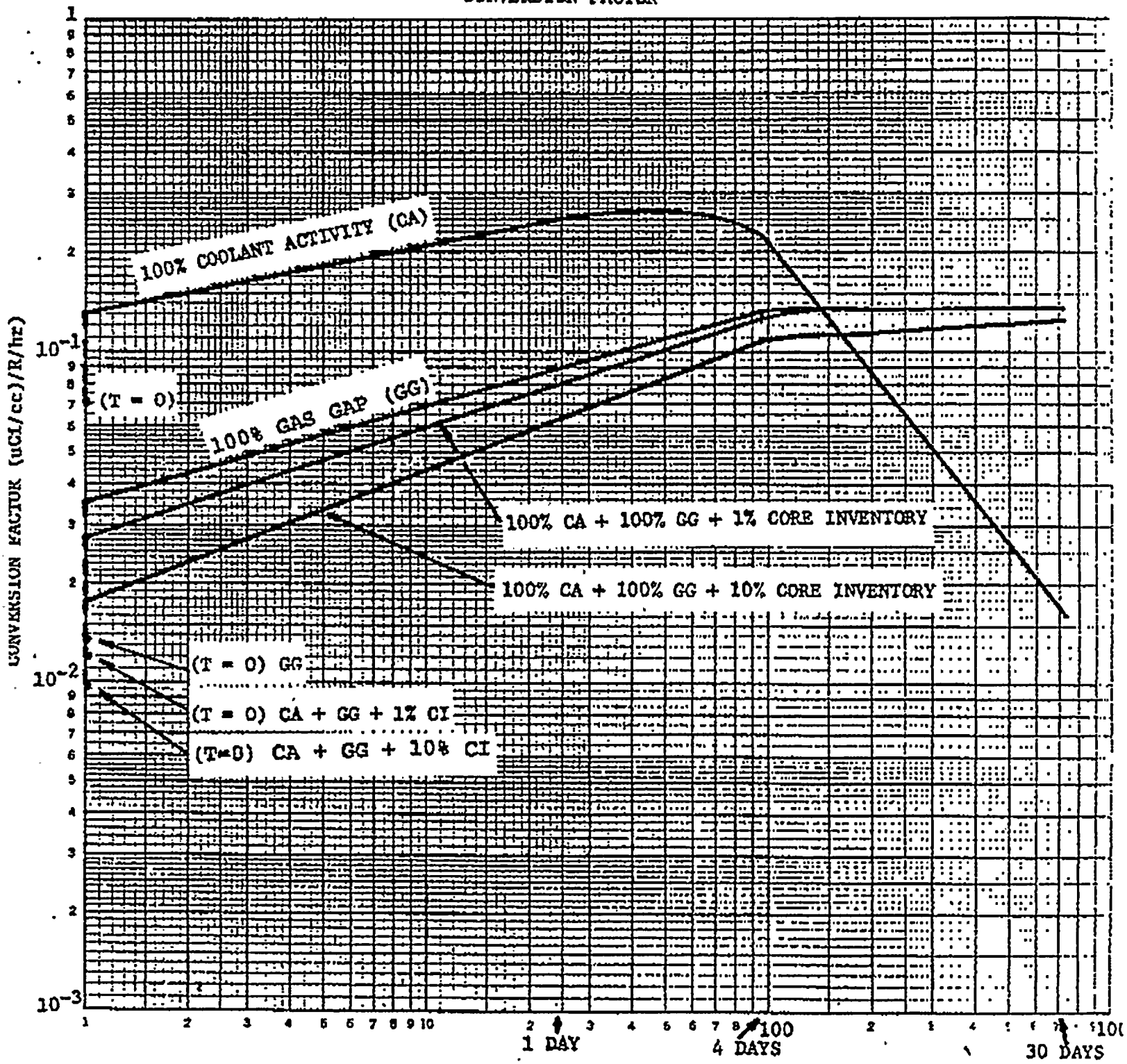


FIGURE 1
CONTAINMENT MONITOR READING vs.
TIME FOLLOWING RELEASE OF ACTIVITY
INTO THE CONTAINMENT

FIGURE 2

CONTAINMENT MONITOR
CONCENTRATION/DOSE RATE
CONVERSION FACTOR