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RETURN TO 396-SS PDR

nutech
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January 24, 1986
JVM-86-017

Mr. J. P. Roberts
Project Manager
Advanced Fuel and Spent Fuel
Licensing Branch
Division of Fuel Cycle and Material Safety
United States Nuclear Regulatory Commission
Washington, D.C. 20555

Subject: Transmittal of Further Information in Support of Topical Report NUH-001

Reference: Letter, J. V. Massey to J. P. Roberts, 1/17/86 "Transmittal of Information in Support of Topical Report NUH-001", JVM-86-010

Dear John:

I am sending with this letter the remaining information requested by reviewers during our meeting of January 8, 1986.

Attachment 1 to this letter summarizes the analysis performed on the DSC addressing thermally induced bending loads on the shell.

Attachment 2 contains a revised Table 8.2-8 and source references for the dose conversion factors.

Attachment 3 is a brief description of the analysis supporting the neutron dose rates at the HSM air vents.

Attachment 4 is a sample listing of the MORSE code input and output used in analysis of the H. B. Robinson ISFSI facility. Please note that this attachment should properly be submitted with the H. B. Robinson ISFSI SAR, but is included here for two reasons:

1. the reviewers have asked for an early submittal of the MORSE calculations for H. B. Robinson, and

2. the shielding results for the site specific and topical report analyses are comparable. DOT and QADMOD/Albedo calculations were used in the Topical Report.

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Skyshine results for the 184 module array are presented in Table 7.4-1 and Section 7.6 of the NUHOMS Topical Report. Air scattered and air dose contributions from neutrons, primary and secondary gamma rays are included. NUTECH has reviewed the skyshine analysis and finds no fault in the model or computations.

I trust that the information in this transmittal and in the referenced letter completes the open items resulting from our latest meeting. May I say that we have made every attempt to respond fully and promptly to the reviewers' questions. If, however, there remain any outstanding issues, please feel free to contact me at once so that resolution may be obtained in a timely manner.

Very truly yours,

for JVM

John V. Massey, Ph.D.
NUHOMS Program Manager
NUTECH Inc.

JVM/jj

Attachment

cc: D. M. Koss (CP&L)

Attachment 1

Thermal Stress Analysis

Thermal stress analyses were performed for the DSC. These analyses are described in Section 8.1 of the Topical Report.

The maximum primary membrane + bending stress intensity due to differential thermal expansion of the spacer disk and the DSC shell is 20.90 ksi as shown in Table 8.1-7 of the Topical Report. The maximum stress is located at the shell where the spacer disk expands into it.

This type of loading is a typical radial line load on a cylinder. Displacements and forces tend to attenuate very rapidly away from the point of load application. The characteristic length of the DSC shell is $1/\beta = (r^2t^2/3(1-\nu^2))^{\frac{1}{4}} = 2.35$ inches, where $r = 18.25$ inches, $t = 0.5$ inch and $\nu = 0.3$ (see Theory of Plates and Shells by Timoskenko and Woinowsky-Krieger for reference). Since the end cover plate is located 13.72 inches away from the closest disk, it is 5.8 characteristic lengths away. By inspecting Table 84 of Timoskenko, all displacement, rotation, moment and shear quantities attentuate to zero. Therefore application of long cylinder analysis to the DSC analysis is justified.

The maximum primary membrane + bending stress intensity due to pressure load for the DSC is 9.16 ksi as reported in Table 8.1-7 of the Topical Report. This is located at the shell where it ends at the cover plate. The maximum primary membrane + bending stress intensity due to 5 feet drop is 39.19 ksi, and is located at the shell between the end cover plate and the bottom plate of the lead plug. The combined maximum primary membrane + bending stress intensity is reported to be 48.35 ksi as shown in Table 8.2-9 of the Topical Report. This is conservative because maximum stresses of two different locations were added. The effect of the differential thermal expansion as discussed before has attenuated to practically zero at the end plate and hence does not reflect in the addition. As for the location where the maximum stress intensity occurs for the drop accident, the thermal bending moment attenuates to less than 13% of the maximum and the displacement attenuates to less than 1% of the maximum. Since the stresses due to thermal and pressure loads have attenuated at this location, the stresses at this location is less critical than the value reported. Therefore, it can be concluded than the reported stress intensities for the DSC shell presented in the Topical Report are conservative and envelop all load combinations.

Attachment 2

Clarification of
DSC Rupture Accident Doses
(NUHOMS Topical Report Table 8.2-8)

Equations 7, 10, and 11 of U.S.NRC Regulatory Guide 1.109, Revision 1 October 1977, were applied to obtain gamma dose, beta dose, total body and total skin dose. The parameters used follow.

DF^{γ} = 1.72E-5 (mrad.m^3/pCi·yr) DF^{β} = 1.95E-3 (mrad·m^3/pCi.yr)

Q = .30(2.205E+4) = 6.614E+3 (Ci/yr) (instantaneous)

X/Q = 0.005 (Sec/m^3)

X = 1.05E + 6 (pCi/m^3)

DFB = 1.61E-5 (mrem.m^3/pCi·yr), DFS = 1.34E-3 (mrem.m^3/pCi·yr)

The results are as follows:

Dose Type	Dose
gamma air	1.8 E+1 mrad
beta air	2.0 E+3 mrad
total body	1.7 E+1 mrem *
skin	1.4 E+3 mrem

* Note: This value was presented as 1.1E+1 mrem in Rev. 0 of the Topical Report, and will be corrected in the next revision.

ATTACHMENT 3

Discussion of the Relative Attenuation of Gamma Rays and Neutrons through the Air Exhaust Vent

The attached table and figure illustrate the relative attenuation of gamma rays and neutrons as they pass through the HSM air exhaust vent, and the spectral behavior of the neutrons.

Note in the table that if we assign a "peaking" factor equal to the vent exhaust dose (no cap) divided by the nominal HSM roof dose, neutrons have a peaking factor of 1.32/.024 = 55, and gammas have a peaking factor of 495/2.8 = 177. These results are reasonable when one compares neutron and gamma ray albedo data (such as W. E. Selph, "Neutron and Gamma Ray Albedos," ORNL-RSIC-21, 2/68.)

The well-thermalized nature of the neutron population at the air exhaust (refer to figure) indicates that the two-legged duct efficiently attenuates neutron radiation. Any significant streaming path would result in a higher proportion of epithermal or fast neutrons. (Compare the entrance and exit spectra).

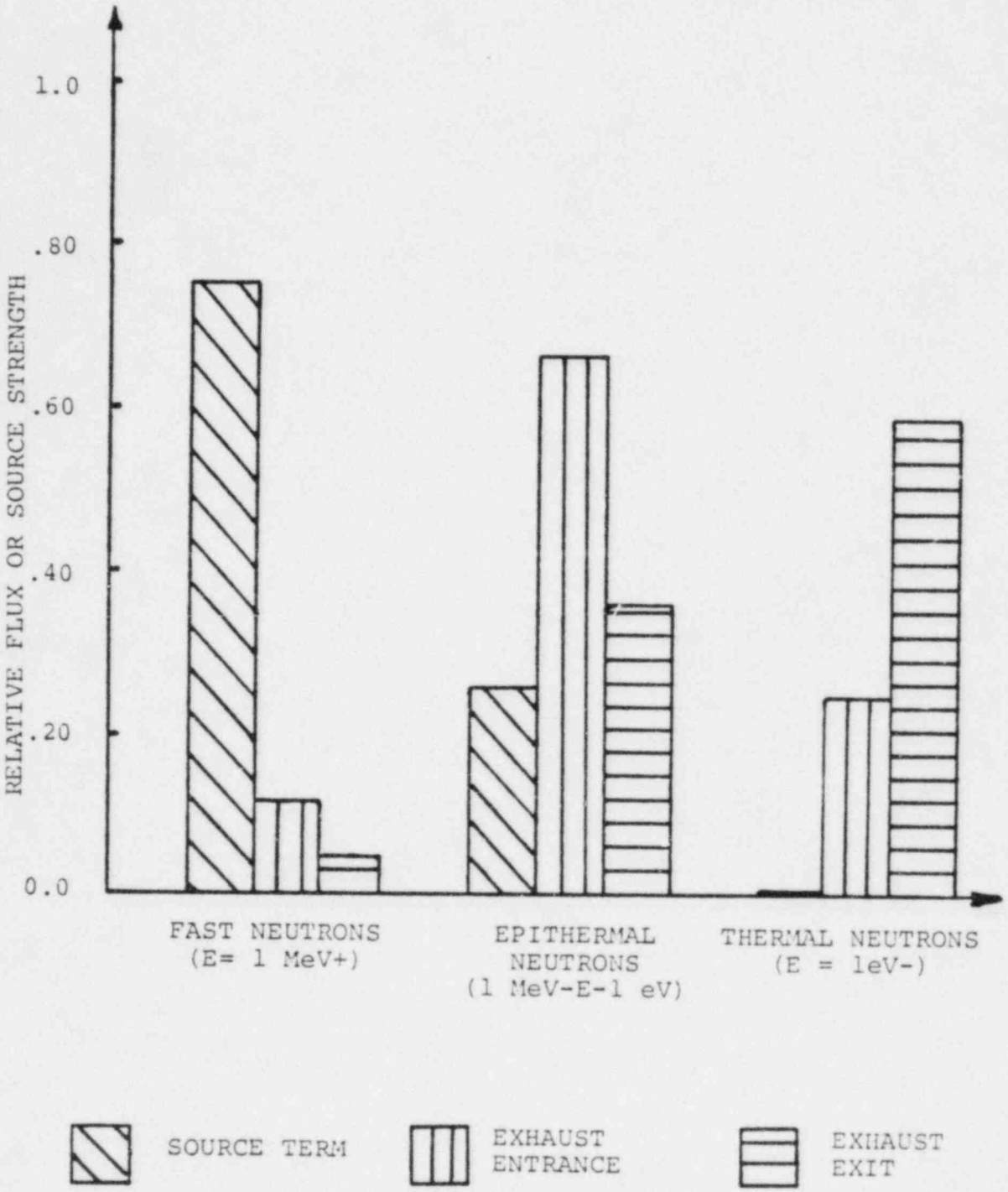
The relative behavior of neutron and gamma ray radiation appears reasonable as modeled. Gamma peaking is more pronounced than neutron -- which is appropriate considering the differences in concrete albedo factors. Furthermore, the low exhaust exit neutron dose rate reported in the Topical Report is justifiable since the "softened" energy spectrum there indicates that no major streaming paths are present.

Dose Rates
(mrem/hr)

Location	Neutron	Gamma	Gamma-to-Neutron Ratio
1) Air Exhaust (with cap)	0.047 (1.96E-5)[1]	11.5 (6.05E-7)	244
2) Air Exhaust (no cap)	1.32 (5.50E-4)	495 (2.61E-5)	375
3) HSM Roof[2]	0.024 (1.00E-5)	2.8 (1.47E-7)	117
4) DSC Surface at Fuel Midplane	2.4×10^3	1.9×10^7	7920

1. Refers to overall attenuation from active fuel midplane, DSC O.D. (Line 4)

2. At active fuel midplane.



NEUTRON ENERGY SPECTRUM FOR THE HSM AIR EXHAUST

Attachment 4

MORSE Input/Output For H. B. Robinson ISFSI

Attachment 4

MORSE Input/Output
for
H. B. ROBINSON ISFSI

```
ISN 0002            SUBROUTINE SDATA(D,XD,YD,ZD,VEL)
ISN 0003            COMMON/INPUT/IADJ(17),MXREG,NFIS(10),MAXGP,IRDS(11),NGPFS
ISN 0004            COMMON/POINT/LFD(20)
ISN 0005             DIMENSION D(1)
ISN 0006             DATA ICALL/0/
ISN 0007             IF(ICALL.NE.0) RETURN
ISN 0008             DO 10 IG=1,NGPFS
ISN 0010             IFS=LFD(IG)+IG-1
ISN 0011            IF(IG.EQ.3) D(IFS)=0.4199E-3
ISN 0012            IF(IG.EQ.9) D(IFS)=0.1662E-2
ISN 0013            IF(IG.EQ.12)D(IFS)=0.1595E-1
ISN 0015             WRITE(6,1000) IG,D(IFS)
ISN 0016             DO 10 IREG=1,MXREG
ISN 0017             IWTHI=LFD(16)+MAXGP*(IREG-1)+IG-1
ISN 0018            IF(D(IFS).LE.1.0E-40) D(IFS)=1.0
ISN 0022             D(IWTHI)=D(IWTHI)*D(IFS)
ISN 0023             IWTLO=IWTHI+MAXGP*MXREG
ISN 0024             D(IWTLO)=D(IWTLO)*D(IFS)
ISN 0025             IWTAV=IWTLO+MAXGP*MXREG
ISN 0026             D(IWTAV)=D(IWTAV)*D(IFS)
ISN 0027          10  WRITE(6,2000) IG,IREG,D(IWTHI),D(IWTLO),D(IWTAV)
ISN 0028             ICALL=1
ISN 0029            RETURN
ISN 0030         1000 FORMAT(I10,2E15.5)
ISN 0031         2000 FORMAT(2I10,3E14.5)
ISN 0032             END
```

User-Supplied Subroutine SDATA

```
ISN 0002          SUBROUTINE BDRYX(D,PA,EXTRD,ND,NMTG)
            C
            C
            C NUTECH DRY STORAGE PROJECT
            C
            C
            C
            C REQUIRES 5 DETECTORS FOR THIS ESTIMATOR
            C
ISN 0003          REAL*8 XDUM,YDUM,ZDUM,UDUM,VDUM,WDUM
ISN 0004          REAL*8 X,Y,Z,U,V,W,XOLD,YOLD,ZOLD,UOLD,VOLD,WOLD
ISN 0005          REAL*8 PA,COS,ARCOS,ARZ
ISN 0006          INTEGER EXTRD
ISN 0007          COMMON /NUTRON/ NAME,IG7,NAMEX,IG,IGO,NMED,MEDOLD,NREG,U,V,W,UOLD
                 * ,VOLD,WOLD,X,Y,Z,XOLD,YOLD,ZOLD,WATE,OLDWT,WTBC,BLZNT,BLZON,AGE ,
                 * OLDAGE,LNP1,LNP2,LNP3,LNP4,LNP5,LNP6,LNP7,LNP8,LNP9,LNP10,LNP11,
                 * LNP12,LNP13,LNP14,LNP15,LNP16,LNP17,LNP18,LNP19,LNP20,LNP21
ISN 0008          COMMON/INPUT/IADJM,MSTRT,MMOST,NITS,NQUIT,NCOLTP,ISTAT,NSPLT,
                 * NKILL,NPAST,NOLEAK,IEBIAS,NKCALC,NORMF, MEDIA,NMIX,MEDALB,MXREG,
                 * NFISTP,NUGA,NDGA,NUGTP, NGOPT,IGGOPT,NOSN,NDSG,NCOEF,NSCT,MAXGP,
                 * IPDSG,ISTP, IFPU,IMOM,IPRIN,IPUN,IXTAPE,JXTAPE,IO6R,IGUPT, ISOUR,
                 * NGPFJ,ISBIAS,NSOUR, NZ,NNE,NE,NT,NA,NRESP,NEX,NEXND,IFLAG(20)
ISN 0009          COMMON/NDET/LOCRSP,LOCXD,LOCID,LOCCO,LOCT,LOCUD,LOCSD, LOCQE,
                 * LOCQT,LOCQTE,LOCQAE,LMAX,EFIRST,EGTOP
ISN 0010          DIMENSION D(1),EXTRD(ND,1)
ISN 0011          DATA ITEST,PI/0,3.14159/
ISN 0012          DATA R1,R2,R3,R4,R5/29.0 ,34.0 ,42.0 ,47.53 ,46.99/
            C  CHECK IF CROSSING AT Z=234.32 CM
ISN 0013          IF(Z.LT.234.31 .OR. Z.GT.234.33) RETURN
ISN 0015          RAD = DSQRT(X*X+Y*Y)
ISN 0016          IF(ITEST.NE.0) GO TO 100
ISN 0018          ITEST = 1
ISN 0019          A1=PI*R1*R1/4.0
ISN 0020          A2=PI*R2*R2/4.0
ISN 0021          A3=PI*R3*R3/4.0
ISN 0022          A4=PI*R4*R4/4.0
ISN 0023          A5=PI*R5*R5/4.0
ISN 0024          AREA1 = A1
ISN 0025          AREA2 = A2-A1
ISN 0026          AREA3 = A3-A2
ISN 0027          AREA4 = A4-A3
ISN 0028          AREA5 = A4-A5
ISN 0029          WRITE(6,1200) AREA1,AREA2,AREA3,AREA4,AREA5
ISN 0030     1200 FORMAT(/,' AREAS OF DETECTORS: ',1P5E12.4)
ISN 0031      100  CONTINUE
            C
ISN 0032          IF(RAD.LT.R1) GO TO 10
ISN 0034          IF(RAD.GE.R1 .AND. RAD.LT.R2) GO TO 20
ISN 0036          IF(RAD.GE.R2 .AND. RAD.LT.R3) GO TO 30
ISN 0038          IF(RAD.GE.R3 .AND. RAD.LT.R4) GO TO 40
ISN 0040          RETURN
            C
ISN 0041      10  AREA=AREA1
ISN 0042          ID=1
ISN 0043          GO TO 400
ISN 0044      20  AREA=AREA2
ISN 0045          ID=2
ISN 0046          GO TO 400
ISN 0047      30  AREA=AREA3
ISN 0048          ID=3
ISN 0049          GO TO 400
ISN 0050      40  AREA=AREA4
ISN 0051          ID=4
            C
ISN 0052     400  CONTINUE
            C  SCORES FLUENCE FOR DETECTOR ID (ID=1,2,3,OR 4)
ISN 0053          COS=W
ISN 0054          ARCOS=DABS(COS)
            C  CHECK FOR GRAZING ANGLE
ISN 0055          IF (ARCOS.LT.0.01) ARCOS=0.005
ISN 0057          CON=WTBC/(ARCOS*AREA)
ISN 0058          L=0
ISN 0059          CALL FLUXST(ID,IG,IG,TA,COSI,L,D(LOCID+3*NE),D(LOCQE), D(LOCT),
                 * D(LOCT+NU*NT),D(LOCCO),D(LOCQTE),D(LOCQAE),D(LOCUD), D(LOCSD),
                 * D(LOCQT),D(LOCRSP),CON,NMTG,NE,ND,NT,NA,NRESP)
            C  COUNTS THE NUMBER OF SCORES IN DETECTOR ID
ISN 0060          EXTRD(ID,1) = EXTRD(ID,1) + 1
            C  IF NOT BETWEEN RADII R5 AND R4 RETURN
ISN 0061          IF(RAD.GE.R4 .OR. RAD.LT.R5) RETURN
            C  SCORES FLUENCE FOR DETECTOR 5
ISN 0063          CON=WTBC/(ARCOS*AREA5)
ISN 0064          ID=5
ISN 0065          L=0
ISN 0066          CALL FLUXST(ID,IG,IG,TA,COSI,L,D(LOCID+3*NE),D(LOCQE), D(LOCT),
                 * D(LOCT+NU*NT),D(LOCCO),D(LOCQTE),D(LOCQAE),D(LOCUD), D(LOCSD),
                 * D(LOCQT),D(LOCRSP),CON,NMTG,NE,ND,NT,NA,NRESP)
ISN 0067          EXTRD(ID,1) = EXTRD(ID,1) + 1
ISN 0068          RETURN
ISN 0069          END
```

User-Supplied Subroutine BDRYX

```
NUHOMS CASK/CANISTER ANNULAR STREAMING, NEUTRON AND SEC. GAMMA DOSES
    420R9RAR0947
1$$  0  400  1000 20*  1  0  0  1  1  1  4R0
2$$  6  13  0R  3  1
3$$  22  18 1  3R0  3  4  2  40  0  1  4R0  4  0  0 1
4$$  0  22  1  0
5$$  5  22 40  0  0  2  8  2  4R0  1  5R0  1  9R0
 T
3D CASK/CANISTER MODEL
0  0  1  20
RPP  1  0.      11.11  0.     11.11  0.      1000.
RPP  2  0.      11.43  0.     11.43  0.      1000.
RPP  3 14.29   36.51  0.     11.11  0.      1000.
RPP  4 13.97   36.83  0.     11.43  0.      1000.
RPP  5  1.59   23.81 14.29  36.51  0.      1000.
RPP  6  1.27   24.13 13.97  36.83  0.      1000.
RPP  7  0.0 1000. 0.0 1000. 0.0 1000.
RPP  8 -5.     1010. -5.    1010. -5.      1010.
RCC  9  0.     0.    145.55   0.     0.      5.08  1000.
RCC 10  5R0.0     182.88     1000.
RCC 11  5R0.0     193.84     1000.
RCC 12  5R0.0     198.12     1000.
RCC 13  5R0.0     219.72     1000.
RCC 14  5R0.0     221.34     1000.
RCC 15  5R0.0     224.15     1000.
RCC 16  5R0.0     227.12     1000.
RCC 17  5R0.0     230.09     1000.
RCC 18  5R0.0     233.05     1000.
RCC 19  5R0.0     255.27     63.03
RCC 20  5R0.0     234.32     46.99
RCC 21  5R0.0     217.19     45.72
RCC 22  5R0.0     1000.      34.82
RCC 23  5R0.0     1000.      43.18
RCC 24  5R0.0     1000.      47.63
RCC 25  5R0.0     1000.      48.90
RCC 26  5R0.0     1000.      52.06
RCC 27  5R0.0     234.32     1000.
 END
SFL   1 10 OR 3 10 OR 5 10
CZ1   1 12 -10 OR 3 12 -10 OR 5 12 -10
CZ2   1 13 -12 OR 3 13 -12 OR 5 13 -12
CPL   2 13 -1 OR 4 13 -3 OR 6 13 -5
SS1   7 9 21 -2 -4 -6
SS2   7 12 21 -11 -2 -4 -6
SS3   7 12 25 -24 OR 7 12 20 -21
SS4  7  13 25 -12 -24 OR 7 14 20 -13 OR 7 13 20 -23 -21 -12
SS5  7 15 22 -14 OR 7 16 20 -14 OR 7 16 19 -13 -24
SS6  7 17 20 -22 -16 OR 7 17 19 -24 -15
SS7  7 19 -24 -17 OR 7 20 -22 -17 OR 7 20 22 -18
SS8  7 19 13 -26
IV1  7 24 27 -20 OR 7 13 23 -2 -4 -6 -21 OR 7 21 -12 -2 -4 -6 OR 7
      21 11 -2 -4 -6 -9
IV2  7 19 24 -27
PB1  7 16 22 -15
PB2  7 17 22 -16
PB  7 18 22 -17
NEU   7 13 26 -25
ALB   8 -7
EVD   7 -19
 END
1 2 3 1 2 3 2 4 5 6 7 8 1 2 5 6 7 8 1 1
20R0
1 4 4 2 8R3 2R1000 3R5 6 80 0
T
6**  80.  4R0.  36.51  0.  36.51  0.0  182.86
8**  40R5.  40R2.10  40R.843  40R.680  40R.454  40R.229  40R.116
     40R10.0
     40R.200  40R.0876  40R.0378  40R.026  40R.0182  40R.00916
     40R.00462  40R.400
     40R1.  40R.438  40R.187  40R.131  40R.0908  40R.0458
     40R.0231  40R2.
     32R0.5
10** 1.00  .438  .187  .131  .0908  .0458  .0231  2.00
     2.775+4  1.470+5  5.590+5  2.184+6  5.185+6  7.152+6  1.566+7
     1.304+7  3.117+6  1.734+7  3.140+7  2.872+7  1.957+7  2.352+6
     1.200+4  8.731+2  5.742+1  8.101+0  1.982+0  2.786-1  6.144-2
     1.701-2  18R0.
     108R0.0
     2.775+4  1.470+5  5.590+5  2.184+6  5.185+6  7.152+6  1.566+7
     1.304+7  3.117+6  1.734+7  3.140+7  2.872+7  1.957+7  2.352+6
     1.200+4  8.731+2  5.742+1  8.101+0  1.982+0  2.786-1  6.144-2
     1.701-2  18R0.
12$$ 5R1  3R2  3  2  3  2R9
13$$ 92235  92238  8016  40000  26000  6010  6012  26000
     26000  26000  82000  92235  92238
14** 3.590-5  5.637-3  1.124-2  2.308-3  7.021-4  3.794-3
     4.871-3  3.381-2  8.421-2  1.460-2  3.352-2  1.060-4
     4.796-2
17**
     2.775+4  1.470+5  5.590+5  2.184+6  5.185+6  7.152+6  1.566+7
     1.304+7  3.117+6  1.734+7  3.140+7  2.872+7  1.957+7  2.352+6
     1.200+4  8.731+2  5.742+1  8.101+0  1.982+0  2.786-1  6.144-2
     1.701-2
16** 110.  100.  95.  90.  85.  84.  83.  80.  78.  76.  65.  60.
     55.  35.  30.  25.  20.  5R10.
 T
 NUHOMS CASK/CANISTER
 NEUTRON DOSE (MR/HR/NEUTRON SOURCE)
 SECONDARY GAMMA DOSE (MR/HR/NEUTRON SOURCE)
FLUENCE PER LV
19**  18R0.0
 20** 2.080-1  1.656-1  1.475-1  1.476-1  1.404-1  1.332-1  1.296-1
      1.260-1  1.260-1  1.296-1  1.332-1  1.188-1  5.400-2  6.480-3
      4.320-3  4.500-3  4.680-3  4.500-3  4.320-3  4.140-3  3.960-3
      3.780-3  18R0.0
      22R0.0   9.792-3  8.280-3  6.840-3  5.760-3  4.752-3  3.960-3
      3.492-3  2.938-3  2.412-3  1.908-3  1.602-3  1.260-3  9.216-4
      6.372-4  4.312-4  2.376-4  1.404-4  3.024-4
21$$ 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22
     23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40
 T
END
```

Neutron/2ndry Gamma Run Input

THIS CASE WAS RUN ON SUNDAY, DECEMBER 22, 1985

NEUTRON DOSE (RD/HR/NEUTRON SOURCE)

DETECTOR	RESPONSES(DETECTOR) UNCOLL RESPONSE	FSD UNCOLL	NUMBER CASK/CANISTER TOTAL RESPONSE	FSD TOTAL
1	0.0	0.0	2.0235E-06	0.07658
2	0.0	0.0	1.7348E-06	0.05713
3	0.0	0.0	1.3775E-06	0.05936
4	0.0	0.0	1.2962E-06	0.06642
5	0.0	0.0	1.3255E-06	0.16288

SECONDARY GAMMA DOSE (RD/HR/NEUTRON SOURCE)

DETECTOR	RESPONSES(DETECTOR) UNCOLL RESPONSE	FSD UNCOLL	NUMBER CASK/CANISTER TOTAL RESPONSE	FSD TOTAL
1	0.0	0.0	1.6900E-09	0.61997
2	0.0	0.0	1.4329E-09	0.20575
3	0.0	0.0	2.7348E-09	0.29039
4	0.0	0.0	2.3477E-09	0.18746
5	0.0	0.0	7.4492E-09	0.33963

FLUENCE(ENERGY,DETECTOR) FLUENCE PER EV

DETECTOR NO. ENERGIES	1	2	3	4	5
1.492E+07	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
1.220E+07	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
1.000E+07	1.449E-16 0.604	1.100E-16 0.620	0.380E-17 0.653	5.806E-17 0.642	4.668E-17 0.790
8.180E+06	0.0 0.0	1.273E-15 1.000	0.0 0.0	0.0 0.0	0.0 0.0
6.360E+06	4.195E-16 1.000	9.873E-16 0.694	4.785E-15 0.567	2.747E-15 1.000	0.0 0.0
4.960E+06	0.582E-14 0.824	6.910E-14 0.579	4.106E-14 1.000	2.015E-14 0.694	0.0 0.0
4.060E+06	1.107E-13 0.507	7.915E-14 0.606	4.466E-14 0.470	4.128E-14 0.551	0.0 0.0
3.010E+06	1.688E-13 0.545	1.734E-13 0.312	1.295E-13 0.355	7.552E-14 0.373	1.142E-13 0.707
2.460E+06	1.736E-13 0.328	1.366E-13 0.359	1.122E-13 0.431	8.127E-14 0.398	4.646E-14 0.361
2.350E+06	4.043E-13 0.356	4.119E-13 0.291	2.375E-13 0.286	1.044E-13 0.289	1.201E-13 0.710
1.930E+06	1.031E-12 0.154	9.640E-13 0.141	8.176E-13 0.176	5.590E-13 0.209	3.895E-13 0.826
1.110E+06	1.095E-11 0.147	7.975E-12 0.081	6.141E-12 0.121	5.606E-12 0.139	6.353E-12 0.405
5.500E+05	4.527E-11 0.069	4.223E-11 0.063	3.412E-11 0.054	3.361E-11 0.077	3.344E-11 0.165
1.110E+05	5.914E-11 0.103	5.765E-11 0.101	5.103E-11 0.122	5.141E-11 0.153	5.888E-11 0.205
3.350E+03	3.213E-10 0.743	2.965E-10 0.181	2.913E-10 0.213	2.713E-10 0.314	3.043E-10 0.473
5.830E+02	1.293E-09 0.440	1.733E-09 0.503	5.755E-10 0.256	9.403E-10 0.327	1.075E-09 0.449
1.010E+02	2.053E-09 0.825	3.284E-09 0.436	2.082E-09 0.300	6.567E-09 0.547	1.237E-08 0.592
2.900E+01					

Neutron/2ndry Gamma Run Output

FLUENCE(ENERGY,DETECTOR) FLUENCE PER EV

(DETECTOR NO.) ENERGIES	1	2	3	4	5
2.000E+01	2.533E-09 0.805	2.320E-09 0.458	3.834E-10 0.718	2.593E-09 0.817	5.529E-09 1.000
1.010E+01	2.036E-09 1.000	1.727E-09 1.000	8.742E-09 0.963	1.459E-09 0.824	0.0 0.0
3.000E+00	4.914E-10 1.000	3.130E-09 1.000	1.382E-09 1.000	8.135E-09 1.000	0.0 0.0
1.120E+00	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
4.140E-01	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
1.000E-07					
ENERGIES					
1.000E+07	0.0 0.0	0.0 0.0	2.016E-15 1.000	1.507E-15 1.000	0.0 0.0
8.000E+06	1.000E-13 0.036	1.285E-14 0.453	9.000E-14 0.396	8.972E-14 0.335	2.995E-13 0.490
6.500E+06	3.430E-15 1.000	2.570E-14 0.574	9.534E-15 0.532	1.909E-14 0.779	1.215E-13 1.000
5.000E+06	0.0 0.0	8.043E-14 0.541	4.784E-14 0.476	2.413E-14 0.660	0.0 0.0
4.000E+06	2.287E-15 1.000	1.317E-14 0.525	6.125E-14 0.344	7.915E-14 0.440	4.572E-13 0.600
3.000E+06	3.652E-14 0.737	5.963E-14 0.400	1.808E-14 0.713	0.0 0.0	0.0 0.0
2.500E+06	1.297E-14 0.620	4.672E-14 0.454	5.108E-14 0.539	7.304E-14 0.609	7.837E-14 1.000
2.000E+06	2.523E-14 0.517	7.547E-14 0.402	5.226E-14 0.418	1.838E-13 0.433	0.0 0.0
1.660E+06	1.744E-14 0.671	7.120E-14 0.423	3.605E-14 0.479	1.141E-13 0.509	0.0 0.0
1.330E+06	1.112E-13 0.404	1.043E-13 0.456	1.490E-13 0.307	1.593E-13 0.344	6.645E-15 1.000
1.000E+06	2.404E-13 0.401	5.861E-14 0.504	2.077E-13 0.377	9.283E-14 0.485	0.0 0.0
8.000E+05	1.335E-13 0.447	1.081E-13 0.411	3.277E-12 0.837	1.300E-13 0.289	3.009E-13 0.822
6.000E+05	3.100E-13 0.417	4.900E-13 0.389	4.298E-13 0.247	5.817E-13 0.300	4.410E-14 1.000
4.000E+05	4.639E-13 0.814	1.467E-13 0.804	4.076E-13 0.208	2.695E-13 0.415	7.677E-13 0.350
3.000E+05	1.728E-13 0.576	4.327E-13 0.377	8.163E-13 0.275	1.125E-12 0.310	1.149E-13 1.000
2.000E+05	1.571E-13 0.430	3.786E-13 0.477	1.034E-12 0.473	9.420E-13 0.300	1.181E-12 0.516
1.000E+05	0.0 0.0	0.0 0.0	0.0 0.0	9.723E-16 1.000	0.0 0.0
5.000E+04	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
1.000E+04					

Neutron/2ndry Gamma Run Output

```
PRIMARY GAMMA DOSE W/ SOURCE FROM 150.63 TO 182.88, NUTECH CASK
     1368988A62171
1$$  0  16000 18000  60  1  0  0  1  1  1  4R0
2$$  6  13  88  8  1
3$$  22  18 1  3R0  3  4  2  40 0 1  4R0  4 0  0 1
4$$  0  40  1  0
5$$  6  22 40  0  0  2  8  2  4R0  1  5R0  1  9R0
 T
3D CASK/CANISTER MODEL, Z STARTS FROM 150.0 CM
0  0  1  20
RPP  1  0.      11.11  0.      11.11  150.0  1000.
RPP  2  0.      11.43  0.      11.43  150.0  1000.
RPP  3  14.29   36.51  0.      11.11  150.0  1000.
RPP  4  13.97   36.83  0.      11.43  150.0  1000.
RPP  5  1.59    23.81  14.29   36.51  150.0  1000.
RPP  6  1.27    24.13  13.97   36.83  150.0  1000.
RPP  7  0.0   1000.    0.0   1000.   150.0  1000.
RPP  8  -5.     1010.  -5.     1010.  -5.     1010.
RCC  9  0.      0.     145.55  0.     0.     5.08  1000.
RCC 10  5R0.0   182.88   1000.
RCC 11  5R0.0   193.84   1000.
RCC 12  5R0.0   198.92   1000.
RCC 13  5R0.0   219.72   1000.
RCC 14  5R0.0   221.44   1000.
RCC 15  5R0.0   224.16   1000.
RCC 16  5R0.0   227.12   1000.
RCC 17  5R0.0   230.09   1000.
RCC 18  5R0.0   233.05   1000.
RCC 19  5R0.0   255.27   63.02
RCC 20  5R0.0   234.32   46.99
RCC 21  5R0.0   217.18   45.72
RCC 22  5R0.0   1000.    34.82
RCC 23  5R0.0   1000.    43.18
RCC 24  5R0.0   1000.    47.63
RCC 25  5R0.0   1000.    48.90
RCC 26  5R0.0   1000.    59.08
RCC 27  5R0.0   234.32   1000.
 END
SFL     1 10 OR 3 10 OR 5 10
NZ1     1 12 -10 OR 3 12 -10 OR 5 12 -10
NZ2     1 13 -12 OR 3 13 -12 OR 5 13 -12
BRL     2 13 -1 OR 4 13 -3 OR 6 13 -5
SS2     7 12 21 -11 -2 -4 -6
SS3     7 12 25 -24 OR 7 12 20 -21
SS4   7   13 25 -12 -24 OR 7 14 20 -13 OR 7 13 20 -23 -21 -12
SS5   7 15 22 -14 OR 7 16 20 -14 OR 7 16 19 -13 -24
SS6   7 17 20 -22 -16 OR 7 17 19 -24 -16
SS7   7 19 -24 -17 OR 7 20 -22 -17 OR 7 20 22 -18
SS8   7 19 13 -26
IV1   7 24 27 -20 OR 7 13 23 -2 -4 -6 -21 OR 7 21 -12 -2 -4 -6 OR 7
        21 11 -2 -4 -6
IV2   7 19 24 -27
PB1   7 16 22 -15
PB2   7 17 22 -16
PB   7 18 22 -17
DEU     7 13 26 -25
ALB     8 -7
EVD     7 -19
 END
1 2 3 1 3 2 4 5 6 7 8 1 2 5 6 7 8 1 1
19R0
1 4 4 2 7R3 2R1000 3R5 6 8R 0
0
6**   110,  4R0,  36.51  0,  36.51  150.63  182.88
8**   40R5,  40R2.19  40R.945  40R.650  40R.454  40R.229  40R.116
      40R10.0
      40R.200  40R.0876  40R.0378  40R.026  40R.0182  40R.00916
      40R.00462  40R.400
      40R1.  40R.438  40R.189  40R.131  40R.0908  40R.0458
      40R.0231  40R2.
      320R.8
10** 1.00  .438  .189  .131  .0908  .0458  .0231  2.00
     2.775+4   1.478+5   5.590+5   2.184+6   5.185+6   7.152+6   1.566+7
     1.304+7   3.117+6   1.734+7   3.146+7   2.872+7   1.957+7   2.352+6
     1.200+4   8.731+2   5.742+1   8.101+0   1.982+0   2.786-1   6.144-2
     1.781-2   18R0.
     160R0.0
     2.775+4   1.478+5   5.590+5   2.184+6   5.185+6   7.152+6   1.566+7
     1.304+7   3.117+6   1.734+7   3.146+7   2.872+7   1.957+7   2.352+6
     1.200+4   8.731+2   5.742+1   8.101+0   1.982+0   2.786-1   6.144-2
     1.781-2   18R0.
12$$ 5R1  3R2  3  4  5  2R6
13$$ 92235  92238  8016  40000  26000  5010  6012  26000
     26000  26000  82000  92235  92238
14** 3.599-5  5.637-3  1.194-2  2.388-3  7.021-4  3.794-3
     4.871-3  3.381-2  8.421-2  1.459-2  3.352-2  1.060-4
     4.796-2
17**  22R0.0
     1.162+4   1.011+5   0.0       8.770+5   9.068+8   7.075+9   1.976+11
     4.452+11  0.        2.337+13  6.072+13  0.        2.795+14  1.085+13
     1.785+13  2.185+13  5.371+13  2.461+13
18**  22R1.  3.77  3.76  3.18  2.35  1.34  0.85  0.46  0.20  0.08  0.02
      4.4-3  8.4-4  7.6-5  1.3-6  1.8-8  3.7-12  1.0-15  1.0-15
 T
 NUHOMS CASK/CANISTER
PRIMARY GAMMA DOSE (MR/HR/SOURCE GAMMA)
PRIMARY GAMMA FLUENCE (GAMMA/CM**2/SOURCE GAMMA)
FLUENCE PER EV
19**  1840.0
20**
     22R0.0    9.792-3   8.280-3   6.840-3   5.760-3   4.752-3   3.960-3
     3.492-3   2.988-3   2.412-4   1.908-3   1.602-3   1.260-3   9.216-4
     6.372-4   4.392-4   2.376-4   1.404-4   3.024-4
     22R0.0  18R1.0
21$$ 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22
     23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40
 T
END
```

Primary Gamma Run Input

THIS CASE WAS RUN ON SATURDAY, DECEMBER 28, 1985

PRIMARY GAMMA DOSE (MR/HR/SOURCE GAMMA)

DETECTOR	RESPONSES(DETECTOR) NUHOMS CASK/CANISTER UNCOLL RESPONSE	FSD UNCOLL	TOTAL RESPONSE	FSD TOTAL
1	0.0	0.0	1.2221E-13	0.32818
2	0.0	0.0	8.9803E-14	0.24997
3	0.0	0.0	3.7699E-13	0.18848
4	0.0	0.0	3.2965E-13	0.24410
5	0.0	0.0	1.0102E-13	0.19277
6	0.0	0.0	3.5552E-13	0.14428

PRIMARY GAMMA FLUENCE (GAMMA/CM**2/SOURCE GAMMA)

DETECTOR	RESPONSES(DETECTOR) NUHOMS CASK/CANISTER UNCOLL RESPONSE	FSD UNCOLL	TOTAL RESPONSE	FSD TOTAL
1	0.0	0.0	5.9978E-11	0.34466
2	0.0	0.0	5.0305E-11	0.27190
3	0.0	0.0	2.5713E-10	0.21700
4	0.0	0.0	1.8936E-10	0.23407
5	0.0	0.0	5.3652E-11	0.20718
6	0.0	0.0	2.2639E-10	0.15554

FLUENCE(ENERGY,DETECTOR) FLUENCE PER EV

DETECTOR NO. / ENERGIES	1	2	3	4	5	6
1.492E+07	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0
1.220E+07	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0
1.000E+07	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0
8.180E+06	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0
6.360E+06	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0
4.960E+06	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0
4.060E+06	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0
3.010E+06	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0
2.460E+06	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0
2.350E+06	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0
1.830E+06	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0
1.110E+06	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0
5.500E+05	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0
1.110E+05	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0
3.350E+03	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0
5.830E+02	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0
1.010E+02	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0
2.900E+01						

FLUENCE(ENERGY,DETECTOR) FLUENCE PER EV

DETECTOR NO. / ENERGIES	1	2	3	4	5	6
2.900E+01	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
1.010E+01	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
3.060E+00	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
1.120E+00	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
4.140E-01	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
1.000E-02						
ENERGIES						
1.000E+07	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
8.000E+06	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
6.500E+06	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
5.000E+06	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
4.000E+06	0.0 0.0	5.944E-21 0.847	2.792E-20 0.707	0.0 0.0	3.88 E-21 0.847	1.526E-20 0.707
3.000E+06	9.511E-20 0.512	2.528E-19 0.635	1.101E-19 0.608	6.939E-20 0.721	1.982E-19 0.532	9.165E-20 0.517
2.500E+06	8.570E-18 0.518	3.962E-18 0.379	6.922E-18 0.205	9.186E-18 0.347	5.556E-18 0.321	7.949E-18 0.201
2.000E+06	1.855E-17 0.673	5.524E-18 0.346	2.052E-17 0.300	1.516E-17 0.325	1.003E-17 0.443	1.809E-17 0.219
1.660E+06	0.0 0.0	0.0 0.0	3.434E-17 1.000	0.0 0.0	0.0 0.0	1.877E-17 1.000
1.330E+06	9.139E-17 0.613	6.382E-17 0.407	1.495E-16 0.286	2.651E-16 0.954	7.335E-17 0.349	2.019E-16 0.286
1.000E+06	9.515E-17 0.521	6.932E-17 0.477	3.625E-16 0.399	2.221E-16 0.348	7.826E-17 0.347	2.988E-16 0.285
8.000E+05	8.124E-19 0.751	5.894E-17 0.692	3.894E-16 0.448	2.375E-16 0.382	3.752E-17 0.686	3.188E-16 0.319
6.000E+05	0.0 0.0	0.0 0.0	1.808E-16 0.944	9.437E-19 1.000	0.0 0.0	9.924E-17 0.940
4.000E+05	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
3.000E+05	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
2.000E+05	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
1.000E+05	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
5.000E+04	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0

Primary Gamma Run Output

DOCKET NO. M-39

CONTROL NO. 26363

DATE OF DOC. 01/24/86

DATE RCVD. 01/27/86

FCUF _____ PDR ✓

FCAF ✓ LPDR _____

WM _____ I&E REF. _____

WMUR _____ SAFEGUARDS ✓

FCTC _____ OTHER _____

DESCRIPTION:

transmittal of further information in support of Topical Report NUH-001

01/29/86 INITIAL Ltr