LABORATORY NOTEBOOK

CNWRA/SwRI

NOTEBOOK NO. 345

ISSUED TO Dan Pomerening

ON June 9, **19**99

DEPARTMENT

RETURNED June 10 **19**99

NOTE: During an audit, it was determined that these data/info should be put into scientific notebooks. They were, promptly.

[signature] 6/10/99

CNWRA
CONTROLLED
COPY 345

—SCIENTIFIC NOTEBOOK CO.—
2831 LAWRENCE AVE.
P.O. BOX 238
STEVENSVILLE, MI 49127
616-429-8285

INSTRUCTIONS

1. **The primary purpose of this notebook is to protect your and the Company's Patent-Rights by keeping records of all original work in a form acceptable as evidence if any legal conflict arises.**

2. • When starting a page, enter the title, project number, and book number.
   • Use ink for permanence -- avoid pencil.
   • Record your work as you progress, including any spur-of-the-moment ideas which may be developed later.
   • Avoid making notes on loose paper to be recopied.
   • Record your work in such a manner that a co-worker can continue from where you stop. You might be ill and to protect your priority it could be urgent that the work continue while you are absent.

3. • Give a complete account of your experiments and the results, both positive and negative, including your observations.
   • Record all diagrams, layouts, plans, procedures, new ideas, or anything pertinent to your work including the details of any discussions with suppliers, or other people outside the Company.
   • Do not try to erase any incorrect entries; draw lines deleting them, note the corrections, sign and date the changes. This extra care is worthwhile because of the necessity of original data to prove priority of new discoveries.

4. • After entering your data, sign and date the entries.
   • Explain your work to at least two witnesses who are not co-inventors, and have them sign and date the pages in the place provided.
   • Record the names of operators and witnesses present during any demonstration and have at least two witnesses sign the page. If no witnesses are present during an experiment of importance, repeat it in the presence of two witnesses.

5. Since computer programs can be patented these instructions apply to the development of computer software. In this case a description of the structure and operation of the program should be recorded in the notebook, together with a basic flow diagram which illustrates the essential features of the program. In the course of developing the code, the number of lines of code written each day should be recorded in the notebook, together with a statement of the portion of the flow diagram to which the section of code is directed.

6. This notebook and its contents are the exclusive property of the Company. It is confidential and the contents are not to be disclosed to anyone unless authorized by the Company. You must return it when completed, upon request, or upon termination of employment. It should be kept in a protected place. **If loss occurs, notify your supervisor immediately, and make a written report describing the circumstances of the loss.**

Form 590

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SCIENTIFIC NOTEBOOK CO.

| | | |

Project No. 20-1405-031

TITLE Review of the CISF TSAR

Book No. 345

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Investigators: A. Ghosh
J. Weldy
P. Mackin
D. Pomerening
A. Armstrong
G. Cragnolino
L. Deere
A. Chowdhury
J. Simonis
A. Garabedian
N. Cheruvu
D. Deere

The objective of this project is to review the Topical Safety Analysis Report (TSAR) for the Centralized Interim Storage Facility (CISF) submitted to the Nuclear Regulatory Commission (NRC) by the Department of Energy (DOE). The review consisted of ensuring that the proposed facility will meet all applicable NRC regulations including 10 CFR 20 and 10 CFR 72. This notebook documents calculations that were performed by CNWRA staff during their review of the TSAR to allow the reviewers to conclude that the proposed facility will meet NRC requirements.

The review has been conducted by a number of reviewers with a variety of technical disciplines. The review of the technical areas in the TSAR was conducted by reviewers with appropriate backgrounds in that technical area. The reviewers were familiar with NRC regulations and the NRC Standard Review Plan NUREG-1567

To Page No. ____

Witnessed & Understood by me,	Date	Invented by James Weldy	Date
		Recorded by James Weldy	6/9/99

Project No. 20-1405-031
Book No. 345
TITLE Review of the CISF TSAR

From Page No.

JRW

James Weldy
20-1405-031

Calculation of Dose Rate from an Array of CISF casks

9/14/98

The MCNP code will be used to confirm the dose rates calculated by the licensee in the CISF TSAR at the fence boundary. Since the cask SARs have been evaluated independently by NRC reviewers already, it is assumed that the dose rates on the side and top of the casks are correct and will be used in the calculation. Therefore, the geometry will be modeled as an array of 6000 casks and I will calculate the dose 700 m from the nearest cask in the centerline of the array.

Properties of air, concrete, and soil - from "Principles of Radiation Shielding" by Chilton, Shultis, and Faw (1984)

Concrete - ordinary - Density = 2.35 g/cm³
- Oxygen = 49.6 %
- Silicon = 31.4 %
- Calcium = 8.26 %
- Aluminum = 4.55 %
- other = 6.19 %

Air - Density = 0.001209 g/cm³
- O = 21.2 %
- N = 77.8 %
- C = 0.01 %
- Ar = 0.9 %

Soil - U.S. Average - Density = 1.6 g/cm³
- O = 50.2 %
- Si = 26.5 %
- Al = 6.7 %
- Fe = 5.5 %
- Ca = 5.0 %
- Other = 6.1 %

Witnessed & Understood by me, | Date | Invented by James Weldy | Date 6/9/98
Recorded by James Weldy

TITLE

From Page No.

James Weldy
20-1405-031
Book No. 345
Review of the CISF TSAR
8/16/98
/home/jweldy/mcnp/cisfinal/cis3of

```
Calculation of the dose around array of PWR MPCs for CISF
C Gamma source from radial sides
C
C Cell Cards
C
35 2 -2.406 -210 100 -187 imp:n,p=0.1 u=3 $ Concrete side shield
40 7 -0.001293 210:187:-100 imp:n,p=1 u=3 $ air around cask
C _____End of cask description - universe 3
82 0 -330 325 -340 335 -186 102 u=2 lat=1 imp:n,p=1 fill=0:74 0:3 &
     0:0 3 149R 5 149R $cask lattice
63 7 -0.001293 -300 #82 u=2 imp:n,p=1
C ______ Universe 2
76 0 -322 314 -310 302 -185 104 u=1 fill=2 imp:n,p=1  $pad-cask lattice
77 7 -0.001293 #76 -300 u=1 imp:n,p=1 $ other air - one pad only
C _______ Universe 4
73 0 -323 315 -313 305 -183 103 u=4 fill=2 lat=1 imp:n,p=1
C ______ Universe 1
70 0 -324 316 -405 307 -182 101 fill=4 (0 0 0) imp:n,p=1 $ lattice left
72 0 -435 420 -405 307 -182 101 fill=4 (47244 0 0) imp:n,p=1 $latt right
50 0 300 imp:n,p=0 $ rest of universe
60 8 -1.6 -101 -300 imp:n,p=1 $ ground under cask
80 7 -0.001293 -300 500 -600 700 -800 -900 #70 #72 #60 imp:n,p=1 $ air
81 7 -0.001293 -300 -500 505 700 -800 -900 #60 imp:n,p=10 $ air
93 7 -0.001293 -300 -505 510 700 -800 -900 #60 imp:n,p=10 $ air
83 7 -0.001293 -300 -510 515 700 -800 -900 #60 imp:n,p=100 $ air
84 7 -0.001293 -300 -515 520 700 -800 -900 #60 imp:n,p=100 $ air
85 7 -0.001293 -300 -520 525 700 -800 -900 #60 imp:n,p=1000 $ air
86 7 -0.001293 -300 -525 530 700 -800 -900 #60 imp:n,p=10000 $ air
87 7 -0.001293 -300 -530 535 700 -800 -900 #60 imp:n,p=10000 $ air
88 7 -0.001293 -300 -535 540 700 -800 -900 #60 imp:n,p=10 $ air
89 7 -0.001293 -300 -540 -900 #60 imp:n,p=0.0001 $ other air
90 7 -0.001293 -300 600 -900 #60 imp:n,p=0.0001
91 7 -0.001293 -300 -700 -900 -600 #60 imp:n,p=0.0001
92 7 -0.001293 -300 800 -900 #60 -600 imp:n,p=0.0001
94 7 -0.001293 -300 900 imp:n,p=0.0001
95 7 -0.001293 -300 imp:n,p=1 u=5

C
C Surface Cards
C
100 pz 0
101 pz 0.004
102 pz 0.001
103 pz 0.003
104 pz 0.002
182 pz 554.0596
183 pz 554.0597
185 pz 554.0598
186 pz 554.0599
187 pz 554.06
188 pz 75
189 pz 150
210 cz 190.5
300 so 720000
302 py -457.2
305 py -457.199
307 py -457.198
310 py 1371.6
313 py 2895.6
314 px -304.8
```

JRW

To Page No.

Witnessed & Understood by me, | Recorded by

/home/jwelly/mcnp/cisfinal/cis20E

James Welly
20-1405-031
Book No. 345
Review of the CISF TSAR
8/16/98

```
315 px -304.799
316 px -304.798
322 px 4.54152e4
323 px 4.5415199e4
324 px 4.5415198e4
325 px -304.8
330 px 304.8
335 py -457.2
340 py 457.2
405 py 65074.799
420 px 46939.199
435 px 92659.198
500 py -10457.2
505 py -20457.2
510 py -30457.2
515 py -40457.2
520 py -50457.2
525 py -60457.2
530 py -70457.2
535 py -80457.2
540 py -90000
600 py 70000
700 px -20000
800 px 120000
850 px 46162
855 px 46192.4
900 pz 8000

c
C Material Cards
c
m2   1001 -2.389e-2 8016 -1.281
     11023 -6.986e-2 13027 -8.192e-2
     14028 -.809 20040 -0.1057
     26056 -0.0338
m7   6012 -1.18e-7
     7014 -9.409e-4
     8016 -2.567e-4
     18040 -1.126e-5
m8   8016   -50.2
     14000  -28.5
     13027  -8.7
     26056  -5.5
     20000  -5.0
mode p
nps 100000000
c dbcn 0 0 100 300
c sdef sur=300 nrm=-1 erg=d1
c void
sdef erg=d1 axs=0 0 1 rad=d2 ext=d3 par=2 pos=d5 $ cel= d8
si1 A 0.1 0.125 0.15 0.175 0.20 0.25 0.35 0.55 0.850 &
    1.250 1.75 2.25
sp1 0.2652 0.1663 0.0855 0.0567 0.0307 0.043 0.0575 0.0726 0.0895 &
    0.0920 0.0245 0.0166
si2 0 190.5
sp2 -21 1
si3 A 554.061 554.062
sp3 1 1
si5 L 0 0 0 609.6 0 0 1219.2 0 0 1828.8 0 0 2438.4 0 0 3048 0 0 3657.6 0 0 &
    4267.2 0 0 4876.8 0 0 5486.4 0 0 6096 0 0 6705.6 0 0 &
```

JRW

TITLE

From Page No

e No.

Witnessed & Un

/home/jwelly/mcnp/cisfinal/cis20E

Book No. 315

James Welly
20-1405-031
Review of the CISF TSAR
8/16/98

```
4267.2 64617.6 0 4876.8 64617.6 0 5486.4 64617.6 0 6096 64617.6 0 6705.6 &
64617.6 0 7315.2 64617.6 0 7924.8 64617.6 0 8534.4 64617.6 0 9144 64617.6 0&
9753.6 64617.6 0 10363.2 64617.6 0 &
10972.8 64617.6 0 11582.4 64617.6 0 12192 64617.6 0 12801.6 64617.6 0 &
13411.2 64617.6 0 14020.8 64617.6 0 14630.4 64617.6 0 15240 64617.6 0 &
15849.6 64617.6 0 16459.2 64617.6 0 &
17068.8 64617.6 0 17678.4 64617.6 0 18288 64617.6 0 18897.6 64617.6 0 &
19507.2 64617.6 0 20116.8 64617.6 0 20726.4 64617.6 0 21336 64617.6 0 &
21945.6 64617.6 0 22555.2 64617.6 0 &
23164.8 64617.6 0 23774.4 64617.6 0 24384 64617.6 0 24993.6 64617.6 0 &
25603.2 64617.6 0 26212.8 64617.6 0 26822.4 64617.6 0 27432 64617.6 0 &
28041.6 64617.6 0 28651.2 64617.6 0 &
29260.8 64617.6 0 29870.4 64617.6 0 30480 64617.6 0 31089.6 64617.6 0 &
31699.2 64617.6 0 32308.8 64617.6 0 32918.4 64617.6 0 33528 64617.6 0 &
34137.6 64617.6 0 34747.2 64617.6 0 &
35356.8 64617.6 0 35966.4 64617.6 0 36576 64617.6 0 37185.6 64617.6 0 &
37795.2 64617.6 0 38404.8 64617.6 0 39014.4 64617.6 0 39624 64617.6 0 &
40233.6 64617.6 0 40843.2 64617.6 0 &
41452.8 64617.6 0 42062.4 64617.6 0 42672 64617.6 0 43281.6 64617.6 0 &
43891.2 64617.6 0 44500.8 64617.6 0 45110.4 64617.6 0 47244 64617.6 0 &
47853.6 64617.6 0 48463.2 64617.6 0 &
49072.8 64617.6 0 49672.4 64617.6 0 50292 64617.6 0 &
50901.6 64617.6 0 51511.2 64617.6 0 52120.8 64617.6 0 52730.4 64617.6 0 &
53340 64617.6 0 53949.6 64617.6 0 &
54559.2 64617.6 0 55168.8 64617.6 0 55778.4 64617.6 0 56388 64617.6 0 &
56997.6 64617.6 0 57607.2 64617.6 0 58216.8 64617.6 0 58826.4 64617.6 0 &
59436 64617.6 0 60045.6 64617.6 0 &
60655.2 64617.6 0 61264.8 64617.6 0 61874.4 64617.6 0 62484 64617.6 0 &
63093.6 64617.6 0 63703.2 64617.6 0 64312.8 64617.6 0 64922.4 64617.6 0 &
65532 64617.6 0 66141.6 64617.6 0 &
66751.2 64617.6 0 67360.8 64617.6 0 67970.4 64617.6 0 68580 64617.6 0 &
69189.6 64617.6 0 69799.2 64617.6 0 70408.8 64617.6 0 71018.4 64617.6 0 &
71628 64617.6 0 72237.6 64617.6 0 &
72847.2 64617.6 0 73456.8 64617.6 0 74066.4 64617.6 0 74676 64617.6 0 &
75285.6 64617.6 0 75895.2 64617.6 0 76504.8 64617.6 0 77114.4 64617.6 0 &
77724 64617.6 0 78333.6 64617.6 0 &
78943.2 64617.6 0 79552.8 64617.6 0 80162.4 64617.6 0 80772 64617.6 0 &
81381.6 64617.6 0 81991.2 64617.6 0 82600.8 64617.6 0 83210.4 64617.6 0 &
83820 64617.6 0 84429.6 64617.6 0 &
85039.2 64617.6 0 85648.8 64617.6 0 86258.4 64617.6 0 86868 64617.6 0 &
87477.6 64617.6 0 88087.2 64617.6 0 88696.8 64617.6 0 89306.4 64617.6 0 &
89916 64617.6 0 90525.6 64617.6 0 &
91135.2 64617.6 0 91744.8 64617.6 0 92354.4 64617.6 0
sp5 D 1 5999R
f45:p 46177.2  -70457.2  100 15 &
      46177.2  -80457.2  100 15 $ south end between rows 700 m
f2:p 500 505 510 520 525 530 535
fs2 -188 -850 189 855
sd2 1 1 1 1 2280 1 1 1 1 2280 1 1 1 1 2280 1 1 1 1 2280 1 1 1 1 2280 &
    1 1 1 1 2280 1 1 1 1 2280
e0  0.1 0.125 0.15 0.175 0.2 0.25 0.35 0.55 0.85 1.25 1.75 2.25 &
    2.75 3.5 3.75 4.25 5.0 10.0
de0  0.05 0.07 0.1 0.15 0.2 0.25 0.35 0.55 1.0 &
     1.4 1.8 2.2 2.8 3.25 4.25 5 5.75 6.75 7.5 9 11
df0  log 2.9e-7 2.58e-7 2.83e-7 3.79e-7 5.01e-7 6.31e-7 8.78e-7 1.27e-6 &
     1.98e-6 2.51e-6 2.99e-6 3.42e-6 4.01e-6 4.41e-6 5.23e-6 5.8e-6 6.37e-6 &
     7.11e-6 7.66e-6 8.77e-6 1.03e-5
c mrem/hr = 2.0412e4 (gammas/sec/cm2)*1.14e5 cm2 * 6000 casks*1000 mrem/rem
fm45 1.396181e16 $ convert result into mrem/hr
fm2 1.396181e16 $ convert result into mrem/hr
```

ge No

Project No.______
Book No.______ TITLE ______________

From Page No. ____

/home/jweldy/mcnp/cisfinal/cis20E

prdmp -5000 -120 0
cut:p 9e99 0.001 -1e-6 -0.0000001

James Weldy
20 1405-031
Book No. 345
Review of the CISF TSAR
8/16/98

JRW

Output file – note only the relevant pages are included. The entire file is located in /home/jweldy/mcnp/cisfinal/cis20Eo

James Weldy
20-1405-031
Book No. 345
Review of the CISF TSAR

```
mcnp     version 4a    ld=10/01/93                                08/20/98 16:41:32
**********************************************************************************
c i=contjw o=cis20Eo r=cis20Er

starting from dump no.   11 from file cis20Er     nps =  16990132    ctm = 1205.07    probid =   08/19/98 13:42:39

Calculation of the dose around array of PWR MPCs for CISF

  1-        continue
  2-        nps 150000000

      13 warning messages so far.
****************************************************************************************************
dump no.   12 on file cis20Er       nps =  18947454     coll =       151060982     ctm = 1325.08     nrn =      2314730741
****************************************************************************************************
dump no.   13 on file cis20Er       nps =  19603411     coll =       175573421     ctm = 1499.37     nrn =      2677710845
****************************************************************************************************
dump no.   14 on file cis20Er       nps =  21677257     coll =       188265793     ctm = 1619.37     nrn =      2875429085
****************************************************************************************************
dump no.   15 on file cis20Er       nps =  23628766     coll =       201191948     ctm = 1739.37     nrn =      3077359226
****************************************************************************************************
dump no.   16 on file cis20Er       nps =  24275277     coll =       218172778     ctm = 1859.37     nrn =      3319524103

problem summary

     run terminated by tty interrupt.                                                      08/21/98 08:22:52
                                                                                 probid =   08/19/98 13:42:39
     Calculation of the dose around array of PWR MPCs for CISF
     continue

photon creation      tracks      weight        energy           photon loss           tracks      weight        energy
                                 (per source particle)                                            (per source particle)

source              25944785   1.0000E+00   9.6967E-01          escape                     0   0.            0.
                                                                energy cutoff              0   0.            0.
                                                                time cutoff                0   0.            0.
weight window              0   0.           0.                  weight window              0   0.            0.
cell importance     75962187   1.1768E+00   7.4951E-01          cell importance     87228508   1.1594E+00    7.3162E-01
weight cutoff              0   0.           0.                  weight cutoff              0   0.            0.
energy importance          0   0.           0.                  energy importance          0   0.            0.
dxtran                     0   0.           0.                  dxtran                     0   0.            0.
forced collisions          0   0.           0.                  forced collisions          0   0.            0.
exp. transform             0   0.           0.                  exp. transform             0   0.            0.
from neutrons              0   0.           0.                  compton scatter            0   0.            9.2290E-01
bremsstrahlung       2216235   1.2982E-01   3.4943E-03          capture             18185155   1.2395E+00    6.7314E-02
  annihilation         54904   2.9290E-03   1.4968E-03          pair production        27452   1.4645E-03    2.7710E-03
electron x-rays            0   0.           0.
1st fluorescence     1263004   9.0768E-02   4.2231E-04
2nd fluorescence           0   0.           0.
    total          105441115   2.4004E+00   1.7246E+00              total          105441115   2.4004E+00    1.7246E+00
```

JRW

To Page No. ______

Witnessed & Understood by me,	Date	Invented by	Date
		Recorded by	

/home/jwelly/mcnp/cisfinal/cis20E0 James Weldy
20-1405-031
Book No. 345
Review of the CISF TSAR
8/20/98

From Pa

```
tally for  photons

this tally is modified by a dose function.

this tally is all multiplied by  1.39618E+16

detector located at x,y,z = 4.61772E+04-7.04572E+04 1.00000E+02
     energy
   1.0000E-01   4.35172E-05 0.4036
   1.2500E-01   1.69343E-05 0.3089
   1.5000E-01   1.42925E-05 0.3115
   1.7500E-01   1.56307E-05 0.3290
   2.0000E-01   1.29846E-05 0.3024
   2.5000E-01   4.02465E-05 0.3166
   3.5000E-01   4.64994E-05 0.1966
   5.5000E-01   8.15005E-05 0.1459
   8.5000E-01   1.21138E-04 0.0789
   1.2500E+00   1.56847E-04 0.0383
   1.7500E+00   1.13592E-04 0.0232
   2.2500E+00   3.23123E-05 0.0478
   2.7500E+00   0.00000E+00 0.0000
   3.5000E+00   0.00000E+00 0.0000
   3.7500E+00   0.00000E+00 0.0000
   4.2500E+00   0.00000E+00 0.0000
   5.0000E+00   0.00000E+00 0.0000
   1.0000E+01   0.00000E+00 0.0000
     total      6.95496E-04 0.0873

detector located at x,y,z = 4.61772E+04-7.04572E+04 1.00000E+02
 uncollided photon flux
     energy
   1.0000E-01   1.82285E-07 0.0964
   1.2500E-01   2.59326E-08 0.0855
   1.5000E-01   2.40636E-08 0.1293
   1.7500E-01   2.96116E-08 0.3952
   2.0000E-01   2.84583E-08 0.1537
   2.5000E-01   4.98243E-08 0.1269
   3.5000E-01   8.37288E-08 0.1821
   5.5000E-01   8.70442E-08 0.0854
   8.5000E-01   1.05811E-07 0.0781
   1.2500E+00   3.11113E-07 0.0349
   1.7500E+00   7.56409E-07 0.0106
   2.2500E+00   8.22437E-07 0.0156
   2.7500E+00   0.00000E+00 0.0000
   3.5000E+00   0.00000E+00 0.0000
   3.7500E+00   0.00000E+00 0.0000
   4.2500E+00   0.00000E+00 0.0000
   5.0000E+00   0.00000E+00 0.0000
   1.0000E+01   0.00000E+00 0.0000
     total      2.50672E-06 0.0172
```

detector score diagnostics

times average score	transmissions	cumulative fraction of transmissions	tally per history	cumulative fraction of total tally
1.00000E-01	51364381	0.72819	1.78733E-15	0.03352
1.00000E+00	15480724	0.94766	1.03623E-14	0.22783
2.00000E+00	1809392	0.97331	5.26738E-15	0.32660
5.00000E+00	1200436	0.99033	7.72301E-15	0.47144
1.00000E+01	393586	0.99691	5.63703E-15	0.57715
1.00000E+02	253637	0.99950	1.10518E-14	0.79564

Witne

JW

Input File

/home/jwelly/mcnp/cisfinal/cis20F James Weldy
20-1405-031
Book No. 345
Review of the CISF TSAR
8/20/98

TITLE

From P

```
Calculation of the dose around array of PWR MPCs for CISF
C Gamma source from radial sides
C
C Cell Cards

35 2 -2.406 -210 100 -187 imp:n,p=0.1 u=3 $ Concrete side shield
40 7 -0.001293 210:187:-100 imp:n,p=1 u=3 $ air around cask
C _____End of cask description - universe 3
82 0 -330 325 -340 335 -186 102 u=2 lat=1 imp:n,p=1 fill=0:74 0:3 &
     0:0 3 149R 5 149R $cask lattice
63 7 -0.001293 -300 #82 u=2 imp:n,p=1
C ______ Universe 2
76 0 -322 314 -310 302 -185 104 u=1 fill=2 imp:n,p=1  $pad-cask lattice
77 7 -0.001293 #76 -300 u=1 imp:n,p=1 $ other air - one pad only
C ________ Universe 4
73 0 -323 315 -313 305 -183 103 u=4 fill=2 lat=1 imp:n,p=1
C _______ Universe 1
70 0 -324 316 -405 307 -182 101 fill=4 (0 0 0) imp:n,p=1 $ lattice left
72 0 -435 420 -405 307 -182 101 fill=4 (47244 0 0) imp:n,p=1 $latt right
50 0 300 imp:n,p=0 $ rest of universe
60 8 -1.6 -101 -300 imp:n,p=1 $ ground under cask
80 7 -0.001293 -300 500 -600 700 -800 -900 #70 #72 #60 imp:n,p=1 $ air
81 7 -0.001293 -300 -500 505 700 -800 -900 #60 imp:n,p=10 $ air
93 7 -0.001293 -300 -505 510 700 -800 -900 #60 imp:n,p=10 $ air
83 7 -0.001293 -300 -510 515 700 -800 -900 #60 imp:n,p=100 $ air
84 7 -0.001293 -300 -515 520 700 -800 -900 #60 imp:n,p=100 $ air
85 7 -0.001293 -300 -520 525 700 -800 -900 #60 imp:n,p=1000 $ air
86 7 -0.001293 -300 -525 530 700 -800 -900 #60 imp:n,p=10000 $ air
87 7 -0.001293 -300 -530 535 700 -800 -900 #60 imp:n,p=10000 $ air
     -0.001293 -300 -535 540 700 -800 -900 #60 imp:n,p=10 $ air
     -0.001293 -300 -540 -900 #60 imp:n,p=0.0001 $ other air
90 7 -0.001293 -300 600 -900 #60 imp:n,p=0.0001
91 7 -0.001293 -300 -700 -900 -600 #60 imp:n,p=0.0001
92 7 -0.001293 -300 800 -900 -600 #60 imp:n,p=0.0001
94 7 -0.001293 -300 900 imp:n,p=0.0001
95 7 -0.001293 -300 imp:n,p=1 u=5


C
C Surface Cards
C
100 pz 0
101 pz 0.004
102 pz 0.001
103 pz 0.003
104 pz 0.002
182 pz 554.0596
183 pz 554.0597
185 pz 554.0598
186 pz 554.0599
187 pz 554.06
188 pz 75
189 pz 150
210 cz 190.5
300 so 720000
302 py -457.2
    py -457.199
307 py -457.198
310 py 1371.6
313 py 2895.6
314 px -304.8
```

Witne

JW

/home/jwelly/mcnp/cisfinal/cis20F

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```
315 px -304.798
316 px -304.798
322 px 4.54152e4
323 px 4.5415199e4
    px 4.5415198e4
325 px -304.8
330 px 304.8
335 py -457.2
340 py 457.2
405 py 65074.799
420 px 46939.199
435 px 92659.198
500 py -10457.2
505 py -20457.2
510 py -30457.2
515 py -40457.2
520 py -50457.2
525 py -60457.2
530 py -70457.2
535 py -80457.2
540 py -90000
600 py 70000
700 px -20000
800 px 120000
850 px 46162
855 px 46192.4
900 pz 8000

c
   terial Cards
c
m2   1001 -2.389e-2 8016 -1.281
     11023 -6.986e-2 13027 -8.192e-2
     14028 -.809 20040 -0.1057
     26056 -0.0338
m7   6012 -1.18e-7
     7014 -9.409e-4
     8016 -2.567e-4
     18040 -1.126e-5
m8   8016   -50.2
     14000   -26.5
     13027   -6.7
     26056   -5.5
     20000   -5.0
mode p
nps 100000000
c dbcn 0 0 100 300
c sdef sur=300 nrm=-1 erg=d1
c void
sdef erg=d1 axs=0 0 1 rad=d2 ext=d3 par=2 pos=d5 $ cel= d8
si1 A 0.1 0.125 0.15 0.175 0.20 0.25 0.35 0.55 0.850 &
    1.250 1.75 2.25
sp1 0.2652 0.1663 0.0855 0.0567 0.0307 0.043 0.0575 0.0726 0.0895 &
    0.0920 0.0245 0.0166
si2 290.5 290.51
    -21 1
si3 A 0 554.06
sp3 1 1
si5 L 0 0 0 609.6 0 0 1219.2 0 0 1828.8 0 0 2438.4 0 0 3048 0 0 3657.6 0 0 &
    4267.2 0 0 4876.8 0 0 5486.4 0 0 6096 0 0 6705.6 0 0 &
```

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```
4267.2 64617.6 0 4876.8 64617.6 0 5486.4 64617.6 0 6096 64617.6 0 6705.6 64617.6 0 &
64617.6 0 7315.2 64617.6 0 7924.8 64617.6 0 8534.4 64617.6 0 9144 64617.6 0&
9753.6 64617.6 0 10363.2 64617.6 0 &
10972.8 64617.6 0 11582.4 64617.6 0 12192 64617.6 0 12801.6 64617.6 0 &
3411.2 64617.6 0 14020.8 64617.6 0 14630.4 64617.6 0 15240 64617.6 0 &
15849.6 64617.6 0 16459.2 64617.6 0 &
17068.8 64617.6 0 17678.4 64617.6 0 18288 64617.6 0 18897.6 64617.6 0 &
19507.2 64617.6 0 20116.8 64617.6 0 20726.4 64617.6 0 21336 64617.6 0 &
21945.6 64617.6 0 22555.2 64617.6 0 &
23164.8 64617.6 0 23774.4 64617.6 0 24384 64617.6 0 24993.6 64617.6 0 &
25603.2 64617.6 0 26212.8 64617.6 0 26822.4 64617.6 0 27432 64617.6 0 &
28041.6 64617.6 0 28651.2 64617.6 0 &
29260.8 64617.6 0 29870.4 64617.6 0 30480 64617.6 0 31089.6 64617.6 0 &
31699.2 64617.6 0 32308.8 64617.6 0 32918.4 64617.6 0 33528 64617.6 0 &
34137.6 64617.6 0 34747.2 64617.6 0 &
35356.8 64617.6 0 35966.4 64617.6 0 36576 64617.6 0 37185.6 64617.6 0 &
37795.2 64617.6 0 38404.8 64617.6 0 39014.4 64617.6 0 39624 64617.6 0 &
40233.6 64617.6 0 40843.2 64617.6 0 &
41452.8 64617.6 0 42062.4 64617.6 0 42672 64617.6 0 43281.6 64617.6 0 &
43891.2 64617.6 0 44500.8 64617.6 0 45110.4 64617.6 0 47244 64617.6 0 &
47853.6 64617.6 0 48463.2 64617.6 0 &
49072.8 64617.6 0 49672.4 64617.6 0 50292 64617.6 0 &
50901.6 64617.6 0 51511.2 64617.6 0 52120.8 64617.6 0 52730.4 64617.6 0 &
53340 64617.6 0 53949.6 64617.6 0 &
54559.2 64617.6 0 55168.8 64617.6 0 55778.4 64617.6 0 56388 64617.6 0 &
56997.6 64617.6 0 57607.2 64617.6 0 58216.8 64617.6 0 58826.4 64617.6 0 &
59436 64617.6 0 60045.6 64617.6 0 &
60655.2 64617.6 0 61264.8 64617.6 0 61874.4 64617.6 0 62484 64617.6 0 &
63093.6 64617.6 0 63703.2 64617.6 0 64312.8 64617.6 0 64922.4 64617.6 0 &
5532 64617.6 0 66141.6 64617.6 0 &
66751.2 64617.6 0 67360.8 64617.6 0 67970.4 64617.6 0 68580 64617.6 0 &
69189.6 64617.6 0 69799.2 64617.6 0 70408.8 64617.6 0 71018.4 64617.6 0 &
71628 64617.6 0 72237.6 64617.6 0 &
72847.2 64617.6 0 73456.8 64617.6 0 74066.4 64617.6 0 74676 64617.6 0 &
75285.6 64617.6 0 75895.2 64617.6 0 76504.8 64617.6 0 77114.4 64617.6 0 &
77724 64617.6 0 78333.6 64617.6 0 &
78943.2 64617.6 0 79552.8 64617.6 0 80162.4 64617.6 0 80772 64617.6 0 &
81381.6 64617.6 0 81991.2 64617.6 0 82600.8 64617.6 0 83210.4 64617.6 0 &
83820 64617.6 0 84429.6 64617.6 0 &
85039.2 64617.6 0 85648.8 64617.6 0 86258.4 64617.6 0 86868 64617.6 0 &
87477.6 64617.6 0 88087.2 64617.6 0 88696.8 64617.6 0 89306.4 64617.6 0 &
89916 64617.6 0 90525.6 64617.6 0 &
91135.2 64617.6 0 91744.8 64617.6 0 92354.4 64617.6 0
sp5 D 1 5999R
f45:p 46177.2  -70457.2  100 15 &
      46177.2  -80457.2  100 15 $ south end between rows 700 m
f2:p 500 505 510 520 525 530 535
fs2 -188 -850 189 855
sd2 1 1 1 1 2280 1 1 1 1 2280 1 1 1 1 2280 1 1 1 1 2280 1 1 1 1 2280 &
    1 1 1 1 2280 1 1 1 1 2280
e0  0.1 0.125 0.15 0.175 0.2 0.25 0.35 0.55 0.85 1.25 1.75 2.25 &
    2.75 3.5 3.75 4.25 5.0 10.0
de0  0.05 0.07 0.1 0.15 0.2 0.25 0.35 0.55 1.0 &
     1.4 1.8 2.2 2.8 3.25 4.25 5 5.75 6.75 7.5 9 11
df0  log 2.9e-7 2.58e-7 2.83e-7 3.79e-7 5.01e-7 6.31e-7 8.78e-7 1.27e-6 &
     1.98e-6 2.51e-6 2.99e-6 3.42e-6 4.01e-6 4.41e-6 5.23e-6 5.8e-6 6.37e-6 &
     7.11e-6 7.88e-6 8.77e-6 1.03e-5
c mrem/hr = 1.7740e4 (gammas/sec/cm2)*2*pi*290.5*554.06 * 6000 casks*1000 mrem/rem
fm45 1.0764e17 $ convert result into mrem/hr
fm2 1.0764e17 $ convert result into mrem/hr
```

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```
prdmp -5000 -120 0
cut:p 9e99 0.001 -1e-6 -0.0000001
```

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8/29/98

JLW

To Page No.______

Witnessed & Understood by me,	Date	Invented by	Date
		Recorded by	

Output file

/home/jweldy/mcnp/cisfinal/cis20Fo James Weldy
20-1405-031
Book No. 345
Review of the CISF TSAR

```
1mcnp     version 4a    ld=10/01/93                  08/11/98 16:44:03
**************************************************************************

c i=contjw o=cis20Fo r=cis20Fr

starting from dump no.  116 from file cis20Fr      nps = 191055524     ctm =18821.72     probid =    08/20/98 08:46:00

Calculation of the dose around array of PWR MPCs for CISF

   1-        continue
   2-        nps 1500000000

      119 warning messages so far.

*********************************************************************************************************
dump no.  117 on file cis20Fr      nps = 193151124     coll =      2318331441     ctm =18941.73     nrn =     32988737333

*********************************************************************************************************
dump no.  118 on file cis20Fr      nps = 194770259     coll =      2342274969     ctm =19123.67     nrn =     33337680069

*********************************************************************************************************
dump no.  119 on file cis20Fr      nps = 196927770     coll =      2355227469     ctm =19243.67     nrn =     33530561459

*********************************************************************************************************
dump no.  120 on file cis20Fr      nps = 199210509     coll =      2368024188     ctm =19363.67     nrn =     33722513080

*********************************************************************************************************
dump no.  121 on file cis20Fr      nps = 201331764     coll =      2380993843     ctm =19483.67     nrn =     33917162947

*********************************************************************************************************
dump no.  122 on file cis20Fr      nps = 203517285     coll =      2394014003     ctm =19603.68     nrn =     34111875936

*********************************************************************************************************
dump no.  123 on file cis20Fr      nps = 205749677     coll =      2406931735     ctm =19723.68     nrn =     34305289392

*********************************************************************************************************
dump no.  124 on file cis20Fr      nps = 207887192     coll =      2420027014     ctm =19843.68     nrn =     34501023586

*********************************************************************************************************
dump no.  125 on file cis20Fr      nps = 210096458     coll =      2432975003     ctm =19963.69     nrn =     34694547834

*********************************************************************************************************
dump no.  126 on file cis20Fr      nps = 212258865     coll =      2446050464     ctm =20083.70     nrn =     34889854895

*********************************************************************************************************
dump no.  127 on file cis20Fr      nps = 214415312     coll =      2459012785     ctm =20203.70     nrn =     35083612509

*********************************************************************************************************
dump no.  128 on file cis20Fr      nps = 216653395     coll =      2471857993     ctm =20323.70     nrn =     35276138411
```

James Welty
20-1705-031
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9/11/98
Review of the CISF TSAR
/home/jwelty/mcnp/cisfinal/cis2050

```
5.01+10      1 3.87-19  -18.412 **************************
6.31+10      0 0.00+00    0.000
- 94+10      0 0.00+00    0.000
  J0+11      0 0.00+00    0.000
1.26+11      0 0.00+00    0.000
1.58+11      1 1.22-19  -18.912 *
 total      10 3.99-08          d-----------------------------------------d-------------------------------------------d


cumulative tally number for tally   2        nonzero tally mean(m) = 2.769E+10   nps = 250730760    print table 162

  abscissa      cum    ordinate   plot of the cumulative number of tallies in the tally fluctuation chart bin from 0 to 100 percent
   tally       number  cum pct:---------10---------20---------30---------40---------50---------60---------70---------80---------90-------100
 5.01188E+09      3    30.000|*********|*********|*********|         |         |         |         |         |         |         |
 6.30956E+09      5    50.000|*********|*********|*********|*********|*********|         |         |         |         |         |
 7.94331E+09      6    60.000|*********|*********|*********|*********|*********|*********|         |         |         |         |
 1.00000E+10      6    60.000|*********|*********|*********|*********|*********|*********|         |         |         |         |
 1.25893E+10      6    60.000|*********|*********|*********|*********|*********|*********|         |         |         |         |
 1.58490E+10      6    60.000|*********|*********|*********|*********|*********|*********|         |         |         |         |
 1.99526E+10      7    70.000|*********|*********|*********|*********|*********|*********|*********|         |         |         |
 2.51190E+10      7    70.000|*********|*********|*********|*********|*********|*********|*********|         |         |         |
 3.16228E+10      7    70.000|mmmmmmmmm|mmmmmmmmm|mmmmmmmmm|mmmmmmmmm|mmmmmmmmm|mmmmmmmmm|mmmmmmmmm|         |         |         |
 3.98109E+10      8    80.000|*********|*********|*********|*********|*********|*********|*********|*********|         |         |
 5.01188E+10      9    90.000|*********|*********|*********|*********|*********|*********|*********|*********|*********|         |
 6.30956E+10      9    90.000|*********|*********|*********|*********|*********|*********|*********|*********|*********|         |
 7.94331E+10      9    90.000|*********|*********|*********|*********|*********|*********|*********|*********|*********|         |
 1.00000E+11      9    90.000|*********|*********|*********|*********|*********|*********|*********|*********|*********|         |
 1.25893E+11      9    90.000|*********|*********|*********|*********|*********|*********|*********|*********|*********|         |
 ‘ 58490E+11     10   100.000|*********|*********|*********|*********|*********|*********|*********|*********|*********|*********|
   total         10   100.000:---------10---------20---------30---------40---------50---------60---------70---------80---------90-------100
1tally  45        nps =250730760
           tally type 5    particle flux at a point detector.
           tally for  photons

           this tally is modified by a dose function.

           this tally is all multiplied by  1.07640E+17

 detector located at x,y,z = 4.61772E+04-7.04572E+04 1.00000E+02
      energy
   1.0000E-01   3.44182E-04 0.4065
   1.2500E-01   8.85313E-05 0.3050
   1.5000E-01   5.82102E-05 0.2342
   1.7500E-01   6.41200E-05 0.3720
   2.0000E-01   6.38418E-05 0.2717
   2.5000E-01   8.93254E-05 0.1977
   3.5000E-01   1.59029E-04 0.1782
   5.5000E-01   3.67605E-04 0.1535
   8.5000E-01   4.44223E-04 0.1028
   1.2500E+00   5.80569E-04 0.0425
   1.7500E+00   5.52714E-04 0.1322
   2.2500E+00   2.27160E-04 0.0117
   2.7500E+00   0.00000E+00 0.0000
   3.5000E+00   0.00000E+00 0.0000
   3.7500E+00   0.00000E+00 0.0000
   4.2500E+00   0.00000E+00 0.0000
   5.0000E+00   0.00000E+00 0.0000
   1.0000E+01   0.00000E+00 0.0000
     total      3.01251E-03 0.0890
```

Recorded by James Welty | JRW 6/9/98

1 James Weldy
20-1405-031
9/18/98
Book No. 345

Review of the CISF TSAR

Calculation of Dose Rate from an Array of CISF casks.

Flux distribution on exterior of cask from page II-163 of DOE Calcs.

0	
210	↑
210–240	2.32216×10^{-2}
240–270	2.9339×10^{-2}
270–300	3.34389×10^{-2}
300–330	3.17413×10^{-2}
330–340	2.60473×10^{-2}
340–350	1.75947×10^{-2}
350	↓
450	

Assume that the measured fluxes at the top + bottom extend all the way to the edge of the cask. (extremely conservative as the flux will drop considerably past the region outside the fuel). Each 30 cm segment constitutes $\frac{30\ cm}{450\ cm} = 0.0667$ of the outside area. Therefore, areally averaged flux on outside of cask is equal to 2.39416×10^{-2}, or 71.6% of the maximum. This factor should be applied to the dose rate calculated from the sides of the cask.

Dose rate from max. flux around entire side of casks: 3.01×10^{-3} mrem/hr

Dose rate from top of casks: 6.95×10^{-7} mrem/hr - from MCNP calcs

Total dose rate from cask array $= 0.716 \times 3.01 \times 10^{-3} + 6.95 \times 10^{-7}$
$= 2.85 \times 10^{-3}$ mrem/hr

Total annual dose from cask array = 24.98 mrem/yr assuming 100% occupation by a member of the public

This confirms that the dose calculation performed by the DOE is acceptable

JRW

Independent Calculations for CIS TSAR:

Confirm that doses in unrestricted areas will be less than 2 mrem/hr.

Page 9.3-4: Calculation of dose rates in unrestricted areas of the transfer facility

1. Locker room: 18 in of concrete, 22 ft from source

from Hubbell, $\frac{\mu}{\rho}$ of concrete for 800 keV γ's (about 90% of source term is this or less) is 0.071 cm^2/g

$$\dot{D} = \dot{D}_o \cdot B \cdot e^{-\mu/\rho \cdot \rho \cdot x} \cdot G$$

$\dot{D}$ = Dose rate in area (mrem/hr)

$\dot{D}_o$ = 10 mrem/hr at 2 m

$\frac{\mu}{\rho}$ = attenuation coefficient $(\frac{cm^2}{g})$

ρ = density (g/cm^3) = 2.35 for concrete

x = thickness of shielding (cm)

G = Geometry factor - use cask as line source and dose falls off as $\frac{1}{r}$ - conservative est.

B = Buildup factor (from RHH) - for 800 keV γ through 18 in concrete (mix of Al + Fe): 19.25

$$\dot{D} = 10\ mrem/hr \cdot 17.25 \cdot e^{-0.071 \cdot 2.35 \cdot 18\,in \cdot \frac{2.54\,cm}{in}} \cdot \frac{2\,m \cdot 100}{22\,ft \cdot 12 \cdot 2.54}$$

$$\dot{D} = 10\ mrem/hr \cdot \frac{1}{358}$$

$\dot{D}$ = 0.028 mrem/hr. Much less than allowable dose rate in unrestricted area of 2 mrem/hr

2. Remote operating room: 18 in of concrete, no distance given so G = 1

$$\dot{D} = 10\ mrem/hr \cdot 19.25 \cdot e^{-0.071 \cdot 2.35 \cdot 18 \cdot 2.54}$$

$$\dot{D} = 10\ mrem/hr \cdot \frac{1}{106.8}$$

$\dot{D}$ = 0.094 mrem/hr. Much less than 2 mrem/hr.

3. Crane operating room: 10 in of concrete, 50 ft. from source

$$\dot{D} = 10\ mrem/hr \cdot 8.5 \cdot e^{-0.071 \cdot 2.35 \cdot 10 \cdot 2.54} \cdot \left(\frac{2\,m \cdot 100}{50\,ft \cdot 12 \cdot 2.54}\right)^2$$ ← far enough to follow $\frac{1}{r^2}$

$$\dot{D} = 10\ mrem/hr \cdot \frac{1}{473}$$

$\dot{D}$ = ~~0.10~~ 0.021 mrem/hr. Much less than 2 mrem/hr

JRW

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20-1405-031
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Review of the CISF TSAR

Independent Calcs - 17 9.3-4 - Dose rates in operational areas

11-14-97

4. Remote operating cubicles 12 in concrete, 20 feet away

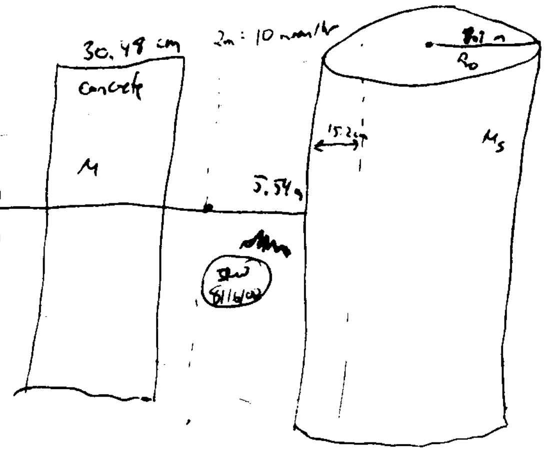
$\dot{D} = 10 \text{ mrem/hr} \cdot 10.75 \cdot e^{-0.071 \cdot 2.35 \cdot 12 \cdot 2.54} \cdot \frac{2 \cdot 100}{20 \cdot 12 \cdot 2.54}$

$\dot{D} = 10 \text{ mrem/hr} \cdot \frac{1}{45.8}$

$\dot{D} = 0.22 \text{ mrem/hr}$

This one is kind of close. Lets model it more accurately.

- Ignore attenuation of air
- Assume activity is evenly distributed w/in cylinder
- Approximate as line source w/in cylinder
- Density $\approx [2.31 \text{ g/cm}^3 \text{ (fuel)} + 2.41 \text{ (concrete)}]/2 = 2.36 \text{ g/cm}^3$ (JRW 8/16/00)
- Use M for concrete and 800 keV for cask



First, calculate the 10 mrem/hr at 2 m back to a line source photon emission rate

$\frac{a}{R_0} = \frac{2}{1.9} = 1.05 \approx 10$

$M_s/\rho = M/\rho = 0.07103 \frac{cm^2}{g}$

$M_s(a + R_0) = 0.07103 \frac{cm^2}{g} \cdot 3.9 \text{ m} \cdot 100 \text{ cm/m} = 27.7 \frac{cm^2}{g} \cdot 2.36 \text{ g/cm}^3$

$M_s(a+R_0) = 65.4$

$m = 1.7$

$b = \Sigma M \cdot t = \cdot 2.36 \cdot 0 = 0$ (JRW 8/16/00)

$\frac{1}{m} M_s z = 1.5$

$z = 15.2 \text{ cm}, \quad \theta_{c_1} = \theta_{c_2} = \tan^{-1}\left(\frac{277}{215.2}\right) = 0.91 \text{ rad} = 52°$

$\phi = \frac{S_v \cdot R_0^2}{4(a+z)} [F(\theta_2, b) + F(\theta, b)]$

$\dot{D} \phi' = \frac{S_v \cdot (190 \text{ cm})^2}{4(215.2 \text{ cm})} [.83 + .83] = S_v \cdot 139.2 \frac{\gamma}{sec \cdot cm^2}$ (JRW 8/16/00)

$S_v = \frac{10 \text{ mrem/hr} \cdot \phi' \text{ γ/sec/cm}^2\text{/mrem/hr}}{139.2} = 7.18 \times 10^{-2} \cdot \phi' \frac{\gamma/sec}{cm^3}$ (JRW 8/16/00)

R_0: radius of cask

a = distance between dose point and front of cask

S_v = emission rate from source $\left(\frac{\gamma/sec}{cm^3}\right)$

JRW

James Welty
20-1405-031
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Independent Calcs - Dose rates in operational areas - page 9-3.4

11-14-97

4. (cont)

Now, calculate the dose at 20 feet behind 12 inches of concrete

$S_v = 7.18 \times 10^{-2} \cdot \phi' \frac{\gamma/sec}{cm^3}$

$a = 6.1 \text{ m}$

$R_0 = 1.9 \text{ m}$

$\frac{M_s}{\rho_s} = \frac{M}{\rho} = 0.07103 \frac{cm^2}{g}$ (E = 800 keV)

$\rho_s = 2.36 \frac{g}{cm^3}$

$\rho = 2.41 \frac{g}{cm^3}$

$\frac{a}{R_0} = \frac{6.1}{1.9} = 3.21 \approx 10$

$M_s(a + R_0) = 0.07103(610 + 190) \cdot 2.36 = 56.8 \cdot 2.36 = 134$

$m = 2$

$b' = \Sigma M t = 12 \text{ in} \cdot 2.54 \text{ cm/in} \cdot 0.07103 \frac{cm^2}{g} \cdot 2.41 \frac{g}{cm^3}$

$b' = 5.2$

$\frac{1}{m} M_s z = 1.08$

$z = 12.9 \text{ cm}$

$b = 0.07103 \cdot 2.41 \cdot 12 \text{ in} \cdot 2.54 + 0.07103 \cdot 2.36 \cdot 12.9$

$b = 7.38$

$\theta_1 = \theta_2 = \tan^{-1}\left(\frac{277}{623}\right) = 0.4184 = 24°$

$\phi = \frac{S_v R_0^2}{4(a+z)} [F(\theta_2, b) + F(\theta_1, b)] \cdot B$ (JRW 11-14-97)

$\phi = \frac{7.18 \times 10^{-2} \cdot \phi' (190 \text{ cm})^2}{4(610 + 12.9)}$ ~~$[1.05 \times 10^{-4} + 1.05 \times 10^{-4}]$~~ $[2.1 \times 10^{-4} + 2.1 \times 10^{-4}] \cdot B$

$\frac{\phi}{\phi'} = \dot{D} = 1.04 [2.1 \times 10^{-4}] \cdot 2 \cdot B$

$\dot{D} =$ ~~$2.18 \times 10^{-4} \frac{mrem}{hr}$~~ $4.37 \times 10^{-4} \frac{mrem}{hr} \cdot B$ (JRW 11-14-97)

B = Buildup factor for a plane, monodirectional source

$B = B_{Fe}$ (assumed) ≈ 6.2 → from Hubbell (1982)

$\dot{D} = 2.71 \times 10^{-3}$ mrem/hr ∴ we can see that the rough estimate is very conservative. The conclusion in the TSAR is accurate.

JRW

Recorded by	James Welty	Date
Recorded by	James Welty	6/9/99

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Review of the CISF TSAR
James Weldy
20-1405-031
11/14/97
Book No. 345

Independent Calculation for the dose rate at the queuing area

From before, emission rate from the cask $= 7.18 \times 10^{-2}\ \phi'\ \frac{\gamma/sec}{cm^3}$

Total emission rate from cask: $7.18 \times 10^{-2}\ \phi'\ \frac{\gamma/sec}{cm^3} \cdot \pi (190\ cm)^2 \cdot 554\ cm$

Total emission rate $= 4.51 \times 10^6 \cdot \phi'\ \gamma/sec = S$

Far enough to consider this a point source and consider air attenuation

$\frac{\mu}{\rho}_{air} = 0.0707\ (E = 900\ keV)\ \frac{cm^2}{g}$

$\rho_{air} = 0.001293\ \frac{g}{cm^3}$

$\phi = \frac{S}{4\pi r^2} B e^{-\mu x}$ — neglect buildup in air

$\phi = \frac{4.51 \times 10^6 \cdot \phi'\ \gamma/sec}{4\pi \cdot (5000\ cm)^2} \cdot 1 \cdot e^{-.0707 \cdot .001293 \cdot 5000}$

$\frac{1}{\phi'} \cdot \phi = 0.014\ mrem/hr\ e^{-.457}$

$\dot{D}_{cask} = 0.0089\ mrem/hr$

$\dot{D}_{Total} = 0.044\ mrem/hr$ — 50 m setback is plenty to reduce dose to below 2 mrem/hr

JRW

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12-17-97

Calculation of dose to an off-site individual from the release of Cs-137 from external contamination of 6000 storage casks in CISF TSAR

Allowable Concentration on storage cask $= 300\ dpm/cm^2$

$= 300\ dpm/cm^2 \cdot \frac{1\ Bq}{60\ dpm} \cdot \frac{1\ Ci}{3.7 \times 10^{10}\ Bq}$

$= 1.35 \times 10^{-10}\ Ci/cm^2$

Surface area of storage cask = top + sides

$= \pi r^2 + 2\pi r h$

$= \pi \cdot (190.5\ cm)^2 + 2 \cdot \pi \cdot 190.5\ cm \cdot 554.06\ cm$

$= 1.14 \times 10^5\ cm^2 + 6.632 \times 10^5\ cm^2$

$= 7.772 \times 10^5\ cm^2/cask$

Source term: Conc. · Surface Area · # of casks

$= 1.35 \times 10^{-10}\ Ci/cm^2 \cdot 7.772 \times 10^5\ cm^2/cask \cdot 6000\ casks$

$= 0.63\ Ci$

Assume that 0.63 Ci are released in 1 year. Since this is a generic site, use a Gaussian Plume model with stability class F, wind speed 1 m/sec, and assume the wind blows towards the receptor 50% of the year. Also assume a lid height of 1000 m. Receptor point is 700 m away

$\frac{\chi}{Q} = \frac{1}{\bar{u}\,\pi\,\sigma_y\,\sigma_z} \cdot 0.5$

My results: 4.11 mrem/yr
~~CAP-88 results: 4.5919 mrem/yr~~
Conclusions based on hand calculations JRW 1/25/98

$\bar{u} = 1\ m/sec$

$\sigma_y = 27\ m$

$\sigma_z = 10\ m$

$\frac{\chi}{Q} = \frac{1}{1\ m/sec \cdot \pi \cdot 27\ m \cdot 10\ m} = 1.18 \times 10^{-3}\ \frac{sec}{m^3} \cdot 0.5$

$\chi_{receptor} = 1.18 \times 10^{-3}\ \frac{sec}{m^3} \cdot 0.63\ Ci/yr \cdot \frac{1\ yr}{3.16 \times 10^7\ sec} \cdot 0.5$

$\chi_{receptor} = 1.18 \times 10^{-11}\ \frac{Ci}{m^3}$

Air breathed in 1 yr $= 8.33 \times 10^6\ L = 8330\ m^3$

Cs-137 inhaled $= 1.18 \times 10^{-11}\ \frac{Ci}{m^3} \cdot 8330\ m^3 = 9.83 \times 10^{-8}\ Ci$ (Eckerman, 1988)

$Dose_{inh} = 9.83 \times 10^{-8}\ Ci \cdot 8.63 \times 10^{-9}\ \frac{Sv}{Bq} \cdot \frac{100\ rem}{1\ Sv} \cdot \frac{3.7 \times 10^{10}\ Bq}{Ci} = 3.14\ mrem$

Dose ground = 9.18 × 10⁻¹¹ Ci/m³ · [illegible] · 8.6 × [illegible] mrem/(Ci/m²) · 3.16 × 10⁷ s/yr = 0.77 mrem (+ LaPlante, 1997)

m is less than 5 mrem, so is acceptable

JRW

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THIS GROUP OF CALCULATIONS COVERS A REVIEW OF CHAPTERS 3 "PRINCIPAL DESIGN CRITERIA", 7 "INSTALLATION DESIGN AND STRUCTURAL EVALUATION" OF THE TSAR "CENTRALIZED INTERIM STORAGE FACILITY TOPICAL SAFETY ANALYSIS REPORT"

THE REVIEW WAS IN SUPPORT OF CHAPTERS 4 & 5 OF "ASSESSMENT REPORT OF TOPICAL SAFETY ANALYSIS REPORT FOR THE CENTRALIZED INTERIM STORAGE FACILITY (DOCKET NO 72-21)"

THIS IS A TOPICAL REPORT AND THEREFORE THE INFORMATION PRESENTED IN THE TSAR IS LIMITED. ONLY LIMITED CHECKS OF THE PRELIMINARY ANALYSIS ARE GIVEN. COPIES OF CALCULATIONS PRODUCED ~~AT~~ (DSP 6/9/99) DURING THE REVIEW ARE INCLUDED HERE.

					Analysis
LONG BEAMS	6×3	②	5497	lbsec²/in	[5735]
	6×4	①	~~5556~~ 6311	lbsec²/in	[6316]

DSP 8/16/2000 └ side and end walls

MODAL	freq	Effective	
X DIREC	5.505	17771	
	8.46	42419	Σ 71%
Y-DIREC	5.616	9484	
	23.66	2447	
	24.66	2728	
	31.83	2936	Σ 57%
Z-DIREC	3.701	68819	≈ 93%

DTP

DTP

Y - Vertical
X - Longitudinal Direct
Z - Cross direct.

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THE MASS OF THE MAJOR BEAMS IN THE TRANSFER FACILITY WAS FOUND TO BE PROPERLY IMPLEMENTED IN THE ANALYSIS

THE RESOLVED MODAL MASS IN THE ANALYSIS WAS CHECKED. THE Z-DIREC WAS 93% THE X-DIRECTION WAS 71% AND THE Y-DIRECTION WAS 57%

THE GEOMETRY OF THE SLAB WAS THEN CHECKED, MASS & INERTIA

23 July 98

Slab Geometry checks

720 960
60' × 80' × 3'

14,400 ft³ ⇒ 2,160,000 lbs ⇒ 5,596 lbsec²/in

DSP 8/16/2000

ANALYSIS 5745.3 lbsec²/in — 2.6% high ~~[illegible]~~ added thickness) use 37" got 5745.3 lbsec²/in ✓

$I = \frac{1}{12} b t^3$

AREA

$I_1 = \frac{1}{12}(720)(960)^3 = .531 \times 10^{11}$ in⁴

$I_2 = \frac{1}{12}(960)(720)^3 = .299 \times 10^{11}$ in⁴

$I_p = \frac{1}{12}(720)(960)(720^2 + 960^2) = .829 \times 10^{11}$ in⁴

MASS MOMENT OF INERTIA

$I_1 = \frac{1}{12}(\text{mass})(960)^2 = .441 \times 10^9$ lbsec²in ✓

$I_2 = \frac{1}{12}(\text{mass})(720)^2 = .248 \times 10^9$ " ✓

$I_p = \frac{1}{12}(\text{mass})(960^2 + 720^2) = .689 \times 10^9$ " ✓

ADDITIONAL CHECKS OF THE BUILDING STRUCTURE WERE MADE. THE CALCULATED WALL & ROOF WEIGHT COMPARED TO THE ANALYSIS

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From P.

Building Checks
Checks 7/23/99
DJP

Wall Height 75' 18" Thick

Building Length 250'

Building Width 88'

Vertical Columns 2×11 @ 4×8 (6) (5)
2×2 @ 4×3 (6)

Long Beams 1×2 @ 6'×5' @ 128'
1×2 @ 6×4' @ 150'
1×2 @ 6×4' @ 176'
2×1 @ 3×4' Roof

Roof Beams 11 @ 5×4'
Comer @ 6×4

Roof 14" Thick

Walls 75'×260'×2'×18" = 56,250 ft³ ⇒ 8.438×10⁶
End Walls 75'×88'×2'×18" = 19,800 ft³ ⇒ 2.970×10⁶
Roof 88'×250'×14" = 25,666 ft³ = 3.850×10⁶

15.258×10⁶ lb

Analysis (18) Walls = 77683 ≈ (29554)
(19) Roof = 10247 ≈ (9974)

39,530 lb sec²/in

Vertical Columns 360,000 lbs each (932.6 lb sec²/in)
Analysis [22,897] 20,518 lb sec²/in total
135,000 lbs each (349.7 lb sec²/in)
Analysis [1546] 1,399 lb sec²/in

Roof Beams Analysis
3×4 450,000 lbs each 1,166 lb sec²/in ⇒ 2332 (4) [2486]
5×4 264,000 lbs each 684 lb sec²/in ⇒ 6155 (8) [6260]
6×4 4663 (10) [4935]

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As noted this was a topical report. Detailed results were not given. Based on checks of the model geometry the seismic analysis is considered adequate.

DJP

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I have reviewed this scientific notebook and find it in compliance with QAP-001. There is sufficient information regarding procedures used for conducting tests, acquiring and analyzing data so that another qualified individual could repeat the activity.

[signature] 6/10/99

MGFE Manager

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		Recorded by	

ADDITIONAL INFORMATION FOR SCIENTIFIC NOTEBOOK #: 345

Document Date:	06/09/1999
Availability:	Southwest Research Institute® Center for Nuclear Waste Regulatory Analyses 6220 Culebra Road San Antonio, Texas 78228
Contact:	Southwest Research Institute® Center for Nuclear Waste Regulatory Analyses 6220 Culebra Road San Antonio, TX 78228-5166 Attn.: Director of Administration 210.522.5054
Data Sensitivity:	■"Non-Sensitive" □ Sensitive □"Non-Sensitive - Copyright" □ Sensitive - Copyright
Date Generated:	10/04/2000
Operating System: (including version number)	Windows
Application Used: (including version number)	Various
Media Type: (CDs, 3 1/2, 5 1/4 disks, etc.)	1 CD
File Types: (.exe, .bat, .zip, etc.)	Various
Remarks: (computer runs, etc.)	Media contains schielding calculations for CISF