~~XXXX~~ RMIS View/Print Document Cover Sheet ~~XXXX~~

This document was retrieved from the Boeing ISEARCH System.

Accession #: D196050130

Document #: SD-FF-TA-040

Title/Desc:

RADIOLOGICAL CONSEQUENCES OF A POSTULATED DROP OF
A MAXIMALLY LOADED FFTF FUEL CASK

Sept 22, 1995
Station 35 **22**

ENGINEERING DATA TRANSMITTAL

Page 1 of 1
1. EDT 605973

2. To: (Receiving Organization) FFTF Engineering/18200	3. From: (Originating Organization) Consequence Analysis/8M400	4. Related EDT No.:
5. Proj./Prog./Dept./Div.: FFTF	6. Cog. Engr.: P. L. Scott	7. Purchase Order No.:
8. Originator Remarks: This document is for Approval and Release.		9. Equip./Component No.:
		10. System/Bldg./Facility: FFTF
11. Receiver Remarks:		12. Major Assm. Dwg. No.:
		13. Permit/Permit Application No.:
		14. Required Response Date:

15. DATA TRANSMITTED					(F)	(G)	(H)	(I)
(A) Item No.	(B) Document/Drawing No.	(C) Sheet No.	(D) Rev. No.	(E) Title or Description of Data Transmitted	Approval Designator	Reason for Transmittal	Originator Disposition	Receiver Disposition
1	WHC-SD-FF-TA-039		0	Radiological Consequences of a Hypothetical Disruption of a Maximally Loaded FFTF Fuel Cask	SQ	1	1	
2	WHC-SD-FF-TA-040		0	Radiological Consequences of a Postulated Drop of a Maximally Loaded FFTF Fuel Cask	SQ	1	1	

16. KEY					
Approval Designator (F)		Reason for Transmittal (G)		Disposition (H) & (I)	
E, S, Q, D or N/A (see WHC-CM-3-5, Sec. 12.7)		1. Approval 2. Release 3. Information	4. Review 5. Post-Review 6. Dist. (Receipt Acknow. Required)	1. Approved 2. Approved w/comment 3. Disapproved w/comment	4. Reviewed no/comment 5. Reviewed w/comment 6. Receipt acknowledged

17. SIGNATURE/DISTRIBUTION (See Approval Designator for required signatures)										(G)	(H)
Reason	Disp.	(J) Name	(K) Signature	(L) Date	(M) MSIN	(J) Name	(K) Signature	(L) Date	(M) MSIN	Reason	Disp.
		Cog. Eng. P.L. Scott	<i>P.L. Scott</i>	9/1/95	N2-02	J. C. Van Keuren	<i>J. C. Van Keuren</i>	8/30/95	H4-64		
		Cog. Mgr. S. Guttenberg	<i>S. Guttenberg</i>	9/7/95	N2-53	D. S. Leach	<i>D. S. Leach</i>	9/15/95	H4-64		
		QA J.E. Parker	<i>J.E. Parker</i>	9/9/95	N2-11	S.W. Hiller	<i>S.W. Hiller</i>	9/7/95	N2-02		
		Safety R.O. Zimmerman	<i>R.O. Zimmerman</i>	9/1/95	N2-10	W.A. Dautel	<i>W.A. Dautel</i>	9/7/95	N2-13		
		Env.				R.B. Packard	<i>R.B. Packard</i>	9/7/95	N2-02		

18. D.A. Hiller <i>D.A. Hiller</i> Signature of EDT Date 8/28/95 Originator	19. S.W. Hiller <i>S.W. Hiller</i> Authorized Representative Date 9/7/95 for Receiving Organization	20. S. Guttenberg <i>S. Guttenberg</i> Cognizant Manager Date 9/20/95	21. DOE APPROVAL (if required) Ctrl. No. ☐ Approved ☐ Approved w/comments ☐ Disapproved w/comments
---	---	--	---

RELEASE AUTHORIZATION

Document Number: WHC-SD-FF-TA-040, Rev. 0

Document Title: Radiological Consequences of a Postulated Drop of a Maximally Loaded FFTF Fuel Cask

Release Date: 9/22/95

**This document was reviewed following the
procedures described in WHC-CM-3-4 and is:**

APPROVED FOR PUBLIC RELEASE

WHC Information Release Administration Specialist:

C. WILLINGHAM

9/22/95

TRADEMARK DISCLAIMER. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof or its contractors or subcontractors.

This report has been reproduced from the best available copy. Available in paper copy. Printed in the United States of America. To obtain copies of this report, contact:

Westinghouse Hanford Company - Document Control Services
P.O. Box 1970, Mailstop H6-08, Richland, WA 99352
Telephone: (509) 372-2420; Fax: (509) 376-4989

SUPPORTING DOCUMENT

1. Total Pages 19

2. Title

Radiological Consequences of a Postulated Drop of a Maximally Loaded FFTF Fuel Cask

3. Number

WHC-SD-FF-TA-040

4. Rev No.

0

5. Key Words

ISC, FFTF

6. Author

Name: D. A. Himes

Signature *[Signature]* 3/28/95

Organization/Charge Code 8M400/B193F

7. Abstract

Onsite and site boundary radiological consequences were estimated for a postulated accidental drop of an Interim Storage Cask (ISC) loaded with 7 assemblies at the maximum available burnup. The postulated cask drop was assumed to occur from the maximum physically attainable height during crane movement of the cask. The resulting onsite and site boundary doses of 45 mSv and 0.04 mSv are far below the corresponding 1 Sv and 250 mSv risk guidelines for highly unlikely accidents.

8. RELEASE STAMP

OFFICIAL RELEASE	22
DATE	Sept 22, 1995
Station 35	on

RADIOLOGICAL CONSEQUENCES OF A POSTULATED DROP OF A MAXIMALLY LOADED FFTF FUEL CASK

D.A. Himes
8/21/95

Radiological consequences onsite and at the site boundary are required for a postulated accidental drop of an Interim Storage Cask (ISC) loaded with 7 assemblies at the maximum available burnup. Several assemblies exist in the inventory with average burnups approaching 200,000 MWd/MTHM. The maximum assembly is the ACO-4 experiment with 199,400 MWd/MTHM average burnup. There are a few metal fuel assemblies and some carbide pins from AC-3 and ACN-1, however these are expected to be bounded by the high burnup driver fuel assemblies assumed for this analysis.

The postulated cask drop is to occur from the maximum physically attainable height during crane movement of the cask. The assemblies or pin containers will be contained within a Core Component Container (CCC) which will be placed inside the ISC. The ISC is fabricated of reinforced concrete with a 1.5 in. thick stainless steel liner, and is equipped with a crushable pad impact limiter which supports the CCC. In spite of the presence of the impact limiter, the postulated drop is assumed to mechanically shock the fuel enough to cause cracking in 100% of the pins and to crush and expose 1% of the fuel material. Such an impact, however, is not expected to be able to produce a major escape path out of the cask. Instead, such an impact would, at most, produce some possible cracked welds or a lid seal failure.

Source Term Development:

The cask drop is conservatively assumed to produce failure of the seven fuel assemblies similar to, but less severe than, a previously analyzed hypothetical cask disruption accident (Himes 1993). 100% of the pins were assumed to fail in the fueled region, and, as before, 100% of the noble gases and tritium and 5% of the halogens were assumed to escape from the cask. However, only 1% of the pellets were assumed to be crushed and exposed, and only 1% of the particulates released from the fuel pins were assumed to follow the tortuous path out of the Core Component Container and the damaged Interim Storage Cask to the environment. The release fractions in terms of the inventory in one assembly were developed as follows.

Noble gases and tritium: 100% of pins breached
 100% release
=> Net release fraction = 1.0E+0

Halogens: 100% of pins breached
10% release (cold fuel)
50% plateout
=> Net release fraction = 5.0E-2

Volatile solids (Cd & Cs): 100% of pins breached
1% of pellets crushed and exposed
5% release from exposed pellets
1% release through cracks in cask
=> Net release fraction = 5.0E-6

Nonvolatile solids: 100% of pins breached
1% of pellets crushed and exposed
1% release from exposed pellets
5% respirable ($\leq 10 \mu\text{m}$)
1% release through cracks in cask
=> Net release fraction = 5.0E-8

The 1% of pellets crushed and exposed must have the cladding actually removed or cracked and grossly deformed, since a simple crack in the cladding, while allowing the passage of gas, is not usually wide enough to allow passage of a significant amount of particulate material. The 5% respirable fraction corresponds to the particle fraction small enough to reach the lower lungs. It is permissible to take credit for this fraction in this case since nearly all of the dose from the nonvolatile particles is due to the transuranics (for which the nonrespirable fraction does not produce a significant dose).

The inventory per assembly was derived from an ORIGEN2 run for a standard driver with an average burn-up of 150,000 MWd/MTHM which has decayed for 5 years to a decay heat rate of approximately 250 W (Nguyen 1992, Simons 1991). The resulting releases are shown in Table 1.

Table 1: Releases to environment from one fuel assembly due to postulated cask drop

Isotope	1 Assembly Inventory (Ci)	Release due to 1 Assembly (Ci)
H 3	7.82E+1	7.8E+1
KR85	6.74E+2	6.74E+2
SR90	5.04E+3	2.5E-4
Y 90	5.05E+3	2.5E-4
TC99	1.99E+0	1.0E-7
RU106	4.89E+3	2.5E-4
AG110M	8.89E+0	4.5E-7
CD113M	1.29E+1	6.5E-5

Isotope	1 Assembly Inventory (Ci)	Release due to 1 Assembly (Ci)
SB125	1.21E+3	6.1E-5
TE125M	2.95E+2	1.5E-5
I 129	6.63E-3	3.3E-4
CS134	2.51E+3	1.3E-2
CS137	1.37E+4	6.9E-2
CE144	1.66E+3	8.3E-5
PR144M	1.99E+1	1.0E-6
PR144	1.66E+3	8.3E-5
PM147	8.73E+3	4.4E-4
SM151	5.21E+2	2.6E-5
EU154	5.08E+2	2.5E-5
EU155	1.15E+3	5.8E-5
PU238	2.81E+2	1.4E-5
PU239	3.49E+2	1.8E-5
PU240	2.68E+2	1.3E-5
PU241	1.46E+4	7.3E-4
AM241	2.53E+2	1.3E-5
AM242M	1.93E+1	9.7E-7
AM242	1.93E+1	9.7E-7
CM242	2.04E+1	1.0E-6
CM244	2.04E+1	1.0E-6

Receptor Descriptions:

Onsite:

For a ground level release, this receptor is normally at a distance of 100 m in the worst direction. Doses calculated for this receptor include inhalation and submersion. This release is assumed to be of short duration so no evacuation is assumed.

Site Boundary:

This receptor is located at the site boundary in the worst direction and is assumed to stay at this location for the duration of the accident. Doses calculated include inhalation and submersion. In sectors where the site is bounded by the Columbia River, this receptor is assumed to be located on the near bank of the river. For this analysis, the receptor is evaluated for both the present and proposed site boundaries.

Agricultural Area:

This is the residence of the ingestion pathway receptor (IPR). This receptor is assumed to grow his own food, including a variety of crops, meat and dairy products and to continue to do so at this location for 50 years following the accident. No credit is taken for uncontaminated foodstuffs brought in from outside the area. Note that potential

ingestion and ground shine doses are not included in the comparison to risk guidelines (WHC, 1988) since, in the case of an accident, any contaminated land or products would not be used, and ingestion and ground shine would not, therefore, be actual exposure pathways. The release is assumed to occur just prior to the autumn harvest in order to maximize consequences with regard to the time of the accident. In sectors where the site is bounded by the Columbia River, this receptor is assumed to be located on the far bank of the river. For this analysis, the IPR is evaluated for both the present and proposed site boundaries.

TRANSPORT ASSUMPTIONS:

Acute 99.5 percentile ground level release dispersion factors (X/Q) were generated using the GXQ code (Hey 1994) at the 16 sectors at 100 m and at the 16 sector locations around both the present and proposed site boundaries. These results are summarized in tables 2 and 3 below. The asterisks identify the worst case locations.

Table 2: Onsite 99.5% X/Qs at 100 m for releases in the 400 Area

Sector	X/Q (s/m ³)
S	*3.17E-2*
SSW	2.32E-2
SW	1.46E-2
WSW	1.05E-2
W	1.43E-2
WNW	1.25E-2
NW	1.53E-2
NNW	2.37E-2
N	*3.17E-2*
NNE	2.62E-2
NE	1.68E-2
ENE	1.50E-2
E	1.73E-2
ESE	1.61E-2
SE	2.66E-2
SSE	2.56E-2
all (95%)	3.11E-2

Table 3: Acute 99.5% X/Q values at site boundary
locations for ground level release at FFTF complex

Sector	Present Site Boundary		Proposed Site Boundary	
	Distance (km)	X/Q (s/m^3)	Distance (km)	X/Q (s/m^3)
S	8.7	*2.90E-5*	8.7	*2.90E-5*
SSW	7.0	2.82E-5	7.0	2.82E-5
SW	7.0	1.67E-5	7.0	1.67E-5
WSW	13.1	3.92E-6	7.0	8.72E-6
W	22.2	3.61E-6	9.3	1.12E-5
WNW	36.4	1.83E-6	14.6	5.72E-6
NW	41.9	1.65E-6	32.0	2.33E-6
NNW	41.9	3.12E-6	20.4	7.47E-6
N	16.2	1.32E-5	13.7	1.63E-5
NNE	13.1	1.43E-5	11.1	1.76E-5
NE	9.0	1.48E-5	9.0	1.48E-5
ENE	7.6	1.53E-5	7.6	1.53E-5
E	7.2	2.03E-5	7.2	2.03E-5
ESE	7.5	1.79E-5	7.5	1.79E-5
SE	8.7	2.44E-5	8.7	2.44E-5
SSE	8.8	2.32E-5	8.8	2.32E-5

Code Documentation:

GXQ version 4.0 (12/19/94) (Hey 1994)
Joint Frequency Data: 200 Areas, 10 m, Pasquill A-G (1983-1991 Average)

GXQ input/output files are attached for reference.

GENII version 1.485 (12/3/90) (Napier 1988)
GENII Default Parameter Values (3/28/90)
Radionuclide Library - Times <100 years (7/23/93)
External Dose Factor Library (5/8/90)
Worst-Case Solubilities, Yearly Dose Increments (7/23/93)

Typical GENII input file is attached for reference.

RESULTS:

The resulting effective dose equivalents (EDE) for releases due to 1 fuel assembly at an average burnup of 150,000 MWd/MTHM decayed to 250 W (inventory shown in Table 1) are shown in Table 4.

Table 4: Resulting doses for postulated cask drop due to 1 assembly with inventory shown in Table 1

Receptor	Dose Type	Effective Dose (rem)	Equivalent EDE (mSv)
Onsite (100 m S or N)	Inhalation	4.4E-1	4.4E+0
	Submersion	1.2E-2	1.2E-1
	Total	4.5E-1	4.5E+0
Site Boundary (8.7 km S)	Inhalation	3.9E-4	3.9E-3
	Submersion	1.1E-5	1.1E-4
	Total	4.0E-4	4.0E-3
IPR (8.7 km S)	Inhalation	3.9E-4	3.9E-3
	Submersion	1.1E-5	1.1E-4
	Ingestion	2.2E-2	2.2E-1
	Ground Shine	4.2E-4	4.2E-3
	Total	2.3E-2	2.3E-1

About 74% of the total dose shown above is due to the TRU isotopes. Of the remaining 26% Cs-134 and Cs-137 account for about 6% with the remainder being almost entirely due to the tritium (17%) and Kr-85 (3%). Once the decay heat of an assembly has decreased enough (due to decay of short-live fission products) to be handled and stored dry, most of the dose is due to the long-lived TRU and Cesium isotopes, and tends to increase slowly with decay time due to buildup of Am-241. The 5 year decayed fuel represented by the inventory in Table 1 will therefore bound the same fuel decayed 4 years.

The doses shown above in Table 3 must be multiplied by 7 to account for the 7 assemblies in the maximally loaded cask. In addition, an adjustment must be made for the higher burnup of some of the assemblies which could be in the cask. The highest average burnup of the available assemblies is 199,400 MWd/MTHM for ACO-4. This is a factor of 1.33 higher than the burnup assumed for Table 3. The doses per assembly were therefore adjusted for burnup by simply multiplying by 1.33. This is extremely conservative since the dose does not go to zero for zero burnup, and there are relatively few assemblies with burnups above 150,000 MWd/MTHM. Along with the multiplier of 7 for the number of assemblies in the cask, the total adjustment factor for the doses shown in Table 3 is, therefore, 9.3. For simplicity and added conservatism, the doses in Table 3 were multiplied by a factor of 10. This should also be enough adjustment to account for the minor variations in enrichment, loading, etc. in the test assemblies. The results are shown below in Table 5 for the maximally loaded cask.

Table 5: Resulting doses for postulated drop
of a maximally loaded cask

Receptor	Dose Type	Effective Dose (rem)	Equivalent EDE (mSv)
Onsite (100 m S or N)	Inhalation	4.4E+0	4.4E+1
	Submersion	<u>1.2E-1</u>	<u>1.2E+0</u>
	Total	4.5E+0	4.5E+1
Site Boundary (8.7 km S)	Inhalation	3.9E-3	3.9E-2
	Submersion	<u>1.1E-4</u>	<u>1.1E-3</u>
	Total	4.0E-3	4.0E-2
IPR (8.7 km S)	Inhalation	3.9E-3	3.9E-2
	Submersion	1.1E-4	1.1E-3
	Ingestion	2.2E-1	2.2E+0
	Ground Shine	<u>4.2E-3</u>	<u>4.2E-2</u>
	Total	2.3E-1	2.3E+0

Both the onsite and offsite doses are far below the 1 Sv (100 rem) onsite and the 250 mSv (25 rem) offsite radiological risk guidelines for credible events with frequencies between $10^{-4}/y$ and $10^{-6}/y$ (WHC 1988).

References:

- Hey, B. E., 1994, *GXQ Program User's Guide*, WHC-SD-GN-SWD-30002, Rev. 1, Westinghouse Hanford Company, Richland, Washington, Dec. 19, 1994.
- Himes, D. A., 1993, *Radiological Consequences of a Hypothetical Disruption of an Interim Storage Cask (ISC)*, Radiological & Toxicological Analysis, 29250-DAH-93001, January 13, 1993.
- Napier, B. A., et al., 1988, *GENII - The Hanford Environmental Radiation Dosimetry Software System*, PNL-6584, Pacific Northwest Laboratory, Richland, Washington, November, 1988.
- Nguyen, L. V., 1992, *Radiological Analysis of 150,000 MWd/MTHM Spent Fuel With 250 Watt Decay Heat For A Seismically Initiated Beyond Design Basis Accident*, WHC-SD-FF-TA-027 Rev. 0, May 11, 1992.
- Simons, R. L., 1991, Memo to L. R. Besel, *Radiation Source Terms for the FFTF Off-Load Program*, August 16, 1991.
- WHC, 1988, *Safety Analysis Manual*, WHC-CM-4-46, Westinghouse Hanford Company, Richland Washington, September 30, 1988.

**GXQ File
Site Boundary**

GXQ Version 4.0A
December 19, 1994

General Purpose Atmospheric Dispersion Code
Produced by Westinghouse Hanford Company

Users Guide documented in WHC-SD-GN-SWD-30002 Rev. 1.

Validation documented in WHC-SD-GN-SWD-30003 Rev. 1.

Code Custodian is: Brit E. Hey

Westinghouse Hanford Company

P.O. Box 1970

Richland, WA 99352

(509) 376-2921

Run Date = 08/14/95

Run Time = 08:41:36.05

INPUT ECHO:

FFTF X/Qs - present boundary - 100 m - proposed boundary - 99.5%/sector

c GXQ Version 4.0 Input File

c mode

1

c

c MODE CHOICE:

c mode = 1 then X/Q based on Hanford site specific meteorology

c mode = 2 then X/Q based on atmospheric stability class and wind speed

c mode = 3 then X/Q plot file is created

c

c LOGICAL CHOICES:

c ifox inorm icdf ichk isite ipop

T F F F F F

c ifox = t then joint frequency used to compute frequency to exceed X/Q

c = f then joint frequency used to compute annual average X/Q

c inorm = t then joint frequency data is normalized (as in GENII)

c = f then joint frequency data is un-normalized

c icdf = t then cumulative distribution file created (CDF.OUT)

c = f then no cumulative distribution file created

c ichk = t then X/Q parameter print option turned on

c = f then no parameter print

c isite = t then X/Q based on joint frequency data for all 16 sectors

c = f then X/Q based on joint frequency data of individual sectors

c ipop = t then X/Q is population weighted

```

c      = f then no population weighting
c
c X/Q AND WIND SPEED ADJUSTMENT MODELS:
c   ipuff idep isrc iwind
c     0     0     0     0
c DIFFUSION COEFFICIENT ADJUSTMENT MODELS:
c   iwake ipm  iflow ientr
c     0     0     0     0
c EFFECTIVE RELEASE HEIGHT ADJUSTMENT MODELS:
c (irise igrnd)iwash igrav
c   0     0     0     0
c ipuff = 1 then X/Q calculated using puff model
c       = 0 then X/Q calculated using default continuous plume model
c idep  = 1 then plume depletion model turned on (Chamberlain model)
c isrc  = 1 then X/Q multiplied by scalar
c       = 2 then X/Q adjusted by wind speed function
c iwind = 1 then wind speed corrected for plume height
c iwake = 1 then NRC RG 1.145 building wake model turned on
c       = 2 then MACCS virtual distance building wake model turned on
c ipm   = 1 then NRC RG 1.145 plume meander model turned on
c       = 2 then 5th Power Law plume meander model turned on
c       = 3 then sector average model turned on
c iflow = 1 then sigmas adjusted for volume flow rate
c ientr = 1 then method of Pasquill used to account for entrainment
c irise = 1 then MACCS buoyant plume rise model turned on
c       = 2 then ISC2 momentum/buoyancy plume rise model turned on
c igrnd = 1 then Mills buoyant plume rise modification for ground effects
c iwash = 1 then stack downwash model turned on
c igrav = 1 then gravitational settling model turned on
c       = 0 unless specified otherwise, 0 turns model off
c

```

c PARAMETER INPUT:

release height hs(m)	reference anemometer height ha(m)	mixing height hm(m)	frequency to exceed Cx(%)	
0.00000E+00	1.00000E+01	1.00000E+03	5.00000E-01	
initial plume width Wb(m)	initial plume height Hb(m)	release duration trd(hr)	deposition velocity vd(m/s)	gravitational settling velocity vg(m/s)
0.00000E+00	1.00000E+01	0.00000E+00	1.00000E-02	1.00000E-02
ambient temperature Tamb(C)	initial plume temperature T0(C)	initial plume flow rate V0(m3/s)	release diameter d(m)	convective heat release rate(l) qh(w)

```

c      2.00000E+01    2.20000E+01    1.00000E+00    1.00000E+00    0.00000E+00
c
c (1) If zero then buoyant flux based on plume/ambient temperature difference.
c
c      X/Q            Wind
c      scaling        Speed
c      factor          Exponent
c      c(?)            a(?)
c
c      1.00000E+00    7.80000E-01
c
c RECEPTOR DEPENDENT DATA (no line limit)
c FOR MODE      make      RECEPTOR DEPENDENT DATA
c 1 (site specific)      sector distance receptor-height
c 2 (by class & wind speed) class windspeed distance offset receptor-height
c 3 (create plot file)    class windspeed xmax imax ymax jmax xqmin power
c
c RECEPTOR PARAMETER DESCRIPTION
c sector = 0, 1, 2... (all, S, SSW, etc.)
c distance = receptor distance (m)
c receptor height = height of receptor (m)
c class = 1, 2, 3, 4, 5, 6, 7 (P-G stability class A, B, C, D, E, F, G)
c windspeed = anemometer wind speed (m/s)
c offset = offset from plume centerline (m)
c xmax = maximum distance to plot or calculate to (m)
c imax = distance intervals
c ymax = maximum offset to plot (m)
c jmax = offset intervals
c xqmin = minimum scaled X/Q to calculate
c power = exponent in power function step size
  
```

MODE:
 Site specific X/Q calculated.

LOGICAL CHOICES:
 Joint frequency used to calculate X/Q based on frequency of exceedance.
 No normalization of joint frequency.
 X/Q calculated for single sector.

MODELS SELECTED:
 Default Gaussian plume model selected.

WARNING/ERROR MESSAGES:

JOINT FREQUENCY DATA:
 400 AREA (FFTF) - 10 M - Pasquill A - G (1983 - 1991 Average)
 Created 8/26/92 KR

FFTF X/Qs - present boundary - 100 m - proposed boundary - 99.5%/sector

SECTOR	DISTANCE (m)	RECEPT HEIGHT (m)	SECT. FREQ. (%)	POPULATION	TOTAL POPULATION SCALED X/Q (s/m3)	AVERAGE INDIVIDUAL SCALED X/Q (s/m3)	ATM. STAB. CLASS	WIND SPEED (m/s)
S	8700	0	7.29	1	2.90E-05	2.90E-05	F	0.89
SSW	7000	0	5.75	1	2.82E-05	2.82E-05	G	2.65
SW	7000	0	3.41	1	1.67E-05	1.67E-05	E	0.89
WSW	13100	0	2.22	1	3.92E-06	3.92E-06	F	4.70
W	22200	0	2.87	1	3.61E-06	3.61E-06	E	0.89
WNW	36400	0	2.65	1	1.83E-06	1.83E-06	F	2.65
NW	41900	0	4.08	1	1.65E-06	1.65E-06	E	0.89
NNW	41900	0	7.41	1	3.12E-06	3.12E-06	G	2.65
N	16200	0	13.26	1	1.32E-05	1.32E-05	F	0.89
NNE	13100	0	12.15	1	1.43E-05	1.43E-05	G	2.65
NE	9000	0	6.95	1	1.48E-05	1.48E-05	G	4.70
ENE	7600	0	3.94	1	1.53E-05	1.53E-05	E	0.89
E	7200	0	5.45	1	2.03E-05	2.03E-05	G	4.70
ESE	7500	0	6.48	1	1.79E-05	1.79E-05	G	4.70
SE	8700	0	9.75	1	2.44E-05	2.44E-05	G	2.65
SSE	8800	0	6.32	1	2.32E-05	2.32E-05	G	2.65
S	100	0	7.29	1	3.17E-02	3.17E-02	F	0.89
SSW	100	0	5.75	1	2.32E-02	2.32E-02	G	2.65
SW	100	0	3.41	1	1.46E-02	1.46E-02	E	0.89
WSW	100	0	2.22	1	1.05E-02	1.05E-02	F	2.65
W	100	0	2.87	1	1.43E-02	1.43E-02	E	0.89
WNW	100	0	2.65	1	1.25E-02	1.25E-02	F	2.65
NW	100	0	4.08	1	1.53E-02	1.53E-02	E	0.89
NNW	100	0	7.41	1	2.37E-02	2.37E-02	G	2.65
N	100	0	13.26	1	3.17E-02	3.17E-02	F	0.89
NNE	100	0	12.15	1	2.62E-02	2.62E-02	G	2.65
NE	100	0	6.95	1	1.68E-02	1.68E-02	G	4.70
ENE	100	0	3.94	1	1.50E-02	1.50E-02	E	0.89
E	100	0	5.45	1	1.73E-02	1.73E-02	G	4.70
ESE	100	0	6.48	1	1.61E-02	1.61E-02	G	4.70
SE	100	0	9.75	1	2.66E-02	2.66E-02	G	2.65
SSE	100	0	6.32	1	2.56E-02	2.56E-02	G	2.65
S	8700	0	7.29	1	2.90E-05	2.90E-05	F	0.89
SSW	7000	0	5.75	1	2.82E-05	2.82E-05	G	2.65
SW	7000	0	3.41	1	1.67E-05	1.67E-05	E	0.89
WSW	7000	0	2.22	1	8.72E-06	8.72E-06	F	4.70
W	9300	0	2.87	1	1.12E-05	1.12E-05	E	0.89
WNW	14600	0	2.65	1	5.72E-06	5.72E-06	F	2.65
NW	32000	0	4.08	1	2.33E-06	2.33E-06	E	0.89
NNW	20400	0	7.41	1	7.47E-06	7.47E-06	G	2.65
N	13700	0	13.26	1	1.63E-05	1.63E-05	F	0.89

NNE	11100	0	12.15	1	1.76E-05	1.76E-05	G	2.65
NE	9000	0	6.95	1	1.48E-05	1.48E-05	G	4.70
ENE	7600	0	3.94	1	1.53E-05	1.53E-05	E	0.89
E	7200	0	5.45	1	2.03E-05	2.03E-05	G	4.70
ESE	7500	0	6.48	1	1.79E-05	1.79E-05	G	4.70
SE	8700	0	9.75	1	2.44E-05	2.44E-05	G	2.65
SSE	8800	0	6.32	1	2.32E-05	2.32E-05	G	2.65

GENII Input File
Offsite Receptor 7.2 km E

Program GENII Input File ##### 8 Jul 88 ###
Title: fftf fuel cask drop - 1 assembly - OS 100 m S or N - 150,000 MWD/MTHM
\GENII\fftf2os.in Created on 08-15-1995 at 10:17

OPTIONS===== Default =====
F Near-field scenario? (Far-field) NEAR-FIELD: narrowly-focused
F Population dose? (Individual) release, single site
T Acute release? (Chronic) FAR-FIELD: wide-scale release,
Maximum Individual data set used multiple sites
Complete
TRANSPORT OPTIONS===== Section EXPOSURE PATHWAY OPTIONS===== Section
T Air Transport 1 F Finite plume, external 5
F Surface Water Transport 2 T Infinite plume, external 5
F Biotic Transport (near-field) 3,4 F Ground, external 5
F Waste Form Degradation (near) 3,4 F Recreation, external 5
T Inhalation uptake 5,6
F Drinking water ingestion 7,8
F Aquatic foods ingestion 7,8
F Terrestrial foods ingestion 7,9
F Animal product ingestion 7,10
F Inadvertent soil ingestion
REPORT OPTIONS=====
T Report AEDE only
T Report by radionuclide
T Report by exposure pathway
F Debug report on screen

INVENTORY #####

4 Inventory input activity units: (1-pCi 2-uCi 3-mCi 4-Ci 5-Bq)
0 Surface soil source units (1- m2 2- m3 3- kg)
Equilibrium question goes here

Use when	Release Terms			Basic Concentrations				
	transport selected			near-field scenario, optionally				
Release Radio- nuclide	Air /yr	Surface Water /yr	Buried Waste /m3	Air /m3	Surface Soil /unit	Deep Soil /m3	Ground Water /L	Surface Water /L
H 3	7.82E+1							
KR85	6.74E+2							
SR90	2.52E-4							
Y 90	2.53E-4							
TC99	9.95E-8							
RU106	2.45E-4							
AG110M	4.45E-7							
CD113M	6.45E-5							
SB125	6.05E-5							
TE125M	1.48E-5							
I 129	3.32E-4							
CS134	1.26E-2							
CS137	6.85E-2							

CE144 8.30E-5
PR144 8.30E-5
PR144M 9.95E-7
PM147 4.37E-4
SM151 2.61E-5
EU154 2.54E-5
EU155 5.75E-5
PU238 1.41E-5
PU239 1.75E-5
PU240 1.34E-5
PU241 7.30E-4
AM241 1.27E-5
AM242M 9.65E-7
AM242 9.65E-7
CM242 1.02E-6
CM244 1.02E-6

-----Derived Concentrations-----				
Use when	measured values are known			
Release	Terres.	Animal	Drink	Aquatic
Radio-	Plant	Product	Water	Food
nuclide	/kg	/kg	/L	/kg

TIME #####

1 Intake ends after (yr)
50 Dose calc. ends after (yr)
0 Release ends after (yr)
0 No. of years of air deposition prior to the intake period
0 No. of years of irrigation water deposition prior to the intake period

FAR-FIELD SCENARIOS (IF POPULATION DOSE) #####

0 Definition option: 1-Use population grid in file POP.IN
0 2-Use total entered on this line

NEAR-FIELD SCENARIOS #####

Prior to the beginning of the intake period: (yr)
0 When was the inventory disposed? (Package degradation starts)
0 When was LOIC? (Biotic transport starts)
0 Fraction of roots in upper soil (top 15 cm)
0 Fraction of roots in deep soil
0 Manual redistribution: deep soil/surface soil dilution factor
0 Source area for external dose modification factor (m2)

TRANSPORT #####

====AIR TRANSPORT=====SECTION 1=====
0-Calculate PM |0 Release type (0-3)

1	Option: 1-Use chi/Q or PM value	F	Stack release (T/F)
	2-Select MI dist & dir	0	Stack height (m)
	3-Specify MI dist & dir	0	Stack flow (m3/sec)
3.17E-2	Chi/Q or PM value	0	Stack radius (m)
0	MI sector index (1=S)	0	Effluent temp. (C)
0	MI distance from release point (m)	0	Building x-section (m2)
F	Use jf data, (T/F) else chi/Q grid	0	Building height (m)

====SURFACE WATER TRANSPORT=====SECTION 2=====

0	Mixing ratio model: 0-use value, 1-river, 2-lake
0	Mixing ratio, dimensionless
0	Average river flow rate for: MIXFLG=0 (m3/s), MIXFLG=1,2 (m/s),
0	Transit time to irrigation withdrawal location (hr)
	If mixing ratio model > 0:
0	Rate of effluent discharge to receiving water body (m3/s)
0	Longshore distance from release point to usage location (m)
0	Offshore distance to the water intake (m)
0	Average water depth in surface water body (m)
0	Average river width (m), MIXFLG=1 only
0	Depth of effluent discharge point to surface water (m), lake only

====WASTE FORM AVAILABILITY=====SECTION 3=====

0	Waste form/package half life, (yr)
0	Waste thickness, (m)
0	Depth of soil overburden, m

====BIOTIC TRANSPORT OF BURIED SOURCE=====SECTION 4=====

T	Consider during inventory decay/buildup period (T/F)?	
T	Consider during intake period (T/F)?	1-Arid non agricultural
0	Pre-Intake site condition.....	2-Humid non agricultural
		3-Agricultural

EXPOSURE #####

====EXTERNAL EXPOSURE=====SECTION 5=====

	Exposure time:		Residential irrigation:
0	Plume (hr)	T	Consider: (T/F)
0	Soil contamination (hr)	0	Source: 1-ground water
0	Swimming (hr)		2-surface water
0	Boating (hr)	0	Application rate (in/yr)
0	Shoreline activities (hr)	0	Duration (mo/yr)
0	Shoreline type: (1-river, 2-lake, 3-ocean, 4-tidal basin)		
0	Transit time for release to reach aquatic recreation (hr)		
1.0	Average fraction of time submersed in acute cloud (hr/person hr)		

====INHALATION=====SECTION 6=====

8766.0	Hours of exposure to contamination per year
0	0-No resus- 1-Use Mass Loading 2-Use Anspaugh model
0	pension Mass loading factor (g/m3) Top soil available (cm)

====INGESTION POPULATION=====SECTION 7=====

Atmospheric production definition (select option):

0-Use food-weighted chi/Q, (food-sec/m3), enter value on this line

1-Use population-weighted chi/Q

2-Use uniform production

3-Use chi/Q and production grids (PRODUCTION will be overridden)

Population ingesting aquatic foods, 0 defaults to total (person)

Population ingesting drinking water, 0 defaults to total (person)

Consider dose from food exported out of region (default=F)

Note below: S* or Source: 0-none, 1-ground water, 2-surface water

3-Derived concentration entered above

==== AQUATIC FOODS / DRINKING WATER INGESTION=====SECTION 8=====

Salt water? (default is fresh)

USE ? FOOD T/F TYPE	TRAN- SIT hr	PROD- UCTION kg/yr	-CONSUMPTION- HOLDUP da	RATE kg/yr	DRINKING WATER	
F FISH	0.00	0.0E+00	0.00	0.0	0	Source (see above)
F MOLLUS	0.00	0.0E+00	0.00	0.0	T	Treatment? T/F
F CRUSTA	0.00	0.0E+00	0.00	0.0	0	Holdup/transit(da)
F PLANTS	0.00	0.0E+00	0.00	0.0	0	Consumption (L/yr)

====TERRESTRIAL FOOD INGESTION=====SECTION 9=====

USE ? FOOD T/F TYPE	GROW TIME da	--IRRIGATION-- S RATE * in/yr		TIME mo/yr	YIELD kg/m2	PROD- UCTION kg/yr	--CONSUMPTION-- HOLDUP da	RATE kg/yr
F LEAF V	0.00	0	0.0	0.0	0.0	0.0E+00	0.0	0.0
F ROOT V	0.00	0	0.0	0.0	0.0	0.0E+00	0.0	0.0
F FRUIT	0.00	0	0.0	0.0	0.0	0.0E+00	0.0	0.0
F GRAIN	0.00	0	0.0	0.0	0.0	0.0E+00	0.0	0.0

====ANIMAL PRODUCTION CONSUMPTION=====SECTION 10=====

---HUMAN---		TOTAL		DRINK	---STORED FEED---						
USE ? FOOD T/F TYPE	CONSUMPTION RATE kg/yr	HOLDUP da	PROD- UCTION kg/yr	WATER CONTAM FRACT.	DIET FRAC- TION	GROW TIME da	--IRRIGATION-- S RATE * in/yr		TIME mo/yr	YIELD kg/m3	STOR- AGE da
F BEEF	0.0	0.0	0.00	0.00	0.00	0.0	0	0.0	0.00	0.00	0.0
F POULTR	0.0	0.0	0.00	0.00	0.00	0.0	0	0.0	0.00	0.00	0.0
F MILK	0.0	0.0	0.00	0.00	0.00	0.0	0	0.0	0.00	0.00	0.0
F EGG	0.0	0.0	0.00	0.00	0.00	0.0	0	0.0	0.00	0.00	0.0
					---FRESH FORAGE---						
BEEF					0.00	0.0	0	0.0	0.00	0.00	0.0
MILK					0.00	0.0	0	0.0	0.00	0.00	0.0

CHECKLIST FOR PEER REVIEW

Document Reviewed: **RADIOLOGICAL CONSEQUENCES OF A POSTULATED DROP OF A
MAXIMALLY LOADED FFTF FUEL CASK, WHC-SD-FF-TA-040,**
Rev. 0, D.A. Himes, 8/21/95

Scope of Review: entire document

Yes	No	NA	
☒	☐	☐	* Previous reviews complete and cover analysis, up to scope of this review, with no gaps.
☒	☐	☐	Problem completely defined.
☒	☐	☐	Accident scenarios developed in a clear and logical manner.
☒	☐	☐	Necessary assumptions explicitly stated and supported.
☒	☐	☐	Computer codes and data files documented.
☒	☐	☐	Data used in calculations explicitly stated in document.
☒	☐	☐	Data checked for consistency with original source information as applicable.
☐	☐	☒	Mathematical derivations checked including dimensional consistency of results.
☒	☐	☐	Models appropriate and used within range of validity or use outside range of established validity justified.
☒	☐	☐	Hand calculations checked for errors. Spreadsheet results should be treated exactly the same as hand calculations.
☒	☐	☐	Software input correct and consistent with document reviewed.
☒	☐	☐	Software output consistent with input and with results reported in document reviewed.
☒	☐	☐	Limits/criteria/guidelines applied to analysis results are appropriate and referenced. Limits/criteria/guidelines checked against references.
☒	☐	☐	Safety margins consistent with good engineering practices.
☒	☐	☐	Conclusions consistent with analytical results and applicable limits.
☒	☐	☐	Results and conclusions address all points required in the problem statement.
☐	☐	☒	Format consistent with appropriate NRC Regulatory Guide or other standards
☐	☒	*	Review calculations, comments, and/or notes are attached.
☒	☐	☐	Document approved.

J.C. Van Keulen J C Van Keulen
Reviewer (Printed Name and Signature)

8/24/95
Date

* Any calculations, comments, or notes generated as part of this review should be signed, dated and attached to this checklist. Such material should be labeled and recorded in such a manner as to be intelligible to a technically qualified third party.

HEDOP REVIEW CHECKLIST
for
Radiological and Nonradiological Release Calculations

Document reviewed (include title or description of calculation, document number, author, and date, as applicable):

RADIOLOGICAL CONSEQUENCES OF A POSTULATED DROP OF A MAXIMALLY LOADED FFTF FUEL CASK, WHC-SD-FF-TA-040, Rev. 0, D.A. Himes, 8/21/95

Submitted by: D.A. Himes

Date Submitted: 8/28/95

Scope of Review: entire document

YES NO* N/A

☒	☐	☐	1. A detailed technical review and approval of the environmental transport and dose calculation portion of the analysis has been performed and documented.
☐	☐	☒	2. Detailed technical review(s) and approval(s) of scenario and release determinations have been performed and documented.
☒	☐	☐	3. HEDOP-approved code(s) were used.
☒	☐	☐	4. Receptor locations were selected according to HEDOP recommendations.
☒	☐	☐	5. All applicable environmental pathways and code options were included and are appropriate for the calculations.
☒	☐	☐	6. Hanford site data were used.
☐	☐	☒	7. Model adjustments external to the computer program were justified and performed correctly.
☒	☐	☐	8. The analysis is consistent with HEDOP recommendations.
☐	☐	☒	9. Supporting notes, calculations, comments, comment resolutions, or other information is attached. (Use the "Page 1 of X" page numbering format and sign and date each added page.)
☒	☐		10. Approval is granted on behalf of the Hanford Environmental Dose Overview Panel.

* All "NO" responses must be explained and use of nonstandard methods justified.

Janet S. Davis Janet S. Davis

8/28/95

HEDOP-Approved Reviewer (Printed Name and Signature)

Date

COMMENTS (add additional signed and dated pages if necessary):

2. Release determinations are based on inventories provided in previous analyses.
3. GXQ (not HEDOP-approved) was used to calculate HQs because GENII does not calculate HQs in accordance with NRC Regulatory Guide 1.145. GENII (HEDOP-approved) was used for dose calculations.