

LOCA DOSE CONSEQUENCES USING AST METHODS

Licensee Document Number: SM-1080538201-003, Version 2

Method/Computer Program Used: RADTRAD Version 3.10

Regulatory Guidance: RG-1.183, including Appendix A

Model Discussion:

The calculation was performed in four parts, evaluating the contributions from four separate release paths: Containment mini-purge, Containment Leakage, ECCS Leakage Outside of Containment, and potential leakage from the Refueling Water Storage Tank (RWST). The dose contributions from each of these pathways were summed to obtain the doses to the Main Control Room (MCR), the Exclusion Area Boundary (EAB), and the Low Population Zone (LPZ). The accident duration is 30 days, per FNP Current Licensing Basis (CLB).

Results and Acceptance Limits:

Release	EAB (rem TEDE)	LPZ (rem TEDE)	Control Room (rem TEDE)
Containment Purge	0.001	0.0004	0.002
Containment Leakage	12.9	5.6	3.6
ESF Leakage	0.25	0.23	0.81
RWST Back-leakage	0.13	0.13	0.26
Total	13.2	6.0	4.7
Acceptance Limit	25	25	5

(Note that rounding is applied to all values)

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Key Assumptions and Inputs:

Source Term Parameters

Parameter

Value

Reactor Power Level: 2775 MWt (+2% uncertainty = 2831 MWt)

Reactor Peaking Factor: 1.7

Core Cycle-to-Cycle Augments:

Isotope	Factor
Kr-85	1.15
Xe-133	1.05
Xe-135	1.03
Cs-134	1.35
Cs-136	1.25
Cs-137	1.20
Halogens	1.03
Other Noble Gases	1.03
Other Particulates	1.03

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Core Source Term:

Nuclide	Activity (Ci)	Core Factor	Adjusted Activity (Ci)	Nuclide	Activity (Ci)	Core Factor	Adjusted Activity (Ci)
Co-58	0.00E+00	1.03	0.00E+00	Te-134	1.30E+08	1.03	1.34E+08
Co-60	0.00E+00	1.03	0.00E+00	I-130	2.50E+06	1.03	2.58E+06
Br-82	3.80E+05	1.03	3.91E+05	I-131	7.50E+07	1.03	7.73E+07
Br-83	9.70E+06	1.03	9.99E+06	I-132	1.10E+08	1.03	1.13E+08
Br-84	1.70E+07	1.03	1.75E+07	I-133	1.60E+08	1.03	1.65E+08
Kr-83m	9.70E+06	1.03	9.99E+06	I-134	1.70E+08	1.03	1.75E+08
Kr-85	7.20E+05	1.15	8.28E+05	I-135	1.50E+08	1.03	1.55E+08
Kr-85m	2.10E+07	1.03	2.16E+07	Xe-131m	8.40E+05	1.03	8.65E+05
Kr-87	4.00E+07	1.03	4.12E+07	Xe-133	1.50E+08	1.05	1.58E+08
Kr-88	5.70E+07	1.03	5.87E+07	Xe-133m	4.80E+06	1.03	4.94E+06
Rb-86	1.40E+05	1.03	1.44E+05	Xe-135	3.50E+07	1.03	3.61E+07
Rb-89	7.40E+07	1.03	7.62E+07	Xe-135m	3.00E+07	1.03	3.09E+07
Sr-89	7.70E+07	1.03	7.93E+07	Xe-138	1.30E+08	1.03	1.34E+08
Sr-90	5.70E+06	1.03	5.87E+06	Cs-134	1.10E+07	1.35	1.49E+07
Sr-91	9.50E+07	1.03	9.79E+07	Cs-134m	3.60E+06	1.03	3.71E+06
Sr-92	1.00E+08	1.03	1.03E+08	Cs-136	3.30E+06	1.25	4.13E+06
Y-90	5.90E+06	1.03	6.08E+06	Cs-137	7.60E+06	1.20	9.12E+06
Y-91	9.90E+07	1.03	1.02E+08	Cs-138	1.40E+08	1.03	1.44E+08
Y-91m	5.50E+07	1.03	5.67E+07	Ba-139	1.40E+08	1.03	1.44E+08
Y-92	1.00E+08	1.03	1.03E+08	Ba-140	1.30E+08	1.03	1.34E+08
Y-93	1.20E+08	1.03	1.24E+08	Ba-141	1.30E+08	1.03	1.34E+08
Y-95	1.30E+08	1.03	1.34E+08	La-140	1.40E+08	1.03	1.44E+08
Zr-95	1.30E+08	1.03	1.34E+08	La-141	1.30E+08	1.03	1.34E+08
Zr-97	1.30E+08	1.03	1.34E+08	La-143	1.20E+08	1.03	1.24E+08
Nb-95	1.30E+08	1.03	1.34E+08	La-142	1.20E+08	1.03	1.24E+08
Nb-95m	9.40E+05	1.03	9.68E+05	Ce-141	1.30E+08	1.03	1.34E+08
Nb-97	1.30E+08	1.03	1.34E+08	Ce-143	1.20E+08	1.03	1.24E+08
Mo-99	1.40E+08	1.03	1.44E+08	Ce-144	9.40E+07	1.03	9.68E+07
Tc-99m	1.20E+08	1.03	1.24E+08	Pr-143	1.20E+08	1.03	1.24E+08
Ru-103	1.10E+08	1.03	1.13E+08	Nd-147	5.10E+07	1.03	5.25E+07
Ru-105	7.60E+07	1.03	7.83E+07	Pm-147	9.70E+06	1.03	9.99E+06

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Nuclide	Activity (Ci)	Core Factor	Adjusted Activity (Ci)	Nuclide	Activity (Ci)	Core Factor	Adjusted Activity (Ci)
Ru-106	3.40E+07	1.03	3.50E+07	Pm-148	2.10E+07	1.03	2.16E+07
Rh-103m	1.00E+08	1.03	1.03E+08	Pm-148m	2.30E+06	1.03	2.37E+06
Rh-105	6.90E+07	1.03	7.11E+07	Pm-149	4.60E+07	1.03	4.74E+07
Pd-109	2.20E+07	1.03	2.27E+07	Pm-151	1.50E+07	1.03	1.55E+07
Sb-124	8.80E+04	1.03	9.06E+04	Sm-153	3.30E+07	1.03	3.40E+07
Sb-125	9.40E+05	1.03	9.68E+05	Eu-154	7.10E+05	1.03	7.31E+05
Sb-126	7.90E+04	1.03	8.14E+04	Eu-155	4.60E+05	1.03	4.74E+05
Sb-127	7.90E+06	1.03	8.14E+06	Eu-156	1.20E+07	1.03	1.24E+07
Sb-129	2.40E+07	1.03	2.47E+07	Np-238	2.30E+07	1.03	2.37E+07
Te-125m	2.00E+05	1.03	2.06E+05	Np-239	1.40E+09	1.03	1.44E+09
Te-127	7.80E+06	1.03	8.03E+06	Pu-238	1.60E+05	1.03	1.65E+05
Te-127m	1.00E+06	1.03	1.03E+06	Pu-239	2.20E+04	1.03	2.27E+04
Te-129	2.40E+07	1.03	2.47E+07	Pu-240	3.10E+04	1.03	3.19E+04
Te-129m	3.50E+06	1.03	3.61E+06	Pu-241	8.30E+06	1.03	8.55E+06
Te-131	6.70E+07	1.03	6.90E+07	Pu-243	1.80E+07	1.03	1.85E+07
Te-131m	1.10E+07	1.03	1.13E+07	Am-241	8.20E+03	1.03	8.45E+03
Te-132	1.10E+08	1.03	1.13E+08	Am-242	4.50E+06	1.03	4.64E+06
Te-133	9.10E+07	1.03	9.37E+07	Cm-242	2.20E+06	1.03	2.27E+06
Te-133m	5.80E+07	1.03	5.97E+07	Cm-244	1.30E+05	1.03	1.34E+05

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Initial RCS Source Term:	Accounts for 1% Failed Fuel (limitation from previous operating experience, not accident related).
Initial RCS Source Term:	The Iodine concentration is set at the 0.5 $\mu\text{Ci/gm}$
RCS Mass:	441,900 lbm
Release Fractions:	Per RG-1.183
Release Timing:	Per RG-1.183

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RCS Source Term

Nuclide	Activity ($\mu\text{Ci/gm}$)
Kr-85	7.70E+00
Kr-85m	1.80E+00
Kr-87	1.20E+00
Kr-88	3.50E+00
I-131	3.528E-01
I-132	5.796E-01
I-133	6.804E-01
I-134	1.588E-01
I-135	4.788E-01
Xe-133	2.40E+02
Xe-135	7.90E+00
Kr-83m	4.50E-01
Br-83	8.80E-02
Br-84	5.00E-02
I-130	2.20E-02
Xe-131m	2.90E+00
Xe-133m	4.60E+00
Xe-135m	4.50E-01
Xe-138	7.20E-01

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Containment Leakage Parameters:

<u>Parameter</u>	<u>Value</u>
Containment Volume	2.03E6 cubic Feet
Sprayed Volume	1,668,660 cubic feet
Unsprayed Volume	361,240 cubic feet
Containment Leakage	0.15% of volume per day for first 24 Hours 0.075% of volume per day for remainder
Containment Leakage Filtration	None
Containment Long Term Sump pH	$7.0 \leq \text{pH} \leq 10.5$ (no re-evolution of Iodine)
Containment spray removal λ , Elemental	13.7 hr^{-1}
Containment spray removal λ , Aerosol	5.45 hr^{-1} during injection mode 5.03 hr^{-1} during recirculation mode
Containment Spray Organic removal	None
Natural Deposition, Aerosol only	0.1 hr^{-1} in unsprayed areas only
Containment Spray Start	90 seconds
Containment Spray Stop	8 Hours
Containment Spray Flow	2,480 gal/min in injection phase 2,290 gal/min in recirculation phase
Iodine Chemical Form	95% Cesium Iodide, 4.85% elemental, 0.15% organic

Containment Purge Leakage

<u>Parameter</u>	<u>Value</u>
Iodine Chemical Form	95% Cesium Iodide, 4.85% elemental, 0.15% organic
Containment Purge Filtration	None
Removal by wall deposition	0%
Removal by Sprays	0%
Containment Purge Isolation	≤ 30 seconds
Containment Purge Flowrate	2850 CFM

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ECCS Leakage:

Sump Volume:	49,200 cubic feet
Sump temperature	Varies, max is 261 °F
ESF Leakage Initiation Time	20 minutes
ESF Leakage Iodine Flashing Factor:	10%
Iodine Species ECCS Leakage Released to the Atmosphere	
Elemental	97%
Organic	3%
ECCS Leakage Rate	40,000 cc/hr

RWST Leakage Parameters:

<u>Parameter</u>	<u>Value</u>
ECCS Recirculation Start Time	20 minutes
Iodine Species ECCS Leakage Released to the Atmosphere from the RWST	
Elemental	100%
Organic	0%
ECCS Leakage Rate to the RWST	2 gal/min
RWST Leakage Iodine Flashing Factors:	Varies with temp. and pH
RWST Capacity	505,562 gallons
RWST Volume at Transfer to Recirculation	29,002 gallons

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CR Parameters

<u>Parameter</u>	<u>Value</u>
CR Volume	114,000 ft ³
CR Pressurization Mode Initiation	Automatic at 60 Seconds
CR Ventilation System Normal Flow Rate	1950 cfm < 60 seconds
CR Ventilation System Makeup Rate	375 cfm > 60 seconds
CR Ventilation System Recirculation Flow Rate	2700 cfm > 60 seconds
CR Ventilation System Charcoal Filter Efficiencies	
Pressurization Filters	98.5% all iodines
Recirculation Filters	94.5% elemental and organic 98.5% particulate
CR Unfiltered Inleakage	315 cfm
CR Ingress/Egress Unfiltered Inleakage	10 cfm
CR Breathing Rate	3.5E-4 m ³ /sec
Occupancy Factors	
0-24 hours	1.0
1 - 4 days	0.6
4 -30 days	0.4

Atmospheric Dispersion Factors (sec/m³) :

Containment Releases:

<u>Time (hr)</u>	<u>EAB</u>	<u>LPZ</u>	<u>CR</u>
0 – 2	7.6E-4	2.80E-4	1.66E-03
2 – 8	-	1.10E-4	1.36E-03
8 – 24	-	1.00E-5	6.81E-04
24 – 96	-	5.40E-6	5.60E-04
96 – 720	-	2.90E-6	4.21E-04

Plant Vent Releases:

<u>Time (hr)</u>	<u>EAB</u>	<u>LPZ</u>	<u>CR</u>
0 – 2	7.6E-4	2.80E-4	1.65E-03
2 – 8	-	1.10E-4	1.38E-03
8 – 24	-	1.00E-5	7.20E-04
24 – 96	-	5.40E-6	5.47E-04
96 – 720	-	2.90E-6	3.63E-04

Plant Vent to Normal CR HVAC Intake:

0 – 0.0083 (hour) 2.79E-03 sec/m³ (for containment purge model)

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RWST Releases:

Time (hr)	EAB	LPZ	CR
0 – 2	7.6E-4	2.80E-4	4.97E-04
2 – 8	-	1.10E-4	3.82E-04
8 – 24	-	1.00E-5	1.70E-04
24 – 96	-	5.40E-6	1.28E-04
96 – 720	-	2.90E-6	1.00E-04

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