

**Responses to Information Requests from Senator Jim Webb  
Letter of April 15, 2011**

**(1) The assumed magnitudes of the total releases (in Curies) to the atmosphere of the radioisotopes dominating the inhalation, cloudshine, and 4-day groundshine effective whole body doses and the thyroid inhalation doses.**

The NRC's decision to recommend an evacuation area around the Fukushima Daiichi reactor site out to 50-miles was informed in part by two computer calculations that were conservative, rough estimates that would not necessarily characterize an actual release. The "Calculation 1" assessment assumed an ex-vessel, unfiltered release from a totally failed containment and actual meteorological conditions during early morning hours. The assumed total release to the atmosphere for this assessment was 1.7E+08 Ci. The "Calculation 2" assessment represented multiple unit failures using an increased reactor inventory at Unit 2 as a surrogate for 30 percent core damage at Units 2 and 3 and a 100 percent damaged Unit 4 spent fuel pool. The assumed total release to the atmosphere for this assessment was 2.1E+08 Ci. Information regarding the specific magnitude of total releases to the atmosphere for both of these assessments is included at the end of this enclosure.

**(2) The assumed duration of the releases.**

The NRC had a large degree of uncertainty about plant conditions at the time it made the decision on the 50-mile evacuation zone. The computer calculations and subsequent recommended protective action decisions were based on conservative estimates of fuel damage, containment, and other release and meteorological conditions. Prudent and conservative "durations of release" were assumed for each of the computer calculations and assessments. These assumptions are listed below:

- "Calculation 1" assumed a Unit 2 ex-vessel, unfiltered release from a totally failed containment for approximately 10 hours.
- "Calculation 2" represented multiple unit failures using an increased reactor inventory at Unit 2 as a surrogate for 30 percent core damage at Unit 2 and 3 and a 100 percent damaged Unit 4 spent fuel pool for approximately 15 hours. To account for the combined inventories of the three units, the staff adjusted the reactor power level and the number of assemblies in the calculation. In addition, the source term included two additional days of decay before release. For the multi-unit assessment, the increased decay time before release and the greater atmospheric dispersion significantly reduced the resultant dose estimate.

While these calculations were initially based on a large scale quick release, we are now observing that this has become a long-term chronic release. Nevertheless, it signifies the severity of this accident and the recommended protective actions remain in place.

**(3) The assumed wind speed and deposition velocities.**

Since communications were limited, there was a large degree of uncertainty about plant conditions and associated meteorological data at the time of the decision-making process.

Enclosure

The computer models did, however, use “Actual Observations” as meteorological model data appropriate for the Fukushima Daiichi vicinity.

- “Calculation 1” assumed meteorological data during early morning hours, when there were lower wind speeds, relatively stable air, and light precipitation – conditions that would degrade dispersion and increase downwind doses.
- “Calculation 2” assumed meteorological data during a period of higher wind speeds, less stable atmospheric conditions, and no precipitation – conditions that would improve atmospheric dispersion and decrease downwind doses.

**(4) Any assumptions concerning wind wander.**

The NRC modified winds for topography, however no wind wander assumptions were used.

**(5) The height of the assumed release including any height increase of the mid-line of the plume due to heat buoyancy effects.**

Both calculations used an assumed release height of 10 meters.

**(6) The dose conversion factor that the NRC uses for iodine-131 (I-131) for converting exposure to airborne I-131 measured in Ci-seconds/m<sup>3</sup> exposure to thyroid doses in rem for adults and children of different ages.**

The NRC calculates thyroid dose to adults from inhalation by using the dose conversion factors from Table II.1 in EPA Federal Guidance Report (FGR) 11, <http://www.epa.gov/radiation/docs/federal/520-1-88-020.pdf>. Given a release rate of airborne I-131 measured in Ci-seconds/m<sup>3</sup>, a standard breathing rate of 20 m<sup>3</sup>/day is applied to give the intake to the receptor (adult) in curies of I-131. The FGR-11 dose conversion factor for I-131 is 1.08x10<sup>6</sup> rem/Ci.

For dose from external exposure from submersion in the plume, the NRC uses dose conversion factors from Table III.1 in EPA FGR-12, <http://www.epa.gov/radiation/docs/federal/402-r-93-081.pdf>. The dose to the thyroid is much less for external exposure to I-131 than for inhalation. The FGR-11 thyroid dose conversion factor for external exposure to I-131 is 6.70x10<sup>-2</sup> rem-m<sup>3</sup>/Ci-s.

The NRC does not calculate dose to children from a reactor accident plume in our response during the early phase of the event.

## CALCULATION 1

15 March 2011 02:51am (EDT), NRC Operations Center, Protective Measures Team

These data are based on system condition estimates for a hypothetical, single reactor site, 2350 MWt, Boiling Water Reactor. Model results are projections only and may **not** be representative of an actual release. This projection uses modeled forecast meteorological conditions and is subject to change.

### Case Summary

**Event Type** Nuclear Power Plant

#### Location

Name: Fukushima Unit 2  
City, county, state: <undefined>, <undefined>, <undefined>  
Lat / Long / Elev: 37.4214° N, 141.0325° E, 0 m  
Time zone: <undefined>  
Population: not available

#### Reactor Parameters

Reactor power: 2350 MWt  
Average fuel burn-up: 30000 MWD / MTU  
Containment type: BWR Mark I  
Containment volume: 2.50E+05 ft<sup>3</sup>  
Design pressure: 60 lb/in<sup>2</sup>  
Design leak rate: 0.54 %/d  
Coolant mass: 1.25E+05 kg  
Assemblies in core: 550

#### Source Term

Type: Time Core Is Uncovered  
Shutdown: 2011/03/11 14:46  
Core uncovered: 2011/03/15 00:00  
Core recovered: No

#### Release Pathway

Type: BWR - Release Through Dry Well  
via direct, unfiltered pathway  
Description: Ex Vessel  
Release height: 10. m

Release events  
2011/03/15 00:00 Leak rate (% vol) Total failure  
2011/03/15 00:00 Sprays Off

## Meteorology

Type: Actual Observations  
Dataset name: Fukushima 2011 03-14 1600  
Dataset desc: Obs/fcsts for Fukushima Unit 1

Summary of data at release point:	Type	Dir deg	Speed m/s	Stab class	Precip	Temp °C
2011/03/12 14:00	Obs	265	1.0	B	?	
2011/03/12 15:00	Obs	265	1.0	B	?	
2011/03/12 16:00	Obs	277	1.3	B	?	
2011/03/12 17:00	Obs	260	2.4	B	?	
2011/03/12 18:00	Obs	241	1.4	E	?	
2011/03/12 19:00	Obs	236	2.1	E	?	
2011/03/12 20:00	Obs	239	2.1	E	?	
2011/03/12 21:00	Obs	229	3.8	E	?	
2011/03/12 22:00	Obs	224	5.1	E	?	
2011/03/12 23:00	Obs	226	3.9	E	?	
2011/03/13 00:00	Obs	228	4.1	E	?	
2011/03/13 01:00	Obs	235	2.6	E	?	
2011/03/13 02:00	Obs	233	3.9	E	?	
2011/03/13 03:00	Obs	225	1.8	E	?	
2011/03/13 04:00	Obs	225	1.3	E	?	
2011/03/13 05:00	Obs	225	2.2	E	?	
2011/03/13 06:00	Obs	225	2.2	E	?	
2011/03/13 07:00	Obs	248	2.7	E	?	
2011/03/13 08:00	Obs	248	2.7	E	?	
2011/03/13 09:00	Obs	270	3.1	E	?	
2011/03/13 12:00	Obs	271	7.4	D	?	
2011/03/13 13:00	Obs	276	6.2	D	?	
2011/03/13 14:00	Obs	312	2.8	B	?	
2011/03/14 18:00	Obs	258	4.8	unk	?	
2011/03/14 19:00	Obs	268	5.0	unk	?	
2011/03/14 20:00	Obs	330	2.2	unk	?	
2011/03/14 21:00	Fcst	337	4.6	unk	?	
2011/03/14 22:00	Fcst	323	7.2	unk	?	
2011/03/14 23:00	Fcst	305	6.6	unk	?	
2011/03/15 00:00	Fcst	015	8.6	unk	?	
2011/03/15 02:00	Fcst	002	7.5	unk	?	
2011/03/15 03:00	Fcst	347	5.2	E	None	
2011/03/15 04:00	Fcst	332	5.6	E	None	
2011/03/15 05:00	Fcst	332	4.0	E	None	
2011/03/15 06:00	Fcst	344	3.5	E	Lgt rain	
2011/03/15 07:00	Fcst	026	3.8	E	Lgt rain	
2011/03/15 08:00	Fcst	044	4.4	E	Lgt rain	
2011/03/15 09:00	Fcst	020	4.2	E	Lgt rain	
2011/03/15 10:00	Fcst	010	3.4	E	None	
2011/03/15 11:00	Fcst	030	3.5	D	Lgt rain	
2011/03/15 12:00	Fcst	027	3.0	D	Lgt rain	
2011/03/15 13:00	Fcst	037	3.4	D	Lgt rain	
2011/03/15 14:00	Fcst	053	3.7	B	None	
2011/03/15 15:00	Fcst	058	3.7	B	None	
2011/03/15 16:00	Fcst	067	3.2	C	Lgt rain	
2011/03/15 17:00	Fcst	081	3.9	C	Lgt rain	
2011/03/15 18:00	Fcst	089	4.7	B	None	
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2011/03/16 00:00	Fcst	011	5.1	D	Lgt rain
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2011/03/16 02:00	Fcst	350	5.3	D	Lgt rain
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2011/03/16 05:00	Fcst	298	4.8	D	None
2011/03/16 06:00	Fcst	314	5.6	D	None
2011/03/16 07:00	Fcst	312	4.7	D	None
2011/03/16 08:00	Fcst	331	4.9	D	None
2011/03/16 09:00	Fcst	353	4.1	D	None

Dataset options: Est. missing stability using: Wind speed, time of day, etc.  
 Adjust stability for consistency: No  
 Modify winds for topography: Yes

### Calculations

Case description: Fukushima Unit 2 ex-vessel met 14MAR 1600  
 End of calculations: 2011/03/15 10:00  
 Start of release to atmosphere + 10 h  
 Distance of calculation: Close-in + to 50 miles  
 Close-in distances: 0.5, 1.0, 1.5, 2.0, 3.0, 5.0, 7.0, 10.0 miles

### Source Term

Total amount released to atmosphere: 1.7E+08 Ci

Nuclide	Ci	Nuclide	Ci	Nuclide	Ci
Am-241	5.3E-01	Nb-97	7.6E+02	Sr-92	2.8E-03
Ba-140	8.8E+06	Nd-147	1.4E+05	Tc-99m	1.5E+05
Ce-141	4.4E+05	Np-239	2.1E+06	Te-127	1.0E+06
Ce-143	7.2E+04	Pm-147	4.2E+02	Te-127m	2.2E+05
Ce-144*	3.7E+05	Pr-143	3.4E+05	Te-129	5.7E+05
Cm-242	1.1E+04	Pr-144	3.7E+05	Te-129m	8.8E+05
Cs-134	3.6E+06	Pu-238	9.1E-01	Te-131	9.6E+04
Cs-136	1.2E+06	Pu-239	1.1E+00	Te-131m	4.3E+05
Cs-137*	2.5E+06	Pu-241	3.5E+04	Te-132	1.0E+07
I-131	1.9E+07	Rb-86	4.6E+04	Xe-131m	7.0E+05
I-132	1.9E+07	Rb-88	3.1E-02	Xe-133	8.2E+07
I-133	3.1E+06	Rh-103m	3.2E+05	Xe-133m	1.4E+06
I-135	7.0E+03	Rh-105	4.9E+04	Xe-135	5.1E+05
Kr-83m	1.7E-07	Ru-103	3.2E+05	Xe-135m	9.1E+03
Kr-85	5.1E+05	Ru-105	4.7E-01	Y-90	2.4E+04
Kr-85m	3.9E+01	Ru-106*	9.5E+04	Y-91	3.2E+05
Kr-88	6.1E-02	Sb-127	7.1E+05	Y-91m	2.8E+03
La-140	5.4E+05	Sb-129	5.9E+00	Y-92	8.7E-02
La-141	1.4E-01	Sr-89	5.2E+06	Y-93	7.5E+02
Mo-99	1.6E+05	Sr-90	4.2E+05	Zr-95	4.4E+05
Nb-95	4.6E+05	Sr-91	1.4E+04	Zr-97*	1.3E+04

Notes:

- Nuclides with \* in name include implicit daughters.

## Maximum Dose Values (rem) - Close-In

Dist from release miles (kilometers)	0.5 (0.8)	1. (1.61)	1.5 (2.41)	2. (3.22)	3. (4.83)	5. (8.05)	7. (11.27)	10. (16.09)
Total EDE	<u>5.4E+03</u>	<u>2.0E+03</u>	<u>1.2E+03</u>	<u>8.2E+02</u>	<u>4.8E+02</u>	<u>2.4E+02</u>	<u>1.6E+02</u>	<u>9.5E+01</u>
Thyroid CDE	<u>2.8E+04</u>	<u>1.1E+04</u>	<u>6.2E+03</u>	<u>4.3E+03</u>	<u>2.5E+03</u>	<u>1.3E+03</u>	<u>8.4E+02</u>	<u>5.1E+02</u>
Inhalation CEDE	<u>3.7E+03</u>	<u>1.4E+03</u>	<u>8.0E+02</u>	<u>5.6E+02</u>	<u>3.3E+02</u>	<u>1.7E+02</u>	<u>1.1E+02</u>	<u>6.7E+01</u>
Cloudshine	1.9E+01	9.3E+00	5.8E+00	4.1E+00	2.5E+00	1.4E+00	9.7E-01	6.2E-01
4-day Groundshine	1.7E+03	6.5E+02	3.8E+02	2.6E+02	1.5E+02	7.3E+01	4.6E+01	2.8E+01
Inter Phase 1st Yr	<u>2.4E+04</u>	<u>9.4E+03</u>	<u>5.4E+03</u>	<u>3.8E+03</u>	<u>2.2E+03</u>	<u>1.1E+03</u>	<u>6.6E+02</u>	<u>3.9E+02</u>
Inter Phase 2nd Yr	<u>1.1E+04</u>	<u>4.4E+03</u>	<u>2.6E+03</u>	<u>1.8E+03</u>	<u>1.0E+03</u>	<u>4.9E+02</u>	<u>3.1E+02</u>	<u>1.8E+02</u>

## Maximum Dose Values (rem) - To 50 mi

Dist from release miles (kilometers)	15 (24.1)	20 (32.2)	30 (48.3)	40 (64.4)	50 (80.5)
Total EDE	<u>8.6E+01</u>	<u>6.3E+01</u>	<u>3.7E+01</u>	<u>1.8E+01</u>	<u>8.1E+00</u>
Thyroid CDE	<u>3.3E+02</u>	<u>2.7E+02</u>	<u>1.3E+02</u>	<u>5.9E+01</u>	<u>2.3E+01</u>
Inhalation CEDE	3.9E+01	3.1E+01	1.3E+01	4.4E+00	1.3E+00
Cloudshine	4.5E-01	3.8E-01	1.7E-01	7.4E-02	2.7E-02
4-day Groundshine	4.7E+01	3.2E+01	2.4E+01	1.3E+01	6.7E+00
Inter Phase 1st Yr	<u>7.2E+02</u>	<u>4.8E+02</u>	<u>3.8E+02</u>	<u>2.2E+02</u>	<u>1.3E+02</u>
Inter Phase 2nd Yr	<u>3.4E+02</u>	<u>2.3E+02</u>	<u>1.8E+02</u>	<u>1.1E+02</u>	<u>6.9E+01</u>

### Notes:

- Doses exceeding PAGs are underlined.
- Early-Phase PAGs: TEDE - 1 rem, Thyroid (iodine) CDE - 5 rem
- Intermediate-Phase EPA PAGs: 1st year - 2 rem, 2nd year - 0.5 rem
- \*\*\* indicates values less than 1 mrem
- To view all values - use Detailed Results | Numeric Table
- Total EDE = Inhalation CEDE + Cloudshine + 4-Day Groundshine

TEDE - Total Effective Dose Equivalent

CDE - Committed Dose Equivalent

CEDE - Committed Effective Dose Equivalent

PAGs – Protective Action Guidelines

EPA – Environmental Protection Agency

## CALCULATION 2

16 March 2011 02:24am (EDT), NRC Operations Center, Protective Measures Team

These data are based on system condition estimates for a hypothetical, four reactor site. Model results are projections only and may **not** be representative of an actual release. This projection uses modeled forecast meteorological conditions and is subject to change.

### Case Summary

#### Event Type

Nuclear Power Plant

#### Location

Name: Fukushima unit 2, 3, 4  
City, county, state: <undefined>, <undefined>, <undefined>  
Lat / Long / Elev: 37.4214° N, 141.0325° E, 0 m  
Time zone: <undefined>  
Population: not available

#### Reactor Parameters

Reactor power: 3760 MWt  
Average fuel burn-up: 30000 MWD / MTU  
Containment type: BWR Mark I  
Containment volume: 2.50E+05 ft<sup>3</sup>  
Design pressure: 60 lb/in<sup>2</sup>  
Design leak rate: 0.54 %/d  
Coolant mass: 1.25E+05 kg  
Assemblies in core: 917

#### Source Term

Type: Time Core Is Uncovered  
Shutdown: 2011/03/11 14:46  
Core uncovered: 2011/03/16 19:50  
Core recovered: No

#### Release Pathway

Type: BWR - Release Through Dry Well  
via direct, unfiltered pathway

Description: total failure

Release height: 10. m

#### Release events

2011/03/16 19:50 Leak rate (% vol) Total failure  
2011/03/16 19:50 Sprays Off

#### Meteorology

Type: Actual Observations  
Dataset name: Fukushima 2011-03-16 0935  
Dataset desc: Obs/fcsts for Fukushima Unit 1

Summary of data at release point:	Type	Dir deg	Speed m/s	Stab class	Precip	Temp °C
2011/03/12 14:00	Obs	265	1.0	B	?	
2011/03/12 15:00	Obs	265	1.0	B	?	

2011/03/12 16:00	Obs	277	1.3	B	?
2011/03/12 17:00	Obs	260	2.4	B	?
2011/03/12 18:00	Obs	241	1.4	E	?
2011/03/12 19:00	Obs	236	2.1	E	?
2011/03/12 20:00	Obs	239	2.1	E	?
2011/03/12 21:00	Obs	229	3.8	E	?
2011/03/12 22:00	Obs	224	5.1	E	?
2011/03/12 23:00	Obs	226	3.9	E	?
2011/03/13 00:00	Obs	228	4.1	E	?
2011/03/13 01:00	Obs	235	2.6	E	?
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2011/03/13 03:00	Obs	225	1.8	E	?
2011/03/13 04:00	Obs	225	1.3	E	?
2011/03/13 05:00	Obs	225	2.2	E	?
2011/03/13 06:00	Obs	225	2.2	E	?
2011/03/13 07:00	Obs	248	2.7	E	?
2011/03/13 08:00	Obs	248	2.7	E	?
2011/03/13 09:00	Obs	270	3.1	E	?
2011/03/13 12:00	Obs	271	7.4	D	?
2011/03/13 13:00	Obs	276	6.2	D	?
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2011/03/14 20:00	Obs	330	2.2	unk	?
2011/03/14 21:00	Fcst	337	4.6	unk	?
2011/03/14 22:00	Fcst	323	7.2	unk	?
2011/03/14 23:00	Fcst	305	6.6	unk	?
2011/03/15 00:00	Fcst	015	8.6	unk	?
2011/03/15 02:00	Fcst	002	7.5	unk	?
2011/03/15 03:00	Fcst	347	5.2	E	None
2011/03/15 04:00	Fcst	332	5.6	E	None
2011/03/15 05:00	Fcst	332	4.0	E	None
2011/03/15 06:00	Fcst	344	3.5	E	Lgt rain
2011/03/15 07:00	Fcst	026	3.8	E	Lgt rain
2011/03/15 08:00	Fcst	044	4.4	E	Lgt rain
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2011/03/15 10:00	Fcst	010	3.4	E	None
2011/03/15 11:00	Fcst	030	3.5	D	Lgt rain
2011/03/15 12:00	Fcst	027	3.0	D	Lgt rain
2011/03/15 13:00	Fcst	037	3.4	D	Lgt rain
2011/03/15 14:00	Fcst	053	3.7	B	None
2011/03/15 15:00	Fcst	058	3.7	B	None
2011/03/15 16:00	Fcst	067	3.2	C	Lgt rain
2011/03/15 17:00	Fcst	081	3.9	C	Lgt rain
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2011/03/15 20:00	Fcst	083	4.4	B	Lgt rain
2011/03/15 21:00	Fcst	074	4.6	C	Lgt rain
2011/03/15 22:00	Fcst	054	5.0	D	Lgt rain
2011/03/15 23:00	Fcst	029	5.6	D	Rain
2011/03/16 00:00	Fcst	011	5.1	D	Lgt rain
2011/03/16 01:00	Fcst	346	4.3	C	Lgt rain
2011/03/16 02:00	Fcst	350	5.3	D	Lgt rain
2011/03/16 03:00	Fcst	323	5.6	D	Lgt rain
2011/03/16 04:00	Fcst	316	5.4	D	None
2011/03/16 05:00	Fcst	298	4.8	D	None



2011/03/16 06:00	Fcst	314	5.6	D	None
2011/03/16 07:00	Fcst	312	4.7	D	None
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2011/03/16 09:00	Fcst	299	4.2	D	None
2011/03/16 10:00	Fcst	312	5.4	C	None
2011/03/16 11:00	Fcst	309	7.5	C	None
2011/03/16 12:00	Fcst	304	7.2	C	None
2011/03/16 13:00	Fcst	314	8.8	C	None
2011/03/16 14:00	Fcst	325	10.4	C	None
2011/03/16 15:00	Fcst	324	12.3	C	None
2011/03/16 16:00	Fcst	304	14.7	D	None
2011/03/16 17:00	Fcst	299	14.2	D	None
2011/03/16 18:00	Fcst	297	11.3	D	None
2011/03/16 19:00	Fcst	316	9.8	D	None
2011/03/16 20:00	Fcst	309	9.4	D	None
2011/03/16 21:00	Fcst	294	9.5	D	None
2011/03/16 22:00	Fcst	299	7.6	D	None
2011/03/16 23:00	Fcst	300	9.7	D	None
2011/03/17 00:00	Fcst	294	5.0	D	None
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2011/03/17 02:00	Fcst	287	6.6	D	None
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2011/03/17 10:00	Fcst	307	5.0	C	None
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2011/03/17 12:00	Fcst	315	9.3	C	None
2011/03/17 13:00	Fcst	299	11.1	C	None
2011/03/17 14:00	Fcst	292	11.8	C	None
2011/03/17 15:00	Fcst	286	10.7	C	None
2011/03/17 16:00	Fcst	298	9.3	D	None
2011/03/17 17:00	Fcst	286	8.5	D	None
2011/03/17 18:00	Fcst	285	10.6	D	None
2011/03/17 19:00	Fcst	288	11.1	D	None
2011/03/17 20:00	Fcst	301	11.3	D	None
2011/03/17 21:00	Fcst	311	10.1	D	None
2011/03/17 22:00	Fcst	307	8.4	D	None
2011/03/17 23:00	Fcst	303	8.7	D	None
2011/03/18 00:00	Fcst	311	7.1	D	None
2011/03/18 01:00	Fcst	316	3.4	D	None
2011/03/18 02:00	Fcst	310	6.0	D	None
2011/03/18 03:00	Fcst	319	7.4	D	None
2011/03/18 04:00	Fcst	316	6.3	D	None
2011/03/18 05:00	Fcst	307	4.9	D	None
2011/03/18 06:00	Fcst	311	4.4	D	None
2011/03/18 07:00	Fcst	326	5.1	C	None
2011/03/18 08:00	Fcst	343	5.4	C	None
2011/03/18 09:00	Fcst	344	6.1	C	None

Dataset options:

Est. missing stability using: Wind speed, time of day, etc.  
Adjust stability for consistency: No  
Modify winds for topography: Yes

## Calculations

Case description: Unit 2 and 3 with 33% core damage each, Unit 4 with 100% spent fuel full core  
End of calculations: 2011/03/17 10:50  
Start of release to atmosphere + 15 h  
Distance of calculation: Close-in + to 50 miles  
Close-in distances: 0.5, 1.0, 1.5, 2.0, 3.0, 5.0, 7.0, 10.0 miles

## Source Term

Total amount released to atmosphere: 2.1E+08 Ci

Nuclide	Ci	Nuclide	Ci	Nuclide	Ci
Am-241	1.3E+00	Nd-147	2.1E+05	Tc-99m	1.6E+05
Ba-140	1.3E+07	Np-239	2.0E+06	Te-127	1.2E+06
Ce-141	6.7E+05	Pm-147	9.5E+02	Te-127m	3.5E+05
Ce-143	4.6E+04	Pr-143	5.0E+05	Te-129	8.9E+05
Ce-144*	6.0E+05	Pr-144	5.9E+05	Te-129m	1.4E+06
Cm-242	1.8E+04	Pu-238	2.2E+00	Te-131	5.6E+04
Cs-134	5.7E+06	Pu-239	2.1E+00	Te-131m	2.5E+05
Cs-136	1.8E+06	Pu-241	5.6E+04	Te-132	1.1E+07
Cs-137*	4.0E+06	Rb-86	6.8E+04	Xe-131m	1.0E+06
I-131	2.6E+07	Rb-88	1.1E-06	Xe-133	1.0E+08
I-132	2.0E+07	Rh-103m	5.0E+05	Xe-133m	1.2E+06
I-133	1.1E+06	Rh-105	3.3E+04	Xe-135	3.0E+04
I-135	1.1E+02	Ru-103	5.0E+05	Xe-135m	1.7E+02
Kr-85	8.1E+05	Ru-105	8.0E-04	Y-90	3.8E+04
Kr-85m	7.2E-02	Ru-106*	1.5E+05	Y-91	4.9E+05
Kr-88	2.1E-06	Sb-127	8.2E+05	Y-91m	1.8E+02
La-140	8.0E+05	Sb-129	8.4E-03	Y-92	2.7E-05
La-141	9.9E-05	Sr-89	8.1E+06	Y-93	6.0E+01
Mo-99	1.6E+05	Sr-90	6.7E+05	Zr-95	6.9E+05
Nb-95	7.4E+05	Sr-91	9.0E+02	Zr-97*	3.5E+03
Nb-97	2.0E+02	Sr-92	6.1E-08		

### Notes:

- Nuclides with \* in name include implicit daughters.

## Maximum Dose Values (rem) - Close-In

Dist from release miles (kilometers)	0.5 (0.8)	1. (1.61)	1.5 (2.41)	2. (3.22)	3. (4.83)	5. (8.05)	7. (11.27)	10. (16.09)
Total EDE	<u>5.4E+03</u>	<u>1.5E+03</u>	<u>6.7E+02</u>	<u>3.9E+02</u>	<u>1.8E+02</u>	<u>7.5E+01</u>	<u>4.0E+01</u>	<u>1.4E+01</u>
Thyroid CDE	<u>2.9E+04</u>	<u>7.9E+03</u>	<u>3.6E+03</u>	<u>2.1E+03</u>	<u>9.6E+02</u>	<u>4.0E+02</u>	<u>2.1E+02</u>	<u>7.5E+01</u>
Inhalation CEDE	3.8E+03	1.0E+03	4.8E+02	2.8E+02	1.3E+02	5.4E+01	2.9E+01	1.0E+01
Cloudshine	2.2E+01	8.0E+00	3.9E+00	2.3E+00	8.0E-01	2.6E-01	2.1E-01	1.1E-01
4-day Groundshine	1.5E+03	4.1E+02	1.9E+02	1.1E+02	5.0E+01	2.1E+01	1.1E+01	4.4E+00
Inter Phase 1st Yr	<u>2.6E+04</u>	<u>7.0E+03</u>	<u>3.2E+03</u>	<u>1.9E+03</u>	<u>8.5E+02</u>	<u>3.5E+02</u>	<u>1.9E+02</u>	<u>7.5E+01</u>
Inter Phase 2nd Yr	<u>1.3E+04</u>	<u>3.5E+03</u>	<u>1.6E+03</u>	<u>9.2E+02</u>	<u>4.2E+02</u>	<u>1.8E+02</u>	<u>9.5E+01</u>	<u>3.8E+01</u>

### Notes:

- Doses exceeding PAGs are underlined.
- Early-Phase PAGs: TEDE - 1 rem, Thyroid (iodine) CDE - 5 rem
- Intermediate-Phase EPA PAGs: 1st year - 2 rem, 2nd year - 0.5 rem
- \*\*\* indicates values less than 1 mrem
- To view all values - use Detailed Results | Numeric Table
- Total EDE = Inhalation CEDE + Cloudshine + 4-Day Groundshine

## Maximum Dose Values (rem) - To 50 mi

Dist from release miles (kilometers)	15 (24.1)	20 (32.2)	30 (48.3)	40 (64.4)	50 (80.5)
Total EDE	<u>1.5E+01</u>	<u>1.3E+01</u>	<u>1.1E+01</u>	<u>1.0E+01</u>	<u>9.9E+00</u>
Thyroid CDE	<u>8.6E+01</u>	<u>7.0E+01</u>	<u>5.2E+01</u>	<u>4.9E+01</u>	<u>4.8E+01</u>
Inhalation CEDE	1.1E+01	9.2E+00	7.7E+00	7.6E+00	7.3E+00
Cloudshine	1.2E-01	9.7E-02	7.3E-02	7.0E-02	6.6E-02
4-day Groundshine	4.1E+00	3.4E+00	2.8E+00	2.7E+00	2.5E+00
Inter Phase 1st Yr	<u>7.1E+01</u>	<u>6.0E+01</u>	<u>4.7E+01</u>	<u>4.5E+01</u>	<u>4.3E+01</u>
Inter Phase 2nd Yr	<u>3.6E+01</u>	<u>3.0E+01</u>	<u>2.3E+01</u>	<u>2.2E+01</u>	<u>2.1E+01</u>

### Notes:

- Doses exceeding PAGs are underlined.
- Early-Phase PAGs: TEDE - 1 rem, Thyroid (iodine) CDE - 5 rem
- Intermediate-Phase EPA PAGs: 1st year - 2 rem, 2nd year - 0.5 rem
- \*\*\* indicates values less than 1 mrem
- To view all values - use Detailed Results | Numeric Table
- Total EDE = CEDE Inhalation + Cloudshine + 4-Day Groundshine
- Total Acute Bone = Bone Inhalation + Cloudshine + Period Groundshine

TEDE - Total Effective Dose Equivalent

CDE - Committed Dose Equivalent

CEDE - Committed Effective Dose Equivalent

PAGs – Protective Action Guidelines

EPA – Environmental Protection Agency