From: Pilgrim, Gary T. CONTRACTOR <(b)(6)> on behalf of DTRA Operations Center <(b)(6)>
Sent: Tuesday, March 15, 2011 12:00 PM
To: (b)(6)
Subject: FW: RFI-216U-Update
Attachments: RFI_216U_0900Z_15MAR2011_rev0.pdf

Attached is the update for 15 March 2011 0900Z.

Mr. Gary Pilgrim
Operations Center Support
phone: 703.767.2116
Unclas: (b)(6)
Sipr: (b)(6)

-----Original Message-----
From: DTRA Reachback [mailto (b)(6)
Sent: Tuesday, March 15, 2011 11:08 AM
To: DTRA Operations Center
Cc: Reachback
Subject: RFI-216U-Update

Ops:

Please review and release the updated analysis to all requestors. Thank you.

Respectfully,

Defense Threat Reduction Agency

COM: (703) 767-3448, (DSN 427-)

STE: 427-2138

NIPR: (b)(6)

SIPR: (b)(6)

JWICS: (b)(6)

R&D Enterprise

Innovation & Systems Engineering Office

Reachback Division

Planning: Model of a Nuclear Reactor Incident in Japan as a Result of an Earthquake – Update 0300Z 15 MAR

RFI – 216U

15MAR2011

Requestor: USFJ

As of 1445Z 16MAR11

R&D Enterprise
Innovation & Systems Engineering Office
Reachback Division
(703) 767-3448, DSN 427-

Distribution: ~~Limited to DoD and authorized contractors. Further distribution contact DTRA.~~
Derived From: Navy
Reason: E.O. 12958 sections 1.4 (e), (g) and (h).

Request Summary

- (~~FOUO~~) Request data
  - Requestor: (b)(6)
  - Contact: (b)(6)
  - Request: A model of a nuclear incident at the Fukushima Daiichi – 1 and -3 nuclear power plant in Japan.

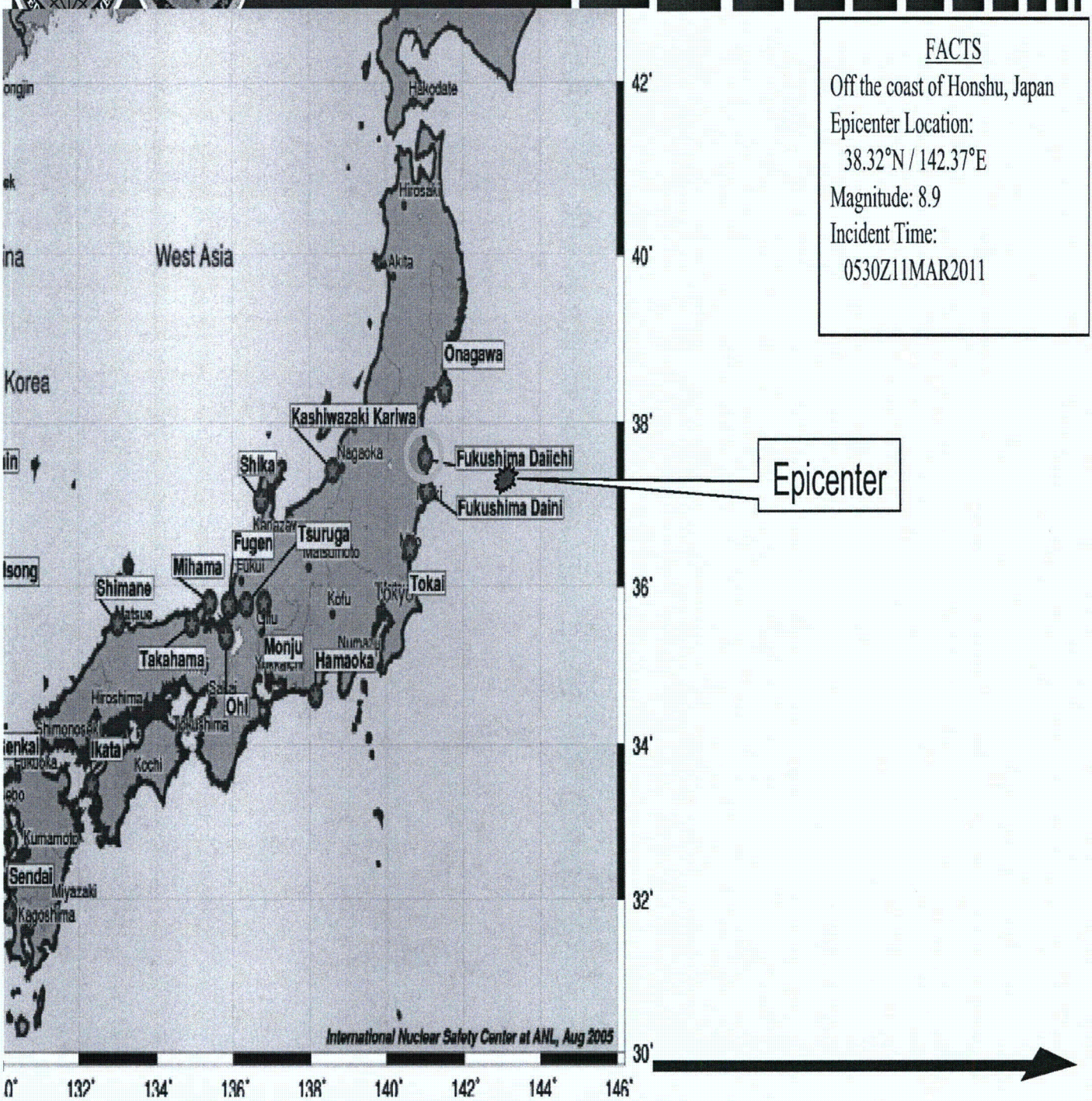
Location: Fukushima Daiichi, Japan Latitude: 37.42139° N Longitude: 141.0325° E
Time: 0900Z Date: 15MAR2011
Hazard: Accident at nuclear facility in Japan
Weather: Global Numerical Weather Prediction: 0.5°×0.5° resolution GFS from NCEP
Comments: This is a periodic update. We will continue to update this product with any additional information that becomes available.

- (~~FOUO~~) Solution
  - Summary: Integrated dose plots provided on the following slides
  - Employment: Real World
  - Reachback: Team

Possible Release – Situational Details Unknown

Nuclear Power Plants

SCOPING PURPOSES ONLY



FACTS

Off the coast of Honshu, Japan

Epicenter Location:
38.32°N / 142.37°E

Magnitude: 8.9

Incident Time:
0530Z11MAR2011

Fukushima Daiichi-1 Status

- Partial core damage from exposed fuel
- As of 2200 March 14, Japan time, sea water is being injected
- The reactor is described as "more stable"
- Suspected pipe broken and release to Containment which is believed "functional"
- Hydrogen explosion has damaged reactor building roof
- **Due to days of cool-down and injection of sea water, it will never be possible to produce power at the reactor (now unusable), but there is no further risk of total meltdown as long as core remains covered with seawater**

Source: USNRC Emergency Operations Center Status Update, 1730Z 14MAR2011

Fukushima Daiichi-2 Status

- RCIC has failed
- Coolant was stopped for quite some time so core damage is assumed. Core was most likely totally uncovered for some time.
- *Large hydrogen explosion on 14 Mar*
- *Suspected leak from containment*

Source: USNRC Emergency Operations Center Status Update, 1730Z 14MAR2011

Fukushima Daiichi-3 Status

- Condition described as essentially the same as Unit 1
- As of 2200 March 14, Japan time, sea water is being injected
- Hydrogen explosion has damaged reactor building roof
- Containment described as "functional"
- Alternate methods to inject water into the core are being investigated.
- Due to days of cool-down and injection of sea water, it will never be possible to produce power at the reactor (now unusable), but there is no further risk of total meltdown as long as core remains covered with seawater

Source: USNRC Emergency Operations Center Status Update, 1730Z 14MAR2011

Status of additional reactors

- Fukushima Daiichi-4, -5, and -6 and Daini-1, -2, -3, and -4
  - The reactors are shut down
  - Sufficient level of reactor coolant to ensure safety is maintained
  - Tokyo Electric Power Company (TEPCO) does not believe that there is any reactor coolant leakage inside the reactor containment vessel
  - Fire in spent fuel pool extinguished on 14Mar
- Onagawa
  - At 2145 CET 13MAR2011, IAEA reported that Japanese authorities had informed it that radioactivity levels at the site boundary have returned to normal background levels

Source: USNRC Emergency Operations Center Status Update, 1730Z 14MAR2011

Possible Release – Situational Details Unknown

Fukushima Daiichi DTRA Modeling Assumptions Most Likely

- **Scenario: some core damage; primary containment building integrity intact; venting occurring to reduce core temperature and pressure**

- Continuous Release – Steam released for decay heat removal
- HPAC –Release Assumptions:
  - ✓ Shut down time of reactor concurrent with earthquake
  - ✓ Continuous Small Release starting at 09Z
  - ✓ NFAC Reactor Accident
    - ✓ Containment monitor reading: 10 R/hr (unconfirmed)
    - ✓ Sprayers: Off (unconfirmed)
    - ✓ Filters: On (unconfirmed)
  - ✓ Weather 40 km GFS

Fukushima Daiichi DTRA Modeling

- **Summary of Models Provided in this Briefing**

- Assumption – Fukushima Daiichi #1, 2, and #3 suffered damage resulting in a continuous release/leak of a small portion of its inventory. Release occurs consistently throughout times shown in this product. (Precise details of this release are highly uncertain and time-varying)

Possible Release – Situational Details Unknown

Fukushima Daiichi (Impacts) – Most Likely

Assumed Core Damage & Venting

- Weather
  - Surface winds in the vicinity of the power plant are currently NNE. Scattered rain and snow showers are forecasted for central and southern Japan for 15MAR. Northwesterly (offshore) winds between 10-20 kts are forecasted for Wednesday (16MAR). **This means that any possible release through Wednesday will move to the S and later to SE**
- Japan has evacuated out to 20 km around site; ground operations should carefully monitor conditions within this zone.
- Operations in the area of the facility should include monitoring equipment.
- Air operations minimally impacted, but coordination with local authorities recommended
- Radiation hazard is above background. Level of concern should be less than 0.1 Rem integrated dose (see worst case in next slides)
- **As core pressure and temperature lower and stabilize, radiation levels will lower accordingly.**

Possible Release – Situational Details Unknown

Fukushima Daiichi – Plume at 2100Z 15MAR2011 (Far);

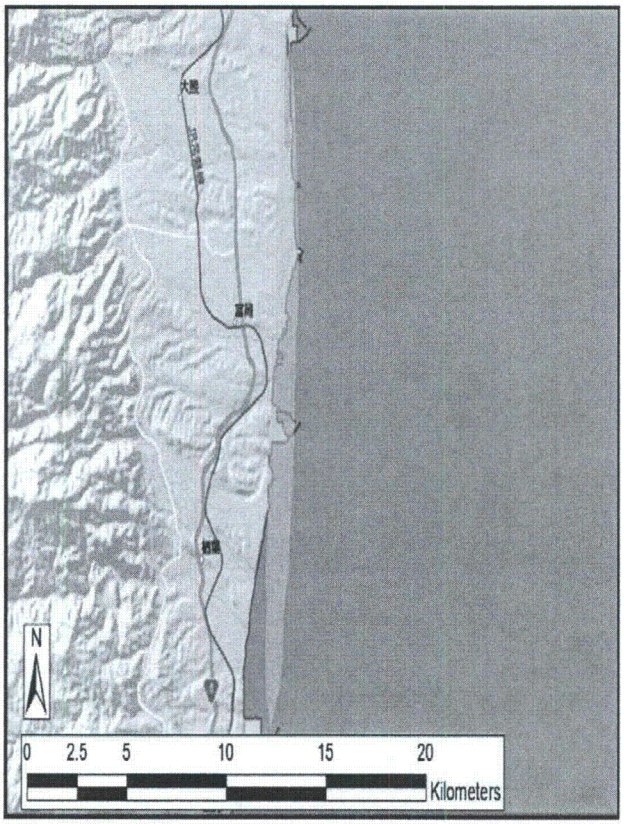
GFS Forecast valid @ 2100Z 15MAR2011 From 0000Z 15MAR2011 Run

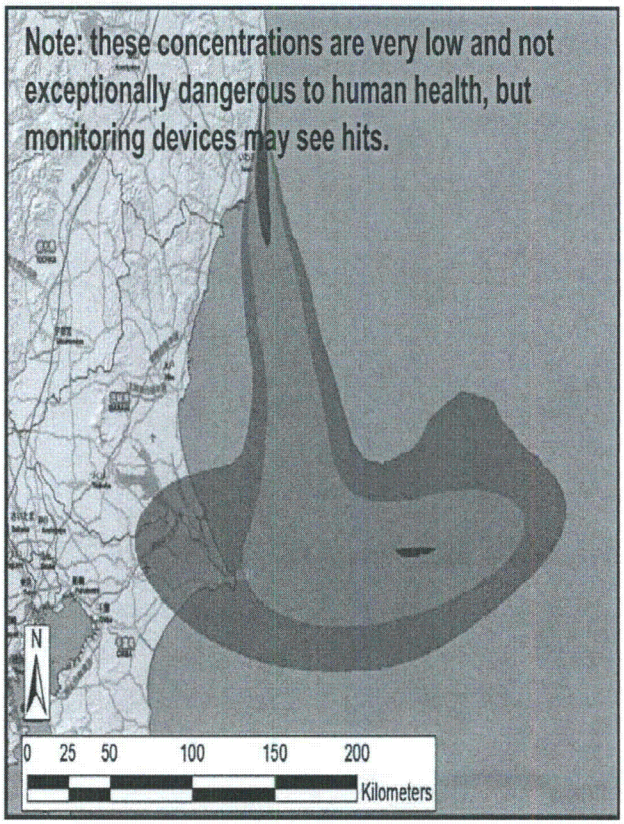
ALLEXTEFF(Rate) RTH Radiation Field 15-Mar-11 21:00:00Z	REM/hr
1 urem/hr	1.0E-06
100 nrem/hr	1.0E-07
10 nrem/hr	1.0E-08
1 nrem/hr	1.0E-09

FACTS

Fukushima Daiichi
37.42139°N/ 141.0325°E
0900Z 15MAR2011
Type: Nuclear Facility Accident
Weather: 40 km GFS
Model: HPAC 5.0 SP1
Static Population Estimates:
LandScan 2009

Total Activity Isotope Air Concentration 15-Mar-11 2100Z	uCi/mL
10 nCi/m3	1.0E-08
1 nCi/m3	1.0E-09
100 pCi/m3	1.0E-10
10 pCi/m3	1.0E-11
1 pCi/m3	1.0E-12
100 fCi/m3	1.0E-13
10 fCi/m3	1.0E-14





Possible Release – Situational Details Unknown

Fukushima Daiichi – Plume at 0300Z 16MAR2011 (Far);

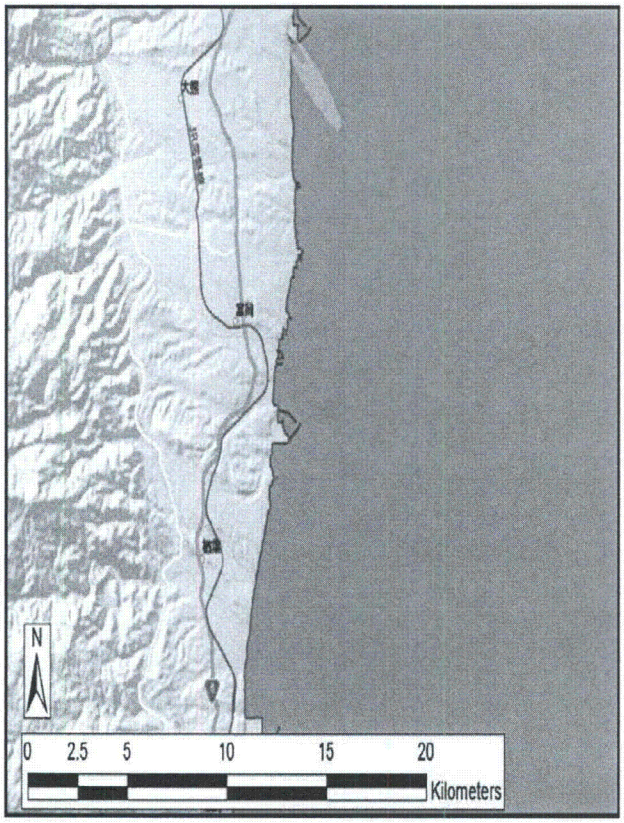
GFS Forecast valid @ 0300Z 16MAR2011 From 0000Z 15MAR2011 Run

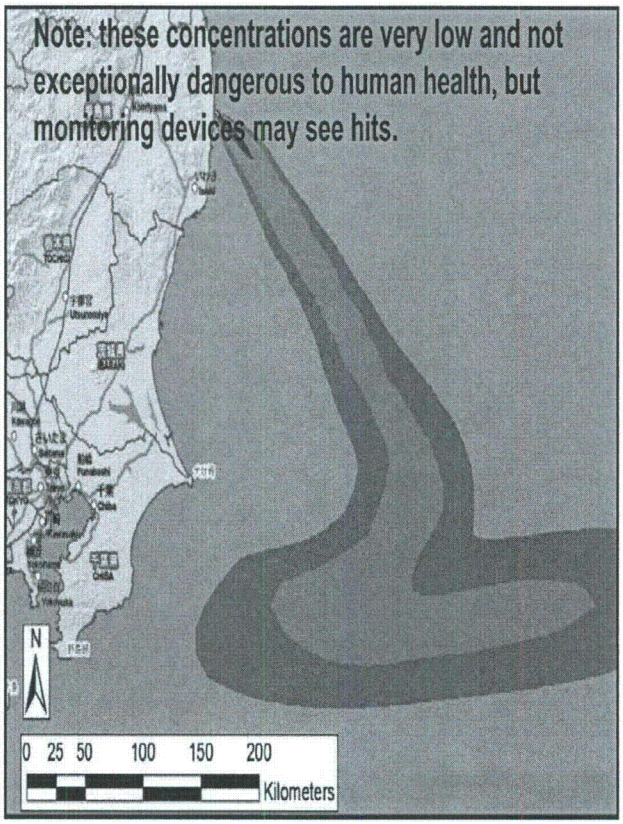
ALLEXTEFF(Rate) RTH Radiation Field 16-Mar-11 03:00:00Z (18.000 hr)	REM/hr
1 urem/hr	1.0E-06
100 nrem/hr	1.0E-07
10 nrem/hr	1.0E-08
1 nrem/hr	1.0E-09

FACTS

Fukushima Daiichi
37.42139°N/ 141.0325°E
0900Z 15MAR2011
Type: Nuclear Facility Accident
Weather: 40 km GFS
Model: HPAC 5.0 SP1
Static Population Estimates:
LandScan 2009

Total Activity Isotope Air Concentration 16-Mar-11 0300Z	uCi/mL
10 nCi/m3	1.0E-08
1 nCi/m3	1.0E-09
100 pCi/m3	1.0E-10
10 pCi/m3	1.0E-11
1 pCi/m3	1.0E-12
100 fCi/m3	1.0E-13
10 fCi/m3	1.0E-14





As of 1445Z 16MAR11

Possible Release – Situational Details Unknown

Fukushima Daiichi – Plume at 0900Z 16MAR2011 (Far);

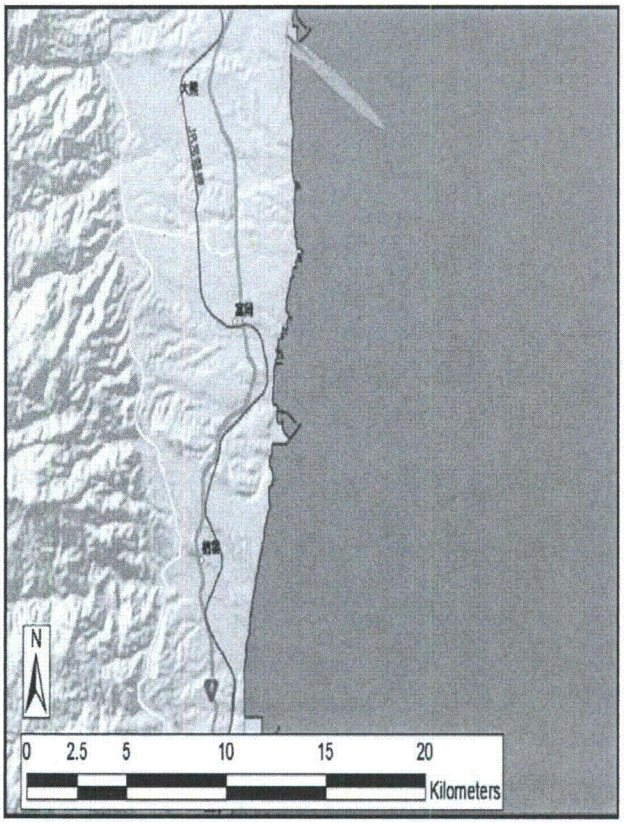
GFS Forecast valid @ 0900Z 16MAR2011 From 0000Z 15MAR2011 Run

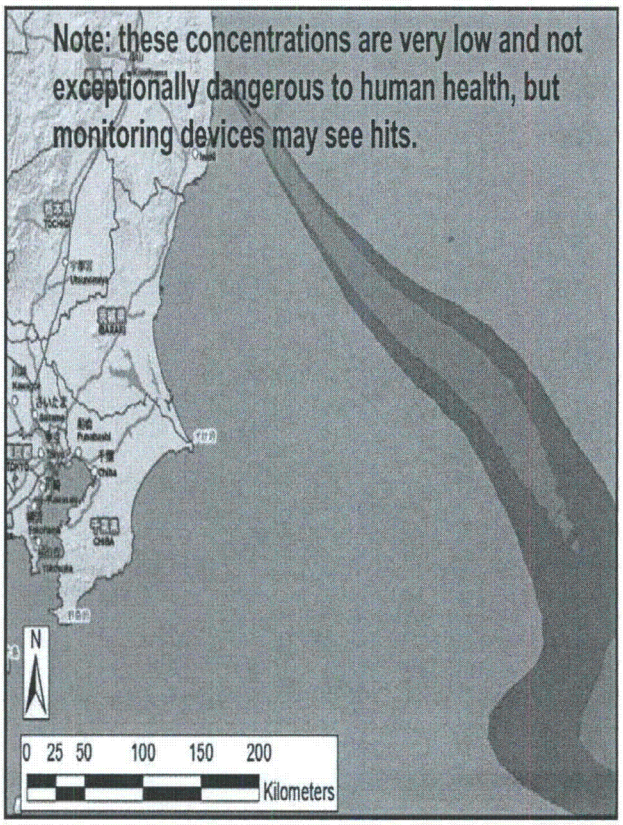
ALLEXTEFF(Rate) RTH Radiation Field 16-Mar-11 09:00:00Z	REM/hr
100 nrem/hr	1.0E-07
10 nrem/hr	1.0E-08
1 nrem/hr	1.0E-09

FACTS

Fukushima Daiichi
37.42139°N/ 141.0325°E
0900Z 15MAR2011
Type: Nuclear Facility Accident
Weather: 40 km GFS
Model: HPAC 5.0 SP1
Static Population Estimates:
LandScan 2009

Total Activity Isotope Air Concentration 16-Mar-11 0900Z	uCi/mL
10 nCi/m3	1.0E-08
1 nCi/m3	1.0E-09
100 pCi/m3	1.0E-10
10 pCi/m3	1.0E-11
1 pCi/m3	1.0E-12
100 fCi/m3	1.0E-13
10 fCi/m3	1.0E-14





As of 1445Z 16MAR11

Possible Release – Situational Details Unknown

Fukushima Daiichi – Plume at 1500Z 16MAR2011 (Far);

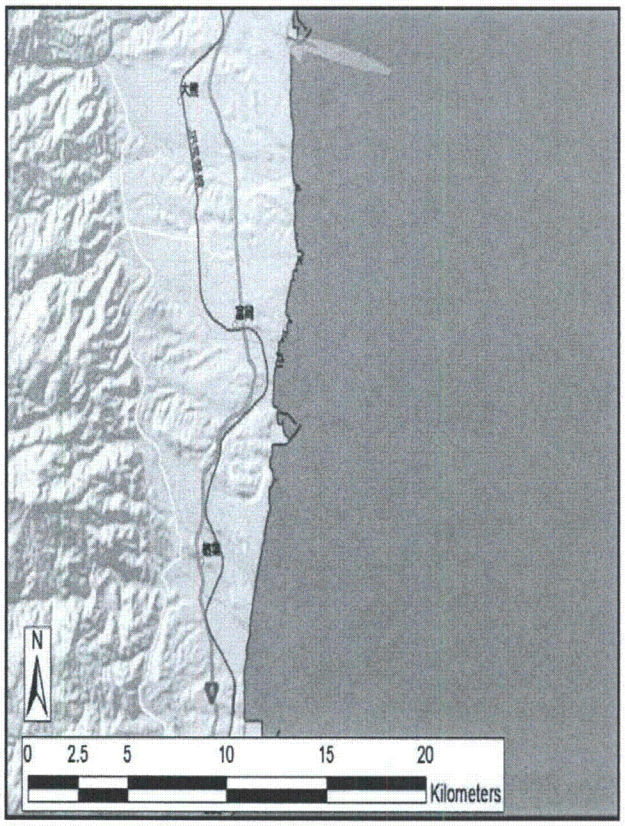
GFS Forecast valid @ 1500Z 16MAR2011 From 0000Z 15MAR2011 Run

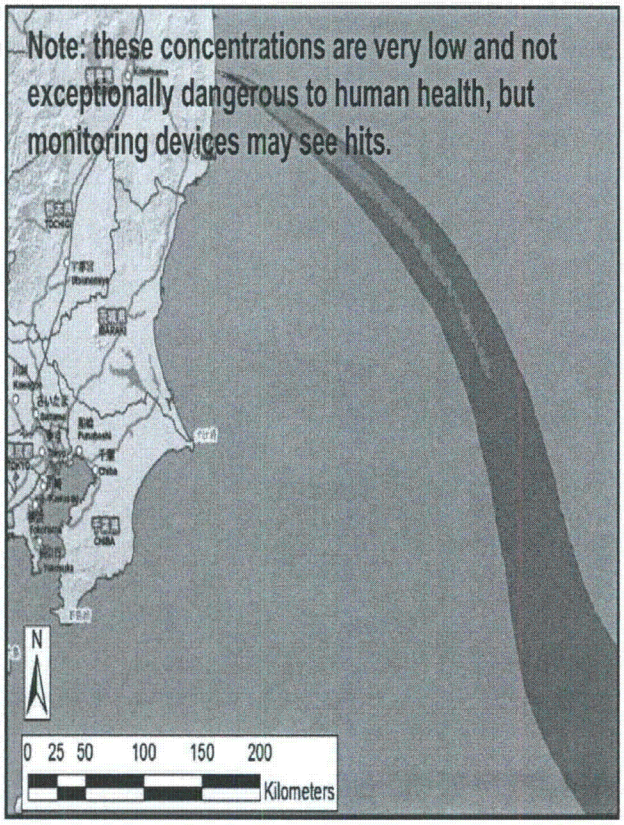
ALLEXTEFF(Rate) RTH Radiation Field 16-Mar-11 15:00:00Z	REM/hr
1 urem/hr	1.0E-06
100 nrem/hr	1.0E-07
10 nrem/hr	1.0E-08
1 nrem/hr	1.0E-09

FACTS

Fukushima Daiichi
37.42139°N/ 141.0325°E
0900Z 15MAR2011
Type: Nuclear Facility Accident
Weather: 40 km GFS
Model: HPAC 5.0 SP1
Static Population Estimates:
LandScan 2009

Total Activity Isotope Air Concentration 16-Mar-11 1500Z	uCi/mL
10 nCi/m3	1.0E-08
1 nCi/m3	1.0E-09
100 pCi/m3	1.0E-10
10 pCi/m3	1.0E-11
1 pCi/m3	1.0E-12
100 fCi/m3	1.0E-13
10 fCi/m3	1.0E-14





Possible Release – Situational Details Unknown

Fukushima Daiichi – Plume at 2100Z 16MAR2011 (Far);

GFS Forecast valid @ 2100Z 16MAR2011 From 0000Z 15MAR2011 Run

ALLEXTEFF(Rate)
RTH Radiation Field
16-Mar-11 21:00:00Z

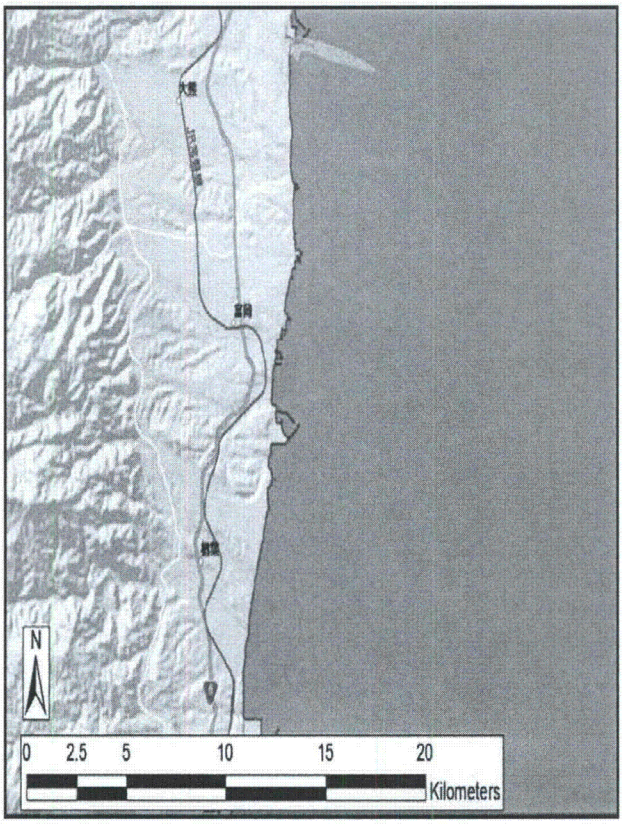
	REM/hr
100 nrem/hr	1.0E-07
10 nrem/hr	1.0E-08
1 nrem/hr	1.0E-09

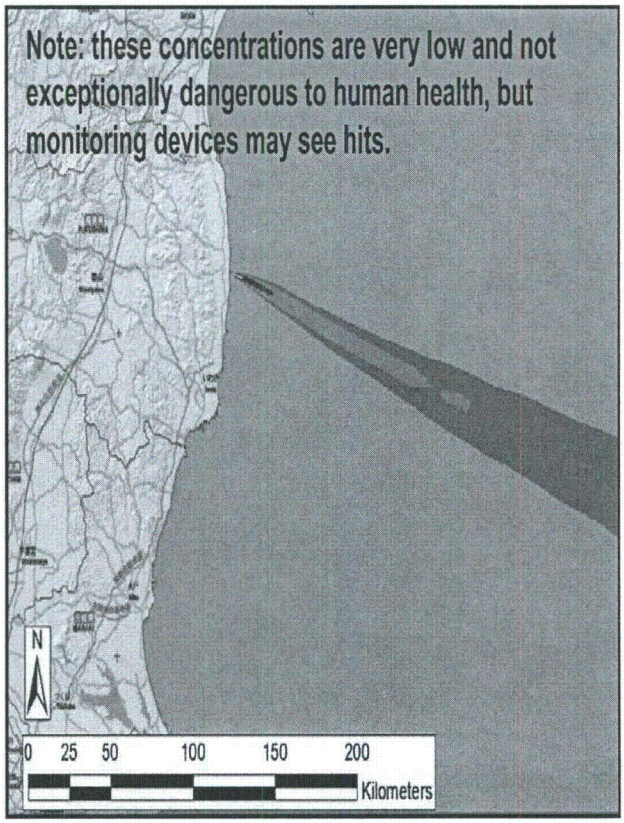
FACTS

Fukushima Daiichi
37.42139°N/ 141.0325°E
0900Z 15MAR2011
Type: Nuclear Facility Accident
Weather: 40 km GFS
Model: HPAC 5.0 SP1
Static Population Estimates:
LandScan 2009

Total Activity
Isotope Air Concentration
16-Mar-11 21:00:00Z

	uCi/mL
10 nCi/m3	1.0E-08
1 nCi/m3	1.0E-09
100 pCi/m3	1.0E-10
10 pCi/m3	1.0E-11
1 pCi/m3	1.0E-12
100 fCi/m3	1.0E-13
10 fCi/m3	1.0E-14





Possible Release – Situational Details Unknown

Fukushima Daiichi – Plume at 0300Z 17MAR2011 (Far);

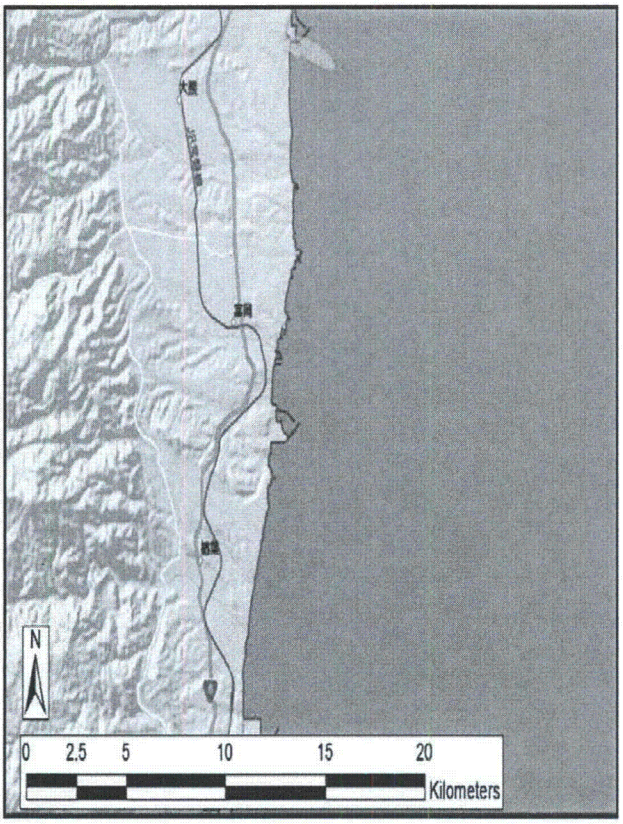
GFS Forecast valid @ 0300Z 17MAR2011 From 0000Z 15MAR2011 Run

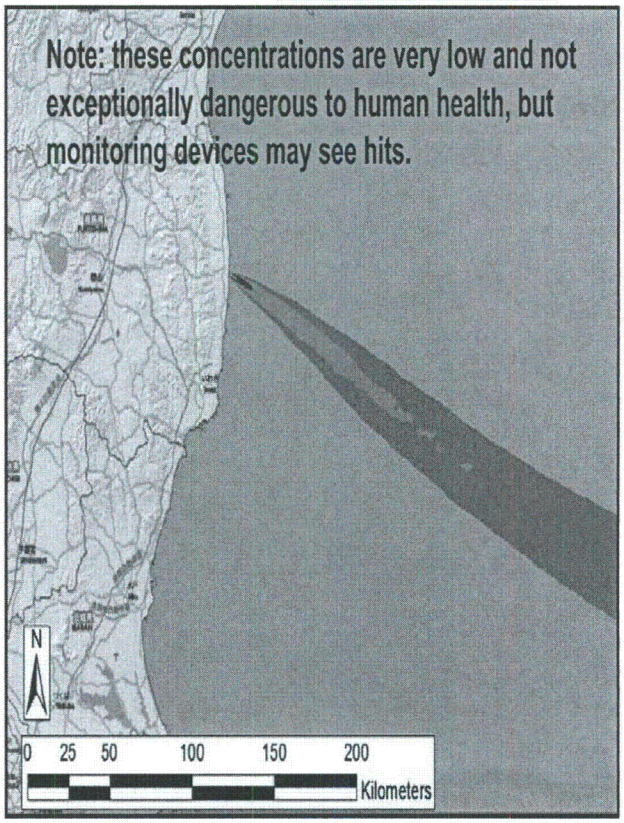
ALLEXTEFF(Rate) RTH Radiation Field 17-Mar-11 03:00:00Z	REM/hr
100 nrem/hr	1.0E-07
10 nrem/hr	1.0E-08
1 nrem/hr	1.0E-09

FACTS

Fukushima Daiichi
37.42139°N/ 141.0325°E
0900Z 15MAR2011
Type: Nuclear Facility Accident
Weather: 40 km GFS
Model: HPAC 5.0 SP1
Static Population Estimates:
LandScan 2009

Total Activity Isotope Air Concentration 17-Mar-11 0300Z	uCi/mL
10 nCi/m3	1.0E-08
1 nCi/m3	1.0E-09
100 pCi/m3	1.0E-10
10 pCi/m3	1.0E-11
1 pCi/m3	1.0E-12
100 fCi/m3	1.0E-13
10 fCi/m3	1.0E-14





As of 1445Z 16MAR11

Possible Release – Situational Details Unknown

Fukushima Daiichi – Plume at 0900Z 17MAR2011 (Far);

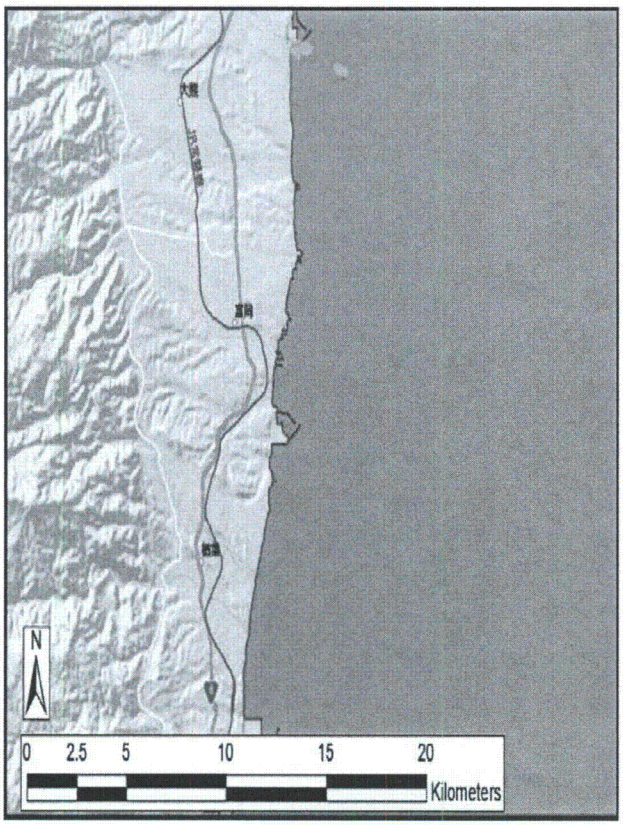
GFS Forecast valid @ 0900Z 17MAR2011 From 0000Z 15MAR2011 Run

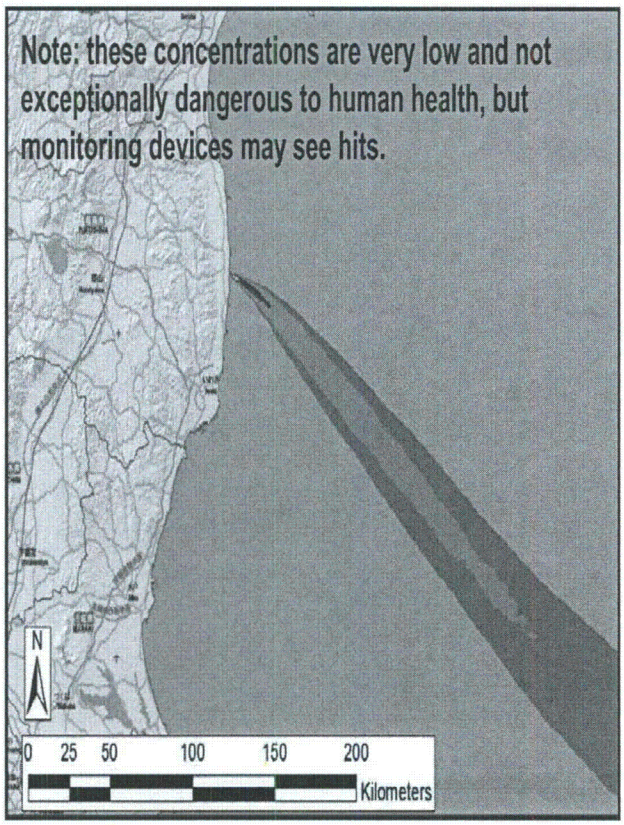
ALLEXTEFF(Rate) RTH Radiation Field 17-Mar-11 09:00:00Z	REM/hr
100 nrem/hr	1.0E-07
10 nrem/hr	1.0E-08
1 nrem/hr	1.0E-09

FACTS

Fukushima Daiichi
37.42139°N/ 141.0325°E
0900Z 15MAR2011
Type: Nuclear Facility Accident
Weather: 40 km GFS
Model: HPAC 5.0 SP1
Static Population Estimates:
LandScan 2009

Total Activity Isotope Air Concentration 17-Mar-11 0900Z	uCi/mL
10 pCi/m3	1.0E-11
1 pCi/m3	1.0E-12
100 fCi/m3	1.0E-13
10 fCi/m3	1.0E-14



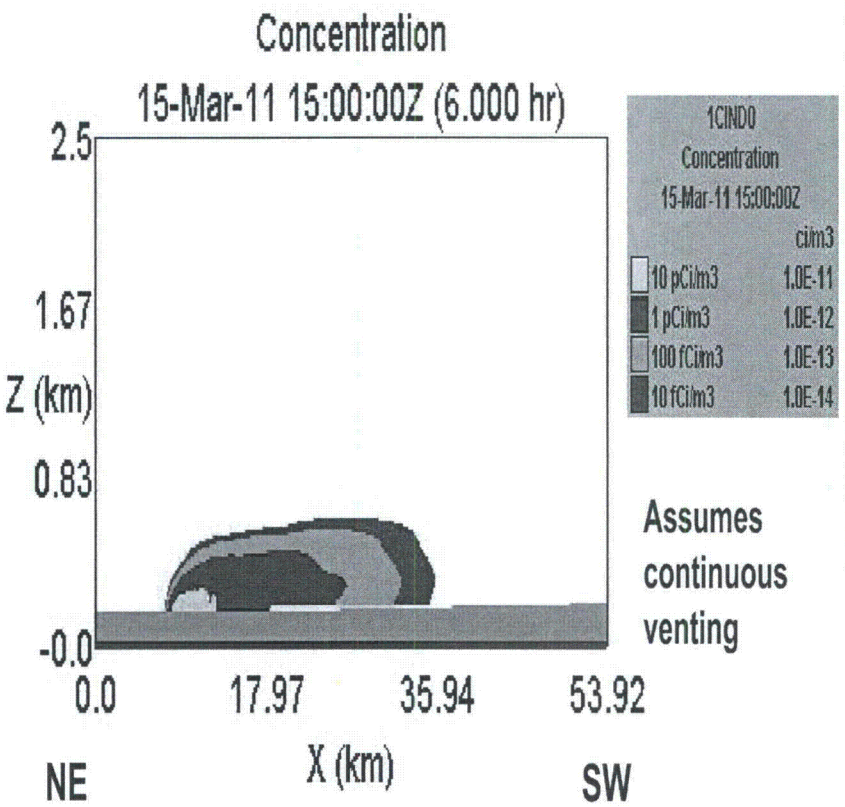


Possible Release – Situational Details Unknown

Fukushima Daiichi-1

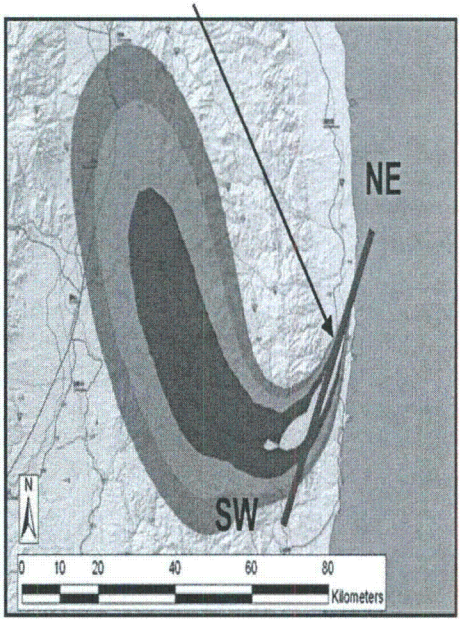
Most Likely Release Scenario

Vertical Slice @ 0900Z 15 March



Assumes continuous venting

Slice cross-section



Note: The plume will change shape and structure as a function of time – slices at other times were similar or smaller. Higher concentrations were generally at or below 1 km elevation, lower concentrations up to approx 1 km or a little above.

FACTS

Fukushima Daiichi
37.42139°N/ 141.0325°E
0900Z 15MAR2011
Type: Nuclear Facility Accident
Weather: 40 km GFS
Model: HPAC 5.0 SP1
Static Population Estimates:
LandScan 2009

Backup: Radiation Unit Conversions

- Activity
  - 1 Curie (Ci) = 3.7×10^{10} Becquerels (Bq) = 3.7×10^{10} disintegrations/sec
  - Activity is a measure of atomic disintegrations per second.
  - Exponentially decays with age and is relative to specific radio-nuclide and age.
- Exposure or Dose Rate
  - 1 Gray (Gy) = 100 centi-Gray (cGy)
  - 1 centi-Gray (cGy) = 1 radiation absorbed dose unit (rad)
  - Dose is a measure of the energy deposited into a given mass.
  - Exposure when integrated over a time combined with an estimate of human tissue damage yields dose. Radiation detectors usually display instantaneous dose rate (e.g., cGy/hr, rad/hr).
- Dose Equivalent
  - 1 Sievert (Sv) = 100 centi-Sievert (cSv)
  - 1 centi-Sievert (cSv) = 1 Roentgen Equivalent to Man (REM)
  - An equivalent measurement or estimation of possible damage from ionizing radiation to human tissue. Dose Equivalent varies with type of human tissue exposed, ingestion, shielding, time, radiation type and energy.
- Exposure
  - 1 roentgen (R) = 2.58 * 10^-4 Coulombs (C) per kg (in air)
  - Used to measure x and gamma ray radiation. 1 R ~ 1 rad ~ 1 rem for x and gamma.

Possible Release – Situational Details Unknown

Backup: Radiation Exposure Reference

Exposure	cGy / Rad / REM / cSv	Reference
Cross Country Civilian Flight (cosmic radiation)	0.004	
Medical X-Ray (Chest)	0.01	Mettler FA, et al: Effective Doses in Radiology and Diagnostic Nuclear Medicine, 2008
Mammogram	0.4	Mettler FA, et al: Effective Doses in Radiology and Diagnostic Nuclear Medicine, 2008
CT (Chest, Abdomen, and Pelvis)	1.8	Mettler FA, et al: Effective Doses in Radiology and Diagnostic Nuclear Medicine, 2008
Chemobyl Evacuation Zone	10	
Hiroshima Survivor Inside Structure	78	
Nagasaki Survivor Inside Structure	156	
Average Background Annual Exposure in U.S. (Total)	0.62	NCRP No. 160 (2006)

U.S. Civilian Standards	cGy / Rad / REM / cSv	
Maximum Annual Public Exposure	0.1	(10 CFR 20.1301)
Maximum Radiation Worker Annual Dose	5	(10 CFR 20.1201)
General Emergency	1	(NUREG-0654/FEMA REP 1)
Protective Actions (shelter or evacuate)	1.0-5.0	(EPA 400-R-92-001, 1992)
Evacuation required	5	(EPA 400-R-92-001, 1992)
1st Responder Dose Protecting valuable property 1	10	(EPA 400-R-92-001, 1992)
1st Responder Dose Lifesaving or protection of large populations 1	25	(EPA 400-R-92-001, 1992)
Maximum 1st Responder Dose	25	(EPA 400-R-92-001, 1992)

Military OEG*	cGy / Rad / REM / cSv	
Wartime high-priority missions, to include life-saving	125	NATO STANAG-2473, 3 May 2000; USAFRRI, SP 03-1, April 2003
Operations other than war based on mission priorities and risk analysis	75	NATO STANAG-2473, 3 May 2000; USAFRRI, SP 03-1, April 2003

Note: Sieverts=Grays and Rad=REM for beta and gamma radiation as the Quality Factor is one.

[1]FEMA: Planning Guidance for Protection and Recovery Following Radiological Dispersal Device (RDD) and Improvised Nuclear Device (IND) Incidents

From: PMT09 Hoc
Sent: Tuesday, March 15, 2011 3:58 AM
To: Hoc, PMT12
Subject: action item for morning of

Action Item, PMT or perhaps RST

If a spent fuel pool burns, (zirconium fire) how long does the fire last? Assume no cooling...

What is the terminal condition? Does the fuel melt go critical? Does the melt eat through the SFP concrete?

Charlie Tinkler, should be at work, but home # (b)(6)

Jason Schaparow, could also help

Casey Wagoner, "Dicoda consultant" in Albuquerque could help perhaps... 2 hour time diff... may not be available

From: DTRA Operations Center <(b)(6)>
Sent: Tuesday, March 15, 2011 1:16 AM
To: (b)(6)

Subject: RFI 216 Update
Attachments: RFI_216U_0300Z_15MAR2011_rev0.pdf

<<RFI_216U_0300Z_15MAR2011_rev0.pdf>>

ALCON,

Attached is RFI 216 Update for 0300Z 15Mar2011.

V/r
Mr. Chris Seigfreid
DTRA Operations Center
SAIC, Controller
703-767-2116

Planning: Model of a Nuclear Reactor Incident in Japan as a Result of an Earthquake – Update 0300Z 15 MAR

RFI – 216U

14MAR2011

Requestor: USFJ

As of 0515Z 15MAR11

R&D Enterprise
Innovation & Systems Engineering Office
Reachback Division
(703) 767-3448, DSN 427-

Distribution: ~~Limited to DoD and authorized contractors. Further distribution contact DTRA.~~
Derived From: Navy
Reason: E.O. 12958 sections 1.4 (e), (g) and (h).

Request Summary

- ~~(FOUO)~~ Request data
  - Requestor: (b)(6)
  - Contact: (b)(6)
  - Request: A model of a nuclear incident at the Fukushima Daiichi – 1 and -3 nuclear power plant in Japan.

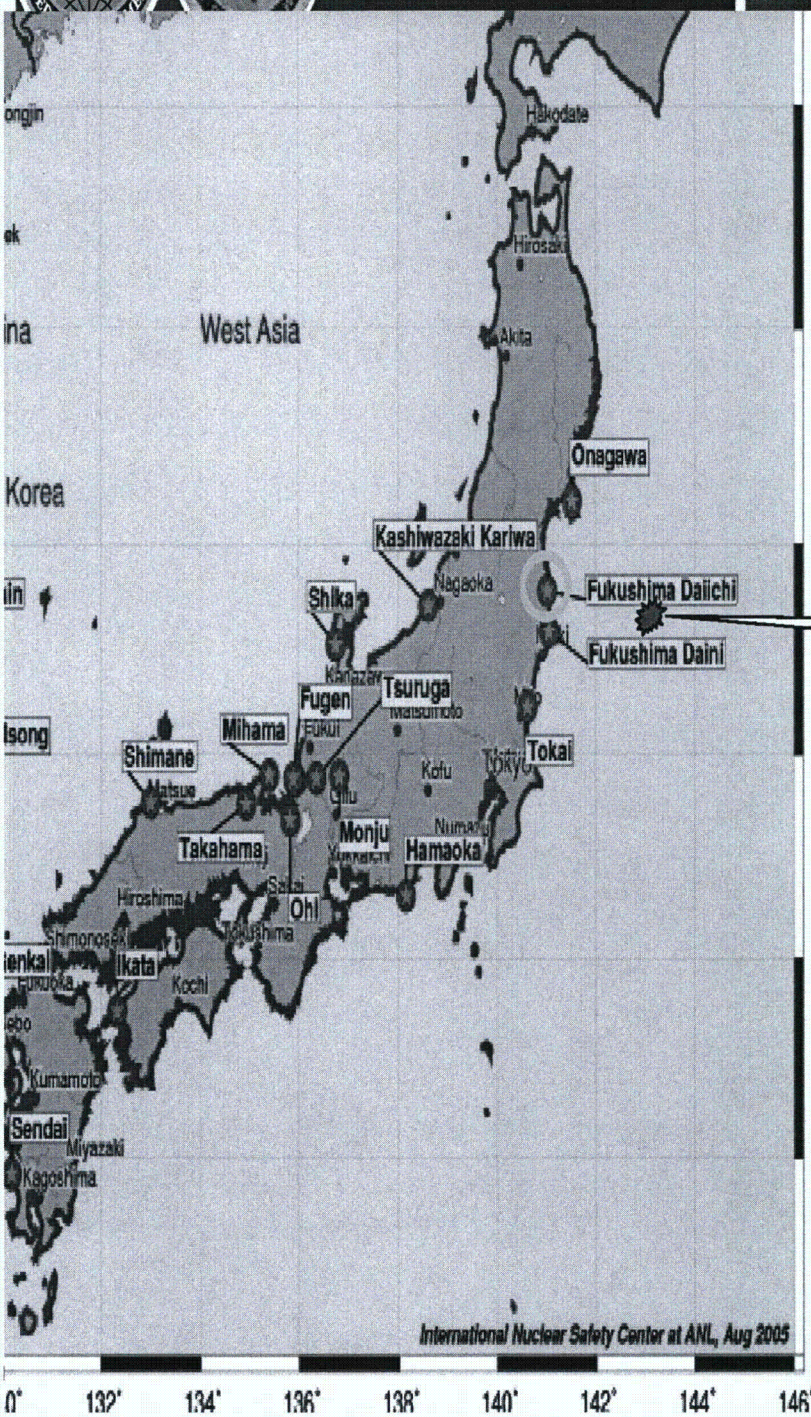
Location: Fukushima Daiichi, Japan Latitude: 37.42139° N Longitude: 141.0325° E
Time: 0530Z Date: 12MAR2011
Hazard: Accident at nuclear facility in Japan
Weather: Global Numerical Weather Prediction: 0.5°×0.5° resolution GFS from NCEP
Comments: This is a periodic update. We will continue to update this product with any additional information that becomes available.

- ~~(FOUO)~~ Solution
  - Summary: Integrated dose plots provided on the following slides
  - Employment: Real World
  - Reachback: Team

Possible Release – Situational Details Unknown

Nuclear Power Plants

SCOPING PURPOSES ONLY



FACTS

Off the coast of Honshu, Japan

Epicenter Location:
38.32°N / 142.37°E

Magnitude: 8.9

Incident Time:
0530Z11MAR2011

Epicenter

As of 0515Z 15MAR11

Fukushima Daiichi-1 Status

- Partial core damage from exposed fuel
- As of 2200 March 14, Japan time, sea water is being injected
- The reactor is described as "more stable"
- Containment described as "functional"
- Hydrogen explosion has damaged reactor building roof
- **Due to days of cool-down and injection of sea water, it will never be possible to produce power at the reactor (now unusable), but there is no further risk of total meltdown as long as core remains covered with seawater**

Source: USNRC Emergency Operations Center Status Update, 1730Z 14MAR2011

Fukushima Daiichi-2 Status

- RCIC has failed
- Coolant was stopped for quite some time so core damage is assumed. Core was most likely totally uncovered for some time
- *DTRA Reachback is aware of explosion earlier in the day, however, we have received no recent updates from the NRC concerning the current condition of this reactor. Information will be provided as it becomes available.*

Source: USNRC Emergency Operations Center Status Update, 1730Z 14MAR2011

Fukushima Daiichi-3 Status

- Condition described as essentially the same as Unit 1
- As of 2200 March 14, Japan time, sea water is being injected
- Hydrogen explosion has damaged reactor building roof
- Containment described as "functional"
- Alternate methods to inject water into the core are being investigated.
- Due to days of cool-down and injection of sea water, it will never be possible to produce power at the reactor (now unusable), but there is no further risk of total meltdown as long as core remains covered with seawater

Source: USNRC Emergency Operations Center Status Update, 1730Z 14MAR2011

Status of additional reactors

- Fukushima Daiichi-4, -5, and -6 and Daini-1, -2, -3, and -4
  - The reactors are shut down
  - Sufficient level of reactor coolant to ensure safety is maintained
  - Tokyo Electric Power Company (TEPCO) does not believe that there is any reactor coolant leakage inside the reactor containment vessel
- Onagawa
  - At 2145 CET 13MAR2011, IAEA reported that Japanese authorities had informed it that radioactivity levels at the site boundary have returned to normal background levels

Source: USNRC Emergency Operations Center Status Update, 1730Z 14MAR2011

Possible Release – Situational Details Unknown

Fukushima Daiichi DTRA Modeling Assumptions Most Likely

- **Scenario: some core damage; primary containment building integrity intact; venting occurring to reduce core temperature and pressure**

- Continuous Release – Steam released for decay heat removal
- HPAC –Release Assumptions:
  - ✓ Shut down time of reactor concurrent with earthquake
  - ✓ Continuous Small Release starting at 15Z
  - ✓ NFAC Reactor Accident
    - ✓ Containment monitor reading: 10 R/hr (unconfirmed)
    - ✓ Sprayers: Off (unconfirmed)
    - ✓ Filters: On (unconfirmed)
  - ✓ Weather 40 km GFS

Fukushima Daiichi DTRA Modeling

- **Summary of Models Provided in this Briefing**

- Assumption – Fukushima Daiichi #1 and #3 suffered damage resulting in a continuous release/leak of a small portion of its inventory. Release occurs consistently throughout times shown in this product. (Precise details of this release are highly uncertain and time-varying)

Possible Release – Situational Details Unknown

Fukushima Daiichi (Impacts) – Most Likely

Assumed Core Damage & Venting

- Weather
  - Surface winds in the vicinity of the power plant are currently NNE and will continue on a trend toward the ENE for the rest of today (15MAR). Scattered rain and snow showers are forecasted for central and southern Japan for 15MAR. Northwesterly (offshore) winds between 10-20 kts are forecasted for Wednesday (16MAR). **This means that any possible release on Tuesday through Wednesday morning may move inland, to the SW and W.**

- Japan has evacuated out to 20 km around site; ground operations should carefully monitor conditions within this zone.
- Operations in the area of the facility should include monitoring equipment.
- Air operations minimally impacted, but coordination with local authorities recommended
- Radiation hazard is above background. Level of concern should be less than 0.1 Rem integrated dose (see worst case in next slides)
- **As core pressure and temperature lower and stabilize, radiation levels will lower accordingly.**

Possible Release – Situational Details Unknown

Fukushima Daiichi – Plume at 0300Z 15MAR2011 (Far);

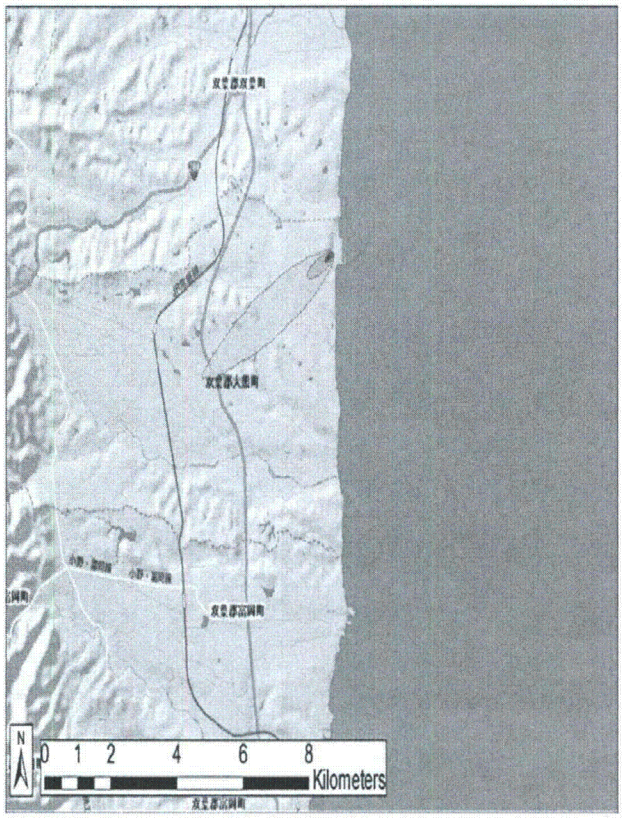
GFS Forecast valid @ 0300Z 15MAR2011 From 0000Z 14MAR2011 Run

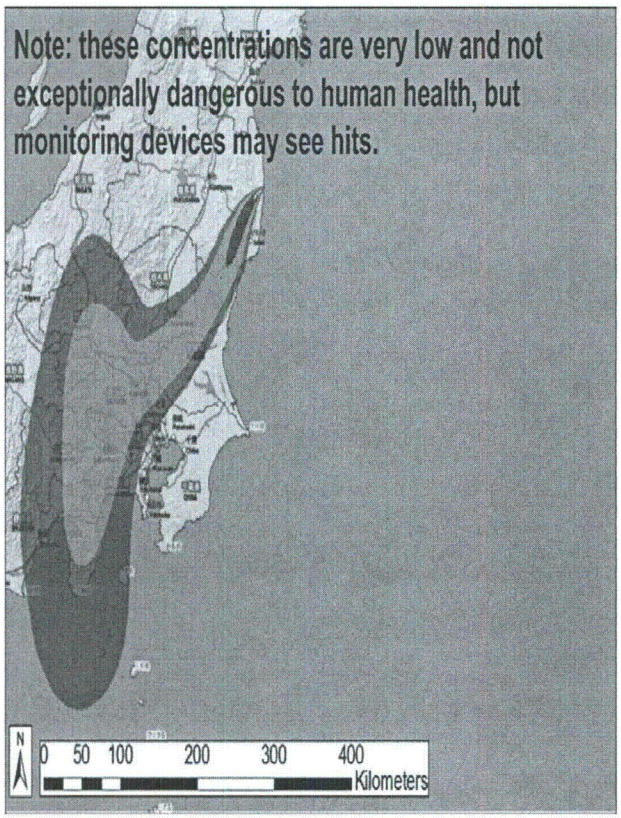
ALLEXTEFF(Rate) RTH Radiation Field 15-Mar-11 03:00:00Z	REM/hr
1 urem/hr	1.0E-06
100 nrem/hr	1.0E-07
10 nrem/hr	1.0E-08
1 nrem/hr	1.0E-09

FACTS

Fukushima Daiichi
37.42139°N/ 141.0325°E
2100Z 14MAR2011
Type: Nuclear Facility Accident
Weather: 40 km GFS
Model: HPAC 5.0 SP1
Static Population Estimates:
LandScan 2009

Total Activity Isotope Air Concentration 15-Mar-11 03:00:00Z	Ci/m3
10 nCi/m3	1.0E-08
1 nCi/m3	1.0E-09
100 pCi/m3	1.0E-10
10 pCi/m3	1.0E-11
1 pCi/m3	1.0E-12
100 fCi/m3	1.0E-13
10 fCi/m3	1.0E-14





Possible Release – Situational Details Unknown

Fukushima Daiichi – Plume at 0900Z 15MAR2011 (Far);

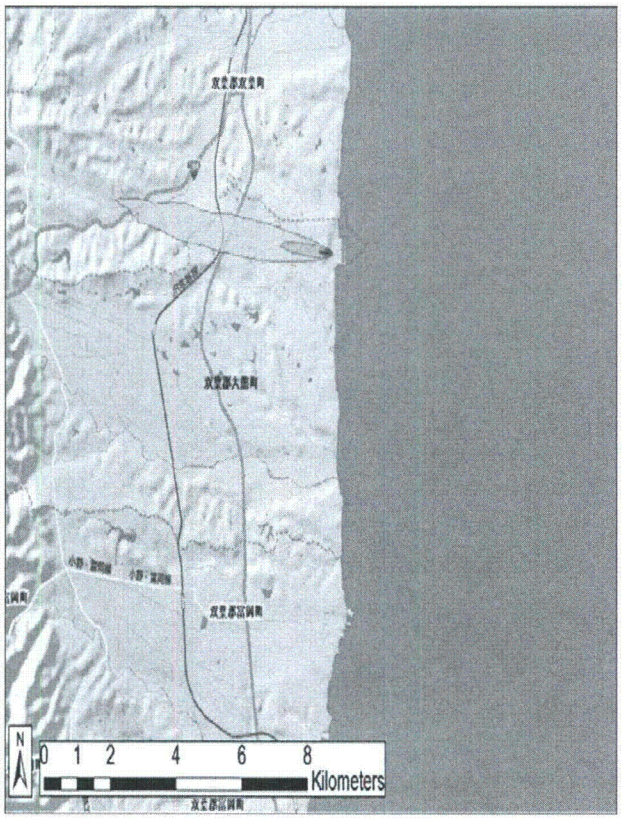
GFS Forecast valid @ 0900Z 15MAR2011 From 0000Z 14MAR2011 Run

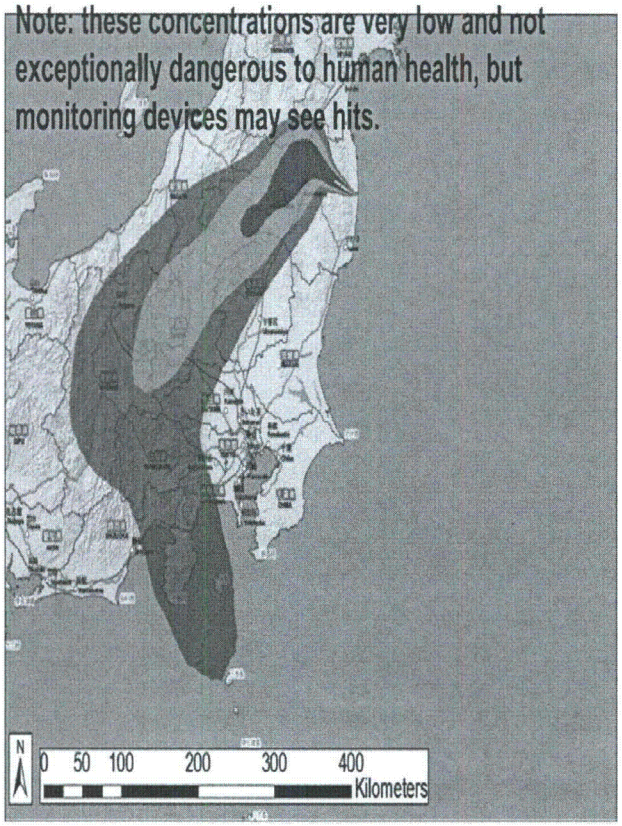
ALLEXTEFF(Rate) RTH Radiation Field 15-Mar-11 09:00:00Z	REM/hr
1 urem/hr	1.0E-06
100 nrem/hr	1.0E-07
10 nrem/hr	1.0E-08
1 nrem/hr	1.0E-09

FACTS

Fukushima Daiichi
37.42139°N/ 141.0325°E
2100Z 14MAR2011
Type: Nuclear Facility Accident
Weather: 40 km GFS
Model: HPAC 5.0 SP1
Static Population Estimates:
LandScan 2009

Total Activity Isotope Air Concentration 15-Mar-11 09:00:00Z	Ci/m3
10 nCi/m3	1.0E-08
1 nCi/m3	1.0E-09
100 pCi/m3	1.0E-10
10 pCi/m3	1.0E-11
1 pCi/m3	1.0E-12
100 fCi/m3	1.0E-13
10 fCi/m3	1.0E-14





Possible Release – Situational Details Unknown

Fukushima Daiichi – Plume at 1500Z 15MAR2011 (Far);

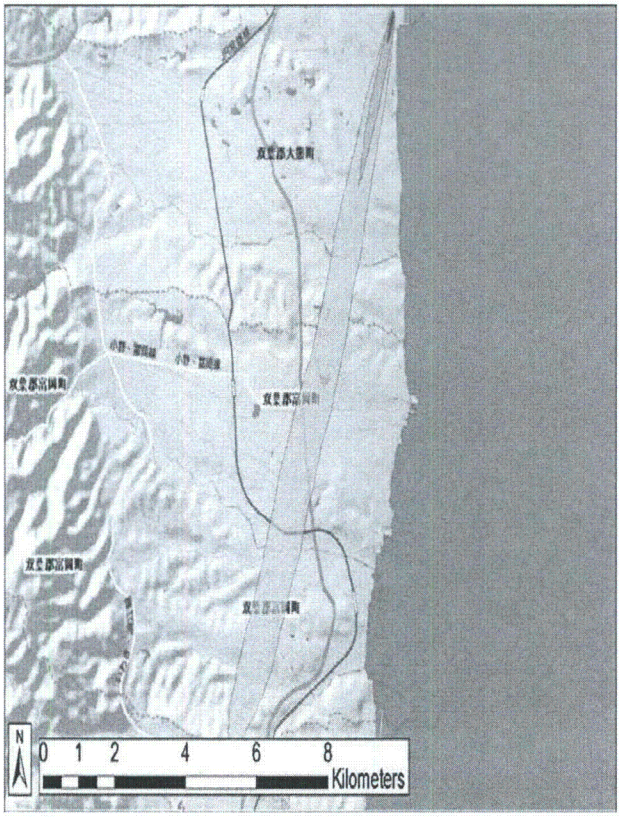
GFS Forecast valid @ 1500Z 15MAR2011 From 0000Z 14MAR2011 Run

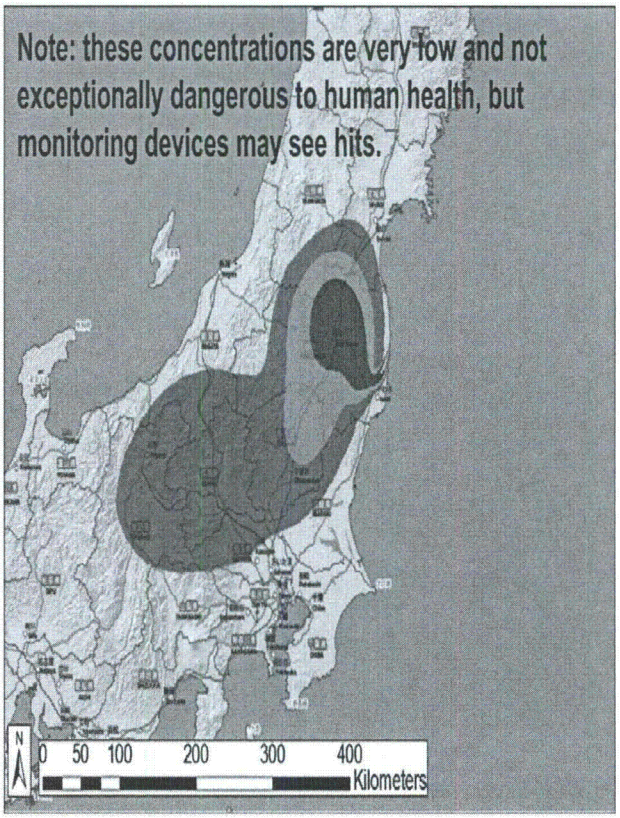
ALLEXTEFF(Rate) RTH Radiation Field 15-Mar-11 15:00:00Z	REM/hr
1 urem/hr	1.0E-06
100 nrem/hr	1.0E-07
10 nrem/hr	1.0E-08
1 nrem/hr	1.0E-09

FACTS

Fukushima Daiichi
37.42139°N/ 141.0325°E
2100Z 14MAR2011
Type: Nuclear Facility Accident
Weather: 40 km GFS
Model: HPAC 5.0 SP1
Static Population Estimates:
LandScan 2009

Total Activity Isotope Air Concentration 15-Mar-11 15:00:00Z	Ci/m3
10 nCi/m3	1.0E-08
1 nCi/m3	1.0E-09
100 pCi/m3	1.0E-10
10 pCi/m3	1.0E-11
1 pCi/m3	1.0E-12
100 fCi/m3	1.0E-13
10 fCi/m3	1.0E-14





Possible Release – Situational Details Unknown

Fukushima Daiichi – Plume at 2100Z 15MAR2011 (Far);

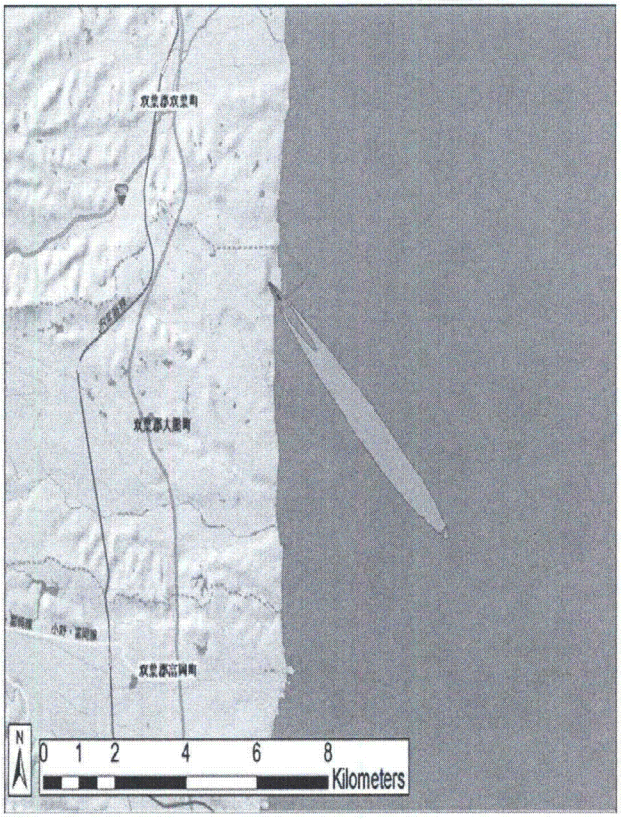
GFS Forecast valid @ 0300Z 15MAR2011 From 0000Z 14MAR2011 Run

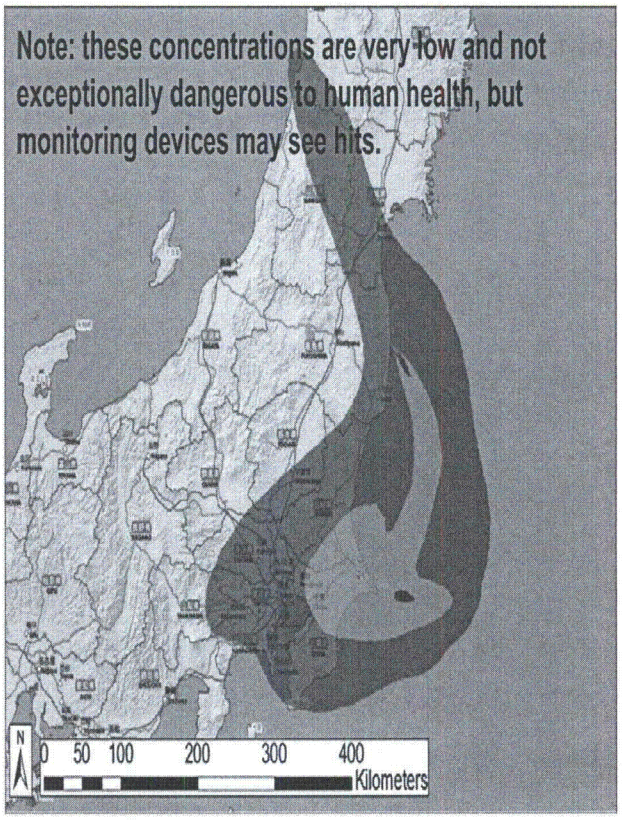
ALLEXTEFF(Rate) RTH Radiation Field 15-Mar-11 21:00:00Z	REM/hr
1 urem/hr	1.0E-06
100 nrem/hr	1.0E-07
10 nrem/hr	1.0E-08
1 nrem/hr	1.0E-09

FACTS

Fukushima Daiichi
37.42139°N/ 141.0325°E
2100Z 14MAR2011
Type: Nuclear Facility Accident
Weather: 40 km GFS
Model: HPAC 5.0 SP1
Static Population Estimates:
LandScan 2009

Total Activity Isotope Air Concentration 15-Mar-11 21:00:00Z	Ci/m3
10 nCi/m3	1.0E-08
1 nCi/m3	1.0E-09
100 pCi/m3	1.0E-10
10 pCi/m3	1.0E-11
1 pCi/m3	1.0E-12
100 fCi/m3	1.0E-13
10 fCi/m3	1.0E-14





Possible Release – Situational Details Unknown

Fukushima Daiichi – Plume at 0300Z 16MAR2011 (Far);

GFS Forecast valid @ 0300Z 16MAR2011 From 0000Z 14MAR2011 Run

FACTS

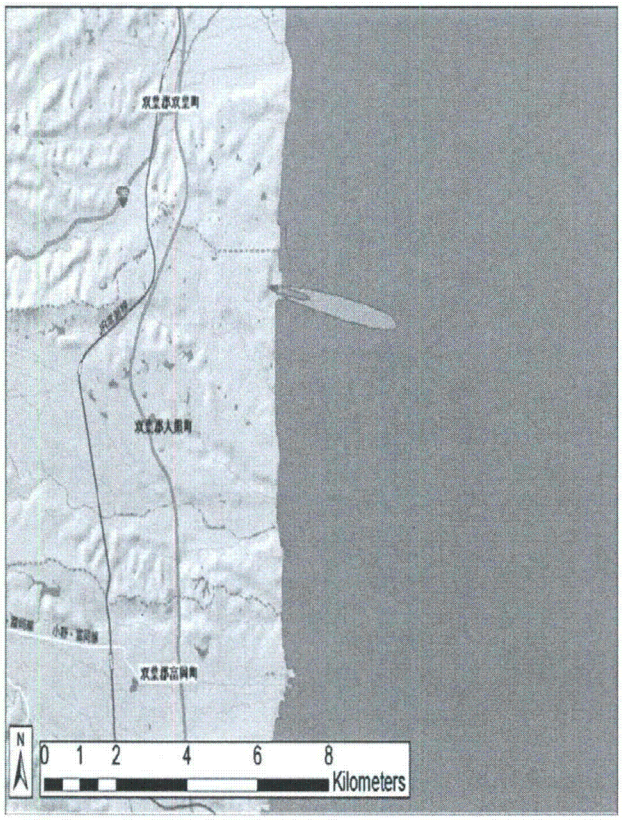
Fukushima Daiichi
37.42139°N/ 141.0325°E
2100Z 14MAR2011
Type: Nuclear Facility Accident
Weather: 40 km GFS
Model: HPAC 5.0 SP1
Static Population Estimates:
LandScan 2009

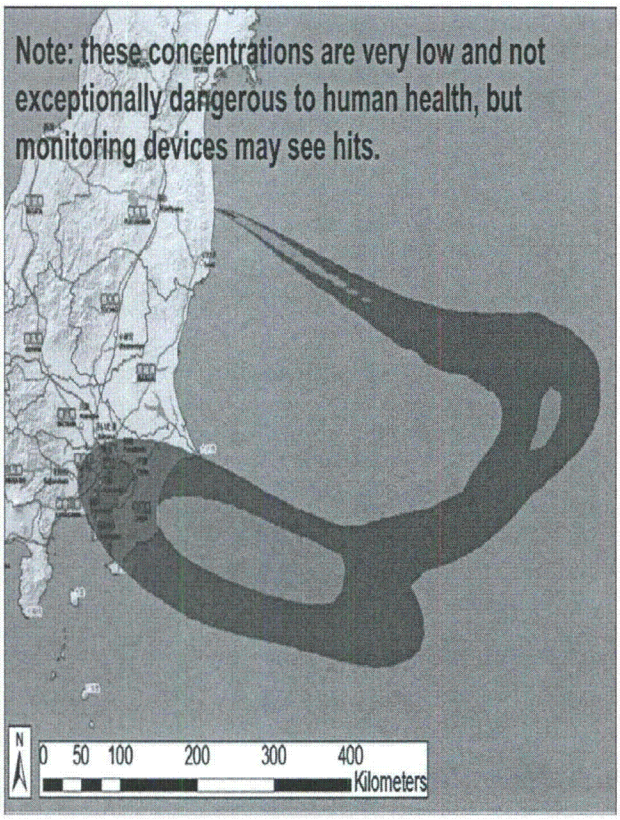
ALLEXTEFF(Rate)
RTH Radiation Field
16-Mar-11 03:00:00Z

	REM/hr
100 nrem/hr	1.0E-07
10 nrem/hr	1.0E-08
1 nrem/hr	1.0E-09

Total Activity
Isotope Air Concentration
16-Mar-11 03:00:00Z

	Ci/m3
10 nCi/m3	1.0E-08
1 nCi/m3	1.0E-09
100 pCi/m3	1.0E-10
10 pCi/m3	1.0E-11
1 pCi/m3	1.0E-12
100 fCi/m3	1.0E-13
10 fCi/m3	1.0E-14





As of 0515Z 15MAR11

Possible Release – Situational Details Unknown

Fukushima Daiichi – Plume at 1500Z 16MAR2011 (Far);

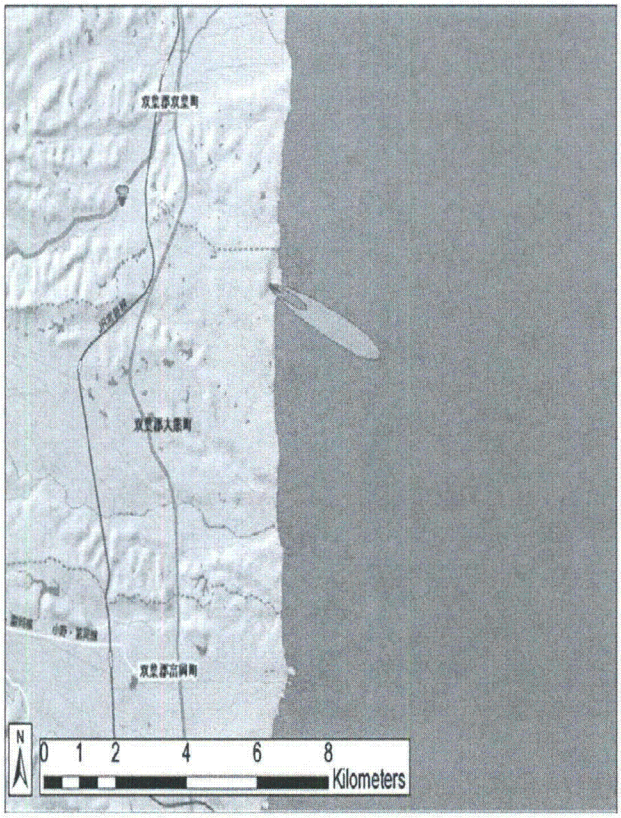
GFS Forecast valid @ 1500Z 16MAR2011 From 0000Z 14MAR2011 Run

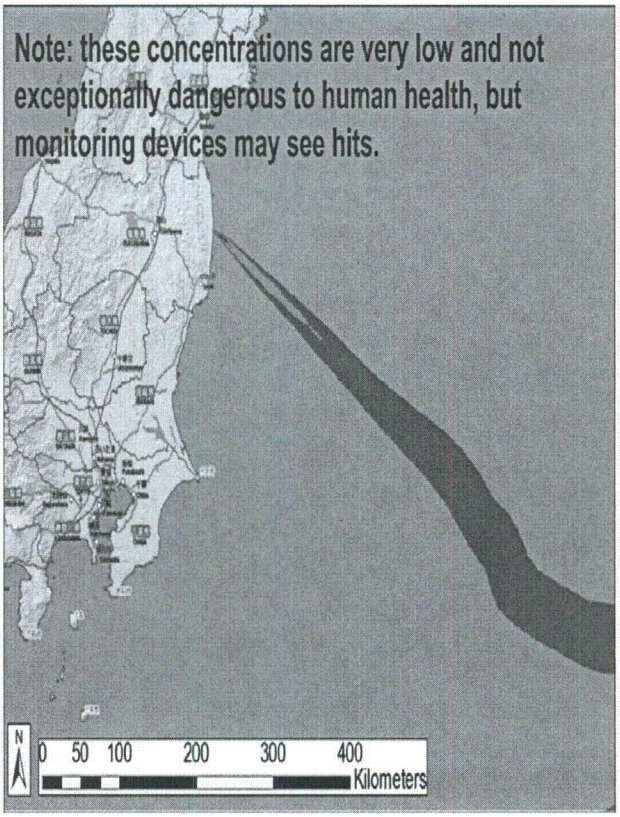
ALLEXTEFF(Rate) RTH Radiation Field 16-Mar-11 15:00:00Z	REM/hr
100 nrem/hr	1.0E-07
10 nrem/hr	1.0E-08
1 nrem/hr	1.0E-09

FACTS

Fukushima Daiichi
37.42139°N/ 141.0325°E
2100Z 14MAR2011
Type: Nuclear Facility Accident
Weather: 40 km GFS
Model: HPAC 5.0 SP1
Static Population Estimates:
LandScan 2009

Total Activity Isotope Air Concentration 16-Mar-11 15:00:00Z	Ci/m3
10 nCi/m3	1.0E-08
1 nCi/m3	1.0E-09
100 pCi/m3	1.0E-10
10 pCi/m3	1.0E-11
1 pCi/m3	1.0E-12
100 fCi/m3	1.0E-13
10 fCi/m3	1.0E-14





Possible Release – Situational Details Unknown

Fukushima Daiichi – Plume at 0300Z 17MAR2011 (Far);

GFS Forecast valid @ 0300Z 17MAR2011 From 0000Z 14MAR2011 Run

FACTS

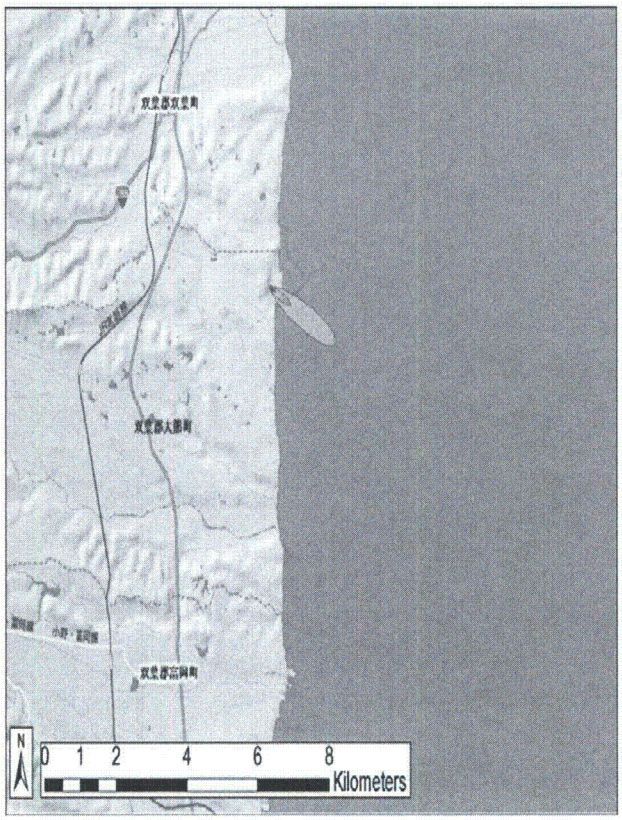
Fukushima Daiichi
37.42139°N/ 141.0325°E
2100Z 14MAR2011
Type: Nuclear Facility Accident
Weather: 40 km GFS
Model: HPAC 5.0 SP1
Static Population Estimates:
LandScan 2009

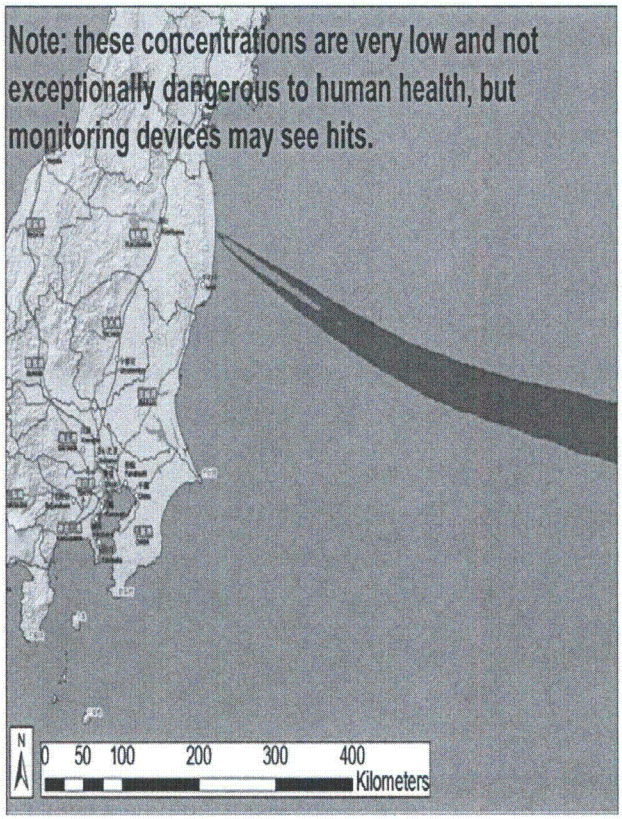
ALLEXTEFF(Rate)
RTH Radiation Field
17-Mar-11 03:00:00Z

	REM/hr
100 nrem/hr	1.0E-07
10 nrem/hr	1.0E-08
1 nrem/hr	1.0E-09

Total Activity
Isotope Air Concentration
17-Mar-11 03:00:00Z

	Ci/m3
10 nCi/m3	1.0E-08
1 nCi/m3	1.0E-09
100 pCi/m3	1.0E-10
10 pCi/m3	1.0E-11
1 pCi/m3	1.0E-12
100 fCi/m3	1.0E-13
10 fCi/m3	1.0E-14



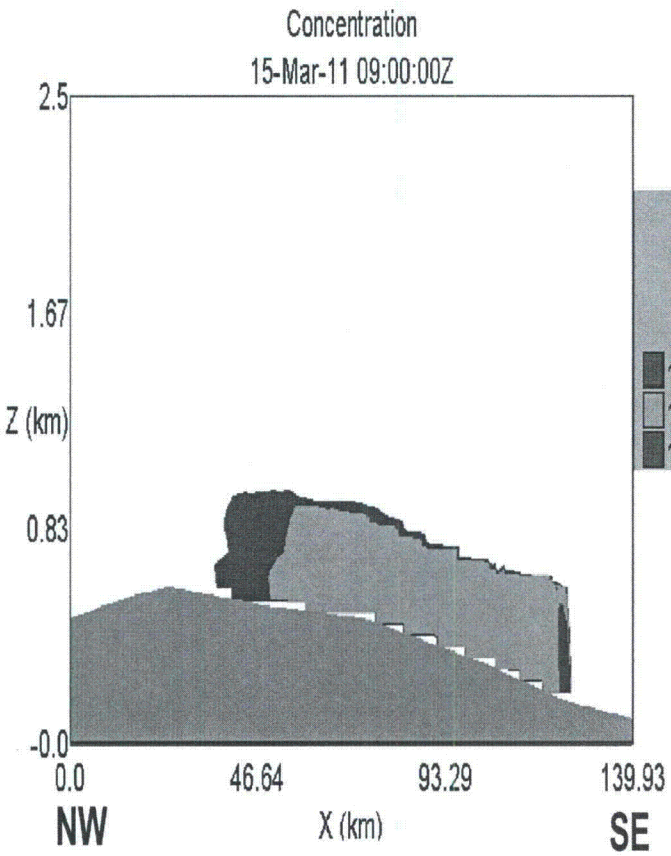


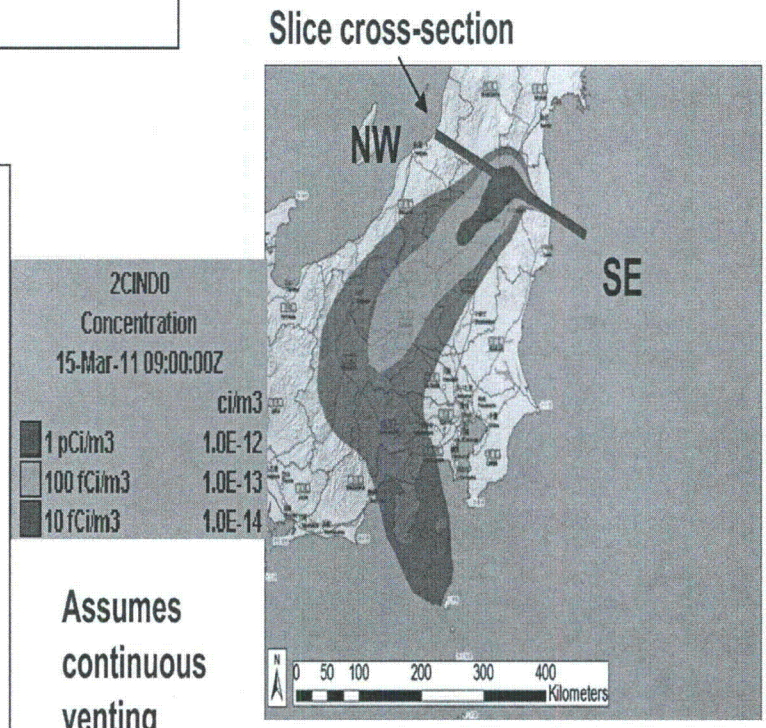
Possible Release – Situational Details Unknown

Fukushima Daiichi-1

Most Likely Release Scenario

Vertical Slice @ 0300Z 15 March





Assumes continuous venting

Note: The plume will change shape and structure as a function of time – slices at other times were similar or smaller. Higher concentrations were generally at or below 1 km elevation, lower concentrations up to approx 1 km or a little above.

FACTS

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37.42139°N/ 141.0325°E
2100Z 14MAR2011
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Model: HPAC 5.0 SP1
Static Population Estimates:
LandScan 2009

Backup: Radiation Unit Conversions

- Activity
  - 1 Curie (Ci) = 3.7×10^{10} Becquerels (Bq) = 3.7×10^{10} disintegrations/sec
  - Activity is a measure of atomic disintegrations per second.
  - Exponentially decays with age and is relative to specific radio-nuclide and age.
- Exposure or Dose Rate
  - 1 Gray (Gy) = 100 centi-Gray (cGy)
  - 1 centi-Gray (cGy) = 1 radiation absorbed dose unit (rad)
  - Dose is a measure of the energy deposited into a given mass.
  - Exposure when integrated over a time combined with an estimate of human tissue damage yields dose. Radiation detectors usually display instantaneous dose rate (e.g., cGy/hr, rad/hr).
- Dose Equivalent
  - 1 Sievert (Sv) = 100 centi-Sievert (cSv)
  - 1 centi-Sievert (cSv) = 1 Roentgen Equivalent to Man (REM)
  - An equivalent measurement or estimation of possible damage from ionizing radiation to human tissue. Dose Equivalent varies with type of human tissue exposed, ingestion, shielding, time, radiation type and energy.
- Exposure
  - 1 roentgen (R) = 2.58 * 10^-4 Coulombs (C) per kg (in air)
  - Used to measure x and gamma ray radiation. 1 R ~ 1 rad ~ 1 rem for x and gamma.

Possible Release – Situational Details Unknown

Backup: Radiation Exposure Reference

Exposure	cGy / Rad / REM / cSv	Reference
Cross Country Civilian Flight (cosmic radiation)	0.004	
Medical X-Ray (Chest)	0.01	Mettler FA, et al: Effective Doses in Radiology and Diagnostic Nuclear Medicine, 2008
Mammogram	0.4	Mettler FA, et al: Effective Doses in Radiology and Diagnostic Nuclear Medicine, 2008
CT (Chest, Abdomen, and Pelvis)	1.8	Mettler FA, et al: Effective Doses in Radiology and Diagnostic Nuclear Medicine, 2008
Chemobyl Evacuation Zone	10	
Hiroshima Survivor Inside Structure	78	
Nagasaki Survivor Inside Structure	156	
Average Background Annual Exposure in U.S. (Total)	0.62	NCRP No. 160 (2006)

U.S. Civilian Standards	cGy / Rad / REM / cSv	
Maximum Annual Public Exposure	0.1	(10 CFR 20.1301)
Maximum Radiation Worker Annual Dose	5	(10 CFR 20.1201)
General Emergency	1	(NUREG-0654/FEMA REP 1)
Protective Actions (shelter or evacuate)	1.0-5.0	(EPA 400-R-92-001, 1992)
Evacuation required	5	(EPA 400-R-92-001, 1992)
1st Responder Dose Protecting valuable property 1	10	(EPA 400-R-92-001, 1992)
1st Responder Dose Lifesaving or protection of large populations 1	25	(EPA 400-R-92-001, 1992)
Maximum 1st Responder Dose	25	(EPA 400-R-92-001, 1992)

Military OEG*	cGy / Rad / REM / cSv	
Wartime high-priority missions, to include life-saving	125	NATO STANAG-2473, 3 May 2000; USAFRRI, SP 03-1, April 2003
Operations other than war based on mission priorities and risk analysis	75	NATO STANAG-2473, 3 May 2000; USAFRRI, SP 03-1, April 2003

Note: Sieverts=Grays and Rad=REM for beta and gamma radiation as the Quality Factor is one.

[1]FEMA: Planning Guidance for Protection and Recovery Following Radiological Dispersal Device (RDD) and Improvised Nuclear Device (IND) Incidents

From: paul.holland@exeloncorp.com
Sent: Monday, March 14, 2011 11:16 PM
To: PMT09 Hoc
Subject: Calculations from Exelon
Attachments: Yokosuka Navy Base.xlsx

TEDE			Thyroid	
1.50E-08	uCi/ml	Sample Results	1.50E-08	uCi/ml
1.20E+06	cc/hr	standard man breathing rate	1.20E+06	cc/hr
3.29E-02	Rem/uCi	Federal Guidance Report 11	1.08E+06	Rem/uCi
1.20E+01	Hours	Exposure time	1.20E+01	Hours
7.11E-03	Rem		2.33E-01	Rem

Sample Results
standard man breathing rate
Federal Guidance Report 11
Exposure time

From: LIA03 Hoc
Sent: Monday, March 14, 2011 7:58 PM
To: PMT09 Hoc
Subject: FW: Activity and Dose Estimate information for Plume over Yokosuka

Information from Tony Ulses.
andrea

-----Original Message-----
From: Ulses, Anthony
Sent: Monday, March 14, 2011 7:48 PM
To: LIA03 Hoc
Subject: Fw: Activity and Dose Estimate information for Plume over Yokosuka

Please pass to PMT

Sent from NRC BlackBerry
Anthony Ulses
(b)(6)

----- Original Message -----
From: (b)(6)
To: Ulses, Anthony
Sent: Mon Mar 14 19:32:02 2011
Subject: Activity and Dose Estimate information for Plume over Yokosuka

Mr. Ulses,

I have been asked to pass you the following radiological data and dose information. Please call the following number when you receive this
information: 046-816-7164.

Radiological Data identified on Fleet Activities Yokosuka Base on 15 March
2011 at approx. 0700:

Airborne radioactivity:

YR-95 Barge 6000ccpm (1.5E-8 uCi/ml)
CVN-73 USS GEORGE WASHINGTON APD (7E-9 uCi/ml) Berth 12 area (450 uuCi/direct probe)

This radioactivity will result in the following dose over a 12 hr period:

20 mrem TEDE
120 mrem CDE-Thyroid

We want you to be informed that we will be taking the following limited precautionary actions:

Sheltering of children, at schools, minimizing time outdoors and securing building external ventilation.

Sincerely,
Richard O'Malley
NACCC Program Manager
COMSUBGRU SEVEN

(O) 243-2398
From US (VOIP): (b)(6)
DSN: 315-243-2398
Cell: (b)(6) (local)
(b)(6) (from US)

From: DTRA Operations Center <(b)(6)>
Sent: Monday, March 14, 2011 7:44 PM
To:

(b)(6)

Subject: RFI 216 update

ALCON,

If you did not receive the update please go to the following (CAC Enabled) link. If you are unable to access the portal page please contact the DTRA Ops Center to arrange delivery of product updates. Due to the file size we are receiving "Undeliverable" replies. Thank you.

https://214.3.33.100/cfFocus/ExercisePlayer/index.cfm

Click on Files/Links
Click on Compelted RFI's
Product loceated on left.

V/r
Mr. Chris Seigfreid
DTRA Operations Center
SAIC, Controller
703-767-2000

-----Original Message-----
From: DTRA Reachback (b)(6)
Sent: Monday, March 14, 2011 7:05 PM
To: DTRA Operations Center
Cc: Reachback
Subject: RFI_0216U update

Ops:

Here is the latest update to RFI_0216U. Please release to appropriate members.

Very Respectfully,

Defense Threat Reduction Agency

(703) 767-3448, (DSN 427-)

Unclass: (b)(6)

SIPR: (b)(6)

JWICS: (b)(6)

R&D Enterprise

Innovation & Systems Engineering Office

Reachback Division

From: Lonkert, Brian CONTRACTOR <(b)(6)> on behalf of DTRA Operations Center <(b)(6)>

Sent: Monday, March 14, 2011 11:59 AM

To: (b)(6)

Subject: FW: RFI

Attachments: RFI_216U_1200Z_14MAR2011_GFS_rev2.PPT

Attached is the updated product.

V/R

Brian M. Lonkert
Operations Center Support
Defense Threat Reduction Agency
Operations Center (DTRA/CW-OPS)
(b)(6)
703.767.2116

-----Original Message-----
From: DTRA Reachback (b)(6)
Sent: Monday, March 14, 2011 11:42 AM
To: DTRA Operations Center
Cc: Reachback
Subject: RFI

Ops,

Updated the wording to stress that we will try to incorporate later information and will update periodically.

Respectfully,

Defense Threat Reduction Agency

COM: (703) 767-3448, (DSN 427-)

STE: 427-2138

NIPR: (b)(6)

SIPR: (b)(6)

JWICS: (b)(6)

R&D Enterprise

Innovation & Systems Engineering Office

Reachback Division

Planning: Model of a Nuclear Reactor Incident in Japan as a result of an earthquake – Update 1500Z 14 Mar

RFI – 216U

14MAR2011

Requestor: USFJ

As of 141515ZMAR11

R&D Enterprise
Innovation & Systems Engineering Office
Reachback Division
(703) 767-3448, DSN 427-

Distribution: ~~Limited to DoD and authorized contractors. Further distribution contact DTRA.~~
Derived From: Navy
Reason: E.O. 12958 sections 1.4 (e), (g) and (h).

Request Summary

- (FOUO) Request data
  - Requestor: (b)(6)
  - Contact: (b)(6)
  - Request: A model of a nuclear incident at the Fukushima Daiichi – 1 and -3 nuclear power plant in Japan.

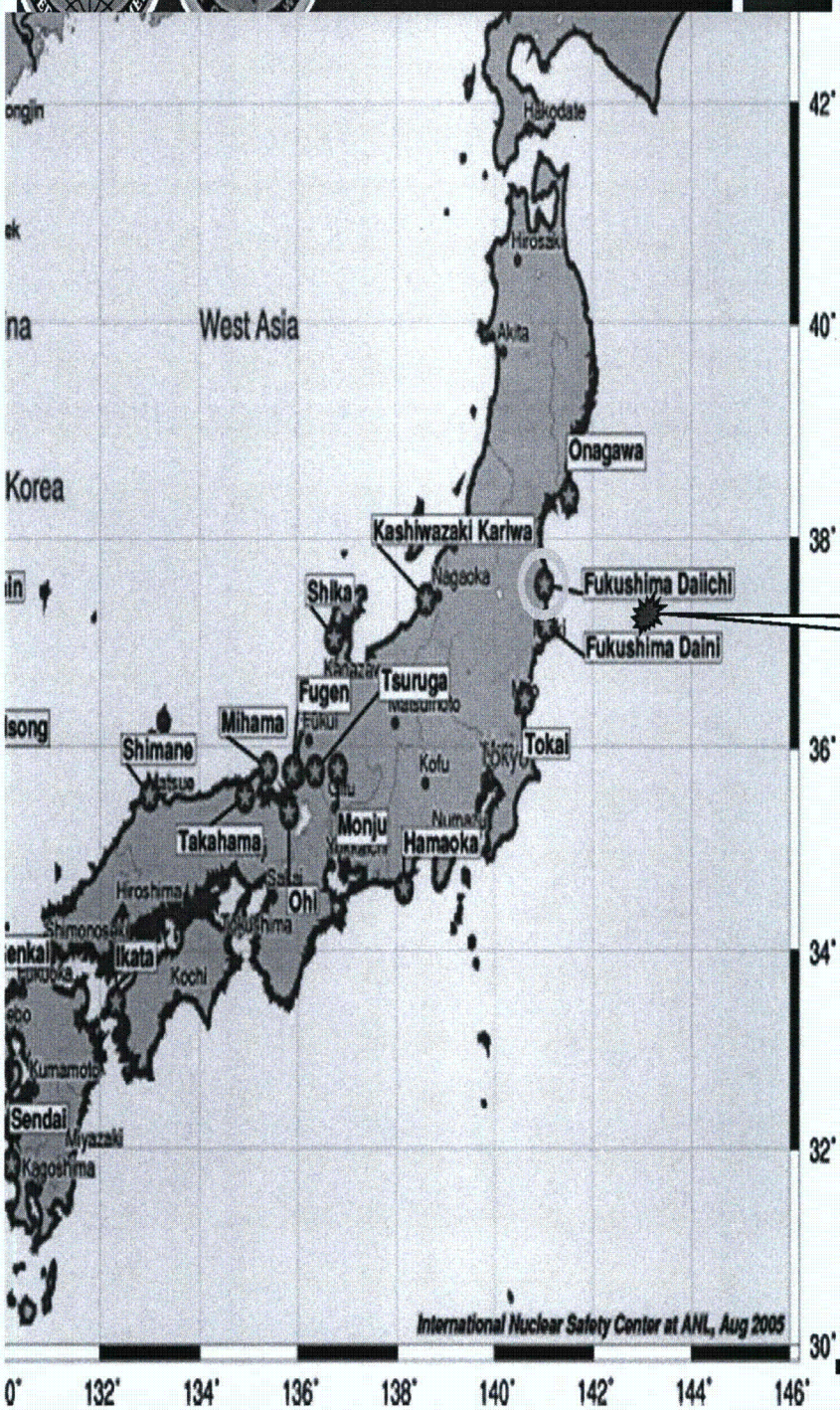
Location: Fukushima Daiichi, Japan Latitude: 37.42139° N Longitude: 141.0325° E
Time: 0530Z Date: 12MAR2011
Hazard: Accident at nuclear facility in Japan
Weather: Global Numerical Weather Prediction: 0.5° × 0.5° resolution GFS from NCEP
Comments: This is a periodic update. We will continue to update this product with any additional information that becomes available.

- (FOUO) Solution
  - Summary: Integrated dose plots provided on the following slides
  - Employment: Real World
  - Reachback: Team

Possible Release – Situational Details Unknown

Nuclear Power Plants

SCOPING PURPOSES ONLY



FACTS

Off the coast of Honshu, Japan

Epicenter Location:

38.32° N / 142.37° E

Magnitude: 8.9

Incident Time:

0530Z11MAR2011

Epicenter

As of 141515ZMAR11

Fukushima Daiichi-1 Status

- The reactor is shut down. No offsite power, no diesel electric generators working
- Explosion occurred at Unit 1 following 12MAR2011 0636Z earthquake. The secondary containment was damaged
- At 1120Z 12 MAR2011, operators began injecting sea water and boric acid into the reactor core. The combination acts to cool the reactor and absorb neutrons, helping to stabilize the core.
- Sea water is also being used to provide external cooling to the torus
- Water level in the reactor is out of measuring range, but at least 170 cm below the top of the core
- The national government has instructed the evacuation for those locals residents within 20 km radius of the site. An estimated 170,000 people have been evacuated. Full evacuation is not complete
- Radiation levels at the boundary of the site have been reported to be above background. Radiation monitoring at 0520Z 13MAR2011 indicates highest level is at measuring point MP4 of 47.1 uSv/hour (4.7 mrem/hour). The Japan Nuclear and Industrial Safety Agency (NISA) confirmed presence of cesium-137 and iodine-131 in the vicinity of the site. Radiation levels at the boundary of the site have been reported to be above background.
- **Due to days of cool-down and injection of sea water, it will never be possible to produce power at the reactor, but there is no further risk of total meltdown.**

Source: USNRC Emergency Operations Center Status Update, 0200Z 14MAR2011

Fukushima Daiichi-3 Status

- The reactor is shut down. No offsite power, no diesel electric generators working
- Tokyo Electric Power Company (TEPCO) is working with the Japanese national government to reduce the pressure in the reactor containment. Containment remains intact.
- TEPCO informed Japanese Cabinet that Unit-3 water injection stopped and water level decreased exposing fuel. Reactor water level decreased to -150 to -200 cm below the top of the core
- Efforts to restart the Reactor Core Isolation Cooling System failed at 2010Z 12MAR2011. Emergency Core Cooling System flow could not be confirmed. *Core Damage Likely.*
- Alternate methods to inject water into the core are being investigated.
- Containment sprays used to lower the pressure within the reactor containment have been cancelled
- There was a confirmed deliberate venting that occurred at approx 2100 Z – 2240 Z 12 March. This correlated with increased detector readings at some locations.
- A reactor pressure vessel manual safety valve was opened to lower the reactor pressure. The valve opening procedure ended at 0220Z 13MAR2011. This procedure was immediately followed by injection of sea water and boric acid into the reactor core.
- TEPCO does not believe there is any reactor coolant leakage inside the reactor containment vessel.
- At 0200Z 14MAR2011, a hydrogen explosion has occurred. Explosion is believed at this time to not compromise primary containment.
- **Due to days of cool-down and injection of sea water, it will never be possible to produce power at the reactor, but there is no further risk of total meltdown.**

Source: USNRC Emergency Operations Center Status Update, 0200Z 14MAR2011

Possible Release – Situational Details Unknown

Fukushima Daiichi DTRA Modeling Assumptions

Most Likely

- **Scenario: some core damage; primary containment building integrity intact; venting occurring to reduce core temperature and pressure**

- Continuous Release – Steam released for decay heat removal
- HPAC –Release Assumptions:
  - ✓ Shut down time of reactor concurrent with earthquake
  - ✓ Release time concurrent with explosion
  - ✓ NFAC Reactor Accident
    - ✓ Containment monitor reading: 10 Rem/hr (unconfirmed)
    - ✓ Sprayers: Off (unconfirmed)
    - ✓ Filters: On (unconfirmed)
  - ✓ Weather 40 km GFS

Fukushima Daiichi DTRA Modeling

- **Summary of Models Provided in this Briefing**

- Assumption – Fukushima Daiichi #1 and #3 suffered damage resulting in a continuous release/leak of a small portion of its inventory. Release occurs consistently throughout times shown in this product. (Precise details of this release are highly uncertain and time-varying)

Possible Release – Situational Details Unknown

Fukushima Daiichi (Impacts) – Most Likely

Assumed Core Damage & Venting

- Weather
  - NW winds (offshore) will becoming northerly (along shore Monday night (14MAR). By Tuesday morning (15MAR) winds will becoming northeasterly (onshore) with increasing chance of precipitation (rain). NE winds are expected through Wednesday morning (16MAR). **This means that any radiation released may move inland, to the SW and W, once the wind shift occurs (exact timing of shift is uncertain).**
- Japan has evacuated out to 20 km around site; ground operations should carefully monitor conditions within this zone.
- Operations in the area of the facility should include monitoring equipment.
- Air operations minimally impacted, but coordination with local authorities recommended
- Radiation hazard is above background. Level of concern is 0.1 Rem integrated dose (see next slides)
- As core pressure and temperature lower and stabilize, radiation levels will lower accordingly.

Possible Release – Situational Details Unknown

Fukushima Daiichi – Plume at 1200Z 14MAR2011 (Far); GFS Forecast valid @ 1200 Z 14MAR2011

ALLEXTEFF(Rate)
RTH Radiation Field
14-Mar-11 12:00:00Z (6.000 hr)

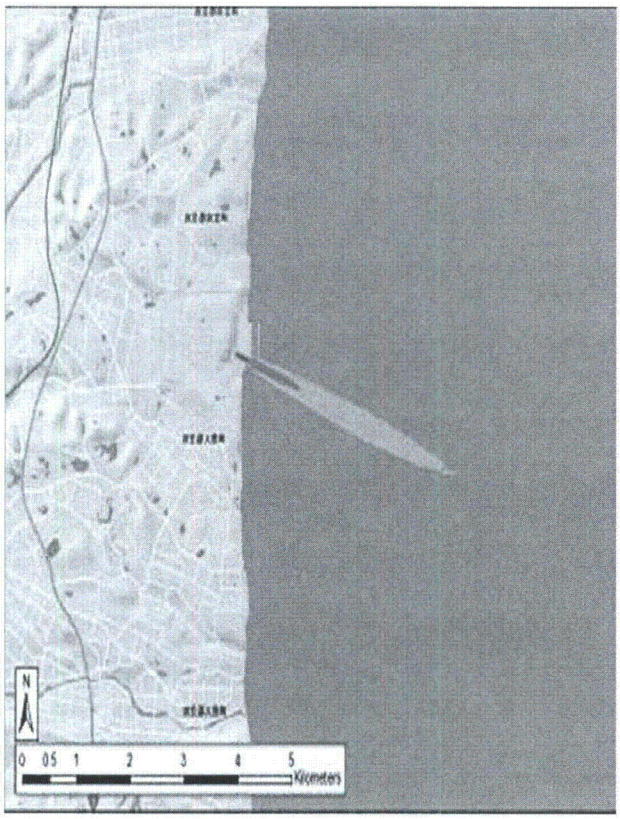
REM/hr
1.0E-06
1.0E-07
1.0E-08
1.0E-09

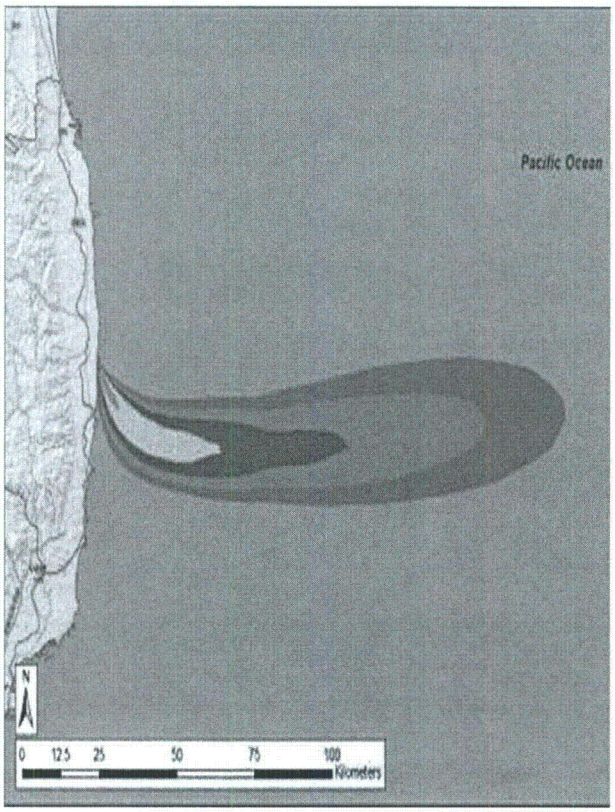
FACTS

Fukushima Daiichi
37.42139° N/ 141.0325° E
0530Z 12MAR2011
Type: Nuclear Facility Accident
Weather: 40 km GFS
Model: HPAC 5.0 SP1
Static Population Estimates:
LandScan 2009

Total Activity
Isotope Air Concentration
14-Mar-11 12:00:00Z (6.000 hr)

Ci/m3
1.0E-08
1.0E-09
1.0E-10
1.0E-11
1.0E-12
1.0E-13
1.0E-14





Possible Release – Situational Details Unknown

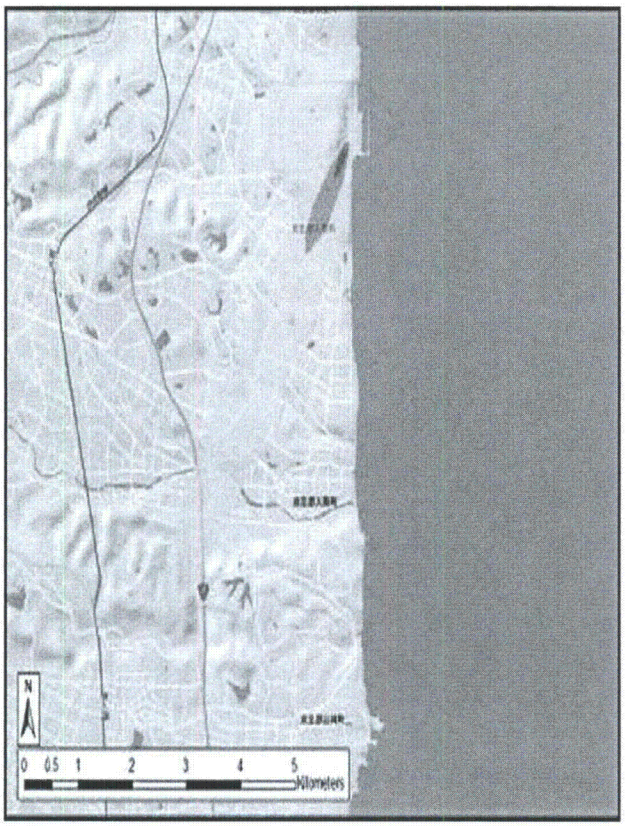
Fukushima Daiichi – Plume at 0000Z 15MAR2011 (Far); GFS Forecast valid @ 1200 Z 14MAR2011

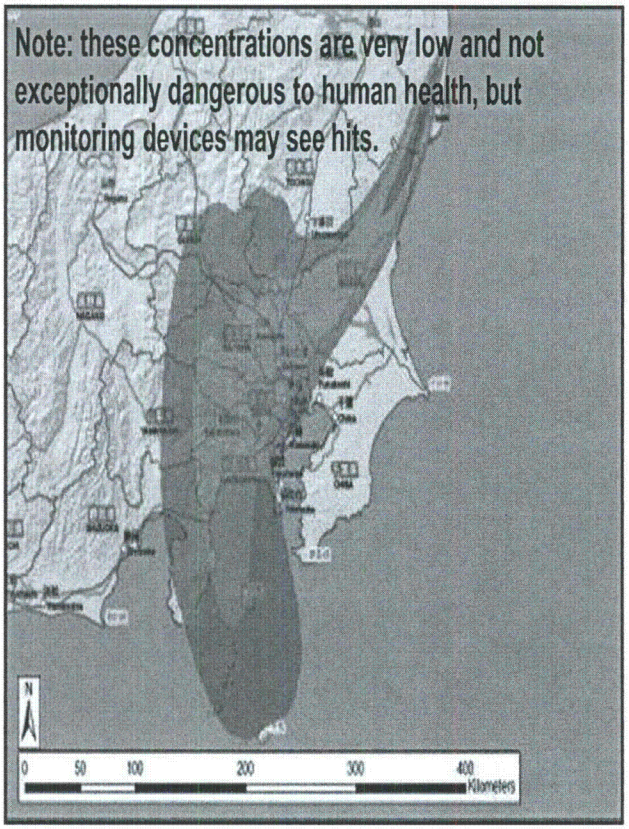
ALLEXTEFF(Rate)
RTH Radiation Field
15-Mar-11 00:00:00Z (18.000 hr)
REM/hr
1.0E-06
1.0E-07
1.0E-08
1.0E-09

FACTS

Fukushima Daiichi
37.42139° N/ 141.0325° E
0530Z 12MAR2011
Type: Nuclear Facility Accident
Weather: 40 km GFS
Model: HPAC 5.0 SP1
Static Population Estimates:
LandScan 2009

Total Activity
Isotope Air Concentration
15-Mar-11 00:00:00Z (18.000 hr)
Ci/m3
1.0E-08
1.0E-09
1.0E-10
1.0E-11
1.0E-12
1.0E-13
1.0E-14





Possible Release – Situational Details Unknown

Fukushima Daiichi – Plume at 1200Z 15MAR2011 (Far); GFS Forecast valid @ 1200 Z 14MAR2011

ALLEXTEFF(Rate)
RTH Radiation Field
15-Mar-11 12:00:00Z (30.000 hr)

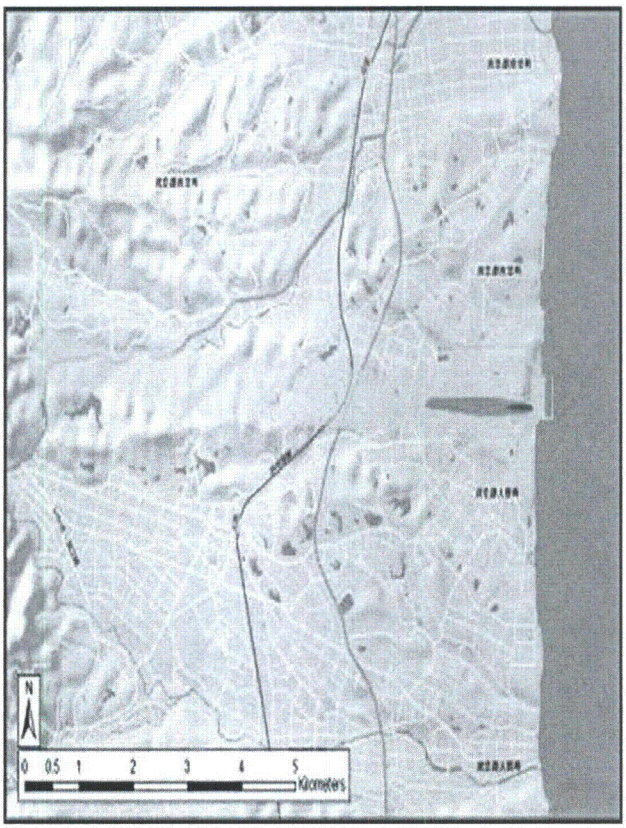
REM/hr
1.0E-06
1.0E-07
1.0E-08
1.0E-09

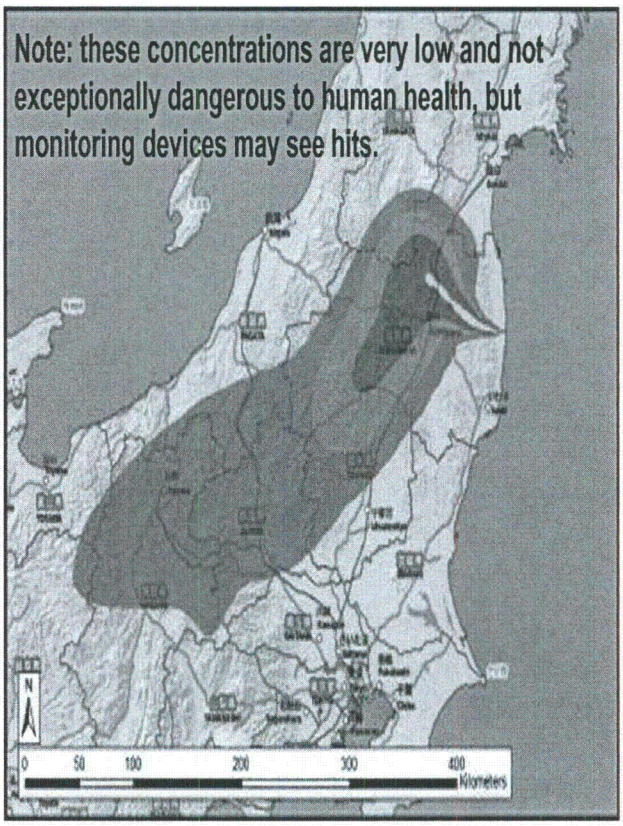
FACTS

Fukushima Daiichi
37.42139° N/ 141.0325° E
0530Z 12MAR2011
Type: Nuclear Facility Accident
Weather: 40 km GFS
Model: HPAC 5.0 SP1
Static Population Estimates:
LandScan 2009

Total Activity
Isotope Air Concentration
15-Mar-11 12:00:00Z (30.000 hr)

Ci/m3
1.0E-08
1.0E-09
1.0E-10
1.0E-11
1.0E-12
1.0E-13
1.0E-14





Possible Release – Situational Details Unknown

Fukushima Daiichi – Plume at 1800Z 15MAR2011 (Far); GFS Forecast valid @ 1200 Z 14MAR2011

ALLEXTEFF(Rate)
RTH Radiation Field
15-Mar-11 18:00:00Z (36.000 hr)

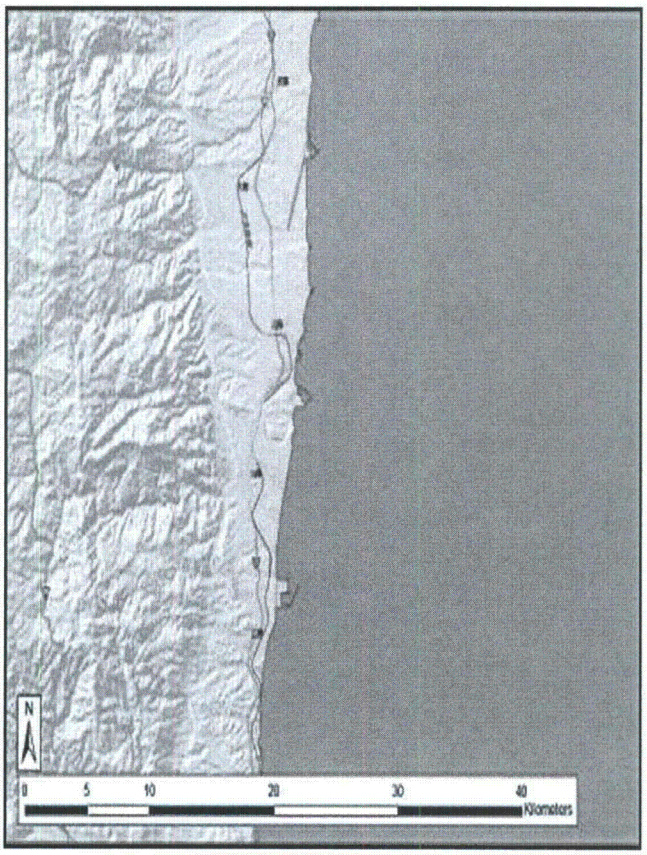
REM/hr
1.0E-06
1.0E-07
1.0E-08
1.0E-09

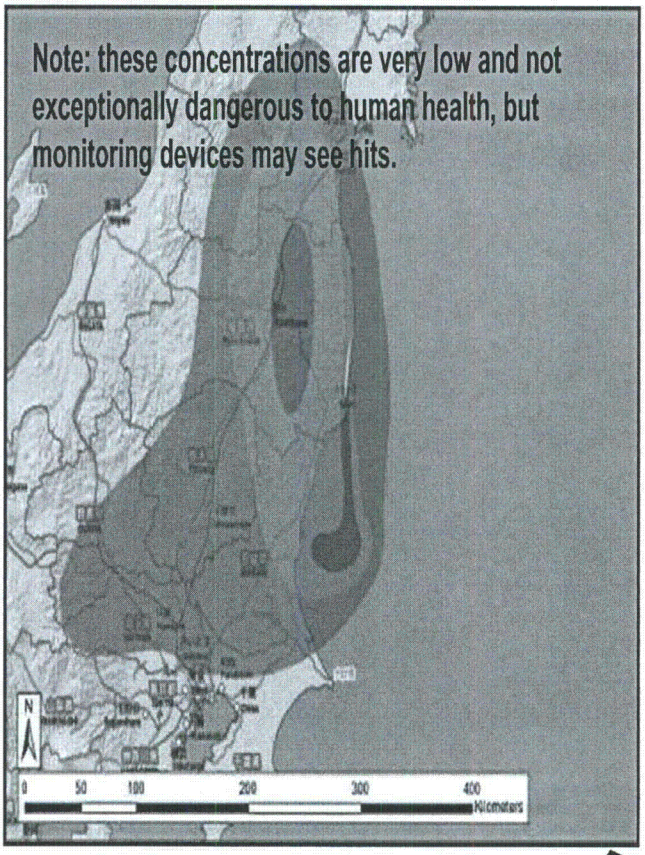
FACTS

Fukushima Daiichi
37.42139° N/ 141.0325° E
0530Z 12MAR2011
Type: Nuclear Facility Accident
Weather: 40 km GFS
Model: HPAC 5.0 SP1
Static Population Estimates:
LandScan 2009

Total Activity
Isotope Air Concentration
15-Mar-11 18:00:00Z (36.000 hr)

Ci/m3
1.0E-08
1.0E-09
1.0E-10
1.0E-11
1.0E-12
1.0E-13
1.0E-14





Possible Release – Situational Details Unknown

Fukushima Daiichi – Plume at 0000Z 16MAR2011 (Far); GFS Forecast valid @ 1200 Z 14MAR2011

ALLEXTEFF(Rate)
RTH Radiation Field
16-Mar-11 00:00:00Z (42.000 hr)

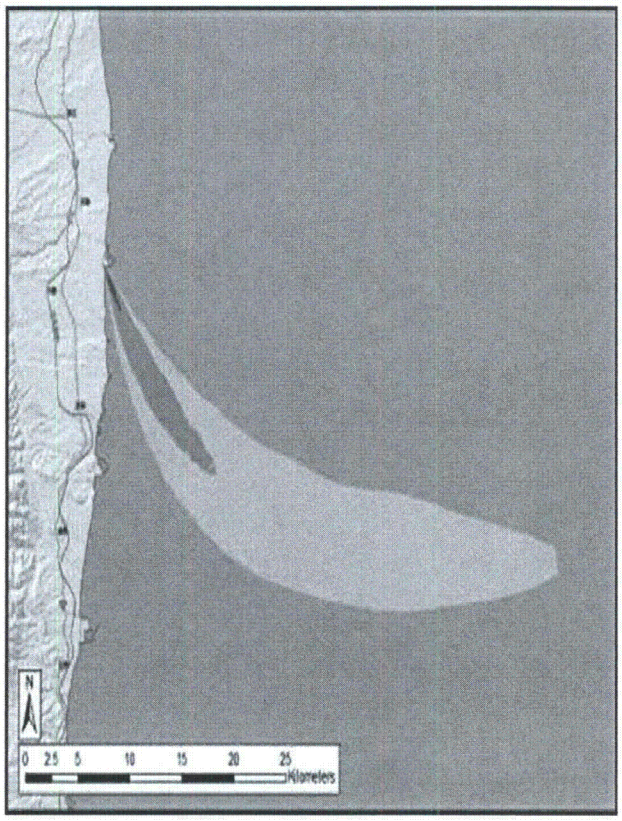
	REM/hr
■	1.0E-07
□	1.0E-08
□	1.0E-09

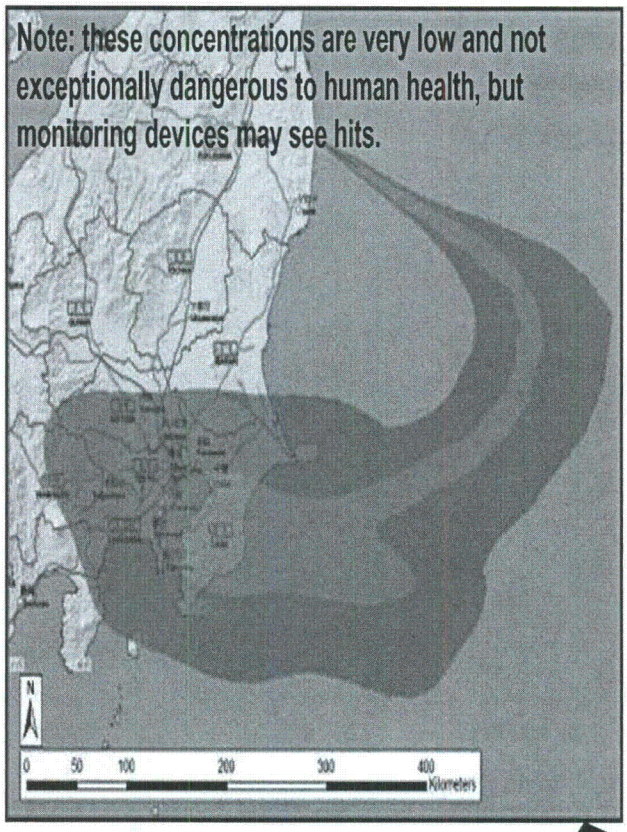
FACTS

Fukushima Daiichi
37.42139° N/ 141.0325° E
0530Z 12MAR2011
Type: Nuclear Facility Accident
Weather: 40 km GFS
Model: HPAC 5.0 SP1
Static Population Estimates:
LandScan 2009

Total Activity
Isotope Air Concentration
16-Mar-11 00:00:00Z (42.000 hr)

	Ci/m3
□	1.0E-08
■	1.0E-09
□	1.0E-10
□	1.0E-11
■	1.0E-12
□	1.0E-13
■	1.0E-14





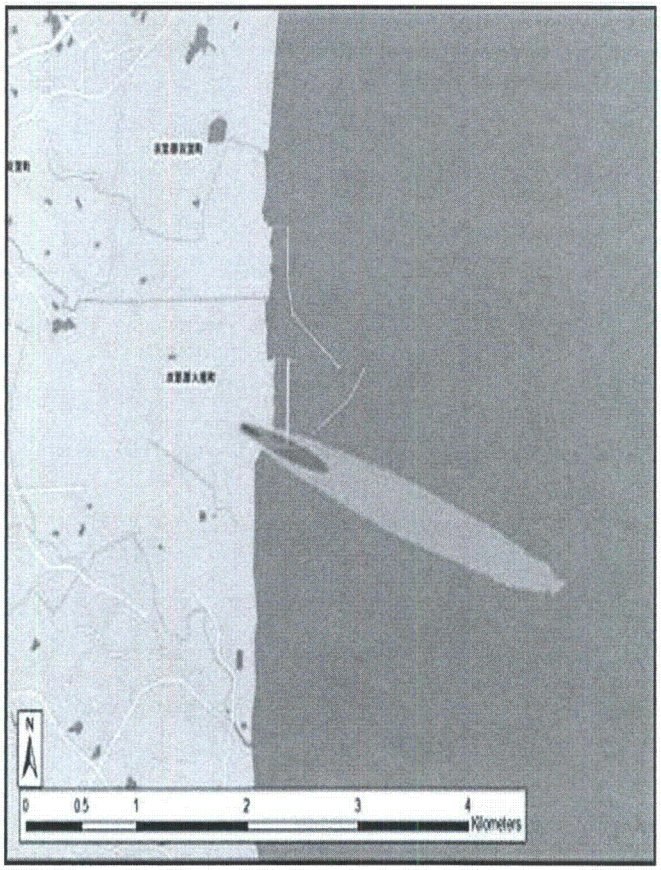
Possible Release – Situational Details Unknown

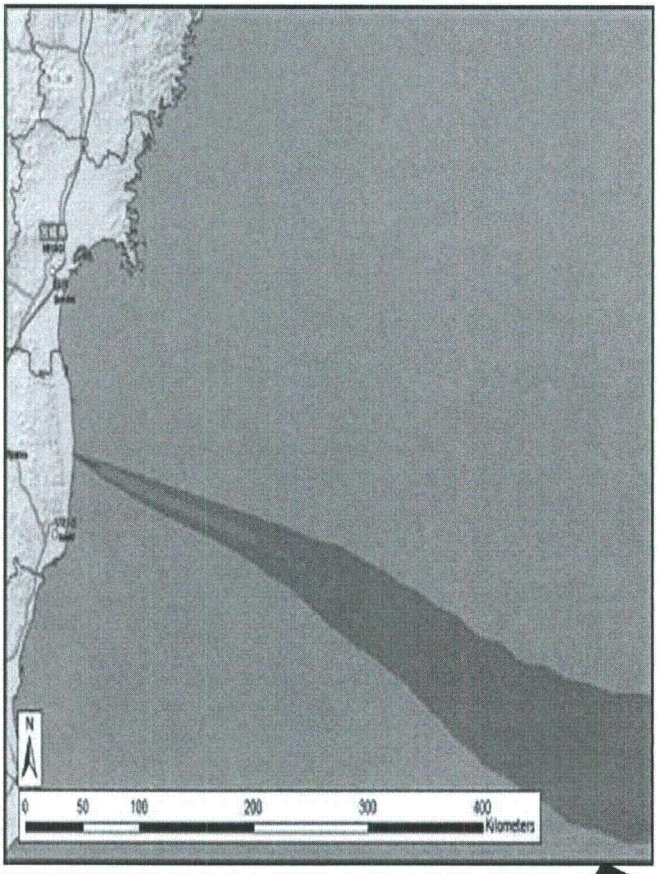
Fukushima Daiichi – Plume at 0600Z 16MAR2011 (Far); GFS Forecast valid @ 1200 Z 14MAR2011

ALLEXTEFF(Rate)
RTH Radiation Field
16-Mar-11 06:00:00Z (48.000 hr)
REM/hr
1.0E-07
1.0E-08
1.0E-09

FACTS
Fukushima Daiichi
37.42139° N/ 141.0325° E
0530Z 12MAR2011
Type: Nuclear Facility Accident
Weather: 40 km GFS
Model: HPAC 5.0 SP1
Static Population Estimates:
LandScan 2009

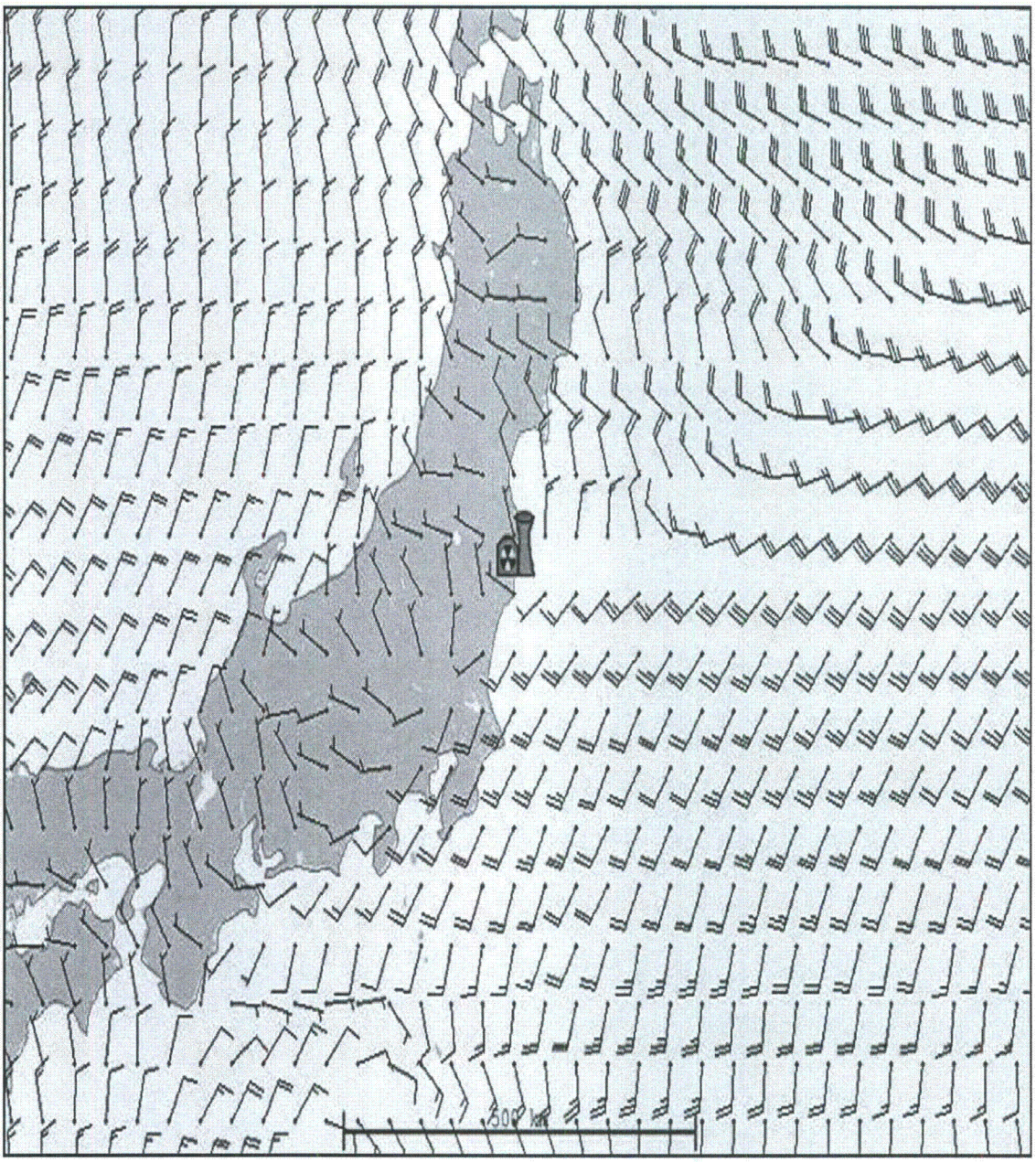
Total Activity
Isotope Air Concentration
16-Mar-11 06:00:00Z (48.000 hr)
Ci/m3
1.0E-08
1.0E-09
1.0E-10
1.0E-11
1.0E-12
1.0E-13
1.0E-14





Possible Release – Situational Details Unknown

10 m Forecasted Winds– 1200Z 14MAR2011

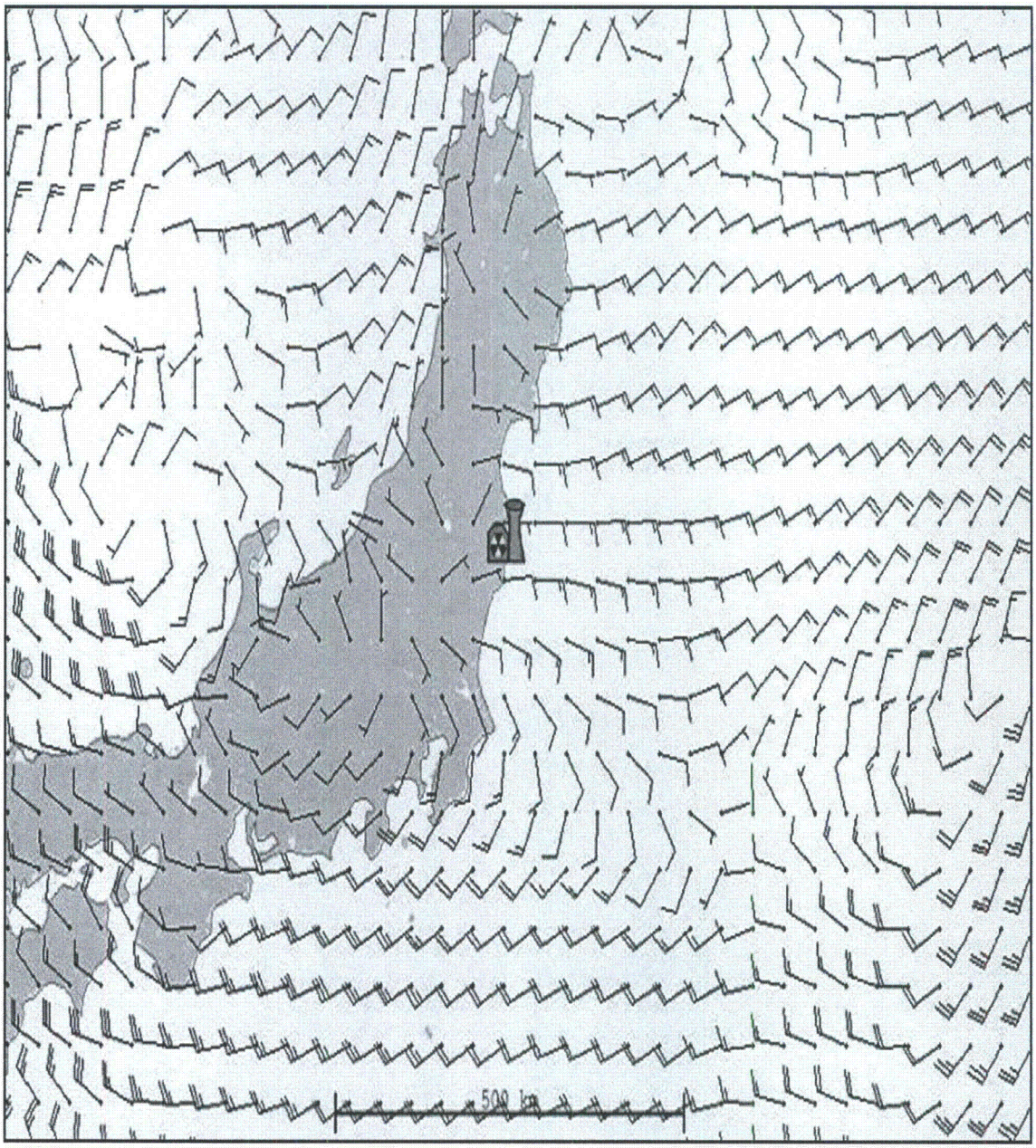


Possible Release – Situational Details Unknown

10 m Forecasted Winds– 0000Z 15MAR2011

Possible Release – Situational Details Unknown

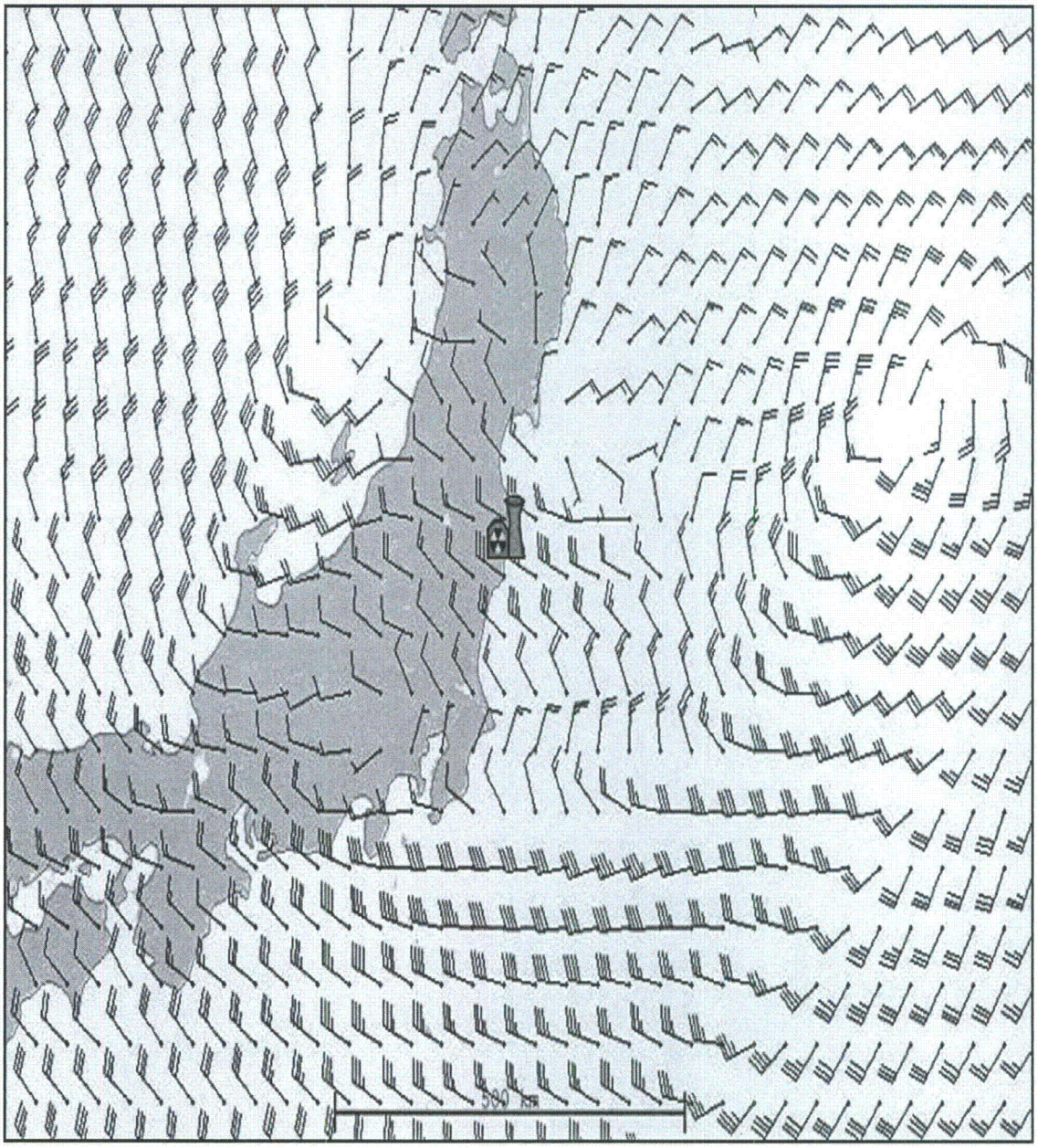
10 m Forecasted Winds– 1200Z 15MAR2011



As of 141515ZMAR11

Possible Release – Situational Details Unknown

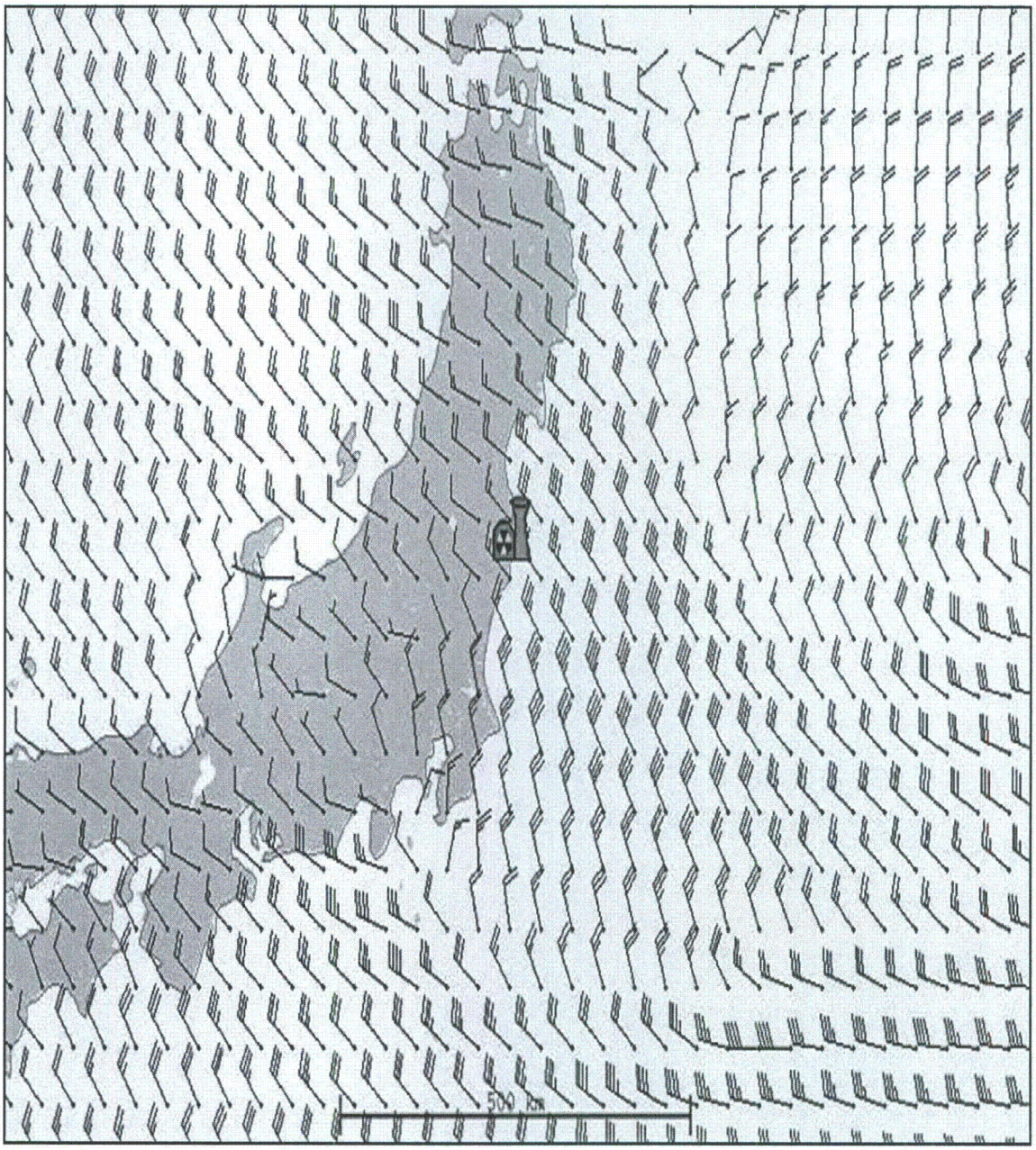
10 m Forecasted Winds– 0000Z 16MAR2011



As of 141515ZMAR11

Possible Release – Situational Details Unknown

10 m Forecasted Winds– 1200Z 16MAR2011



As of 141515ZMAR11

Possible Release – Situational Details Unknown

Fukushima Daiichi-1 DTRA Modeling Assumptions – Most Dangerous

- **Scenario:** Modeled as a moderate reactor accident. The source terms mainly involve the noble gas components of the reactor inventory. **(There is no evidence this scenario has occurred)**
- Partial Core Melt – Heat Induced Fuel Element Failure (Core was Uncovered)
- Continuing Release – Steam released for decay heat removal
- HPAC –Release Assumptions:
  - ✓ Shut down time of reactor concurrent with earthquake
  - ✓ Release time concurrent with explosion
  - ✓ NFAC Reactor Accident (moderate pre-defined for plant)
  - ✓ Weather 15 km WRF – Mesoscale Numerical Weather Prediction (FNMOC)

Possible Release – Situational Details Unknown

Fukushima Daiichi-1 (Ground Impact)

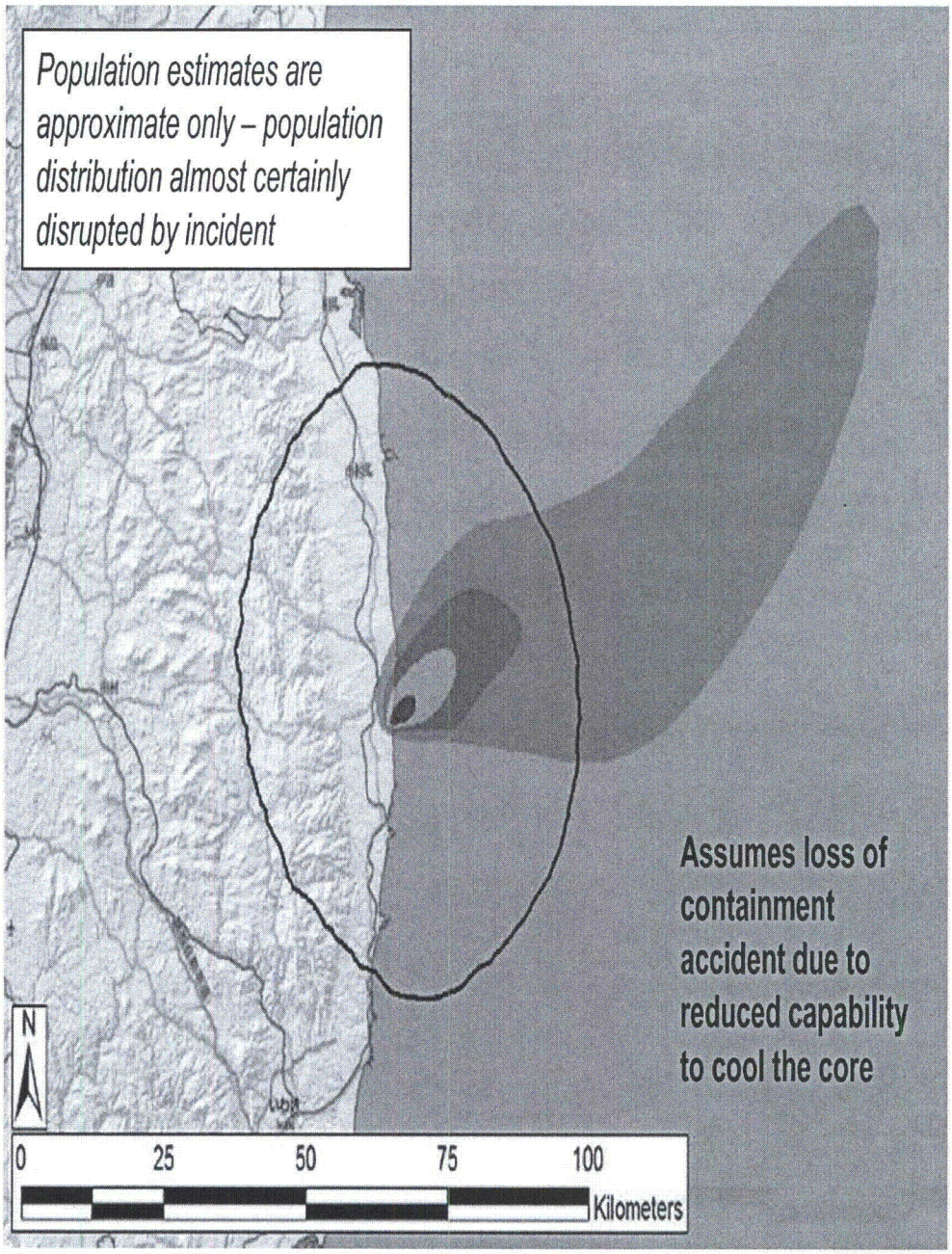
Assumed Core Damage & Containment Bypass – Most Dangerous

- Weather
  - NW winds (offshore) will becoming northerly (along shore Monday night (14MAR). By Tuesday morning (15MAR) winds will becoming northeasterly (onshore) with increasing chance of precipitation (rain). NE winds are expected through Wednesday morning (16MAR).
- Japan has evacuated out to 12 miles around site; ground operations should carefully monitor conditions within this zone.
- Operations in the area of the facility should include monitoring equipment.
- 1.0 rem level for shelter and 5.0 rem level for evacuation on next slide are based on US Protective Action Guidelines (PAG).
- Best protection is time (minimize exposure), distance (away from site), and shielding.

Possible Release – Situational Details Unknown

Fukushima Daiichi-1 (Effect at Ground Level)

Moderate Reactor Incident –Most Dangerous



Combined HPAC Integrated Radiation Dose
"Best Estimate" - Mean Contours
14-Mar-11 06:00:00Z (24.000 hr)

Protective Action Regions
50 Year TEDE Dose

	cSv (Rem)	In contour population
Emer Life Saving	25.0	1,095
Evacuate	5.0	2,577
Shelter	1.0	4,257
Monitor	0.1	10,512

Exceedance Contour
50 Year TEDE Dose

	cSv (Rem)	In contour population
10%	1.0	141,271

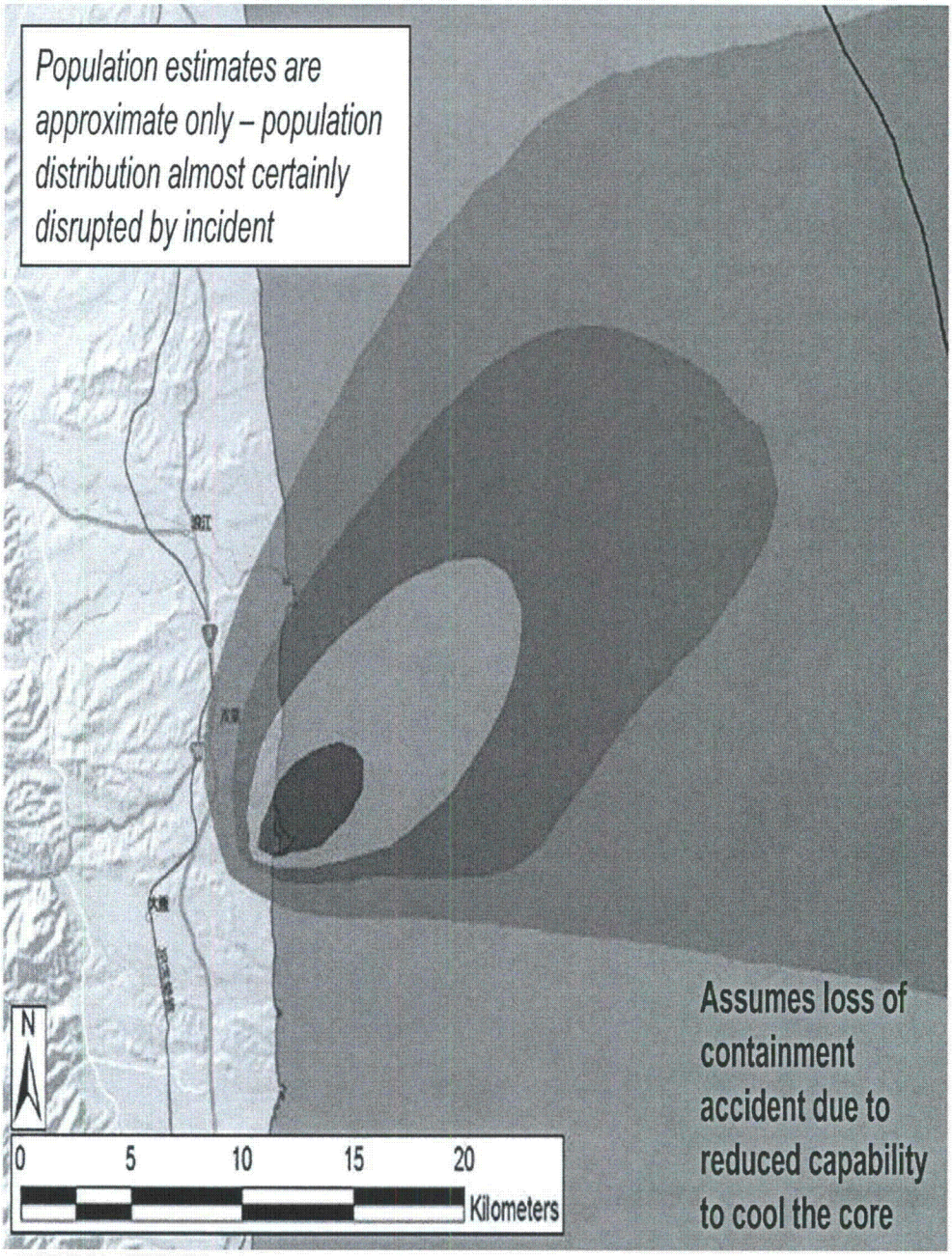
FACTS

Fukushima Daiichi
37.42139° N/ 141.0325° E
0530Z 12MAR2011
Type: Nuclear Facility Accident
Weather: 15 km WRF
Model: HPAC 5.0 SP1
Static Population Estimates:
LandScan 2009

Possible Release – Situational Details Unknown

Fukushima Daiichi-1 (Effect at Ground Level)

Moderate Reactor Incident –Most Dangerous



Combined HPAC Integrated Radiation Dose
"Best Estimate" - Mean Contours
14-Mar-11 06:00:00Z (24.000 hr)

Protective Action Regions
50 Year TEDE Dose

	cSv (Rem)	In contour population
Emer Life Saving	25.0	1,095
Evacuate	5.0	2,577
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Exceedance Contour
50 Year TEDE Dose

	cSv (Rem)	In contour population
10%	1.0	141,271

FACTS

Fukushima Daiichi
37.42139° N/ 141.0325° E
0530Z 12MAR2011
Type: Nuclear Facility Accident
Weather: 15 km WRF
Model: HPAC 5.0 SP1
Static Population Estimates:
LandScan 2009

Possible Release – Situational Details Unknown

Fukushima Daiichi-1 (Air Operations Impacts)

Moderate Reactor Incident –Most Dangerous

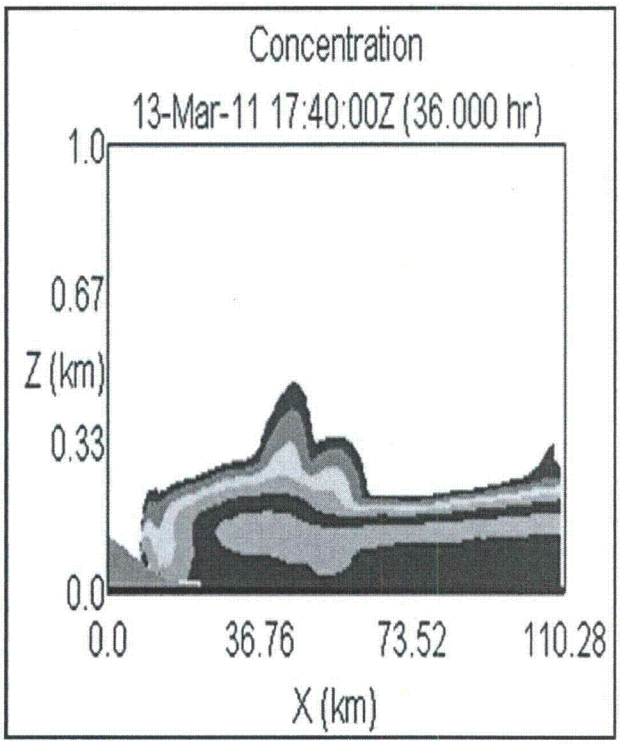
- The vertical extent of the radiation hazard is based on our worse case scenario.
- Based on our forecasted winds, radioactive cloud extends to a height of 3,500 ft, and ~35 miles downwind.
- Higher radiation levels may be encountered closer to the facility and the plume centerline.
- Recommend aircraft stay above 3,500 ft in the vicinity of the plume.
- Operations close to the facility should include monitoring equipment.

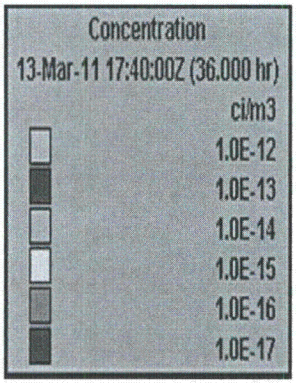
Possible Release – Situational Details Unknown

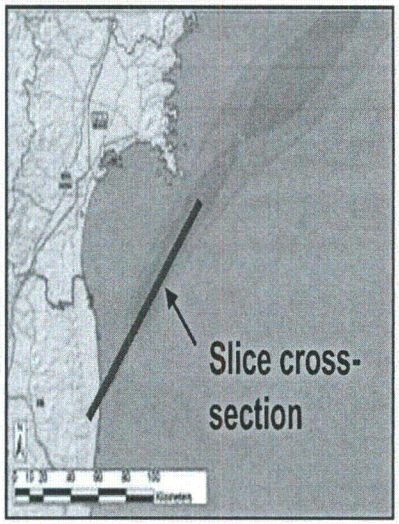
Fukushima Daiichi-1

Most Likely Release Scenario

Vertical Slice @ 1740Z 13 March







Assumes loss of containment accident due to reduced capability to cool the core

Note: The plume will change shape and structure as a function of time – slices at other times were similar or smaller. Higher concentrations were generally at or below 0.5 km elevation, lower concentrations up to approx 1 km.

FACTS

Fukushima Daiichi
37.42139° N/ 141.0325° E
0530Z 12MAR2011
Type: Nuclear Facility Accident
Weather: 15 km WRF
Model: HPAC 5.0 SP1
Static Population Estimates:
LandScan 2009

Backup: Radiation Human Effects – Military Application

Human Effects Contours (Integrated): These holistic effects are designed to facilitate Warfighter decisions and application.

50% expected mortality within 60 days for the population in the contour
50% of the population in the contour may experience nausea and vomiting
5% of the population in the contour may experience nausea and vomiting
Maximum dose allowed for life saving (25 cSv (Rem))
Personnel within the 5.0 cSv (Rem) contour may need to be evacuated
Personnel within the 1.0 cSv (Rem) contour may need to shelter
Personnel within the 0.1 cSv (Rem) contour may need to be monitored
90% confidence level that 1.0 Rem exposure is possible. Accounts for atmospheric uncertainties

Combined HPAC Integrated Radiation Dose

Probable Acute Effects
All External Effective Dose

	cSv (Rem)	In contour population
50% Fatalities (LD50/60)	410.0	Values
50% Vomiting	240.0	
5% Vomiting	75.0	Vary

Protective Action Regions
50 Year TEDE Dose

	cSv (Rem)	In contour population
Emer Life Saving	25.0	Values
Evacuate	5.0	
Shelter	1.0	Vary
Monitor	0.1	

Exceedance Contour
50 Year TEDE Dose

	cSv (Rem)	In contour population
10%	1.0	Values Vary

Notes: Casualty numerical figures are based upon a population database (LandScan). LandScan is based on the 2000 census for the U.S. (other nations vary), overhead imagery, geo-economic, and other observable data and was updated in 2009. Population is assumed static for calculations. The population numbers next to associated hazard levels are the people contained within the entire contour based upon LandScan 2009 or otherwise noted. For planning purposes, estimates are assumed to be accurate within +10/-5%. Validation testing indicates agreement within 20% for select examined areas. The population data will not predict major shifts in personnel such as relocations (i.e.: religious pilgrimages, refuges, evacuations), events (i.e.: inaugurations, Olympics), or other population shifts. In such cases the population database needs to be updated to reflect actual conditions.

Backup: Radiation Unit Conversions

- Activity
  - 1 Curie (Ci) = 3.7×10^{10} Becquerels (Bq) = 3.7×10^{10} disintegrations/sec
  - Activity is a measure of atomic disintegrations per second.
  - Exponentially decays with age and is relative to specific radio-nuclide and age.
- Exposure or Dose Rate
  - 1 Gray (Gy) = 100 centi-Gray (cGy)
  - 1 centi-Gray (cGy) = 1 radiation absorbed dose unit (rad)
  - Dose is a measure of the energy deposited into a given mass.
  - Exposure when integrated over a time combined with an estimate of human tissue damage yields dose. Radiation detectors usually display instantaneous dose rate (e.g., cGy/hr, rad/hr).
- Dose Equivalent
  - 1 Sievert (Sv) = 100 centi-Sievert (cSv)
  - 1 centi-Sievert (cSv) = 1 Roentgen Equivalent to Man (REM)
  - An equivalent measurement or estimation of possible damage from ionizing radiation to human tissue. Dose Equivalent varies with type of human tissue exposed, ingestion, shielding, time, radiation type and energy.
- Exposure
  - 1 roentgen (R) = 2.58 * 10^-4 Coulombs (C) per kg (in air)
  - Used to measure x and gamma ray radiation. 1 R ~ 1 rad ~ 1 rem for x and gamma.

Possible Release – Situational Details Unknown

Backup: Radiation Exposure Reference

Exposure	cGy / Rad / REM / cSv	Reference
Cross Country Civilian Flight (cosmic radiation)	0.004	
Medical X-Ray (Chest)	0.01	Mettler FA, et al: Effective Doses in Radiology and Diagnostic Nuclear Medicine, 2008
Mammogram	0.4	Mettler FA, et al: Effective Doses in Radiology and Diagnostic Nuclear Medicine, 2008
CT (Chest, Abdomen, and Pelvis)	1.8	Mettler FA, et al: Effective Doses in Radiology and Diagnostic Nuclear Medicine, 2008
Chernobyl Evacuation Zone	10	
Hiroshima Survivor Inside Structure	78	
Nagasaki Survivor Inside Structure	156	
Average Background Annual Exposure in U.S. (Total)	0.62	NCRP No. 160 (2006)

U.S. Civilian Standards	cGy / Rad / REM / cSv	
Maximum Annual Public Exposure	0.1	(10 CFR 20.1301)
Maximum Radiation Worker Annual Dose	5	(10 CFR 20.1201)
General Emergency	1	(NUREG-0654/FEMA REP 1)
Protective Actions (shelter or evacuate)	1.0-5.0	(EPA 400-R-92-001, 1992)
Evacuation required	5	(EPA 400-R-92-001, 1992)
1st Responder Dose Protecting valuable property 1	10	(EPA 400-R-92-001, 1992)
1st Responder Dose Lifesaving or protection of large populations 1	25	(EPA 400-R-92-001, 1992)
Maximum 1st Responder Dose	25	(EPA 400-R-92-001, 1992)

Military OEG*	cGy / Rad / REM / cSv	
Wartime high-priority missions, to include life-saving	125	NATO STANAG-2473, 3 May 2000; USAFRRI, SP 03-1, April 2003
Operations other than war based on mission priorities and risk analysis	75	NATO STANAG-2473, 3 May 2000; USAFRRI, SP 03-1, April 2003

Note: Sieverts=Grays and Rad=REM for beta and gamma radiation as the Quality Factor is one.

[1]FEMA: Planning Guidance for Protection and Recovery Following Radiological Dispersal Device (RDD) and Improvised Nuclear Device (IND) Incidents