Ingestion Pathway Exercise-Related DOE Lessons Learned from the Fukushima Daiichi Response

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Topics

- Overview of the response
- Lessons Learned
- Communicating Risk

Japanese Earthquake/Tsunami

- Occurred 14:46 March 11, 2011
- Magnitude:9.0 Mw
- Epicenter location: 38° 6”N and 142° 51”E, and 24km in depth
- It is said that the height of tsunami attacked Fukushima NPP was more than 14m

Source: Nuclear and Industrial Safety Agency (NISA)

Accident Summary

Taken from near the south side of Unit 5, looking east

Taken from radwaste building 4th floor, looking north

O.P. : Onahama bay construction base level

http://www.tepco.co.jp/en/nu/fukushima-np/f1/images/f12np-gaiyou_e_1.pdf

Response Timeline

- March 11 (Friday):
  - DOE/NNSA activated the following assets
    - Nuclear Incident Team (NIT) in Washington, DC
    - DOE/NNSA Consequence Management expertise on the U.S. Agency for International Development (U.S.AID) Disaster Assistance Response Team (DART) in Tokyo
    - National Atmospheric Release Advisory Center (NARAC) at Lawrence Livermore National Laboratory (LLNL)
    - Consequence Management Home Team (CMHT) at Remote Sensing Laboratory (RSL), Sandia National Laboratory (SNL), LLNL, and Los Alamos National Laboratory (LANL)
    - The Radiation Emergency Assistance Center/Training Site (REAC/TS) in Oak Ridge, TN

Response Timeline (cont'd)

- March 14, 2011 (Monday)
  - At White House direction, DOE deployed a tailored CMRT and AMS capability via military airlift to Yokota Air Base
  - 33 personnel and 17,000 lbs of equipment

Deploying to Japan

Response Timeline (cont'd)

- March 16: CM Assets arrive at Yokota AB and fly first AMS Test flight
- March 17: First aerial measurement activities over plant conducted; first field monitoring mission completed
- March 22: Initial data published on DOE website

Customers/Partners

United States

- Department of State
  - American Embassy
- Department of Defense
  - U.S. Forces Japan (USFJ)
- White House
- Nuclear Regulatory Commission
- Advisory Team for Environment , Food and Health (EPA, CDC/HHS, USDA)

Japan

- Ministry of Foreign Affairs (MOFA)
- Japan Atomic Energy Agency (JAEA)
- Ministry of Defense (MOD)
- Ministry of Economy, Trade and Industry (METI)
  - Nuclear and Industrial Safety Agency (NISA)
- Ministry of Education, Culture, Sports, Science & Technology (MEXT)
  - Nuclear Safety Technology Center (NUSTEC)
- Ministry of Agriculture, Forestry and Fisheries (MAFF)
- Ministry of Health, Labour & Welfare (MLHW)

Consequence Management Home Team (CMHT)

- Assessment scientists
  - RSL, Sandia, Los Alamos, Livermore
- 24/7 bridge line coordinator
- NARAC atmospheric modeling
- GIS specialist
- Database management
- Logistics
- Aerial Measuring System specialist

- *Many of these people were deployed to Japan*

Aerial Monitoring

What was done

- Employed fixed wing and helicopter platforms
- Up to 3 aircraft per day
- Analyzed DOE and GOJ data

Why it was done

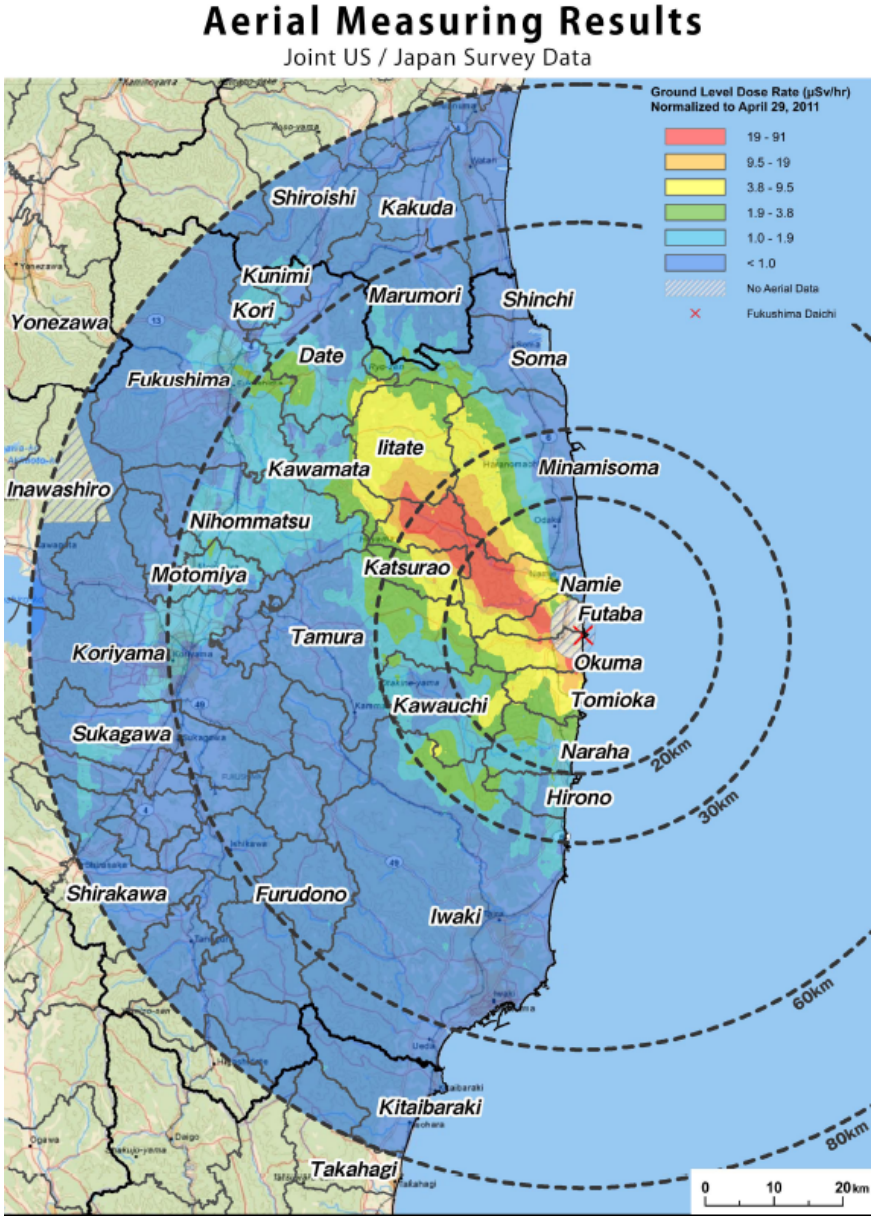
- To map ground deposition out to 80 km from FDNPP
- To provide data to support evacuation, relocation, and agricultural decisions

Complications in AMS Analysis

- Over 500 hundred hours of aerial data acquired
  - Non-DOE airframes employed
  - Up to 3 airframes flying simultaneously
  - ~ Dozen operators over course of response
  - Changing detector configurations

- Other fundamental differences from exercises
  - Aerial data of predominant use for product generation
  - Exploratory analysis
  - Subtleties typically ignored become important
  - Inability to escape contamination
  - Prolonged timelines and need for crew turn-over

Fukushima Daiichi Deposition



Ground Monitoring

What was done

- Contamination swipes
- Mobile mapping
- In-situ and exposure rate
- Air and soil sampling
- Compile DOE, DoD, GOJ data

Why it was done

- Health and safety of USG personnel
- Calibrate aerial measurements
- Define Isotopic mix
- Characterize the inhalation component of integrated dose
- Assess vertical and horizontal migration of deposited material

Activities 3/11 – 5/28

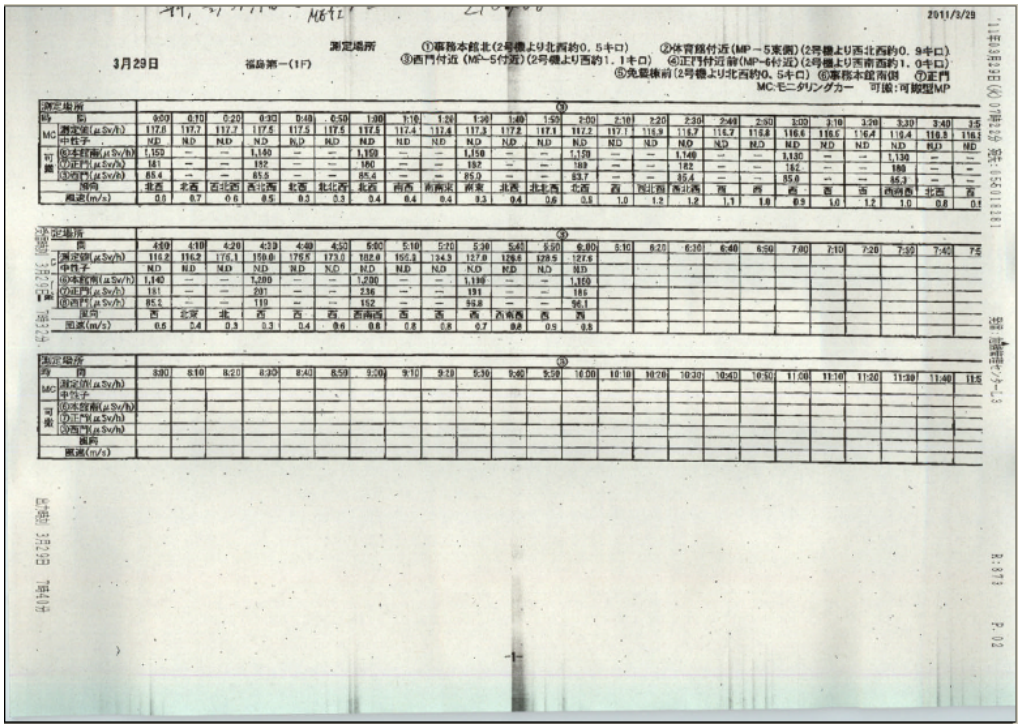
- Daily monitoring activities at the U.S. Embassy, U.S. military installations, and in support of “ground truth” measurements for AMS.
  - ~650 air samples
  - > 100 in situ spectra
  - ~95 soil samples
    - 89 Japanese samples
    - “Core” samples

First Data Received – US Based

ID	Latitude	Longitude	Date Taken	Type	Field(Raw)	Field Measurement Units
142139	38.6300000	143.7000000	3/13/2011 10:00:00 AM	Gamma	0.6	mRem/hr
142141	38.6300000	143.7000000	3/13/2011 10:00:00 AM	Gamma	2	mRem/hr
142137	38.5000000	143.1800000	3/13/2011 8:45:00 AM	Gamma	0.9	mRem/hr
142135	38.4650000	142.7900000	3/13/2011 8:00:00 AM	Gamma	0.3	mRem/hr
142133			3/13/2011 4:00:00 AM	Beta	400	cpm
142131			3/13/2011 4:00:00 AM	Beta	2500	cpm
142129			3/13/2011 4:00:00 AM	Gamma	0.6	mR/hr

ID	Latitude	Longitude	Collection Date	Sample#	Sample Type	Value	Units	Radiation
7065	39.630000	143.650000	3/13/2011 2:20:00 PM	Deck Swipe 1	Swipe			
7061	38.530000	143.550000	3/13/2011 9:30:00 AM	USS RR 0930Z	Air Filter	2.00E-03	uCi/m3	Beta
7059	38.380000	142.600000	3/13/2011 7:30:00 AM	USS RR 0730Z	Air Filter	2.50E+03	uCi/m3	Beta
7057	38.433000	142.495000	3/13/2011 5:30:00 AM	USS RR 0530Z	Air Filter	3.00E-03	uCi/m3	Beta
7055			3/13/2011 5:12:15 AM	Japan#1	Air Filter	7.50E-09	uCi/m3	Beta

Managing Multiple Data Streams



- Data were received via emails, faxes, and websites
- Redundant data
  - Updates and corrections to previous sets

計測日	計測時間	計測場所	γ線	中性子線	風向	風速 (m/s)
	午後9時25分	正門	6.8μSv/h	0.001μSv/h未満	南西	0.9
	午後9時30分	正門	29.7μSv/h	0.001μSv/h未満	南東	1.0
	午後9時35分	正門	760.0μSv/h	0.001μSv/h未満	南東	1.6
	午後9時37分	正門	3130.0μSv/h	0.001μSv/h未満	南	1.7
	午後10時15分	正門	431.7μSv/h	0.001μSv/h未満	北	1.2
	午後10時20分	正門	336.6μSv/h	0.001μSv/h未満	北	1.2
	午後10時25分	正門	301.9μSv/h	0.001μSv/h未満	南西	4.6
	午後10時35分	正門	326.2μSv/h	0.001μSv/h未満	北東	4.2
	午後10時40分	正門	293.7μSv/h	-	北北東	4.4
	午後10時45分	正門	271.7μSv/h	-	北北東	4.4
	午後10時50分	正門	267.0μSv/h	-	北北東	4.4
	午後10時55分	正門	263.0μSv/h	-	北北東	4.4
	午後11時00分	正門	252.7μSv/h	-	北北東	4.8
	午後11時05分	正門	242.8μSv/h	-	北東	2.2
	午後11時10分	正門	235.3μSv/h	-	北東	2.1
	午後11時15分	正門	231.5μSv/h	-	北	2.2
	午後11時20分	正門	227.0μSv/h	-	北	2.2
	午後11時25分	正門	216.0μSv/h	-	北北西	1.8
	午後11時30分	正門	216.0μSv/h	-	北北西	1.8
	午後11時35分	正門	211.3μSv/h	-	北北東	1.8
	午後11時40分	正門	205.6μSv/h	-	北北西	1.1
	午後11時45分	正門	201.7μSv/h	-	北西	1.0
	午後11時50分	正門	196.2μSv/h	-	西北西	0.9
	午後11時55分	正門	192.3μSv/h	-	西	0.8
3月15日	午前0時00分	正門	188.9μSv/h	-	西北西	0.7
	午前0時05分	正門	185.0μSv/h	-	西北西	0.7
	午前0時10分	正門	181.0μSv/h	-	北北東	0.6
	午前0時15分	正門	177.3μSv/h	-	北東	0.6
	午前0時20分	正門	175.8μSv/h	-	北東	0.5
	午前0時25分	正門	173.3μSv/h	-	北	0.5
	午前0時30分	正門	168.0μSv/h	-	北	0.6
	午前0時35分	正門	164.9μSv/h	-	北	0.7
	午前0時40分	正門	164.4μSv/h	-	北北東	0.8
	午前0時45分	正門	167.6μSv/h	-	東北東	0.8
	午前0時50分	正門	164.3μSv/h	-	北	0.6
	午前0時55分	正門	151.7μSv/h	-	北西	0.5
	午前1時00分	正門	150.3μSv/h	-	北北西	0.5
	午前1時05分	正門	147.1μSv/h	-	北北東	0.7
	午前1時20分	正門	137.8μSv/h	0.01μSv/h未満	北北西	1.3
	午前1時30分	正門	135.5μSv/h	0.02μSv/h	北北東	1.1
	午前1時40分	正門	130.4μSv/h	0.01μSv/h	北	1.0
	午前1時50分	正門	123.3μSv/h	0.01μSv/h未満	北東	2.8
	午前2時00分	正門	120.2μSv/h	0.01μSv/h未満	北北東	3.4
	午前2時10分	正門	114.1μSv/h	0.01μSv/h未満	北北東	3.2
	午前2時20分	正門	111.4μSv/h	0.01μSv/h未満	北	3.6
	午前2時30分	正門	109.6μSv/h	0.01μSv/h未満	北東	3.6
	午前2時40分	正門	105.4μSv/h	0.01μSv/h未満	北北東	3.4
	午前3時10分	正門	94.3μSv/h	0.01μSv/h未満	北	3.4
	午前3時20分	正門	92.8μSv/h	0.01μSv/h未満	北東	4.2
	午前3時40分	正門	87.0μSv/h	0.01μSv/h未満	北北西	2.0
	午前4時00分	正門	81.9μSv/h	0.01μSv/h未満	北	2.1
	午前4時20分	正門	77.6μSv/h	0.01μSv/h未満	北東	1.0
	午前4時40分	正門	73.6μSv/h	0.01μSv/h未満	北	0.8
	午前5時00分	正門	70.0μSv/h	0.01μSv/h未満	北東	0.9
	午前5時20分	正門	67.4μSv/h	0.01μSv/h未満	北北西	0.7
	午前5時40分	正門	65.7μSv/h	0.01μSv/h未満	北	0.7
	午前6時00分	正門	73.2μSv/h	0.01μSv/h未満	北	0.8
	午前8時20分	正門	807.7μSv/h	0.01μSv/h未満	北東	1.5
	午前8時31分	正門	8217.0μSv/h	0.01μSv/h未満	北東	1.5
	午前8時40分	正門	1726.0μSv/h	0.01μSv/h未満	北	1.6
	午前8時50分	正門	2208.0μSv/h	0.01μSv/h未満	北	1.8

Field Sampling/Monitoring Lessons

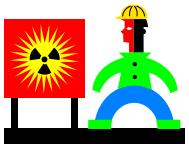
- Planned routes alterations common
- Teams spent 4-6 hours each way in transit
- Severely limited quantity of samples that could be collected

Data Challenges Potential Issues

- Volume of data – Storage Concerns
  - Over half a million monitoring data points
  - Over 600 samples (results x3)
  - Hundreds of in-situ gamma spec
- Evaluation of data
- Protection of personal data across multiple agencies
  - Real-time dosimetry and reporting

Communicating Risk

- Map details varied
  - Consumer dose limits (PACOM, DOE, etc.)
  - Units (SI vs traditional)
- Colors matter
- Unchanging breakpoints
- Guidance, not numbers

Dose Rate	Cs-137 Contamination	Dose	Increased Cancer
 2.5 Sv/hr Life threatening dose within hours		10 Sv (over a short period of time) – Almost 100% mortality	
		5 Sv (over a short period of time) – 50% of people die within 60 days without treatment	
		100 mSv – (over a short period of time) white blood cell count is temporarily affected	1 in 100
		80 mSv – dose to the lungs per year of a smoker who smokes 1.5 packs per day	1 in 125
 20 µSv/hr Typical Worker Turnback Level	Above this level public is excluded from entry	50 mSv per year – dose radiation workers are allowed to receive annually	1 in 200
~3 µSv/hr	450,000 Bq/m^2 ground contamination	20 mSv in the first year after an incident –Consideration for temporary relocation of public	1 in 500
~1 µSv/hr	166,000 Bq/m^2 ground contamination 	50 mSv in 50 years after an incident Consideration of permanent relocation of public	1 in 10,000
	~10,000 Bq/m^2 ground contamination (aerial detection limit)	6.2 mSv average annual background radiation dose	
Not distinguishable from background dose rate	500 Bq/kg food ~1100 Bq/m^2 ground contamination 	1 mSv per year allowable public dose.	1 in 10,000
	(Based on Japanese Ministry of Health, Labor and Welfare 2002 guidance)		(Nominal cancer incidence is 42 in 100, BEIR VII)

Note: This document is valid only for the Fukushima Daiichi source term and cannot be applied to nuclear detonation events.

Questions?