From: Kreuter, Jane
To: Abogunde, Maryann; Abrams, Charlotte; Adler, James; Afshar-Tous, Mugeh; Apostolakis, George; Armstrong, Janine; Ash, Darren; Astwood, Heather; Baker, Stephen; Barkley, Richard; Barrett, Andy; Batkin, Joshua; Bavol, Rochelle; Bergman, Thomas; Boger, Bruce; Borchardt, Bill; Bozin, Sunny; Bradford, Anna; Brenner, Eliot; Bubar, Patrice; Burns, Stephen; Burris, Steve; Carter, Mary; Case, Michael; Casto, Chuck; Chimood, Jane; Coates, Carlotta; Coggins, Angela; Cool, Donald; Cullingford, Michael; DANDI Calendar; Dapas, Marc; Davis, Roger; Dean, Bill; Decker, David; Dehn, Jeff; Dembek, Stephen; Diaz-Toro, Diana; Diec, David; Doane, Margaret; Dorman, Dan; Droggitis, Spiros; Dyer, Jim; Eisenberg, Wendy; Emche, Danielle; English, Lance; Essig, Thomas; Fehst, Geraldine; Fenstermacher, Amy; Ferkile, Andrea; Floyd, Daphene; Foggie, Kirk; Fragoyannis, Nancy; Franovich, Mike; Gibbs, Catina; Grobe, Jack; Hackett, Edwin; Haney, Catherine; Harris, Tim; Hayden, Elizabeth; Henderson, Karen; Herr, Linda; Hiltz, Thomas; Hirsch, Patricia; Holahan, Gary; Holahan, Patricia; Hopkins, Jon; Howell, Art; Hudson, Sharon; Jackson, Kia; Jaczko, Gregory; Jasinski, Robert; Johnson, Michael; Jones, Andrea; Jones, Cynthia; Kasputys, Clare; Killian, Michelle; Kim, Grace; Kock, Andrea; Kolb, Elaine; Kreuter, Jane; Layton, Michael; Leeds, Eric; Loyd, Susan; Lyons-Burke, Kathy; Magwood, William; Mamish, Nader; Matthews, David; Mayfield, Michael; Mavros, Lauren; McCree, Victor; McDevitt, Joan; Miller, Charles; Mitchell, Linda; Monninger, John; Moore, Scott; Morell, Gregory; Nieh, Ho; Oliveto, Betsy; Ostendorff, William; Owens, Janice; Pace, Patti; Pangburn, George; Quinones, Lauren; Ramsey, Jack; Reyes, Luis; Rodriguez, Veronica; Rosales-Cooper, Cindy; Rothschild, Trip; Satorius, Mark; Schmidt, Rebecca; Schroer, Suzanne; Schwartzman, Jennifer; Shaffer, Mark; Sharkey, Jeffry; Shepherd, Jill; Sheron, Brian; Skeen, David; Smiroldo, Elizabeth; Smith, Shawn; Smith, Wilkins; Sosa, Belkys; Speiser, Herald; Svinicki, Kristine; Vietti-Cook, Annette; Virgilio, Martin; Warren, Roberta; Weaver, Doug; Weber, Michael; Wiggins, Jim; Williams, Shawn; Wittick, Brian; Young, Francis; Zimmerman, Roy; Zorn, Jason
Subject: OIP Weekly
Date: Friday, March 11, 2011 2:19:30 PM
Attachments: OIP Weekly News 3-14-2011.docx

Don't forget to **spring ahead** this weekend- change your clocks!

Jane A. Kreuter
U.S. Nuclear Regulatory Commission
Office of International Programs
Phone: 301-415-1780
Fax: 301-415-2395
E-Mail: Jane.Kreuter@nrc.gov

XX\1

INTERNATIONAL ITEMS OF INTEREST
OFFICE OF INTERNATIONAL PROGRAMS
Week of March 14, 2011

OIP Vision: *To expand nuclear safety and security worldwide through lasting partnerships.*
Our Mission: *OIP enhances nuclear safety and security through global partnerships by exchanging information and by licensing the import and export of material and equipment according to US laws and policy.*

1. Commission Activities

Nothing to report

2. Export/Import Activities

An export license (XCOM1213) was issued to ATI Wah Chang for the export of Zircaloy-4 Trex Tubes to Argentina for use in fuel bundles for the Embaise and Atucha I & II Nuclear Power Plants.

An export license amendment (PXB139.01) was issued to Schlumberger Technology Corporation to export Category 2 quantities of Am-241/Be, Category 2 or lower quantities of Cs-137, Th-232 (not to exceed 1.1E-6 TBq), and Na-22 (not to exceed 1.1E-4 TBq) for use in oil and gas well logging operations in Iraq.

3. Conventions, Treaties, Legal Obligations and Interagency Activities

During the week of March 7, Karen Henderson of OIP attended three meetings led by Ambassador Bonnie Jenkins at the U.S. Department of State: 1) coordination meeting in advance of the U.S.-South Africa nonproliferation meetings; 2) regularly scheduled interagency meeting to discuss nuclear-related activities in East Africa; and 3) interagency discussion of uranium mining and recovery, with a focus on the proposed International Atomic Energy Agency (IAEA) guidance for security.

On March 14, Steve Dembek of OIP and Nancy Fragoyannis of OIP will attend a sub-IPC meeting at the National Security Council. The meeting will include discussions on topics associated with the four-year lockdown/cleanout effort.

4. Bilateral Activities

From March 13 to 19, Neale Griffis of HR, and Thomas Essig of OIP, will travel to Trinidad-and-Tobago, to present radiation safety and radioactive source management training to government policy makers and inspectors. Trinidad-and-Tobago has recently written, and is about to implement new regulations for the licensing and inspection of radioactive materials, and has requested this training in support of the program.

On March 19, Ms. Bushra Ali Ahmed, Director General of the Iraqi Radiation Protection Center, will visit NRC Headquarters and hold discussions with FSME managers and staff on NRC's regulatory process with regards to decommissioning.

5. Multinational Activities

From March 15 to 19, Martin Virgilio, Deputy Executive Director for Reactor and Preparedness Programs, Office of Executive Director for Operations (OEDO), and Shawn Williams of OEDO, will travel to Vienna, Austria, to participate and support the U.S. Representative to the IAEA Commission on Safety Standards (CSS). The support will include attending the Joint CSS and Advisory Group on Security Task Force meeting.

From March 18 to 25, Catherine Haney, Director, Nuclear Material Safety and Safeguards and Shawn Smith of NMSS will travel to Paris, France, to attend the 44th Session of the Radioactive Waste Management Committee meeting. Ms. Haney will also attend meetings of the Regulators' Forum and the Planning Committee for the 2011 International Conference on Geologic Repositories.

From March 14 to 20, Robert (Brad) Harvey of NRO will travel to Bariloche, Argentina, to lecture at a regional Latin American IAEA training course on site selection and evaluation for nuclear installations.

From March 14 to 20, Elizabeth Hayden, Director, Office of Public Affairs, will travel to Paris, France, to participate in the 12th meeting of the Nuclear Energy Agency (NEA) Committee on Nuclear Regulatory Activities Working Group on Public Communication of Nuclear Regulatory Organizations where she will assist in identifying teams and the structure of work for two new programs on social media and communication plans.

From March 12 to 17, Jack Ramsey, Senior Level Advisor for International Nuclear Safety Assistance, OIP, will travel to Vienna, Austria, to participate in a meeting of the IAEA-administered Regulatory Cooperation Forum.

From March 12 to 20, Hilda Klasky of UT-Battelle, LLC, will travel to Fountainebleau, France, to represent Oak Ridge National Laboratory (ORNL) at EURATOM PERFORM 60 Network meetings. Ms. Klasky will collaborate with others to organize benchmark exercises between ORNL DISFRAC fracture code and Advanced Fracture Module of SP 1.

From March 12 to 20, Steven Arndt of NRR; and Leroy Hardin of RES, will travel to Garching, Germany, to participate in the International Electrotechnical Commission (IEC) International Standards Committee meetings. Mr. Arndt will represent the NRC's interest in the development of new IEC codes in the area of digital instrumentation and control and cyber security. Mr. Hardin will participate in the development of the IEC computer security draft standard and the IEC Field Programmable Gate Array final draft standard.

6. OIP Communications

1. Letter to Robin DeLaBarre, DOS, from Nader L. Mamish, re 10 CFR Part 110 Non-Appendix P export and import cases completed in February 2011 (ML110610308)
2. Letter to Sean Oehlbert, DOE, from Nader L. Mamish, re subsequent arrangement to retransfer from Atomic Energy of Canada, to Belgium (ML11068A028)

CONTACT: Janice Owens, 415-3684 regarding export/ import, IAEA, and NEA activities
Charlotte Abrams, 415-2933 regarding international cooperation activities
Steve Dembek, 415-2342 regarding other activities

Stutzke, Martin

From: Stutzke, Martin NRC/RES/DRA
Sent: Monday, March 14, 2011 3:21 PM
To: Ake, Jon; Kammerer, Annie; Hayden, Elizabeth
Cc: Burnell, Scott; Manoly, Kamal; Munson, Clifford; Chokshi, Nilesh
Subject: RE: EXAMPLE OF REQUEST: Earthquake plans/reports/risk analysis for San Onofre nuclear power plant

It's misleading to say that the GI-199 Safety/Risk Assessment determined which plants were OK and which were not. The purpose of the assessment was to determine, on a generic basis, if the risk associated with increased seismic hazard estimates in the Central and Eastern US (CEUS) warrants further investigation for potential imposition of cost-justified backfits. We determined that the seismic core-damage frequencies for 27 plants had increased by 1E-5/y or more, relative to what we thought upon conclusion of the Individual Plant Examination of External Events (Generic Letter 88-20, Supplement 4). This finding is the basis for continuing GI-199 and transitioning it to NRR for development of a generic letter that will request information needed to identify potential plant-specific backfits.

We presented a map that showed the locations of the 27 plants in the GI-199 "continue zone" during a public meeting held October 6, 2010 (see Slide #25 in ML102770665). The GI-199 Safety/Risk Assessment (ML100270582) is also publically available. It does not specifically identify the 27 plants, but contains information in appendices that could be used to figure out which CEUS plants are in the "continue zone."

Marty

From: Ake, Jon
Sent: Monday, March 14, 2011 2:08 PM
To: Kammerer, Annie; Hayden, Elizabeth
Cc: Burnell, Scott; Manoly, Kamal; Munson, Clifford; Stutzke, Martin; Chokshi, Nilesh
Subject: RE: EXAMPLE OF REQUEST: Earthquake plans/reports/risk analysis for San Onofre nuclear power plant

As Annie has pointed out, all 96 operating reactors in the Central and Eastern U.S. were evaluated as part of the GI-199 assessment. Currently a Generic Letter is being prepared requesting additional seismic and plant-specific information, that letter will be sent to all NPP licensees in the CEUS. It is important to note that the Generic Letter has not yet been finalized, the specific information requests are being developed and reviewed internally. So, at this time we are unable to state exactly what path (analysis, back-fit etc.) a particular plant may follow as a result of the Generic Letter.

Kamal, Marty, Cliff-
Is this an accurate representation of our current path?

From: Kammerer, Annie
Sent: Monday, March 14, 2011 11:53 AM
To: Hayden, Elizabeth
Cc: Burnell, Scott; Ake, Jon
Subject: RE: EXAMPLE OF REQUEST: Earthquake plans/reports/risk analysis for San Onofre nuclear power plant

The list that was analyzed was basically everything in the CEUS. I don't think we made the list of which plants were OK and which not public due to too much uncertainty. Jon Ake would know.

Jon, can you answer? Did we make the list of plant names and which screened in public?

From: Hayden, Elizabeth
Sent: Monday, March 14, 2011 1:48 PM
To: Kammerer, Annie

XX/2

Cc: Burnell, Scott
Subject: RE: EXAMPLE OF REQUEST: Earthquake plans/reports/risk analysis for San Onofre nuclear power plant

Is the list of plants that were analyzed and those found problematic public?

Beth Hayden
Senior Advisor
Office of Public Affairs
U.S. Nuclear Regulatory Commission
--- Protecting People and the Environment
301-415-8202
elizabeth.hayden@nrc.gov

From: Kammerer, Annie
Sent: Monday, March 14, 2011 1:24 PM
To: Hayden, Elizabeth
Cc: Burnell, Scott
Subject: RE: EXAMPLE OF REQUEST: Earthquake plans/reports/risk analysis for San Onofre nuclear power plant

Yes. Wolf Creek was analyzed as part of GI-199. It was not one of the plants that the NRC identified as problematic (i.e. staff believes this plant still has adequate margin given the latest ground shaking estimates). However, due to uncertainties in the data available to our staff, we will be sending a letter to all US plants in the central and eastern US.

I hope this helps.

From: Hayden, Elizabeth
Sent: Monday, March 14, 2011 1:18 PM
To: Kammerer, Annie
Cc: Burnell, Scott
Subject: FW: EXAMPLE OF REQUEST: Earthquake plans/reports/risk analysis for San Onofre nuclear power plant

Annie,

Can you help with this question we received from a reporter?

Also, can you verify whether Wolf Creek is one of the plants evaluated in GSI-199?

Beth Hayden
Senior Advisor
Office of Public Affairs
U.S. Nuclear Regulatory Commission
--- Protecting People and the Environment
301-415-8202
elizabeth.hayden@nrc.gov

From: Uselding, Lara
Sent: Monday, March 14, 2011 1:10 PM
To: Hayden, Elizabeth; Screnci, Diane
Subject: EXAMPLE OF REQUEST: Earthquake plans/reports/risk analysis for San Onofre nuclear power plant

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From: keith.darce@uniontrib.com [mailto:keith.darce@uniontrib.com]
Sent: Monday, March 14, 2011 12:08 PM

To: Uselding, Lara
Subject: Earthquake plans/reports/risk analysis for San Onofre nuclear power plant

Lara,

I am trying to track down any documents on file with the NRC concerning the risk of earthquakes occurring near the San Onofre nuclear plant north of San Diego. I am particularly interested in emergency plans, analysis of the risks faced by the plant from earthquakes and predictions of the types of damage and dangers that could be created by earthquake damage to the plant. I'm also interested in documents looking at the risk and dangers posed by tsunamis to the plant. Can you tell me if these types of documents exist and when I might be able to get them? I am trying to turn a story around on this topic for tomorrow's (Tuesday's) edition of the paper.

Thanks,
Keith

Keith Darcé
Biotechnology writer
The San Diego Union-Tribune
keith.darce@uniontrib.com
619.293.1020
www.signonsandiego.com/news/business/biotech/
Follow me on Twitter at **KeithDarce**

Stutzke, Martin

From: Stutzke, Martin NRC/RES/DRA
Sent: Monday, March 14, 2011 9:51 AM
To: Coyne, Kevin
Subject: PRA Info on Tsunamis and Aftershocks

The Diablo Canyon PRA considered a tsunami leading to flooding of the ASW pumps. Nothing in the San Onofre PRA on tsunamis.

Seismic PRAs do not consider damage from earthquake aftershocks. To do so, you'd need to predict the fragility of the plant SSCs following the main shock.

Marty

Martin A. Stutzke
Senior Technical Advisor for PRA Technologies
Division of Risk Assessment
Office of Nuclear Regulatory Research
U.S. Nuclear Regulatory Commission
(301) 251-7614

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From: Flory, Shirley
To: Case, Michael; Coe, Doug; Coyne, Kevin; Gibson, Kathy; Uhle, Jennifer; Richards, Stuart; Scott, Michael; Sheron, Brian; Valentin, Andrea
Subject: NUCLEAR NEWS FLASHES
Date: Monday, March 14, 2011 2:45:27 PM
Attachments: nn110311.txt

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Nuclear News Flashes
Friday, Mar 11, 2011

[Inside This Issue:]

*** Japanese nuclear plant still without cooling after earthquake, radiation increases

Tokyo Electric Power Co. was still trying to restore power by press time to restart the cooling system at a nuclear power plant shut after a record earthquake struck the country's northeastern region March 11.

According to statements by the Japanese Nuclear and Industrial Safety Agency, Tepco has brought three to four mobile power generators to the Fukushima Daiichi nuclear power plant. An agency update, issued at 4:30 am March 12 local time, said workers were connecting cables to the generators.

Tepco said in a statement 6 am local time March 12 that it has detected radiation levels higher than normal at the plant.

In an earlier statement, Tepco said it will take measures to relieve pressure in the reactor containment vessels for some units at the plant "in order to fully secure safety." It did not name the units.

NISA said the containment pressure at unit 1 may have reached more than double the designed maximum level.

Pressure relief will release "slightly radioactive vapor," Taro Ishida, US spokesman for the Federation of Electric Power Companies of Japan, said in a March 11 statement.

Fukushima Daiichi-1, -2 and -3 shut automatically after an 8.9 magnitude earthquake struck. Tepco reported that emergency diesel generators stopped working and left the reactors with no power for cooling. The company said the government has ordered thousands of residents living in a 10-km (6.2-mile) radius of the plant to evacuate.

The other three units at the plant were already shut down for inspection when the earthquake hit.

Another eight reactors along the same coastline also shut automatically after the earthquake, Ishida said.

*** Areva, Rolls-Royce sign cooperation deal

Areva and Rolls-Royce have signed an industrial cooperation agreement for the British company to supply key components to the first third-generation nuclear reactors to be built in the UK.

The agreement was signed March 11 at the Royal Academy of Engineering in London by Areva CEO Anne Lauvergeon
and John Rose, chief executive of Rolls-Royce.

"The agreement will cover three areas of cooperation with Rolls-Royce. Firstly, manufacturing work on high precision long-lead components for the European pressurized water reactors," Lauvergeon said at the signing ceremony. She added that "as the nuclear renaissance takes off around the world, we will join forces in global nuclear projects in areas like engineering, manufacturing, the supply chain and training. And, lastly, our cooperation will extend to waste management projects."

Lawrie Haynes, president of Rolls-Royce Nuclear, said at a press briefing following the ceremony that the UK company has a nuclear supply chain of 270 companies.

French EDF and its partner Centrica plan to build four Areva-designed 1,600-MW EPRs in the UK. The first unit is expected online by 2018.

Areva is also looking to supply EPRs to other consortiums planning UK reactors â€" E.On and RWE's joint venture Horizon Nuclear Power, and another led by GDF Suez, Iberdrola and Scottish & Southern Energy.

*** NRC monitoring Diablo Canyon after tsunami warning

NRC's Region IV office will continue monitoring Diablo Canyon after a three-foot wave from a tsunami caused by a major earthquake in eastern Japan came ashore near the plant, NRC spokeswoman Lara Uselding said March 11.

NRC said in a statement that day that senior officials at NRC headquarters in Rockville, Maryland continue to follow events related to the 8.9 magnitude earthquake that occurred off Japan's eastern coast and subsequent tsunami.

NRC began monitoring Diablo Canyon when Pacific Gas & Electric issued a notice of an unusual event at 4:23 am EST March 11 after receiving a tsunami warning from the West California Emergency Management Agency. The warning will remain in effect until local, county and state emergency agencies lift it, PG&E spokesman Paul Flake said in an interview that evening.

Diablo Canyon, outside San Luis Obispo, has two 1,197-MW reactors. Both operated at 100% power March 11, PG&E said.

A tsunami advisory was issued to Southern California Edison's San Onofre plant, on the California coast about 250 miles south of Diablo Canyon. San Onofre's two 1,127-MW reactors operated at 100% and 98% power March 11. SCE said in a statement that as a precautionary measure, SCE personnel have been placed on standby in coastal areas.

NRC said March 11 it was monitoring the spent fuel storage installation at PG&E's shuttered Humboldt Bay nuclear power plant and NRC-regulated nuclear material sites in Hawaii and Alaska.

*** State challenges could derail Vermont Yankee's continued operation

NRC expects to issue a 20-year renewal of Vermont Yankee's operating license March 15 or 16, but legal issues within the state could preclude the plant from operating beyond the March 2012 expiration of its current license, a regulatory and environmental attorney said March 11.

"Entergy signed an agreement with the state in 2002 when it acquired the plant [from a consortium of local electric utilities] in which Entergy said it will leave it up to the Vermont Legislature to vote to approve the public convenience certificate" needed for the reactor to operate beyond March 2012, Pat Parenteau, a Vermont Law School professor, said in a March 11 interview.

Parenteau said Entergy could file a lawsuit asking a federal court to invalidate the 2002 agreement, contending the 1954 Atomic Energy Act prohibits states "from regulating health and safety aspects of nuclear power plant operations." The US Supreme Court upheld that interpretation in 1983 but also affirmed states can deny permits for reactor operations if they "believe there are better and more cost effective ways of providing energy," he said.

NRC Chairman Gregory Jaczko said March 10 after the commission dismissed the final challenges to the plant's license renewal that issuance of state operating permits required for power plants, and issues related to generator reliability, are "all in the purview of the state."

Entergy said in November it was seeking a buyer for Vermont Yankee. Entergy spokesman Michael Burns said March 9 he could not comment on a potential sale, citing "the confidential nature of the process."

*** Honeywell fined more than $12 million

Honeywell must pay more than $12 million in fines after pleading guilty March 11 to a felony offense for knowingly storing hazardous chemical waste without a permit at its Metropolis, Illinois uranium conversion facility, the US Department of Justice said in a March 11 statement.

The company will pay an $11.8 million federal fine and a separate $690,000 fine to the state of Illinois, Justice said. The company will also have to implement a $200,000 household hazardous waste collection and disposal program for Metropolis.

Honeywell said in a statement March 11 that it reported the permitting violation "to the appropriate regulatory agency" in 2006 and said it will pay the fine and implement the environmental projects that are conditions of the probation. Honeywell also said no injuries or environmental impact resulted from the violation.

Justice said Honeywell failed in 2002 to obtain the necessary permit to store potassium hydroxide mud, which results from the scrubbing of air emissions from the UF6 conversion process, and did not obtain and comply with a proper permit until March 2010. Justice said that in 2009, US Environmental Protection Agency special agents executed a search warrant and found "nearly 7,500 illegally stored drums containing waste that was both hazardous and radioactive."

The case was heard in federal district court in Benton, Illinois .

*** US reactor report

â€" American Electric Power's DC Cook-1 was planning to power down March 11 in preparation for a shutdown March 12 for a maintenance outage, the utility said in a statement. The mid-cycle outage will repair the unit's main generator hydrogen seal, it said.

***

Contact Us:

| To reach Platts |
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Stutzke, Martin

From: Stutzke, Martin NRC/RES/DRA
Sent: Tuesday, March 15, 2011 10:25 AM
To: Ake, Jon; Kammerer, Annie
Subject: FW: NBC deadline question for NRC on seismic hazard estimates

Importance: High

We need information to answer Question #3 concerning the development of new consensus seismic hazard curves:

1. What is the official project name?
2. Who is the overall project manager and his/her contact information?
3. Is there a public website that provides overview information on the project?
4. List of all participating organizations (domestic and international)?
5. Projected schedule? (I think this is by December 2011)

FYI – The reporter's understanding on Question #1 is correct. I'm working on Question #2 by going to the Region IV SRAs to find out what licensees have available. We will defer Question #4 to NRR.

Marty

From: Beasley, Benjamin
Sent: Tuesday, March 15, 2011 9:36 AM
To: Stutzke, Martin; Ake, Jon
Cc: Kauffman, John
Subject: FW: NBC deadline question for NRC on seismic hazard estimates
Importance: High

I am still reading this but need to give you the heads up. I am walking to the 6th floor to get permission to work on this.

Ben

From: Wilson, George
Sent: Tuesday, March 15, 2011 9:31 AM
To: Beasley, Benjamin
Subject: FW: NBC deadline question for NRC on seismic hazard estimates
Importance: High

fyi

From: Hiland, Patrick
Sent: Tuesday, March 15, 2011 9:20 AM
To: Wilson, George; Manoly, Kamal
Cc: Stutzke, Martin; Ake, Jon; Coe, Doug; Skeen, David; Scales, Kerby
Subject: FW: NBC deadline question for NRC on seismic hazard estimates
Importance: High

Need to work with OPA, and RES. Kamal should coordinate with RES, and I suggest Marty/Jon respond directly through RES. Doug Coe is good source also for the GI. Get OPA involved.

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From: Bill Dedman [mailto:Bill.Dedman@msnbc.com]
Sent: Tuesday, March 15, 2011 9:06 AM
To: Manoly, Kamal; Sheron, Brian; Hiland, Patrick; OPA Resource
Subject: NBC deadline question for NRC on seismic hazard estimates

Good morning,

My name is Bill Dedman. I'm a reporter for NBC News and msnbc.com, writing an article today about:

SAFETY/RISK ASSESSMENT RESULTS FOR GENERIC ISSUE 199, "IMPLICATIONS OF UPDATED PROBABILISTIC SEISMIC HAZARD ESTIMATES IN CENTRAL AND EASTERN UNITED STATES ON EXISTING PLANTS"

I reached out to NRC Public Affairs yesterday but have not heard back, and my deadline is end-of-day today. I'm hoping to get on the phone today with someone from NRC to make sure I'm conveying this information accurately to the public. If nothing else, I'm hoping one of the technical people can help clarify the points below. My telephone number is 203-451-9995.

I've read Director Brian Sheron's memo of Sept. 2, 2010, to Mr. Patrick Hiland; the safety/risk assessment of August 2010; its appendices A through D; NRC Information Notice 2010-18; and the fact sheet from public affairs from November 2010.

I have these questions:

1. I'd like to make sure that I accurately place in layman's terms the seismic hazard estimates. I need to make sure that I'm understanding the nomenclature for expressing the seismic core-damage frequencies. Let's say there's an estimate expressed as "2.5E-06." (I'm looking at Table D-2 of the safety/risk assessment of August 2010.) I believe that this expression means the same as 2.5 x 10^-06, or 0.0000025, or 2.5 divided by one million. In layman's terms, that means an expectation, on average, of 2.5 events every million years, or once every 400,000 years. Similarly, "2.5E-05" would be 2.5 divided by 100,000, or 2.5 events every 100,000 years, on average, or once every 40,000 years. Is this correct?

2. These documents give updated probabilistic seismic hazard estimates for existing nuclear power plants in the Central and Eastern U.S. What document has the latest seismic hazard estimates (probabilistic or not) for existing nuclear power plants in the Western U.S.?

3. The documents refer to newer data on the way. Have NRC, USGS et al. released those? I'm referring to this: "New consensus seismic-hazard estimates will become available in late 2010 or early 2011 (these are a product of a joint NRC, U.S. Department of Energy, U.S. Geological Survey (USGS) and Electric Power Research Institute (EPRI) project). These consensus seismic hazard estimates will supersede the existing EPRI, Lawrence Livermore National Laboratory, and USGS hazard estimates used in the GI-199 Safety/Risk Assessment."

4. What is the timetable now for consideration of any regulatory changes from this research?

Thank you for your help.

Regards,

Bill Dedman

Stutzke, Martin

From: Stutzke, Martin NRC/RES/DRA
Sent: Tuesday, March 15, 2011 10:39 AM
To: Runyan, Michael
Subject: FW: NBC deadline question for NRC on seismic hazard estimates

Importance: High

Mike –

I was given your name by Don Marksberry. By way of introduction, I'm one of the PRA SLS working in RES/DRA, and coauthored the Safety/Risk Assessment of GI-199 concerning the impact of updated seismic hazard estimates in the Central and Eastern US.

We are trying to answer Question #2 (see below). Since GI-199 focused in CEUS plants, we did not collect recent information on seismic hazards and seismic core-damage frequencies for the Western US plants (Columbia, Diablo Canyon, San Onofre, and Palo Verde). I am hoping that you might have or can readily obtain this information. Specifically, here's what we would like to know:

1. What is the current estimate of seismic core-damage frequency at each Western US plant?
2. What is the current estimate of exceeding the safe shutdown earthquake (SSE) at each Western US plant? To get a complete picture, we'd like to know the annual exceedence frequencies for various spectral frequencies (e.g., 1 Hz, 5 Hz, and 10 Hz) as well as peak ground acceleration.

Thanks in advance,

Marty

Martin A. Stutzke
Senior Technical Advisor of PRA Technologies
Division of Risk Analysis
Office of Nuclear Regulatory Research
301-251-7614

From: Beasley, Benjamin
Sent: Tuesday, March 15, 2011 9:36 AM
To: Stutzke, Martin; Ake, Jon
Cc: Kauffman, John
Subject: FW: NBC deadline question for NRC on seismic hazard estimates
Importance: High

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From: Wilson, George
Sent: Tuesday, March 15, 2011 9:31 AM
To: Beasley, Benjamin
Subject: FW: NBC deadline question for NRC on seismic hazard estimates
Importance: High

XX\6

fyi

From: Hiland, Patrick
Sent: Tuesday, March 15, 2011 9:20 AM
To: Wilson, George; Manoly, Kamal
Cc: Stutzke, Martin; Ake, Jon; Coe, Doug; Skeen, David; Scales, Kerby
Subject: FW: NBC deadline question for NRC on seismic hazard estimates
Importance: High

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From: Bill Dedman [mailto:Bill.Dedman@msnbc.com]
Sent: Tuesday, March 15, 2011 9:06 AM
To: Manoly, Kamal; Sheron, Brian; Hiland, Patrick; OPA Resource
Subject: NBC deadline question for NRC on seismic hazard estimates

Good morning,

My name is Bill Dedman. I'm a reporter for NBC News and msnbc.com, writing an article today about:

SAFETY/RISK ASSESSMENT RESULTS FOR GENERIC ISSUE 199, "IMPLICATIONS OF UPDATED PROBABILISTIC SEISMIC HAZARD ESTIMATES IN CENTRAL AND EASTERN UNITED STATES ON EXISTING PLANTS"

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I've read Director Brian Sheron's memo of Sept. 2, 2010, to Mr. Patrick Hiland; the safety/risk assessment of August 2010; its appendices A through D; NRC Information Notice 2010-18; and the fact sheet from public affairs from November 2010.

I have these questions:

1. I'd like to make sure that I accurately place in layman's terms the seismic hazard estimates. I need to make sure that I'm understanding the nomenclature for expressing the seismic core-damage frequencies. Let's say there's an estimate expressed as "2.5E-06." (I'm looking at Table D-2 of the safety/risk assessment of August 2010.) I believe that this expression means the same as 2.5 x 10^-06, or 0.0000025, or 2.5 divided by one million. In layman's terms, that means an expectation, on average, of 2.5 events every million years, or once every 400,000 years. Similarly, "2.5E-05" would be 2.5 divided by 100,000, or 2.5 events every 100,000 years, on average, or once every 40,000 years. Is this correct?

2. These documents give updated probabilistic seismic hazard estimates for existing nuclear power plants in the Central and Eastern U.S. What document has the latest seismic hazard estimates (probabilistic or not) for existing nuclear power plants in the Western U.S.?

3. The documents refer to newer data on the way. Have NRC, USGS et al. released those? I'm referring to this: "New consensus seismic-hazard estimates will become available in late 2010 or early 2011 (these are a product of a joint NRC, U.S. Department of Energy, U.S. Geological Survey (USGS) and Electric Power Research Institute (EPRI) project). These consensus seismic hazard estimates will supersede the existing EPRI, Lawrence Livermore National Laboratory, and USGS hazard estimates used in the GI-199 Safety/Risk Assessment."

4. What is the timetable now for consideration of any regulatory changes from this research?

Thank you for your help.

Regards,

Bill Dedman

Stutzke, Martin

From:	Stutzke, Martin NRC/RES/DRA
Sent:	Tuesday, March 15, 2011 1:44 PM
To:	Mahoney, Michael; Giitter, Joseph; Hiland, Patrick
Cc:	Kammerer, Annie; Ake, Jon
Subject:	Plant Seismic information to Support NRC Hearing on Wednesday
Attachments:	SSE Exceed and SCDF.xlsx

I've prepared a spreadsheet that provides the following information for each operating plant:

1. Safe shutdown earthquake (SSE)

2. Annual frequency of exceeding the SSE

   For Western US plants (Columbia, Diablo Canyon, San Onofre, and Palo Verde), this information is based on the seismic hazard curve for peak ground acceleration as reported in the IPEEE. For the Central and Eastern US (CEUS) plants, this information is based on the 2008 US Geological Survey seismic hazard curves (adjusted for site-specific soil amplification) for peak ground acceleration, 10 Hz, 5 Hz, and 1 Hz spectral frequencies as developed for the Safety/Risk Assessment of Generic Issue 199 (GI-199).

3. The review-level earthquake (RLE) used in the IPEEE

   This information was obtained from the IPEEE submittals, and is reported in NUREG-1742. The RLE is only applicable to those plants that used seismic margins analysis (SMA) to respond to the IPEEE (Generic Letter 88-20, Supplement 4). The RLE is specified in terms of the high confidence of low probability of failure (HCLPF) for peak ground acceleration. The HCLPF is the acceleration value at which there is a 1% probability of core damage. The RLE is not applicable to plants that performed seismic PRAs.

4. The seismic core-damage frequency

   For most Western US plants (Columbia, Diablo Canyon, and San Onofre), this information is based on IPEEE submittals as summarized in NUREG-1742. For Palo Verde, I made an estimate using the methods developed for GI-199. For the CEUS plants, this information was developed in the Safety/Risk Assessment of GI-199.

5. The method used in the IPEEE to assess seismic risk, as reported in NUREG-1742

The attached spreadsheet also provides fleetwide summary statistics for the frequencies of exceeding the SSE and the seismic core-damage frequencies (average, median, minimum, maximum, etc.).

Please note that the GI-199 Safety/Risk Assessment is publically available (ML100270582). NUREG-1742 is available in the Electronic Reading Room on the public website. IPEEEs are no longer publically available (following the 9/11/2001 event).

Martin A. Stutzke
Senior Technical Advisor for PRA Technologies
Division of Risk Assessment
Office of Nuclear Regulatory Research
U.S. Nuclear Regulatory Commission
(301) 251-7614

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SEISMIC INFORMATION: SSE, SSE EXCEEDANCE FREQUENCIES, REVIEW-LEVEL EARTHQUAKES, ANDSEISMIC CORE-DAMAGE FREQUENCIES

Plant	Docket	SSE (g's)	Frequency of Exceeding the SSE (per year)	RLE (HCLPF) (g's)	Seismic Core Damage Frequency (per year)	IPEEE Method	Source
Arkansas 1	05000313	0.2	2.8E-04	0.3	4.1E-06	0.3g full-scope EPRI SMA	GI-199
Arkansas 2	05000368	0.2	9.7E-05	0.3	4.1E-06	0.3g focused-scope EPRI SMA	GI-199
Beaver Valley 1	05000334	0.12	3.3E-04	n/a	4.8E-05	seismic PRA	GI-199
Beaver Valley 2	05000412	0.12	2.7E-04	n/a	2.2E-05	seismic PRA	GI-199
Braidwood 1	05000456	0.2	6.7E-05	0.3	7.3E-06	0.3g focused-scope EPRI SMA	GI-199
Braidwood 2	05000457	0.2	6.7E-05	0.3	7.3E-06	0.3g focused-scope EPRI SMA	GI-199
Browns Ferry 1	05000259	0.2	2.5E-04	0.3	3.7E-06	0.3g focused-scope EPRI SMA	GI-199
Browns Ferry 2	05000260	0.2	2.5E-04	0.26	5.4E-06	0.3g focused-scope EPRI SMA	GI-199
Browns Ferry 3	05000296	0.2	2.5E-04	0.26	5.4E-06	0.3g focused-scope EPRI SMA	GI-199
Brunswick 1	05000325	0.16	7.3E-04	0.3	1.5E-05	0.3g focused-scope EPRI SMA	GI-199
Brunswick 2	05000324	0.16	7.3E-04	0.3	1.5E-05	0.3g focused-scope EPRI SMA	GI-199
Byron 1	05000454	0.2	5.2E-05	0.3	5.8E-06	0.3g focused-scope EPRI SMA	GI-199
Byron 2	05000455	0.2	5.2E-05	0.3	5.8E-06	0.3g focused-scope EPRI SMA	GI-199
Callaway	05000483	0.2	3.8E-05	0.3	2.0E-06	0.3g focused-scope EPRI SMA	GI-199
Calvert Cliffs 1	05000317	0.15	1.9E-04	n/a	1.0E-05	seismic PRA	GI-199
Calvert Cliffs 2	05000318	0.15	1.9E-04	n/a	1.2E-05	seismic PRA	GI-199
Catawba 1	05000413	0.15	1.4E-04	n/a	3.7E-05	seismic PRA	GI-199
Catawba 2	05000414	0.15	1.4E-04	n/a	3.7E-05	seismic PRA	GI-199
Clinton	05000461	0.25	5.8E-05	0.3	2.5E-06	0.3g focused-scope EPRI SMA	GI-199
Columbia	05000397	0.25	1.7E-04	n/a	2.1E-05	seismic PRA	IPEEE
Comanche Peak 1	05000445	0.12	1.6E-05	0.12	4.0E-06	reduced-scope EPRI SMA; SSE = 0.12g	GI-199
Comanche Peak 2	05000446	0.12	1.6E-05	0.12	4.0E-06	reduced-scope EPRI SMA; SSE = 0.12g	GI-199
Cooper	05000298	0.2	1.5E-04	0.3	7.0E-06	0.3g focused-scope EPRI SMA	GI-199
Crystal River 3	05000302	0.1	8.9E-05	0.1	2.2E-05	reduced-scope EPRI SMA; SSE = 0.1g	GI-199
D.C. Cook 1	05000315	0.2	2.1E-04	n/a	2.2E-05	seismic PRA	GI-199
D.C. Cook 2	05000316	0.2	2.1E-04	n/a	2.2E-05	seismic PRA	GI-199
Davis Besse	05000346	0.15	6.3E-05	0.26	6.7E-06	reduced-scope EPRI SMA	GI-199
Diablo Canyon 1	05000275	0.75	3.9E-03	n/a	4.2E-05	seismic PRA	IPEEE
Diablo Canyon 2	05000323	0.75	3.9E-03	n/a	4.2E-05	seismic PRA	IPEEE
Dresden 2	05000237	0.2	9.7E-05	0.26	1.9E-05	0.3g focused-scope EPRI SMA	GI-199
Dresden 3	05000249	0.2	9.7E-05	0.26	1.9E-05	0.3g focused-scope EPRI SMA	GI-199
Duane Arnold	05000331	0.12	2.3E-04	0.12	3.2E-05	reduced-scope EPRI SMA; SSE = 0.12g	GI-199
Farley 1	05000348	0.1	1.0E-04	0.1	2.8E-05	reduced-scope EPRI SMA; SSE = 0.1g	GI-199
Farley 2	05000364	0.1	1.0E-04	0.1	2.8E-05	reduced-scope EPRI SMA; SSE = 0.1g	GI-199
Fermi 2	05000341	0.15	1.0E-04	0.3	4.2E-06	0.3g focused-scope EPRI SMA	GI-199
Fitzpatrick	05000333	0.15	3.2E-04	0.22	6.1E-06	0.3g focused-scope NRC SMA	GI-199
Fort Calhoun 1	05000285	0.17	3.7E-04	0.25	5.4E-06	0.3g focused-scope NRC SMA	GI-199
Ginna	05000244	0.2	1.0E-04	0.2	1.3E-05	0.3g focused-scope EPRI SMA	GI-199
Grand Gulf	05000416	0.15	1.0E-04	0.15	1.2E-05	reduced-scope EPRI SMA; SSE = 0.15g	GI-199

Hatch 1	05000400	0.148	3.9E-04	0.29	2.3E-06	0.3g focused-scope EPRI SMA	GI-199
Hatch 2	05000321	0.15	2.7E-04	0.3	2.5E-06	0.3g focused-scope EPRI SMA	GI-199
Hope Creek	05000366	0.2	9.7E-05	0.3	2.5E-06	0.3g focused-scope EPRI SMA	GI-199
Indian Point 2	05000354	0.15	4.9E-04	n/a	2.8E-06	seismic PRA	GI-199
Indian Point 3	05000247	0.15	4.9E-04	n/a	3.3E-05	seismic PRA	GI-199
Kewaunee	05000286	0.12	2.8E-04	n/a	1.0E-04	seismic PRA	GI-199
LaSalle 1	05000305	0.2	1.7E-04	n/a	5.1E-06	seismic PRA	GI-199
LaSalle 2	05000373	0.2	1.7E-04	n/a	2.8E-06	seismic PRA	GI-199
Limerick 1	05000374	0.15	1.8E-04	n/a	2.8E-06	seismic PRA	GI-199
Limerick 2	05000352	0.15	1.8E-04	0.15	5.3E-05	reduced-scope EPRI SMA	GI-199
McGuire 1	05000353	0.15	9.5E-05	0.15	5.3E-05	reduced-scope EPRI SMA	GI-199
McGuire 2	05000369	0.15	9.5E-05	n/a	3.1E-05	seismic PRA	GI-199
Millstone 1	05000370	0.254	9.3E-05	n/a	3.1E-05	seismic PRA	GI-199
Millstone 2	05000336	0.17	8.3E-05	0.25	1.1E-05	0.3g focused-scope EPRI SMA	GI-199
Millstone 3	05000423	0.17	8.3E-05	n/a	1.5E-05	seismic PRA	GI-199
Monticello	05000263	0.12	9.3E-05	0.12	1.9E-05	modified focused/expended reduced-scope EPRI SI	GI-199
Nine Mile Point 1	05000220	0.11	1.5E-04	0.27	4.2E-06	0.3g focused-scope EPRI SMA	GI-199
Nine Mile Point 2	05000410	0.15	4.8E-05	0.23	5.6E-06	SPRA and focused-scope EPRI SMA	GI-199
North Anna 1	05000338	0.12	2.1E-04	0.16	4.4E-05	0.3g focused-scope EPRI SMA	GI-199
North Anna 2	05000339	0.12	2.1E-04	0.16	4.4E-05	0.3g focused-scope EPRI SMA	GI-199
Oconee 1	05000269	0.1	9.7E-04	n/a	4.3E-05	seismic PRA	GI-199
Oconee 2	05000270	0.1	9.7E-04	n/a	4.3E-05	seismic PRA	GI-199
Oconee 3	05000287	0.1	9.7E-04	n/a	4.3E-05	seismic PRA	GI-199
Oyster Creek	05000219	0.17	1.5E-04	n/a	1.4E-05	seismic PRA	GI-199
Palisades	05000255	0.2	1.4E-04	n/a	6.4E-06	seismic PRA	GI-199
Palo Verde 1	05000528	0.258	3.5E-05	0.3	3.8E-05	0.3g full-scope EPRI SMA	IPEEE
Palo Verde 2	05000529	0.258	3.5E-05	0.3	3.8E-05	0.3g full-scope EPRI SMA	IPEEE
Palo Verde 3	05000530	0.258	3.5E-05	0.3	3.8E-05	0.3g full-scope EPRI SMA	IPEEE
Peach Bottom 2	05000277	0.12	2.0E-04	0.2	2.4E-05	modified focused-scope EPRI SMA	GI-199
Peach Bottom 3	05000278	0.12	2.0E-04	0.2	2.4E-05	modified focused-scope EPRI SMA	GI-199
Perry	05000440	0.15	2.2E-04	0.3	2.1E-05	0.3g focused-scope EPRI SMA	GI-199
Pilgrim 1	05000293	0.15	8.1E-04	n/a	6.9E-05	seismic PRA	GI-199
Point Beach 1	05000266	0.12	2.0E-04	n/a	1.1E-05	seismic PRA	GI-199
Point Beach 2	05000301	0.12	2.0E-04	n/a	1.1E-05	seismic PRA	GI-199
Prairie Island 1	05000282	0.12	2.0E-04	0.28	3.0E-06	0.3g focused-scope EPRI SMA	GI-199
Prairie Island 2	05000306	0.12	2.0E-04	0.28	3.0E-06	0.3g focused-scope EPRI SMA	GI-199
Quad Cities 1	05000254	0.24	8.2E-04	0.09	2.7E-05	0.3g focused-scope EPRI SMA	GI-199
Quad Cities 2	05000265	0.24	8.2E-04	0.09	2.7E-05	0.3g focused-scope EPRI SMA	GI-199
River Bend	05000458	0.1	2.4E-04	0.1	2.5E-05	reduced-scope EPRI SMA; SSE = 0.1g	GI-199
Robinson (HR)	05000261	0.2	1.1E-03	0.28	1.5E-05	0.3g full-scope EPRI SMA	GI-199
Saint Lucie	05000335	0.1	1.4E-04	0.1	4.6E-05	reduced-scope EPRI SMA; SSE = 0.1g	GI-199
Salem 1	05000389	0.2	2.6E-04	0.1	4.6E-05	reduced-scope EPRI SMA; SSE = 0.1g	GI-199
Salem 2	05000272	0.2	2.6E-04	n/a	9.3E-06	seismic PRA	GI-199
San Onofre 2	05000361	0.67	1.2E-04	n/a	1.7E-05	seismic PRA	IPEEE

San Onofre 3	05000362	0.67	1.2E-04	n/a	1.7E-05	seismic PRA	IPEEE
Seabrook	05000311	0.25	1.3E-04	n/a	9.3E-06	seismic PRA	GI-199
Sequoyah 1	05000443	0.18	7.1E-04	n/a	2.2E-05	seismic PRA	GI-199
Sequoyah 2	05000327	0.18	7.1E-04	0.27	5.1E-05	0.3g full-scope EPRI SMA	GI-199
Shearon Harris 1	05000328	0.15	4.6E-05	0.27	5.1E-05	0.3g full-scope EPRI SMA	GI-199
South Texas 1	05000498	0.1	3.0E-05	n/a	6.2E-06	seismic PRA	GI-199
South Texas 2	05000499	0.1	3.0E-05	n/a	6.2E-06	seismic PRA	GI-199
Summer	05000395	0.15	3.9E-04	0.22	3.8E-05	0.3g focused-scope EPRI SMA	GI-199
Surry 1	05000280	0.15	2.2E-04	n/a	5.7E-06	seismic PRA	GI-199
Surry 2	05000281	0.15	2.2E-04	n/a	5.7E-06	seismic PRA	GI-199
Susquehanna 1	05000387	0.1	1.9E-04	0.21	1.3E-05	0.3g focused-scope EPRI SMA	GI-199
Susquehanna 2	05000388	0.1	1.9E-04	0.21	1.3E-05	0.3g focused-scope EPRI SMA	GI-199
Three Mile Island 1	05000289	0.12	1.0E-04	n/a	4.0E-05	seismic PRA	GI-199
Turkey Point 3	05000250	0.15	3.8E-05	0.15	1.0E-05	site-specific approach; SSE=0.15g	GI-199
Turkey Point 4	05000251	0.15	3.8E-05	0.15	1.0E-05	site-specific approach; SSE=0.15g	GI-199
Vermont Yankee	05000271	0.14	1.2E-04	0.25	8.1E-06	0.3g focused-scope EPRI SMA	GI-199
Vogtle 1	05000424	0.2	1.5E-04	0.3	1.8E-05	0.3g focused-scope EPRI SMA	GI-199
Vogtle 2	05000425	0.2	1.5E-04	0.3	1.8E-05	0.3g focused-scope EPRI SMA	GI-199
Waterford 3	05000382	0.1	1.1E-04	0.1	2.0E-05	reduced-scope EPRI SMA; SSE = 0.1g	GI-199
Watts Bar	05000390	0.18	2.9E-04	0.3	3.6E-05	0.3g focused-scope EPRI SMA	GI-199
Wolf Creek	05000482	0.12	3.7E-05	0.2	1.8E-05	reduced-scope EPRI SMA	GI-199
	25th percentile		9.6E-05		6.0E-06		
	min		1.6E-05		2.0E-06		
	median		1.7E-04		1.5E-05		
	mean		3.1E-04		2.1E-05		
	max		3.9E-03		1.0E-04		
	75th percentile		2.6E-04		3.2E-05		

Stutzke, Martin

From: Stutzke, Martin NRC/RES/DRA
Sent: Tuesday, March 15, 2011 3:24 PM
To: Manoly, Kamal
Cc: Burnell, Scott
Subject: RE: NBC deadline question for NRC on seismic hazard estimates
Attachments: SSE Exceed and SCDF.xlsx

Here's a spreadsheet that I developed earlier today for Joe Giitter and Pat Hiland that shows the SCDFs and frequencies of exceeding the SSE for all plants.

Marty

From: Manoly, Kamal
Sent: Tuesday, March 15, 2011 3:22 PM
To: Stutzke, Martin
Cc: Burnell, Scott
Subject: RE: NBC deadline question for NRC on seismic hazard estimates

Are the numbers handy to you for response to Scott?

From: Stutzke, Martin
Sent: Tuesday, March 15, 2011 3:21 PM
To: Manoly, Kamal
Subject: RE: NBC deadline question for NRC on seismic hazard estimates

They both did seismic PRAs.

From: Manoly, Kamal
Sent: Tuesday, March 15, 2011 3:20 PM
To: Stutzke, Martin; Ake, Jon; Ferrante, Fernando
Subject: FW: NBC deadline question for NRC on seismic hazard estimates

Do you guys know whether Diablo and San Onofre did seismic PRA or seismic margin?

From: Burnell, Scott
Sent: Tuesday, March 15, 2011 3:16 PM
To: Beasley, Benjamin; Wilson, George; Manoly, Kamal
Subject: RE: NBC deadline question for NRC on seismic hazard estimates

Quick follow-up: Any easy way to provide access to the IPEEE seismic CDF numbers for Diablo Canyon, San Onofre, etc?

From: Couret, Ivonne
Sent: Tuesday, March 15, 2011 2:12 PM
To: Burnell, Scott
Cc: Beasley, Benjamin
Subject: FW: NBC deadline question for NRC on seismic hazard estimates

Scott Burnell will respond to the reporter. Thanks to everyone for providing information on this matter. Scott will call you Ben for clarifications. Ivonne

XX/8

From: Beasley, Benjamin
Sent: Tuesday, March 15, 2011 12:52 PM
To: Couret, Ivonne
Cc: Wilson, George; Manoly, Kamal; Ake, Jon; Stutzke, Martin; Kammerer, Annie; Murphy, Andrew; Munson, Clifford; Kauffman, John
Subject: RE: NBC deadline question for NRC on seismic hazard estimates

Ivonne,

Answers are provided in the attached Word document. I will be in a low priority meeting for the next couple of hours. If you want us to support a telephone interview, please call me at 301-873-3070.

Ben

From: Couret, Ivonne
Sent: Tuesday, March 15, 2011 11:31 AM
To: Beasley, Benjamin
Cc: Wilson, George
Subject: RE: NBC deadline question for NRC on seismic hazard estimates

I just spoke to the reporter if we can give him written responses and coordinate a phone interview/review of items. When you guys are ready we can do this before 5p.m. Thanks for ALL you do! Ivonne

---

From: Beasley, Benjamin
Sent: Tuesday, March 15, 2011 11:29 AM
To: Couret, Ivonne
Cc: Wilson, George
Subject: FW: NBC deadline question for NRC on seismic hazard estimates
Importance: High

Ivonne,

I am coordinating the assembly of answers for the NBC reporter on GI-199. We are still working, but draft answers are:

1. His plain language understanding of the risk is correct.

2. The latest seismic hazard estimates for western U.S. nuclear plants are in the IPEEEs. Following 9-11, these documents are no longer publicly available. There are updated USGS seismic estimates for the entire U.S., but these have not been applied to the western plants.

3. The consensus hazard estimates are not out yet. We expect them by the end of the year.

4. The NRC is working on developing a Generic Letter (GL) to request information from affected licensees. The GL will likely be issued in a draft form within the next 2 months to stimulate discussions with industry in a public meeting. After that it has to be approved by CRGR, presented to ACRS and issued as a draft for formal public comments (45 days). After evaluation of the public comments it can then be finalized for issuance. We anticipate to issue the GL by the end of this calendar year. The information from licensees will likely require 3-6 months to complete. Staff's review will commence after receiving licensees' responses. Based on staff's review, a determination can be made regarding cost beneficial backfits where it can be justified.

I will send an update after I get final information. Please let me know if there is something else we can do.

Ben Beasley

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment
Benjamin Beasley, Chief
Operating Experience and Generic Issues Branch
Division of Risk Analysis
Office of Nuclear Regulatory Research
301-251-7676
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Generic Issues Program
Operating Experience Databases

From: Wilson, George
Sent: Tuesday, March 15, 2011 9:31 AM
To: Beasley, Benjamin
Subject: FW: NBC deadline question for NRC on seismic hazard estimates
Importance: High

fyi

From: Hiland, Patrick
Sent: Tuesday, March 15, 2011 9:20 AM
To: Wilson, George; Manoly, Kamal
Cc: Stutzke, Martin; Ake, Jon; Coe, Doug; Skeen, David; Scales, Kerby
Subject: FW: NBC deadline question for NRC on seismic hazard estimates
Importance: High

Need to work with OPA, and RES. Kamal should coordinate with RES, and I suggest Marty/Jon respond directly through RES. Doug Coe is good source also for the GI. Get OPA involved.

From: Bill Dedman [mailto:Bill.Dedman@msnbc.com]
Sent: Tuesday, March 15, 2011 9:06 AM
To: Manoly, Kamal; Sheron, Brian; Hiland, Patrick; OPA Resource
Subject: NBC deadline question for NRC on seismic hazard estimates

Good morning,

My name is Bill Dedman. I'm a reporter for NBC News and msnbc.com, writing an article today about:

SAFETY/RISK ASSESSMENT RESULTS FOR GENERIC ISSUE 199, "IMPLICATIONS OF UPDATED PROBABILISTIC SEISMIC HAZARD ESTIMATES IN CENTRAL AND EASTERN UNITED STATES ON EXISTING PLANTS"

I reached out to NRC Public Affairs yesterday but have not heard back, and my deadline is end-of-day today. I'm hoping to get on the phone today with someone from NRC to make sure I'm conveying this information accurately to the public. If nothing else, I'm hoping one of the technical people can help clarify the points below. My telephone number is 203-451-9995.

I've read Director Brian Sheron's memo of Sept. 2, 2010, to Mr. Patrick Hiland; the safety/risk assessment of August 2010; its appendices A through D; NRC Information Notice 2010-18; and the fact sheet from public affairs from November 2010.

I have these questions:

1. I'd like to make sure that I accurately place in layman's terms the seismic hazard estimates. I need to make sure that I'm understanding the nomenclature for expressing the seismic core-damage frequencies. Let's say there's an estimate expressed as "2.5E-06." (I'm looking at Table D-2 of the safety/risk assessment of August 2010.) I believe that this expression means the same as 2.5 x 10^-06, or 0.0000025, or 2.5 divided by one million. In layman's terms, that means an expectation, on average, of 2.5 events every million years, or once every 400,000 years. Similarly, "2.5E-05" would be 2.5 divided by 100,000, or 2.5 events every 100,000 years, on average, or once every 40,000 years. Is this correct?

2. These documents give updated probabilistic seismic hazard estimates for existing nuclear power plants in the Central and Eastern U.S. What document has the latest seismic hazard estimates (probabilistic or not) for existing nuclear power plants in the Western U.S.?

3. The documents refer to newer data on the way. Have NRC, USGS et al. released those? I'm referring to this: "New consensus seismic-hazard estimates will become available in late 2010 or early 2011 (these are a product of a joint NRC, U.S. Department of Energy, U.S. Geological Survey (USGS) and Electric Power Research Institute (EPRI) project). These consensus seismic hazard estimates will supersede the existing EPRI, Lawrence Livermore National Laboratory, and USGS hazard estimates used in the GI-199 Safety/Risk Assessment."

4. What is the timetable now for consideration of any regulatory changes from this research?

Thank you for your help.

Regards,

Bill Dedman

SEISMIC INFORMATION: SSE, SSE EXCEEDANCE FREQUENCIES, REVIEW-LEVEL EARTHQUAKES, ANDSEISMIC CORE-DAMAGE FREQUENCIES

Plant	Docket	SSE (g's)	Frequency of Exceeding the SSE (per year)	RLE (HCLPF) (g's)	Seismic Core Damage Frequency (per year)	IPEEE Method	Source
Arkansas 1	05000313	0.2	2.8E-04	0.3	4.1E-06	0.3g full-scope EPRI SMA	GI-199
Arkansas 2	05000368	0.2	9.7E-05	0.3	4.1E-06	0.3g focused-scope EPRI SMA	GI-199
Beaver Valley 1	05000334	0.12	3.3E-04	n/a	4.8E-05	seismic PRA	GI-199
Beaver Valley 2	05000412	0.12	2.7E-04	n/a	2.2E-05	seismic PRA	GI-199
Braidwood 1	05000456	0.2	6.7E-05	0.3	7.3E-06	0.3g focused-scope EPRI SMA	GI-199
Braidwood 2	05000457	0.2	6.7E-05	0.3	7.3E-06	0.3g focused-scope EPRI SMA	GI-199
Browns Ferry 1	05000259	0.2	2.5E-04	0.3	3.7E-06	0.3g focused-scope EPRI SMA	GI-199
Browns Ferry 2	05000260	0.2	2.5E-04	0.26	5.4E-06	0.3g focused-scope EPRI SMA	GI-199
Browns Ferry 3	05000296	0.2	2.5E-04	0.26	5.4E-06	0.3g focused-scope EPRI SMA	GI-199
Brunswick 1	05000325	0.16	7.3E-04	0.3	1.5E-05	0.3g focused-scope EPRI SMA	GI-199
Brunswick 2	05000324	0.16	7.3E-04	0.3	1.5E-05	0.3g focused-scope EPRI SMA	GI-199
Byron 1	05000454	0.2	5.2E-05	0.3	5.8E-06	0.3g focused-scope EPRI SMA	GI-199
Byron 2	05000455	0.2	5.2E-05	0.3	5.8E-06	0.3g focused-scope EPRI SMA	GI-199
Callaway	05000483	0.2	3.8E-05	0.3	2.0E-06	0.3g focused-scope EPRI SMA	GI-199
Calvert Cliffs 1	05000317	0.15	1.9E-04	n/a	1.0E-05	seismic PRA	GI-199
Calvert Cliffs 2	05000318	0.15	1.9E-04	n/a	1.2E-05	seismic PRA	GI-199
Catawba 1	05000413	0.15	1.4E-04	n/a	3.7E-05	seismic PRA	GI-199
Catawba 2	05000414	0.15	1.4E-04	n/a	3.7E-05	seismic PRA	GI-199
Clinton	05000461	0.25	5.8E-05	0.3	2.5E-06	0.3g focused-scope EPRI SMA	GI-199
Columbia	05000397	0.25	1.7E-04	n/a	2.1E-05	seismic PRA	IPEEE
Comanche Peak 1	05000445	0.12	1.6E-05	0.12	4.0E-06	reduced-scope EPRI SMA; SSE = 0.12g	GI-199
Comanche Peak 2	05000446	0.12	1.6E-05	0.12	4.0E-06	reduced-scope EPRI SMA; SSE = 0.12g	GI-199
Cooper	05000298	0.2	1.5E-04	0.3	7.0E-06	0.3g focused-scope EPRI SMA	GI-199
Crystal River 3	05000302	0.1	8.9E-05	0.1	2.2E-05	reduced-scope EPRI SMA; SSE = 0.1g	GI-199
D.C. Cook 1	05000315	0.2	2.1E-04	n/a	2.2E-05	seismic PRA	GI-199
D.C. Cook 2	05000316	0.2	2.1E-04	n/a	2.2E-05	seismic PRA	GI-199
Davis Besse	05000346	0.15	6.3E-05	0.26	6.7E-06	reduced-scope EPRI SMA	GI-199
Diablo Canyon 1	05000275	0.75	3.9E-03	n/a	4.2E-05	seismic PRA	IPEEE
Diablo Canyon 2	05000323	0.75	3.9E-03	n/a	4.2E-05	seismic PRA	IPEEE
Dresden 2	05000237	0.2	9.7E-05	0.26	1.9E-05	0.3g focused-scope EPRI SMA	GI-199
Dresden 3	05000249	0.2	9.7E-05	0.26	1.9E-05	0.3g focused-scope EPRI SMA	GI-199
Duane Arnold	05000331	0.12	2.3E-04	0.12	3.2E-05	reduced-scope EPRI SMA; SSE = 0.12g	GI-199
Farley 1	05000348	0.1	1.0E-04	0.1	2.8E-05	reduced-scope EPRI SMA; SSE = 0.1g	GI-199
Farley 2	05000364	0.1	1.0E-04	0.1	2.8E-05	reduced-scope EPRI SMA; SSE = 0.1g	GI-199
Fermi 2	05000341	0.15	1.0E-04	0.3	4.2E-06	0.3g focused-scope EPRI SMA	GI-199
Fitzpatrick	05000333	0.15	3.2E-04	0.22	6.1E-06	0.3g focused-scope NRC SMA	GI-199
Fort Calhoun 1	05000285	0.17	3.7E-04	0.25	5.4E-06	0.3g focused-scope NRC SMA	GI-199
Ginna	05000244	0.2	1.0E-04	0.2	1.3E-05	0.3g focused-scope EPRI SMA	GI-199
Grand Gulf	05000416	0.15	1.0E-04	0.15	1.2E-05	reduced-scope EPRI SMA; SSE = 0.15g	GI-199

Hatch 1	05000400	0.148	3.9E-04	0.29	2.3E-06	0.3g focused-scope EPRI SMA	GI-199
Hatch 2	05000321	0.15	2.7E-04	0.3	2.5E-06	0.3g focused-scope EPRI SMA	GI-199
Hope Creek	05000366	0.2	9.7E-05	0.3	2.5E-06	0.3g focused-scope EPRI SMA	GI-199
Indian Point 2	05000354	0.15	4.9E-04	n/a	2.8E-06	seismic PRA	GI-199
Indian Point 3	05000247	0.15	4.9E-04	n/a	3.3E-05	seismic PRA	GI-199
Kewaunee	05000286	0.12	2.8E-04	n/a	1.0E-04	seismic PRA	GI-199
LaSalle 1	05000305	0.2	1.7E-04	n/a	5.1E-06	seismic PRA	GI-199
LaSalle 2	05000373	0.2	1.7E-04	n/a	2.8E-06	seismic PRA	GI-199
Limerick 1	05000374	0.15	1.8E-04	n/a	2.8E-06	seismic PRA	GI-199
Limerick 2	05000352	0.15	1.8E-04	0.15	5.3E-05	reduced-scope EPRI SMA	GI-199
McGuire 1	05000353	0.15	9.5E-05	0.15	5.3E-05	reduced-scope EPRI SMA	GI-199
McGuire 2	05000369	0.15	9.5E-05	n/a	3.1E-05	seismic PRA	GI-199
Millstone 1	05000370	0.254	9.3E-05	n/a	3.1E-05	seismic PRA	GI-199
Millstone 2	05000336	0.17	8.3E-05	0.25	1.1E-05	0.3g focused-scope EPRI SMA	GI-199
Millstone 3	05000423	0.17	8.3E-05	n/a	1.5E-05	seismic PRA	GI-199
Monticello	05000263	0.12	9.3E-05	0.12	1.9E-05	modified focused/expended reduced-scope EPRI SI	GI-199
Nine Mile Point 1	05000220	0.11	1.5E-04	0.27	4.2E-06	0.3g focused-scope EPRI SMA	GI-199
Nine Mile Point 2	05000410	0.15	4.8E-05	0.23	5.6E-06	SPRA and focused-scope EPRI SMA	GI-199
North Anna 1	05000338	0.12	2.1E-04	0.16	4.4E-05	0.3g focused-scope EPRI SMA	GI-199
North Anna 2	05000339	0.12	2.1E-04	0.16	4.4E-05	0.3g focused-scope EPRI SMA	GI-199
Oconee 1	05000269	0.1	9.7E-04	n/a	4.3E-05	seismic PRA	GI-199
Oconee 2	05000270	0.1	9.7E-04	n/a	4.3E-05	seismic PRA	GI-199
Oconee 3	05000287	0.1	9.7E-04	n/a	4.3E-05	seismic PRA	GI-199
Oyster Creek	05000219	0.17	1.5E-04	n/a	1.4E-05	seismic PRA	GI-199
Palisades	05000255	0.2	1.4E-04	n/a	6.4E-06	seismic PRA	GI-199
Palo Verde 1	05000528	0.258	3.5E-05	0.3	3.8E-05	0.3g full-scope EPRI SMA	IPEEE
Palo Verde 2	05000529	0.258	3.5E-05	0.3	3.8E-05	0.3g full-scope EPRI SMA	IPEEE
Palo Verde 3	05000530	0.258	3.5E-05	0.3	3.8E-05	0.3g full-scope EPRI SMA	IPEEE
Peach Bottom 2	05000277	0.12	2.0E-04	0.2	2.4E-05	modified focused-scope EPRI SMA	GI-199
Peach Bottom 3	05000278	0.12	2.0E-04	0.2	2.4E-05	modified focused-scope EPRI SMA	GI-199
Perry	05000440	0.15	2.2E-04	0.3	2.1E-05	0.3g focused-scope EPRI SMA	GI-199
Pilgrim 1	05000293	0.15	8.1E-04	n/a	6.9E-05	seismic PRA	GI-199
Point Beach 1	05000266	0.12	2.0E-04	n/a	1.1E-05	seismic PRA	GI-199
Point Beach 2	05000301	0.12	2.0E-04	n/a	1.1E-05	seismic PRA	GI-199
Prairie Island 1	05000282	0.12	2.0E-04	0.28	3.0E-06	0.3g focused-scope EPRI SMA	GI-199
Prairie Island 2	05000306	0.12	2.0E-04	0.28	3.0E-06	0.3g focused-scope EPRI SMA	GI-199
Quad Cities 1	05000254	0.24	8.2E-04	0.09	2.7E-05	0.3g focused-scope EPRI SMA	GI-199
Quad Cities 2	05000265	0.24	8.2E-04	0.09	2.7E-05	0.3g focused-scope EPRI SMA	GI-199
River Bend	05000458	0.1	2.4E-04	0.1	2.5E-05	reduced-scope EPRI SMA; SSE = 0.1g	GI-199
Robinson (HR)	05000261	0.2	1.1E-03	0.28	1.5E-05	0.3g full-scope EPRI SMA	GI-199
Saint Lucie	05000335	0.1	1.4E-04	0.1	4.6E-05	reduced-scope EPRI SMA; SSE = 0.1g	GI-199
Salem 1	05000389	0.2	2.6E-04	0.1	4.6E-05	reduced-scope EPRI SMA; SSE = 0.1g	GI-199
Salem 2	05000272	0.2	2.6E-04	n/a	9.3E-06	seismic PRA	GI-199
San Onofre 2	05000361	0.67	1.2E-04	n/a	1.7E-05	seismic PRA	IPEEE

San Onofre 3	05000362	0.67	1.2E-04	n/a	1.7E-05	seismic PRA	IPEEE
Seabrook	05000311	0.25	1.3E-04	n/a	9.3E-06	seismic PRA	GI-199
Sequoyah 1	05000443	0.18	7.1E-04	n/a	2.2E-05	seismic PRA	GI-199
Sequoyah 2	05000327	0.18	7.1E-04	0.27	5.1E-05	0.3g full-scope EPRI SMA	GI-199
Shearon Harris 1	05000328	0.15	4.6E-05	0.27	5.1E-05	0.3g full-scope EPRI SMA	GI-199
South Texas 1	05000498	0.1	3.0E-05	n/a	6.2E-06	seismic PRA	GI-199
South Texas 2	05000499	0.1	3.0E-05	n/a	6.2E-06	seismic PRA	GI-199
Summer	05000395	0.15	3.9E-04	0.22	3.8E-05	0.3g focused-scope EPRI SMA	GI-199
Surry 1	05000280	0.15	2.2E-04	n/a	5.7E-06	seismic PRA	GI-199
Surry 2	05000281	0.15	2.2E-04	n/a	5.7E-06	seismic PRA	GI-199
Susquehanna 1	05000387	0.1	1.9E-04	0.21	1.3E-05	0.3g focused-scope EPRI SMA	GI-199
Susquehanna 2	05000388	0.1	1.9E-04	0.21	1.3E-05	0.3g focused-scope EPRI SMA	GI-199
Three Mile Island 1	05000289	0.12	1.0E-04	n/a	4.0E-05	seismic PRA	GI-199
Turkey Point 3	05000250	0.15	3.8E-05	0.15	1.0E-05	site-specific approach; SSE=0.15g	GI-199
Turkey Point 4	05000251	0.15	3.8E-05	0.15	1.0E-05	site-specific approach; SSE=0.15g	GI-199
Vermont Yankee	05000271	0.14	1.2E-04	0.25	8.1E-06	0.3g focused-scope EPRI SMA	GI-199
Vogtle 1	05000424	0.2	1.5E-04	0.3	1.8E-05	0.3g focused-scope EPRI SMA	GI-199
Vogtle 2	05000425	0.2	1.5E-04	0.3	1.8E-05	0.3g focused-scope EPRI SMA	GI-199
Waterford 3	05000382	0.1	1.1E-04	0.1	2.0E-05	reduced-scope EPRI SMA; SSE = 0.1g	GI-199
Watts Bar	05000390	0.18	2.9E-04	0.3	3.6E-05	0.3g focused-scope EPRI SMA	GI-199
Wolf Creek	05000482	0.12	3.7E-05	0.2	1.8E-05	reduced-scope EPRI SMA	GI-199
		25th percentile	9.6E-05		6.0E-06		
		min	1.6E-05		2.0E-06		
		median	1.7E-04		1.5E-05		
		mean	3.1E-04		2.1E-05		
		max	3.9E-03		1.0E-04		
		75th percentile	2.6E-04		3.2E-05		

Stutzke, Martin

From: Stutzke, Martin NRC/RES/DRA
Sent: Tuesday, March 15, 2011 3:20 PM
To: Beasley, Benjamin
Subject: RE: NBC deadline question for NRC on seismic hazard estimates
Attachments: SSE Exceed and SCDF.xlsx

Look in NUREG-1742, which in the Electronic Reading Room on the public website.

I've attached a spreadsheet that I developed for Joe Giitter and Pat Hiland early today, in preparation for the Congressional briefing to be held tomorrow.. The SCDF estimates for Columbia, Diablo Canyon, and San Onofre are the ones reported in NUREG-1742. I estimated the SCDF for Palo Verde using the GI-199 Safety/Risk Assessment method.

Marty

From: Beasley, Benjamin
Sent: Tuesday, March 15, 2011 3:17 PM
To: Stutzke, Martin
Subject: FW: NBC deadline question for NRC on seismic hazard estimates

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From: Burnell, Scott
Sent: Tuesday, March 15, 2011 3:16 PM
To: Beasley, Benjamin; Wilson, George; Manoly, Kamal
Subject: RE: NBC deadline question for NRC on seismic hazard estimates

Quick follow-up: Any easy way to provide access to the IPEEE seismic CDF numbers for Diablo Canyon, San Onofre, etc?

From: Couret, Ivonne
Sent: Tuesday, March 15, 2011 2:12 PM
To: Burnell, Scott
Cc: Beasley, Benjamin
Subject: FW: NBC deadline question for NRC on seismic hazard estimates

Scott Burnell will respond to the reporter. Thanks to everyone for providing information on this matter. Scott will call you Ben for clarifications. Ivonne

---

From: Beasley, Benjamin
Sent: Tuesday, March 15, 2011 12:52 PM
To: Couret, Ivonne
Cc: Wilson, George; Manoly, Kamal; Ake, Jon; Stutzke, Martin; Kammerer, Annie; Murphy, Andrew; Munson, Clifford; Kauffman, John
Subject: RE: NBC deadline question for NRC on seismic hazard estimates

Ivonne,

Answers are provided in the attached Word document. I will be in a low priority meeting for the next couple of hours. If you want us to support a telephone interview, please call me at 301-873-3070.

XX\9

Ben

From: Couret, Ivonne
Sent: Tuesday, March 15, 2011 11:31 AM
To: Beasley, Benjamin
Cc: Wilson, George
Subject: RE: NBC deadline question for NRC on seismic hazard estimates

I just spoke to the reporter if we can give him written responses and coordinate a phone interview/review of items. When you guys are ready we can do this before 5p.m. Thanks for ALL you do! Ivonne

---

From: Beasley, Benjamin
Sent: Tuesday, March 15, 2011 11:29 AM
To: Couret, Ivonne
Cc: Wilson, George
Subject: FW: NBC deadline question for NRC on seismic hazard estimates
Importance: High

Ivonne,

I am coordinating the assembly of answers for the NBC reporter on GI-199. We are still working, but draft answers are:

1. His plain language understanding of the risk is correct.

2. The latest seismic hazard estimates for western U.S. nuclear plants are in the IPEEEs. Following 9-11, these documents are no longer publicly available. There are updated USGS seismic estimates for the entire U.S., but these have not been applied to the western plants.

3. The consensus hazard estimates are not out yet. We expect them by the end of the year.

4. The NRC is working on developing a Generic Letter (GL) to request information from affected licensees. The GL will likely be issued in a draft form within the next 2 months to stimulate discussions with industry in a public meeting. After that it has to be approved by CRGR, presented to ACRS and issued as a draft for formal public comments (45 days). After evaluation of the public comments it can then be finalized for issuance. We anticipate to issue the GL by the end of this calendar year. The information from licensees will likely require 3-6 months to complete. Staff's review will commence after receiving licensees' responses. Based on staff's review, a determination can be made regarding cost beneficial backfits where it can be justified.

I will send an update after I get final information. Please let me know if there is something else we can do.

Ben Beasley

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment
Benjamin Beasley, Chief
Operating Experience and Generic Issues Branch
Division of Risk Analysis
Office of Nuclear Regulatory Research
301-251-7676
Benjamin.Beasley@nrc.gov
Generic Issues Program

Operating Experience Databases

From: Wilson, George
Sent: Tuesday, March 15, 2011 9:31 AM
To: Beasley, Benjamin
Subject: FW: NBC deadline question for NRC on seismic hazard estimates
Importance: High

fyi

From: Hiland, Patrick
Sent: Tuesday, March 15, 2011 9:20 AM
To: Wilson, George; Manoly, Kamal
Cc: Stutzke, Martin; Ake, Jon; Coe, Doug; Skeen, David; Scales, Kerby
Subject: FW: NBC deadline question for NRC on seismic hazard estimates
Importance: High

Need to work with OPA, and RES. Kamal should coordinate with RES, and I suggest Marty/Jon respond directly through RES. Doug Coe is good source also for the GI. Get OPA involved.

From: Bill Dedman [mailto:Bill.Dedman@msnbc.com]
Sent: Tuesday, March 15, 2011 9:06 AM
To: Manoly, Kamal; Sheron, Brian; Hiland, Patrick; OPA Resource
Subject: NBC deadline question for NRC on seismic hazard estimates

Good morning,

My name is Bill Dedman. I'm a reporter for NBC News and msnbc.com, writing an article today about:

SAFETY/RISK ASSESSMENT RESULTS FOR GENERIC ISSUE 199, "IMPLICATIONS OF UPDATED PROBABILISTIC SEISMIC HAZARD ESTIMATES IN CENTRAL AND EASTERN UNITED STATES ON EXISTING PLANTS"

I reached out to NRC Public Affairs yesterday but have not heard back, and my deadline is end-of-day today. I'm hoping to get on the phone today with someone from NRC to make sure I'm conveying this information accurately to the public. If nothing else, I'm hoping one of the technical people can help clarify the points below. My telephone number is 203-451-9995.

I've read Director Brian Sheron's memo of Sept. 2, 2010, to Mr. Patrick Hiland; the safety/risk assessment of August 2010; its appendices A through D; NRC Information Notice 2010-18; and the fact sheet from public affairs from November 2010.

I have these questions:

1. I'd like to make sure that I accurately place in layman's terms the seismic hazard estimates. I need to make sure that I'm understanding the nomenclature for expressing the seismic core-damage frequencies. Let's say there's an estimate expressed as "2.5E-06." (I'm looking at Table D-2 of the safety/risk assessment of August 2010.) I believe that this expression means the same as 2.5 x 10^-06, or 0.0000025, or 2.5 divided by one million. In layman's terms, that means an expectation, on average, of 2.5 events every million years, or once every 400,000 years. Similarly, "2.5E-05" would be 2.5 divided by 100,000, or 2.5 events every 100,000 years, on average, or once every 40,000 years. Is this correct?

2. These documents give updated probabilistic seismic hazard estimates for existing nuclear power plants in the Central and Eastern U.S. What document has the latest seismic hazard estimates (probabilistic or not) for existing nuclear power plants in the Western U.S.?

3. The documents refer to newer data on the way. Have NRC, USGS et al. released those? I'm referring to this: "New consensus seismic-hazard estimates will become available in late 2010 or early 2011 (these are a product of a joint NRC, U.S. Department of Energy, U.S. Geological Survey (USGS) and Electric Power Research Institute (EPRI) project). These consensus seismic hazard estimates will supersede the existing EPRI, Lawrence Livermore National Laboratory, and USGS hazard estimates used in the GI-199 Safety/Risk Assessment."

4. What is the timetable now for consideration of any regulatory changes from this research?

Thank you for your help.

Regards,

Bill Dedman

SEISMIC INFORMATION: SSE, SSE EXCEEDANCE FREQUENCIES, REVIEW-LEVEL EARTHQUAKES, ANDSEISMIC CORE-DAMAGE FREQUENCIES

Plant	Docket	SSE (g's)	Frequency of Exceeding the SSE (per year)	RLE (HCLPF) (g's)	Seismic Core Damage Frequency (per year)	IPEEE Method	Source
Arkansas 1	05000313	0.2	2.8E-04	0.3	4.1E-06	0.3g full-scope EPRI SMA	GI-199
Arkansas 2	05000368	0.2	9.7E-05	0.3	4.1E-06	0.3g focused-scope EPRI SMA	GI-199
Beaver Valley 1	05000334	0.12	3.3E-04	n/a	4.8E-05	seismic PRA	GI-199
Beaver Valley 2	05000412	0.12	2.7E-04	n/a	2.2E-05	seismic PRA	GI-199
Braidwood 1	05000456	0.2	6.7E-05	0.3	7.3E-06	0.3g focused-scope EPRI SMA	GI-199
Braidwood 2	05000457	0.2	6.7E-05	0.3	7.3E-06	0.3g focused-scope EPRI SMA	GI-199
Browns Ferry 1	05000259	0.2	2.5E-04	0.3	3.7E-06	0.3g focused-scope EPRI SMA	GI-199
Browns Ferry 2	05000260	0.2	2.5E-04	0.26	5.4E-06	0.3g focused-scope EPRI SMA	GI-199
Browns Ferry 3	05000296	0.2	2.5E-04	0.26	5.4E-06	0.3g focused-scope EPRI SMA	GI-199
Brunswick 1	05000325	0.16	7.3E-04	0.3	1.5E-05	0.3g focused-scope EPRI SMA	GI-199
Brunswick 2	05000324	0.16	7.3E-04	0.3	1.5E-05	0.3g focused-scope EPRI SMA	GI-199
Byron 1	05000454	0.2	5.2E-05	0.3	5.8E-06	0.3g focused-scope EPRI SMA	GI-199
Byron 2	05000455	0.2	5.2E-05	0.3	5.8E-06	0.3g focused-scope EPRI SMA	GI-199
Callaway	05000483	0.2	3.8E-05	0.3	2.0E-06	0.3g focused-scope EPRI SMA	GI-199
Calvert Cliffs 1	05000317	0.15	1.9E-04	n/a	1.0E-05	seismic PRA	GI-199
Calvert Cliffs 2	05000318	0.15	1.9E-04	n/a	1.2E-05	seismic PRA	GI-199
Catawba 1	05000413	0.15	1.4E-04	n/a	3.7E-05	seismic PRA	GI-199
Catawba 2	05000414	0.15	1.4E-04	n/a	3.7E-05	seismic PRA	GI-199
Clinton	05000461	0.25	5.8E-05	0.3	2.5E-06	0.3g focused-scope EPRI SMA	GI-199
Columbia	05000397	0.25	1.7E-04	n/a	2.1E-05	seismic PRA	IPEEE
Comanche Peak 1	05000445	0.12	1.6E-05	0.12	4.0E-06	reduced-scope EPRI SMA; SSE = 0.12g	GI-199
Comanche Peak 2	05000446	0.12	1.6E-05	0.12	4.0E-06	reduced-scope EPRI SMA; SSE = 0.12g	GI-199
Cooper	05000298	0.2	1.5E-04	0.3	7.0E-06	0.3g focused-scope EPRI SMA	GI-199
Crystal River 3	05000302	0.1	8.9E-05	0.1	2.2E-05	reduced-scope EPRI SMA; SSE = 0.1g	GI-199
D.C. Cook 1	05000315	0.2	2.1E-04	n/a	2.2E-05	seismic PRA	GI-199
D.C. Cook 2	05000316	0.2	2.1E-04	n/a	2.2E-05	seismic PRA	GI-199
Davis Besse	05000346	0.15	6.3E-05	0.26	6.7E-06	reduced-scope EPRI SMA	GI-199
Diablo Canyon 1	05000275	0.75	3.9E-03	n/a	4.2E-05	seismic PRA	IPEEE
Diablo Canyon 2	05000323	0.75	3.9E-03	n/a	4.2E-05	seismic PRA	IPEEE
Dresden 2	05000237	0.2	9.7E-05	0.26	1.9E-05	0.3g focused-scope EPRI SMA	GI-199
Dresden 3	05000249	0.2	9.7E-05	0.26	1.9E-05	0.3g focused-scope EPRI SMA	GI-199
Duane Arnold	05000331	0.12	2.3E-04	0.12	3.2E-05	reduced-scope EPRI SMA; SSE = 0.12g	GI-199
Farley 1	05000348	0.1	1.0E-04	0.1	2.8E-05	reduced-scope EPRI SMA; SSE = 0.1g	GI-199
Farley 2	05000364	0.1	1.0E-04	0.1	2.8E-05	reduced-scope EPRI SMA; SSE = 0.1g	GI-199
Fermi 2	05000341	0.15	1.0E-04	0.3	4.2E-06	0.3g focused-scope EPRI SMA	GI-199
Fitzpatrick	05000333	0.15	3.2E-04	0.22	6.1E-06	0.3g focused-scope NRC SMA	GI-199
Fort Calhoun 1	05000285	0.17	3.7E-04	0.25	5.4E-06	0.3g focused-scope NRC SMA	GI-199
Ginna	05000244	0.2	1.0E-04	0.2	1.3E-05	0.3g focused-scope EPRI SMA	GI-199
Grand Gulf	05000416	0.15	1.0E-04	0.15	1.2E-05	reduced-scope EPRI SMA; SSE = 0.15g	GI-199

Hatch 1	05000400	0.148	3.9E-04	0.29	2.3E-06	0.3g focused-scope EPRI SMA	GI-199
Hatch 2	05000321	0.15	2.7E-04	0.3	2.5E-06	0.3g focused-scope EPRI SMA	GI-199
Hope Creek	05000366	0.2	9.7E-05	0.3	2.5E-06	0.3g focused-scope EPRI SMA	GI-199
Indian Point 2	05000354	0.15	4.9E-04	n/a	2.8E-06	seismic PRA	GI-199
Indian Point 3	05000247	0.15	4.9E-04	n/a	3.3E-05	seismic PRA	GI-199
Kewaunee	05000286	0.12	2.8E-04	n/a	1.0E-04	seismic PRA	GI-199
LaSalle 1	05000305	0.2	1.7E-04	n/a	5.1E-06	seismic PRA	GI-199
LaSalle 2	05000373	0.2	1.7E-04	n/a	2.8E-06	seismic PRA	GI-199
Limerick 1	05000374	0.15	1.8E-04	n/a	2.8E-06	seismic PRA	GI-199
Limerick 2	05000352	0.15	1.8E-04	0.15	5.3E-05	reduced-scope EPRI SMA	GI-199
McGuire 1	05000353	0.15	9.5E-05	0.15	5.3E-05	reduced-scope EPRI SMA	GI-199
McGuire 2	05000369	0.15	9.5E-05	n/a	3.1E-05	seismic PRA	GI-199
Millstone 1	05000370	0.254	9.3E-05	n/a	3.1E-05	seismic PRA	GI-199
Millstone 2	05000336	0.17	8.3E-05	0.25	1.1E-05	0.3g focused-scope EPRI SMA	GI-199
Millstone 3	05000423	0.17	8.3E-05	n/a	1.5E-05	seismic PRA	GI-199
Monticello	05000263	0.12	9.3E-05	0.12	1.9E-05	modified focused/expended reduced-scope EPRI SI	GI-199
Nine Mile Point 1	05000220	0.11	1.5E-04	0.27	4.2E-06	0.3g focused-scope EPRI SMA	GI-199
Nine Mile Point 2	05000410	0.15	4.8E-05	0.23	5.6E-06	SPRA and focused-scope EPRI SMA	GI-199
North Anna 1	05000338	0.12	2.1E-04	0.16	4.4E-05	0.3g focused-scope EPRI SMA	GI-199
North Anna 2	05000339	0.12	2.1E-04	0.16	4.4E-05	0.3g focused-scope EPRI SMA	GI-199
Oconee 1	05000269	0.1	9.7E-04	n/a	4.3E-05	seismic PRA	GI-199
Oconee 2	05000270	0.1	9.7E-04	n/a	4.3E-05	seismic PRA	GI-199
Oconee 3	05000287	0.1	9.7E-04	n/a	4.3E-05	seismic PRA	GI-199
Oyster Creek	05000219	0.17	1.5E-04	n/a	1.4E-05	seismic PRA	GI-199
Palisades	05000255	0.2	1.4E-04	n/a	6.4E-06	seismic PRA	GI-199
Palo Verde 1	05000528	0.258	3.5E-05	0.3	3.8E-05	0.3g full-scope EPRI SMA	IPEEE
Palo Verde 2	05000529	0.258	3.5E-05	0.3	3.8E-05	0.3g full-scope EPRI SMA	IPEEE
Palo Verde 3	05000530	0.258	3.5E-05	0.3	3.8E-05	0.3g full-scope EPRI SMA	IPEEE
Peach Bottom 2	05000277	0.12	2.0E-04	0.2	2.4E-05	modified focused-scope EPRI SMA	GI-199
Peach Bottom 3	05000278	0.12	2.0E-04	0.2	2.4E-05	modified focused-scope EPRI SMA	GI-199
Perry	05000440	0.15	2.2E-04	0.3	2.1E-05	0.3g focused-scope EPRI SMA	GI-199
Pilgrim 1	05000293	0.15	8.1E-04	n/a	6.9E-05	seismic PRA	GI-199
Point Beach 1	05000266	0.12	2.0E-04	n/a	1.1E-05	seismic PRA	GI-199
Point Beach 2	05000301	0.12	2.0E-04	n/a	1.1E-05	seismic PRA	GI-199
Prairie Island 1	05000282	0.12	2.0E-04	0.28	3.0E-06	0.3g focused-scope EPRI SMA	GI-199
Prairie Island 2	05000306	0.12	2.0E-04	0.28	3.0E-06	0.3g focused-scope EPRI SMA	GI-199
Quad Cities 1	05000254	0.24	8.2E-04	0.09	2.7E-05	0.3g focused-scope EPRI SMA	GI-199
Quad Cities 2	05000265	0.24	8.2E-04	0.09	2.7E-05	0.3g focused-scope EPRI SMA	GI-199
River Bend	05000458	0.1	2.4E-04	0.1	2.5E-05	reduced-scope EPRI SMA; SSE = 0.1g	GI-199
Robinson (HR)	05000261	0.2	1.1E-03	0.28	1.5E-05	0.3g full-scope EPRI SMA	GI-199
Saint Lucie	05000335	0.1	1.4E-04	0.1	4.6E-05	reduced-scope EPRI SMA; SSE = 0.1g	GI-199
Salem 1	05000389	0.2	2.6E-04	0.1	4.6E-05	reduced-scope EPRI SMA; SSE = 0.1g	GI-199
Salem 2	05000272	0.2	2.6E-04	n/a	9.3E-06	seismic PRA	GI-199
San Onofre 2	05000361	0.67	1.2E-04	n/a	1.7E-05	seismic PRA	IPEEE

San Onofre 3	05000362	0.67	1.2E-04	n/a	1.7E-05	seismic PRA	IPEEE
Seabrook	05000311	0.25	1.3E-04	n/a	9.3E-06	seismic PRA	GI-199
Sequoyah 1	05000443	0.18	7.1E-04	n/a	2.2E-05	seismic PRA	GI-199
Sequoyah 2	05000327	0.18	7.1E-04	0.27	5.1E-05	0.3g full-scope EPRI SMA	GI-199
Shearon Harris 1	05000328	0.15	4.6E-05	0.27	5.1E-05	0.3g full-scope EPRI SMA	GI-199
South Texas 1	05000498	0.1	3.0E-05	n/a	6.2E-06	seismic PRA	GI-199
South Texas 2	05000499	0.1	3.0E-05	n/a	6.2E-06	seismic PRA	GI-199
Summer	05000395	0.15	3.9E-04	0.22	3.8E-05	0.3g focused-scope EPRI SMA	GI-199
Surry 1	05000280	0.15	2.2E-04	n/a	5.7E-06	seismic PRA	GI-199
Surry 2	05000281	0.15	2.2E-04	n/a	5.7E-06	seismic PRA	GI-199
Susquehanna 1	05000387	0.1	1.9E-04	0.21	1.3E-05	0.3g focused-scope EPRI SMA	GI-199
Susquehanna 2	05000388	0.1	1.9E-04	0.21	1.3E-05	0.3g focused-scope EPRI SMA	GI-199
Three Mile Island 1	05000289	0.12	1.0E-04	n/a	4.0E-05	seismic PRA	GI-199
Turkey Point 3	05000250	0.15	3.8E-05	0.15	1.0E-05	site-specific approach; SSE=0.15g	GI-199
Turkey Point 4	05000251	0.15	3.8E-05	0.15	1.0E-05	site-specific approach; SSE=0.15g	GI-199
Vermont Yankee	05000271	0.14	1.2E-04	0.25	8.1E-06	0.3g focused-scope EPRI SMA	GI-199
Vogtle 1	05000424	0.2	1.5E-04	0.3	1.8E-05	0.3g focused-scope EPRI SMA	GI-199
Vogtle 2	05000425	0.2	1.5E-04	0.3	1.8E-05	0.3g focused-scope EPRI SMA	GI-199
Waterford 3	05000382	0.1	1.1E-04	0.1	2.0E-05	reduced-scope EPRI SMA; SSE = 0.1g	GI-199
Watts Bar	05000390	0.18	2.9E-04	0.3	3.6E-05	0.3g focused-scope EPRI SMA	GI-199
Wolf Creek	05000482	0.12	3.7E-05	0.2	1.8E-05	reduced-scope EPRI SMA	GI-199

25th percentile	9.6E-05	6.0E-06
min	1.6E-05	2.0E-06
median	1.7E-04	1.5E-05
mean	3.1E-04	2.1E-05
max	3.9E-03	1.0E-04
75th percentile	2.6E-04	3.2E-05

From:	Flory, Shirley
To:	Case, Michael; Coe, Doug; Coyne, Kevin; Gibson, Kathy; Uhle, Jennifer; Richards, Stuart; Scott, Michael; Sheron, Brian; Valentin, Andrea
Subject:	NUCLEAR NEWS FLASHES
Date:	Tuesday, March 15, 2011 9:15:26 AM
Attachments:	nn110314.txt

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Nuclear News Flashes
Monday, Mar 14, 2011

[Inside This Issue:]

*** Fukushima I radiation levels 'significant': IRSN chairman

Agnes Buzyn, chairman of France's Institute of Radiological Protection and Nuclear Safety, IRSN, said radiation levels around Japan's Fukushima I site are "significant" but refused to quantify that term.

During a Paris press conference March 14, Buzyn and Andre-Claude Lacoste, chairman of France's Nuclear Safety Authority, said they could not provide any numbers indicating the radiation doses people near the Fukushima I might have received, because they did not know enough about the measurements involved. Buzyn said voluntary venting of radioactive gases from the nuclear units would lead to peaks of radiation that might not be representative of potential dose rates over a longer period.

Buzyn said IRSN had calculated the doses around the site independently using its own assumptions and that "the 20-kilometer zone [that Japanese authorities ordered evacuated] seems to us quite adequate in relation to the measurements" that Tepco and Japanese authorities have made public.

According to French criteria, the 20-km zone corresponds to projected doses of several tens of milliSieverts..

Workers attempting to keep the Fukushima I units cooled have no doubt received larger doses, Lacoste and Buzyn said, but could not quantify them.

Tokyo Electric Power Co., the plant operator, released data measured March 14 showing dose rates near the site perimeter of up to 10 mSv/h but varying widely by time and place.

The statutory limit of public dose for planning purposes is 1 mSv per year but that does not apply to accident conditions.

*** Fukushima I accident could worsen: French nuclear safety chief

The accident at Japan's Fukushima-I reactor site is already more severe than the 1979 Three Mile Island-2 accident in the US and could get worse, the chairman of France's Nuclear Safety Authority Andre-Claude Lacoste told a Paris press conference March 14.

Lacoste said there was "no doubt" that fuel had melted in the cores of Fukushima I-1 and -3, and that "[most probably], a core melt has begun at unit 2."

He said the degree of severity depended on how long operator Tokyo Electric Power Co. is able to maintain cooling of nuclear fuel at these units and others along Japan's east coast north of Tokyo. The area was hit by an extreme earthquake and tsunami March 11.

For the time being, he said, "it's not a nuclear catastrophe, but we cannot guarantee that it will not become a nuclear catastrophe."

Lacoste said events at Fukushima were of "unprecedented proportions" in that several nuclear power units were simultaneously facing a major accident risk and potentially up to 11 units could be at risk at Fukushima I and II, Onagawa and Tokai.

*** Onagawa, Tokai sites 'under control,' ASN says

The situation at the Onagawa and Tokai nuclear power sites appears less severe than at Tokyo Electric Power Co.'s Fukushima I and II sites, French nuclear safety officials said March 14, citing Japanese authorities and other sources of information.

Tohoku Electric Power Co. operates three BWRs at Onagawa; Japan Atomic Power Co. operates one BWR at Tokai. All are on Japan's Pacific coast, which was hit by an earthquake and a tsunami of unprecedented force March 11. Tokai is about 120 kilometers (about 75 miles) north of Tokyo. Tepco's Fukushima stations are about 50 km farther north and about 167 km south of Onagawa.

Thomas Houdre of safety agency ASN said at a press briefing in Paris that a site emergency had been declared at Onagawa when increased radiation levels were measured. But ASN said the radiation was confirmed as being due to releases from Fukushima I. "There doesn't seem to be any particular problem from a technical viewpoint" at Onagawa, he said. ASN, in a statement late March 14, quoted Japanese authorities as saying the three units were "under control."

At Tokai, ASN said, a seawater pump powered by a diesel generator was knocked out by the tsunami but a backup pump used to cool the reactor was operating normally, according to Japanese authorities. ASN said JAPC "is in control of the situation and the temperature in the reactor is decreasing steadily."

Houdre said that for the stations to remain safe, the operators must continue to have power and cooling water for each of the units over the long term.

*** U spot price tumbles $8/lb after Japanese nuclear events

The spot price of uranium tumbled March 14 to about $60 a pound U3O8, down roughly $8/lb from the March 11 price, as the continuing crisis at several Japanese nuclear reactors punctured the bullishness of many investors.

Many analysts suggested the spot price will likely continue to fall over the next few days, although some sources suggested several buyers are ready to step in to help stabilize the price near $60/lb.

The share prices of uranium-related companies also dropped, many by as much as 27% from their March 11 close.

Ux Consulting's broker average price, or BAP, was $59.83/lb March 14, down $8.25/lb from March 11. The BAP is a daily calculated midpoint of the bids and offers reported by three brokers â€" ICAP Energy, Evolution Markets and MF Global, according to UxC. TradeTech's new daily price March 14 was $60/lb, down $7.75/lb from its March 11 price.

*** Government requests safety review of Finnish reactors

The Finnish Radiation & Nuclear Authority, or STUK, will conduct a special safety review of Finnish nuclear units at the government's request, Minister of Economic Affairs Mauri Pekkarinen said in a statement March 14.

Pekkarinen said that he wants STUK to look at how well Finnish reactors are prepared to withstand severe floods. His statement followed the March 11 earthquake and tsunami that resulted in an accident at the Fukushima I site.

STUK should review emergency backup power systems at the Finnish reactors and their ability to continue operating during power failures, Pekkarinen said. He said he also wants information on designs being considered for two new nuclear reactors in Finland.

*** No spent fuel damage at Fukushima I-1 and -3, IAEA says

Hydrogen explosions at Tokyo Electric Power Co.'s Fukushima I-1 and -3 involved buildings housing the units' spent fuel pools, but an IAEA official said March 14 that, based on available information, the spent fuel pools were not damaged.

If the pools had been damaged, "a significant release of radiation would have been seen," said Denis Flory, deputy director general, head of the IAEA Department of Nuclear Safety and Security.

"We have received no information to that effect and so from that we infer that there is no damage to the spent fuel pools," Flory said at an IAEA press briefing in Vienna. He said the roofs had been blown off the buildings housing the spent fuel pools in the two explosions.

At the same briefing, James Lyons, IAEA division director of safety at nuclear installations, said the IAEA has "no indication" any fuel in the cores of Fukushima reactors has melted.

IAEA Director General Yukima Amano said the IAEA's information is coming from Tepco, via the Japanese national regulator, the Nuclear and Industrial Safety Agency.

Robert Alvarez, a senior scholar at the Institute for Policy Studies in Washington, said steam seen in satellite images of unit 3 could be from boiling coolant in the spent fuel pool, which was exposed by the blast. Alvarez spoke on a conference call March 14 sponsored by the anti-nuclear organization Friends of the Earth. If the capability to maintain water in the spent fuel pool is lost, radiation levels could rise and fuel could catch fire, he said.

*** No design or human errors issues seen yet at Fukushima, IAEA says

IAEA officials said there is no reason to believe at this stage that reactor design issues or human error played any role in the incidents unfolding at the Fukushima I nuclear power plant in Japan.

IAEA Director General Yukima Amano said March 14 that the combination of the massive earthquake that stuck Japan March 11 and the ensuing tsunami were "beyond imagination and experience."

At a press briefing in Vienna, he said the work following the events was to shut down the reactors at Fukushima I (also called Fukushima Daiichi), contain any radiation and cool the core. He said the reactors shut as expected, there was a small release of radiation and now efforts are focused on cooling the cores.

He praised the efforts of Japanese authorities and nuclear plant operators, noting many workers suffered their own personal tragedies.

"At this stage, I cannot speculate whether there was some human errors or not," Amano said.

Denis Flory, deputy director general, head of the Department of Nuclear Safety and Security at the IAEA, said there was no immediately apparent connection between the designs that have had problems following the earthquake and tsunami and those that have not.

"The design connection is that they're all on the east coast of Japan, which has had a huge catastrophe," he said. "Some reactors were shut down with no problems," he said. "Where there were problems, it was where there was no power for decay heat removal."

*** US nuclear utilities may face higher costs, more oversight: analysts

Credit rating agencies predicted higher costs and greater regulatory oversight for US nuclear plant operators following the earthquake, tsunami and nuclear reactor damage in Japan.

The accident in Japan does not have an immediate effect on credit ratings for US utilities, Standard and Poor's Ratings Services and Moody's Investors Services said in separate reports March 14. S&P, like Platts, is owned by The McGraw-Hill Companies.

Moody's Senior Vice President Jim Hempstead wrote, "For now, we assume near-term operating costs for US nuclear facilities are likely to rise, and the magnitude of the increase could be affected by the unfolding events in Japan."

Any additional costs imposed by new regulatory requirements could particularly squeeze merchant operators, S&P report authors Managing Director John Whitlock and directors Dimitri Nikas, Aneesh Prabhu and Todd Shipman said.

The events in Japan may add uncertainty to NRG's plan for two new units at the South Texas Project, because Tokyo Electric Power, which had planned to take a stake in those units, might now scale back its international investment plans, Moody's said.

The event also could erode public support for nuclear energy, especially in California, New York and the New England region, Barclays Capital analysts said in a report March 14. New units could be required to add more passive safety systems, and operators of coastal plants could be required to add additional backup power generating capacity, including mobile diesel generators, the Barclays analysts said.

*** US reactors operating safely, NRC chairman says

NRC Chairman Gregory Jaczko said March 14 that while his agency will look at what led to problems at Japan's Fukushima nuclear units, he is assured that US reactors are operating safely.

At a White House press conference, Jaczko said, "Right now, we continue to believe that nuclear power plants in this country operate safely and securely. So we believe we have a very solid and strong regulatory infrastructure in place right now. But of course, as we always do, as an independent regulatory agency, we will continue to ... take new information and see if there are changes that we need to make with our ... program."

Jaczko also said NRC sent two experts to Japan, with three others from DOE, to work with a US Agency for International Development-led team in Tokyo to assist the Japanese government. The agencies are also preparing to send more personnel, he said.

Jaczko said that there is a "low probability" of harmful radiation exposure in the US or its territories from the releases in Japan.

*** Southern remains committed to new Vogtle units

Southern Co. said in a March 14 statement it "remains committed to completing the new Vogtle units on schedule and on budget" but that it also is tracking developments in Japan and "working closely with our industry peers to monitor any potential impact here."

Southern, whose Georgia Power and Southern Nuclear Operating Co. subsidiaries are leading the development of two nuclear units at the Vogtle station in Georgia, said it "does not anticipate the events in Japan to impact the construction schedule or the company's ability to stay on budget."

It said that every US nuclear unit, including those at Southern's Farley, Hatch and Vogtle stations, was "designed, licensed and built to endure environmental hazards and disasters in meeting the NRC requirements."

NRG Energy spokesman David Knox said March 14 it is too soon to comment on the impact of the Japanese quake on US nuclear development.

Nuclear Innovation North America, an 88%-12% joint venture of NRG Energy and Tokyo-based Toshiba, respectively,
plans to add two nuclear units at the South Texas nuclear project. Tokyo Electric Power Co., which owns and operates the Fukushima Daiichi nuclear power plant affected by the earthquake, last May committed to buy up to a 499-MW stake in the South Texas nuclear expansion.

*** Nuclear will remain part of US energy policy: DOE official

The US will continue to make use of nuclear power as part of its energy policy going forward, despite the release of radiation from reactors at the Japanese Fukushima I nuclear power plant following a massive earthquake and tsunami, a senior US DOE official said March 14.

"We view nuclear energy as a very important component to the overall portfolio we are trying to build for our clean-energy future," said DOE Deputy Secretary Daniel Poneman. "But, be assured that we will take the safety of that as our paramount concern." Poneman made the comments during a White House news conference.

*** Reactor report

â€" Byron-1 was shut for a refueling and maintenance outage late March 13, Exelon spokesman Paul Dempsey said March 14. He did not say how long the outage would last. About a third of the reactor's 193 fuel assemblies will be replaced and around 10,000 maintenance activities â€" a number "a little higher than normal" â€" will be performed during the outage, he said.

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Lee, Richard

From: Salay, Michael
Sent: Wednesday, March 16, 2011 10:06 AM
To: Gauntt, Randall O; Humphries, Larry Laron
Cc: Lee, Richard; Esmaili, Hossein
Subject: Peach Bottom Deck

Importance: High

Randy, Larry,

We have received a request from GRS for the Peach Bottom deck. Richard mentioned that the SOARCA deck contains safeguards information so we cannot provide. Are there other Peach Bottom decks (e.g. that used MSIV) that do not contain safeguards information?

Please get back to me as soon as possible.

Randy – I just left a phone message with you to the same effect.

Thank you,
-Mike

Michael Salay
United States Nuclear Regulatory Commission
Washington, DC 20555
MS: C3-C07M
michael.salay@nrc.gov
tel: 301-251-7543
fax: 301-251-7436

Lee, Richard

From: Santiago, Patricia
Sent: Wednesday, March 16, 2011 12:37 PM
To: Chang, Richard; Armstrong, Kenneth
Subject: FW: MELCOR input deck for Germany
Attachments: image001.gif

FYI

From: Tinkler, Charles
Sent: Wednesday, March 16, 2011 12:35 PM
To: Gibson, Kathy; Santiago, Patricia; Uhle, Jennifer
Cc: Scott, Michael
Subject: RE: MELCOR input deck for Germany

Regarding requests from GRS

Martin Sonnenkalb at GRS is one of the foremost international MELCOR experts. (he runs MELCOR and is quite knowledgeable)

He already has the MELCOR code and I would be fairly sure he has MELCOR decks for each of the designs GRS has a direct interest in.

Why would he need a Peach Bottom input file? GRS has the capability with the MELCOR code to analyze their own plants.

From: Gibson, Kathy
Sent: Wednesday, March 16, 2011 8:37 AM
To: Santiago, Patricia; Tinkler, Charles; Lee, Richard
Cc: Scott, Michael
Subject: Re: MELCOR input deck for Germany
Importance: High

Hold on, is there someone who can do this besides Charlie? Someone in Richard's branch?

From: Santiago, Patricia
To: Tinkler, Charles
Cc: Gibson, Kathy; Scott, Michael
Sent: Wed Mar 16 08:33:11 2011
Subject: FW: MELCOR input deck for Germany

Morning Charlie,

Can you email Diane back with your contact information and cc management.

Thanks again Charlie!

From: Uhle, Jennifer
Sent: Wednesday, March 16, 2011 8:22 AM
To: Santiago, Patricia; Gibson, Kathy; Scott, Michael
Subject: Fw: MELCOR input deck for Germany

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We should be able to do this from our aircraft impact SFP work. Charlie knows. J

From: Diane.JACKSON@oecd.org <Diane.JACKSON@oecd.org>
To: Uhle, Jennifer
Sent: Wed Mar 16 08:18:04 2011
Subject: MELCOR input deck for Germany

Hello Jennifer –

How are you? I am sure overly busy with Japan, as many of us are. We have requests for information from all over in many forms.

As I am sure you know, the German government has ordered the shutdown of 7 of their plants that were built before 1980. GRS would like to run MELCOR on Mark 1 containments to fight back with some analysis.

Would NRC/RES be able to share an input deck for Mark 1 containment with GRS? Maybe someone from SOARCA branch could talk with someone in GRS?

If so, I can send along a NRC name and number or I can get my German colleague here to give me the GRS contact, so that NRC can contact GRS directly.

Diane Jackson, Nuclear Safety Specialist
Nuclear Safety Division, OECD Nuclear Energy Agency (NEA)
Tel.: +33 (0)1 45 24 10 55, Diane.Jackson@oecd.org

Update your bookmarks! On 1 December 2010, the NEA is moving to: www.oecd-nea.org

Lee, Richard

From: Chang, Richard
Sent: Wednesday, March 16, 2011 12:46 PM
To: mtl@dycoda.com
Cc: Lee, Richard; Salay, Michael; Randy Gauntt; Esmaili, Hossein; Santiago, Patricia
Subject: RE: Peach Bottom Deck
Attachments: FW: MELCOR input deck for Germany

All,

Charlie has sent a response to Kathy and Jennifer. Let's see if sending Draft Appendix A of SOARCA is sufficient for now. I will keep abreast of this.

Thanks,
Richard

From: M.T. Leonard [mailto:mtl@dycoda.com]
Sent: Wednesday, March 16, 2011 12:41 PM
To: Esmaili, Hossein
Cc: Lee, Richard; Salay, Michael; Randy Gauntt; Chang, Richard
Subject: Re: Peach Bottom Deck

Hossein --
There are versions of the BWR/4 Mark I model to choose from. Some for 1.8.5; others for 1.8.6. Richard Chang asked me about this earlier today. Perhaps a phone discussion about the options would help. Pls coordinate with Chang and Randy Gauntt.

Mark

Sent on the Now Network from my Sprint® BlackBerry

From: "Esmaili, Hossein" <Hossein.Esmaili@nrc.gov>
Date: Wed, 16 Mar 2011 12:27:06 -0400
To: mtl@dycoda.com<mtl@dycoda.com>
Cc: Lee, Richard<Richard.Lee@nrc.gov>; Salay, Michael<Michael.Salay@nrc.gov>
Subject: FW: Peach Bottom Deck

Hi Mark,

Richard asked me to contact you if you have any information about the item below since Larry does not know and Randy is not available now.

Thanks

hossein

From: Salay, Michael
Sent: Wednesday, March 16, 2011 10:06 AM
To: Gauntt, Randall O; Humphries, Larry Laron
Cc: Lee, Richard; Esmaili, Hossein

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Subject: Peach Bottom Deck
Importance: High

Randy, Larry,

We have received a request from GRS for the Peach Bottom deck. Richard mentioned that the SOARCA deck contains safeguards information so we cannot provide. Are there other Peach Bottom decks (e.g. that used MSIV) that do not contain safeguards information?

Please get back to me as soon as possible.

Randy – I just left a phone message with you to the same effect.

Thank you,
-Mike

Michael Salay
United States Nuclear Regulatory Commission
Washington, DC 20555
MS: C3-C07M
michael.salay@nrc.gov
tel: 301-251-7543
fax: 301-251-7436

Lee, Richard

From: Lee, Richard
Sent: Thursday, March 17, 2011 8:00 AM
To: RES_DSA_FSTB
Cc: Voglewede, John; Sudhamay Basu
Subject: FW: RES support for commission meeting on Monday 3/21.
Attachments: Assistance with Commission Brief

For your information.
Sud: We need to dig up the Mark -1 liner issue resolution stuff.

From: Gibson, Kathy
Sent: Wednesday, March 16, 2011 11:36 PM
To: Scott, Michael; Lee, Richard; Santiago, Patricia; Tinkler, Charles; Zigh, Ghani; Navarro, Carlos
Cc: Armstrong, Kenneth
Subject: Fw: RES support for commission meeting on Monday 3/21.

This is a heads up. You will likely be involved in preparing materials for this briefing.

Mike, would you please coordinate this effort and keep me informed? I will be on the night shift Saturday and Sunday night in the Ops Center, so I may or may not be available (I.e. Awake) for the briefing depending on what time the briefing is scheduled.

Thanks, all!

From: Dion, Jeanne
To: Coe, Doug; Gibson, Kathy; Coyne, Kevin; Case, Michael; Sheron, Brian; Uhle, Jennifer
Cc: Rini, Brett; Armstrong, Kenneth
Sent: Wed Mar 16 18:42:32 2011
Subject: RES support for commission meeting on Monday 3/21.

NRR has requested RES to support a commission briefing on Monday 3/21. They are looking for background information, slides, key messages, talking points and possible Q&A- see the attached message. This might be a public meeting- our input will need to be fairly high level. NRR will provide more information after the EDO alignment meeting tomorrow 3/17.

Bill Borchardt's presentation, "Overview of Japanese Event and US response"
- RES to provide slides/information on "Advancing our understanding of safety and risk" (more info to come)

Mike Weber's presentation, "Situation assessment for US reactors and applicants"
- RES to provide slides/information on "Consequence Projections in Japan and what we might expect to see in the US"

Marty Virgilio's presentation, "Situation assessment for US reactors and applicants."
-RES to assist NRR as requested.

I will be in a meeting tomorrow morning (8am to noon)- Kenneth Armstrong will attend the 8:45am meeting.

Thanks,

XX\14

Jeanne Dion
Technical Assistant (Acting)

U.S. Nuclear Regulatory Commission
Office of Nuclear Regulatory Research
Jeanne.dion@nrc.gov
301-251-7482

Lee, Richard

From: Lee, Richard
Sent: Thursday, March 17, 2011 8:13 AM
To: Rubin, Stuart; Boyd, Christopher; Aissa, Mourad; Algama, Don; Esmaili, Hossein; Flanagan, Michelle; Lee, Richard; Notafrancesco, Allen; Raynaud, Patrick; Salay, Michael; Scott, Harold; Wagner, Katie
Cc: Voglewede, John
Subject: FW: UPDATE from NEI and WNN
Attachments: 3-16-11-Fukishima.ppt; ATT00003..htm; TEPCO-SNF.pdf; ATT00004..htm

fyi

From: Michael Corradini [mailto:corradin@cae.wisc.edu]
Sent: Wednesday, March 16, 2011 7:04 PM
To: Lee, Richard; Basu, Sudhamay; Tinkler, Charles
Subject: UPDATE from NEI and WNN

HOW DID JACZKO KNOW THERE IS NO WATER?

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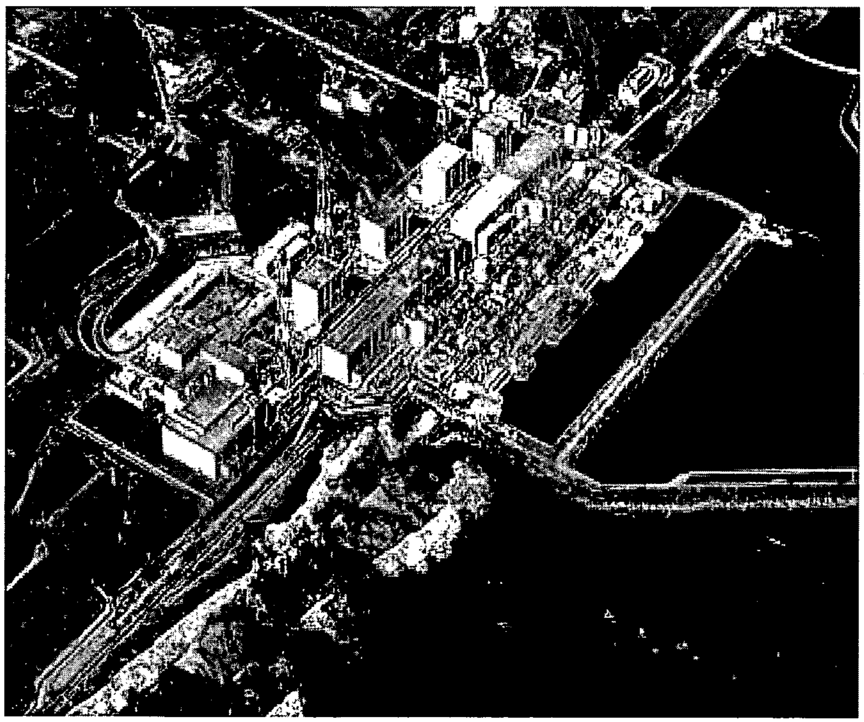
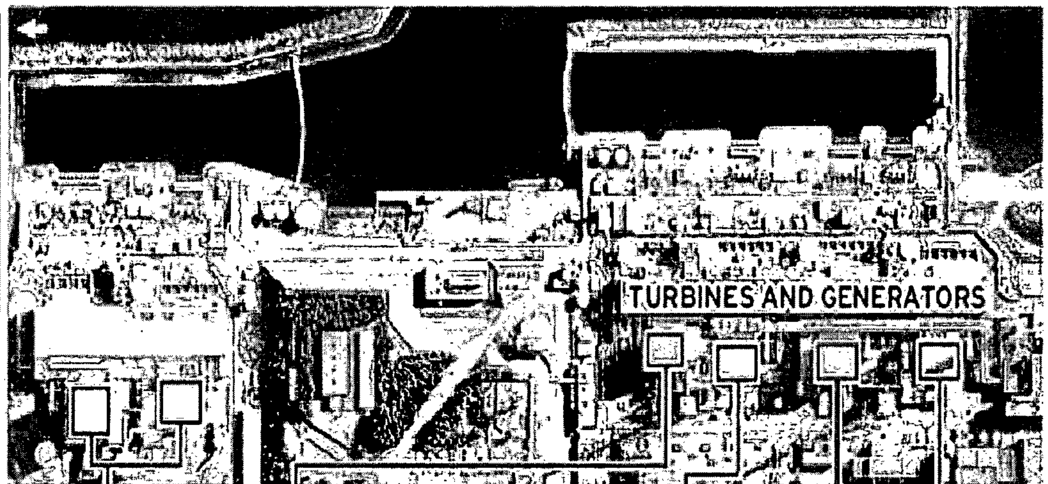
Fukushima Daiichi Nuclear Station

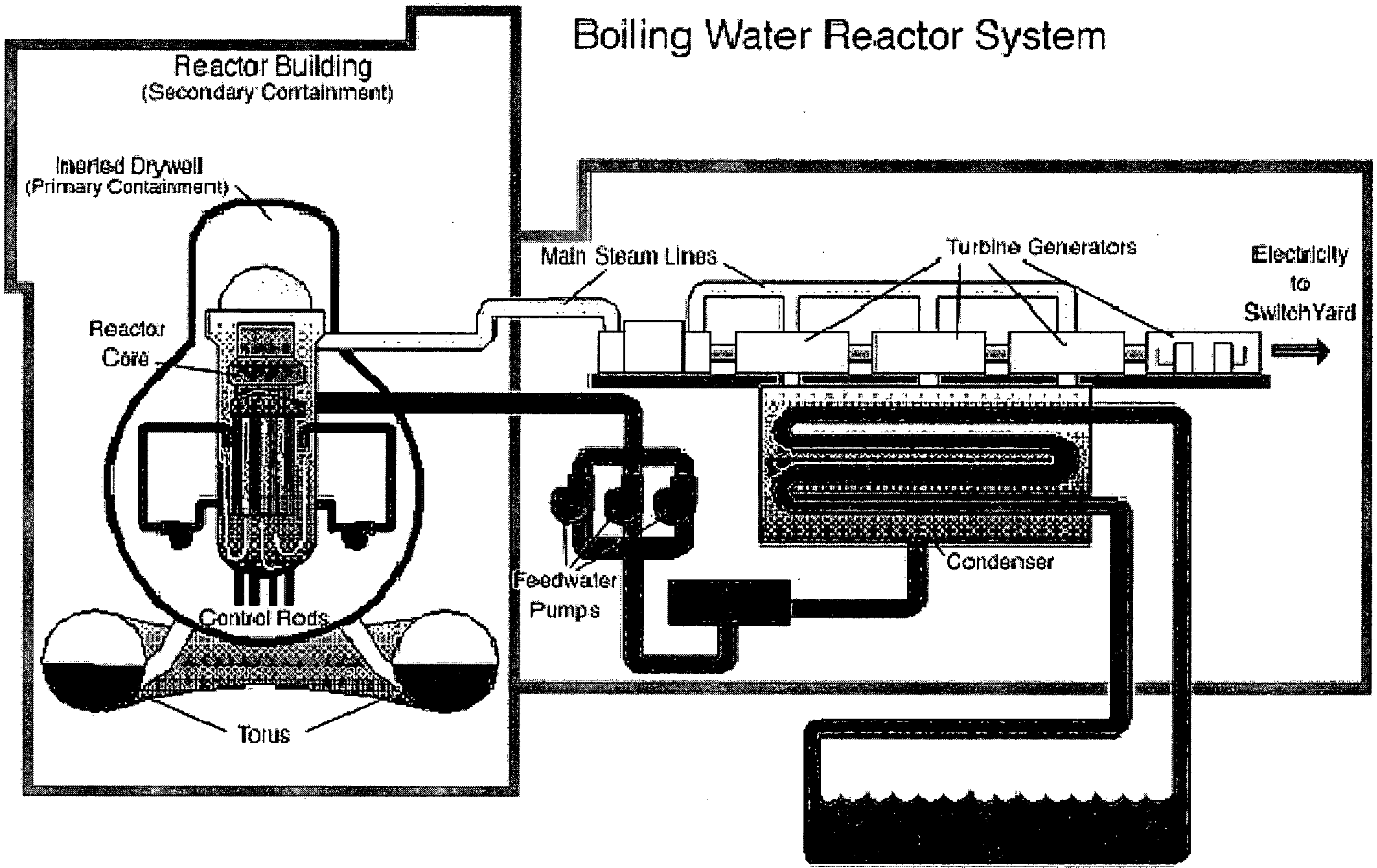
- Six BWR units at the Fukushima Nuclear Station:
  - Unit 1: 439 MWe BWR, 1971 (unit was in <u>operation</u> prior to event)
  - Unit 2: 760 MWe BWR, 1974 (unit was in <u>operation</u> prior to event)
  - Unit 3: 760 MWe BWR, 1976 (unit was in <u>operation</u> prior to event)
  - Unit 4: 760 MWe BWR, 1978 (unit was in <u>outage</u> prior to event)
  - Unit 5: 760 MWe BWR, 1978 (unit was in <u>outage</u> prior to event)
  - Unit 6: 1067 MWe BWR, 1979 (unit was in <u>outage</u> prior to event)





Fukushima Daiichi Unit 1

- Typical BWR 3 and 4 Reactor Design
- Some similarities to Duane Arnold Power Plant in Iowa



Fukushima Daiichi Unit 1

■Mechanism of Boiling Water Reactor Power Station

Primary Containment Vessel (Dry Well)

It would confine radioactive substances discharged from the reactor facilities if some pipes were broken by accident.

Reactor Pressure Vessel

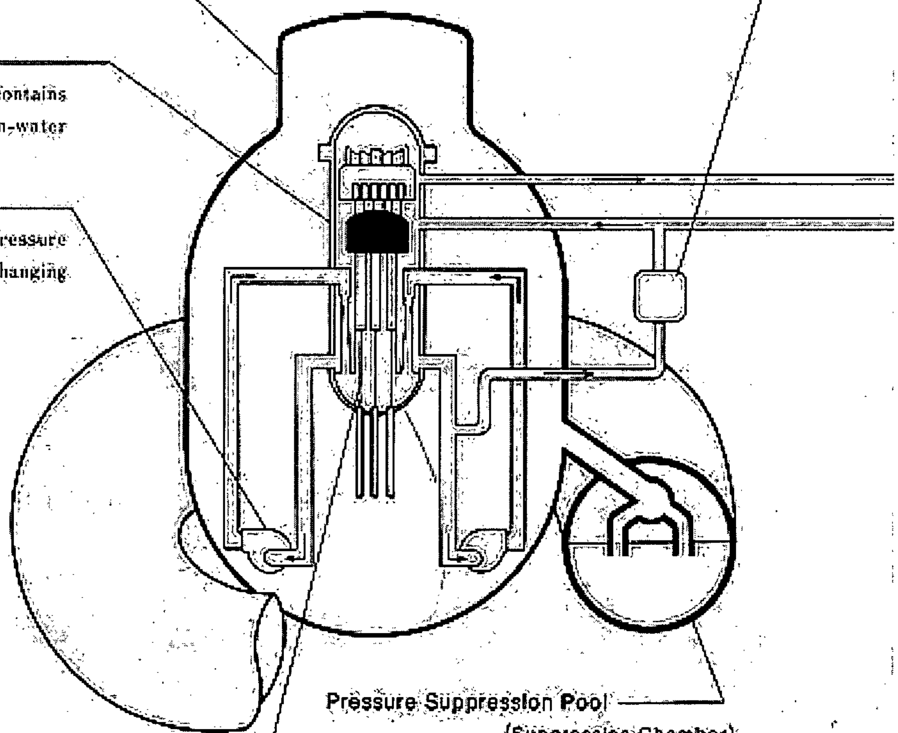
It is made of 12cm thick steel and contains fuel, control rods, jet pumps, steam-water separator and steam dryer.

Primary Recirculation pump

It circulates water in the reactor pressure vessel and changes reactor power by changing water quantity.

Cleanup Water System

It maintains the purity of the water circulating through the reactor.



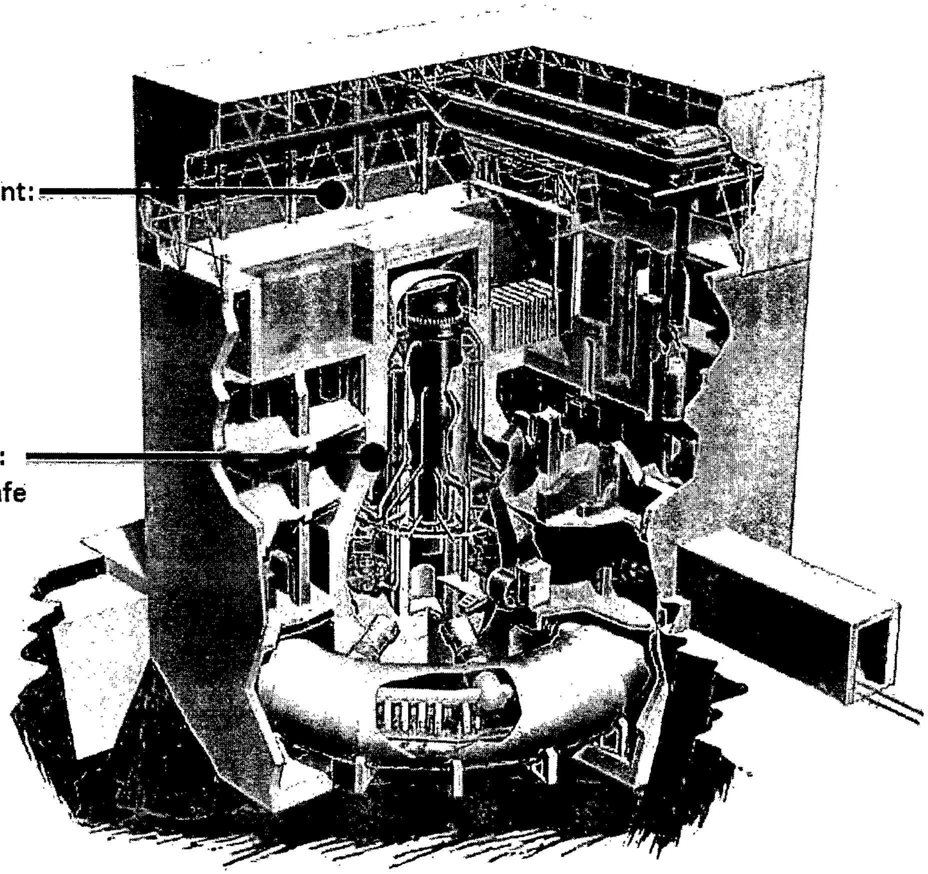
Pressure Suppression Pool (Suppression Chamber)

It always contains water. Should pipes in the primary containment vessel ever break, leaked steam would be conducted into the pool, where it would be cooled down and condensed with a large amount of water to suppress any rise in pressure in the primary containment vessel.

Control Rods

They are used to start and stop the reactor and to change reactor power (amount of nuclear fission) by individually inserting and extracting from the bottom of the reactor.

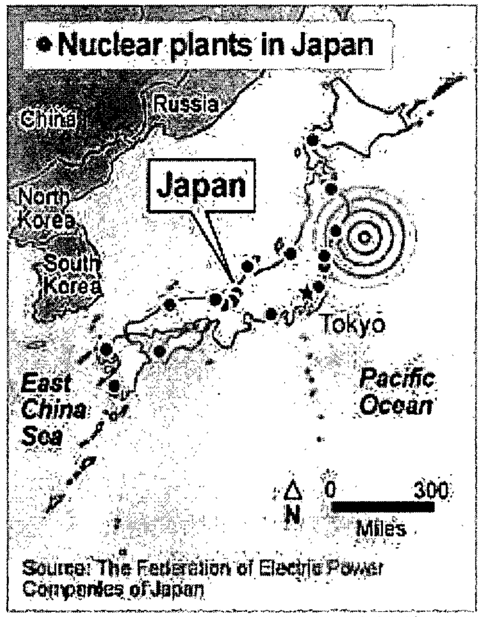
Fukushima Daiichi Unit 1



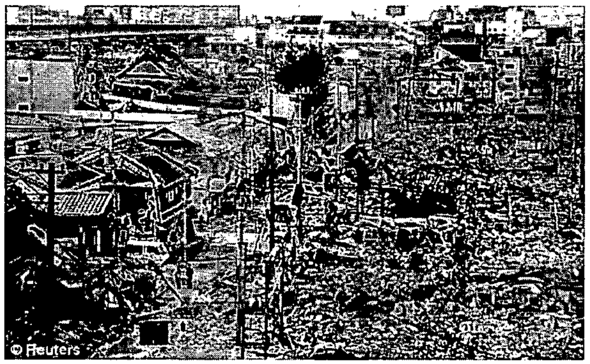
Boiling Water Reactor Design

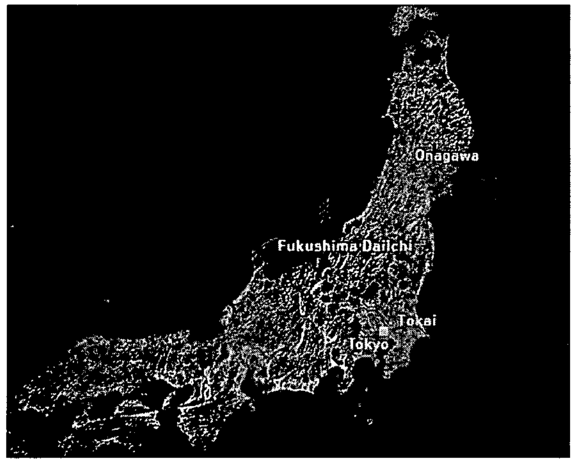
Event Initiation

- The Fukushima nuclear facilities were damaged in a magnitude 9 earthquake on March 11 (Japan time), centered offshore of the Sendai region, which contains the capital Tokyo.
  - Plant designed for magnitude 8.2 earthquake. An 9 magnitude quake is much greater in magnitude.
- Serious secondary effects followed including a significantly larger tsunami, significant aftershocks and a major fire at a fossil fuel installation.



By Janet Loehrke, USA TODAY





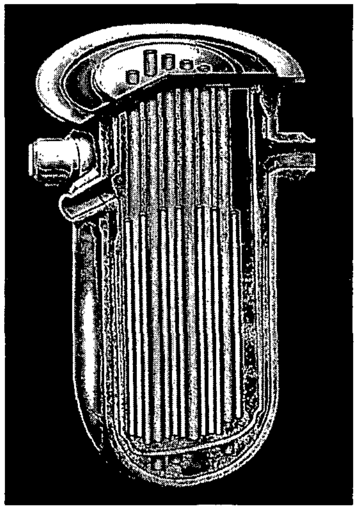
Initial Response

- Nuclear reactors were shutdown automatically. Within seconds the control rods were inserted into core and nuclear chain reaction stopped.
- Cooling systems were placed in operation to remove the residual heat. The residual heat load is about 3% of the heat load under normal operating conditions decreasing to much less than 1% after days.
- Earthquake resulted in the loss of offsite power which is the normal supply to a plant when it is shutdown.
- Emergency Diesel Generators started and powered station emergency cooling systems.
- One hour later, the station was struck by the tsunami. The tsunami was larger than what the plant was designed for (20ft waves). The tsunami took out all multiple sets of the backup Emergency Diesel generators and likely damaged the service water pumps which provide cooling from the sea.
- Reactor operators were able to utilize emergency battery power to provide power for cooling the core for 8 hours.
- Operators followed abnormal operating procedures and emergency operating procedures.

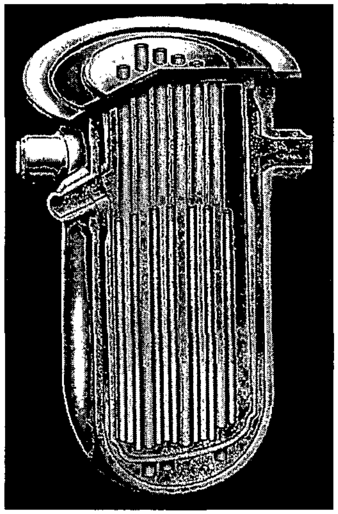
Loss of Makeup

- Offsite power could not be restored and delays occurred obtaining and connecting portable generators.
- After the batteries ran out, residual heat could not be carried away any more.
- Reactor temperatures increased and water levels in the reactor decreased, eventually uncovering and overheating the core.
- Hydrogen was produced from metal-clad/water reactions in the reactor.
- Operators vented the reactor to relieve steam pressure and energy (and hydrogen) was released into the primary containment (drywell) causing primary containment temperatures and pressures to increase.
- Operators took actions to vent the primary containment to control containment pressure and hydrogen levels through the wetwell. Required to protect the primary containment from failure.
- Primary Containment Venting is through a filtered path that travels through duct work in the secondary containment to an elevated release point on the refuel floor (on top of the reactor building).
- A hydrogen detonation subsequently occurred while venting the reactor building above the drywell. Occurred shortly following an aftershock at the station. Spark likely ignited hydrogen.

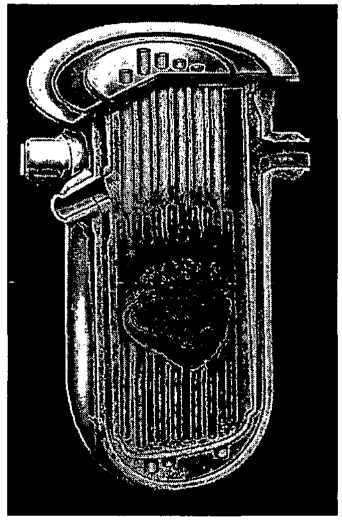
Core Damage Sequence



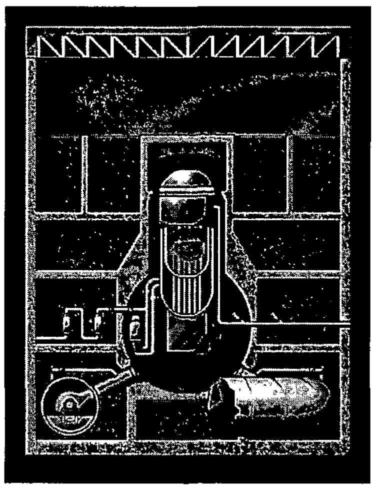
Core Uncovered



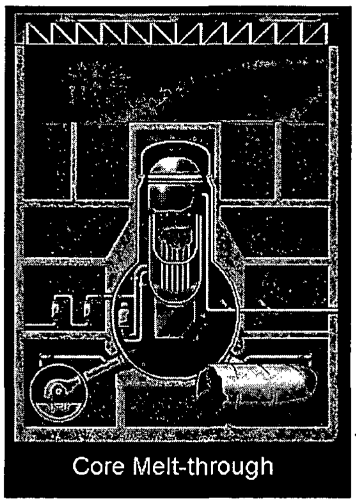
Fuel Overheating



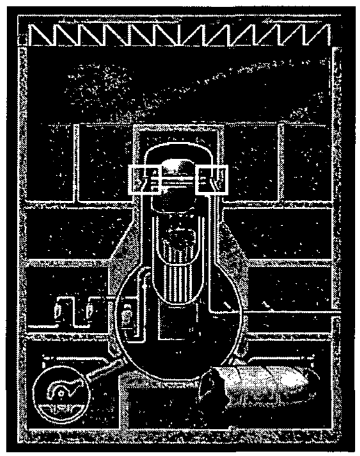
Fuel melting - Core Damaged



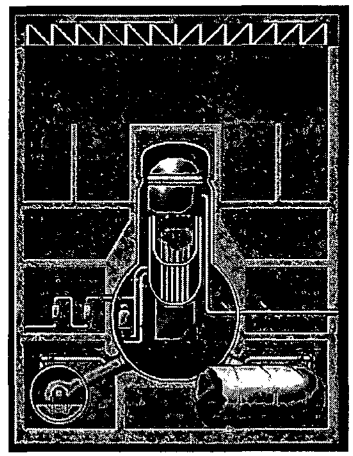
Core Damaged but retained in vessel



Some portions of core melt into lower RPV head

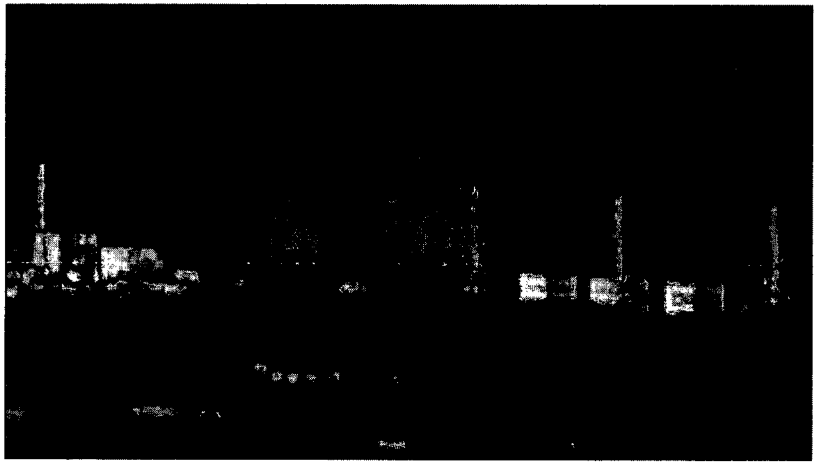


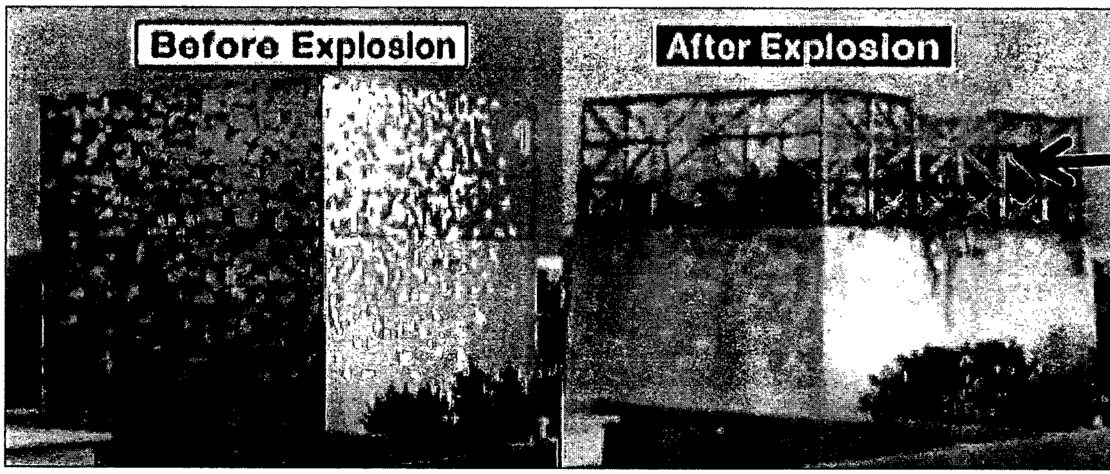
Containment pressurizes. Leakage possible at drywell head



Releases of hydrogen into secondary containment

Hydrogen Detonation at Unit 1





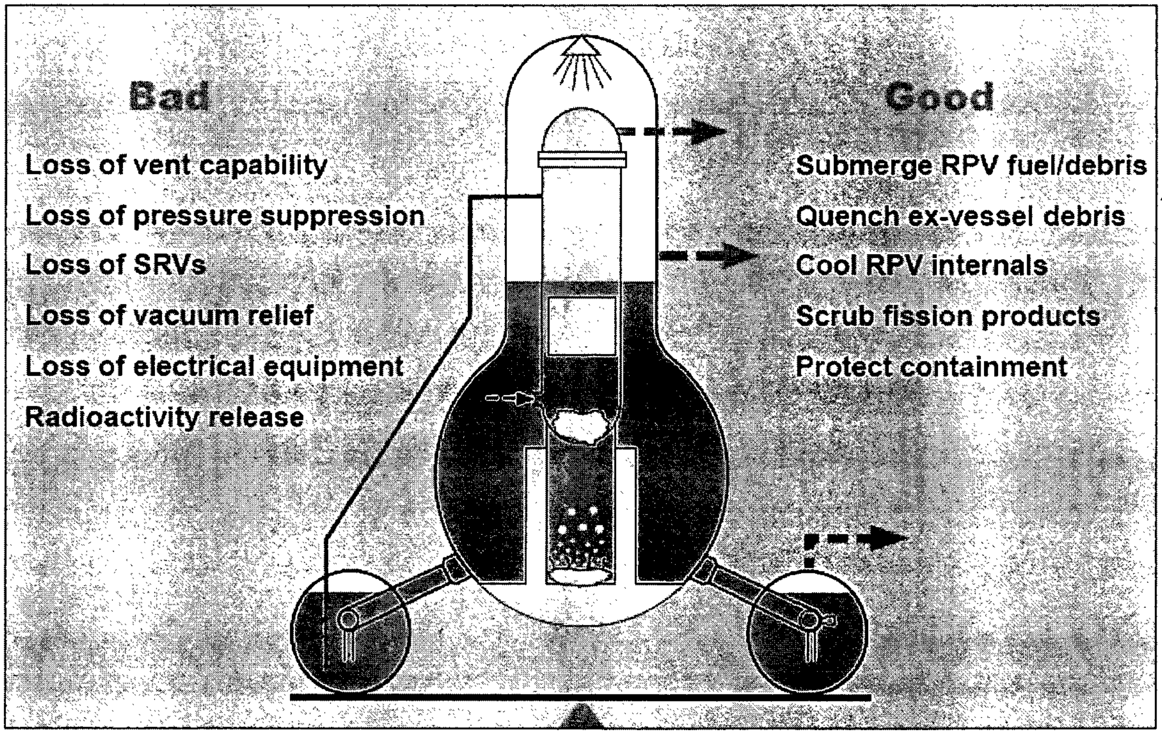
Refuel Floor

Reactor Building

Mitigating Actions

- The station was able to deploy portable power generators and utilize portable fire pumps to inject sea water into the reactor and primary containment.
- Station operators began flooding the reactor vessel
- Reports suggest that pumps were also injecting water into the containment – but it's unclear
- Boric acid was added to the seawater used for injection. Boric acid is "liquid control rod". The boron captures neutrons and speeds up the cooling down of the core. Boron also reduces the release of iodine by buffering the containment water pH.

Containment Flooding Effects



Emergency Response

- Equivalent of General Emergency declared to the initial events in Unit 1 on Friday.
- Evacuation of public performed within 20 km (13 miles) of plant; approximately 200,000 people evacuated and sheltering in place within 30km (20 miles).
- Similar hydrogen detonation subsequently occurred at Unit 3 late on Sunday, March 14th (Japan time). Primary containment appears to remain intact at Unit's 1 and 3 throughout the accident. There was considerable damage to the secondary containment (reactor building). A similar scenario occurred in Unit 2 on Tuesday.
- Recorded radiation levels have spiked after each event (above) at the Fukushima Daiichi site (140-800mrem/hr). Radiation levels were subsequently reduced to a few millirem after the after cooling was restored. The NRC's radiation dose limit for the public is 100 millirem per year and natural background is about 300 mrem per year.
- Several injured workers were reported at the plant with radiation exposure of ~10rem.
- Authorities distributed Potassium-iodide tablets to protect the public from potential health effects of radioactive isotopes of iodine that could potentially be released. This is quickly taken up by the body and its presence prevents the take-up of iodine-131 should people be exposed to it.
- Over 300 after shocks have occurred and continue to challenge station response.
- THE SITUATION FOR SPENT FUEL POOLS HAS NOT BEEN ADDRESSED HERE

ISSF 2010: Session 6

Integrity Inspection of Dry Storage Casks and Spent Fuels at Fukushima Daiichi Nuclear Power Station

16 November 2010

Yumiko Kumano

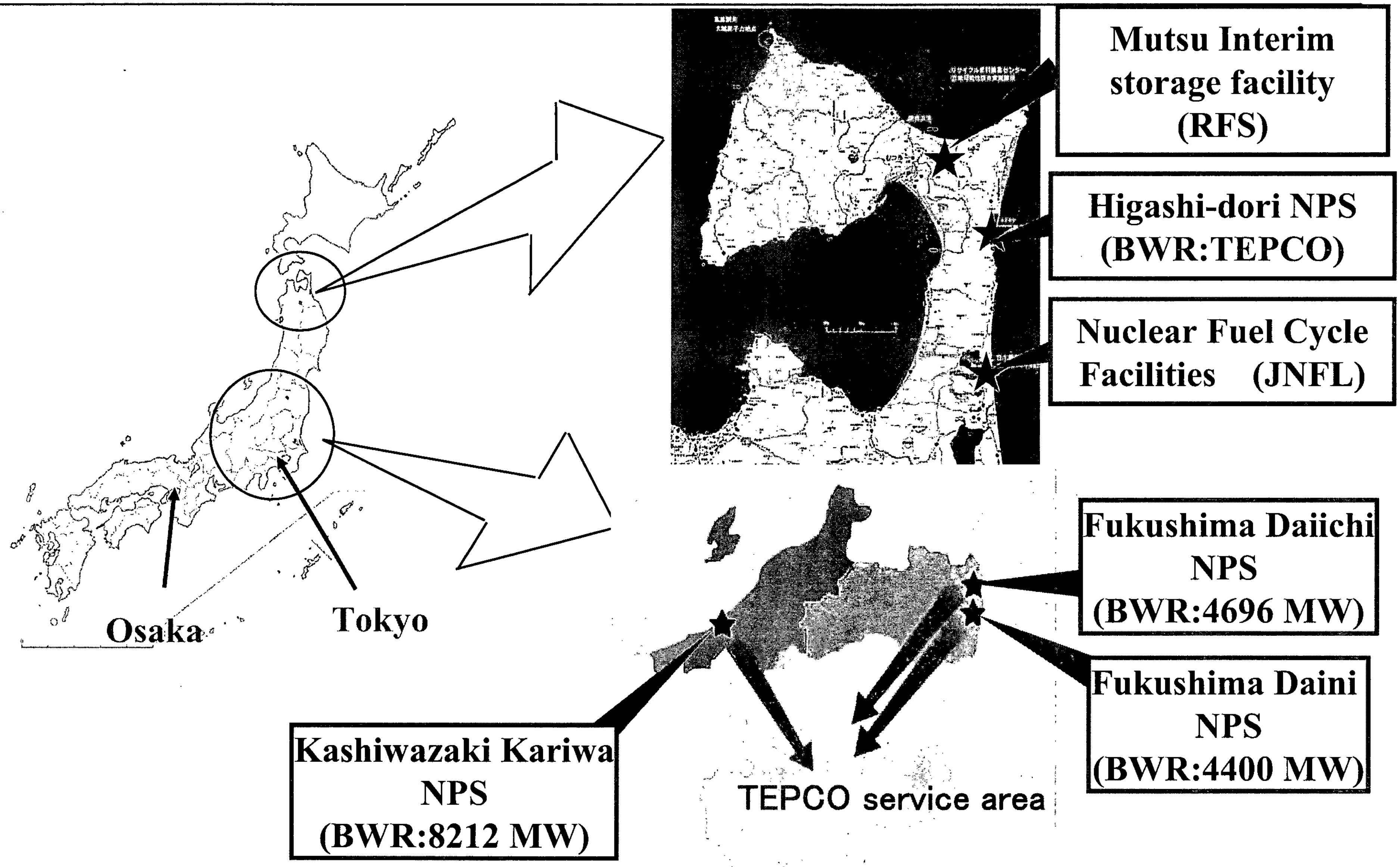
Tokyo Electric Power Company

TEPCO TOKYO ELECTRIC POWER COMPANY

Introduction

- In Japan, currently 54 nuclear power plants are in operation.
- The general strategy for the management of spent fuels is "to store spent fuels safely until being reprocessed".
- Japanese utilities are coping with safe storage of spent fuels / operation of Rokkasho reprocessing facility.

Site Location



Storage Status of Spent Fuel at TEPCO's NPSs

	Number of NPPs	Storage amount (ton-U) (as of Mar/2010)	Storage capacity (ton-U)	Occupancy (%)
Fukushima-Daiichi	6	1,760	2,100	84%
Fukushima-Daini	4	1,060	1,360	78%
Kashiwazaki-Kariwa	7	2,190	2,910	75%
Total	17	5,010	6,370	

Measures for increasing Storage Capacity

	Already done	Additional measures
Fukushima-Daiichi Unit 1-6	✓Increase in the capacity of spent fuel pools by re-racking ✓Installation of common spent fuel pool ✓Installation of dry cask storage facility	Installation of additional dry casks
Fukushima-Daini Unit 1-4	✓Increase in the capacity of spent fuel pools by re-racking	—
Kashiwazaki-Kariwa Unit 1-7	✓Increase in the capacity of spent fuel pools by re-racking	Increase in a fuel pool capacity * at Unit 5

TEPCO's Decision for Further Storage

In order to increase the flexibility for coping with increasing amount of the spent fuels, TEPCO decided to construct <u>an off-site interim spent fuel storage facility.</u>

Establishment of RFS, Recyclable-Fuel Storage Company
(a joint company with JAPC)

RFS will begin operation of the Japanese first off-site interim spent fuel storage facility at Mutsu in 2012.

Outline of Mutsu Facility

- **Final Storage Capacity : 5,000tU**
- **Storage Period : up to 50 years**
- **Construction Schedule :**

  First building: 3,000 tU capacity

  ⇨License for operation was permitted on 13/May/2010

  ⇨Construction began on 31/Aug./2010

  Second building: 2,000tU capacity
- **Cask Type: Dry metal dual-purpose cask**
- **Main Equipment & Devices:**

  -Equipment for carrying in, storing and carrying out fuels :

  -Metal Casks

  -Storage buildings

  -Metal cask handling equipment, etc.

  -No equipment for opening lids and surveying inside casks

Outline of Mutsu Facility (2)

Role sharing :

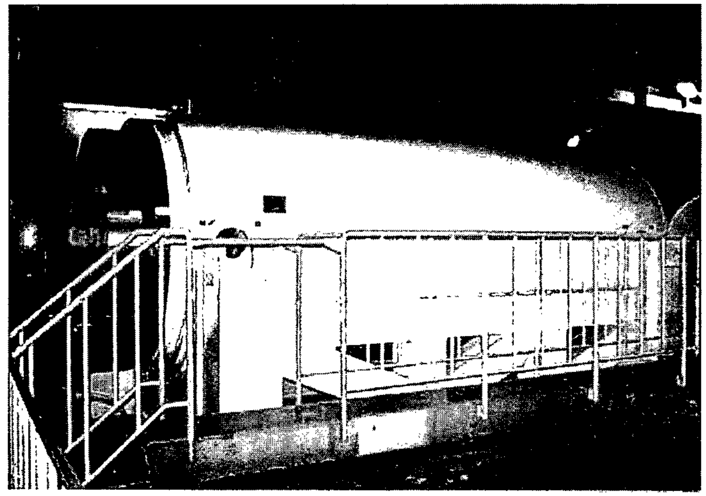
- RFS
  - Responsible for designing/builiding/operating Mutsu storage facility for up to 50 years
- TEPCO,JAPC
  - Responsible for loading spent fuels in metal casks
  - Responsible for transporting casks before / after storage at RFS facility
  - Responsible for accumulation of data about a long-term storage of spent fuels under dry conditions

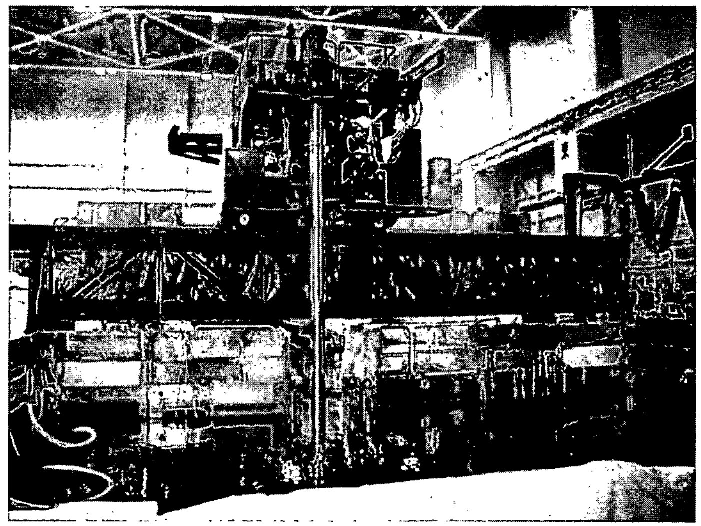
    (Japanese authority made a demand for periodical investigations of dry casks in order to accumulate knowledge on a long-term storage in the safety assessment guideline for off-site interims storage facilities.)

Storage Status of Spent Fuel at Fukushima-Daiichi NPS

➢ Approx. 700 spent fuel assemblies are generated every year.

⇨Stored in spent fuel pools / dry casks





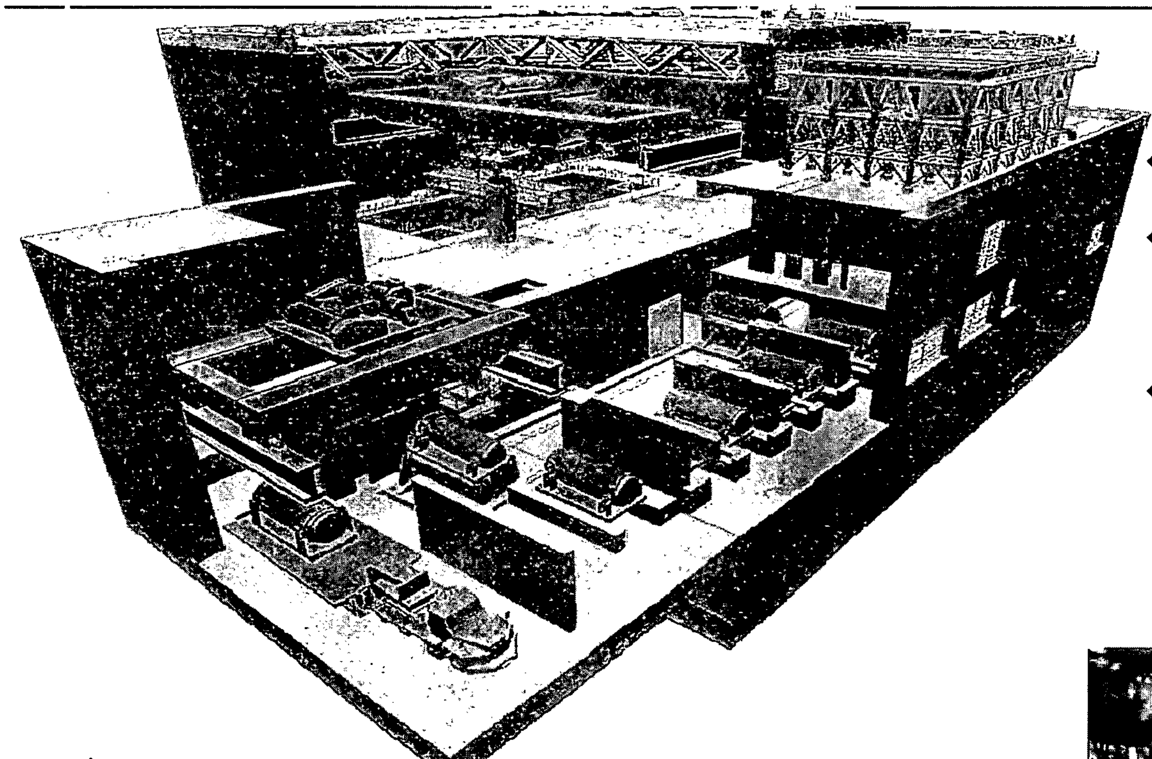
Storage Status of spent fuel (as of Mar. 2010)

(Assemblies)

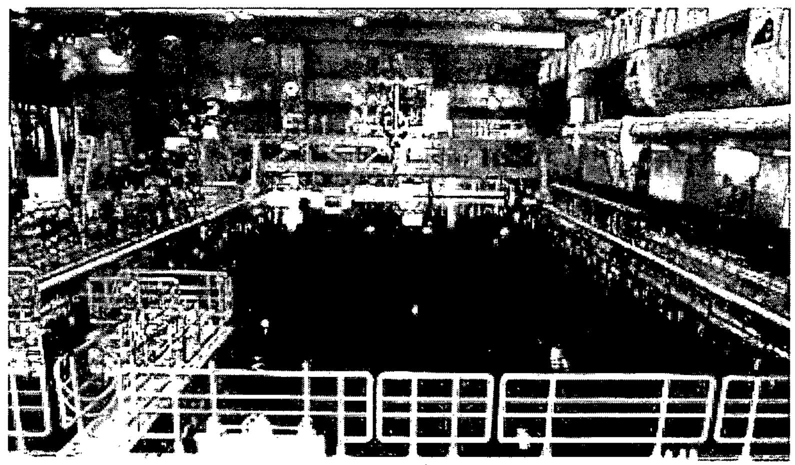
Storage method	Storage Amount	Capacity (existing facilities)
Spent fuel pool at each reactor unit	3,450	8,310
Dry cask	408	408
Common pool	6,291	6,840
Total	10,149	15,558

Approx. 450% of the total core capacity of 6 plants

Outline of Common Spent Fuel Storage Pool (1)

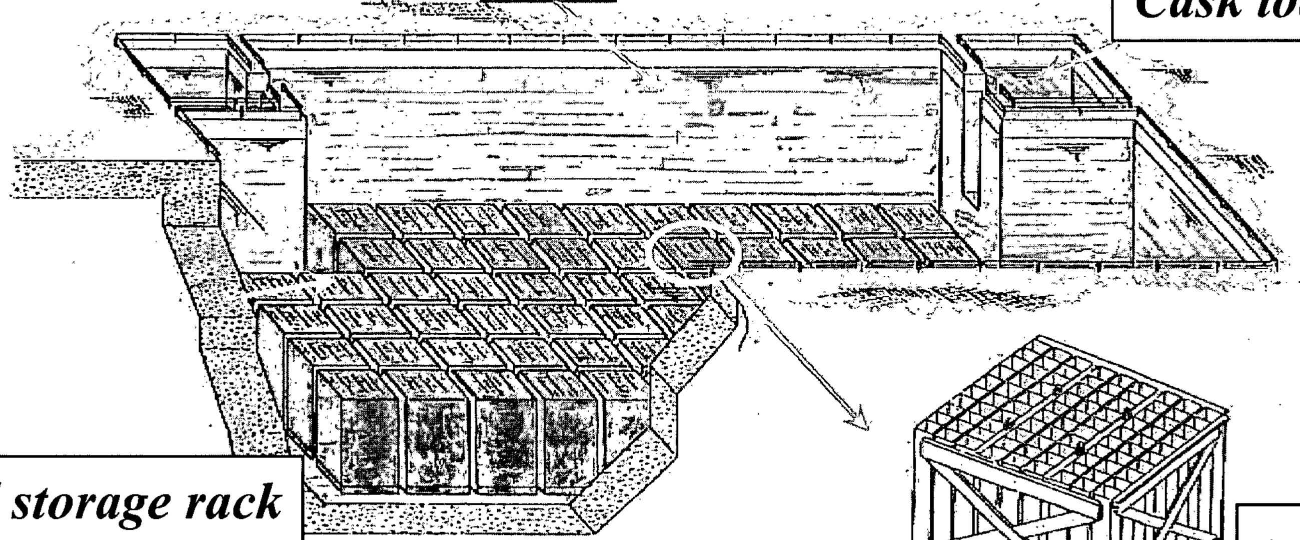


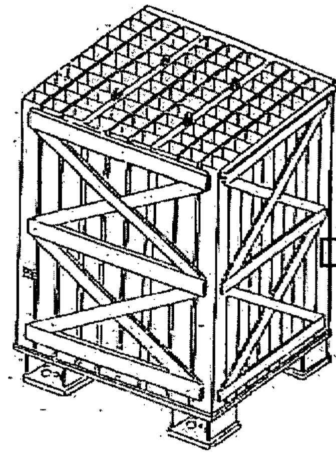
- *In operation since 1997*
- *A large-scale pool*
  12m x 29m x 11m(depth)
- *fuels more than 19-month cooling*



- *Capacity: 6,840 assemblies*
  ⇨*corresponds to 200% of total core capacity*
- *Storage amount: 6,291 assemblies*
  ⇨*corresponds to 90% of the pool capacity*

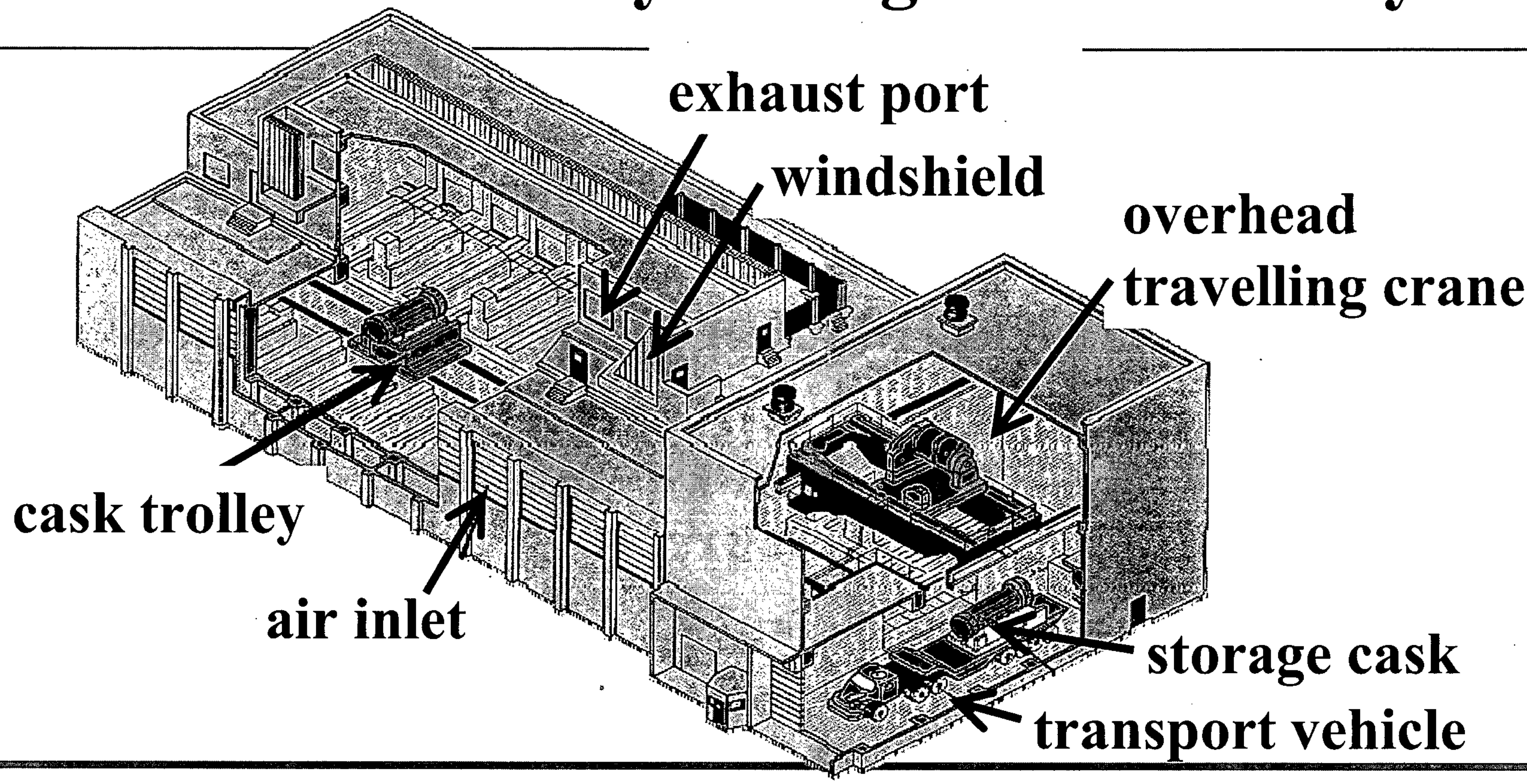
Outline of Common Spent Fuel Storage Pool (2)





【monitoring items】
- pool water temperature
- water level of the pool
- area radiation in the building
- radioactivity in the air dust

Outline of Dry Storage Cask Facility



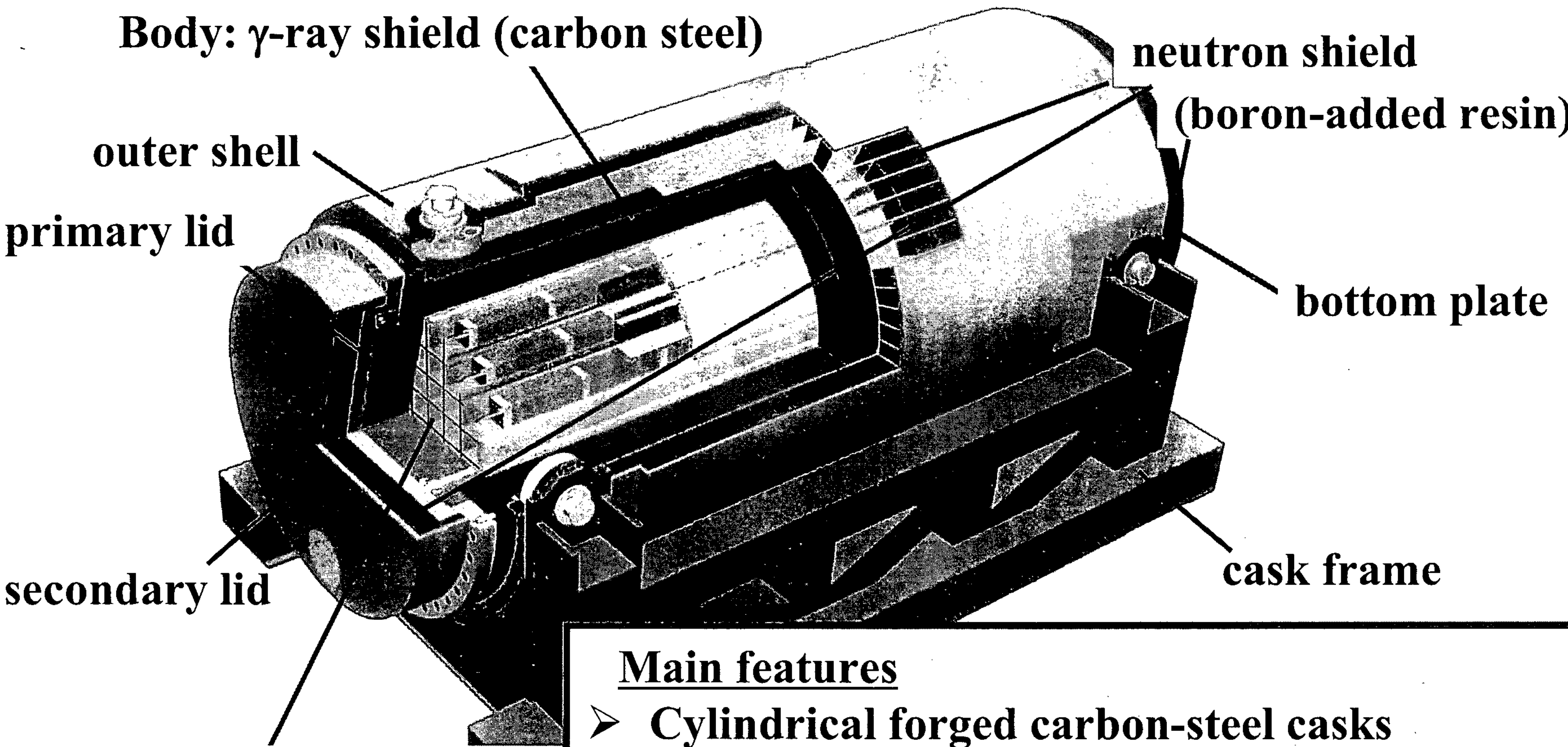
- ◆*Originally designed for transport casks*
  - → *Modified the license in 1994 / dry cask storage since 1995*
- ◆*Permission for the storage of 20 casks*
  - *-9 dry casks are in operation,11 casks are to be installed.*
- ◆*Efficient use of existing building→Casks are laid down in horizontal*
- ◆ *Natural-convection cooling*

Specification of Dry Casks

	Large type	Medium type	
Weight (t)	115	96	
Length (m)	5.6	5.6	
Diameter (m)	2.4	2.2	
Assemblies in a cask	52	37	
Number of casks	5	2	2
Fuel type	8 x 8	8 x 8	New 8 x 8
Cooling-off period (years)	> 7	> 7	> 5
Average burn-up (MWD/T)	<24,000	<24,000	<29,000

Additional 11casks are being prepared for installation.

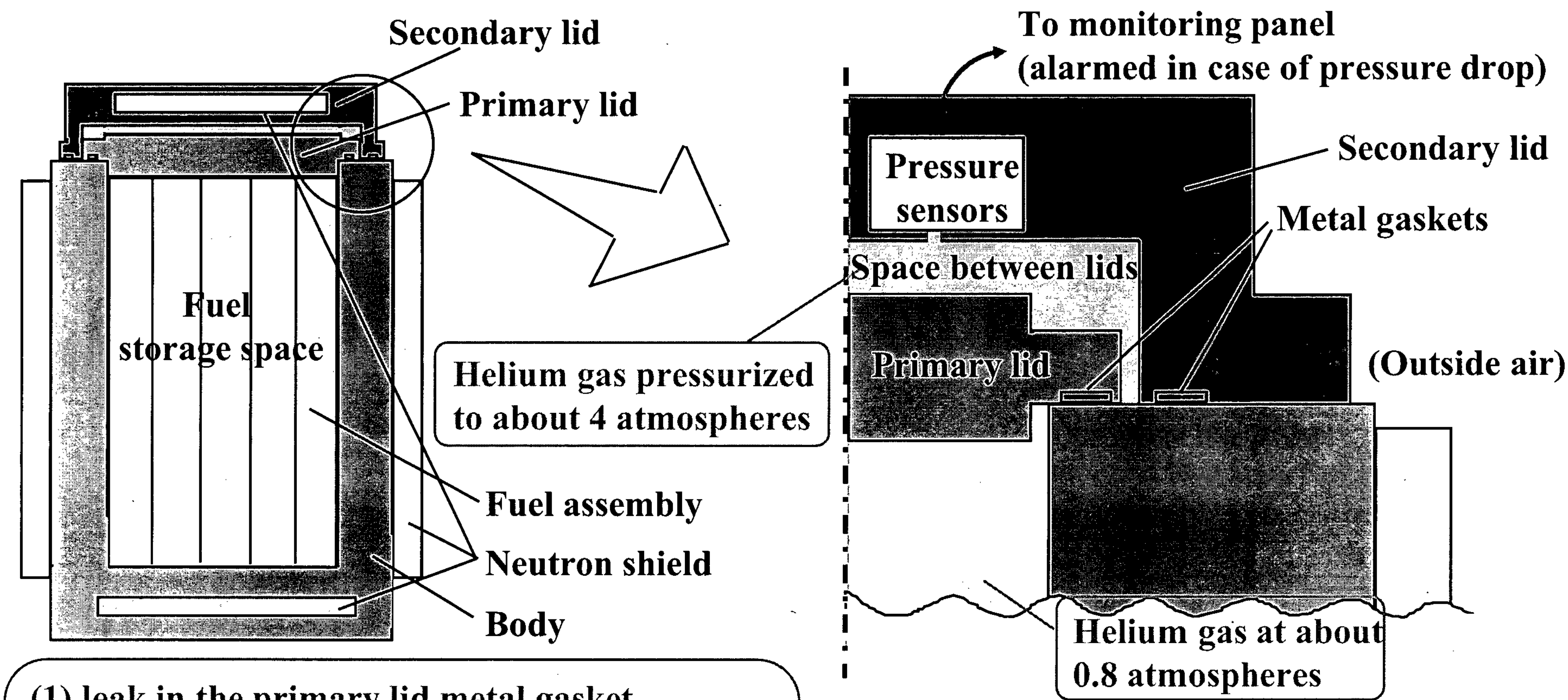
Structure of Dry Cask



<u>Main features</u>

- Cylindrical forged carbon-steel casks
- Similarity with transport casks
- Enhanced sealing/ monitoring functions
- Inner gas substituted with helium
- Steel for γ-ray shield/ resin for neutron shield
- Borated-aluminum alloy basket for sub-criticality

Design Features Concerning Containment



(1) leak in the primary lid metal gasket

Space between lids —Helium gas→ Fuel storage space

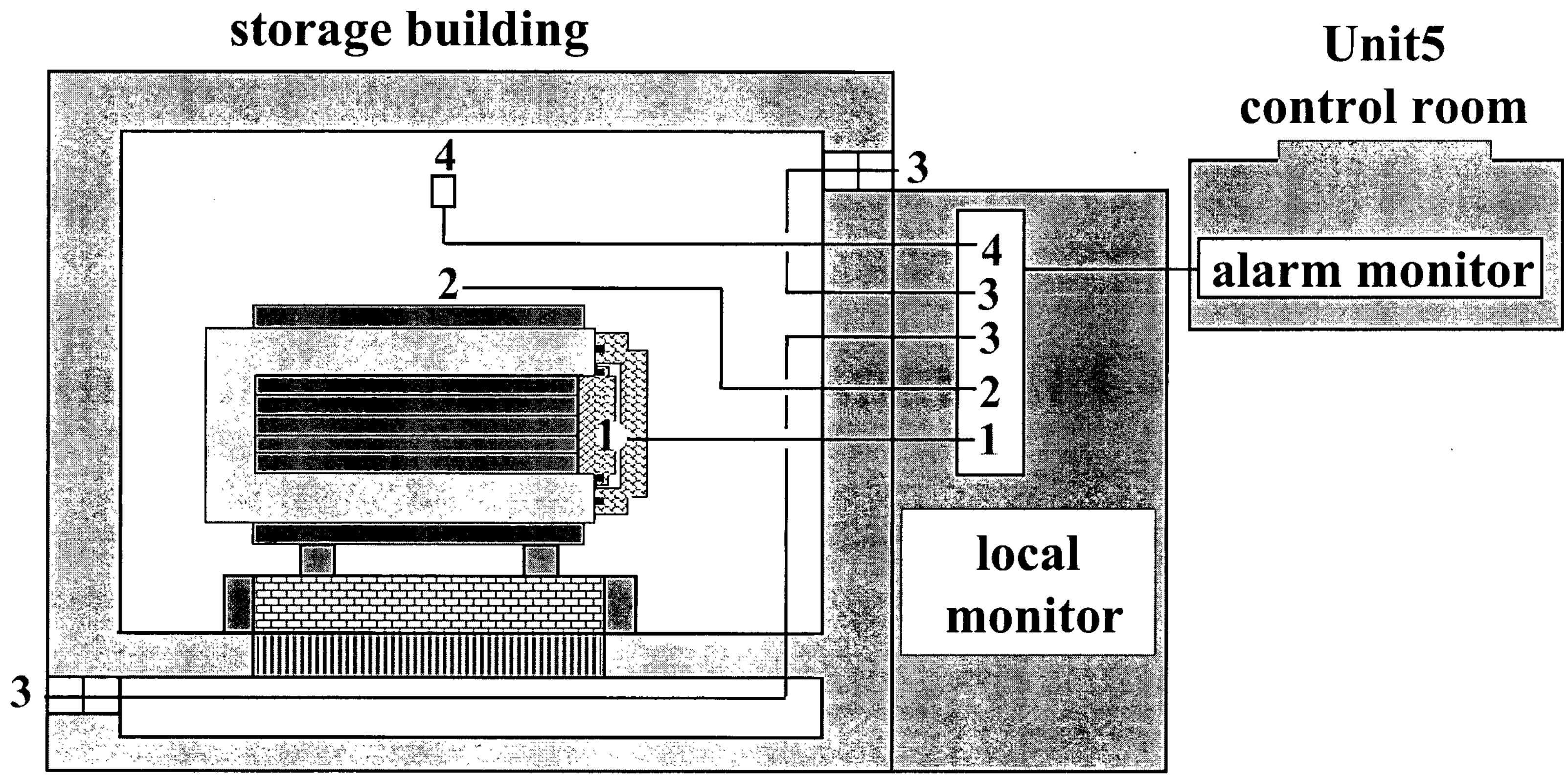
(2) leak in the secondary lid metal gasket

Space between lids —Helium gas→ Outside air

Alarmed in case of pressure drop →

Even if a leak in a metal gasket occurs, no radioactive material inside the cask (in the spent fuel storage space) is released outside the cask.

Monitoring System at Normal Conditions



1. pressure between primary /secondary lids
2. surface temperature
3. inlet and outlet air temperature / temperature difference
4. area radiation in the building

Outline of Integrity Inspections

Time Series

- 1995:Start of operation
- 2000:First inspection after 5-year storage
- 2005: Second inspection after 10-year storage

Target

- A cask was selected as the test target which contained the maximum heat source inside the cask.

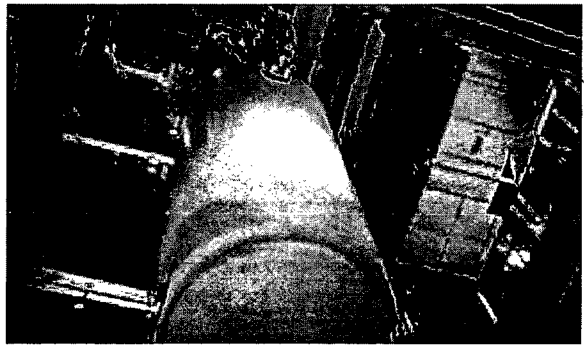
(Estimated temperature of fuel cladding:90-140 degrees C)

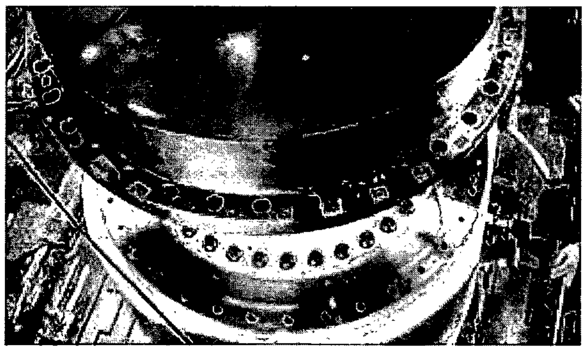
Inspection Items

- Gas sampling in order to detect Kr-85
- Visual inspection of sealing parts
- Leak test of the primary lid
- Visual inspection of fuel cladding for two bundles

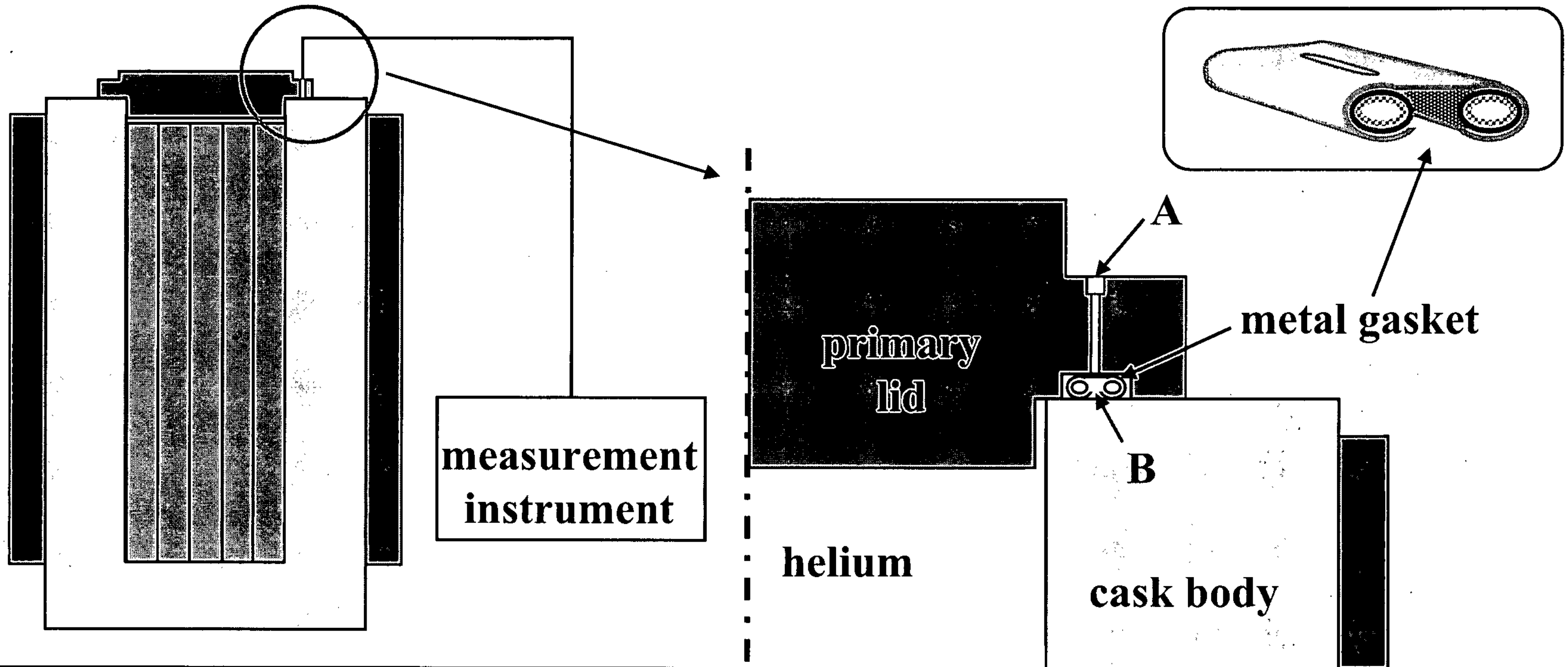
Procedure of the Inspections

1)Transportation of a cask from the cask storage building to a reactor building
2) Leak test of the secondary lid
3) Secondary lid opening / visual inspection
4) Leak test of the primary lid
5) Inner gas sampling for Kr-85 detection
6) Reflood / removal of bolts
7) Transportation into fuel pool
8) Primary lid opening / visual inspection
9) Lift up of a fuel bundle / visual inspection





Leak Test for a Primary Lid



【PROCEDURE】

1. A flexible pipe is connected to a detection hole (A).
2. The other end of the pipe is connected to the measurement instrument.
3. Helium among the doubled layer of a metal gasket (B) is vacuumed by a vacuum pump which is installed in the measurement instrument.
4. Flow rate of helium gas passing through the metal gasket is measured.
5. The measured amount is converted into leak rate.

Result of the Investigation in 2000
(1) sealing performance

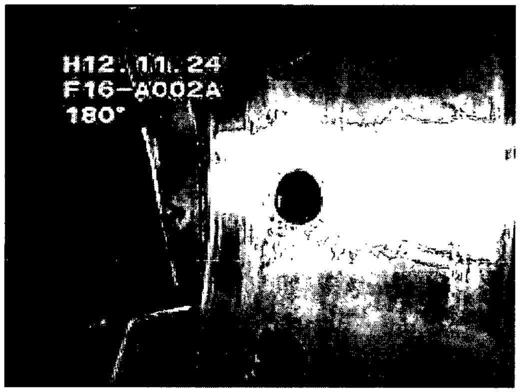
- **Leak test for the primary lid**

  measured value: 5.3×10^{-8} Pa・m^3/s

  required criteria: $<1 \times 10^{-6}$ Pa・m^3/s

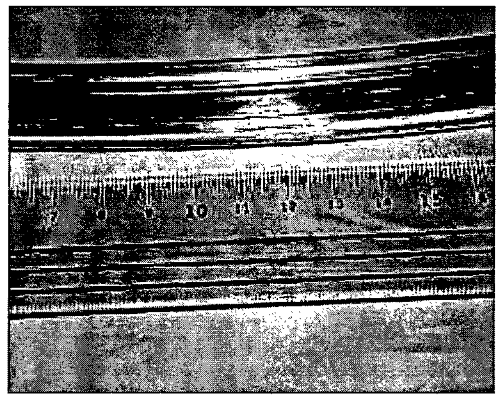
  ⇨ No problem found in the confinement performance

- **Visual inspection of the primary lid**



←Flange surface of the cask

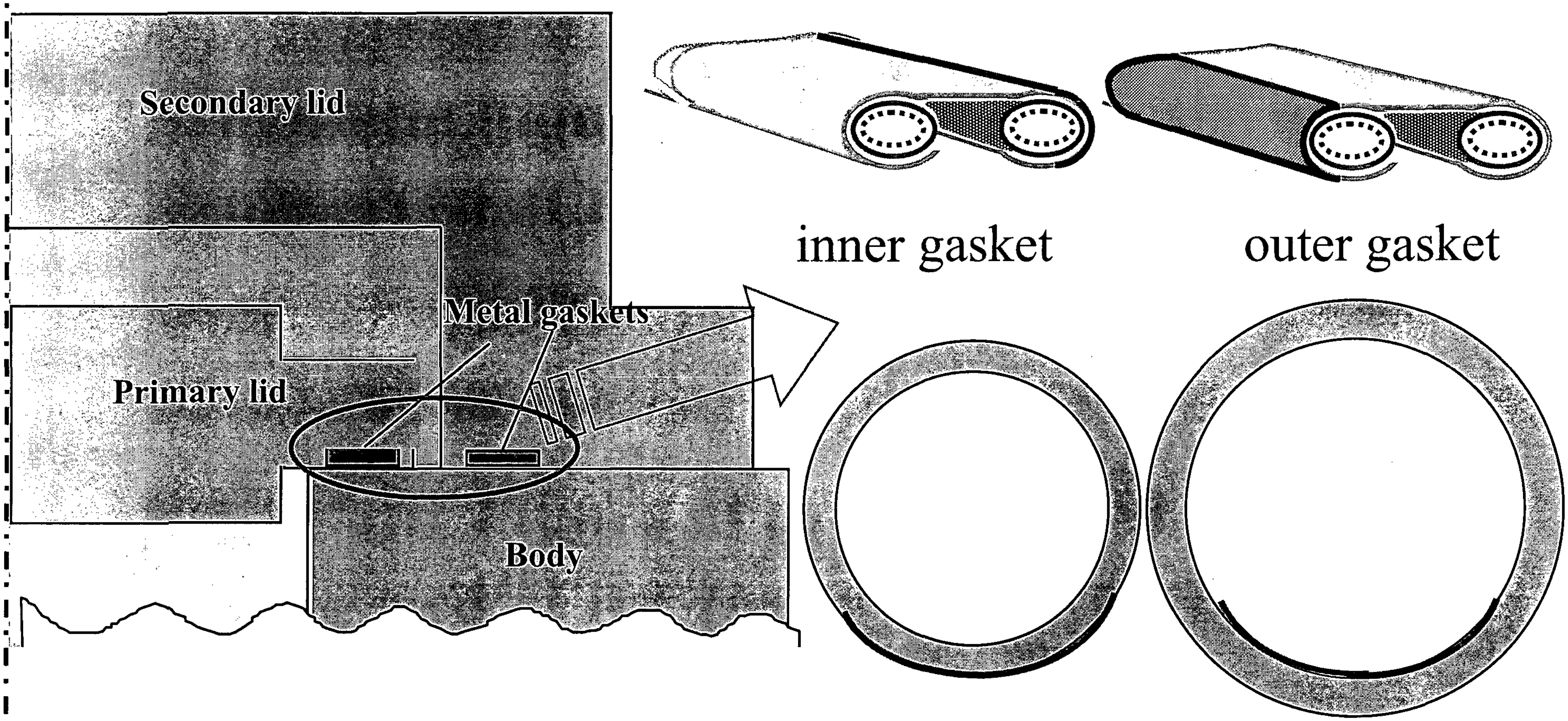
Metal gasket of the primary lid →



⇨ Nothing abnormal occurred on confinement, but white coloring was observed on the gasket's surface due to residual water.

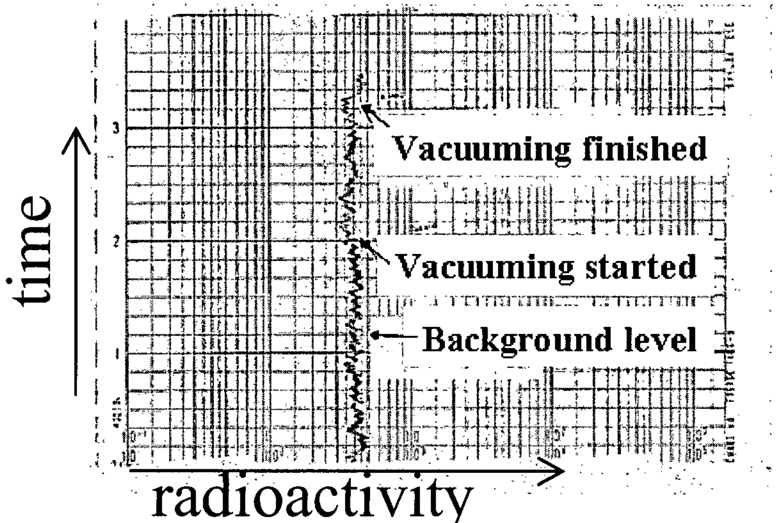
- All metal gaskets were replaced.
- Procedure manual was updated so that residual water could be completely removed.

Schematic Figure of the Whitened Region observed at the Investigation in 2000



Result of the Investigation in 2000
(2) integrity of fuel cladding

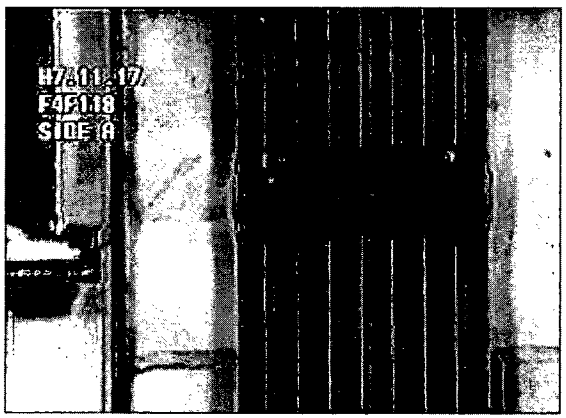
➢Inner gas sampling for measuring Kr-85 concentration



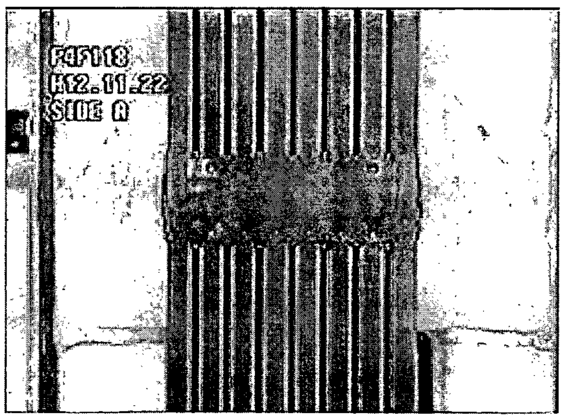
⇨No leak of Kr-85 from the spent fuel was observed based on the measurement of radioactivity of the sampled gas.

➢Visual inspection of a fuel assembly

17/Nov/1995



22/Nov/2000



⇨No signal of any defect was observed.

Target: New 8X8 BWR assembly (approx.32 GWd/t)

Result of the Investigation in 2005
(1) sealing performance

➢ <u>Leak test for the primary lid after five-year use since 2001</u>

measured value: 1.6×10^{-7} Pa･m³/s

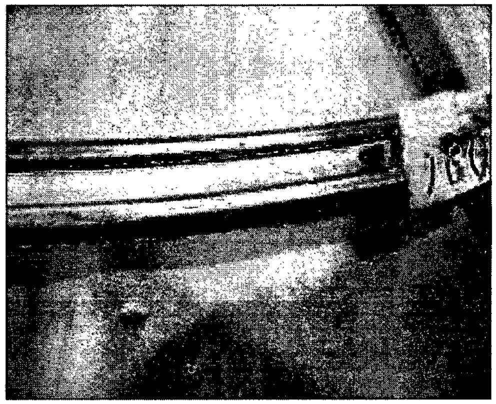
required criteria: $<1 \times 10^{-6}$ Pa･m³/s

⇨No problem found in the confinement performance

➢ <u>Visual inspection of the primary lid</u>

←Flange surface of the cask

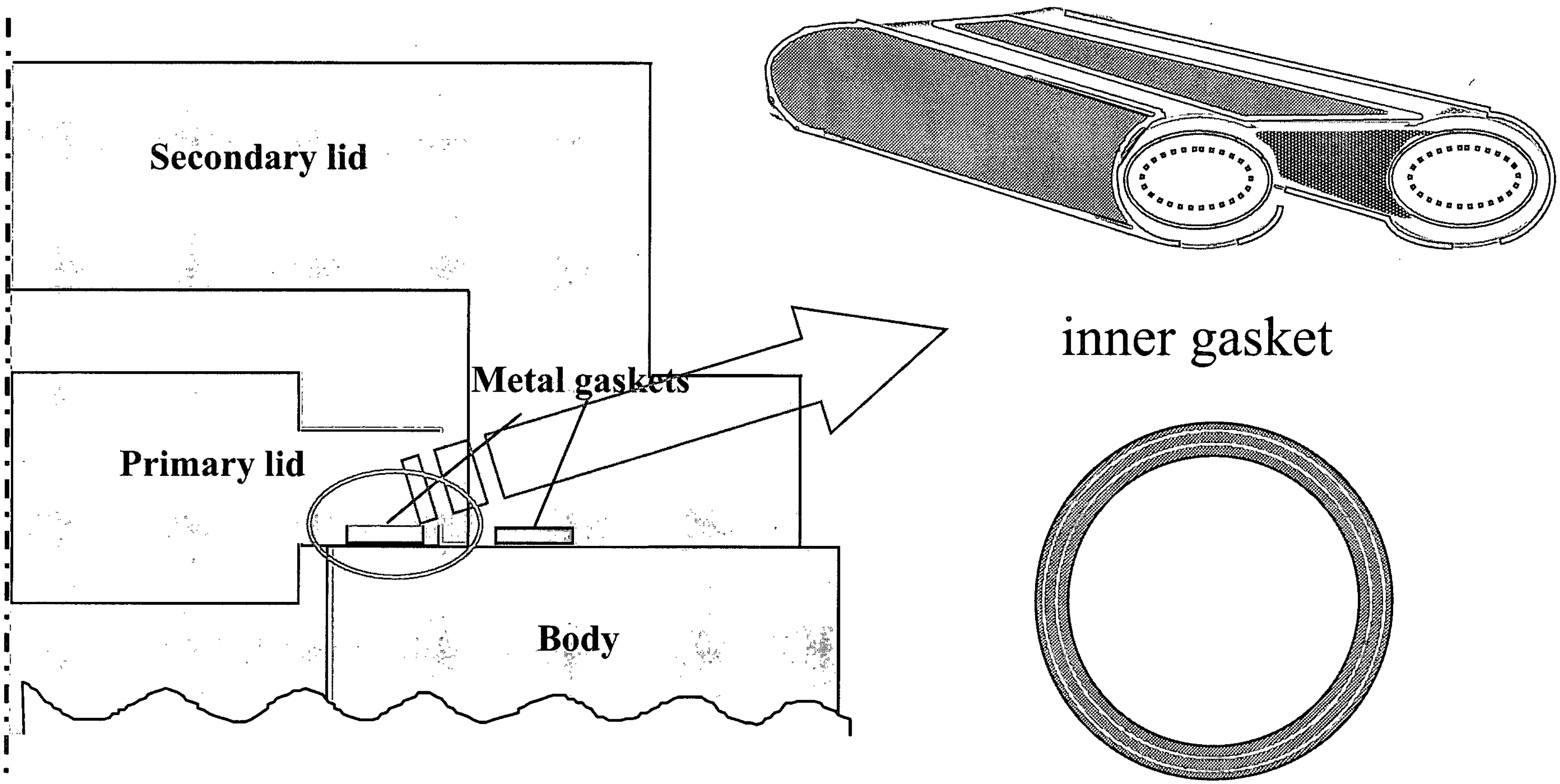
Metal gasket of the primary lid →



⇨Nothing abnormal occurred on confinement, but white color change was observed on the surface of the gasket due to immersion to reactor pool water for several days before opening the primary lid.

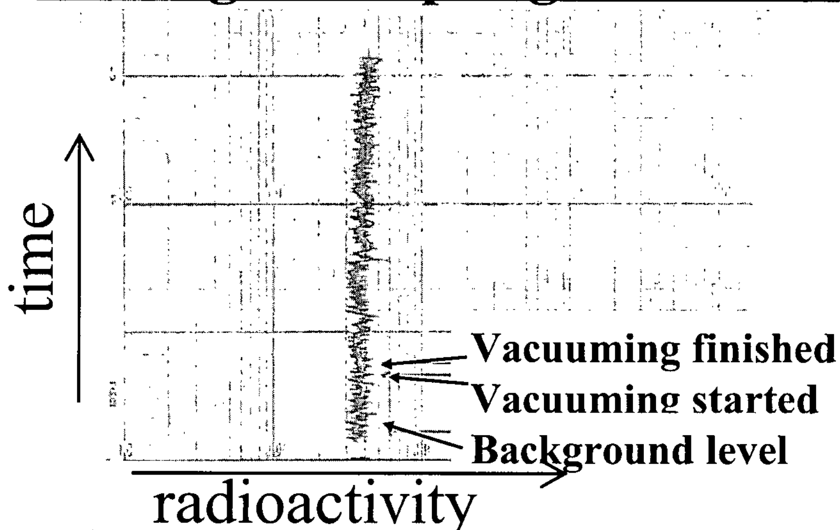
➢Procedure manual will be additionally updated in order to reduce the immersion duration.

Schematic Figure of the Whitened Region observed at the Investigation in 2005



Result of the Investigation in 2005
(2) integrity of fuel cladding

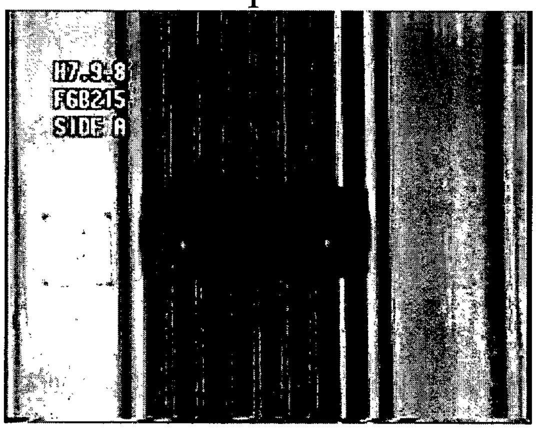
➢ **Inner gas sampling for measuring Kr-85 concentration**



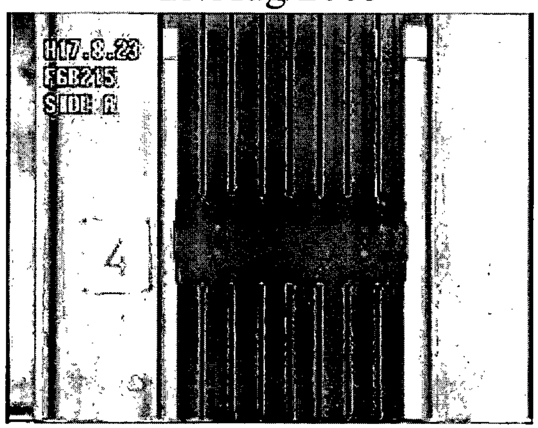
⇨ **No leak of Kr-85 from the spent fuel was observed based on the measurement of radioactivity of the sampled gas.**

➢ **Visual inspection of a fuel assembly**

8/Sep/1995



23/Aug/2005



⇨ **No signal of any defect was observed.**

Target: 8X8 BWR assembly (approx.28 GWd/t)

Conclusions

- Integrity of storage casks and fuel bundles was carefully investigated after 5- and 10- year storage in dry condition.
- The result did not indicate any significance of defect / degradation of the system.
- Our procedure manual was updated in order to reflect the lesson learned from these investigations.
- Next investigation will be held in a few years.
- These knowledge and data will be accumulated to support future transport after storage, etc.

CONGRESSIONAL REPORT - PLUS PLANT STATUS (BELOW)

NRC Chairman Gregory Jaczko told members of Congress today that there is no water remaining in the fuel pool at Unit 4 at Fukushima Daiichi nuclear power plant. Jaczko told members of the House Energy and Commerce Committee that "we believe that secondary containment has been destroyed and there is no water in the spent fuel pool...radiation levels are extremely high, which could impact the ability to take corrective measures."

There is no updated information available from either Tokyo Electric Power or Japanese safety or regulatory officials on the status of the Fukushima plant. Japan's Nuclear and Industrial Safety Agency said it also is concerned about the spent fuel storage pool at reactor 3 at the Fukushima Daiichi site.

Also testifying before the House committee, Energy Secretary Steven Chu restated the administration's commitment to nuclear energy. "The American people should have full confidence that the United States has rigorous safety regulations in place to ensure that our nuclear power is generated safely and responsibly," Chu testified. "Information is still coming in about the events unfolding in Japan, but the administration is committed to learning from Japan's experience as we work to continue to strengthen America's nuclear industry.

"Safety remains at the forefront of our effort to responsibly develop America's energy resources, and we will continue to incorporate best practices and lessons learned into that process." Chu said. "To meet our energy needs, the administration believes we must rely on a diverse set of energy sources, including renewables like wind and solar, natural gas, clean coal and nuclear power."

The administration and Nuclear Regulatory Commission on Wednesday said that they believe it is appropriate for U.S. residents within 50 miles of the Fukushima reactors to evacuate. In response to nuclear emergencies, the NRC works with other U.S. agencies to monitor radioactive releases and predict their path. All the available information continues to indicate Hawaii, Alaska, the U.S. Territories and the U.S. West Coast are not expected to experience any harmful levels of radioactivity.

The situation in relation to the release of radioactive material from the Fukushima No. 1 Nuclear Plant remains serious. The current situation (as of 3pm, 15 March) is as follows:

	Hydrogen explosion	Pumping in of seawater	Release of water vapor	Condition of reactor
No. 1 reactor	Occurred (12 March)	In place	In place	Partial fuel rod damage
No. 2 reactor	Possibility	In place	In place	Rupture of suppression pool
No. 3 reactor	Occurred (14 March)	In place	In place	Possibility of partial fuel rod damage
No. 4 reactor	Possibility	In place	In place	Water temperature storing spent fuels rising
No. 5 &6 Reactor	Undergoing periodic examination	--	--	Temperature rising

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Horn, Brian

From: Horn, Brian
Sent: Thursday, March 17, 2011 6:47 AM
To: Owens, Janice
Cc: Habighorst, Peter
Subject: RE: General guidance to export licensees

release

Morning Janice:

Good work.

I have marked a couple of possible word changes to your draft e-mail. (changes are marked in Red).

Brian Horn
492-3122

From: Owens, Janice
Sent: Wednesday, March 16, 2011 8:57 PM
To: Caldwell, Robert; Habighorst, Peter
Cc: Mamish, Nader; Collins, Chiquita; Bukharin, Oleg; Horn, Brian; Aguilar, Santiago; Kim, Grace; Fragoyannis, Nancy
Subject: General guidance to export licensees

As promised, here is a draft email message to the companies currently licensed or who have applications pending for exports of LEU (UF6 or UO2) to Japan. We believe that given the present circumstances, a short email message is the best means of communicating with them. I do not think there is a reason to delay shipments to operating Japanese reactors; but we do not know how long fuel fabrication facilities in Tokai Mura, Japan will be shut down and the operating fuel fabrication facility in Osaka, Japan is not a back-up on all the export licenses.

I would like to thank Chiquita Collins for being this matter to OIP's attention and we look forward to receiving your feedback. Please give first priority to the draft message to AREVA that I sent to you earlier. Thank you,

Janice Owens

AREVA NP;
Mitsui & Co. (USA), Inc;
Transnuclear Inc.;
Transport Logistics International
Edlow International ?
GNFA ?

> In light of developments in Japan, the NRC staff is advising export licensees and export license applicants that shipments of low enriched uranium (LEU) or natural uranium to Japanese fuel fabrication facilities and/or Japanese reactors may need to be delayed, rescheduled, rerouted or cancelled. In addition to the power reactors that have been shut down due to the earthquake, we understand that nuclear fuel fabrication facilities located in Tokai Mura, Japan have also been temporarily shut down. Those who currently hold active licenses or who have submitted applications for licenses authorizing exports to Japan need to assess their plans to determine whether alterative arrangements potentially requiring amendments are required.

Staff in the NRC Office of International Programs is prepared to work with you and to coordinate with staff in the Office of Nuclear Security and Incident Response (NSIR). During this time, please be advised that the required 10-day advance notification for shipments of special nuclear material of low strategic significance to NSIR's Director, Division of Security Policy, (AdvanceNotificationsResource@nrc.gov), may not be sufficient.

Please contact me if you have questions or need additional information.

Janice E. Owens
Branch Chief, Export Controls and International Organizations
Office of International Programs
U.S. Nuclear Regulatory Commission
301-415-3684
301-415-2395 (fax)
Janice.Owens@nrc.gov

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

Lee, Richard

From: Hoc, PMT12
Sent: Thursday, March 17, 2011 11:05 AM
To: Gibson, Kathy
Cc: Lee, Richard
Subject: FW: RASCAL Runs justifying U.S. PARs
Attachments: RASCAL Run of 03152011_0251AM (used in 03162011 NRC Press Release).pdf; RASCAL Run of 03162011_1224PM (used in 03162011 NRC Press Release).pdf

7

Hi Kathy.

FYI - Here are the full RASCAL runs from the press release. We now have Richard's name and can contact him as necessary. **This info can't be shared outside NRC**. The ET confirmed for us that MACCS code will not be used to benchmark RASCAL and that RES staff should not engage further efforts to use MACCS for this event.

K. Brock

XX/17

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K. Brock

XX\18

Re-run of 3/16/11 run @ 12:24pm found in press release. Ignore run date/time on this copy

Summary Report

Case description: Fukushima U2, U3 and U4 SFP approximate site release
Run date/time: 2011/03/17 08:48

Maximum Dose Values (rem) - Close-In

Dist from release								
miles	0.5	1.	1.5	2.	3.	5.	7.	10.
(kilometers)	(0.8)	(1.61)	(2.41)	(3.22)	(4.83)	(8.05)	(11.27)	(16.09)
Total EDE	5.4E+03	1.5E+03	6.7E+02	3.9E+02	1.8E+02	7.5E+01	4.0E+01	1.4E+01
Thyroid CDE	2.9E+04	7.9E+03	3.6E+03	2.1E+03	9.6E+02	4.0E+02	2.1E+02	7.5E+01
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	2.6E+04	7.0E+03	3.2E+03	1.9E+03	8.5E+02	3.5E+02	1.9E+02	7.5E+01
Inter Phase 2nd Yr	1.3E+04	3.5E+03	1.6E+03	9.2E+02	4.2E+02	1.8E+02	9.5E+01	3.8E+01

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	15	20	30	40	50
(kilometers)	(24.1)	(32.2)	(48.3)	(64.4)	(80.5)
Total EDE	1.5E+01	1.3E+01	1.1E+01	1.0E+01	9.9E+00
Thyroid CDE	8.6E+01	7.0E+01	5.2E+01	4.9E+01	4.8E+01
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	7.1E+01	6.0E+01	4.7E+01	4.5E+01	4.3E+01
Inter Phase 2nd Yr	3.6E+01	3.0E+01	2.3E+01	2.2E+01	2.1E+01

Notes:
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- Intermediate-Phase 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

Case Summary

Event Type Nuclear Power Plant

Location

Name: Fukushima U4
City, county, state: <undefined>, <undefined>, <undefined>
Lat / Long / Elev: 37.4214° N, 141.0325° E, 0 m
UTC Offset: 9 hours
Population: not available

Reactor Parameters

Summary Report

Reactor power:	3760 MWt
Average fuel burn-up:	30000 MWD / MTU
Containment type:	BWR Mark I
Containment volume:	2.50E+05 ft^3
Design pressure:	60 lb/in^2
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:	Fukushima - U2, U3 and U4 SFP release approximation
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	?	
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	?	

Summary Report

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
2011/03/15 19:00	Fcst	085	4.4	B	None
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
2011/03/16 08:00	Fcst	331	4.9	D	None
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
2011/03/17 01:00	Fcst	286	7.0	D	None
2011/03/17 02:00	Fcst	287	6.6	D	None
2011/03/17 03:00	Fcst	293	6.5	D	None
2011/03/17 04:00	Fcst	300	6.3	D	None
2011/03/17 05:00	Fcst	311	5.9	D	None
2011/03/17 06:00	Fcst	295	7.4	D	None

Summary Report

2011/03/17 07:00	Fcst	303	8.4	C	None
2011/03/17 08:00	Fcst	333	4.8	C	None
2011/03/17 09:00	Fcst	321	5.9	C	None
2011/03/17 10:00	Fcst	307	5.0	C	None
2011/03/17 11:00	Fcst	292	8.4	C	None
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

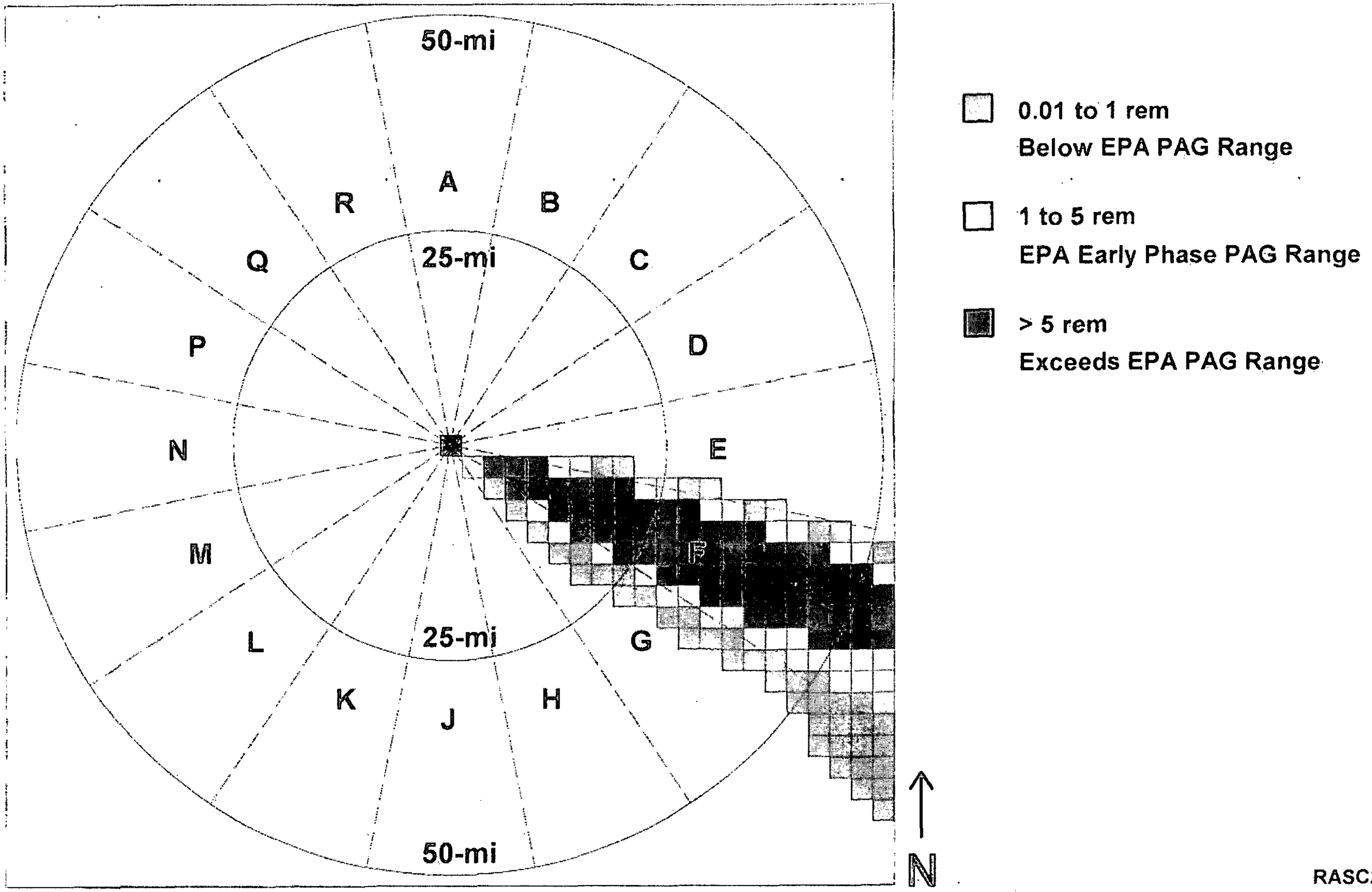
Case description: Fukushima U2, U3 and U4 SFP approximate site release
End of calculations: 2011/03/17 10:50
Start of release to atmosphere + 15 h
Distance of calculation: Close-in + to 50 miles
Close-in distances: 0.5, 1.0, 1.5, 2.0, 3.0, 5.0, 7.0, 10.0 miles

Total Effective Dose Equivalent

Accumulated between 2011/03/16 19:50 and 2011/03/17 10:50

Fukushima U2, U3 and U4 SFP approximate site release

Fukushima U4



RASCAL v4.1

Re-run of 3/15/11 2:51 run found in press release. Ignore rundate/time on this copy.

Summary Report

Case description: Fukushima Unit 2 mid night release 14MAR
Run date/time: 2011/03/15 03:04

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	5.4E+03	2.0E+03	1.2E+03	8.2E+02	4.8E+02	2.4E+02	1.6E+02	9.5E+01
Thyroid CDE	2.8E+04	1.1E+04	6.2E+03	4.3E+03	2.5E+03	1.3E+03	8.4E+02	5.1E+02
Inhalation CEDE	3.7E+03	1.4E+03	8.0E+02	5.6E+02	3.3E+02	1.7E+02	1.1E+02	6.7E+01
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	2.4E+04	9.3E+03	5.4E+03	3.8E+03	2.2E+03	1.0E+03	6.6E+02	3.9E+02
Inter Phase 2nd Yr	1.1E+04	4.4E+03	2.6E+03	1.8E+03	1.0E+03	4.9E+02	3.1E+02	1.8E+02

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	8.6E+01	6.3E+01	3.7E+01	1.8E+01	8.1E+00
Thyroid CDE	3.3E+02	2.7E+02	1.3E+02	5.9E+01	2.5E+01
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	2.9E-02
4-day Groundshine	4.7E+01	3.2E+01	2.4E+01	1.3E+01	6.7E+00
Inter Phase 1st Yr	7.1E+02	4.7E+02	3.8E+02	2.2E+02	1.3E+02
Inter Phase 2nd Yr	3.4E+02	2.3E+02	1.8E+02	1.1E+02	6.9E+01

Notes:
- Doses exceeding PAGs are underlined.
- Early-Phase PAGs: TEDE - 1 rem, Thyroid (iodine) CDE - 5 rem
- Intermediate-Phase 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

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
UTC Offset: 9 hours
Population: not available

Reactor Parameters

Summary Report

Reactor power:	2350 MWt
Average fuel burn-up:	30000 MWD / MTU
Containment type:	BWR Mark I
Containment volume:	2.50E+05 ft^3
Design pressure:	60 lb/in^2
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:	Unit 2 mid-night release 3-14-11
Release height:	10. m

Release events

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

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	?	

Summary Report

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
2011/03/15 19:00	Fcst	085	4.4	B	None
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
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

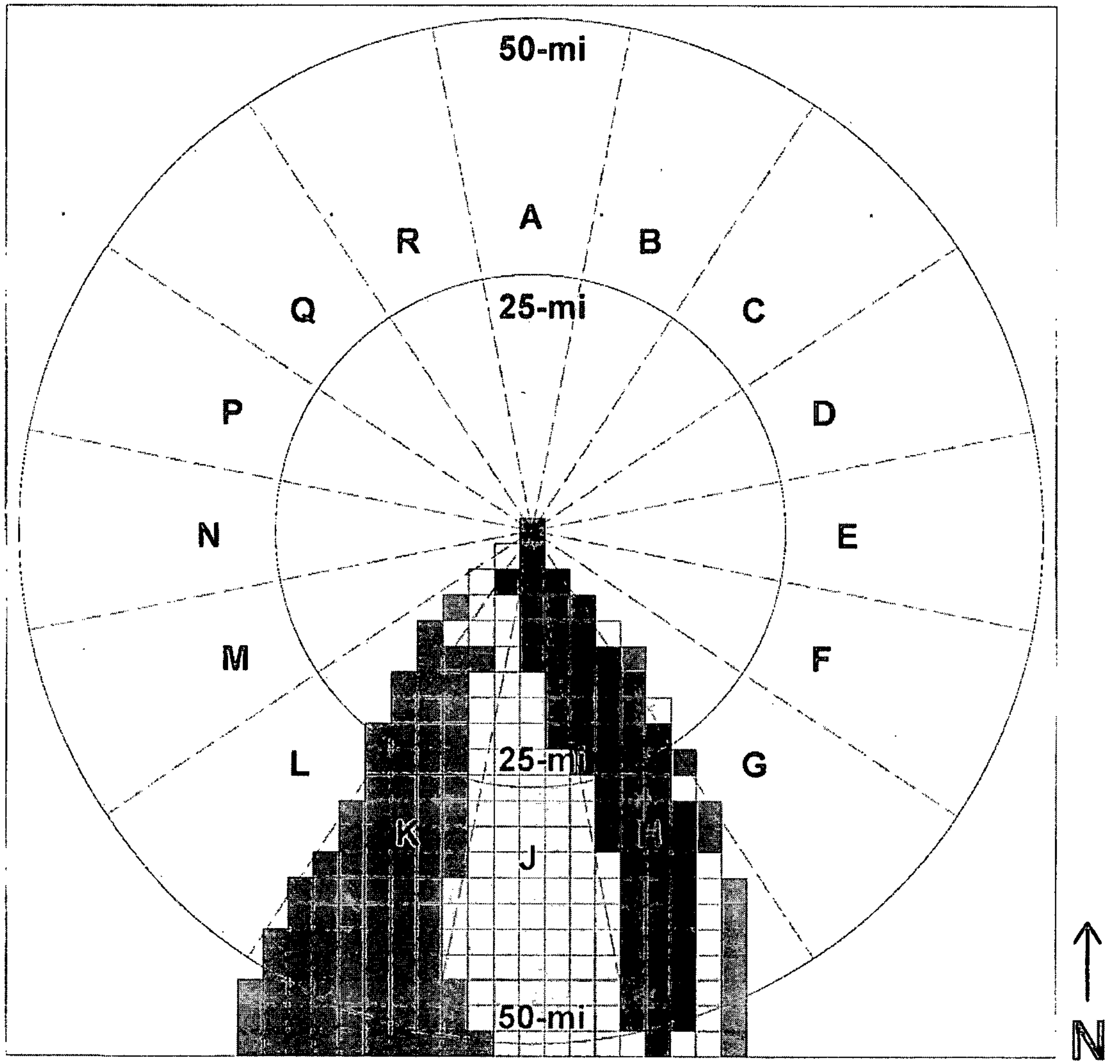
Case description: Fukushima Unit 2 mid night release 14MAR
End of calculations: 2011/03/15 16:00
Start of release to atmosphere + 16 h
Distance of calculation: Close-in + to 50 miles
Close-in distances: 0.5, 1.0, 1.5, 2.0, 3.0, 5.0, 7.0, 10.0 miles

Total Effective Dose Equivalent

Accumulated between 2011/03/15 00:00 and 2011/03/15 16:00

Fukushima Unit 2 mid night release 14MAR

Fukushima Unit 2



0.01 to 1 rem
Below EPA PAG Range

1 to 5 rem
EPA Early Phase PAG Range

> 5 rem
Exceeds EPA PAG Range

RASCAL v4.1

Re-run of 3/15/11 2:51 run found in press release. Ignore run date/time on this copy.

Summary Report

Case description: Fukushima Unit 2 mid night release 14MAR
Run date/time: 2011/03/15 03:04

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	5.4E+03	2.0E+03	1.2E+03	8.2E+02	4.8E+02	2.4E+02	1.6E+02	9.5E+01
Thyroid CDE	2.8E+04	1.1E+04	6.2E+03	4.3E+03	2.5E+03	1.3E+03	8.4E+02	5.1E+02
Inhalation CEDE	3.7E+03	1.4E+03	8.0E+02	5.6E+02	3.3E+02	1.7E+02	1.1E+02	6.7E+01
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	2.4E+04	9.3E+03	5.4E+03	3.8E+03	2.2E+03	1.0E+03	6.6E+02	3.9E+02
Inter Phase 2nd Yr	1.1E+04	4.4E+03	2.6E+03	1.8E+03	1.0E+03	4.9E+02	3.1E+02	1.8E+02

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	8.6E+01	6.3E+01	3.7E+01	1.8E+01	8.1E+00
Thyroid CDE	3.3E+02	2.7E+02	1.3E+02	5.9E+01	2.5E+01
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	2.9E-02
4-day Groundshine	4.7E+01	3.2E+01	2.4E+01	1.3E+01	6.7E+00
Inter Phase 1st Yr	7.1E+02	4.7E+02	3.8E+02	2.2E+02	1.3E+02
Inter Phase 2nd Yr	3.4E+02	2.3E+02	1.8E+02	1.1E+02	6.9E+01

Notes:
- Doses exceeding PAGs are underlined.
- Early-Phase PAGs: TEDE - 1 rem, Thyroid (iodine) CDE - 5 rem
- Intermediate-Phase 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

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
UTC Offset: 9 hours
Population: not available

Reactor Parameters

Summary Report

Reactor power:	2350 MWt
Average fuel burn-up:	30000 MWD / MTU
Containment type:	BWR Mark I
Containment volume:	2.50E+05 ft^3
Design pressure:	60 lb/in^2
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:	Unit 2 mid-night release 3-14-11
Release height:	10. m

Release events

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

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	?	
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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	?	

Summary Report

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
2011/03/15 19:00	Fcst	085	4.4	B	None
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
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

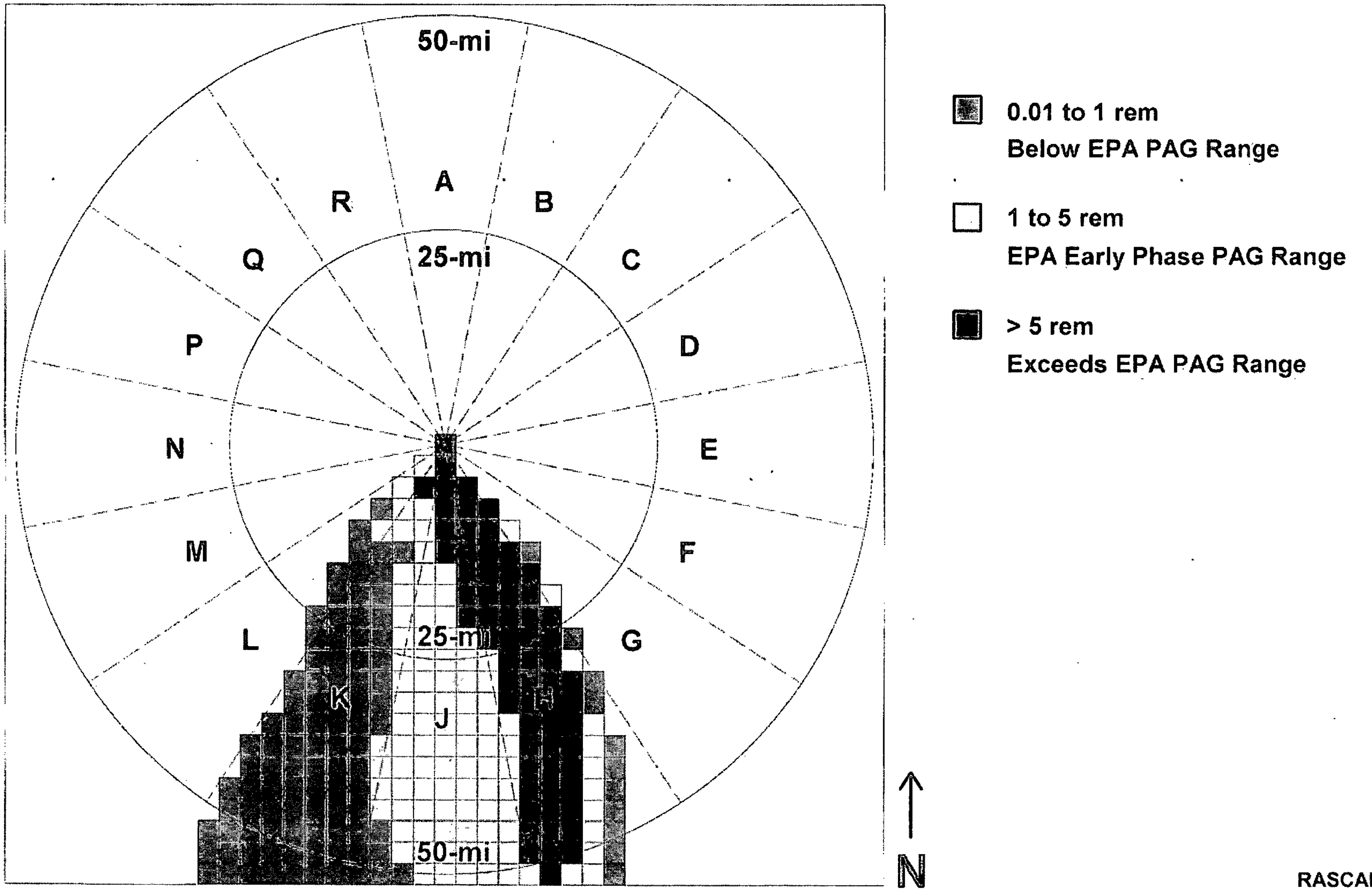
Case description: Fukushima Unit 2 mid night release 14MAR
End of calculations: 2011/03/15 16:00
Start of release to atmosphere + 16 h
Distance of calculation: Close-in + to 50 miles
Close-in distances: 0.5, 1.0, 1.5, 2.0, 3.0, 5.0, 7.0, 10.0 miles

Total Effective Dose Equivalent

Accumulated between 2011/03/15 00:00 and 2011/03/15 16:00

Fukushima Unit 2 mid night release 14MAR

Fukushima Unit 2



RASCAL v4.1

Re-run of 3/16/11 run @ 12:24pm found in press release. Ignore run date/time on this copy

Summary Report

Case description: Fukushima U2, U3 and U4 SFP approximate site release
Run date/time: 2011/03/17 08:48

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	5.4E+03	1.5E+03	6.7E+02	3.9E+02	1.8E+02	7.5E+01	4.0E+01	1.4E+01
Thyroid CDE	2.9E+04	7.9E+03	3.6E+03	2.1E+03	9.6E+02	4.0E+02	2.1E+02	7.5E+01
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	2.6E+04	7.0E+03	3.2E+03	1.9E+03	8.5E+02	3.5E+02	1.9E+02	7.5E+01
Inter Phase 2nd Yr	1.3E+04	3.5E+03	1.6E+03	9.2E+02	4.2E+02	1.8E+02	9.5E+01	3.8E+01

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	1.5E+01	1.3E+01	1.1E+01	1.0E+01	9.9E+00
Thyroid CDE	8.6E+01	7.0E+01	5.2E+01	4.9E+01	4.8E+01
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	7.1E+01	6.0E+01	4.7E+01	4.5E+01	4.3E+01
Inter Phase 2nd Yr	3.6E+01	3.0E+01	2.3E+01	2.2E+01	2.1E+01

Notes:
- Doses exceeding PAGs are underlined.
- Early-Phase PAGs: TEDE - 1 rem, Thyroid (iodine) CDE - 5 rem
- Intermediate-Phase 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

Case Summary

Event Type Nuclear Power Plant

Location
Name: Fukushima U4
City, county, state: <undefined>, <undefined>, <undefined>
Lat / Long / Elev: 37.4214° N, 141.0325° E, 0 m
UTC Offset: 9 hours
Population: not available

Reactor Parameters

Summary Report

Reactor power:	3760 MWt
Average fuel burn-up:	30000 MWD / MTU
Containment type:	BWR Mark I
Containment volume:	2.50E+05 ft^3
Design pressure:	60 lb/in^2
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:	Fukushima - U2, U3 and U4 SFP release approximation
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	?	
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	?	

Summary Report

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
2011/03/15 19:00	Fcst	085	4.4	B	None
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
2011/03/16 08:00	Fcst	331	4.9	D	None
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
2011/03/17 01:00	Fcst	286	7.0	D	None
2011/03/17 02:00	Fcst	287	6.6	D	None
2011/03/17 03:00	Fcst	293	6.5	D	None
2011/03/17 04:00	Fcst	300	6.3	D	None
2011/03/17 05:00	Fcst	311	5.9	D	None
2011/03/17 06:00	Fcst	295	7.4	D	None

2011/03/17 07:00	Fcst	303	8.4	C	None
2011/03/17 08:00	Fcst	333	4.8	C	None
2011/03/17 09:00	Fcst	321	5.9	C	None
2011/03/17 10:00	Fcst	307	5.0	C	None
2011/03/17 11:00	Fcst	292	8.4	C	None
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

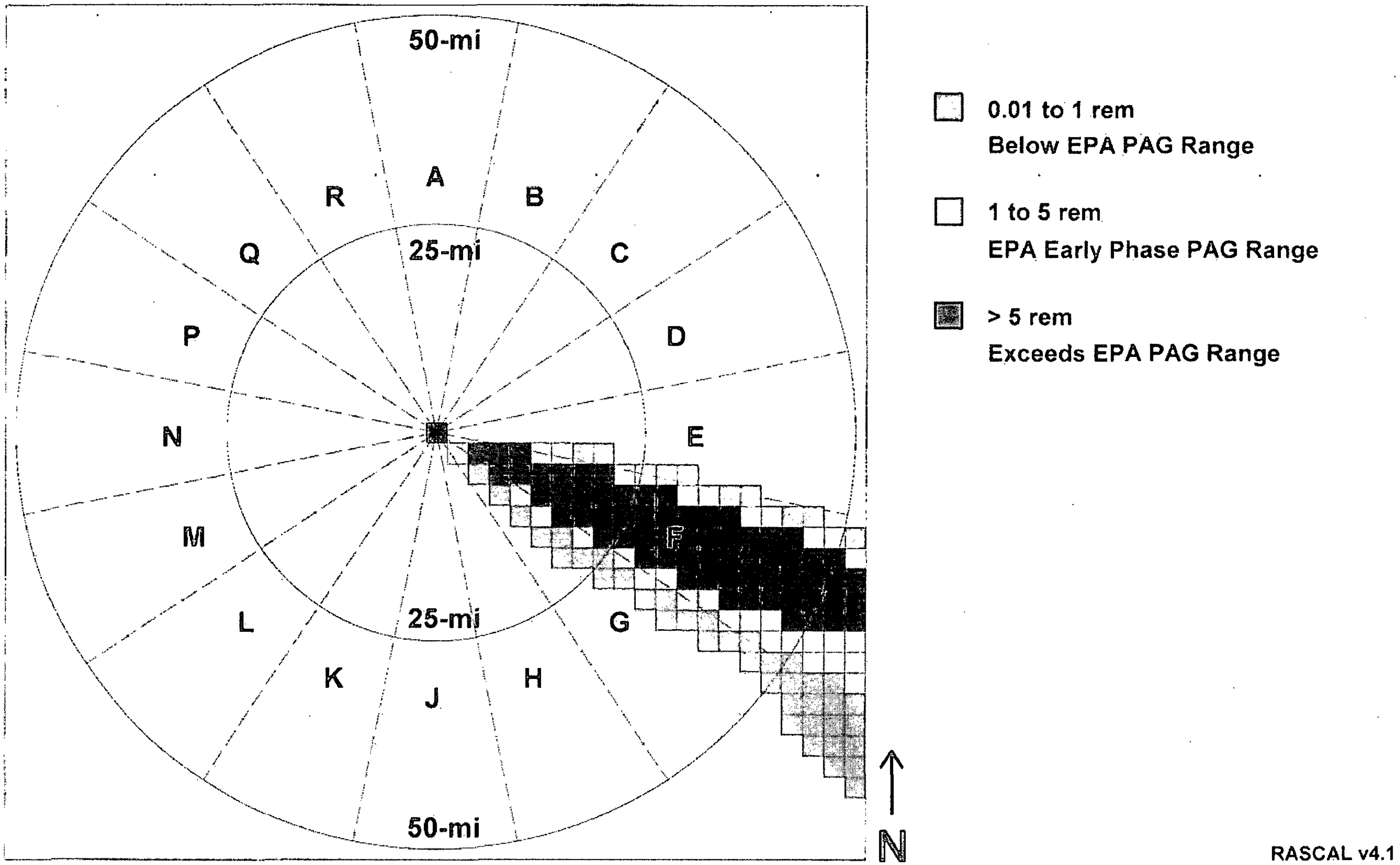
Case description: Fukushima U2, U3 and U4 SFP approximate site release
End of calculations: 2011/03/17 10:50
Start of release to atmosphere + 15 h
Distance of calculation: Close-in + to 50 miles
Close-in distances: 0.5, 1.0, 1.5, 2.0, 3.0, 5.0, 7.0, 10.0 miles

Total Effective Dose Equivalent

Accumulated between 2011/03/16 19:50 and 2011/03/17 10:50

Fukushima U2, U3 and U4 SFP approximate site release

Fukushima U4



From:	Flory, Shirley
To:	Case, Michael; Coe, Doug; Coyne, Kevin; Gibson, Kathy; Uhle, Jennifer; Richards, Stuart; Scott, Michael; Sheron, Brian; Valentin, Andrea
Subject:	NUCLEAR NEWS FLASHES
Date:	Thursday, March 17, 2011 10:35:09 AM
Attachments:	nn110316.txt

XX\19

Nuclear News Flashes
Wednesday, Mar 16, 2011

[Inside This Issue:]

*** Up to 6 feet of Fukushima cores without water cover

Between one and two meters (two meters is about 6.5 feet) of the fuel cores in reactors 1, 2 and 3 of the Fukushima I nuclear power plant in Japan are not covered by water, IAEA Director General Yukima Amano said at a press briefing in Vienna March 16.

Amano said the situation at the six-reactor Fukushima I nuclear power station, also known as Fukushima Daiichi, was very serious and core damage has been confirmed in reactors 1, 2 and 3.

In addition, he said temperatures rises have been observed in the spent fuel pools of reactors 4, 5 and 6 at the site.

Amano said the evacuation of a 20-kilometer (12.4-mile) zone around the plant has been completed and residents living between 20 km and 30 km of the plant have been advised to take shelter.

Amano said he would fly to Japan as soon as possible to investigate how the agency can help and report back to the IAEA's board of governors.

He said the IAEA's Fukushima Accident Coordination Team formed March 15 to be sent to Japan will include nuclear safety and radioprotection experts.

*** Fukushima I-5 reactor core water level drop

The water covering the nuclear fuel core of reactor 5 at the Fukushima I nuclear plant in Japan fell 40 centimeters (15.7 inches) between 7 am and noon Greenwich Mean Time March 15, the IAEA said March 16.

The IAEA did not say why the water level had fallen, but it did say the water level remained above the top of the fuel assemblies in the core.

The development opens a new front in the battle by Tokyo Electric Power Co. to secure the six-reactor nuclear plant site against potential meltdowns and radioactive releases.

Until now, no significant problems had been reported at units 5 and 6 at Fukushima I, both of which were already in cold shutdown when the March 11 earthquake and tsunami struck.

The water is already boiling in the spent fuel pool of unit 4, and Tepco is struggling to maintain cooling of the reactor cores at units 1, 2 and 3.

IAEA said Wednesday that Japanese authorities informed it that at noon GMT March 15 the water level in unit 5 had dropped to 201 cm above the top of the fuel. This was a 40 cm decrease since 7 am GMT that day. Officials at the plant were planning to use an operational diesel generator at unit 6 to supply water to unit 5.

*** China suspends new plant approval in Fukushima's wake

China, which leads the world in nuclear power expansion, will suspend new nuclear power plant approval, according to the state-owned Xinhua News Agency.

Xinhua reported March 16 the government has also ordered a "comprehensive safety check" on all operating nuclear plants and those under construction. It said the decisions were made during a State Council Standing Committee meeting the same day.

Chinese Premier Wen Jiabao presided over the meeting and was briefed on the situation at Japan's Fukushima I nuclear power plant, where a meltdown is under way after an earthquake followed by a tsunami cut off all power supply, Xinhua said.

Officials at the meeting decided to "speed up" the development of a nuclear safety plan and to "suspend nuclear power projects review and approval, including early site work" until the plan is approved, the

Xinhua report said. It also said that officials at the meeting decided to "adjust and improve" a nuclear power roadmap for the next few years.

China had planned to launch nuclear energy projects during 2011-2015 that would have a combined generating capacity of 40,000 MW, according to the government's draft 12th Five-Year Plan. The National People's Congress â€" China's national parliament â€" met earlier this month to discuss the plan. It is unclear what the parliament decided after the meeting ended March 14.

China has 10,744 MW of nuclear generating capacity online, according to Platts data. One megawatt equals 0.001 gigawatt. There are 13 nuclear power units, totaling 10.8 GW, operating in China. Twenty-eight more units, totaling 30.8 GW, are under construction or have received a construction permit, totaling 30.8 GW.

*** Spot price of uranium falls to at least $50/lb

The spot price of uranium continued to fall to at least $50 a pound U3O8 and possibly as low as $47/lb, several analysts said. According to TradeTech, the spot price March 16 was $50/lb, down $5/lb from the March 15 price. The spot U3O8 price has dropped by at least $18/lb since the March 11 earthquake and tsunami hit Japan. The fall in the spot price was accelerated by the announcement by the Chinese government that new nuclear power plant approvals would be temporarily suspended and that safety inspections of nuclear power plants under construction would be conducted.

*** ARMZ deal to buy Mantra killed by events in Japan

An A$1.2 billion ($1.17 billion) uranium deal has been canceled in the wake of the nuclear accident unfolding at Japan's Fukushima-I, also called Fukushima Daiichi, nuclear power plant.

Canada's Uranium One said March 16 that a deal by its majority shareholder, Russia's Atomredmetzoloto, to buy Perth, Australia-based Mantra Resources Ltd. will not go forward under the existing agreement.

Uranium One said events in Japan "are likely to have a material adverse effect" on the business, results of operations, assets or liabilities, financial position or prospects of Mantra.

ARMZ considers that the requirements in the December agreement between ARMZ and Mantra could not be satisfied because the agreement requires that there be "no material adverse change" prior to closing the deal, Uranium One said.

Uranium One said ARMZ would explore "alternative approaches" to buying Mantra. Mantra's Mkuju River Project in southern Tanzania has reserves of 39,000 metric tons of uranium, according to ARMZ's December 15 announcement of the deal.

ARMZ was to pay $8 per share â€" representing a 15.5% premium to Mantra's 20-day volume weighted average price on the Australian Stock Exchange at the time of the announcement â€" which put Mantra's value at $1.2 billion of resource.

When the deal closed, Uranium One was to operate and finance Mantra's assets, the companies said at the time.

*** Worst-case Fukushima fallout 'higher than Chernobyl': French expert

The events at Japan's Fukushima I nuclear power plant could potentially lead to higher total radioactive fallout than that from the 1986 Chernobyl accident, the head of France's nuclear safety institute, IRSN, said March 16.

Jacques Repussard said IRSN, along with its US counterparts, has modeled possible radioactive releases under different scenarios of what might happen at the Japanese plant.

He said that in the worst-case scenario, if the six reactor cores and spent fuel pools at Fukushima I, also known as Fukushima Daiichi, cannot be cooled, the releases of radioactive cesium and other radionuclides from "several cores over a longer period" could be "higher than [those from] Chernobyl."

He added that under some accident scenarios, the 20-kilometer evacuation zone and the 30-km sheltering zone ordered around Fukushima I "could be insufficient."

He said Tokyo would be slightly contaminated but that the level of contamination would not pose a problem for human health.

*** Vladivostok radiation level rises slightly

Radiation levels in the Russian Pacific port city of Vladivostok, about 500 miles northwest of Japan's damaged Fukushima I nuclear power plant, rose to 14 microroentgens an hour at 4:00 GMT March 16, from 12 microroentgens the previous day.

The roentgen is a unit of measurement for exposure to ionizing radiation, such as X-ray and gamma rays.

The results follow tests started that day on sea scallops to monitor radiation levels in Russia's Far East, state-run local water firm Primvodokanal said on its web site March 16.

The regional emergencies ministry says up to 30 microroentgens an hour is considered safe, Primvodokanal said.

"If the radiation in the water rises, the health of the molluscs will change as they react to the ions in heavy metal," it said. "So far, this has not happened."

Scientists first started using this method to check for pollution in Russia's Far East waters last year.

The Far East's regional emergencies ministry said in a statement March 16 that it does not see any danger from radiation to the region from the nuclear crisis in Japan, though it is checking radiation levels round-the-clock.

*** French Socialists call for rethinking nuclear, not a phase-out

France's Socialist Party stopped short of calling for a phase-out of nuclear power in a policy laid out in a document circulated March 16 at a parliamentary hearing on Japan's ongoing nuclear accident.

The party said a phase-out was "hypothetical" since some 80% of France's electricity is supplied by its 58 nuclear power units. But it said the country should "sincerely" look for alternatives to nuclear. In the meantime, there should be no nuclear generating capacity added in France, it said.

The party called for immediate safety audits for all French nuclear plants "without waiting for experience feedback from the accidents in Japan." The audits should probe the justification for plant life extension, it said.

The French government has also called for such audits, but Environment Minister Nathalie Kosciusko-Morizet said at the hearing that the audits would be done under criteria to be worked out on an EU level by the EU nuclear regulators' group, Ensreg.

French Green party EELV has called for phasing out nuclear within 25 years. Green Party MP Yves Cochet said at the hearing that goal was "possible." He called for a national debate on nuclear power, followed by a referendum on closing the French reactors.

Nuclear policy is shaping up as an issue in the 2012 presidential and legislative elections.

In the last national elections in 2007, PS candidate Segolene Royal ran on a platform hostile to new nuclear. She lost to Nicolas Sarkozy, who is openly pro-nuclear. This year, Sarkozy is trailing in opinion polls, but the Socialists are not doing well either and could need the support of the Greens, for whom the nuclear issue is central, to form a coalition.

The far-right National Front's leader Marine Le Pen is running strongly in opinion polls. The party opposes nuclear power.

*** EU nuclear regulators to set 'stress test' criteria

The European Nuclear Safety Regulators Group will meet in April to work out standards and criteria for the planned "stress tests" of European nuclear power plants, French Environment Minister Nathalie Kosciusko-Morizet said March 16.

Kosciusko-Morizet told a French parliamentary hearing on the ongoing accident at Japan's Fukushima I nuclear power plant that the criteria will be used to assess the safety of France's 58 reactors.

Industry Minister Eric Besson said the safety audit would include issues of seismic resistance, flooding, loss of cooling resources and "tools to cope with core melt," such as the "core catcher," or core retention chamber, in Areva's EPR design.

The EU group includes nuclear and radiation safety regulators from all 27 EU member states, some of which, such as Austria, are officially anti-nuclear.

France has 58 reactors, about a third of the EU total, and gets more than 75% of its electricity from nuclear power plants.

A French energy official said it would take time to work out details of the planned "stress tests" and to determine how the nuclear safety audits will be done.

*** Medvedev convinced nuclear power can be safe

Russian President Dmitry Medvedev said March 16 he is convinced nuclear power can be safe, if the location of plant, its design and operator are chosen properly, Russian news agency Itar-Tass reported.

"The construction of new nuclear power stations has arrested great attention, in the wake of the colossal calamity experienced by Japan," he said after talks with Turkish Prime Minister Recep Tayyip Erdogan, with whom he discussed, among other things, Russia's work to build what would become Turkey's first nuclear power plant at Akkuyu.

"Everybody is asking the simple question: Can nuclear power be safe?" the Russian president said, referring to the ongoing accident at the Japanese nuclear power plant Fukushima I.

"With all of these conditions met, nuclear power is absolutely safe and very beneficial to humankind," he said.

For the Akkuyu plant, Russia will used a "fundamentally new control pattern," which includes the "trinity of opportunities" â€" construction of the station, ownership, and its management, Medvedev said.

"This certainly increases our responsibility [and] our Turkish partners are interested in this to a no small degree," he said.

*** Russia to lend Belarus US$6 billion to build first nuclear plant

Russia will arrange a state loan of "about" $US6 billion to fund Belarusia's first nuclear power plant, Russian Prime Minister Vladimir Putin told local Russian media March 16.

The loan agreement will be concluded "within a month," he said, according to Itar-Tass.

The two countries signed an agreement to cooperate in the construction of the two-unit, 2,400-MW plant in Astravets March 15, Russian state nuclear corporation Rosatom said that day. The first unit is to start commercial operation in 2017 and the second in 2018.

The agreement was signed by Rosatom Director General Sergey Kirienko and Belarusian energy minister Alexander Ozerets, in the presence of Putin and his Belarusian counterpart Mikhail Myasnikovich.

Myashnikovich said the plant would create a "technological basis" for a common Russian-Belarusian electricity market, which Kazakhstan might join in the future, Itar-Tass said March 16.

Rosatom subsidiary Atomstroyexport is to be the general contractor of the project.

Kirienko said March 16 that a general agreement on the construction of the plant would be signed in May.

*** SKB submits application for spent fuel repository

SKB submitted a repository application to the Swedish Radiation Safety Authority and an environmental court March 16 as the nuclear crisis at Fukushima I in Japan continued unfolding.

"Of course we have considered doing this in the context of what's happened, but I don't think anything that's happening now in Japan speaks against going ahead with this," Claes Thegerstroem, chief executive of the Swedish Nuclear Fuel & Waste Management Co., or SKB, said at a press conference March 16.

SKB also submitted an application to build a factory to manufacture the copper and steel canisters for the spent fuel.

They will review the applications in parallel and make recommendations to the Swedish government, which will make the final decision.

The proposed repository would be built at the Forsmark nuclear plant, while the factory would be near the Oskarshamn nuclear power plant.

The canisters would be placed 500 meters deep in granite bedrock. Bentonite clay would be placed around them as a buffer against radioactive leaks reaching the atmosphere.

SKB is jointly owned by Sweden's nuclear utilities.

*** US nuclear industry to conduct review of severe accident response: NEI

The US nuclear power industry will take "several actions" to assess its capability to respond to severe accidents like the unfolding disaster at two plants in Fukushima, a senior industry official testified at a March 16 hearing.

Anthony Pietrangelo, senior vice president and chief nuclear officer at the Nuclear Energy Institute, said at the Senate Environment and Public Works hearing that the chief nuclear officers of US nuclear utilities have all agreed to verify "capability to mitigate severe adverse events" at their reactors, "including loss of major safety systems."

NEI said in a March 16 statement that the industry agreed to "verify each company's capability to mitigate conditions that result from severe adverse events, including the loss of significant operational and safety systems due to natural events, fires, aircraft impact and explosions. Specific actions include testing and inspecting equipment required to mitigate these events and verifying that qualifications of operators and support staff required to implement them are current."

Operators will "verify that the capability to mitigate a total loss of electric power to a nuclear power plant is proper and functional. This will require inspections verifying that all required materials are adequate and properly staged and that procedures are implemented," NEI said.

Loss of offsite power and emergency diesel generators crippled safety systems at the Fukushima I reactors after the March 11 earthquake and tsunami, allowing nuclear fuel in the reactors' cores and spent fuel pools to overheat. This overheating led to hydrogen explosions and possibly breaches of containment at some of the reactors, releasing large amounts of radioactivity.

The US operators will "verify the capability to mitigate flooding and the impact of floods on systems inside and outside the plant. Specific actions include verifying required materials and equipment are properly located to protect them from flood," the group said.

NEI said nuclear plant workers will "perform walk downs and inspection of important equipment needed to successfully respond to fire and flood events" and identify the potential that the equipment's function could be lost during seismic events appropriate for the site and develop mitigating strategies for potential vulnerabilities.

"We have no fatalities due to radioactive releases in our country. We're proud of our safety record," Pietrangelo said at the hearing.

The nuclear industry "will apply lessons learned" from the Fukushima events to "make it even less probable" that such accidents will occur in the US, he said.

*** NRC recommends broader evacuation from Japan nuclear disaster: Jaczko

The US Nuclear Regulatory Commission believes it is "appropriate to evacuate to a much larger distance" from the region around the damaged Japanese nuclear power reactors, NRC Chairman Jaczko said March 16 in testimony before subcommittees of the House Energy and Commerce Committee.

If a similar accident occurred in the US, Jaczko said, the NRC believes it would be appropriate to evacuate "to a much larger radius than has currently been provided in Japan," Jaczko said in his opening statement. The US Ambassador in Japan is now informing US citizens there that it is "appropriate to evacuate to a much larger distance," up to 50 miles from the crippled nuclear power reactors, he said.

Japanese authorities are evacuating people from a 20-kilometer zone around the Fukushima nuclear plants. Those located between 20 and 30 km of the plants are being told to shelter in place.

"We have indication of radiation levels that would be lethal within a fairly short period of time. So they're very significant," Jaczko told the subcommittees at the hearing. "These very, very high readings" are "recent developments," he said at the hearing, mid-afternoon US time.

Jaczko did not provide quantitative estimates of the releases or doses resulting from them, nor did he say how close to the plant the readings were taken.

The three reactors at the Fukushima I plant, also called Fukushima Daiichi, that were operating at the time of the March 11 earthquake are believed to have "suffered some degree of core damage from insufficient cooling caused by the loss of offsite power and the inability of emergency diesel generators to operate successfully after the tsunami," Jaczko said. He did not provide details on the extent of the damage.

"Stable cooling" has now been established at Fukushima I-1 and -3 by flooding the reactor vessels with seawater, Jaczko said. "The primary containment is described as functional" for those units, he said.

"We believe core cooling is not stable" at Fukushima I-2, but "believe that primary containment is continuing to function," Jaczko said.

It is believed that the water level in the unit 2 spent fuel pool is "decreasing," Jaczko said. The "structural integrity has been compromised" at the unit 3 pool, and there may have been interaction of zirconium fuel cladding and water in that pool, he said.

At Fukushima I-4, a hydrogen explosion took place "due to uncovering of the spent fuel pool," Jaczko said. The secondary containment was "destroyed" by the blast "and there is no water in the spent fuel pool," he said.

"Radiation levels are very high" at unit 4, "which could impact the ability to take corrective measures," Jaczko said.

According to an IAEA report, Jaczko said, the water level is "down a bit" in the spent fuel pool at unit 5. There is "no significant information at this time" on unit 6, he said.

*** US reactor report

â€" The power level at Palisades was reduced to 52% early March 16 so a planned inspection of electric cables could be done. The reactor will remain at that level until the inspection is completed, Entergy spokesman Mark Savage said in an e-mail. The cables run between a 2,400-volt A/C bus and the 345-kilovolt bus at the rear of the plant's switchyard, he said. Savage could not say when the plant would return to full power.

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Lee, Richard

From: Gauld, Ian C. [gauldi@ornl.gov]
Sent: Friday, March 18, 2011 2:38 PM
To: Lee, Richard
Cc: Parks, Cecil V.
Subject: RE: Fukushima data
Attachments: F4-pool-105d.txt; F4-pool-500d.txt; F4-reactor.txt

Richard

Here are the is Fukushima unit 4 pool data. Two source files: one for the hottest fuel with 105 day cooling, the other for 500 day fuel. These data are normalized to a metric ton of uranium. This will make it easier to convert to grams/W etc if needed, since operating power was 25 MW/t. If an assembly basis, or total inventory basis are preferred, this can be quickly changed. The metric tons of 105 day fuel in the pool is 94 t (548 assemblies = full core), and 113 t of longer cooled fuel (657 assemblies).

Also, please replace the reactor core data (file F4-reactor.txt) with the attached file. Some of the longer cooling time step were not correct.

Thanks

Ian

XX/20

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decay, following irradiation identified by: power=  25.00mw, burnup=  39500.mwd, flux=
4.05E+13n/cm**2-sec

                                                element concentrations, grams
                                                basis = full core inventory 548 assemblies (94t
              charge  discharge   2E-03 h   3E-03 h   5E-03 h   8E-03 h   2E-02 h   3E-02 h   7E-02 h
0.2 h      0.3 h      1.0 h      1.5 h      2.0 h      4.0 h      6.0 h      8.0 h     10.0 h
    he      1.518E-01 5.545E+01 5.545E+01 5.545E+01 5.545E+01 5.545E+01 5.545E+01 5.545E+01 5.545E+01
5.545E+01 5.545E+01 5.545E+01 5.546E+01 5.546E+01 5.547E+01 5.548E+01 5.549E+01 5.550E+01
    tl      1.279E-12 3.625E-10 3.625E-10 3.625E-10 3.625E-10 3.625E-10 3.625E-10 3.625E-10 3.625E-10
3.625E-10 3.625E-10 3.748E-10 3.626E-10 3.626E-10 3.675E-10 3.675E-10 3.675E-10 3.674E-10
    pb      3.437E-07 1.404E-04 1.404E-04 1.404E-04 1.404E-04 1.404E-04 1.404E-04 1.404E-04 1.404E-04
1.404E-04 1.404E-04 1.404E-04 1.404E-04 1.404E-04 1.404E-04 1.405E-04 1.405E-04 1.405E-04
    bi      1.357E-10 5.190E-08 5.190E-08 5.190E-08 5.190E-08 5.190E-08 5.190E-08 5.190E-08 5.190E-08
5.190E-08 5.190E-08 5.190E-08 5.191E-08 5.191E-08 5.192E-08 5.192E-08 5.193E-08 5.193E-08
    po      2.213E-13 7.718E-11 7.718E-11 7.718E-11 7.718E-11 7.718E-11 7.718E-11 7.718E-11 7.718E-11
7.718E-11 7.719E-11 7.719E-11 7.719E-11 7.720E-11 7.721E-11 7.723E-11 7.724E-11 7.726E-11
    at      6.091E-20 4.539E-17 4.540E-17 4.540E-17 4.540E-17 4.539E-17 4.539E-17 4.539E-17 4.539E-17
4.539E-17 4.539E-17 4.540E-17 4.540E-17 4.540E-17 4.543E-17 4.544E-17 4.545E-17 4.546E-17
    rn      1.324E-12 3.548E-10 3.548E-10 3.548E-10 3.548E-10 3.548E-10 3.548E-10 3.548E-10 3.548E-10
3.548E-10 3.551E-10 3.549E-10 3.549E-10 3.549E-10 3.548E-10 3.548E-10 3.547E-10 3.547E-10
    fr      6.986E-16 4.392E-13 4.392E-13 4.392E-13 4.392E-13 4.392E-13 4.392E-13 4.392E-13 4.392E-13
4.392E-13 4.392E-13 4.393E-13 4.393E-13 4.393E-13 4.396E-13 4.397E-13 4.398E-13 4.399E-13
    ra      3.533E-08 6.747E-06 6.747E-06 6.747E-06 6.747E-06 6.747E-06 6.747E-06 6.747E-06 6.747E-06
6.747E-06 6.747E-06 6.747E-06 6.747E-06 6.747E-06 6.747E-06 6.748E-06 6.748E-06 6.748E-06
    ac      5.191E-09 7.170E-07 7.170E-07 7.170E-07 7.170E-07 7.170E-07 7.170E-07 7.170E-07 7.170E-07
7.170E-07 7.170E-07 7.170E-07 7.170E-07 7.170E-07 7.171E-07 7.172E-07 7.174E-07 7.175E-07
    th      2.133E-03 2.484E-01 2.484E-01 2.484E-01 2.484E-01 2.484E-01 2.484E-01 2.484E-01 2.484E-01
2.484E-01 2.484E-01 2.484E-01 2.484E-01 2.484E-01 2.484E-01 2.484E-01 2.484E-01 2.484E-01
    pa      3.415E-04 5.130E-02 5.130E-02 5.130E-02 5.130E-02 5.130E-02 5.130E-02 5.130E-02 5.130E-02
5.130E-02 5.130E-02 5.130E-02 5.130E-02 5.130E-02 5.131E-02 5.131E-02 5.131E-02 5.131E-02
     u      9.649E+05 8.925E+07 8.925E+07 8.925E+07 8.925E+07 8.925E+07 8.925E+07 8.925E+07 8.925E+07
8.925E+07 8.925E+07 8.925E+07 8.925E+07 8.925E+07 8.925E+07 8.925E+07 8.925E+07 8.924E+07
    np      2.870E+02 4.931E+04 4.931E+04 4.931E+04 4.931E+04 4.931E+04 4.931E+04 4.931E+04 4.931E+04
4.931E+04 4.931E+04 4.927E+04 4.924E+04 4.921E+04 4.908E+04 4.895E+04 4.882E+04 4.870E+04
    pu      7.185E+03 8.213E+05 8.213E+05 8.213E+05 8.213E+05 8.213E+05 8.213E+05 8.213E+05 8.213E+05
8.213E+05 8.213E+05 8.214E+05 8.214E+05 8.215E+05 8.216E+05 8.217E+05 8.219E+05 8.220E+05
    am      6.734E+01 1.728E+04 1.728E+04 1.728E+04 1.728E+04 1.728E+04 1.728E+04 1.728E+04 1.728E+04
1.728E+04 1.728E+04 1.728E+04 1.728E+04 1.728E+04 1.728E+04 1.728E+04 1.728E+04 1.728E+04
    cm      1.137E+01 5.389E+03 5.389E+03 5.389E+03 5.389E+03 5.389E+03 5.389E+03 5.389E+03 5.389E+03
5.389E+03 5.389E+03 5.389E+03 5.390E+03 5.390E+03 5.391E+03 5.392E+03 5.392E+03 5.393E+03
    bk      1.175E-08 8.000E-05 8.000E-05 8.000E-05 8.000E-05 8.000E-05 8.000E-05 8.000E-05 8.000E-05
8.000E-05 8.001E-05 8.001E-05 8.001E-05 8.001E-05 7.999E-05 7.997E-05 7.995E-05 7.993E-05
    cf      7.074E-09 5.351E-05 5.351E-05 5.351E-05 5.351E-05 5.351E-05 5.351E-05 5.351E-05 5.351E-05
5.351E-05 5.352E-05 5.353E-05 5.354E-05 5.355E-05 5.358E-05 5.361E-05 5.363E-05 5.365E-05
    es      2.726E-13 9.931E-09 9.931E-09 9.931E-09 9.931E-09 9.931E-09 9.931E-09 9.931E-09 9.931E-09
9.932E-09 9.932E-09 9.935E-09 9.937E-09 9.939E-09 9.947E-09 9.954E-09 9.962E-09 9.969E-09
  totals    9.724E+05 9.014E+07 9.014E+07 9.014E+07 9.014E+07 9.014E+07 9.014E+07 9.014E+07 9.014E+07
9.014E+07 9.014E+07 9.014E+07 9.014E+07 9.014E+07 9.014E+07 9.014E+07 9.014E+07 9.014E+07
□
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actinides         page   74
decay, following irradiation identified by: power=  25.00mw, burnup=  39500.mwd, flux=
4.05E+13n/cm**2-sec

                                                 element radioactivity, curies
                                                 basis = full core inventory 548 assemblies (94t
              charge  discharge   2E-03 h   3E-03 h   5E-03 h   8E-03 h   2E-02 h   3E-02 h   7E-02 h
0.2 h      0.3 h      1.0 h      1.5 h      2.0 h      4.0 h      6.0 h      8.0 h     10.0 h
    tl      3.786E-04 1.073E-01 1.073E-01 1.073E-01 1.073E-01 1.073E-01 1.073E-01 1.073E-01 1.073E-01
1.073E-01 1.073E-01 1.110E-01 1.074E-01 1.074E-01 1.088E-01 1.088E-01 1.088E-01 1.088E-01
    pb      1.053E-03 2.986E-01 2.986E-01 2.986E-01 2.986E-01 2.986E-01 2.986E-01 2.986E-01 2.986E-01
2.986E-01 2.986E-01 2.986E-01 2.986E-01 2.986E-01 2.986E-01 2.985E-01 2.985E-01 2.985E-01
    bi      1.053E-03 2.986E-01 2.986E-01 2.986E-01 2.986E-01 2.986E-01 2.986E-01 2.986E-01 2.986E-01
2.986E-01 2.986E-01 2.987E-01 2.987E-01 2.987E-01 2.987E-01 2.987E-01 2.987E-01 2.987E-01
    po      1.727E-03 4.898E-01 4.906E-01 4.906E-01 4.906E-01 4.905E-01 4.904E-01 4.902E-01 4.900E-01
4.898E-01 4.901E-01 4.899E-01 4.899E-01 4.899E-01 4.899E-01 4.899E-01 4.898E-01 4.898E-01
    at      9.808E-08 7.309E-05 7.310E-05 7.310E-05 7.310E-05 7.310E-05 7.310E-05 7.310E-05 7.310E-05
7.309E-05 7.309E-05 7.310E-05 7.311E-05 7.311E-05 7.316E-05 7.317E-05 7.319E-05 7.321E-05
    rn      1.053E-03 2.986E-01 2.986E-01 2.986E-01 2.986E-01 2.986E-01 2.986E-01 2.986E-01 2.986E-01
2.986E-01 2.988E-01 2.986E-01 2.986E-01 2.986E-01 2.985E-01 2.985E-01 2.985E-01 2.984E-01
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7.380E-05 7.381E-05 7.381E-05 7.382E-05 7.382E-05 7.387E-05 7.389E-05 7.391E-05 7.392E-05
    ra      1.053E-03 2.986E-01 2.986E-01 2.986E-01 2.986E-01 2.986E-01 2.986E-01 2.986E-01 2.986E-01
2.986E-01 2.986E-01 2.986E-01 2.986E-01 2.986E-01 2.986E-01 2.985E-01 2.985E-01 2.985E-01
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2.053E-03 2.019E-03 1.881E-03 1.785E-03 1.694E-03 1.377E-03 1.125E-03 9.228E-04 7.619E-04
     th      3.482E-01 1.139E+02 1.139E+02 1.139E+02 1.139E+02 1.139E+02 1.138E+02 1.137E+02 1.135E+02
1.130E+02 1.123E+02 1.100E+02 1.088E+02 1.077E+02 1.036E+02 9.977E+01 9.615E+01 9.272E+01
     pa      5.183E-01 1.173E+02 1.173E+02 1.172E+02 1.172E+02 1.172E+02 1.171E+02 1.170E+02 1.169E+02
1.168E+02 1.166E+02 1.157E+02 1.151E+02 1.145E+02 1.122E+02 1.099E+02 1.078E+02 1.057E+02
      u      6.271E+03 1.394E+09 1.390E+09 1.386E+09 1.382E+09 1.375E+09 1.354E+09 1.318E+09 1.244E+09
1.046E+09 8.009E+08 2.820E+08 1.481E+08 9.286E+07 5.483E+07 5.329E+07 5.281E+07 5.236E+07
     np      6.598E+01 1.367E+09 1.367E+09 1.367E+09 1.367E+09 1.367E+09 1.367E+09 1.367E+09 1.367E+09
1.366E+09 1.365E+09 1.357E+09 1.349E+09 1.341E+09 1.309E+09 1.277E+09 1.246E+09 1.216E+09
     pu      8.515E+04 4.181E+07 4.180E+07 4.180E+07 4.179E+07 4.177E+07 4.174E+07 4.167E+07 4.153E+07
4.109E+07 4.044E+07 3.784E+07 3.605E+07 3.438E+07 2.876E+07 2.452E+07 2.131E+07 1.888E+07
     am      1.278E+02 1.730E+07 1.730E+07 1.730E+07 1.730E+07 1.729E+07 1.729E+07 1.727E+07 1.724E+07
1.713E+07 1.698E+07 1.634E+07 1.587E+07 1.543E+07 1.376E+07 1.229E+07 1.098E+07 9.811E+06
     cm      1.713E+04 5.099E+06 5.099E+06 5.099E+06 5.099E+06 5.099E+06 5.099E+06 5.099E+06 5.099E+06
5.099E+06 5.099E+06 5.099E+06 5.099E+06 5.099E+06 5.099E+06 5.099E+06 5.099E+06 5.099E+06
     bk      1.926E-05 4.464E-01 4.462E-01 4.461E-01 4.460E-01 4.458E-01 4.452E-01 4.441E-01 4.418E-01
4.350E-01 4.247E-01 3.853E-01 3.593E-01 3.360E-01 2.642E-01 2.176E-01 1.873E-01 1.676E-01
     cf      5.202E-07 6.670E-03 6.670E-03 6.670E-03 6.670E-03 6.670E-03 6.670E-03 6.670E-03 6.670E-03
6.670E-03 6.670E-03 6.671E-03 6.672E-03 6.672E-03 6.673E-03 6.673E-03 6.673E-03 6.672E-03
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2.051E-04 2.052E-04 2.052E-04 2.053E-04 2.053E-04 2.055E-04 2.057E-04 2.059E-04 2.061E-04
  totals     1.087E+05 2.825E+09 2.821E+09 2.817E+09 2.813E+09 2.806E+09 2.785E+09 2.749E+09 2.675E+09
2.475E+09 2.229E+09 1.698E+09 1.555E+09 1.489E+09 1.411E+09 1.372E+09 1.336E+09 1.302E+09
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decay, following irradiation identified by: power= 25.00mw, burnup= 39500.mwd, flux=
4.05E+13n/cm**2-sec

```
                                            element thermal power, watts
                                            basis = full core inventory 548 assemblies (94t
            charge  discharge   2E-03 h   3E-03 h   5E-03 h   8E-03 h   2E-02 h   3E-02 h   7E-02 h
0.2 h     0.3 h     1.0 h     1.5 h     2.0 h     4.0 h     6.0 h     8.0 h    10.0 h
     tl      8.848E-06 2.509E-03 2.509E-03 2.509E-03 2.509E-03 2.509E-03 2.509E-03 2.509E-03 2.509E-03
2.509E-03 2.510E-03 2.594E-03 2.510E-03 2.510E-03 2.544E-03 2.544E-03 2.544E-03 2.544E-03
     pb      1.991E-06 5.647E-04 5.647E-04 5.647E-04 5.647E-04 5.647E-04 5.647E-04 5.647E-04 5.647E-04
5.647E-04 5.647E-04 5.647E-04 5.647E-04 5.647E-04 5.646E-04 5.646E-04 5.645E-04 5.645E-04
     bi      1.764E-05 5.001E-03 5.001E-03 5.001E-03 5.001E-03 5.001E-03 5.001E-03 5.001E-03 5.001E-03
5.001E-03 5.001E-03 5.002E-03 5.003E-03 5.003E-03 5.003E-03 5.003E-03 5.002E-03 5.002E-03
     po      7.888E-05 2.237E-02 2.240E-02 2.240E-02 2.240E-02 2.240E-02 2.239E-02 2.239E-02 2.238E-02
2.237E-02 2.239E-02 2.238E-02 2.238E-02 2.238E-02 2.238E-02 2.237E-02 2.237E-02 2.237E-02
     at      4.185E-09 3.119E-06 3.119E-06 3.119E-06 3.119E-06 3.119E-06 3.119E-06 3.119E-06 3.119E-06
3.119E-06 3.119E-06 3.119E-06 3.120E-06 3.120E-06 3.122E-06 3.123E-06 3.123E-06 3.124E-06
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1.134E-02 1.135E-02 1.134E-02 1.134E-02 1.134E-02 1.133E-02 1.133E-02 1.133E-02 1.133E-02
     fr      3.799E-09 2.823E-06 2.823E-06 2.823E-06 2.823E-06 2.823E-06 2.823E-06 2.823E-06 2.823E-06
2.823E-06 2.823E-06 2.823E-06 2.824E-06 2.824E-06 2.826E-06 2.826E-06 2.827E-06 2.828E-06
     ra      3.613E-05 1.025E-02 1.025E-02 1.025E-02 1.025E-02 1.025E-02 1.025E-02 1.025E-02 1.025E-02
1.025E-02 1.025E-02 1.025E-02 1.025E-02 1.025E-02 1.024E-02 1.024E-02 1.024E-02 1.024E-02
     ac      3.606E-09 1.791E-05 1.791E-05 1.791E-05 1.790E-05 1.790E-05 1.788E-05 1.785E-05 1.780E-05
1.762E-05 1.735E-05 1.628E-05 1.553E-05 1.482E-05 1.235E-05 1.038E-05 8.804E-06 7.549E-06
     th      1.991E-04 1.169E-01 1.169E-01 1.169E-01 1.169E-01 1.168E-01 1.167E-01 1.165E-01 1.161E-01
1.150E-01 1.136E-01 1.100E-01 1.083E-01 1.070E-01 1.025E-01 9.828E-02 9.433E-02 9.059E-02
     pa      2.074E-03 5.969E-01 5.968E-01 5.967E-01 5.966E-01 5.964E-01 5.960E-01 5.955E-01 5.949E-01
5.939E-01 5.925E-01 5.869E-01 5.828E-01 5.787E-01 5.629E-01 5.479E-01 5.337E-01 5.201E-01
      u      1.219E+01 3.741E+06 3.730E+06 3.719E+06 3.709E+06 3.688E+06 3.633E+06 3.534E+06 3.334E+06
2.795E+06 2.131E+06 7.231E+05 3.598E+05 2.099E+05 1.070E+05 1.032E+05 1.022E+05 1.014E+05
     np      1.726E-01 3.537E+06 3.537E+06 3.537E+06 3.537E+06 3.537E+06 3.537E+06 3.537E+06 3.536E+06
3.534E+06 3.530E+06 3.505E+06 3.483E+06 3.461E+06 3.374E+06 3.292E+06 3.211E+06 3.133E+06
     pu      6.249E+01 4.719E+04 4.718E+04 4.717E+04 4.717E+04 4.715E+04 4.711E+04 4.703E+04 4.686E+04
4.637E+04 4.561E+04 4.262E+04 4.056E+04 3.864E+04 3.218E+04 2.729E+04 2.360E+04 2.081E+04
     am      3.919E+00 7.466E+04 7.465E+04 7.464E+04 7.464E+04 7.462E+04 7.458E+04 7.450E+04 7.434E+04
7.384E+04 7.307E+04 6.996E+04 6.772E+04 6.555E+04 5.758E+04 5.060E+04 4.449E+04 3.914E+04
     cm      6.243E+02 1.856E+05 1.856E+05 1.856E+05 1.856E+05 1.856E+05 1.856E+05 1.856E+05 1.856E+05
1.856E+05 1.856E+05 1.856E+05 1.856E+05 1.856E+05 1.856E+05 1.856E+05 1.856E+05 1.856E+05
     bk      3.765E-09 2.246E-03 2.245E-03 2.245E-03 2.244E-03 2.242E-03 2.238E-03 2.230E-03 2.214E-03
2.166E-03 2.094E-03 1.816E-03 1.633E-03 1.469E-03 9.634E-04 6.351E-04 4.217E-04 2.830E-04
     cf      2.704E-08 3.808E-04 3.808E-04 3.808E-04 3.808E-04 3.808E-04 3.808E-04 3.808E-04 3.808E-04
3.809E-04 3.809E-04 3.809E-04 3.809E-04 3.809E-04 3.810E-04 3.810E-04 3.810E-04 3.810E-04
     es      2.322E-10 8.189E-06 8.189E-06 8.189E-06 8.189E-06 8.189E-06 8.189E-06 8.189E-06 8.189E-06
8.190E-06 8.190E-06 8.193E-06 8.195E-06 8.197E-06 8.205E-06 8.214E-06 8.222E-06 8.230E-06
  totals     7.031E+02 7.585E+06 7.574E+06 7.564E+06 7.553E+06 7.532E+06 7.477E+06 7.378E+06 7.177E+06
6.635E+06 5.965E+06 4.526E+06 4.137E+06 3.961E+06 3.757E+06 3.658E+06 3.567E+06 3.480E+06
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     Fukushima Daiichi 4   fission
products   page   76
decay, following irradiation identified by: power= 25.00mw, burnup= 39500.mwd, flux=
4.05E+13n/cm**2-sec

element concentrations, grams
basis = full core inventory 548 assemblies (94t

	charge	discharge	2E-03 h	3E-03 h	5E-03 h	8E-03 h	2E-02 h	3E-02 h	7E-02 h
h	4.918E-02	7.516E+00	7.516E+00	7.516E+00	7.516E+00	7.516E+00	7.516E+00	7.516E+00	7.516E+00
he	9.221E-01	1.308E+02	1.308E+02	1.308E+02	1.308E+02	1.308E+02	1.308E+02	1.308E+02	1.308E+02
li	1.169E-02	1.089E+00	1.089E+00	1.089E+00	1.089E+00	1.089E+00	1.089E+00	1.089E+00	1.089E+00
be	7.985E-03	1.142E+00	1.142E+00	1.142E+00	1.142E+00	1.142E+00	1.142E+00	1.142E+00	1.142E+00
b	5.155E-04	7.494E-02	7.494E-02	7.494E-02	7.494E-02	7.494E-02	7.494E-02	7.494E-02	7.494E-02
c	2.331E-03	3.546E-01	3.546E-01	3.546E-01	3.546E-01	3.546E-01	3.546E-01	3.546E-01	3.546E-01
n	2.889E-04	3.511E-02	3.511E-02	3.511E-02	3.511E-02	3.511E-02	3.511E-02	3.511E-02	3.511E-02
ne	3.983E-03	4.834E-01	4.834E-01	4.834E-01	4.834E-01	4.834E-01	4.834E-01	4.834E-01	4.834E-01
co	0.000E+00	1.473E-10	4.060E-15	3.378E-19	1.562E-23	6.012E-32	0.000E+00	0.000E+00	0.000E+00
ni	2.920E-13	1.008E-05	1.007E-05	1.006E-05	1.006E-05	1.006E-05	1.005E-05	1.005E-05	1.005E-05
cu	7.123E-12	5.491E-05	5.484E-05	5.481E-05	5.478E-05	5.475E-05	5.470E-05	5.465E-05	5.458E-05
zn	1.209E-03	1.902E-01	1.902E-01	1.902E-01	1.902E-01	1.902E-01	1.902E-01	1.902E-01	1.902E-01
ga	1.922E-03	3.078E-01	3.078E-01	3.078E-01	3.078E-01	3.078E-01	3.078E-01	3.078E-01	3.078E-01
ge	3.066E-01	4.240E+01	4.240E+01	4.240E+01	4.240E+01	4.240E+01	4.240E+01	4.240E+01	4.240E+01
as	9.313E-02	1.299E+01	1.299E+01	1.299E+01	1.299E+01	1.298E+01	1.298E+01	1.298E+01	1.298E+01
se	4.487E+01	6.048E+03	6.048E+03	6.048E+03	6.048E+03	6.048E+03	6.048E+03	6.048E+03	6.048E+03
br	1.754E+01	2.363E+03	2.363E+03	2.363E+03	2.363E+03	2.363E+03	2.363E+03	2.363E+03	2.363E+03
kr	3.151E+02	4.126E+04	4.126E+04	4.126E+04	4.126E+04	4.126E+04	4.126E+04	4.126E+04	4.126E+04
rb	2.995E+02	3.917E+04	3.917E+04	3.917E+04	3.917E+04	3.917E+04	3.917E+04	3.917E+04	3.917E+04
sr	7.807E+02	1.003E+05	1.003E+05	1.003E+05	1.003E+05	1.003E+05	1.003E+05	1.003E+05	1.003E+05
y	4.069E+02	5.269E+04	5.269E+04	5.269E+04	5.269E+04	5.269E+04	5.269E+04	5.269E+04	5.269E+04
zr	3.013E+03	4.046E+05	4.046E+05	4.046E+05	4.046E+05	4.046E+05	4.046E+05	4.046E+05	4.046E+05
nb	2.614E+01	2.607E+03	2.607E+03	2.607E+03	2.607E+03	2.607E+03	2.607E+03	2.607E+03	2.607E+03
mo	2.677E+03	3.724E+05	3.724E+05	3.724E+05	3.724E+05	3.724E+05	3.724E+05	3.724E+05	3.724E+05
tc	6.631E+02	8.869E+04	8.869E+04	8.869E+04	8.869E+04	8.869E+04	8.869E+04	8.869E+04	8.869E+04
ru	1.779E+03	2.664E+05	2.664E+05	2.664E+05	2.664E+05	2.664E+05	2.664E+05	2.664E+05	2.664E+05
rh	3.785E+02	4.758E+04	4.758E+04	4.758E+04	4.758E+04	4.758E+04	4.758E+04	4.758E+04	4.758E+04
pd	7.614E+02	1.407E+05	1.407E+05	1.407E+05	1.407E+05	1.407E+05	1.407E+05	1.407E+05	1.407E+05
ag	4.825E+01	8.373E+03	8.373E+03	8.373E+03	8.373E+03	8.373E+03	8.373E+03	8.373E+03	8.373E+03
cd	4.303E+01	8.891E+03	8.891E+03	8.891E+03	8.891E+03	8.891E+03	8.891E+03	8.891E+03	8.891E+03
in	1.487E+00	1.690E+02	1.690E+02	1.690E+02	1.690E+02	1.690E+02	1.690E+02	1.690E+02	1.690E+02
sn	3.505E+01	5.453E+03	5.453E+03	5.453E+03	5.453E+03	5.453E+03	5.453E+03	5.453E+03	5.453E+03
sb	1.139E+01	1.656E+03	1.656E+03	1.656E+03	1.656E+03	1.656E+03	1.656E+03	1.656E+03	1.656E+03
te	3.647E+02	5.280E+04	5.280E+04	5.280E+04	5.280E+04	5.280E+04	5.280E+04	5.280E+04	5.280E+04
i	1.463E+02	2.231E+04	2.231E+04	2.231E+04	2.231E+04	2.231E+04	2.231E+04	2.231E+04	2.231E+04
xe	4.203E+03	5.986E+05	5.986E+05	5.986E+05	5.986E+05	5.986E+05	5.986E+05	5.986E+05	5.986E+05
cs	2.350E+03	3.205E+05	3.205E+05	3.205E+05	3.205E+05	3.205E+05	3.205E+05	3.205E+05	3.205E+05

	0.2 h	0.3 h	1.0 h	1.5 h	2.0 h	4.0 h	6.0 h	8.0 h	10.0 h
h	7.516E+00	7.516E+00	7.516E+00	7.516E+00	7.516E+00	7.516E+00	7.515E+00	7.515E+00	7.515E+00
he	1.308E+02	1.308E+02	1.308E+02	1.308E+02	1.308E+02	1.308E+02	1.308E+02	1.308E+02	1.308E+02
li	1.089E+00	1.089E+00	1.089E+00	1.089E+00	1.089E+00	1.089E+00	1.089E+00	1.089E+00	1.089E+00
be	1.142E+00	1.142E+00	1.142E+00	1.142E+00	1.142E+00	1.142E+00	1.142E+00	1.142E+00	1.142E+00
b	7.494E-02	7.494E-02	7.494E-02	7.494E-02	7.494E-02	7.494E-02	7.494E-02	7.494E-02	7.494E-02
c	3.546E-01	3.546E-01	3.546E-01	3.546E-01	3.546E-01	3.546E-01	3.546E-01	3.546E-01	3.546E-01
n	3.511E-02	3.511E-02	3.511E-02	3.511E-02	3.511E-02	3.511E-02	3.511E-02	3.511E-02	3.511E-02
ne	4.834E-01	4.834E-01	4.834E-01	4.834E-01	4.834E-01	4.834E-01	4.834E-01	4.834E-01	4.834E-01
co	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ni	1.003E-05	1.001E-05	9.928E-06	9.865E-06	9.803E-06	9.557E-06	9.317E-06	9.084E-06	8.856E-06
cu	5.448E-05	5.437E-05	5.396E-05	5.366E-05	5.336E-05	5.217E-05	5.102E-05	4.989E-05	4.878E-05
zn	1.902E-01	1.902E-01	1.902E-01	1.902E-01	1.902E-01	1.901E-01	1.901E-01	1.900E-01	1.900E-01
ga	3.078E-01	3.077E-01	3.077E-01	3.077E-01	3.077E-01	3.076E-01	3.075E-01	3.075E-01	3.075E-01
ge	4.240E+01	4.240E+01	4.240E+01	4.240E+01	4.240E+01	4.239E+01	4.239E+01	4.239E+01	4.239E+01
as	1.298E+01	1.298E+01	1.298E+01	1.298E+01	1.298E+01	1.297E+01	1.296E+01	1.296E+01	1.296E+01
se	6.048E+03	6.048E+03	6.048E+03	6.048E+03	6.048E+03	6.048E+03	6.048E+03	6.048E+03	6.048E+03
br	2.363E+03	2.363E+03	2.363E+03	2.363E+03	2.363E+03	2.363E+03	2.363E+03	2.363E+03	2.363E+03
kr	4.126E+04	4.126E+04	4.125E+04	4.125E+04	4.125E+04	4.125E+04	4.125E+04	4.125E+04	4.125E+04
rb	3.917E+04	3.917E+04	3.917E+04	3.917E+04	3.917E+04	3.917E+04	3.917E+04	3.917E+04	3.917E+04
sr	1.003E+05	1.003E+05	1.003E+05	1.003E+05	1.003E+05	1.003E+05	1.003E+05	1.003E+05	1.003E+05
y	5.269E+04	5.269E+04	5.269E+04	5.269E+04	5.269E+04	5.269E+04	5.268E+04	5.268E+04	5.268E+04
zr	4.046E+05	4.046E+05	4.046E+05	4.046E+05	4.046E+05	4.046E+05	4.046E+05	4.046E+05	4.046E+05
nb	2.607E+03	2.607E+03	2.607E+03	2.607E+03	2.607E+03	2.607E+03	2.607E+03	2.606E+03	2.606E+03
mo	3.724E+05	3.724E+05	3.724E+05	3.724E+05	3.724E+05	3.724E+05	3.724E+05	3.724E+05	3.724E+05
tc	8.869E+04	8.869E+04	8.869E+04	8.869E+04	8.869E+04	8.870E+04	8.870E+04	8.871E+04	8.871E+04
ru	2.664E+05	2.664E+05	2.664E+05	2.664E+05	2.664E+05	2.664E+05	2.664E+05	2.664E+05	2.664E+05
rh	4.758E+04	4.758E+04	4.758E+04	4.758E+04	4.758E+04	4.759E+04	4.759E+04	4.759E+04	4.760E+04
pd	1.407E+05	1.407E+05	1.407E+05	1.407E+05	1.407E+05	1.407E+05	1.407E+05	1.407E+05	1.407E+05
ag	8.373E+03	8.373E+03	8.374E+03	8.374E+03	8.374E+03	8.375E+03	8.375E+03	8.376E+03	8.376E+03
cd	8.891E+03	8.891E+03	8.891E+03	8.891E+03	8.891E+03	8.892E+03	8.892E+03	8.892E+03	8.893E+03
in	1.690E+02	1.690E+02	1.690E+02	1.690E+02	1.690E+02	1.690E+02	1.690E+02	1.690E+02	1.691E+02
sn	5.453E+03	5.453E+03	5.453E+03	5.453E+03	5.453E+03	5.453E+03	5.453E+03	5.452E+03	5.452E+03
sb	1.656E+03	1.655E+03	1.655E+03	1.654E+03	1.654E+03	1.653E+03	1.652E+03	1.651E+03	1.651E+03
te	5.280E+04	5.279E+04	5.279E+04	5.279E+04	5.279E+04	5.278E+04	5.277E+04	5.277E+04	5.276E+04
i	2.231E+04	2.231E+04	2.230E+04	2.230E+04	2.229E+04	2.228E+04	2.226E+04	2.225E+04	2.224E+04
xe	5.986E+05	5.986E+05	5.987E+05	5.987E+05	5.987E+05	5.987E+05	5.987E+05	5.987E+05	5.987E+05
cs	3.205E+05	3.205E+05	3.205E+05	3.205E+05	3.205E+05	3.205E+05	3.206E+05	3.206E+05	3.206E+05

ba 1.138E+03 1.652E+05 1.652E+05 1.652E+05 1.652E+05 1.652E+05 1.652E+05 1.652E+05 1.652E+05
1.652E+05 1.652E+05 1.652E+05 1.652E+05 1.652E+05 1.652E+05 1.652E+05 1.652E+05 1.652E+05
la 9.997E+02 1.380E+05 1.380E+05 1.380E+05 1.380E+05 1.380E+05 1.380E+05 1.380E+05 1.380E+05
1.380E+05 1.380E+05 1.380E+05 1.380E+05 1.380E+05 1.380E+05 1.380E+05 1.380E+05 1.380E+05
ce 2.220E+03 2.980E+05 2.980E+05 2.980E+05 2.980E+05 2.980E+05 2.980E+05 2.980E+05 2.980E+05
2.980E+05 2.980E+05 2.980E+05 2.980E+05 2.980E+05 2.980E+05 2.980E+05 2.980E+05 2.980E+05
pr 9.066E+02 1.242E+05 1.242E+05 1.242E+05 1.242E+05 1.242E+05 1.242E+05 1.242E+05 1.242E+05
1.242E+05 1.242E+05 1.242E+05 1.242E+05 1.242E+05 1.242E+05 1.242E+05 1.242E+05 1.242E+05
nd 3.064E+03 4.307E+05 4.307E+05 4.307E+05 4.307E+05 4.307E+05 4.307E+05 4.307E+05 4.307E+05
4.307E+05 4.307E+05 4.307E+05 4.307E+05 4.307E+05 4.307E+05 4.307E+05 4.308E+05 4.308E+05
pm 1.731E+02 1.722E+04 1.722E+04 1.722E+04 1.722E+04 1.722E+04 1.722E+04 1.722E+04 1.722E+04
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sm 5.339E+02 7.853E+04 7.853E+04 7.853E+04 7.853E+04 7.853E+04 7.853E+04 7.853E+04 7.853E+04
7.853E+04 7.853E+04 7.854E+04 7.854E+04 7.854E+04 7.854E+04 7.854E+04 7.855E+04 7.855E+04
eu 9.383E+01 1.603E+04 1.603E+04 1.603E+04 1.603E+04 1.603E+04 1.603E+04 1.603E+04 1.603E+04
1.603E+04 1.603E+04 1.603E+04 1.603E+04 1.603E+04 1.603E+04 1.603E+04 1.604E+04 1.604E+04
gd 4.894E+01 1.164E+04 1.164E+04 1.164E+04 1.164E+04 1.164E+04 1.164E+04 1.164E+04 1.164E+04
1.164E+04 1.165E+04 1.165E+04 1.165E+04 1.165E+04 1.165E+04 1.165E+04 1.165E+04 1.165E+04
tb 1.324E+00 2.464E+02 2.464E+02 2.464E+02 2.464E+02 2.464E+02 2.464E+02 2.464E+02 2.464E+02
2.464E+02 2.464E+02 2.464E+02 2.464E+02 2.464E+02 2.464E+02 2.465E+02 2.465E+02 2.465E+02
dy 5.366E-01 1.075E+02 1.075E+02 1.075E+02 1.075E+02 1.075E+02 1.075E+02 1.075E+02 1.075E+02
1.075E+02 1.075E+02 1.075E+02 1.076E+02 1.076E+02 1.076E+02 1.076E+02 1.076E+02 1.076E+02
ho 2.567E-02 7.678E+00 7.678E+00 7.678E+00 7.678E+00 7.678E+00 7.678E+00 7.678E+00 7.678E+00
7.678E+00 7.678E+00 7.679E+00 7.679E+00 7.679E+00 7.679E+00 7.679E+00 7.679E+00 7.679E+00
er 9.237E-03 2.551E+00 2.551E+00 2.551E+00 2.551E+00 2.551E+00 2.551E+00 2.551E+00 2.551E+00
2.551E+00 2.551E+00 2.551E+00 2.551E+00 2.551E+00 2.552E+00 2.552E+00 2.552E+00 2.553E+00
tm 2.945E-04 4.376E-02 4.376E-02 4.376E-02 4.376E-02 4.376E-02 4.376E-02 4.376E-02 4.376E-02
4.376E-02 4.376E-02 4.376E-02 4.376E-02 4.376E-02 4.377E-02 4.377E-02 4.377E-02 4.377E-02
yb 2.447E-04 4.435E-02 4.435E-02 4.435E-02 4.435E-02 4.435E-02 4.435E-02 4.435E-02 4.435E-02
4.435E-02 4.435E-02 4.435E-02 4.435E-02 4.435E-02 4.436E-02 4.436E-02 4.437E-02 4.437E-02
lu 4.026E-17 1.141E-12 1.141E-12 1.141E-12 1.141E-12 1.141E-12 1.141E-12 1.141E-12 1.140E-12
1.140E-12 1.139E-12 1.136E-12 1.134E-12 1.131E-12 1.122E-12 1.112E-12 1.103E-12 1.093E-12
totals 2.755E+04 3.864E+06 3.864E+06 3.864E+06 3.864E+06 3.864E+06 3.864E+06 3.864E+06 3.864E+06
3.864E+06 3.864E+06 3.864E+06 3.864E+06 3.864E+06 3.864E+06 3.864E+06 3.864E+06 3.864E+06
□
Fukushima Daiichi 4 fission
products page 77
decay, following irradiation identified by: power= 25.00mw, burnup= 39500.mwd, flux=
4.05E+13n/cm**2-sec

element radioactivity, curies
basis = full core inventory 548 assemblies (94t
charge discharge 2E-03 h 3E-03 h 5E-03 h 8E-03 h 2E-02 h 3E-02 h 7E-02 h
0.2 h 0.3 h 1.0 h 1.5 h 2.0 h 4.0 h 6.0 h 8.0 h 10.0 h
h 4.226E+02 6.404E+04 6.404E+04 6.404E+04 6.404E+04 6.404E+04 6.404E+04 6.404E+04 6.404E+04
6.404E+04 6.404E+04 6.404E+04 6.404E+04 6.404E+04 6.404E+04 6.404E+04 6.404E+04 6.404E+04
he 0.000E+00 5.649E+04 2.812E+02 1.993E+00 1.037E-02 3.825E-07 7.855E-19 0.000E+00 0.000E+00
0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
li 0.000E+00 3.856E+03 2.142E+01 1.827E-01 1.157E-03 6.246E-08 3.505E-19 0.000E+00 0.000E+00
0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
be 1.660E-04 4.752E+03 6.689E+02 4.851E+02 3.567E+02 1.965E+02 4.081E+01 2.288E+00 2.851E-02
2.364E-02 2.364E-02 2.364E-02 2.364E-02 2.364E-02 2.364E-02 2.364E-02 2.364E-02 2.364E-02
c 9.526E-03 1.452E+02 2.687E+01 6.418E+00 2.318E+00 1.468E+00 1.437E+00 1.437E+00 1.437E+00
1.437E+00 1.437E+00 1.437E+00 1.437E+00 1.437E+00 1.437E+00 1.437E+00 1.437E+00 1.437E+00
co 0.000E+00 8.486E+01 1.609E-03 1.339E-07 6.192E-12 2.383E-20 0.000E+00 0.000E+00 0.000E+00
0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
ni 2.540E-07 8.276E+02 2.310E+02 1.336E+02 8.728E+01 4.684E+01 1.714E+01 9.652E+00 8.755E+00
8.729E+00 8.711E+00 8.637E+00 8.583E+00 8.529E+00 8.315E+00 8.106E+00 7.903E+00 7.705E+00
cu 5.645E-06 7.333E+03 1.907E+03 1.262E+03 8.952E+02 5.663E+02 3.081E+02 1.781E+02 1.072E+02
6.165E+01 5.102E+01 4.948E+01 4.920E+01 4.892E+01 4.781E+01 4.672E+01 4.566E+01 4.463E+01
zn 4.495E-06 1.279E+05 3.611E+04 2.245E+04 1.660E+04 1.151E+04 7.389E+03 5.047E+03 3.017E+03
1.684E+03 1.551E+03 1.485E+03 1.450E+03 1.422E+03 1.343E+03 1.289E+03 1.243E+03 1.201E+03
ga 6.451E-06 8.981E+05 2.874E+05 1.737E+05 1.235E+05 8.223E+04 4.685E+04 2.843E+04 1.724E+04
9.001E+03 6.233E+03 4.410E+03 4.160E+03 3.966E+03 3.323E+03 2.836E+03 2.464E+03 2.178E+03
ge 4.179E-06 1.002E+07 3.671E+06 2.720E+06 2.147E+06 1.544E+06 9.044E+05 5.367E+05 3.998E+05
3.697E+05 3.456E+05 2.625E+05 2.152E+05 1.777E+05 8.981E+04 5.321E+04 3.682E+04 2.852E+04
as 1.362E-04 2.331E+07 1.250E+07 1.015E+07 8.450E+06 6.175E+06 3.226E+06 1.616E+06 1.059E+06
8.120E+05 6.245E+05 4.378E+05 4.042E+05 3.744E+05 2.653E+05 1.917E+05 1.496E+05 1.267E+05
se 6.016E-02 5.991E+07 4.655E+07 4.069E+07 3.638E+07 3.078E+07 2.311E+07 1.723E+07 1.224E+07
6.852E+06 4.172E+06 1.202E+06 5.651E+05 2.963E+05 4.604E+04 1.057E+04 2.738E+03 9.084E+02
br 4.412E-06 1.214E+08 9.601E+07 8.680E+07 8.038E+07 7.151E+07 5.648E+07 4.151E+07 2.850E+07
1.962E+07 1.596E+07 9.551E+06 7.052E+06 5.479E+06 2.677E+06 1.548E+06 9.447E+05 6.055E+05
kr 8.464E+03 2.457E+08 2.005E+08 1.850E+08 1.740E+08 1.598E+08 1.398E+08 1.229E+08 1.075E+08
9.019E+07 8.181E+07 6.695E+07 5.834E+07 5.107E+07 3.113E+07 1.984E+07 1.306E+07 8.846E+06
rb 1.865E+02 3.567E+08 2.634E+08 2.302E+08 2.129E+08 1.972E+08 1.760E+08 1.493E+08 1.177E+08
8.347E+07 6.387E+07 3.705E+07 3.044E+07 2.637E+07 1.609E+07 9.930E+06 6.147E+06 3.825E+06
sr 4.516E+05 5.414E+08 4.302E+08 4.154E+08 4.022E+08 3.807E+08 3.419E+08 3.043E+08 2.696E+08
2.327E+08 2.094E+08 1.825E+08 1.730E+08 1.647E+08 1.388E+08 1.212E+08 1.087E+08 9.968E+07
y 6.102E+05 7.969E+08 5.777E+08 5.363E+08 5.172E+08 5.023E+08 4.918E+08 4.818E+08 4.612E+08

```
4.095E+08 3.578E+08 2.856E+08 2.713E+08 2.628E+08 2.360E+08 2.110E+08 1.889E+08 1.702E+08
   zr      7.444E+05 6.291E+08 3.947E+08 3.278E+08 2.969E+08 2.667E+08 2.336E+08 2.138E+08 2.068E+08
2.059E+08 2.052E+08 2.024E+08 2.003E+08 1.983E+08 1.906E+08 1.834E+08 1.769E+08 1.708E+08
   nb      1.036E+06 9.488E+08 6.984E+08 5.863E+08 5.175E+08 4.475E+08 3.818E+08 3.466E+08 3.265E+08
3.120E+08 3.081E+08 3.038E+08 3.005E+08 2.970E+08 2.830E+08 2.692E+08 2.563E+08 2.443E+08
   mo      3.497E+01 6.374E+08 5.921E+08 5.638E+08 5.403E+08 5.046E+08 4.401E+08 3.710E+08 3.061E+08
2.421E+08 1.913E+08 1.248E+08 1.171E+08 1.149E+08 1.121E+08 1.098E+08 1.075E+08 1.053E+08
   tc      4.521E+01 7.430E+08 7.096E+08 6.896E+08 6.723E+08 6.451E+08 5.946E+08 5.356E+08 4.603E+08
3.596E+08 2.771E+08 1.403E+08 1.148E+08 1.067E+08 1.025E+08 1.015E+08 1.003E+08 9.889E+07
   ru      7.912E+05 3.383E+08 3.276E+08 3.222E+08 3.177E+08 3.111E+08 2.996E+08 2.866E+08 2.689E+08
2.427E+08 2.304E+08 2.204E+08 2.152E+08 2.104E+08 1.945E+08 1.828E+08 1.742E+08 1.679E+08
   rh      7.904E+05 4.457E+08 4.345E+08 4.261E+08 4.184E+08 4.052E+08 3.787E+08 3.491E+08 3.214E+08
2.947E+08 2.778E+08 2.525E+08 2.458E+08 2.422E+08 2.351E+08 2.301E+08 2.257E+08 2.219E+08
   pd      2.223E-01 3.470E+07 3.398E+07 3.358E+07 3.327E+07 3.283E+07 3.209E+07 3.131E+07 3.040E+07
2.915E+07 2.807E+07 2.552E+07 2.448E+07 2.371E+07 2.137E+07 1.936E+07 1.755E+07 1.591E+07
   ag      1.731E+03 5.091E+07 4.826E+07 4.660E+07 4.522E+07 4.319E+07 4.015E+07 3.809E+07 3.690E+07
3.548E+07 3.423E+07 3.137E+07 3.022E+07 2.938E+07 2.684E+07 2.466E+07 2.270E+07 2.092E+07
   cd      1.247E+02 4.436E+06 3.099E+06 2.849E+06 2.687E+06 2.505E+06 2.276E+06 2.068E+06 1.860E+06
1.661E+06 1.557E+06 1.302E+06 1.168E+06 1.067E+06 8.330E+05 7.201E+05 6.537E+05 6.100E+05
   in      5.330E-02 1.067E+07 5.043E+06 4.393E+06 4.061E+06 3.724E+06 3.352E+06 3.085E+06 2.844E+06
2.525E+06 2.286E+06 1.827E+06 1.635E+06 1.497E+06 1.163E+06 9.635E+05 8.251E+05 7.276E+05
   sn      1.070E+03 9.054E+07 8.178E+07 7.730E+07 7.346E+07 6.736E+07 5.565E+07 4.245E+07 2.925E+07
1.742E+07 1.295E+07 8.376E+06 6.594E+06 5.300E+06 2.684E+06 1.782E+06 1.414E+06 1.240E+06
   sb      5.962E+03 2.375E+08 2.210E+08 2.171E+08 2.138E+08 2.085E+08 1.973E+08 1.801E+08 1.518E+08
1.070E+08 8.004E+07 4.428E+07 3.388E+07 2.806E+07 1.886E+07 1.516E+07 1.283E+07 1.117E+07
   te      4.000E+04 5.165E+08 4.924E+08 4.779E+08 4.663E+08 4.503E+08 4.297E+08 4.179E+08 4.071E+08
3.773E+08 3.373E+08 2.351E+08 1.945E+08 1.694E+08 1.318E+08 1.219E+08 1.167E+08 1.128E+08
    i      1.942E+04 7.690E+08 7.238E+08 7.020E+08 6.858E+08 6.639E+08 6.302E+08 6.002E+08 5.762E+08
5.582E+08 5.465E+08 5.017E+08 4.699E+08 4.420E+08 3.688E+08 3.311E+08 3.064E+08 2.870E+08
   xe      8.580E+03 5.769E+08 5.237E+08 5.037E+08 4.875E+08 4.631E+08 4.230E+08 3.833E+08 3.383E+08
2.730E+08 2.315E+08 1.932E+08 1.903E+08 1.906E+08 1.938E+08 1.945E+08 1.931E+08 1.904E+08
   cs      1.633E+05 5.161E+08 4.308E+08 4.113E+08 3.978E+08 3.758E+08 3.335E+08 2.902E+08 2.500E+08
2.032E+08 1.631E+08 8.709E+07 6.202E+07 4.819E+07 3.297E+07 3.134E+07 3.094E+07 3.074E+07
   ba      2.055E+05 6.204E+08 5.482E+08 5.112E+08 4.855E+08 4.557E+08 4.260E+08 4.115E+08 3.934E+08
3.487E+08 2.994E+08 2.101E+08 1.845E+08 1.686E+08 1.373E+08 1.256E+08 1.210E+08 1.189E+08
   la      1.442E+05 6.151E+08 5.699E+08 5.443E+08 5.243E+08 4.964E+08 4.519E+08 4.151E+08 3.918E+08
3.676E+08 3.407E+08 2.797E+08 2.546E+08 2.355E+08 1.856E+08 1.586E+08 1.428E+08 1.329E+08
   ce      1.298E+06 4.886E+08 4.679E+08 4.575E+08 4.501E+08 4.395E+08 4.183E+08 3.901E+08 3.563E+08
3.190E+08 3.005E+08 2.821E+08 2.793E+08 2.779E+08 2.740E+08 2.703E+08 2.667E+08 2.633E+08
   pr      9.773E+05 4.267E+08 4.157E+08 4.079E+08 4.021E+08 3.952E+08 3.858E+08 3.740E+08 3.543E+08
3.241E+08 3.037E+08 2.598E+08 2.450E+08 2.369E+08 2.222E+08 2.133E+08 2.063E+08 2.007E+08
   nd      3.254E+04 9.777E+07 9.672E+07 9.585E+07 9.501E+07 9.357E+07 9.074E+07 8.745E+07 8.353E+07
7.692E+07 7.026E+07 5.871E+07 5.505E+07 5.241E+07 4.601E+07 4.303E+07 4.158E+07 4.082E+07
   pm      1.740E+05 1.037E+08 1.030E+08 1.026E+08 1.022E+08 1.014E+08 9.981E+07 9.751E+07 9.415E+07
8.863E+07 8.428E+07 7.952E+07 7.885E+07 7.843E+07 7.689E+07 7.533E+07 7.379E+07 7.229E+07
   sm      3.173E+02 4.011E+07 4.008E+07 4.005E+07 4.002E+07 3.997E+07 3.984E+07 3.959E+07 3.911E+07
3.802E+07 3.700E+07 3.527E+07 3.470E+07 3.430E+07 3.306E+07 3.195E+07 3.089E+07 2.987E+07
   eu      1.931E+04 2.302E+07 2.301E+07 2.300E+07 2.299E+07 2.297E+07 2.292E+07 2.287E+07 2.280E+07
2.268E+07 2.252E+07 2.207E+07 2.188E+07 2.175E+07 2.143E+07 2.121E+07 2.102E+07 2.084E+07
   gd      1.182E+00 4.919E+05 4.912E+05 4.904E+05 4.895E+05 4.876E+05 4.819E+05 4.708E+05 4.500E+05
4.161E+05 3.990E+05 3.841E+05 3.770E+05 3.700E+05 3.434E+05 3.187E+05 2.958E+05 2.745E+05
   tb      2.197E+02 1.832E+05 1.831E+05 1.830E+05 1.829E+05 1.828E+05 1.823E+05 1.815E+05 1.796E+05
1.739E+05 1.654E+05 1.502E+05 1.483E+05 1.477E+05 1.468E+05 1.461E+05 1.454E+05 1.447E+05
   dy      1.314E-03 3.890E+04 3.805E+04 3.730E+04 3.654E+04 3.518E+04 3.220E+04 2.842E+04 2.444E+04
2.159E+04 2.041E+04 1.681E+04 1.459E+04 1.267E+04 7.303E+03 4.334E+03 2.690E+03 1.778E+03
   ho      1.958E-03 5.929E+03 5.925E+03 5.921E+03 5.918E+03 5.911E+03 5.898E+03 5.878E+03 5.844E+03
5.769E+03 5.695E+03 5.547E+03 5.467E+03 5.390E+03 5.106E+03 4.854E+03 4.624E+03 4.413E+03
   er      2.194E-02 9.579E+01 9.555E+01 9.551E+01 9.550E+01 9.550E+01 9.549E+01 9.548E+01 9.543E+01
9.527E+01 9.501E+01 9.395E+01 9.319E+01 9.246E+01 8.975E+01 8.736E+01 8.525E+01 8.337E+01
   tm      1.867E-01 5.764E+01 5.764E+01 5.764E+01 5.764E+01 5.764E+01 5.764E+01 5.764E+01 5.764E+01
5.764E+01 5.763E+01 5.761E+01 5.759E+01 5.758E+01 5.750E+01 5.741E+01 5.731E+01 5.721E+01
   yb      3.994E-07 2.799E-04 2.799E-04 2.799E-04 2.799E-04 2.799E-04 2.799E-04 2.799E-04 2.799E-04
2.798E-04 2.798E-04 2.796E-04 2.795E-04 2.794E-04 2.789E-04 2.784E-04 2.779E-04 2.774E-04
   lu      4.418E-12 1.940E-07 1.926E-07 1.913E-07 1.899E-07 1.874E-07 1.812E-07 1.717E-07 1.569E-07
1.363E-07 1.286E-07 1.268E-07 1.265E-07 1.263E-07 1.252E-07 1.241E-07 1.231E-07 1.220E-07
  totals   7.524E+06 1.112E+10 9.617E+09 9.083E+09 8.730E+09 8.287E+09 7.645E+09 7.049E+09 6.449E+09
5.692E+09 5.121E+09 4.185E+09 3.904E+09 3.726E+09 3.339E+09 3.122E+09 2.967E+09 2.844E+09
□
    Fukushima Daiichi 4                                                                    fission
products          page   78
decay, following irradiation identified by: power=  25.00mw, burnup=  39500.mwd, flux=
4.05E+13n/cm**2-sec

                                              element thermal power, watts
                                              basis = full core inventory 548 assemblies (94t
              charge  discharge   2E-03 h   3E-03 h   5E-03 h   8E-03 h   2E-02 h   3E-02 h   7E-02 h
0.2 h     0.3 h     1.0 h     1.5 h     2.0 h     4.0 h     6.0 h     8.0 h    10.0 h
    h      1.425E-02 2.160E+00 2.160E+00 2.160E+00 2.160E+00 2.160E+00 2.160E+00 2.160E+00 2.160E+00
2.160E+00 2.160E+00 2.160E+00 2.160E+00 2.160E+00 2.160E+00 2.160E+00 2.160E+00 2.160E+00
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    he      0.000E+00 5.806E+02 2.617E+00 1.855E-02 9.652E-05 3.560E-09 7.310E-21 0.000E+00 0.000E+00
0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
    li      0.000E+00 2.177E+02 1.304E+00 1.112E-02 7.041E-05 3.802E-09 2.133E-20 0.000E+00 0.000E+00
0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
    be      1.998E-07 4.838E+01 2.343E+01 1.754E+01 1.290E+01 7.106E+00 1.475E+00 8.194E-02 2.043E-04
2.842E-05 2.842E-05 2.842E-05 2.842E-05 2.842E-05 2.842E-05 2.842E-05 2.842E-05 2.842E-05
    c       2.793E-06 5.423E+00 9.596E-01 1.883E-01 3.366E-02 1.573E-03 4.216E-04 4.214E-04 4.214E-04
4.214E-04 4.214E-04 4.214E-04 4.214E-04 4.214E-04 4.214E-04 4.214E-04 4.214E-04 4.214E-04
    co      0.000E+00 2.843E+00 3.285E-05 2.733E-09 1.264E-13 4.865E-22 0.000E+00 0.000E+00 0.000E+00
0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
    ni      9.788E-11 1.322E+01 3.323E+00 2.004E+00 1.275E+00 6.060E-01 1.182E-01 1.296E-02 3.505E-03
3.363E-03 3.356E-03 3.328E-03 3.307E-03 3.286E-03 3.204E-03 3.123E-03 3.045E-03 2.969E-03
    cu      1.040E-08 1.946E+02 3.738E+01 2.388E+01 1.613E+01 9.236E+00 4.213E+00 1.857E+00 7.058E-01
2.261E-01 1.358E-01 1.248E-01 1.240E-01 1.233E-01 1.204E-01 1.175E-01 1.148E-01 1.121E-01
    zn      6.800E-09 2.797E+03 5.710E+02 3.102E+02 2.099E+02 1.243E+02 5.977E+01 3.349E+01 1.544E+01
4.196E+00 3.174E+00 2.950E+00 2.832E+00 2.732E+00 2.436E+00 2.233E+00 2.080E+00 1.958E+00
    ga      1.226E-07 2.786E+04 6.766E+03 3.707E+03 2.457E+03 1.511E+03 7.748E+02 4.111E+02 2.400E+02
1.327E+02 7.925E+01 4.187E+01 3.979E+01 3.879E+01 3.566E+01 3.322E+01 3.128E+01 2.971E+01
    ge      2.233E-10 2.370E+05 4.646E+04 3.115E+04 2.264E+04 1.435E+04 6.794E+03 2.961E+03 1.592E+03
1.408E+03 1.333E+03 1.074E+03 9.249E+02 8.049E+02 5.123E+02 3.757E+02 3.023E+02 2.557E+02
    as      6.476E-07 6.480E+05 2.478E+05 1.872E+05 1.480E+05 9.951E+04 4.264E+04 1.595E+04 8.696E+03
7.149E+03 6.145E+03 4.926E+03 4.493E+03 4.053E+03 2.426E+03 1.343E+03 7.401E+02 4.312E+02
    se      1.993E-05 1.074E+06 7.380E+05 6.022E+05 5.069E+05 3.895E+05 2.432E+05 1.512E+05 9.919E+04
6.040E+04 3.995E+04 1.133E+04 4.663E+03 2.006E+03 1.414E+02 2.579E+01 6.110E+00 1.674E+00
    br      7.278E-08 3.143E+06 2.288E+06 1.987E+06 1.781E+06 1.503E+06 1.055E+06 6.495E+05 3.525E+05
2.235E+05 1.767E+05 8.050E+04 4.744E+04 2.971E+04 9.395E+03 5.983E+03 4.606E+03 3.826E+03
    kr      1.269E+01 3.972E+06 2.955E+06 2.644E+06 2.435E+06 2.174E+06 1.832E+06 1.546E+06 1.275E+06
9.653E+05 8.338E+05 6.534E+05 5.539E+05 4.719E+05 2.598E+05 1.511E+05 9.124E+04 5.659E+04
    rb      8.420E-01 8.699E+06 5.856E+06 4.992E+06 4.563E+06 4.185E+06 3.683E+06 3.049E+06 2.292E+06
1.496E+06 1.092E+06 6.025E+05 4.895E+05 4.224E+05 2.569E+05 1.579E+05 9.714E+04 5.986E+04
    sr      1.409E+03 7.823E+06 5.441E+06 5.148E+06 4.891E+06 4.479E+06 3.765E+06 3.129E+06 2.582E+06
1.972E+06 1.582E+06 1.221E+06 1.135E+06 1.063E+06 8.388E+05 6.874E+05 5.820E+05 5.061E+05
    y       2.325E+03 1.316E+07 7.073E+06 5.965E+06 5.451E+06 5.051E+06 4.817E+06 4.680E+06 4.408E+06
3.707E+06 2.986E+06 1.967E+06 1.790E+06 1.705E+06 1.485E+06 1.286E+06 1.109E+06 9.604E+05
    zr      3.752E+03 6.305E+06 2.813E+06 2.001E+06 1.695E+06 1.447E+06 1.225E+06 1.106E+06 1.065E+06
1.060E+06 1.056E+06 1.041E+06 1.030E+06 1.020E+06 9.794E+05 9.420E+05 9.076E+05 8.759E+05
    nb      4.936E+03 1.337E+07 8.116E+06 6.055E+06 4.883E+06 3.764E+06 2.771E+06 2.236E+06 1.924E+06
1.702E+06 1.651E+06 1.622E+06 1.603E+06 1.584E+06 1.505E+06 1.427E+06 1.354E+06 1.287E+06
    mo      1.401E-01 6.021E+06 5.333E+06 4.948E+06 4.642E+06 4.190E+06 3.398E+06 2.598E+06 1.935E+06
1.427E+06 1.063E+06 5.471E+05 4.806E+05 4.632E+05 4.490E+05 4.396E+05 4.305E+05 4.215E+05
    tc      3.736E-02 9.031E+06 8.351E+06 7.973E+06 7.662E+06 7.190E+06 6.351E+06 5.497E+06 4.586E+06
3.280E+06 2.138E+06 4.738E+05 2.102E+05 1.311E+05 9.619E+04 9.494E+04 9.380E+04 9.250E+04
    ru      1.643E+03 1.855E+06 1.712E+06 1.651E+06 1.604E+06 1.536E+06 1.423E+06 1.308E+06 1.169E+06
9.777E+05 8.926E+05 8.265E+05 7.912E+05 7.586E+05 6.508E+05 5.717E+05 5.137E+05 4.711E+05
    rh      3.015E+03 2.223E+06 2.102E+06 2.025E+06 1.958E+06 1.847E+06 1.619E+06 1.371E+06 1.137E+06
8.875E+05 7.546E+05 6.279E+05 6.008E+05 5.880E+05 5.696E+05 5.606E+05 5.541E+05 5.489E+05
    pd      2.158E-05 1.151E+05 1.064E+05 1.022E+05 9.934E+04 9.553E+04 8.923E+04 8.274E+04 7.633E+04
6.969E+04 6.477E+04 5.414E+04 5.060E+04 4.845E+04 4.323E+04 3.908E+04 3.534E+04 3.197E+04
    ag      1.852E+01 1.990E+05 1.667E+05 1.511E+05 1.393E+05 1.231E+05 9.898E+04 8.152E+04 7.042E+04
6.126E+04 5.826E+04 5.491E+04 5.367E+04 5.274E+04 4.973E+04 4.694E+04 4.433E+04 4.189E+04
    cd      4.692E-01 4.989E+04 2.539E+04 2.204E+04 1.990E+04 1.760E+04 1.509E+04 1.307E+04 1.081E+04
8.528E+03 7.799E+03 6.658E+03 5.995E+03 5.437E+03 3.905E+03 3.029E+03 2.501E+03 2.171E+03
    in      1.298E-04 2.255E+05 5.810E+04 4.436E+04 3.834E+04 3.289E+04 2.748E+04 2.386E+04 2.094E+04
1.776E+04 1.536E+04 1.033E+04 8.190E+03 6.734E+03 3.921E+03 2.807E+03 2.183E+03 1.782E+03
    sn      4.193E+00 1.223E+06 1.062E+06 9.955E+05 9.391E+05 8.489E+05 6.754E+05 4.830E+05 2.995E+05
1.517E+05 1.031E+05 6.522E+04 5.250E+04 4.288E+04 2.135E+04 1.251E+04 8.472E+03 6.504E+03
    sb      2.132E+01 4.422E+06 3.967E+06 3.873E+06 3.798E+06 3.683E+06 3.457E+06 3.120E+06 2.565E+06
1.690E+06 1.184E+06 5.826E+05 4.126E+05 3.176E+05 1.782E+05 1.327E+05 1.068E+05 8.888E+04
    te      7.370E+01 4.846E+06 4.345E+06 4.047E+06 3.811E+06 3.491E+06 3.090E+06 2.897E+06 2.785E+06
2.505E+06 2.139E+06 1.262E+06 9.308E+05 7.268E+05 4.247E+05 3.580E+05 3.325E+05 3.165E+05
    i       6.787E+01 1.142E+07 1.032E+07 9.816E+06 9.445E+06 8.952E+06 8.195E+06 7.511E+06 6.990E+06
6.693E+06 6.530E+06 5.796E+06 5.268E+06 4.809E+06 3.676E+06 3.184E+06 2.909E+06 2.711E+06
    xe      9.116E+00 5.422E+06 4.484E+06 4.175E+06 3.933E+06 3.576E+06 3.005E+06 2.479E+06 1.945E+06
1.232E+06 7.927E+05 3.873E+05 3.464E+05 3.408E+05 3.505E+05 3.538E+05 3.503E+05 3.421E+05
    cs      9.021E+02 9.319E+06 7.375E+06 6.994E+06 6.745E+06 6.337E+06 5.529E+06 4.685E+06 3.950E+06
3.279E+06 2.704E+06 1.343E+06 8.294E+05 5.439E+05 2.399E+05 2.153E+05 2.129E+05 2.124E+05
    ba      6.844E+02 5.414E+06 4.392E+06 3.902E+06 3.573E+06 3.203E+06 2.845E+06 2.689E+06 2.521E+06
2.113E+06 1.671E+06 9.240E+05 7.426E+05 6.429E+05 4.640E+05 4.003E+05 3.756E+05 3.655E+05
    la      2.421E+03 9.167E+06 8.298E+06 7.804E+06 7.424E+06 6.904E+06 6.090E+06 5.417E+06 5.041E+06
4.800E+06 4.537E+06 3.818E+06 3.476E+06 3.211E+06 2.565E+06 2.264E+06 2.112E+06 2.028E+06
    ce      1.230E+03 2.256E+06 2.036E+06 1.931E+06 1.857E+06 1.759E+06 1.571E+06 1.325E+06 1.043E+06
7.691E+05 6.698E+05 6.021E+05 5.917E+05 5.863E+05 5.702E+05 5.550E+05 5.405E+05 5.265E+05
    pr      6.335E+03 3.482E+06 3.289E+06 3.160E+06 3.066E+06 2.962E+06 2.839E+06 2.687E+06 2.431E+06
2.053E+06 1.825E+06 1.324E+06 1.159E+06 1.078E+06 9.825E+05 9.444E+05 9.152E+05 8.918E+05
    nd      7.875E+01 4.664E+05 4.553E+05 4.467E+05 4.386E+05 4.252E+05 3.997E+05 3.720E+05 3.421E+05
2.994E+05 2.588E+05 1.909E+05 1.712E+05 1.576E+05 1.250E+05 1.103E+05 1.034E+05 1.000E+05
    pm      2.322E+02 5.038E+05 4.929E+05 4.857E+05 4.794E+05 4.691E+05 4.479E+05 4.203E+05 3.838E+05
3.356E+05 3.015E+05 2.622E+05 2.578E+05 2.558E+05 2.497E+05 2.441E+05 2.388E+05 2.339E+05
    sm      3.746E-02 9.611E+04 9.573E+04 9.547E+04 9.524E+04 9.484E+04 9.385E+04 9.214E+04 8.901E+04
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8.272E+04 7.760E+04 7.076E+04 6.909E+04 6.809E+04 6.552E+04 6.331E+04 6.120E+04 5.920E+04
    eu      1.753E+02 2.186E+05 2.184E+05 2.183E+05 2.181E+05 2.178E+05 2.172E+05 2.163E+05 2.153E+05
2.140E+05 2.125E+05 2.081E+05 2.063E+05 2.051E+05 2.026E+05 2.012E+05 2.000E+05 1.989E+05
    gd      1.039E-03 1.445E+03 1.439E+03 1.433E+03 1.426E+03 1.412E+03 1.372E+03 1.299E+03 1.171E+03
9.748E+02 8.838E+02 8.265E+02 8.096E+02 7.941E+02 7.367E+02 6.837E+02 6.345E+02 5.888E+02
    tb      1.863E+00 1.063E+03 1.061E+03 1.060E+03 1.059E+03 1.057E+03 1.051E+03 1.041E+03 1.021E+03
9.649E+02 8.837E+02 7.392E+02 7.219E+02 7.173E+02 7.139E+02 7.124E+02 7.111E+02 7.097E+02
    dy      1.535E-06 7.532E+01 7.464E+01 7.403E+01 7.343E+01 7.235E+01 7.000E+01 6.697E+01 6.348E+01
5.960E+01 5.634E+01 4.609E+01 3.984E+01 3.446E+01 1.940E+01 1.108E+01 6.481E+00 3.934E+00
    ho      9.023E-06 2.671E+01 2.665E+01 2.659E+01 2.654E+01 2.645E+01 2.626E+01 2.602E+01 2.569E+01
2.507E+01 2.451E+01 2.371E+01 2.337E+01 2.306E+01 2.188E+01 2.082E+01 1.986E+01 1.896E+01
    er      1.340E-05 1.671E-01 1.668E-01 1.668E-01 1.668E-01 1.668E-01 1.667E-01 1.666E-01 1.664E-01
1.658E-01 1.647E-01 1.605E-01 1.574E-01 1.545E-01 1.439E-01 1.348E-01 1.269E-01 1.201E-01
    tm      2.707E-04 1.800E-01 1.800E-01 1.800E-01 1.800E-01 1.800E-01 1.800E-01 1.800E-01 1.800E-01
1.800E-01 1.800E-01 1.799E-01 1.798E-01 1.797E-01 1.793E-01 1.788E-01 1.783E-01 1.777E-01
    yb      1.016E-09 7.122E-07 7.122E-07 7.122E-07 7.122E-07 7.122E-07 7.122E-07 7.122E-07 7.122E-07
7.121E-07 7.120E-07 7.116E-07 7.113E-07 7.110E-07 7.097E-07 7.084E-07 7.071E-07 7.058E-07
    lu      4.877E-14 1.498E-09 1.498E-09 1.498E-09 1.497E-09 1.497E-09 1.495E-09 1.493E-09 1.490E-09
1.485E-09 1.482E-09 1.477E-09 1.474E-09 1.471E-09 1.459E-09 1.446E-09 1.434E-09 1.421E-09
  totals    2.935E+04 1.364E+08 1.043E+08 9.448E+07 8.837E+07 8.106E+07 7.092E+07 6.194E+07 5.362E+07
4.415E+07 3.743E+07 2.664E+07 2.338E+07 2.134E+07 1.732E+07 1.546E+07 1.429E+07 1.344E+07


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actinides          page   79
decay, following irradiation identified by: power=  25.00mw, burnup=  39500.mwd, flux=
4.05E+13n/cm**2-sec

                                                  element concentrations, grams
                                                  basis = full core inventory 548 assemblies (94t
          initial    12.0 h     15.0 h     20.0 h     24.0 h     36.0 h     48.0 h     72.0 h     96.0 h
144.0 h   192.0 h   240.0 h
    he      5.550E+01 5.551E+01 5.552E+01 5.555E+01 5.557E+01 5.562E+01 5.568E+01 5.580E+01 5.591E+01
5.614E+01 5.637E+01 5.660E+01
    tl      3.674E-10 3.674E-10 3.649E-10 3.629E-10 3.635E-10 3.794E-10 3.793E-10 3.697E-10 3.698E-10
3.641E-10 3.651E-10 3.664E-10
    pb      1.405E-04 1.405E-04 1.406E-04 1.407E-04 1.407E-04 1.409E-04 1.411E-04 1.414E-04 1.417E-04
1.424E-04 1.431E-04 1.438E-04
    bi      5.193E-08 5.194E-08 5.194E-08 5.195E-08 5.196E-08 5.297E-08 5.300E-08 5.255E-08 5.263E-08
5.247E-08 5.269E-08 5.291E-08
    po      7.726E-11 7.727E-11 7.729E-11 7.733E-11 7.736E-11 7.745E-11 7.753E-11 7.771E-11 7.788E-11
7.822E-11 7.856E-11 7.890E-11
    at      4.546E-17 4.547E-17 4.548E-17 4.550E-17 4.551E-17 4.552E-17 4.550E-17 4.539E-17 4.519E-17
4.457E-17 4.370E-17 4.265E-17
    rn      3.547E-10 3.547E-10 3.546E-10 3.546E-10 3.545E-10 3.544E-10 3.544E-10 3.544E-10 3.545E-10
3.552E-10 3.562E-10 3.575E-10
    fr      4.399E-13 4.400E-13 4.401E-13 4.403E-13 4.404E-13 4.405E-13 4.404E-13 4.394E-13 4.377E-13
4.320E-13 4.241E-13 4.145E-13
    ra      6.748E-06 6.748E-06 6.749E-06 6.749E-06 6.750E-06 6.752E-06 6.754E-06 6.759E-06 6.765E-06
6.779E-06 6.795E-06 6.812E-06
    ac      7.175E-07 7.177E-07 7.180E-07 7.185E-07 7.189E-07 7.203E-07 7.216E-07 7.244E-07 7.272E-07
7.327E-07 7.382E-07 7.437E-07
    th      2.484E-01 2.484E-01 2.484E-01 2.485E-01 2.485E-01 2.485E-01 2.486E-01 2.487E-01 2.489E-01
2.492E-01 2.495E-01 2.499E-01
    pa      5.131E-02 5.131E-02 5.132E-02 5.132E-02 5.132E-02 5.133E-02 5.133E-02 5.133E-02 5.133E-02
5.133E-02 5.133E-02 5.134E-02
     u      8.924E+07 8.924E+07 8.924E+07 8.924E+07 8.924E+07 8.924E+07 8.924E+07 8.924E+07 8.924E+07
8.924E+07 8.924E+07 8.924E+07
    np      4.870E+04 4.857E+04 4.840E+04 4.812E+04 4.791E+04 4.733E+04 4.684E+04 4.606E+04 4.548E+04
4.476E+04 4.437E+04 4.418E+04
    pu      8.220E+05 8.221E+05 8.223E+05 8.226E+05 8.228E+05 8.234E+05 8.239E+05 8.247E+05 8.254E+05
8.262E+05 8.266E+05 8.268E+05
    am      1.728E+04 1.729E+04 1.729E+04 1.729E+04 1.729E+04 1.730E+04 1.730E+04 1.731E+04 1.733E+04
1.736E+04 1.738E+04 1.741E+04
    cm      5.393E+03 5.393E+03 5.393E+03 5.394E+03 5.393E+03 5.392E+03 5.390E+03 5.384E+03 5.378E+03
5.365E+03 5.352E+03 5.340E+03
    bk      7.993E-05 7.991E-05 7.989E-05 7.985E-05 7.982E-05 7.973E-05 7.965E-05 7.947E-05 7.930E-05
7.896E-05 7.862E-05 7.828E-05
    cf      5.365E-05 5.367E-05 5.369E-05 5.373E-05 5.375E-05 5.384E-05 5.392E-05 5.408E-05 5.425E-05
5.457E-05 5.489E-05 5.522E-05
    es      9.969E-09 9.976E-09 9.987E-09 1.000E-08 1.002E-08 1.005E-08 1.009E-08 1.014E-08 1.018E-08
1.022E-08 1.022E-08 1.017E-08
  totals    9.014E+07 9.014E+07 9.014E+07 9.014E+07 9.014E+07 9.014E+07 9.014E+07 9.014E+07 9.014E+07
9.014E+07 9.014E+07 9.014E+07
□
     Fukushima Daiichi 4
actinides          page   80
decay, following irradiation identified by: power=  25.00mw, burnup=  39500.mwd, flux=
4.05E+13n/cm**2-sec
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element radioactivity, curies
basis = full core inventory 548 assemblies (94t

	initial	12.0 h	15.0 h	20.0 h	24.0 h	36.0 h	48.0 h	72.0 h	96.0 h	144.0 h	192.0 h	240.0 h
tl	1.088E-01	1.088E-01	1.080E-01	1.075E-01	1.076E-01	1.124E-01	1.123E-01	1.095E-01	1.095E-01	1.078E-01	1.081E-01	1.085E-01
pb	2.985E-01	2.985E-01	2.984E-01	2.984E-01	2.983E-01	2.982E-01	2.981E-01	2.980E-01	2.981E-01	2.986E-01	2.994E-01	3.004E-01
bi	2.987E-01	2.986E-01	2.986E-01	2.985E-01	2.984E-01	3.126E-01	3.125E-01	3.046E-01	3.046E-01	2.999E-01	3.008E-01	3.018E-01
po	4.898E-01	4.897E-01	4.896E-01	4.895E-01	4.894E-01	4.984E-01	4.983E-01	4.932E-01	4.934E-01	4.910E-01	4.924E-01	4.941E-01
at	7.321E-05	7.322E-05	7.324E-05	7.327E-05	7.328E-05	7.330E-05	7.327E-05	7.309E-05	7.277E-05	7.176E-05	7.037E-05	6.867E-05
rn	2.984E-01	2.984E-01	2.984E-01	2.983E-01	2.983E-01	2.982E-01	2.981E-01	2.981E-01	2.983E-01	2.989E-01	2.997E-01	3.008E-01
fr	7.392E-05	7.394E-05	7.396E-05	7.398E-05	7.400E-05	7.401E-05	7.399E-05	7.381E-05	7.350E-05	7.249E-05	7.110E-05	6.941E-05
ra	2.985E-01	2.984E-01	2.984E-01	2.983E-01	2.983E-01	2.982E-01	2.981E-01	2.982E-01	2.983E-01	2.989E-01	2.998E-01	3.009E-01
ac	7.619E-04	6.334E-04	4.876E-04	3.315E-04	2.566E-04	1.593E-04	1.342E-04	1.260E-04	1.253E-04	1.247E-04	1.237E-04	1.224E-04
th	9.272E+01	8.947E+01	8.491E+01	7.810E+01	7.327E+01	6.159E+01	5.315E+01	4.267E+01	3.720E+01	3.288E+01	3.170E+01	3.139E+01
pa	1.057E+02	1.038E+02	1.010E+02	9.678E+01	9.373E+01	8.605E+01	8.017E+01	7.219E+01	6.749E+01	6.308E+01	6.155E+01	6.101E+01
u	5.236E+07	5.191E+07	5.125E+07	5.016E+07	4.931E+07	4.684E+07	4.450E+07	4.016E+07	3.624E+07	2.951E+07	2.403E+07	1.957E+07
np	1.216E+09	1.186E+09	1.143E+09	1.075E+09	1.023E+09	8.831E+08	7.621E+08	5.674E+08	4.225E+08	2.343E+08	1.299E+08	7.205E+07
pu	1.888E+07	1.705E+07	1.510E+07	1.322E+07	1.243E+07	1.156E+07	1.140E+07	1.137E+07	1.136E+07	1.136E+07	1.136E+07	1.136E+07
am	9.811E+06	8.776E+06	7.433E+06	5.656E+06	4.559E+06	2.426E+06	1.323E+06	4.225E+05	1.512E+05	3.528E+04	2.198E+04	2.044E+04
cm	5.099E+06	5.099E+06	5.098E+06	5.097E+06	5.095E+06	5.089E+06	5.081E+06	5.062E+06	5.043E+06	5.003E+06	4.963E+06	4.924E+06
bk	1.676E-01	1.547E-01	1.434E-01	1.351E-01	1.326E-01	1.308E-01	1.306E-01	1.303E-01	1.300E-01	1.294E-01	1.289E-01	1.283E-01
cf	6.672E-03	6.672E-03	6.670E-03	6.668E-03	6.666E-03	6.659E-03	6.653E-03	6.641E-03	6.629E-03	6.606E-03	6.585E-03	6.564E-03
es	2.061E-04	2.063E-04	2.066E-04	2.071E-04	2.074E-04	2.084E-04	2.093E-04	2.108E-04	2.120E-04	2.132E-04	2.133E-04	2.123E-04
totals	1.302E+09	1.269E+09	1.222E+09	1.149E+09	1.095E+09	9.491E+08	8.244E+08	6.244E+08	4.753E+08	2.802E+08	1.703E+08	1.079E+08

0
Fukushima Daiichi 4
actinides page 81
decay, following irradiation identified by: power= 25.00mw, burnup= 39500.mwd, flux= 4.05E+13n/cm**2-sec

element thermal power, watts
basis = full core inventory 548 assemblies (94t

	initial	12.0 h	15.0 h	20.0 h	24.0 h	36.0 h	48.0 h	72.0 h	96.0 h	144.0 h	192.0 h	240.0 h
tl	2.544E-03	2.543E-03	2.526E-03	2.512E-03	2.516E-03	2.627E-03	2.626E-03	2.559E-03	2.560E-03	2.521E-03	2.527E-03	2.536E-03
pb	5.645E-04	5.644E-04	5.643E-04	5.642E-04	5.641E-04	5.638E-04	5.637E-04	5.635E-04	5.637E-04	5.646E-04	5.661E-04	5.681E-04
bi	5.002E-03	5.001E-03	5.000E-03	4.999E-03	4.998E-03	5.235E-03	5.233E-03	5.101E-03	5.102E-03	5.023E-03	5.037E-03	5.054E-03
po	2.237E-02	2.237E-02	2.236E-02	2.236E-02	2.236E-02	2.283E-02	2.283E-02	2.256E-02	2.257E-02	2.243E-02	2.249E-02	2.257E-02
at	3.124E-06	3.125E-06	3.125E-06	3.127E-06	3.127E-06	3.128E-06	3.127E-06	3.119E-06	3.105E-06	3.062E-06	3.003E-06	2.930E-06
rn	1.133E-02	1.133E-02	1.133E-02	1.133E-02	1.132E-02	1.132E-02	1.132E-02	1.132E-02	1.132E-02	1.135E-02	1.138E-02	1.142E-02
fr	2.828E-06	2.828E-06	2.829E-06	2.830E-06	2.831E-06	2.831E-06	2.830E-06	2.823E-06	2.811E-06	2.772E-06	2.718E-06	2.653E-06
ra	1.024E-02	1.024E-02	1.024E-02	1.024E-02	1.024E-02	1.023E-02	1.023E-02	1.023E-02	1.024E-02	1.026E-02	1.029E-02	1.032E-02
ac	7.549E-06	6.546E-06	5.410E-06	4.192E-06	3.609E-06	2.849E-06	2.651E-06	2.581E-06	2.566E-06	2.531E-06	2.482E-06	2.423E-06
th	9.059E-02	8.705E-02	8.208E-02	7.465E-02	6.940E-02	5.666E-02	4.747E-02	3.606E-02	3.012E-02	2.545E-02	2.422E-02	2.392E-02
pa	5.201E-01	5.071E-01	4.888E-01	4.609E-01	4.409E-01	3.905E-01	3.519E-01	2.997E-01	2.689E-01	2.401E-01	2.301E-01	2.266E-01
u	1.014E+05	1.005E+05	9.922E+04	9.712E+04	9.547E+04	9.069E+04	8.615E+04	7.775E+04	7.016E+04	5.713E+04	4.653E+04	3.789E+04

```
     np      3.133E+06 3.057E+06 2.946E+06 2.770E+06 2.637E+06 2.275E+06 1.962E+06 1.460E+06 1.087E+06
6.019E+05 3.335E+05 1.848E+05
     pu      2.081E+04 1.870E+04 1.646E+04 1.430E+04 1.339E+04 1.241E+04 1.223E+04 1.220E+04 1.221E+04
1.223E+04 1.224E+04 1.225E+04
     am      3.914E+04 3.445E+04 2.848E+04 2.082E+04 1.626E+04 7.952E+03 4.113E+03 1.456E+03 8.321E+02
6.298E+02 6.150E+02 6.162E+02
     cm      1.856E+05 1.856E+05 1.855E+05 1.855E+05 1.854E+05 1.852E+05 1.849E+05 1.842E+05 1.835E+05
1.821E+05 1.806E+05 1.792E+05
     bk      2.830E-04 1.929E-04 1.133E-04 5.545E-05 3.821E-05 2.653E-05 2.563E-05 2.550E-05 2.544E-05
2.533E-05 2.522E-05 2.512E-05
     cf      3.810E-04 3.810E-04 3.810E-04 3.810E-04 3.809E-04 3.808E-04 3.807E-04 3.804E-04 3.802E-04
3.797E-04 3.792E-04 3.787E-04
     es      8.230E-06 8.237E-06 8.249E-06 8.267E-06 8.281E-06 8.321E-06 8.357E-06 8.417E-06 8.462E-06
8.512E-06 8.514E-06 8.474E-06
   totals    3.480E+06 3.396E+06 3.276E+06 3.088E+06 2.947E+06 2.571E+06 2.250E+06 1.736E+06 1.353E+06
8.540E+05 5.735E+05 4.147E+05
□
     Fukushima Daiichi 4                                                                         fission
products          page   82
decay, following irradiation identified by: power=  25.00mw, burnup=  39500.mwd, flux=
4.05E+13n/cm**2-sec


                                                 element concentrations, grams
                                                 basis = full core inventory 548 assemblies (94t
             initial     12.0 h     15.0 h     20.0 h     24.0 h     36.0 h     48.0 h     72.0 h     96.0 h
144.0 h   192.0 h   240.0 h
      h      7.515E+00 7.515E+00 7.515E+00 7.515E+00 7.515E+00 7.514E+00 7.514E+00 7.513E+00 7.512E+00
7.510E+00 7.508E+00 7.506E+00
     he      1.308E+02 1.308E+02 1.308E+02 1.308E+02 1.308E+02 1.308E+02 1.308E+02 1.308E+02 1.308E+02
1.308E+02 1.308E+02 1.308E+02
     li      1.089E+00 1.089E+00 1.089E+00 1.089E+00 1.089E+00 1.089E+00 1.089E+00 1.089E+00 1.089E+00
1.089E+00 1.089E+00 1.089E+00
     be      1.142E+00 1.142E+00 1.142E+00 1.142E+00 1.142E+00 1.142E+00 1.142E+00 1.142E+00 1.142E+00
1.142E+00 1.142E+00 1.142E+00
      b      7.494E-02 7.494E-02 7.494E-02 7.494E-02 7.494E-02 7.494E-02 7.494E-02 7.494E-02 7.494E-02
7.494E-02 7.494E-02 7.494E-02
      c      3.546E-01 3.546E-01 3.546E-01 3.546E-01 3.546E-01 3.546E-01 3.546E-01 3.546E-01 3.546E-01
3.546E-01 3.546E-01 3.546E-01
      n      3.511E-02 3.511E-02 3.511E-02 3.511E-02 3.511E-02 3.511E-02 3.511E-02 3.511E-02 3.511E-02
3.511E-02 3.511E-02 3.511E-02
     ne      4.834E-01 4.834E-01 4.834E-01 4.834E-01 4.834E-01 4.834E-01 4.834E-01 4.834E-01 4.834E-01
4.834E-01 4.834E-01 4.834E-01
     ni      8.856E-06 8.634E-06 8.311E-06 7.800E-06 7.414E-06 6.366E-06 5.467E-06 4.031E-06 2.972E-06
1.616E-06 8.786E-07 4.777E-07
     cu      4.878E-05 4.770E-05 4.612E-05 4.361E-05 4.169E-05 3.644E-05 3.186E-05 2.434E-05 1.860E-05
1.086E-05 6.339E-06 3.701E-06
     zn      1.900E-01 1.900E-01 1.899E-01 1.898E-01 1.898E-01 1.896E-01 1.895E-01 1.893E-01 1.891E-01
1.889E-01 1.889E-01 1.888E-01
     ga      3.075E-01 3.074E-01 3.074E-01 3.073E-01 3.073E-01 3.073E-01 3.072E-01 3.071E-01 3.071E-01
3.070E-01 3.070E-01 3.069E-01
     ge      4.239E+01 4.239E+01 4.238E+01 4.238E+01 4.238E+01 4.238E+01 4.238E+01 4.238E+01 4.238E+01
4.238E+01 4.238E+01 4.238E+01
     as      1.296E+01 1.295E+01 1.295E+01 1.294E+01 1.294E+01 1.292E+01 1.291E+01 1.289E+01 1.288E+01
1.286E+01 1.286E+01 1.285E+01
     se      6.048E+03 6.048E+03 6.048E+03 6.048E+03 6.048E+03 6.048E+03 6.048E+03 6.048E+03 6.048E+03
6.048E+03 6.048E+03 6.048E+03
     br      2.363E+03 2.363E+03 2.363E+03 2.363E+03 2.363E+03 2.362E+03 2.362E+03 2.362E+03 2.362E+03
2.362E+03 2.362E+03 2.362E+03
     kr      4.125E+04 4.125E+04 4.125E+04 4.125E+04 4.125E+04 4.125E+04 4.125E+04 4.125E+04 4.125E+04
4.125E+04 4.125E+04 4.125E+04
     rb      3.917E+04 3.917E+04 3.917E+04 3.917E+04 3.917E+04 3.917E+04 3.917E+04 3.917E+04 3.917E+04
3.917E+04 3.918E+04 3.918E+04
     sr      1.003E+05 1.003E+05 1.003E+05 1.003E+05 1.003E+05 1.003E+05 1.002E+05 1.002E+05 1.002E+05
1.001E+05 1.001E+05 1.000E+05
      y      5.268E+04 5.268E+04 5.268E+04 5.267E+04 5.267E+04 5.266E+04 5.266E+04 5.265E+04 5.264E+04
5.262E+04 5.260E+04 5.259E+04
     zr      4.046E+05 4.046E+05 4.046E+05 4.046E+05 4.046E+05 4.046E+05 4.046E+05 4.045E+05 4.045E+05
4.045E+05 4.045E+05 4.045E+05
     nb      2.606E+03 2.606E+03 2.605E+03 2.605E+03 2.604E+03 2.603E+03 2.602E+03 2.600E+03 2.598E+03
2.592E+03 2.584E+03 2.575E+03
     mo      3.724E+05 3.724E+05 3.724E+05 3.724E+05 3.724E+05 3.724E+05 3.724E+05 3.725E+05 3.725E+05
3.726E+05 3.727E+05 3.727E+05
     tc      8.871E+04 8.872E+04 8.873E+04 8.874E+04 8.874E+04 8.877E+04 8.879E+04 8.882E+04 8.884E+04
8.888E+04 8.890E+04 8.891E+04
     ru      2.664E+05 2.664E+05 2.664E+05 2.664E+05 2.663E+05 2.663E+05 2.663E+05 2.662E+05 2.661E+05
2.659E+05 2.658E+05 2.656E+05
     rh      4.760E+04 4.760E+04 4.760E+04 4.761E+04 4.761E+04 4.763E+04 4.765E+04 4.769E+04 4.773E+04
4.783E+04 4.793E+04 4.803E+04
     pd      1.407E+05 1.407E+05 1.407E+05 1.407E+05 1.407E+05 1.407E+05 1.408E+05 1.408E+05 1.408E+05
```

1.409E+05 1.409E+05 1.410E+05
ag 8.376E+03 8.377E+03 8.377E+03 8.378E+03 8.378E+03 8.379E+03 8.378E+03 8.377E+03 8.375E+03
8.372E+03 8.369E+03 8.366E+03
cd 8.893E+03 8.893E+03 8.893E+03 8.894E+03 8.894E+03 8.896E+03 8.897E+03 8.899E+03 8.901E+03
8.905E+03 8.907E+03 8.910E+03
in 1.691E+02 1.691E+02 1.691E+02 1.692E+02 1.692E+02 1.693E+02 1.695E+02 1.696E+02 1.698E+02
1.700E+02 1.701E+02 1.701E+02
sn 5.452E+03 5.452E+03 5.452E+03 5.452E+03 5.452E+03 5.452E+03 5.451E+03 5.451E+03 5.451E+03
5.450E+03 5.449E+03 5.449E+03
sb 1.651E+03 1.650E+03 1.649E+03 1.648E+03 1.648E+03 1.646E+03 1.644E+03 1.641E+03 1.639E+03
1.635E+03 1.632E+03 1.630E+03
te 5.276E+04 5.276E+04 5.275E+04 5.274E+04 5.273E+04 5.270E+04 5.267E+04 5.263E+04 5.260E+04
5.255E+04 5.251E+04 5.249E+04
i 2.224E+04 2.223E+04 2.222E+04 2.220E+04 2.218E+04 2.215E+04 2.212E+04 2.208E+04 2.204E+04
2.199E+04 2.194E+04 2.190E+04
xe 5.987E+05 5.987E+05 5.987E+05 5.987E+05 5.987E+05 5.987E+05 5.988E+05 5.988E+05 5.988E+05
5.988E+05 5.988E+05 5.988E+05
cs 3.206E+05 3.206E+05 3.206E+05 3.206E+05 3.206E+05 3.207E+05 3.207E+05 3.208E+05 3.208E+05
3.209E+05 3.209E+05 3.209E+05
ba 1.652E+05 1.652E+05 1.652E+05 1.652E+05 1.652E+05 1.652E+05 1.651E+05 1.651E+05 1.650E+05
1.650E+05 1.649E+05 1.648E+05
la 1.380E+05 1.380E+05 1.380E+05 1.380E+05 1.380E+05 1.380E+05 1.380E+05 1.380E+05 1.380E+05
1.380E+05 1.380E+05 1.380E+05
ce 2.980E+05 2.980E+05 2.979E+05 2.979E+05 2.979E+05 2.979E+05 2.978E+05 2.977E+05 2.977E+05
2.975E+05 2.974E+05 2.972E+05
pr 1.242E+05 1.242E+05 1.242E+05 1.242E+05 1.242E+05 1.243E+05 1.243E+05 1.243E+05 1.243E+05
1.244E+05 1.244E+05 1.244E+05
nd 4.308E+05 4.308E+05 4.308E+05 4.308E+05 4.308E+05 4.309E+05 4.309E+05 4.310E+05 4.311E+05
4.313E+05 4.315E+05 4.317E+05
pm 1.721E+04 1.721E+04 1.721E+04 1.720E+04 1.720E+04 1.719E+04 1.718E+04 1.717E+04 1.717E+04
1.716E+04 1.716E+04 1.716E+04
sm 7.855E+04 7.855E+04 7.855E+04 7.856E+04 7.857E+04 7.858E+04 7.859E+04 7.862E+04 7.864E+04
7.869E+04 7.872E+04 7.876E+04
eu 1.604E+04 1.604E+04 1.604E+04 1.604E+04 1.604E+04 1.604E+04 1.604E+04 1.604E+04 1.603E+04
1.601E+04 1.599E+04 1.597E+04
gd 1.165E+04 1.165E+04 1.166E+04 1.166E+04 1.166E+04 1.167E+04 1.168E+04 1.169E+04 1.171E+04
1.173E+04 1.176E+04 1.178E+04
tb 2.465E+02 2.465E+02 2.465E+02 2.465E+02 2.465E+02 2.465E+02 2.465E+02 2.464E+02 2.463E+02
2.461E+02 2.460E+02 2.458E+02
dy 1.076E+02 1.076E+02 1.076E+02 1.076E+02 1.077E+02 1.077E+02 1.078E+02 1.079E+02 1.080E+02
1.082E+02 1.084E+02 1.085E+02
ho 7.679E+00 7.679E+00 7.678E+00 7.678E+00 7.678E+00 7.676E+00 7.676E+00 7.675E+00 7.674E+00
7.674E+00 7.673E+00 7.673E+00
er 2.553E+00 2.553E+00 2.554E+00 2.554E+00 2.555E+00 2.556E+00 2.557E+00 2.558E+00 2.559E+00
2.560E+00 2.561E+00 2.561E+00
tm 4.377E-02 4.377E-02 4.378E-02 4.378E-02 4.378E-02 4.379E-02 4.380E-02 4.380E-02 4.381E-02
4.381E-02 4.380E-02 4.379E-02
yb 4.437E-02 4.438E-02 4.438E-02 4.439E-02 4.440E-02 4.443E-02 4.445E-02 4.450E-02 4.455E-02
4.463E-02 4.471E-02 4.478E-02
lu 1.093E-12 1.084E-12 1.070E-12 1.048E-12 1.030E-12 9.792E-13 9.306E-13 8.406E-13 7.593E-13
6.196E-13 5.056E-13 4.127E-13
totals 3.864E+06 3.864E+06 3.864E+06 3.864E+06 3.864E+06 3.864E+06 3.864E+06 3.864E+06 3.864E+06
3.864E+06 3.864E+06 3.864E+06
□
Fukushima Daiichi 4 fission
products page 83
decay, following irradiation identified by: power= 25.00mw, burnup= 39500.mwd, flux=
4.05E+13n/cm**2-sec

element radioactivity, curies
basis = full core inventory 548 assemblies (94t
initial 12.0 h 15.0 h 20.0 h 24.0 h 36.0 h 48.0 h 72.0 h 96.0 h
144.0 h 192.0 h 240.0 h
h 6.404E+04 6.403E+04 6.403E+04 6.403E+04 6.403E+04 6.402E+04 6.402E+04 6.401E+04 6.400E+04
6.398E+04 6.396E+04 6.394E+04
be 2.364E-02 2.364E-02 2.364E-02 2.364E-02 2.364E-02 2.364E-02 2.364E-02 2.364E-02 2.364E-02
2.364E-02 2.364E-02 2.364E-02
c 1.437E+00 1.437E+00 1.437E+00 1.437E+00 1.437E+00 1.437E+00 1.437E+00 1.437E+00 1.437E+00
1.437E+00 1.437E+00 1.437E+00
ni 7.705E+00 7.512E+00 7.231E+00 6.786E+00 6.450E+00 5.539E+00 4.756E+00 3.507E+00 2.586E+00
1.406E+00 7.644E-01 4.156E-01
cu 4.463E+01 4.362E+01 4.214E+01 3.979E+01 3.801E+01 3.312E+01 2.887E+01 2.193E+01 1.666E+01
9.624E+00 5.562E+00 3.217E+00
zn 1.201E+03 1.162E+03 1.108E+03 1.026E+03 9.654E+02 8.064E+02 6.742E+02 4.714E+02 3.296E+02
1.612E+02 7.883E+01 3.855E+01
ga 2.178E+03 1.958E+03 1.715E+03 1.455E+03 1.323E+03 1.082E+03 9.183E+02 6.604E+02 4.681E+02
2.309E+02 1.131E+02 5.532E+01
ge 2.852E+04 2.361E+04 1.884E+04 1.358E+04 1.057E+04 5.028E+03 2.402E+03 5.505E+02 1.263E+02
6.655E+00 3.580E-01 2.562E-02

```
      as      1.267E+05 1.140E+05 1.038E+05 9.432E+04 8.837E+04 7.263E+04 5.925E+04 3.897E+04 2.546E+04
1.081E+04 4.584E+03 1.945E+03
      se      9.084E+02 4.733E+02 3.439E+02 3.064E+02 2.882E+02 2.387E+02 1.964E+02 1.321E+02 8.924E+01
4.265E+01 2.281E+01 1.438E+01
      br      6.055E+05 4.123E+05 2.644E+05 1.725E+05 1.451E+05 1.090E+05 8.595E+04 5.365E+04 3.349E+04
1.305E+04 5.085E+03 1.982E+03
      kr      8.846E+06 6.169E+06 3.826E+06 2.100E+06 1.553E+06 1.118E+06 1.064E+06 1.055E+06 1.055E+06
1.054E+06 1.054E+06 1.054E+06
      rb      3.825E+06 2.399E+06 1.225E+06 4.544E+05 2.533E+05 1.363E+05 1.277E+05 1.227E+05 1.183E+05
1.098E+05 1.019E+05 9.461E+04
      sr      9.968E+07 9.286E+07 8.534E+07 7.706E+07 7.263E+07 6.521E+07 6.196E+07 5.955E+07 5.856E+07
5.714E+07 5.582E+07 5.454E+07
       y      1.702E+08 1.547E+08 1.365E+08 1.161E+08 1.056E+08 8.924E+07 8.261E+07 7.804E+07 7.650E+07
7.472E+07 7.314E+07 7.161E+07
      zr      1.708E+08 1.653E+08 1.577E+08 1.469E+08 1.398E+08 1.240E+08 1.141E+08 1.039E+08 9.936E+07
9.552E+07 9.323E+07 9.120E+07
      nb      2.443E+08 2.332E+08 2.182E+08 1.970E+08 1.828E+08 1.520E+08 1.330E+08 1.140E+08 1.072E+08
1.035E+08 1.027E+08 1.022E+08
      mo      1.053E+08 1.031E+08 9.987E+07 9.476E+07 9.085E+07 8.008E+07 7.059E+07 5.485E+07 4.262E+07
2.573E+07 1.553E+07 9.377E+06
      tc      9.889E+07 9.740E+07 9.500E+07 9.080E+07 8.737E+07 7.739E+07 6.832E+07 5.311E+07 4.127E+07
2.491E+07 1.504E+07 9.081E+06
      ru      1.679E+08 1.632E+08 1.584E+08 1.538E+08 1.518E+08 1.493E+08 1.481E+08 1.461E+08 1.443E+08
1.406E+08 1.371E+08 1.337E+08
      rh      2.219E+08 2.184E+08 2.137E+08 2.069E+08 2.021E+08 1.900E+08 1.804E+08 1.663E+08 1.568E+08
1.454E+08 1.389E+08 1.343E+08
      pd      1.591E+07 1.442E+07 1.245E+07 9.746E+06 8.018E+06 4.478E+06 2.514E+06 8.070E+05 2.671E+05
3.306E+04 4.993E+03 9.815E+02
      ag      2.092E+07 1.932E+07 1.721E+07 1.432E+07 1.247E+07 8.661E+06 6.481E+06 4.410E+06 3.558E+06
2.798E+06 2.341E+06 1.981E+06
      cd      6.100E+05 5.789E+05 5.452E+05 5.048E+05 4.786E+05 4.124E+05 3.566E+05 2.680E+05 2.030E+05
1.202E+05 7.548E+04 5.113E+04
      in      7.276E+05 6.592E+05 5.918E+05 5.277E+05 4.945E+05 4.204E+05 3.598E+05 2.636E+05 1.931E+05
1.037E+05 5.567E+04 2.988E+04
      sn      1.240E+06 1.145E+06 1.067E+06 9.963E+05 9.565E+05 8.633E+05 7.910E+05 6.865E+05 6.154E+05
5.226E+05 4.593E+05 4.095E+05
      sb      1.117E+07 9.935E+06 8.633E+06 7.339E+06 6.737E+06 5.812E+06 5.300E+06 4.537E+06 3.923E+06
2.987E+06 2.334E+06 1.878E+06
      te      1.128E+08 1.095E+08 1.053E+08 9.938E+07 9.531E+07 8.490E+07 7.612E+07 6.177E+07 5.065E+07
3.501E+07 2.505E+07 1.857E+07
       i      2.870E+08 2.706E+08 2.497E+08 2.223E+08 2.051E+08 1.683E+08 1.440E+08 1.125E+08 9.227E+07
6.678E+07 5.065E+07 3.929E+07
      xe      1.904E+08 1.867E+08 1.801E+08 1.684E+08 1.595E+08 1.378E+08 1.234E+08 1.054E+08 9.242E+07
7.144E+07 5.504E+07 4.237E+07
      cs      3.074E+07 3.062E+07 3.050E+07 3.040E+07 3.034E+07 3.022E+07 3.011E+07 2.990E+07 2.970E+07
2.933E+07 2.899E+07 2.868E+07
      ba      1.189E+08 1.179E+08 1.169E+08 1.156E+08 1.147E+08 1.119E+08 1.092E+08 1.040E+08 9.907E+07
9.001E+07 8.187E+07 7.458E+07
      la      1.329E+08 1.264E+08 1.202E+08 1.149E+08 1.127E+08 1.096E+08 1.075E+08 1.032E+08 9.868E+07
8.952E+07 8.074E+07 7.262E+07
      ce      2.633E+08 2.600E+08 2.552E+08 2.479E+08 2.425E+08 2.286E+08 2.176E+08 2.017E+08 1.912E+08
1.789E+08 1.717E+08 1.666E+08
      pr      2.007E+08 1.961E+08 1.911E+08 1.852E+08 1.822E+08 1.773E+08 1.747E+08 1.707E+08 1.669E+08
1.591E+08 1.517E+08 1.449E+08
      nd      4.082E+07 4.036E+07 3.990E+07 3.933E+07 3.891E+07 3.770E+07 3.653E+07 3.429E+07 3.219E+07
2.838E+07 2.501E+07 2.204E+07
      pm      7.229E+07 7.084E+07 6.875E+07 6.548E+07 6.305E+07 5.660E+07 5.123E+07 4.296E+07 3.705E+07
2.958E+07 2.536E+07 2.285E+07
      sm      2.987E+07 2.890E+07 2.752E+07 2.540E+07 2.385E+07 1.981E+07 1.650E+07 1.150E+07 8.034E+06
3.930E+06 1.931E+06 9.574E+05
      eu      2.084E+07 2.067E+07 2.043E+07 2.007E+07 1.981E+07 1.915E+07 1.860E+07 1.768E+07 1.689E+07
1.548E+07 1.421E+07 1.305E+07
      gd      2.745E+05 2.548E+05 2.278E+05 1.890E+05 1.628E+05 1.041E+05 6.656E+04 2.728E+04 1.125E+04
2.036E+03 5.010E+02 2.444E+02
      tb      1.447E+05 1.440E+05 1.430E+05 1.413E+05 1.400E+05 1.362E+05 1.325E+05 1.257E+05 1.195E+05
1.086E+05 9.949E+04 9.183E+04
      dy      1.778E+03 1.269E+03 8.905E+02 6.692E+02 6.091E+02 5.349E+02 4.826E+02 3.936E+02 3.210E+02
2.135E+02 1.420E+02 9.449E+01
      ho      4.413E+03 4.216E+03 3.943E+03 3.536E+03 3.246E+03 2.529E+03 1.990E+03 1.269E+03 8.455E+02
4.242E+02 2.422E+02 1.496E+02
      er      8.337E+01 8.168E+01 7.944E+01 7.630E+01 7.419E+01 6.908E+01 6.500E+01 5.829E+01 5.274E+01
4.387E+01 3.702E+01 3.152E+01
      tm      5.721E+01 5.710E+01 5.692E+01 5.658E+01 5.629E+01 5.531E+01 5.422E+01 5.188E+01 4.954E+01
4.535E+01 4.209E+01 3.969E+01
      yb      2.774E-04 2.769E-04 2.761E-04 2.749E-04 2.739E-04 2.709E-04 2.680E-04 2.623E-04 2.567E-04
2.458E-04 2.354E-04 2.254E-04
      lu      1.220E-07 1.210E-07 1.195E-07 1.170E-07 1.150E-07 1.093E-07 1.038E-07 9.375E-08 8.466E-08
6.904E-08 5.631E-08 4.593E-08
  totals      2.844E+09 2.742E+09 2.617E+09 2.454E+09 2.352E+09 2.131E+09 1.982E+09 1.784E+09 1.652E+09
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1.473E+09 1.350E+09 1.258E+09

□

Fukushima Daiichi 4 fission products page 84

decay, following irradiation identified by: power= 25.00mw, burnup= 39500.mwd, flux= 4.05E+13n/cm**2-sec

element thermal power, watts

basis = full core inventory 548 assemblies (94t

	initial	12.0 h	15.0 h	20.0 h	24.0 h	36.0 h	48.0 h	72.0 h	96.0 h	144.0 h	192.0 h	240.0 h
h	2.160E+00	2.160E+00	2.160E+00	2.160E+00	2.160E+00	2.159E+00	2.159E+00	2.159E+00	2.159E+00	2.158E+00	2.157E+00	2.157E+00
be	2.842E-05	2.842E-05	2.842E-05	2.842E-05	2.842E-05	2.842E-05	2.842E-05	2.842E-05	2.842E-05	2.841E-05	2.841E-05	2.841E-05
c	4.214E-04	4.214E-04	4.214E-04	4.214E-04	4.214E-04	4.214E-04	4.214E-04	4.214E-04	4.214E-04	4.214E-04	4.214E-04	4.214E-04
ni	2.969E-03	2.894E-03	2.786E-03	2.615E-03	2.485E-03	2.134E-03	1.833E-03	1.351E-03	9.963E-04	5.417E-04	2.945E-04	1.601E-04
cu	1.121E-01	1.094E-01	1.056E-01	9.950E-02	9.487E-02	8.225E-02	7.131E-02	5.361E-02	4.032E-02	2.283E-02	1.294E-02	7.346E-03
zn	1.958E+00	1.858E+00	1.735E+00	1.577E+00	1.473E+00	1.222E+00	1.020E+00	7.132E-01	4.987E-01	2.439E-01	1.193E-01	5.832E-02
ga	2.971E+01	2.842E+01	2.686E+01	2.485E+01	2.355E+01	2.027E+01	1.740E+01	1.255E+01	8.895E+00	4.387E+00	2.149E+00	1.051E+00
ge	2.557E+02	2.216E+02	1.823E+02	1.335E+02	1.044E+02	5.000E+01	2.395E+01	5.494E+00	1.260E+00	6.634E-02	3.493E-03	1.842E-04
as	4.312E+02	2.797E+02	1.856E+02	1.418E+02	1.294E+02	1.051E+02	8.536E+01	5.572E+01	3.619E+01	1.523E+01	6.423E+00	2.714E+00
se	1.674E+00	6.338E-01	3.413E-01	2.848E-01	2.670E-01	2.202E-01	1.803E-01	1.197E-01	7.921E-02	3.525E-02	1.652E-02	8.574E-03
br	3.826E+03	3.344E+03	2.907E+03	2.503E+03	2.286E+03	1.795E+03	1.418E+03	8.850E+02	5.525E+02	2.153E+02	8.389E+01	3.269E+01
kr	5.659E+04	3.583E+04	1.873E+04	7.207E+03	3.963E+03	1.800E+03	1.608E+03	1.582E+03	1.582E+03	1.581E+03	1.581E+03	1.580E+03
rb	5.986E+04	3.697E+04	1.812E+04	5.761E+03	2.541E+03	6.898E+02	5.806E+02	5.540E+02	5.338E+02	4.955E+02	4.600E+02	4.270E+02
sr	5.061E+05	4.495E+05	3.881E+05	3.214E+05	2.864E+05	2.285E+05	2.042E+05	1.881E+05	1.833E+05	1.782E+05	1.736E+05	1.692E+05
y	9.604E+05	8.387E+05	6.990E+05	5.486E+05	4.750E+05	3.672E+05	3.263E+05	2.998E+05	2.923E+05	2.854E+05	2.796E+05	2.741E+05
zr	8.759E+05	8.466E+05	8.069E+05	7.505E+05	7.128E+05	6.300E+05	5.783E+05	5.247E+05	5.013E+05	4.815E+05	4.700E+05	4.597E+05
nb	1.287E+06	1.224E+06	1.140E+06	1.020E+06	9.399E+05	7.661E+05	6.594E+05	5.514E+05	5.133E+05	4.928E+05	4.887E+05	4.865E+05
mo	4.215E+05	4.128E+05	4.000E+05	3.795E+05	3.638E+05	3.207E+05	2.827E+05	2.197E+05	1.707E+05	1.030E+05	6.220E+04	3.755E+04
tc	9.250E+04	9.110E+04	8.886E+04	8.493E+04	8.172E+04	7.239E+04	6.390E+04	4.968E+04	3.860E+04	2.330E+04	1.407E+04	8.494E+03
ru	4.711E+05	4.398E+05	4.076E+05	3.778E+05	3.656E+05	3.516E+05	3.469E+05	3.405E+05	3.346E+05	3.231E+05	3.120E+05	3.012E+05
rh	5.489E+05	5.444E+05	5.386E+05	5.301E+05	5.241E+05	5.085E+05	4.961E+05	4.783E+05	4.667E+05	4.537E+05	4.473E+05	4.433E+05
pd	3.197E+04	2.891E+04	2.487E+04	1.936E+04	1.584E+04	8.694E+03	4.779E+03	1.453E+03	4.471E+02	4.474E+01	5.054E+00	6.866E-01
ag	4.189E+04	3.964E+04	3.660E+04	3.231E+04	2.947E+04	2.319E+04	1.915E+04	1.458E+04	1.230E+04	1.011E+04	8.932E+03	8.070E+03
cd	2.171E+03	1.958E+03	1.759E+03	1.574E+03	1.478E+03	1.268E+03	1.098E+03	8.300E+02	6.332E+02	3.823E+02	2.464E+02	1.722E+02
in	1.782E+03	1.515E+03	1.270E+03	1.068E+03	9.829E+02	8.264E+02	7.069E+02	5.178E+02	3.793E+02	2.038E+02	1.094E+02	5.870E+01
sn	6.504E+03	5.502E+03	4.811E+03	4.424E+03	4.306E+03	4.104E+03	3.939E+03	3.648E+03	3.396E+03	2.965E+03	2.604E+03	2.294E+03
sb	8.888E+04	7.574E+04	6.193E+04	4.838E+04	4.225E+04	3.371E+04	2.988E+04	2.507E+04	2.143E+04	1.595E+04	1.213E+04	9.454E+03
te	3.165E+05	3.038E+05	2.878E+05	2.659E+05	2.510E+05	2.145E+05	1.854E+05	1.417E+05	1.110E+05	7.237E+04	5.026E+04	3.672E+04
i	2.711E+06	2.548E+06	2.347E+06	2.087E+06	1.927E+06	1.591E+06	1.366E+06	1.061E+06	8.500E+05	5.706E+05	3.954E+05	2.792E+05
xe	3.421E+05	3.310E+05	3.110E+05	2.754E+05	2.485E+05	1.870E+05	1.513E+05	1.181E+05	1.014E+05	7.786E+04	5.990E+04	4.607E+04
cs	2.124E+05	2.121E+05	2.116E+05	2.110E+05	2.105E+05	2.092E+05	2.079E+05	2.053E+05	2.029E+05	1.985E+05	1.944E+05	1.908E+05
ba	3.655E+05	3.608E+05	3.571E+05	3.532E+05	3.504E+05	3.421E+05	3.341E+05	3.188E+05	3.042E+05	2.774E+05	2.533E+05	2.317E+05
la	2.028E+06	1.978E+06	1.934E+06	1.894E+06	1.875E+06	1.838E+06	1.804E+06	1.732E+06	1.657E+06	1.503E+06	1.355E+06	1.219E+06
ce	5.265E+05	5.130E+05	4.938E+05	4.643E+05	4.428E+05	3.878E+05	3.447E+05	2.842E+05	2.465E+05	2.069E+05	1.888E+05	1.788E+05

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     pr      8.918E+05 8.729E+05 8.524E+05 8.281E+05 8.159E+05 7.970E+05 7.884E+05 7.776E+05 7.685E+05
7.514E+05 7.353E+05 7.203E+05
     nd      1.000E+05 9.822E+04 9.673E+04 9.520E+04 9.418E+04 9.124E+04 8.841E+04 8.300E+04 7.792E+04
6.868E+04 6.053E+04 5.335E+04
     pm      2.339E+05 2.291E+05 2.223E+05 2.118E+05 2.040E+05 1.833E+05 1.658E+05 1.383E+05 1.180E+05
9.049E+04 7.314E+04 6.141E+04
     sm      5.920E+04 5.728E+04 5.454E+04 5.034E+04 4.726E+04 3.925E+04 3.269E+04 2.277E+04 1.588E+04
7.740E+03 3.773E+03 1.840E+03
     eu      1.989E+05 1.978E+05 1.962E+05 1.938E+05 1.919E+05 1.868E+05 1.822E+05 1.738E+05 1.662E+05
1.521E+05 1.393E+05 1.277E+05
     gd      5.888E+02 5.465E+02 4.886E+02 4.054E+02 3.492E+02 2.231E+02 1.426E+02 5.829E+01 2.389E+01
4.121E+00 8.286E-01 2.795E-01
     tb      7.097E+02 7.084E+02 7.063E+02 7.030E+02 7.004E+02 6.927E+02 6.852E+02 6.710E+02 6.577E+02
6.333E+02 6.115E+02 5.920E+02
     dy      3.934E+00 2.522E+00 1.486E+00 9.063E-01 7.700E-01 6.527E-01 5.882E-01 4.797E-01 3.912E-01
2.602E-01 1.731E-01 1.151E-01
     ho      1.896E+01 1.812E+01 1.695E+01 1.520E+01 1.396E+01 1.088E+01 8.557E+00 5.460E+00 3.636E+00
1.825E+00 1.042E+00 6.436E-01
     er      1.201E-01 1.142E-01 1.066E-01 9.674E-02 9.057E-02 7.743E-02 6.847E-02 5.575E-02 4.654E-02
3.409E-02 2.632E-02 2.114E-02
     tm      1.777E-01 1.771E-01 1.761E-01 1.743E-01 1.727E-01 1.672E-01 1.610E-01 1.478E-01 1.345E-01
1.109E-01 9.278E-02 7.982E-02
     yb      7.058E-07 7.046E-07 7.027E-07 6.995E-07 6.970E-07 6.895E-07 6.821E-07 6.675E-07 6.532E-07
6.255E-07 5.990E-07 5.736E-07
     lu      1.421E-09 1.409E-09 1.391E-09 1.362E-09 1.339E-09 1.271E-09 1.208E-09 1.090E-09 9.830E-10
8.002E-10 6.514E-10 5.303E-10
   totals    1.344E+07 1.278E+07 1.201E+07 1.107E+07 1.051E+07 9.388E+06 8.673E+06 7.759E+06 7.162E+06
6.351E+06 5.784E+06 5.349E+06
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Fukushima 4
actinides page 87
decay, following irradiation identified by: power= 25.00mw, burnup= 39500.mwd, flux=
4.05E+13n/cm**2-sec

element concentrations, grams
basis = 1 t uranium

	initial	150.0 d	200.0 d	250.0 d	300.0 d	350.0 d	400.0 d	450.0 d	500.0 d
he	6.985E-01	7.341E-01	7.679E-01	7.968E-01	8.217E-01	8.434E-01	8.625E-01	8.795E-01	8.948E-01
tl	4.846E-12	5.336E-12	5.828E-12	6.316E-12	6.800E-12	7.280E-12	7.754E-12	8.222E-12	8.685E-12
pb	1.911E-06	2.119E-06	2.371E-06	2.645E-06	2.942E-06	3.260E-06	3.600E-06	3.962E-06	4.344E-06
bi	6.557E-10	6.942E-10	7.336E-10	7.728E-10	8.118E-10	8.506E-10	8.891E-10	9.272E-10	9.651E-10
po	9.988E-13	1.069E-12	1.141E-12	1.210E-12	1.276E-12	1.340E-12	1.404E-12	1.468E-12	1.534E-12
at	1.392E-19	1.324E-19	1.316E-19	1.316E-19	1.318E-19	1.319E-19	1.320E-19	1.322E-19	1.323E-19
rn	4.693E-12	5.151E-12	5.609E-12	6.065E-12	6.517E-12	6.966E-12	7.411E-12	7.851E-12	8.287E-12
fr	1.567E-15	1.537E-15	1.568E-15	1.606E-15	1.644E-15	1.683E-15	1.722E-15	1.760E-15	1.799E-15
ra	8.282E-08	8.803E-08	9.361E-08	9.926E-08	1.050E-07	1.107E-07	1.166E-07	1.224E-07	1.284E-07
ac	1.070E-08	1.202E-08	1.348E-08	1.494E-08	1.639E-08	1.784E-08	1.929E-08	2.073E-08	2.217E-08
th	2.825E-03	2.904E-03	2.992E-03	3.080E-03	3.168E-03	3.256E-03	3.344E-03	3.432E-03	3.520E-03
pa	5.478E-04	5.487E-04	5.496E-04	5.505E-04	5.514E-04	5.523E-04	5.532E-04	5.541E-04	5.550E-04
u	9.494E+05	9.494E+05	9.494E+05	9.494E+05	9.494E+05	9.494E+05	9.494E+05	9.494E+05	9.494E+05
np	4.693E+02	4.693E+02	4.693E+02	4.693E+02	4.693E+02	4.694E+02	4.694E+02	4.694E+02	4.694E+02
pu	8.790E+03	8.785E+03	8.779E+03	8.773E+03	8.767E+03	8.760E+03	8.754E+03	8.747E+03	8.741E+03
am	1.993E+02	2.059E+02	2.132E+02	2.205E+02	2.277E+02	2.348E+02	2.419E+02	2.490E+02	2.560E+02
cm	5.148E+01	4.957E+01	4.779E+01	4.632E+01	4.509E+01	4.406E+01	4.318E+01	4.244E+01	4.180E+01
bk	6.780E-07	6.151E-07	5.519E-07	4.953E-07	4.444E-07	3.988E-07	3.579E-07	3.212E-07	2.882E-07
cf	7.338E-07	7.929E-07	8.518E-07	9.043E-07	9.510E-07	9.927E-07	1.030E-06	1.063E-06	1.092E-06
es	2.733E-11	1.711E-11	1.299E-11	1.100E-11	9.604E-12	8.449E-12	7.447E-12	6.567E-12	5.791E-12
totals	9.589E+05	9.589E+05	9.589E+05	9.589E+05	9.589E+05	9.589E+05	9.589E+05	9.589E+05	9.589E+05

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Fukushima 4
actinides page 88
decay, following irradiation identified by: power= 25.00mw, burnup= 39500.mwd, flux=
4.05E+13n/cm**2-sec

element radioactivity, curies
basis = 1 t uranium

	initial	150.0 d	200.0 d	250.0 d	300.0 d	350.0 d	400.0 d	450.0 d	500.0 d
tl	1.435E-03	1.580E-03	1.726E-03	1.870E-03	2.014E-03	2.156E-03	2.296E-03	2.435E-03	2.572E-03
pb	3.991E-03	4.396E-03	4.800E-03	5.202E-03	5.601E-03	5.996E-03	6.386E-03	6.772E-03	7.153E-03
bi	3.992E-03	4.396E-03	4.800E-03	5.202E-03	5.601E-03	5.996E-03	6.386E-03	6.772E-03	7.153E-03
po	6.546E-03	7.211E-03	7.874E-03	8.534E-03	9.188E-03	9.836E-03	1.048E-02	1.111E-02	1.173E-02
at	2.242E-07	2.132E-07	2.119E-07	2.120E-07	2.122E-07	2.124E-07	2.126E-07	2.128E-07	2.131E-07
rn	3.990E-03	4.395E-03	4.800E-03	5.202E-03	5.601E-03	5.995E-03	6.386E-03	6.772E-03	7.152E-03
fr	2.349E-07	2.252E-07	2.254E-07	2.269E-07	2.285E-07	2.302E-07	2.319E-07	2.335E-07	2.352E-07
ra	3.990E-03	4.395E-03	4.800E-03	5.202E-03	5.601E-03	5.996E-03	6.386E-03	6.772E-03	7.153E-03
ac	9.981E-07	1.083E-06	1.187E-06	1.293E-06	1.398E-06	1.503E-06	1.608E-06	1.713E-06	1.817E-06
th	3.337E-01	3.341E-01	3.345E-01	3.349E-01	3.353E-01	3.357E-01	3.361E-01	3.365E-01	3.368E-01
pa	6.466E-01	6.467E-01	6.468E-01	6.468E-01	6.468E-01	6.468E-01	6.468E-01	6.468E-01	6.468E-01
u	1.660E+01	4.636E+00	4.502E+00	4.485E+00	4.468E+00	4.452E+00	4.436E+00	4.420E+00	4.404E+00
np	2.731E+01	2.731E+01	2.730E+01	2.730E+01	2.730E+01	2.730E+01	2.730E+01	2.730E+01	2.730E+01
pu	1.194E+05	1.188E+05	1.180E+05	1.173E+05	1.166E+05	1.158E+05	1.151E+05	1.144E+05	1.136E+05
am	2.633E+02	2.860E+02	3.110E+02	3.359E+02	3.606E+02	3.851E+02	4.094E+02	4.336E+02	4.576E+02
cm	3.603E+04	3.030E+04	2.510E+04	2.089E+04	1.748E+04	1.473E+04	1.250E+04	1.069E+04	9.225E+03
bk	1.112E-03	1.008E-03	9.048E-04	8.120E-04	7.286E-04	6.538E-04	5.867E-04	5.265E-04	4.725E-04
cf	6.541E-05	6.423E-05	6.298E-05	6.175E-05	6.055E-05	5.937E-05	5.822E-05	5.709E-05	5.598E-05
es	3.232E-07	1.051E-07	3.999E-08	2.377E-08	1.858E-08	1.590E-08	1.392E-08	1.226E-08	1.080E-08
totals	1.557E+05	1.494E+05	1.435E+05	1.385E+05	1.344E+05	1.310E+05	1.280E+05	1.255E+05	1.234E+05

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Fukushima 4
actinides page 89
decay, following irradiation identified by: power= 25.00mw, burnup= 39500.mwd, flux=
4.05E+13n/cm**2-sec

element thermal power, watts
basis = 1 t uranium

	initial	150.0 d	200.0 d	250.0 d	300.0 d	350.0 d	400.0 d	450.0 d	500.0 d
tl	3.355E-05	3.695E-05	4.035E-05	4.373E-05	4.708E-05	5.039E-05	5.368E-05	5.692E-05	6.012E-05
pb	7.548E-06	8.313E-06	9.078E-06	9.838E-06	1.059E-05	1.134E-05	1.208E-05	1.281E-05	1.353E-05
bi	6.685E-05	7.362E-05	8.040E-05	8.714E-05	9.381E-05	1.004E-04	1.070E-04	1.134E-04	1.198E-04
po	2.990E-04	3.293E-04	3.597E-04	3.898E-04	4.197E-04	4.492E-04	4.785E-04	5.074E-04	5.359E-04
at	9.567E-09	9.096E-09	9.042E-09	9.045E-09	9.054E-09	9.064E-09	9.073E-09	9.083E-09	9.092E-09
rn	1.515E-04	1.669E-04	1.822E-04	1.975E-04	2.126E-04	2.276E-04	2.425E-04	2.571E-04	2.716E-04
fr	8.680E-09	8.257E-09	8.212E-09	8.219E-09	8.230E-09	8.242E-09	8.254E-09	8.267E-09	8.279E-09
ra	1.369E-04	1.509E-04	1.647E-04	1.785E-04	1.922E-04	2.058E-04	2.192E-04	2.324E-04	2.455E-04
ac	8.201E-09	7.864E-09	7.871E-09	7.925E-09	7.983E-09	8.041E-09	8.100E-09	8.158E-09	8.216E-09
th	2.787E-04	2.907E-04	3.040E-04	3.171E-04	3.302E-04	3.431E-04	3.558E-04	3.684E-04	3.809E-04
pa	2.393E-03	2.393E-03	2.394E-03	2.394E-03	2.394E-03	2.394E-03	2.394E-03	2.394E-03	2.394E-03

u	7.804E-02	5.491E-02	5.469E-02	5.470E-02	5.471E-02	5.472E-02	5.473E-02	5.474E-02	5.475E-02
np	7.773E-02	7.772E-02	7.772E-02	7.772E-02	7.772E-02	7.772E-02	7.772E-02	7.772E-02	7.772E-02
pu	1.328E+02	1.336E+02	1.344E+02	1.349E+02	1.354E+02	1.357E+02	1.359E+02	1.361E+02	1.362E+02
am	8.165E+00	8.922E+00	9.758E+00	1.059E+01	1.141E+01	1.223E+01	1.304E+01	1.385E+01	1.465E+01
cm	1.310E+03	1.101E+03	9.109E+02	7.574E+02	6.331E+02	5.326E+02	4.512E+02	3.853E+02	3.319E+02
bk	2.175E-07	1.973E-07	1.770E-07	1.589E-07	1.426E-07	1.279E-07	1.148E-07	1.030E-07	9.244E-08
cf	3.812E-06	3.720E-06	3.623E-06	3.531E-06	3.441E-06	3.355E-06	3.271E-06	3.190E-06	3.112E-06
es	1.287E-08	4.161E-09	1.565E-09	9.210E-10	7.167E-10	6.127E-10	5.364E-10	4.722E-10	4.162E-10
totals	1.451E+03	1.243E+03	1.055E+03	9.030E+02	7.801E+02	6.806E+02	6.003E+02	5.354E+02	4.829E+02

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Fukushima 4 fission
products page 90
decay, following irradiation identified by: power= 25.00mw, burnup= 39500.mwd, flux=
4.05E+13n/cm**2-sec

element concentrations, grams
basis = 1 t uranium

	initial	150.0 d	200.0 d	250.0 d	300.0 d	350.0 d	400.0 d	450.0 d	500.0 d
h	7.882E-02	7.835E-02	7.782E-02	7.729E-02	7.677E-02	7.626E-02	7.575E-02	7.524E-02	7.474E-02
he	1.393E+00	1.393E+00	1.394E+00	1.394E+00	1.395E+00	1.395E+00	1.396E+00	1.396E+00	1.397E+00
li	1.159E-02	1.159E-02	1.159E-02	1.159E-02	1.159E-02	1.159E-02	1.159E-02	1.159E-02	1.159E-02
be	1.215E-02	1.215E-02	1.215E-02	1.215E-02	1.215E-02	1.215E-02	1.215E-02	1.215E-02	1.215E-02
b	7.973E-04	7.973E-04	7.973E-04	7.973E-04	7.973E-04	7.973E-04	7.973E-04	7.973E-04	7.973E-04
c	3.772E-03	3.772E-03	3.772E-03	3.772E-03	3.772E-03	3.771E-03	3.771E-03	3.771E-03	3.771E-03
n	3.737E-04	3.737E-04	3.738E-04	3.738E-04	3.739E-04	3.739E-04	3.740E-04	3.741E-04	3.741E-04
ne	5.142E-03	5.142E-03	5.142E-03	5.142E-03	5.142E-03	5.142E-03	5.142E-03	5.142E-03	5.142E-03
ni	1.366E-21	1.517E-27	3.672E-34	8.888E-41	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
cu	3.114E-19	1.716E-24	2.464E-30	3.537E-36	5.070E-42	0.000E+00	0.000E+00	0.000E+00	0.000E+00
zn	2.008E-03	2.008E-03	2.008E-03	2.008E-03	2.008E-03	2.008E-03	2.008E-03	2.008E-03	2.008E-03
ga	3.265E-03	3.265E-03	3.265E-03	3.265E-03	3.265E-03	3.265E-03	3.265E-03	3.265E-03	3.265E-03
ge	4.509E-01	4.509E-01	4.509E-01	4.509E-01	4.509E-01	4.509E-01	4.509E-01	4.509E-01	4.509E-01
as	1.367E-01	1.367E-01	1.367E-01	1.367E-01	1.367E-01	1.367E-01	1.367E-01	1.367E-01	1.367E-01
se	6.434E+01	6.434E+01	6.434E+01	6.434E+01	6.434E+01	6.434E+01	6.434E+01	6.434E+01	6.434E+01
br	2.513E+01	2.513E+01	2.513E+01	2.513E+01	2.513E+01	2.513E+01	2.513E+01	2.513E+01	2.513E+01
kr	4.383E+02	4.381E+02	4.378E+02	4.376E+02	4.374E+02	4.371E+02	4.369E+02	4.367E+02	4.364E+02
rb	4.172E+02	4.175E+02	4.177E+02	4.179E+02	4.182E+02	4.184E+02	4.187E+02	4.189E+02	4.191E+02
sr	1.048E+03	1.044E+03	1.040E+03	1.038E+03	1.035E+03	1.033E+03	1.031E+03	1.029E+03	1.027E+03
y	5.532E+02	5.517E+02	5.506E+02	5.499E+02	5.495E+02	5.493E+02	5.491E+02	5.490E+02	5.490E+02
zr	4.296E+03	4.296E+03	4.296E+03	4.297E+03	4.298E+03	4.300E+03	4.302E+03	4.304E+03	4.306E+03
nb	1.534E+01	1.026E+01	6.328E+00	3.815E+00	2.270E+00	1.340E+00	7.875E-01	4.617E-01	2.706E-01
mo	4.006E+03	4.018E+03	4.026E+03	4.031E+03	4.033E+03	4.035E+03	4.036E+03	4.037E+03	4.037E+03
tc	9.461E+02	9.461E+02	9.461E+02	9.461E+02	9.461E+02	9.461E+02	9.461E+02	9.461E+02	9.461E+02
ru	2.779E+03	2.766E+03	2.755E+03	2.746E+03	2.738E+03	2.730E+03	2.723E+03	2.717E+03	2.712E+03
rh	5.350E+02	5.380E+02	5.395E+02	5.401E+02	5.403E+02	5.404E+02	5.405E+02	5.405E+02	5.405E+02
pd	1.523E+03	1.532E+03	1.542E+03	1.551E+03	1.559E+03	1.566E+03	1.573E+03	1.579E+03	1.585E+03
ag	8.876E+01	8.871E+01	8.866E+01	8.861E+01	8.858E+01	8.855E+01	8.852E+01	8.849E+01	8.847E+01
cd	9.502E+01	9.507E+01	9.512E+01	9.516E+01	9.520E+01	9.523E+01	9.526E+01	9.528E+01	9.530E+01
in	1.818E+00	1.819E+00	1.820E+00	1.820E+00	1.820E+00	1.821E+00	1.821E+00	1.821E+00	1.821E+00
sn	5.788E+01	5.787E+01	5.785E+01	5.784E+01	5.783E+01	5.782E+01	5.782E+01	5.781E+01	5.781E+01
sb	1.686E+01	1.664E+01	1.641E+01	1.619E+01	1.597E+01	1.576E+01	1.555E+01	1.535E+01	1.516E+01
te	5.572E+02	5.572E+02	5.573E+02	5.574E+02	5.576E+02	5.577E+02	5.579E+02	5.581E+02	5.583E+02
i	2.320E+02	2.323E+02	2.324E+02	2.325E+02	2.326E+02	2.326E+02	2.327E+02	2.327E+02	2.327E+02
xe	6.370E+03	6.370E+03	6.370E+03	6.370E+03	6.370E+03	6.370E+03	6.370E+03	6.370E+03	6.370E+03
cs	3.398E+03	3.389E+03	3.380E+03	3.371E+03	3.362E+03	3.354E+03	3.346E+03	3.337E+03	3.329E+03
ba	1.763E+03	1.772E+03	1.781E+03	1.790E+03	1.799E+03	1.807E+03	1.815E+03	1.824E+03	1.832E+03
la	1.466E+03	1.466E+03	1.466E+03	1.466E+03	1.466E+03	1.466E+03	1.466E+03	1.466E+03	1.466E+03
ce	3.089E+03	3.064E+03	3.040E+03	3.020E+03	3.002E+03	2.986E+03	2.973E+03	2.960E+03	2.950E+03
pr	1.341E+03	1.344E+03	1.345E+03	1.345E+03	1.345E+03	1.345E+03	1.345E+03	1.345E+03	1.345E+03
nd	4.656E+03	4.679E+03	4.702E+03	4.721E+03	4.739E+03	4.755E+03	4.768E+03	4.781E+03	4.792E+03
pm	1.722E+02	1.666E+02	1.606E+02	1.549E+02	1.494E+02	1.441E+02	1.389E+02	1.340E+02	1.292E+02
sm	8.511E+02	8.567E+02	8.627E+02	8.684E+02	8.739E+02	8.792E+02	8.843E+02	8.892E+02	8.939E+02
eu	1.669E+02	1.665E+02	1.662E+02	1.658E+02	1.655E+02	1.651E+02	1.648E+02	1.644E+02	1.641E+02
gd	1.284E+02	1.287E+02	1.291E+02	1.295E+02	1.299E+02	1.302E+02	1.306E+02	1.309E+02	1.313E+02
tb	2.577E+00	2.569E+00	2.563E+00	2.559E+00	2.557E+00	2.555E+00	2.554E+00	2.554E+00	2.554E+00
dy	1.193E+00	1.201E+00	1.207E+00	1.210E+00	1.213E+00	1.214E+00	1.215E+00	1.216E+00	1.216E+00
ho	8.163E-02	8.163E-02	8.163E-02	8.163E-02	8.163E-02	8.163E-02	8.163E-02	8.163E-02	8.163E-02
er	2.725E-02	2.725E-02	2.725E-02	2.725E-02	2.725E-02	2.725E-02	2.725E-02	2.725E-02	2.725E-02
tm	4.429E-04	4.335E-04	4.248E-04	4.176E-04	4.115E-04	4.064E-04	4.019E-04	3.980E-04	3.946E-04
yb	5.033E-04	5.127E-04	5.214E-04	5.286E-04	5.347E-04	5.399E-04	5.443E-04	5.482E-04	5.516E-04
lu	3.606E-19	5.371E-21	6.133E-23	8.081E-25	1.145E-26	1.673E-28	2.475E-30	3.680E-32	5.482E-34
totals	4.110E+04	4.110E+04	4.110E+04	4.110E+04	4.110E+04	4.110E+04	4.110E+04	4.110E+04	4.110E+04

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Fukushima 4 fission
products page 91
decay, following irradiation identified by: power= 25.00mw, burnup= 39500.mwd, flux=
4.05E+13n/cm**2-sec

element radioactivity, curies
basis = 1 t uranium

	initial	150.0 d	200.0 d	250.0 d	300.0 d	350.0 d	400.0 d	450.0 d	500.0 d
h	6.703E+02	6.657E+02	6.606E+02	6.556E+02	6.505E+02	6.455E+02	6.406E+02	6.357E+02	6.308E+02
be	2.511E-04	2.510E-04	2.510E-04	2.510E-04	2.510E-04	2.510E-04	2.510E-04	2.510E-04	2.510E-04
c	1.529E-02	1.529E-02	1.529E-02	1.529E-02	1.529E-02	1.529E-02	1.529E-02	1.529E-02	1.529E-02
ni	1.188E-15	1.320E-21	3.194E-28	7.733E-35	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
cu	2.369E-13	1.300E-18	1.865E-24	2.677E-30	3.837E-36	0.000E+00	0.000E+00	0.000E+00	0.000E+00
zn	7.185E-16	7.354E-23	1.259E-30	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ga	3.740E-15	2.414E-15	2.124E-15	1.869E-15	1.645E-15	1.447E-15	1.274E-15	1.121E-15	9.860E-16
ge	2.424E-07	1.586E-08	7.668E-10	3.707E-11	1.793E-12	8.806E-14	5.460E-15	1.323E-15	9.956E-16
as	1.569E-05	5.332E-06	2.542E-06	1.520E-06	9.683E-07	6.262E-07	4.063E-07	2.638E-07	1.713E-07
se	8.689E-02	8.688E-02	8.688E-02	8.687E-02	8.687E-02	8.687E-02	8.687E-02	8.687E-02	8.687E-02
br	9.180E-19	3.100E-25	1.441E-31	7.701E-38	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
kr	1.102E+04	1.093E+04	1.084E+04	1.074E+04	1.065E+04	1.055E+04	1.046E+04	1.037E+04	1.028E+04
rb	2.943E+01	5.534E+00	8.682E-01	1.378E-01	2.253E-02	3.995E-03	8.712E-04	2.798E-04	1.368E-04
sr	2.226E+05	1.609E+05	1.249E+05	1.067E+05	9.731E+04	9.245E+04	8.986E+04	8.840E+04	8.753E+04
y	3.073E+05	2.169E+05	1.595E+05	1.276E+05	1.098E+05	9.980E+04	9.416E+04	9.091E+04	8.898E+04
zr	3.468E+05	2.131E+05	1.240E+05	7.217E+04	4.200E+04	2.444E+04	1.423E+04	8.279E+03	4.819E+03
nb	6.067E+05	4.057E+05	2.501E+05	1.507E+05	8.962E+04	5.287E+04	3.103E+04	1.816E+04	1.060E+04
mo	3.911E-06	3.613E-08	3.608E-08	3.608E-08	3.608E-08	3.608E-08	3.608E-08	3.608E-08	3.608E-08
tc	1.619E+01	1.619E+01	1.619E+01	1.619E+01	1.619E+01	1.619E+01	1.619E+01	1.619E+01	1.619E+01
ru	5.708E+05	4.414E+05	3.620E+05	3.132E+05	2.784E+05	2.508E+05	2.273E+05	2.065E+05	1.879E+05
rh	5.705E+05	4.413E+05	3.620E+05	3.132E+05	2.784E+05	2.508E+05	2.273E+05	2.065E+05	1.879E+05
pd	1.632E-01	1.356E-01	1.310E-01	1.304E-01	1.303E-01	1.303E-01	1.303E-01	1.303E-01	1.303E-01
ag	2.055E+03	1.811E+03	1.577E+03	1.373E+03	1.195E+03	1.040E+03	9.052E+02	7.880E+02	6.859E+02
cd	5.820E+01	2.916E+01	1.366E+01	6.526E+00	3.244E+00	1.732E+00	1.033E+00	7.094E-01	5.574E-01
in	2.724E-02	1.428E-02	6.975E-03	3.410E-03	1.669E-03	8.173E-04	4.007E-04	1.966E-04	9.651E-05
sn	7.230E+02	5.763E+02	4.522E+02	3.568E+02	2.834E+02	2.267E+02	1.829E+02	1.491E+02	1.229E+02
sb	7.882E+03	7.571E+03	7.269E+03	6.997E+03	6.744E+03	6.506E+03	6.279E+03	6.063E+03	5.854E+03
te	2.034E+04	1.325E+04	9.070E+03	6.662E+03	5.126E+03	4.077E+03	3.328E+03	2.781E+03	2.374E+03
i	8.302E+01	1.746E+00	5.455E-02	3.184E-02	3.153E-02	3.153E-02	3.153E-02	3.153E-02	3.153E-02
xe	5.553E+01	4.029E+00	2.213E-01	1.245E-02	8.306E-04	1.045E-04	2.860E-05	1.040E-05	3.979E-06
cs	2.649E+05	2.587E+05	2.522E+05	2.460E+05	2.401E+05	2.344E+05	2.290E+05	2.238E+05	2.188E+05
ba	1.210E+05	1.172E+05	1.165E+05	1.161E+05	1.157E+05	1.154E+05	1.150E+05	1.146E+05	1.143E+05
la	4.426E+03	3.833E+02	2.529E+01	1.669E+00	1.102E-01	7.277E-03	4.878E-04	3.977E-05	1.020E-05
ce	8.138E+05	6.692E+05	5.683E+05	4.948E+05	4.353E+05	3.844E+05	3.401E+05	3.010E+05	2.665E+05
pr	7.115E+05	6.336E+05	5.607E+05	4.964E+05	4.395E+05	3.892E+05	3.446E+05	3.051E+05	2.702E+05
nd	5.829E+02	3.403E+01	1.449E+00	6.169E-02	2.627E-03	1.118E-04	4.763E-06	2.046E-07	1.053E-08
pm	1.642E+05	1.566E+05	1.499E+05	1.441E+05	1.387E+05	1.337E+05	1.289E+05	1.243E+05	1.199E+05
sm	3.411E+02	3.408E+02	3.404E+02	3.401E+02	3.397E+02	3.394E+02	3.390E+02	3.386E+02	3.383E+02
eu	1.107E+04	9.473E+03	9.148E+03	9.001E+03	8.873E+03	8.749E+03	8.627E+03	8.507E+03	8.389E+03
gd	1.566E+00	1.376E+00	1.192E+00	1.033E+00	8.950E-01	7.753E-01	6.717E-01	5.819E-01	5.041E-01
tb	2.693E+02	1.749E+02	1.083E+02	6.705E+01	4.152E+01	2.571E+01	1.592E+01	9.855E+00	6.102E+00
dy	1.181E-04	9.513E-05	7.483E-05	5.886E-05	4.630E-05	3.642E-05	2.865E-05	2.254E-05	1.773E-05
ho	4.225E-04	4.224E-04	4.224E-04	4.224E-04	4.223E-04	4.223E-04	4.223E-04	4.222E-04	4.222E-04
er	2.983E-04	1.080E-05	2.706E-07	6.778E-09	1.698E-10	4.252E-12	1.065E-13	2.668E-15	6.682E-17
tm	2.534E-01	2.114E-01	1.746E-01	1.459E-01	1.233E-01	1.055E-01	9.141E-02	8.009E-02	7.095E-02
yb	3.069E-07	1.159E-07	3.928E-08	1.331E-08	4.512E-09	1.529E-09	5.182E-10	1.756E-10	5.952E-11
lu	3.783E-14	5.399E-16	5.923E-18	7.626E-20	1.069E-21	1.555E-23	2.297E-25	3.413E-27	5.082E-29
totals	4.760E+06	3.760E+06	3.069E+06	2.617E+06	2.299E+06	2.060E+06	1.872E+06	1.717E+06	1.586E+06

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Fukushima 4 fission products page 92

decay, following irradiation identified by: power= 25.00mw, burnup= 39500.mwd, flux= 4.05E+13n/cm**2-sec

element thermal power, watts
basis = 1 t uranium

	initial	150.0 d	200.0 d	250.0 d	300.0 d	350.0 d	400.0 d	450.0 d	500.0 d
h	2.261E-02	2.245E-02	2.228E-02	2.211E-02	2.194E-02	2.177E-02	2.161E-02	2.144E-02	2.128E-02
be	3.015E-07	3.014E-07	3.013E-07	3.013E-07	3.013E-07	3.013E-07	3.013E-07	3.013E-07	3.013E-07
c	4.483E-06	4.483E-06	4.483E-06	4.483E-06	4.483E-06	4.482E-06	4.482E-06	4.482E-06	4.482E-06
ni	4.579E-19	5.085E-25	1.231E-31	2.979E-38	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
cu	3.868E-16	2.096E-21	2.998E-27	4.300E-33	6.164E-39	0.000E+00	0.000E+00	0.000E+00	0.000E+00
zn	1.087E-18	1.112E-25	1.904E-33	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ga	4.675E-17	2.420E-17	2.129E-17	1.874E-17	1.649E-17	1.451E-17	1.277E-17	1.123E-17	9.883E-18
ge	1.295E-11	8.475E-13	4.097E-14	1.980E-15	9.581E-17	4.704E-18	2.909E-19	6.993E-20	5.254E-20
as	6.600E-08	1.255E-08	2.563E-09	8.699E-10	4.520E-10	2.775E-10	1.779E-10	1.152E-10	7.479E-11
se	2.879E-05	2.877E-05	2.876E-05	2.875E-05	2.875E-05	2.874E-05	2.874E-05	2.874E-05	2.874E-05
br	1.289E-20	6.078E-28	2.792E-34	1.493E-40	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
kr	1.653E+01	1.640E+01	1.625E+01	1.611E+01	1.597E+01	1.583E+01	1.569E+01	1.555E+01	1.541E+01
rb	1.329E-01	2.502E-02	3.935E-03	6.274E-04	1.033E-04	1.832E-05	3.833E-06	1.073E-06	4.249E-07
sr	5.645E+02	3.520E+02	2.283E+02	1.658E+02	1.341E+02	1.180E+02	1.097E+02	1.054E+02	1.030E+02
y	1.279E+03	9.531E+02	7.458E+02	6.304E+02	5.658E+02	5.294E+02	5.085E+02	4.962E+02	4.887E+02
zr	1.748E+03	1.074E+03	6.251E+02	3.638E+02	2.117E+02	1.232E+02	7.170E+01	4.172E+01	2.428E+01
nb	2.895E+03	1.937E+03	1.194E+03	7.197E+02	4.280E+02	2.525E+02	1.482E+02	8.673E+01	5.065E+01
mo	1.552E-08	3.604E-12	3.422E-12	3.422E-12	3.422E-12	3.422E-12	3.422E-12	3.422E-12	3.422E-12
tc	8.120E-03	8.120E-03	8.120E-03	8.120E-03	8.120E-03	8.120E-03	8.120E-03	8.120E-03	8.120E-03
ru	6.170E+02	2.897E+02	1.305E+02	6.369E+01	3.520E+01	2.262E+01	1.670E+01	1.360E+01	1.172E+01
rh	3.802E+03	3.477E+03	3.158E+03	2.873E+03	2.615E+03	2.382E+03	2.169E+03	1.976E+03	1.800E+03

pd	1.099E-05	7.790E-06	7.263E-06	7.194E-06	7.185E-06	7.184E-06	7.184E-06	7.184E-06	7.184E-06
ag	3.397E+01	2.997E+01	2.609E+01	2.271E+01	1.977E+01	1.721E+01	1.498E+01	1.304E+01	1.135E+01
cd	2.181E-01	1.086E-01	5.016E-02	2.331E-02	1.095E-02	5.275E-03	2.662E-03	1.458E-03	9.036E-04
in	7.434E-05	3.915E-05	1.921E-05	9.434E-06	4.636E-06	2.280E-06	1.122E-06	5.524E-07	2.722E-07
sn	2.075E+00	1.618E+00	1.242E+00	9.553E-01	7.356E-01	5.673E-01	4.384E-01	3.396E-01	2.639E-01
sb	2.675E+01	2.502E+01	2.360E+01	2.247E+01	2.152E+01	2.068E+01	1.992E+01	1.921E+01	1.853E+01
te	2.969E+01	1.654E+01	9.882E+00	6.648E+00	4.859E+00	3.752E+00	3.008E+00	2.481E+00	2.097E+00
i	2.821E-01	5.843E-03	9.304E-05	1.580E-05	1.476E-05	1.475E-05	1.475E-05	1.475E-05	1.475E-05
xe	5.356E-02	3.874E-03	2.137E-04	1.237E-05	9.558E-07	1.613E-07	5.097E-08	1.906E-08	7.321E-09
cs	1.574E+03	1.514E+03	1.451E+03	1.392E+03	1.335E+03	1.280E+03	1.228E+03	1.179E+03	1.132E+03
ba	4.718E+02	4.600E+02	4.576E+02	4.561E+02	4.547E+02	4.533E+02	4.518E+02	4.504E+02	4.490E+02
la	7.430E+01	6.435E+00	4.246E-01	2.802E-02	1.849E-03	1.220E-04	8.054E-06	5.329E-07	3.653E-08
ce	6.273E+02	4.743E+02	3.844E+02	3.281E+02	2.863E+02	2.521E+02	2.227E+02	1.970E+02	1.744E+02
pr	5.125E+03	4.586E+03	4.060E+03	3.595E+03	3.183E+03	2.819E+03	2.496E+03	2.210E+03	1.957E+03
nd	1.411E+00	8.236E-02	3.507E-03	1.493E-04	6.357E-06	2.707E-07	1.155E-08	5.120E-10	4.237E-11
pm	1.166E+02	8.396E+01	6.646E+01	5.783E+01	5.306E+01	5.001E+01	4.772E+01	4.581E+01	4.409E+01
sm	4.012E-02	4.008E-02	4.004E-02	4.000E-02	3.995E-02	3.991E-02	3.987E-02	3.983E-02	3.979E-02
eu	7.614E+01	6.071E+01	5.809E+01	5.724E+01	5.657E+01	5.592E+01	5.529E+01	5.466E+01	5.404E+01
gd	1.377E-03	1.210E-03	1.048E-03	9.080E-04	7.867E-04	6.815E-04	5.904E-04	5.115E-04	4.431E-04
tb	2.362E+00	1.534E+00	9.500E-01	5.882E-01	3.642E-01	2.255E-01	1.396E-01	8.646E-02	5.354E-02
dy	3.862E-08	3.111E-08	2.447E-08	1.925E-08	1.514E-08	1.191E-08	9.370E-09	7.371E-09	5.798E-09
ho	4.442E-06	4.442E-06	4.442E-06	4.441E-06	4.441E-06	4.441E-06	4.440E-06	4.440E-06	4.439E-06
er	1.821E-07	6.596E-09	1.652E-10	4.138E-12	1.036E-13	2.596E-15	6.503E-17	1.629E-18	4.080E-20
tm	3.660E-04	2.890E-04	2.228E-04	1.720E-04	1.332E-04	1.034E-04	8.063E-05	6.314E-05	4.970E-05
yb	7.810E-10	2.949E-10	9.996E-11	3.388E-11	1.148E-11	3.891E-12	1.319E-12	4.469E-13	1.515E-13
lu	3.542E-16	4.150E-18	3.594E-20	3.887E-22	4.961E-24	6.925E-26	1.006E-27	1.485E-29	2.206E-31
totals	1.908E+04	1.536E+04	1.264E+04	1.077E+04	9.422E+03	8.396E+03	7.580E+03	6.907E+03	6.336E+03

Fukushima 4
actinides page 81
decay, following irradiation identified by: power= 25.00mw, burnup= 39500.mwd, flux= 4.05E+13n/cm**2-sec

element concentrations, grams
basis = 1 t uranium

	charge	discharge	0.1 d	0.3 d	1.0 d	3.0 d	10.0 d	30.0 d	100.0 d	105.0 d
he	1.518E-01	5.899E-01	5.900E-01	5.903E-01	5.911E-01	5.936E-01	6.021E-01	6.252E-01	6.941E-01	6.985E-01
tl	1.279E-12	3.856E-12	3.897E-12	3.864E-12	3.988E-12	3.867E-12	3.886E-12	4.072E-12	4.838E-12	4.846E-12
pb	3.437E-07	1.493E-06	1.494E-06	1.494E-06	1.497E-06	1.504E-06	1.530E-06	1.605E-06	1.888E-06	1.911E-06
bi	1.357E-10	5.521E-10	5.522E-10	5.524E-10	5.603E-10	5.553E-10	5.623E-10	5.866E-10	6.541E-10	6.557E-10
po	2.213E-13	8.211E-13	8.213E-13	8.217E-13	8.230E-13	8.267E-13	8.394E-13	8.751E-13	9.907E-13	9.988E-13
at	6.091E-20	4.829E-19	4.832E-19	4.835E-19	4.841E-19	4.829E-19	4.537E-19	3.151E-19	1.412E-19	1.392E-19
rn	1.324E-12	3.775E-12	3.775E-12	3.774E-12	3.771E-12	3.770E-12	3.803E-12	3.976E-12	4.688E-12	4.693E-12
fr	6.986E-16	4.673E-15	4.676E-15	4.679E-15	4.685E-15	4.675E-15	4.409E-15	3.140E-15	1.581E-15	1.567E-15
ra	3.533E-08	7.178E-08	7.178E-08	7.179E-08	7.181E-08	7.191E-08	7.247E-08	7.454E-08	8.250E-08	8.282E-08
ac	5.191E-09	7.627E-09	7.628E-09	7.631E-09	7.648E-09	7.706E-09	7.912E-09	8.498E-09	1.055E-08	1.070E-08
th	2.133E-03	2.642E-03	2.642E-03	2.643E-03	2.643E-03	2.646E-03	2.658E-03	2.693E-03	2.816E-03	2.825E-03
pa	3.415E-04	5.458E-04	5.458E-04	5.458E-04	5.460E-04	5.461E-04	5.461E-04	5.465E-04	5.478E-04	5.478E-04
u	9.649E+05	9.494E+05	9.494E+05	9.494E+05	9.494E+05	9.494E+05	9.494E+05	9.494E+05	9.494E+05	9.494E+05
np	2.870E+02	5.246E+02	5.232E+02	5.199E+02	5.096E+02	4.900E+02	4.700E+02	4.689E+02	4.693E+02	4.693E+02
pu	7.185E+03	8.737E+03	8.739E+03	8.743E+03	8.753E+03	8.774E+03	8.796E+03	8.797E+03	8.790E+03	8.790E+03
am	6.734E+01	1.838E+02	1.838E+02	1.839E+02	1.839E+02	1.842E+02	1.852E+02	1.882E+02	1.986E+02	1.993E+02
cm	1.137E+01	5.733E+01	5.734E+01	5.736E+01	5.738E+01	5.728E+01	5.681E+01	5.551E+01	5.171E+01	5.148E+01
bk	1.175E-08	8.511E-07	8.511E-07	8.506E-07	8.491E-07	8.455E-07	8.328E-07	7.975E-07	6.854E-07	6.780E-07
cf	7.074E-09	5.693E-07	5.698E-07	5.705E-07	5.719E-07	5.753E-07	5.874E-07	6.209E-07	7.269E-07	7.338E-07
es	2.726E-13	1.056E-10	1.057E-10	1.059E-10	1.066E-10	1.079E-10	1.082E-10	8.969E-11	2.928E-11	2.733E-11
totals	9.724E+05	9.589E+05	9.589E+05	9.589E+05	9.589E+05	9.589E+05	9.589E+05	9.589E+05	9.589E+05	9.589E+05

Fukushima 4
actinides page 82
decay, following irradiation identified by: power= 25.00mw, burnup= 39500.mwd, flux= 4.05E+13n/cm**2-sec

element radioactivity, curies
basis = 1 t uranium

	charge	discharge	0.1 d	0.3 d	1.0 d	3.0 d	10.0 d	30.0 d	100.0 d	105.0 d
tl	3.786E-04	1.142E-03	1.154E-03	1.144E-03	1.181E-03	1.145E-03	1.151E-03	1.206E-03	1.433E-03	1.435E-03
pb	1.053E-03	3.177E-03	3.177E-03	3.176E-03	3.174E-03	3.171E-03	3.201E-03	3.354E-03	3.985E-03	3.991E-03
bi	1.053E-03	3.177E-03	3.178E-03	3.177E-03	3.285E-03	3.185E-03	3.201E-03	3.354E-03	3.985E-03	3.992E-03
po	1.727E-03	5.211E-03	5.212E-03	5.210E-03	5.277E-03	5.212E-03	5.251E-03	5.502E-03	6.538E-03	6.546E-03
at	9.808E-08	7.776E-07	7.781E-07	7.786E-07	7.796E-07	7.775E-07	7.305E-07	5.074E-07	2.274E-07	2.242E-07
rn	1.053E-03	3.176E-03	3.176E-03	3.175E-03	3.173E-03	3.171E-03	3.200E-03	3.354E-03	3.985E-03	3.990E-03
fr	1.033E-07	7.852E-07	7.857E-07	7.862E-07	7.872E-07	7.852E-07	7.384E-07	5.159E-07	2.379E-07	2.349E-07
ra	1.053E-03	3.177E-03	3.176E-03	3.176E-03	3.173E-03	3.172E-03	3.201E-03	3.354E-03	3.985E-03	3.990E-03
ac	4.736E-07	2.224E-05	1.728E-05	1.062E-05	2.730E-06	1.340E-06	1.302E-06	1.122E-06	9.907E-07	

9.981E-07

th	3.482E-01	1.212E+00	1.137E+00	1.038E+00	7.795E-01	4.539E-01	3.339E-01	3.329E-01	3.337E-01	3.337E-01
pa	5.183E-01	1.248E+00	1.213E+00	1.155E+00	9.971E-01	7.680E-01	6.491E-01	6.461E-01	6.466E-01	6.466E-01
u	6.271E+03	1.483E+07	7.779E+05	5.637E+05	5.246E+05	4.272E+05	2.082E+05	2.670E+04	2.471E+01	1.660E+01
np	6.598E+01	1.454E+07	1.420E+07	1.338E+07	1.089E+07	6.036E+06	7.665E+05	2.142E+03	2.731E+01	2.731E+01
pu	8.515E+04	4.448E+05	3.524E+05	2.392E+05	1.322E+05	1.209E+05	1.208E+05	1.205E+05	1.195E+05	1.194E+05
am	1.278E+02	1.841E+05	1.604E+05	1.221E+05	4.850E+04	4.494E+03	2.175E+02	2.252E+02	2.608E+02	2.633E+02
cm	1.713E+04	5.424E+04	5.425E+04	5.425E+04	5.420E+04	5.386E+04	5.238E+04	4.837E+04	3.673E+04	3.603E+04
bk	1.926E-05	4.748E-03	3.394E-03	2.105E-03	1.411E-03	1.386E-03	1.365E-03	1.307E-03	1.124E-03	1.112E-03
cf	5.202E-07	7.096E-05	7.098E-05	7.099E-05	7.091E-05	7.065E-05	6.983E-05	6.823E-05	6.555E-05	6.541E-05
es	5.816E-09	2.182E-06	2.185E-06	2.190E-06	2.207E-06	2.243E-06	2.258E-06	1.817E-06	3.677E-07	3.232E-07
totals	1.087E+05	3.006E+07	1.555E+07	1.436E+07	1.165E+07	6.643E+06	1.148E+06	1.980E+05	1.565E+05	1.557E+05

Fukushima 4
actinides page 83
decay, following irradiation identified by: power= 25.00mw, burnup= 39500.mwd, flux= 4.05E+13n/cm**2-sec

element thermal power, watts
basis = 1 t uranium

	charge	discharge	0.1 d	0.3 d	1.0 d	3.0 d	10.0 d	30.0 d	100.0 d	105.0 d
tl	8.848E-06	2.670E-05	2.698E-05	2.675E-05	2.761E-05	2.677E-05	2.690E-05	2.819E-05	3.350E-05	3.355E-05
pb	1.991E-06	6.007E-06	6.007E-06	6.006E-06	6.001E-06	5.996E-06	6.053E-06	6.343E-06	7.537E-06	7.548E-06
bi	1.764E-05	5.320E-05	5.322E-05	5.321E-05	5.502E-05	5.335E-05	5.361E-05	5.618E-05	6.675E-05	6.685E-05
po	7.888E-05	2.380E-04	2.381E-04	2.380E-04	2.416E-04	2.381E-04	2.398E-04	2.513E-04	2.986E-04	2.990E-04
at	4.185E-09	3.318E-08	3.320E-08	3.322E-08	3.327E-08	3.318E-08	3.117E-08	2.165E-08	9.702E-09	9.567E-09
rn	3.997E-05	1.206E-04	1.206E-04	1.206E-04	1.205E-04	1.204E-04	1.215E-04	1.273E-04	1.513E-04	1.515E-04
fr	3.799E-09	3.003E-08	3.005E-08	3.007E-08	3.011E-08	3.003E-08	2.822E-08	1.961E-08	8.802E-09	8.680E-09
ra	3.613E-05	1.090E-04	1.090E-04	1.090E-04	1.089E-04	1.088E-04	1.098E-04	1.151E-04	1.368E-04	1.369E-04
ac	3.606E-09	1.905E-07	1.519E-07	9.991E-08	3.839E-08	2.746E-08	2.578E-08	1.801E-08	8.309E-09	8.201E-09
th	1.991E-04	1.244E-03	1.128E-03	1.020E-03	7.383E-04	3.836E-04	2.545E-04	2.586E-04	2.774E-04	2.787E-04
pa	2.074E-03	6.350E-03	6.122E-03	5.737E-03	4.690E-03	3.188E-03	2.411E-03	2.391E-03	2.393E-03	2.393E-03
u	1.219E+01	3.979E+04	1.664E+03	1.091E+03	1.016E+03	8.271E+02	4.031E+02	5.174E+01	9.372E-02	7.804E-02
np	1.726E-01	3.763E+04	3.663E+04	3.450E+04	2.805E+04	1.553E+04	1.965E+03	5.464E+00	7.773E-02	7.773E-02
pu	6.249E+01	5.020E+02	3.957E+02	2.655E+02	1.424E+02	1.298E+02	1.303E+02	1.309E+02	1.327E+02	1.328E+02
am	3.919E+00	7.943E+02	6.795E+02	4.983E+02	1.730E+02	1.548E+01	6.555E+00	6.894E+00	8.081E+00	8.165E+00
cm	6.243E+02	1.974E+03	1.974E+03	1.974E+03	1.973E+03	1.960E+03	1.906E+03	1.760E+03	1.335E+03	1.310E+03
bk	3.765E-09	2.390E-05	1.436E-05	5.279E-06	4.065E-07	2.713E-07	2.672E-07	2.559E-07	2.199E-07	2.175E-07
cf	2.704E-08	4.052E-06	4.053E-06	4.054E-06	4.052E-06	4.047E-06	4.029E-06	3.979E-06	3.822E-06	3.812E-06
es	2.322E-10	8.712E-08	8.722E-08	8.743E-08	8.810E-08	8.954E-08	9.015E-08	7.253E-08	1.465E-08	1.287E-08
totals	7.031E+02	8.069E+04	4.135E+04	3.833E+04	3.136E+04	1.847E+04	4.412E+03	1.955E+03	1.476E+03	1.451E+03

Fukushima 4 fission products page 84
decay, following irradiation identified by: power= 25.00mw, burnup= 39500.mwd, flux= 4.05E+13n/cm**2-sec

element concentrations, grams
basis = 1 t uranium

	charge	discharge	0.1 d	0.3 d	1.0 d	3.0 d	10.0 d	30.0 d	100.0 d	105.0 d
h	4.918E-02	7.995E-02	7.995E-02	7.995E-02	7.994E-02	7.992E-02	7.985E-02	7.963E-02	7.888E-02	7.882E-02
he	9.221E-01	1.392E+00	1.392E+00	1.392E+00	1.392E+00	1.392E+00	1.392E+00	1.392E+00	1.393E+00	1.393E+00
li	1.169E-02	1.159E-02	1.159E-02	1.159E-02	1.159E-02	1.159E-02	1.159E-02	1.159E-02	1.159E-02	1.159E-02
be	7.985E-03	1.215E-02	1.215E-02	1.215E-02	1.215E-02	1.215E-02	1.215E-02	1.215E-02	1.215E-02	1.215E-02
b	5.155E-04	7.973E-04	7.973E-04	7.973E-04	7.973E-04	7.973E-04	7.973E-04	7.973E-04	7.973E-04	7.973E-04
c	2.331E-03	3.772E-03	3.772E-03	3.772E-03	3.772E-03	3.772E-03	3.772E-03	3.772E-03	3.772E-03	3.772E-03
n	2.889E-04	3.735E-04	3.735E-04	3.735E-04	3.736E-04	3.736E-04	3.736E-04	3.736E-04	3.737E-04	3.737E-04
ne	3.983E-03	5.142E-03	5.142E-03	5.142E-03	5.142E-03	5.142E-03	5.142E-03	5.142E-03	5.142E-03	5.142E-03
ni	2.920E-13	1.072E-07	1.038E-07	9.762E-08	7.887E-08	4.288E-08	5.082E-09	1.147E-11	6.267E-21	1.366E-21
cu	7.123E-12	5.842E-07	5.651E-07	5.355E-07	4.435E-07	2.589E-07	3.937E-08	1.811E-10	1.196E-18	3.114E-19
zn	1.209E-03	2.024E-03	2.023E-03	2.022E-03	2.019E-03	2.013E-03	2.009E-03	2.008E-03	2.008E-03	2.008E-03
ga	1.922E-03	3.275E-03	3.273E-03	3.271E-03	3.269E-03	3.267E-03	3.265E-03	3.265E-03	3.265E-03	3.265E-03
ge	3.066E-01	4.511E-01	4.510E-01	4.509E-01	4.509E-01	4.509E-01	4.509E-01	4.509E-01	4.509E-01	4.509E-01
as	9.313E-02	1.381E-01	1.380E-01	1.379E-01	1.376E-01	1.371E-01	1.367E-01	1.367E-01	1.367E-01	1.367E-01
se	4.487E+01	6.434E+01	6.434E+01	6.434E+01	6.434E+01	6.434E+01	6.434E+01	6.434E+01	6.434E+01	6.434E+01
br	1.754E+01	2.514E+01	2.514E+01	2.513E+01	2.513E+01	2.513E+01	2.513E+01	2.513E+01	2.513E+01	2.513E+01
kr	3.151E+02	4.389E+02	4.389E+02	4.389E+02	4.388E+02	4.388E+02	4.388E+02	4.387E+02	4.383E+02	4.383E+02
rb	2.995E+02	4.167E+02	4.167E+02	4.167E+02	4.167E+02	4.167E+02	4.168E+02	4.169E+02	4.172E+02	4.172E+02
sr	7.807E+02	1.067E+03	1.067E+03	1.067E+03	1.067E+03	1.066E+03	1.064E+03	1.059E+03	1.048E+03	1.048E+03
y	4.069E+02	5.606E+02	5.605E+02	5.605E+02	5.603E+02	5.601E+02	5.594E+02	5.577E+02	5.534E+02	5.532E+02
zr	3.013E+03	4.304E+03	4.304E+03	4.304E+03	4.304E+03	4.304E+03	4.303E+03	4.301E+03	4.296E+03	4.296E+03
nb	2.614E+01	2.774E+01	2.774E+01	2.773E+01	2.770E+01	2.766E+01	2.739E+01	2.564E+01	1.599E+01	1.534E+01
mo	2.677E+03	3.962E+03	3.962E+03	3.962E+03	3.962E+03	3.962E+03	3.965E+03	3.976E+03	4.005E+03	4.006E+03
tc	6.631E+02	9.435E+02	9.436E+02	9.437E+02	9.441E+02	9.449E+02	9.459E+02	9.461E+02	9.461E+02	9.461E+02
ru	1.779E+03	2.834E+03	2.834E+03	2.834E+03	2.833E+03	2.832E+03	2.826E+03	2.812E+03	2.781E+03	2.779E+03
rh	3.785E+02	5.062E+02	5.062E+02	5.063E+02	5.065E+02	5.073E+02	5.110E+02	5.197E+02	5.345E+02	5.350E+02
pd	7.614E+02	1.496E+03	1.496E+03	1.497E+03	1.497E+03	1.498E+03	1.500E+03	1.505E+03	1.522E+03	1.523E+03
ag	4.825E+01	8.908E+01	8.909E+01	8.910E+01	8.913E+01	8.911E+01	8.900E+01	8.887E+01	8.876E+01	8.876E+01
cd	4.303E+01	9.459E+01	9.459E+01	9.460E+01	9.462E+01	9.467E+01	9.479E+01	9.491E+01	9.502E+01	9.502E+01
in	1.487E+00	1.797E+00	1.798E+00	1.798E+00	1.800E+00	1.805E+00	1.810E+00	1.813E+00	1.818E+00	1.818E+00
sn	3.505E+01	5.801E+01	5.801E+01	5.801E+01	5.800E+01	5.799E+01	5.796E+01	5.793E+01	5.789E+01	5.788E+01
sb	1.139E+01	1.762E+01	1.759E+01	1.757E+01	1.753E+01	1.746E+01	1.734E+01	1.722E+01	1.688E+01	1.686E+01
te	3.647E+02	5.617E+02	5.615E+02	5.614E+02	5.609E+02	5.599E+02	5.584E+02	5.577E+02	5.572E+02	5.572E+02
i	1.463E+02	2.373E+02	2.371E+02	2.368E+02	2.360E+02	2.348E+02	2.330E+02	2.315E+02	2.320E+02	2.320E+02
xe	4.203E+03	6.369E+03	6.369E+03	6.369E+03	6.369E+03	6.370E+03	6.370E+03	6.370E+03	6.370E+03	6.370E+03
cs	2.350E+03	3.410E+03	3.410E+03	3.410E+03	3.411E+03	3.412E+03	3.414E+03	3.412E+03	3.399E+03	3.398E+03
ba	1.138E+03	1.758E+03	1.758E+03	1.758E+03	1.757E+03	1.756E+03	1.754E+03	1.752E+03	1.762E+03	1.763E+03
la	9.997E+02	1.469E+03	1.469E+03	1.468E+03	1.468E+03	1.468E+03	1.468E+03	1.467E+03	1.466E+03	

1.466E+03

ce	2.220E+03	3.170E+03	3.170E+03	3.170E+03	3.169E+03	3.167E+03	3.162E+03	3.145E+03	3.092E+03	3.089E+03
pr	9.066E+02	1.321E+03	1.321E+03	1.321E+03	1.322E+03	1.322E+03	1.324E+03	1.328E+03	1.341E+03	1.341E+03
nd	3.064E+03	4.582E+03	4.582E+03	4.582E+03	4.583E+03	4.586E+03	4.593E+03	4.610E+03	4.654E+03	4.656E+03
pm	1.731E+02	1.832E+02	1.832E+02	1.831E+02	1.830E+02	1.827E+02	1.826E+02	1.815E+02	1.728E+02	1.722E+02
sm	5.339E+02	8.355E+02	8.355E+02	8.356E+02	8.358E+02	8.364E+02	8.379E+02	8.410E+02	8.504E+02	8.511E+02
eu	9.383E+01	1.706E+02	1.706E+02	1.706E+02	1.706E+02	1.706E+02	1.699E+02	1.684E+02	1.670E+02	1.669E+02
gd	4.894E+01	1.239E+02	1.239E+02	1.239E+02	1.241E+02	1.244E+02	1.253E+02	1.269E+02	1.283E+02	1.284E+02
tb	1.324E+00	2.621E+00	2.622E+00	2.622E+00	2.623E+00	2.621E+00	2.615E+00	2.602E+00	2.578E+00	2.577E+00
dy	5.366E-01	1.144E+00	1.144E+00	1.144E+00	1.145E+00	1.148E+00	1.155E+00	1.167E+00	1.191E+00	1.193E+00
ho	2.567E-02	8.168E-02	8.169E-02	8.169E-02	8.168E-02	8.165E-02	8.163E-02	8.163E-02	8.163E-02	8.163E-02
er	9.237E-03	2.714E-02	2.714E-02	2.715E-02	2.718E-02	2.722E-02	2.724E-02	2.725E-02	2.725E-02	2.725E-02
tm	2.945E-04	4.655E-04	4.656E-04	4.656E-04	4.658E-04	4.660E-04	4.658E-04	4.622E-04	4.441E-04	4.429E-04
yb	2.447E-04	4.718E-04	4.719E-04	4.720E-04	4.724E-04	4.734E-04	4.764E-04	4.832E-04	5.022E-04	5.033E-04
lu	4.026E-17	1.214E-14	1.201E-14	1.177E-14	1.096E-14	8.942E-15	4.390E-15	5.805E-16	5.821E-19	3.606E-19
totals	2.755E+04	4.110E+04	4.110E+04	4.110E+04	4.110E+04	4.110E+04	4.110E+04	4.110E+04	4.110E+04	4.110E+04

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Fukushima 4 fission products page 85

decay, following irradiation identified by: power= 25.00mw, burnup= 39500.mwd, flux= 4.05E+13n/cm**2-sec

element radioactivity, curies
basis = 1 t uranium

	charge	discharge	0.1 d	0.3 d	1.0 d	3.0 d	10.0 d	30.0 d	100.0 d	105.0 d
h	4.226E+02	6.813E+02	6.813E+02	6.812E+02	6.812E+02	6.810E+02	6.802E+02	6.781E+02	6.709E+02	6.703E+02
be	1.660E-04	5.056E+01	2.515E-04	2.515E-04	2.515E-04	2.515E-04	2.515E-04	2.513E-04	2.511E-04	2.511E-04
c	9.526E-03	1.545E+00	1.529E-02	1.529E-02	1.529E-02	1.529E-02	1.529E-02	1.529E-02	1.529E-02	1.529E-02
ni	2.540E-07	8.804E+00	9.027E-02	8.493E-02	6.862E-02	3.731E-02	4.421E-03	9.980E-06	5.452E-15	1.188E-15
cu	5.645E-06	7.801E+01	5.180E-01	4.902E-01	4.043E-01	2.333E-01	3.422E-02	1.471E-04	9.105E-13	2.369E-13
zn	4.495E-06	1.361E+03	1.492E+01	1.341E+01	1.027E+01	5.015E+00	4.101E-01	3.208E-04	4.296E-15	7.185E-16
ga	6.451E-06	9.554E+03	4.067E+01	2.767E+01	1.407E+01	7.025E+00	5.904E-01	4.604E-04	8.909E-15	3.740E-15
ge	4.179E-06	1.066E+05	1.631E+03	4.465E+02	1.124E+02	5.856E+00	2.725E-04	2.281E-05	3.281E-07	2.424E-07
as	1.362E-04	2.479E+05	3.730E+03	1.739E+03	9.402E+02	4.146E+02	2.069E+01	4.133E-03	1.819E-05	1.569E-05
se	6.016E-02	6.373E+05	2.015E+03	4.914E+01	3.065E+00	1.406E+00	1.530E-01	8.691E-02	8.689E-02	8.689E-02
br	4.412E-06	1.291E+06	4.903E+04	1.218E+04	1.544E+03	5.707E+02	2.108E+01	1.702E-03	8.717E-18	9.180E-19
kr	8.464E+03	2.614E+06	4.899E+05	1.637E+05	1.652E+04	1.122E+04	1.121E+04	1.117E+04	1.103E+04	1.102E+04
rb	1.865E+02	3.794E+06	2.531E+05	7.918E+04	2.695E+03	1.306E+03	1.006E+03	4.783E+02	3.544E+01	2.943E+01
sr	4.516E+05	5.760E+06	1.688E+06	1.205E+06	7.727E+05	6.335E+05	5.802E+05	4.625E+05	2.320E+05	2.226E+05
y	6.102E+05	8.478E+06	2.735E+06	2.100E+06	1.124E+06	8.302E+05	7.618E+05	6.197E+05	3.206E+05	3.073E+05
zr	7.444E+05	6.692E+06	2.092E+06	1.909E+06	1.487E+06	1.105E+06	9.702E+05	7.813E+05	3.661E+05	3.468E+05
nb	1.036E+06	1.009E+07	3.130E+06	2.781E+06	1.916E+06	1.212E+06	1.087E+06	1.016E+06	6.326E+05	6.067E+05
mo	3.497E+01	6.781E+06	1.214E+06	1.153E+06	9.665E+05	5.835E+05	9.976E+04	6.415E+02	1.372E-05	3.911E-06
tc	4.521E+01	7.904E+06	1.149E+06	1.072E+06	9.295E+05	5.650E+05	9.661E+04	6.374E+02	1.619E+01	1.619E+01

ru	7.912E+05	3.599E+06	2.201E+06	1.887E+06	1.615E+06	1.554E+06	1.423E+06	1.122E+06	5.909E+05	5.708E+05
rh	7.904E+05	4.741E+06	2.556E+06	2.419E+06	2.150E+06	1.769E+06	1.429E+06	1.121E+06	5.906E+05	5.705E+05
pd	2.223E-01	3.691E+05	2.466E+05	1.942E+05	8.530E+04	8.585E+03	1.044E+01	8.309E-01	1.706E-01	1.632E-01
ag	1.731E+03	5.416E+05	3.065E+05	2.495E+05	1.327E+05	4.692E+04	2.108E+04	5.388E+03	2.085E+03	2.055E+03
cd	1.247E+02	4.720E+04	1.066E+04	7.199E+03	5.092E+03	2.851E+03	5.439E+02	1.862E+02	6.287E+01	5.820E+01
in	5.330E-02	1.135E+05	1.499E+04	9.305E+03	5.257E+03	2.807E+03	3.175E+02	7.083E-01	2.927E-02	2.724E-02
sn	1.070E+03	9.632E+05	4.801E+04	1.624E+04	1.018E+04	7.303E+03	4.357E+03	1.809E+03	7.427E+02	7.230E+02
sb	5.962E+03	2.527E+06	2.667E+05	1.453E+05	7.166E+04	4.827E+04	1.998E+04	8.893E+03	7.920E+03	7.882E+03
te	4.000E+04	5.495E+06	1.661E+06	1.261E+06	1.014E+06	6.571E+05	1.975E+05	5.480E+04	2.146E+04	2.034E+04
i	1.942E+04	8.181E+06	4.497E+06	3.356E+06	2.182E+06	1.196E+06	4.180E+05	5.503E+04	1.277E+02	8.302E+01
xe	8.580E+03	6.137E+06	2.036E+06	2.062E+06	1.696E+06	1.121E+06	4.507E+05	3.466E+04	7.485E+01	5.553E+01
cs	1.633E+05	5.491E+06	4.446E+05	3.304E+05	3.228E+05	3.181E+05	3.051E+05	2.847E+05	2.657E+05	2.649E+05
ba	2.055E+05	6.600E+06	1.695E+06	1.302E+06	1.220E+06	1.106E+06	7.934E+05	3.455E+05	1.223E+05	1.210E+05
la	1.442E+05	6.544E+06	2.369E+06	1.577E+06	1.199E+06	1.098E+06	7.725E+05	2.613E+05	5.809E+03	4.426E+03
ce	1.298E+06	5.198E+06	2.947E+06	2.853E+06	2.580E+06	2.146E+06	1.773E+06	1.416E+06	8.355E+05	8.138E+05
pr	9.773E+05	4.539E+06	2.474E+06	2.223E+06	1.938E+06	1.816E+06	1.541E+06	1.082E+06	7.216E+05	7.115E+05
nd	3.254E+04	1.040E+06	5.393E+05	4.473E+05	4.139E+05	3.648E+05	2.345E+05	6.635E+04	7.993E+02	5.829E+02
pm	1.740E+05	1.103E+06	8.311E+05	7.915E+05	6.707E+05	4.570E+05	2.431E+05	1.866E+05	1.652E+05	1.642E+05
sm	3.173E+02	4.267E+05	3.620E+05	3.330E+05	2.537E+05	1.224E+05	1.019E+04	3.491E+02	3.412E+02	3.411E+02
eu	1.931E+04	2.449E+05	2.305E+05	2.244E+05	2.108E+05	1.881E+05	1.388E+05	6.142E+04	1.151E+04	1.107E+04
gd	1.182E+00	5.233E+03	3.878E+03	3.242E+03	1.732E+03	2.902E+02	2.600E+00	1.943E+00	1.589E+00	1.566E+00
tb	2.197E+02	1.949E+03	1.568E+03	1.550E+03	1.489E+03	1.337E+03	9.770E+02	5.938E+02	2.825E+02	2.693E+02
dy	1.314E-03	4.138E+02	1.205E+02	3.441E+01	6.480E+00	4.187E+00	1.005E+00	1.721E-02	1.209E-04	1.181E-04
ho	1.958E-03	6.308E+01	5.670E+01	5.015E+01	3.453E+01	1.351E+01	1.591E+00	2.580E-02	4.225E-04	4.225E-04
er	2.194E-02	1.019E+00	9.775E-01	9.156E-01	7.892E-01	6.202E-01	3.354E-01	7.526E-02	4.313E-04	2.983E-04
tm	1.867E-01	6.132E-01	6.123E-01	6.101E-01	5.989E-01	5.519E-01	4.222E-01	3.491E-01	2.587E-01	2.534E-01
yb	3.994E-07	2.978E-06	2.971E-06	2.958E-06	2.914E-06	2.790E-06	2.398E-06	1.556E-06	3.420E-07	3.069E-07
lu	4.418E-12	2.064E-09	1.341E-09	1.314E-09	1.223E-09	9.974E-10	4.886E-10	6.413E-11	6.135E-14	3.783E-14
totals	7.524E+06	1.183E+08	3.855E+07	3.217E+07	2.500E+07	1.898E+07	1.339E+07	9.002E+06	4.906E+06	4.760E+06

Fukushima 4 fission products page 86

decay, following irradiation identified by: power= 25.00mw, burnup= 39500.mwd, flux= 4.05E+13n/cm**2-sec

element thermal power, watts

basis = 1 t uranium

	charge	discharge	0.1 d	0.3 d	1.0 d	3.0 d	10.0 d	30.0 d	100.0 d	105.0 d
h	1.425E-02	2.298E-02	2.298E-02	2.298E-02	2.297E-02	2.297E-02	2.294E-02	2.287E-02	2.263E-02	2.261E-02
be	1.998E-07	5.146E-01	3.024E-07	3.023E-07	3.023E-07	3.023E-07	3.022E-07	3.020E-07	3.016E-07	3.015E-07
c	2.793E-06	5.769E-02	4.483E-06	4.483E-06	4.483E-06	4.483E-06	4.483E-06	4.483E-06	4.483E-06	4.483E-06
ni	9.788E-11	1.407E-01	3.478E-05	3.272E-05	2.644E-05	1.437E-05	1.704E-06	3.845E-09	2.101E-18	4.579E-19
cu	1.040E-08	2.071E+00	1.305E-03	1.233E-03	1.009E-03	5.704E-04	7.815E-05	2.885E-07	1.491E-15	3.868E-16
zn	6.800E-09	2.976E+01	2.831E-02	2.273E-02	1.567E-02	7.587E-03	6.204E-04	4.854E-07	6.499E-18	

1.087E-18										
ga	1.226E-07	2.964E+02	4.053E-01	3.404E-01	2.505E-01	1.335E-01	1.122E-02	8.750E-06	1.447E-16	4.675E-17
ge	2.233E-10	2.522E+03	7.721E+00	3.480E+00	1.111E+00	5.844E-02	1.960E-06	1.218E-09	1.753E-11	1.295E-11
as	6.476E-07	6.894E+03	3.935E+01	9.959E+00	1.376E+00	5.928E-01	2.887E-02	6.631E-06	7.982E-08	6.600E-08
se	1.993E-05	1.142E+04	1.135E+01	1.141E-01	2.840E-03	1.273E-03	9.122E-05	2.883E-05	2.879E-05	2.879E-05
br	7.278E-08	3.344E+04	2.289E+02	5.378E+01	2.432E+01	9.415E+00	3.478E-01	2.808E-05	1.341E-19	1.289E-20
kr	1.269E+01	4.225E+04	4.431E+03	1.183E+03	4.216E+01	1.683E+01	1.681E+01	1.675E+01	1.654E+01	1.653E+01
rb	8.420E-01	9.254E+04	4.050E+03	1.255E+03	2.703E+01	5.894E+00	4.543E+00	2.159E+00	1.601E-01	1.329E-01
sr	1.409E+03	8.322E+04	1.075E+04	6.594E+03	3.047E+03	2.001E+03	1.800E+03	1.393E+03	5.972E+02	5.645E+02
y	2.325E+03	1.400E+05	1.761E+04	1.252E+04	5.053E+03	3.189E+03	2.916E+03	2.404E+03	1.327E+03	1.279E+03
zr	3.752E+03	6.707E+04	1.076E+04	9.798E+03	7.583E+03	5.582E+03	4.891E+03	3.938E+03	1.846E+03	1.748E+03
nb	4.936E+03	1.422E+05	1.668E+04	1.472E+04	9.809E+03	5.866E+03	5.176E+03	4.843E+03	3.019E+03	2.895E+03
mo	1.401E-01	6.405E+04	4.873E+03	4.618E+03	3.871E+03	2.337E+03	3.995E+02	2.569E+00	5.480E-08	1.552E-08
tc	3.736E-02	9.607E+04	1.352E+03	1.003E+03	8.694E+02	5.285E+02	9.036E+01	5.892E-01	8.120E-03	8.120E-03
ru	1.643E+03	1.974E+04	7.812E+03	5.689E+03	3.889E+03	3.623E+03	3.204E+03	2.258E+03	6.720E+02	6.170E+02
rh	3.015E+03	2.365E+04	6.192E+03	5.920E+03	5.575E+03	5.088E+03	4.716E+03	4.477E+03	3.841E+03	3.802E+03
pd	2.158E-05	1.224E+03	5.017E+02	3.914E+02	1.685E+02	1.546E+01	7.305E-03	8.825E-05	1.185E-05	1.099E-05
ag	1.852E+01	2.117E+03	5.542E+02	4.825E+02	3.135E+02	1.552E+02	8.585E+01	4.828E+01	3.444E+01	3.397E+01
cd	4.692E-01	5.307E+02	5.375E+01	2.853E+01	1.573E+01	8.829E+00	1.832E+00	7.002E-01	2.356E-01	2.181E-01
in	1.298E-04	2.399E+03	6.257E+01	2.551E+01	1.044E+01	5.515E+00	6.237E-01	1.451E-03	7.983E-05	7.434E-05
sn	4.193E+00	1.301E+04	3.913E+02	1.036E+02	4.581E+01	3.881E+01	2.440E+01	8.049E+00	2.140E+00	2.075E+00
sb	2.132E+01	4.704E+04	2.869E+03	1.233E+03	4.494E+02	2.667E+02	1.006E+02	3.414E+01	2.698E+01	2.675E+01
te	7.370E+01	5.155E+04	6.590E+03	3.625E+03	2.671E+03	1.508E+03	3.906E+02	1.035E+02	3.191E+01	2.969E+01
i	6.787E+01	1.215E+05	4.786E+04	3.197E+04	2.050E+04	1.128E+04	2.970E+03	2.090E+02	4.342E-01	2.821E-01
xe	9.116E+00	5.768E+04	3.639E+03	3.747E+03	2.642E+03	1.256E+03	4.901E+02	3.730E+01	7.232E-02	5.356E-02
cs	9.021E+02	9.914E+04	4.394E+03	2.270E+03	2.240E+03	2.185E+03	2.029E+03	1.789E+03	1.582E+03	1.574E+03
ba	6.844E+02	5.760E+04	6.259E+03	4.073E+03	3.727E+03	3.391E+03	2.465E+03	1.138E+03	4.755E+02	4.718E+02
la	2.421E+03	9.752E+04	3.231E+04	2.299E+04	1.995E+04	1.843E+04	1.297E+04	4.386E+03	9.751E+01	7.430E+01
ce	1.230E+03	2.400E+04	6.201E+03	5.811E+03	4.710E+03	3.024E+03	1.902E+03	1.396E+03	6.522E+02	6.273E+02
pr	6.335E+03	3.705E+04	1.109E+04	9.860E+03	8.680E+03	8.272E+03	7.662E+03	6.578E+03	5.190E+03	5.125E+03
nd	7.875E+01	4.962E+03	1.583E+03	1.123E+03	1.002E+03	8.830E+02	5.676E+02	1.606E+02	1.934E+00	1.411E+00
pm	2.322E+02	5.360E+03	2.707E+03	2.563E+03	2.171E+03	1.472E+03	6.533E+02	2.861E+02	1.219E+02	1.166E+02
sm	3.746E-02	1.022E+03	7.178E+02	6.599E+02	5.028E+02	2.422E+02	1.958E+01	5.491E-02	4.012E-02	4.012E-02
eu	1.753E+02	2.325E+03	2.174E+03	2.133E+03	2.042E+03	1.849E+03	1.358E+03	5.811E+02	8.056E+01	7.614E+01
gd	1.039E-03	1.537E+01	8.321E+00	6.955E+00	3.714E+00	6.201E-01	2.973E-03	1.707E-03	1.397E-03	1.377E-03
tb	1.863E+00	1.130E+01	7.615E+00	7.570E+00	7.451E+00	7.138E+00	6.297E+00	4.905E+00	2.478E+00	2.362E+00
dy	1.535E-06	8.012E-01	3.266E-01	8.514E-02	8.192E-03	5.103E-03	1.225E-03	2.082E-05	3.956E-08	3.862E-08
ho	9.023E-06	2.842E-01	2.427E-01	2.153E-01	1.485E-01	5.808E-02	6.847E-03	1.136E-04	4.442E-06	4.442E-06
er	1.340E-05	1.778E-03	1.620E-03	1.382E-03	9.635E-04	5.931E-04	2.249E-04	4.597E-05	2.633E-07	1.821E-07
tm	2.707E-04	1.915E-03	1.911E-03	1.899E-03	1.837E-03	1.572E-03	8.492E-04	5.455E-04	3.757E-04	3.660E-04

yb	1.016E-09	7.577E-09	7.561E-09	7.528E-09	7.415E-09	7.101E-09	6.103E-09	3.959E-09	8.703E-10	7.810E-10
lu	4.877E-14	1.594E-11	1.562E-11	1.530E-11	1.424E-11	1.159E-11	5.641E-12	7.231E-13	5.850E-16	3.542E-16
totals	2.935E+04	1.451E+06	2.148E+05	1.565E+05	1.116E+05	8.253E+04	5.691E+04	3.610E+04	1.962E+04	1.908E+04

Fukushima 4
actinides page 81
decay, following irradiation identified by: power= 25.00mw, burnup= 39500.mwd, flux= 4.05E+13n/cm**2-sec

element concentrations, grams
basis = 1 t uranium

	charge	discharge	0.1 d	0.3 d	1.0 d	3.0 d	10.0 d	30.0 d	100.0 d	105.0 d
he	1.518E-01	5.899E-01	5.900E-01	5.903E-01	5.911E-01	5.936E-01	6.021E-01	6.252E-01	6.941E-01	6.985E-01
tl	1.279E-12	3.856E-12	3.897E-12	3.864E-12	3.988E-12	3.867E-12	3.886E-12	4.072E-12	4.838E-12	4.846E-12
pb	3.437E-07	1.493E-06	1.494E-06	1.494E-06	1.497E-06	1.504E-06	1.530E-06	1.605E-06	1.888E-06	1.911E-06
bi	1.357E-10	5.521E-10	5.522E-10	5.524E-10	5.603E-10	5.553E-10	5.623E-10	5.866E-10	6.541E-10	6.557E-10
po	2.213E-13	8.211E-13	8.213E-13	8.217E-13	8.230E-13	8.267E-13	8.394E-13	8.751E-13	9.907E-13	9.988E-13
at	6.091E-20	4.829E-19	4.832E-19	4.835E-19	4.841E-19	4.829E-19	4.537E-19	3.151E-19	1.412E-19	1.392E-19
rn	1.324E-12	3.775E-12	3.775E-12	3.774E-12	3.771E-12	3.770E-12	3.803E-12	3.976E-12	4.688E-12	4.693E-12
fr	6.986E-16	4.673E-15	4.676E-15	4.679E-15	4.685E-15	4.675E-15	4.409E-15	3.140E-15	1.581E-15	1.567E-15
ra	3.533E-08	7.178E-08	7.178E-08	7.179E-08	7.181E-08	7.191E-08	7.247E-08	7.454E-08	8.250E-08	8.282E-08
ac	5.191E-09	7.627E-09	7.628E-09	7.631E-09	7.648E-09	7.706E-09	7.912E-09	8.498E-09	1.055E-08	1.070E-08
th	2.133E-03	2.642E-03	2.642E-03	2.643E-03	2.643E-03	2.646E-03	2.658E-03	2.693E-03	2.816E-03	2.825E-03
pa	3.415E-04	5.458E-04	5.458E-04	5.458E-04	5.460E-04	5.461E-04	5.461E-04	5.465E-04	5.478E-04	5.478E-04
u	9.649E+05	9.494E+05	9.494E+05	9.494E+05	9.494E+05	9.494E+05	9.494E+05	9.494E+05	9.494E+05	9.494E+05
np	2.870E+02	5.246E+02	5.232E+02	5.199E+02	5.096E+02	4.900E+02	4.700E+02	4.689E+02	4.693E+02	4.693E+02
pu	7.185E+03	8.737E+03	8.739E+03	8.743E+03	8.753E+03	8.774E+03	8.796E+03	8.797E+03	8.790E+03	8.790E+03
am	6.734E+01	1.838E+02	1.838E+02	1.839E+02	1.839E+02	1.842E+02	1.852E+02	1.882E+02	1.986E+02	1.993E+02
cm	1.137E+01	5.733E+01	5.734E+01	5.736E+01	5.738E+01	5.728E+01	5.681E+01	5.551E+01	5.171E+01	5.148E+01
bk	1.175E-08	8.511E-07	8.511E-07	8.506E-07	8.491E-07	8.455E-07	8.328E-07	7.975E-07	6.854E-07	6.780E-07
cf	7.074E-09	5.693E-07	5.698E-07	5.705E-07	5.719E-07	5.753E-07	5.874E-07	6.209E-07	7.269E-07	7.338E-07
es	2.726E-13	1.056E-10	1.057E-10	1.059E-10	1.066E-10	1.079E-10	1.082E-10	8.969E-11	2.928E-11	2.733E-11
totals	9.724E+05	9.589E+05	9.589E+05	9.589E+05	9.589E+05	9.589E+05	9.589E+05	9.589E+05	9.589E+05	9.589E+05

Fukushima 4
actinides page 82
decay, following irradiation identified by: power= 25.00mw, burnup= 39500.mwd, flux= 4.05E+13n/cm**2-sec

element radioactivity, curies
basis = 1 t uranium

	charge	discharge	0.1 d	0.3 d	1.0 d	3.0 d	10.0 d	30.0 d	100.0 d	105.0 d
tl	3.786E-04	1.142E-03	1.154E-03	1.144E-03	1.181E-03	1.145E-03	1.151E-03	1.206E-03	1.433E-03	1.435E-03
pb	1.053E-03	3.177E-03	3.177E-03	3.176E-03	3.174E-03	3.171E-03	3.201E-03	3.354E-03	3.985E-03	3.991E-03
bi	1.053E-03	3.177E-03	3.178E-03	3.177E-03	3.285E-03	3.185E-03	3.201E-03	3.354E-03	3.985E-03	3.992E-03
po	1.727E-03	5.211E-03	5.212E-03	5.210E-03	5.277E-03	5.212E-03	5.251E-03	5.502E-03	6.538E-03	6.546E-03
at	9.808E-08	7.776E-07	7.781E-07	7.786E-07	7.796E-07	7.775E-07	7.305E-07	5.074E-07	2.274E-07	2.242E-07
rn	1.053E-03	3.176E-03	3.176E-03	3.175E-03	3.173E-03	3.171E-03	3.200E-03	3.354E-03	3.985E-03	3.990E-03
fr	1.033E-07	7.852E-07	7.857E-07	7.862E-07	7.872E-07	7.852E-07	7.384E-07	5.159E-07	2.379E-07	2.349E-07
ra	1.053E-03	3.177E-03	3.176E-03	3.176E-03	3.173E-03	3.172E-03	3.201E-03	3.354E-03	3.985E-03	3.990E-03
ac	4.736E-07	2.224E-05	1.728E-05	1.062E-05	2.730E-06	1.340E-06	1.302E-06	1.122E-06	9.907E-07	

9.981E-07

th	3.482E-01	1.212E+00	1.137E+00	1.038E+00	7.795E-01	4.539E-01	3.339E-01	3.329E-01	3.337E-01	3.337E-01
pa	5.183E-01	1.248E+00	1.213E+00	1.155E+00	9.971E-01	7.680E-01	6.491E-01	6.461E-01	6.466E-01	6.466E-01
u	6.271E+03	1.483E+07	7.779E+05	5.637E+05	5.246E+05	4.272E+05	2.082E+05	2.670E+04	2.471E+01	1.660E+01
np	6.598E+01	1.454E+07	1.420E+07	1.338E+07	1.089E+07	6.036E+06	7.665E+05	2.142E+03	2.731E+01	2.731E+01
pu	8.515E+04	4.448E+05	3.524E+05	2.392E+05	1.322E+05	1.209E+05	1.208E+05	1.205E+05	1.195E+05	1.194E+05
am	1.278E+02	1.841E+05	1.604E+05	1.221E+05	4.850E+04	4.494E+03	2.175E+02	2.252E+02	2.608E+02	2.633E+02
cm	1.713E+04	5.424E+04	5.425E+04	5.425E+04	5.420E+04	5.386E+04	5.238E+04	4.837E+04	3.673E+04	3.603E+04
bk	1.926E-05	4.748E-03	3.394E-03	2.105E-03	1.411E-03	1.386E-03	1.365E-03	1.307E-03	1.124E-03	1.112E-03
cf	5.202E-07	7.096E-05	7.098E-05	7.099E-05	7.091E-05	7.065E-05	6.983E-05	6.823E-05	6.555E-05	6.541E-05
es	5.816E-09	2.182E-06	2.185E-06	2.190E-06	2.207E-06	2.243E-06	2.258E-06	1.817E-06	3.677E-07	3.232E-07
totals	1.087E+05	3.006E+07	1.555E+07	1.436E+07	1.165E+07	6.643E+06	1.148E+06	1.980E+05	1.565E+05	1.557E+05

Fukushima 4
actinides page 83
decay, following irradiation identified by: power= 25.00mw, burnup= 39500.mwd, flux= 4.05E+13n/cm**2-sec

element thermal power, watts
basis = 1 t uranium

	charge	discharge	0.1 d	0.3 d	1.0 d	3.0 d	10.0 d	30.0 d	100.0 d	105.0 d
tl	8.848E-06	2.670E-05	2.698E-05	2.675E-05	2.761E-05	2.677E-05	2.690E-05	2.819E-05	3.350E-05	3.355E-05
pb	1.991E-06	6.007E-06	6.007E-06	6.006E-06	6.001E-06	5.996E-06	6.053E-06	6.343E-06	7.537E-06	7.548E-06
bi	1.764E-05	5.320E-05	5.322E-05	5.321E-05	5.502E-05	5.335E-05	5.361E-05	5.618E-05	6.675E-05	6.685E-05
po	7.888E-05	2.380E-04	2.381E-04	2.380E-04	2.416E-04	2.381E-04	2.398E-04	2.513E-04	2.986E-04	2.990E-04
at	4.185E-09	3.318E-08	3.320E-08	3.322E-08	3.327E-08	3.318E-08	3.117E-08	2.165E-08	9.702E-09	9.567E-09
rn	3.997E-05	1.206E-04	1.206E-04	1.206E-04	1.205E-04	1.204E-04	1.215E-04	1.273E-04	1.513E-04	1.515E-04
fr	3.799E-09	3.003E-08	3.005E-08	3.007E-08	3.011E-08	3.003E-08	2.822E-08	1.961E-08	8.802E-09	8.680E-09
ra	3.613E-05	1.090E-04	1.090E-04	1.090E-04	1.089E-04	1.088E-04	1.098E-04	1.151E-04	1.368E-04	1.369E-04
ac	3.606E-09	1.905E-07	1.519E-07	9.991E-08	3.839E-08	2.746E-08	2.578E-08	1.801E-08	8.309E-09	8.201E-09
th	1.991E-04	1.244E-03	1.128E-03	1.020E-03	7.383E-04	3.836E-04	2.545E-04	2.586E-04	2.774E-04	2.787E-04
pa	2.074E-03	6.350E-03	6.122E-03	5.737E-03	4.690E-03	3.188E-03	2.411E-03	2.391E-03	2.393E-03	2.393E-03
u	1.219E+01	3.979E+04	1.664E+03	1.091E+03	1.016E+03	8.271E+02	4.031E+02	5.174E+01	9.372E-02	7.804E-02
np	1.726E-01	3.763E+04	3.663E+04	3.450E+04	2.805E+04	1.553E+04	1.965E+03	5.464E+00	7.773E-02	7.773E-02
pu	6.249E+01	5.020E+02	3.957E+02	2.655E+02	1.424E+02	1.298E+02	1.303E+02	1.309E+02	1.327E+02	1.328E+02
am	3.919E+00	7.943E+02	6.795E+02	4.983E+02	1.730E+02	1.548E+01	6.555E+00	6.894E+00	8.081E+00	8.165E+00
cm	6.243E+02	1.974E+03	1.974E+03	1.974E+03	1.973E+03	1.960E+03	1.906E+03	1.760E+03	1.335E+03	1.310E+03
bk	3.765E-09	2.390E-05	1.436E-05	5.279E-06	4.065E-07	2.713E-07	2.672E-07	2.559E-07	2.199E-07	2.175E-07
cf	2.704E-08	4.052E-06	4.053E-06	4.054E-06	4.052E-06	4.047E-06	4.029E-06	3.979E-06	3.822E-06	3.812E-06
es	2.322E-10	8.712E-08	8.722E-08	8.743E-08	8.810E-08	8.954E-08	9.015E-08	7.253E-08	1.465E-08	1.287E-08
totals	7.031E+02	8.069E+04	4.135E+04	3.833E+04	3.136E+04	1.847E+04	4.412E+03	1.955E+03	1.476E+03	1.451E+03

Fukushima 4 fission products page 84
decay, following irradiation identified by: power= 25.00mw, burnup= 39500.mwd, flux= 4.05E+13n/cm**2-sec

F4-pool-105d (2).txt
element concentrations, grams
basis = 1 t uranium

	charge	discharge	0.1 d	0.3 d	1.0 d	3.0 d	10.0 d	30.0 d	100.0 d	105.0 d
h	4.918E-02	7.995E-02	7.995E-02	7.995E-02	7.994E-02	7.992E-02	7.985E-02	7.963E-02	7.888E-02	7.882E-02
he	9.221E-01	1.392E+00	1.392E+00	1.392E+00	1.392E+00	1.392E+00	1.392E+00	1.392E+00	1.393E+00	1.393E+00
li	1.169E-02	1.159E-02	1.159E-02	1.159E-02	1.159E-02	1.159E-02	1.159E-02	1.159E-02	1.159E-02	1.159E-02
be	7.985E-03	1.215E-02	1.215E-02	1.215E-02	1.215E-02	1.215E-02	1.215E-02	1.215E-02	1.215E-02	1.215E-02
b	5.155E-04	7.973E-04	7.973E-04	7.973E-04	7.973E-04	7.973E-04	7.973E-04	7.973E-04	7.973E-04	7.973E-04
c	2.331E-03	3.772E-03	3.772E-03	3.772E-03	3.772E-03	3.772E-03	3.772E-03	3.772E-03	3.772E-03	3.772E-03
n	2.889E-04	3.735E-04	3.735E-04	3.735E-04	3.736E-04	3.736E-04	3.736E-04	3.736E-04	3.737E-04	3.737E-04
ne	3.983E-03	5.142E-03	5.142E-03	5.142E-03	5.142E-03	5.142E-03	5.142E-03	5.142E-03	5.142E-03	5.142E-03
ni	2.920E-13	1.072E-07	1.038E-07	9.762E-08	7.887E-08	4.288E-08	5.082E-09	1.147E-11	6.267E-21	1.366E-21
cu	7.123E-12	5.842E-07	5.651E-07	5.355E-07	4.435E-07	2.589E-07	3.937E-08	1.811E-10	1.196E-18	3.114E-19
zn	1.209E-03	2.024E-03	2.023E-03	2.022E-03	2.019E-03	2.013E-03	2.009E-03	2.008E-03	2.008E-03	2.008E-03
ga	1.922E-03	3.275E-03	3.273E-03	3.271E-03	3.269E-03	3.267E-03	3.265E-03	3.265E-03	3.265E-03	3.265E-03
ge	3.066E-01	4.511E-01	4.510E-01	4.509E-01	4.509E-01	4.509E-01	4.509E-01	4.509E-01	4.509E-01	4.509E-01
as	9.313E-02	1.381E-01	1.380E-01	1.379E-01	1.376E-01	1.371E-01	1.367E-01	1.367E-01	1.367E-01	1.367E-01
se	4.487E+01	6.434E+01	6.434E+01	6.434E+01	6.434E+01	6.434E+01	6.434E+01	6.434E+01	6.434E+01	6.434E+01
br	1.754E+01	2.514E+01	2.514E+01	2.513E+01	2.513E+01	2.513E+01	2.513E+01	2.513E+01	2.513E+01	2.513E+01
kr	3.151E+02	4.389E+02	4.389E+02	4.389E+02	4.388E+02	4.388E+02	4.388E+02	4.387E+02	4.383E+02	4.383E+02
rb	2.995E+02	4.167E+02	4.167E+02	4.167E+02	4.167E+02	4.167E+02	4.168E+02	4.169E+02	4.172E+02	4.172E+02
sr	7.807E+02	1.067E+03	1.067E+03	1.067E+03	1.067E+03	1.066E+03	1.064E+03	1.059E+03	1.048E+03	1.048E+03
y	4.069E+02	5.606E+02	5.605E+02	5.605E+02	5.603E+02	5.601E+02	5.594E+02	5.577E+02	5.534E+02	5.532E+02
zr	3.013E+03	4.304E+03	4.304E+03	4.304E+03	4.304E+03	4.304E+03	4.303E+03	4.301E+03	4.296E+03	4.296E+03
nb	2.614E+01	2.774E+01	2.774E+01	2.773E+01	2.770E+01	2.766E+01	2.739E+01	2.564E+01	1.599E+01	1.534E+01
mo	2.677E+03	3.962E+03	3.962E+03	3.962E+03	3.962E+03	3.962E+03	3.965E+03	3.976E+03	4.005E+03	4.006E+03
tc	6.631E+02	9.435E+02	9.436E+02	9.437E+02	9.441E+02	9.449E+02	9.459E+02	9.461E+02	9.461E+02	9.461E+02
ru	1.779E+03	2.834E+03	2.834E+03	2.834E+03	2.833E+03	2.832E+03	2.826E+03	2.812E+03	2.781E+03	2.779E+03
rh	3.785E+02	5.062E+02	5.062E+02	5.063E+02	5.065E+02	5.073E+02	5.110E+02	5.197E+02	5.345E+02	5.350E+02
pd	7.614E+02	1.496E+03	1.496E+03	1.497E+03	1.497E+03	1.498E+03	1.500E+03	1.505E+03	1.522E+03	1.523E+03
ag	4.825E+01	8.908E+01	8.909E+01	8.910E+01	8.913E+01	8.911E+01	8.900E+01	8.887E+01	8.876E+01	8.876E+01
cd	4.303E+01	9.459E+01	9.459E+01	9.460E+01	9.462E+01	9.467E+01	9.479E+01	9.491E+01	9.502E+01	9.502E+01
in	1.487E+00	1.797E+00	1.798E+00	1.798E+00	1.800E+00	1.805E+00	1.810E+00	1.813E+00	1.818E+00	1.818E+00
sn	3.505E+01	5.801E+01	5.801E+01	5.801E+01	5.800E+01	5.799E+01	5.796E+01	5.793E+01	5.789E+01	5.788E+01
sb	1.139E+01	1.762E+01	1.759E+01	1.757E+01	1.753E+01	1.746E+01	1.734E+01	1.722E+01	1.688E+01	1.686E+01
te	3.647E+02	5.617E+02	5.615E+02	5.614E+02	5.609E+02	5.599E+02	5.584E+02	5.577E+02	5.572E+02	5.572E+02
i	1.463E+02	2.373E+02	2.371E+02	2.368E+02	2.360E+02	2.348E+02	2.330E+02	2.315E+02	2.320E+02	2.320E+02
xe	4.203E+03	6.369E+03	6.369E+03	6.369E+03	6.369E+03	6.370E+03	6.370E+03	6.370E+03	6.370E+03	6.370E+03
cs	2.350E+03	3.410E+03	3.410E+03	3.410E+03	3.411E+03	3.412E+03	3.414E+03	3.412E+03	3.399E+03	3.398E+03
ba	1.138E+03	1.758E+03	1.758E+03	1.758E+03	1.757E+03	1.756E+03	1.754E+03	1.752E+03	1.762E+03	1.763E+03
la	9.997E+02	1.469E+03	1.469E+03	1.468E+03	1.468E+03	1.468E+03	1.468E+03	1.467E+03	1.466E+03	

										1.466E+03
ce	2.220E+03	3.170E+03	3.170E+03	3.170E+03	3.169E+03	3.167E+03	3.162E+03	3.145E+03	3.092E+03	3.089E+03
pr	9.066E+02	1.321E+03	1.321E+03	1.321E+03	1.322E+03	1.322E+03	1.324E+03	1.328E+03	1.341E+03	1.341E+03
nd	3.064E+03	4.582E+03	4.582E+03	4.582E+03	4.583E+03	4.586E+03	4.593E+03	4.610E+03	4.654E+03	4.656E+03
pm	1.731E+02	1.832E+02	1.832E+02	1.831E+02	1.830E+02	1.827E+02	1.826E+02	1.815E+02	1.728E+02	1.722E+02
sm	5.339E+02	8.355E+02	8.355E+02	8.356E+02	8.358E+02	8.364E+02	8.379E+02	8.410E+02	8.504E+02	8.511E+02
eu	9.383E+01	1.706E+02	1.706E+02	1.706E+02	1.706E+02	1.706E+02	1.699E+02	1.684E+02	1.670E+02	1.669E+02
gd	4.894E+01	1.239E+02	1.239E+02	1.239E+02	1.241E+02	1.244E+02	1.253E+02	1.269E+02	1.283E+02	1.284E+02
tb	1.324E+00	2.621E+00	2.622E+00	2.622E+00	2.623E+00	2.621E+00	2.615E+00	2.602E+00	2.578E+00	2.577E+00
dy	5.366E-01	1.144E+00	1.144E+00	1.144E+00	1.145E+00	1.148E+00	1.155E+00	1.167E+00	1.191E+00	1.193E+00
ho	2.567E-02	8.168E-02	8.169E-02	8.169E-02	8.168E-02	8.165E-02	8.163E-02	8.163E-02	8.163E-02	8.163E-02
er	9.237E-03	2.714E-02	2.714E-02	2.715E-02	2.718E-02	2.722E-02	2.724E-02	2.725E-02	2.725E-02	2.725E-02
tm	2.945E-04	4.655E-04	4.656E-04	4.656E-04	4.658E-04	4.660E-04	4.658E-04	4.622E-04	4.441E-04	4.429E-04
yb	2.447E-04	4.718E-04	4.719E-04	4.720E-04	4.724E-04	4.734E-04	4.764E-04	4.832E-04	5.022E-04	5.033E-04
lu	4.026E-17	1.214E-14	1.201E-14	1.177E-14	1.096E-14	8.942E-15	4.390E-15	5.805E-16	5.821E-19	3.606E-19
totals	2.755E+04	4.110E+04	4.110E+04	4.110E+04	4.110E+04	4.110E+04	4.110E+04	4.110E+04	4.110E+04	4.110E+04

Fukushima 4 fission products page 85
decay, following irradiation identified by: power= 25.00mw, burnup= 39500.mwd, flux= 4.05E+13n/cm**2-sec

element radioactivity, curies
basis = 1 t uranium

	charge	discharge	0.1 d	0.3 d	1.0 d	3.0 d	10.0 d	30.0 d	100.0 d	105.0 d
h	4.226E+02	6.813E+02	6.813E+02	6.812E+02	6.812E+02	6.810E+02	6.802E+02	6.781E+02	6.709E+02	6.703E+02
be	1.660E-04	5.056E+01	2.515E-04	2.515E-04	2.515E-04	2.515E-04	2.515E-04	2.513E-04	2.511E-04	2.511E-04
c	9.526E-03	1.545E+00	1.529E-02	1.529E-02	1.529E-02	1.529E-02	1.529E-02	1.529E-02	1.529E-02	1.529E-02
ni	2.540E-07	8.804E+00	9.027E-02	8.493E-02	6.862E-02	3.731E-02	4.421E-03	9.980E-06	5.452E-15	1.188E-15
cu	5.645E-06	7.801E+01	5.180E-01	4.902E-01	4.043E-01	2.333E-01	3.422E-02	1.471E-04	9.105E-13	2.369E-13
zn	4.495E-06	1.361E+03	1.492E+01	1.341E+01	1.027E+01	5.015E+00	4.101E-01	3.208E-04	4.296E-15	7.185E-16
ga	6.451E-06	9.554E+03	4.067E+01	2.767E+01	1.407E+01	7.025E+00	5.904E-01	4.604E-04	8.909E-15	3.740E-15
ge	4.179E-06	1.066E+05	1.631E+03	4.465E+02	1.124E+02	5.856E+00	2.725E-04	2.281E-05	3.281E-07	2.424E-07
as	1.362E-04	2.479E+05	3.730E+03	1.739E+03	9.402E+02	4.146E+02	2.069E+01	4.133E-03	1.819E-05	1.569E-05
se	6.016E-02	6.373E+05	2.015E+03	4.914E+01	3.065E+00	1.406E+00	1.530E-01	8.691E-02	8.689E-02	8.689E-02
br	4.412E-06	1.291E+06	4.903E+04	1.218E+04	1.544E+03	5.707E+02	2.108E+01	1.702E-03	8.717E-18	9.180E-19
kr	8.464E+03	2.614E+06	4.899E+05	1.637E+05	1.652E+04	1.122E+04	1.121E+04	1.117E+04	1.103E+04	1.102E+04
rb	1.865E+02	3.794E+06	2.531E+05	7.918E+04	2.695E+03	1.306E+03	1.006E+03	4.783E+02	3.544E+01	2.943E+01
sr	4.516E+05	5.760E+06	1.688E+06	1.205E+06	7.727E+05	6.335E+05	5.802E+05	4.625E+05	2.320E+05	2.226E+05
y	6.102E+05	8.478E+06	2.735E+06	2.100E+06	1.124E+06	8.302E+05	7.618E+05	6.197E+05	3.206E+05	3.073E+05
zr	7.444E+05	6.692E+06	2.092E+06	1.909E+06	1.487E+06	1.105E+06	9.702E+05	7.813E+05	3.661E+05	3.468E+05
nb	1.036E+06	1.009E+07	3.130E+06	2.781E+06	1.916E+06	1.212E+06	1.087E+06	1.016E+06	6.326E+05	6.067E+05
mo	3.497E+01	6.781E+06	1.214E+06	1.153E+06	9.665E+05	5.835E+05	9.976E+04	6.415E+02	1.372E-05	3.911E-06
tc	4.521E+01	7.904E+06	1.149E+06	1.072E+06	9.295E+05	5.650E+05	9.661E+04	6.374E+02	1.619E+01	1.619E+01

ru	7.912E+05	3.599E+06	2.201E+06	1.887E+06	1.615E+06	1.554E+06	1.423E+06	1.122E+06	5.909E+05	5.708E+05
rh	7.904E+05	4.741E+06	2.556E+06	2.419E+06	2.150E+06	1.769E+06	1.429E+06	1.121E+06	5.906E+05	5.705E+05
pd	2.223E-01	3.691E+05	2.466E+05	1.942E+05	8.530E+04	8.585E+03	1.044E+01	8.309E-01	1.706E-01	1.632E-01
ag	1.731E+03	5.416E+05	3.065E+05	2.495E+05	1.327E+05	4.692E+04	2.108E+04	5.388E+03	2.085E+03	2.055E+03
cd	1.247E+02	4.720E+04	1.066E+04	7.199E+03	5.092E+03	2.851E+03	5.439E+02	1.862E+02	6.287E+01	5.820E+01
in	5.330E-02	1.135E+05	1.499E+04	9.305E+03	5.257E+03	2.807E+03	3.175E+02	7.083E-01	2.927E-02	2.724E-02
sn	1.070E+03	9.632E+05	4.801E+04	1.624E+04	1.018E+04	7.303E+03	4.357E+03	1.809E+03	7.427E+02	7.230E+02
sb	5.962E+03	2.527E+06	2.667E+05	1.453E+05	7.166E+04	4.827E+04	1.998E+04	8.893E+03	7.920E+03	7.882E+03
te	4.000E+04	5.495E+06	1.661E+06	1.261E+06	1.014E+06	6.571E+05	1.975E+05	5.480E+04	2.146E+04	2.034E+04
i	1.942E+04	8.181E+06	4.497E+06	3.356E+06	2.182E+06	1.196E+06	4.180E+05	5.503E+04	1.277E+02	8.302E+01
xe	8.580E+03	6.137E+06	2.036E+06	2.062E+06	1.696E+06	1.121E+06	4.507E+05	3.466E+04	7.485E+01	5.553E+01
cs	1.633E+05	5.491E+06	4.446E+05	3.304E+05	3.228E+05	3.181E+05	3.051E+05	2.847E+05	2.657E+05	2.649E+05
ba	2.055E+05	6.600E+06	1.695E+06	1.302E+06	1.220E+06	1.106E+06	7.934E+05	3.455E+05	1.223E+05	1.210E+05
la	1.442E+05	6.544E+06	2.369E+06	1.577E+06	1.199E+06	1.098E+06	7.725E+05	2.613E+05	5.809E+03	4.426E+03
ce	1.298E+06	5.198E+06	2.947E+06	2.853E+06	2.580E+06	2.146E+06	1.773E+06	1.416E+06	8.355E+05	8.138E+05
pr	9.773E+05	4.539E+06	2.474E+06	2.223E+06	1.938E+06	1.816E+06	1.541E+06	1.082E+06	7.216E+05	7.115E+05
nd	3.254E+04	1.040E+06	5.393E+05	4.473E+05	4.139E+05	3.648E+05	2.345E+05	6.635E+04	7.993E+02	5.829E+02
pm	1.740E+05	1.103E+06	8.311E+05	7.915E+05	6.707E+05	4.570E+05	2.431E+05	1.866E+05	1.652E+05	1.642E+05
sm	3.173E+02	4.267E+05	3.620E+05	3.330E+05	2.537E+05	1.224E+05	1.019E+04	3.491E+02	3.412E+02	3.411E+02
eu	1.931E+04	2.449E+05	2.305E+05	2.244E+05	2.108E+05	1.881E+05	1.388E+05	6.142E+04	1.151E+04	1.107E+04
gd	1.182E+00	5.233E+03	3.878E+03	3.242E+03	1.732E+03	2.902E+02	2.600E+00	1.943E+00	1.589E+00	1.566E+00
tb	2.197E+02	1.949E+03	1.568E+03	1.550E+03	1.489E+03	1.337E+03	9.770E+02	5.938E+02	2.825E+02	2.693E+02
dy	1.314E-03	4.138E+02	1.205E+02	3.441E+01	6.480E+00	4.187E+00	1.005E+00	1.721E-02	1.209E-04	1.181E-04
ho	1.958E-03	6.308E+01	5.670E+01	5.015E+01	3.453E+01	1.351E+01	1.591E+00	2.580E-02	4.225E-04	4.225E-04
er	2.194E-02	1.019E+00	9.775E-01	9.156E-01	7.892E-01	6.202E-01	3.354E-01	7.526E-02	4.313E-04	2.983E-04
tm	1.867E-01	6.132E-01	6.123E-01	6.101E-01	5.989E-01	5.519E-01	4.222E-01	3.491E-01	2.587E-01	2.534E-01
yb	3.994E-07	2.978E-06	2.971E-06	2.958E-06	2.914E-06	2.790E-06	2.398E-06	1.556E-06	3.420E-07	3.069E-07
lu	4.418E-12	2.064E-09	1.341E-09	1.314E-09	1.223E-09	9.974E-10	4.886E-10	6.413E-11	6.135E-14	3.783E-14
totals	7.524E+06	1.183E+08	3.855E+07	3.217E+07	2.500E+07	1.898E+07	1.339E+07	9.002E+06	4.906E+06	4.760E+06

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Fukushima 4 fission products page 86
decay, following irradiation identified by: power= 25.00mw, burnup= 39500.mwd, flux= 4.05E+13n/cm**2-sec

element thermal power, watts
basis = 1 t uranium

	charge	discharge	0.1 d	0.3 d	1.0 d	3.0 d	10.0 d	30.0 d	100.0 d	105.0 d
h	1.425E-02	2.298E-02	2.298E-02	2.298E-02	2.297E-02	2.297E-02	2.294E-02	2.287E-02	2.263E-02	2.261E-02
be	1.998E-07	5.146E-01	3.024E-07	3.023E-07	3.023E-07	3.023E-07	3.022E-07	3.020E-07	3.016E-07	3.015E-07
c	2.793E-06	5.769E-02	4.483E-06	4.483E-06	4.483E-06	4.483E-06	4.483E-06	4.483E-06	4.483E-06	4.483E-06
ni	9.788E-11	1.407E-01	3.478E-05	3.272E-05	2.644E-05	1.437E-05	1.704E-06	3.845E-09	2.101E-18	4.579E-19
cu	1.040E-08	2.071E+00	1.305E-03	1.233E-03	1.009E-03	5.704E-04	7.815E-05	2.885E-07	1.491E-15	3.868E-16
zn	6.800E-09	2.976E+01	2.831E-02	2.273E-02	1.567E-02	7.587E-03	6.204E-04	4.854E-07	6.499E-18	

1.087E-18

ga	1.226E-07	2.964E+02	4.053E-01	3.404E-01	2.505E-01	1.335E-01	1.122E-02	8.750E-06	1.447E-16	4.675E-17
ge	2.233E-10	2.522E+03	7.721E+00	3.480E+00	1.111E+00	5.844E-02	1.960E-06	1.218E-09	1.753E-11	1.295E-11
as	6.476E-07	6.894E+03	3.935E+01	9.959E+00	1.376E+00	5.928E-01	2.887E-02	6.631E-06	7.982E-08	6.600E-08
se	1.993E-05	1.142E+04	1.135E+01	1.141E-01	2.840E-03	1.273E-03	9.122E-05	2.883E-05	2.879E-05	2.879E-05
br	7.278E-08	3.344E+04	2.289E+02	5.378E+01	2.432E+01	9.415E+00	3.478E-01	2.808E-05	1.341E-19	1.289E-20
kr	1.269E+01	4.225E+04	4.431E+03	1.183E+03	4.216E+01	1.683E+01	1.681E+01	1.675E+01	1.654E+01	1.653E+01
rb	8.420E-01	9.254E+04	4.050E+03	1.255E+03	2.703E+01	5.894E+00	4.543E+00	2.159E+00	1.601E-01	1.329E-01
sr	1.409E+03	8.322E+04	1.075E+04	6.594E+03	3.047E+03	2.001E+03	1.800E+03	1.393E+03	5.972E+02	5.645E+02
y	2.325E+03	1.400E+05	1.761E+04	1.252E+04	5.053E+03	3.189E+03	2.916E+03	2.404E+03	1.327E+03	1.279E+03
zr	3.752E+03	6.707E+04	1.076E+04	9.798E+03	7.583E+03	5.582E+03	4.891E+03	3.938E+03	1.846E+03	1.748E+03
nb	4.936E+03	1.422E+05	1.668E+04	1.472E+04	9.809E+03	5.866E+03	5.176E+03	4.843E+03	3.019E+03	2.895E+03
mo	1.401E-01	6.405E+04	4.873E+03	4.618E+03	3.871E+03	2.337E+03	3.995E+02	2.569E+00	5.480E-08	1.552E-08
tc	3.736E-02	9.607E+04	1.352E+03	1.003E+03	8.694E+02	5.285E+02	9.036E+01	5.892E-01	8.120E-03	8.120E-03
ru	1.643E+03	1.974E+04	7.812E+03	5.689E+03	3.889E+03	3.623E+03	3.204E+03	2.258E+03	6.720E+02	6.170E+02
rh	3.015E+03	2.365E+04	6.192E+03	5.920E+03	5.575E+03	5.088E+03	4.716E+03	4.477E+03	3.841E+03	3.802E+03
pd	2.158E-05	1.224E+03	5.017E+02	3.914E+02	1.685E+02	1.546E+01	7.305E-03	8.825E-05	1.185E-05	1.099E-05
ag	1.852E+01	2.117E+03	5.542E+02	4.825E+02	3.135E+02	1.552E+02	8.585E+01	4.828E+01	3.444E+01	3.397E+01
cd	4.692E-01	5.307E+02	5.375E+01	2.853E+01	1.573E+01	8.829E+00	1.832E+00	7.002E-01	2.356E-01	2.181E-01
in	1.298E-04	2.399E+03	6.257E+01	2.551E+01	1.044E+01	5.515E+00	6.237E-01	1.451E-03	7.983E-05	7.434E-05
sn	4.193E+00	1.301E+04	3.913E+02	1.036E+02	4.581E+01	3.881E+01	2.440E+01	8.049E+00	2.140E+00	2.075E+00
sb	2.132E+01	4.704E+04	2.869E+03	1.233E+03	4.494E+02	2.667E+02	1.006E+02	3.414E+01	2.698E+01	2.675E+01
te	7.370E+01	5.155E+04	6.590E+03	3.625E+03	2.671E+03	1.508E+03	3.906E+02	1.035E+02	3.191E+01	2.969E+01
i	6.787E+01	1.215E+05	4.786E+04	3.197E+04	2.050E+04	1.128E+04	2.970E+03	2.090E+02	4.342E-01	2.821E-01
xe	9.116E+00	5.768E+04	3.639E+03	3.747E+03	2.642E+03	1.256E+03	4.901E+02	3.730E+01	7.232E-02	5.356E-02
cs	9.021E+02	9.914E+04	4.394E+03	2.270E+03	2.240E+03	2.185E+03	2.029E+03	1.789E+03	1.582E+03	1.574E+03
ba	6.844E+02	5.760E+04	6.259E+03	4.073E+03	3.727E+03	3.391E+03	2.465E+03	1.138E+03	4.755E+02	4.718E+02
la	2.421E+03	9.752E+04	3.231E+04	2.299E+04	1.995E+04	1.843E+04	1.297E+04	4.386E+03	9.751E+01	7.430E+01
ce	1.230E+03	2.400E+04	6.201E+03	5.811E+03	4.710E+03	3.024E+03	1.902E+03	1.396E+03	6.522E+02	6.273E+02
pr	6.335E+03	3.705E+04	1.109E+04	9.860E+03	8.680E+03	8.272E+03	7.662E+03	6.578E+03	5.190E+03	5.125E+03
nd	7.875E+01	4.962E+03	1.583E+03	1.123E+03	1.002E+03	8.830E+02	5.676E+02	1.606E+02	1.934E+00	1.411E+00
pm	2.322E+02	5.360E+03	2.707E+03	2.563E+03	2.171E+03	1.472E+03	6.533E+02	2.861E+02	1.219E+02	1.166E+02
sm	3.746E-02	1.022E+03	7.178E+02	6.599E+02	5.028E+02	2.422E+02	1.958E+01	5.491E-02	4.012E-02	4.012E-02
eu	1.753E+02	2.325E+03	2.174E+03	2.133E+03	2.042E+03	1.849E+03	1.358E+03	5.811E+02	8.056E+01	7.614E+01
gd	1.039E-03	1.537E+01	8.321E+00	6.955E+00	3.714E+00	6.201E-01	2.973E-03	1.707E-03	1.397E-03	1.377E-03
tb	1.863E+00	1.130E+01	7.615E+00	7.570E+00	7.451E+00	7.138E+00	6.297E+00	4.905E+00	2.478E+00	2.362E+00
dy	1.535E-06	8.012E-01	3.266E-01	8.514E-02	8.192E-03	5.103E-03	1.225E-03	2.082E-05	3.956E-08	3.862E-08
ho	9.023E-06	2.842E-01	2.427E-01	2.153E-01	1.485E-01	5.808E-02	6.847E-03	1.136E-04	4.442E-06	4.442E-06
er	1.340E-05	1.778E-03	1.620E-03	1.382E-03	9.635E-04	5.931E-04	2.249E-04	4.597E-05	2.633E-07	1.821E-07
tm	2.707E-04	1.915E-03	1.911E-03	1.899E-03	1.837E-03	1.572E-03	8.492E-04	5.455E-04	3.757E-04	3.660E-04

yb	1.016E-09	7.577E-09	7.561E-09	7.528E-09	7.415E-09	7.101E-09	6.103E-09	3.959E-09	8.703E-10	7.810E-10
lu	4.877E-14	1.594E-11	1.562E-11	1.530E-11	1.424E-11	1.159E-11	5.641E-12	7.231E-13	5.850E-16	3.542E-16
totals	2.935E+04	1.451E+06	2.148E+05	1.565E+05	1.116E+05	8.253E+04	5.691E+04	3.610E+04	1.962E+04	1.908E+04

Fukushima 4
actinides page 87
decay, following irradiation identified by: power= 25.00mw, burnup= 39500.mwd, flux= 4.05E+13n/cm**2-sec

element concentrations, grams
basis = 1 t uranium

	initial	150.0 d	200.0 d	250.0 d	300.0 d	350.0 d	400.0 d	450.0 d	500.0 d
he	6.985E-01	7.341E-01	7.679E-01	7.968E-01	8.217E-01	8.434E-01	8.625E-01	8.795E-01	8.948E-01
tl	4.846E-12	5.336E-12	5.828E-12	6.316E-12	6.800E-12	7.280E-12	7.754E-12	8.222E-12	8.685E-12
pb	1.911E-06	2.119E-06	2.371E-06	2.645E-06	2.942E-06	3.260E-06	3.600E-06	3.962E-06	4.344E-06
bi	6.557E-10	6.942E-10	7.336E-10	7.728E-10	8.118E-10	8.506E-10	8.891E-10	9.272E-10	9.651E-10
po	9.988E-13	1.069E-12	1.141E-12	1.210E-12	1.276E-12	1.340E-12	1.404E-12	1.468E-12	1.534E-12
at	1.392E-19	1.324E-19	1.316E-19	1.316E-19	1.318E-19	1.319E-19	1.320E-19	1.322E-19	1.323E-19
rn	4.693E-12	5.151E-12	5.609E-12	6.065E-12	6.517E-12	6.966E-12	7.411E-12	7.851E-12	8.287E-12
fr	1.567E-15	1.537E-15	1.568E-15	1.606E-15	1.644E-15	1.683E-15	1.722E-15	1.760E-15	1.799E-15
ra	8.282E-08	8.803E-08	9.361E-08	9.926E-08	1.050E-07	1.107E-07	1.166E-07	1.224E-07	1.284E-07
ac	1.070E-08	1.202E-08	1.348E-08	1.494E-08	1.639E-08	1.784E-08	1.929E-08	2.073E-08	2.217E-08
th	2.825E-03	2.904E-03	2.992E-03	3.080E-03	3.168E-03	3.256E-03	3.344E-03	3.432E-03	3.520E-03
pa	5.478E-04	5.487E-04	5.496E-04	5.505E-04	5.514E-04	5.523E-04	5.532E-04	5.541E-04	5.550E-04
u	9.494E+05	9.494E+05	9.494E+05	9.494E+05	9.494E+05	9.494E+05	9.494E+05	9.494E+05	9.494E+05
np	4.693E+02	4.693E+02	4.693E+02	4.693E+02	4.693E+02	4.694E+02	4.694E+02	4.694E+02	4.694E+02
pu	8.790E+03	8.785E+03	8.779E+03	8.773E+03	8.767E+03	8.760E+03	8.754E+03	8.747E+03	8.741E+03
am	1.993E+02	2.059E+02	2.132E+02	2.205E+02	2.277E+02	2.348E+02	2.419E+02	2.490E+02	2.560E+02
cm	5.148E+01	4.957E+01	4.779E+01	4.632E+01	4.509E+01	4.406E+01	4.318E+01	4.244E+01	4.180E+01
bk	6.780E-07	6.151E-07	5.519E-07	4.953E-07	4.444E-07	3.988E-07	3.579E-07	3.212E-07	2.882E-07
cf	7.338E-07	7.929E-07	8.518E-07	9.043E-07	9.510E-07	9.927E-07	1.030E-06	1.063E-06	1.092E-06
es	2.733E-11	1.711E-11	1.299E-11	1.100E-11	9.604E-12	8.449E-12	7.447E-12	6.567E-12	5.791E-12
totals	9.589E+05	9.589E+05	9.589E+05	9.589E+05	9.589E+05	9.589E+05	9.589E+05	9.589E+05	9.589E+05

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Fukushima 4
actinides page 88
decay, following irradiation identified by: power= 25.00mw, burnup= 39500.mwd, flux= 4.05E+13n/cm**2-sec

element radioactivity, curies
basis = 1 t uranium

	initial	150.0 d	200.0 d	250.0 d	300.0 d	350.0 d	400.0 d	450.0 d	500.0 d
tl	1.435E-03	1.580E-03	1.726E-03	1.870E-03	2.014E-03	2.156E-03	2.296E-03	2.435E-03	2.572E-03
pb	3.991E-03	4.396E-03	4.800E-03	5.202E-03	5.601E-03	5.996E-03	6.386E-03	6.772E-03	7.153E-03
bi	3.992E-03	4.396E-03	4.800E-03	5.202E-03	5.601E-03	5.996E-03	6.386E-03	6.772E-03	7.153E-03
po	6.546E-03	7.211E-03	7.874E-03	8.534E-03	9.188E-03	9.836E-03	1.048E-02	1.111E-02	1.173E-02
at	2.242E-07	2.132E-07	2.119E-07	2.120E-07	2.122E-07	2.124E-07	2.126E-07	2.128E-07	2.131E-07
rn	3.990E-03	4.395E-03	4.800E-03	5.202E-03	5.601E-03	5.995E-03	6.386E-03	6.772E-03	7.152E-03
fr	2.349E-07	2.252E-07	2.254E-07	2.269E-07	2.285E-07	2.302E-07	2.319E-07	2.335E-07	2.352E-07
ra	3.990E-03	4.395E-03	4.800E-03	5.202E-03	5.601E-03	5.996E-03	6.386E-03	6.772E-03	7.153E-03
ac	9.981E-07	1.083E-06	1.187E-06	1.293E-06	1.398E-06	1.503E-06	1.608E-06	1.713E-06	1.817E-06
th	3.337E-01	3.341E-01	3.345E-01	3.349E-01	3.353E-01	3.357E-01	3.361E-01	3.365E-01	3.368E-01
pa	6.466E-01	6.467E-01	6.468E-01	6.468E-01	6.468E-01	6.468E-01	6.468E-01	6.468E-01	6.468E-01
u	1.660E+01	4.636E+00	4.502E+00	4.485E+00	4.468E+00	4.452E+00	4.436E+00	4.420E+00	4.404E+00
np	2.731E+01	2.731E+01	2.730E+01	2.730E+01	2.730E+01	2.730E+01	2.730E+01	2.730E+01	2.730E+01
pu	1.194E+05	1.188E+05	1.180E+05	1.173E+05	1.166E+05	1.158E+05	1.151E+05	1.144E+05	1.136E+05
am	2.633E+02	2.860E+02	3.110E+02	3.359E+02	3.606E+02	3.851E+02	4.094E+02	4.336E+02	4.576E+02
cm	3.603E+04	3.030E+04	2.510E+04	2.089E+04	1.748E+04	1.473E+04	1.250E+04	1.069E+04	9.225E+03
bk	1.112E-03	1.008E-03	9.048E-04	8.120E-04	7.286E-04	6.538E-04	5.867E-04	5.265E-04	4.725E-04
cf	6.541E-05	6.423E-05	6.298E-05	6.175E-05	6.055E-05	5.937E-05	5.822E-05	5.709E-05	5.598E-05
es	3.232E-07	1.051E-07	3.999E-08	2.377E-08	1.858E-08	1.590E-08	1.392E-08	1.226E-08	1.080E-08
totals	1.557E+05	1.494E+05	1.435E+05	1.385E+05	1.344E+05	1.310E+05	1.280E+05	1.255E+05	1.234E+05

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Fukushima 4
actinides page 89
decay, following irradiation identified by: power= 25.00mw, burnup= 39500.mwd, flux= 4.05E+13n/cm**2-sec

element thermal power, watts
basis = 1 t uranium

	initial	150.0 d	200.0 d	250.0 d	300.0 d	350.0 d	400.0 d	450.0 d	500.0 d
tl	3.355E-05	3.695E-05	4.035E-05	4.373E-05	4.708E-05	5.039E-05	5.368E-05	5.692E-05	6.012E-05
pb	7.548E-06	8.313E-06	9.078E-06	9.838E-06	1.059E-05	1.134E-05	1.208E-05	1.281E-05	1.353E-05
bi	6.685E-05	7.362E-05	8.040E-05	8.714E-05	9.381E-05	1.004E-04	1.070E-04	1.134E-04	1.198E-04
po	2.990E-04	3.293E-04	3.597E-04	3.898E-04	4.197E-04	4.492E-04	4.785E-04	5.074E-04	5.359E-04
at	9.567E-09	9.096E-09	9.042E-09	9.045E-09	9.054E-09	9.064E-09	9.073E-09	9.083E-09	9.092E-09
rn	1.515E-04	1.669E-04	1.822E-04	1.975E-04	2.126E-04	2.276E-04	2.425E-04	2.571E-04	2.716E-04
fr	8.680E-09	8.257E-09	8.212E-09	8.219E-09	8.230E-09	8.242E-09	8.254E-09	8.267E-09	8.279E-09
ra	1.369E-04	1.509E-04	1.647E-04	1.785E-04	1.922E-04	2.058E-04	2.192E-04	2.324E-04	2.455E-04
ac	8.201E-09	7.864E-09	7.871E-09	7.925E-09	7.983E-09	8.041E-09	8.100E-09	8.158E-09	8.216E-09
th	2.787E-04	2.907E-04	3.040E-04	3.171E-04	3.302E-04	3.431E-04	3.558E-04	3.684E-04	3.809E-04
pa	2.393E-03	2.393E-03	2.394E-03	2.394E-03	2.394E-03	2.394E-03	2.394E-03	2.394E-03	2.394E-03

u	7.804E-02	5.491E-02	5.469E-02	5.470E-02	5.471E-02	5.472E-02	5.473E-02	5.474E-02	5.475E-02
np	7.773E-02	7.772E-02	7.772E-02	7.772E-02	7.772E-02	7.772E-02	7.772E-02	7.772E-02	7.772E-02
pu	1.328E+02	1.336E+02	1.344E+02	1.349E+02	1.354E+02	1.357E+02	1.359E+02	1.361E+02	1.362E+02
am	8.165E+00	8.922E+00	9.758E+00	1.059E+01	1.141E+01	1.223E+01	1.304E+01	1.385E+01	1.465E+01
cm	1.310E+03	1.101E+03	9.109E+02	7.574E+02	6.331E+02	5.326E+02	4.512E+02	3.853E+02	3.319E+02
bk	2.175E-07	1.973E-07	1.770E-07	1.589E-07	1.426E-07	1.279E-07	1.148E-07	1.030E-07	9.244E-08
cf	3.812E-06	3.720E-06	3.623E-06	3.531E-06	3.441E-06	3.355E-06	3.271E-06	3.190E-06	3.112E-06
es	1.287E-08	4.161E-09	1.565E-09	9.210E-10	7.167E-10	6.127E-10	5.364E-10	4.722E-10	4.162E-10
totals	1.451E+03	1.243E+03	1.055E+03	9.030E+02	7.801E+02	6.806E+02	6.003E+02	5.354E+02	4.829E+02

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Fukushima 4 fission
products page 90
decay, following irradiation identified by: power= 25.00mw, burnup= 39500.mwd, flux=
4.05E+13n/cm**2-sec

element concentrations, grams
basis = 1 t uranium

	initial	150.0 d	200.0 d	250.0 d	300.0 d	350.0 d	400.0 d	450.0 d	500.0 d
h	7.882E-02	7.835E-02	7.782E-02	7.729E-02	7.677E-02	7.626E-02	7.575E-02	7.524E-02	7.474E-02
he	1.393E+00	1.393E+00	1.394E+00	1.394E+00	1.395E+00	1.395E+00	1.396E+00	1.396E+00	1.397E+00
li	1.159E-02	1.159E-02	1.159E-02	1.159E-02	1.159E-02	1.159E-02	1.159E-02	1.159E-02	1.159E-02
be	1.215E-02	1.215E-02	1.215E-02	1.215E-02	1.215E-02	1.215E-02	1.215E-02	1.215E-02	1.215E-02
b	7.973E-04	7.973E-04	7.973E-04	7.973E-04	7.973E-04	7.973E-04	7.973E-04	7.973E-04	7.973E-04
c	3.772E-03	3.772E-03	3.772E-03	3.772E-03	3.772E-03	3.771E-03	3.771E-03	3.771E-03	3.771E-03
n	3.737E-04	3.737E-04	3.738E-04	3.738E-04	3.739E-04	3.739E-04	3.740E-04	3.741E-04	3.741E-04
ne	5.142E-03	5.142E-03	5.142E-03	5.142E-03	5.142E-03	5.142E-03	5.142E-03	5.142E-03	5.142E-03
ni	1.366E-21	1.517E-27	3.672E-34	8.888E-41	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
cu	3.114E-19	1.716E-24	2.464E-30	3.537E-36	5.070E-42	0.000E+00	0.000E+00	0.000E+00	0.000E+00
zn	2.008E-03	2.008E-03	2.008E-03	2.008E-03	2.008E-03	2.008E-03	2.008E-03	2.008E-03	2.008E-03
ga	3.265E-03	3.265E-03	3.265E-03	3.265E-03	3.265E-03	3.265E-03	3.265E-03	3.265E-03	3.265E-03
ge	4.509E-01	4.509E-01	4.509E-01	4.509E-01	4.509E-01	4.509E-01	4.509E-01	4.509E-01	4.509E-01
as	1.367E-01	1.367E-01	1.367E-01	1.367E-01	1.367E-01	1.367E-01	1.367E-01	1.367E-01	1.367E-01
se	6.434E+01	6.434E+01	6.434E+01	6.434E+01	6.434E+01	6.434E+01	6.434E+01	6.434E+01	6.434E+01
br	2.513E+01	2.513E+01	2.513E+01	2.513E+01	2.513E+01	2.513E+01	2.513E+01	2.513E+01	2.513E+01
kr	4.383E+02	4.381E+02	4.378E+02	4.376E+02	4.374E+02	4.371E+02	4.369E+02	4.367E+02	4.364E+02
rb	4.172E+02	4.175E+02	4.177E+02	4.179E+02	4.182E+02	4.184E+02	4.187E+02	4.189E+02	4.191E+02
sr	1.048E+03	1.044E+03	1.040E+03	1.038E+03	1.035E+03	1.033E+03	1.031E+03	1.029E+03	1.027E+03
y	5.532E+02	5.517E+02	5.506E+02	5.499E+02	5.495E+02	5.493E+02	5.491E+02	5.490E+02	5.490E+02
zr	4.296E+03	4.296E+03	4.296E+03	4.297E+03	4.298E+03	4.300E+03	4.302E+03	4.304E+03	4.306E+03
nb	1.534E+01	1.026E+01	6.328E+00	3.815E+00	2.270E+00	1.340E+00	7.875E-01	4.617E-01	2.706E-01
mo	4.006E+03	4.018E+03	4.026E+03	4.031E+03	4.033E+03	4.035E+03	4.036E+03	4.037E+03	4.037E+03
tc	9.461E+02	9.461E+02	9.461E+02	9.461E+02	9.461E+02	9.461E+02	9.461E+02	9.461E+02	9.461E+02
ru	2.779E+03	2.766E+03	2.755E+03	2.746E+03	2.738E+03	2.730E+03	2.723E+03	2.717E+03	2.712E+03
rh	5.350E+02	5.380E+02	5.395E+02	5.401E+02	5.403E+02	5.404E+02	5.405E+02	5.405E+02	5.405E+02
pd	1.523E+03	1.532E+03	1.542E+03	1.551E+03	1.559E+03	1.566E+03	1.573E+03	1.579E+03	1.585E+03
ag	8.876E+01	8.871E+01	8.866E+01	8.861E+01	8.858E+01	8.855E+01	8.852E+01	8.849E+01	8.847E+01
cd	9.502E+01	9.507E+01	9.512E+01	9.516E+01	9.520E+01	9.523E+01	9.526E+01	9.528E+01	9.530E+01
in	1.818E+00	1.819E+00	1.820E+00	1.820E+00	1.820E+00	1.821E+00	1.821E+00	1.821E+00	1.821E+00
sn	5.788E+01	5.787E+01	5.785E+01	5.784E+01	5.783E+01	5.782E+01	5.782E+01	5.781E+01	5.781E+01
sb	1.686E+01	1.664E+01	1.641E+01	1.619E+01	1.597E+01	1.576E+01	1.555E+01	1.535E+01	1.516E+01
te	5.572E+02	5.572E+02	5.573E+02	5.574E+02	5.576E+02	5.577E+02	5.579E+02	5.581E+02	5.583E+02
i	2.320E+02	2.323E+02	2.324E+02	2.325E+02	2.326E+02	2.326E+02	2.327E+02	2.327E+02	2.327E+02
xe	6.370E+03	6.370E+03	6.370E+03	6.370E+03	6.370E+03	6.370E+03	6.370E+03	6.370E+03	6.370E+03
cs	3.398E+03	3.389E+03	3.380E+03	3.371E+03	3.362E+03	3.354E+03	3.346E+03	3.337E+03	3.329E+03
ba	1.763E+03	1.772E+03	1.781E+03	1.790E+03	1.799E+03	1.807E+03	1.815E+03	1.824E+03	1.832E+03
la	1.466E+03	1.466E+03	1.466E+03	1.466E+03	1.466E+03	1.466E+03	1.466E+03	1.466E+03	1.466E+03
ce	3.089E+03	3.064E+03	3.040E+03	3.020E+03	3.002E+03	2.986E+03	2.973E+03	2.960E+03	2.950E+03
pr	1.341E+03	1.344E+03	1.345E+03	1.345E+03	1.345E+03	1.345E+03	1.345E+03	1.345E+03	1.345E+03
nd	4.656E+03	4.679E+03	4.702E+03	4.721E+03	4.739E+03	4.755E+03	4.768E+03	4.781E+03	4.792E+03
pm	1.722E+02	1.666E+02	1.606E+02	1.549E+02	1.494E+02	1.441E+02	1.389E+02	1.340E+02	1.292E+02
sm	8.511E+02	8.567E+02	8.627E+02	8.684E+02	8.739E+02	8.792E+02	8.843E+02	8.892E+02	8.939E+02
eu	1.669E+02	1.665E+02	1.662E+02	1.658E+02	1.655E+02	1.651E+02	1.648E+02	1.644E+02	1.641E+02
gd	1.284E+02	1.287E+02	1.291E+02	1.295E+02	1.299E+02	1.302E+02	1.306E+02	1.309E+02	1.313E+02
tb	2.577E+00	2.569E+00	2.563E+00	2.559E+00	2.557E+00	2.555E+00	2.554E+00	2.554E+00	2.554E+00
dy	1.193E+00	1.201E+00	1.207E+00	1.210E+00	1.213E+00	1.214E+00	1.215E+00	1.216E+00	1.216E+00
ho	8.163E-02	8.163E-02	8.163E-02	8.163E-02	8.163E-02	8.163E-02	8.163E-02	8.163E-02	8.163E-02
er	2.725E-02	2.725E-02	2.725E-02	2.725E-02	2.725E-02	2.725E-02	2.725E-02	2.725E-02	2.725E-02
tm	4.429E-04	4.335E-04	4.248E-04	4.176E-04	4.115E-04	4.064E-04	4.019E-04	3.980E-04	3.946E-04
yb	5.033E-04	5.127E-04	5.214E-04	5.286E-04	5.347E-04	5.399E-04	5.443E-04	5.482E-04	5.516E-04
lu	3.606E-19	5.371E-21	6.133E-23	8.081E-25	1.145E-26	1.673E-28	2.475E-30	3.680E-32	5.482E-34
totals	4.110E+04	4.110E+04	4.110E+04	4.110E+04	4.110E+04	4.110E+04	4.110E+04	4.110E+04	4.110E+04

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Fukushima 4 fission
products page 91
decay, following irradiation identified by: power= 25.00mw, burnup= 39500.mwd, flux=
4.05E+13n/cm**2-sec

element radioactivity, curies
basis = 1 t uranium

	initial	150.0 d	200.0 d	250.0 d	300.0 d	350.0 d	400.0 d	450.0 d	500.0 d
h	6.703E+02	6.657E+02	6.606E+02	6.556E+02	6.505E+02	6.455E+02	6.406E+02	6.357E+02	6.308E+02
be	2.511E-04	2.510E-04	2.510E-04	2.510E-04	2.510E-04	2.510E-04	2.510E-04	2.510E-04	2.510E-04
c	1.529E-02	1.529E-02	1.529E-02	1.529E-02	1.529E-02	1.529E-02	1.529E-02	1.529E-02	1.529E-02
ni	1.188E-15	1.320E-21	3.194E-28	7.733E-35	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
cu	2.369E-13	1.300E-18	1.865E-24	2.677E-30	3.837E-36	0.000E+00	0.000E+00	0.000E+00	0.000E+00
zn	7.185E-16	7.354E-23	1.259E-30	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ga	3.740E-15	2.414E-15	2.124E-15	1.869E-15	1.645E-15	1.447E-15	1.274E-15	1.121E-15	9.860E-16
ge	2.424E-07	1.586E-08	7.668E-10	3.707E-11	1.793E-12	8.806E-14	5.460E-15	1.323E-15	9.956E-16
as	1.569E-05	5.332E-06	2.542E-06	1.520E-06	9.683E-07	6.262E-07	4.063E-07	2.638E-07	1.713E-07
se	8.689E-02	8.688E-02	8.688E-02	8.687E-02	8.687E-02	8.687E-02	8.687E-02	8.687E-02	8.687E-02
br	9.180E-19	3.100E-25	1.441E-31	7.701E-38	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
kr	1.102E+04	1.093E+04	1.084E+04	1.074E+04	1.065E+04	1.055E+04	1.046E+04	1.037E+04	1.028E+04
rb	2.943E+01	5.534E+00	8.682E-01	1.378E-01	2.253E-02	3.995E-03	8.712E-04	2.798E-04	1.368E-04
sr	2.226E+05	1.609E+05	1.249E+05	1.067E+05	9.731E+04	9.245E+04	8.986E+04	8.840E+04	8.753E+04
y	3.073E+05	2.169E+05	1.595E+05	1.276E+05	1.098E+05	9.980E+04	9.416E+04	9.091E+04	8.898E+04
zr	3.468E+05	2.131E+05	1.240E+05	7.217E+04	4.200E+04	2.444E+04	1.423E+04	8.279E+03	4.819E+03
nb	6.067E+05	4.057E+05	2.501E+05	1.507E+05	8.962E+04	5.287E+04	3.103E+04	1.816E+04	1.060E+04
mo	3.911E-06	3.613E-08	3.608E-08	3.608E-08	3.608E-08	3.608E-08	3.608E-08	3.608E-08	3.608E-08
tc	1.619E+01	1.619E+01	1.619E+01	1.619E+01	1.619E+01	1.619E+01	1.619E+01	1.619E+01	1.619E+01
ru	5.708E+05	4.414E+05	3.620E+05	3.132E+05	2.784E+05	2.508E+05	2.273E+05	2.065E+05	1.879E+05
rh	5.705E+05	4.413E+05	3.620E+05	3.132E+05	2.784E+05	2.508E+05	2.273E+05	2.065E+05	1.879E+05
pd	1.632E-01	1.356E-01	1.310E-01	1.304E-01	1.303E-01	1.303E-01	1.303E-01	1.303E-01	1.303E-01
ag	2.055E+03	1.811E+03	1.577E+03	1.373E+03	1.195E+03	1.040E+03	9.052E+02	7.880E+02	6.859E+02
cd	5.820E+01	2.916E+01	1.366E+01	6.526E+00	3.244E+00	1.732E+00	1.033E+00	7.094E-01	5.574E-01
in	2.724E-02	1.428E-02	6.975E-03	3.410E-03	1.669E-03	8.173E-04	4.007E-04	1.966E-04	9.651E-05
sn	7.230E+02	5.763E+02	4.522E+02	3.568E+02	2.834E+02	2.267E+02	1.829E+02	1.491E+02	1.229E+02
sb	7.882E+03	7.571E+03	7.269E+03	6.997E+03	6.744E+03	6.506E+03	6.279E+03	6.063E+03	5.854E+03
te	2.034E+04	1.325E+04	9.070E+03	6.662E+03	5.126E+03	4.077E+03	3.328E+03	2.781E+03	2.374E+03
i	8.302E+01	1.746E+00	5.455E-02	3.184E-02	3.153E-02	3.153E-02	3.153E-02	3.153E-02	3.153E-02
xe	5.553E+01	4.029E+00	2.213E-01	1.245E-02	8.306E-04	1.045E-04	2.860E-05	1.040E-05	3.979E-06
cs	2.649E+05	2.587E+05	2.522E+05	2.460E+05	2.401E+05	2.344E+05	2.290E+05	2.238E+05	2.188E+05
ba	1.210E+05	1.172E+05	1.165E+05	1.161E+05	1.157E+05	1.154E+05	1.150E+05	1.146E+05	1.143E+05
la	4.426E+03	3.833E+02	2.529E+01	1.669E+00	1.102E-01	7.277E-03	4.878E-04	3.977E-05	1.020E-05
ce	8.138E+05	6.692E+05	5.683E+05	4.948E+05	4.353E+05	3.844E+05	3.401E+05	3.010E+05	2.665E+05
pr	7.115E+05	6.336E+05	5.607E+05	4.964E+05	4.395E+05	3.892E+05	3.446E+05	3.051E+05	2.702E+05
nd	5.829E+02	3.403E+01	1.449E+00	6.169E-02	2.627E-03	1.118E-04	4.763E-06	2.046E-07	1.053E-08
pm	1.642E+05	1.566E+05	1.499E+05	1.441E+05	1.387E+05	1.337E+05	1.289E+05	1.243E+05	1.199E+05
sm	3.411E+02	3.408E+02	3.404E+02	3.401E+02	3.397E+02	3.394E+02	3.390E+02	3.386E+02	3.383E+02
eu	1.107E+04	9.473E+03	9.148E+03	9.001E+03	8.873E+03	8.749E+03	8.627E+03	8.507E+03	8.389E+03
gd	1.566E+00	1.376E+00	1.192E+00	1.033E+00	8.950E-01	7.753E-01	6.717E-01	5.819E-01	5.041E-01
tb	2.693E+02	1.749E+02	1.083E+02	6.705E+01	4.152E+01	2.571E+01	1.592E+01	9.855E+00	6.102E+00
dy	1.181E-04	9.513E-05	7.483E-05	5.886E-05	4.630E-05	3.642E-05	2.865E-05	2.254E-05	1.773E-05
ho	4.225E-04	4.224E-04	4.224E-04	4.224E-04	4.223E-04	4.223E-04	4.223E-04	4.222E-04	4.222E-04
er	2.983E-04	1.080E-05	2.706E-07	6.778E-09	1.698E-10	4.252E-12	1.065E-13	2.668E-15	6.682E-17
tm	2.534E-01	2.114E-01	1.746E-01	1.459E-01	1.233E-01	1.055E-01	9.141E-02	8.009E-02	7.095E-02
yb	3.069E-07	1.159E-07	3.928E-08	1.331E-08	4.512E-09	1.529E-09	5.182E-10	1.756E-10	5.952E-11
lu	3.783E-14	5.399E-16	5.923E-18	7.626E-20	1.069E-21	1.555E-23	2.297E-25	3.413E-27	5.082E-29
totals	4.760E+06	3.760E+06	3.069E+06	2.617E+06	2.299E+06	2.060E+06	1.872E+06	1.717E+06	1.586E+06

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Fukushima 4 fission products page 92
decay, following irradiation identified by: power= 25.00mw, burnup= 39500.mwd, flux= 4.05E+13n/cm**2-sec

element thermal power, watts
basis = 1 t uranium

	initial	150.0 d	200.0 d	250.0 d	300.0 d	350.0 d	400.0 d	450.0 d	500.0 d
h	2.261E-02	2.245E-02	2.228E-02	2.211E-02	2.194E-02	2.177E-02	2.161E-02	2.144E-02	2.128E-02
be	3.015E-07	3.014E-07	3.013E-07	3.013E-07	3.013E-07	3.013E-07	3.013E-07	3.013E-07	3.013E-07
c	4.483E-06	4.483E-06	4.483E-06	4.483E-06	4.483E-06	4.482E-06	4.482E-06	4.482E-06	4.482E-06
ni	4.579E-19	5.085E-25	1.231E-31	2.979E-38	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
cu	3.868E-16	2.096E-21	2.998E-27	4.300E-33	6.164E-39	0.000E+00	0.000E+00	0.000E+00	0.000E+00
zn	1.087E-18	1.112E-25	1.904E-33	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ga	4.675E-17	2.420E-17	2.129E-17	1.874E-17	1.649E-17	1.451E-17	1.277E-17	1.123E-17	9.883E-18
ge	1.295E-11	8.475E-13	4.097E-14	1.980E-15	9.581E-17	4.704E-18	2.909E-19	6.993E-20	5.254E-20
as	6.600E-08	1.255E-08	2.563E-09	8.699E-10	4.520E-10	2.775E-10	1.779E-10	1.152E-10	7.479E-11
se	2.879E-05	2.877E-05	2.876E-05	2.875E-05	2.875E-05	2.874E-05	2.874E-05	2.874E-05	2.874E-05
br	1.289E-20	6.078E-28	2.792E-34	1.493E-40	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
kr	1.653E+01	1.640E+01	1.625E+01	1.611E+01	1.597E+01	1.583E+01	1.569E+01	1.555E+01	1.541E+01
rb	1.329E-01	2.502E-02	3.935E-03	6.274E-04	1.033E-04	1.832E-05	3.833E-06	1.073E-06	4.249E-07
sr	5.645E+02	3.520E+02	2.283E+02	1.658E+02	1.341E+02	1.180E+02	1.097E+02	1.054E+02	1.030E+02
y	1.279E+03	9.531E+02	7.458E+02	6.304E+02	5.658E+02	5.294E+02	5.085E+02	4.962E+02	4.887E+02
zr	1.748E+03	1.074E+03	6.251E+02	3.638E+02	2.117E+02	1.232E+02	7.170E+01	4.172E+01	2.428E+01
nb	2.895E+03	1.937E+03	1.194E+03	7.197E+02	4.280E+02	2.525E+02	1.482E+02	8.673E+01	5.065E+01
mo	1.552E-08	3.604E-12	3.422E-12	3.422E-12	3.422E-12	3.422E-12	3.422E-12	3.422E-12	3.422E-12
tc	8.120E-03	8.120E-03	8.120E-03	8.120E-03	8.120E-03	8.120E-03	8.120E-03	8.120E-03	8.120E-03
ru	6.170E+02	2.897E+02	1.305E+02	6.369E+01	3.520E+01	2.262E+01	1.670E+01	1.360E+01	1.172E+01
rh	3.802E+03	3.477E+03	3.158E+03	2.873E+03	2.615E+03	2.382E+03	2.169E+03	1.976E+03	1.800E+03

pd	1.099E-05	7.790E-06	7.263E-06	7.194E-06	7.185E-06	7.184E-06	7.184E-06	7.184E-06	7.184E-06
ag	3.397E+01	2.997E+01	2.609E+01	2.271E+01	1.977E+01	1.721E+01	1.498E+01	1.304E+01	1.135E+01
cd	2.181E-01	1.086E-01	5.016E-02	2.331E-02	1.095E-02	5.275E-03	2.662E-03	1.458E-03	9.036E-04
in	7.434E-05	3.915E-05	1.921E-05	9.434E-06	4.636E-06	2.280E-06	1.122E-06	5.524E-07	2.722E-07
sn	2.075E+00	1.618E+00	1.242E+00	9.553E-01	7.356E-01	5.673E-01	4.384E-01	3.396E-01	2.639E-01
sb	2.675E+01	2.502E+01	2.360E+01	2.247E+01	2.152E+01	2.068E+01	1.992E+01	1.921E+01	1.853E+01
te	2.969E+01	1.654E+01	9.882E+00	6.648E+00	4.859E+00	3.752E+00	3.008E+00	2.481E+00	2.097E+00
i	2.821E-01	5.843E-03	9.304E-05	1.580E-05	1.476E-05	1.475E-05	1.475E-05	1.475E-05	1.475E-05
xe	5.356E-02	3.874E-03	2.137E-04	1.237E-05	9.558E-07	1.613E-07	5.097E-08	1.906E-08	7.321E-09
cs	1.574E+03	1.514E+03	1.451E+03	1.392E+03	1.335E+03	1.280E+03	1.228E+03	1.179E+03	1.132E+03
ba	4.718E+02	4.600E+02	4.576E+02	4.561E+02	4.547E+02	4.533E+02	4.518E+02	4.504E+02	4.490E+02
la	7.430E+01	6.435E+00	4.246E-01	2.802E-02	1.849E-03	1.220E-04	8.054E-06	5.329E-07	3.653E-08
ce	6.273E+02	4.743E+02	3.844E+02	3.281E+02	2.863E+02	2.521E+02	2.227E+02	1.970E+02	1.744E+02
pr	5.125E+03	4.586E+03	4.060E+03	3.595E+03	3.183E+03	2.819E+03	2.496E+03	2.210E+03	1.957E+03
nd	1.411E+00	8.236E-02	3.507E-03	1.493E-04	6.357E-06	2.707E-07	1.155E-08	5.120E-10	4.237E-11
pm	1.166E+02	8.396E+01	6.646E+01	5.783E+01	5.306E+01	5.001E+01	4.772E+01	4.581E+01	4.409E+01
sm	4.012E-02	4.008E-02	4.004E-02	4.000E-02	3.995E-02	3.991E-02	3.987E-02	3.983E-02	3.979E-02
eu	7.614E+01	6.071E+01	5.809E+01	5.724E+01	5.657E+01	5.592E+01	5.529E+01	5.466E+01	5.404E+01
gd	1.377E-03	1.210E-03	1.048E-03	9.080E-04	7.867E-04	6.815E-04	5.904E-04	5.115E-04	4.431E-04
tb	2.362E+00	1.534E+00	9.500E-01	5.882E-01	3.642E-01	2.255E-01	1.396E-01	8.646E-02	5.354E-02
dy	3.862E-08	3.111E-08	2.447E-08	1.925E-08	1.514E-08	1.191E-08	9.370E-09	7.371E-09	5.798E-09
ho	4.442E-06	4.442E-06	4.442E-06	4.441E-06	4.441E-06	4.441E-06	4.440E-06	4.440E-06	4.439E-06
er	1.821E-07	6.596E-09	1.652E-10	4.138E-12	1.036E-13	2.596E-15	6.503E-17	1.629E-18	4.080E-20
tm	3.660E-04	2.890E-04	2.228E-04	1.720E-04	1.332E-04	1.034E-04	8.063E-05	6.314E-05	4.970E-05
yb	7.810E-10	2.949E-10	9.996E-11	3.388E-11	1.148E-11	3.891E-12	1.319E-12	4.469E-13	1.515E-13
lu	3.542E-16	4.150E-18	3.594E-20	3.887E-22	4.961E-24	6.925E-26	1.006E-27	1.485E-29	2.206E-31
totals	1.908E+04	1.536E+04	1.264E+04	1.077E+04	9.422E+03	8.396E+03	7.580E+03	6.907E+03	6.336E+03

Fukushima Daiichi 4
actinides page 73
decay, following irradiation identified by: power= 25.00mw, burnup= 39500.mwd, flux= 4.05E+13n/cm**2-sec

element concentrations, grams
basis = full core inventory 548 assemblies (94t

	charge	discharge	2E-03 h	3E-03 h	5E-03 h	8E-03 h	2E-02 h	3E-02 h	7E-02 h	0.2 h	0.3 h	1.0 h	1.5 h	2.0 h	4.0 h	6.0 h	8.0 h	10.0 h
he	1.518E-01	5.545E+01	5.545E+01	5.545E+01	5.545E+01	5.545E+01	5.545E+01	5.545E+01	5.545E+01	5.545E+01	5.545E+01	5.545E+01	5.546E+01	5.546E+01	5.547E+01	5.548E+01	5.549E+01	5.550E+01
tl	1.279E-12	3.625E-10	3.625E-10	3.625E-10	3.625E-10	3.625E-10	3.625E-10	3.625E-10	3.625E-10	3.625E-10	3.625E-10	3.748E-10	3.626E-10	3.626E-10	3.675E-10	3.675E-10	3.675E-10	3.674E-10
pb	3.437E-07	1.404E-04	1.404E-04	1.404E-04	1.404E-04	1.404E-04	1.404E-04	1.404E-04	1.404E-04	1.404E-04	1.404E-04	1.404E-04	1.404E-04	1.404E-04	1.404E-04	1.405E-04	1.405E-04	1.405E-04
bi	1.357E-10	5.190E-08	5.190E-08	5.190E-08	5.190E-08	5.190E-08	5.190E-08	5.190E-08	5.190E-08	5.190E-08	5.190E-08	5.190E-08	5.191E-08	5.191E-08	5.192E-08	5.192E-08	5.193E-08	5.193E-08
po	2.213E-13	7.718E-11	7.718E-11	7.718E-11	7.718E-11	7.718E-11	7.718E-11	7.718E-11	7.718E-11	7.718E-11	7.719E-11	7.719E-11	7.719E-11	7.720E-11	7.721E-11	7.723E-11	7.724E-11	7.726E-11
at	6.091E-20	4.539E-17	4.540E-17	4.540E-17	4.540E-17	4.539E-17	4.539E-17	4.539E-17	4.539E-17	4.539E-17	4.539E-17	4.540E-17	4.540E-17	4.540E-17	4.543E-17	4.544E-17	4.545E-17	4.546E-17
rn	1.324E-12	3.548E-10	3.548E-10	3.548E-10	3.548E-10	3.548E-10	3.548E-10	3.548E-10	3.548E-10	3.548E-10	3.551E-10	3.549E-10	3.549E-10	3.549E-10	3.548E-10	3.548E-10	3.547E-10	3.547E-10
fr	6.986E-16	4.392E-13	4.392E-13	4.392E-13	4.392E-13	4.392E-13	4.392E-13	4.392E-13	4.392E-13	4.392E-13	4.392E-13	4.393E-13	4.393E-13	4.393E-13	4.396E-13	4.397E-13	4.398E-13	4.399E-13
ra	3.533E-08	6.747E-06	6.747E-06	6.747E-06	6.747E-06	6.747E-06	6.747E-06	6.747E-06	6.747E-06	6.747E-06	6.747E-06	6.747E-06	6.747E-06	6.747E-06	6.747E-06	6.748E-06	6.748E-06	6.748E-06
ac	5.191E-09	7.170E-07	7.170E-07	7.170E-07	7.170E-07	7.170E-07	7.170E-07	7.170E-07	7.170E-07	7.170E-07	7.170E-07	7.170E-07	7.170E-07	7.170E-07	7.171E-07	7.172E-07	7.174E-07	7.175E-07
th	2.133E-03	2.484E-01	2.484E-01	2.484E-01	2.484E-01	2.484E-01	2.484E-01	2.484E-01	2.484E-01	2.484E-01	2.484E-01	2.484E-01	2.484E-01	2.484E-01	2.484E-01	2.484E-01	2.484E-01	2.484E-01
pa	3.415E-04	5.130E-02	5.130E-02	5.130E-02	5.130E-02	5.130E-02	5.130E-02	5.130E-02	5.130E-02	5.130E-02	5.130E-02	5.130E-02	5.130E-02	5.130E-02	5.131E-02	5.131E-02	5.131E-02	5.131E-02
u	9.649E+05	8.925E+07	8.925E+07	8.925E+07	8.925E+07	8.925E+07	8.925E+07	8.925E+07	8.925E+07	8.925E+07	8.925E+07	8.925E+07	8.925E+07	8.925E+07	8.925E+07	8.925E+07	8.925E+07	8.924E+07
np	2.870E+02	4.931E+04	4.931E+04	4.931E+04	4.931E+04	4.931E+04	4.931E+04	4.931E+04	4.931E+04	4.931E+04	4.931E+04	4.927E+04	4.924E+04	4.921E+04	4.908E+04	4.895E+04	4.882E+04	4.870E+04
pu	7.185E+03	8.213E+05	8.213E+05	8.213E+05	8.213E+05	8.213E+05	8.213E+05	8.213E+05	8.213E+05	8.213E+05	8.213E+05	8.214E+05	8.214E+05	8.215E+05	8.216E+05	8.217E+05	8.219E+05	8.220E+05
am	6.734E+01	1.728E+04	1.728E+04	1.728E+04	1.728E+04	1.728E+04	1.728E+04	1.728E+04	1.728E+04	1.728E+04	1.728E+04	1.728E+04	1.728E+04	1.728E+04	1.728E+04	1.728E+04	1.728E+04	1.728E+04
cm	1.137E+01	5.389E+03	5.389E+03	5.389E+03	5.389E+03	5.389E+03	5.389E+03	5.389E+03	5.389E+03	5.389E+03	5.389E+03	5.389E+03	5.390E+03	5.390E+03	5.391E+03	5.392E+03	5.392E+03	5.393E+03
bk	1.175E-08	8.000E-05	8.000E-05	8.000E-05	8.000E-05	8.000E-05	8.000E-05	8.000E-05	8.000E-05	8.000E-05	8.001E-05	8.001E-05	8.001E-05	8.001E-05	7.999E-05	7.997E-05	7.995E-05	7.993E-05
cf	7.074E-09	5.351E-05	5.351E-05	5.351E-05	5.351E-05	5.351E-05	5.351E-05	5.351E-05	5.351E-05	5.351E-05	5.352E-05	5.353E-05	5.354E-05	5.355E-05	5.358E-05	5.361E-05	5.363E-05	5.365E-05
es	2.726E-13	9.931E-09	9.931E-09	9.931E-09	9.931E-09	9.931E-09	9.931E-09	9.931E-09	9.931E-09	9.932E-09	9.932E-09	9.935E-09	9.937E-09	9.939E-09	9.947E-09	9.954E-09	9.962E-09	9.969E-09
totals	9.724E+05	9.014E+07	9.014E+07	9.014E+07	9.014E+07	9.014E+07	9.014E+07	9.014E+07	9.014E+07	9.014E+07	9.014E+07	9.014E+07	9.014E+07	9.014E+07	9.014E+07	9.014E+07	9.014E+07	9.014E+07

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Fukushima Daiichi 4
actinides page 74
decay, following irradiation identified by: power= 25.00mw, burnup= 39500.mwd, flux= 4.05E+13n/cm**2-sec

element radioactivity, curies
basis = full core inventory 548 assemblies (94t

	charge	discharge	2E-03 h	3E-03 h	5E-03 h	8E-03 h	2E-02 h	3E-02 h	7E-02 h	0.2 h	0.3 h	1.0 h	1.5 h	2.0 h	4.0 h	6.0 h	8.0 h	10.0 h
tl	3.786E-04	1.073E-01	1.073E-01	1.073E-01	1.073E-01	1.073E-01	1.073E-01	1.073E-01	1.073E-01	1.073E-01	1.073E-01	1.110E-01	1.074E-01	1.074E-01	1.088E-01	1.088E-01	1.088E-01	1.088E-01
pb	1.053E-03	2.986E-01	2.986E-01	2.986E-01	2.986E-01	2.986E-01	2.986E-01	2.986E-01	2.986E-01	2.986E-01	2.986E-01	2.986E-01	2.986E-01	2.986E-01	2.986E-01	2.985E-01	2.985E-01	2.985E-01
bi	1.053E-03	2.986E-01	2.986E-01	2.986E-01	2.986E-01	2.986E-01	2.986E-01	2.986E-01	2.986E-01	2.986E-01	2.986E-01	2.987E-01	2.987E-01	2.987E-01	2.987E-01	2.987E-01	2.987E-01	2.987E-01
po	1.727E-03	4.898E-01	4.906E-01	4.906E-01	4.906E-01	4.905E-01	4.904E-01	4.902E-01	4.900E-01	4.898E-01	4.901E-01	4.899E-01	4.899E-01	4.899E-01	4.899E-01	4.899E-01	4.898E-01	4.898E-01
at	9.808E-08	7.309E-05	7.310E-05	7.310E-05	7.310E-05	7.310E-05	7.310E-05	7.310E-05	7.310E-05	7.309E-05	7.309E-05	7.310E-05	7.311E-05	7.311E-05	7.316E-05	7.317E-05	7.319E-05	7.321E-05
rn	1.053E-03	2.986E-01	2.986E-01	2.986E-01	2.986E-01	2.986E-01	2.986E-01	2.986E-01	2.986E-01	2.986E-01	2.988E-01	2.986E-01	2.986E-01	2.986E-01	2.985E-01	2.985E-01	2.985E-01	2.984E-01
fr	1.033E-07	7.380E-05	7.380E-05	7.380E-05	7.380E-05	7.380E-05	7.380E-05	7.380E-05	7.380E-05	7.380E-05	7.381E-05	7.381E-05	7.382E-05	7.382E-05	7.387E-05	7.389E-05	7.391E-05	7.392E-05
ra	1.053E-03	2.986E-01	2.986E-01	2.986E-01	2.986E-01	2.986E-01	2.986E-01	2.986E-01	2.986E-01	2.986E-01	2.986E-01	2.986E-01	2.986E-01	2.986E-01	2.986E-01	2.985E-01	2.985E-01	2.985E-01

ac 4.736E-07 2.091E-03 2.090E-03 2.090E-03 2.089E-03 2.089E-03 2.087E-03 2.083E-03 2.076E-03
2.053E-03 2.019E-03 1.881E-03 1.785E-03 1.694E-03 1.377E-03 1.125E-03 9.228E-04 7.619E-04
th 3.482E-01 1.139E+02 1.139E+02 1.139E+02 1.139E+02 1.139E+02 1.138E+02 1.137E+02 1.135E+02
1.130E+02 1.123E+02 1.100E+02 1.088E+02 1.077E+02 1.036E+02 9.977E+01 9.615E+01 9.272E+01
pa 5.183E-01 1.173E+02 1.173E+02 1.172E+02 1.172E+02 1.172E+02 1.171E+02 1.170E+02 1.169E+02
1.168E+02 1.166E+02 1.157E+02 1.151E+02 1.145E+02 1.122E+02 1.099E+02 1.078E+02 1.057E+02
u 6.271E+03 1.394E+09 1.390E+09 1.386E+09 1.382E+09 1.375E+09 1.354E+09 1.318E+09 1.244E+09
1.046E+09 8.009E+08 2.820E+08 1.481E+08 9.286E+07 5.483E+07 5.329E+07 5.281E+07 5.236E+07
np 6.598E+01 1.367E+09 1.367E+09 1.367E+09 1.367E+09 1.367E+09 1.367E+09 1.367E+09 1.367E+09
1.366E+09 1.365E+09 1.357E+09 1.349E+09 1.341E+09 1.309E+09 1.277E+09 1.246E+09 1.216E+09
pu 8.515E+04 4.181E+07 4.180E+07 4.180E+07 4.179E+07 4.177E+07 4.174E+07 4.167E+07 4.153E+07
4.109E+07 4.044E+07 3.784E+07 3.605E+07 3.438E+07 2.876E+07 2.452E+07 2.131E+07 1.888E+07
am 1.278E+02 1.730E+07 1.730E+07 1.730E+07 1.730E+07 1.729E+07 1.729E+07 1.727E+07 1.724E+07
1.713E+07 1.698E+07 1.634E+07 1.587E+07 1.543E+07 1.376E+07 1.229E+07 1.098E+07 9.811E+06
cm 1.713E+04 5.099E+06 5.099E+06 5.099E+06 5.099E+06 5.099E+06 5.099E+06 5.099E+06 5.099E+06
5.099E+06 5.099E+06 5.099E+06 5.099E+06 5.099E+06 5.099E+06 5.099E+06 5.099E+06 5.099E+06
bk 1.926E-05 4.464E-01 4.462E-01 4.461E-01 4.460E-01 4.458E-01 4.452E-01 4.441E-01 4.418E-01
4.350E-01 4.247E-01 3.853E-01 3.593E-01 3.360E-01 2.642E-01 2.176E-01 1.873E-01 1.676E-01
cf 5.202E-07 6.670E-03 6.670E-03 6.670E-03 6.670E-03 6.670E-03 6.670E-03 6.670E-03 6.670E-03
6.670E-03 6.670E-03 6.671E-03 6.672E-03 6.672E-03 6.673E-03 6.673E-03 6.673E-03 6.672E-03
es 5.816E-09 2.051E-04 2.051E-04 2.051E-04 2.051E-04 2.051E-04 2.051E-04 2.051E-04 2.051E-04
2.051E-04 2.052E-04 2.052E-04 2.053E-04 2.053E-04 2.055E-04 2.057E-04 2.059E-04 2.061E-04
totals 1.087E+05 2.825E+09 2.821E+09 2.817E+09 2.813E+09 2.806E+09 2.785E+09 2.749E+09 2.675E+09
2.475E+09 2.229E+09 1.698E+09 1.555E+09 1.489E+09 1.411E+09 1.372E+09 1.336E+09 1.302E+09

Fukushima Daiichi 4
actinides page 75
decay, following irradiation identified by: power= 25.00mw, burnup= 39500.mwd, flux=
4.05E+13n/cm**2-sec

element thermal power, watts
basis = full core inventory 548 assemblies (94t
charge discharge 2E-03 h 3E-03 h 5E-03 h 8E-03 h 2E-02 h 3E-02 h 7E-02 h
0.2 h 0.3 h 1.0 h 1.5 h 2.0 h 4.0 h 6.0 h 8.0 h 10.0 h
tl 8.848E-06 2.509E-03 2.509E-03 2.509E-03 2.509E-03 2.509E-03 2.509E-03 2.509E-03 2.509E-03
2.509E-03 2.510E-03 2.594E-03 2.510E-03 2.510E-03 2.544E-03 2.544E-03 2.544E-03 2.544E-03
pb 1.991E-06 5.647E-04 5.647E-04 5.647E-04 5.647E-04 5.647E-04 5.647E-04 5.647E-04 5.647E-04
5.647E-04 5.647E-04 5.647E-04 5.647E-04 5.647E-04 5.646E-04 5.646E-04 5.645E-04 5.645E-04
bi 1.764E-05 5.001E-03 5.001E-03 5.001E-03 5.001E-03 5.001E-03 5.001E-03 5.001E-03 5.001E-03
5.001E-03 5.001E-03 5.002E-03 5.003E-03 5.003E-03 5.003E-03 5.003E-03 5.002E-03 5.002E-03
po 7.888E-05 2.237E-02 2.240E-02 2.240E-02 2.240E-02 2.240E-02 2.239E-02 2.239E-02 2.238E-02
2.237E-02 2.239E-02 2.238E-02 2.238E-02 2.238E-02 2.238E-02 2.237E-02 2.237E-02 2.237E-02
at 4.185E-09 3.119E-06 3.119E-06 3.119E-06 3.119E-06 3.119E-06 3.119E-06 3.119E-06 3.119E-06
3.119E-06 3.119E-06 3.119E-06 3.120E-06 3.120E-06 3.122E-06 3.123E-06 3.123E-06 3.124E-06
rn 3.997E-05 1.134E-02 1.134E-02 1.134E-02 1.134E-02 1.134E-02 1.134E-02 1.134E-02 1.134E-02
1.134E-02 1.135E-02 1.134E-02 1.134E-02 1.134E-02 1.133E-02 1.133E-02 1.133E-02 1.133E-02
fr 3.799E-09 2.823E-06 2.823E-06 2.823E-06 2.823E-06 2.823E-06 2.823E-06 2.823E-06 2.823E-06
2.823E-06 2.823E-06 2.823E-06 2.824E-06 2.824E-06 2.826E-06 2.826E-06 2.827E-06 2.828E-06
ra 3.613E-05 1.025E-02 1.025E-02 1.025E-02 1.025E-02 1.025E-02 1.025E-02 1.025E-02 1.025E-02
1.025E-02 1.025E-02 1.025E-02 1.025E-02 1.025E-02 1.024E-02 1.024E-02 1.024E-02 1.024E-02
ac 3.606E-09 1.791E-05 1.791E-05 1.791E-05 1.790E-05 1.790E-05 1.788E-05 1.785E-05 1.780E-05
1.762E-05 1.735E-05 1.628E-05 1.553E-05 1.482E-05 1.235E-05 1.038E-05 8.804E-06 7.549E-06
th 1.991E-04 1.169E-01 1.169E-01 1.169E-01 1.169E-01 1.168E-01 1.167E-01 1.165E-01 1.161E-01
1.150E-01 1.136E-01 1.100E-01 1.083E-01 1.070E-01 1.025E-01 9.828E-02 9.433E-02 9.059E-02
pa 2.074E-03 5.969E-01 5.968E-01 5.967E-01 5.966E-01 5.964E-01 5.960E-01 5.955E-01 5.949E-01
5.939E-01 5.925E-01 5.869E-01 5.828E-01 5.787E-01 5.629E-01 5.479E-01 5.337E-01 5.201E-01
u 1.219E+01 3.741E+06 3.730E+06 3.719E+06 3.709E+06 3.688E+06 3.633E+06 3.534E+06 3.334E+06
2.795E+06 2.131E+06 7.231E+05 3.598E+05 2.099E+05 1.070E+05 1.032E+05 1.022E+05 1.014E+05
np 1.726E-01 3.537E+06 3.537E+06 3.537E+06 3.537E+06 3.537E+06 3.537E+06 3.537E+06 3.536E+06
3.534E+06 3.530E+06 3.505E+06 3.483E+06 3.461E+06 3.374E+06 3.292E+06 3.211E+06 3.133E+06
pu 6.249E+01 4.719E+04 4.718E+04 4.717E+04 4.717E+04 4.715E+04 4.711E+04 4.703E+04 4.686E+04
4.637E+04 4.561E+04 4.262E+04 4.056E+04 3.864E+04 3.218E+04 2.729E+04 2.360E+04 2.081E+04
am 3.919E+00 7.466E+04 7.465E+04 7.464E+04 7.464E+04 7.462E+04 7.458E+04 7.450E+04 7.434E+04
7.384E+04 7.307E+04 6.996E+04 6.772E+04 6.555E+04 5.758E+04 5.060E+04 4.449E+04 3.914E+04
cm 6.243E+02 1.856E+05 1.856E+05 1.856E+05 1.856E+05 1.856E+05 1.856E+05 1.856E+05 1.856E+05
1.856E+05 1.856E+05 1.856E+05 1.856E+05 1.856E+05 1.856E+05 1.856E+05 1.856E+05 1.856E+05
bk 3.765E-09 2.246E-03 2.245E-03 2.245E-03 2.244E-03 2.242E-03 2.238E-03 2.230E-03 2.214E-03
2.166E-03 2.094E-03 1.816E-03 1.633E-03 1.469E-03 9.634E-04 6.351E-04 4.217E-04 2.830E-04
cf 2.704E-08 3.808E-04 3.808E-04 3.808E-04 3.808E-04 3.808E-04 3.808E-04 3.808E-04 3.808E-04
3.809E-04 3.809E-04 3.809E-04 3.809E-04 3.809E-04 3.810E-04 3.810E-04 3.810E-04 3.810E-04
es 2.322E-10 8.189E-06 8.189E-06 8.189E-06 8.189E-06 8.189E-06 8.189E-06 8.189E-06 8.189E-06
8.190E-06 8.190E-06 8.193E-06 8.195E-06 8.197E-06 8.205E-06 8.214E-06 8.222E-06 8.230E-06
totals 7.031E+02 7.585E+06 7.574E+06 7.564E+06 7.553E+06 7.532E+06 7.477E+06 7.378E+06 7.177E+06
6.635E+06 5.965E+06 4.526E+06 4.137E+06 3.961E+06 3.757E+06 3.658E+06 3.567E+06 3.480E+06

Fukushima Daiichi 4 fission
products page 76
decay, following irradiation identified by: power= 25.00mw, burnup= 39500.mwd, flux=
4.05E+13n/cm**2-sec

element concentrations, grams
basis = full core inventory 548 assemblies (94t

	charge	discharge	2E-03 h	3E-03 h	5E-03 h	8E-03 h	2E-02 h	3E-02 h	7E-02 h	0.2 h	0.3 h	1.0 h	1.5 h	2.0 h	4.0 h	6.0 h	8.0 h	10.0 h
h	4.918E-02	7.516E+00	7.516E+00	7.516E+00	7.516E+00	7.516E+00	7.516E+00	7.516E+00	7.516E+00	7.516E+00	7.516E+00	7.516E+00	7.516E+00	7.516E+00	7.516E+00	7.515E+00	7.515E+00	7.515E+00
he	9.221E-01	1.308E+02	1.308E+02	1.308E+02	1.308E+02	1.308E+02	1.308E+02	1.308E+02	1.308E+02	1.308E+02	1.308E+02	1.308E+02	1.308E+02	1.308E+02	1.308E+02	1.308E+02	1.308E+02	1.308E+02
li	1.169E-02	1.089E+00	1.089E+00	1.089E+00	1.089E+00	1.089E+00	1.089E+00	1.089E+00	1.089E+00	1.089E+00	1.089E+00	1.089E+00	1.089E+00	1.089E+00	1.089E+00	1.089E+00	1.089E+00	1.089E+00
be	7.985E-03	1.142E+00	1.142E+00	1.142E+00	1.142E+00	1.142E+00	1.142E+00	1.142E+00	1.142E+00	1.142E+00	1.142E+00	1.142E+00	1.142E+00	1.142E+00	1.142E+00	1.142E+00	1.142E+00	1.142E+00
b	5.155E-04	7.494E-02	7.494E-02	7.494E-02	7.494E-02	7.494E-02	7.494E-02	7.494E-02	7.494E-02	7.494E-02	7.494E-02	7.494E-02	7.494E-02	7.494E-02	7.494E-02	7.494E-02	7.494E-02	7.494E-02
c	2.331E-03	3.546E-01	3.546E-01	3.546E-01	3.546E-01	3.546E-01	3.546E-01	3.546E-01	3.546E-01	3.546E-01	3.546E-01	3.546E-01	3.546E-01	3.546E-01	3.546E-01	3.546E-01	3.546E-01	3.546E-01
n	2.889E-04	3.511E-02	3.511E-02	3.511E-02	3.511E-02	3.511E-02	3.511E-02	3.511E-02	3.511E-02	3.511E-02	3.511E-02	3.511E-02	3.511E-02	3.511E-02	3.511E-02	3.511E-02	3.511E-02	3.511E-02
ne	3.983E-03	4.834E-01	4.834E-01	4.834E-01	4.834E-01	4.834E-01	4.834E-01	4.834E-01	4.834E-01	4.834E-01	4.834E-01	4.834E-01	4.834E-01	4.834E-01	4.834E-01	4.834E-01	4.834E-01	4.834E-01
co	0.000E+00	1.473E-10	4.060E-15	3.378E-19	1.562E-23	6.012E-32	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ni	2.920E-13	1.008E-05	1.007E-05	1.006E-05	1.006E-05	1.006E-05	1.005E-05	1.005E-05	1.005E-05	1.003E-05	1.001E-05	9.928E-06	9.865E-06	9.803E-06	9.557E-06	9.317E-06	9.084E-06	8.856E-06
cu	7.123E-12	5.491E-05	5.484E-05	5.481E-05	5.478E-05	5.475E-05	5.470E-05	5.465E-05	5.458E-05	5.448E-05	5.437E-05	5.396E-05	5.366E-05	5.336E-05	5.217E-05	5.102E-05	4.989E-05	4.878E-05
zn	1.209E-03	1.902E-01	1.902E-01	1.902E-01	1.902E-01	1.902E-01	1.902E-01	1.902E-01	1.902E-01	1.902E-01	1.902E-01	1.902E-01	1.902E-01	1.902E-01	1.901E-01	1.901E-01	1.900E-01	1.900E-01
ga	1.922E-03	3.078E-01	3.078E-01	3.078E-01	3.078E-01	3.078E-01	3.078E-01	3.078E-01	3.078E-01	3.078E-01	3.077E-01	3.077E-01	3.077E-01	3.077E-01	3.076E-01	3.075E-01	3.075E-01	3.075E-01
ge	3.066E-01	4.240E+01	4.240E+01	4.240E+01	4.240E+01	4.240E+01	4.240E+01	4.240E+01	4.240E+01	4.240E+01	4.240E+01	4.240E+01	4.240E+01	4.240E+01	4.239E+01	4.239E+01	4.239E+01	4.239E+01
as	9.313E-02	1.299E+01	1.299E+01	1.299E+01	1.299E+01	1.298E+01	1.298E+01	1.298E+01	1.298E+01	1.298E+01	1.298E+01	1.298E+01	1.298E+01	1.298E+01	1.297E+01	1.296E+01	1.296E+01	1.296E+01
se	4.487E+01	6.048E+03	6.048E+03	6.048E+03	6.048E+03	6.048E+03	6.048E+03	6.048E+03	6.048E+03	6.048E+03	6.048E+03	6.048E+03	6.048E+03	6.048E+03	6.048E+03	6.048E+03	6.048E+03	6.048E+03
br	1.754E+01	2.363E+03	2.363E+03	2.363E+03	2.363E+03	2.363E+03	2.363E+03	2.363E+03	2.363E+03	2.363E+03	2.363E+03	2.363E+03	2.363E+03	2.363E+03	2.363E+03	2.363E+03	2.363E+03	2.363E+03
kr	3.151E+02	4.126E+04	4.126E+04	4.126E+04	4.126E+04	4.126E+04	4.126E+04	4.126E+04	4.126E+04	4.126E+04	4.126E+04	4.125E+04	4.125E+04	4.125E+04	4.125E+04	4.125E+04	4.125E+04	4.125E+04
rb	2.995E+02	3.917E+04	3.917E+04	3.917E+04	3.917E+04	3.917E+04	3.917E+04	3.917E+04	3.917E+04	3.917E+04	3.917E+04	3.917E+04	3.917E+04	3.917E+04	3.917E+04	3.917E+04	3.917E+04	3.917E+04
sr	7.807E+02	1.003E+05	1.003E+05	1.003E+05	1.003E+05	1.003E+05	1.003E+05	1.003E+05	1.003E+05	1.003E+05	1.003E+05	1.003E+05	1.003E+05	1.003E+05	1.003E+05	1.003E+05	1.003E+05	1.003E+05
y	4.069E+02	5.269E+04	5.269E+04	5.269E+04	5.269E+04	5.269E+04	5.269E+04	5.269E+04	5.269E+04	5.269E+04	5.269E+04	5.269E+04	5.269E+04	5.269E+04	5.269E+04	5.268E+04	5.268E+04	5.268E+04
zr	3.013E+03	4.046E+05	4.046E+05	4.046E+05	4.046E+05	4.046E+05	4.046E+05	4.046E+05	4.046E+05	4.046E+05	4.046E+05	4.046E+05	4.046E+05	4.046E+05	4.046E+05	4.046E+05	4.046E+05	4.046E+05
nb	2.614E+01	2.607E+03	2.607E+03	2.607E+03	2.607E+03	2.607E+03	2.607E+03	2.607E+03	2.607E+03	2.607E+03	2.607E+03	2.607E+03	2.607E+03	2.607E+03	2.607E+03	2.607E+03	2.606E+03	2.606E+03
mo	2.677E+03	3.724E+05	3.724E+05	3.724E+05	3.724E+05	3.724E+05	3.724E+05	3.724E+05	3.724E+05	3.724E+05	3.724E+05	3.724E+05	3.724E+05	3.724E+05	3.724E+05	3.724E+05	3.724E+05	3.724E+05
tc	6.631E+02	8.869E+04	8.869E+04	8.869E+04	8.869E+04	8.869E+04	8.869E+04	8.869E+04	8.869E+04	8.869E+04	8.869E+04	8.869E+04	8.869E+04	8.869E+04	8.870E+04	8.870E+04	8.871E+04	8.871E+04
ru	1.779E+03	2.664E+05	2.664E+05	2.664E+05	2.664E+05	2.664E+05	2.664E+05	2.664E+05	2.664E+05	2.664E+05	2.664E+05	2.664E+05	2.664E+05	2.664E+05	2.664E+05	2.664E+05	2.664E+05	2.664E+05
rh	3.785E+02	4.758E+04	4.758E+04	4.758E+04	4.758E+04	4.758E+04	4.758E+04	4.758E+04	4.758E+04	4.758E+04	4.758E+04	4.758E+04	4.758E+04	4.758E+04	4.759E+04	4.759E+04	4.759E+04	4.760E+04
pd	7.614E+02	1.407E+05	1.407E+05	1.407E+05	1.407E+05	1.407E+05	1.407E+05	1.407E+05	1.407E+05	1.407E+05	1.407E+05	1.407E+05	1.407E+05	1.407E+05	1.407E+05	1.407E+05	1.407E+05	1.407E+05
ag	4.825E+01	8.373E+03	8.373E+03	8.373E+03	8.373E+03	8.373E+03	8.373E+03	8.373E+03	8.373E+03	8.373E+03	8.373E+03	8.374E+03	8.374E+03	8.374E+03	8.375E+03	8.375E+03	8.376E+03	8.376E+03
cd	4.303E+01	8.891E+03	8.891E+03	8.891E+03	8.891E+03	8.891E+03	8.891E+03	8.891E+03	8.891E+03	8.891E+03	8.891E+03	8.891E+03	8.891E+03	8.891E+03	8.892E+03	8.892E+03	8.892E+03	8.893E+03
in	1.487E+00	1.690E+02	1.690E+02	1.690E+02	1.690E+02	1.690E+02	1.690E+02	1.690E+02	1.690E+02	1.690E+02	1.690E+02	1.690E+02	1.690E+02	1.690E+02	1.690E+02	1.690E+02	1.690E+02	1.691E+02
sn	3.505E+01	5.453E+03	5.453E+03	5.453E+03	5.453E+03	5.453E+03	5.453E+03	5.453E+03	5.453E+03	5.453E+03	5.453E+03	5.453E+03	5.453E+03	5.453E+03	5.453E+03	5.453E+03	5.452E+03	5.452E+03
sb	1.139E+01	1.656E+03	1.656E+03	1.656E+03	1.656E+03	1.656E+03	1.656E+03	1.656E+03	1.656E+03	1.656E+03	1.655E+03	1.655E+03	1.654E+03	1.654E+03	1.653E+03	1.652E+03	1.651E+03	1.651E+03
te	3.647E+02	5.280E+04	5.280E+04	5.280E+04	5.280E+04	5.280E+04	5.280E+04	5.280E+04	5.280E+04	5.280E+04	5.279E+04	5.279E+04	5.279E+04	5.279E+04	5.278E+04	5.277E+04	5.277E+04	5.276E+04
i	1.463E+02	2.231E+04	2.231E+04	2.231E+04	2.231E+04	2.231E+04	2.231E+04	2.231E+04	2.231E+04	2.231E+04	2.231E+04	2.230E+04	2.230E+04	2.229E+04	2.228E+04	2.226E+04	2.225E+04	2.224E+04
xe	4.203E+03	5.986E+05	5.986E+05	5.986E+05	5.986E+05	5.986E+05	5.986E+05	5.986E+05	5.986E+05	5.986E+05	5.986E+05	5.987E+05	5.987E+05	5.987E+05	5.987E+05	5.987E+05	5.987E+05	5.987E+05
cs	2.350E+03	3.205E+05	3.205E+05	3.205E+05	3.205E+05	3.205E+05	3.205E+05	3.205E+05	3.205E+05	3.205E+05	3.205E+05	3.205E+05	3.205E+05	3.205E+05	3.205E+05	3.206E+05	3.206E+05	3.206E+05

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     ba      1.138E+03 1.652E+05 1.652E+05 1.652E+05 1.652E+05 1.652E+05 1.652E+05 1.652E+05 1.652E+05
1.652E+05 1.652E+05 1.652E+05 1.652E+05 1.652E+05 1.652E+05 1.652E+05 1.652E+05 1.652E+05
     la      9.997E+02 1.380E+05 1.380E+05 1.380E+05 1.380E+05 1.380E+05 1.380E+05 1.380E+05 1.380E+05
1.380E+05 1.380E+05 1.380E+05 1.380E+05 1.380E+05 1.380E+05 1.380E+05 1.380E+05 1.380E+05
     ce      2.220E+03 2.980E+05 2.980E+05 2.980E+05 2.980E+05 2.980E+05 2.980E+05 2.980E+05 2.980E+05
2.980E+05 2.980E+05 2.980E+05 2.980E+05 2.980E+05 2.980E+05 2.980E+05 2.980E+05 2.980E+05
     pr      9.066E+02 1.242E+05 1.242E+05 1.242E+05 1.242E+05 1.242E+05 1.242E+05 1.242E+05 1.242E+05
1.242E+05 1.242E+05 1.242E+05 1.242E+05 1.242E+05 1.242E+05 1.242E+05 1.242E+05 1.242E+05
     nd      3.064E+03 4.307E+05 4.307E+05 4.307E+05 4.307E+05 4.307E+05 4.307E+05 4.307E+05 4.307E+05
4.307E+05 4.307E+05 4.307E+05 4.307E+05 4.307E+05 4.307E+05 4.307E+05 4.308E+05 4.308E+05
     pm      1.731E+02 1.722E+04 1.722E+04 1.722E+04 1.722E+04 1.722E+04 1.722E+04 1.722E+04 1.722E+04
1.722E+04 1.722E+04 1.722E+04 1.722E+04 1.722E+04 1.722E+04 1.722E+04 1.721E+04 1.721E+04
     sm      5.339E+02 7.853E+04 7.853E+04 7.853E+04 7.853E+04 7.853E+04 7.853E+04 7.853E+04 7.853E+04
7.853E+04 7.853E+04 7.854E+04 7.854E+04 7.854E+04 7.854E+04 7.854E+04 7.855E+04 7.855E+04
     eu      9.383E+01 1.603E+04 1.603E+04 1.603E+04 1.603E+04 1.603E+04 1.603E+04 1.603E+04 1.603E+04
1.603E+04 1.603E+04 1.603E+04 1.603E+04 1.603E+04 1.603E+04 1.603E+04 1.604E+04 1.604E+04
     gd      4.894E+01 1.164E+04 1.164E+04 1.164E+04 1.164E+04 1.164E+04 1.164E+04 1.164E+04 1.164E+04
1.164E+04 1.165E+04 1.165E+04 1.165E+04 1.165E+04 1.165E+04 1.165E+04 1.165E+04 1.165E+04
     tb      1.324E+00 2.464E+02 2.464E+02 2.464E+02 2.464E+02 2.464E+02 2.464E+02 2.464E+02 2.464E+02
2.464E+02 2.464E+02 2.464E+02 2.464E+02 2.464E+02 2.464E+02 2.465E+02 2.465E+02 2.465E+02
     dy      5.366E-01 1.075E+02 1.075E+02 1.075E+02 1.075E+02 1.075E+02 1.075E+02 1.075E+02 1.075E+02
1.075E+02 1.075E+02 1.075E+02 1.076E+02 1.076E+02 1.076E+02 1.076E+02 1.076E+02 1.076E+02
     ho      2.567E-02 7.678E+00 7.678E+00 7.678E+00 7.678E+00 7.678E+00 7.678E+00 7.678E+00 7.678E+00
7.678E+00 7.678E+00 7.679E+00 7.679E+00 7.679E+00 7.679E+00 7.679E+00 7.679E+00 7.679E+00
     er      9.237E-03 2.551E+00 2.551E+00 2.551E+00 2.551E+00 2.551E+00 2.551E+00 2.551E+00 2.551E+00
2.551E+00 2.551E+00 2.551E+00 2.551E+00 2.551E+00 2.552E+00 2.552E+00 2.552E+00 2.553E+00
     tm      2.945E-04 4.376E-02 4.376E-02 4.376E-02 4.376E-02 4.376E-02 4.376E-02 4.376E-02 4.376E-02
4.376E-02 4.376E-02 4.376E-02 4.376E-02 4.376E-02 4.377E-02 4.377E-02 4.377E-02 4.377E-02
     yb      2.447E-04 4.435E-02 4.435E-02 4.435E-02 4.435E-02 4.435E-02 4.435E-02 4.435E-02 4.435E-02
4.435E-02 4.435E-02 4.435E-02 4.435E-02 4.435E-02 4.436E-02 4.436E-02 4.437E-02 4.437E-02
     lu      4.026E-17 1.141E-12 1.141E-12 1.141E-12 1.141E-12 1.141E-12 1.141E-12 1.141E-12 1.140E-12
1.140E-12 1.139E-12 1.136E-12 1.134E-12 1.131E-12 1.122E-12 1.112E-12 1.103E-12 1.093E-12
  totals     2.755E+04 3.864E+06 3.864E+06 3.864E+06 3.864E+06 3.864E+06 3.864E+06 3.864E+06 3.864E+06
3.864E+06 3.864E+06 3.864E+06 3.864E+06 3.864E+06 3.864E+06 3.864E+06 3.864E+06 3.864E+06
□
     Fukushima Daiichi 4                                                                   fission
products          page   77
decay, following irradiation identified by: power=  25.00mw, burnup=  39500.mwd, flux=
4.05E+13n/cm**2-sec

                                                  element radioactivity, curies
                                                 basis = full core inventory 548 assemblies (94t
                   charge  discharge   2E-03 h   3E-03 h   5E-03 h   8E-03 h   2E-02 h   3E-02 h   7E-02 h
0.2 h      0.3 h     1.0 h     1.5 h     2.0 h     4.0 h     6.0 h     8.0 h    10.0 h
      h      4.226E+02 6.404E+04 6.404E+04 6.404E+04 6.404E+04 6.404E+04 6.404E+04 6.404E+04 6.404E+04
6.404E+04 6.404E+04 6.404E+04 6.404E+04 6.404E+04 6.404E+04 6.404E+04 6.404E+04 6.404E+04
     he      0.000E+00 5.649E+04 2.812E+02 1.993E+00 1.037E-02 3.825E-07 7.855E-19 0.000E+00 0.000E+00
0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
     li      0.000E+00 3.856E+03 2.142E+01 1.827E-01 1.157E-03 6.246E-08 3.505E-19 0.000E+00 0.000E+00
0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
     be      1.660E-04 4.752E+03 6.689E+02 4.851E+02 3.567E+02 1.965E+02 4.081E+01 2.288E+00 2.851E-02
2.364E-02 2.364E-02 2.364E-02 2.364E-02 2.364E-02 2.364E-02 2.364E-02 2.364E-02 2.364E-02
      c      9.526E-03 1.452E+02 2.687E+01 6.418E+00 2.318E+00 1.468E+00 1.437E+00 1.437E+00 1.437E+00
1.437E+00 1.437E+00 1.437E+00 1.437E+00 1.437E+00 1.437E+00 1.437E+00 1.437E+00 1.437E+00
     co      0.000E+00 8.486E+01 1.609E-03 1.339E-07 6.192E-12 2.383E-20 0.000E+00 0.000E+00 0.000E+00
0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
     ni      2.540E-07 8.276E+02 2.310E+02 1.336E+02 8.728E+01 4.684E+01 1.714E+01 9.652E+00 8.755E+00
8.729E+00 8.711E+00 8.637E+00 8.583E+00 8.529E+00 8.315E+00 8.106E+00 7.903E+00 7.705E+00
     cu      5.645E-06 7.333E+03 1.907E+03 1.262E+03 8.952E+02 5.663E+02 3.081E+02 1.781E+02 1.072E+02
6.165E+01 5.102E+01 4.948E+01 4.920E+01 4.892E+01 4.781E+01 4.672E+01 4.566E+01 4.463E+01
     zn      4.495E-06 1.279E+05 3.611E+04 2.245E+04 1.660E+04 1.151E+04 7.389E+03 5.047E+03 3.017E+03
1.684E+03 1.551E+03 1.485E+03 1.450E+03 1.422E+03 1.343E+03 1.289E+03 1.243E+03 1.201E+03
     ga      6.451E-06 8.981E+05 2.874E+05 1.737E+05 1.235E+05 8.223E+04 4.685E+04 2.843E+04 1.724E+04
9.001E+03 6.233E+03 4.410E+03 4.160E+03 3.966E+03 3.323E+03 2.836E+03 2.464E+03 2.178E+03
     ge      4.179E-06 1.002E+07 3.671E+06 2.720E+06 2.147E+06 1.544E+06 9.044E+05 5.367E+05 3.998E+05
3.697E+05 3.456E+05 2.625E+05 2.152E+05 1.777E+05 8.981E+04 5.321E+04 3.682E+04 2.852E+04
     as      1.362E-04 2.331E+07 1.250E+07 1.015E+07 8.450E+06 6.175E+06 3.226E+06 1.616E+06 1.059E+06
8.120E+05 6.245E+05 4.378E+05 4.042E+05 3.744E+05 2.653E+05 1.917E+05 1.496E+05 1.267E+05
     se      6.016E-02 5.991E+07 4.655E+07 4.069E+07 3.638E+07 3.078E+07 2.311E+07 1.723E+07 1.224E+07
6.852E+06 4.172E+06 1.202E+06 5.651E+05 2.963E+05 4.604E+04 1.057E+04 2.738E+03 9.084E+02
     br      4.412E-06 1.214E+08 9.601E+07 8.680E+07 8.038E+07 7.151E+07 5.648E+07 4.151E+07 2.850E+07
1.962E+07 1.596E+07 9.551E+06 7.052E+06 5.479E+06 2.677E+06 1.548E+06 9.447E+05 6.055E+05
     kr      8.464E+03 2.457E+08 2.005E+08 1.850E+08 1.740E+08 1.598E+08 1.398E+08 1.229E+08 1.075E+08
9.019E+07 8.181E+07 6.695E+07 5.834E+07 5.107E+07 3.113E+07 1.984E+07 1.306E+07 8.846E+06
     rb      1.865E+02 3.567E+08 2.634E+08 2.302E+08 2.129E+08 1.972E+08 1.760E+08 1.493E+08 1.177E+08
8.347E+07 6.387E+07 3.705E+07 3.044E+07 2.637E+07 1.609E+07 9.930E+06 6.147E+06 3.825E+06
     sr      4.516E+05 5.414E+08 4.302E+08 4.154E+08 4.022E+08 3.807E+08 3.419E+08 3.043E+08 2.696E+08
2.327E+08 2.094E+08 1.825E+08 1.730E+08 1.647E+08 1.388E+08 1.212E+08 1.087E+08 9.968E+07
      y      6.102E+05 7.969E+08 5.777E+08 5.363E+08 5.172E+08 5.023E+08 4.918E+08 4.818E+08 4.612E+08
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4.095E+08 3.578E+08 2.856E+08 2.713E+08 2.628E+08 2.360E+08 2.110E+08 1.889E+08 1.702E+08
    zr     7.444E+05 6.291E+08 3.947E+08 3.278E+08 2.969E+08 2.667E+08 2.336E+08 2.138E+08 2.068E+08
2.059E+08 2.052E+08 2.024E+08 2.003E+08 1.983E+08 1.906E+08 1.834E+08 1.769E+08 1.708E+08
    nb     1.036E+06 9.488E+08 6.984E+08 5.863E+08 5.175E+08 4.475E+08 3.818E+08 3.466E+08 3.265E+08
3.120E+08 3.081E+08 3.038E+08 3.005E+08 2.970E+08 2.830E+08 2.692E+08 2.563E+08 2.443E+08
    mo     3.497E+01 6.374E+08 5.921E+08 5.638E+08 5.403E+08 5.046E+08 4.401E+08 3.710E+08 3.061E+08
2.421E+08 1.913E+08 1.248E+08 1.171E+08 1.149E+08 1.121E+08 1.098E+08 1.075E+08 1.053E+08
    tc     4.521E+01 7.430E+08 7.096E+08 6.896E+08 6.723E+08 6.451E+08 5.946E+08 5.356E+08 4.603E+08
3.596E+08 2.771E+08 1.403E+08 1.148E+08 1.067E+08 1.025E+08 1.015E+08 1.003E+08 9.889E+07
    ru     7.912E+05 3.383E+08 3.276E+08 3.222E+08 3.177E+08 3.111E+08 2.996E+08 2.866E+08 2.689E+08
2.427E+08 2.304E+08 2.204E+08 2.152E+08 2.104E+08 1.945E+08 1.828E+08 1.742E+08 1.679E+08
    rh     7.904E+05 4.457E+08 4.345E+08 4.261E+08 4.184E+08 4.052E+08 3.787E+08 3.491E+08 3.214E+08
2.947E+08 2.778E+08 2.525E+08 2.458E+08 2.422E+08 2.351E+08 2.301E+08 2.257E+08 2.219E+08
    pd     2.223E-01 3.470E+07 3.398E+07 3.358E+07 3.327E+07 3.283E+07 3.209E+07 3.131E+07 3.040E+07
2.915E+07 2.807E+07 2.552E+07 2.448E+07 2.371E+07 2.137E+07 1.936E+07 1.755E+07 1.591E+07
    ag     1.731E+03 5.091E+07 4.826E+07 4.660E+07 4.522E+07 4.319E+07 4.015E+07 3.809E+07 3.690E+07
3.548E+07 3.423E+07 3.137E+07 3.022E+07 2.938E+07 2.684E+07 2.466E+07 2.270E+07 2.092E+07
    cd     1.247E+02 4.436E+06 3.099E+06 2.849E+06 2.687E+06 2.505E+06 2.276E+06 2.068E+06 1.860E+06
1.661E+06 1.557E+06 1.302E+06 1.168E+06 1.067E+06 8.330E+05 7.201E+05 6.537E+05 6.100E+05
    in     5.330E-02 1.067E+07 5.043E+06 4.393E+06 4.061E+06 3.724E+06 3.352E+06 3.085E+06 2.844E+06
2.525E+06 2.286E+06 1.827E+06 1.635E+06 1.497E+06 1.163E+06 9.635E+05 8.251E+05 7.276E+05
    sn     1.070E+03 9.054E+07 8.178E+07 7.730E+07 7.346E+07 6.736E+07 5.565E+07 4.245E+07 2.925E+07
1.742E+07 1.295E+07 8.376E+06 6.594E+06 5.300E+06 2.684E+06 1.782E+06 1.414E+06 1.240E+06
    sb     5.962E+03 2.375E+08 2.210E+08 2.171E+08 2.138E+08 2.085E+08 1.973E+08 1.801E+08 1.518E+08
1.070E+08 8.004E+07 4.428E+07 3.388E+07 2.806E+07 1.886E+07 1.516E+07 1.283E+07 1.117E+07
    te     4.000E+04 5.165E+08 4.924E+08 4.779E+08 4.663E+08 4.503E+08 4.297E+08 4.179E+08 4.071E+08
3.773E+08 3.373E+08 2.351E+08 1.945E+08 1.694E+08 1.318E+08 1.219E+08 1.167E+08 1.128E+08
     i     1.942E+04 7.690E+08 7.238E+08 7.020E+08 6.858E+08 6.639E+08 6.302E+08 6.002E+08 5.762E+08
5.582E+08 5.465E+08 5.017E+08 4.699E+08 4.420E+08 3.688E+08 3.311E+08 3.064E+08 2.870E+08
    xe     8.580E+03 5.769E+08 5.237E+08 5.037E+08 4.875E+08 4.631E+08 4.230E+08 3.833E+08 3.383E+08
2.730E+08 2.315E+08 1.932E+08 1.903E+08 1.906E+08 1.938E+08 1.945E+08 1.931E+08 1.904E+08
    cs     1.633E+05 5.161E+08 4.308E+08 4.113E+08 3.978E+08 3.758E+08 3.335E+08 2.902E+08 2.500E+08
2.032E+08 1.631E+08 8.709E+07 6.202E+07 4.819E+07 3.297E+07 3.134E+07 3.094E+07 3.074E+07
    ba     2.055E+05 6.204E+08 5.482E+08 5.112E+08 4.855E+08 4.557E+08 4.260E+08 4.115E+08 3.934E+08
3.487E+08 2.994E+08 2.101E+08 1.845E+08 1.686E+08 1.373E+08 1.256E+08 1.210E+08 1.189E+08
    la     1.442E+05 6.151E+08 5.699E+08 5.443E+08 5.243E+08 4.964E+08 4.519E+08 4.151E+08 3.918E+08
3.676E+08 3.407E+08 2.797E+08 2.546E+08 2.355E+08 1.856E+08 1.586E+08 1.428E+08 1.329E+08
    ce     1.298E+06 4.886E+08 4.679E+08 4.575E+08 4.501E+08 4.395E+08 4.183E+08 3.901E+08 3.563E+08
3.190E+08 3.005E+08 2.821E+08 2.793E+08 2.779E+08 2.740E+08 2.703E+08 2.667E+08 2.633E+08
    pr     9.773E+05 4.267E+08 4.157E+08 4.079E+08 4.021E+08 3.952E+08 3.858E+08 3.740E+08 3.543E+08
3.241E+08 3.037E+08 2.598E+08 2.450E+08 2.369E+08 2.222E+08 2.133E+08 2.063E+08 2.007E+08
    nd     3.254E+04 9.777E+07 9.672E+07 9.585E+07 9.501E+07 9.357E+07 9.074E+07 8.745E+07 8.353E+07
7.692E+07 7.026E+07 5.871E+07 5.505E+07 5.241E+07 4.601E+07 4.303E+07 4.158E+07 4.082E+07
    pm     1.740E+05 1.037E+08 1.030E+08 1.026E+08 1.022E+08 1.014E+08 9.981E+07 9.751E+07 9.415E+07
8.863E+07 8.428E+07 7.952E+07 7.885E+07 7.843E+07 7.689E+07 7.533E+07 7.379E+07 7.229E+07
    sm     3.173E+02 4.011E+07 4.008E+07 4.005E+07 4.002E+07 3.997E+07 3.984E+07 3.959E+07 3.911E+07
3.802E+07 3.700E+07 3.527E+07 3.470E+07 3.430E+07 3.306E+07 3.195E+07 3.089E+07 2.987E+07
    eu     1.931E+04 2.302E+07 2.301E+07 2.300E+07 2.299E+07 2.297E+07 2.292E+07 2.287E+07 2.280E+07
2.268E+07 2.252E+07 2.207E+07 2.188E+07 2.175E+07 2.143E+07 2.121E+07 2.102E+07 2.084E+07
    gd     1.182E+00 4.919E+05 4.912E+05 4.904E+05 4.895E+05 4.876E+05 4.819E+05 4.708E+05 4.500E+05
4.161E+05 3.990E+05 3.841E+05 3.770E+05 3.700E+05 3.434E+05 3.187E+05 2.958E+05 2.745E+05
    tb     2.197E+02 1.832E+05 1.831E+05 1.830E+05 1.829E+05 1.828E+05 1.823E+05 1.815E+05 1.796E+05
1.739E+05 1.654E+05 1.502E+05 1.483E+05 1.477E+05 1.468E+05 1.461E+05 1.454E+05 1.447E+05
    dy     1.314E-03 3.890E+04 3.805E+04 3.730E+04 3.654E+04 3.518E+04 3.220E+04 2.842E+04 2.444E+04
2.159E+04 2.041E+04 1.681E+04 1.459E+04 1.267E+04 7.303E+03 4.334E+03 2.690E+03 1.778E+03
    ho     1.958E-03 5.929E+03 5.925E+03 5.921E+03 5.918E+03 5.911E+03 5.898E+03 5.878E+03 5.844E+03
5.769E+03 5.695E+03 5.547E+03 5.467E+03 5.390E+03 5.106E+03 4.854E+03 4.624E+03 4.413E+03
    er     2.194E-02 9.579E+01 9.555E+01 9.551E+01 9.550E+01 9.550E+01 9.549E+01 9.548E+01 9.543E+01
9.527E+01 9.501E+01 9.395E+01 9.319E+01 9.246E+01 8.975E+01 8.736E+01 8.525E+01 8.337E+01
    tm     1.867E-01 5.764E+01 5.764E+01 5.764E+01 5.764E+01 5.764E+01 5.764E+01 5.764E+01 5.764E+01
5.764E+01 5.763E+01 5.761E+01 5.759E+01 5.758E+01 5.750E+01 5.741E+01 5.731E+01 5.721E+01
    yb     3.994E-07 2.799E-04 2.799E-04 2.799E-04 2.799E-04 2.799E-04 2.799E-04 2.799E-04 2.799E-04
2.798E-04 2.798E-04 2.796E-04 2.795E-04 2.794E-04 2.789E-04 2.784E-04 2.779E-04 2.774E-04
    lu     4.418E-12 1.940E-07 1.926E-07 1.913E-07 1.899E-07 1.874E-07 1.812E-07 1.717E-07 1.569E-07
1.363E-07 1.286E-07 1.268E-07 1.265E-07 1.263E-07 1.252E-07 1.241E-07 1.231E-07 1.220E-07
  totals   7.524E+06 1.112E+10 9.617E+09 9.083E+09 8.730E+09 8.287E+09 7.645E+09 7.049E+09 6.449E+09
5.692E+09 5.121E+09 4.185E+09 3.904E+09 3.726E+09 3.339E+09 3.122E+09 2.967E+09 2.844E+09
0
    Fukushima Daiichi 4                                                                  fission
products          page   78
decay, following irradiation identified by: power=  25.00mw, burnup=  39500.mwd, flux=
4.05E+13n/cm**2-sec

                                          element thermal power, watts
                                          basis = full core inventory 548 assemblies (94t
            charge  discharge   2E-03 h   3E-03 h   5E-03 h   8E-03 h   2E-02 h   3E-02 h   7E-02 h
0.2 h     0.3 h     1.0 h     1.5 h     2.0 h     4.0 h     6.0 h     8.0 h    10.0 h
     h     1.425E-02 2.160E+00 2.160E+00 2.160E+00 2.160E+00 2.160E+00 2.160E+00 2.160E+00 2.160E+00
2.160E+00 2.160E+00 2.160E+00 2.160E+00 2.160E+00 2.160E+00 2.160E+00 2.160E+00 2.160E+00
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      he     0.000E+00 5.806E+02 2.617E+00 1.855E-02 9.652E-05 3.560E-09 7.310E-21 0.000E+00 0.000E+00
0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
      li     0.000E+00 2.177E+02 1.304E+00 1.112E-02 7.041E-05 3.802E-09 2.133E-20 0.000E+00 0.000E+00
0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
      be     1.998E-07 4.838E+01 2.343E+01 1.754E+01 1.290E+01 7.106E+00 1.475E+00 8.194E-02 2.043E-04
2.842E-05 2.842E-05 2.842E-05 2.842E-05 2.842E-05 2.842E-05 2.842E-05 2.842E-05 2.842E-05
      c      2.793E-06 5.423E+00 9.596E-01 1.883E-01 3.366E-02 1.573E-03 4.216E-04 4.214E-04 4.214E-04
4.214E-04 4.214E-04 4.214E-04 4.214E-04 4.214E-04 4.214E-04 4.214E-04 4.214E-04 4.214E-04
      co     0.000E+00 2.843E+00 3.285E-05 2.733E-09 1.264E-13 4.865E-22 0.000E+00 0.000E+00 0.000E+00
0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
      ni     9.788E-11 1.322E+01 3.323E+00 2.004E+00 1.275E+00 6.060E-01 1.182E-01 1.296E-02 3.505E-03
3.363E-03 3.356E-03 3.328E-03 3.307E-03 3.286E-03 3.204E-03 3.123E-03 3.045E-03 2.969E-03
      cu     1.040E-08 1.946E+02 3.738E+01 2.388E+01 1.613E+01 9.236E+00 4.213E+00 1.857E+00 7.058E-01
2.261E-01 1.358E-01 1.248E-01 1.240E-01 1.233E-01 1.204E-01 1.175E-01 1.148E-01 1.121E-01
      zn     6.800E-09 2.797E+03 5.710E+02 3.102E+02 2.099E+02 1.243E+02 5.977E+01 3.349E+01 1.544E+01
4.196E+00 3.174E+00 2.950E+00 2.832E+00 2.732E+00 2.436E+00 2.233E+00 2.080E+00 1.958E+00
      ga     1.226E-07 2.786E+04 6.766E+03 3.707E+03 2.457E+03 1.511E+03 7.748E+02 4.111E+02 2.400E+02
1.327E+02 7.925E+01 4.187E+01 3.979E+01 3.879E+01 3.566E+01 3.322E+01 3.128E+01 2.971E+01
      ge     2.233E-10 2.370E+05 4.646E+04 3.115E+04 2.264E+04 1.435E+04 6.794E+03 2.961E+03 1.592E+03
1.408E+03 1.333E+03 1.074E+03 9.249E+02 8.049E+02 5.123E+02 3.757E+02 3.023E+02 2.557E+02
      as     6.476E-07 6.480E+05 2.478E+05 1.872E+05 1.480E+05 9.951E+04 4.264E+04 1.595E+04 8.696E+03
7.149E+03 6.145E+03 4.926E+03 4.493E+03 4.053E+03 2.426E+03 1.343E+03 7.401E+02 4.312E+02
      se     1.993E-05 1.074E+06 7.380E+05 6.022E+05 5.069E+05 3.895E+05 2.432E+05 1.512E+05 9.919E+04
6.040E+04 3.995E+04 1.133E+04 4.663E+03 2.006E+03 1.414E+02 2.579E+01 6.110E+00 1.674E+00
      br     7.278E-08 3.143E+06 2.288E+06 1.987E+06 1.781E+06 1.503E+06 1.055E+06 6.495E+05 3.525E+05
2.235E+05 1.767E+05 8.050E+04 4.744E+04 2.971E+04 9.395E+03 5.983E+03 4.606E+03 3.826E+03
      kr     1.269E+01 3.972E+06 2.955E+06 2.644E+06 2.435E+06 2.174E+06 1.832E+06 1.546E+06 1.275E+06
9.653E+05 8.338E+05 6.534E+05 5.539E+05 4.719E+05 2.598E+05 1.511E+05 9.124E+04 5.659E+04
      rb     8.420E-01 8.699E+06 5.856E+06 4.992E+06 4.563E+06 4.185E+06 3.683E+06 3.049E+06 2.292E+06
1.496E+06 1.092E+06 6.025E+05 4.895E+05 4.224E+05 2.569E+05 1.579E+05 9.714E+04 5.986E+04
      sr     1.409E+03 7.823E+06 5.441E+06 5.148E+06 4.891E+06 4.479E+06 3.765E+06 3.129E+06 2.582E+06
1.972E+06 1.582E+06 1.221E+06 1.135E+06 1.063E+06 8.388E+05 6.874E+05 5.820E+05 5.061E+05
      y      2.325E+03 1.316E+07 7.073E+06 5.965E+06 5.451E+06 5.051E+06 4.817E+06 4.680E+06 4.408E+06
3.707E+06 2.986E+06 1.967E+06 1.790E+06 1.705E+06 1.485E+06 1.286E+06 1.109E+06 9.604E+05
      zr     3.752E+03 6.305E+06 2.813E+06 2.001E+06 1.695E+06 1.447E+06 1.225E+06 1.106E+06 1.065E+06
1.060E+06 1.056E+06 1.041E+06 1.030E+06 1.020E+06 9.794E+05 9.420E+05 9.076E+05 8.759E+05
      nb     4.936E+03 1.337E+07 8.116E+06 6.055E+06 4.883E+06 3.764E+06 2.771E+06 2.236E+06 1.924E+06
1.702E+06 1.651E+06 1.622E+06 1.603E+06 1.584E+06 1.505E+06 1.427E+06 1.354E+06 1.287E+06
      mo     1.401E-01 6.021E+06 5.333E+06 4.948E+06 4.642E+06 4.190E+06 3.398E+06 2.598E+06 1.935E+06
1.427E+06 1.063E+06 5.471E+05 4.806E+05 4.632E+05 4.490E+05 4.396E+05 4.305E+05 4.215E+05
      tc     3.736E-02 9.031E+06 8.351E+06 7.973E+06 7.662E+06 7.190E+06 6.351E+06 5.497E+06 4.586E+06
3.280E+06 2.138E+06 4.738E+05 2.102E+05 1.311E+05 9.619E+04 9.494E+04 9.380E+04 9.250E+04
      ru     1.643E+03 1.855E+06 1.712E+06 1.651E+06 1.604E+06 1.536E+06 1.423E+06 1.308E+06 1.169E+06
9.777E+05 8.926E+05 8.265E+05 7.912E+05 7.586E+05 6.508E+05 5.717E+05 5.137E+05 4.711E+05
      rh     3.015E+03 2.223E+06 2.102E+06 2.025E+06 1.958E+06 1.847E+06 1.619E+06 1.371E+06 1.137E+06
8.875E+05 7.546E+05 6.279E+05 6.008E+05 5.880E+05 5.696E+05 5.606E+05 5.541E+05 5.489E+05
      pd     2.158E-05 1.151E+05 1.064E+05 1.022E+05 9.934E+04 9.553E+04 8.923E+04 8.274E+04 7.633E+04
6.969E+04 6.477E+04 5.414E+04 5.060E+04 4.845E+04 4.323E+04 3.908E+04 3.534E+04 3.197E+04
      ag     1.852E+01 1.990E+05 1.667E+05 1.511E+05 1.393E+05 1.231E+05 9.898E+04 8.152E+04 7.042E+04
6.126E+04 5.826E+04 5.491E+04 5.367E+04 5.274E+04 4.973E+04 4.694E+04 4.433E+04 4.189E+04
      cd     4.692E-01 4.989E+04 2.539E+04 2.204E+04 1.990E+04 1.760E+04 1.509E+04 1.307E+04 1.081E+04
8.528E+03 7.799E+03 6.658E+03 5.995E+03 5.437E+03 3.905E+03 3.029E+03 2.501E+03 2.171E+03
      in     1.298E-04 2.255E+05 5.810E+04 4.436E+04 3.834E+04 3.289E+04 2.748E+04 2.386E+04 2.094E+04
1.776E+04 1.536E+04 1.033E+04 8.190E+03 6.734E+03 3.921E+03 2.807E+03 2.183E+03 1.782E+03
      sn     4.193E+00 1.223E+06 1.062E+06 9.955E+05 9.391E+05 8.489E+05 6.754E+05 4.830E+05 2.995E+05
1.517E+05 1.031E+05 6.522E+04 5.250E+04 4.288E+04 2.135E+04 1.251E+04 8.472E+03 6.504E+03
      sb     2.132E+01 4.422E+06 3.967E+06 3.873E+06 3.798E+06 3.683E+06 3.457E+06 3.120E+06 2.565E+06
1.690E+06 1.184E+06 5.826E+05 4.126E+05 3.176E+05 1.782E+05 1.327E+05 1.068E+05 8.888E+04
      te     7.370E+01 4.846E+06 4.345E+06 4.047E+06 3.811E+06 3.491E+06 3.090E+06 2.897E+06 2.785E+06
2.505E+06 2.139E+06 1.262E+06 9.308E+05 7.268E+05 4.247E+05 3.580E+05 3.325E+05 3.165E+05
      i      6.787E+01 1.142E+07 1.032E+07 9.816E+06 9.445E+06 8.952E+06 8.195E+06 7.511E+06 6.990E+06
6.693E+06 6.530E+06 5.796E+06 5.268E+06 4.809E+06 3.676E+06 3.184E+06 2.909E+06 2.711E+06
      xe     9.116E+00 5.422E+06 4.484E+06 4.175E+06 3.933E+06 3.576E+06 3.005E+06 2.479E+06 1.945E+06
1.232E+06 7.927E+05 3.873E+05 3.464E+05 3.408E+05 3.505E+05 3.538E+05 3.503E+05 3.421E+05
      cs     9.021E+02 9.319E+06 7.375E+06 6.994E+06 6.745E+06 6.337E+06 5.529E+06 4.685E+06 3.950E+06
3.279E+06 2.704E+06 1.343E+06 8.294E+05 5.439E+05 2.399E+05 2.153E+05 2.129E+05 2.124E+05
      ba     6.844E+02 5.414E+06 4.392E+06 3.902E+06 3.573E+06 3.203E+06 2.845E+06 2.689E+06 2.521E+06
2.113E+06 1.671E+06 9.240E+05 7.426E+05 6.429E+05 4.640E+05 4.003E+05 3.756E+05 3.655E+05
      la     2.421E+03 9.167E+06 8.298E+06 7.804E+06 7.424E+06 6.904E+06 6.090E+06 5.417E+06 5.041E+06
4.800E+06 4.537E+06 3.818E+06 3.476E+06 3.211E+06 2.565E+06 2.264E+06 2.112E+06 2.028E+06
      ce     1.230E+03 2.256E+06 2.036E+06 1.931E+06 1.857E+06 1.759E+06 1.571E+06 1.325E+06 1.043E+06
7.691E+05 6.698E+05 6.021E+05 5.917E+05 5.863E+05 5.702E+05 5.550E+05 5.405E+05 5.265E+05
      pr     6.335E+03 3.482E+06 3.289E+06 3.160E+06 3.066E+06 2.962E+06 2.839E+06 2.687E+06 2.431E+06
2.053E+06 1.825E+06 1.324E+06 1.159E+06 1.078E+06 9.825E+05 9.444E+05 9.152E+05 8.918E+05
      nd     7.875E+01 4.664E+05 4.553E+05 4.467E+05 4.386E+05 4.252E+05 3.997E+05 3.720E+05 3.421E+05
2.994E+05 2.588E+05 1.909E+05 1.712E+05 1.576E+05 1.250E+05 1.103E+05 1.034E+05 1.000E+05
      pm     2.322E+02 5.038E+05 4.929E+05 4.857E+05 4.794E+05 4.691E+05 4.479E+05 4.203E+05 3.838E+05
3.356E+05 3.015E+05 2.622E+05 2.578E+05 2.558E+05 2.497E+05 2.441E+05 2.388E+05 2.339E+05
      sm     3.746E-02 9.611E+04 9.573E+04 9.547E+04 9.524E+04 9.484E+04 9.385E+04 9.214E+04 8.901E+04
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8.272E+04 7.760E+04 7.076E+04 6.909E+04 6.809E+04 6.552E+04 6.331E+04 6.120E+04 5.920E+04
     eu     1.753E+02 2.186E+05 2.184E+05 2.183E+05 2.181E+05 2.178E+05 2.172E+05 2.163E+05 2.153E+05
2.140E+05 2.125E+05 2.081E+05 2.063E+05 2.051E+05 2.026E+05 2.012E+05 2.000E+05 1.989E+05
     gd     1.039E-03 1.445E+03 1.439E+03 1.433E+03 1.426E+03 1.412E+03 1.372E+03 1.299E+03 1.171E+03
9.748E+02 8.838E+02 8.265E+02 8.096E+02 7.941E+02 7.367E+02 6.837E+02 6.345E+02 5.888E+02
     tb     1.863E+00 1.063E+03 1.061E+03 1.060E+03 1.059E+03 1.057E+03 1.051E+03 1.041E+03 1.021E+03
9.649E+02 8.837E+02 7.392E+02 7.219E+02 7.173E+02 7.139E+02 7.124E+02 7.111E+02 7.097E+02
     dy     1.535E-06 7.532E+01 7.464E+01 7.403E+01 7.343E+01 7.235E+01 7.000E+01 6.697E+01 6.348E+01
5.960E+01 5.634E+01 4.609E+01 3.984E+01 3.446E+01 1.940E+01 1.108E+01 6.481E+00 3.934E+00
     ho     9.023E-06 2.671E+01 2.665E+01 2.659E+01 2.654E+01 2.645E+01 2.626E+01 2.602E+01 2.569E+01
2.507E+01 2.451E+01 2.371E+01 2.337E+01 2.306E+01 2.188E+01 2.082E+01 1.986E+01 1.896E+01
     er     1.340E-05 1.671E-01 1.668E-01 1.668E-01 1.668E-01 1.668E-01 1.667E-01 1.666E-01 1.664E-01
1.658E-01 1.647E-01 1.605E-01 1.574E-01 1.545E-01 1.439E-01 1.348E-01 1.269E-01 1.201E-01
     tm     2.707E-04 1.800E-01 1.800E-01 1.800E-01 1.800E-01 1.800E-01 1.800E-01 1.800E-01 1.800E-01
1.800E-01 1.800E-01 1.799E-01 1.798E-01 1.797E-01 1.793E-01 1.788E-01 1.783E-01 1.777E-01
     yb     1.016E-09 7.122E-07 7.122E-07 7.122E-07 7.122E-07 7.122E-07 7.122E-07 7.122E-07 7.122E-07
7.121E-07 7.120E-07 7.116E-07 7.113E-07 7.110E-07 7.097E-07 7.084E-07 7.071E-07 7.058E-07
     lu     4.877E-14 1.498E-09 1.498E-09 1.498E-09 1.497E-09 1.497E-09 1.495E-09 1.493E-09 1.490E-09
1.485E-09 1.482E-09 1.477E-09 1.474E-09 1.471E-09 1.459E-09 1.446E-09 1.434E-09 1.421E-09
  totals    2.935E+04 1.364E+08 1.043E+08 9.448E+07 8.837E+07 8.106E+07 7.092E+07 6.194E+07 5.362E+07
4.415E+07 3.743E+07 2.664E+07 2.338E+07 2.134E+07 1.732E+07 1.546E+07 1.429E+07 1.344E+07


     Fukushima Daiichi 4
actinides          page   79
decay, following irradiation identified by: power=  25.00mw, burnup=  39500.mwd, flux=
4.05E+13n/cm**2-sec

                                                    element concentrations, grams
                                                    basis = full core inventory 548 assemblies (94t
             initial     12.0 h     15.0 h     20.0 h     24.0 h     36.0 h     48.0 h     72.0 h     96.0 h
144.0 h   192.0 h   240.0 h
     he     5.550E+01 5.551E+01 5.552E+01 5.555E+01 5.557E+01 5.562E+01 5.568E+01 5.580E+01 5.591E+01
5.614E+01 5.637E+01 5.660E+01
     tl     3.674E-10 3.674E-10 3.649E-10 3.629E-10 3.635E-10 3.794E-10 3.793E-10 3.697E-10 3.698E-10
3.641E-10 3.651E-10 3.664E-10
     pb     1.405E-04 1.405E-04 1.406E-04 1.407E-04 1.407E-04 1.409E-04 1.411E-04 1.414E-04 1.417E-04
1.424E-04 1.431E-04 1.438E-04
     bi     5.193E-08 5.194E-08 5.194E-08 5.195E-08 5.196E-08 5.297E-08 5.300E-08 5.255E-08 5.263E-08
5.247E-08 5.269E-08 5.291E-08
     po     7.726E-11 7.727E-11 7.729E-11 7.733E-11 7.736E-11 7.745E-11 7.753E-11 7.771E-11 7.788E-11
7.822E-11 7.856E-11 7.890E-11
     at     4.546E-17 4.547E-17 4.548E-17 4.550E-17 4.551E-17 4.552E-17 4.550E-17 4.539E-17 4.519E-17
4.457E-17 4.370E-17 4.265E-17
     rn     3.547E-10 3.547E-10 3.546E-10 3.546E-10 3.545E-10 3.544E-10 3.544E-10 3.544E-10 3.545E-10
3.552E-10 3.562E-10 3.575E-10
     fr     4.399E-13 4.400E-13 4.401E-13 4.403E-13 4.404E-13 4.405E-13 4.404E-13 4.394E-13 4.377E-13
4.320E-13 4.241E-13 4.145E-13
     ra     6.748E-06 6.748E-06 6.749E-06 6.749E-06 6.750E-06 6.752E-06 6.754E-06 6.759E-06 6.765E-06
6.779E-06 6.795E-06 6.812E-06
     ac     7.175E-07 7.177E-07 7.180E-07 7.185E-07 7.189E-07 7.203E-07 7.216E-07 7.244E-07 7.272E-07
7.327E-07 7.382E-07 7.437E-07
     th     2.484E-01 2.484E-01 2.484E-01 2.485E-01 2.485E-01 2.485E-01 2.486E-01 2.487E-01 2.489E-01
2.492E-01 2.495E-01 2.499E-01
     pa     5.131E-02 5.131E-02 5.132E-02 5.132E-02 5.132E-02 5.133E-02 5.133E-02 5.133E-02 5.133E-02
5.133E-02 5.133E-02 5.134E-02
      u     8.924E+07 8.924E+07 8.924E+07 8.924E+07 8.924E+07 8.924E+07 8.924E+07 8.924E+07 8.924E+07
8.924E+07 8.924E+07 8.924E+07
     np     4.870E+04 4.857E+04 4.840E+04 4.812E+04 4.791E+04 4.733E+04 4.684E+04 4.606E+04 4.548E+04
4.476E+04 4.437E+04 4.418E+04
     pu     8.220E+05 8.221E+05 8.223E+05 8.226E+05 8.228E+05 8.234E+05 8.239E+05 8.247E+05 8.254E+05
8.262E+05 8.266E+05 8.268E+05
     am     1.728E+04 1.729E+04 1.729E+04 1.729E+04 1.729E+04 1.730E+04 1.730E+04 1.731E+04 1.733E+04
1.736E+04 1.738E+04 1.741E+04
     cm     5.393E+03 5.393E+03 5.393E+03 5.394E+03 5.393E+03 5.392E+03 5.390E+03 5.384E+03 5.378E+03
5.365E+03 5.352E+03 5.340E+03
     bk     7.993E-05 7.991E-05 7.989E-05 7.985E-05 7.982E-05 7.973E-05 7.965E-05 7.947E-05 7.930E-05
7.896E-05 7.862E-05 7.828E-05
     cf     5.365E-05 5.367E-05 5.369E-05 5.373E-05 5.375E-05 5.384E-05 5.392E-05 5.408E-05 5.425E-05
5.457E-05 5.489E-05 5.522E-05
     es     9.969E-09 9.976E-09 9.987E-09 1.000E-08 1.002E-08 1.005E-08 1.009E-08 1.014E-08 1.018E-08
1.022E-08 1.022E-08 1.017E-08
  totals    9.014E+07 9.014E+07 9.014E+07 9.014E+07 9.014E+07 9.014E+07 9.014E+07 9.014E+07 9.014E+07
9.014E+07 9.014E+07 9.014E+07

     Fukushima Daiichi 4
actinides          page   80
decay, following irradiation identified by: power=  25.00mw, burnup=  39500.mwd, flux=
4.05E+13n/cm**2-sec
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element radioactivity, curies
basis = full core inventory 548 assemblies (94t

	initial	12.0 h	15.0 h	20.0 h	24.0 h	36.0 h	48.0 h	72.0 h	96.0 h	144.0 h	192.0 h	240.0 h
tl	1.088E-01	1.088E-01	1.080E-01	1.075E-01	1.076E-01	1.124E-01	1.123E-01	1.095E-01	1.095E-01	1.078E-01	1.081E-01	1.085E-01
pb	2.985E-01	2.985E-01	2.984E-01	2.984E-01	2.983E-01	2.982E-01	2.981E-01	2.980E-01	2.981E-01	2.986E-01	2.994E-01	3.004E-01
bi	2.987E-01	2.986E-01	2.986E-01	2.985E-01	2.984E-01	3.126E-01	3.125E-01	3.046E-01	3.046E-01	2.999E-01	3.008E-01	3.018E-01
po	4.898E-01	4.897E-01	4.896E-01	4.895E-01	4.894E-01	4.984E-01	4.983E-01	4.932E-01	4.934E-01	4.910E-01	4.924E-01	4.941E-01
at	7.321E-05	7.322E-05	7.324E-05	7.327E-05	7.328E-05	7.330E-05	7.327E-05	7.309E-05	7.277E-05	7.176E-05	7.037E-05	6.867E-05
rn	2.984E-01	2.984E-01	2.984E-01	2.983E-01	2.983E-01	2.982E-01	2.981E-01	2.981E-01	2.983E-01	2.989E-01	2.997E-01	3.008E-01
fr	7.392E-05	7.394E-05	7.396E-05	7.398E-05	7.400E-05	7.401E-05	7.399E-05	7.381E-05	7.350E-05	7.249E-05	7.110E-05	6.941E-05
ra	2.985E-01	2.984E-01	2.984E-01	2.983E-01	2.983E-01	2.982E-01	2.981E-01	2.982E-01	2.983E-01	2.989E-01	2.998E-01	3.009E-01
ac	7.619E-04	6.334E-04	4.876E-04	3.315E-04	2.566E-04	1.593E-04	1.342E-04	1.260E-04	1.253E-04	1.247E-04	1.237E-04	1.224E-04
th	9.272E+01	8.947E+01	8.491E+01	7.810E+01	7.327E+01	6.159E+01	5.315E+01	4.267E+01	3.720E+01	3.288E+01	3.170E+01	3.139E+01
pa	1.057E+02	1.038E+02	1.010E+02	9.678E+01	9.373E+01	8.605E+01	8.017E+01	7.219E+01	6.749E+01	6.308E+01	6.155E+01	6.101E+01
u	5.236E+07	5.191E+07	5.125E+07	5.016E+07	4.931E+07	4.684E+07	4.450E+07	4.016E+07	3.624E+07	2.951E+07	2.403E+07	1.957E+07
np	1.216E+09	1.186E+09	1.143E+09	1.075E+09	1.023E+09	8.831E+08	7.621E+08	5.674E+08	4.225E+08	2.343E+08	1.299E+08	7.205E+07
pu	1.888E+07	1.705E+07	1.510E+07	1.322E+07	1.243E+07	1.156E+07	1.140E+07	1.137E+07	1.136E+07	1.136E+07	1.136E+07	1.136E+07
am	9.811E+06	8.776E+06	7.433E+06	5.656E+06	4.559E+06	2.426E+06	1.323E+06	4.225E+05	1.512E+05	3.528E+04	2.198E+04	2.044E+04
cm	5.099E+06	5.099E+06	5.098E+06	5.097E+06	5.095E+06	5.089E+06	5.081E+06	5.062E+06	5.043E+06	5.003E+06	4.963E+06	4.924E+06
bk	1.676E-01	1.547E-01	1.434E-01	1.351E-01	1.326E-01	1.308E-01	1.306E-01	1.303E-01	1.300E-01	1.294E-01	1.289E-01	1.283E-01
cf	6.672E-03	6.672E-03	6.670E-03	6.668E-03	6.666E-03	6.659E-03	6.653E-03	6.641E-03	6.629E-03	6.606E-03	6.585E-03	6.564E-03
es	2.061E-04	2.063E-04	2.066E-04	2.071E-04	2.074E-04	2.084E-04	2.093E-04	2.108E-04	2.120E-04	2.132E-04	2.133E-04	2.123E-04
totals	1.302E+09	1.269E+09	1.222E+09	1.149E+09	1.095E+09	9.491E+08	8.244E+08	6.244E+08	4.753E+08	2.802E+08	1.703E+08	1.079E+08

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Fukushima Daiichi 4
actinides page 81
decay, following irradiation identified by: power= 25.00mw, burnup= 39500.mwd, flux= 4.05E+13n/cm**2-sec

element thermal power, watts
basis = full core inventory 548 assemblies (94t

	initial	12.0 h	15.0 h	20.0 h	24.0 h	36.0 h	48.0 h	72.0 h	96.0 h	144.0 h	192.0 h	240.0 h
tl	2.544E-03	2.543E-03	2.526E-03	2.512E-03	2.516E-03	2.627E-03	2.626E-03	2.559E-03	2.560E-03	2.521E-03	2.527E-03	2.536E-03
pb	5.645E-04	5.644E-04	5.643E-04	5.642E-04	5.641E-04	5.638E-04	5.637E-04	5.635E-04	5.637E-04	5.646E-04	5.661E-04	5.681E-04
bi	5.002E-03	5.001E-03	5.000E-03	4.999E-03	4.998E-03	5.235E-03	5.233E-03	5.101E-03	5.102E-03	5.023E-03	5.037E-03	5.054E-03
po	2.237E-02	2.237E-02	2.236E-02	2.236E-02	2.236E-02	2.283E-02	2.283E-02	2.256E-02	2.257E-02	2.243E-02	2.249E-02	2.257E-02
at	3.124E-06	3.125E-06	3.125E-06	3.127E-06	3.127E-06	3.128E-06	3.127E-06	3.119E-06	3.105E-06	3.062E-06	3.003E-06	2.930E-06
rn	1.133E-02	1.133E-02	1.133E-02	1.133E-02	1.132E-02	1.132E-02	1.132E-02	1.132E-02	1.132E-02	1.135E-02	1.138E-02	1.142E-02
fr	2.828E-06	2.828E-06	2.829E-06	2.830E-06	2.831E-06	2.831E-06	2.830E-06	2.823E-06	2.811E-06	2.772E-06	2.718E-06	2.653E-06
ra	1.024E-02	1.024E-02	1.024E-02	1.024E-02	1.024E-02	1.023E-02	1.023E-02	1.023E-02	1.024E-02	1.026E-02	1.029E-02	1.032E-02
ac	7.549E-06	6.546E-06	5.410E-06	4.192E-06	3.609E-06	2.849E-06	2.651E-06	2.581E-06	2.566E-06	2.531E-06	2.482E-06	2.423E-06
th	9.059E-02	8.705E-02	8.208E-02	7.465E-02	6.940E-02	5.666E-02	4.747E-02	3.606E-02	3.012E-02	2.545E-02	2.422E-02	2.392E-02
pa	5.201E-01	5.071E-01	4.888E-01	4.609E-01	4.409E-01	3.905E-01	3.519E-01	2.997E-01	2.689E-01	2.401E-01	2.301E-01	2.266E-01
u	1.014E+05	1.005E+05	9.922E+04	9.712E+04	9.547E+04	9.069E+04	8.615E+04	7.775E+04	7.016E+04	5.713E+04	4.653E+04	3.789E+04

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     np      3.133E+06 3.057E+06 2.946E+06 2.770E+06 2.637E+06 2.275E+06 1.962E+06 1.460E+06 1.087E+06
6.019E+05 3.335E+05 1.848E+05
     pu      2.081E+04 1.870E+04 1.646E+04 1.430E+04 1.339E+04 1.241E+04 1.223E+04 1.220E+04 1.221E+04
1.223E+04 1.224E+04 1.225E+04
     am      3.914E+04 3.445E+04 2.848E+04 2.082E+04 1.626E+04 7.952E+03 4.113E+03 1.456E+03 8.321E+02
6.298E+02 6.150E+02 6.162E+02
     cm      1.856E+05 1.856E+05 1.855E+05 1.855E+05 1.854E+05 1.852E+05 1.849E+05 1.842E+05 1.835E+05
1.821E+05 1.806E+05 1.792E+05
     bk      2.830E-04 1.929E-04 1.133E-04 5.545E-05 3.821E-05 2.653E-05 2.563E-05 2.550E-05 2.544E-05
2.533E-05 2.522E-05 2.512E-05
     cf      3.810E-04 3.810E-04 3.810E-04 3.810E-04 3.809E-04 3.808E-04 3.807E-04 3.804E-04 3.802E-04
3.797E-04 3.792E-04 3.787E-04
     es      8.230E-06 8.237E-06 8.249E-06 8.267E-06 8.281E-06 8.321E-06 8.357E-06 8.417E-06 8.462E-06
8.512E-06 8.514E-06 8.474E-06
   totals    3.480E+06 3.396E+06 3.276E+06 3.088E+06 2.947E+06 2.571E+06 2.250E+06 1.736E+06 1.353E+06
8.540E+05 5.735E+05 4.147E+05

   Fukushima Daiichi 4                                                                     fission
products         page   82
decay, following irradiation identified by: power=  25.00mw, burnup=  39500.mwd, flux=
4.05E+13n/cm**2-sec

                                                 element concentrations, grams
                                                 basis = full core inventory 548 assemblies (94t
             initial    12.0 h    15.0 h    20.0 h    24.0 h    36.0 h    48.0 h    72.0 h    96.0 h
144.0 h   192.0 h   240.0 h
      h      7.515E+00 7.515E+00 7.515E+00 7.515E+00 7.515E+00 7.514E+00 7.514E+00 7.513E+00 7.512E+00
7.510E+00 7.508E+00 7.506E+00
     he      1.308E+02 1.308E+02 1.308E+02 1.308E+02 1.308E+02 1.308E+02 1.308E+02 1.308E+02 1.308E+02
1.308E+02 1.308E+02 1.308E+02
     li      1.089E+00 1.089E+00 1.089E+00 1.089E+00 1.089E+00 1.089E+00 1.089E+00 1.089E+00 1.089E+00
1.089E+00 1.089E+00 1.089E+00
     be      1.142E+00 1.142E+00 1.142E+00 1.142E+00 1.142E+00 1.142E+00 1.142E+00 1.142E+00 1.142E+00
1.142E+00 1.142E+00 1.142E+00
      b      7.494E-02 7.494E-02 7.494E-02 7.494E-02 7.494E-02 7.494E-02 7.494E-02 7.494E-02 7.494E-02
7.494E-02 7.494E-02 7.494E-02
      c      3.546E-01 3.546E-01 3.546E-01 3.546E-01 3.546E-01 3.546E-01 3.546E-01 3.546E-01 3.546E-01
3.546E-01 3.546E-01 3.546E-01
      n      3.511E-02 3.511E-02 3.511E-02 3.511E-02 3.511E-02 3.511E-02 3.511E-02 3.511E-02 3.511E-02
3.511E-02 3.511E-02 3.511E-02
     ne      4.834E-01 4.834E-01 4.834E-01 4.834E-01 4.834E-01 4.834E-01 4.834E-01 4.834E-01 4.834E-01
4.834E-01 4.834E-01 4.834E-01
     ni      8.856E-06 8.634E-06 8.311E-06 7.800E-06 7.414E-06 6.366E-06 5.467E-06 4.031E-06 2.972E-06
1.616E-06 8.786E-07 4.777E-07
     cu      4.878E-05 4.770E-05 4.612E-05 4.361E-05 4.169E-05 3.644E-05 3.186E-05 2.434E-05 1.860E-05
1.086E-05 6.339E-06 3.701E-06
     zn      1.900E-01 1.900E-01 1.899E-01 1.898E-01 1.898E-01 1.896E-01 1.895E-01 1.893E-01 1.891E-01
1.889E-01 1.889E-01 1.888E-01
     ga      3.075E-01 3.074E-01 3.074E-01 3.073E-01 3.073E-01 3.073E-01 3.072E-01 3.071E-01 3.071E-01
3.070E-01 3.070E-01 3.069E-01
     ge      4.239E+01 4.239E+01 4.238E+01 4.238E+01 4.238E+01 4.238E+01 4.238E+01 4.238E+01 4.238E+01
4.238E+01 4.238E+01 4.238E+01
     as      1.296E+01 1.295E+01 1.295E+01 1.294E+01 1.294E+01 1.292E+01 1.291E+01 1.289E+01 1.288E+01
1.286E+01 1.286E+01 1.285E+01
     se      6.048E+03 6.048E+03 6.048E+03 6.048E+03 6.048E+03 6.048E+03 6.048E+03 6.048E+03 6.048E+03
6.048E+03 6.048E+03 6.048E+03
     br      2.363E+03 2.363E+03 2.363E+03 2.363E+03 2.363E+03 2.362E+03 2.362E+03 2.362E+03 2.362E+03
2.362E+03 2.362E+03 2.362E+03
     kr      4.125E+04 4.125E+04 4.125E+04 4.125E+04 4.125E+04 4.125E+04 4.125E+04 4.125E+04 4.125E+04
4.125E+04 4.125E+04 4.125E+04
     rb      3.917E+04 3.917E+04 3.917E+04 3.917E+04 3.917E+04 3.917E+04 3.917E+04 3.917E+04 3.917E+04
3.917E+04 3.918E+04 3.918E+04
     sr      1.003E+05 1.003E+05 1.003E+05 1.003E+05 1.003E+05 1.003E+05 1.002E+05 1.002E+05 1.002E+05
1.001E+05 1.001E+05 1.000E+05
      y      5.268E+04 5.268E+04 5.268E+04 5.267E+04 5.267E+04 5.266E+04 5.266E+04 5.265E+04 5.264E+04
5.262E+04 5.260E+04 5.259E+04
     zr      4.046E+05 4.046E+05 4.046E+05 4.046E+05 4.046E+05 4.046E+05 4.046E+05 4.045E+05 4.045E+05
4.045E+05 4.045E+05 4.045E+05
     nb      2.606E+03 2.606E+03 2.605E+03 2.605E+03 2.604E+03 2.603E+03 2.602E+03 2.600E+03 2.598E+03
2.592E+03 2.584E+03 2.575E+03
     mo      3.724E+05 3.724E+05 3.724E+05 3.724E+05 3.724E+05 3.724E+05 3.724E+05 3.725E+05 3.725E+05
3.726E+05 3.727E+05 3.727E+05
     tc      8.871E+04 8.872E+04 8.873E+04 8.874E+04 8.874E+04 8.877E+04 8.879E+04 8.882E+04 8.884E+04
8.888E+04 8.890E+04 8.891E+04
     ru      2.664E+05 2.664E+05 2.664E+05 2.664E+05 2.663E+05 2.663E+05 2.663E+05 2.662E+05 2.661E+05
2.659E+05 2.658E+05 2.656E+05
     rh      4.760E+04 4.760E+04 4.760E+04 4.761E+04 4.761E+04 4.763E+04 4.765E+04 4.769E+04 4.773E+04
4.783E+04 4.793E+04 4.803E+04
     pd      1.407E+05 1.407E+05 1.407E+05 1.407E+05 1.407E+05 1.407E+05 1.408E+05 1.408E+05 1.408E+05
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```
1.409E+05 1.409E+05 1.410E+05
    ag      8.376E+03 8.377E+03 8.377E+03 8.378E+03 8.378E+03 8.379E+03 8.378E+03 8.377E+03 8.375E+03
8.372E+03 8.369E+03 8.366E+03
    cd      8.893E+03 8.893E+03 8.893E+03 8.894E+03 8.894E+03 8.896E+03 8.897E+03 8.899E+03 8.901E+03
8.905E+03 8.907E+03 8.910E+03
    in      1.691E+02 1.691E+02 1.691E+02 1.692E+02 1.692E+02 1.693E+02 1.695E+02 1.696E+02 1.698E+02
1.700E+02 1.701E+02 1.701E+02
    sn      5.452E+03 5.452E+03 5.452E+03 5.452E+03 5.452E+03 5.452E+03 5.451E+03 5.451E+03 5.451E+03
5.450E+03 5.449E+03 5.449E+03
    sb      1.651E+03 1.650E+03 1.649E+03 1.648E+03 1.648E+03 1.646E+03 1.644E+03 1.641E+03 1.639E+03
1.635E+03 1.632E+03 1.630E+03
    te      5.276E+04 5.276E+04 5.275E+04 5.274E+04 5.273E+04 5.270E+04 5.267E+04 5.263E+04 5.260E+04
5.255E+04 5.251E+04 5.249E+04
     i      2.224E+04 2.223E+04 2.222E+04 2.220E+04 2.218E+04 2.215E+04 2.212E+04 2.208E+04 2.204E+04
2.199E+04 2.194E+04 2.190E+04
    xe      5.987E+05 5.987E+05 5.987E+05 5.987E+05 5.987E+05 5.987E+05 5.988E+05 5.988E+05 5.988E+05
5.988E+05 5.988E+05 5.988E+05
    cs      3.206E+05 3.206E+05 3.206E+05 3.206E+05 3.206E+05 3.207E+05 3.207E+05 3.208E+05 3.208E+05
3.209E+05 3.209E+05 3.209E+05
    ba      1.652E+05 1.652E+05 1.652E+05 1.652E+05 1.652E+05 1.652E+05 1.651E+05 1.651E+05 1.650E+05
1.650E+05 1.649E+05 1.648E+05
    la      1.380E+05 1.380E+05 1.380E+05 1.380E+05 1.380E+05 1.380E+05 1.380E+05 1.380E+05 1.380E+05
1.380E+05 1.380E+05 1.380E+05
    ce      2.980E+05 2.980E+05 2.979E+05 2.979E+05 2.979E+05 2.979E+05 2.978E+05 2.977E+05 2.977E+05
2.975E+05 2.974E+05 2.972E+05
    pr      1.242E+05 1.242E+05 1.242E+05 1.242E+05 1.242E+05 1.243E+05 1.243E+05 1.243E+05 1.243E+05
1.244E+05 1.244E+05 1.244E+05
    nd      4.308E+05 4.308E+05 4.308E+05 4.308E+05 4.308E+05 4.309E+05 4.309E+05 4.310E+05 4.311E+05
4.313E+05 4.315E+05 4.317E+05
    pm      1.721E+04 1.721E+04 1.721E+04 1.720E+04 1.720E+04 1.719E+04 1.718E+04 1.717E+04 1.717E+04
1.716E+04 1.716E+04 1.716E+04
    sm      7.855E+04 7.855E+04 7.855E+04 7.856E+04 7.857E+04 7.858E+04 7.859E+04 7.862E+04 7.864E+04
7.869E+04 7.872E+04 7.876E+04
    eu      1.604E+04 1.604E+04 1.604E+04 1.604E+04 1.604E+04 1.604E+04 1.604E+04 1.604E+04 1.603E+04
1.601E+04 1.599E+04 1.597E+04
    gd      1.165E+04 1.165E+04 1.166E+04 1.166E+04 1.166E+04 1.167E+04 1.168E+04 1.169E+04 1.171E+04
1.173E+04 1.176E+04 1.178E+04
    tb      2.465E+02 2.465E+02 2.465E+02 2.465E+02 2.465E+02 2.465E+02 2.465E+02 2.464E+02 2.463E+02
2.461E+02 2.460E+02 2.458E+02
    dy      1.076E+02 1.076E+02 1.076E+02 1.076E+02 1.077E+02 1.077E+02 1.078E+02 1.079E+02 1.080E+02
1.082E+02 1.084E+02 1.085E+02
    ho      7.679E+00 7.679E+00 7.678E+00 7.678E+00 7.678E+00 7.676E+00 7.676E+00 7.675E+00 7.674E+00
7.674E+00 7.673E+00 7.673E+00
    er      2.553E+00 2.553E+00 2.554E+00 2.554E+00 2.555E+00 2.556E+00 2.557E+00 2.558E+00 2.559E+00
2.560E+00 2.561E+00 2.561E+00
    tm      4.377E-02 4.377E-02 4.378E-02 4.378E-02 4.378E-02 4.379E-02 4.380E-02 4.380E-02 4.381E-02
4.381E-02 4.380E-02 4.379E-02
    yb      4.437E-02 4.438E-02 4.438E-02 4.439E-02 4.440E-02 4.443E-02 4.445E-02 4.450E-02 4.455E-02
4.463E-02 4.471E-02 4.478E-02
    lu      1.093E-12 1.084E-12 1.070E-12 1.048E-12 1.030E-12 9.792E-13 9.306E-13 8.406E-13 7.593E-13
6.196E-13 5.056E-13 4.127E-13
  totals    3.864E+06 3.864E+06 3.864E+06 3.864E+06 3.864E+06 3.864E+06 3.864E+06 3.864E+06 3.864E+06
3.864E+06 3.864E+06 3.864E+06
□
   Fukushima Daiichi 4                                                                   fission
products          page   83
decay, following irradiation identified by: power=  25.00mw, burnup=  39500.mwd, flux=
4.05E+13n/cm**2-sec

                                               element radioactivity, curies
                                               basis = full core inventory 548 assemblies (94t
              initial     12.0 h     15.0 h     20.0 h     24.0 h     36.0 h     48.0 h     72.0 h     96.0 h
144.0 h    192.0 h   240.0 h
     h      6.404E+04 6.403E+04 6.403E+04 6.403E+04 6.403E+04 6.402E+04 6.402E+04 6.401E+04 6.400E+04
6.398E+04 6.396E+04 6.394E+04
    be      2.364E-02 2.364E-02 2.364E-02 2.364E-02 2.364E-02 2.364E-02 2.364E-02 2.364E-02 2.364E-02
2.364E-02 2.364E-02 2.364E-02
     c      1.437E+00 1.437E+00 1.437E+00 1.437E+00 1.437E+00 1.437E+00 1.437E+00 1.437E+00 1.437E+00
1.437E+00 1.437E+00 1.437E+00
    ni      7.705E+00 7.512E+00 7.231E+00 6.786E+00 6.450E+00 5.539E+00 4.756E+00 3.507E+00 2.586E+00
1.406E+00 7.644E-01 4.156E-01
    cu      4.463E+01 4.362E+01 4.214E+01 3.979E+01 3.801E+01 3.312E+01 2.887E+01 2.193E+01 1.666E+01
9.624E+00 5.562E+00 3.217E+00
    zn      1.201E+03 1.162E+03 1.108E+03 1.026E+03 9.654E+02 8.064E+02 6.742E+02 4.714E+02 3.296E+02
1.612E+02 7.883E+01 3.855E+01
    ga      2.178E+03 1.958E+03 1.715E+03 1.455E+03 1.323E+03 1.082E+03 9.183E+02 6.604E+02 4.681E+02
2.309E+02 1.131E+02 5.532E+01
    ge      2.852E+04 2.361E+04 1.884E+04 1.358E+04 1.057E+04 5.028E+03 2.402E+03 5.505E+02 1.263E+02
6.655E+00 3.580E-01 2.562E-02
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as	1.267E+05	1.140E+05	1.038E+05	9.432E+04	8.837E+04	7.263E+04	5.925E+04	3.897E+04	2.546E+04	1.081E+04	4.584E+03	1.945E+03
se	9.084E+02	4.733E+02	3.439E+02	3.064E+02	2.882E+02	2.387E+02	1.964E+02	1.321E+02	8.924E+01	4.265E+01	2.281E+01	1.438E+01
br	6.055E+05	4.123E+05	2.644E+05	1.725E+05	1.451E+05	1.090E+05	8.595E+04	5.365E+04	3.349E+04	1.305E+04	5.085E+03	1.982E+03
kr	8.846E+06	6.169E+06	3.826E+06	2.100E+06	1.553E+06	1.118E+06	1.064E+06	1.055E+06	1.055E+06	1.054E+06	1.054E+06	1.054E+06
rb	3.825E+06	2.399E+06	1.225E+06	4.544E+05	2.533E+05	1.363E+05	1.277E+05	1.227E+05	1.183E+05	1.098E+05	1.019E+05	9.461E+04
sr	9.968E+07	9.286E+07	8.534E+07	7.706E+07	7.263E+07	6.521E+07	6.196E+07	5.955E+07	5.856E+07	5.714E+07	5.582E+07	5.454E+07
y	1.702E+08	1.547E+08	1.365E+08	1.161E+08	1.056E+08	8.924E+07	8.261E+07	7.804E+07	7.650E+07	7.472E+07	7.314E+07	7.161E+07
zr	1.708E+08	1.653E+08	1.577E+08	1.469E+08	1.398E+08	1.240E+08	1.141E+08	1.039E+08	9.936E+07	9.552E+07	9.323E+07	9.120E+07
nb	2.443E+08	2.332E+08	2.182E+08	1.970E+08	1.828E+08	1.520E+08	1.330E+08	1.140E+08	1.072E+08	1.035E+08	1.027E+08	1.022E+08
mo	1.053E+08	1.031E+08	9.987E+07	9.476E+07	9.085E+07	8.008E+07	7.059E+07	5.485E+07	4.262E+07	2.573E+07	1.553E+07	9.377E+06
tc	9.889E+07	9.740E+07	9.500E+07	9.080E+07	8.737E+07	7.739E+07	6.832E+07	5.311E+07	4.127E+07	2.491E+07	1.504E+07	9.081E+06
ru	1.679E+08	1.632E+08	1.584E+08	1.538E+08	1.518E+08	1.493E+08	1.481E+08	1.461E+08	1.443E+08	1.406E+08	1.371E+08	1.337E+08
rh	2.219E+08	2.184E+08	2.137E+08	2.069E+08	2.021E+08	1.900E+08	1.804E+08	1.663E+08	1.568E+08	1.454E+08	1.389E+08	1.343E+08
pd	1.591E+07	1.442E+07	1.245E+07	9.746E+06	8.018E+06	4.478E+06	2.514E+06	8.070E+05	2.671E+05	3.306E+04	4.993E+03	9.815E+02
ag	2.092E+07	1.932E+07	1.721E+07	1.432E+07	1.247E+07	8.661E+06	6.481E+06	4.410E+06	3.558E+06	2.798E+06	2.341E+06	1.981E+06
cd	6.100E+05	5.789E+05	5.452E+05	5.048E+05	4.786E+05	4.124E+05	3.566E+05	2.680E+05	2.030E+05	1.202E+05	7.548E+04	5.113E+04
in	7.276E+05	6.592E+05	5.918E+05	5.277E+05	4.945E+05	4.204E+05	3.598E+05	2.636E+05	1.931E+05	1.037E+05	5.567E+04	2.988E+04
sn	1.240E+06	1.145E+06	1.067E+06	9.963E+05	9.565E+05	8.633E+05	7.910E+05	6.865E+05	6.154E+05	5.226E+05	4.593E+05	4.095E+05
sb	1.117E+07	9.935E+06	8.633E+06	7.339E+06	6.737E+06	5.812E+06	5.300E+06	4.537E+06	3.923E+06	2.987E+06	2.334E+06	1.878E+06
te	1.128E+08	1.095E+08	1.053E+08	9.938E+07	9.531E+07	8.490E+07	7.612E+07	6.177E+07	5.065E+07	3.501E+07	2.505E+07	1.857E+07
i	2.870E+08	2.706E+08	2.497E+08	2.223E+08	2.051E+08	1.683E+08	1.440E+08	1.125E+08	9.227E+07	6.678E+07	5.065E+07	3.929E+07
xe	1.904E+08	1.867E+08	1.801E+08	1.684E+08	1.595E+08	1.378E+08	1.234E+08	1.054E+08	9.242E+07	7.144E+07	5.504E+07	4.237E+07
cs	3.074E+07	3.062E+07	3.050E+07	3.040E+07	3.034E+07	3.022E+07	3.011E+07	2.990E+07	2.970E+07	2.933E+07	2.899E+07	2.868E+07
ba	1.189E+08	1.179E+08	1.169E+08	1.156E+08	1.147E+08	1.119E+08	1.092E+08	1.040E+08	9.907E+07	9.001E+07	8.187E+07	7.458E+07
la	1.329E+08	1.264E+08	1.202E+08	1.149E+08	1.127E+08	1.096E+08	1.075E+08	1.032E+08	9.868E+07	8.952E+07	8.074E+07	7.262E+07
ce	2.633E+08	2.600E+08	2.552E+08	2.479E+08	2.425E+08	2.286E+08	2.176E+08	2.017E+08	1.912E+08	1.789E+08	1.717E+08	1.666E+08
pr	2.007E+08	1.961E+08	1.911E+08	1.852E+08	1.822E+08	1.773E+08	1.747E+08	1.707E+08	1.669E+08	1.591E+08	1.517E+08	1.449E+08
nd	4.082E+07	4.036E+07	3.990E+07	3.933E+07	3.891E+07	3.770E+07	3.653E+07	3.429E+07	3.219E+07	2.838E+07	2.501E+07	2.204E+07
pm	7.229E+07	7.084E+07	6.875E+07	6.548E+07	6.305E+07	5.660E+07	5.123E+07	4.296E+07	3.705E+07	2.958E+07	2.536E+07	2.285E+07
sm	2.987E+07	2.890E+07	2.752E+07	2.540E+07	2.385E+07	1.981E+07	1.650E+07	1.150E+07	8.034E+06	3.930E+06	1.931E+06	9.574E+05
eu	2.084E+07	2.067E+07	2.043E+07	2.007E+07	1.981E+07	1.915E+07	1.860E+07	1.768E+07	1.689E+07	1.548E+07	1.421E+07	1.305E+07
gd	2.745E+05	2.548E+05	2.278E+05	1.890E+05	1.628E+05	1.041E+05	6.656E+04	2.728E+04	1.125E+04	2.036E+03	5.010E+02	2.444E+02
tb	1.447E+05	1.440E+05	1.430E+05	1.413E+05	1.400E+05	1.362E+05	1.325E+05	1.257E+05	1.195E+05	1.086E+05	9.949E+04	9.183E+04
dy	1.778E+03	1.269E+03	8.905E+02	6.692E+02	6.091E+02	5.349E+02	4.826E+02	3.936E+02	3.210E+02	2.135E+02	1.420E+02	9.449E+01
ho	4.413E+03	4.216E+03	3.943E+03	3.536E+03	3.246E+03	2.529E+03	1.990E+03	1.269E+03	8.455E+02	4.242E+02	2.422E+02	1.496E+02
er	8.337E+01	8.168E+01	7.944E+01	7.630E+01	7.419E+01	6.908E+01	6.500E+01	5.829E+01	5.274E+01	4.387E+01	3.702E+01	3.152E+01
tm	5.721E+01	5.710E+01	5.692E+01	5.658E+01	5.629E+01	5.531E+01	5.422E+01	5.188E+01	4.954E+01	4.535E+01	4.209E+01	3.969E+01
yb	2.774E-04	2.769E-04	2.761E-04	2.749E-04	2.739E-04	2.709E-04	2.680E-04	2.623E-04	2.567E-04	2.458E-04	2.354E-04	2.254E-04
lu	1.220E-07	1.210E-07	1.195E-07	1.170E-07	1.150E-07	1.093E-07	1.038E-07	9.375E-08	8.466E-08	6.904E-08	5.631E-08	4.593E-08
totals	2.844E+09	2.742E+09	2.617E+09	2.454E+09	2.352E+09	2.131E+09	1.982E+09	1.784E+09	1.652E+09			

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1.473E+09 1.350E+09 1.258E+09

    Fukushima Daiichi 4                                                                    fission
products          page   84
decay, following irradiation identified by: power=  25.00mw, burnup=  39500.mwd, flux=
4.05E+13n/cm**2-sec

                                                  element thermal power, watts
                                                  basis = full core inventory 548 assemblies (94t
           initial     12.0 h    15.0 h     20.0 h     24.0 h     36.0 h     48.0 h     72.0 h     96.0 h
144.0 h   192.0 h   240.0 h
     h     2.160E+00 2.160E+00 2.160E+00 2.160E+00 2.160E+00 2.159E+00 2.159E+00 2.159E+00 2.159E+00
2.158E+00 2.157E+00 2.157E+00
    be     2.842E-05 2.842E-05 2.842E-05 2.842E-05 2.842E-05 2.842E-05 2.842E-05 2.842E-05 2.842E-05
2.841E-05 2.841E-05 2.841E-05
     c     4.214E-04 4.214E-04 4.214E-04 4.214E-04 4.214E-04 4.214E-04 4.214E-04 4.214E-04 4.214E-04
4.214E-04 4.214E-04 4.214E-04
    ni     2.969E-03 2.894E-03 2.786E-03 2.615E-03 2.485E-03 2.134E-03 1.833E-03 1.351E-03 9.963E-04
5.417E-04 2.945E-04 1.601E-04
    cu     1.121E-01 1.094E-01 1.056E-01 9.950E-02 9.487E-02 8.225E-02 7.131E-02 5.361E-02 4.032E-02
2.283E-02 1.294E-02 7.346E-03
    zn     1.958E+00 1.858E+00 1.735E+00 1.577E+00 1.473E+00 1.222E+00 1.020E+00 7.132E-01 4.987E-01
2.439E-01 1.193E-01 5.832E-02
    ga     2.971E+01 2.842E+01 2.686E+01 2.485E+01 2.355E+01 2.027E+01 1.740E+01 1.255E+01 8.895E+00
4.387E+00 2.149E+00 1.051E+00
    ge     2.557E+02 2.216E+02 1.823E+02 1.335E+02 1.044E+02 5.000E+01 2.395E+01 5.494E+00 1.260E+00
6.634E-02 3.493E-03 1.842E-04
    as     4.312E+02 2.797E+02 1.856E+02 1.418E+02 1.294E+02 1.051E+02 8.536E+01 5.572E+01 3.619E+01
1.523E+01 6.423E+00 2.714E+00
    se     1.674E+00 6.338E-01 3.413E-01 2.848E-01 2.670E-01 2.202E-01 1.803E-01 1.197E-01 7.921E-02
3.525E-02 1.652E-02 8.574E-03
    br     3.826E+03 3.344E+03 2.907E+03 2.503E+03 2.286E+03 1.795E+03 1.418E+03 8.850E+02 5.525E+02
2.153E+02 8.389E+01 3.269E+01
    kr     5.659E+04 3.583E+04 1.873E+04 7.207E+03 3.963E+03 1.800E+03 1.608E+03 1.582E+03 1.582E+03
1.581E+03 1.581E+03 1.580E+03
    rb     5.986E+04 3.697E+04 1.812E+04 5.761E+03 2.541E+03 6.898E+02 5.806E+02 5.540E+02 5.338E+02
4.955E+02 4.600E+02 4.270E+02
    sr     5.061E+05 4.495E+05 3.881E+05 3.214E+05 2.864E+05 2.285E+05 2.042E+05 1.881E+05 1.833E+05
1.782E+05 1.736E+05 1.692E+05
     y     9.604E+05 8.387E+05 6.990E+05 5.486E+05 4.750E+05 3.672E+05 3.263E+05 2.998E+05 2.923E+05
2.854E+05 2.796E+05 2.741E+05
    zr     8.759E+05 8.466E+05 8.069E+05 7.505E+05 7.128E+05 6.300E+05 5.783E+05 5.247E+05 5.013E+05
4.815E+05 4.700E+05 4.597E+05
    nb     1.287E+06 1.224E+06 1.140E+06 1.020E+06 9.399E+05 7.661E+05 6.594E+05 5.514E+05 5.133E+05
4.928E+05 4.887E+05 4.865E+05
    mo     4.215E+05 4.128E+05 4.000E+05 3.795E+05 3.638E+05 3.207E+05 2.827E+05 2.197E+05 1.707E+05
1.030E+05 6.220E+04 3.755E+04
    tc     9.250E+04 9.110E+04 8.886E+04 8.493E+04 8.172E+04 7.239E+04 6.390E+04 4.968E+04 3.860E+04
2.330E+04 1.407E+04 8.494E+03
    ru     4.711E+05 4.398E+05 4.076E+05 3.778E+05 3.656E+05 3.516E+05 3.469E+05 3.405E+05 3.346E+05
3.231E+05 3.120E+05 3.012E+05
    rh     5.489E+05 5.444E+05 5.386E+05 5.301E+05 5.241E+05 5.085E+05 4.961E+05 4.783E+05 4.667E+05
4.537E+05 4.473E+05 4.433E+05
    pd     3.197E+04 2.891E+04 2.487E+04 1.936E+04 1.584E+04 8.694E+03 4.779E+03 1.453E+03 4.471E+02
4.474E+01 5.054E+00 6.866E-01
    ag     4.189E+04 3.964E+04 3.660E+04 3.231E+04 2.947E+04 2.319E+04 1.915E+04 1.458E+04 1.230E+04
1.011E+04 8.932E+03 8.070E+03
    cd     2.171E+03 1.958E+03 1.759E+03 1.574E+03 1.478E+03 1.268E+03 1.098E+03 8.300E+02 6.332E+02
3.823E+02 2.464E+02 1.722E+02
    in     1.782E+03 1.515E+03 1.270E+03 1.068E+03 9.829E+02 8.264E+02 7.069E+02 5.178E+02 3.793E+02
2.038E+02 1.094E+02 5.870E+01
    sn     6.504E+03 5.502E+03 4.811E+03 4.424E+03 4.306E+03 4.104E+03 3.939E+03 3.648E+03 3.396E+03
2.965E+03 2.604E+03 2.294E+03
    sb     8.888E+04 7.574E+04 6.193E+04 4.838E+04 4.225E+04 3.371E+04 2.988E+04 2.507E+04 2.143E+04
1.595E+04 1.213E+04 9.454E+03
    te     3.165E+05 3.038E+05 2.878E+05 2.659E+05 2.510E+05 2.145E+05 1.854E+05 1.417E+05 1.110E+05
7.237E+04 5.026E+04 3.672E+04
     i     2.711E+06 2.548E+06 2.347E+06 2.087E+06 1.927E+06 1.591E+06 1.366E+06 1.061E+06 8.500E+05
5.706E+05 3.954E+05 2.792E+05
    xe     3.421E+05 3.310E+05 3.110E+05 2.754E+05 2.485E+05 1.870E+05 1.513E+05 1.181E+05 1.014E+05
7.786E+04 5.990E+04 4.607E+04
    cs     2.124E+05 2.121E+05 2.116E+05 2.110E+05 2.105E+05 2.092E+05 2.079E+05 2.053E+05 2.029E+05
1.985E+05 1.944E+05 1.908E+05
    ba     3.655E+05 3.608E+05 3.571E+05 3.532E+05 3.504E+05 3.421E+05 3.341E+05 3.188E+05 3.042E+05
2.774E+05 2.533E+05 2.317E+05
    la     2.028E+06 1.978E+06 1.934E+06 1.894E+06 1.875E+06 1.838E+06 1.804E+06 1.732E+06 1.657E+06
1.503E+06 1.355E+06 1.219E+06
    ce     5.265E+05 5.130E+05 4.938E+05 4.643E+05 4.428E+05 3.878E+05 3.447E+05 2.842E+05 2.465E+05
2.069E+05 1.888E+05 1.788E+05
```

pr	8.918E+05	8.729E+05	8.524E+05	8.281E+05	8.159E+05	7.970E+05	7.884E+05	7.776E+05	7.685E+05	7.514E+05	7.353E+05	7.203E+05
nd	1.000E+05	9.822E+04	9.673E+04	9.520E+04	9.418E+04	9.124E+04	8.841E+04	8.300E+04	7.792E+04	6.868E+04	6.053E+04	5.335E+04
pm	2.339E+05	2.291E+05	2.223E+05	2.118E+05	2.040E+05	1.833E+05	1.658E+05	1.383E+05	1.180E+05	9.049E+04	7.314E+04	6.141E+04
sm	5.920E+04	5.728E+04	5.454E+04	5.034E+04	4.726E+04	3.925E+04	3.269E+04	2.277E+04	1.588E+04	7.740E+03	3.773E+03	1.840E+03
eu	1.989E+05	1.978E+05	1.962E+05	1.938E+05	1.919E+05	1.868E+05	1.822E+05	1.738E+05	1.662E+05	1.521E+05	1.393E+05	1.277E+05
gd	5.888E+02	5.465E+02	4.886E+02	4.054E+02	3.492E+02	2.231E+02	1.426E+02	5.829E+01	2.389E+01	4.121E+00	8.286E-01	2.795E-01
tb	7.097E+02	7.084E+02	7.063E+02	7.030E+02	7.004E+02	6.927E+02	6.852E+02	6.710E+02	6.577E+02	6.333E+02	6.115E+02	5.920E+02
dy	3.934E+00	2.522E+00	1.486E+00	9.063E-01	7.700E-01	6.527E-01	5.882E-01	4.797E-01	3.912E-01	2.602E-01	1.731E-01	1.151E-01
ho	1.896E+01	1.812E+01	1.695E+01	1.520E+01	1.396E+01	1.088E+01	8.557E+00	5.460E+00	3.636E+00	1.825E+00	1.042E+00	6.436E-01
er	1.201E-01	1.142E-01	1.066E-01	9.674E-02	9.057E-02	7.743E-02	6.847E-02	5.575E-02	4.654E-02	3.409E-02	2.632E-02	2.114E-02
tm	1.777E-01	1.771E-01	1.761E-01	1.743E-01	1.727E-01	1.672E-01	1.610E-01	1.478E-01	1.345E-01	1.109E-01	9.278E-02	7.982E-02
yb	7.058E-07	7.046E-07	7.027E-07	6.995E-07	6.970E-07	6.895E-07	6.821E-07	6.675E-07	6.532E-07	6.255E-07	5.990E-07	5.736E-07
lu	1.421E-09	1.409E-09	1.391E-09	1.362E-09	1.339E-09	1.271E-09	1.208E-09	1.090E-09	9.830E-10	8.002E-10	6.514E-10	5.303E-10
totals	1.344E+07	1.278E+07	1.201E+07	1.107E+07	1.051E+07	9.388E+06	8.673E+06	7.759E+06	7.162E+06	6.351E+06	5.784E+06	5.349E+06

Lee, Richard

From: Wagner, John C. [wagnerjc@ornl.gov]
Sent: Friday, March 18, 2011 2:27 PM
To: Carlson, Donald
Cc: Lee, Richard; Tinkler, Charles; Parks, Cecil V.; Busby, Jeremy T.
Subject: RE: FW:
Attachments: Issue Table.doc

Don,
let me know if this works

From: Carlson, Donald [Donald.Carlson@nrc.gov]
Sent: Friday, March 18, 2011 2:17 PM
To: Wagner, John C.
Cc: Lee, Richard; Tinkler, Charles; Parks, Cecil V.; Busby, Jeremy T.
Subject: RE: FW:

Our e-mail security prevents us from viewing table formats, etc. Can you do a screen shot and pdf it?

Thanks

-----Original Message-----
From: Wagner, John C. [mailto:wagnerjc@ornl.gov]
Sent: Friday, March 18, 2011 2:07 PM
To: Carlson, Donald; Carlson, Donald
Cc: Lee, Richard; Tinkler, Charles; Parks, Cecil V.; Busby, Jeremy T.
Subject: FW:

Don,
per our phone conversation, here is the table I mentioned that could be flushed out into something to support decision making. Please recognize that this was just a rough strawman for consdieration of worthiness to flush out. After taking briefly with Cecil, we plan to have folks here work on flushing this out.

Best Regards,
John

From: Wagner, John C.
Sent: Friday, March 18, 2011 12:06 PM
To: Parks, Cecil V.
Subject:

Cecil,
If we think there is some likelihood that entombment of the spent fuel pools will be considered and we have time to get input from experts, I think we need to develop a set of relevant characteristics that we try to optimize on. Although I cannot develop this on my own - I don't have all the needed knowledge/expertise - I can offer a strawman that could be flushed out. this is very rough. if you think I/we should flush this out, let me know asap. i have not discussed this with anyone else

Issue

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Importance

Desired characteristic to consider

Near or longer term concern

Thermal

High

Maximum thermal conductivity; water or substance that supports convection best

Both

Chemical reactions with fuel/clad

High

Minimize to extent possible, no exothermic reactions

Both

Criticality safety

Medium to Low

maximize neutron absorption to extent possible; inclusion of Boron

Both

Confinement

High to Medium

Maximize confinement of contamination

Both

Post-crisis clean-up

Medium to High

Potential for airborne contamination; structural integrity

Long

Post-crisis integrity

Medium to High

Potential to continue maintaining functionality

Long

Structural

High

Minimize weight, particularly if structural integrity of pool walls and supporting structures are in question

Both

Radiation dose

Medium to Low

Maximize gamma and, to a lesser extent, neutron attenuation

Both

Premise for table: If there is some likelihood that entombment of the spent fuel pools will be considered and we have time to get input from experts, we should develop a set of relevant characteristics to support selecting the optimal material to be used.

DRAFT table to support material selection

Issue	**Importance**	**Desired characteristic to consider**	**Near or longer term concern**
Thermal	High	Maximum thermal conductivity; water or substance that supports convection best	Both
Chemical reactions with fuel/clad	High	Minimize to extent possible, no exothermic reactions	Both
Criticality safety	Medium to Low	maximize neutron absorption to extent possible; inclusion of Boron	Both
Confinement	High to Medium	Maximize confinement of contamination	Both
Post-crisis clean-up	Medium to High	Potential for airborne contamination; structural integrity	Long
Post-crisis integrity	Medium to High	Potential to continue maintaining functionality	Long
Structural	High	Minimize weight, particularly if structural integrity of pool walls and supporting structures are in question	Both
Radiation dose	Medium to Low	Maximize gamma and, to a lesser extent, neutron attenuation	Both

Lee, Richard

From: Gauld, Ian C. [gauldi@ornl.gov]
Sent: Friday, March 18, 2011 1:58 PM
To: Lee, Richard
Cc: Parks, Cecil V.
Subject: RE: Fukushima
Attachments: F4-reactor.txt

Richard

Attached are Fukushima 4 data that can be applied to MELCOR. Inventories in grams, curies, and watts for the decay times used by MELCOR (covers up to 10 days only). Note the data are for the entire core inventory of 548 assemblies, 94 t uranium. This will cover units 2-5 (except that unit 4 was defueled). The MELCOR folks often normalize data to operating power (watts of kW). I haven't done this to keep it general. The core operating power was 2381 MW (25 MW/t). If they want me to normalize it or group by RN class I can.

For the spent fuel pools this normalization should probably not be used – it applies only to short times where source is proportional to operating power. I'll send you data for the pools shortly. It will include 550 assemblies offloaded 105 days ago, plus other longer cooled fuel. I'll send data for each group, since any fuel failures will be driven by the hottest fuel, so I don't want to underestimate by averaging with hot with cooler fuel.

These results can be modified or renormalized very quickly , depending on what you need. Just let me know.

Thanks

Ian

From: Lee, Richard [mailto:Richard.Lee@nrc.gov]
Sent: Friday, March 18, 2011 7:44 AM
To: Parks, Cecil V.
Cc: Gauld, Ian C.
Subject: RE: Fukushima

Cecil:
Sorry, I forgot. Here's they are.

(1)Could you send me the inventories scaled to each of the 6 units of Fukushima, that could be used as input to MELCOR. (MELCOR inputs organized differently than ORIGEN output)
(2) Summarize inventories (in curies) for I, Cs, etc. (lumping all isotopes for each element).
(3) Looking a the spent fuel pool, at Fukushima, what are the packing (e.g,, spacing, neutron poisons used, ,etc.,) using high densities racks vs. low densities racks. There are high density racks installed at Fukushima, but we do not know whether they been used or not. What is our educated guess?

Thanks,
Richard

From: Parks, Cecil V. [mailto:parkscv@ornl.gov]
Sent: Friday, March 18, 2011 1:30 AM
To: Lee, Richard
Subject: Fukushima

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Richard:
You were going to send me presentation you got from Corradini – would you please send?

We have done some decay heat (MOX vs. UO2) and inventory analyses in response to questions we have received. I will send you that info tomorrow.
Thanks,
Cecil

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actinides page 73
decay, following irradiation identified by: power= 25.00mw, burnup= 39500.mwd, flux=
4.05E+13n/cm**2-sec

element concentrations, grams
basis = full core inventory 548 assemblies (94t
charge discharge 2E-03 h 3E-03 h 5E-03 h 8E-03 h 2E-02 h 3E-02 h 7E-02 h
0.2 h 0.3 h 1.0 h 1.5 h 2.0 h 4.0 h 6.0 h 8.0 h 10.0 h
he 1.518E-01 5.545E+01 5.545E+01 5.545E+01 5.545E+01 5.545E+01 5.545E+01 5.545E+01 5.545E+01
5.545E+01 5.545E+01 5.545E+01 5.546E+01 5.546E+01 5.547E+01 5.548E+01 5.549E+01 5.550E+01
tl 1.279E-12 3.625E-10 3.625E-10 3.625E-10 3.625E-10 3.625E-10 3.625E-10 3.625E-10 3.625E-10
3.625E-10 3.625E-10 3.748E-10 3.626E-10 3.626E-10 3.675E-10 3.675E-10 3.675E-10 3.674E-10
pb 3.437E-07 1.404E-04 1.404E-04 1.404E-04 1.404E-04 1.404E-04 1.404E-04 1.404E-04 1.404E-04
1.404E-04 1.404E-04 1.404E-04 1.404E-04 1.404E-04 1.404E-04 1.405E-04 1.405E-04 1.405E-04
bi 1.357E-10 5.190E-08 5.190E-08 5.190E-08 5.190E-08 5.190E-08 5.190E-08 5.190E-08 5.190E-08
5.190E-08 5.190E-08 5.190E-08 5.191E-08 5.191E-08 5.192E-08 5.192E-08 5.193E-08 5.193E-08
po 2.213E-13 7.718E-11 7.718E-11 7.718E-11 7.718E-11 7.718E-11 7.718E-11 7.718E-11 7.718E-11
7.718E-11 7.719E-11 7.719E-11 7.719E-11 7.720E-11 7.721E-11 7.723E-11 7.724E-11 7.726E-11
at 6.091E-20 4.539E-17 4.540E-17 4.540E-17 4.540E-17 4.539E-17 4.539E-17 4.539E-17 4.539E-17
4.539E-17 4.539E-17 4.540E-17 4.540E-17 4.540E-17 4.543E-17 4.544E-17 4.545E-17 4.546E-17
rn 1.324E-12 3.548E-10 3.548E-10 3.548E-10 3.548E-10 3.548E-10 3.548E-10 3.548E-10 3.548E-10
3.548E-10 3.551E-10 3.549E-10 3.549E-10 3.549E-10 3.548E-10 3.548E-10 3.547E-10 3.547E-10
fr 6.986E-16 4.392E-13 4.392E-13 4.392E-13 4.392E-13 4.392E-13 4.392E-13 4.392E-13 4.392E-13
4.392E-13 4.392E-13 4.393E-13 4.393E-13 4.393E-13 4.396E-13 4.397E-13 4.398E-13 4.399E-13
ra 3.533E-08 6.747E-06 6.747E-06 6.747E-06 6.747E-06 6.747E-06 6.747E-06 6.747E-06 6.747E-06
6.747E-06 6.747E-06 6.747E-06 6.747E-06 6.747E-06 6.747E-06 6.748E-06 6.748E-06 6.748E-06
ac 5.191E-09 7.170E-07 7.170E-07 7.170E-07 7.170E-07 7.170E-07 7.170E-07 7.170E-07 7.170E-07
7.170E-07 7.170E-07 7.170E-07 7.170E-07 7.170E-07 7.171E-07 7.172E-07 7.174E-07 7.175E-07
th 2.133E-03 2.484E-01 2.484E-01 2.484E-01 2.484E-01 2.484E-01 2.484E-01 2.484E-01 2.484E-01
2.484E-01 2.484E-01 2.484E-01 2.484E-01 2.484E-01 2.484E-01 2.484E-01 2.484E-01 2.484E-01
pa 3.415E-04 5.130E-02 5.130E-02 5.130E-02 5.130E-02 5.130E-02 5.130E-02 5.130E-02 5.130E-02
5.130E-02 5.130E-02 5.130E-02 5.130E-02 5.130E-02 5.131E-02 5.131E-02 5.131E-02 5.131E-02
u 9.649E+05 8.925E+07 8.925E+07 8.925E+07 8.925E+07 8.925E+07 8.925E+07 8.925E+07 8.925E+07
8.925E+07 8.925E+07 8.925E+07 8.925E+07 8.925E+07 8.925E+07 8.925E+07 8.925E+07 8.924E+07
np 2.870E+02 4.931E+04 4.931E+04 4.931E+04 4.931E+04 4.931E+04 4.931E+04 4.931E+04 4.931E+04
4.931E+04 4.931E+04 4.927E+04 4.924E+04 4.921E+04 4.908E+04 4.895E+04 4.882E+04 4.870E+04
pu 7.185E+03 8.213E+05 8.213E+05 8.213E+05 8.213E+05 8.213E+05 8.213E+05 8.213E+05 8.213E+05
8.213E+05 8.213E+05 8.214E+05 8.214E+05 8.215E+05 8.216E+05 8.217E+05 8.219E+05 8.220E+05
am 6.734E+01 1.728E+04 1.728E+04 1.728E+04 1.728E+04 1.728E+04 1.728E+04 1.728E+04 1.728E+04
1.728E+04 1.728E+04 1.728E+04 1.728E+04 1.728E+04 1.728E+04 1.728E+04 1.728E+04 1.728E+04
cm 1.137E+01 5.389E+03 5.389E+03 5.389E+03 5.389E+03 5.389E+03 5.389E+03 5.389E+03 5.389E+03
5.389E+03 5.389E+03 5.389E+03 5.390E+03 5.390E+03 5.391E+03 5.392E+03 5.392E+03 5.393E+03
bk 1.175E-08 8.000E-05 8.000E-05 8.000E-05 8.000E-05 8.000E-05 8.000E-05 8.000E-05 8.000E-05
8.000E-05 8.001E-05 8.001E-05 8.001E-05 8.001E-05 7.999E-05 7.997E-05 7.995E-05 7.993E-05
cf 7.074E-09 5.351E-05 5.351E-05 5.351E-05 5.351E-05 5.351E-05 5.351E-05 5.351E-05 5.351E-05
5.351E-05 5.352E-05 5.353E-05 5.354E-05 5.355E-05 5.358E-05 5.361E-05 5.363E-05 5.365E-05
es 2.726E-13 9.931E-09 9.931E-09 9.931E-09 9.931E-09 9.931E-09 9.931E-09 9.931E-09 9.931E-09
9.932E-09 9.932E-09 9.935E-09 9.937E-09 9.939E-09 9.947E-09 9.954E-09 9.962E-09 9.969E-09
totals 9.724E+05 9.014E+07 9.014E+07 9.014E+07 9.014E+07 9.014E+07 9.014E+07 9.014E+07 9.014E+07
9.014E+07 9.014E+07 9.014E+07 9.014E+07 9.014E+07 9.014E+07 9.014E+07 9.014E+07 9.014E+07

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decay, following irradiation identified by: power= 25.00mw, burnup= 39500.mwd, flux=
4.05E+13n/cm**2-sec

element radioactivity, curies
basis = full core inventory 548 assemblies (94t
charge discharge 2E-03 h 3E-03 h 5E-03 h 8E-03 h 2E-02 h 3E-02 h 7E-02 h
0.2 h 0.3 h 1.0 h 1.5 h 2.0 h 4.0 h 6.0 h 8.0 h 10.0 h
tl 3.786E-04 1.073E-01 1.073E-01 1.073E-01 1.073E-01 1.073E-01 1.073E-01 1.073E-01 1.073E-01
1.073E-01 1.073E-01 1.110E-01 1.074E-01 1.074E-01 1.088E-01 1.088E-01 1.088E-01 1.088E-01
pb 1.053E-03 2.986E-01 2.986E-01 2.986E-01 2.986E-01 2.986E-01 2.986E-01 2.986E-01 2.986E-01
2.986E-01 2.986E-01 2.986E-01 2.986E-01 2.986E-01 2.986E-01 2.985E-01 2.985E-01 2.985E-01
bi 1.053E-03 2.986E-01 2.986E-01 2.986E-01 2.986E-01 2.986E-01 2.986E-01 2.986E-01 2.986E-01
2.986E-01 2.986E-01 2.987E-01 2.987E-01 2.987E-01 2.987E-01 2.987E-01 2.987E-01 2.987E-01
po 1.727E-03 4.898E-01 4.906E-01 4.906E-01 4.906E-01 4.906E-01 4.905E-01 4.904E-01 4.902E-01 4.900E-01
4.898E-01 4.901E-01 4.899E-01 4.899E-01 4.899E-01 4.899E-01 4.899E-01 4.898E-01 4.898E-01
at 9.808E-08 7.309E-05 7.310E-05 7.310E-05 7.310E-05 7.310E-05 7.310E-05 7.310E-05 7.310E-05
7.309E-05 7.309E-05 7.310E-05 7.311E-05 7.311E-05 7.316E-05 7.317E-05 7.319E-05 7.321E-05
rn 1.053E-03 2.986E-01 2.986E-01 2.986E-01 2.986E-01 2.986E-01 2.986E-01 2.986E-01 2.986E-01
2.986E-01 2.988E-01 2.986E-01 2.986E-01 2.986E-01 2.985E-01 2.985E-01 2.985E-01 2.984E-01
fr 1.033E-07 7.380E-05 7.380E-05 7.380E-05 7.380E-05 7.380E-05 7.380E-05 7.380E-05 7.380E-05
7.380E-05 7.381E-05 7.381E-05 7.382E-05 7.382E-05 7.387E-05 7.389E-05 7.391E-05 7.392E-05
ra 1.053E-03 2.986E-01 2.986E-01 2.986E-01 2.986E-01 2.986E-01 2.986E-01 2.986E-01 2.986E-01
2.986E-01 2.986E-01 2.986E-01 2.986E-01 2.986E-01 2.986E-01 2.985E-01 2.985E-01 2.985E-01
ac 4.736E-07 2.091E-03 2.090E-03 2.090E-03 2.089E-03 2.089E-03 2.087E-03 2.083E-03 2.076E-03

```
2.053E-03 2.019E-03 1.881E-03 1.785E-03 1.694E-03 1.377E-03 1.125E-03 9.228E-04 7.619E-04
     th      3.482E-01 1.139E+02 1.139E+02 1.139E+02 1.139E+02 1.139E+02 1.138E+02 1.137E+02 1.135E+02
1.130E+02 1.123E+02 1.100E+02 1.088E+02 1.077E+02 1.036E+02 9.977E+01 9.615E+01 9.272E+01
     pa      5.183E-01 1.173E+02 1.173E+02 1.172E+02 1.172E+02 1.172E+02 1.171E+02 1.170E+02 1.169E+02
1.168E+02 1.166E+02 1.157E+02 1.151E+02 1.145E+02 1.122E+02 1.099E+02 1.078E+02 1.057E+02
      u      6.271E+03 1.394E+09 1.390E+09 1.386E+09 1.382E+09 1.375E+09 1.354E+09 1.318E+09 1.244E+09
1.046E+09 8.009E+08 2.820E+08 1.481E+08 9.286E+07 5.483E+07 5.329E+07 5.281E+07 5.236E+07
     np      6.598E+01 1.367E+09 1.367E+09 1.367E+09 1.367E+09 1.367E+09 1.367E+09 1.367E+09 1.367E+09
1.366E+09 1.365E+09 1.357E+09 1.349E+09 1.341E+09 1.309E+09 1.277E+09 1.246E+09 1.216E+09
     pu      8.515E+04 4.181E+07 4.180E+07 4.180E+07 4.179E+07 4.177E+07 4.174E+07 4.167E+07 4.153E+07
4.109E+07 4.044E+07 3.784E+07 3.605E+07 3.438E+07 2.876E+07 2.452E+07 2.131E+07 1.888E+07
     am      1.278E+02 1.730E+07 1.730E+07 1.730E+07 1.730E+07 1.729E+07 1.729E+07 1.727E+07 1.724E+07
1.713E+07 1.698E+07 1.634E+07 1.587E+07 1.543E+07 1.376E+07 1.229E+07 1.098E+07 9.811E+06
     cm      1.713E+04 5.099E+06 5.099E+06 5.099E+06 5.099E+06 5.099E+06 5.099E+06 5.099E+06 5.099E+06
5.099E+06 5.099E+06 5.099E+06 5.099E+06 5.099E+06 5.099E+06 5.099E+06 5.099E+06 5.099E+06
     bk      1.926E-05 4.464E-01 4.462E-01 4.461E-01 4.460E-01 4.458E-01 4.452E-01 4.441E-01 4.418E-01
4.350E-01 4.247E-01 3.853E-01 3.593E-01 3.360E-01 2.642E-01 2.176E-01 1.873E-01 1.676E-01
     cf      5.202E-07 6.670E-03 6.670E-03 6.670E-03 6.670E-03 6.670E-03 6.670E-03 6.670E-03 6.670E-03
6.670E-03 6.670E-03 6.671E-03 6.672E-03 6.672E-03 6.673E-03 6.673E-03 6.673E-03 6.672E-03
     es      5.816E-09 2.051E-04 2.051E-04 2.051E-04 2.051E-04 2.051E-04 2.051E-04 2.051E-04 2.051E-04
2.051E-04 2.052E-04 2.052E-04 2.053E-04 2.053E-04 2.055E-04 2.057E-04 2.059E-04 2.061E-04
  totals     1.087E+05 2.825E+09 2.821E+09 2.817E+09 2.813E+09 2.806E+09 2.785E+09 2.749E+09 2.675E+09
2.475E+09 2.229E+09 1.698E+09 1.555E+09 1.489E+09 1.411E+09 1.372E+09 1.336E+09 1.302E+09
0
     Fukushima Daiichi 4
actinides          page   75
decay, following irradiation identified by: power=  25.00mw, burnup=  39500.mwd, flux=
4.05E+13n/cm**2-sec

                                           element thermal power, watts
                                           basis = full core inventory 548 assemblies (94t
             charge  discharge   2E-03 h   3E-03 h   5E-03 h   8E-03 h   2E-02 h   3E-02 h   7E-02 h
0.2 h     0.3 h     1.0 h     1.5 h     2.0 h     4.0 h     6.0 h     8.0 h    10.0 h
     tl      8.848E-06 2.509E-03 2.509E-03 2.509E-03 2.509E-03 2.509E-03 2.509E-03 2.509E-03 2.509E-03
2.509E-03 2.510E-03 2.594E-03 2.510E-03 2.510E-03 2.544E-03 2.544E-03 2.544E-03 2.544E-03
     pb      1.991E-06 5.647E-04 5.647E-04 5.647E-04 5.647E-04 5.647E-04 5.647E-04 5.647E-04 5.647E-04
5.647E-04 5.647E-04 5.647E-04 5.647E-04 5.647E-04 5.646E-04 5.646E-04 5.645E-04 5.645E-04
     bi      1.764E-05 5.001E-03 5.001E-03 5.001E-03 5.001E-03 5.001E-03 5.001E-03 5.001E-03 5.001E-03
5.001E-03 5.001E-03 5.002E-03 5.003E-03 5.003E-03 5.003E-03 5.003E-03 5.002E-03 5.002E-03
     po      7.888E-05 2.237E-02 2.240E-02 2.240E-02 2.240E-02 2.240E-02 2.239E-02 2.239E-02 2.238E-02
2.237E-02 2.239E-02 2.238E-02 2.238E-02 2.238E-02 2.238E-02 2.237E-02 2.237E-02 2.237E-02
     at      4.185E-09 3.119E-06 3.119E-06 3.119E-06 3.119E-06 3.119E-06 3.119E-06 3.119E-06 3.119E-06
3.119E-06 3.119E-06 3.119E-06 3.120E-06 3.120E-06 3.122E-06 3.123E-06 3.123E-06 3.124E-06
     rn      3.997E-05 1.134E-02 1.134E-02 1.134E-02 1.134E-02 1.134E-02 1.134E-02 1.134E-02 1.134E-02
1.134E-02 1.135E-02 1.134E-02 1.134E-02 1.134E-02 1.133E-02 1.133E-02 1.133E-02 1.133E-02
     fr      3.799E-09 2.823E-06 2.823E-06 2.823E-06 2.823E-06 2.823E-06 2.823E-06 2.823E-06 2.823E-06
2.823E-06 2.823E-06 2.823E-06 2.824E-06 2.824E-06 2.826E-06 2.826E-06 2.827E-06 2.828E-06
     ra      3.613E-05 1.025E-02 1.025E-02 1.025E-02 1.025E-02 1.025E-02 1.025E-02 1.025E-02 1.025E-02
1.025E-02 1.025E-02 1.025E-02 1.025E-02 1.025E-02 1.024E-02 1.024E-02 1.024E-02 1.024E-02
     ac      3.606E-09 1.791E-05 1.791E-05 1.790E-05 1.790E-05 1.788E-05 1.785E-05 1.780E-05
1.762E-05 1.735E-05 1.628E-05 1.553E-05 1.482E-05 1.235E-05 1.038E-05 8.804E-06 7.549E-06
     th      1.991E-04 1.169E-01 1.169E-01 1.169E-01 1.169E-01 1.168E-01 1.167E-01 1.165E-01 1.161E-01
1.150E-01 1.136E-01 1.100E-01 1.083E-01 1.070E-01 1.025E-01 9.828E-02 9.433E-02 9.059E-02
     pa      2.074E-03 5.969E-01 5.968E-01 5.967E-01 5.966E-01 5.964E-01 5.960E-01 5.955E-01 5.949E-01
5.939E-01 5.925E-01 5.869E-01 5.828E-01 5.787E-01 5.629E-01 5.479E-01 5.337E-01 5.201E-01
      u      1.219E+01 3.741E+06 3.730E+06 3.719E+06 3.709E+06 3.688E+06 3.633E+06 3.534E+06 3.334E+06
2.795E+06 2.131E+06 7.231E+05 3.598E+05 2.099E+05 1.070E+05 1.032E+05 1.022E+05 1.014E+05
     np      1.726E-01 3.537E+06 3.537E+06 3.537E+06 3.537E+06 3.537E+06 3.537E+06 3.537E+06 3.536E+06
3.534E+06 3.530E+06 3.505E+06 3.483E+06 3.461E+06 3.374E+06 3.292E+06 3.211E+06 3.133E+06
     pu      6.249E+01 4.719E+04 4.718E+04 4.717E+04 4.717E+04 4.715E+04 4.711E+04 4.703E+04 4.686E+04
4.637E+04 4.561E+04 4.262E+04 4.056E+04 3.864E+04 3.218E+04 2.729E+04 2.360E+04 2.081E+04
     am      3.919E+00 7.466E+04 7.465E+04 7.464E+04 7.464E+04 7.462E+04 7.458E+04 7.450E+04 7.434E+04
7.384E+04 7.307E+04 6.996E+04 6.772E+04 6.555E+04 5.758E+04 5.060E+04 4.449E+04 3.914E+04
     cm      6.243E+02 1.856E+05 1.856E+05 1.856E+05 1.856E+05 1.856E+05 1.856E+05 1.856E+05 1.856E+05
1.856E+05 1.856E+05 1.856E+05 1.856E+05 1.856E+05 1.856E+05 1.856E+05 1.856E+05 1.856E+05
     bk      3.765E-09 2.246E-03 2.245E-03 2.245E-03 2.244E-03 2.242E-03 2.238E-03 2.230E-03 2.214E-03
2.166E-03 2.094E-03 1.816E-03 1.633E-03 1.469E-03 9.634E-04 6.351E-04 4.217E-04 2.830E-04
     cf      2.704E-08 3.808E-04 3.808E-04 3.808E-04 3.808E-04 3.808E-04 3.808E-04 3.808E-04 3.808E-04
3.809E-04 3.809E-04 3.809E-04 3.809E-04 3.809E-04 3.810E-04 3.810E-04 3.810E-04 3.810E-04
     es      2.322E-10 8.189E-06 8.189E-06 8.189E-06 8.189E-06 8.189E-06 8.189E-06 8.189E-06 8.189E-06
8.190E-06 8.190E-06 8.193E-06 8.195E-06 8.197E-06 8.205E-06 8.214E-06 8.222E-06 8.230E-06
  totals     7.031E+02 7.585E+06 7.574E+06 7.564E+06 7.553E+06 7.532E+06 7.477E+06 7.378E+06 7.177E+06
6.635E+06 5.965E+06 4.526E+06 4.137E+06 3.961E+06 3.757E+06 3.658E+06 3.567E+06 3.480E+06
0
     Fukushima Daiichi 4                                                                     fission
products         page   76
decay, following irradiation identified by: power=  25.00mw, burnup=  39500.mwd, flux=
4.05E+13n/cm**2-sec
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element concentrations, grams
basis = full core inventory 548 assemblies (94t

	charge	discharge	2E-03 h	3E-03 h	5E-03 h	8E-03 h	2E-02 h	3E-02 h	7E-02 h	0.2 h	0.3 h	1.0 h	1.5 h	2.0 h	4.0 h	6.0 h	8.0 h	10.0 h
h	4.918E-02	7.516E+00	7.516E+00	7.516E+00	7.516E+00	7.516E+00	7.516E+00	7.516E+00	7.516E+00	7.516E+00	7.516E+00	7.516E+00	7.516E+00	7.516E+00	7.516E+00	7.515E+00	7.515E+00	7.515E+00
he	9.221E-01	1.308E+02	1.308E+02	1.308E+02	1.308E+02	1.308E+02	1.308E+02	1.308E+02	1.308E+02	1.308E+02	1.308E+02	1.308E+02	1.308E+02	1.308E+02	1.308E+02	1.308E+02	1.308E+02	1.308E+02
li	1.169E-02	1.089E+00	1.089E+00	1.089E+00	1.089E+00	1.089E+00	1.089E+00	1.089E+00	1.089E+00	1.089E+00	1.089E+00	1.089E+00	1.089E+00	1.089E+00	1.089E+00	1.089E+00	1.089E+00	1.089E+00
be	7.985E-03	1.142E+00	1.142E+00	1.142E+00	1.142E+00	1.142E+00	1.142E+00	1.142E+00	1.142E+00	1.142E+00	1.142E+00	1.142E+00	1.142E+00	1.142E+00	1.142E+00	1.142E+00	1.142E+00	1.142E+00
b	5.155E-04	7.494E-02	7.494E-02	7.494E-02	7.494E-02	7.494E-02	7.494E-02	7.494E-02	7.494E-02	7.494E-02	7.494E-02	7.494E-02	7.494E-02	7.494E-02	7.494E-02	7.494E-02	7.494E-02	7.494E-02
c	2.331E-03	3.546E-01	3.546E-01	3.546E-01	3.546E-01	3.546E-01	3.546E-01	3.546E-01	3.546E-01	3.546E-01	3.546E-01	3.546E-01	3.546E-01	3.546E-01	3.546E-01	3.546E-01	3.546E-01	3.546E-01
n	2.889E-04	3.511E-02	3.511E-02	3.511E-02	3.511E-02	3.511E-02	3.511E-02	3.511E-02	3.511E-02	3.511E-02	3.511E-02	3.511E-02	3.511E-02	3.511E-02	3.511E-02	3.511E-02	3.511E-02	3.511E-02
ne	3.983E-03	4.834E-01	4.834E-01	4.834E-01	4.834E-01	4.834E-01	4.834E-01	4.834E-01	4.834E-01	4.834E-01	4.834E-01	4.834E-01	4.834E-01	4.834E-01	4.834E-01	4.834E-01	4.834E-01	4.834E-01
co	0.000E+00	1.473E-10	4.060E-15	3.378E-19	1.562E-23	6.012E-32	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ni	2.920E-13	1.008E-05	1.007E-05	1.006E-05	1.006E-05	1.006E-05	1.005E-05	1.005E-05	1.005E-05	1.003E-05	1.001E-05	9.928E-06	9.865E-06	9.803E-06	9.557E-06	9.317E-06	9.084E-06	8.856E-06
cu	7.123E-12	5.491E-05	5.484E-05	5.481E-05	5.478E-05	5.475E-05	5.470E-05	5.465E-05	5.458E-05	5.448E-05	5.437E-05	5.396E-05	5.366E-05	5.336E-05	5.217E-05	5.102E-05	4.989E-05	4.878E-05
zn	1.209E-03	1.902E-01	1.902E-01	1.902E-01	1.902E-01	1.902E-01	1.902E-01	1.902E-01	1.902E-01	1.902E-01	1.902E-01	1.902E-01	1.902E-01	1.902E-01	1.901E-01	1.901E-01	1.900E-01	1.900E-01
ga	1.922E-03	3.078E-01	3.078E-01	3.078E-01	3.078E-01	3.078E-01	3.078E-01	3.078E-01	3.078E-01	3.078E-01	3.077E-01	3.077E-01	3.077E-01	3.077E-01	3.076E-01	3.075E-01	3.075E-01	3.075E-01
ge	3.066E-01	4.240E+01	4.240E+01	4.240E+01	4.240E+01	4.240E+01	4.240E+01	4.240E+01	4.240E+01	4.240E+01	4.240E+01	4.240E+01	4.240E+01	4.240E+01	4.239E+01	4.239E+01	4.239E+01	4.239E+01
as	9.313E-02	1.299E+01	1.299E+01	1.299E+01	1.299E+01	1.298E+01	1.298E+01	1.298E+01	1.298E+01	1.298E+01	1.298E+01	1.298E+01	1.298E+01	1.298E+01	1.297E+01	1.296E+01	1.296E+01	1.296E+01
se	4.487E+01	6.048E+03	6.048E+03	6.048E+03	6.048E+03	6.048E+03	6.048E+03	6.048E+03	6.048E+03	6.048E+03	6.048E+03	6.048E+03	6.048E+03	6.048E+03	6.048E+03	6.048E+03	6.048E+03	6.048E+03
br	1.754E+01	2.363E+03	2.363E+03	2.363E+03	2.363E+03	2.363E+03	2.363E+03	2.363E+03	2.363E+03	2.363E+03	2.363E+03	2.363E+03	2.363E+03	2.363E+03	2.363E+03	2.363E+03	2.363E+03	2.363E+03
kr	3.151E+02	4.126E+04	4.126E+04	4.126E+04	4.126E+04	4.126E+04	4.126E+04	4.126E+04	4.126E+04	4.126E+04	4.126E+04	4.125E+04	4.125E+04	4.125E+04	4.125E+04	4.125E+04	4.125E+04	4.125E+04
rb	2.995E+02	3.917E+04	3.917E+04	3.917E+04	3.917E+04	3.917E+04	3.917E+04	3.917E+04	3.917E+04	3.917E+04	3.917E+04	3.917E+04	3.917E+04	3.917E+04	3.917E+04	3.917E+04	3.917E+04	3.917E+04
sr	7.807E+02	1.003E+05	1.003E+05	1.003E+05	1.003E+05	1.003E+05	1.003E+05	1.003E+05	1.003E+05	1.003E+05	1.003E+05	1.003E+05	1.003E+05	1.003E+05	1.003E+05	1.003E+05	1.003E+05	1.003E+05
y	4.069E+02	5.269E+04	5.269E+04	5.269E+04	5.269E+04	5.269E+04	5.269E+04	5.269E+04	5.269E+04	5.269E+04	5.269E+04	5.269E+04	5.269E+04	5.269E+04	5.269E+04	5.268E+04	5.268E+04	5.268E+04
zr	3.013E+03	4.046E+05	4.046E+05	4.046E+05	4.046E+05	4.046E+05	4.046E+05	4.046E+05	4.046E+05	4.046E+05	4.046E+05	4.046E+05	4.046E+05	4.046E+05	4.046E+05	4.046E+05	4.046E+05	4.046E+05
nb	2.614E+01	2.607E+03	2.607E+03	2.607E+03	2.607E+03	2.607E+03	2.607E+03	2.607E+03	2.607E+03	2.607E+03	2.607E+03	2.607E+03	2.607E+03	2.607E+03	2.607E+03	2.607E+03	2.606E+03	2.606E+03
mo	2.677E+03	3.724E+05	3.724E+05	3.724E+05	3.724E+05	3.724E+05	3.724E+05	3.724E+05	3.724E+05	3.724E+05	3.724E+05	3.724E+05	3.724E+05	3.724E+05	3.724E+05	3.724E+05	3.724E+05	3.724E+05
tc	6.631E+02	8.869E+04	8.869E+04	8.869E+04	8.869E+04	8.869E+04	8.869E+04	8.869E+04	8.869E+04	8.869E+04	8.869E+04	8.869E+04	8.869E+04	8.869E+04	8.870E+04	8.870E+04	8.871E+04	8.871E+04
ru	1.779E+03	2.664E+05	2.664E+05	2.664E+05	2.664E+05	2.664E+05	2.664E+05	2.664E+05	2.664E+05	2.664E+05	2.664E+05	2.664E+05	2.664E+05	2.664E+05	2.664E+05	2.664E+05	2.664E+05	2.664E+05
rh	3.785E+02	4.758E+04	4.758E+04	4.758E+04	4.758E+04	4.758E+04	4.758E+04	4.758E+04	4.758E+04	4.758E+04	4.758E+04	4.758E+04	4.758E+04	4.758E+04	4.759E+04	4.759E+04	4.759E+04	4.760E+04
pd	7.614E+02	1.407E+05	1.407E+05	1.407E+05	1.407E+05	1.407E+05	1.407E+05	1.407E+05	1.407E+05	1.407E+05	1.407E+05	1.407E+05	1.407E+05	1.407E+05	1.407E+05	1.407E+05	1.407E+05	1.407E+05
ag	4.825E+01	8.373E+03	8.373E+03	8.373E+03	8.373E+03	8.373E+03	8.373E+03	8.373E+03	8.373E+03	8.373E+03	8.373E+03	8.374E+03	8.374E+03	8.374E+03	8.375E+03	8.375E+03	8.376E+03	8.376E+03
cd	4.303E+01	8.891E+03	8.891E+03	8.891E+03	8.891E+03	8.891E+03	8.891E+03	8.891E+03	8.891E+03	8.891E+03	8.891E+03	8.891E+03	8.891E+03	8.891E+03	8.892E+03	8.892E+03	8.892E+03	8.893E+03
in	1.487E+00	1.690E+02	1.690E+02	1.690E+02	1.690E+02	1.690E+02	1.690E+02	1.690E+02	1.690E+02	1.690E+02	1.690E+02	1.690E+02	1.690E+02	1.690E+02	1.690E+02	1.690E+02	1.690E+02	1.691E+02
sn	3.505E+01	5.453E+03	5.453E+03	5.453E+03	5.453E+03	5.453E+03	5.453E+03	5.453E+03	5.453E+03	5.453E+03	5.453E+03	5.453E+03	5.453E+03	5.453E+03	5.453E+03	5.453E+03	5.452E+03	5.452E+03
sb	1.139E+01	1.656E+03	1.656E+03	1.656E+03	1.656E+03	1.656E+03	1.656E+03	1.656E+03	1.656E+03	1.656E+03	1.655E+03	1.655E+03	1.654E+03	1.654E+03	1.653E+03	1.652E+03	1.651E+03	1.651E+03
te	3.647E+02	5.280E+04	5.280E+04	5.280E+04	5.280E+04	5.280E+04	5.280E+04	5.280E+04	5.280E+04	5.280E+04	5.279E+04	5.279E+04	5.279E+04	5.279E+04	5.278E+04	5.277E+04	5.277E+04	5.276E+04
i	1.463E+02	2.231E+04	2.231E+04	2.231E+04	2.231E+04	2.231E+04	2.231E+04	2.231E+04	2.231E+04	2.231E+04	2.231E+04	2.230E+04	2.230E+04	2.229E+04	2.228E+04	2.226E+04	2.225E+04	2.224E+04
xe	4.203E+03	5.986E+05	5.986E+05	5.986E+05	5.986E+05	5.986E+05	5.986E+05	5.986E+05	5.986E+05	5.986E+05	5.986E+05	5.987E+05	5.987E+05	5.987E+05	5.987E+05	5.987E+05	5.987E+05	5.987E+05
cs	2.350E+03	3.205E+05	3.205E+05	3.205E+05	3.205E+05	3.205E+05	3.205E+05	3.205E+05	3.205E+05	3.205E+05	3.205E+05	3.205E+05	3.205E+05	3.205E+05	3.205E+05	3.206E+05	3.206E+05	3.206E+05
ba	1.138E+03	1.652E+05	1.652E+05	1.652E+05	1.652E+05	1.652E+05	1.652E+05	1.652E+05	1.652E+05									

1.652E+05 1.652E+05 1.652E+05 1.652E+05 1.652E+05 1.652E+05 1.652E+05 1.652E+05 1.652E+05
la 9.997E+02 1.380E+05 1.380E+05 1.380E+05 1.380E+05 1.380E+05 1.380E+05 1.380E+05 1.380E+05
1.380E+05 1.380E+05 1.380E+05 1.380E+05 1.380E+05 1.380E+05 1.380E+05 1.380E+05 1.380E+05
ce 2.220E+03 2.980E+05 2.980E+05 2.980E+05 2.980E+05 2.980E+05 2.980E+05 2.980E+05 2.980E+05
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pr 9.066E+02 1.242E+05 1.242E+05 1.242E+05 1.242E+05 1.242E+05 1.242E+05 1.242E+05 1.242E+05
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nd 3.064E+03 4.307E+05 4.307E+05 4.307E+05 4.307E+05 4.307E+05 4.307E+05 4.307E+05 4.307E+05
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pm 1.731E+02 1.722E+04 1.722E+04 1.722E+04 1.722E+04 1.722E+04 1.722E+04 1.722E+04 1.722E+04
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sm 5.339E+02 7.853E+04 7.853E+04 7.853E+04 7.853E+04 7.853E+04 7.853E+04 7.853E+04 7.853E+04
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eu 9.383E+01 1.603E+04 1.603E+04 1.603E+04 1.603E+04 1.603E+04 1.603E+04 1.603E+04 1.603E+04
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gd 4.894E+01 1.164E+04 1.164E+04 1.164E+04 1.164E+04 1.164E+04 1.164E+04 1.164E+04 1.164E+04
1.164E+04 1.165E+04 1.165E+04 1.165E+04 1.165E+04 1.165E+04 1.165E+04 1.165E+04 1.165E+04
tb 1.324E+00 2.464E+02 2.464E+02 2.464E+02 2.464E+02 2.464E+02 2.464E+02 2.464E+02 2.464E+02
2.464E+02 2.464E+02 2.464E+02 2.464E+02 2.464E+02 2.464E+02 2.465E+02 2.465E+02 2.465E+02
dy 5.366E-01 1.075E+02 1.075E+02 1.075E+02 1.075E+02 1.075E+02 1.075E+02 1.075E+02 1.075E+02
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ho 2.567E-02 7.678E+00 7.678E+00 7.678E+00 7.678E+00 7.678E+00 7.678E+00 7.678E+00 7.678E+00
7.678E+00 7.678E+00 7.679E+00 7.679E+00 7.679E+00 7.679E+00 7.679E+00 7.679E+00 7.679E+00
er 9.237E-03 2.551E+00 2.551E+00 2.551E+00 2.551E+00 2.551E+00 2.551E+00 2.551E+00 2.551E+00
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tm 2.945E-04 4.376E-02 4.376E-02 4.376E-02 4.376E-02 4.376E-02 4.376E-02 4.376E-02 4.376E-02
4.376E-02 4.376E-02 4.376E-02 4.376E-02 4.376E-02 4.377E-02 4.377E-02 4.377E-02 4.377E-02
yb 2.447E-04 4.435E-02 4.435E-02 4.435E-02 4.435E-02 4.435E-02 4.435E-02 4.435E-02 4.435E-02
4.435E-02 4.435E-02 4.435E-02 4.435E-02 4.435E-02 4.436E-02 4.436E-02 4.437E-02 4.437E-02
lu 4.026E-17 1.141E-12 1.141E-12 1.141E-12 1.141E-12 1.141E-12 1.141E-12 1.141E-12 1.140E-12
1.140E-12 1.139E-12 1.136E-12 1.134E-12 1.131E-12 1.122E-12 1.112E-12 1.103E-12 1.093E-12
totals 2.755E+04 3.864E+06 3.864E+06 3.864E+06 3.864E+06 3.864E+06 3.864E+06 3.864E+06 3.864E+06
3.864E+06 3.864E+06 3.864E+06 3.864E+06 3.864E+06 3.864E+06 3.864E+06 3.864E+06 3.864E+06
□
Fukushima Daiichi 4 fission
products page 77
decay, following irradiation identified by: power= 25.00mw, burnup= 39500.mwd, flux=
4.05E+13n/cm**2-sec

element radioactivity, curies
basis = full core inventory 548 assemblies (94t
charge discharge 2E-03 h 3E-03 h 5E-03 h 8E-03 h 2E-02 h 3E-02 h 7E-02 h
0.2 h 0.3 h 1.0 h 1.5 h 2.0 h 4.0 h 6.0 h 8.0 h 10.0 h
h 4.226E+02 6.404E+04 6.404E+04 6.404E+04 6.404E+04 6.404E+04 6.404E+04 6.404E+04 6.404E+04
6.404E+04 6.404E+04 6.404E+04 6.404E+04 6.404E+04 6.404E+04 6.404E+04 6.404E+04 6.404E+04
he 0.000E+00 5.649E+04 2.812E+02 1.993E+00 1.037E-02 3.825E-07 7.855E-19 0.000E+00 0.000E+00
0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
li 0.000E+00 3.856E+03 2.142E+01 1.827E-01 1.157E-03 6.246E-08 3.505E-19 0.000E+00 0.000E+00
0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
be 1.660E-04 4.752E+03 6.689E+02 4.851E+02 3.567E+02 1.965E+02 4.081E+01 2.288E+00 2.851E-02
2.364E-02 2.364E-02 2.364E-02 2.364E-02 2.364E-02 2.364E-02 2.364E-02 2.364E-02 2.364E-02
c 9.526E-03 1.452E+02 2.687E+01 6.418E+00 2.318E+00 1.468E+00 1.437E+00 1.437E+00 1.437E+00
1.437E+00 1.437E+00 1.437E+00 1.437E+00 1.437E+00 1.437E+00 1.437E+00 1.437E+00 1.437E+00
co 0.000E+00 8.486E+01 1.609E-03 1.339E-07 6.192E-12 2.383E-20 0.000E+00 0.000E+00 0.000E+00
0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
ni 2.540E-07 8.276E+02 2.310E+02 1.336E+02 8.728E+01 4.684E+01 1.714E+01 9.652E+00 8.755E+00
8.729E+00 8.711E+00 8.637E+00 8.583E+00 8.529E+00 8.315E+00 8.106E+00 7.903E+00 7.705E+00
cu 5.645E-06 7.333E+03 1.907E+03 1.262E+03 8.952E+02 5.663E+02 3.081E+02 1.781E+02 1.072E+02
6.165E+01 5.102E+01 4.948E+01 4.920E+01 4.892E+01 4.781E+01 4.672E+01 4.566E+01 4.463E+01
zn 4.495E-06 1.279E+05 3.611E+04 2.245E+04 1.660E+04 1.151E+04 7.389E+03 5.047E+03 3.017E+03
1.684E+03 1.551E+03 1.485E+03 1.450E+03 1.422E+03 1.343E+03 1.289E+03 1.243E+03 1.201E+03
ga 6.451E-06 8.981E+05 2.874E+05 1.737E+05 1.235E+05 8.223E+04 4.685E+04 2.843E+04 1.724E+04
9.001E+03 6.233E+03 4.410E+03 4.160E+03 3.966E+03 3.323E+03 2.836E+03 2.464E+03 2.178E+03
ge 4.179E-06 1.002E+07 3.671E+06 2.720E+06 2.147E+06 1.544E+06 9.044E+05 5.367E+05 3.998E+05
3.697E+05 3.456E+05 2.625E+05 2.152E+05 1.777E+05 8.981E+04 5.321E+04 3.682E+04 2.852E+04
as 1.362E-04 2.331E+07 1.250E+07 1.015E+07 8.450E+06 6.175E+06 3.226E+06 1.616E+06 1.059E+06
8.120E+05 6.245E+05 4.378E+05 4.042E+05 3.744E+05 2.653E+05 1.917E+05 1.496E+05 1.267E+05
se 6.016E-02 5.991E+07 4.655E+07 4.069E+07 3.638E+07 3.078E+07 2.311E+07 1.723E+07 1.224E+07
6.852E+06 4.172E+06 1.202E+06 5.651E+05 2.963E+05 4.604E+04 1.057E+04 2.738E+03 9.084E+02
br 4.412E-06 1.214E+08 9.601E+07 8.680E+07 8.038E+07 7.151E+07 5.648E+07 4.151E+07 2.850E+07
1.962E+07 1.596E+07 9.551E+06 7.052E+06 5.479E+06 2.677E+06 1.548E+06 9.447E+05 6.055E+05
kr 8.464E+03 2.457E+08 2.005E+08 1.850E+08 1.740E+08 1.598E+08 1.398E+08 1.229E+08 1.075E+08
9.019E+07 8.181E+07 6.695E+07 5.834E+07 5.107E+07 3.113E+07 1.984E+07 1.306E+07 8.846E+06
rb 1.865E+02 3.567E+08 2.634E+08 2.302E+08 2.129E+08 1.972E+08 1.760E+08 1.493E+08 1.177E+08
8.347E+07 6.387E+07 3.705E+07 3.044E+07 2.637E+07 1.609E+07 9.930E+06 6.147E+06 3.825E+06
sr 4.516E+05 5.414E+08 4.302E+08 4.154E+08 4.022E+08 3.807E+08 3.419E+08 3.043E+08 2.696E+08
2.327E+08 2.094E+08 1.825E+08 1.730E+08 1.647E+08 1.388E+08 1.212E+08 1.087E+08 9.968E+07
y 6.102E+05 7.969E+08 5.777E+08 5.363E+08 5.172E+08 5.023E+08 4.918E+08 4.818E+08 4.612E+08
4.095E+08 3.578E+08 2.856E+08 2.713E+08 2.628E+08 2.360E+08 2.110E+08 1.889E+08 1.702E+08

zr 7.444E+05 6.291E+08 3.947E+08 3.278E+08 2.969E+08 2.667E+08 2.336E+08 2.138E+08 2.068E+08
2.059E+08 2.052E+08 2.024E+08 2.003E+08 1.983E+08 1.906E+08 1.834E+08 1.769E+08 1.708E+08
nb 1.036E+06 9.488E+08 6.984E+08 5.863E+08 5.175E+08 4.475E+08 3.818E+08 3.466E+08 3.265E+08
3.120E+08 3.081E+08 3.038E+08 3.005E+08 2.970E+08 2.830E+08 2.692E+08 2.563E+08 2.443E+08
mo 3.497E+01 6.374E+08 5.921E+08 5.638E+08 5.403E+08 5.046E+08 4.401E+08 3.710E+08 3.061E+08
2.421E+08 1.913E+08 1.248E+08 1.171E+08 1.149E+08 1.121E+08 1.098E+08 1.075E+08 1.053E+08
tc 4.521E+01 7.430E+08 7.096E+08 6.896E+08 6.723E+08 6.451E+08 5.946E+08 5.356E+08 4.603E+08
3.596E+08 2.771E+08 1.403E+08 1.148E+08 1.067E+08 1.025E+08 1.015E+08 1.003E+08 9.889E+07
ru 7.912E+05 3.383E+08 3.276E+08 3.222E+08 3.177E+08 3.111E+08 2.996E+08 2.866E+08 2.689E+08
2.427E+08 2.304E+08 2.204E+08 2.152E+08 2.104E+08 1.945E+08 1.828E+08 1.742E+08 1.679E+08
rh 7.904E+05 4.457E+08 4.345E+08 4.261E+08 4.184E+08 4.052E+08 3.787E+08 3.491E+08 3.214E+08
2.947E+08 2.778E+08 2.525E+08 2.458E+08 2.422E+08 2.351E+08 2.301E+08 2.257E+08 2.219E+08
pd 2.223E-01 3.470E+07 3.398E+07 3.358E+07 3.327E+07 3.283E+07 3.209E+07 3.131E+07 3.040E+07
2.915E+07 2.807E+07 2.552E+07 2.448E+07 2.371E+07 2.137E+07 1.936E+07 1.755E+07 1.591E+07
ag 1.731E+03 5.091E+07 4.826E+07 4.660E+07 4.522E+07 4.319E+07 4.015E+07 3.809E+07 3.690E+07
3.548E+07 3.423E+07 3.137E+07 3.022E+07 2.938E+07 2.684E+07 2.466E+07 2.270E+07 2.092E+07
cd 1.247E+02 4.436E+06 3.099E+06 2.849E+06 2.687E+06 2.505E+06 2.276E+06 2.068E+06 1.860E+06
1.661E+06 1.557E+06 1.302E+06 1.168E+06 1.067E+06 8.330E+05 7.201E+05 6.537E+05 6.100E+05
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2.525E+06 2.286E+06 1.827E+06 1.635E+06 1.497E+06 1.163E+06 9.635E+05 8.251E+05 7.276E+05
sn 1.070E+03 9.054E+07 8.178E+07 7.730E+07 7.346E+07 6.736E+07 5.565E+07 4.245E+07 2.925E+07
1.742E+07 1.295E+07 8.376E+06 6.594E+06 5.300E+06 2.684E+06 1.782E+06 1.414E+06 1.240E+06
sb 5.962E+03 2.375E+08 2.210E+08 2.171E+08 2.138E+08 2.085E+08 1.973E+08 1.801E+08 1.518E+08
1.070E+08 8.004E+07 4.428E+07 3.388E+07 2.806E+07 1.886E+07 1.516E+07 1.283E+07 1.117E+07
te 4.000E+04 5.165E+08 4.924E+08 4.779E+08 4.663E+08 4.503E+08 4.297E+08 4.179E+08 4.071E+08
3.773E+08 3.373E+08 2.351E+08 1.945E+08 1.694E+08 1.318E+08 1.219E+08 1.167E+08 1.128E+08
i 1.942E+04 7.690E+08 7.238E+08 7.020E+08 6.858E+08 6.639E+08 6.302E+08 6.002E+08 5.762E+08
5.582E+08 5.465E+08 5.017E+08 4.699E+08 4.420E+08 3.688E+08 3.311E+08 3.064E+08 2.870E+08
xe 8.580E+03 5.769E+08 5.237E+08 5.037E+08 4.875E+08 4.631E+08 4.230E+08 3.833E+08 3.383E+08
2.730E+08 2.315E+08 1.932E+08 1.903E+08 1.906E+08 1.938E+08 1.945E+08 1.931E+08 1.904E+08
cs 1.633E+05 5.161E+08 4.308E+08 4.113E+08 3.978E+08 3.758E+08 3.335E+08 2.902E+08 2.500E+08
2.032E+08 1.631E+08 8.709E+07 6.202E+07 4.819E+07 3.297E+07 3.134E+07 3.094E+07 3.074E+07
ba 2.055E+05 6.204E+08 5.482E+08 5.112E+08 4.855E+08 4.557E+08 4.260E+08 4.115E+08 3.934E+08
3.487E+08 2.994E+08 2.101E+08 1.845E+08 1.686E+08 1.373E+08 1.256E+08 1.210E+08 1.189E+08
la 1.442E+05 6.151E+08 5.699E+08 5.443E+08 5.243E+08 4.964E+08 4.519E+08 4.151E+08 3.918E+08
3.676E+08 3.407E+08 2.797E+08 2.546E+08 2.355E+08 1.856E+08 1.586E+08 1.428E+08 1.329E+08
ce 1.298E+06 4.886E+08 4.679E+08 4.575E+08 4.501E+08 4.395E+08 4.183E+08 3.901E+08 3.563E+08
3.190E+08 3.005E+08 2.821E+08 2.793E+08 2.779E+08 2.740E+08 2.703E+08 2.667E+08 2.633E+08
pr 9.773E+05 4.267E+08 4.157E+08 4.079E+08 4.021E+08 3.952E+08 3.858E+08 3.740E+08 3.543E+08
3.241E+08 3.037E+08 2.598E+08 2.450E+08 2.369E+08 2.222E+08 2.133E+08 2.063E+08 2.007E+08
nd 3.254E+04 9.777E+07 9.672E+07 9.585E+07 9.501E+07 9.357E+07 9.074E+07 8.745E+07 8.353E+07
7.692E+07 7.026E+07 5.871E+07 5.505E+07 5.241E+07 4.601E+07 4.303E+07 4.158E+07 4.082E+07
pm 1.740E+05 1.037E+08 1.030E+08 1.026E+08 1.022E+08 1.014E+08 9.981E+07 9.751E+07 9.415E+07
8.863E+07 8.428E+07 7.952E+07 7.885E+07 7.843E+07 7.689E+07 7.533E+07 7.379E+07 7.229E+07
sm 3.173E+02 4.011E+07 4.008E+07 4.005E+07 4.002E+07 3.997E+07 3.984E+07 3.959E+07 3.911E+07
3.802E+07 3.700E+07 3.527E+07 3.470E+07 3.430E+07 3.306E+07 3.195E+07 3.089E+07 2.987E+07
eu 1.931E+04 2.302E+07 2.301E+07 2.300E+07 2.299E+07 2.297E+07 2.292E+07 2.287E+07 2.280E+07
2.268E+07 2.252E+07 2.207E+07 2.188E+07 2.175E+07 2.143E+07 2.121E+07 2.102E+07 2.084E+07
gd 1.182E+00 4.919E+05 4.912E+05 4.904E+05 4.895E+05 4.876E+05 4.819E+05 4.708E+05 4.500E+05
4.161E+05 3.990E+05 3.841E+05 3.770E+05 3.700E+05 3.434E+05 3.187E+05 2.958E+05 2.745E+05
tb 2.197E+02 1.832E+05 1.831E+05 1.830E+05 1.829E+05 1.828E+05 1.823E+05 1.815E+05 1.796E+05
1.739E+05 1.654E+05 1.502E+05 1.483E+05 1.477E+05 1.468E+05 1.461E+05 1.454E+05 1.447E+05
dy 1.314E-03 3.890E+04 3.805E+04 3.730E+04 3.654E+04 3.518E+04 3.220E+04 2.842E+04 2.444E+04
2.159E+04 2.041E+04 1.681E+04 1.459E+04 1.267E+04 7.303E+03 4.334E+03 2.690E+03 1.778E+03
ho 1.958E-03 5.929E+03 5.925E+03 5.921E+03 5.918E+03 5.911E+03 5.898E+03 5.878E+03 5.844E+03
5.769E+03 5.695E+03 5.547E+03 5.467E+03 5.390E+03 5.106E+03 4.854E+03 4.624E+03 4.413E+03
er 2.194E-02 9.579E+01 9.555E+01 9.551E+01 9.550E+01 9.550E+01 9.549E+01 9.548E+01 9.543E+01
9.527E+01 9.501E+01 9.395E+01 9.319E+01 9.246E+01 8.975E+01 8.736E+01 8.525E+01 8.337E+01
tm 1.867E-01 5.764E+01 5.764E+01 5.764E+01 5.764E+01 5.764E+01 5.764E+01 5.764E+01 5.764E+01
5.764E+01 5.763E+01 5.761E+01 5.759E+01 5.758E+01 5.750E+01 5.741E+01 5.731E+01 5.721E+01
yb 3.994E-07 2.799E-04 2.799E-04 2.799E-04 2.799E-04 2.799E-04 2.799E-04 2.799E-04 2.799E-04
2.798E-04 2.798E-04 2.796E-04 2.795E-04 2.794E-04 2.789E-04 2.784E-04 2.779E-04 2.774E-04
lu 4.418E-12 1.940E-07 1.926E-07 1.913E-07 1.899E-07 1.874E-07 1.812E-07 1.717E-07 1.569E-07
1.363E-07 1.286E-07 1.268E-07 1.265E-07 1.263E-07 1.252E-07 1.241E-07 1.231E-07 1.220E-07
totals 7.524E+06 1.112E+10 9.617E+09 9.083E+09 8.730E+09 8.287E+09 7.645E+09 7.049E+09 6.449E+09
5.692E+09 5.121E+09 4.185E+09 3.904E+09 3.726E+09 3.339E+09 3.122E+09 2.967E+09 2.844E+09
□
Fukushima Daiichi 4 fission
products page 78
decay, following irradiation identified by: power= 25.00mw, burnup= 39500.mwd, flux=
4.05E+13n/cm**2-sec

element thermal power, watts
basis = full core inventory 548 assemblies (94t
charge discharge 2E-03 h 3E-03 h 5E-03 h 8E-03 h 2E-02 h 3E-02 h 7E-02 h
0.2 h 0.3 h 1.0 h 1.5 h 2.0 h 4.0 h 6.0 h 8.0 h 10.0 h
h 1.425E-02 2.160E+00 2.160E+00 2.160E+00 2.160E+00 2.160E+00 2.160E+00 2.160E+00 2.160E+00
2.160E+00 2.160E+00 2.160E+00 2.160E+00 2.160E+00 2.160E+00 2.160E+00 2.160E+00 2.160E+00
he 0.000E+00 5.806E+02 2.617E+00 1.855E-02 9.652E-05 3.560E-09 7.310E-21 0.000E+00 0.000E+00

```
0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
   li     0.000E+00 2.177E+02 1.304E+00 1.112E-02 7.041E-05 3.802E-09 2.133E-20 0.000E+00 0.000E+00
0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
   be     1.998E-07 4.838E+01 2.343E+01 1.754E+01 1.290E+01 7.106E+00 1.475E+00 8.194E-02 2.043E-04
2.842E-05 2.842E-05 2.842E-05 2.842E-05 2.842E-05 2.842E-05 2.842E-05 2.842E-05 2.842E-05
   c      2.793E-06 5.423E+00 9.596E-01 1.883E-01 3.366E-02 1.573E-03 4.216E-04 4.214E-04 4.214E-04
4.214E-04 4.214E-04 4.214E-04 4.214E-04 4.214E-04 4.214E-04 4.214E-04 4.214E-04 4.214E-04
   co     0.000E+00 2.843E+00 3.285E-05 2.733E-09 1.264E-13 4.865E-22 0.000E+00 0.000E+00 0.000E+00
0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
   ni     9.788E-11 1.322E+01 3.323E+00 2.004E+00 1.275E+00 6.060E-01 1.182E-01 1.296E-02 3.505E-03
3.363E-03 3.356E-03 3.328E-03 3.307E-03 3.286E-03 3.204E-03 3.123E-03 3.045E-03 2.969E-03
   cu     1.040E-08 1.946E+02 3.738E+01 2.388E+01 1.613E+01 9.236E+00 4.213E+00 1.857E+00 7.058E-01
2.261E-01 1.358E-01 1.248E-01 1.240E-01 1.233E-01 1.204E-01 1.175E-01 1.148E-01 1.121E-01
   zn     6.800E-09 2.797E+03 5.710E+02 3.102E+02 2.099E+02 1.243E+02 5.977E+01 3.349E+01 1.544E+01
4.196E+00 3.174E+00 2.950E+00 2.832E+00 2.732E+00 2.436E+00 2.233E+00 2.080E+00 1.958E+00
   ga     1.226E-07 2.786E+04 6.766E+03 3.707E+03 2.457E+03 1.511E+03 7.748E+02 4.111E+02 2.400E+02
1.327E+02 7.925E+01 4.187E+01 3.979E+01 3.879E+01 3.566E+01 3.322E+01 3.128E+01 2.971E+01
   ge     2.233E-10 2.370E+05 4.646E+04 3.115E+04 2.264E+04 1.435E+04 6.794E+03 2.961E+03 1.592E+03
1.408E+03 1.333E+03 1.074E+03 9.249E+02 8.049E+02 5.123E+02 3.757E+02 3.023E+02 2.557E+02
   as     6.476E-07 6.480E+05 2.478E+05 1.872E+05 1.480E+05 9.951E+04 4.264E+04 1.595E+04 8.696E+03
7.149E+03 6.145E+03 4.926E+03 4.493E+03 4.053E+03 2.426E+03 1.343E+03 7.401E+02 4.312E+02
   se     1.993E-05 1.074E+06 7.380E+05 6.022E+05 5.069E+05 3.895E+05 2.432E+05 1.512E+05 9.919E+04
6.040E+04 3.995E+04 1.133E+04 4.663E+03 2.006E+03 1.414E+02 2.579E+01 6.110E+00 1.674E+00
   br     7.278E-08 3.143E+06 2.288E+06 1.987E+06 1.781E+06 1.503E+06 1.055E+06 6.495E+05 3.525E+05
2.235E+05 1.767E+05 8.050E+04 4.744E+04 2.971E+04 9.395E+03 5.983E+03 4.606E+03 3.826E+03
   kr     1.269E+01 3.972E+06 2.955E+06 2.644E+06 2.435E+06 2.174E+06 1.832E+06 1.546E+06 1.275E+06
9.653E+05 8.338E+05 6.534E+05 5.539E+05 4.719E+05 2.598E+05 1.511E+05 9.124E+04 5.659E+04
   rb     8.420E-01 8.699E+06 5.856E+06 4.992E+06 4.563E+06 4.185E+06 3.683E+06 3.049E+06 2.292E+06
1.496E+06 1.092E+06 6.025E+05 4.895E+05 4.224E+05 2.569E+05 1.579E+05 9.714E+04 5.986E+04
   sr     1.409E+03 7.823E+06 5.441E+06 5.148E+06 4.891E+06 4.479E+06 3.765E+06 3.129E+06 2.582E+06
1.972E+06 1.582E+06 1.221E+06 1.135E+06 1.063E+06 8.388E+05 6.874E+05 5.820E+05 5.061E+05
   y      2.325E+03 1.316E+07 7.073E+06 5.965E+06 5.451E+06 5.051E+06 4.817E+06 4.680E+06 4.408E+06
3.707E+06 2.986E+06 1.967E+06 1.790E+06 1.705E+06 1.485E+06 1.286E+06 1.109E+06 9.604E+05
   zr     3.752E+03 6.305E+06 2.813E+06 2.001E+06 1.695E+06 1.447E+06 1.225E+06 1.106E+06 1.065E+06
1.060E+06 1.056E+06 1.041E+06 1.030E+06 1.020E+06 9.794E+05 9.420E+05 9.076E+05 8.759E+05
   nb     4.936E+03 1.337E+07 8.116E+06 6.055E+06 4.883E+06 3.764E+06 2.771E+06 2.236E+06 1.924E+06
1.702E+06 1.651E+06 1.622E+06 1.603E+06 1.584E+06 1.505E+06 1.427E+06 1.354E+06 1.287E+06
   mo     1.401E-01 6.021E+06 5.333E+06 4.948E+06 4.642E+06 4.190E+06 3.398E+06 2.598E+06 1.935E+06
1.427E+06 1.063E+06 5.471E+05 4.806E+05 4.632E+05 4.490E+05 4.396E+05 4.305E+05 4.215E+05
   tc     3.736E-02 9.031E+06 8.351E+06 7.973E+06 7.662E+06 7.190E+06 6.351E+06 5.497E+06 4.586E+06
3.280E+06 2.138E+06 4.738E+05 2.102E+05 1.311E+05 9.619E+04 9.494E+04 9.380E+04 9.250E+04
   ru     1.643E+03 1.855E+06 1.712E+06 1.651E+06 1.604E+06 1.536E+06 1.423E+06 1.308E+06 1.169E+06
9.777E+05 8.926E+05 8.265E+05 7.912E+05 7.586E+05 6.508E+05 5.717E+05 5.137E+05 4.711E+05
   rh     3.015E+03 2.223E+06 2.102E+06 2.025E+06 1.958E+06 1.847E+06 1.619E+06 1.371E+06 1.137E+06
8.875E+05 7.546E+05 6.279E+05 6.008E+05 5.880E+05 5.696E+05 5.606E+05 5.541E+05 5.489E+05
   pd     2.158E-05 1.151E+05 1.064E+05 1.022E+05 9.934E+04 9.553E+04 8.923E+04 8.274E+04 7.633E+04
6.969E+04 6.477E+04 5.414E+04 5.060E+04 4.845E+04 4.323E+04 3.908E+04 3.534E+04 3.197E+04
   ag     1.852E+01 1.990E+05 1.667E+05 1.511E+05 1.393E+05 1.231E+05 9.898E+04 8.152E+04 7.042E+04
6.126E+04 5.826E+04 5.491E+04 5.367E+04 5.274E+04 4.973E+04 4.694E+04 4.433E+04 4.189E+04
   cd     4.692E-01 4.989E+04 2.539E+04 2.204E+04 1.990E+04 1.760E+04 1.509E+04 1.307E+04 1.081E+04
8.528E+03 7.799E+03 6.658E+03 5.995E+03 5.437E+03 3.905E+03 3.029E+03 2.501E+03 2.171E+03
   in     1.298E-04 2.255E+05 5.810E+04 4.436E+04 3.834E+04 3.289E+04 2.748E+04 2.386E+04 2.094E+04
1.776E+04 1.536E+04 1.033E+04 8.190E+03 6.734E+03 3.921E+03 2.807E+03 2.183E+03 1.782E+03
   sn     4.193E+00 1.223E+06 1.062E+06 9.955E+05 9.391E+05 8.489E+05 6.754E+05 4.830E+05 2.995E+05
1.517E+05 1.031E+05 6.522E+04 5.250E+04 4.288E+04 2.135E+04 1.251E+04 8.472E+03 6.504E+03
   sb     2.132E+01 4.422E+06 3.967E+06 3.873E+06 3.798E+06 3.683E+06 3.457E+06 3.120E+06 2.565E+06
1.690E+06 1.184E+06 5.826E+05 4.126E+05 3.176E+05 1.782E+05 1.327E+05 1.068E+05 8.888E+04
   te     7.370E+01 4.846E+06 4.345E+06 4.047E+06 3.811E+06 3.491E+06 3.090E+06 2.897E+06 2.785E+06
2.505E+06 2.139E+06 1.262E+06 9.308E+05 7.268E+05 4.247E+05 3.580E+05 3.325E+05 3.165E+05
   i      6.787E+01 1.142E+07 1.032E+07 9.816E+06 9.445E+06 8.952E+06 8.195E+06 7.511E+06 6.990E+06
6.693E+06 6.530E+06 5.796E+06 5.268E+06 4.809E+06 3.676E+06 3.184E+06 2.909E+06 2.711E+06
   xe     9.116E+00 5.422E+06 4.484E+06 4.175E+06 3.933E+06 3.576E+06 3.005E+06 2.479E+06 1.945E+06
1.232E+06 7.927E+05 3.873E+05 3.464E+05 3.408E+05 3.505E+05 3.538E+05 3.503E+05 3.421E+05
   cs     9.021E+02 9.319E+06 7.375E+06 6.994E+06 6.745E+06 6.337E+06 5.529E+06 4.685E+06 3.950E+06
3.279E+06 2.704E+06 1.343E+06 8.294E+05 5.439E+05 2.399E+05 2.153E+05 2.129E+05 2.124E+05
   ba     6.844E+02 5.414E+06 4.392E+06 3.902E+06 3.573E+06 3.203E+06 2.845E+06 2.689E+06 2.521E+06
2.113E+06 1.671E+06 9.240E+05 7.426E+05 6.429E+05 4.640E+05 4.003E+05 3.756E+05 3.655E+05
   la     2.421E+03 9.167E+06 8.298E+06 7.804E+06 7.424E+06 6.904E+06 6.090E+06 5.417E+06 5.041E+06
4.800E+06 4.537E+06 3.818E+06 3.476E+06 3.211E+06 2.565E+06 2.264E+06 2.112E+06 2.028E+06
   ce     1.230E+03 2.256E+06 2.036E+06 1.931E+06 1.857E+06 1.759E+06 1.571E+06 1.325E+06 1.043E+06
7.691E+05 6.698E+05 6.021E+05 5.917E+05 5.863E+05 5.702E+05 5.550E+05 5.405E+05 5.265E+05
   pr     6.335E+03 3.482E+06 3.289E+06 3.160E+06 3.066E+06 2.962E+06 2.839E+06 2.687E+06 2.431E+06
2.053E+06 1.825E+06 1.324E+06 1.159E+06 1.078E+06 9.825E+05 9.444E+05 9.152E+05 8.918E+05
   nd     7.875E+01 4.664E+05 4.553E+05 4.467E+05 4.386E+05 4.252E+05 3.997E+05 3.720E+05 3.421E+05
2.994E+05 2.588E+05 1.909E+05 1.712E+05 1.576E+05 1.250E+05 1.103E+05 1.034E+05 1.000E+05
   pm     2.322E+02 5.038E+05 4.929E+05 4.857E+05 4.794E+05 4.691E+05 4.479E+05 4.203E+05 3.838E+05
3.356E+05 3.015E+05 2.622E+05 2.578E+05 2.558E+05 2.497E+05 2.441E+05 2.388E+05 2.339E+05
   sm     3.746E-02 9.611E+04 9.573E+04 9.547E+04 9.524E+04 9.484E+04 9.385E+04 9.214E+04 8.901E+04
8.272E+04 7.760E+04 7.076E+04 6.909E+04 6.809E+04 6.552E+04 6.331E+04 6.120E+04 5.920E+04
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eu 1.753E+02 2.186E+05 2.184E+05 2.183E+05 2.181E+05 2.178E+05 2.172E+05 2.163E+05 2.153E+05
2.140E+05 2.125E+05 2.081E+05 2.063E+05 2.051E+05 2.026E+05 2.012E+05 2.000E+05 1.989E+05
gd 1.039E-03 1.445E+03 1.439E+03 1.433E+03 1.426E+03 1.412E+03 1.372E+03 1.299E+03 1.171E+03
9.748E+02 8.838E+02 8.265E+02 8.096E+02 7.941E+02 7.367E+02 6.837E+02 6.345E+02 5.888E+02
tb 1.863E+00 1.063E+03 1.061E+03 1.060E+03 1.059E+03 1.057E+03 1.051E+03 1.041E+03 1.021E+03
9.649E+02 8.837E+02 7.392E+02 7.219E+02 7.173E+02 7.139E+02 7.124E+02 7.111E+02 7.097E+02
dy 1.535E-06 7.532E+01 7.464E+01 7.403E+01 7.343E+01 7.235E+01 7.000E+01 6.697E+01 6.348E+01
5.960E+01 5.634E+01 4.609E+01 3.984E+01 3.446E+01 1.940E+01 1.108E+01 6.481E+00 3.934E+00
ho 9.023E-06 2.671E+01 2.665E+01 2.659E+01 2.654E+01 2.645E+01 2.626E+01 2.602E+01 2.569E+01
2.507E+01 2.451E+01 2.371E+01 2.337E+01 2.306E+01 2.188E+01 2.082E+01 1.986E+01 1.896E+01
er 1.340E-05 1.671E-01 1.668E-01 1.668E-01 1.668E-01 1.668E-01 1.667E-01 1.666E-01 1.664E-01
1.658E-01 1.647E-01 1.605E-01 1.574E-01 1.545E-01 1.439E-01 1.348E-01 1.269E-01 1.201E-01
tm 2.707E-04 1.800E-01 1.800E-01 1.800E-01 1.800E-01 1.800E-01 1.800E-01 1.800E-01 1.800E-01
1.800E-01 1.800E-01 1.799E-01 1.798E-01 1.797E-01 1.793E-01 1.788E-01 1.783E-01 1.777E-01
yb 1.016E-09 7.122E-07 7.122E-07 7.122E-07 7.122E-07 7.122E-07 7.122E-07 7.122E-07 7.122E-07
7.121E-07 7.120E-07 7.116E-07 7.113E-07 7.110E-07 7.097E-07 7.084E-07 7.071E-07 7.058E-07
lu 4.877E-14 1.498E-09 1.498E-09 1.498E-09 1.497E-09 1.497E-09 1.495E-09 1.493E-09 1.490E-09
1.485E-09 1.482E-09 1.477E-09 1.474E-09 1.471E-09 1.459E-09 1.446E-09 1.434E-09 1.421E-09
totals 2.935E+04 1.364E+08 1.043E+08 9.448E+07 8.837E+07 8.106E+07 7.092E+07 6.194E+07 5.362E+07
4.415E+07 3.743E+07 2.664E+07 2.338E+07 2.134E+07 1.732E+07 1.546E+07 1.429E+07 1.344E+07

Fukushima Daiichi 4
actinides page 79
decay, following irradiation identified by: power= 25.00mw, burnup= 39500.mwd, flux=
4.05E+13n/cm**2-sec

element concentrations, grams
basis = full core inventory 548 assemblies (94t
initial 12.0 h 15.0 h 20.0 h 24.0 h 36.0 h 48.0 h 72.0 h 96.0 h
144.0 h 192.0 h 240.0 h
he 5.550E+01 5.556E+01 5.557E+01 5.559E+01 5.561E+01 5.567E+01 5.573E+01 5.585E+01 5.596E+01
5.619E+01 5.642E+01 5.664E+01
tl 3.674E-10 3.796E-10 3.671E-10 3.629E-10 3.634E-10 3.793E-10 3.792E-10 3.697E-10 3.699E-10
3.643E-10 3.653E-10 3.666E-10
pb 1.405E-04 1.407E-04 1.407E-04 1.408E-04 1.409E-04 1.410E-04 1.412E-04 1.415E-04 1.419E-04
1.426E-04 1.432E-04 1.439E-04
bi 5.193E-08 5.293E-08 5.209E-08 5.198E-08 5.199E-08 5.300E-08 5.303E-08 5.258E-08 5.267E-08
5.252E-08 5.273E-08 5.296E-08
po 7.726E-11 7.734E-11 7.737E-11 7.740E-11 7.743E-11 7.752E-11 7.760E-11 7.778E-11 7.795E-11
7.829E-11 7.863E-11 7.897E-11
at 4.546E-17 4.550E-17 4.551E-17 4.552E-17 4.552E-17 4.551E-17 4.547E-17 4.532E-17 4.509E-17
4.440E-17 4.349E-17 4.241E-17
rn 3.547E-10 3.545E-10 3.545E-10 3.545E-10 3.544E-10 3.544E-10 3.544E-10 3.544E-10 3.547E-10
3.554E-10 3.565E-10 3.577E-10
fr 4.399E-13 4.403E-13 4.404E-13 4.405E-13 4.405E-13 4.404E-13 4.401E-13 4.388E-13 4.367E-13
4.305E-13 4.222E-13 4.123E-13
ra 6.748E-06 6.750E-06 6.750E-06 6.751E-06 6.752E-06 6.754E-06 6.756E-06 6.762E-06 6.768E-06
6.783E-06 6.799E-06 6.816E-06
ac 7.175E-07 7.187E-07 7.190E-07 7.196E-07 7.200E-07 7.214E-07 7.228E-07 7.255E-07 7.283E-07
7.338E-07 7.394E-07 7.449E-07
th 2.484E-01 2.485E-01 2.485E-01 2.485E-01 2.485E-01 2.486E-01 2.487E-01 2.488E-01 2.490E-01
2.493E-01 2.496E-01 2.499E-01
pa 5.131E-02 5.132E-02 5.132E-02 5.132E-02 5.133E-02 5.133E-02 5.133E-02 5.133E-02 5.133E-02
5.133E-02 5.133E-02 5.134E-02
u 8.924E+07 8.924E+07 8.924E+07 8.924E+07 8.924E+07 8.924E+07 8.924E+07 8.924E+07 8.924E+07
8.924E+07 8.924E+07 8.924E+07
np 4.870E+04 4.801E+04 4.786E+04 4.761E+04 4.742E+04 4.692E+04 4.649E+04 4.580E+04 4.529E+04
4.465E+04 4.432E+04 4.415E+04
pu 8.220E+05 8.227E+05 8.229E+05 8.231E+05 8.233E+05 8.238E+05 8.243E+05 8.250E+05 8.256E+05
8.263E+05 8.267E+05 8.269E+05
am 1.728E+04 1.729E+04 1.729E+04 1.729E+04 1.729E+04 1.730E+04 1.731E+04 1.732E+04 1.733E+04
1.736E+04 1.739E+04 1.742E+04
cm 5.393E+03 5.394E+03 5.393E+03 5.393E+03 5.392E+03 5.390E+03 5.388E+03 5.382E+03 5.375E+03
5.362E+03 5.350E+03 5.337E+03
bk 7.993E-05 7.983E-05 7.981E-05 7.978E-05 7.975E-05 7.966E-05 7.957E-05 7.940E-05 7.923E-05
7.889E-05 7.855E-05 7.821E-05
cf 5.365E-05 5.374E-05 5.376E-05 5.380E-05 5.382E-05 5.391E-05 5.399E-05 5.415E-05 5.431E-05
5.464E-05 5.496E-05 5.528E-05
es 9.969E-09 1.001E-08 1.002E-08 1.004E-08 1.005E-08 1.008E-08 1.011E-08 1.016E-08 1.020E-08
1.022E-08 1.021E-08 1.015E-08
totals 9.014E+07 9.014E+07 9.014E+07 9.014E+07 9.014E+07 9.014E+07 9.014E+07 9.014E+07 9.014E+07
9.014E+07 9.014E+07 9.014E+07
□
Fukushima Daiichi 4
actinides page 80
decay, following irradiation identified by: power= 25.00mw, burnup= 39500.mwd, flux=
4.05E+13n/cm**2-sec

element radioactivity, curies
basis = full core inventory 548 assemblies (94t

	initial	12.0 h	15.0 h	20.0 h	24.0 h	36.0 h	48.0 h	72.0 h	96.0 h	144.0 h	192.0 h	240.0 h
tl	1.088E-01	1.124E-01	1.087E-01	1.074E-01	1.076E-01	1.123E-01	1.123E-01	1.095E-01	1.095E-01	1.079E-01	1.082E-01	1.086E-01
pb	2.985E-01	2.983E-01	2.983E-01	2.982E-01	2.982E-01	2.981E-01	2.980E-01	2.980E-01	2.981E-01	2.987E-01	2.996E-01	3.006E-01
bi	2.987E-01	3.127E-01	3.003E-01	2.984E-01	2.983E-01	3.125E-01	3.124E-01	3.046E-01	3.047E-01	3.001E-01	3.010E-01	3.020E-01
po	4.898E-01	4.986E-01	4.906E-01	4.894E-01	4.893E-01	4.983E-01	4.982E-01	4.933E-01	4.935E-01	4.912E-01	4.927E-01	4.945E-01
at	7.321E-05	7.328E-05	7.329E-05	7.330E-05	7.330E-05	7.328E-05	7.321E-05	7.297E-05	7.260E-05	7.150E-05	7.003E-05	6.829E-05
rn	2.984E-01	2.983E-01	2.983E-01	2.982E-01	2.982E-01	2.981E-01	2.981E-01	2.982E-01	2.984E-01	2.990E-01	3.000E-01	3.011E-01
fr	7.392E-05	7.399E-05	7.400E-05	7.401E-05	7.402E-05	7.399E-05	7.393E-05	7.370E-05	7.333E-05	7.223E-05	7.077E-05	6.903E-05
ra	2.985E-01	2.983E-01	2.983E-01	2.982E-01	2.982E-01	2.981E-01	2.981E-01	2.982E-01	2.984E-01	2.990E-01	3.000E-01	3.011E-01
ac	7.619E-04	2.899E-04	2.426E-04	1.921E-04	1.679E-04	1.364E-04	1.283E-04	1.256E-04	1.252E-04	1.245E-04	1.234E-04	1.221E-04
th	9.272E+01	7.562E+01	7.215E+01	6.696E+01	6.328E+01	5.437E+01	4.794E+01	3.995E+01	3.579E+01	3.249E+01	3.160E+01	3.136E+01
pa	1.057E+02	9.522E+01	9.301E+01	8.964E+01	8.720E+01	8.105E+01	7.633E+01	6.993E+01	6.616E+01	6.262E+01	6.139E+01	6.095E+01
u	5.236E+07	4.973E+07	4.910E+07	4.806E+07	4.725E+07	4.488E+07	4.263E+07	3.847E+07	3.472E+07	2.827E+07	2.302E+07	1.875E+07
np	1.216E+09	1.049E+09	1.011E+09	9.507E+08	9.051E+08	7.810E+08	6.739E+08	5.018E+08	3.737E+08	2.072E+08	1.149E+08	6.372E+07
pu	1.888E+07	1.277E+07	1.229E+07	1.182E+07	1.163E+07	1.141E+07	1.137E+07	1.136E+07	1.136E+07	1.136E+07	1.136E+07	1.135E+07
am	9.811E+06	5.076E+06	4.322E+06	3.316E+06	2.691E+06	1.461E+06	8.123E+05	2.709E+05	1.031E+05	2.987E+04	2.134E+04	2.038E+04
cm	5.099E+06	5.096E+06	5.095E+06	5.092E+06	5.090E+06	5.082E+06	5.073E+06	5.054E+06	5.035E+06	4.995E+06	4.955E+06	4.916E+06
bk	1.676E-01	1.336E-01	1.323E-01	1.313E-01	1.309E-01	1.306E-01	1.305E-01	1.302E-01	1.299E-01	1.293E-01	1.288E-01	1.282E-01
cf	6.672E-03	6.667E-03	6.665E-03	6.662E-03	6.660E-03	6.654E-03	6.648E-03	6.636E-03	6.624E-03	6.601E-03	6.580E-03	6.560E-03
es	2.061E-04	2.073E-04	2.075E-04	2.079E-04	2.083E-04	2.092E-04	2.100E-04	2.113E-04	2.123E-04	2.133E-04	2.131E-04	2.120E-04
totals	1.302E+09	1.122E+09	1.082E+09	1.019E+09	9.718E+08	8.438E+08	7.338E+08	5.570E+08	4.249E+08	2.519E+08	1.543E+08	9.876E+07

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Fukushima Daiichi 4
actinides page 81
decay, following irradiation identified by: power= 25.00mw, burnup= 39500.mwd, flux= 4.05E+13n/cm**2-sec

element thermal power, watts
basis = full core inventory 548 assemblies (94t

	initial	12.0 h	15.0 h	20.0 h	24.0 h	36.0 h	48.0 h	72.0 h	96.0 h	144.0 h	192.0 h	240.0 h
tl	2.544E-03	2.628E-03	2.541E-03	2.512E-03	2.515E-03	2.626E-03	2.625E-03	2.559E-03	2.560E-03	2.522E-03	2.529E-03	2.538E-03
pb	5.645E-04	5.642E-04	5.641E-04	5.640E-04	5.639E-04	5.637E-04	5.636E-04	5.636E-04	5.638E-04	5.649E-04	5.665E-04	5.685E-04
bi	5.002E-03	5.238E-03	5.029E-03	4.998E-03	4.996E-03	5.233E-03	5.232E-03	5.101E-03	5.103E-03	5.026E-03	5.040E-03	5.058E-03
po	2.237E-02	2.284E-02	2.242E-02	2.235E-02	2.235E-02	2.283E-02	2.282E-02	2.256E-02	2.257E-02	2.244E-02	2.251E-02	2.259E-02
at	3.124E-06	3.127E-06	3.127E-06	3.128E-06	3.128E-06	3.127E-06	3.124E-06	3.114E-06	3.098E-06	3.051E-06	2.989E-06	2.914E-06
rn	1.133E-02	1.133E-02	1.132E-02	1.132E-02	1.132E-02	1.132E-02	1.132E-02	1.132E-02	1.133E-02	1.135E-02	1.139E-02	1.143E-02
fr	2.828E-06	2.830E-06	2.831E-06	2.831E-06	2.831E-06	2.830E-06	2.828E-06	2.819E-06	2.804E-06	2.762E-06	2.705E-06	2.638E-06
ra	1.024E-02	1.024E-02	1.023E-02	1.023E-02	1.023E-02	1.023E-02	1.023E-02	1.023E-02	1.024E-02	1.026E-02	1.029E-02	1.033E-02
ac	7.549E-06	3.868E-06	3.500E-06	3.105E-06	2.916E-06	2.669E-06	2.603E-06	2.574E-06	2.560E-06	2.522E-06	2.471E-06	2.410E-06
th	9.059E-02	7.195E-02	6.817E-02	6.251E-02	5.851E-02	4.880E-02	4.180E-02	3.311E-02	2.859E-02	2.504E-02	2.412E-02	2.390E-02
pa	5.201E-01	4.507E-01	4.361E-01	4.140E-01	3.980E-01	3.577E-01	3.268E-01	2.849E-01	2.602E-01	2.371E-01	2.290E-01	2.262E-01
u	1.014E+05	9.629E+04	9.506E+04	9.305E+04	9.147E+04	8.689E+04	8.254E+04	7.449E+04	6.722E+04	5.474E+04	4.458E+04	3.630E+04
np	3.133E+06	2.703E+06	2.605E+06	2.449E+06	2.331E+06	2.011E+06	1.735E+06	1.291E+06	9.609E+05			

```
5.322E+05 2.949E+05 1.634E+05
     pu      2.081E+04 1.378E+04 1.323E+04 1.270E+04 1.248E+04 1.224E+04 1.220E+04 1.220E+04 1.221E+04
1.223E+04 1.224E+04 1.225E+04
     am      3.914E+04 1.839E+04 1.530E+04 1.131E+04 8.930E+03 4.568E+03 2.528E+03 1.089E+03 7.403E+02
6.229E+02 6.148E+02 6.168E+02
     cm      1.856E+05 1.855E+05 1.854E+05 1.853E+05 1.852E+05 1.850E+05 1.846E+05 1.839E+05 1.832E+05
1.818E+05 1.803E+05 1.789E+05
     bk      2.830E-04 4.500E-05 3.577E-05 2.905E-05 2.705E-05 2.567E-05 2.554E-05 2.548E-05 2.542E-05
2.531E-05 2.520E-05 2.509E-05
     cf      3.810E-04 3.809E-04 3.809E-04 3.809E-04 3.808E-04 3.807E-04 3.806E-04 3.803E-04 3.801E-04
3.796E-04 3.791E-04 3.786E-04
     es      8.230E-06 8.274E-06 8.285E-06 8.302E-06 8.315E-06 8.351E-06 8.384E-06 8.437E-06 8.477E-06
8.516E-06 8.509E-06 8.461E-06
  totals     3.480E+06 3.017E+06 2.914E+06 2.751E+06 2.630E+06 2.300E+06 2.017E+06 1.563E+06 1.224E+06
7.816E+05 5.326E+05 3.914E+05
□
     Fukushima Daiichi 4                                                                            fission
products          page   82
decay, following irradiation identified by: power=   25.00mw, burnup=   39500.mwd, flux=
4.05E+13n/cm**2-sec

                                                 element concentrations, grams
                                                 basis = full core inventory 548 assemblies (94t
               initial      12.0 h     15.0 h     20.0 h     24.0 h     36.0 h     48.0 h     72.0 h     96.0 h
144.0 h   192.0 h   240.0 h
      h      7.515E+00 7.515E+00 7.515E+00 7.514E+00 7.514E+00 7.514E+00 7.513E+00 7.512E+00 7.511E+00
7.509E+00 7.507E+00 7.505E+00
     he      1.308E+02 1.308E+02 1.308E+02 1.308E+02 1.308E+02 1.308E+02 1.308E+02 1.308E+02 1.308E+02
1.308E+02 1.308E+02 1.308E+02
     li      1.089E+00 1.089E+00 1.089E+00 1.089E+00 1.089E+00 1.089E+00 1.089E+00 1.089E+00 1.089E+00
1.089E+00 1.089E+00 1.089E+00
     be      1.142E+00 1.142E+00 1.142E+00 1.142E+00 1.142E+00 1.142E+00 1.142E+00 1.142E+00 1.142E+00
1.142E+00 1.142E+00 1.142E+00
      b      7.494E-02 7.494E-02 7.494E-02 7.494E-02 7.494E-02 7.494E-02 7.494E-02 7.494E-02 7.494E-02
7.494E-02 7.494E-02 7.494E-02
      c      3.546E-01 3.546E-01 3.546E-01 3.546E-01 3.546E-01 3.546E-01 3.546E-01 3.546E-01 3.546E-01
3.546E-01 3.546E-01 3.546E-01
      n      3.511E-02 3.511E-02 3.511E-02 3.511E-02 3.511E-02 3.511E-02 3.511E-02 3.511E-02 3.511E-02
3.511E-02 3.511E-02 3.511E-02
     ne      4.834E-01 4.834E-01 4.834E-01 4.834E-01 4.834E-01 4.834E-01 4.834E-01 4.834E-01 4.834E-01
4.834E-01 4.834E-01 4.834E-01
     ni      8.856E-06 7.605E-06 7.321E-06 6.870E-06 6.530E-06 5.607E-06 4.815E-06 3.550E-06 2.618E-06
1.423E-06 7.739E-07 4.207E-07
     cu      4.878E-05 4.264E-05 4.123E-05 3.898E-05 3.727E-05 3.258E-05 2.848E-05 2.176E-05 1.663E-05
9.706E-06 5.667E-06 3.308E-06
     zn      1.900E-01 1.898E-01 1.898E-01 1.897E-01 1.896E-01 1.895E-01 1.894E-01 1.892E-01 1.891E-01
1.889E-01 1.889E-01 1.888E-01
     ga      3.075E-01 3.073E-01 3.073E-01 3.073E-01 3.073E-01 3.072E-01 3.072E-01 3.071E-01 3.070E-01
3.070E-01 3.070E-01 3.069E-01
     ge      4.239E+01 4.238E+01 4.238E+01 4.238E+01 4.238E+01 4.238E+01 4.238E+01 4.238E+01 4.238E+01
4.238E+01 4.238E+01 4.238E+01
     as      1.296E+01 1.294E+01 1.293E+01 1.293E+01 1.292E+01 1.291E+01 1.290E+01 1.288E+01 1.287E+01
1.286E+01 1.286E+01 1.285E+01
     se      6.048E+03 6.048E+03 6.048E+03 6.048E+03 6.048E+03 6.048E+03 6.048E+03 6.048E+03 6.048E+03
6.048E+03 6.048E+03 6.048E+03
     br      2.363E+03 2.363E+03 2.363E+03 2.363E+03 2.362E+03 2.362E+03 2.362E+03 2.362E+03 2.362E+03
2.362E+03 2.362E+03 2.362E+03
     kr      4.125E+04 4.125E+04 4.125E+04 4.125E+04 4.125E+04 4.125E+04 4.125E+04 4.125E+04 4.125E+04
4.125E+04 4.125E+04 4.125E+04
     rb      3.917E+04 3.917E+04 3.917E+04 3.917E+04 3.917E+04 3.917E+04 3.917E+04 3.917E+04 3.917E+04
3.917E+04 3.918E+04 3.918E+04
     sr      1.003E+05 1.003E+05 1.003E+05 1.003E+05 1.003E+05 1.003E+05 1.002E+05 1.002E+05 1.002E+05
1.001E+05 1.001E+05 1.000E+05
      y      5.268E+04 5.267E+04 5.267E+04 5.267E+04 5.266E+04 5.266E+04 5.265E+04 5.265E+04 5.264E+04
5.262E+04 5.260E+04 5.258E+04
     zr      4.046E+05 4.046E+05 4.046E+05 4.046E+05 4.046E+05 4.046E+05 4.045E+05 4.045E+05 4.045E+05
4.045E+05 4.045E+05 4.044E+05
     nb      2.606E+03 2.604E+03 2.604E+03 2.604E+03 2.603E+03 2.602E+03 2.601E+03 2.599E+03 2.597E+03
2.590E+03 2.583E+03 2.573E+03
     mo      3.724E+05 3.724E+05 3.724E+05 3.724E+05 3.724E+05 3.724E+05 3.725E+05 3.725E+05 3.725E+05
3.726E+05 3.727E+05 3.728E+05
     tc      8.871E+04 8.874E+04 8.875E+04 8.876E+04 8.876E+04 8.878E+04 8.880E+04 8.883E+04 8.885E+04
8.888E+04 8.890E+04 8.892E+04
     ru      2.664E+05 2.664E+05 2.663E+05 2.663E+05 2.663E+05 2.663E+05 2.662E+05 2.661E+05 2.661E+05
2.659E+05 2.658E+05 2.656E+05
     rh      4.760E+04 4.761E+04 4.761E+04 4.762E+04 4.763E+04 4.764E+04 4.766E+04 4.771E+04 4.775E+04
4.785E+04 4.795E+04 4.805E+04
     pd      1.407E+05 1.407E+05 1.407E+05 1.407E+05 1.407E+05 1.408E+05 1.408E+05 1.408E+05 1.408E+05
1.409E+05 1.410E+05 1.410E+05
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ag 8.376E+03 8.378E+03 8.378E+03 8.379E+03 8.379E+03 8.378E+03 8.378E+03 8.376E+03 8.374E+03
8.371E+03 8.368E+03 8.366E+03
cd 8.893E+03 8.894E+03 8.895E+03 8.895E+03 8.896E+03 8.897E+03 8.898E+03 8.900E+03 8.902E+03
8.905E+03 8.908E+03 8.910E+03
in 1.691E+02 1.692E+02 1.692E+02 1.693E+02 1.693E+02 1.694E+02 1.695E+02 1.697E+02 1.698E+02
1.700E+02 1.701E+02 1.702E+02
sn 5.452E+03 5.452E+03 5.452E+03 5.452E+03 5.452E+03 5.452E+03 5.451E+03 5.451E+03 5.450E+03
5.450E+03 5.449E+03 5.449E+03
sb 1.651E+03 1.648E+03 1.648E+03 1.647E+03 1.646E+03 1.645E+03 1.643E+03 1.640E+03 1.638E+03
1.635E+03 1.632E+03 1.630E+03
te 5.276E+04 5.273E+04 5.272E+04 5.271E+04 5.270E+04 5.268E+04 5.265E+04 5.262E+04 5.259E+04
5.254E+04 5.251E+04 5.249E+04
i 2.224E+04 2.219E+04 2.218E+04 2.216E+04 2.215E+04 2.212E+04 2.210E+04 2.206E+04 2.203E+04
2.198E+04 2.193E+04 2.190E+04
xe 5.987E+05 5.987E+05 5.987E+05 5.987E+05 5.987E+05 5.988E+05 5.988E+05 5.988E+05 5.988E+05
5.988E+05 5.988E+05 5.988E+05
cs 3.206E+05 3.206E+05 3.206E+05 3.207E+05 3.207E+05 3.207E+05 3.207E+05 3.208E+05 3.208E+05
3.209E+05 3.209E+05 3.210E+05
ba 1.652E+05 1.652E+05 1.652E+05 1.652E+05 1.652E+05 1.651E+05 1.651E+05 1.651E+05 1.650E+05
1.649E+05 1.649E+05 1.648E+05
la 1.380E+05 1.380E+05 1.380E+05 1.380E+05 1.380E+05 1.380E+05 1.380E+05 1.380E+05 1.380E+05
1.380E+05 1.380E+05 1.380E+05
ce 2.980E+05 2.979E+05 2.979E+05 2.979E+05 2.979E+05 2.978E+05 2.978E+05 2.977E+05 2.976E+05
2.975E+05 2.974E+05 2.972E+05
pr 1.242E+05 1.242E+05 1.242E+05 1.243E+05 1.243E+05 1.243E+05 1.243E+05 1.243E+05 1.243E+05
1.244E+05 1.244E+05 1.244E+05
nd 4.308E+05 4.308E+05 4.308E+05 4.309E+05 4.309E+05 4.309E+05 4.310E+05 4.311E+05 4.312E+05
4.314E+05 4.316E+05 4.318E+05
pm 1.721E+04 1.720E+04 1.720E+04 1.719E+04 1.719E+04 1.718E+04 1.718E+04 1.717E+04 1.717E+04
1.716E+04 1.716E+04 1.716E+04
sm 7.855E+04 7.856E+04 7.857E+04 7.857E+04 7.858E+04 7.859E+04 7.861E+04 7.863E+04 7.865E+04
7.869E+04 7.873E+04 7.877E+04
eu 1.604E+04 1.604E+04 1.604E+04 1.604E+04 1.604E+04 1.604E+04 1.604E+04 1.603E+04 1.603E+04
1.601E+04 1.599E+04 1.597E+04
gd 1.165E+04 1.166E+04 1.166E+04 1.167E+04 1.167E+04 1.168E+04 1.168E+04 1.170E+04 1.171E+04
1.174E+04 1.176E+04 1.178E+04
tb 2.465E+02 2.465E+02 2.465E+02 2.465E+02 2.465E+02 2.465E+02 2.465E+02 2.464E+02 2.463E+02
2.461E+02 2.459E+02 2.458E+02
dy 1.076E+02 1.077E+02 1.077E+02 1.077E+02 1.077E+02 1.078E+02 1.078E+02 1.079E+02 1.080E+02
1.082E+02 1.084E+02 1.086E+02
ho 7.679E+00 7.678E+00 7.677E+00 7.677E+00 7.677E+00 7.676E+00 7.675E+00 7.674E+00 7.674E+00
7.673E+00 7.673E+00 7.673E+00
er 2.553E+00 2.554E+00 2.555E+00 2.555E+00 2.556E+00 2.557E+00 2.558E+00 2.559E+00 2.559E+00
2.560E+00 2.561E+00 2.561E+00
tm 4.377E-02 4.378E-02 4.378E-02 4.379E-02 4.379E-02 4.379E-02 4.380E-02 4.380E-02 4.381E-02
4.381E-02 4.380E-02 4.378E-02
yb 4.437E-02 4.440E-02 4.440E-02 4.441E-02 4.442E-02 4.445E-02 4.447E-02 4.452E-02 4.456E-02
4.465E-02 4.473E-02 4.480E-02
lu 1.093E-12 1.039E-12 1.026E-12 1.004E-12 9.876E-13 9.386E-13 8.920E-13 8.057E-13 7.278E-13
5.939E-13 4.846E-13 3.956E-13
totals 3.864E+06 3.864E+06 3.864E+06 3.864E+06 3.864E+06 3.864E+06 3.864E+06 3.864E+06 3.864E+06
3.864E+06 3.864E+06 3.864E+06
□
Fukushima Daiichi 4 fission
products page 83
decay, following irradiation identified by: power= 25.00mw, burnup= 39500.mwd, flux=
4.05E+13n/cm**2-sec

element radioactivity, curies
basis = full core inventory 548 assemblies (94t
initial 12.0 h 15.0 h 20.0 h 24.0 h 36.0 h 48.0 h 72.0 h 96.0 h
144.0 h 192.0 h 240.0 h
h 6.404E+04 6.403E+04 6.403E+04 6.403E+04 6.403E+04 6.402E+04 6.402E+04 6.401E+04 6.400E+04
6.398E+04 6.396E+04 6.394E+04
be 2.364E-02 2.364E-02 2.364E-02 2.364E-02 2.364E-02 2.364E-02 2.364E-02 2.364E-02 2.364E-02
2.364E-02 2.364E-02 2.364E-02
c 1.437E+00 1.437E+00 1.437E+00 1.437E+00 1.437E+00 1.437E+00 1.437E+00 1.437E+00 1.437E+00
1.437E+00 1.437E+00 1.437E+00
ni 7.705E+00 6.616E+00 6.369E+00 5.977E+00 5.681E+00 4.878E+00 4.189E+00 3.089E+00 2.278E+00
1.238E+00 6.733E-01 3.661E-01
cu 4.463E+01 3.889E+01 3.758E+01 3.548E+01 3.389E+01 2.954E+01 2.574E+01 1.956E+01 1.486E+01
8.585E+00 4.962E+00 2.870E+00
zn 1.201E+03 9.951E+02 9.510E+02 8.822E+02 8.309E+02 6.946E+02 5.808E+02 4.061E+02 2.840E+02
1.389E+02 6.792E+01 3.321E+01
ga 2.178E+03 1.383E+03 1.296E+03 1.184E+03 1.114E+03 9.433E+02 8.021E+02 5.729E+02 4.045E+02
1.990E+02 9.744E+01 4.766E+01
ge 2.852E+04 1.198E+04 9.931E+03 7.283E+03 5.688E+03 2.717E+03 1.300E+03 2.981E+02 6.838E+01
3.608E+00 1.974E-01 1.699E-02
as 1.267E+05 9.127E+04 8.696E+04 8.020E+04 7.509E+04 6.132E+04 4.983E+04 3.265E+04 2.130E+04

										9.040E+03	3.834E+03	1.627E+03
se	9.084E+02	2.971E+02	2.838E+02	2.625E+02	2.464E+02	2.029E+02	1.665E+02	1.121E+02	7.603E+01	3.701E+01	2.042E+01	1.337E+01
br	6.055E+05	1.564E+05	1.406E+05	1.237E+05	1.135E+05	8.939E+04	7.062E+04	4.408E+04	2.752E+04	1.072E+04	4.179E+03	1.628E+03
kr	8.846E+06	1.773E+06	1.471E+06	1.228E+06	1.143E+06	1.068E+06	1.057E+06	1.055E+06	1.055E+06	1.054E+06	1.054E+06	1.053E+06
rb	3.825E+06	3.299E+05	2.270E+05	1.590E+05	1.407E+05	1.284E+05	1.255E+05	1.209E+05	1.164E+05	1.081E+05	1.003E+05	9.315E+04
sr	9.968E+07	7.466E+07	7.173E+07	6.813E+07	6.605E+07	6.234E+07	6.059E+07	5.907E+07	5.824E+07	5.686E+07	5.555E+07	5.428E+07
y	1.702E+08	1.104E+08	1.035E+08	9.547E+07	9.101E+07	8.338E+07	7.995E+07	7.726E+07	7.608E+07	7.438E+07	7.282E+07	7.129E+07
zr	1.708E+08	1.432E+08	1.381E+08	1.309E+08	1.261E+08	1.155E+08	1.087E+08	1.016E+08	9.823E+07	9.499E+07	9.280E+07	9.079E+07
nb	2.443E+08	1.897E+08	1.796E+08	1.655E+08	1.560E+08	1.356E+08	1.230E+08	1.103E+08	1.058E+08	1.032E+08	1.026E+08	1.021E+08
mo	1.053E+08	9.278E+07	8.990E+07	8.530E+07	8.179E+07	7.209E+07	6.355E+07	4.938E+07	3.836E+07	2.316E+07	1.398E+07	8.441E+06
tc	9.889E+07	8.908E+07	8.652E+07	8.229E+07	7.900E+07	6.976E+07	6.152E+07	4.781E+07	3.715E+07	2.243E+07	1.354E+07	8.175E+06
ru	1.679E+08	1.527E+08	1.515E+08	1.502E+08	1.495E+08	1.482E+08	1.472E+08	1.453E+08	1.435E+08	1.399E+08	1.364E+08	1.330E+08
rh	2.219E+08	2.045E+08	2.010E+08	1.957E+08	1.918E+08	1.819E+08	1.738E+08	1.619E+08	1.538E+08	1.438E+08	1.378E+08	1.335E+08
pd	1.591E+07	8.840E+06	7.637E+06	5.989E+06	4.933E+06	2.767E+06	1.561E+06	5.070E+05	1.704E+05	2.190E+04	3.468E+03	7.338E+02
ag	2.092E+07	1.335E+07	1.207E+07	1.030E+07	9.156E+06	6.768E+06	5.368E+06	3.975E+06	3.342E+06	2.691E+06	2.260E+06	1.915E+06
cd	6.100E+05	4.913E+05	4.726E+05	4.439E+05	4.226E+05	3.653E+05	3.163E+05	2.384E+05	1.813E+05	1.085E+05	6.912E+04	4.765E+04
in	7.276E+05	5.096E+05	4.873E+05	4.549E+05	4.315E+05	3.693E+05	3.161E+05	2.315E+05	1.696E+05	9.112E+04	4.890E+04	2.624E+04
sn	1.240E+06	9.754E+05	9.476E+05	9.066E+05	8.771E+05	8.019E+05	7.421E+05	6.538E+05	5.920E+05	5.078E+05	4.481E+05	4.002E+05
sb	1.117E+07	7.005E+06	6.621E+06	6.177E+06	5.920E+06	5.375E+06	4.958E+06	4.267E+06	3.699E+06	2.831E+06	2.225E+06	1.802E+06
te	1.128E+08	9.729E+07	9.435E+07	8.984E+07	8.650E+07	7.749E+07	6.968E+07	5.680E+07	4.676E+07	3.256E+07	2.346E+07	1.753E+07
i	2.870E+08	2.133E+08	2.013E+08	1.845E+08	1.733E+08	1.475E+08	1.288E+08	1.031E+08	8.573E+07	6.288E+07	4.796E+07	3.734E+07
xe	1.904E+08	1.638E+08	1.573E+08	1.476E+08	1.408E+08	1.254E+08	1.147E+08	9.965E+07	8.761E+07	6.767E+07	5.212E+07	4.012E+07
cs	3.074E+07	3.037E+07	3.033E+07	3.028E+07	3.024E+07	3.013E+07	3.002E+07	2.982E+07	2.962E+07	2.925E+07	2.892E+07	2.862E+07
ba	1.189E+08	1.151E+08	1.144E+08	1.133E+08	1.124E+08	1.096E+08	1.070E+08	1.019E+08	9.710E+07	8.824E+07	8.029E+07	7.316E+07
la	1.329E+08	1.137E+08	1.124E+08	1.109E+08	1.100E+08	1.078E+08	1.057E+08	1.013E+08	9.677E+07	8.765E+07	7.899E+07	7.101E+07
ce	2.633E+08	2.451E+08	2.412E+08	2.352E+08	2.307E+08	2.193E+08	2.101E+08	1.968E+08	1.879E+08	1.771E+08	1.706E+08	1.657E+08
pr	2.007E+08	1.836E+08	1.817E+08	1.793E+08	1.779E+08	1.751E+08	1.730E+08	1.691E+08	1.652E+08	1.576E+08	1.503E+08	1.435E+08
nd	4.082E+07	3.912E+07	3.881E+07	3.830E+07	3.790E+07	3.672E+07	3.558E+07	3.340E+07	3.136E+07	2.764E+07	2.436E+07	2.147E+07
pm	7.229E+07	6.425E+07	6.246E+07	5.968E+07	5.760E+07	5.206E+07	4.744E+07	4.026E+07	3.510E+07	2.850E+07	2.473E+07	2.246E+07
sm	2.987E+07	2.461E+07	2.348E+07	2.172E+07	2.042E+07	1.701E+07	1.419E+07	9.903E+06	6.920E+06	3.388E+06	1.667E+06	8.287E+05
eu	2.084E+07	1.994E+07	1.975E+07	1.946E+07	1.925E+07	1.868E+07	1.820E+07	1.734E+07	1.658E+07	1.520E+07	1.396E+07	1.282E+07
gd	2.745E+05	1.754E+05	1.569E+05	1.302E+05	1.121E+05	7.171E+04	4.588E+04	1.884E+04	7.804E+03	1.462E+03	4.052E+02	2.283E+02
tb	1.447E+05	1.407E+05	1.397E+05	1.381E+05	1.368E+05	1.331E+05	1.296E+05	1.230E+05	1.170E+05	1.066E+05	9.778E+04	9.040E+04
dy	1.778E+03	6.334E+02	5.997E+02	5.653E+02	5.445E+02	4.909E+02	4.433E+02	3.616E+02	2.949E+02	1.961E+02	1.305E+02	8.679E+01
ho	4.413E+03	3.387E+03	3.178E+03	2.862E+03	2.635E+03	2.069E+03	1.642E+03	1.066E+03	7.228E+02	3.741E+02	2.180E+02	1.361E+02
er	8.337E+01	7.521E+01	7.370E+01	7.145E+01	6.984E+01	6.563E+01	6.203E+01	5.587E+01	5.068E+01	4.231E+01	3.578E+01	3.051E+01
tm	5.721E+01	5.644E+01	5.622E+01	5.582E+01	5.549E+01	5.441E+01	5.326E+01	5.090E+01	4.860E+01	4.459E+01	4.152E+01	3.928E+01
yb	2.774E-04	2.744E-04	2.736E-04	2.724E-04	2.714E-04	2.685E-04	2.656E-04	2.599E-04	2.544E-04	2.436E-04	2.333E-04	2.234E-04
lu	1.220E-07	1.160E-07	1.145E-07	1.121E-07	1.102E-07	1.047E-07	9.950E-08	8.985E-08	8.114E-08	6.617E-08	5.397E-08	4.402E-08
totals	2.844E+09	2.401E+09	2.330E+09	2.230E+09	2.162E+09	2.004E+09	1.888E+09	1.723E+09	1.607E+09	1.444E+09	1.329E+09	1.242E+09

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decay, following irradiation identified by: power= 25.00mw, burnup= 39500.mwd, flux= 4.05E+13n/cm**2-sec

element thermal power, watts

basis = full core inventory 548 assemblies (94t

	initial	12.0 h	15.0 h	20.0 h	24.0 h	36.0 h	48.0 h	72.0 h	96.0 h	144.0 h	192.0 h	240.0 h
h	2.160E+00	2.160E+00	2.160E+00	2.160E+00	2.159E+00	2.159E+00	2.159E+00	2.159E+00	2.158E+00	2.158E+00	2.157E+00	2.156E+00
be	2.842E-05	2.842E-05	2.842E-05	2.842E-05	2.842E-05	2.842E-05	2.842E-05	2.842E-05	2.842E-05	2.841E-05	2.841E-05	2.841E-05
c	4.214E-04	4.214E-04	4.214E-04	4.214E-04	4.214E-04	4.214E-04	4.214E-04	4.214E-04	4.214E-04	4.214E-04	4.214E-04	4.214E-04
ni	2.969E-03	2.549E-03	2.454E-03	2.303E-03	2.189E-03	1.880E-03	1.614E-03	1.190E-03	8.776E-04	4.771E-04	2.594E-04	1.410E-04
cu	1.121E-01	9.716E-02	9.375E-02	8.833E-02	8.423E-02	7.302E-02	6.332E-02	4.761E-02	3.581E-02	2.028E-02	1.150E-02	6.529E-03
zn	1.958E+00	1.523E+00	1.449E+00	1.339E+00	1.259E+00	1.051E+00	8.787E-01	6.144E-01	4.296E-01	2.101E-01	1.027E-01	5.024E-02
ga	2.971E+01	2.418E+01	2.325E+01	2.183E+01	2.078E+01	1.786E+01	1.523E+01	1.089E+01	7.687E+00	3.782E+00	1.852E+00	9.058E-01
ge	2.557E+02	1.181E+02	9.820E+01	7.225E+01	5.653E+01	2.707E+01	1.297E+01	2.975E+00	6.825E-01	3.593E-02	1.891E-03	9.991E-05
as	4.312E+02	1.348E+02	1.270E+02	1.164E+02	1.088E+02	8.840E+01	7.154E+01	4.656E+01	3.022E+01	1.272E+01	5.367E+00	2.269E+00
se	1.674E+00	2.755E-01	2.628E-01	2.427E-01	2.275E-01	1.865E-01	1.522E-01	1.008E-01	6.675E-02	2.993E-02	1.427E-02	7.616E-03
br	3.826E+03	2.388E+03	2.238E+03	2.021E+03	1.867E+03	1.475E+03	1.165E+03	7.272E+02	4.540E+02	1.769E+02	6.894E+01	2.686E+01
kr	5.659E+04	5.228E+03	3.512E+03	2.277E+03	1.900E+03	1.618E+03	1.587E+03	1.582E+03	1.582E+03	1.581E+03	1.580E+03	1.580E+03
rb	5.986E+04	3.766E+03	2.122E+03	1.041E+03	7.570E+02	5.859E+02	5.667E+02	5.455E+02	5.256E+02	4.879E+02	4.529E+02	4.205E+02
sr	5.061E+05	3.024E+05	2.793E+05	2.511E+05	2.350E+05	2.070E+05	1.946E+05	1.856E+05	1.821E+05	1.772E+05	1.727E+05	1.683E+05
y	9.604E+05	5.080E+05	4.608E+05	4.071E+05	3.783E+05	3.309E+05	3.105E+05	2.958E+05	2.905E+05	2.841E+05	2.784E+05	2.729E+05
zr	8.759E+05	7.309E+05	7.043E+05	6.665E+05	6.412E+05	5.853E+05	5.501E+05	5.128E+05	4.955E+05	4.789E+05	4.678E+05	4.576E+05
nb	1.287E+06	9.789E+05	9.219E+05	8.422E+05	7.891E+05	6.737E+05	6.028E+05	5.310E+05	5.055E+05	4.915E+05	4.882E+05	4.861E+05
mo	4.215E+05	3.716E+05	3.600E+05	3.416E+05	3.275E+05	2.887E+05	2.545E+05	1.977E+05	1.536E+05	9.275E+04	5.600E+04	3.381E+04
tc	9.250E+04	8.333E+04	8.092E+04	7.697E+04	7.390E+04	6.525E+04	5.754E+04	4.472E+04	3.475E+04	2.098E+04	1.266E+04	7.646E+03
ru	4.711E+05	3.708E+05	3.635E+05	3.562E+05	3.528E+05	3.475E+05	3.441E+05	3.380E+05	3.322E+05	3.207E+05	3.097E+05	2.990E+05
rh	5.489E+05	5.271E+05	5.226E+05	5.159E+05	5.109E+05	4.980E+05	4.877E+05	4.728E+05	4.631E+05	4.520E+05	4.463E+05	4.427E+05
pd	3.197E+04	1.751E+04	1.507E+04	1.173E+04	9.607E+03	5.279E+03	2.907E+03	8.878E+02	2.748E+02	2.807E+01	3.277E+00	4.666E-01
ag	4.189E+04	3.083E+04	2.883E+04	2.597E+04	2.405E+04	1.971E+04	1.683E+04	1.346E+04	1.167E+04	9.823E+03	8.734E+03	7.914E+03
cd	2.171E+03	1.523E+03	1.458E+03	1.365E+03	1.299E+03	1.125E+03	9.762E+02	7.405E+02	5.675E+02	3.468E+02	2.271E+02	1.616E+02
in	1.782E+03	1.019E+03	9.661E+02	8.962E+02	8.487E+02	7.254E+02	6.209E+02	4.548E+02	3.332E+02	1.790E+02	9.607E+01	5.156E+01
sn	6.504E+03	4.356E+03	4.284E+03	4.196E+03	4.134E+03	3.966E+03	3.812E+03	3.539E+03	3.299E+03	2.885E+03	2.535E+03	2.235E+03
sb	8.888E+04	4.495E+04	4.111E+04	3.687E+04	3.461E+04	3.040E+04	2.764E+04	2.346E+04	2.012E+04	1.504E+04	1.149E+04	9.006E+03
te	3.165E+05	2.583E+05	2.476E+05	2.316E+05	2.199E+05	1.899E+05	1.652E+05	1.277E+05	1.009E+05	6.676E+04	4.689E+04	3.459E+04
i	2.711E+06	2.003E+06	1.892E+06	1.739E+06	1.636E+06	1.399E+06	1.222E+06	9.646E+05	7.793E+05	5.276E+05	3.672E+05	2.602E+05
xe	3.421E+05	2.615E+05	2.422E+05	2.139E+05	1.952E+05	1.559E+05	1.336E+05	1.103E+05	9.583E+04	7.373E+04	5.671E+04	4.361E+04
cs	2.124E+05	2.108E+05	2.104E+05	2.099E+05	2.094E+05	2.081E+05	2.068E+05	2.043E+05	2.020E+05	1.976E+05	1.936E+05	1.900E+05
ba	3.655E+05	3.518E+05	3.497E+05	3.462E+05	3.435E+05	3.355E+05	3.276E+05	3.126E+05	2.984E+05	2.721E+05	2.486E+05	2.275E+05
la	2.028E+06	1.884E+06	1.872E+06	1.855E+06	1.843E+06	1.810E+06	1.775E+06	1.701E+06	1.624E+06	1.471E+06	1.326E+06	1.192E+06
ce	5.265E+05	4.533E+05	4.377E+05	4.136E+05	3.960E+05	3.512E+05	3.160E+05	2.664E+05	2.352E+05	2.020E+05	1.863E+05	1.772E+05
pr	8.918E+05	8.214E+05	8.140E+05	8.042E+05	7.991E+05	7.895E+05	7.834E+05	7.737E+05	7.649E+05			

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7.480E+05 7.321E+05 7.173E+05
    nd      1.000E+05 9.468E+04 9.393E+04 9.269E+04 9.172E+04 8.887E+04 8.611E+04 8.084E+04 7.590E+04
6.690E+04 5.896E+04 5.197E+04
    pm      2.339E+05 2.079E+05 2.022E+05 1.932E+05 1.865E+05 1.685E+05 1.533E+05 1.291E+05 1.111E+05
8.624E+04 7.033E+04 5.944E+04
    sm      5.920E+04 4.878E+04 4.653E+04 4.305E+04 4.047E+04 3.370E+04 2.810E+04 1.959E+04 1.367E+04
6.663E+03 3.248E+03 1.585E+03
    eu      1.989E+05 1.928E+05 1.915E+05 1.893E+05 1.876E+05 1.829E+05 1.786E+05 1.706E+05 1.631E+05
1.493E+05 1.368E+05 1.254E+05
    gd      5.888E+02 3.762E+02 3.364E+02 2.791E+02 2.404E+02 1.536E+02 9.820E+01 4.018E+01 1.650E+01
2.890E+00 6.234E-01 2.451E-01
    tb      7.097E+02 7.017E+02 6.997E+02 6.965E+02 6.939E+02 6.864E+02 6.792E+02 6.653E+02 6.523E+02
6.285E+02 6.073E+02 5.881E+02
    dy      3.934E+00 8.220E-01 7.514E-01 6.936E-01 6.650E-01 5.983E-01 5.403E-01 4.406E-01 3.594E-01
2.390E-01 1.590E-01 1.058E-01
    ho      1.896E+01 1.457E+01 1.367E+01 1.231E+01 1.133E+01 8.900E+00 7.060E+00 4.585E+00 3.109E+00
1.609E+00 9.379E-01 5.856E-01
    er      1.201E-01 9.350E-02 8.921E-02 8.323E-02 7.923E-02 6.979E-02 6.258E-02 5.159E-02 4.340E-02
3.217E-02 2.508E-02 2.027E-02
    tm      1.777E-01 1.735E-01 1.722E-01 1.700E-01 1.681E-01 1.621E-01 1.556E-01 1.422E-01 1.292E-01
1.067E-01 8.969E-02 7.767E-02
    yb      7.058E-07 6.983E-07 6.964E-07 6.932E-07 6.907E-07 6.833E-07 6.760E-07 6.615E-07 6.473E-07
6.199E-07 5.936E-07 5.685E-07
    lu      1.421E-09 1.350E-09 1.333E-09 1.305E-09 1.282E-09 1.218E-09 1.157E-09 1.044E-09 9.418E-10
7.666E-10 6.241E-10 5.080E-10
  totals    1.344E+07 1.077E+07 1.039E+07 9.876E+06 9.538E+06 8.775E+06 8.235E+06 7.485E+06 6.962E+06
6.218E+06 5.684E+06 5.271E+06
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Fukushima Daiichi 4
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decay, following irradiation identified by: power= 25.00mw, burnup= 39500.mwd, flux= 4.05E+13n/cm**2-sec

element concentrations, grams
basis = full core inventory 548 assemblies (94t

	charge	discharge	2E-03 h	3E-03 h	5E-03 h	8E-03 h	2E-02 h	3E-02 h	7E-02 h	0.2 h	0.3 h	1.0 h	1.5 h	2.0 h	4.0 h	6.0 h	8.0 h	10.0 h
he	1.518E-01	5.545E+01	5.545E+01	5.545E+01	5.545E+01	5.545E+01	5.545E+01	5.545E+01	5.545E+01	5.545E+01	5.545E+01	5.545E+01	5.546E+01	5.546E+01	5.547E+01	5.548E+01	5.549E+01	5.550E+01
tl	1.279E-12	3.625E-10	3.625E-10	3.625E-10	3.625E-10	3.625E-10	3.625E-10	3.625E-10	3.625E-10	3.625E-10	3.625E-10	3.748E-10	3.626E-10	3.626E-10	3.675E-10	3.675E-10	3.675E-10	3.674E-10
pb	3.437E-07	1.404E-04	1.404E-04	1.404E-04	1.404E-04	1.404E-04	1.404E-04	1.404E-04	1.404E-04	1.404E-04	1.404E-04	1.404E-04	1.404E-04	1.404E-04	1.404E-04	1.405E-04	1.405E-04	1.405E-04
bi	1.357E-10	5.190E-08	5.190E-08	5.190E-08	5.190E-08	5.190E-08	5.190E-08	5.190E-08	5.190E-08	5.190E-08	5.190E-08	5.190E-08	5.191E-08	5.191E-08	5.192E-08	5.192E-08	5.193E-08	5.193E-08
po	2.213E-13	7.718E-11	7.718E-11	7.718E-11	7.718E-11	7.718E-11	7.718E-11	7.718E-11	7.718E-11	7.718E-11	7.719E-11	7.719E-11	7.719E-11	7.720E-11	7.721E-11	7.723E-11	7.724E-11	7.726E-11
at	6.091E-20	4.539E-17	4.540E-17	4.540E-17	4.540E-17	4.539E-17	4.539E-17	4.539E-17	4.539E-17	4.539E-17	4.539E-17	4.540E-17	4.540E-17	4.540E-17	4.543E-17	4.544E-17	4.545E-17	4.546E-17
rn	1.324E-12	3.548E-10	3.548E-10	3.548E-10	3.548E-10	3.548E-10	3.548E-10	3.548E-10	3.548E-10	3.548E-10	3.551E-10	3.549E-10	3.549E-10	3.549E-10	3.548E-10	3.548E-10	3.547E-10	3.547E-10
fr	6.986E-16	4.392E-13	4.392E-13	4.392E-13	4.392E-13	4.392E-13	4.392E-13	4.392E-13	4.392E-13	4.392E-13	4.392E-13	4.393E-13	4.393E-13	4.393E-13	4.396E-13	4.397E-13	4.398E-13	4.399E-13
ra	3.533E-08	6.747E-06	6.747E-06	6.747E-06	6.747E-06	6.747E-06	6.747E-06	6.747E-06	6.747E-06	6.747E-06	6.747E-06	6.747E-06	6.747E-06	6.747E-06	6.747E-06	6.748E-06	6.748E-06	6.748E-06
ac	5.191E-09	7.170E-07	7.170E-07	7.170E-07	7.170E-07	7.170E-07	7.170E-07	7.170E-07	7.170E-07	7.170E-07	7.170E-07	7.170E-07	7.170E-07	7.170E-07	7.171E-07	7.172E-07	7.174E-07	7.175E-07
th	2.133E-03	2.484E-01	2.484E-01	2.484E-01	2.484E-01	2.484E-01	2.484E-01	2.484E-01	2.484E-01	2.484E-01	2.484E-01	2.484E-01	2.484E-01	2.484E-01	2.484E-01	2.484E-01	2.484E-01	2.484E-01
pa	3.415E-04	5.130E-02	5.130E-02	5.130E-02	5.130E-02	5.130E-02	5.130E-02	5.130E-02	5.130E-02	5.130E-02	5.130E-02	5.130E-02	5.130E-02	5.130E-02	5.131E-02	5.131E-02	5.131E-02	5.131E-02
u	9.649E+05	8.925E+07	8.925E+07	8.925E+07	8.925E+07	8.925E+07	8.925E+07	8.925E+07	8.925E+07	8.925E+07	8.925E+07	8.925E+07	8.925E+07	8.925E+07	8.925E+07	8.925E+07	8.925E+07	8.924E+07
np	2.870E+02	4.931E+04	4.931E+04	4.931E+04	4.931E+04	4.931E+04	4.931E+04	4.931E+04	4.931E+04	4.931E+04	4.931E+04	4.927E+04	4.924E+04	4.921E+04	4.908E+04	4.895E+04	4.882E+04	4.870E+04
pu	7.185E+03	8.213E+05	8.213E+05	8.213E+05	8.213E+05	8.213E+05	8.213E+05	8.213E+05	8.213E+05	8.213E+05	8.213E+05	8.214E+05	8.214E+05	8.215E+05	8.216E+05	8.217E+05	8.219E+05	8.220E+05
am	6.734E+01	1.728E+04	1.728E+04	1.728E+04	1.728E+04	1.728E+04	1.728E+04	1.728E+04	1.728E+04	1.728E+04	1.728E+04	1.728E+04	1.728E+04	1.728E+04	1.728E+04	1.728E+04	1.728E+04	1.728E+04
cm	1.137E+01	5.389E+03	5.389E+03	5.389E+03	5.389E+03	5.389E+03	5.389E+03	5.389E+03	5.389E+03	5.389E+03	5.389E+03	5.389E+03	5.390E+03	5.390E+03	5.391E+03	5.392E+03	5.392E+03	5.393E+03
bk	1.175E-08	8.000E-05	8.000E-05	8.000E-05	8.000E-05	8.000E-05	8.000E-05	8.000E-05	8.000E-05	8.000E-05	8.001E-05	8.001E-05	8.001E-05	8.001E-05	7.999E-05	7.997E-05	7.995E-05	7.993E-05
cf	7.074E-09	5.351E-05	5.351E-05	5.351E-05	5.351E-05	5.351E-05	5.351E-05	5.351E-05	5.351E-05	5.351E-05	5.352E-05	5.353E-05	5.354E-05	5.355E-05	5.358E-05	5.361E-05	5.363E-05	5.365E-05
es	2.726E-13	9.931E-09	9.931E-09	9.931E-09	9.931E-09	9.931E-09	9.931E-09	9.931E-09	9.931E-09	9.932E-09	9.932E-09	9.935E-09	9.937E-09	9.939E-09	9.947E-09	9.954E-09	9.962E-09	9.969E-09
totals	9.724E+05	9.014E+07	9.014E+07	9.014E+07	9.014E+07	9.014E+07	9.014E+07	9.014E+07	9.014E+07	9.014E+07	9.014E+07	9.014E+07	9.014E+07	9.014E+07	9.014E+07	9.014E+07	9.014E+07	9.014E+07

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actinides page 74
decay, following irradiation identified by: power= 25.00mw, burnup= 39500.mwd, flux= 4.05E+13n/cm**2-sec

element radioactivity, curies
basis = full core inventory 548 assemblies (94t

	charge	discharge	2E-03 h	3E-03 h	5E-03 h	8E-03 h	2E-02 h	3E-02 h	7E-02 h	0.2 h	0.3 h	1.0 h	1.5 h	2.0 h	4.0 h	6.0 h	8.0 h	10.0 h
tl	3.786E-04	1.073E-01	1.073E-01	1.073E-01	1.073E-01	1.073E-01	1.073E-01	1.073E-01	1.073E-01	1.073E-01	1.073E-01	1.110E-01	1.074E-01	1.074E-01	1.088E-01	1.088E-01	1.088E-01	1.088E-01
pb	1.053E-03	2.986E-01	2.986E-01	2.986E-01	2.986E-01	2.986E-01	2.986E-01	2.986E-01	2.986E-01	2.986E-01	2.986E-01	2.986E-01	2.986E-01	2.986E-01	2.986E-01	2.985E-01	2.985E-01	2.985E-01
bi	1.053E-03	2.986E-01	2.986E-01	2.986E-01	2.986E-01	2.986E-01	2.986E-01	2.986E-01	2.986E-01	2.986E-01	2.986E-01	2.987E-01	2.987E-01	2.987E-01	2.987E-01	2.987E-01	2.987E-01	2.987E-01
po	1.727E-03	4.898E-01	4.906E-01	4.906E-01	4.906E-01	4.905E-01	4.904E-01	4.902E-01	4.900E-01	4.898E-01	4.901E-01	4.899E-01	4.899E-01	4.899E-01	4.899E-01	4.899E-01	4.898E-01	4.898E-01
at	9.808E-08	7.309E-05	7.310E-05	7.310E-05	7.310E-05	7.310E-05	7.310E-05	7.310E-05	7.310E-05	7.309E-05	7.309E-05	7.310E-05	7.311E-05	7.311E-05	7.316E-05	7.317E-05	7.319E-05	7.321E-05
rn	1.053E-03	2.986E-01	2.986E-01	2.986E-01	2.986E-01	2.986E-01	2.986E-01	2.986E-01	2.986E-01	2.986E-01	2.988E-01	2.986E-01	2.986E-01	2.986E-01	2.985E-01	2.985E-01	2.985E-01	2.984E-01
fr	1.033E-07	7.380E-05	7.380E-05	7.380E-05	7.380E-05	7.380E-05	7.380E-05	7.380E-05	7.380E-05	7.380E-05	7.381E-05	7.381E-05	7.382E-05	7.382E-05	7.387E-05	7.389E-05	7.391E-05	7.392E-05
ra	1.053E-03	2.986E-01	2.986E-01	2.986E-01	2.986E-01	2.986E-01	2.986E-01	2.986E-01	2.986E-01	2.986E-01	2.986E-01	2.986E-01	2.986E-01	2.986E-01	2.986E-01	2.985E-01	2.985E-01	2.985E-01
ac	4.736E-07	2.091E-03	2.090E-03	2.090E-03	2.089E-03	2.089E-03	2.087E-03	2.083E-03	2.076E-03									

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2.053E-03 2.019E-03 1.881E-03 1.785E-03 1.694E-03 1.377E-03 1.125E-03 9.228E-04 7.619E-04
     th      3.482E-01 1.139E+02 1.139E+02 1.139E+02 1.139E+02 1.139E+02 1.138E+02 1.137E+02 1.135E+02
1.130E+02 1.123E+02 1.100E+02 1.088E+02 1.077E+02 1.036E+02 9.977E+01 9.615E+01 9.272E+01
     pa      5.183E-01 1.173E+02 1.173E+02 1.172E+02 1.172E+02 1.172E+02 1.171E+02 1.170E+02 1.169E+02
1.168E+02 1.166E+02 1.157E+02 1.151E+02 1.145E+02 1.122E+02 1.099E+02 1.078E+02 1.057E+02
     u       6.271E+03 1.394E+09 1.390E+09 1.386E+09 1.382E+09 1.375E+09 1.354E+09 1.318E+09 1.244E+09
1.046E+09 8.009E+08 2.820E+08 1.481E+08 9.286E+07 5.483E+07 5.329E+07 5.281E+07 5.236E+07
     np      6.598E+01 1.367E+09 1.367E+09 1.367E+09 1.367E+09 1.367E+09 1.367E+09 1.367E+09 1.367E+09
1.366E+09 1.365E+09 1.357E+09 1.349E+09 1.341E+09 1.309E+09 1.277E+09 1.246E+09 1.216E+09
     pu      8.515E+04 4.181E+07 4.180E+07 4.180E+07 4.179E+07 4.177E+07 4.174E+07 4.167E+07 4.153E+07
4.109E+07 4.044E+07 3.784E+07 3.605E+07 3.438E+07 2.876E+07 2.452E+07 2.131E+07 1.888E+07
     am      1.278E+02 1.730E+07 1.730E+07 1.730E+07 1.730E+07 1.729E+07 1.729E+07 1.727E+07 1.724E+07
1.713E+07 1.698E+07 1.634E+07 1.587E+07 1.543E+07 1.376E+07 1.229E+07 1.098E+07 9.811E+06
     cm      1.713E+04 5.099E+06 5.099E+06 5.099E+06 5.099E+06 5.099E+06 5.099E+06 5.099E+06 5.099E+06
5.099E+06 5.099E+06 5.099E+06 5.099E+06 5.099E+06 5.099E+06 5.099E+06 5.099E+06 5.099E+06
     bk      1.926E-05 4.464E-01 4.462E-01 4.461E-01 4.460E-01 4.458E-01 4.452E-01 4.441E-01 4.418E-01
4.350E-01 4.247E-01 3.853E-01 3.593E-01 3.360E-01 2.642E-01 2.176E-01 1.873E-01 1.676E-01
     cf      5.202E-07 6.670E-03 6.670E-03 6.670E-03 6.670E-03 6.670E-03 6.670E-03 6.670E-03 6.670E-03
6.670E-03 6.670E-03 6.671E-03 6.672E-03 6.672E-03 6.673E-03 6.673E-03 6.673E-03 6.672E-03
     es      5.816E-09 2.051E-04 2.051E-04 2.051E-04 2.051E-04 2.051E-04 2.051E-04 2.051E-04 2.051E-04
2.051E-04 2.052E-04 2.052E-04 2.053E-04 2.053E-04 2.055E-04 2.057E-04 2.059E-04 2.061E-04
  totals     1.087E+05 2.825E+09 2.821E+09 2.817E+09 2.813E+09 2.806E+09 2.785E+09 2.749E+09 2.675E+09
2.475E+09 2.229E+09 1.698E+09 1.555E+09 1.489E+09 1.411E+09 1.372E+09 1.336E+09 1.302E+09

     Fukushima Daiichi 4
actinides          page   75
decay, following irradiation identified by: power=  25.00mw, burnup=  39500.mwd, flux=
4.05E+13n/cm**2-sec

                                                    element thermal power, watts
                                                    basis = full core inventory 548 assemblies (94t
                 charge  discharge   2E-03 h   3E-03 h   5E-03 h   8E-03 h   2E-02 h   3E-02 h   7E-02 h
0.2 h     0.3 h     1.0 h     1.5 h     2.0 h     4.0 h     6.0 h     8.0 h    10.0 h
     tl      8.848E-06 2.509E-03 2.509E-03 2.509E-03 2.509E-03 2.509E-03 2.509E-03 2.509E-03 2.509E-03
2.509E-03 2.510E-03 2.594E-03 2.510E-03 2.510E-03 2.544E-03 2.544E-03 2.544E-03 2.544E-03
     pb      1.991E-06 5.647E-04 5.647E-04 5.647E-04 5.647E-04 5.647E-04 5.647E-04 5.647E-04 5.647E-04
5.647E-04 5.647E-04 5.647E-04 5.647E-04 5.647E-04 5.646E-04 5.646E-04 5.645E-04 5.645E-04
     bi      1.764E-05 5.001E-03 5.001E-03 5.001E-03 5.001E-03 5.001E-03 5.001E-03 5.001E-03 5.001E-03
5.001E-03 5.001E-03 5.002E-03 5.003E-03 5.003E-03 5.003E-03 5.003E-03 5.002E-03 5.002E-03
     po      7.888E-05 2.237E-02 2.240E-02 2.240E-02 2.240E-02 2.240E-02 2.239E-02 2.239E-02 2.238E-02
2.237E-02 2.239E-02 2.238E-02 2.238E-02 2.238E-02 2.238E-02 2.237E-02 2.237E-02 2.237E-02
     at      4.185E-09 3.119E-06 3.119E-06 3.119E-06 3.119E-06 3.119E-06 3.119E-06 3.119E-06 3.119E-06
3.119E-06 3.119E-06 3.119E-06 3.120E-06 3.120E-06 3.122E-06 3.123E-06 3.123E-06 3.124E-06
     rn      3.997E-05 1.134E-02 1.134E-02 1.134E-02 1.134E-02 1.134E-02 1.134E-02 1.134E-02 1.134E-02
1.134E-02 1.135E-02 1.134E-02 1.134E-02 1.134E-02 1.133E-02 1.133E-02 1.133E-02 1.133E-02
     fr      3.799E-09 2.823E-06 2.823E-06 2.823E-06 2.823E-06 2.823E-06 2.823E-06 2.823E-06 2.823E-06
2.823E-06 2.823E-06 2.823E-06 2.824E-06 2.824E-06 2.826E-06 2.826E-06 2.827E-06 2.828E-06
     ra      3.613E-05 1.025E-02 1.025E-02 1.025E-02 1.025E-02 1.025E-02 1.025E-02 1.025E-02 1.025E-02
1.025E-02 1.025E-02 1.025E-02 1.025E-02 1.025E-02 1.024E-02 1.024E-02 1.024E-02 1.024E-02
     ac      3.606E-09 1.791E-05 1.791E-05 1.791E-05 1.790E-05 1.790E-05 1.788E-05 1.785E-05 1.780E-05
1.762E-05 1.735E-05 1.628E-05 1.553E-05 1.482E-05 1.235E-05 1.038E-05 8.804E-06 7.549E-06
     th      1.991E-04 1.169E-01 1.169E-01 1.169E-01 1.169E-01 1.168E-01 1.167E-01 1.165E-01 1.161E-01
1.150E-01 1.136E-01 1.100E-01 1.083E-01 1.070E-01 1.025E-01 9.828E-02 9.433E-02 9.059E-02
     pa      2.074E-03 5.969E-01 5.968E-01 5.967E-01 5.966E-01 5.964E-01 5.960E-01 5.955E-01 5.949E-01
5.939E-01 5.925E-01 5.869E-01 5.828E-01 5.787E-01 5.629E-01 5.479E-01 5.337E-01 5.201E-01
     u       1.219E+01 3.741E+06 3.730E+06 3.719E+06 3.709E+06 3.688E+06 3.633E+06 3.534E+06 3.334E+06
2.795E+06 2.131E+06 7.231E+05 3.598E+05 2.099E+05 1.070E+05 1.032E+05 1.022E+05 1.014E+05
     np      1.726E-01 3.537E+06 3.537E+06 3.537E+06 3.537E+06 3.537E+06 3.537E+06 3.537E+06 3.536E+06
3.534E+06 3.530E+06 3.505E+06 3.483E+06 3.461E+06 3.374E+06 3.292E+06 3.211E+06 3.133E+06
     pu      6.249E+01 4.719E+04 4.718E+04 4.717E+04 4.717E+04 4.715E+04 4.711E+04 4.703E+04 4.686E+04
4.637E+04 4.561E+04 4.262E+04 4.056E+04 3.864E+04 3.218E+04 2.729E+04 2.360E+04 2.081E+04
     am      3.919E+00 7.466E+04 7.465E+04 7.464E+04 7.464E+04 7.462E+04 7.458E+04 7.450E+04 7.434E+04
7.384E+04 7.307E+04 6.996E+04 6.772E+04 6.555E+04 5.758E+04 5.060E+04 4.449E+04 3.914E+04
     cm      6.243E+02 1.856E+05 1.856E+05 1.856E+05 1.856E+05 1.856E+05 1.856E+05 1.856E+05 1.856E+05
1.856E+05 1.856E+05 1.856E+05 1.856E+05 1.856E+05 1.856E+05 1.856E+05 1.856E+05 1.856E+05
     bk      3.765E-09 2.246E-03 2.245E-03 2.245E-03 2.244E-03 2.242E-03 2.238E-03 2.230E-03 2.214E-03
2.166E-03 2.094E-03 1.816E-03 1.633E-03 1.469E-03 9.634E-04 6.351E-04 4.217E-04 2.830E-04
     cf      2.704E-08 3.808E-04 3.808E-04 3.808E-04 3.808E-04 3.808E-04 3.808E-04 3.808E-04 3.808E-04
3.809E-04 3.809E-04 3.809E-04 3.809E-04 3.809E-04 3.810E-04 3.810E-04 3.810E-04 3.810E-04
     es      2.322E-10 8.189E-06 8.189E-06 8.189E-06 8.189E-06 8.189E-06 8.189E-06 8.189E-06 8.189E-06
8.190E-06 8.190E-06 8.193E-06 8.195E-06 8.197E-06 8.205E-06 8.214E-06 8.222E-06 8.230E-06
  totals     7.031E+02 7.585E+06 7.574E+06 7.564E+06 7.553E+06 7.532E+06 7.477E+06 7.378E+06 7.177E+06
6.635E+06 5.965E+06 4.526E+06 4.137E+06 3.961E+06 3.757E+06 3.658E+06 3.567E+06 3.480E+06

     Fukushima Daiichi 4                                                                    fission
products          page   76
decay, following irradiation identified by: power=  25.00mw, burnup=  39500.mwd, flux=
4.05E+13n/cm**2-sec
```

element concentrations, grams
basis = full core inventory 548 assemblies (94t

	charge	discharge	2E-03 h	3E-03 h	5E-03 h	8E-03 h	2E-02 h	3E-02 h	7E-02 h
h	4.918E-02	7.516E+00	7.516E+00	7.516E+00	7.516E+00	7.516E+00	7.516E+00	7.516E+00	7.516E+00
he	9.221E-01	1.308E+02	1.308E+02	1.308E+02	1.308E+02	1.308E+02	1.308E+02	1.308E+02	1.308E+02
li	1.169E-02	1.089E+00	1.089E+00	1.089E+00	1.089E+00	1.089E+00	1.089E+00	1.089E+00	1.089E+00
be	7.985E-03	1.142E+00	1.142E+00	1.142E+00	1.142E+00	1.142E+00	1.142E+00	1.142E+00	1.142E+00
b	5.155E-04	7.494E-02	7.494E-02	7.494E-02	7.494E-02	7.494E-02	7.494E-02	7.494E-02	7.494E-02
c	2.331E-03	3.546E-01	3.546E-01	3.546E-01	3.546E-01	3.546E-01	3.546E-01	3.546E-01	3.546E-01
n	2.889E-04	3.511E-02	3.511E-02	3.511E-02	3.511E-02	3.511E-02	3.511E-02	3.511E-02	3.511E-02
ne	3.983E-03	4.834E-01	4.834E-01	4.834E-01	4.834E-01	4.834E-01	4.834E-01	4.834E-01	4.834E-01
co	0.000E+00	1.473E-10	4.060E-15	3.378E-19	1.562E-23	6.012E-32	0.000E+00	0.000E+00	0.000E+00
ni	2.920E-13	1.008E-05	1.007E-05	1.006E-05	1.006E-05	1.006E-05	1.005E-05	1.005E-05	1.005E-05
cu	7.123E-12	5.491E-05	5.484E-05	5.481E-05	5.478E-05	5.475E-05	5.470E-05	5.465E-05	5.458E-05
zn	1.209E-03	1.902E-01	1.902E-01	1.902E-01	1.902E-01	1.902E-01	1.902E-01	1.902E-01	1.902E-01
ga	1.922E-03	3.078E-01	3.078E-01	3.078E-01	3.078E-01	3.078E-01	3.078E-01	3.078E-01	3.078E-01
ge	3.066E-01	4.240E+01	4.240E+01	4.240E+01	4.240E+01	4.240E+01	4.240E+01	4.240E+01	4.240E+01
as	9.313E-02	1.299E+01	1.299E+01	1.299E+01	1.299E+01	1.298E+01	1.298E+01	1.298E+01	1.298E+01
se	4.487E+01	6.048E+03	6.048E+03	6.048E+03	6.048E+03	6.048E+03	6.048E+03	6.048E+03	6.048E+03
br	1.754E+01	2.363E+03	2.363E+03	2.363E+03	2.363E+03	2.363E+03	2.363E+03	2.363E+03	2.363E+03
kr	3.151E+02	4.126E+04	4.126E+04	4.126E+04	4.126E+04	4.126E+04	4.126E+04	4.126E+04	4.126E+04
rb	2.995E+02	3.917E+04	3.917E+04	3.917E+04	3.917E+04	3.917E+04	3.917E+04	3.917E+04	3.917E+04
sr	7.807E+02	1.003E+05	1.003E+05	1.003E+05	1.003E+05	1.003E+05	1.003E+05	1.003E+05	1.003E+05
y	4.069E+02	5.269E+04	5.269E+04	5.269E+04	5.269E+04	5.269E+04	5.269E+04	5.269E+04	5.269E+04
zr	3.013E+03	4.046E+05	4.046E+05	4.046E+05	4.046E+05	4.046E+05	4.046E+05	4.046E+05	4.046E+05
nb	2.614E+01	2.607E+03	2.607E+03	2.607E+03	2.607E+03	2.607E+03	2.607E+03	2.607E+03	2.607E+03
mo	2.677E+03	3.724E+05	3.724E+05	3.724E+05	3.724E+05	3.724E+05	3.724E+05	3.724E+05	3.724E+05
tc	6.631E+02	8.869E+04	8.869E+04	8.869E+04	8.869E+04	8.869E+04	8.869E+04	8.869E+04	8.869E+04
ru	1.779E+03	2.664E+05	2.664E+05	2.664E+05	2.664E+05	2.664E+05	2.664E+05	2.664E+05	2.664E+05
rh	3.785E+02	4.758E+04	4.758E+04	4.758E+04	4.758E+04	4.758E+04	4.758E+04	4.758E+04	4.758E+04
pd	7.614E+02	1.407E+05	1.407E+05	1.407E+05	1.407E+05	1.407E+05	1.407E+05	1.407E+05	1.407E+05
ag	4.825E+01	8.373E+03	8.373E+03	8.373E+03	8.373E+03	8.373E+03	8.373E+03	8.373E+03	8.373E+03
cd	4.303E+01	8.891E+03	8.891E+03	8.891E+03	8.891E+03	8.891E+03	8.891E+03	8.891E+03	8.891E+03
in	1.487E+00	1.690E+02	1.690E+02	1.690E+02	1.690E+02	1.690E+02	1.690E+02	1.690E+02	1.690E+02
sn	3.505E+01	5.453E+03	5.453E+03	5.453E+03	5.453E+03	5.453E+03	5.453E+03	5.453E+03	5.453E+03
sb	1.139E+01	1.656E+03	1.656E+03	1.656E+03	1.656E+03	1.656E+03	1.656E+03	1.656E+03	1.656E+03
te	3.647E+02	5.280E+04	5.280E+04	5.280E+04	5.280E+04	5.280E+04	5.280E+04	5.280E+04	5.280E+04
i	1.463E+02	2.231E+04	2.231E+04	2.231E+04	2.231E+04	2.231E+04	2.231E+04	2.231E+04	2.231E+04
xe	4.203E+03	5.986E+05	5.986E+05	5.986E+05	5.986E+05	5.986E+05	5.986E+05	5.986E+05	5.986E+05
cs	2.350E+03	3.205E+05	3.205E+05	3.205E+05	3.205E+05	3.205E+05	3.205E+05	3.205E+05	3.205E+05
ba	1.138E+03	1.652E+05	1.652E+05	1.652E+05	1.652E+05	1.652E+05	1.652E+05	1.652E+05	1.652E+05

	0.2 h	0.3 h	1.0 h	1.5 h	2.0 h	4.0 h	6.0 h	8.0 h	10.0 h
h	7.516E+00	7.516E+00	7.516E+00	7.516E+00	7.516E+00	7.516E+00	7.515E+00	7.515E+00	7.515E+00
he	1.308E+02	1.308E+02	1.308E+02	1.308E+02	1.308E+02	1.308E+02	1.308E+02	1.308E+02	1.308E+02
li	1.089E+00	1.089E+00	1.089E+00	1.089E+00	1.089E+00	1.089E+00	1.089E+00	1.089E+00	1.089E+00
be	1.142E+00	1.142E+00	1.142E+00	1.142E+00	1.142E+00	1.142E+00	1.142E+00	1.142E+00	1.142E+00
b	7.494E-02	7.494E-02	7.494E-02	7.494E-02	7.494E-02	7.494E-02	7.494E-02	7.494E-02	7.494E-02
c	3.546E-01	3.546E-01	3.546E-01	3.546E-01	3.546E-01	3.546E-01	3.546E-01	3.546E-01	3.546E-01
n	3.511E-02	3.511E-02	3.511E-02	3.511E-02	3.511E-02	3.511E-02	3.511E-02	3.511E-02	3.511E-02
ne	4.834E-01	4.834E-01	4.834E-01	4.834E-01	4.834E-01	4.834E-01	4.834E-01	4.834E-01	4.834E-01
co	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ni	1.003E-05	1.001E-05	9.928E-06	9.865E-06	9.803E-06	9.557E-06	9.317E-06	9.084E-06	8.856E-06
cu	5.448E-05	5.437E-05	5.396E-05	5.366E-05	5.336E-05	5.217E-05	5.102E-05	4.989E-05	4.878E-05
zn	1.902E-01	1.902E-01	1.902E-01	1.902E-01	1.902E-01	1.901E-01	1.901E-01	1.900E-01	1.900E-01
ga	3.078E-01	3.077E-01	3.077E-01	3.077E-01	3.077E-01	3.076E-01	3.075E-01	3.075E-01	3.075E-01
ge	4.240E+01	4.240E+01	4.240E+01	4.240E+01	4.240E+01	4.239E+01	4.239E+01	4.239E+01	4.239E+01
as	1.298E+01	1.298E+01	1.298E+01	1.298E+01	1.298E+01	1.297E+01	1.296E+01	1.296E+01	1.296E+01
se	6.048E+03	6.048E+03	6.048E+03	6.048E+03	6.048E+03	6.048E+03	6.048E+03	6.048E+03	6.048E+03
br	2.363E+03	2.363E+03	2.363E+03	2.363E+03	2.363E+03	2.363E+03	2.363E+03	2.363E+03	2.363E+03
kr	4.126E+04	4.126E+04	4.125E+04	4.125E+04	4.125E+04	4.125E+04	4.125E+04	4.125E+04	4.125E+04
rb	3.917E+04	3.917E+04	3.917E+04	3.917E+04	3.917E+04	3.917E+04	3.917E+04	3.917E+04	3.917E+04
sr	1.003E+05	1.003E+05	1.003E+05	1.003E+05	1.003E+05	1.003E+05	1.003E+05	1.003E+05	1.003E+05
y	5.269E+04	5.269E+04	5.269E+04	5.269E+04	5.269E+04	5.269E+04	5.268E+04	5.268E+04	5.268E+04
zr	4.046E+05	4.046E+05	4.046E+05	4.046E+05	4.046E+05	4.046E+05	4.046E+05	4.046E+05	4.046E+05
nb	2.607E+03	2.607E+03	2.607E+03	2.607E+03	2.607E+03	2.607E+03	2.607E+03	2.606E+03	2.606E+03
mo	3.724E+05	3.724E+05	3.724E+05	3.724E+05	3.724E+05	3.724E+05	3.724E+05	3.724E+05	3.724E+05
tc	8.869E+04	8.869E+04	8.869E+04	8.869E+04	8.869E+04	8.870E+04	8.870E+04	8.871E+04	8.871E+04
ru	2.664E+05	2.664E+05	2.664E+05	2.664E+05	2.664E+05	2.664E+05	2.664E+05	2.664E+05	2.664E+05
rh	4.758E+04	4.758E+04	4.758E+04	4.758E+04	4.758E+04	4.759E+04	4.759E+04	4.759E+04	4.760E+04
pd	1.407E+05	1.407E+05	1.407E+05	1.407E+05	1.407E+05	1.407E+05	1.407E+05	1.407E+05	1.407E+05
ag	8.373E+03	8.373E+03	8.374E+03	8.374E+03	8.374E+03	8.375E+03	8.375E+03	8.376E+03	8.376E+03
cd	8.891E+03	8.891E+03	8.891E+03	8.891E+03	8.891E+03	8.892E+03	8.892E+03	8.892E+03	8.893E+03
in	1.690E+02	1.690E+02	1.690E+02	1.690E+02	1.690E+02	1.690E+02	1.690E+02	1.690E+02	1.691E+02
sn	5.453E+03	5.453E+03	5.453E+03	5.453E+03	5.453E+03	5.453E+03	5.453E+03	5.452E+03	5.452E+03
sb	1.656E+03	1.655E+03	1.655E+03	1.654E+03	1.654E+03	1.653E+03	1.652E+03	1.651E+03	1.651E+03
te	5.280E+04	5.279E+04	5.279E+04	5.279E+04	5.279E+04	5.278E+04	5.277E+04	5.277E+04	5.276E+04
i	2.231E+04	2.231E+04	2.230E+04	2.230E+04	2.229E+04	2.228E+04	2.226E+04	2.225E+04	2.224E+04
xe	5.986E+05	5.986E+05	5.987E+05	5.987E+05	5.987E+05	5.987E+05	5.987E+05	5.987E+05	5.987E+05
cs	3.205E+05	3.205E+05	3.205E+05	3.205E+05	3.205E+05	3.205E+05	3.206E+05	3.206E+05	3.206E+05

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1.652E+05 1.652E+05 1.652E+05 1.652E+05 1.652E+05 1.652E+05 1.652E+05 1.652E+05 1.652E+05
     la      9.997E+02 1.380E+05 1.380E+05 1.380E+05 1.380E+05 1.380E+05 1.380E+05 1.380E+05 1.380E+05
1.380E+05 1.380E+05 1.380E+05 1.380E+05 1.380E+05 1.380E+05 1.380E+05 1.380E+05 1.380E+05
     ce      2.220E+03 2.980E+05 2.980E+05 2.980E+05 2.980E+05 2.980E+05 2.980E+05 2.980E+05 2.980E+05
2.980E+05 2.980E+05 2.980E+05 2.980E+05 2.980E+05 2.980E+05 2.980E+05 2.980E+05 2.980E+05
     pr      9.066E+02 1.242E+05 1.242E+05 1.242E+05 1.242E+05 1.242E+05 1.242E+05 1.242E+05 1.242E+05
1.242E+05 1.242E+05 1.242E+05 1.242E+05 1.242E+05 1.242E+05 1.242E+05 1.242E+05 1.242E+05
     nd      3.064E+03 4.307E+05 4.307E+05 4.307E+05 4.307E+05 4.307E+05 4.307E+05 4.307E+05 4.307E+05
4.307E+05 4.307E+05 4.307E+05 4.307E+05 4.307E+05 4.307E+05 4.307E+05 4.308E+05 4.308E+05
     pm      1.731E+02 1.722E+04 1.722E+04 1.722E+04 1.722E+04 1.722E+04 1.722E+04 1.722E+04 1.722E+04
1.722E+04 1.722E+04 1.722E+04 1.722E+04 1.722E+04 1.722E+04 1.722E+04 1.721E+04 1.721E+04
     sm      5.339E+02 7.853E+04 7.853E+04 7.853E+04 7.853E+04 7.853E+04 7.853E+04 7.853E+04 7.853E+04
7.853E+04 7.853E+04 7.854E+04 7.854E+04 7.854E+04 7.854E+04 7.854E+04 7.855E+04 7.855E+04
     eu      9.383E+01 1.603E+04 1.603E+04 1.603E+04 1.603E+04 1.603E+04 1.603E+04 1.603E+04 1.603E+04
1.603E+04 1.603E+04 1.603E+04 1.603E+04 1.603E+04 1.603E+04 1.603E+04 1.604E+04 1.604E+04
     gd      4.894E+01 1.164E+04 1.164E+04 1.164E+04 1.164E+04 1.164E+04 1.164E+04 1.164E+04 1.164E+04
1.164E+04 1.165E+04 1.165E+04 1.165E+04 1.165E+04 1.165E+04 1.165E+04 1.165E+04 1.165E+04
     tb      1.324E+00 2.464E+02 2.464E+02 2.464E+02 2.464E+02 2.464E+02 2.464E+02 2.464E+02 2.464E+02
2.464E+02 2.464E+02 2.464E+02 2.464E+02 2.464E+02 2.464E+02 2.465E+02 2.465E+02 2.465E+02
     dy      5.366E-01 1.075E+02 1.075E+02 1.075E+02 1.075E+02 1.075E+02 1.075E+02 1.075E+02 1.075E+02
1.075E+02 1.075E+02 1.075E+02 1.076E+02 1.076E+02 1.076E+02 1.076E+02 1.076E+02 1.076E+02
     ho      2.567E-02 7.678E+00 7.678E+00 7.678E+00 7.678E+00 7.678E+00 7.678E+00 7.678E+00 7.678E+00
7.678E+00 7.678E+00 7.679E+00 7.679E+00 7.679E+00 7.679E+00 7.679E+00 7.679E+00 7.679E+00
     er      9.237E-03 2.551E+00 2.551E+00 2.551E+00 2.551E+00 2.551E+00 2.551E+00 2.551E+00 2.551E+00
2.551E+00 2.551E+00 2.551E+00 2.551E+00 2.551E+00 2.552E+00 2.552E+00 2.552E+00 2.553E+00
     tm      2.945E-04 4.376E-02 4.376E-02 4.376E-02 4.376E-02 4.376E-02 4.376E-02 4.376E-02 4.376E-02
4.376E-02 4.376E-02 4.376E-02 4.376E-02 4.376E-02 4.377E-02 4.377E-02 4.377E-02 4.377E-02
     yb      2.447E-04 4.435E-02 4.435E-02 4.435E-02 4.435E-02 4.435E-02 4.435E-02 4.435E-02 4.435E-02
4.435E-02 4.435E-02 4.435E-02 4.435E-02 4.435E-02 4.436E-02 4.436E-02 4.437E-02 4.437E-02
     lu      4.026E-17 1.141E-12 1.141E-12 1.141E-12 1.141E-12 1.141E-12 1.141E-12 1.141E-12 1.140E-12
1.140E-12 1.139E-12 1.136E-12 1.134E-12 1.131E-12 1.122E-12 1.112E-12 1.103E-12 1.093E-12
   totals    2.755E+04 3.864E+06 3.864E+06 3.864E+06 3.864E+06 3.864E+06 3.864E+06 3.864E+06 3.864E+06
3.864E+06 3.864E+06 3.864E+06 3.864E+06 3.864E+06 3.864E+06 3.864E+06 3.864E+06 3.864E+06

     Fukushima Daiichi 4                                                                    fission
products          page   77
decay, following irradiation identified by: power=  25.00mw, burnup=  39500.mwd, flux=
4.05E+13n/cm**2-sec

                                        element radioactivity, curies
                                      basis = full core inventory 548 assemblies (94t
             charge  discharge   2E-03 h   3E-03 h   5E-03 h   8E-03 h   2E-02 h   3E-02 h   7E-02 h
0.2 h     0.3 h     1.0 h     1.5 h     2.0 h     4.0 h     6.0 h     8.0 h    10.0 h
      h      4.226E+02 6.404E+04 6.404E+04 6.404E+04 6.404E+04 6.404E+04 6.404E+04 6.404E+04 6.404E+04
6.404E+04 6.404E+04 6.404E+04 6.404E+04 6.404E+04 6.404E+04 6.404E+04 6.404E+04 6.404E+04
     he      0.000E+00 5.649E+04 2.812E+02 1.993E+00 1.037E-02 3.825E-07 7.855E-19 0.000E+00 0.000E+00
0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
     li      0.000E+00 3.856E+03 2.142E+01 1.827E-01 1.157E-03 6.246E-08 3.505E-19 0.000E+00 0.000E+00
0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
     be      1.660E-04 4.752E+03 6.689E+02 4.851E+02 3.567E+02 1.965E+02 4.081E+01 2.288E+00 2.851E-02
2.364E-02 2.364E-02 2.364E-02 2.364E-02 2.364E-02 2.364E-02 2.364E-02 2.364E-02 2.364E-02
      c      9.526E-03 1.452E+02 2.687E+01 6.418E+00 2.318E+00 1.468E+00 1.437E+00 1.437E+00 1.437E+00
1.437E+00 1.437E+00 1.437E+00 1.437E+00 1.437E+00 1.437E+00 1.437E+00 1.437E+00 1.437E+00
     co      0.000E+00 8.486E+01 1.609E-03 1.339E-07 6.192E-12 2.383E-20 0.000E+00 0.000E+00 0.000E+00
0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
     ni      2.540E-07 8.276E+02 2.310E+02 1.336E+02 8.728E+01 4.684E+01 1.714E+01 9.652E+00 8.755E+00
8.729E+00 8.711E+00 8.637E+00 8.583E+00 8.529E+00 8.315E+00 8.106E+00 7.903E+00 7.705E+00
     cu      5.645E-06 7.333E+03 1.907E+03 1.262E+03 8.952E+02 5.663E+02 3.081E+02 1.781E+02 1.072E+02
6.165E+01 5.102E+01 4.948E+01 4.920E+01 4.892E+01 4.781E+01 4.672E+01 4.566E+01 4.463E+01
     zn      4.495E-06 1.279E+05 3.611E+04 2.245E+04 1.660E+04 1.151E+04 7.389E+03 5.047E+03 3.017E+03
1.684E+03 1.551E+03 1.485E+03 1.450E+03 1.422E+03 1.343E+03 1.289E+03 1.243E+03 1.201E+03
     ga      6.451E-06 8.981E+05 2.874E+05 1.737E+05 1.235E+05 8.223E+04 4.685E+04 2.843E+04 1.724E+04
9.001E+03 6.233E+03 4.410E+03 4.160E+03 3.966E+03 3.323E+03 2.836E+03 2.464E+03 2.178E+03
     ge      4.179E-06 1.002E+07 3.671E+06 2.720E+06 2.147E+06 1.544E+06 9.044E+05 5.367E+05 3.998E+05
3.697E+05 3.456E+05 2.625E+05 2.152E+05 1.777E+05 8.981E+04 5.321E+04 3.682E+04 2.852E+04
     as      1.362E-04 2.331E+07 1.250E+07 1.015E+07 8.450E+06 6.175E+06 3.226E+06 1.616E+06 1.059E+06
8.120E+05 6.245E+05 4.378E+05 4.042E+05 3.744E+05 2.653E+05 1.917E+05 1.496E+05 1.267E+05
     se      6.016E-02 5.991E+07 4.655E+07 4.069E+07 3.638E+07 3.078E+07 2.311E+07 1.723E+07 1.224E+07
6.852E+06 4.172E+06 1.202E+06 5.651E+05 2.963E+05 4.604E+04 1.057E+04 2.738E+03 9.084E+02
     br      4.412E-06 1.214E+08 9.601E+07 8.680E+07 8.038E+07 7.151E+07 5.648E+07 4.151E+07 2.850E+07
1.962E+07 1.596E+07 9.551E+06 7.052E+06 5.479E+06 2.677E+06 1.548E+06 9.447E+05 6.055E+05
     kr      8.464E+03 2.457E+08 2.005E+08 1.850E+08 1.740E+08 1.598E+08 1.398E+08 1.229E+08 1.075E+08
9.019E+07 8.181E+07 6.695E+07 5.834E+07 5.107E+07 3.113E+07 1.984E+07 1.306E+07 8.846E+06
     rb      1.865E+02 3.567E+08 2.634E+08 2.302E+08 2.129E+08 1.972E+08 1.760E+08 1.493E+08 1.177E+08
8.347E+07 6.387E+07 3.705E+07 3.044E+07 2.637E+07 1.609E+07 9.930E+06 6.147E+06 3.825E+06
     sr      4.516E+05 5.414E+08 4.302E+08 4.154E+08 4.022E+08 3.807E+08 3.419E+08 3.043E+08 2.696E+08
2.327E+08 2.094E+08 1.825E+08 1.730E+08 1.647E+08 1.388E+08 1.212E+08 1.087E+08 9.968E+07
      y      6.102E+05 7.969E+08 5.777E+08 5.363E+08 5.172E+08 5.023E+08 4.918E+08 4.818E+08 4.612E+08
4.095E+08 3.578E+08 2.856E+08 2.713E+08 2.628E+08 2.360E+08 2.110E+08 1.889E+08 1.702E+08
```

zr 7.444E+05 6.291E+08 3.947E+08 3.278E+08 2.969E+08 2.667E+08 2.336E+08 2.138E+08 2.068E+08
2.059E+08 2.052E+08 2.024E+08 2.003E+08 1.983E+08 1.906E+08 1.834E+08 1.769E+08 1.708E+08
nb 1.036E+06 9.488E+08 6.984E+08 5.863E+08 5.175E+08 4.475E+08 3.818E+08 3.466E+08 3.265E+08
3.120E+08 3.081E+08 3.038E+08 3.005E+08 2.970E+08 2.830E+08 2.692E+08 2.563E+08 2.443E+08
mo 3.497E+01 6.374E+08 5.921E+08 5.638E+08 5.403E+08 5.046E+08 4.401E+08 3.710E+08 3.061E+08
2.421E+08 1.913E+08 1.248E+08 1.171E+08 1.149E+08 1.121E+08 1.098E+08 1.075E+08 1.053E+08
tc 4.521E+01 7.430E+08 7.096E+08 6.896E+08 6.723E+08 6.451E+08 5.946E+08 5.356E+08 4.603E+08
3.596E+08 2.771E+08 1.403E+08 1.148E+08 1.067E+08 1.025E+08 1.015E+08 1.003E+08 9.889E+07
ru 7.912E+05 3.383E+08 3.276E+08 3.222E+08 3.177E+08 3.111E+08 2.996E+08 2.866E+08 2.689E+08
2.427E+08 2.304E+08 2.204E+08 2.152E+08 2.104E+08 1.945E+08 1.828E+08 1.742E+08 1.679E+08
rh 7.904E+05 4.457E+08 4.345E+08 4.261E+08 4.184E+08 4.052E+08 3.787E+08 3.491E+08 3.214E+08
2.947E+08 2.778E+08 2.525E+08 2.458E+08 2.422E+08 2.351E+08 2.301E+08 2.257E+08 2.219E+08
pd 2.223E-01 3.470E+07 3.398E+07 3.358E+07 3.327E+07 3.283E+07 3.209E+07 3.131E+07 3.040E+07
2.915E+07 2.807E+07 2.552E+07 2.448E+07 2.371E+07 2.137E+07 1.936E+07 1.755E+07 1.591E+07
ag 1.731E+03 5.091E+07 4.826E+07 4.660E+07 4.522E+07 4.319E+07 4.015E+07 3.809E+07 3.690E+07
3.548E+07 3.423E+07 3.137E+07 3.022E+07 2.938E+07 2.684E+07 2.466E+07 2.270E+07 2.092E+07
cd 1.247E+02 4.436E+06 3.099E+06 2.849E+06 2.687E+06 2.505E+06 2.276E+06 2.068E+06 1.860E+06
1.661E+06 1.557E+06 1.302E+06 1.168E+06 1.067E+06 8.330E+05 7.201E+05 6.537E+05 6.100E+05
in 5.330E-02 1.067E+07 5.043E+06 4.393E+06 4.061E+06 3.724E+06 3.352E+06 3.085E+06 2.844E+06
2.525E+06 2.286E+06 1.827E+06 1.635E+06 1.497E+06 1.163E+06 9.635E+05 8.251E+05 7.276E+05
sn 1.070E+03 9.054E+07 8.178E+07 7.730E+07 7.346E+07 6.736E+07 5.565E+07 4.245E+07 2.925E+07
1.742E+07 1.295E+07 8.376E+06 6.594E+06 5.300E+06 2.684E+06 1.782E+06 1.414E+06 1.240E+06
sb 5.962E+03 2.375E+08 2.210E+08 2.171E+08 2.138E+08 2.085E+08 1.973E+08 1.801E+08 1.518E+08
1.070E+08 8.004E+07 4.428E+07 3.388E+07 2.806E+07 1.886E+07 1.516E+07 1.283E+07 1.117E+07
te 4.000E+04 5.165E+08 4.924E+08 4.779E+08 4.663E+08 4.503E+08 4.297E+08 4.179E+08 4.071E+08
3.773E+08 3.373E+08 2.351E+08 1.945E+08 1.694E+08 1.318E+08 1.219E+08 1.167E+08 1.128E+08
i 1.942E+04 7.690E+08 7.238E+08 7.020E+08 6.858E+08 6.639E+08 6.302E+08 6.002E+08 5.762E+08
5.582E+08 5.465E+08 5.017E+08 4.699E+08 4.420E+08 3.688E+08 3.311E+08 3.064E+08 2.870E+08
xe 8.580E+03 5.769E+08 5.237E+08 5.037E+08 4.875E+08 4.631E+08 4.230E+08 3.833E+08 3.383E+08
2.730E+08 2.315E+08 1.932E+08 1.903E+08 1.906E+08 1.938E+08 1.945E+08 1.931E+08 1.904E+08
cs 1.633E+05 5.161E+08 4.308E+08 4.113E+08 3.978E+08 3.758E+08 3.335E+08 2.902E+08 2.500E+08
2.032E+08 1.631E+08 8.709E+07 6.202E+07 4.819E+07 3.297E+07 3.134E+07 3.094E+07 3.074E+07
ba 2.055E+05 6.204E+08 5.482E+08 5.112E+08 4.855E+08 4.557E+08 4.260E+08 4.115E+08 3.934E+08
3.487E+08 2.994E+08 2.101E+08 1.845E+08 1.686E+08 1.373E+08 1.256E+08 1.210E+08 1.189E+08
la 1.442E+05 6.151E+08 5.699E+08 5.443E+08 5.243E+08 4.964E+08 4.519E+08 4.151E+08 3.918E+08
3.676E+08 3.407E+08 2.797E+08 2.546E+08 2.355E+08 1.856E+08 1.586E+08 1.428E+08 1.329E+08
ce 1.298E+06 4.886E+08 4.679E+08 4.575E+08 4.501E+08 4.395E+08 4.183E+08 3.901E+08 3.563E+08
3.190E+08 3.005E+08 2.821E+08 2.793E+08 2.779E+08 2.740E+08 2.703E+08 2.667E+08 2.633E+08
pr 9.773E+05 4.267E+08 4.157E+08 4.079E+08 4.021E+08 3.952E+08 3.858E+08 3.740E+08 3.543E+08
3.241E+08 3.037E+08 2.598E+08 2.450E+08 2.369E+08 2.222E+08 2.133E+08 2.063E+08 2.007E+08
nd 3.254E+04 9.777E+07 9.672E+07 9.585E+07 9.501E+07 9.357E+07 9.074E+07 8.745E+07 8.353E+07
7.692E+07 7.026E+07 5.871E+07 5.505E+07 5.241E+07 4.601E+07 4.303E+07 4.158E+07 4.082E+07
pm 1.740E+05 1.037E+08 1.030E+08 1.026E+08 1.022E+08 1.014E+08 9.981E+07 9.751E+07 9.415E+07
8.863E+07 8.428E+07 7.952E+07 7.885E+07 7.843E+07 7.689E+07 7.533E+07 7.379E+07 7.229E+07
sm 3.173E+02 4.011E+07 4.008E+07 4.005E+07 4.002E+07 3.997E+07 3.984E+07 3.959E+07 3.911E+07
3.802E+07 3.700E+07 3.527E+07 3.470E+07 3.430E+07 3.306E+07 3.195E+07 3.089E+07 2.987E+07
eu 1.931E+04 2.302E+07 2.301E+07 2.300E+07 2.299E+07 2.297E+07 2.292E+07 2.287E+07 2.280E+07
2.268E+07 2.252E+07 2.207E+07 2.188E+07 2.175E+07 2.143E+07 2.121E+07 2.102E+07 2.084E+07
gd 1.182E+00 4.919E+05 4.912E+05 4.904E+05 4.895E+05 4.876E+05 4.819E+05 4.708E+05 4.500E+05
4.161E+05 3.990E+05 3.841E+05 3.770E+05 3.700E+05 3.434E+05 3.187E+05 2.958E+05 2.745E+05
tb 2.197E+02 1.832E+05 1.831E+05 1.830E+05 1.829E+05 1.828E+05 1.823E+05 1.815E+05 1.796E+05
1.739E+05 1.654E+05 1.502E+05 1.483E+05 1.477E+05 1.468E+05 1.461E+05 1.454E+05 1.447E+05
dy 1.314E-03 3.890E+04 3.805E+04 3.730E+04 3.654E+04 3.518E+04 3.220E+04 2.842E+04 2.444E+04
2.159E+04 2.041E+04 1.681E+04 1.459E+04 1.267E+04 7.303E+03 4.334E+03 2.690E+03 1.778E+03
ho 1.958E-03 5.929E+03 5.925E+03 5.921E+03 5.918E+03 5.911E+03 5.898E+03 5.878E+03 5.844E+03
5.769E+03 5.695E+03 5.547E+03 5.467E+03 5.390E+03 5.106E+03 4.854E+03 4.624E+03 4.413E+03
er 2.194E-02 9.579E+01 9.555E+01 9.551E+01 9.550E+01 9.550E+01 9.549E+01 9.548E+01 9.543E+01
9.527E+01 9.501E+01 9.395E+01 9.319E+01 9.246E+01 8.975E+01 8.736E+01 8.525E+01 8.337E+01
tm 1.867E-01 5.764E+01 5.764E+01 5.764E+01 5.764E+01 5.764E+01 5.764E+01 5.764E+01 5.764E+01
5.764E+01 5.763E+01 5.761E+01 5.759E+01 5.758E+01 5.750E+01 5.741E+01 5.731E+01 5.721E+01
yb 3.994E-07 2.799E-04 2.799E-04 2.799E-04 2.799E-04 2.799E-04 2.799E-04 2.799E-04 2.799E-04
2.798E-04 2.798E-04 2.796E-04 2.795E-04 2.794E-04 2.789E-04 2.784E-04 2.779E-04 2.774E-04
lu 4.418E-12 1.940E-07 1.926E-07 1.913E-07 1.899E-07 1.874E-07 1.812E-07 1.717E-07 1.569E-07
1.363E-07 1.286E-07 1.268E-07 1.265E-07 1.263E-07 1.252E-07 1.241E-07 1.231E-07 1.220E-07
totals 7.524E+06 1.112E+10 9.617E+09 9.083E+09 8.730E+09 8.287E+09 7.645E+09 7.049E+09 6.449E+09
5.692E+09 5.121E+09 4.185E+09 3.904E+09 3.726E+09 3.339E+09 3.122E+09 2.967E+09 2.844E+09
□
Fukushima Daiichi 4 fission
products page 78
decay, following irradiation identified by: power= 25.00mw, burnup= 39500.mwd, flux=
4.05E+13n/cm**2-sec

element thermal power, watts
basis = full core inventory 548 assemblies (94t
charge discharge 2E-03 h 3E-03 h 5E-03 h 8E-03 h 2E-02 h 3E-02 h 7E-02 h
0.2 h 0.3 h 1.0 h 1.5 h 2.0 h 4.0 h 6.0 h 8.0 h 10.0 h
h 1.425E-02 2.160E+00 2.160E+00 2.160E+00 2.160E+00 2.160E+00 2.160E+00 2.160E+00 2.160E+00
2.160E+00 2.160E+00 2.160E+00 2.160E+00 2.160E+00 2.160E+00 2.160E+00 2.160E+00 2.160E+00
he 0.000E+00 5.806E+02 2.617E+00 1.855E-02 9.652E-05 3.560E-09 7.310E-21 0.000E+00 0.000E+00

```
0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
     li     0.000E+00 2.177E+02 1.304E+00 1.112E-02 7.041E-05 3.802E-09 2.133E-20 0.000E+00 0.000E+00
0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
     be     1.998E-07 4.838E+01 2.343E+01 1.754E+01 1.290E+01 7.106E+00 1.475E+00 8.194E-02 2.043E-04
2.842E-05 2.842E-05 2.842E-05 2.842E-05 2.842E-05 2.842E-05 2.842E-05 2.842E-05 2.842E-05
     c      2.793E-06 5.423E+00 9.596E-01 1.883E-01 3.366E-02 1.573E-03 4.216E-04 4.214E-04 4.214E-04
4.214E-04 4.214E-04 4.214E-04 4.214E-04 4.214E-04 4.214E-04 4.214E-04 4.214E-04 4.214E-04
     co     0.000E+00 2.843E+00 3.285E-05 2.733E-09 1.264E-13 4.865E-22 0.000E+00 0.000E+00 0.000E+00
0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
     ni     9.788E-11 1.322E+01 3.323E+00 2.004E+00 1.275E+00 6.060E-01 1.182E-01 1.296E-02 3.505E-03
3.363E-03 3.356E-03 3.328E-03 3.307E-03 3.286E-03 3.204E-03 3.123E-03 3.045E-03 2.969E-03
     cu     1.040E-08 1.946E+02 3.738E+01 2.388E+01 1.613E+01 9.236E+00 4.213E+00 1.857E+00 7.058E-01
2.261E-01 1.358E-01 1.248E-01 1.240E-01 1.233E-01 1.204E-01 1.175E-01 1.148E-01 1.121E-01
     zn     6.800E-09 2.797E+03 5.710E+02 3.102E+02 2.099E+02 1.243E+02 5.977E+01 3.349E+01 1.544E+01
4.196E+00 3.174E+00 2.950E+00 2.832E+00 2.732E+00 2.436E+00 2.233E+00 2.080E+00 1.958E+00
     ga     1.226E-07 2.786E+04 6.766E+03 3.707E+03 2.457E+03 1.511E+03 7.748E+02 4.111E+02 2.400E+02
1.327E+02 7.925E+01 4.187E+01 3.979E+01 3.879E+01 3.566E+01 3.322E+01 3.128E+01 2.971E+01
     ge     2.233E-10 2.370E+05 4.646E+04 3.115E+04 2.264E+04 1.435E+04 6.794E+03 2.961E+03 1.592E+03
1.408E+03 1.333E+03 1.074E+03 9.249E+02 8.049E+02 5.123E+02 3.757E+02 3.023E+02 2.557E+02
     as     6.476E-07 6.480E+05 2.478E+05 1.872E+05 1.480E+05 9.951E+04 4.264E+04 1.595E+04 8.696E+03
7.149E+03 6.145E+03 4.926E+03 4.493E+03 4.053E+03 2.426E+03 1.343E+03 7.401E+02 4.312E+02
     se     1.993E-05 1.074E+06 7.380E+05 6.022E+05 5.069E+05 3.895E+05 2.432E+05 1.512E+05 9.919E+04
6.040E+04 3.995E+04 1.133E+04 4.663E+03 2.006E+03 1.414E+02 2.579E+01 6.110E+00 1.674E+00
     br     7.278E-08 3.143E+06 2.288E+06 1.987E+06 1.781E+06 1.503E+06 1.055E+06 6.495E+05 3.525E+05
2.235E+05 1.767E+05 8.050E+04 4.744E+04 2.971E+04 9.395E+03 5.983E+03 4.606E+03 3.826E+03
     kr     1.269E+01 3.972E+06 2.955E+06 2.644E+06 2.435E+06 2.174E+06 1.832E+06 1.546E+06 1.275E+06
9.653E+05 8.338E+05 6.534E+05 5.539E+05 4.719E+05 2.598E+05 1.511E+05 9.124E+04 5.659E+04
     rb     8.420E-01 8.699E+06 5.856E+06 4.992E+06 4.563E+06 4.185E+06 3.683E+06 3.049E+06 2.292E+06
1.496E+06 1.092E+06 6.025E+05 4.895E+05 4.224E+05 2.569E+05 1.579E+05 9.714E+04 5.986E+04
     sr     1.409E+03 7.823E+06 5.441E+06 5.148E+06 4.891E+06 4.479E+06 3.765E+06 3.129E+06 2.582E+06
1.972E+06 1.582E+06 1.221E+06 1.135E+06 1.063E+06 8.388E+05 6.874E+05 5.820E+05 5.061E+05
     y      2.325E+03 1.316E+07 7.073E+06 5.965E+06 5.451E+06 5.051E+06 4.817E+06 4.680E+06 4.408E+06
3.707E+06 2.986E+06 1.967E+06 1.790E+06 1.705E+06 1.485E+06 1.286E+06 1.109E+06 9.604E+05
     zr     3.752E+03 6.305E+06 2.813E+06 2.001E+06 1.695E+06 1.447E+06 1.225E+06 1.106E+06 1.065E+06
1.060E+06 1.056E+06 1.041E+06 1.030E+06 1.020E+06 9.794E+05 9.420E+05 9.076E+05 8.759E+05
     nb     4.936E+03 1.337E+07 8.116E+06 6.055E+06 4.883E+06 3.764E+06 2.771E+06 2.236E+06 1.924E+06
1.702E+06 1.651E+06 1.622E+06 1.603E+06 1.584E+06 1.505E+06 1.427E+06 1.354E+06 1.287E+06
     mo     1.401E-01 6.021E+06 5.333E+06 4.948E+06 4.642E+06 4.190E+06 3.398E+06 2.598E+06 1.935E+06
1.427E+06 1.063E+06 5.471E+05 4.806E+05 4.632E+05 4.490E+05 4.396E+05 4.305E+05 4.215E+05
     tc     3.736E-02 9.031E+06 8.351E+06 7.973E+06 7.662E+06 7.190E+06 6.351E+06 5.497E+06 4.586E+06
3.280E+06 2.138E+06 4.738E+05 2.102E+05 1.311E+05 9.619E+04 9.494E+04 9.380E+04 9.250E+04
     ru     1.643E+03 1.855E+06 1.712E+06 1.651E+06 1.604E+06 1.536E+06 1.423E+06 1.308E+06 1.169E+06
9.777E+05 8.926E+05 8.265E+05 7.912E+05 7.586E+05 6.508E+05 5.717E+05 5.137E+05 4.711E+05
     rh     3.015E+03 2.223E+06 2.102E+06 2.025E+06 1.958E+06 1.847E+06 1.619E+06 1.371E+06 1.137E+06
8.875E+05 7.546E+05 6.279E+05 6.008E+05 5.880E+05 5.696E+05 5.606E+05 5.541E+05 5.489E+05
     pd     2.158E-05 1.151E+05 1.064E+05 1.022E+05 9.934E+04 9.553E+04 8.923E+04 8.274E+04 7.633E+04
6.969E+04 6.477E+04 5.414E+04 5.060E+04 4.845E+04 4.323E+04 3.908E+04 3.534E+04 3.197E+04
     ag     1.852E+01 1.990E+05 1.667E+05 1.511E+05 1.393E+05 1.231E+05 9.898E+04 8.152E+04 7.042E+04
6.126E+04 5.826E+04 5.491E+04 5.367E+04 5.274E+04 4.973E+04 4.694E+04 4.433E+04 4.189E+04
     cd     4.692E-01 4.989E+04 2.539E+04 2.204E+04 1.990E+04 1.760E+04 1.509E+04 1.307E+04 1.081E+04
8.528E+03 7.799E+03 6.658E+03 5.995E+03 5.437E+03 3.905E+03 3.029E+03 2.501E+03 2.171E+03
     in     1.298E-04 2.255E+05 5.810E+04 4.436E+04 3.834E+04 3.289E+04 2.748E+04 2.386E+04 2.094E+04
1.776E+04 1.536E+04 1.033E+04 8.190E+03 6.734E+03 3.921E+03 2.807E+03 2.183E+03 1.782E+03
     sn     4.193E+00 1.223E+06 1.062E+06 9.955E+05 9.391E+05 8.489E+05 6.754E+05 4.830E+05 2.995E+05
1.517E+05 1.031E+05 6.522E+04 5.250E+04 4.288E+04 2.135E+04 1.251E+04 8.472E+03 6.504E+03
     sb     2.132E+01 4.422E+06 3.967E+06 3.873E+06 3.798E+06 3.683E+06 3.457E+06 3.120E+06 2.565E+06
1.690E+06 1.184E+06 5.826E+05 4.126E+05 3.176E+05 1.782E+05 1.327E+05 1.068E+05 8.888E+04
     te     7.370E+01 4.846E+06 4.345E+06 4.047E+06 3.811E+06 3.491E+06 3.090E+06 2.897E+06 2.785E+06
2.505E+06 2.139E+06 1.262E+06 9.308E+05 7.268E+05 4.247E+05 3.580E+05 3.325E+05 3.165E+05
     i      6.787E+01 1.142E+07 1.032E+07 9.816E+06 9.445E+06 8.952E+06 8.195E+06 7.511E+06 6.990E+06
6.693E+06 6.530E+06 5.796E+06 5.268E+06 4.809E+06 3.676E+06 3.184E+06 2.909E+06 2.711E+06
     xe     9.116E+00 5.422E+06 4.484E+06 4.175E+06 3.933E+06 3.576E+06 3.005E+06 2.479E+06 1.945E+06
1.232E+06 7.927E+05 3.873E+05 3.464E+05 3.408E+05 3.505E+05 3.538E+05 3.503E+05 3.421E+05
     cs     9.021E+02 9.319E+06 7.375E+06 6.994E+06 6.745E+06 6.337E+06 5.529E+06 4.685E+06 3.950E+06
3.279E+06 2.704E+06 1.343E+06 8.294E+05 5.439E+05 2.399E+05 2.153E+05 2.129E+05 2.124E+05
     ba     6.844E+02 5.414E+06 4.392E+06 3.902E+06 3.573E+06 3.203E+06 2.845E+06 2.689E+06 2.521E+06
2.113E+06 1.671E+06 9.240E+05 7.426E+05 6.429E+05 4.640E+05 4.003E+05 3.756E+05 3.655E+05
     la     2.421E+03 9.167E+06 8.298E+06 7.804E+06 7.424E+06 6.904E+06 6.090E+06 5.417E+06 5.041E+06
4.800E+06 4.537E+06 3.818E+06 3.476E+06 3.211E+06 2.565E+06 2.264E+06 2.112E+06 2.028E+06
     ce     1.230E+03 2.256E+06 2.036E+06 1.931E+06 1.857E+06 1.759E+06 1.571E+06 1.325E+06 1.043E+06
7.691E+05 6.698E+05 6.021E+05 5.917E+05 5.863E+05 5.702E+05 5.550E+05 5.405E+05 5.265E+05
     pr     6.335E+03 3.482E+06 3.289E+06 3.160E+06 3.066E+06 2.962E+06 2.839E+06 2.687E+06 2.431E+06
2.053E+06 1.825E+06 1.324E+06 1.159E+06 1.078E+06 9.825E+05 9.444E+05 9.152E+05 8.918E+05
     nd     7.875E+01 4.664E+05 4.553E+05 4.467E+05 4.386E+05 4.252E+05 3.997E+05 3.720E+05 3.421E+05
2.994E+05 2.588E+05 1.909E+05 1.712E+05 1.576E+05 1.250E+05 1.103E+05 1.034E+05 1.000E+05
     pm     2.322E+02 5.038E+05 4.929E+05 4.857E+05 4.794E+05 4.691E+05 4.479E+05 4.203E+05 3.838E+05
3.356E+05 3.015E+05 2.622E+05 2.578E+05 2.558E+05 2.497E+05 2.441E+05 2.388E+05 2.339E+05
     sm     3.746E-02 9.611E+04 9.573E+04 9.547E+04 9.524E+04 9.484E+04 9.385E+04 9.214E+04 8.901E+04
8.272E+04 7.760E+04 7.076E+04 6.909E+04 6.809E+04 6.552E+04 6.331E+04 6.120E+04 5.920E+04
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     eu     1.753E+02 2.186E+05 2.184E+05 2.183E+05 2.181E+05 2.178E+05 2.172E+05 2.163E+05 2.153E+05
2.140E+05 2.125E+05 2.081E+05 2.063E+05 2.051E+05 2.026E+05 2.012E+05 2.000E+05 1.989E+05
     gd     1.039E-03 1.445E+03 1.439E+03 1.433E+03 1.426E+03 1.412E+03 1.372E+03 1.299E+03 1.171E+03
9.748E+02 8.838E+02 8.265E+02 8.096E+02 7.941E+02 7.367E+02 6.837E+02 6.345E+02 5.888E+02
     tb     1.863E+00 1.063E+03 1.061E+03 1.060E+03 1.059E+03 1.057E+03 1.051E+03 1.041E+03 1.021E+03
9.649E+02 8.837E+02 7.392E+02 7.219E+02 7.173E+02 7.139E+02 7.124E+02 7.111E+02 7.097E+02
     dy     1.535E-06 7.532E+01 7.464E+01 7.403E+01 7.343E+01 7.235E+01 7.000E+01 6.697E+01 6.348E+01
5.960E+01 5.634E+01 4.609E+01 3.984E+01 3.446E+01 1.940E+01 1.108E+01 6.481E+00 3.934E+00
     ho     9.023E-06 2.671E+01 2.665E+01 2.659E+01 2.654E+01 2.645E+01 2.626E+01 2.602E+01 2.569E+01
2.507E+01 2.451E+01 2.371E+01 2.337E+01 2.306E+01 2.188E+01 2.082E+01 1.986E+01 1.896E+01
     er     1.340E-05 1.671E-01 1.668E-01 1.668E-01 1.668E-01 1.668E-01 1.667E-01 1.666E-01 1.664E-01
1.658E-01 1.647E-01 1.605E-01 1.574E-01 1.545E-01 1.439E-01 1.348E-01 1.269E-01 1.201E-01
     tm     2.707E-04 1.800E-01 1.800E-01 1.800E-01 1.800E-01 1.800E-01 1.800E-01 1.800E-01 1.800E-01
1.800E-01 1.800E-01 1.799E-01 1.798E-01 1.797E-01 1.793E-01 1.788E-01 1.783E-01 1.777E-01
     yb     1.016E-09 7.122E-07 7.122E-07 7.122E-07 7.122E-07 7.122E-07 7.122E-07 7.122E-07 7.122E-07
7.121E-07 7.120E-07 7.116E-07 7.113E-07 7.110E-07 7.097E-07 7.084E-07 7.071E-07 7.058E-07
     lu     4.877E-14 1.498E-09 1.498E-09 1.498E-09 1.497E-09 1.497E-09 1.495E-09 1.493E-09 1.490E-09
1.485E-09 1.482E-09 1.477E-09 1.474E-09 1.471E-09 1.459E-09 1.446E-09 1.434E-09 1.421E-09
  totals    2.935E+04 1.364E+08 1.043E+08 9.448E+07 8.837E+07 8.106E+07 7.092E+07 6.194E+07 5.362E+07
4.415E+07 3.743E+07 2.664E+07 2.338E+07 2.134E+07 1.732E+07 1.546E+07 1.429E+07 1.344E+07


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actinides          page   79
decay, following irradiation identified by: power=  25.00mw, burnup=  39500.mwd, flux=
4.05E+13n/cm**2-sec

                                                 element concentrations, grams
                                                 basis = full core inventory 548 assemblies (94t
              initial     12.0 h     15.0 h     20.0 h     24.0 h     36.0 h     48.0 h     72.0 h     96.0 h
144.0 h   192.0 h   240.0 h
     he     5.550E+01 5.556E+01 5.557E+01 5.559E+01 5.561E+01 5.567E+01 5.573E+01 5.585E+01 5.596E+01
5.619E+01 5.642E+01 5.664E+01
     tl     3.674E-10 3.796E-10 3.671E-10 3.629E-10 3.634E-10 3.793E-10 3.792E-10 3.697E-10 3.699E-10
3.643E-10 3.653E-10 3.666E-10
     pb     1.405E-04 1.407E-04 1.407E-04 1.408E-04 1.409E-04 1.410E-04 1.412E-04 1.415E-04 1.419E-04
1.426E-04 1.432E-04 1.439E-04
     bi     5.193E-08 5.293E-08 5.209E-08 5.198E-08 5.199E-08 5.300E-08 5.303E-08 5.258E-08 5.267E-08
5.252E-08 5.273E-08 5.296E-08
     po     7.726E-11 7.734E-11 7.737E-11 7.740E-11 7.743E-11 7.752E-11 7.760E-11 7.778E-11 7.795E-11
7.829E-11 7.863E-11 7.897E-11
     at     4.546E-17 4.550E-17 4.551E-17 4.552E-17 4.552E-17 4.551E-17 4.547E-17 4.532E-17 4.509E-17
4.440E-17 4.349E-17 4.241E-17
     rn     3.547E-10 3.545E-10 3.545E-10 3.545E-10 3.544E-10 3.544E-10 3.544E-10 3.544E-10 3.547E-10
3.554E-10 3.565E-10 3.577E-10
     fr     4.399E-13 4.403E-13 4.404E-13 4.405E-13 4.405E-13 4.404E-13 4.401E-13 4.388E-13 4.367E-13
4.305E-13 4.222E-13 4.123E-13
     ra     6.748E-06 6.750E-06 6.750E-06 6.751E-06 6.752E-06 6.754E-06 6.756E-06 6.762E-06 6.768E-06
6.783E-06 6.799E-06 6.816E-06
     ac     7.175E-07 7.187E-07 7.190E-07 7.196E-07 7.200E-07 7.214E-07 7.228E-07 7.255E-07 7.283E-07
7.338E-07 7.394E-07 7.449E-07
     th     2.484E-01 2.485E-01 2.485E-01 2.485E-01 2.485E-01 2.486E-01 2.487E-01 2.488E-01 2.490E-01
2.493E-01 2.496E-01 2.499E-01
     pa     5.131E-02 5.132E-02 5.132E-02 5.132E-02 5.133E-02 5.133E-02 5.133E-02 5.133E-02 5.133E-02
5.133E-02 5.133E-02 5.134E-02
      u     8.924E+07 8.924E+07 8.924E+07 8.924E+07 8.924E+07 8.924E+07 8.924E+07 8.924E+07 8.924E+07
8.924E+07 8.924E+07 8.924E+07
     np     4.870E+04 4.801E+04 4.786E+04 4.761E+04 4.742E+04 4.692E+04 4.649E+04 4.580E+04 4.529E+04
4.465E+04 4.432E+04 4.415E+04
     pu     8.220E+05 8.227E+05 8.229E+05 8.231E+05 8.233E+05 8.238E+05 8.243E+05 8.250E+05 8.256E+05
8.263E+05 8.267E+05 8.269E+05
     am     1.728E+04 1.729E+04 1.729E+04 1.729E+04 1.729E+04 1.730E+04 1.731E+04 1.732E+04 1.733E+04
1.736E+04 1.739E+04 1.742E+04
     cm     5.393E+03 5.394E+03 5.393E+03 5.393E+03 5.392E+03 5.390E+03 5.388E+03 5.382E+03 5.375E+03
5.362E+03 5.350E+03 5.337E+03
     bk     7.993E-05 7.983E-05 7.981E-05 7.978E-05 7.975E-05 7.966E-05 7.957E-05 7.940E-05 7.923E-05
7.889E-05 7.855E-05 7.821E-05
     cf     5.365E-05 5.374E-05 5.376E-05 5.380E-05 5.382E-05 5.391E-05 5.399E-05 5.415E-05 5.431E-05
5.464E-05 5.496E-05 5.528E-05
     es     9.969E-09 1.001E-08 1.002E-08 1.004E-08 1.005E-08 1.008E-08 1.011E-08 1.016E-08 1.020E-08
1.022E-08 1.021E-08 1.015E-08
  totals    9.014E+07 9.014E+07 9.014E+07 9.014E+07 9.014E+07 9.014E+07 9.014E+07 9.014E+07 9.014E+07
9.014E+07 9.014E+07 9.014E+07
□
     Fukushima Daiichi 4
actinides          page   80
decay, following irradiation identified by: power=  25.00mw, burnup=  39500.mwd, flux=
4.05E+13n/cm**2-sec
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                                       element radioactivity, curies
                                       basis = full core inventory 548 assemblies (94t
          initial     12.0 h     15.0 h     20.0 h     24.0 h     36.0 h     48.0 h     72.0 h     96.0 h
144.0 h   192.0 h   240.0 h
     tl      1.088E-01 1.124E-01 1.087E-01 1.074E-01 1.076E-01 1.123E-01 1.123E-01 1.095E-01 1.095E-01
1.079E-01 1.082E-01 1.086E-01
     pb      2.985E-01 2.983E-01 2.983E-01 2.982E-01 2.982E-01 2.981E-01 2.980E-01 2.980E-01 2.981E-01
2.987E-01 2.996E-01 3.006E-01
     bi      2.987E-01 3.127E-01 3.003E-01 2.984E-01 2.983E-01 3.125E-01 3.124E-01 3.046E-01 3.047E-01
3.001E-01 3.010E-01 3.020E-01
     po      4.898E-01 4.986E-01 4.906E-01 4.894E-01 4.893E-01 4.983E-01 4.982E-01 4.933E-01 4.935E-01
4.912E-01 4.927E-01 4.945E-01
     at      7.321E-05 7.328E-05 7.329E-05 7.330E-05 7.330E-05 7.328E-05 7.321E-05 7.297E-05 7.260E-05
7.150E-05 7.003E-05 6.829E-05
     rn      2.984E-01 2.983E-01 2.983E-01 2.982E-01 2.982E-01 2.981E-01 2.981E-01 2.982E-01 2.984E-01
2.990E-01 3.000E-01 3.011E-01
     fr      7.392E-05 7.399E-05 7.400E-05 7.401E-05 7.402E-05 7.399E-05 7.393E-05 7.370E-05 7.333E-05
7.223E-05 7.077E-05 6.903E-05
     ra      2.985E-01 2.983E-01 2.983E-01 2.982E-01 2.982E-01 2.981E-01 2.981E-01 2.982E-01 2.984E-01
2.990E-01 3.000E-01 3.011E-01
     ac      7.619E-04 2.899E-04 2.426E-04 1.921E-04 1.679E-04 1.364E-04 1.283E-04 1.256E-04 1.252E-04
1.245E-04 1.234E-04 1.221E-04
     th      9.272E+01 7.562E+01 7.215E+01 6.696E+01 6.328E+01 5.437E+01 4.794E+01 3.995E+01 3.579E+01
3.249E+01 3.160E+01 3.136E+01
     pa      1.057E+02 9.522E+01 9.301E+01 8.964E+01 8.720E+01 8.105E+01 7.633E+01 6.993E+01 6.616E+01
6.262E+01 6.139E+01 6.095E+01
      u      5.236E+07 4.973E+07 4.910E+07 4.806E+07 4.725E+07 4.488E+07 4.263E+07 3.847E+07 3.472E+07
2.827E+07 2.302E+07 1.875E+07
     np      1.216E+09 1.049E+09 1.011E+09 9.507E+08 9.051E+08 7.810E+08 6.739E+08 5.018E+08 3.737E+08
2.072E+08 1.149E+08 6.372E+07
     pu      1.888E+07 1.277E+07 1.229E+07 1.182E+07 1.163E+07 1.141E+07 1.137E+07 1.136E+07 1.136E+07
1.136E+07 1.136E+07 1.135E+07
     am      9.811E+06 5.076E+06 4.322E+06 3.316E+06 2.691E+06 1.461E+06 8.123E+05 2.709E+05 1.031E+05
2.987E+04 2.134E+04 2.038E+04
     cm      5.099E+06 5.096E+06 5.095E+06 5.092E+06 5.090E+06 5.082E+06 5.073E+06 5.054E+06 5.035E+06
4.995E+06 4.955E+06 4.916E+06
     bk      1.676E-01 1.336E-01 1.323E-01 1.313E-01 1.309E-01 1.306E-01 1.305E-01 1.302E-01 1.299E-01
1.293E-01 1.288E-01 1.282E-01
     cf      6.672E-03 6.667E-03 6.665E-03 6.662E-03 6.660E-03 6.654E-03 6.648E-03 6.636E-03 6.624E-03
6.601E-03 6.580E-03 6.560E-03
     es      2.061E-04 2.073E-04 2.075E-04 2.079E-04 2.083E-04 2.092E-04 2.100E-04 2.113E-04 2.123E-04
2.133E-04 2.131E-04 2.120E-04
  totals     1.302E+09 1.122E+09 1.082E+09 1.019E+09 9.718E+08 8.438E+08 7.338E+08 5.570E+08 4.249E+08
2.519E+08 1.543E+08 9.876E+07

     Fukushima Daiichi 4
actinides          page   81
decay, following irradiation identified by: power=  25.00mw, burnup=  39500.mwd, flux=
4.05E+13n/cm**2-sec

                                       element thermal power, watts
                                       basis = full core inventory 548 assemblies (94t
          initial     12.0 h     15.0 h     20.0 h     24.0 h     36.0 h     48.0 h     72.0 h     96.0 h
144.0 h   192.0 h   240.0 h
     tl      2.544E-03 2.628E-03 2.541E-03 2.512E-03 2.515E-03 2.626E-03 2.625E-03 2.559E-03 2.560E-03
2.522E-03 2.529E-03 2.538E-03
     pb      5.645E-04 5.642E-04 5.641E-04 5.640E-04 5.639E-04 5.637E-04 5.636E-04 5.636E-04 5.638E-04
5.649E-04 5.665E-04 5.685E-04
     bi      5.002E-03 5.238E-03 5.029E-03 4.998E-03 4.996E-03 5.233E-03 5.232E-03 5.101E-03 5.103E-03
5.026E-03 5.040E-03 5.058E-03
     po      2.237E-02 2.284E-02 2.242E-02 2.235E-02 2.235E-02 2.283E-02 2.282E-02 2.256E-02 2.257E-02
2.244E-02 2.251E-02 2.259E-02
     at      3.124E-06 3.127E-06 3.127E-06 3.128E-06 3.128E-06 3.127E-06 3.124E-06 3.114E-06 3.098E-06
3.051E-06 2.989E-06 2.914E-06
     rn      1.133E-02 1.133E-02 1.132E-02 1.132E-02 1.132E-02 1.132E-02 1.132E-02 1.132E-02 1.133E-02
1.135E-02 1.139E-02 1.143E-02
     fr      2.828E-06 2.830E-06 2.831E-06 2.831E-06 2.831E-06 2.830E-06 2.828E-06 2.819E-06 2.804E-06
2.762E-06 2.705E-06 2.638E-06
     ra      1.024E-02 1.024E-02 1.023E-02 1.023E-02 1.023E-02 1.023E-02 1.023E-02 1.023E-02 1.024E-02
1.026E-02 1.029E-02 1.033E-02
     ac      7.549E-06 3.868E-06 3.500E-06 3.105E-06 2.916E-06 2.669E-06 2.603E-06 2.574E-06 2.560E-06
2.522E-06 2.471E-06 2.410E-06
     th      9.059E-02 7.195E-02 6.817E-02 6.251E-02 5.851E-02 4.880E-02 4.180E-02 3.311E-02 2.859E-02
2.504E-02 2.412E-02 2.390E-02
     pa      5.201E-01 4.507E-01 4.361E-01 4.140E-01 3.980E-01 3.577E-01 3.268E-01 2.849E-01 2.602E-01
2.371E-01 2.290E-01 2.262E-01
      u      1.014E+05 9.629E+04 9.506E+04 9.305E+04 9.147E+04 8.689E+04 8.254E+04 7.449E+04 6.722E+04
5.474E+04 4.458E+04 3.630E+04
     np      3.133E+06 2.703E+06 2.605E+06 2.449E+06 2.331E+06 2.011E+06 1.735E+06 1.291E+06 9.609E+05
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5.322E+05 2.949E+05 1.634E+05
     pu     2.081E+04 1.378E+04 1.323E+04 1.270E+04 1.248E+04 1.224E+04 1.220E+04 1.220E+04 1.221E+04
1.223E+04 1.224E+04 1.225E+04
     am     3.914E+04 1.839E+04 1.530E+04 1.131E+04 8.930E+03 4.568E+03 2.528E+03 1.089E+03 7.403E+02
6.229E+02 6.148E+02 6.168E+02
     cm     1.856E+05 1.855E+05 1.854E+05 1.853E+05 1.852E+05 1.850E+05 1.846E+05 1.839E+05 1.832E+05
1.818E+05 1.803E+05 1.789E+05
     bk     2.830E-04 4.500E-05 3.577E-05 2.905E-05 2.705E-05 2.567E-05 2.554E-05 2.548E-05 2.542E-05
2.531E-05 2.520E-05 2.509E-05
     cf     3.810E-04 3.809E-04 3.809E-04 3.809E-04 3.808E-04 3.807E-04 3.806E-04 3.803E-04 3.801E-04
3.796E-04 3.791E-04 3.786E-04
     es     8.230E-06 8.274E-06 8.285E-06 8.302E-06 8.315E-06 8.351E-06 8.384E-06 8.437E-06 8.477E-06
8.516E-06 8.509E-06 8.461E-06
  totals    3.480E+06 3.017E+06 2.914E+06 2.751E+06 2.630E+06 2.300E+06 2.017E+06 1.563E+06 1.224E+06
7.816E+05 5.326E+05 3.914E+05

     Fukushima Daiichi 4                                                                    fission
products        page   82
decay, following irradiation identified by: power=  25.00mw, burnup=  39500.mwd, flux=
4.05E+13n/cm**2-sec

                                             element concentrations, grams
                                             basis = full core inventory 548 assemblies (94t
            initial     12.0 h    15.0 h     20.0 h     24.0 h     36.0 h     48.0 h     72.0 h     96.0 h
144.0 h   192.0 h   240.0 h
      h     7.515E+00 7.515E+00 7.515E+00 7.514E+00 7.514E+00 7.514E+00 7.513E+00 7.512E+00 7.511E+00
7.509E+00 7.507E+00 7.505E+00
     he     1.308E+02 1.308E+02 1.308E+02 1.308E+02 1.308E+02 1.308E+02 1.308E+02 1.308E+02 1.308E+02
1.308E+02 1.308E+02 1.308E+02
     li     1.089E+00 1.089E+00 1.089E+00 1.089E+00 1.089E+00 1.089E+00 1.089E+00 1.089E+00 1.089E+00
1.089E+00 1.089E+00 1.089E+00
     be     1.142E+00 1.142E+00 1.142E+00 1.142E+00 1.142E+00 1.142E+00 1.142E+00 1.142E+00 1.142E+00
1.142E+00 1.142E+00 1.142E+00
      b     7.494E-02 7.494E-02 7.494E-02 7.494E-02 7.494E-02 7.494E-02 7.494E-02 7.494E-02 7.494E-02
7.494E-02 7.494E-02 7.494E-02
      c     3.546E-01 3.546E-01 3.546E-01 3.546E-01 3.546E-01 3.546E-01 3.546E-01 3.546E-01 3.546E-01
3.546E-01 3.546E-01 3.546E-01
      n     3.511E-02 3.511E-02 3.511E-02 3.511E-02 3.511E-02 3.511E-02 3.511E-02 3.511E-02 3.511E-02
3.511E-02 3.511E-02 3.511E-02
     ne     4.834E-01 4.834E-01 4.834E-01 4.834E-01 4.834E-01 4.834E-01 4.834E-01 4.834E-01 4.834E-01
4.834E-01 4.834E-01 4.834E-01
     ni     8.856E-06 7.605E-06 7.321E-06 6.870E-06 6.530E-06 5.607E-06 4.815E-06 3.550E-06 2.618E-06
1.423E-06 7.739E-07 4.207E-07
     cu     4.878E-05 4.264E-05 4.123E-05 3.898E-05 3.727E-05 3.258E-05 2.848E-05 2.176E-05 1.663E-05
9.706E-06 5.667E-06 3.308E-06
     zn     1.900E-01 1.898E-01 1.898E-01 1.897E-01 1.896E-01 1.895E-01 1.894E-01 1.892E-01 1.891E-01
1.889E-01 1.889E-01 1.888E-01
     ga     3.075E-01 3.073E-01 3.073E-01 3.073E-01 3.073E-01 3.072E-01 3.072E-01 3.071E-01 3.070E-01
3.070E-01 3.070E-01 3.069E-01
     ge     4.239E+01 4.238E+01 4.238E+01 4.238E+01 4.238E+01 4.238E+01 4.238E+01 4.238E+01 4.238E+01
4.238E+01 4.238E+01 4.238E+01
     as     1.296E+01 1.294E+01 1.293E+01 1.293E+01 1.292E+01 1.291E+01 1.290E+01 1.288E+01 1.287E+01
1.286E+01 1.286E+01 1.285E+01
     se     6.048E+03 6.048E+03 6.048E+03 6.048E+03 6.048E+03 6.048E+03 6.048E+03 6.048E+03 6.048E+03
6.048E+03 6.048E+03 6.048E+03
     br     2.363E+03 2.363E+03 2.363E+03 2.363E+03 2.362E+03 2.362E+03 2.362E+03 2.362E+03 2.362E+03
2.362E+03 2.362E+03 2.362E+03
     kr     4.125E+04 4.125E+04 4.125E+04 4.125E+04 4.125E+04 4.125E+04 4.125E+04 4.125E+04 4.125E+04
4.125E+04 4.125E+04 4.125E+04
     rb     3.917E+04 3.917E+04 3.917E+04 3.917E+04 3.917E+04 3.917E+04 3.917E+04 3.917E+04 3.917E+04
3.917E+04 3.918E+04 3.918E+04
     sr     1.003E+05 1.003E+05 1.003E+05 1.003E+05 1.003E+05 1.003E+05 1.002E+05 1.002E+05 1.002E+05
1.001E+05 1.001E+05 1.000E+05
      y     5.268E+04 5.267E+04 5.267E+04 5.267E+04 5.266E+04 5.266E+04 5.265E+04 5.265E+04 5.264E+04
5.262E+04 5.260E+04 5.258E+04
     zr     4.046E+05 4.046E+05 4.046E+05 4.046E+05 4.046E+05 4.046E+05 4.045E+05 4.045E+05 4.045E+05
4.045E+05 4.045E+05 4.044E+05
     nb     2.606E+03 2.604E+03 2.604E+03 2.604E+03 2.603E+03 2.602E+03 2.601E+03 2.599E+03 2.597E+03
2.590E+03 2.583E+03 2.573E+03
     mo     3.724E+05 3.724E+05 3.724E+05 3.724E+05 3.724E+05 3.724E+05 3.725E+05 3.725E+05 3.725E+05
3.726E+05 3.727E+05 3.728E+05
     tc     8.871E+04 8.874E+04 8.875E+04 8.876E+04 8.876E+04 8.878E+04 8.880E+04 8.883E+04 8.885E+04
8.888E+04 8.890E+04 8.892E+04
     ru     2.664E+05 2.664E+05 2.663E+05 2.663E+05 2.663E+05 2.663E+05 2.662E+05 2.661E+05 2.661E+05
2.659E+05 2.658E+05 2.656E+05
     rh     4.760E+04 4.761E+04 4.761E+04 4.762E+04 4.763E+04 4.764E+04 4.766E+04 4.771E+04 4.775E+04
4.785E+04 4.795E+04 4.805E+04
     pd     1.407E+05 1.407E+05 1.407E+05 1.407E+05 1.407E+05 1.408E+05 1.408E+05 1.408E+05 1.408E+05
1.409E+05 1.410E+05 1.410E+05
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     ag     8.376E+03 8.378E+03 8.378E+03 8.379E+03 8.379E+03 8.378E+03 8.378E+03 8.376E+03 8.374E+03
8.371E+03 8.368E+03 8.366E+03
     cd     8.893E+03 8.894E+03 8.895E+03 8.895E+03 8.896E+03 8.897E+03 8.898E+03 8.900E+03 8.902E+03
8.905E+03 8.908E+03 8.910E+03
     in     1.691E+02 1.692E+02 1.692E+02 1.693E+02 1.693E+02 1.694E+02 1.695E+02 1.697E+02 1.698E+02
1.700E+02 1.701E+02 1.702E+02
     sn     5.452E+03 5.452E+03 5.452E+03 5.452E+03 5.452E+03 5.452E+03 5.451E+03 5.451E+03 5.450E+03
5.450E+03 5.449E+03 5.449E+03
     sb     1.651E+03 1.648E+03 1.648E+03 1.647E+03 1.646E+03 1.645E+03 1.643E+03 1.640E+03 1.638E+03
1.635E+03 1.632E+03 1.630E+03
     te     5.276E+04 5.273E+04 5.272E+04 5.271E+04 5.270E+04 5.268E+04 5.265E+04 5.262E+04 5.259E+04
5.254E+04 5.251E+04 5.249E+04
      i     2.224E+04 2.219E+04 2.218E+04 2.216E+04 2.215E+04 2.212E+04 2.210E+04 2.206E+04 2.203E+04
2.198E+04 2.193E+04 2.190E+04
     xe     5.987E+05 5.987E+05 5.987E+05 5.987E+05 5.987E+05 5.988E+05 5.988E+05 5.988E+05 5.988E+05
5.988E+05 5.988E+05 5.988E+05
     cs     3.206E+05 3.206E+05 3.206E+05 3.207E+05 3.207E+05 3.207E+05 3.207E+05 3.208E+05 3.208E+05
3.209E+05 3.209E+05 3.210E+05
     ba     1.652E+05 1.652E+05 1.652E+05 1.652E+05 1.652E+05 1.651E+05 1.651E+05 1.651E+05 1.650E+05
1.649E+05 1.649E+05 1.648E+05
     la     1.380E+05 1.380E+05 1.380E+05 1.380E+05 1.380E+05 1.380E+05 1.380E+05 1.380E+05 1.380E+05
1.380E+05 1.380E+05 1.380E+05
     ce     2.980E+05 2.979E+05 2.979E+05 2.979E+05 2.979E+05 2.978E+05 2.978E+05 2.977E+05 2.976E+05
2.975E+05 2.974E+05 2.972E+05
     pr     1.242E+05 1.242E+05 1.242E+05 1.243E+05 1.243E+05 1.243E+05 1.243E+05 1.243E+05 1.243E+05
1.244E+05 1.244E+05 1.244E+05
     nd     4.308E+05 4.308E+05 4.308E+05 4.309E+05 4.309E+05 4.309E+05 4.310E+05 4.311E+05 4.312E+05
4.314E+05 4.316E+05 4.318E+05
     pm     1.721E+04 1.720E+04 1.720E+04 1.719E+04 1.719E+04 1.718E+04 1.718E+04 1.717E+04 1.717E+04
1.716E+04 1.716E+04 1.716E+04
     sm     7.855E+04 7.856E+04 7.857E+04 7.857E+04 7.858E+04 7.859E+04 7.861E+04 7.863E+04 7.865E+04
7.869E+04 7.873E+04 7.877E+04
     eu     1.604E+04 1.604E+04 1.604E+04 1.604E+04 1.604E+04 1.604E+04 1.604E+04 1.603E+04 1.603E+04
1.601E+04 1.599E+04 1.597E+04
     gd     1.165E+04 1.166E+04 1.166E+04 1.167E+04 1.167E+04 1.168E+04 1.168E+04 1.170E+04 1.171E+04
1.174E+04 1.176E+04 1.178E+04
     tb     2.465E+02 2.465E+02 2.465E+02 2.465E+02 2.465E+02 2.465E+02 2.465E+02 2.464E+02 2.463E+02
2.461E+02 2.459E+02 2.458E+02
     dy     1.076E+02 1.077E+02 1.077E+02 1.077E+02 1.077E+02 1.078E+02 1.078E+02 1.079E+02 1.080E+02
1.082E+02 1.084E+02 1.086E+02
     ho     7.679E+00 7.678E+00 7.677E+00 7.677E+00 7.677E+00 7.676E+00 7.675E+00 7.674E+00 7.674E+00
7.673E+00 7.673E+00 7.673E+00
     er     2.553E+00 2.554E+00 2.555E+00 2.555E+00 2.556E+00 2.557E+00 2.558E+00 2.559E+00 2.559E+00
2.560E+00 2.561E+00 2.561E+00
     tm     4.377E-02 4.378E-02 4.378E-02 4.379E-02 4.379E-02 4.379E-02 4.380E-02 4.380E-02 4.381E-02
4.381E-02 4.380E-02 4.378E-02
     yb     4.437E-02 4.440E-02 4.440E-02 4.441E-02 4.442E-02 4.445E-02 4.447E-02 4.452E-02 4.456E-02
4.465E-02 4.473E-02 4.480E-02
     lu     1.093E-12 1.039E-12 1.026E-12 1.004E-12 9.876E-13 9.386E-13 8.920E-13 8.057E-13 7.278E-13
5.939E-13 4.846E-13 3.956E-13
  totals    3.864E+06 3.864E+06 3.864E+06 3.864E+06 3.864E+06 3.864E+06 3.864E+06 3.864E+06 3.864E+06
3.864E+06 3.864E+06 3.864E+06
□
     Fukushima Daiichi 4                                                                     fission
products        page  83
decay, following irradiation identified by: power=  25.00mw, burnup=  39500.mwd, flux=
4.05E+13n/cm**2-sec

                                                element radioactivity, curies
                                                basis = full core inventory 548 assemblies (94t
            initial     12.0 h     15.0 h     20.0 h     24.0 h     36.0 h     48.0 h     72.0 h     96.0 h
144.0 h   192.0 h   240.0 h
      h     6.404E+04 6.403E+04 6.403E+04 6.403E+04 6.403E+04 6.402E+04 6.402E+04 6.401E+04 6.400E+04
6.398E+04 6.396E+04 6.394E+04
     be     2.364E-02 2.364E-02 2.364E-02 2.364E-02 2.364E-02 2.364E-02 2.364E-02 2.364E-02 2.364E-02
2.364E-02 2.364E-02 2.364E-02
      c     1.437E+00 1.437E+00 1.437E+00 1.437E+00 1.437E+00 1.437E+00 1.437E+00 1.437E+00 1.437E+00
1.437E+00 1.437E+00 1.437E+00
     ni     7.705E+00 6.616E+00 6.369E+00 5.977E+00 5.681E+00 4.878E+00 4.189E+00 3.089E+00 2.278E+00
1.238E+00 6.733E-01 3.661E-01
     cu     4.463E+01 3.889E+01 3.758E+01 3.548E+01 3.389E+01 2.954E+01 2.574E+01 1.956E+01 1.486E+01
8.585E+00 4.962E+00 2.870E+00
     zn     1.201E+03 9.951E+02 9.510E+02 8.822E+02 8.309E+02 6.946E+02 5.808E+02 4.061E+02 2.840E+02
1.389E+02 6.792E+01 3.321E+01
     ga     2.178E+03 1.383E+03 1.296E+03 1.184E+03 1.114E+03 9.433E+02 8.021E+02 5.729E+02 4.045E+02
1.990E+02 9.744E+01 4.766E+01
     ge     2.852E+04 1.198E+04 9.931E+03 7.283E+03 5.688E+03 2.717E+03 1.300E+03 2.981E+02 6.838E+01
3.608E+00 1.974E-01 1.699E-02
     as     1.267E+05 9.127E+04 8.696E+04 8.020E+04 7.509E+04 6.132E+04 4.983E+04 3.265E+04 2.130E+04
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9.040E+03 3.834E+03 1.627E+03
    se     9.084E+02 2.971E+02 2.838E+02 2.625E+02 2.464E+02 2.029E+02 1.665E+02 1.121E+02 7.603E+01
3.701E+01 2.042E+01 1.337E+01
    br     6.055E+05 1.564E+05 1.406E+05 1.237E+05 1.135E+05 8.939E+04 7.062E+04 4.408E+04 2.752E+04
1.072E+04 4.179E+03 1.628E+03
    kr     8.846E+06 1.773E+06 1.471E+06 1.228E+06 1.143E+06 1.068E+06 1.057E+06 1.055E+06 1.055E+06
1.054E+06 1.054E+06 1.053E+06
    rb     3.825E+06 3.299E+05 2.270E+05 1.590E+05 1.407E+05 1.284E+05 1.255E+05 1.209E+05 1.164E+05
1.081E+05 1.003E+05 9.315E+04
    sr     9.968E+07 7.466E+07 7.173E+07 6.813E+07 6.605E+07 6.234E+07 6.059E+07 5.907E+07 5.824E+07
5.686E+07 5.555E+07 5.428E+07
     y     1.702E+08 1.104E+08 1.035E+08 9.547E+07 9.101E+07 8.338E+07 7.995E+07 7.726E+07 7.608E+07
7.438E+07 7.282E+07 7.129E+07
    zr     1.708E+08 1.432E+08 1.381E+08 1.309E+08 1.261E+08 1.155E+08 1.087E+08 1.016E+08 9.823E+07
9.499E+07 9.280E+07 9.079E+07
    nb     2.443E+08 1.897E+08 1.796E+08 1.655E+08 1.560E+08 1.356E+08 1.230E+08 1.103E+08 1.058E+08
1.032E+08 1.026E+08 1.021E+08
    mo     1.053E+08 9.278E+07 8.990E+07 8.530E+07 8.179E+07 7.209E+07 6.355E+07 4.938E+07 3.836E+07
2.316E+07 1.398E+07 8.441E+06
    tc     9.889E+07 8.908E+07 8.652E+07 8.229E+07 7.900E+07 6.976E+07 6.152E+07 4.781E+07 3.715E+07
2.243E+07 1.354E+07 8.175E+06
    ru     1.679E+08 1.527E+08 1.515E+08 1.502E+08 1.495E+08 1.482E+08 1.472E+08 1.453E+08 1.435E+08
1.399E+08 1.364E+08 1.330E+08
    rh     2.219E+08 2.045E+08 2.010E+08 1.957E+08 1.918E+08 1.819E+08 1.738E+08 1.619E+08 1.538E+08
1.438E+08 1.378E+08 1.335E+08
    pd     1.591E+07 8.840E+06 7.637E+06 5.989E+06 4.933E+06 2.767E+06 1.561E+06 5.070E+05 1.704E+05
2.190E+04 3.468E+03 7.338E+02
    ag     2.092E+07 1.335E+07 1.207E+07 1.030E+07 9.156E+06 6.768E+06 5.368E+06 3.975E+06 3.342E+06
2.691E+06 2.260E+06 1.915E+06
    cd     6.100E+05 4.913E+05 4.726E+05 4.439E+05 4.226E+05 3.653E+05 3.163E+05 2.384E+05 1.813E+05
1.085E+05 6.912E+04 4.765E+04
    in     7.276E+05 5.096E+05 4.873E+05 4.549E+05 4.315E+05 3.693E+05 3.161E+05 2.315E+05 1.696E+05
9.112E+04 4.890E+04 2.624E+04
    sn     1.240E+06 9.754E+05 9.476E+05 9.066E+05 8.771E+05 8.019E+05 7.421E+05 6.538E+05 5.920E+05
5.078E+05 4.481E+05 4.002E+05
    sb     1.117E+07 7.005E+06 6.621E+06 6.177E+06 5.920E+06 5.375E+06 4.958E+06 4.267E+06 3.699E+06
2.831E+06 2.225E+06 1.802E+06
    te     1.128E+08 9.729E+07 9.435E+07 8.984E+07 8.650E+07 7.749E+07 6.968E+07 5.680E+07 4.676E+07
3.256E+07 2.346E+07 1.753E+07
     i     2.870E+08 2.133E+08 2.013E+08 1.845E+08 1.733E+08 1.475E+08 1.288E+08 1.031E+08 8.573E+07
6.288E+07 4.796E+07 3.734E+07
    xe     1.904E+08 1.638E+08 1.573E+08 1.476E+08 1.408E+08 1.254E+08 1.147E+08 9.965E+07 8.761E+07
6.767E+07 5.212E+07 4.012E+07
    cs     3.074E+07 3.037E+07 3.033E+07 3.028E+07 3.024E+07 3.013E+07 3.002E+07 2.982E+07 2.962E+07
2.925E+07 2.892E+07 2.862E+07
    ba     1.189E+08 1.151E+08 1.144E+08 1.133E+08 1.124E+08 1.096E+08 1.070E+08 1.019E+08 9.710E+07
8.824E+07 8.029E+07 7.316E+07
    la     1.329E+08 1.137E+08 1.124E+08 1.109E+08 1.100E+08 1.078E+08 1.057E+08 1.013E+08 9.677E+07
8.765E+07 7.899E+07 7.101E+07
    ce     2.633E+08 2.451E+08 2.412E+08 2.352E+08 2.307E+08 2.193E+08 2.101E+08 1.968E+08 1.879E+08
1.771E+08 1.706E+08 1.657E+08
    pr     2.007E+08 1.836E+08 1.817E+08 1.793E+08 1.779E+08 1.751E+08 1.730E+08 1.691E+08 1.652E+08
1.576E+08 1.503E+08 1.435E+08
    nd     4.082E+07 3.912E+07 3.881E+07 3.830E+07 3.790E+07 3.672E+07 3.558E+07 3.340E+07 3.136E+07
2.764E+07 2.436E+07 2.147E+07
    pm     7.229E+07 6.425E+07 6.246E+07 5.968E+07 5.760E+07 5.206E+07 4.744E+07 4.026E+07 3.510E+07
2.850E+07 2.473E+07 2.246E+07
    sm     2.987E+07 2.461E+07 2.348E+07 2.172E+07 2.042E+07 1.701E+07 1.419E+07 9.903E+06 6.920E+06
3.388E+06 1.667E+06 8.287E+05
    eu     2.084E+07 1.994E+07 1.975E+07 1.946E+07 1.925E+07 1.868E+07 1.820E+07 1.734E+07 1.658E+07
1.520E+07 1.396E+07 1.282E+07
    gd     2.745E+05 1.754E+05 1.569E+05 1.302E+05 1.121E+05 7.171E+04 4.588E+04 1.884E+04 7.804E+03
1.462E+03 4.052E+02 2.283E+02
    tb     1.447E+05 1.407E+05 1.397E+05 1.381E+05 1.368E+05 1.331E+05 1.296E+05 1.230E+05 1.170E+05
1.066E+05 9.778E+04 9.040E+04
    dy     1.778E+03 6.334E+02 5.997E+02 5.653E+02 5.445E+02 4.909E+02 4.433E+02 3.616E+02 2.949E+02
1.961E+02 1.305E+02 8.679E+01
    ho     4.413E+03 3.387E+03 3.178E+03 2.862E+03 2.635E+03 2.069E+03 1.642E+03 1.066E+03 7.228E+02
3.741E+02 2.180E+02 1.361E+02
    er     8.337E+01 7.521E+01 7.370E+01 7.145E+01 6.984E+01 6.563E+01 6.203E+01 5.587E+01 5.068E+01
4.231E+01 3.578E+01 3.051E+01
    tm     5.721E+01 5.644E+01 5.622E+01 5.582E+01 5.549E+01 5.441E+01 5.326E+01 5.090E+01 4.860E+01
4.459E+01 4.152E+01 3.928E+01
    yb     2.774E-04 2.744E-04 2.736E-04 2.724E-04 2.714E-04 2.685E-04 2.656E-04 2.599E-04 2.544E-04
2.436E-04 2.333E-04 2.234E-04
    lu     1.220E-07 1.160E-07 1.145E-07 1.121E-07 1.102E-07 1.047E-07 9.950E-08 8.985E-08 8.114E-08
6.617E-08 5.397E-08 4.402E-08
 totals    2.844E+09 2.401E+09 2.330E+09 2.230E+09 2.162E+09 2.004E+09 1.888E+09 1.723E+09 1.607E+09
1.444E+09 1.329E+09 1.242E+09
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0
Fukushima Daiichi 4 fission products page 84
decay, following irradiation identified by: power= 25.00mw, burnup= 39500.mwd, flux= 4.05E+13n/cm**2-sec

element thermal power, watts
basis = full core inventory 548 assemblies (94t

	initial	12.0 h	15.0 h	20.0 h	24.0 h	36.0 h	48.0 h	72.0 h	96.0 h	144.0 h	192.0 h	240.0 h
h	2.160E+00	2.160E+00	2.160E+00	2.160E+00	2.159E+00	2.159E+00	2.159E+00	2.159E+00	2.158E+00	2.158E+00	2.157E+00	2.156E+00
be	2.842E-05	2.842E-05	2.842E-05	2.842E-05	2.842E-05	2.842E-05	2.842E-05	2.842E-05	2.842E-05	2.841E-05	2.841E-05	2.841E-05
c	4.214E-04	4.214E-04	4.214E-04	4.214E-04	4.214E-04	4.214E-04	4.214E-04	4.214E-04	4.214E-04	4.214E-04	4.214E-04	4.214E-04
ni	2.969E-03	2.549E-03	2.454E-03	2.303E-03	2.189E-03	1.880E-03	1.614E-03	1.190E-03	8.776E-04	4.771E-04	2.594E-04	1.410E-04
cu	1.121E-01	9.716E-02	9.375E-02	8.833E-02	8.423E-02	7.302E-02	6.332E-02	4.761E-02	3.581E-02	2.028E-02	1.150E-02	6.529E-03
zn	1.958E+00	1.523E+00	1.449E+00	1.339E+00	1.259E+00	1.051E+00	8.787E-01	6.144E-01	4.296E-01	2.101E-01	1.027E-01	5.024E-02
ga	2.971E+01	2.418E+01	2.325E+01	2.183E+01	2.078E+01	1.786E+01	1.523E+01	1.089E+01	7.687E+00	3.782E+00	1.852E+00	9.058E-01
ge	2.557E+02	1.181E+02	9.820E+01	7.225E+01	5.653E+01	2.707E+01	1.297E+01	2.975E+00	6.825E-01	3.593E-02	1.891E-03	9.991E-05
as	4.312E+02	1.348E+02	1.270E+02	1.164E+02	1.088E+02	8.840E+01	7.154E+01	4.656E+01	3.022E+01	1.272E+01	5.367E+00	2.269E+00
se	1.674E+00	2.755E-01	2.628E-01	2.427E-01	2.275E-01	1.865E-01	1.522E-01	1.008E-01	6.675E-02	2.993E-02	1.427E-02	7.616E-03
br	3.826E+03	2.388E+03	2.238E+03	2.021E+03	1.867E+03	1.475E+03	1.165E+03	7.272E+02	4.540E+02	1.769E+02	6.894E+01	2.686E+01
kr	5.659E+04	5.228E+03	3.512E+03	2.277E+03	1.900E+03	1.618E+03	1.587E+03	1.582E+03	1.582E+03	1.581E+03	1.580E+03	1.580E+03
rb	5.986E+04	3.766E+03	2.122E+03	1.041E+03	7.570E+02	5.859E+02	5.667E+02	5.455E+02	5.256E+02	4.879E+02	4.529E+02	4.205E+02
sr	5.061E+05	3.024E+05	2.793E+05	2.511E+05	2.350E+05	2.070E+05	1.946E+05	1.856E+05	1.821E+05	1.772E+05	1.727E+05	1.683E+05
y	9.604E+05	5.080E+05	4.608E+05	4.071E+05	3.783E+05	3.309E+05	3.105E+05	2.958E+05	2.905E+05	2.841E+05	2.784E+05	2.729E+05
zr	8.759E+05	7.309E+05	7.043E+05	6.665E+05	6.412E+05	5.853E+05	5.501E+05	5.128E+05	4.955E+05	4.789E+05	4.678E+05	4.576E+05
nb	1.287E+06	9.789E+05	9.219E+05	8.422E+05	7.891E+05	6.737E+05	6.028E+05	5.310E+05	5.055E+05	4.915E+05	4.882E+05	4.861E+05
mo	4.215E+05	3.716E+05	3.600E+05	3.416E+05	3.275E+05	2.887E+05	2.545E+05	1.977E+05	1.536E+05	9.275E+04	5.600E+04	3.381E+04
tc	9.250E+04	8.333E+04	8.092E+04	7.697E+04	7.390E+04	6.525E+04	5.754E+04	4.472E+04	3.475E+04	2.098E+04	1.266E+04	7.646E+03
ru	4.711E+05	3.708E+05	3.635E+05	3.562E+05	3.528E+05	3.475E+05	3.441E+05	3.380E+05	3.322E+05	3.207E+05	3.097E+05	2.990E+05
rh	5.489E+05	5.271E+05	5.226E+05	5.159E+05	5.109E+05	4.980E+05	4.877E+05	4.728E+05	4.631E+05	4.520E+05	4.463E+05	4.427E+05
pd	3.197E+04	1.751E+04	1.507E+04	1.173E+04	9.607E+03	5.279E+03	2.907E+03	8.878E+02	2.748E+02	2.807E+01	3.277E+00	4.666E-01
ag	4.189E+04	3.083E+04	2.883E+04	2.597E+04	2.405E+04	1.971E+04	1.683E+04	1.346E+04	1.167E+04	9.823E+03	8.734E+03	7.914E+03
cd	2.171E+03	1.523E+03	1.458E+03	1.365E+03	1.299E+03	1.125E+03	9.762E+02	7.405E+02	5.675E+02	3.468E+02	2.271E+02	1.616E+02
in	1.782E+03	1.019E+03	9.661E+02	8.962E+02	8.487E+02	7.254E+02	6.209E+02	4.548E+02	3.332E+02	1.790E+02	9.607E+01	5.156E+01
sn	6.504E+03	4.356E+03	4.284E+03	4.196E+03	4.134E+03	3.966E+03	3.812E+03	3.539E+03	3.299E+03	2.885E+03	2.535E+03	2.235E+03
sb	8.888E+04	4.495E+04	4.111E+04	3.687E+04	3.461E+04	3.040E+04	2.764E+04	2.346E+04	2.012E+04	1.504E+04	1.149E+04	9.006E+03
te	3.165E+05	2.583E+05	2.476E+05	2.316E+05	2.199E+05	1.899E+05	1.652E+05	1.277E+05	1.009E+05	6.676E+04	4.689E+04	3.459E+04
i	2.711E+06	2.003E+06	1.892E+06	1.739E+06	1.636E+06	1.399E+06	1.222E+06	9.646E+05	7.793E+05	5.276E+05	3.672E+05	2.602E+05
xe	3.421E+05	2.615E+05	2.422E+05	2.139E+05	1.952E+05	1.559E+05	1.336E+05	1.103E+05	9.583E+04	7.373E+04	5.671E+04	4.361E+04
cs	2.124E+05	2.108E+05	2.104E+05	2.099E+05	2.094E+05	2.081E+05	2.068E+05	2.043E+05	2.020E+05	1.976E+05	1.936E+05	1.900E+05
ba	3.655E+05	3.518E+05	3.497E+05	3.462E+05	3.435E+05	3.355E+05	3.276E+05	3.126E+05	2.984E+05	2.721E+05	2.486E+05	2.275E+05
la	2.028E+06	1.884E+06	1.872E+06	1.855E+06	1.843E+06	1.810E+06	1.775E+06	1.701E+06	1.624E+06	1.471E+06	1.326E+06	1.192E+06
ce	5.265E+05	4.533E+05	4.377E+05	4.136E+05	3.960E+05	3.512E+05	3.160E+05	2.664E+05	2.352E+05	2.020E+05	1.863E+05	1.772E+05
pr	8.918E+05	8.214E+05	8.140E+05	8.042E+05	7.991E+05	7.895E+05	7.834E+05	7.737E+05	7.649E+05			

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7.480E+05 7.321E+05 7.173E+05
      nd     1.000E+05 9.468E+04 9.393E+04 9.269E+04 9.172E+04 8.887E+04 8.611E+04 8.084E+04 7.590E+04
6.690E+04 5.896E+04 5.197E+04
      pm     2.339E+05 2.079E+05 2.022E+05 1.932E+05 1.865E+05 1.685E+05 1.533E+05 1.291E+05 1.111E+05
8.624E+04 7.033E+04 5.944E+04
      sm     5.920E+04 4.878E+04 4.653E+04 4.305E+04 4.047E+04 3.370E+04 2.810E+04 1.959E+04 1.367E+04
6.663E+03 3.248E+03 1.585E+03
      eu     1.989E+05 1.928E+05 1.915E+05 1.893E+05 1.876E+05 1.829E+05 1.786E+05 1.706E+05 1.631E+05
1.493E+05 1.368E+05 1.254E+05
      gd     5.888E+02 3.762E+02 3.364E+02 2.791E+02 2.404E+02 1.536E+02 9.820E+01 4.018E+01 1.650E+01
2.890E+00 6.234E-01 2.451E-01
      tb     7.097E+02 7.017E+02 6.997E+02 6.965E+02 6.939E+02 6.864E+02 6.792E+02 6.653E+02 6.523E+02
6.285E+02 6.073E+02 5.881E+02
      dy     3.934E+00 8.220E-01 7.514E-01 6.936E-01 6.650E-01 5.983E-01 5.403E-01 4.406E-01 3.594E-01
2.390E-01 1.590E-01 1.058E-01
      ho     1.896E+01 1.457E+01 1.367E+01 1.231E+01 1.133E+01 8.900E+00 7.060E+00 4.585E+00 3.109E+00
1.609E+00 9.379E-01 5.856E-01
      er     1.201E-01 9.350E-02 8.921E-02 8.323E-02 7.923E-02 6.979E-02 6.258E-02 5.159E-02 4.340E-02
3.217E-02 2.508E-02 2.027E-02
      tm     1.777E-01 1.735E-01 1.722E-01 1.700E-01 1.681E-01 1.621E-01 1.556E-01 1.422E-01 1.292E-01
1.067E-01 8.969E-02 7.767E-02
      yb     7.058E-07 6.983E-07 6.964E-07 6.932E-07 6.907E-07 6.833E-07 6.760E-07 6.615E-07 6.473E-07
6.199E-07 5.936E-07 5.685E-07
      lu     1.421E-09 1.350E-09 1.333E-09 1.305E-09 1.282E-09 1.218E-09 1.157E-09 1.044E-09 9.418E-10
7.666E-10 6.241E-10 5.080E-10
   totals    1.344E+07 1.077E+07 1.039E+07 9.876E+06 9.538E+06 8.775E+06 8.235E+06 7.485E+06 6.962E+06
6.218E+06 5.684E+06 5.271E+06

□
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Lee, Richard

From: Dehn, Jeff
Sent: Friday, March 18, 2011 11:39 AM
To: Gauntt, Randall O
Cc: Wagner, Katie; Lee, Richard; Sangimino, Donna-Marie
Subject: RE: Fukushima
Attachments: SFP Reports.docx

Hi Randy,

We've discussed internally, and the documents are approved for distribution to IRSN (but not for further distribution outside of IRSN). Attached are the cover pages to the documents under consideration. Do you have them readily available to send to IRSN? If not, I can go through ADAMS and collect the documents one by one.

Thank you,
Jeff Dehn

International Relations Specialist
Office of Nuclear Regulatory Research (RES)
US Nuclear Regulatory Commission
jeff.dehn@nrc.gov
301-251-7672

From: Gauntt, Randall O <rogaunt@sandia.gov>
To: 'CLEMENT Bernard' <bernard.clement@irsn.fr>; Lee, Richard; Tinkler, Charles
Cc: 'VOLA Didier' <didier.vola@irsn.fr>; 'BONNET Jean-Michel' <jean-michel.bonnet@irsn.fr>
Sent: Thu Mar 17 12:02:44 2011
Subject: RE: Fukushima

From: CLEMENT Bernard [mailto:bernard.clement@irsn.fr]
Sent: Thursday, March 17, 2011 5:47 AM
To: Gauntt, Randall O
Cc: VOLA Didier; BONNET Jean-Michel
Subject: Fukushima

Dear Randy,

As you may imagine, we are looking at the possible accident progression in Fukushima power plant. A t the time being we are looking at the problem of the spent fuel storage pool of reactor #4.

We will make evaluations of the consequences of the loss of water for different scenarios of emptying, calculate heat-up and associated source term.

You certainly have made such evaluations in the past using MELCOR calculations. So i have the following question: would it be possible for you to send us some results so as we can make cross-comparisons with our results.

You can certainly understand that this is an urgent request.

XX\23

Bernard
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SANDIA LETTER REPORT
Revision 3 Completed: June 2008

Evaluation of a BWR Spent Fuel Pool Accident Response to Loss-of-Coolant Inventory Scenarios Using MELCOR 1.8.5

K. C. Wagner
R. O. Gauntt

Prepared by
Sandia National Laboratories
Albuquerque, New Mexico 87185 and Livermore, California 94550

Sandia is a multiprogram laboratory operated by Sandia Corporation,
a Lockheed Martin Company, for the United States Department of Energy's
National Nuclear Security Administration under Contract DE-AC04-94AL85000.

Sandia National Laboratories

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SANDIA REPORT

Revision 0
Draft

Analysis of Spent Fuel Pool Flow Patterns Using Computational Fluid Dynamics: Supplement – Thermal Plume Response

Draft Completed: July 2003

Prepared by
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SANDIA REPORT

Revision 0
Draft

MELCOR 1.8.5 Separate Effect Analyses of Spent Fuel Pool Assembly Accident Response

Draft Completed: June 2003

Prepared by
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SANDIA LETTER REPORT
Revision 2 Completed: January 2008

Analysis of Emergency Spray Mitigation of Spent Fuel Pool Loss-of-Coolant Inventory Accidents

K. C. Wagner
R. O. Gauntt

Prepared by
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Albuquerque, New Mexico 87185 and Livermore, California 94550

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a Lockheed Martin Company, for the United States Department of Energy's
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SANDIA REPORT

Revision 0
Draft

Analysis of Spent Fuel Pool Flow Patterns Using Computational Fluid Dynamics: Part 2 – Partial Water Cases

Draft Completed: April 28, 2003

Prepared by
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SANDIA REPORT

Revision 0
Draft

Analysis of Spent Fuel Pool Flow Patterns Using Computational Fluid Dynamics: Part 1 -Air Cases

Draft Completed: May 2003

Prepared by
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Analysis of BWR Spent Fuel Pool Flow Patterns Using Computational Fluid Dynamics: Supplemental Air Cases

Draft Completed: July 2005
Revision 1 Completed: August 2005
Revision 2 Completed: October 2005

Prepared for:
United States Nuclear Regulatory Commission, Office of Nuclear Regulatory Research

Don Helton, Project Manager

Prepared by:
K. C. Wagner
R. O. Gauntt

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SANDIA LETTER REPORT
Revision 2 Completed: November 2006

Mitigation of Spent Fuel Pool Loss-of-Coolant Inventory Accidents And Extension of Reference Plant Analyses to Other Spent Fuel Pools

K. C. Wagner
R. O. Gauntt

Prepared by
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Albuquerque, New Mexico 87185 and Livermore, California 94550

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SANDIA LETTER REPORT
Revision 3 Completed: June 2008

Additional MELCOR Analyses of BWR Spent Fuel Pool Assembly Accident Response

K. C. Wagner
R. O. Gauntt

Prepared by
Sandia National Laboratories
Albuquerque, New Mexico 87185 and Livermore, California 94550

Sandia is a multiprogram laboratory operated by Sandia Corporation,
a Lockheed Martin Company, for the United States Department of Energy's
National Nuclear Security Administration under Contract DE-AC04-94AL85000.

Sandia National Laboratories

Lee, Richard

From: Gauntt, Randall O [rogaunt@sandia.gov]
Sent: Friday, March 18, 2011 9:34 PM
To: PMT09 Hoc; PMT11 Hoc; Hoc, PMT12; Schaperow, Jason; Hart, Michelle; Tinkler, Charles; Lee, Richard
Cc: Pickering, Susan Y; McClellan, Yvonne; Orrell, Stanley A
Subject: MOX versus LEU in SFP Accidents
Attachments: MOX Versus LEU.docx

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MOX Versus LEU

R. O. Gauntt

Sandia National Laboratories

Sandia has characterized fission product release from MOX fuels, and their differences from LEU fuels for the USNRC in the context of proposed revisions to the NRIEG-1465 regulatory source term. These characterizations are based on both historical fission product release rate experiments done at ORNL as well as more contemporary experimental studies performed in the VERCORS facility in France. Release rate models are incorporated in th4e MELCOR code that capture these differences. In short, release rate of volatile fission products (Cs, I and Te) are observed to be higher in MOX fuels relative to LEU when release is taking place at lower temperatures (~2000K), but becomes comparable to LEU rates when the temperatures exceed 2400K.

In reactor accidents with significant fuel damage, these differences in release rate at lower temperatures ultimately has no appreciable effect on total releases for reactor accidents because fuel temperatures rapidly escalate through the lower temperature range and volatiles are nearly completely released. This might not be the case for spent fuel pool accidents involving MOX as MELCOR analyses for pool accidents often produce heatup behavior that lingers extensively in the ~2000K temperature range. In these cases, we would expect to see elevated release rate for volatiles in MOX spent fuel relative to LEU spent fuel. The larger differences are for the volatile fission products such as Cs, I and Te. Release rates for Pu are low for both MOX and for LEU, and while there are isotopic differences in Pu content for LEU and for MOX, both fuels contain Pu on discharge.

We would recommend at some point a comparative study of fission product release behavior for MOX versus LEU in spent fuel pool accidents using the MELCOR specific models for MOX and LEU release, in order to evaluate this potential difference in volatile release behavior at SFP accident temperatures.

Lee, Richard

From: Armstrong, Kenneth
Sent: Friday, March 18, 2011 3:36 PM
To: Wagner, Katie
Cc: Gibson, Kathy; Lee, Richard
Subject: RE: Staffing Plan
Attachments: JapaneventstaffingforOpCenter.xlsx

Katie,

The OpCenter is looking for additional staffing next week and the attached list are volunteers from DSA. Please note that all references on volunteering to go to Japan have been removed (please double check me). Also, please note when communicating with the OpCenter that our expertise and experience vary widely and if they are looking for anything in particular to please let us know.

Jeanne Dion has the sheet for the office if that is desired.

Thanks!

From: Gibson, Kathy
Sent: Friday, March 18, 2011 3:33 PM
To: Wagner, Katie; Armstrong, Kenneth
Cc: Lee, Richard
Subject: Fw: Staffing Plan

Katie,
Ken is sending you a file with a table of information we collected from staff on their willingness to work in Ops Center and go to Japan. Ops center is looking for more people to staff Ops center (see below).

Ken is preparing a table that I would like you to send to the ops center email address below with a message that says this is a list of people from RES/DSA that are willing to work in the Ops Center and the Ops Center should feel free to contact the individuals directly that they need.

Thx

From: OST02 HOC
To: Abrams, Charlotte; Adams, John; Afshar-Tous, Mugeh; Alemu, Bezakulu; Alter, Peter; Anderson, James; Ashkeboussi, Nima; Athey, George <george.athey@nrc.gov>; Baker, Stephen; Bergman, Thomas; Berry, Rollie; Bhachu, Ujagar; Bloom, Steven; Blount, Tom; Boger, Bruce; Borchardt, Bill; Bower, Anthony; Bowman, Gregory; Brandon, Lou; Brandt, Philip; Brock, Kathryn; Brown, Cris; Brown, David; Brown, Eva; Brown, Frederick; Brown, Michael; Bukharin, Oleg; Camper, Larry; Carpenter, Cynthia; Carter, Mary <may.carter@nrc.gov>; Case, Michael; Casto, Greg; Cecere, Bethany; Cervera, Margaret; Chazell, Russell; Chen, Yen-Ju; Cheok, Michael; Chokshi, Nilesh; Chowdhury, Prosanta; Circle, Jeff; Clement, Richard; Clinton, Rebecca; Coggins, Anita <anita.coggins@nrc.gov>; Collins, Frank; Cool, Donald; Costa, Arlon; Crutchley, Mary Glenn; Cruz, Zahira; Cutaiar, Robert <robert.cutaiar@nrc.gov>; Dacus, Eugene; DeCicco, Joseph; Decker, David; Dembek, Stephen; Devlin, Stephanie; Doane, Margaret; Dorman, Dan; Dorsey, Cynthia; Dozier, Jerry; Droggitis, Spiros; Dube, Donald; Dudes, Laura; Eads, Johnny; Emche, Danielle; English, Lance; Erlanger, Craig; Esmaili, Hossein; Figueroa, Roberto; Fiske, Jonathan; Floyd, Daphene; Foggie, Kirk; Foster, Jack; Fragoyannis, Nancy; Franovich, Rani; Frazier, Alan; Freshwater, David <david.freshwater@nrc.gov>; Fuller, Edward; Galletta, Thomas; Gambone, Kimberly; Gibson, Kathy; Giitter, Joseph; Gilmer, James; Gordon, Dennis; Gott, William; Grant, Jeffery; Grimes, Kelly; Grobe, Jack; Gulla, Gerald; Hale, Jerry; Hardesty, Duane; Harris, Tim; Hart, Ken; Hart, Michelle; Harvey, Brad; Hasselberg, Rick; Henderson, Karen; Hiland, Patrick; Holahan, Patricia; Holahan, Vincent; Holian, Brian; Howard, Tabitha; Huffert, Anthony; Hurd, Sapna; Huyck, Doug; Isom, James; Jackson, Karen; Jacobson, Jeff <jeff.jacobson@nrc.gov>; Jessie, Janelle; Johnson, Michael; Jolicoeur, John; Jones, Andrea; Jones, Cynthia; Kahler, Carolyn; Kammerer, Annie;

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Karas, Rebecca; Khan, Omar; Kolb, Timothy; Kotzalas, Margie; Kowalczik, Jeffrey; Kratchman, Jessica; Kugler, Andrew; Lamb, Christopher; Lane, John; Larson, Emily; Laur, Steven; LaVie, Steve; Lewis, Robert; Li, Yong; Lising, Jason; Lombard, Mark; Lubinski, John; Lui, Christiana; Lynch, Jeffery; Mamish, Nader; Manahan, Michelle; Marksberry, Don; Marshall, Jane; Masao, Nagai <nagai.masao@nrc.gov>; Maupin, Cardilia <cardilia.maupin@nrc.gov>; Mayros, Lauren; Mazaika, Michael; McConnell, Keith; McCoppin, Michael; McDermott, Brian; McGinty, Tim; McGovern, Denise; McMurtray, Anthony; Merritt, Christina; Meyer, Karen; Miller, Charles; Miller, Chris; Milligan, Patricia; Mohseni, Aby; Moore, Scott; Morlang, Gary; Morris, Scott; Mroz (Sahm), Sara; Munson, Clifford; Murray, Charles; Nerret, Amanda; Nguyen, Carolyn <carolyn.nguyen@nrc.gov>; Norris, Michael; Norton, Charles; Ordaz, Vonna; Owens, Janice; Padovan, Mark; Parillo, John; Patel, Jay; Perin, Vanice; Pope, Tia; Powell, Amy; Purdy, Gary; Quinlan, Kevin; Ragland, Robert; Ragland, Randolph; Ralph, Melissa; Ramsey, Jack; Reed, Elizabeth; Reed, Sara <sara.reed@nrc.gov>; Reed, Wendy; Reis, Terrence; Resner, Mark; Riley (OCA), Timothy; Riner, Kelly; Rini, Brett; Robinson, Edward; Rodriguez-Luccioni, Hector; Rosenberg, Stacey; Ross-Lee, MaryJane; Roundtree, Amy; Ruland, William; Salay, Michael; Salter, Susan; Salus, Amy; Sanfilippo, Nathan; Scarbrough, Thomas; Schaperow, Jason; Schmidt, Duane; Schmidt, Rebecca; Schoenebeck, Greg; Schrader, Eric; Schwartzman, Jennifer; Seber, Dogan; See, Kenneth; Shane, Raeann; Shea, James; Shepherd, Jill; Sheron, Brian; Skeen, David; Sloan, Scott; Smiroldo, Elizabeth; Smith, Brooke; Smith, Theodore; Stahl, Eric; Stang, Annette; Steger (Tucci), Christine; Stieve, Alice; Stone, Rebecca; Stransky, Robert; Sturz, Fritz; Sullivan, Randy; Sun, Casper; Tappert, John; Temple, Jeffrey; Thaggard, Mark; Thomas, Eric; Thorp, John; Tobin, Jennifer; Trefethan, Jean <jean.trefethan@nrc.gov>; Tschiltz, Michael; Turtil, Richard; Uhle, Jennifer; Valencia, Sandra; Vaughn, James; Vick, Lawrence; Virgilio, Martin; Virgilio, Rosetta; Ward, Leonard; Wastler, Sandra; Watson, Bruce; Webber, Robert; Weber, Michael; White, Bernard; Wiggins, Jim; Wiggins, Jim; Williams, Donna; Williams, Joseph; Williamson, Linda; Willis, Dori; Wimbush, Andrea; Wittick, Brian; Wray, John; Wright, Lisa (Gibney); Wright, Ned; Wunder, George; Young, Francis; Zimmerman, Roy
Sent: Fri Mar 18 15:06:29 2011
Subject: Staffing Plan

This list is for next week Sat 3/19 at 7a.m. to Friday 3/25. We do recognize that some positions do not have full staffing. We are looking to fill those. If you know anyone who would want to fill them, have them contact OPS Center at 816-5100.

Last	First	Position	Phone (301)	Room	Op Center Staffing (Y/N)	Shift Priority 1 (7am-3pm) 2 (3pm-11pm) 3 (11pm-7am)	Area of expertise (BWR, Dose Assessment/HP, Fuels, Nuclear, Severe Accident, Systems Analysis, T/H, EST or RST etc)	Additional Notes
Directors Office								
Gibson	**Kathy**	**Division Director**	**251-7499**	**3-A02**	Y	1	Management, PMT	Already supporting Op Center
Scott	**Michael**	**Deputy Division Director (acting)**	**251-7524**	**3-B01**	Y	1,2	Management, RST	
Bajorek	Stephen	Sr. Lvl. Advisor	251-7561	3-D03	Y	1,2,3	System Analysis, T/H	Not available March 24-27
Tinkler	Charles	Sr. Lvl. Advisor	251-7496	2-D01	Y	1	Severe Accident, Systems Analysis, T/H	Already supporting Op Center
Rubin	Stuart	Sr. Lvl. Advisor	251-7527	3-B04	Y	1,2	BWR, Severe Accident, System Analysis, EST	
Voglewede	John	Sr. Lvl. Advisor	251-7555	3-D01	Y	1,2,3	Fuels	
Armstrong	Kenneth	Tech. Assistant	251-7551	3-A01	Y	1,2,3	Coordination, Systems Analysis, T/H	
Bowlin	Elizabeth	Mgmt. Analyst	251-7955	3-A10	Y	1,2,3	Liaison, Coordination	
Code Development Branch								
Hudson	Nathanael	Reactor Syst. Eng.	254-7534	3-C06	Y	3	Nuclear, Systems Analysis, T/H	
Staudenmeier	Joseph	Sr. Reactor Syst. Eng.	251-7522	3-A23	Y	1	Systems Analysis, T/H	
Thurston	Carl	Reactor Syst. Eng.	251-7517	3-C16	Y	2	Systems Analysis, T/H	
Velazquez-Lo	Alex	Reactor Syst. Eng.	251-7509	3-A09	Y	1,2,3	System Analysis, T/H	after March 23, 2011
Whitman	Joshua	Reactor Syst. Eng.	251-7514	3-A17	Y	1,2,3	System Analysis	prior TEPCO experence
Fuel and Source Term Branch								
Aissa	Mourad	Sr. Crit. Saf. & Reac. Phys.	251-7511	3-A12	Y	1	Severe Accident, T/H	Op Center Mon-Wed
Algama	Don	Reactor Syst. Eng.	251-7940	3-C26	Y	1,2,3	Core Design, Nuclear	Japanese language experience and cultural experience
Esmaili	Hossein	Sr. Reactor Syst. Eng.	251-7554	3-C34	Y	1,2	Severe Accident, T/H	Already supporting Op Center
Flanagan	Michelle	Reactor Syst. Eng.	251-7547	3-C27	Y	1,2	Fuels, Communication	
Raynaud	Patrick	Reactor Syst. Eng.	251-7542	3-C25	Y		Fuel	traveling from 3/18 to 3/23
Salay	Michael	Reactor Syst. Eng.	251-7543	3-C20	Y	1,2,3	Severe Accident	Already supporting Op Center
Wagner	Katie	General Eng.	251-7552	3-C32	Y	1,2,3	Communication	
Health Effects Branch								
Anzenberg	Vered	Nuclear Eng.	251-7546	3-A20	Y	1,2,3	Dose Assessment/HP	
Huffert	Tony	Sr. Health Physicist	251-7506	3-C01	Y	1,2,3	Dose Assessment/HP, RASCAL	Already supporting Op Center (like 1st shift, will do 2nd or 3rd if needed)
Lewis	Doris	Health Physicist	251-7559	3-C38	Y	1	Dose Assessment/HP	Already supporting Op Center
Sun	Casper	Health Physicist	251-7912	3-C21	Y	1,2	Dose Assessment/HP, RASCAL	member of the RST, available after 3/21/11
Tomon	John	Health Physicist	251-7904	3-C23	Y	1,2,3	Dose Assessment/HP	
New and Advanced Reactors Branch								
Zaki	**Tarek**	**Branch Chief (acting)**	**251-7986**	**3-A11**	Y	2	T/H	
Barr	Jonathan	Reactor Syst. Eng.	251-7538	3-C12	Y	1,2,3	Coordination, Nuclear	
Corson	James	Reactor Syst. Eng.	251-7902	3-C05	Y	1,3	Severe Accident	
Kelly	Joseph	Sr. Reactor Syst. Eng.	251-7510	3-A18	Y	1,2,3	Systems Analysis, T/H	
Nosek	Andrew	Reactor Syst. Eng.	251-7476	2-C13	Y	1,2,3	Offsite Transport and Dose Response, T/H	
Rubin	Michael	Reactor Syst. Eng.	251-7549	3-C29	Y	2	T/H	
Skarda	Ray	Reactor Syst. Eng.	251-7969	3-C13	Y	1,2,3	Nuclear Threat Assessment, Severe Accident, System Analysis, T/H	
Reactors Systems Anaylsis Branch								
Elkins	**Scott**	**Branch Chief**	**251-7544**	**3-D02**	Y	1,2	System Analysis	Day Shift on Monday, Wednesday and/or Thursday
Dorn	Jaclyn	Reactor Systems Eng.	251-7565	3-C31	Y	1,2,3	System Analysis, T/H	
Frankl	Steve	Sr. Reactor Syst. Eng.	251-7901	3-C02	Y	1,2	BWR, Fuel, Nuclear, System Analysis, T/H	
Harrington	Ron	Reactor Systems Eng.	251-7532	3-C03	Y	1	System Analysis, T/H, HOO/HERO	
Krepel	Scott	Reactor Systems Eng.	251-7421	3-A21	Y	1,2	BWR, System Analysis	
Lien	Peter	Sr. Reactor Syst. Eng.	251-7540	3-C14	Y	1,2,3	System Analysis, T/H	Shift 1 or 2 preferred
Marshall	Shawn	Reactor Systems Eng.	251-7523	3-A26	Y	2	Coordination, T/H	
Ramirez	Annie	Chemical Eng. (NSPDP)	251-7537	3-C10	Y	1	T/H, Severe Accident	
Yarsky	Peter	Sr. Reactor Syst. Eng.	251-7518	3-A19	Y	1	BWR, Containment Systems, System Analysis, T/H	
Special Projects Branch								
Santiago	**Patricia**	**Branch Chief**	**251-7982**	**2-D04**	Y	1,2,3	Dose Assessment/HP	
Chang	Richard	Program Manager	251-7980	2-A17	Y	1,2,3	Coordination	
Gonzalez	Sergio	STUDENT ENGINEER (C	251-7453	2-C18	Y	1	Coordination	
Navarro	Carlos	Reactor Syst. Eng.	251-7485	2-C26	Y	1,2,3	Dose Assessment (RASCAL)	
Schaperow	Jason	Sr. Reactor Syst. Eng.	251-7452	2-A19	Y	1	Severe Accident, Systems Analysis, T/H	Already supporting Op Center

From:	Flory, Shirley
To:	Case, Michael; Coe, Doug; Coyne, Kevin; Gibson, Kathy; Uhle, Jennifer; Richards, Stuart; Scott, Michael; Sheron, Brian; Valentin, Andrea
Subject:	NUCLEAR NEWS FLASHES
Date:	Friday, March 18, 2011 11:25:28 AM
Attachments:	nn110317.txt

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Nuclear News Flashes
Thursday, Mar 17, 2011

[Inside This Issue:]

*** Fukushima I recovery effort continues

Tokyo Electric Power Co. and Japanese authorities March 17 continued trying to keep fuel covered with water and restore electric supply to the Fukushima I nuclear power plant.

Units 1, 2 and 3 had partially melted cores, and the spent fuel pools at units 3 and 4 were at the boiling point, according to an update by France's Institute of Radiological Protection and Nuclear Safety, IRSN, at 5 pm Paris time March 17.

The Fukushima plant is in Japan's Tohoku region, which is about 250 km (155 miles) north of Tokyo and was hit with a 9.0-magnitude earthquake and resulting tsunami,

Thierry Charles, IRSN's head expert on the Japanese crisis, told a midday press briefing there was a "ray of hope" for the reactor site, compared to the "very pessimistic" outlook the day before. Japan's Self Defense Forces had managed to drop water from helicopters onto the spent fuel pools and Tepco had said it expected to restore regular electric power to emergency cooling systems for the three damaged reactors, he said.

Tepco said it would not be able to restore power lines to the site until March 18. Restoration of power would theoretically allow restarting of pumps that could re-establish longer-term residual heat removal.

On March 16, the main source of concern for foreign experts was unit 4's spent fuel pool, which contains about 1,500 fuel elements and has a heat load of about 3 MW, according to IRSN's calculations. IRSN said that pool was boiling on March 16.

But on March 17, Charles and other IRSN experts in the institute's crisis management team said the focus of concern had shifted to the unit 3 spent fuel pool, where an earlier hydrogen explosion had blown out the side of the reactor building, which is next to the fuel pool, and the fuel pool was suspected to be damaged.

Japanese authorities said a Self Defense Force helicopter had been able to dump 15 metric tons of water onto the unit 3 pool, but a large part of the water had probably not reached the pool. The absence of a steam cloud above the building in aerial photographs March 17 suggested that the operation had worked to cool the fuel, IRSN said in the afternoon update. But if the pool is damaged, water must be continually poured in to keep the fuel elements covered, IRSN experts said.

The Japanese response team brought fire trucks and anti-riot vehicles capable of hosing over a distance of 80 meters (about 262 feet) to 100 meters to the site in an attempt to fill the fuel pools from the ground.

High radiation levels apparently hampered that operation, at least temporarily, on March 17. But late that day, Japanese media reported that the hosing operations had resumed.

*** Fukushima releases 'one-tenth' those from Chernobyl: IRSN

Releases up to now from Japan's Fukushima I nuclear power plant are about one-tenth of what were released from the Chernobyl-4 reactor in Ukraine in 1986, experts of France's Institute of Radiological Protection and Nuclear Safety, IRSN, said March 17.

They said the calculation was a rough one and based on releases to date of the volatile elements that dominate the health impact of radioactive fallout: iodine, tellurium and cesium. Noble gases like xenon and krypton have also been released but have little health impact.

Chernobyl released about 5.8 E18 becquerels (5.8 Exabecquerels) of those elements, according to IRSN. The releases of those elements from Fukushima so far amount to about 7.5 E17 becquerels, according to Thierry Charles, IRSN's fuel cycle safety director and head spokesman on the technical aspects of the Japanese accident.

Charles said IRSN had calculated the releases based on the inventory of the three reactors that have had partial core melt â€" units 1, 2 and 3 â€" and the assumed degree of fuel degradation and had postulated that the three units had released volatile elements from the equivalent of one reactor core.

IRSN has also modeled the movement of the radioactive plume from the Fukushima site, beginning on March 12 and extrapolated out to March 20. The models show that the plume got closer to Tokyo on March 16 but was pushed out to sea the following day by winds from the west.

In any case, IRSN experts said, the doses in Tokyo are not of a nature to cause health problems.

At the press briefing, French Environment Minister Nathalie Kosciusko-Morizet said the French government would recommend evacuating people within a radius of 60 kilometers (37 miles) of the site, instead of 20 km as is now the case, but only if the situation got worse. Tokyo is about 250 km from the site.

Patrick Gourmelon, IRSN's medical expert, said that there was no need for any member of the public to take stable iodine tablets to avert thyroid cancer, adding that the tablets can create other health problems.

People in France, as in the US, have been buying the tablets, and Gourmelon said it was urgent to tell them not to take the medicine.

According to IRSN's calculations, except in the 30-km zone around the plant, doses to the thyroid from the Fukushima plume, even for an infant exposed over 24 hours, do not reach the level of 100 milliSieverts at which authorities recommend taking stable iodine. The latter is absorbed by the thyroid, preventing radioactive iodine from being absorbed.

*** IAEA: At least 20 workers contaminated at Fukushima I

The IAEA said March 17 that at least 20 people, one of whom had "significant exposure," were contaminated by radioactivity at Tokyo Electric Power Co.'s Fukushima I nuclear power plant.

The IAEA said 17 people â€” nine Tepco employees and eight subcontractor employees â€" had "deposition of radioactive materials to their faces," but were not taken to a hospital because the exposure levels were low.

It said the worker who had significant exposure incurred that exposure during "vent work and was transported to an offsite center."

Two policemen exposed to radiation were decontaminated, it said. Also, there are firemen who were exposed to radiation but those exposures were still under investigation, IAEA said.

Four workers had minor injuries due to the explosion at Fukushima I-1 on March 11, it said. The explosion at unit 3 on March 14 injured 11 people, it said, but did not elaborate.

The IAEA based its information on a March 16 statement from the Japanese Chief Cabinet Secretary.

*** Obama orders comprehensive review of US nuclear plants

President Barack Obama has ordered the NRC to conduct a "comprehensive" safety review of nuclear power plants in the country, in light of the ongoing crisis at the Fukushima I nuclear power plant in Japan.

US nuclear power plants have undergone "exhaustive studies" to ensure safety in emergencies, he announced March 17. Nevertheless, the US has the responsibility to learn from the crisis in Japan at Tokyo Electric Power Co.'s Fukushima site, he said. He did not provide details on the scope of the review. Obama called nuclear power "an important part of our own energy future."

Earlier that day, Senators Barbara Boxer of California and Tom Carper of Delaware, both Democrats, sent a letter to NRC Chairman Gregory Jaczko requesting the agency assess US nuclear power plants' "capacity to withstand catastrophic natural or man-made disasters including scenarios that may be considered remote like the recent events in Japan."

Boxer chairs the Committee on Environment and Public Works and Carper chairs that committee's Clean Air and Nuclear Safety subcommittee that oversees the NRC. "Special and immediate attention should be given to those US nuclear reactors that share similar characteristics as the failing reactors in Japan," they said.

The senators asked NRC to supply information "as soon as possible" on several other issues, including data on "all US nuclear facilities subject to significant seismic activity and/or tsunamis." They also requested information on Japan's radiation monitoring system and measures to ensure the safety of spent fuel pools at power reactors in the US.

In a statement, Erich Pica, president of the anti-nuclear Friends of the Earth, said Obama "should immediately halt his push for expansion of this dangerous industry."

But Marvin Fertel, president and CEO of the Nuclear Energy Institute, said in a statement that a review of US nuclear plants "is an appropriate step after an event of this scale and we expect that the [NRC] will conduct its own assessment."

*** No risk in US from Japan nuclear accident: NRC chairman

There "can't be harm to anyone" in the US from the ongoing nuclear power accident in Japan, NRC Chairman Gregory Jaczko said at a White House press briefing March 17.

Jaczko said the NRC's recommendation March 16 that US citizens in Japan evacuate from a 50-mile radius around the Fukushima I nuclear power plant was "a prudent measure based on how we would respond in the US" to a similar accident.

Japanese authorities are evacuating people from a 20-kilometer (about 12.4 mile) radius around the plant and telling those within 20 km to 30 km of the plant to shelter in place.

Jaczko said the NRC recommendation was based on "some very preliminary modeling." NRC released data March 17 from "computer calculations" that it said support its recommendation

White House Press Secretary Jay Carney said at the briefing, "We have no reason to question the recommendations that have been made, or the assessments that have been made, by the Japanese authorities."

Daniel Poneman, DOE deputy secretary of energy, said at the briefing that aerial monitoring flights are providing the US with "independent" information on radiation levels near the plant,

Ralph Andersen, senior director for radiation safety and environmental protection at the Nuclear Energy Institute, said during an NEI telephone press briefing March 17 that the NRC's evacuation recommendation for US citizens was "highly conservative."

"I don't see any contradiction" between the US and Japanese recommended evacuation zones, Andersen said, because to evacuate everyone from a 50-mile radius would be an enormous task compared with recommending that US citizens near the plant relocate.

*** S&P predicts more licensing scrutiny from NRC after Japan accident

The nuclear accident in Japan could slow NRC's renewal of licenses for operating units and delay the final approval of new reactor designs and licenses to build and operate new units, Standard & Poor's Ratings Services said March 16.

The damage to multiple reactors at Tokyo Electric Power Co.'s Fukushima I plant might result in slower

NRC licensing actions, which could move forward "with some fits and starts," S&P analysts wrote. NRC, the nuclear industry and the Institute of Nuclear Power Operations will review the incident for its implications, and "it is likely that these reviews will lead to delays in building new units and increase costs for operating existing units," S&P said.

Reactor vendors seeking design certifications may have to go back and prove the designs meet any new standards, and this could delay final rulemaking on the issue, S&P said.

The news from Japan has put the brakes on talks between CPS Energy and NRG Energy about buying power from proposed new units at the South Texas Project site, and that project may now stall, S&P said.

The aftermath of the earthquake and tsunami could cause a disruption in the supply of nuclear equipment and parts, hurting new reactor construction in the US, S&P said.

Of nuclear operators, Exelon is most exposed to credit concerns because it is a merchant generator without access to ratepayers to cover any costs from new regulatory requirements and about a quarter of its fleet consists of General Electric boiling water reactors of the same Mark I containment design as seen at Fukushima I, S&P said.

*** NRC publishes proposed fiscal 2011 fee rule for comment

The NRC will seek to recover about $915.7 million in fees from licensees and applicants under the agency's proposed fee recovery rule for fiscal 2011.

The agency's proposed schedule of fees to recover 90% of the agency's budget, as required by statute, was published in the March 17 Federal Register. This represents an increase in fee recovery of about $4.6 million over the fiscal 2010 budget.

The proposed fee rule is based on the agency's fiscal 2011 budget request, NRC said. Congress has not passed a fiscal 2011 budget and the federal government is being funded by a series of continuing resolutions at about their fiscal 2010 levels.

NRC proposes an increase in the fee it charges for staff time to $273 an hour, up from $259 in the fiscal 2010 rule. The annual fee charged for an operating power reactor would be $4.669 million, down from $4.784 million in fiscal 2010. The public comment period on the proposed rule ends April 18 and the agency said it plans to publish the final rule no later than June.

*** Reactor report

â€" Palisades returned to full power early March 17 after a planned inspection of electric cables connecting buses at the rear of the plant switchyard. Entergy reduced the plant's power to 52% early March 16 to perform that work.

***

Contact Us:

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| Tel: +65-6530-6430 |

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Stutzke, Martin

From: Stutzke, Martin NRC/RES/DRA
Sent: Friday, March 18, 2011 11:06 AM
To: Beasley, Benjamin
Subject: RE: RES support for commission meeting on Monday 3/21.

I will be there.

Marty

From: Beasley, Benjamin
Sent: Friday, March 18, 2011 7:50 AM
To: Stutzke, Martin
Subject: FW: RES support for commission meeting on Monday 3/21.

Marty,

I know you are occupied. This is what I called about Thursday. George Wilson is handling the Commission briefing for Pat. Kamal is at his son's wedding in California. George called me to ask that you be in his pit crew at the briefing to answer questions that may arise regarding GI-199.

Ben

From: Coyne, Kevin
Sent: Thursday, March 17, 2011 2:10 PM
To: Beasley, Benjamin
Subject: RE: RES support for commission meeting on Monday 3/21.

Ben –

Are you, John, and/or Marty able to support the Commission meeting?

From: Beasley, Benjamin
Sent: Thursday, March 17, 2011 11:14 AM
To: Wilson, George
Cc: Kauffman, John; Killian, Lauren; Manoly, Kamal; Coyne, Kevin; Stutzke, Martin
Subject: FW: RES support for commission meeting on Monday 3/21.

George,

As I mentioned on the phone call, we took the liberty of drafting a key message for the GI-199 Comm Plan. It is provided in John's message below.

I will talk to Kevin Coyne (acting director) and Marty about support for the Commission briefing. Let us know if you need anything else for the briefing or the Comm Plan.

Ben

From: Kauffman, John
Sent: Thursday, March 17, 2011 10:15 AM
To: Beasley, Benjamin
Subject: RE: RES support for commission meeting on Monday 3/21.

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Ben,

For GI-199 and the Fukushima Daiichi earthquake and tsunami a key message could be (this is from Annie's document (answers 3 and 22 combined)),

> US plants are designed for appropriate earthquake shaking levels and are safe. Currently the NRC is conducting a program called Generic Issue 199, which is reviewing the adequacy of the earthquake design of US NPPs in central and eastern North America based on the latest data and analysis techniques. The NRC will look closely at all aspects of the response of the plants in Japan to the earthquake and tsunami to determine if any actions need to be taken in US plants and if any changes are necessary to NRC regulations.

Key messages from the GI-199 Communications Plan (slightly tweaked) are:

> (1) In August 2010, the Safety/Risk Assessment for GI-199 was completed. That assessment found that operating nuclear power plants are safe: Plants have adequate safety margin for seismic issues. The NRC's Safety/Risk Assessment confirmed that overall seismic risk estimates remain small and that adequate protection is maintained.
>
> (2) Though still small, some seismic hazard estimates have increased: Updates to seismic data and models indicate increased seismic hazard estimates for some operating nuclear power plant sites in the Central and Eastern United States.
>
> (3) Assessment of GI-199 will continue: Plants are safe (see key message 1), but the NRC has separate criteria for evaluating whether plant improvements may be imposed. The NRC's Safety/Risk Assessment used readily available information and found that for about one-quarter of the currently operating plants, the estimated core damage frequency change is large enough to warrant further attention. Action may include obtaining additional, updated information and developing methods to determine if plant improvements to reduce seismic risk are warranted.

From: Sheron, Brian
To: Bonaccorso, Amy; Calvo, Antony; Case, Michael; Coe, Doug; Correia, Richard; Dion, Jeanne; Gibson, Kathy; Lui, Christiana; Richards, Stuart; Rini, Brett; Sangimino, Donna-Marie; Uhle, Jennifer; Valentin, Andrea
Subject: FW: OIP Weekly
Date: Friday, March 18, 2011 4:42:50 PM
Attachments: OIP Weekly News 3-21-2011.docx

From: Kreuter, Jane
Sent: Friday, March 18, 2011 4:20 PM
To: Abogunde, Maryann; Abrams, Charlotte; Adler, James; Afshar-Tous, Mugeh; Apostolakis, George; Armstrong, Janine; Ash, Darren; Astwood, Heather; Baker, Stephen; Barkley, Richard; Barrett, Andy; Batkin, Joshua; Bavol, Rochelle; Bergman, Thomas; Bloom, Steven; Boger, Bruce; Borchardt, Bill; Bozin, Sunny; Bradford, Anna; Brenner, Eliot; Bubar, Patrice; Burns, Stephen; Burris, Steve; Carter, Mary; Case, Michael; Casto, Chuck; Chimood, Jane; Coates, Carlotta; Coggins, Angela; Cool, Donald; Cullingford, Michael; DANDI_Calendar; Dapas, Marc; Davis, Roger; Dean, Bill; Decker, David; Dehn, Jeff; Dembek, Stephen; Diaz-Toro, Diana; Diec, David; Doane, Margaret; Dorman, Dan; Droggitis, Spiros; Dyer, Jim; Eisenberg, Wendy; Emche, Danielle; English, Lance; Essig, Thomas; Fehst, Geraldine; Fenstermacher, Amy; Ferkile, Andrea; Floyd, Daphene; Foggie, Kirk; Fragoyannis, Nancy; Franovich, Mike; Gibbs, Catina; Grobe, Jack; Hackett, Edwin; Haney, Catherine; Harris, Tim; Hayden, Elizabeth; Henderson, Karen; Herr, Linda; Hiltz, Thomas; Hirsch, Patricia; Holahan, Gary; Holahan, Patricia; Hopkins, Jon; Howell, Art; Hudson, Sharon; Jackson, Kia; Jaczko, Gregory; Jasinski, Robert; Johnson, Michael; Jones, Andrea; Jones, Cynthia; Kasputys, Clare; Killian, Michelle; Kim, Grace; Kock, Andrea; Kolb, Elaine; Kreuter, Jane; Layton, Michael; Leeds, Eric; Lisann, Elizabeth; Loyd, Susan; Lyons-Burke, Kathy; Magwood, William; Mamish, Nader; Matthews, David; Mayfield, Michael; Mayros, Lauren; McCree, Victor; McDevitt, Joan; Miller, Charles; Mitchell, Linda; Monninger, John; Moore, Scott; Morell, Gregory; Newell, Trenton; Nieh, Ho; Oliveto, Betsy; Ostendorff, William; Owens, Janice; Pace, Patti; Pangburn, George; Quinones, Lauren; Ramsey, Jack; Reyes, Luis; Rodriguez, Veronica; Rosales-Cooper, Cindy; Rothschild, Trip; Satorius, Mark; Schmidt, Rebecca; Schroer, Suzanne; Schwartzman, Jennifer; Shaffer, Mark; Sharkey, Jeffry; Shepherd, Jill; Sheron, Brian; Skeen, David; Smiroldo, Elizabeth; Smith, Shawn; Smith, Wilkins; Sosa, Belkys; Speiser, Herald; Svinicki, Kristine; Vietti-Cook, Annette; Virgilio, Martin; Warren, Roberta; Weaver, Doug; Weber, Michael; Wiggins, Jim; Williams, Shawn; Wittick, Brian; Young, Francis; Zimmerman, Roy; Zorn, Jason
Subject: OIP Weekly

Have a GREAT weekend!

Jane A. Kreuter
U.S. Nuclear Regulatory Commission
Office of International Programs
Phone: 301-415-1780
Fax: 301-415-2395
E-Mail: Jane.Kreuter@nrc.gov

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INTERNATIONAL ITEMS OF INTEREST
OFFICE OF INTERNATIONAL PROGRAMS
Week of March 21, 2011

OIP Vision: *To expand nuclear safety and security worldwide through lasting partnerships.*
Our Mission: *OIP enhances nuclear safety and security through global partnerships by exchanging information and by licensing the import and export of material and equipment according to US laws and policy.*

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Nothing to report

2. Export/Import Activities

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3. Conventions, Treaties, Legal Obligations and Interagency Activities

Nothing to report

4. Bilateral Activities

On March 19 to April 1, 2011, Dr. Peter Kohut from Brookhaven National Laboratory (BNL) and Skip Young of OIP will travel to Kiev, Ukraine and Yerevan, Armenia, to review the status of the current nuclear safety assistance projects between NRC and Ukrainian and Armenian regulators. Dr. Kohut and Mr. Young, accompanied by Dr. Pranab Samanta (BNL), will also travel to Khmelnitsky Nuclear Power Plant to participate in a risked informed inspection workshop. The workshop will be conducted by BNL and State Science Engineering Centre (SSEC) who developed the initial inspection guide under contract with BNL for the State Nuclear Regulatory Committee of Ukraine (SNRCU). SSEC is the technical service organization for SNRCU

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Embassy in Tokyo, Japan for activities related to the Fukushima Nuclear Power Plant. The NRC team is being led by Chuck Casto.

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From: Kreuter, Jane
To: Abogunde, Maryann; Abrams, Charlotte; Adler, James; Afshar-Tous, Mugeh; Apostolakis, George; Armstrong, Janine; Ash, Darren; Astwood, Heather; Baker, Stephen; Barkley, Richard; Barrett, Andy; Batkin, Joshua; Bavol, Rochelle; Bergman, Thomas; Bloom, Steven; Boger, Bruce; Borchardt, Bill; Bozin, Sunny; Bradford, Anna; Brenner, Eliot; Bubar, Patrice; Burns, Stephen; Burris, Steve; Carter, Mary; Case, Michael; Casto, Chuck; Chimood, Jane; Coates, Carlotta; Coggins, Angela; Cool, Donald; Cullingford, Michael; DANDI Calendar; Dapas, Marc; Davis, Roger; Dean, Bill; Decker, David; Dehn, Jeff; Dembek, Stephen; Diaz-Toro, Diana; Diec, David; Doane, Margaret; Dorman, Dan; Droggitis, Spiros; Dyer, Jim; Eisenberg, Wendy; Emche, Danielle; English, Lance; Essig, Thomas; Fehst, Geraldine; Fenstermacher, Amy; Ferkile, Andrea; Floyd, Daphene; Foggie, Kirk; Fragoyannis, Nancy; Franovich, Mike; Gibbs, Catina; Grobe, Jack; Hackett, Edwin; Haney, Catherine; Harris, Tim; Hayden, Elizabeth; Henderson, Karen; Herr, Linda; Hiltz, Thomas; Hirsch, Patricia; Holahan, Gary; Holahan, Patricia; Hopkins, Jon; Howell, Art; Hudson, Sharon; Jackson, Kia; Jaczko, Gregory; Jasinski, Robert; Johnson, Michael; Jones, Andrea; Jones, Cynthia; Kasputys, Clare; Killian, Michelle; Kim, Grace; Kock, Andrea; Kolb, Elaine; Kreuter, Jane; Layton, Michael; Leeds, Eric; Lisann, Elizabeth; Loyd, Susan; Lyons-Burke, Kathy; Magwood, William; Mamish, Nader; Matthews, David; Mayfield, Michael; Mayros, Lauren; McCree, Victor; McDevitt, Joan; Miller, Charles; Mitchell, Linda; Monninger, John; Moore, Scott; Morell, Gregory; Newell, Trenton; Nieh, Ho; Oliveto, Betsy; Ostendorff, William; Owens, Janice; Pace, Patti; Pangburn, George; Quinones, Lauren; Ramsey, Jack; Reyes, Luis; Rodriguez, Veronica; Rosales-Cooper, Cindy; Rothschild, Trip; Satorius, Mark; Schmidt, Rebecca; Schroer, Suzanne; Schwartzman, Jennifer; Shaffer, Mark; Sharkey, Jeffry; Shepherd, Jill; Sheron, Brian; Skeen, David; Smiroldo, Elizabeth; Smith, Shawn; Smith, Wilkins; Sosa, Belkys; Speiser, Herald; Svinicki, Kristine; Vietti-Cook, Annette; Virgilio, Martin; Warren, Roberta; Weaver, Doug; Weber, Michael; Wiggins, Jim; Williams, Shawn; Wittick, Brian; Young, Francis; Zimmerman, Roy; Zorn, Jason
Subject: OIP Weekly
Date: Friday, March 18, 2011 4:20:11 PM
Attachments: OIP Weekly News 3-21-2011.docx

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Jane A. Kreuter
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Office of International Programs
Phone: 301-415-1780
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OFFICE OF INTERNATIONAL PROGRAMS
Week of March 21, 2011

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Subject:	Dry Run for 3/21 CM re: Japanese Event & U.S. Response
Location:	O-17H1
Start:	Mon 3/21/2011 7:30 AM
End:	Mon 3/21/2011 8:00 AM
Recurrence:	(none)
Meeting Status:	Meeting organizer
Organizer:	Borchardt, Bill
Required Attendees:	Howe, Allen; Brenner, Eliot; Doane, Margaret; Leeds, Eric

Rct 3/17

XX/30

From: E&E Publishing, LLC <ealerts@eenews.net>
Sent: Monday, March 21, 2011 12:46 PM
To: Virgilio, Martin
Subject: March 21 -- Greenwire is ready

AN E&E PUBLISHING SERVICE

NUCLEAR CRISIS: JAPAN & THE FUTURE OF ENERGY POLICY

The devastating earthquake and tsunami in Japan has spawned a major nuclear disaster. E&E examines the implications for energy the environment, security and public health. Click here to go to the report.

GREENWIRE -- MON., MARCH 21, 2011 -- Read the full edition

1. SUPREME COURT: Justices decide -- narrowly -- against hearing enviro search case

The Supreme Court declined today to take up the question of whether an environmental inspection of a private property can be viewed as an unconstitutional search and seizure. It was a close call, with four of the nine justices expressing considerable interest in the issue. Only four votes are needed for the court to hear a case, so they had the power to have forced that outcome if they had wanted to.

TOP STORIES

2. **BIOFUELS:** Brazil, U.S. to expand aviation partnership
3. **BIOFUELS:** Marines trying to get Afghan farmers hooked on energy crops
4. **SUPERFUND:** EPA, NYC brace for grueling cleanups of 2 industrial waterways

JAPAN EARTHQUAKE

5. **NUCLEAR CRISIS:** New repairs delay work at hobbled Japanese plant
6. **NUCLEAR CRISIS:** NRC sees signs of stability in Japan, plans review of U.S. reactors
7. **COAL:** Int'l demand rises as nuclear concerns linger
8. **NUCLEAR CRISIS:** Japanese plant has history of accidents

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9. **SAFETY:** TEPCO failed to carry out scheduled inspections at crippled plant

10. **FOOD SAFETY:** Japan finds contaminated milk, spinach

11. **NUCLEAR WASTE:** Spent-fuel storage plan near Lake Michigan comes under scrutiny

12. **NUCLEAR:** Three Mile Island neighbors flush with memories

CONGRESS

13. **OFFSHORE DRILLING:** House Resources chairman blasts Obama's Brazilian energy comments

14. **CLIMATE:** Energy subpanel to hold Texas field hearing on EPA regs

POLITICS

15. **CAMPAIGN 2012:** Pawlenty to take first step in White House run

ENERGY

16. **NUCLEAR CRISIS:** NRC plans meetings to discuss reactors in N.Y., S.C.

17. **NUCLEAR:** U.S., Chile sign energy accord

LAW AND LOBBYING

18. **AGRICULTURE:** Food group challenges USDA's modified alfalfa approval

FEDERAL AGENCIES

19. **WORK FORCE:** GOP promotes Senate bill to end defined benefit pensions

AIR AND WATER

20. **DRINKING WATER:** DuPont reaches settlement over chemical detected in N.J. wells

NATURAL RESOURCES

21. **OCEANS:** Gulf goop is likely river sediment -- Coast Guard

22. **GULF SPILL:** Flooding farmland didn't keep birds away from oily marshes -- state expert

23. **GULF OF MEXICO:** Recreational fishermen vie for larger share of red snapper harvest

WASTES & HAZARDOUS SUBSTANCES

24. **CHEMICALS:** Bayer ends MIC production at W.Va. plant

SOCIETY

25. **MINING:** Drilling, panning are top skills in this college tourney

E&ETV'S ONPOINT

26. **EFFICIENCY:** Alliance to Save Energy's Callahan weighs in on light bulb debate

Get all of the stories in today's Greenwire, plus an in-depth archive with thousands of articles on your issues, detailed Special Reports and much more at http://www.greenwire.com

Forgot your passcodes? Call us at 202-628-6500 now and we'll set you up instantly.

To send a press release, fax 202-737-5299 or e-mail editorial@eenews.net.

ABOUT GREENWIRE

Greenwire is written and produced by the staff of E&E Publishing, LLC. The one-stop source for those who need to stay on top of all of today's major energy and environmental action with an average of more than 20 stories a day, Greenwire covers the complete spectrum, from electricity industry restructuring to Clean Air Act litigation to public lands management. Greenwire publishes daily at Noon.

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Phone: 202-628-6500. Fax: 202-737-5299.
www.eenews.net

From: E&E Publishing, LLC <ealerts@eenews.net>
Sent: Tuesday, March 22, 2011 12:56 PM
To: Virgilio, Martin
Subject: March 22 -- Greenwire is ready

AN E&E PUBLISHING SERVICE

NUCLEAR CRISIS: JAPAN & THE FUTURE OF ENERGY POLICY

The devastating earthquake and tsunami in Japan has spawned a major nuclear disaster. E&E examines the implications for energy the environment, security and public health. Click here to go to the report.

GREENWIRE -- TUE., MARCH 22, 2011 -- Read the full edition

1. WATER POLLUTION: Ocean dumpers sail home leaving EPA agents in their wake

To hear Rick Stickle tell it, John Karayannides was the mastermind behind the dumping of 440 tons of oil-soaked grain from a U.S. cargo ship into the South China Sea in 1999. Though Stickle owned the Iowa-based Sabine Transportation Co., Karayannides ran the company's shipping operations. And when a problem on a cargo vessel led to the contamination of a shipment of relief supplies bound for Bangladesh, Stickle said Karayannides came up with the plan and gave orders to throw the ruined grain overboard. But a federal jury did not buy his story. Stickle was convicted in 2005 of ordering the illegal dumping and in obstructing an investigation by the U.S. Coast Guard. Stickle said in a recent interview that he dreams of the day he will cross paths with Karayannides. And that is one area where Stickle and U.S. EPA are in agreement.

TOP STORIES

2. **NUCLEAR WASTE:** Court hints Yucca lawsuit may be premature
3. **BUDGET:** Congress' failure to pass spending bill creates chaos in agencies
4. **DEFENSE:** Marine Corps unveils plan to cut frontline energy use

JAPAN EARTHQUAKE

5. **NUCLEAR CRISIS:** Japan disaster creates new hurdles for Midwest reactor plans

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6. **NUCLEAR CRISIS:** Tokyo Electric is no stranger to power-supply problems
7. **NUCLEAR CRISIS:** A turning point and setbacks at crippled Japanese plant
8. **RADIATION:** Plume detected over East Coast and as far as Iceland
9. **NUCLEAR CRISIS:** Japanese regulators extended reactor's life despite safety warnings
10. **UTILITIES:** Japanese nuclear operator slammed for lack of openness
11. **BUSINESS:** Japan quake sends ripples through global industries

POLITICS

12. **MINING:** MSHA 'a different agency' in wake of W.Va. disaster -- Main

ENERGY

13. **COAL:** Interior, Wyo. expected to announce Powder River Basin deal
14. **RENEWABLE ENERGY:** BLM, Colo. ink agreement on geothermal leasing
15. **NATURAL GAS:** Utilities must embrace long-term contracts, market forces -- report
16. **NATURAL GAS:** Haynesville may have surpassed Barnett as top shale play
17. **NUCLEAR:** Changes expected at N.Y.'s Indian Point
18. **NUCLEAR:** Texas plant stalled while NRC investigates Japan accident
19. **NUCLEAR SAFETY:** Court requires Exelon, NRC to review licensing of Oyster Creek plant
20. **MINING:** Resurrected Australian deal is rare bright spot for uranium markets
21. **NATURAL GAS:** Industry poised for resurgence after nuclear, oil crises

LAW AND LOBBYING

22. **CHEMICALS:** 5 pesticide industry groups support Obama admin in ESA lawsuit
23. **BIOTECH:** Bayer ordered to pay $136M for rice contamination

AIR AND WATER

24. **WATER:** Amid international tumult, World Water Day struggles to make a splash
25. **WATER:** Most Americans clueless about water sources -- poll
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AN E&E PUBLISHING SERVICE

ONPOINT -- TUE., MARCH 22, 2011 -- Go to www.eenews.tv

AN E&ETV ENCORE PRESENTATION

Originally aired: March 17, 2011

NUCLEAR CRISIS: Former CEQ Chairman Frampton says Japanese disaster worse than Three Mile Island

How does Japan's Fukushima nuclear event compare to the United States' Three Mile Island incident? During today's OnPoint, George Frampton, the deputy director and chief of staff for the Nuclear Regulatory Commission's special inquiry group into the Three Mile Island accident, explains why Fukushima is a more serious event than Three Mile Island. Frampton, also the former chairman of the White House Council on Environmental Quality and currently senior of counsel and a member of the clean energy and climate industry group at Covington & Burling, also explains how Fukushima will affect the U.S. nuclear industry.

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Nuclear News Flashes
Friday, Mar 18, 2011

[Inside This Issue:]

*** Tepco works to restore offsite power to Fukushima I

Tokyo Electric Power Co. said it was taking steps to restore offsite power at its Fukushima I nuclear power plant, starting March 19 with unit 2.

Tepco said in a statement at 4 pm Tokyo time March 18 that it has connected the plant to an external transmission line and "confirmed that electricity can be supplied."

Tepco said it plans to restore power first to unit 2, which it said "is expected to be less damaged."
The utility has scheduled the work to connect cables and electrical transmission gear to provide back-up power to units 1 and 2 on March 19, Japan's Nuclear and Industrial Safety Agency said March 18.

Units 3 through 6 are scheduled to be connected March 20, NISA said.

"After checking pumps and other equipments are functional, we will restore the damaged items, putting priority on the equipments for sending cooling water to the reactor," Tepco said.

About 160 workers, including 13 Tepco employees, are working to restore power supply to the reactors, the utility said.

A diesel generator located in unit 6 was operable and providing power to that unit and unit 5, NISA said in an update late March 18. Water is being provided to the reactor vessel and spent fuel pools of the two units, NISA said.

*** NISA's Level 5 rating of Fukushima events excluded worker exposure

The new rating of the Fukushima I accident at Level 5 on the seven-level International Nuclear Event Scale excluded worker exposure, according to reports Japan's Nuclear and Industrial Safety Agency filed with the IAEA March 18.

The initial Fukushima INES rating on March 12 was Level 4. Both ratings are provisional.

NISA said in the reports on units 1, 2 and 3 that at least one worker had received a radiation dose in excess of the annual limit of 100 milliSievert. But it said radiological impact was not taken into account in the rating "because the correspond(ing) work still continues."

Dose information has not been released. Radiation levels on the site remain very high, and the allowed intervention dose was raised March 17 to 250 milliSievert, 2.5 times the statutory annual occupational limit.

NISA said the Level 5 rating was chosen on the assumption that no more than a few percent of the Fukushima core inventories was released.

French regulator Philippe Jamet told journalists March 18 that Level 5 was "not necessarily reasonable" given the scope of the accident at the Japanese plant. The 1979 accident at the Three Mile Island-2 nuclear unit in the US was rated at Level 5. That accident involved fuel melt but no containment failure, and affected a single reactor unit. The 1986 Chernobyl-4 accident was rated Level 7.

*** French prime minister promises stricter criteria for nuclear plant exports

France will export nuclear power plants only to countries with the technical and organizational capacity to manage a major accident like the one at Fukushima I in Japan, French Prime Minister Francois Fillon said late March 17.

In an interview on state-owned France 2 television, Fillon said the events at the Japanese nuclear power plant will lead France to "set stricter requirements" for nuclear exports.

A French nuclear safety official said March 18 the government would apply both technical and political criteria to determine whether a given country qualifies to receive French nuclear technology.

The official said exports would be denied to countries with unstable political and organizational structures and countries that don't have the technical resources to manage a major nuclear accident.

State-owned Areva is the world's largest integrated nuclear technologies and services vendor. Before power and cooling to the Fukushima plant were knocked out by an earthquake and tsunami March 11, Areva was in discussion with numerous countries to sell nuclear reactors and had expected to sign contracts for supply of its EPR with several countries, notably India, in the near future. Several countries have postponed nuclear construction plans in the past days.

Fillon also said French authorities would not hesitate to close any French reactor if it failed to pass "stress tests" planned in cooperation with other EU countries, but said a reactor's age was not a determining factor. He said the decision will be up to nuclear regulator ASN.

*** Tepco says tsunami, not earthquake, led to Fukushima accident

Tokyo Electric Power Co. believes the loss of cooling at Fukushima I was not caused by the earthquake but by a tsunami that exceeded the design basis of the plant, the company said in a statement March 18.

The condition of the plant following the 9.0-magnitude earthquake March 11 was "good and well controlled," Tepco said. Ground acceleration as measured at the foundation of two of the three reactors â€" units 3, 4 and 6 â€" for which data are available was below the design basis, Tepco said.

At unit 3, the horizontal acceleration was 507 Gal, a measure equal to 1 centimeter per second per second, compared to the design basis of between 441 and 449 Gal, Tepco said. Vertical acceleration was less than design basis, the company said.

The tsunami was estimated to have been more than 10 meters (33 feet), which was more than the design basis of 5.7 meters, Tepco said.

*** US military equipment enlisted to help at Fukushima I

The US military said March 18 it is flying unmanned reconnaissance aircraft over the site of the Fukushima I nuclear power plant and has sent firefighting equipment to help Japan cool spent fuel pools there.

Global Hawk unmanned surveillance and reconnaissance aircraft are making flights over the site in an effort to help Japanese authorities learn more about the situation on the ground, Master Sgt. Donald Preston said in a March 18 phone interview from Japan. Two fire engines from US military bases near Tokyo were provided to the Japanese government to help cool spent fuel pools at Fukushima I (also called Fukushima Daiichi), Pentagon spokesman Cmdr. Leslie Hull-Ryde said in a March 18 email.

Japan's Nuclear and Industrial Safety Agency said March 18 that one US military fire truck was used to spray water onto one of the spent fuel pools at Fukushima I in an expanding effort to control radiation releases.

Three reactor cores at Fukushima I were damaged following a massive earthquake and tsunami a week ago.

The US has been using equipment mounted on helicopters and planes to help measure radiation levels in the region of the plant, Adm. Robert Willard, head of the US Pacific command, said at a Pentagon briefing March 18. The US is sharing "sensing data" with the Japanese, he said, according to a transcript provided by the US Department of Defense.

*** Fukushima recovery will take 'years': ASN commissioner

Permanent means must be found for cooling the damaged units at Tokyo Electric Power Co.'s Fukushima I nuclear power plant, French regulator Philippe Jamet said March 18, saying stable electricity supply and heat removal must be established to last for "years."

Jamet, a commissioner of the Nuclear Safety Authority, ASN, told a press briefing in Paris that even if the efforts under way to connect the station to outside power supply are successful, the situation will remain makeshift until a permanent and stable power supply is restored.

He also said that while the emergency water dumping and hosing operations under way to maintain water in spent fuel pools are justified, permanent means must also be established to keep the reactors and pools cool over the long term.

Jamet was asked about the conflicts between information on the spent fuel pool of unit 4 given this week by French safety officials and by NRC Chairman Gregory Jaczko.

Jaczko told a congressional committee March 16 that the unit 4 pool was without water, but the next day French expert organization IRSN said there appeared to be water in the pool.

"The information [from Japan] is difficult to understand and leaves room for interpretation," Jamet said. "It's possible that NRC has a different judgment on certain issues."

He said ASN has been conferring "every day with our US, British and Canadian" counterparts on the Fukushima accident.

*** US nuclear industry to seek answers in Fukushima I events

The US nuclear industry will seek answers to Fukushima I's design features and emergency responses to draw lessons, said an industry official.

Topping the list of questions the US industry has is "what in the world happened around the spent fuel pools," said David Helwig, who was interviewed after a Nuclear Energy Institute meeting March 18. He said he was asked to come up with a list of priorities for future investigations at Fukushima I.

The spent fuel pools at two of the units at Fukushima I may be boiling, and some of the pools may have been damaged, French nuclear authorities said this week. The water level of the spent fuel pools at units 3 and 4 are low, with possible damage to fuel, the Japan Atomic Industrial Forum said March 17. Helwig said the "substantial challenges" at the spent fuel pools were "highly unlikely" scenarios.

Helwig is president of Helwig Consulting Services, which specializes in nuclear design and engineering. He said the US industry will also study the plant design at Fukushima I. "There's a whole litany of questions about design features" related to the failure of the emergency diesel generators and the possible hydrogen explosions on site, he said.

In addition, he said, the US industry will want to compare its emergency operating procedures with the responses in Japan following the March 11 earthquake and tsunami.

*** Senators introduce international nuclear safety bill

A bill introduced March 17 by two US senators would call on other nations to enhance their nuclear power safety programs and transparency.

Senators Daniel Akaka of Hawaii and Thomas Carper of Delaware, both Democrats, introduced the Furthering International Nuclear Safety Act of 2011 to "enhance worldwide cooperation on nuclear safety," Carper's office said in a March 18 statement.

Carper is chairman of the Committee on Environment and Public Works' Clean Air and Nuclear Safety Subcommittee, which oversees the NRC.

US Representative Jeff Fortenberry, a Nebraska Republican, plans to introduce a companion bill later this month in the House of Representatives, the statement said.

Akaka said in the statement that the bill "would build on the international Convention on Nuclear Safety by improving information sharing, strategic planning, and performance evaluation, so nations can work together to prevent nuclear catastrophe."

The statement said the legislation would require the US representative to the convention to encourage reforms such as "the use of performance metrics for countries to assess their own nuclear safety progress" and "increased public availability of information about nuclear safety efforts."

The IAEA would be encouraged "to provide additional support for safety, when possible," and "all countries that have or are considering a civilian nuclear power program [would be encouraged] to join the Convention."

The legislation would also require the US federal government to develop a "strategic plan for international cooperation on nuclear power safety."

*** Correction

A report in the March 17 Nuclear News Flashes mistakenly attributed a quotation from a White House briefing. The quotation should have read as follows: Daniel Poneman, DOE deputy secretary of energy, said at a White House briefing March 17, "We have no reason to question the assessments that have been made, or the recommendations that have been made, by the Japanese authorities."

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Nuclear News Flashes
Saturday, Mar 19, 2011

[Inside This Issue:]

*** Some success cooling reactors, spent fuel at Fukushima: Cabinet Secretary Edano

Efforts to spray water into the disabled reactors and spent fuel pools at the Fukushima I nuclear power plant March 19 have been "successful," but work continues to install piping to provide consistent water supply to responders, Chief Cabinet Secretary Yukio Edano said in a briefing.

Yasuo Sato of the Tokyo Fire Department said during a briefing March 19 that Tokyo firefighters used unmanned vehicles to spray water into the spent fuel pool and reactor at Fukushima I-3.

Edano said these efforts have achieved "a certain degree of stability," but workers will continue to "try to ensure stable water spray [at] the number three and four reactors so there will be [a] much improved situation."

Sato said the firefighters' initial efforts to approach units 3 and 4 that morning were complicated by debris from the earthquake and tsunami that hit March 11. Eventually, the spraying equipment was put in place using an 800-meter hose, Japan television network NHK reported.

Radiation levels near the operation "fell to almost zero" shortly after firefighters began to spray water into the Unit 3 reactor and spent fuel pool, Sato said.

The initial plan was to spray more than 1,200 mt of water over seven hours, but the operation has been extended until 12:30 am March 20 (1530 GMT March 19) local time, Sato said. As much as 3,800 liters of water per minute has been sprayed during the operation, he said.

Tepco said March 19 that it had succeeded in restoring electric power to Fukushima I-1 and -2. This power is needed to operate cooling equipment at the disabled plant.

Tepco said that as of midnight March 19 local time, it is working to restore electric power to units 3 and 4. The utility said it aims to restore power at units 3-6 on March 20. Workers will attempt to reactivate instrumentation at units 1 and 2, assess the state of cooling equipment damaged in the disaster, and try to restore function of the cooling systems, Tepco said.

The Japan Atomic Industrial Forum, the nation's nuclear industry group, said in an update that as of 10 pm March 19 local time, fuel elements were "exposed partially or fully" in the reactors at units 1, 2 and 3. The fuel must be kept submerged to prevent risk of a core melt. Core and fuel integrity are "damaged" at those three units, JAIF said.

"Damage [is] suspected" to containment vessel integrity, which seals the reactor vessel as an additional layer of defense in depth, at unit 2. It is "not damaged" at units 1, 4, 5 and 6, JAIF said, and "might be not damaged" at unit 3.

Water levels remain "low" at the spent fuel pools of units 3 and 4, JAIF said. Used fuel elements in the pools must be kept underwater to prevent overheating that can damage fuel and generate explosive hydrogen gas. Water injection is being "considered" for the pool at unit 1, it said.

Spent fuel pool temperature is "increasing" at unit 6, JAIF said without providing details. Pool temperature is "high but decreasing" at unit 5, a favorable update from six hours previous when the temperature was listed as "increasing." No information is available on the unit 2 spent fuel pool, it said.

David Lochbaum, a nuclear engineer with the Union of Concerned Scientists, said in a telephone briefing the morning of March 19 in the US that emergency diesel generators have restored cooling of the pools at units 5 and 6. It appears "cooling was restored before those pools got into distress," Lochbaum said.

*** Fukushima I 'cloud' reaches North America, heads toward Europe

The radioactive “cloud” from Japan’s Fukushima I nuclear power plant north of Tokyo covered most of North America and northeastern Siberia March 18, and was passing over the northern Atlantic and the Caribbean March 19, France’s Institute of Radiological Protection and Nuclear Safety, IRSN, said in an information bulletin late March 19.

IRSN is modeling the movement of the radioactive cloud in collaboration with Meteo France, the state meteorological service.

IRSN said the Fukushima plume, which carries Iodine-131 and cesium-137 among other isotopes, would reach metropolitan France on March 23 or 24.

The plume has been moving since March 12 in accordance with atmospheric currents in the northern hemisphere. There is almost no exchange between the atmospheres of the northern and southern hemispheres, French experts have said.

IRSN said that concentrations of Cs-137 in the cloud were “extremely low,” too low to be detected by IRSN’s Teleray radioactivity monitoring network. IRSN is also publishing measurements from that network, which has 163 stations in metropolitan France and seven in French overseas territories, as well as one recently installed at the French Embassy in Tokyo. Teleray continually measures gamma radiation expressed in nanoSieverts per hour.

IRSN said that it agreed with the US Environmental Protection Agency that the level of concentrations of cesium in the Fukushima fallout would not have health or environmental consequences and would be so low that only specialized laboratories such as its own could detect them. It said it would publish the results of environmental measurements “as soon as possible, that is, several days after the passage of the plume.”

The models of the fallout movements and all ambient radioactivity measurements are posted on IRSN's website, www.irsn.fr.

*** French industry group sends equipment to Fukushima

Intra, a joint venture of EDF, Areva and the CEA, is sending 130 tons of robots and specialized equipment to help Japan cope with the aftermath of the Fukushima I nuclear power plant accident, EDF said late March 18.

An Antonov 225, the world's largest plane, was scheduled to leave France this weekend for Tokyo's Narita airport, carrying remote-controlled machines designed by Intra to operate instead of human beings in and around buildings in radiologically hostile environments.

The cargo comprises equipment for taking measurements of environmental radioactivity and remotely controlled robotic machines, EDF said in a statement. The equipment is capable of working inside or outside buildings, to conduct clearing work and "complex technical movements" such as clearing debris, setting up measurement posts or taking samples. It can measure radioactivity and take and transmit films, EDF said.

EDF said it already sent 100 mt of boric acid to Japan to be used in cooling the Fukushima reactors.

Intra is majority owned by EDF and headquartered near EDF's Chinon nuclear power plant.

EDF said France was the only country that used the experience of the 1986 Chernobyl accident to design and build a fleet of machines to cope with extreme situations and train personnel capable of using them.

*** Japanese government considering ban on food sales near Fukushima I

Japan is considering whether to ban the sale and shipment of food products originating in the Fukushima Prefecture, the area around the damaged Fukushima I nuclear power plant, after elevated levels of radiation were found in milk, Yukio Edano, the Japanese government's chief cabinet secretary, said during a March 19 briefing.

Edano said tests of milk collected 30 kilometers (nearly 19 miles) from the Fukushima station and spinach collected in the Ibaraki Prefecture, 65 km south of the station, detected radiation levels "exceeding the government-set limit," according to the Japan Atomic Industrial Authority's March 19 summary of the briefing. Edano said the government might set limits on food consumption instead. Edano did not say when the government would decide whether to ban or restrict food sales, according to JAIF.

The test found elevated levels of radioactive iodine in the foods sampled March 16 through March 18, the IAEA said March 19.

Edano did not say what levels of radiation were detected in the sampled food products, but that the radiation poses "no immediate threat to health," JAIF reported. "For reference, the radiation detected in milk, even if taken in all through a year, is just equivalent to [the] radiation dose" from a single CT (Computerized tomography) scan and the radiation detected in the spinach samples equal one-fifth of a CT scan, he said.

*** CORRECTION

Dose limits to workers at Japan's Fukushima nuclear power plant were misstated in a March 18 Nuclear News Flash. The story should have indicated that "at least one worker received a dose above the authorized intervention limit of 100 mSv," and that "the allowed intervention dose was raised March 17 from 100 mSv to 250 mSv. The statutory occupational limit is 100 mSv over five years.

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Nuclear News Flashes
Sunday, Mar 20, 2011

[Inside This Issue:]

*** Recovery efforts continue at Fukushima nuclear power plant

Pressure levels rose March 20, then later stabilized, in one of the crippled reactors at the Fukushima I nuclear power plant in Japan, government and industry officials said.

Plans being considered earlier March 20 to vent radioactive steam from unit 3 to reduce pressure were deferred, and workers will continue to monitor reactor pressure, Tokyo Electric Power Co. said in a statement the afternoon of March 20 (local time).

Efforts continue to restore outside electric power to instruments and safety systems at the site's six reactors and spent fuel pools. The Japan Atomic Industrial Forum, the nation's nuclear industry group, said in an update that as of 10 pm March 20 local time, an external AC power cable had been connected to the "distribution switchboards" at units 1 and 2, but core cooling systems requiring AC power are still "not functional" at those units and unit 3.

Tepco said in its most recent statement that as of 2 pm local time March 20 it was still working to restore external AC power to units 3 and 4.

Fuel is still "partially or fully exposed" in units 1, 2 and 3, JAIF said. This creates risk of fuel damage, generation of explosive hydrogen gas and possible core melting.

Reactor pressure levels are "stable" at units 1 and 3, but are "unknown" for unit 2, JAIF said.

Injection of seawater to cool reactor cores continues at units 1, 2 and 3, Tepco said.

Cooling capability was restored March 20 to spent fuel pools at unit 5 and 6, where temperatures had been rising, JAIF said. Emergency workers continued efforts to spray water into the pools at units 3 and 4 and had some effect, it said without providing details. Seawater "injection" continues at the unit 2 pool and is being considered for the unit 1 pool, it said.

*** Fukushima units remain in 'precarious' situation: ASN

The situation at Japan's Fukushima I nuclear power plant "remains serious and precarious," Olivier Gupta, deputy director general of France's nuclear safety authority ASN, told journalists in Paris the morning of March 20 (local time).

Gupta said that the most serious short-term danger was at the plant's unit 3 reactor, where operator Tepco had earlier in the day planned to vent the reactor vessel to relieve mounting pressure without knowing for sure whether the pressure suppression pool at the bottom of the containment was intact. Tepco later deferred those plans, saying pressure had stabilized.

"If the pool is too damaged, the [radioactive] releases will not be filtered" before attaining the atmosphere, Gupta said. The pool is designed in normal operation to trap radionuclides via a bubbling mechanism before the containment gases are vented.

Tepco said that the proposed venting would release radioactive materials totaling 6.5 x 10+E18Bq (6.5 Exabecquerels),"which surpasses the standard for a serious accident."

On March 18, France's Institute of Radiological Protection and Nuclear Safety had estimated that radioactive releases from the Fukushima plant so far were about an order of magnitude lower than that. Most of the releases have been from voluntary venting of the reactors at units 1, 2 and 3 to prevent pressure from building up inside. Up to now, all those releases have been filtered.

Gupta said that although Tepco was doing what it could to restore power and cooling to the stricken reactors and spent fuel pools at Fukushima, "the situation from a technical viewpoint has not changed significantly for several days."

Gupta added that the situation cannot be considered stabilized until Tepco has restored more permanent power supply and more lasting means of cooling the units than those being used now.

*** Food contamination around Fukushima requires countermeasures: ASN

Concentrations of iodine-131 in milk from cows within 20 kilometers (about 12 miles) of Japan's stricken Fukushima I nuclear power station have reached levels 10 times or more the maximum admissible levels, and "no one should consume this milk," Jean-Luc Godet, director for ionizing radiation of France's Nuclear Safety Authority, ASN, said March 20.

Godet said ASN had received information on a limited number of samples that were taken of foodstuffs around the plant through the IAEA. The milk samples vary between 1,000 and 1,500 becquerels per kilogram, he said, compared to a Japanese limit for consumption of 100 Bq/kg, which he said was consistent with international standards.

I-131 measured in spinach as far as 160 kilometers from the plant site are also high, Godet said at a press briefing in Paris.

"The government must take measures to prohibit sale or consumption" of these foodstuffs, he said.

He said measurements of I-131 in tap water were not on a level that posed a health risk.

I-131 has a half-life of seven days, meaning that "after a month it will no longer be measurable" in the environment. Iodine is accompanied in the Fukushima radioactive plume by cesium-137 and strontium-90, which have much longer half-lives and so present a longer-term problem. People near the plant were protected from external exposure by evacuation and sheltering, and now they must be prohibited from consuming contaminated food, he said.

*** Focus must remain on cooling Fukushima's damaged reactors: Jaczko

NRC Chairman Gregory Jaczko said in an interview on C-SPAN the morning of March 20 that the most urgent priority remains restoring reliable cooling to Fukushima's reactors and spent fuel pools.

Jaczko declined to assess the plant's current safety status, but said "it's still a very difficult situation."

Jaczko also declined to comment on a March 19 report in the New York Times about Tokyo Electric Power Co.'s early response to the plant's problems, saying "we will have an opportunity when the crisis is resolved to go back and see how decisions were made."

The newspaper reported that executives may have "wasted precious time in the early hours of the nuclear crisis, either because of complacency or because they did not want to resort to emergency measures that could destroy the valuable plant."

The story cited Kuni Yogo, formerly an atomic energy policy planner in Japan's Science and Technology Agency, as saying he believed Tepco executives "did not recognize the risks soon enough. They failed to cool the reactors on the day of the earthquake, March 11, and even after a hydrogen explosion the following day, they waited more than four hours to start dousing the reactors with seawater. They did not even try to put water into the spent fuel pools for several days."

The US NRC is conducting short-term and long-term safety reviews to determine what issues the Fukushima accident raises for the US fleet of 104 nuclear power reactors, roughly a fourth of which are similar in design and vintage to the reactors at Fukushima. The NRC staff will brief the commission March 21 on the accident.

Much more detailed information on the events in Japan will be available to inform the long-term NRC safety review, which will take "several months," Jaczko said.

*** US nuclear power plants safe: Energy secretary Chu

US Energy Secretary Steven Chu on March 20 defended the safety of US nuclear power plants and said the US is working with Japanese officials to address the crisis at Tokyo Electric Power Co.'s Fukushima I nuclear power plant.

Chu said on Fox News he has confidence in Japan's public statements about the accident. "There's no evidence I've ever heard that the Japanese were holding back," Chu said. "We are getting information from them, we have confidence in that information."

Chu also repeated assurances that US residents are not in danger from the Japanese reactors, and said

US nuclear plants are safe, including reactors in New York and California.

Although some US lawmakers have questioned whether the Diablo Canyon nuclear plant near San Louis Obispo, California, could withstand a major earthquake, Chu said on CNN's State of the Union that the plant was built to survive any likely tremor. "The probability is so low, we're looking for a potential earthquake that could occur once every seven to ten thousands years," Chu said.

Chu said the NRC will review the safety of US nuclear plants, including the Indian Point plant about 40 miles (about 64 km) from New York City. "And again, we're going to have to look at whether this reactor should remain," Chu said on Fox News Sunday. "But, again, I don't want to jump to some judgment about what we should do going forward."

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Nuclear News Flashes
Monday, Mar 21, 2011

[Inside This Issue:]

*** Fukushima I electric supply not yet stable, ASN says

Electricity supply to Japan's Fukushima I nuclear power plant "is not stabilized," French nuclear safety officials said March 21, despite the success of Tokyo Electric Power Co. in bringing a new power cable to the site and hooking it to a temporary transformer.

Andre-Claude Lacoste, chairman of nuclear safety authority ASN, said at a press briefing that it would take Tepco "surely several days, and possibly more," for the Japanese utility to verify the state of each piece of equipment that needs to be reconnected to the power supply.

He said it was important not to connect pumps that were still wet in the reactor buildings, as that might cause a short-circuit that could trigger a hydrogen explosion.

Lacoste said the situation was more complicated at Fukushima I units 3 and 4, which had been doused with dozens of tons of water over the past two days to restore the margin of safety in their spent fuel pools. Those spraying operations had left water in the reactor building that may have damaged pumps and other equipment, he said.

In an update on the Fukushima I situation at 3 pm local time on March 21, France's Institute of Radiological Protection and Nuclear Safety, ASN's technical support organization, said that unit 1 had been reconnected to the grid it shares with unit 2, "but no equipment was put into operation."

IRSN said that Tepco was giving "priority to putting the control room and the cooling system" of unit 1 into service.

Japan's Nuclear and Industrial Safety Agency said March 21 that smoke was seen coming from unit 2 that evening, local time. Similar smoke seen at unit 3 a little earlier that day died down, NISA said.

Units 5 and 6 are now receiving power from the grid in addition to that from two diesel generators, IRSN said. Tepco said over the weekend that those two units had reached cold shutdown after power was restored and cooling systems were turned back on.

*** EC might review EU nuclear safety rules in 2012

The European Commission could review EU nuclear safety legislation as early as next year, EU energy commissioner Guenther Oettinger said March 21 after an emergency meeting during which EU energy ministers discussed energy security in light of the ongoing Fukushima nuclear accident in Japan.

"We certainly have to speed up the safety review" foreseen for 2014 in the EU's 2009 nuclear safety directive," Oettinger told reporters in Brussels.

EU governments have to transpose the 2009 directive into national law by July 22.

Last week the EC, high-ranking government officials, nuclear regulators and industry executives backed the idea of voluntary safety "stress tests" for EU nuclear power plants based on common criteria expected to be agreed on by mid-2011.

Oettinger said that with the results of stress tests in by the end of this year, the EC next year can propose "an early revision of EU nuclear legislation and perhaps recommend measures to increase nuclear safety."

Hungarian minister Tamas Fellegi, speaking for the Hungarian EU presidency, said the results of the tests "will give us a new foundation to base energy policy on." But he added ministers were keen to avoid "any over-hasty decisions or actions" until it was clear what exactly had happened at Fukushima.

The European Nuclear Safety Regulators Group is to define the tests' scope and key criteria, focusing on risks associated with earthquakes, floods, cooling systems, backup power, age and reactor design.

*** EC approved high-seismic risk reactors in Romania

The European Commission last year approved plans for construction of two nuclear reactors "close to a zone with high seismic risk" in Romania, according to a document released to Platts March 21.

In an opinion under Article 43 of the Euratom Treaty, the EC approved plans for two Candu-6 reactors to be built at Cernavoda, to be known as Cernavoda-3 and -4, while noting that seismic hazard analyses on existing units at the same site show that seismic damage is "the dominant contributor to nuclear power plant risk."

Release of the EC opinion comes 10 days after a massive earthquake and tsunami at the six-reactor Fukushima I nuclear power station.

In light of events in Japan, the EC has promised to require national governments to conduct "stress tests" on their reactors, but details remain to be determined.

The EC opinion, released March 21, but signed November 26, 2010, "strongly recommended" that Romania and the Cernavoda-3 and -4 investors fix the "shortcomings" in the seismic analysis on the existing site which lead to "large uncertainties in the hazard evaluation" as identified by an IAEA International Probabilistic Risk Analysis Review Team.

The EC opinion, requested by Platts on January 11, was released March 21 after the EC obtained the permission of Romanian officials and project investors, Massimo Garribba, of the commission's nuclear energy directorate said in a letter.

*** French experts see 'no consequences' of Fukushima fallout for France

There will be "no consequences whatsoever" in France from fallout from the Fukushima nuclear power plant accident in Japan, the head of French nuclear safety authority ASN told a press briefing March 21. Andre-Claude Lacoste said the level of radioactivity in the Fukushima plume will be "extremely low" when it reaches metropolitan France March 23, "1,000 or 10,000 times less" than fallout from the 1986 Chernobyl accident.

He said that was true even in a worst-case scenario of how the ongoing accident develops, because of the distance between the two countries.

The predictions of the plume's movements were made by the Institute of Radiological Protection and Nuclear Safety, IRSN, and made public late last week. IRSN worked with France's meteorological service to produce the models on the basis of its knowledge of what has been happening at the Japanese plant. The predictions can be accessed at www.irsn.org.

ASN's director of ionizing radiation, Jean-Luc Godet, said radioactive releases from the Fukushima site "have been and remain large" and that although the French experts don't have maps of the contamination, soil and plant contamination will probably occur more than 100 kilometers (about 62 miles) from the site, which is about 250 km north of Tokyo.

Japanese authorities have banned sale and consumption of leafy vegetables from an area about that far from the plant site.

Lacoste said that given past and present releases from Fukushima, "the Japanese will have to manage contaminated territories for decades."

*** Japanese decline French offer of robots for Fukushima: ASN

Japanese authorities declined the French offer to send robotic equipment to help in managing the Fukushima I nuclear power plant accident, Andre-Claude Lacoste, chairman of France's nuclear safety authority ASN, said March 21.

"Up to now, the Japanese have asked for very little help" for Fukushima, Lacoste told a press briefing in Paris. For example, he said, "the Japanese did not follow through on the offer of robots" made by France's nuclear industry last week, because they considered the equipment "ill-adapted" to the job at hand.

EDF announced March 18 that an Antonov 225 was scheduled to leave France over the weekend for Tokyoâ€™s Narita airport, carrying 130 tons of remote-controlled machines designed by Intra, a joint venture of EDF, Areva and the CEA, to operate instead of deploying humans in and around buildings in radiologically hostile environments.

*** Spot uranium price makes turnaround

The spot price of uranium took a U-turn over the weekend and is now back to around $60 a pound U3O8, after falling to $50/lb last week.

TradeTech, which is now publishing a daily price, said the price March 21 was $60/lb, up $10/lb from its March 17 price and up $7/lb from its weekly price published late March 18. Ux Consulting's broker average price, or BAP, was $59.50/lb today, up $3.75/lb from March 18. After about 4 million lb were sold last week â€" with the news being dominated by the events at Japan's Fukushima I nuclear plant â€" supply became scarcer late in the week, analysts said.

But it is unclear if the price will continue to rise in the near term, said one analyst. At $60/lb or higher, there will be fewer buyers, at least until it is clear that the situation at Fukushima I has been stabilized, the analyst said.

*** ARMZ, Mantra amend option agreement

Australia-based Mantra Resources and Russia's Atomredmetzoloto have revised the terms of an agreement they entered into in December for ARMZ to buy Mantra, Canada's Uranium One said March 21.

ARMZ is Uranium One's majority shareholder.

Uranium One said March 16 that a deal by ARMZ to buy Mantra could not go forward under the existing agreement because events in Japan had altered the conditions of the deal.

Under the revised agreement, Mantra shareholders will receive A$7.02 comprising $6.87 in cash to be paid by ARMZ and a cash dividend of $0.15 to be paid by Mantra instead of $8.00 in cash.

The directors of Mantra have agreed unanimously to recommend ARMZ's revised offer and will vote in favor of the agreement "in the absence of a superior proposal and subject to receipt of an updated recommendation from an independent expert that the revised transaction is in the best interests of Mantra shareholders," Uranium One said.

Highland Park SA, which owns 13.5% of the outstanding fully diluted share capital in Mantra, also supports the revised transaction, Uranium One said.

*** Finnish minister presses for EU plans for waste, spent fuel disposal

It is "vital" that plans for nuclear waste and spent fuel disposal be developed as quickly as possible by European Union states if the EU is to continue using nuclear power following the crisis at Fukushima I, Finnish Minister of Economic Affairs Mauri Pekkarinen said in a statement March 21.

Pekkarinen said that establishing plans, as required under the EU directive on nuclear waste management, will help reassure the public that nuclear power is safe. Pekkarinen said he also would like to see all EU states adopt unlimited liability for nuclear plant operators in the case of accidents with third-party consequences, as Finland has done. Pekkarinen has responsibility for energy issues.

*** NRC says review of Fukushima I lessons could bring orders, new rules

NRC will conduct short- and long-term reviews of the Fukushima I accident's implications for US reactors that could lead to new orders or rules for nuclear plants, William Borchardt, the agency's executive director for operations, said March 21.

The NRC will soon begin a 90-day review of the accident at Tokyo Electric Power Co.'s Fukushima I, where three units have experienced damage to their reactor cores after an earthquake and tsunami cut power, he said during a briefing for commissioners. Tepco has said it is close to restoring power to reactors at the site, and the containment structures that enclose three of the reactors at the stricken plant "appear to be functional," Borchardt said.

The agency believes US reactors are safe, and in the past two decades has increased requirements that are designed to help prevent or mitigate severe accidents, Borchardt said.

As part of the short-term review, NRC staff will produce a report within 30 days for commissioners. The report will cover any concerns about existing rules for coping with power loss, severe accidents and spent fuel accident progression, Borchardt said. The short-term review could lead to communications to help US plant operators understand the Japanese events or an NRC order that requires licensees to make changes, Borchardt said.

The longer-term review could lead to changes in the way NRC oversees reactors or new rules for the industry, he said. It is unclear when the longer review will begin, he said, adding that it will involve other federal agencies and input from the industry.

*** South Texas Project expansion project slowed, NINA says

Nuclear Innovation North America, the joint venture of NRG Energy and Toshiba, said it is reducing spending on its planned two-unit expansion project at the South Texas Project nuclear station to allow the NRC and others to "assess the lessons that can be learned from the events in Japan."

NINA said in a statement March 21 that continuing work on South Texas Project units 3 and 4 will be limited to "work related to licensing and securing the federal loan guarantee upon which the project depends."

NINA Chairman and NRG President and CEO David Crane said the company is waiting "until there is more information upon which we can base our long-term decisions."

Tokyo Electric Power Co., the owner and operator of the Fukushima I and II nuclear units, said last year it plans to purchase up to 20% of NINA's 92.375% stake in the expansion project. NINA is a joint venture 88% owned by NRG and 22% owned by Toshiba.

In a related development, CPS Energy said March 21 that it is "indefinitely suspending all discussions" with NRG regarding a possible agreement to purchase additional power from the two planned South Texas units.

The San Antonio municipal utility said last week that its talks with NRG about a possible power purchase agreement were only "on hold." CPS said in a statement March 21 it suspended talks after NINA's decision to slow the project's development.

CPS holds a 7.625% ownership interest in the South Texas expansion project.

*** Japan earthquake impact on Vogtle licensing unclear: Oglethorpe

The Japanese earthquake and tsunami have not affected the construction schedule for the expansion of the Vogtle nuclear power plant in the US, but the regulatory impact is still unclear, Oglethorpe Power COO Michael Price said March 21.

The earthquake and tsunami March 11 did not appear to affect major manufacturing plants in Japan making components for the planned two-unit Vogtle expansion, in which Oglethorpe has a 30% stake, Price said in an earnings conference call with analysts. Containment vessel ring plates made in Japan have been manufactured and are ready to be loaded on a ship at Yokohama harbor, which is operating normally, Price said. The longer-term impact on the supply chain must be reviewed, he said.

The effect of a regulatory review launched by NRC and of possible new regulatory requirements is unknown, he said. "It's unclear what will be required and what it might costs," Price said.

Oglethorpe still expects the amended Westinghouse AP1000 reactor design to be certified by NRC in September, with a combined construction permit-operating license for Vogtle-3 and -4 around the end of the year, he said. "Some risk does exist that the licensing schedule could be impacted," he said.

Oglethorpe has a stake in the two existing Vogtle units and the two-reactor Hatch plant, both in Georgia, and those units are in an area with low seismic risk, he said.

Oglethorpe's partners in the Vogtle expansion project are Georgia Power, MEAG Power and the city of Dalton.

*** NRC issues renewed license for Entergy's Vermont Yankee

The NRC on March 21 issued a 20-year license renewal to Entergy's Vermont Yankee, agency spokesman

Neil Sheehan said.

The NRC action culminates more than six years of reviews by the agency during which local opponents, led by the New England Coalition, challenged the adequacy of Entergy's safety and emergency evacuation plans for the plant. The NRC dismissed a final challenge by the coalition on March 10.

Laurence Smith, a spokesman for Vermont Yankee, said in a statement that the NRC decision "confirms that Vermont Yankee is a safe, reliable source of electricity and capable of operating for another 20 years."

Operation of the 650-MW nuclear power plant beyond March 2012, when its 40-year license expires, is not guaranteed, however. Vermont is the only state where approval by the legislature is needed for state regulators to approve a nuclear power plant's license renewal. Such approval was a condition for sale of the unit to Entergy from a consortium of utilities in 2002.

Both houses of its legislature must vote affirmatively to permit Vermont's Public Service Board to consider the plant's extended operation. The state Senate last year voted to prohibit the board from acting on the plant's license renewal. Vermont Governor Peter Shumlin in a statement March 21 reiterated his determination to see the plant shut next March.

*** Reactor report

â€" Florida Power & Light's Turkey Point-4 was shut early March 21 for a scheduled refueling outage, plant spokeswoman Veronica Swanson said that same day. No major component replacements or repairs are planned for the outage, she said. The company does not provide information on when reactors will return to the grid.

â€" Constellation's Nine Mile Point-1 shut for refueling 12:01 am March 21, spokeswoman Jill Lyon said in an interview March 21. Lyon declined to say how long the outage would last.

â€" Exelon Nuclear's Limerick-1 in Pennsylvania reduced power over the weekend for maintenance, spokesman Joseph Szafran said in an interview March 21. The reactor was operating at 57% power early that morning, according to the NRC's daily reactor status report. Work is being performed on one of the unit's three main transformers and on the main condenser system, Szafran said. He declined to say when Limerick-1 is expected to return to full power.

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From: OPA Resource
Sent: Wednesday, March 23, 2011 5:21 PM
To: Ash, Darren; Barkley, Richard; Batkin, Joshua; Bell, Hubert; Belmore, Nancy; Bergman, Thomas; Bollwerk, Paul; Bonaccorso, Amy; Borchardt, Bill; Bozin, Sunny; Brenner, Eliot; Brock, Terry; Brown, Boris; Bubar, Patrice; Burnell, Scott; Burns, Stephen; Carpenter, Cynthia; Chandrathil, Prema; Clark, Theresa; Collins, Elmo; Couret, Ivonne; Crawford, Carrie; Cutler, Iris; Dacus, Eugene; Dapas, Marc; Davis, Roger; Dean, Bill; Decker, David; Dricks, Victor; Droggitis, Spiros; Flory, Shirley; Franovich, Mike; Gibbs, Catina; Haney, Catherine; Hannah, Roger; Harbuck, Craig; Harrington, Holly; Hasan, Nasreen; Hayden, Elizabeth; Holahan, Gary; Holahan, Patricia; Holian, Brian; Jacobssen, Patricia; Jaczko, Gregory; Jasinski, Robert; Jenkins, Verlyn; Johnson, Michael; Jones, Andrea; Kock, Andrea; Kotzalas, Margie; Ledford, Joey; Lee, Samson; Leeds, Eric; Lepre, Janet; Lew, David; Lewis, Antoinette; Loyd, Susan; Magwood, William; McCrary, Cheryl; McGrady-Finneran, Patricia; McIntyre, David; Mensah, Tanya; Mitlyng, Viktoria; Monninger, John; Montes, David; Nieh, Ho; Ordaz, Vonna; Ostendorff, William; Owen, Lucy; Powell, Amy; Quesenberry, Jeannette; Reddick, Darani; Regan, Christopher; Reyes, Luis; Riddick, Nicole; RidsSecyMailCenter Resource; Riley (OCA), Timothy; Rohrer, Shirley; Samuel, Olive; Satorius, Mark; Schaaf, Robert; Schmidt, Rebecca; Scott, Catherine; Screnci, Diane; Shaffer, Vered; Shane, Raeann; Sharkey, Jeffry; Sheehan, Neil; Sheron, Brian; Siurano-Perez, Osiris; Steger (Tucci), Christine; Svinicki, Kristine; Tabatabai, Omid; Tannenbaum, Anita; Taylor, Renee; Temp, WDM; Thomas, Ann; Uhle, Jennifer; Uselding, Lara; Vietti-Cook, Annette; Virgilio, Martin; Virgilio, Rosetta; Walker-Smith, Antoinette; Weaver, Doug; Weber, Michael; Weil, Jenny; Werner, Greg; Wiggins, Jim; Williams, Evelyn; Zimmerman, Roy; Zorn, Jason
Subject: Press Release: NRC Experts Deploy to Japan as Part of U.S. Government Response
Attachments: 11-055.pdf

To be released in 15 minutes.

Office of Public Affairs
US Nuclear Regulatory Commission
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NRC NEWS

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No. 11-055 March 23, 2011

NUCLEAR REGULATORY COMMISSION DIRECTS STAFF ON CONTINUING AGENCY RESPONSE TO JAPAN EVENTS; ADJUSTS COMMISSION SCHEDULE

The Nuclear Regulatory Commission has voted to launch a two-pronged review of U.S. nuclear power plant safety in the aftermath of the March 11 earthquake and tsunami and the resulting crisis at a Japanese nuclear power plant.

The Commission supported the establishment of an agency task force, made up of current senior managers and former NRC experts with relevant experience. The task force will conduct both short- and long-term analysis of the lessons that can be learned from the situation in Japan, and the results of their work will be made public.

"Our focus is always on ensuring the health and safety of the American people through our licensing and oversight of plants and radioactive materials in this country," Chairman Jaczko said. "Examining all the available information from Japan is essential to understanding the event's implications for the United States. We will perform a systematic and methodical review to see if there are changes that should be made to our programs and regulations to ensure protection of public health and safety."

The Commission set an aggressive schedule for the task force to provide formal updates on the short-term effort in 30, 60 and 90 days. NRC senior technical staff provided the Commission a 90-minute briefing on Monday, as a first step. The staff reiterated their conclusions that the United States and its territories will avoid any harmful radiation levels as a result of the ongoing events at the Fukushima Daiichi plant damaged by the quake and subsequent tsunami.

NRC inspectors who are posted at every U.S. nuclear power plant will also support the task force's short-term effort, supplemented as necessary by experts from the agency's regional and headquarters offices.

"This work will help determine if any additional NRC responses, such as Orders requiring immediate action by U.S. plants, are called for, prior to completing an in-depth investigation of the information from events in Japan," said NRC Executive Director for Operations Bill Borchardt.

The longer-term review will inform any permanent NRC regulation changes determined to be necessary. The Commission said it hopes the task force can begin the long-term evaluation in no later than 90 days, and added that the task force should provide a report with recommended actions within six months of the beginning of that effort.

The Commission also decided to revise its schedule for meetings and briefings to allow ample focus on the agency's response to events in Japan. Open Commission meetings on the status of the NRC response to the Japan earthquake are scheduled for April 14 and 28, a meeting on the staff's 30-day response is planned for May 3 and a meeting on the staff's 60-day response is planned for June 16. A revised Commission meeting schedule will be posted shortly on the NRC website.

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From:	Rihm, Roger
Sent:	Wednesday, March 23, 2011 3:40 PM
To:	Borchardt, Bill; Virgilio, Martin; Weber, Michael; Muessle, Mary; Ash, Darren
Cc:	Landau, Mindy; Taylor, Renee
Subject:	FYR: Draft Statement for EDO @ 3/29 Senate Energy "Briefing"
Attachments:	Testimony_March29_2011.docx
Importance:	High

Per OCA, we have been asked to prepare a written statement for the record (draft attached) and a shorter oral statement (that will be based on the "approved" written statement). The attachment is basically a re-working of Bill's presentation at the recent Commission meeting. The discussion of the SRM will be revised, as necessary, once we have the final SRM.

<u>To allow for OCA and Commission review, I would like to get your comments by COB Thursday</u>.

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NRC Response to Recent Nuclear Events in Japan and the Continuing Safety of the U.S. Commercial Nuclear Reactor Fleet

Thank you, and good morning. Before I begin, I would like to join in your expressions of condolences to the people of Japan. I and many of my colleagues on the NRC staff have had many years of very close and personal interaction with our regulatory counterparts and we would like to extend our condolences to them.

Introduction

We at the NRC are mindful that our primary responsibility is to ensure adequate protection of the public health and safety of the American people. We have been very closely monitoring the activities in Japan and reviewing all available information to allow us to conclude that the U.S. plants continue to operate safely. There has been no reduction in the licensing or oversight function of the NRC as it relates to any of the U.S. licensees.

We have a long history of conservative regulatory decision-making. We've been intelligently using risk insights to help inform our regulatory process, and, over more than 35 years of civilian nuclear power in this country, we have never stopped making improvements to plant designs as we learn from operating experience.

Notwithstanding the very high level of support being provided as a result of events in Japan, we continue to maintain our focus on our domestic responsibilities.

I'd like to begin with a brief overview of the recent events in Japan and our immediate and continuing response. I then want to spend the bulk of my time discussing the reasons for our continuing confidence in the safety of the US commercial nuclear reactor fleet, and the path forward for the NRC in light of the events in Japan.

Overview of Events and the NRC's immediate and Continuing Response

On Friday, March 11th an earthquake hit Japan, resulting in the shutdown of more than 10 reactors. From what we know now, it appears that the reactors' response to the earthquake went according to design. The ensuing tsunami, however, caused the loss of emergency AC power to six units at the Fukushima Daiichi site; and it is those six units that have received the majority of our attention since that time. Units One, Two, and Three, at that six unit site, were in operation at the time. Units Four, Five, and Six were in previously scheduled outages.

Immediately after the tsunami, it appears that there was no injection capability into the reactor vessels on Units One, Two, and Three. On Saturday, March 12th, a hydrogen explosion occurred in Unit One; and then the following Monday, March 14th, a hydrogen explosion in Unit Three. On Tuesday, the 15th of March, there were explosions in Unit Two and in Unit Four from hydrogen originating, we believe, from overheated fuel in the spent fuel pool. [Briefly summarize period of March 16 – 29]

Moving to the NRC response: Shortly after 4:00 AM on Friday, March 11th, the NRC Emergency Operations Center made the first call, informing NRC management of the earthquake and the potential impact on U.S. plants. We went into the monitoring mode at the Emergency Operations Center and the first concern for the NRC was possible impacts of the tsunami of U.S. plants on the West Coast.

On that same day, Friday, March 11th, we dispatched two experts to Japan to help at the embassy and begin interactions with our Japanese regulatory counterparts. By Monday, we had dispatched a total of 11 staff to Japan. We have subsequently rotated in a different group of staff to continue our on-the-ground assistance in Japan. The areas of focus for this team are: 1) to assist the Japanese government and respond to requests from our regulatory counterpart, NISA; 2) to support the U.S. ambassador and his understanding of the nuclear impacts of this event; and 3) to facilitate the information flow from Japan to the U.S. NRC so that we can assess the implications on the U.S. fleet in as timely a manner as possible.

We have an extensive range of stakeholders with whom we have ongoing interaction, including the White House, Congressional staff, our state regulatory counterparts, a number of other federal agencies, and the international regulatory bodies around the world.

The NRC Emergency Operations Center remains in a 24/7 posture. This has involved the efforts of over 250 NRC staff on a rotating basis. The entire agency is coordinating and pulling together in response to this event so that we can provide assistance in Japan while continuing the normal activities necessary to fulfill our domestic responsibilities.

Let me also just note here in concluding this section of my remarks that the U.S. government has an extensive network of radiation monitors across the country. EPA's system has not identified any radiation levels of concern in this country. In fact, natural background from things like rocks, the sun, and buildings, is 100,000 times more than any level that has been detected to date. We feel confident in our conclusion that there is no reason for concern in the United States regarding radioactive releases from Japan.

Continuing Confidence in the Safety of the U.S. Fleet

I will now turn to the factors that assure us of ongoing domestic reactor safety. We have, since the beginning of the regulatory program in the United States, used a philosophy of Defense-in-Depth, which recognizes that nuclear reactors require the highest standards of design, construction, oversight, and operation, and does not rely on a single level of protection for public health and safety. We begin with designs for every individual reactor in this country that take into account site-specific factors and include a detailed evaluation for any natural event, such as earthquakes, tornadoes, hurricanes, floods, and tsunamis, as they relate to that site.

There are multiple physical barriers to fission product release at every reactor design, and beyond that, there are both diverse and redundant safety systems that are required to be maintained in operable condition and frequently tested to that ensure that the plant is in a high condition of readiness to respond to any scenario.

We've taken advantage of the lessons learned from previous operating experience, to implement a program of continuous improvement for the U.S. reactor fleet. We have learned from experience across a wide range of situations, including most significantly, the Three Mile Island accident in the late 1970s. As a result of those lessons learned, we have significantly revised emergency planning requirements and emergency operating procedures. We've addressed many human factors issues regarding how control room employees operate the plant, we added new requirements for hydrogen control to help prevent explosions inside of containment, and we also created requirements for enhanced control room displays of the status of pumps and valves.

We have a post-accident sampling system that requires the monitoring of radioactive material release and possible fuel degradation. And, one of the most significant changes after Three Mile Island was creation of the Resident Inspector Program, which has at least two full-time NRC inspectors on site at each facility who have unfettered access to all licensees' activities 24 hours a day, seven days a week.

Also as a result of operating experience and ongoing research programs, we have developed requirements for severe accident management guidelines. These are programs that perform the "what if" scenario. What if all of this careful design work, and all of these important procedures and practices and instrumentation failed? What procedures and policies and equipment should be in place to deal with the extremely unlikely scenario of a severe accident? The requirements for severe accident management have been in effect for many years and are frequently evaluated by the NRC inspection program.

As a result of the events of September 11, 2001, we did a similar evaluation, and identified important pieces of equipment that, regardless of the cause of a significant fire or explosion at a plant, we want to have staged in advance, as well as new procedures and policies that would help deal with a severe situation.

Our program of continuous improvement based on operating experience will now include evaluation of the significant events in Japan and what we can learn from them. We already have begun enhancing inspection activities through temporary instructions to our inspection staff, including the resident inspectors and the region-based inspectors in our four Regional offices, to look at licensees' readiness to deal with both the design basis accidents and the beyond-design basis accidents.

We've also issued an information notice to the licensees to make them aware of the events in Japan, and the kinds of activities we believe they should be engaged in to verify their readiness. Specifically, we have directed them to verify that their capabilities to mitigate conditions that result from severe accidents, including the loss of significant operational and safety systems, are in effect and operational. They're verifying the capability to mitigate a total loss of electric power to the nuclear plant. They're verifying the capability to mitigate problems associated with flooding, and the impact of floods on systems both inside and outside of the plant. And they're identifying the equipment that's needed for the potential loss of equipment due to seismic events appropriate for the site, because each site has its own unique seismic profiles. The information that we gather from this temporary inspection will be used to evaluate the industry's readiness for similar events, and will aid in our understanding of whether additional regulatory actions need to be taken in the immediate term.

The industry also is independently performing many verification activities at this time to confirm that all of these processes and procedures and rules that have been implemented are still valid.

Over the last 15 or 20 years, there have been a number of new rulemakings that have enhanced the domestic fleet against some of the problems we are seeing in Japan. The station blackout rule requires every plant in this country to analyze what the plant response would be if it were to lose all alternating current so that it could respond using batteries for a period of time, and then have procedures in place to restore alternating current to the site and provide cooling to the core.

The hydrogen rule requires modifications to reduce the impacts of hydrogen generated for beyond-design basis events and core damage. There are equipment qualification rules that require equipment, including pumps and valves, to remain operable under the kinds of environmental temperature and radiation conditions that you would see under a design basis accident. And then, regarding the type of containment design used by the most heavily damaged plants in Japan, we've had a Boiling Water Reactor Mark I Containment Improvement Program since the late 1980s, which has required installation of hardened vent systems for containment cooling and fission product scrubbing, as well as enhanced reliability of the automatic depressurization system.

The final factor I want to mention with regard to our belief in the ongoing safety of the U.S. fleet is the emergency preparedness and planning requirements in place that provide ongoing training, testing, and evaluations of licensees' emergency preparedness programs. In coordination with our federal partner, FEMA, these activities include extensive interaction with state and local governments, as those programs are evaluated and tested on a yearly basis.

The Path Ahead

Beyond the initial steps to address the experience from the events in Japan that I've described to you, we have received direction from the Commission to establish a senior level agency task force to conduct a methodical and systematic review of our processes and regulations to determine whether the agency should make additional improvements to our regulatory system and make recommendations to the Commission for its policy direction. This activity will have both near-term and longer-term objectives.

For the near term effort, we are beginning a 90-day review. This review will evaluate all of the currently available information from the Japanese events to identify immediate or near-term operational or regulatory issues potentially affecting the 104 operating reactors in the U.S., including their spent fuel pools. Areas of investigation will include the ability to protect against natural disasters, response to station blackouts, severe accidents and spent fuel accident progression, radiological consequence analysis, and severe accident management issues regarding equipment. Over this 90-day period, we will develop recommendations, as appropriate, for changes to inspection procedures and licensing review guidance, and recommend whether generic communications, orders, or other regulatory requirements are needed.

This 90-day effort will include a 30-day Quick Look Report to the Commission to provide a snapshot of the regulatory response and the condition of the U.S. fleet based on information we have available at that time. Preparing a Quick Look Report also will ensure that the Commission is both kept informed of ongoing efforts and prepared to resolve any policy recommendations that surface. I believe we will have limited stakeholder involvement in the first 30 days to accomplish this, but over the 90-day and longer-term efforts we will seek additional stakeholder input. These near-term activities will be carried out independent of any industry efforts that might be ongoing. At the end of the 90-day period, a report will be provided to the Commission and, once approved, released to the public.

The task force's longer-term review will begin as soon as the NRC has sufficient technical information from the events in Japan, with a goal of commencing no later than the completion of the 90-day near-term report.

The task force will evaluate all technical and policy issues related to the event to identify additional potential research, generic issues, changes to the reactor oversight process, rulemakings, and adjustments to the regulatory framework that should be pursued by the NRC. We also expect to evaluate potential interagency issues, such as emergency preparedness, and examine the applicability of any lessons learned to non-operating reactors and materials licensees. We expect to seek input from all key stakeholders during this process. A report with appropriate recommendations will be provided to the Commission within 6 months of the start of this evaluation, and made publicly available subsequent to its approval by the Commission.

Conclusion

In conclusion, I want to reiterate that we continue to make our domestic responsibilities for licensing and oversight of the U.S. licensees our top priority and that the U.S. plants continue to operate safely. In light of the events in Japan, there is a near-term evaluation of their relevance to the U.S. fleet underway, and we are continuing to gather together the information necessary for us to take a longer, more thorough look at the events in Japan and their lessons for us. Based on these efforts, we will take all appropriate actions necessary to ensure the continuing safety of the U.S. fleet. This concludes my presentation. I'd be happy to address any questions you have.

From: E&E Publishing, LLC <ealerts@eenews.net>
Sent: Wednesday, March 23, 2011 1:13 PM
To: Virgilio, Martin
Subject: March 23 -- Greenwire is ready

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GREENWIRE -- WED., MARCH 23, 2011 -- Read the full edition

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The March 11 earthquake and tsunami in Japan that triggered widespread fears over nuclear security have thrust an unfamiliar face into the national spotlight: Gregory Jaczko, head of the U.S. Nuclear Regulatory Commission. And the chairman will only grow in prominence as he leads a nationwide security check on the country's 104 nuclear reactors at the behest of President Obama.

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POLITICS

10. **REGULATIONS:** Bush's rulemaking czar blasts EPA's use of 'guidance'
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ABOUT GREENWIRE

Greenwire is written and produced by the staff of E&E Publishing, LLC. The one-stop source for those who need to stay on top of all of today's major energy and environmental action with an average of more than 20 stories a day, Greenwire covers the complete spectrum, from electricity industry restructuring to Clean Air Act litigation to public lands management. Greenwire publishes daily at Noon.

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From: E&E Publishing, LLC <ealerts@eenews.net>
Sent: Wednesday, March 23, 2011 10:11 AM
To: Virgilio, Martin
Subject: E&ETV -- EPA: Clean Energy Group's Bradley discusses 'Utility MACT' proposal

AN E&E PUBLISHING SERVICE

ONPOINT -- WED., MARCH 23, 2011 -- Go to www.eenews.tv

EPA: Clean Energy Group's Bradley discusses 'Utility MACT' proposal

Do the costs of U.S. EPA's recent toxic emissions rules for power plants outweigh the benefits? During today's OnPoint, Michael Bradley, executive director of the Clean Energy Group, reacts to the "Utility MACT" proposal and explains why he believes the rules are within EPA's regulatory authority. He also discusses how Utility MACT will fit in with other air rules coming out of EPA in the short term.

WATCH VIDEO READ TRANSCRIPT

ALSO PLAYING ON E&ETV:

NUCLEAR CRISIS: Former CEQ Chairman Frampton says Japanese disaster worse than Three Mile Island
Three Mile Island investigator George Frampton discusses severity of Fukushim event.

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EFFICIENCY: Alliance to Save Energy's Callahan weighs in on light bulb debate
Alliance to Save Energy's Kateri Callahan discusses prospects for efficiency measures in energy legislation.

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OIL AND GAS: CAP's Weiss discusses politics of rising prices
Center for American Progress' Daniel Weiss says tapping into reserve could hel lower gas prices.

WATCH VIDEO READ TRANSCRIPT

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E&ETV is produced by the staff of E&E Publishing, LLC and broadcast from our state-of-the-art Capitol Hill studios. E&ETV brings viewers insightful interviews with the top policy makers and opinion leaders from the energy and environmental policy world. E&ETV broadcasts daily at 10 a.m.

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From: E&E Publishing, LLC <ealerts@eenews.net>
Sent: Thursday, March 24, 2011 10:22 AM
To: Virgilio, Martin
Subject: E&ETV -- Energy Policy: Former Mich. Gov. Granholm makes case for clean energy standard

AN E&E PUBLISHING SERVICE

ONPOINT -- THU., MARCH 24, 2011 -- Go to www.eenews.tv

ENERGY POLICY: Former Mich. Gov. Granholm makes case for clean energy standard

Can the United States revitalize its manufacturing sector through clean energy policies? During today's OnPoint, former Michigan Gov. Jennifer Granholm (D) makes the case for a clean energy standard, saying it will boost the United States' competitiveness and manufacturing base. Granholm, now a spokeswoman for the Pew Charitable Trusts, also explains why she believes industry can continue to grow under U.S. EPA's air rules. She also explains how she plans to lobby members of Congress on the clean energy issue.

WATCH VIDEO READ TRANSCRIPT

ALSO PLAYING ON E&ETV:

EPA: Clean Energy Group's Bradley discusses 'Utility MACT' proposal
The Clean Energy Group's Michael Bradley discusses costs and benefits of toxic emissions rules.

WATCH VIDEO READ TRANSCRIPT

NUCLEAR CRISIS: Former CEQ Chairman Frampton says Japanese disaster worse than Three Mile Island
Three Mile Island investigator George Frampton discusses severity of Fukushim event.

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EFFICIENCY: Alliance to Save Energy's Callahan weighs in on light bulb debate
Alliance to Save Energy's Kateri Callahan discusses prospects for efficiency measures in energy legislation.

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From: Virgilio, Martin
Sent: Thursday, March 24, 2011 5:34 AM
To: Miller, Charles; Grobe, Jack; Holahan, Gary; nucfed@aol.com; Sanfilippo, Nathan
Cc: Borchardt, Bill; Weber, Michael; Ash, Darren
Subject: Today's Kick off Meeting
Attachments: Task Force Kick Off Meeting.docx

All

Attached is a one pager I developed to help guide today's kick off meeting for Task Force being chartered to respond to the Tasking Memo on actions following the events in Japan.

Marty

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Task Force Kick Off Meeting

Charter

Near Term Actions

- Establish a group dedicated to communications and coordination with national/international stakeholders
- Identify immediate actions needed
- Identify technical issues requiring additional review and priority (H M L)
- Prepare the 30 day quick look report and Commission Meeting briefing material

Longer Term Actions

Conduct a systematic lessons learned review of the event to refine the list of technical issues

Organize and charter working groups to address one or more technical issues
- SES Leads for each WG who would draw upon technical experts from the line as needed

Estimate resources and impacts on other planned work

Establish a Steering Committee responsible for
- Integration
- Direction and Decision Making;
- Formulation of Policy for Commission Consideration

Technical Issues

SBO duration and coping strategies,
50.54(hh)(2) hardware and strategies, execution of strategies (equipment location, environmental considerations, training),
External and internal flooding,
Combustible gas control
SAMG adequacy and execution of strategies
EP,
Seismic including GSI 199,
Tsunami, Hurricanes, Seismic Events

From:	Flory, Shirley
To:	Case, Michael; Coe, Doug; Coyne, Kevin; Gibson, Kathy; Uhle, Jennifer; Richards, Stuart; Scott, Michael; Sheron, Brian; Valentin, Andrea
Subject:	NUCLEAR NEWS FLASHES
Date:	Thursday, March 24, 2011 9:50:50 AM
Attachments:	nn110323.txt

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Nuclear News Flashes
Wednesday, Mar 23, 2011

[Inside This Issue:]

*** Tepco reports progress in stabilizing damaged Fukushima-I reactors

Tokyo Electric Power Co. said March 23 it is restoring electrical power to the Fukushima I nuclear power plant, continuing the company's efforts to restore cooling capabilities to prevent further overheating of nuclear fuel and the release of radiation.

External power cables were laid to all six Fukushima-I reactors by late afternoon March 22, and all were receiving at least some electricity by March 23, Tepco reported.

The IAEA said March 23 that AC power is available at units 1, 2 and 4. It said power has been restored to some instrumentation in all units except unit 3. Unit 3's main control room has lighting, but no electricity to power its instruments or equipment, it said.

Tepco said March 23 that it had delayed planned testing of unit 3's water pumping system when smoke was observed coming from the unit, prompting a temporary evacuation. No cause of the smoke could be determined and radiation levels inside the unit remained stable, the company said.

Tepco said it needs to check equipment before it can switch on the water cooling systems at the four damaged reactors. Once the reactors' central control rooms are again operational, water levels can be checked as well as temperatures in the spent fuel storage pools, it said.

Units 5 and 6 continue to have offsite power and remain in cold shutdown, Tepco said. All six units at the site lost offsite power following the March 11 earthquake and tsunami.

*** Analyst says Japan's nuclear revival is over

Japan's nuclear revival "seems to be over," Laban Yu, an equity analyst at Jefferies International, said in a research note published March 23.

"We estimate nuclear energy accounted for 26% of Japan's electricity production in 2010, up from a recent low of 21% in 2003. The government hoped to increase this to 41% by 2017, and 50% by 2030," Yu said in the report.

"We believe these plans are now defunct," he said. "Not only that, we believe Japan will mothball much of its nuclear capacity â€" especially boiling water reactors built in the 1970s â€" as well as operate its remaining reactors at much lower utilization rates with extended downtimes." This could reduce nuclear generation capacity to 35,000 MW in 2011 and nuclear energy supplied by 34 million tons of oil equivalent, or mtoe, he said.

According to the World Nuclear Association, 27 of Japan's 54 operating reactors are of the BWR design. Of these 27, nine date back to the 1970s. These are units 1-6 of Fukushima I, Shimane-1, Tokai-2 and Tsuruga-1.

In the long term, assuming nuclear power capacity is reduced to 35,000 MW supplying 34 mtoe/year of energy, Jefferies calculate that 89 mtoe/year of energy needs to be secured from other sources by 2025-2030.

*** EU nuclear regulators propose outlines of reactor 'stress tests'

The Western European Nuclear Regulators Association, meeting in Helsinki March 22-23, has drawn up a "first proposal" for the scope, methodology and schedule of "stress tests" on EU nuclear power plants planned in the wake of the ongoing accident at the Fukushima I plant in Japan.

EU energy ministers on March 21 informally endorsed the idea of the tests, which are to check whether each of Europe's 143 power reactors would have resisted the kind of challenges faced by the Fukushima I plant following a major earthquake and beyond-design-basis tsunami on March 11.

The proposal is expected to become the basis for the tests to be applied throughout the EU, ensuring consistency in national audits in EU countries, Switzerland, and probably Russia and Ukraine.

It defines the stress tests as "a targeted reassessment of the safety margins of [nuclear power plants] in the light of the events which occurred in Fukushima." The scope covers initiating events (earthquakes, flooding), consequential prolonged loss of safety functions (electrical power, ultimate heat sink), and accident management issues such as core-melt accidents and hydrogen accumulation and "degraded conditions" in spent fuel storage.

Once the scope and methodology are approved by EU leaders, perhaps in June, licensees would be given six months to do the reassessments and report to national regulators. The latter would publish reports on their reviews within three months. Results would be discussed at a public seminar to which other experts would be invited, the document stipulates.

*** French nuclear safety audits to be launched March 24

The safety audit process for French nuclear power units will be launched March 24, the chairman of French nuclear safety authority ASN, Andre-Claude Lacoste, said March 23.

He told journalists in Helsinki at the close of a meeting of the Western European Nuclear Regulators Association that French Prime Minister Francois Fillon would visit ASN's emergency response center in Paris March 24 and on that occasion, would "give us a letter asking us to make proposals" for the audit process.

The audits â€" France's term for the "stress tests" planned on the EU level â€" are meant to "check the way French [facilities] would resist" if confronted with the same types of challenges that hit Japan's Fukushima I nuclear power plant site March 11, Lacoste said.

Lacoste said he would base his proposal to the French government on Wenra's "first proposal" for a common stress test scope and procedures, made public after the Wenra meeting.

Lacoste said that under "normal" circumstances, "we would wait some time to make a technical analysis and draw lessons" from a severe accident such as that at Fukushima. But this time, "we are obliged to do it much more quickly" because national governments "have decided to do something" to respond to the Japanese accident.

*** Merkel appoints German nuclear ethics panel

Former environment and nuclear safety minister Klaus Toepfer will head an ethics advisory panel appointed March 22 by German Chancellor Angela Merkel to assess the risks that German society is willing to bear from operating nuclear power plants.

The country's existing Reactor Safety Commission will separately study the new technical risks for nuclear plants in light of the Fukushima nuclear plant accident in Japan.

Toepfer, now executive director of the UN Environment Program, will chair the ethics advisory panel, which also includes a philosopher, a Catholic archbishop, a company manager and a union leader.

"I don't rule out that the reviews will have an impact on life spans" of nuclear power plants, Merkel told a news conference in Berlin following a second round of talks with the German states that have nuclear reactors.

Merkel's CDU party could lose power in a key regional election March 27 in the state of Baden-Wuerttemberg, with the opposition Social Democrats and Greens rising in the polls after the nuclear crisis in Japan.

*** Minister says one-year Italian nuclear moratorium part of EU-wide move

Italian minister for economic development Paolo Romani said March 23 that Italy's one-year moratorium on nuclear power plant development, announced that day, meant Italy was moving "fully in line with the other EU countries."

Romani said in a statement that the establishment of a national nuclear waste depository and the role of the nuclear safety agency, as provided for by the EU, "remained confirmed" and were exempt from the moratorium.

The EU states, following events at the Fukushima I nuclear power plant in northeastern Japan, were now establishing a new and shared security policy on nuclear power, he said.

"This is a priority for us and in the coming months we will do our part to ensure that the whole of Europe adopts nuclear safety standards that are concerted and above all reliable," Romani said.

He added that Italy intended to be at the forefront of developing the new energy technologies required to achieve an energy mix that is more balanced and less dependent on fossil fuels, such as renewable energy.

The government faces a referendum June 12 that will decide whether to uphold legislation adopted by the government in 2009 that opened the way for a return to nuclear power.

Italy has had no operational nuclear power plants since 1987 when a public referendum led to the shuttering of its reactors following the 1986 Chernobyl accident in Ukraine.

*** Poland does not rule out nuclear power referendum: prime minister

Polish Prime Minister Donald Tusk said March 23 that his government was not ruling out holding a referendum on the country's plans to build new nuclear power plants.

Asked whether he supported a motion by Poland's left-wing opposition party, SLD, to hold a referendum in light of events in Japan, Tusk said he would not rule it out, adding that "maybe it would be sufficient for the decision to be taken by parliament."

Tusk said at a news conference March 23 that "without the approval of society, this type of enterprise makes no sense."

According to polls published March 21 in the weekly Newsweek Polska, the Polish people are turning against nuclear power. In a poll January 21, 42% said they supported the construction of the country's first nuclear power plant. By March 17, after an earthquake and tsunami struck Japan, 32% were in favor.

Tusk's government has tasked the country's largest power company, Polska Grupa Energetyczna, or PGE, to organize the construction of 6,000 MW of nuclear generation at two sites, with the first unit to be commissioned in 2020. Last week, Hanna Trojanowska, the government's nuclear energy adviser, said the country was "determined to carry out" its nuclear program despite the events in Japan.

Last month, the government approved two bills that will create the legal framework for its planned nuclear power industry. The government wants to get them passed by the end of June to enable the signing of a commercial contract to start construction of the first reactor by the end of 2013.

*** NRC approves plan for review of Japan nuclear accident

The NRC has approved a plan to review lessons from the ongoing accident at Japan's Fukushima I nuclear power plant, the agency said in a statement March 23.

The March 11 earthquake and tsunami crippled the six-unit plant, and emergency workers are struggling to restore power to reactor and spent fuel pool cooling equipment before a core meltdown or fuel pool fire releases larger amounts of radioactivity than have been discharged so far.

Radioactive materials in excess of Japanese legal limits have been detected in produce in the region around the plant and in Tokyo's tap water this week, but that nation's nuclear regulator has said the radiation levels do not pose a major threat to human health even if the contaminated food and water is consumed.

President Barack Obama on March 17 ordered the NRC to conduct a "comprehensive" safety review of all US nuclear power plants in light of the disaster in Japan.

The NRC said March 23 that an agency task force "will conduct both short- and long-term analysis of the lessons that can be learned from the situation in Japan, and the result of their work will be made public."

NRC Chairman Gregory Jaczko said in the statement that the agency "will perform a systematic and methodical review to see if there are changes that should be made to our programs and regulations."

The agency said "the commission set an aggressive schedule for the task force to provide formal updates on the short-term effort in 30, 60 and 90 days."

***

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Stutzke, Martin

From: Stutzke, Martin NRC / RES / DRA
Sent: Thursday, March 24, 2011 6:06 PM
To: Boska, John; Coe, Doug; Beasley, Benjamin
Subject: RE: question on core damage frequency

The seismic CDFs do not assume that the earthquake has happened; rather, the frequency of earthquakes is combined with the probability of core damage to estimate the seismic CDF. In fact, change in the frequency of earthquake occurrence is the issue in GI-199.

Here's some information on CDFs that I pulled from Appendix D of the GI-199 Safety/Risk Assessment report that should help you to put the different CDFs into perspective:

	IP2	IP3
Internal events CDF (from SPAR)	9.6E-6	1.0E-5
Seismic CDF from IPEEE submittal (1994 LLNL seismic hazard)	1.1E-5	4.9E-5
Seismic CDF from IPEEE submittal (1989 EPRI/SOG seismic hazard)	n/a	5.9E-5
Seismic CDF from GI-199 (2008 USGS seismic hazard)	3.3E-5	1.0E-4

Even the IP3 IPEEE indicated that seismic risk was much larger than internal events risk.

During our January 2011 visit, the licensee told us that they does not maintain their seismic PRAs of IP2 and IP3. There's little regulatory motivation for them to do so. First, NUMARC 93-01 (which we endorsed in RG 1.160) excludes contributions from external events when determining risk-significant plant configurations during maintenance. Second, RG 1.174 allows the use of qualitative arguments in certain situations where less than a full-scope PRA is available. Third, there is no regulation that requires Part 50 licensees to have a PRA. So, it's somewhat understandable that the licensee would focus on the internal event CDF (which is readily available from the risk monitoring software used to support Maintenance Rule (a)(4) evaluations), and tend to ignore the contributions from external events such as earthquakes and fires. I expect that the staff will re-examine some or all of these issues in the coming months.

Marty

From: Boska, John
Sent: Wednesday, March 23, 2011 8:34 AM
To: Coe, Doug; Beasley, Benjamin; Stutzke, Martin
Subject: question on core damage frequency
Importance: High

In the meeting the other day, I asked the question about CDF, and I still don't understand it. If I go to a site and ask the VP what the CDF is for his reactor, he will say about 1E-5. But for Indian Point 3, we are saying the seismic risk of CDF is 1E-4. This means the seismic risk of core damage is 10 times greater than all internal accidents combined. If this is true, we should concentrate a lot more on seismic upgrades. I suspect that perhaps the seismic CDF starts by assuming the earthquake occurred, and then calculates CDF. If that is true, it is not a true CDF as we use it for operating reactors. Please let me know which is correct. Thanks.

John Boska
Indian Point Project Manager, NRR/DORL
U.S. Nuclear Regulatory Commission
301-415-2901
email: john.boska@nrc.gov

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From: Flory, Shirley
To: Armstrong, Kenneth; Case, Michael; Coe, Doug; Coyne, Kevin; Cupidon, Les; Dehn, Jeff; Eisenberg, Wendy; Gibson, Kathy; Hudson, Daniel; Ibarra, Jose; Richards, Stuart; Rini, Brett; Rivera-Lugo, Richard; Sangimino, Donna-Marie; Schofer, Maria; Uhle, Jennifer; Valentin, Andrea
Subject: FW: New NRC Daily Notes for March 24, 2011
Date: Thursday, March 24, 2011 4:19:37 PM

From: NRC Daily Notes [mailto:EDO.GroupAccount@nrc.gov] — EDO
Sent: Thursday, March 24, 2011 4:00 PM
To: EDO GroupAccount
Cc: Pena, Alex
Subject: New NRC Daily Notes for March 24, 2011

~~OFFICIAL USE ONLY - SENSITIVE INTERNAL INFORMATION~~

Daily Notes for March 24, 2011

NRO

~~(OUO-SII)~~

On March 24, 2011, the proposed rule on the ESBWR Design Certification was published in the *Federal Register* for public comment (76 FR 16549-16570). The rule proposes to certify the ESBWR standard plant design submitted by GE-Hitachi Nuclear Energy. The public is invited to submit comments on the proposed rule and its supporting documents. The 75-day comment period ends on June 7, 2011.

NSIR

~~(OUO-SII)~~

On March 24, 2011, the NSIR staff met with Industry representatives and NEI as part of the NRC/Industry Security Frequently Asked Questions (SFAQ) review panel to discuss resolution of pending and new questions raised by industry and/or the NRC regarding implementation of 10 CFR Part 73 requirements at Nuclear Power Reactor Facilities. The panel discussed several SFAQs that are in progress.

RIII

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(OUO-SII)

On March 25, U.S. Congressman Tom Petri of Wisconsin will be touring the

Point Beach site. The congressman had requested the tour from the licensee. No interaction with the resident inspection staff is currently planned.

~~(OUO-SII)~~

On March 25, the Deputy Reginoal Administrator and other members of the Region III staff will participate in a public forum in Chicago sponsored by the U. S. Senators (Durbin and Kirk) from Illinois. The forum is based on a joint request from the Senators to the Chairman for participation by the NRC in assuring that the Reactor Sites and the water-storage spent fuel pools in Illinois are safe, given the recent events in Japan and the similarities in design of two of the Illinois Boiling water reactor facilities to the Japanese facilities.

From: E&E Publishing, LLC <ealerts@eenews.net>
Sent: Thursday, March 24, 2011 1:00 PM
To: Virgilio, Martin
Subject: March 24 -- Greenwire is ready

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GREENWIRE -- THU., MARCH 24, 2011 -- Read the full edition

1. CLIMATE: Calif. regulators scramble in wake of court ruling on emissions law

California's climate change law is not in danger of outright reversal following a court decision this week that suspended it, but the deadline for approving a cap-and-trade carbon market later this year is in doubt, according to state government and legal experts following the process. If that deadline, which requires the state's Air Resources Board to vote on cap and trade in October, slips even one day into November, a ripple effect could delay greenhouse gas regulations set to go live on Jan. 1, 2012.

TOP STORIES

2. **NUCLEAR CRISIS:** Psychological risks loom in Tokyo water warning
3. **NUCLEAR CRISIS:** Japan disaster raises questions about backup power at U.S. plants
4. **NUCLEAR CRISIS:** Earthquake risks must be reanalyzed for U.S. reactors

JAPAN EARTHQUAKE

5. **NUCLEAR CRISIS:** Radiation fears prompt stockpiling; 2 plant workers injured
6. **NUCLEAR CRISIS:** Japan spawns a fresh look at disaster planning on U.S.-Mexico border
7. **NUCLEAR CRISIS:** Japanese power demand can't be met without reactors, official says
8. **NUCLEAR CRISIS:** Politics, radiation levels will dictate return to Fukushima
9. **AUTOS:** Production of hybrids, electric vehicles hurt by Japan disaster
10. **FISHERIES:** Radiation fears slow Japanese seafood exports

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CLIMATE CHANGE

11. **REGULATIONS:** EPA to tell Congress cutting black carbon is a 'win-win'

POLITICS

12. **CHEMICALS:** Uneasy industry awaits release of new EPA reporting rules
13. **CLIMATE:** Greenpeace TV ads target Upton
14. **ENERGY POLICY:** Home heating advocates ask Obama to release emergency funds

CLEAN TECH

15. **RARE EARTHS:** Countries jockey for critical elements leadership
16. **ETHANOL:** N.D. team visits Denmark for tips on building cellulosic refinery

ENERGY

17. **NUCLEAR:** NRC requests public comment on new GE reactor design
18. **NATURAL GAS:** Eagle Ford Shale landowners prepare for battle against Texas National Guard
19. **NATURAL GAS:** Palomar pipeline canceled for now
20. **ENERGY EFFICIENCY:** Ohio regulators revive failed light bulb campaign

FEDERAL AGENCIES

21. **EPA:** Enviro groups protest Jackson on visit to Calif. farms
22. **BLM:** Utah man fined for fiery 'fundraiser' on public lands

TRANSPORTATION

23. **HIGH-SPEED RAIL:** N.C. lawmakers line up against federal funds

AIR AND WATER

24. **AIR POLLUTION:** EPA science advisers repeat call for stricter smog standard
25. **DRINKING WATER:** EPA launches S. Calif. perchlorate probe

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26. **EVERGLADES:** Court lets Fla. off the hook for planned reservoir
27. **NATIONAL PARKS:** Wildfire ignited by volcano threatens Hawaiian rainforest

28. **INVASIVE SPECIES:** Ark. senator wants money for fish farmers hurt by carp transport ban

E&ETV'S ONPOINT

29. **ENERGY POLICY:** Former Mich. Gov. Granholm makes case for clean energy standard

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From: E&E Publishing, LLC <ealerts@eenews.net>
Sent: Friday, March 25, 2011 1:19 PM
To: Virgilio, Martin
Subject: March 25 -- Greenwire is ready

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GREENWIRE -- FRI., MARCH 25, 2011 -- Read the full edition

1. OIL AND GAS: Industry sitting on 7,200 drilling permits

The oil and gas industry has nearly 7,200 permits to drill on public lands that it has yet to use, according to Bureau of Land Management data obtained by *Greenwire*. The unused, but still valid, drilling permits paint a starkly different picture from what industry and some in Congress have argued is a concerted effort by the Obama administration to lock up federal lands to energy production, said Dave Alberswerth, senior policy adviser on energy issues for the Wilderness Society and a former Interior Department official in the Clinton administration.

TOP STORIES

2. **NUCLEAR CRISIS:** Japan disaster refuels liability debate in U.S.-India pact
3. **NUCLEAR CRISIS:** Devil's in the details for drinking water accident scenarios
4. **CLIMATE:** 2 Democrats press White House to ease industry's regulatory pain

JAPAN EARTHQUAKE

5. **NUCLEAR CRISIS:** Likely breach in No. 3 reactor raises radiation risk
6. **NUCLEAR CRISIS:** Japan encourages more to evacuate after possible breach discovered
7. **COAL:** Japanese disaster may change global production, prices
8. **NUCLEAR CRISIS:** Information about Fukushima accident still under wraps
9. **NUCLEAR CRISIS:** Pets suffer in wake of disasters
10. **CHINA:** Officials plot nuclear plants without fuel rods

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11. **REGULATIONS:** Ruckelshaus, Whitman bemoan 'siege' on EPA, Clean Air Act

12. **LOBBYING:** Coal group launches ads targeting EPA climate regs

POLITICS

13. **OIL AND GAS:** BLM leasing reforms draw cheers, jeers, lawsuits

14. **RENEWABLE ENERGY:** Cash grants more effective than tax incentives -- study

15. **TRANSPORTATION:** Miles-traveled tax an effective supplement to gas tax -- CBO

ENERGY

16. **COAL:** Salazar may have overstated lease earnings

17. **NUCLEAR:** NRC finds safety breaches at S.C. plant

18. **NUCLEAR SAFETY:** Report highlights 'key shortcomings' in U.S. weapons protection

19. **NATURAL GAS:** API president pushes for domestic drilling to create jobs

20. **ALASKA:** Oil company tax breaks appear dead in state Senate

21. **ALABAMA:** Motivations for environmental award called into question

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22. **DOE:** IG faults oversight of solar-grant recipients

23. **ARMY CORPS:** Conflicting demands, shrinking budgets create unsustainable mission -- report

24. **CHEMICALS:** EPA declassifies 42 industry studies on possible toxins

NATURAL RESOURCES

25. **NATIONAL PARKS:** Interior acquires long-sought tract along Gettysburg battlefield

26. **WILDLIFE:** Ted Turner's bison donation rescues historic herd

27. **FORESTS:** Calif. group raises $7.5M to save redwoods

28. **MINING:** BHP Billiton to put $10B into Australian operations

29. **WOLVES:** Conservation groups ask judge to lift Mont. and Idaho protections

LAW AND LOBBYING

30. **PIPELINES:** Calif. regulators propose reduced fine for San Bruno blast that killed 8

31. **BUSINESS:** GE avoids taxes through lobbying, overseas investment

CLEAN TECH

32. **SMART GRID:** Calif. utility offers opt-out plan for smart meters

33. **WIND:** First DOE-backed renewables project goes online in Hawaii

INTERNATIONAL

34. **EARTHQUAKE:** Severe earthquake rocks Myanmar

35. **ENERGY MARKETS:** BP seeks to salvage Arctic exploration deal

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From: E&E Publishing, LLC <ealerts@eenews.net>
Sent: Friday, March 25, 2011 10:14 AM
To: Virgilio, Martin
Subject: E&ETV -- EPA: Clean Energy Group's Bradley discusses 'Utility MACT' proposal

AN E&E PUBLISHING SERVICE

ONPOINT -- FRI., MARCH 25, 2011 -- Go to www.eenews.tv

AN E&ETV ENCORE PRESENTATION

Originally aired: March 23, 2011

EPA: Clean Energy Group's Bradley discusses 'Utility MACT' proposal

Do the costs of U.S. EPA's recent toxic emissions rules for power plants outweigh the benefits? During today's OnPoint, Michael Bradley, executive director of the Clean Energy Group, reacts to the "Utility MACT" proposal and explains why he believes the rules are within EPA's regulatory authority. He also discusses how Utility MACT will fit in with other air rules coming out of EPA in the short term.

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Three Mile Island investigator George Frampton discusses severity of Fukushim event.

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From: E&E Publishing, LLC <ealerts@eenews.net>
Sent: Friday, March 25, 2011 4:44 PM
To: Virgilio, Martin
Subject: March 25 -- E&ENews PM is ready

AN E&E PUBLISHING SERVICE

E&ENEWS PM -- FRI., MARCH 25, 2011 -- Read the full edition

1. UTILITIES: Ga. nuclear proposal passes environmental review, awaits NRC vote

Southern Co. passed the environmental review for its two proposed reactors in Georgia, the latest sign that the accident at Japan's Fukushima Daiichi plant is not slowing the nuclear industry in the United States. The U.S. Nuclear Regulatory Commission must still vote on the license.

THIS AFTERNOON'S STORIES

2. **NUCLEAR CRISIS:** Groups question U.S. evacuation recommendation
3. **NUCLEAR CRISIS:** Disaster spurs call to strengthen int'l atomic agency
4. **HIGH-SPEED RAIL:** DOT finalizes review of Vegas-Calif. line, pushing it closer to construction
5. **ADVOCACY:** Turn out the lights, it's Earth Hour!
6. **ENERGY MARKETS:** Senators urge FTC to crack down on speculators
7. **GREAT LAKES:** Army Corps says electrical barriers are holding back Asian carp
8. **COAL:** BLM clarifies lease sale revenue claims

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afternoon roundup providing coverage of all the breaking and developing policy news from Capitol Hill, around the country and around the world, E&ENews PM is a must-read for the key players who need to be ahead of the next day's headlines. E&ENews PM publishes daily at 4:30 p.m.

From:	Flory, Shirley
To:	Armstrong, Kenneth; Case, Michael; Coe, Doug; Coyne, Kevin; Cupidon, Les; Dehn, Jeff; Eisenberg, Wendy; Gibson, Kathy; Hudson, Daniel; Ibarra, Jose; Richards, Stuart; Rini, Brett; Rivera-Lugo, Richard; Sangimino, Donna-Marie; Schofer, Maria; Uhle, Jennifer; Valentin, Andrea
Subject:	FW: New NRC Daily Notes for March 25, 2011
Date:	Friday, March 25, 2011 4:01:19 PM

From: NRC Daily Notes [mailto:EDO.GroupAccount@nrc.gov]
Sent: Friday, March 25, 2011 4:00 PM
To: EDO GroupAccount
Cc: Pena, Alex
Subject: New NRC Daily Notes for March 25, 2011

~~OFFICIAL USE ONLY - SENSITIVE INTERNAL INFORMATION~~

Daily Notes for March 25, 2011

NMSS

~~(OUO-SII)~~

On March 29, the direct final rule amending 10 CFR 72.214 to include Amendment No. 1 to Certificate of Compliance (CoC) No. 1030 for the NUHOMS HD System will become effective allowing Part 72 general licensees to load spent fuel in the NUHOMS HD System utilizing this amendment. Amendment No. 1 to the HUHOMS HD System includes changes to: the authorized contents, the minimum off-normal ambient temperature, the minimum initial enrichment of fuel assemblies, the requirements for reconstituted fuel assemblies, the requirements to qualify metal matrix composite neutron absorbers with integral aluminum cladding, and the requirements for neutron absorber tests.

NRO

~~(OUO-SII)~~

On March 24, the staff conducted a Category 3 meeting to discuss the Commission's Staff Requirements Memorandum of March 2, 2011 on SECY-10-1021 regarding risk-informed regulatory guidance for new reactors. Also discussed at this project kick-off meeting were key deliverables, major tasks including the tabletop exercises to test existing risk-informed guidance, and schedule.

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NRR

(OUO/SII)

On March 23 the TI (Temporary Instruction) to independently assess the adequacies of US Nuclear Plants in response to the recent Japanese Fukushima Nuclear Power Plant events was issued. The TI will assess licensee's capabilities to cope with beyond design basis events, station blackouts and flooding events. The equipment staged and preparations for these events will also be assessed under the TI. Completion of this TI at all sites is expected by April 29, and a final report should be available by May 13.

(OUO/SII)

By letter dated March 2, "Diablo Canyon Power Plant Unit Nos. 1 and 2, Exemption from the Requirements of 10 CFR Part 73, Section 55," the staff approved a request for exemption from specific requirements of 10 CFR Part 73. The NRC-approved exemption extended the completion date for new security requirements to June 30, 2011 from March 31, 2010. By letter dated March 18, 2011, PG&E requested another exemption to extend this completion date from June 30, 2011, to March 30, 2012. The original exemption was from 73.55(e)(7)(i)(B) and (i)(3)(vii) and the new exemption request is for the same issue, however, the licensee is requesting this exemption for one specific area.

RII

(OUO/SII)

On March 24, the Department of Justice, Eastern District of Tennessee, issued a news release stating that a former employee for Tennessee Valley Authority's Watts Bar Nuclear Unit 2 construction project was indicted by a federal grand jury for making false statements. The indictment alleged that in August 2010 the individual falsified paperwork for safety related cable measurements. Region II independently became aware of the alleged falsification through a review of corrective action documents in August 2010. The Office of Investigations subsequently initiated an investigation, which is still ongoing.

From:	Flory, Shirley
To:	Armstrong, Kenneth; Case, Michael; Coe, Doug; Coyne, Kevin; Cupidon, Les; Dehn, Jeff; Eisenberg, Wendy; Gibson, Kathy; Hudson, Daniel; Ibarra, Jose; Richards, Stuart; Rini, Brett; Rivera-Lugo, Richard; Sangimino, Donna-Marie; Schofer, Maria; Uhle, Jennifer; Valentin, Andrea
Subject:	FW: One-Week Look Ahead for March 24, 2011
Date:	Friday, March 25, 2011 4:14:35 PM

From: One-Week Look Ahead [mailto:EDO.GroupAccount@nrc.gov]
Sent: Thursday, March 24, 2011 4:05 PM
To: EDO GroupAccount
Cc: Pena, Alex
Subject: One-Week Look Ahead for March 24, 2011

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One-Week Look Ahead for March 24, 2011

NRO

~~(OUO-SII)~~

On March 31 the staff will hold a Category 3 meeting to discuss the Construction Inspection Program in the TWFN Auditorium. The staffs of NRR, NSIR, and all regional offices also will participate.

On March 30-31, the NRO management team will ocnduct an off-site retreat in Baltimore, Md.

NRR

~~(OUO-SII)~~

On March 29, the staff plans to participate in a Category I public meeting at NRC Headquarters to discuss Watts Bar Nuclear Plant, Unit 2, Final Safety Analysis Report Submittals.

~~(OUO-SII)~~

On March 30, the staff plans to participate in a Category 2 public meeting at NRC Headquarters to discuss industry plans and activities to address degradation of
buried and underground piping.

~~(OUO-SII)~~

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On March 30, the staff plans to participate in a Category 1 public meeting at NRC Headquarters to discuss the Pacific Gas and Electric Company (the licensee) preliminary responses to the U.S. Nuclear Regulatory Commission (NRC) staff questions raised during the public meeting with the NRC on January 26, 2011 (Agencywide Documents Access and Management System (ADAMS) Accession Nos. ML 110120564 and ML110420183), related to the licensee's plans to submit an amendment to incorporate a methodology for the review of new geotechnical information in the design and licensing basis for Diablo Canyon Power Plant, Unit Nos. 1 and 2.

RES

~~(OUO-SRI)~~

From March 28-29, RES staff will participate in a planning meeting to be held at the Nuclear Energy Agency Headquarters in Paris, France for the Working Group on Risk Assessment (WGRisk) "Development of best practice guidelines on failure modes taxonomy for reliability assessment of digital instrumentation and control systems for probabilistic safety assessment" project. The NRC presentations are entitled, "Summary of BNL Failure Modes and Effects Analysis (FMEA) Approach" (ML110770273) and "Summary of Inputs on Failure Mode Taxonomies" (ML110770286). These presentations do not discuss any new or unresolved policy issues. Also, on March 31, RES staff will meet with research staff from Eléctricité de France to discuss research related to fire-induced damage of electrical components.

~~(OUO-SRI)~~

From March 28–April 1, RES staff will participate in several meetings supporting the Organization for Economic Cooperation and Development's Committee on the Safety of Nuclear Installations WGRisk in Paris, France. The staff will discuss the progress of risk-related followup items from the last WGRisk annual meeting including tasks associated with new and advanced reactor probabilistic risk assessment (PRA) and knowledge transfer and plans for future cooperative activities. These meetings will help ensure that the agency's international activities in the PRA area remain aligned with NRC priorities. The NRC presentation entitled, "U.S. NRC PRA Research Activities" (ML110810765), does not discuss any new or unresolved policy issues.

~~(OUO-SRI)~~

During the week of March 28, 2011, the Director, RES, plans to approve an Implementing Agreement between the American Institute in Taiwan (AIT) and the Taipei Economic and Cultural Representative Office (TECRO) for participation in the NRC Cooperative Severe Accident Research Program. The NRC will act as the designated representative for AIT to carry out the research under this program.

This exchange will contribute to NRC's goal of leveraging agency resources and verifying the accuracy of its MELCOR severe accident code. This agreement will enter into force upon signature and remain in effect for 5 years. It should be noted that the U.S. Government maintains no diplomatic relations with Taiwan. AIT was created as an entity to facilitate continuing U.S. cooperative activities with Taiwan.

(OUO-SII)

During the week of March 28, 2011, the Director, RES, plans to approve an Implementing Agreement between the American Institute in Taiwan (AIT) and the Taipei Economic and Cultural Representative Office (TECRO) in the area of Cooperative Thermal-Hydraulic Code Applications and Maintenance (CAMP). The NRC will act as the designated representative for AIT to carry out the research under this program. This Agreement defines the terms and conditions by which AIT and TECRO will cooperate in the area of thermal-hydraulic code applications and maintenance. This Agreement will become effective upon signature and will remain in effect for a period of 5 years. It should be noted that the U.S. Government maintains no diplomatic relations with Taiwan. AIT was created to facilitate cooperative activities with Taiwan.

RI

(OUO-SII)

On March 30, the Regional Administrator, members of his staff, and representatives of the Office of Research will meet with Massachusetts Governor Deval Patrick and select members of his cabinet. At the request of the Governor, the NRC is providing an overview of the NRC activities related to the ongoing nuclear event in Japan as well as the seismic adequacy of existing US plants. This meeting will be conducted in the State Capitol Building in Boston. The focus of interest of this meeting is on the Pilgrim Nuclear Power Station in Plymouth, MA, a BWR with a Mark 1 containment.

RIII

(OUO-SII)

On March 28, Exelon plans to host 11 Chinese Nationals and 9 support personnel from the China National Nuclear Corporation (CNNC) as visitors to the Dresden Station. Exelon and China have been working on a cooperative support agreement. The purpose of the visit is to observe the site and meet with Dresden personnel.

From: Flory, Shirley
To: Case, Michael; Coe, Doug; Coyne, Kevin; Gibson, Kathy; Uhle, Jennifer; Richards, Stuart; Scott, Michael; Sheron, Brian; Valentin, Andrea
Subject: NUCLEAR NEWS FLASHES
Date: Friday, March 25, 2011 10:48:45 AM
Attachments: nn110324.txt

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Nuclear News Flashes
Thursday, Mar 24, 2011

[Inside This Issue:]

*** IRSN: Fukushima I-3 vessel might be damaged

France's radiological protection agency, IRSN, said March 24 a possible core melt in unit 3 of the Fukushima I nuclear power plant may have caused corium â€" a mixture of molten metal and fuel â€" to fall to the bottom of the reactor vessel, where an interaction with concrete could have caused a rupture in the reactor vessel.

IRSN said that scenario was only one hypothesis being studied. But it said it believes, based on pressure indications, that unit 3 at Fukushima I, also called Fukushima Daiichi, has experienced a breach in containment that is a source of "continuing" unfiltered radioactive discharges to the environment.

The Japan Atomic Industrial Forum, an industry lobby group that has also been posting daily updates on the reactors, listed the unit 3 reactor vessel as "not damaged" as of 14:00 GMT March 24.

IRSN said in its daily update on the ongoing accident at Tokyo Electric Power Co.'s Fukushima I that a slight increase in temperature at unit 3 was also observed and that significant releases of smoke were being seen from the reactor.

It said seawater injection was continuing to maintain core cooling, but that part of the reactor fuel core remained uncovered.

IRSN said that at Fukushima I-1, rising pressure in the containment could force a new effort to relieve the pressure through venting, which would release additional radiation to the environment.

At unit 2, IRSN said, sea water injection is continuing to maintain core cooling. It said unit 2's containment could also be damaged, but depressurization of containment to the environment was no longer necessary at this time.

Unit 4's reactor has no fuel in the core because it was removed for refueling just prior to the March 11 earthquake and tsunami.

'Still very serious'

Graham Andrew, special adviser to the IAEA Director General on Scientific and Technical Affairs, told member states in a briefing March 24 that the "overall situation" at the Fukushima I reactors is "still very serious," but that there was some positive news to report.

In remarks posted on IAEA's website, Andrew said that, with AC power connected, instrumentation continues to be recovered at units 1, 2 and 4. Workers returned after being evacuated from units 3 and 4 on March 23, following confirmation that black smoke emissions from unit 3 had stopped, he said.

Andrew said dose rates in the unit 1 and 2 containment vessels and suppression chambers have decreased slightly.

*** Russian president calls for global ban on nuclear construction in highly seismic zones

Russian President Dmitry Medvedev said March 24 that there should be a global ban on construction of nuclear power plants in areas at risk for strong earthquakes.

In a video blog devoted to nuclear issues, Medvedev said, "It's probable that additional requirements are needed, especially concerning restrictions on construction of nuclear power plants in seismically hazardous areas. Evidently there ought to be general international requirements, particularly where very powerful earthquakes and subsequent tsunamis are possible."

Russia already prohibits construction of nuclear power stations where there may be a maximum strength, 8.0-magnitude earthquake, he said.

"We already have this rule and, in all probability, we need to apply this [rule] at the international level, because we all know that a disaster of this level, when it happens, never affects just one country. It is, unfortunately, to one degree or another, dangerous for neighboring countries, and indeed for our planet as a whole," he said.

"It's necessary to entrench such norms at the global level," he said.

Medvedev's blog can been viewed at blog.kremlin.ru/. The transcript (in Russian) is at blog.kremlin.ru/post/153/transcript.

*** ASN: Fukushima contamination in Europe 'extremely low'

Contamination from the radioactive plume of Japan's Fukushima I nuclear power plant remains "extremely low," an official with France's nuclear safety authority ASN said March 24.

Jean-Luc Godet, ASN's director of ionizing radiation, said at a press briefing that samples of soil in France had not been analyzed but that Finnish laboratories had measured atmospheric contamination levels of around "a few dozen microbecquerels per cubic meter."

That translates into a dose to an unsheltered person "on the order of a billionth of a milliSievert," Godet said. For comparison, he said, a long-haul flight gives a dose of a few hundredths of a mSv.

Godet said the measurements are consistent with estimates made last week by the Institute of Radiological Protection and Nuclear Safety, IRSN.

Godet said results of sample measurements in France will be available in a couple of days and will be made public.

The anti-nuclear scientists group Criirad said in a statement March 23 that it could not gain access to measurements of ambient radioactivity from the worldwide network of measuring stations maintained by the Comprehensive Test Ban Treaty Organization, a UN organization like the IAEA. The data are available to member states but must be kept confidential under the treaty.

Godet also said that Japan will have to manage territories contaminated by the Fukushima accident close to the plant for "months, years, or more." He said the country is now managing both the "acute" phase of the accident, which is still ongoing, and the post-accidental phase.

*** Reactor report

â€" Sweden's Oskarshamn-3 will be shut from March 28 through April 3 to fix steam turbine valves and replace a fuel element, unit manager Magnus Antonsson said in a statement March 24. Antonsson said the element has a small defect that was slightly damaged by dirt particles in the reactor vessel. He said that during the unit's 2009 maintenance outage, filters were installed to help keep particles out but that the element was probably damaged before then.

*** NRC Inspector General: Defects in safety-related parts going unreported

Defects in safety-related parts used at nuclear power plants are going unreported because of contradictions and lack of clarity in NRC regulations and guidance, leading to a potential reduction in safety margin, the agency's Office of the Inspector General said in a report March 24.

OIG said NRC will have to take further action to ensure its regulations and guidance meet the legal requirements of the Energy Reorganization Act of 1974, which created the NRC from the former Atomic Energy Commission.

Rules under 10 CFR Part 21 are designed to require licensees to report to NRC any information that indicates that basic components fail to comply with regulatory requirements relating to substantial safety hazards or contain defects that could create a substantial safety hazard.

Some standard industry practices are leading to the under-reporting of defects, the report said. Many licensees believe that loss of safety function, not just potential loss, was required for filing a Part 21 report, OIG's report said.

OIG recommended that NRC's Executive Director for Operations revise Part 21 to make it fully confirm with the Energy Reorganization Act, expedite publication of interim guidance that specifies reporting requirements, and correct and update existing guidance.

NRC staff did not provide any formal comments to the report, the OIG said.

US Representative Edward Markey, a Massachusetts Democrat, said in a March 24 statement he will seek additional information from the agency about the potential safety hazard of the unreported defects.

*** Watts Bar-2 contractor indicted for alleged false statements, TVA says

A contractor at Tennessee Valley Authority's Watts Bar-2 was indicted by a federal grand jury March 22 on two counts of making false statements in connection with construction of the unit, the TVA's Inspector General said in a March 24 statement.

The contractor, identified as Matthew David Correll of Hixon, Tennessee, was alleged to have falsified documents saying he had measured cables designed to supply energy to safety systems at the new unit, the statement said. Correll entered a plea of not guilty in US District Court in Chattanooga, the statement said.

The allegations were discovered and investigated by TVA's Office of the Inspector General, the federal utility said in a statement March 24. "This action today is an example of TVA's systems and procedural safeguards working as designed," said Ashok Bhatnagar, senior vice president of nuclear generation development, in the statement.

TVA has procedures to double-check critical work that catch mistakes and infractions, the statement said. TVA said it is reviewing other work performed by Correll.

*** NRC seeking comments on proposed ESBWR certification

The NRC is seeking comments for 75 days on its proposed rule published in the March 24 Federal Register to certify GE Hitachi Nuclear Energy's Economic Simplified Boiling Water Reactor, or ESBWR, design.

NRC staff issued its final safety evaluation report on the design with no open issues earlier this month.

GEH submitted an application for certification of its ESBWR design on August 24, 2005. The ESBWR is a 1,594-MW concept with passive safety features "that would cool down the reactor after an accident without the need for human intervention," said NRC.

NRC is reviewing a combined construction permit-operating license application referencing the ESBWR from Detroit Edison for a potential new unit at the Fermi site in Michigan.

The Federal Register notice is at edocket.access.gpo.gov/2011/pdf/2011-6839.pdf.

*** Unusual event declared at Braidwood due to alarm power interruption

An unusual event was declared March 24 at Exelon Nuclear's Braidwood when power to a plant control room alarm system was temporarily interrupted, the company said in a statement.

The unusual event, the lowest of NRC's four emergency classifications, was declared because there was an interruption to the alarm system for more than 15 minutes. The system was restored and the event terminated within 30 minutes of its declaration, Exelon Nuclear said. "Plant instrumentation for control room operator monitoring was always available to plant personnel," and "there was no impact to plant safety or security," the company said.

Appropriate federal, state and local authorities were notified about the event, it said.

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Stutzke, Martin

From: Stutzke, Martin
Sent: Friday, March 25, 2011 12:48 PM
To: Beasley, Benjamin
Subject: FW: pls review changes and let me know if we need to revise, thanks Marty
Attachments: GI.199.plan.docx; 199.Memo.pdf; GL GSI-199 Schedule.docx

Importance: High

Ben –

Here's the draft PR and GL schedule.

Marty

From: Khanna, Meena
Sent: Friday, March 25, 2011 11:37 AM
To: Stutzke, Martin
Subject: re: pls review changes and let me know if we need to revise, thanks Marty
Importance: High

GENERIC ISSUE 199, "IMPLICATIONS OF UPDATED PROBABILISTIC SEISMIC HAZARD ESTIMATES IN CENTRAL AND EASTERN UNITED STATES ON EXISTING PLANTS"

Objective of GI-199

Initially, the objective of the GI-199 Safety/Risk Assessment was to perform a conservative, screening-level assessment to evaluate if further investigations of seismic safety for operating reactors was warranted consistent with NRC directives. The initial intent was to focus on 27 plants that met the criteria for further examination of cost justified backfits. In 2005, the staff determined that there was enough conservatisms in the calculations and other approximations to increase the scope to the central and eastern U.S. (CEUS) plants (96 plants). In light of the recent Japanese event, the NRC has determined to expand the scope of the plants to all plants in the U.S (104 plants).

- Results of the GI-199 safety risk assessment are not final estimates of plant-specific seismic risk.
- The seismic hazard data and plant-level fragility assumptions were conservative estimates useful as a screening tool.
- The NRC does not rank plants by seismic risk.

Key Messages:

1. Safety/Risk Assessment for GI-199 was completed in August 2010. It is publically available in ADAMS at ML100270582. That assessment found that plants have adequate safety margin for seismic issues and are within their licensing basis.

2. Overall seismic risk estimates remain small and adequate protection is maintained.

3. Updates to seismic data and models indicate increased seismic hazard estimates for some operating nuclear power plant sites in the Central and Eastern United States.

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4. NRC has separate criteria for evaluating whether plant improvements may be imposed through a back-fit.

5. The Safety/Risk Assessment used readily available information and found that for about one-quarter of the currently operating plants, the change in seismic hazard is enough to warrant further NRC review.

6. Action may include obtaining additional, updated information and developing methods to determine if plant improvements to reduce seismic risk are warranted.

<u>Status of Operating Plants and Need for Actions due to Japanese Event</u>:

- Existing plants were designed with considerable margin to be able to withstand the ground motions from the largest earthquake expected in the area around the plant.

- During the mid-to late-1990s, the NRC staff reassessed the margin beyond the design basis as part of the Individual Plant Examination of External Events [IPEEE] program.

- The NRC's safety/risk assessment concluded that the probability of exceeding the design basis ground motion may have increased by a small amount at some plants. Those results also indicate that the probabilities of damage are lower than NRC's guidelines for taking immediate action.

- US plants are designed for appropriate earthquake levels and are safe.

The NRC is conducting a regulatory assessment, which includes reviewing the seismic capacity for plants located in central and eastern United States based on the latest data and analysis techniques.

<u>Timeline for Preparation and Issuance of Generic Letter</u>:

- The NRC is in the process of developing a Generic Letter (GL) that was originally intended to request information from all affected plants (96 plants that are east of the Rockies). However, due to the recent Japanese event, the NRC has determined to expand the scope of the plants to all plants in the U.S.

- An effort is being coordinated with US NRC, Department of Energy, EPRI, and USGS to determine the new consensus seismic hazard estimates, which is scheduled for completion in early 2011. Once this has been completed, the staff will issue the GL to request licensees of all 104 U.S. plants to address specific information n relating to their facilities to enable the staff to complete its regulatory assessment. The information from licensees will likely require 3 to 6 months to complete. Staff's review will commence after receiving licensees' responses. Based on staff's review, a determination can be made regarding whether candidate backfits should be considered for plant improvements to reduce seismic risk and to evaluate their potential cost-justified imposition.

- The GL is planned to be issued in draft form for public comment in the late Spring.

- Processes that are planned for review of the GL include a review by the NRC's Committee to Review Generic Requirements, the Advisory Committee on Reactor Safeguards (ACRS), and the GL will be issued as a draft for public comments (60 days), followed by a second meeting with ACRS.

- GL should be issued by end of 2011, as the new consensus seismic hazard models become available.

- Consensus hazard models are being developed by NRC, DOE, and EPRI. In addition the USGS will review the model.

- Information requested from licensees will likely require 3 to 6 months to prepare. NRC's review will be on-going as information is collected.

- Based on NRC's review, a determination will be made regarding beneficial back-fits.

COMMUNICATION PLAN FOR GENERIC ISSUE 199

March 17, 2011
(ML081850477)

Goal

This plan will guide staff communications and activities with internal and external stakeholders of the United States Nuclear Regulatory Commission (NRC) as they relate to Generic Issue 199 (GI-199), "Implications of Updated Probabilistic Seismic Hazard Estimates in Central and Eastern United States on Existing Plants."

Key Message Following March 11, 2011, Japanese Earthquake

US plants are designed for appropriate earthquake shaking levels and are safe. Currently the NRC is conducting a program called Generic Issue 199, which is reviewing the adequacy of the earthquake design of US NPPs in central and eastern North America based on the latest data and analysis techniques. The NRC will look closely at all aspects of the response of the plants in Japan to the earthquake and tsunami to determine if any actions need to be taken in US plants and if any changes are necessary to NRC regulations.

Key Messages

The key messages to be communicated to stakeholders based on the GI-199 Safety Risk/Assessment (completed in August 2010) are as follows:

(1) **Operating nuclear power plants are safe:** Plants have adequate safety margin for seismic issues. The NRC's Safety/Risk Assessment confirms that overall *seismic risk* estimates remain small and that adequate protection is maintained.

(2) **Though still small, some seismic hazard estimates have increased:** Updates to seismic data and models indicate increased *seismic hazard* estimates for some operating nuclear power plant sites in the Central and Eastern United States.

(3) **Assessment of GI-199 will continue:** Plants are safe (see key message 1), but the NRC has separate criteria for evaluating whether plant improvements may be imposed. The NRC's Safety/Risk Assessment used readily available information and found that for about one-quarter of the currently operating plants, the estimated *core damage frequency* change is large enough to warrant further attention. Action may include obtaining additional, updated information and developing methods to determine if plant improvements to reduce seismic risk are warranted.

Background

This issue was proposed as a Generic Issue in May 2005 after NRC staff's review of updates to the seismic source and ground motion models provided by applicants in support of early site permits for new reactors. The updated seismic information included new Electric Power Research Institute (EPRI) models to estimate earthquake ground motion and updated models for earthquake sources in seismic regions such as eastern Tennessee, and around both Charleston, South Carolina and New Madrid, Missouri. The new data and models resulted in increased estimates of the seismic hazards for some plants in the Central and Eastern United States (CEUS). The staff evaluated this new information along with preliminary results from a 2004 U.S. Geological Survey (USGS) letter report regarding seismic hazard estimates. From this review the staff concluded that the likelihood of exceeding the seismic hazard values, used in plant design and in previous evaluations (such as the Individual Plant Examination of External Events (IPEEE) Program), may be higher than previously understood for some currently operating CEUS sites.

The staff compared the new seismic hazard data with the earlier evaluations conducted as a part of the IPEEE Program. From this comparison, the staff determined that the seismic designs of operating plants in the CEUS still provide adequate safety margins. At the same time, the staff also recognized that the new seismic data and models could reduce available safety margins due to increased estimates of the probability associated with seismic hazards at some of the currently operating sites in the CEUS.

The licensing basis for currently operating plants is based on deterministic analysis of design basis loads from the maximum earthquake level determined from historical data. The licensing basis does not include a probabilistic assessment of seismic hazards or probabilistic assessment of their potential impact on plant structures, systems, and components.

To maintain consistency with the performance-based approach for assessing seismic hazards for new reactors, the staff determined that the screening analysis should consider seismic hazard data and models besides those available from the USGS. This determination was based on the staff's ongoing interactions with stakeholders to develop a new performance-based approach for assessing seismic hazards for new reactors, as described in a memorandum to the Commission, "A Performance-Based Approach to Define the Safe Shutdown Earthquake Ground Motion," dated July 26, 2006 (ADAMS Accession No. ML052360044). The NRC staff held a public meeting, in February 2008, to engage external stakeholders. During the meeting, the representative from the Nuclear Energy Institute (NEI) expressed their willingness to support a collaborative approach to GI-199. This led to a Seismic Risk Memorandum of Understanding Addendum between EPRI and NRC.

The staff collected and analyzed seismic hazard information from the USGS and from other sources, and seismic risk information from IPEEE analyses. EPRI reported that they calculated mean seismic hazard results for all nuclear power plant sites in the CEUS and used these results to perform an independent evaluation of the implications of changes in seismic hazard estimates. The staff completed the review and analysis of seismic data in support of the Safety/Risk Assessment in June 2009.

Audience and Stakeholders

Internal

Internal stakeholders include the Commission, Office of the Executive Director for Operations (OEDO), Office of Nuclear Regulatory Research (RES), Office of Nuclear Reactor Regulation (NRR), Office of New Reactors (NRO), Office of Nuclear Material Safety and Safeguards (NMSS), Office of Federal and State Materials and Environmental Management Programs (FSME), Region I, Region II, Region III, Region IV, Office of Public Affairs (OPA), Advisory Committee on Reactor Safeguards (ACRS), Office of International Programs (OIP), Office of Congressional Affairs (OCA). (See the "Communications Team" section for a list of specific Communication Team members.)

External

External stakeholders include licensees, EPRI, Nuclear Energy Institute, Congressional members, public interest groups, media, and the public.

Communication Timeline

Detailed Activities to Support Release of the GI-199 Safety/Risk Assessment Report				
Stakeholder Group	**Specific Audience**	**Tool**	**Lead**	**Date**
Internal	Regional Offices	Brief	RES-Kauffman	May 12, 2010 (c)
	NRR Office Director	Brief	RES-Kauffman	May 12, 2010 (c)
	NRO Office Director	Brief	RES-Beasley	May 19, 2010 (c)
	Region I Management	Brief	RES-Kauffman	June 3, 2010 (c)
	EDO, Deputy EDOs	Brief	RES-Kauffman	June 22, 2010 (c)
	Commission offices	Technical Assistants Brief	RES-Kauffman	July 8, 2010 (c)
	NRC Chairman	Brief	RES-Kauffman	August 23, 2010
	Commission offices	EDO Daily Note (with link to documents)	RES-Killian	T* (September 1, 2010)
	EDO	Issue Safety/Risk Assessment Report (goes public after 5 working days)	RES-Sheron	T
External	General Public	Safety/Risk Assessment Report made public in ADAMS		T + 6 days (September 7, 2010)
	General Public	Press Release	OPA-Burnell	T + 6 days (September 7, 2010)
	Public and Licensees	Information Notice	NRR-Manoly	T + 6 days (September 7, 2010)
	Congressional Members/staff (as appropriate)	Phone Calls	OCA-Riley	T + 6 days (September 7, 2010)
	International contacts (as appropriate)	Phone Calls	OIP	T + 6 days (September 7, 2010)
	State/local governments (as appropriate)	Phone Calls	Regional State Liaison Officers Region I- McNamara/Tifft Region II – Trojanowski Region III – Barker Region IV - Maier	T + 6 days (September 7, 2010)

	USGS	Phone Call	OCA-Riley	T + 6 days (September 7, 2010)
	General Public	Public Meeting	RES-Beasley	T + [1 month]
	General Public	Seismic Fact Sheet Update	RES-Killian OPA-Burnell	August 26, 2010

* *"T"* refers to the time that the Director, RES endorses the Safety/Risk Assessment panel recommendation.

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Additional Communication Tools

The NRC has an internal Generic Issues Program (GIP) website (http://www.internal.nrc.gov/RES/GIP/index.html) and a public GIP website (http://www.nrc.gov/about-nrc/regulatory/gen-issues.html.). These websites include program information and documents, background and historical information, generic issue status information, and links to related programs.

The staff created a Seismic Issue Fact Sheet (http://www.nrc.gov/reading-rm/doc-collections/fact-sheets/fs-seismic-issues.html).

Questions and Answers

Background

Q1. What is the NRC Generic Issues Program?

A1. The Nuclear Regulatory Commission (NRC) Generic Issues Program (GIP) evaluates technical issues that apply to two or more facilities and that may not be covered by existing regulatory processes or criteria. Issues are evaluated for their effect on safety, security, and/or the environment. The GIP is a program by which these issues can be formally assessed to see if they can be dispositioned by existing regulatory processes or if not, to determine their safety and/or risk significance and how best to treat them. Information on the program is available on the public NRC GIP website (http://www.nrc.gov/about-nrc/regulatory/gen-issues.html); information is also available to NRC staff on the NRC internal GIP website (http://www.internal.nrc.gov/RES/projects/GIP/). Management Directive (MD) 6.4, "Generic Issues Program," contains GIP guidance (available at http://www.nrc.gov/about-nrc/regulatory/gen-issues/policy-procedures.html). MD 6.4 was updated in November 2009 to incorporate program changes described in SECY-07-0022 (available at http://www.nrc.gov/reading-rm/doc-collections/commission/secys/2007/).

Q2. What is Generic Issue 199 about?

A2. Generic Issue 199 investigates the safety and risk implications of updated earthquake-related data and models. These data and models suggest that the probability for earthquake ground shaking above the seismic design basis (see answers A8, A9, and A10) for some nuclear power plants in the Central and Eastern United States is still low, but larger than previous estimates (see answer A12).

Q3. Where can I get current information about Generic Issue 199?

A3. The public NRC Generic Issues Program (GIP) website (http://www.nrc.gov/about-nrc/regulatory/gen-issues.html) contains program information and documents, background and historical information, generic issue status information, and links to related programs. The GI-199 section of the NRC internal GIP website (http://www.internal.nrc.gov/RES/projects/GIP/Individual%20GIs/GI-0199.html) contains additional information about Generic Issue 199 (GI-199) and is available to NRC staff. The latest Generic Issue Management Control System quarterly report, which has regularly updated GI-199 information, is publicly available at http://www.nrc.gov/reading-rm/doc-collections/generic-issues/quarterly/index.html. Additionally, the U.S. Geological Survey data is publicly available at http://earthquake.usgs.gov/hazards/products/conterminous/2008/.

Q4. Are all U.S. plants being evaluated as a part of Generic Issue 199?

A4. The scope of the Generic Issue 199 (GI-199) Safety/Risk Assessment is limited to all plants in the Central and Eastern United States. Although plants at the Columbia, Diablo Canyon, Palo Verde, and San Onofre sites are not included in the GI-199 Safety/Risk Assessment, the Information Notice on GI-199 is addressed to all operating power plants in the U.S. (as well as all independent spent fuel storage installation licensees). The staff will also consider inclusion of operating reactors in the Western U.S. in its future generic communication information requests.

Q5. Does GI-199 affect license renewal?

A5. No. The NRC's regulations for license renewal (10 CFR Part 54) require licensees to manage age-related degradation to ensure that systems, structures, and components (SSCs) will fulfill their safety-related functions, as specified in the current licensing basis, for the period of extended operation. The aging management review conducted by license renewal applicants specifically addresses the impact of age-related degradation on SSC seismic capacity. It should be noted that a plant's licensing basis, including its seismic design basis, is established outside of the license renewal process during initial plant licensing and subsequent license amendments. In addition, the NRC has processes to evaluate the adequacy of plant licensing bases (e.g., the Generic Issues Program) based on new information or operating experience and, if necessary, improve safety (e.g., require plant improvements through the backfit process).

Note: Related to license renewal, the County Executive of Westchester County (New York) and groups from New Jersey submitted a petition for rulemaking on license renewal, including a seismic-related aspect. NRC denied this petition. The petitioners then filed suit in the U.S. Court of Appeals Second Circuit and the court upheld the NRC's position. Details are available on the internal webpage of the Office of General Counsel (under Law Library, Summary of AEC-NRC Litigation, "Spano v. NRC" (2d Cir. 2009): http://www.internal.nrc.gov/ogc/internal/AEC-NRC_Cases.pdf.)

Q6. Are the implications of new seismic hazard estimates being considered for the storage of spent fuel?

A6. Yes, while the GI-199 Safety/Risk Assessment focused solely on operating power reactors in the Central and Eastern U.S., spent fuel storage has been considered by NRC.

The NRC Office of Nuclear Materials Safety and Safeguards (NMSS) was informed of GI-199 and a preliminary screening review was performed in November, 2008 by the NMSS Division of Spent Fuel Storage and Transportation. There is a total of 40 operating independent spent fuel storage installations (ISFSIs) in the Central and Eastern U.S. (CEUS). Except for a wet storage facility at G. E. Morris located in Illinois, the ISFSIs are co-located at the operating and permanently shutdown reactor sites. A review of design earthquakes (DE) used at the existing ISFSI locations in CEUS indicated that the safety margin (defined for ISFSIs as the ratio of DE/SSE, where SSE is the *safe shutdown earthquake* discussed in answer A8) for the cask designs were in the range of 1.20 ~ 3.90. Therefore, NMSS considers that there is significant margin built into the existing designs and has confidence that the ISFSIs can continue to operate safely while the licensees' investigate this issue using their site specific information. Even so, holders of operating license for ISFSIs are included among addressees in the Information Notice on GI-199.

Spent fuel pools (SFPs) were not specifically evaluated as part of GI-199. However, based on their design attributes (as follows), SFPs remain safe. SFPs are constructed of reinforced concrete, several feet thick, with a stainless steel liner to prevent leakage and maintain water quality. Due to their configuration, SFPs are inherently structurally-rugged and are designed to the same seismic requirements as the nuclear plant.

Note: Typically, SFPs are about 40 feet deep and vary in width and length. The fuel is stored in stainless steel racks and submerged with approximately 23 feet of water above the top of the stored fuel. Each plant has a preferred SFP make-up water source (the refueling water storage tank for pressurized water reactors and the condensate storage tank for boiling water reactors). SFPs have alternate means of make-up such as service water systems and the fire water system. SFPs are also typically designed (e.g. with anti-siphon check valves) and instrumented such that leakage is minimized and promptly detected.

Q7. Are the implications of new seismic hazard estimates being considered for fuel cycle facilities?

A7. Yes, while the GI-199 Safety/Risk Assessment focused solely on operating power reactors in the Central and Eastern U.S., fuel cycle facilities have been considered by NRC. Based on preliminary reviews of the updated seismic hazard estimates, NRC staff in the Office of Nuclear Material Safety and Safeguards concluded that, for the fuel cycle facilities within the CEUS, there is no immediate safety concern.

Existing facilities (uranium enrichment, fuel fabrication [high and low enriched]) were mostly built to local building codes. These facilities demonstrate compliance with the performance requirements in 10 CFR 70.61 through their Integrated Safety Analyses (ISAs). 10 CFR Part 70 licensees are required to perform an ISA in which seismic events are addressed (through a combination of design and preventive/mitigative actions). To demonstrate compliance with Part 70, licensees must limit the risk of high and intermediate consequence events, by limiting the likelihood or consequence. It is expected that, in view of this new data, existing facilities will consider the updated information as it relates to the performance requirements and see if additional safety controls are necessary.

In addition to the ISA requirements, new facilities have to meet the even higher baseline design criteria (BDC), which requires the design to provide adequate protection against natural phenomena with consideration of the most severe documented historical events for the site. Three new facilities (LES, USEC ACP, and MOX) are undergoing construction. Conservatism was built into the design of these facilities (i.e., design code factors of safety, elasticity in the structures, and conservatism in the design evaluation) resulting in additional safety margin. All new facilities and new processes at existing facilities are required to meet 10 CFR 70.64(a)(2), which requires adequate protection against natural phenomena.

Note: Regarding some particular facilities, the Paducah Gaseous Diffusion Plant (a 10 CFR Part 76 facility) was designed to meet local building codes at the time of its construction in the early 1950s. Later in the late 1990s, as part of the Certification process, the Paducah plant was evaluated and reinforced to meet a 250 year return earthquake. Honeywell's construction was also consistent with the local building codes when it was built 50 years ago. Later during the 1990s, structural modifications were performed at Honeywell to upgrade the plant so it could withstand a 475-yr recurrence site-specific earthquake.

Q8. How can I learn more about earthquakes?

A8. A fact sheet on seismic issues for existing nuclear power plants is available on the NRC public website at http://www.nrc.gov/reading-rm/doc-collections/fact-sheets/fs-seismic-issues.html. Background information on earthquakes can also be obtained at the U.S. Geological Survey website at http://earthquake.usgs.gov/.

Q9. *What do the following terms mean?*

- ***Annual exceedance frequency***
- ***Core damage frequency***
- ***Design basis earthquake*** **or** ***safe shutdown earthquake***
- ***Ground acceleration***
- ***High confidence of low probability of failure capacity***
- ***Large early release frequency***
- ***Seismic hazard***
- ***Seismic margin***
- ***Seismic risk***

A9. The terms are defined as follows:

- ***Annual exceedance frequency (AEF)*** – Number of times per year that a site's ground motion is expected to exceed a specified acceleration.

- ***Core damage frequency (CDF)*** – Expected number of core damage events per unit of time. *Core damage* refers to the uncovery and heat-up of the reactor core, to the point that prolonged oxidation and severe fuel damage are not only anticipated but also involve enough of the core to result in off-site public health effects if released. *Seismic core damage frequency* refers to the component of total CDF that is due to seismic events.

- ***Design basis earthquake*** **or** ***safe shutdown earthquake (SSE)*** – A *design basis earthquake* is a commonly employed term for the *safe shutdown earthquake* (*SSE*); the SSE is the earthquake ground shaking for which certain structures, systems, and components are designed to remain functional. In the past, the SSE has been commonly characterized by a standardized spectral shape associated with a peak *ground acceleration* value.

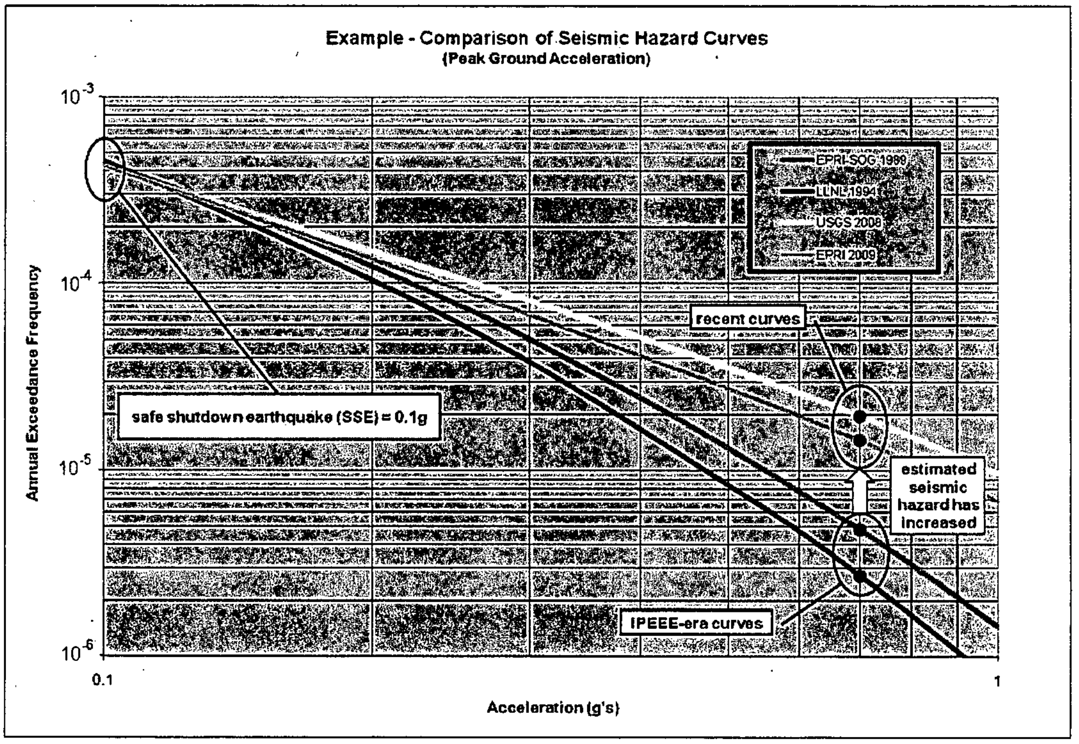
- ***Ground acceleration*** – Acceleration produced at the ground surface by seismic waves, typically expressed in units of *g*, the acceleration of gravity at the earth's surface.

- ***High confidence of low probability of failure (HCLPF) capacity*** – A measure of *seismic margin.* In *seismic risk* assessment, *HCLPF capacity* is defined as the earthquake motion level, at which there is high confidence (95%) of a low probability (at most 5%) of failure of a structure, system, or component.

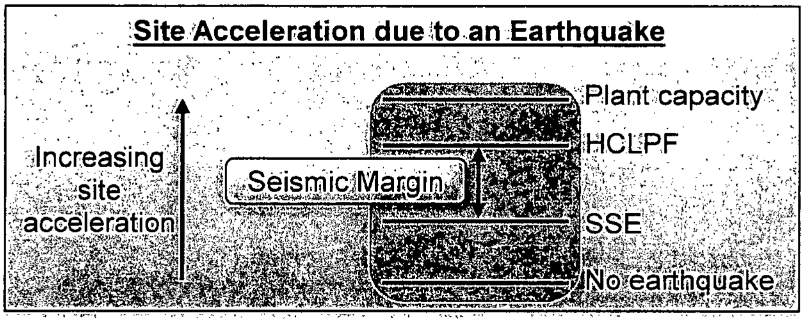
- ***Large early release frequency (LERF)*** – The expected number of large early releases per unit of time. A *large early release* is the rapid, unmitigated release of airborne fission products from the containment building to the environment, occurring before the effective implementation of off-site emergency response and protective actions, such that there is a potential for early health effects. *Seismic large early release frequency* refers to the component of total LERF that is due to seismic events.

- ***Seismic hazard*** – Any physical phenomenon, such as ground motion or ground failure, that is associated with an earthquake and may produce adverse effects on human activities (such as posing a risk to a nuclear facility).

For the representative plant in the chart below, the *annual exceedance frequency* for a 0.7*g* acceleration (e.g., for a large, but highly improbable earthquake) has increased from approximately one in 250,000 years (for IPEEE-era curves) to approximately one in 60,000 years (for recent *seismic hazard* curves). (In other words, the annual exceedance frequency for a 0.7*g* acceleration has increased from about 4×10^{-6} (0.000004) per year for IPEEE-era curves to about 1.8×10^{-5} (0.000018) per year for recent seismic hazard curves.) Note that the curves in this example are virtually indistinguishable at the SSE (design basis) level, but this is not always the case. Ultimately, GI-199 is about understanding the impact of these seismic hazard changes on reactor risk.



- ***Seismic margin*** – The difference between a plant's *HCLPF* capacity and its seismic design basis (*safe shutdown earthquake, SSE*), as shown in the figure below. (Note that the "plant capacity" label in this figure is the acceleration expected to result in core damage half of the time.) (Also see answer A11.)



- ***Seismic risk*** – The risk (frequency of occurrence multiplied by its consequence) of severe earthquake-initiated accidents at a nuclear power plant. A severe accident is an accident that causes core damage, and, possibly, a subsequent release of radioactive materials into the environment. Several risk metrics may be used to express *seismic risk*, such as seismic *core damage frequency* and seismic *large early release frequency*.

Safety

Q10. How was the seismic design basis for an existing nuclear power plant established?

A10. The seismic ground motion used for the design basis was determined from the evaluation of the maximum historic earthquake within 200 miles of the site, without explicitly considering the time spans between such earthquakes; safety margin was then added beyond this maximum historic earthquake to form a hypothetical *design basis earthquake* (see answer A9). The relevant regulation for currently operating plants is 10 CFR Part 100, Appendix A, "Seismic and Geologic Siting Criteria for Nuclear Power Plants" (http://www.nrc.gov/reading-rm/doc-collections/cfr/part100/part100-appa.html).

Q11. Is there margin above the design basis?

A11. Yes, there is margin beyond the design basis (see answer A9). In the mid to late 1990s, NRC staff reviewed the plants' assessments of potential consequences of severe earthquakes (earthquakes well beyond the safety margin included in each plant's design basis), which licensees performed as part of the Individual Plant Examination of External Events program. From this review, the staff determined that seismic designs of operating plants in the Central and Eastern United States have considerable safety margins, for withstanding earthquakes, built into the designs.

Q12. What do you mean by "increased estimates of seismic hazards" at nuclear power plant sites?

A12. *Seismic hazard* (earthquake hazard) represents the chance (or probability) that a specific level of ground shaking could be observed or exceeded at a given location. Our estimates of seismic hazard at some Central and Eastern United States locations have changed based on results from recent research, indicating that earthquakes occurred more often in some locations than previously estimated. Our estimates of seismic hazard have also changed because the models used to predict the level of ground shaking, as caused by a specific magnitude earthquake at a certain distance from a site, changed. The increased estimates of seismic hazard at some locations in the Central and Eastern United States were discussed in a memorandum to the Commission, dated July 26, 2006. (The memorandum is available in the NRC Agencywide Documents Access and Management System [ADAMS] under Accession No. ML052360044).

Q13. What has the Safety/Risk Assessment found and what does it mean for Generic Issue 199?

A13. Results of the Safety/Risk Assessment confirm that currently operating plants have adequate protection against *seismic hazards* (see Safety/Risk Assessment report transmittal memorandum). However, based on a separate criterion in the Generic Issues Program, the estimated *core damage frequency* change is still large enough to warrant further attention regarding the possible imposition of plant improvements. Action could include obtaining information and developing methods to complete plant-specific value-impact analyses.

RES staff developed a methodology and implemented it to assess the risk associated with this issue. Overall *seismic risk* estimates remain small in an absolute sense. All operating plants in the Central and Eastern United States have seismic core damage frequency (SCDF) less than or equal to 10^{-4} (0.0001) per year, which is considered safe (see answer to A15). The SCDF changes (the difference in SCDFs calculated using the old and new seismic hazard information) for a number of plants lie in the range of 10^{-4} to 10^{-5} (0.0001 to 0.00001) per year, which meets the NRC Generic Issues Program numerical risk threshold for an issue to continue to be evaluated for possible regulatory action.

Q14. Are the plants safe? If you are not sure they are safe, why are they not being shut down? If you are sure they are safe, why are you continuing evaluations related to this generic issue?

A14. Yes, currently operating nuclear plants in the Central and Eastern United States remain safe, with no need for immediate action. This determination is based on NRC staff reviews associated with Early Site Permits, the conclusions of the Generic Issue 199 Screening Panel (comprised of technical experts), and the conclusions of the Safety/Risk Assessment Panel (also comprised of technical experts).

No immediate action is needed because: (1) existing plants were designed to withstand anticipated earthquakes with substantial design margins, as confirmed by the results of the Individual Plant Examination of External Events; (2) the probability of exceeding the *safe shutdown earthquake* ground motion (see answer A9) may have increased at some sites, but only by a relatively small amount; (3) the increased probability is primarily in the high structural response frequencies, so buildings and equipment should not be affected (seismic amplitudes at lower frequencies are the primary contributors to building and equipment damage); and (4) the Safety/Risk Assessment Stage results indicate that the probabilities of seismic core damage are lower than the guidelines for taking immediate action.

Even though the staff has determined that existing plants remain safe, the Generic Issues Program criteria direct staff to continue their analysis to determine whether any cost-justified plant improvements can be identified to make plants even safer.

Q15. How do you know the plants are safe?

A15. The Safety/Risk Assessment results confirm that plants are safe. The relevant risk criterion for GI-199 is total *core damage frequency* (CDF). The threshold for taking immediate regulatory action (found in NRR Office Instruction LIC-504, see below) is a total CDF greater than or on the order of 10^{-3} (0.001) per year. For GI-199, the staff calculated seismic CDFs of 10^{-4} (0.0001) per year and below for nuclear power plants operating in the Central and Eastern U.S. (CEUS) (based on the new U.S. Geological Survey seismic hazard curves). The CDF from internal events (estimated using the staff-developed Standardized Plant Analysis of Risk models) and fires (as reported by licensees during the IPEEE process and documented in NUREG-1742), when added to the seismic CDF estimates results in the total risk for each plant to be, at most, 4×10^{-4} (0.0004) per year or below. This is well below the threshold (a CDF of

10^{-3} [0.001] per year) for taking immediate action. Based on the determination that there is no need for immediate action, and that this issue has not changed the licensing basis for any operating plant, the CEUS operating nuclear power plants are considered safe. In addition, as detailed in the GI-199 Safety/Risk Assessment and answers A13 and A14 above, there are additional, qualitative considerations that provide further support to the conclusion that plants are safe.

Note: The NRC has an integrated, risk-informed decision-making process for emergent reactor issues (NRR Office Instruction LIC-504, ADAMS Accession No. ML100541776 [not publically available]). In addition to deterministic criteria, LIC-504 contains risk criteria for determining when an emergent issue requires regulatory action to place or maintain a plant in a safe condition.

Despite NRC's determination that plants are safe to operate, MD 6.4, "Generic Issues Program," contains quantitative risk guidelines that place GI-199 into the category of continued evaluation to determine if cost-beneficial backfits can be justified at any plants.

Note: Also, New U.S. Geological Survey seismic hazard information provides ground acceleration likelihoods at each power plant site for both design basis and beyond design basis earthquakes. This seismic hazard information was combined with an estimate of each plant's resistance to earthquakes (seismic fragility) to produce an estimate of the frequency of damage to the reactor core due to earthquakes. This seismic core damage frequency (SCDF) was combined with estimates of the core-damage frequency (CDF) for internal events and fires, and the total CDF was then compared to risk thresholds used by the NRC to assess and assure that nuclear power plants are operated safely. The frequency calculated for all operating nuclear power plants in the CEUS is in the range considered safe.

Q16. Why are new nuclear plants being built to different seismic design requirements than existing nearby plants? Why are the currently operating plants not required to meet the new standards?

A16. Currently operating plants have been determined to adequately protect the public; new plants are designed to different requirements in order to meet the Nuclear Regulatory Commission's expectation that the new plants will provide enhanced margins of safety (see "Regulation of Advanced Nuclear Power Plants; Statement of Policy" 59 FR 35461 at http://www.nrc.gov/reading-rm/doc-collections/commission/policy/#power). There are two primary ways of determining safety: deterministic assessments (based on past events and engineering judgment) and probabilistic assessments. New plants employ probabilistic methods. Existing plants were built to older standards, based on deterministic assessments. Those standards have been monitored, and were found to be sufficient and appropriate. In order to impose new requirements on existing plants, the NRC must be able to justify the new requirements in accordance with the "Backfit Rule" (10 CFR 50.109, available at http://www.nrc.gov/reading-rm/doc-collections/cfr/part050/part050-0109.html). The NRC needs additional information to justify any new requirements, and the Safety/Risk Assessment Panel recommended taking action to acquire the information.

Q17. How does the occurrence of a new earthquake in the Central or Eastern United States affect Generic Issue 199?

A17. The effect of a single earthquake is small on the estimated *seismic hazard* (defined in answer A9) and hence on Generic Issue 199, unless it occurs in an area not previously recognized as being capable of producing earthquakes, or is larger than previously believed possible in a region. In a seismic hazard study, the seismic source zones are specifically delineated to include a sufficient number of earthquakes to provide a stable estimate of the seismicity rate and are thus relatively insensitive to the addition of a single earthquake. If an earthquake does occur in an area not previously recognized as being capable of producing earthquakes or if an earthquake occurs that is larger than previously believed possible in a region, changes to the seismic hazard model used to develop seismic hazard estimates would be required.

Note: The magnitude 5.2 earthquake that occurred on April 18, 2008 in southeastern Illinois provides a good example of the potential impact of a single earthquake. This earthquake occurred in an area recognized as being capable of producing significant earthquakes (the Wabash Valley seismic source zone) and was smaller than the maximum magnitude event defined for the zone based on geologic investigations (maximum magnitude of 7-7.5). The addition of a single event of this magnitude to the earthquake database for this area would likely change the activity rate by less than a few percent and thus have a very small impact on the estimated seismic hazard at any of the nuclear facilities in the area.

Schedule

Q18. What has been done about this issue since it was identified as a generic issue in the Generic Issues Program?

A18. The following summarizes what has been done on Generic Issue 199 (GI-199):

Prioritization and Screening

- *June 2005:* The issue was logged into the Generic Issues Program (GIP) and, based on the NRC determination that the seismic design of plants in the Central and Eastern United States still provided an adequate level of protection, the Agency decided that this issue was a relatively low priority.
- *November 2005 – February 2007:* The Agency awarded a contract to screen this issue and determine whether it should continue to be evaluated under the GIP. In 2006, the contractor notified RES of problems obtaining information that the contractor wanted to perform its task.
- *April 2007:* The NRC decided to use Agency staff to complete the screening analysis using guidance provided in Management Directive (MD) 6.4 and SECY-07-0022, "Status Report on Proposed Improvements to the Generic Issues Program," dated January 30, 2007. MD 6.4 outlines the seven GIP criteria for use in determining whether proposed generic issues should be designated generic issues (the screening process) and proceed to the Safety/Risk Assessment Stage of the GIP.
- *September 2007:* An initial screening analysis was completed.
- October 2007: For consistency with the performance-based approach for assessing *seismic hazards* for new reactors, the staff determined that the screening analysis should consider seismic hazard data and models besides those available from the U.S.

Geological Survey.

- *February 2008:* The NRC completed the GIP screening with the GI-199 Screening Panel concluding that the issue should proceed to the Safety/Risk Assessment Stage under the GIP. The NRC staff held a public meeting to engage external stakeholders. During the meeting, the representative from NEI expressed their willingness to support a collaborative approach to GI-199. (This led to a Seismic Risk Memorandum of Understanding Addendum between the Electric Power Research Institute and the NRC Office of Nuclear Regulatory Research (RES).)

Safety/Risk Assessment Stage

- GI-199 then entered the Safety/Risk Assessment Stage of the GIP. RES staff collected and analyzed seismic hazard information from the U.S. Geological Survey and other sources, and *seismic risk* information from Individual Plant Examination of External Events analyses.
- *November 2008:* The NRC Office of Nuclear Material Safety and Safeguards (NMSS) performed a preliminary review related to independent spent fuel storage installations (ISFSIs). A review of design earthquakes (DE) used at the existing ISFSI locations in Central and Eastern U.S., indicated that there is significant margin built into the existing designs and NMSS determined that they have confidence that the ISFSIs can continue to operate safely while GI-199 is processed.
- *June 2009:* In support of the Safety/Risk Assessment, the staff completed the review and detailed analysis of seismic data for 96 plants.
- *July 2009 – March 2010:* Several Safety/Risk Assessment Panel meetings were held to determine recommendations in light of stakeholder input that was received.
- *April 2010 – August 2010:* The Safety/Risk Assessment report is finalized. Internal briefings and communications are carried out (to build NRC consensus and to prepare for the release of the Safety/Risk Assessment report and associated public meeting).
- During the process of resolving GI-199, staff responded to Freedom of Information Act requests and held numerous meetings with internal and external stakeholders.

Q19. Why is it taking the NRC so long to process Generic Issue 199?

A19. This is a complicated issue involving the intersection of the probabilistic risk analysis and seismic disciplines. Obtaining data, developing methods, and performing analyses are all required to address the issue. Analyzing a few representative plants for this issue (as is normally done in the Generic Issues Program) is inappropriate because the *seismic hazard* and associated impact to the power plant are very site-specific; so analysis for 96 separate plants is required. (Refer to A14 for a summary of what has been done on GI-199 since it was first identified.) GI-199 has also been a communication-intensive generic issue because it affects many parts of the NRC and industry, and because it is important to NRC and all stakeholders that the Safety/Risk Assessment results are properly conveyed.

Q20. What will happen next regarding Generic Issue 199?

A20. The next step is for the staff to complete the Safety/Risk Assessment Stage of the Generic Issues Program (GIP). The Safety/Risk Assessment report will soon be published, followed by an information notice being sent to all licensees of nuclear power reactors and independent spent fuel storage installations. A public meeting will be held to discuss the results of the Safety/Risk Assessment and the next steps for GI-199. After the Safety/Risk Assessment

Stage, further action regarding GI-199 will be pursued (such as obtaining more detailed, plant-specific information and performing analysis to determine whether plant-specific improvements are warranted). NRC staff will also make presentations to the Advisory Committee on Reactor Safeguards.

Q21. Aside from evaluations for GI-199, what is the NRC's expectation regarding the use of updated probabilistic seismic hazard information in regulatory applications?

A21. It is expected that all NRC licensees that are required to analyze risks and hazards impacting their operations will use the most current seismic hazard information.

Regarding currently operating nuclear power plants, there is no requirement that the plants re-evaluate their seismic design basis (10 CFR 100, Appendix A, "Seismic and Geologic Siting Criteria for Nuclear Power Plants"), but plants do need to use the most updated information available in the case of risk-informed licensing amendments.

Note: The NRC guidance for using probabilistic risk assessment (PRA) in risk-informed decisions on plant-specific changes to the licensing basis is provided in RG 1.174. The scope, level of detail, and technical acceptability of the PRA are to be commensurate with the application for which it is intended and the role that the PRA results play in the integrated decision process. One over-riding requirement is that the PRA should realistically reflect the actual design, construction, operational practices, and operational experience of the plant and its owner. RG 1.200 provides further guidance concerning the technical adequacy of PRAs and states that seismic hazard analysis should include current information. Consistent with this guidance, the staff expects that licensees will use the most recent seismic hazard information available for risk-informed regulatory applications.

Regarding seismic requirements for dry cask storage systems and independent spent fuel storage installations (ISFSIs), the staff also expects that licensees will use the most recent seismic hazard information available for risk-informed regulatory applications.

Note: NRC regulations (in 10 CFR Part 72) require licensees to perform written evaluations to establish that, for their site-specific conditions, the conditions set forth in the Certificate of Compliance (CoC) have been met. They must also perform evaluations showing that cask storage pads and areas have been designed to adequately support the static and dynamic loads of the stored casks, considering potential amplification of earthquakes through soil-structure interaction as well as soil liquefaction potential or other soil instability due to vibratory ground motion.

Stakeholder Interest

Q22. Has the NRC received any requests from government officials regarding seismic issues?

A22. Yes. On November 15, 2007, the NRC received a letter (available in the NRC Agencywide Documents Access and Management System, ADAMS, under Accession No. ML0732500954) from the Attorneys General of six states (Connecticut, Delaware, Illinois, Kentucky, New York, and Vermont). The letter encouraged the NRC to consider siting and safety requirements, including geographic and seismic issues, in the regulatory process for license renewal. The NRC reviewed this letter and responded that the items of concern are addressed in "ongoing regulation [that]... occurs throughout the life of the license... [and that] expand[ing] the scope of license renewal to cover...[the] issues raised in [the] letter...[would be] duplicating the Commission's responsibilities..." (ADAMS Accession No. ML073400603). Additionally, several Freedom of Information Act requests were received, and NRC staff responded to the requests; the U.S. Geological Survey data related to these requests is publicly available under ADAMS Accession No. ML072880133.

Also, the County Executive of Westchester County (New York) and groups from New Jersey submitted a petition for rulemaking on license renewal, including a seismic-related aspect. The NRC denied this petition. The petitioners then filed suit in the U.S. Court of Appeals Second Circuit and the court upheld the NRC position. Details are available on the internal webpage of the NRC Office of General Counsel (under Law Library, Summary of AEC-NRC Litigation, "Spano v. NRC" (2d Cir. 2009): http://www.internal.nrc.gov/ogc/internal/AEC-NRC_Cases.pdf.)

Q23. Will the NRC release the results of the Safety/Risk Assessment? If so, will plant-specific results be included?

A23. The Safety/Risk Assessment report will be made available on the public NRC Generic Issues Program (GIP) website (http://www.nrc.gov/about-nrc/regulatory/gen-issues.html), on the internal NRC GIP website (http://www.internal.nrc.gov/RES/projects/GIP/), and in the NRC Agencywide Document Access and Management System (ADAMS) under Accession No. ML100270582.

Regarding the plant-specific results, they are included in the Safety/Risk Assessment report (in appendix D), and have been used in the aggregate for the determination that further, plant-specific information and analysis is needed to investigate possible plant-specific improvements. (See the last section, "Safety/Risk Assessment Results - Plants in the GIP "Continue Region," of this Communication Plan.)

Note: Results of the Safety/Risk Assessment confirm that currently operating plants have adequate protection against seismic hazards; however, the results also indicated that GI-199 meets the NRC Generic Issues Program numerical risk threshold for an issue to continue to be evaluated for possible regulatory action (see answer A13). The Safety/Risk Assessment utilized simplifying methods and assumptions to produce plant-specific results to determine trends, not to finalize which plants will or will not be further analyzed.

Safety/Risk Assessment Results - Plants in the GIP "Continue Region"

Plant-specific results are included in the Safety/Risk Assessment report (in appendix D) and have been used in the aggregate to determine that further, plant-specific information and analysis is needed to investigate possible plant-specific improvements. Listed below are plants that are currently above the Generic Issues Program (GIP) numerical risk threshold for an issue to continue to be evaluated for possible regulatory action (see answers A13 and A23). (Note that the plants are listed in alphabetical order by NRC region.) During the analysis, this group of plants was referred to as the "plants in the *continue region*."

As more information becomes available and more detailed analysis is performed, this group of plants *will* change. As discussed in answer A4, generic communications on this issue will be addressed to all operating power plants in the United States. More detailed, plant-specific analysis of all plants will allow NRC staff to prioritize plants that may be considered for regulatory action. The need to continue evaluating GI-199 is based on the collective results, not the results for any particular plant.

Region I
Indian Point 2
Indian Point 3
Limerick 1
Limerick 2
Peach Bottom 2
Peach Bottom 3
Seabrook 1

Region II
Crystal River 3
Farley 1
Farley 2
North Anna 1
North Anna 2
Oconee 1
Oconee 2
Oconee 3
Saint Lucie 1
Saint Lucie 2
Sequoyah 1
Sequoyah 2
Summer
Watts Bar 1

Region III
Dresden 2
Dresden 3
Duane Arnold
Perry 1

Region IV
River Bend 1
Wolf Creek 1

Q24. There was a recent Part 21 (60-Day Interim Report) Notification concerning seismic input for control rods that might lead to a failure to scram at Boiling Water Reactors (BWRs). Was this information included in the GI-199 Safety/ Risk Assessment (S/RA)? Could this information change the results of the S/RA?

A24. On September 3, 2010, General Electric Hitachi (GEH) Nuclear Energy submitted a 10CFR50 Part 21 Notification regarding a failure to include seismic input in reactor control blade customer guidance for BWRs. BWRs remain safe because (1) control rods are expected to fully or partially insert even with channel-control rod interference, (2) operators will still have the ability to manually scram partially inserted rods, and (3) the limited time spent at conditions where the failure to scram could occur (low reactor pressure). NRR has been following this Part 21 issue and has determined that the GEH has provided effective interim guidance to the affected licensees that experience channel-control rod interference, and that additional guidance detailed in the Part 21 notice, provides licensees with conservative strategies to assist in the insertion of control rods under low reactor pressure conditions.

The GI-199 S/RA was completed in August, prior to the Part 21 notice. Considering the above, information from the new Part 21 notice would not be expected to change the conclusions of the GI-199 S/RA. Information from this Part 21 Notification will be considered in future efforts to address GI-199.

September 2, 2010

MEMORANDUM TO: Brian W. Sheron, Director
Office of Nuclear Regulatory Research

FROM: Patrick Hiland, Chairman **/RA/**
Safety/Risk Assessment Panel for Generic Issue 199

SUBJECT: SAFETY/RISK ASSESSMENT RESULTS FOR GENERIC ISSUE 199, "IMPLICATIONS OF UPDATED PROBABILISTIC SEISMIC HAZARD ESTIMATES IN CENTRAL AND EASTERN UNITED STATES ON EXISTING PLANTS"

In accordance with Management Directive (MD) 6.4, "Generic Issues Program," a Safety/Risk Assessment panel was established to:

- Determine, on a generic basis, if the risk associated with Generic Issue (GI) 199, "Implications of Updated Probabilistic Seismic Hazard Estimates in Central and Eastern United States (CEUS) on Existing Plants," warrants further investigation for potential imposition as a cost-justified backfit.

- Provide a recommendation regarding the next step (i.e., should the issue continue to the Regulatory Assessment Stage for identification and evaluation of potential generic, cost-justified backfits, be dropped due to low risk, or have other actions taken outside the Generic Issues Program [GIP]).

The panel completed its independent review of the Safety/Risk Assessment (see Enclosure 1) for GI-199. The panel reached the following conclusions and observations:

- Overall seismic core damage risk estimates are consistent with the Commission's Safety Goal Policy Statement because they are within the subsidiary objective of 10^{-4}/year for core damage frequency. The GI-199 Safety/Risk Assessment, based in part on information from the U.S. Nuclear Regulatory Commission's (NRC's) Individual Plant Examination of External Events (IPEEE) program, indicates that no concern exists regarding adequate protection and that the current seismic design of operating reactors provides a safety margin to withstand potential earthquakes exceeding the original design basis.

- The changes in seismic core-damage frequency (SCDF) estimated in the Safety/Risk Assessment Stage of GI-199 for numerous plants lie in the range of 10^{-4}/yr to 10^{-5}/yr, which meet the numerical risk criteria for an issue to proceed to the Regulatory Assessment Stage of the GIP.

CONTACT: John Kauffman, RES/DRA
301-251-7465

- New consensus seismic-hazard estimates will become available in late 2010 or early 2011 (these are a product of a joint NRC, U.S. Department of Energy, U.S. Geological Survey (USGS) and Electric Power Research Institute (EPRI) project). These consensus seismic-hazard estimates will supersede the existing EPRI, Lawrence Livermore National Laboratory, and USGS hazard estimates used in the GI-199 Safety/Risk Assessment.

- Certain factors that affect the development of realistic SCDF estimates will remain unresolved even after the new consensus seismic hazard estimates are developed. The issue is primarily that many IPEEEs did not produce SCDF estimates and so lack some of the information needed to produce such estimates.

  - For a number of the plants that performed reduced-scope seismic margins analyses as part of the IPEEE program, limited detailed information exists regarding plant seismic capacity (the ability of a plant's structures, systems, and components [SSCs] to successfully withstand an earthquake) beyond the required design-basis level.

  - The approach used in the attached Safety/Risk Assessment to estimate SCDF considers the plant-level seismic capacity and, therefore, does not provide insight into which SSCs are important to seismic risk. Such knowledge would be required in order to postulate potential cost-beneficial backfits.

- IPEEE submittals generally provided limited, qualitative information about the seismic capability of containments. Any regulatory analysis of GI-199 should consider potential plant modifications for reducing the probability of seismically induced containment failure as discussed in Section 3.3.1 of NUREG/BR-0058, "Regulatory Analysis Guidelines of the U.S. Nuclear Regulatory Commission."

The panel recommends the following:

- Transfer lead responsibility for subsequent GI-199 actions to the Office of Nuclear Reactor Regulation for regulatory office implementation, including maintenance of the GI-199 Communication Plan and stakeholder briefings and interactions. (Note: the GIP will continue to track the issue and report its status in the Generic Issues Management Control System until all actions are completed).

- Take further actions to address GI-199 outside the GIP (i.e. obtain information and develop methods, as needed, to complete plant-specific value-impact analyses of potential backfits to reduce seismic risk). Any needed Office of Nuclear Regulatory Research support can be obtained using the User Need Request process.

Enclosure:
Safety/Risk Assessment for GI-199

Approved: **/RA/** Date: 9/2/2010
Brian W. Sheron, Director
Office of Nuclear Regulatory Research

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Enclosure:
Safety/Risk Assessment for GI-199

Approved: **/RA/** Date: 9/2/2010
Brian W. Sheron, Director
Office of Nuclear Regulatory Research

DISTRIBUTION: See next page

ADAMS Accession No.: ML100270582

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Memo to Brian W. Sheron from Patrick L. Hiland dated September 2, 2010

SUBJECT: SAFETY/RISK ASSESSMENT RESULTS FOR GENERIC ISSUE 199, "IMPLICATIONS OF UPDATED PROBABILISTIC SEISMIC HAZARD ESTIMATES IN CENTRAL AND EASTERN UNITED STATES ON EXISTING PLANTS"

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Greenwood, Carol

From: Gibson, Kathy
Sent: Saturday, March 26, 2011 1:45 PM
To: Lee, Richard; Tinkler, Charles
Subject: Fw: ANS Technical Brief: MOX Fuel & Fukushima
Attachments: ANS-Technical-Brief-MOX-Fukushima.pdf

I'm using you guys as the clearinghouses for all the stuff I get so you can draw whatever conclusions are appropriate based on all the relevant information coming in.

----- Original Message -----
From: Hoxie, Chris
To: Gibson, Kathy
Sent: Sat Mar 26 13:26:25 2011
Subject: FW: ANS Technical Brief: MOX Fuel & Fukushima

Do you get these? Anyway, briefly it says the fact that its MOX at Japan is not a big deal....

-----Original Message-----
From: ANS Broadcasts [mailto:broadcasts@ans.org]
Sent: Saturday, March 26, 2011 5:02 AM
To: Hoxie, Chris
Subject: ANS Technical Brief: MOX Fuel & Fukushima

The ANS Special Committee on Nuclear Non-Proliferation has prepared the attached Technical Brief on The Impact of Mixed Oxide Fuel Use on Accident Consequences at Fukushima Daiichi.

For additional Fukushima resources, visit the "Featured Content" box on the front page of the American Nuclear Society's website:

http://www.ans.org/

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AMERICAN NUCLEAR SOCIETY

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Fax: 708/352-0499

Date: March 25, 2011

To: Joe Colvin
ANS President

From: Michaele (Mikey) Brady Raap
Chair, ANS Professional Divisions Committee

Below please find the Technical Brief on The Impact of Mixed Oxide Fuel Use on Accident Consequences at Fukushima Daiichi. This Technical Brief contains factual information prepared by the ANS Special Committee on Nuclear Non-Proliferation.

The Impact of Mixed Oxide Fuel Use on Accident Consequences at Fukushima Daiichi

American Nuclear Society Technical Brief – March 2011

Conclusion

Mixed Oxide (MOX) fuel has been used safely in nuclear power reactors for decades. The presence of a limited number of MOX fuel assemblies at Fukushima Daiichi Unit 3 has not had a significant impact on the ability to cool the reactor or on any radioactive releases from the site due to damage from the earthquake and tsunami.

Summary

At the time of the magnitude 9.0 earthquake, Fukushima Daiichi Unit 3 was operating with 32 mixed oxide (MOX) fuel assemblies and 516 low enriched uranium (LEU) fuel assemblies in its reactor core. In other words, less than 6% of the fuel in the Unit 3 core was MOX fuel. There were no other MOX fuel assemblies (new, in operation or used) at the Fukushima Daiichi plant at the time of the accident.

MOX fuel assemblies were loaded into Fukushima Daiichi Unit 3 for the first time in the fall of 2010. The MOX fuel had been used for less than five months at the time of the accident. Differences in initial fuel composition between MOX and LEU fuel can lead to differences in consequences (prompt fatalities and latent cancers) following a core damage event with releases to the environment.

There are indications that Fukushima Daiichi Unit 3 suffered damage to some of its core. The core damage resulted from a loss of core cooling due to damage to plant systems from the tsunami that followed the earthquake. The damage was not related to the presence of MOX fuel.

There have been no prompt fatalities as a result of radiation exposure from Fukushima Daiichi. Prompt evacuation has minimized radiation exposure to the public, so long-term public health consequences from radiation exposure are expected to be small. Given the small number of MOX fuel assemblies at Fukushima Daiichi Unit 3 at the time of the event, coupled with the short time of irradiation of the MOX fuel, it can be concluded that MOX fuel has had and will have no perceptible impact on any consequences from the event.

Background

It is important to note that while LEU fuel begins its useful life with no plutonium, as it is used in a light water reactor it builds up plutonium as a result of the nuclear reactions in the core. By the end of its useful life an LEU fuel assembly contains about 1% plutonium actually generates more power from plutonium than from uranium. All reactor cores contain plutonium; those cores loaded with some MOX fuel contain more.

Mixed oxide (MOX) fuel is comprised of a blend of uranium oxide and plutonium oxide. MOX fuel is predominantly uranium, with average concentrations of plutonium that range from 3-10%. The presence of plutonium produces modest changes in some physical characteristics of the fuel material such as thermal conductivity. However, MOX fuel and low-enriched uranium (LEU) fuel are fundamentally similar. Moreover, the physical dimensions and structural material of a MOX fuel assembly are essentially identical to that of a LEU fuel assembly. To the naked eye, a MOX fuel assembly and a LEU fuel assembly are identical.

Nuclear power plants have been generating electricity for use by the public since the 1950s, and over those years the industry has compiled an enviable safety record. Today over 400 reactors worldwide generate substantial amounts of emissions-free electricity. Dozens of those reactors currently generate power using a mixture of conventional LEU fuel assemblies and MOX fuel assemblies in their reactor cores. The majority of the fuel loaded into these reactors is LEU (60-70% or more), while the remainder (30-40% or less) is MOX. The use of MOX fuel allows the re-use of plutonium that was recovered during nuclear fuel recycling operations. The fabrication and use of MOX fuel has been carried out safely and efficiently on an industrial scale since the 1970s. Safety authorities in France, Belgium, Germany, Switzerland and Japan have all approved the use of MOX fuel in light water reactors using the same rigorous standards that are applied for the licensing of LEU fuel.

Safety is the cornerstone of nuclear power plant operations. Nuclear power plant operators perform safety analyses to determine how the plants will respond during various "what if" problem scenarios. Some of those scenarios involve extreme conditions coupled with multiple equipment failures that lead to estimates of damage to the fuel in the reactor core. Scenarios with significant damage to the reactor core are referred to as severe accidents, and such accidents can result in the calculated release of radionuclides to the environment. Severe accident consequences are the adverse public health effects – fatalities and latent cancers – that arise from the offsite release of radionuclides from a damaged reactor core.

When uranium or plutonium atoms split (fission), they release a relatively large amount of energy which is converted into heat and eventually electricity. The smaller atoms left behind after fission are referred to as fission products. In addition, some of the uranium and plutonium atoms in nuclear fuel assemblies absorb neutrons without fissioning, becoming even heavier atoms called actinides. Both fission products and actinides are radioactive, posing a health hazard if they are released to the environment. Using MOX fuel alters somewhat the "source term," or mix of radionuclides in the core and available for release following a severe accident. The different source term between MOX fuel and LEU fuel leads to different calculated consequences following a postulated severe accident.

In November 1999 the Department of Energy published the Surplus Plutonium Disposition Environmental Impact Statement which documented, among other things, the consequences of four severe accident scenarios at three different reactors using some MOX fuel derived from weapons grade plutonium. Each reactor accident sequence was analyzed with two different reactor core assumptions: a reference case with all LEU fuel, and a second case with a mixed core of approximately 40% MOX fuel and the remainder LEU fuel. For each case the severe accident was assumed to progress in the same manner. Relative to the reference case with all LEU fuel, the offsite consequences to the public with the mixed MOX-LEU core ranged from 4% lower to 22% higher, depending on the reactor studied and the accident sequence. Most cases resulted in consequence increases of 10% or less. The differences between the consequences relate back to differences in the source term. The mixed MOX-LEU core consequences were generally higher because of the presence of more radioactive actinides in the MOX fuel at the time of the postulated accident. However, the differences were modest compared to the uncertainty associated with the consequence calculations for these extremely low probability events.

The type of plutonium used in MOX fuel can also impact severe accident consequences. The aforementioned analysis assumed weapons grade plutonium. If the calculations had been done for MOX fuel containing plutonium from recycled commercial nuclear fuel, as is the practice in Europe and Asia today, the difference between the all uranium cases and the 40% MOX fuel consequences would have been greater than cited above. This is again due primarily to the presence of more radioactive actinides in used "reactor grade" MOX fuel (with plutonium from recycled reactor fuel) than in used weapons grade MOX fuel (with plutonium from retired nuclear weapons).

Turning to the Fukushima Daiichi reactors in Japan, Unit 3 was using some reactor grade MOX fuel at the time of the March 2011 earthquake. Had it been using a 40% MOX fuel core, one could expect an increase in severe accident consequences on the order of 10% for weapons grade MOX. With a 40% reactor grade MOX core, and applying a bounding factor of four increase relative to weapons grade MOX, the overall increase in severe accident consequences would have been on the order of 40% relative to the all LEU fuel case. However, Unit 3 was loaded with only 32 MOX fuel assemblies during refueling operations in the fall of 2010. There are a total of 548 fuel assemblies in the Unit 3 reactor core, so this represents less than 6% of the total fuel in the core. The MOX fuel had been operating in Unit 3 for less than five months; fuel assemblies are typically used for a total of 3-4 years in reactor cores before being replaced by new fuel and discharged to used fuel pools. Therefore, the MOX fuel would have built up relatively few radioactive fission products and actinides at the time of the earthquake and subsequent damage to the reactor core. With these facts in mind – the low percentage of MOX fuel in the core and the short operation time for the MOX fuel – it is evident that the presence of MOX fuel at Fukushima Daiichi Unit 3 has had no significant impact on the offsite releases of radioactivity following the earthquake and tsunami.

Other than the 32 MOX fuel assemblies in the Unit 3 reactor core, at the time of the earthquake there were no other MOX fuel assemblies (new or used) at the Fukushima Daiichi plant. The problems encountered at Fukushima Daiichi reactors stem from plant damage due to the tsunami that followed the earthquake, not the use of MOX fuel in Unit 3.

It is also important to put the public health consequences from the event in perspective. There have been no prompt fatalities as a result of radiation exposure. Moreover, prompt evacuation has minimized the exposure of the population to radiation. At this point, the consequences of the event are expected to be small. MOX fuel effects, if any, would be a small change to an already small number.

In conclusion, MOX fuel has been used safely in nuclear power reactors for decades. The presence of a limited number of MOX fuel assemblies at Fukushima Daiichi Unit 3 has not had a significant impact on the ability to cool the reactor or on any radioactive releases from the site due to damage from the earthquake and tsunami.

Greenwood, Carol

From: Gibson, Kathy
Sent: Saturday, March 26, 2011 1:47 PM
To: Lee, Richard
Subject: Fw: Mark I failure

From: Tinkler, Charles
To: Gibson, Kathy
Sent: Sat Mar 26 13:23:10 2011
Subject: RE: Mark I failure

There was speculation that hydrogen explosion in the reactor building may have damaged the torus/suppression pool.

However, as I have noted and discussed with RST, the unit 3 torus pressure is 2 bar. So, it may be relatively minor damage since the pressure reading is above atmospheric. Leakage may be high on the torus. Alternatively, they may have had trouble closing a vent valve and that is what caused pressure to drop after explosion.

Evidence also suggests unit 3 containment may be flooded up to the drywell – maybe up as high as the RPV lower head. Drywell pressure is 1 bar and torus pressure is a little less than 2 bar.(suggests flooding). Other measurement also suggested flooding. Again we discussed with RST (I talked to Don Helton yesterday before he went on RST shift and he passed it along for their telecom to Japan) View was discussed with ET as well.

From: Gibson, Kathy
Sent: Saturday, March 26, 2011 1:06 PM
To: Tinkler, Charles
Subject: Re: Mark I failure

What is the breech is in the suppression pool like they were saying for I think Unit 3 hydrogen explosion?

From: Tinkler, Charles
To: Gibson, Kathy
Sent: Sat Mar 26 13:03:47 2011
Subject: RE: Mark I failure

Sure, I will set up briefing

More background : Mark I liner failure during severe accidents is a longstanding issue going back 20 years (some plants made changes to reduce risk by adding curbs, others did not – risk was low enough. But it is the sort of thing that is likely to highlighted these days.

Again, SOARCA has shown n that releases are not extreme because of fission products are deposited in suppression pool.

XX/53

From: Gibson, Kathy
Sent: Saturday, March 26, 2011 12:54 PM
To: Tinkler, Charles
Subject: Re: Mark I failure

Can you set up a briefing next week with me and Brian (and Jennifer if she's in) on accident progression in BWRs. I've had BWR training and was inspector at Hope Creek (and Brian has some BWR background) but a refresher of Mark I and severe accidents etc would be helpful - especially for all these Congressional calls Brian is doing. Thanks

---

From: Tinkler, Charles
To: Gibson, Kathy
Sent: Sat Mar 26 12:42:22 2011
Subject: Mark I failure

The Mark I containment is relatively vulnerable to drywell shell/liner melt thru – if the reactor vessel fails and if the drywell floor is dry (not flooded). It also depends if the drywell pedestal region has a large sump or if there are curbs. (design details)

Peach Bottom is fairly vulnerable , for SBO, if the RPV fails then the containment fails but most of the fission products are deposited in the suppression pool so the containment integrity is not so important at that stage.

SOARCA models containment failure but the fission product release is still relatively small because the fp's go to the pool.

Charles Tinkler
Charles.Tinkler@nrc.gov

Greenwood, Carol

From: Gibson, Kathy
Sent: Saturday, March 26, 2011 4:43 PM
To: Sheron, Brian; Lee, Richard; Hoxie, Chris
Cc: Uhle, Jennifer
Subject: Re: Sharing info. with DOE Science Council

I know Joe Staudemeier has been doing calculations and analysis re: salt at request of RST but don't know the specifics.

Chris, if you're checking email, do you know any specifics?

----- Original Message -----
From: Sheron, Brian
To: Lee, Richard
Cc: Uhle, Jennifer; Gibson, Kathy
Sent: Sat Mar 26 16:40:11 2011
Subject: RE: Sharing info. with DOE Science Council

Remember that the lower head is filled with sea salt. Thus, the melt that relocates to the lower head will be mixed with a lot of sea salt. Do we understand what impact the salt has (or doesn't have) on steam explosion dynamics?

-----Original Message-----
From: Lee, Richard
Sent: Saturday, March 26, 2011 4:10 PM
To: Sheron, Brian
Cc: Uhle, Jennifer; Gibson, Kathy
Subject: RE: Sharing info. with DOE Science Council

Brian:

Attached is the preliminary FCI analysis that would like to provide to NRC Op Center in case question on FCI is received. If you are at the Op Center, please provide to them.

Shortly, thereafter I will provide it to John Kelly.

Thanks, Richard

-----Original Message-----
From: Sheron, Brian
Sent: Saturday, March 26, 2011 4:06 PM
To: Gibson, Kathy; Lee, Richard
Cc: Uhle, Jennifer
Subject: RE: Sharing info. with DOE Science Council

Richard, I agree with Kathy.

-----Original Message-----
From: Gibson, Kathy
Sent: Saturday, March 26, 2011 10:35 AM
To: Lee, Richard
Cc: Sheron, Brian; Uhle, Jennifer
Subject: Re: Sharing info. with DOE Science Council

XX/54

Richard,
In general, if information is not proprietary or safeguards or otherwise restricted, we should share whatever information we have with those who can make use of it in the interest of site recovery and radiological safety. In this case, it can be shared. Also make sure Ops Center RST has whatever we have for their assessments. They can pass along to the site team whatever they think is useful.

Thanks,
Kathy

----- Original Message -----
From: Lee, Richard
To: Gibson, Kathy
Sent: Sat Mar 26 09:09:19 2011
Subject: Sharing info. with DOE Science Council

Dear Kathy:

Sud and I had asked Mike Corradini to perform an assessment on Fuel coolant interaction analysis using the NRC TEXAS code. The base calculation (which Randy, Dana, Mike Salay, Sud and I) think could be perhaps the worst case scenario of melt (with stainless steel) coming out of one control rod drive (CRD) hole into a saturated pool of water about 6-7ft from the melt expelling from the CRD hole. The load calculated is not showing a problem in breaching the primary containment structure (for e.g, the liner - assuming that it is still in reasonable condition). Additional parametric studies are ongoing. I have provided the preliminary assessment to Mike Salay and Hossein already.

This is the case where the water did not completed flooded the reactor cavity. If the cavity is completely flooded, the FCI will not be an issue. I think, flooding the reactor cavity is being considered. I know MCCI analysis been carried out by Mitch Farmer (ANL) - which is a DOE directed analysis.

Your advise (and Brian Sheron one if you need to consult with him) is sought for us to share this FCI analysis with the Science Council through John Kelly This will give us some visibility on the pro-active analyses that are on-going at different labs directed by DOE.

Richard

Greenwood, Carol

From: Gibson, Kathy
Sent: Saturday, March 26, 2011 5:14 PM
To: Gavrilas, Mirela
Subject: Fw: Sharing info. with DOE Science Council

Mirela,
Can you add anything to this conversation from your MCCI work?

----- Original Message -----
From: Sheron, Brian
To: Lee, Richard
Cc: Uhle, Jennifer; Gibson, Kathy
Sent: Sat Mar 26 16:54:28 2011
Subject: RE: Sharing info. with DOE Science Council

I'm not talking about ejecting melt into sea water. I'm saying that when the melt relocates from the core to the lower head it will encounter a lower head filled with sea salt as a result of cooling the core with sea water. Thus, the volume of salt mixing with the molten core material will be significant. This will affect the composition of the "corium" that is ejected.

-----Original Message-----
From: Lee, Richard
Sent: Saturday, March 26, 2011 4:44 PM
To: Sheron, Brian
Cc: Uhle, Jennifer; Gibson, Kathy
Subject: RE: Sharing info. with DOE Science Council

No impact of salt. Because, 30 years ago, FCI experiments with ejection into salt water was conducted at SNL (because of floating NPPs been considered at that time).. No affect were found between salt water and clean water.

-----Original Message-----
From: Sheron, Brian
Sent: Saturday, March 26, 2011 4:40 PM
To: Lee, Richard
Cc: Uhle, Jennifer; Gibson, Kathy
Subject: RE: Sharing info. with DOE Science Council

Remember that the lower head is filled with sea salt. Thus, the melt that relocates to the lower head will be mixed with a lot of sea salt. Do we understand what impact the salt has (or doesn't have) on steam explosion dynamics?

-----Original Message-----
From: Lee, Richard
Sent: Saturday, March 26, 2011 4:10 PM
To: Sheron, Brian
Cc: Uhle, Jennifer; Gibson, Kathy
Subject: RE: Sharing info. with DOE Science Council

XX/55

Brian:

Attached is the preliminary FCI analysis that would like to provide to NRC Op Center in case question on FCI is received. If you are at the Op Center, please provide to them.

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Thanks, Richard

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Sent: Saturday, March 26, 2011 4:06 PM
To: Gibson, Kathy; Lee, Richard
Cc: Uhle, Jennifer
Subject: RE: Sharing info. with DOE Science Council

Richard, I agree with Kathy.

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From: Gibson, Kathy
Sent: Saturday, March 26, 2011 10:35 AM
To: Lee, Richard
Cc: Sheron, Brian; Uhle, Jennifer
Subject: Re: Sharing info. with DOE Science Council

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Thanks,
Kathy

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To: Gibson, Kathy
Sent: Sat Mar 26 09:09:19 2011
Subject: Sharing info. with DOE Science Council

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Your advise (and Brian Sheron one if you need to consult with him) is sought for us to share this FCI analysis with the Science Council through John Kelly This will give us some visibility on the pro-active analyses that are on-going at different labs directed by DOE.

Richard

From: Virgilio, Martin
Sent: Saturday, March 26, 2011 5:25 AM
To: Sanfilippo, Nathan
Cc: Miller, Charles; Grobe, Jack; Holahan, Gary; Borchardt, Bill
Subject: REPLY: Draft charter
Attachments: FW: Draft charter

Nathan

Thanks for sharing the draft charter.

Here are a few comments for your consideration.

Scope

Suggest you incorporate the list of Technical Issues to be Evaluated into the first bullet under item (a) and delete the section on page 2.

Suggest you add a bullet under item (a) "near term review" to include resource estimates and impacts on other work that will be associated with the implementing the recommended changes.

Suggest you clarify item (b). We are to provide recommendations around the more detailed assessments that should be undertaken in the longer term. To enable this effort we will need information from the sequence of events and the stakeholders. The bullets on interagency issues and applicability to non Rx licensees might be tasks that need to be accomplished under the longer term review.

Coordination

Suggest you expand the section on Coordination to be Coordination and Communications. Both the near term and the longer term efforts will require communication plans. Also suggest to include a bullet on resource estimates and impacts on other work that will be associated with the communications and coordination.

Staffing

Suggest that you acknowledge that the longer term review will be accomplished by ad hoc work groups, staffed by individuals on a part time bases and that we will develop resource estimates and impacts on other work as part of this project.

Marty

From: Sanfilippo, Nathan
Sent: Friday, March 25, 2011 4:45 PM
To: Miller, Charles; Grobe, Jack; Holahan, Gary
Subject: Draft charter

XX\56

For discussion on Monday morning.

Have a good weekend!
Nathan

Greenwood, Carol

From: Gibson, Kathy
Sent: Sunday, March 27, 2011 4:56 PM
To: Lee, Richard
Subject: Fw: Brian's Q

Fyi - I've been sending so much stuff to Brian I think he loses track of where it came from. ;-) thanks for your follow-up.

----- Original Message -----
From: Sheron, Brian
To: Gibson, Kathy
Cc: Tinkler, Charles
Sent: Sun Mar 27 15:56:05 2011
Subject: RE: Brian's Q

Thanks.

-----Original Message-----
From: Gibson, Kathy
Sent: Sunday, March 27, 2011 10:41 AM
To: Sheron, Brian
Cc: Tinkler, Charles
Subject: Fw: Brian's Q

----- Original Message -----
From: Lee, Richard
To: Hoxie, Chris; Uhle, Jennifer
Cc: Gibson, Kathy
Sent: Sun Mar 27 10:35:35 2011
Subject: RE: Brian's Q

Consulted both Mike and Dana on the matter - Salt effects on molten core materials:

From Mike Corradini:

This will not likely generate a more energetic effect. It will be a dilution to the melt composition and energy. Think of this like any solid that must be melted and mixes with the melt. So no effect there. So if it does stop the melt there with in-vessel retention (which I suspect it would), it would add to the melt volume as it remelts and mixes and dilutes the corium.

I would then expect it to lower the solidus temperature of the mixture. How much, I do not know, but we can see the effect on energetics by altering the solidus. Remember that the if we assume triggering (which we always do), steam explosions are a thermodynamic phenomenon altered minimally by local heat transfer.

XX/57

From: Dana Powers

Core debris will hit the salt and cause it to melt and vaporize. Some fraction of it will be incorporated into the core debris, but much will vaporize - removing heat from the core debris. Vaporized salt will condense on upper internals of the BWR vessel. Salt in the core debris will cause some vaporization of materials - including some fission products - as chlorides, but I would not expect the effect to be especially significant. Again vaporized chlorides will condense on upper internal surfaces.

From: Hoxie, Chris
Sent: Saturday, March 26, 2011 9:41 PM
To: Uhle, Jennifer
Cc: Lee, Richard; Gibson, Kathy
Subject: Brian's Q

In regards to Brian's question about how salt water may influence the dynamics of a fuel coolant interaction:

Here are two references:
http://www.iaea.org/inis/collection/NCLCollectionStore/_Public/42/006/42006251.pdf

On page 396, states that pure water vs. salt water made no difference in an experiment designed to measure peak pressures for fuel coolant interactions in a lab setting.

Reference 2:
Although it might not be one-for-one, here is a reference to research that indicates the salt might actually dampen the steam explosion (or at least it does maybe when lava hits sea water....)

Caveats: This reference 2 is not nuclear oriented. Not specific to the Japan case. This is really complex and should be answered by an expert. Depends so much on the actual conditions in the Japan plants...

At least I did not find anything that says salt makes things worse!

Impure coolants and interaction dynamics of phreatomagmatic eruptions

James D. L. WhiteE-mail The Corresponding Author, *

Geology Department, University of Otago P.O. Box 56, Dunedin 9015, New Zealand
Received 12 January 1996;
revised 18 June 1996;
accepted 18 June 1996. ;
Available online 26 February 1999.

Abstract

Phreatomagmatic eruptions resulting from interaction of magma with groundwater are common in many terrestrial settings, and their explosivity is widely accepted to result from fuel-coolant interaction (FCI) processes. Relatively little attention has been given to the precise nature of the volcanic settings in which phreatomagmatic FCI's take place, but several lines of evidence indicate that they almost inevitably involve mixing of magma with impure, sediment-laden water. Consideration of the effects of these impure coolants on the fuel-coolant interaction process suggests that: (1) impure coolants enhance the ability of magma to mix with large volumes of coolant; and (2) maximum unit-volume explosivity of FCI's is damped relative to interactions with pure water. It is probably unrealistic to back-calculate water-magma mass ratios for most, if not all, phreatomagmatic eruptions because: (1) effects of impure coolants on fragmentation efficiency and eruption explosivity are not

yet known; and (2) aspects of the vent environments in which phreatomagmatism occurs may influence fragmentation processes, explosive efficiency, and resultant particle populations as or more strongly than water-magma mass ratios. To estimate mass ratios for individual bursts, or for eruptions as a whole, one must distinguish particle populations resulting from many different processes in phreatomagmatic vents, including primary fragmentation, induced fragmentation, vent-wall collapse and pyroclast recycling. Incorporation of accidental blocks beyond the zone of phreatomagmatic interaction and ejection of unvaporized water further complicate efforts at reconstruction.

Greenwood, Carol

From: Gibson, Kathy
Sent: Sunday, March 27, 2011 10:42 AM
To: Gavrilas, Mirela
Subject: Fw: Brian's Q

Sorry should have copied you. Please add any insights from MCCI.

----- Original Message -----
From: Gibson, Kathy
To: Sheron, Brian
Cc: Tinkler, Charles
Sent: Sun Mar 27 10:41:09 2011
Subject: Fw: Brian's Q

----- Original Message -----
From: Lee, Richard
To: Hoxie, Chris; Uhle, Jennifer
Cc: Gibson, Kathy
Sent: Sun Mar 27 10:35:35 2011
Subject: RE: Brian's Q

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From: Hoxie, Chris
Sent: Saturday, March 26, 2011 9:41 PM
To: Uhle, Jennifer
Cc: Lee, Richard; Gibson, Kathy
Subject: Brian's Q

XX/58

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Cc: Tinkler, Charles
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XX/59

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From: E&E Publishing, LLC <ealerts@eenews.net>
Sent: Monday, March 28, 2011 7:41 AM
To: Virgilio, Martin
Subject: March 28 -- E&E Daily is ready

AN E&E PUBLISHING SERVICE

E&E DAILY -- MON., MARCH 28, 2011 -- Read the full edition

1. NUCLEAR CRISIS: Japanese reactors, U.S. safety to take center stage on Capitol Hill

Top U.S. nuclear regulators, scientists and industry leaders will flesh out details of the nuclear crisis unfolding in Japan and its implications for nuclear safety in the United States for key Senate and House energy committees this week. A series of hearings will kick off tomorrow when Nuclear Regulatory Commission Executive Director of Operations Bill Borchardt updates the Senate Energy and Natural Resources Committee about the status of the crippled Fukushima Daiichi nuclear reactors on Japan's northeastern coast.

IN THE SENATE

2. **ENERGY POLICY:** Senate panel to take up hydropower, water use measures
3. **MINE SAFETY:** Main says new legislation is crucial
4. **TOXICS:** Erin Brockovich to headline Senate hearing on environmental contaminants
5. **NUCLEAR:** Congress to probe int'l security measures, cleanup of Cold War sites
6. **WORKFORCE:** Senators focus on challenges facing federal agencies' senior execs
7. **NATIONAL PARKS:** Panel to review proposed land purchases, construction cuts
8. **AGRICULTURE:** Lawmakers will consider rising gas prices' effect on farmers
9. **ARMY CORPS:** Agency budget to undergo scrutiny, as some lawmakers push for WRDA
10. **GSA:** Senators to probe green building standards, sale of federal

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properties

IN THE HOUSE

11. **CLIMATE:** Head of controversial warming project to star at House hearing
12. **DOE:** GOP to grill agency officials over proposed hefty spending boosts
13. **OFFSHORE DRILLING:** House Resources to review BOEMRE budget, permitting plans
14. **RESEARCH:** Appropriators face tough decisions on R&D spending
15. **TRANSPORTATION:** Lawmakers gear up to grill DOT over funding for reauthorization proposal
16. **OIL AND GAS:** House Resources panel to continue probe of price spikes
17. **TRANSPORTATION:** Before beer, pizza and bill writing, T&I panel to hear from key groups
18. **NOAA:** Proposed cuts to tsunami warning systems may heat up House hearings
19. **REGULATIONS:** House GOP to continue attempt to unravel red tape
20. **WATER:** Lawmakers to weigh reform of nearly broke flood insurance program
21. **CHEMICAL SECURITY:** House panel to weigh extending DHS program
22. **OIL AND GAS:** Hearing to encourage Canadian oil amid wait on Keystone XL permit
23. **INNOVATION:** Small business programs hit spotlight as authorization clock ticks down
24. **CONSUMER PROTECTION:** House appropriators target CPSC budget amid criticism from GOP
25. **ENERGY POLICY:** House panel to explore energy potential on Indian lands

E&ETV'S ONPOINT

26. **EPA:** Bracewell & Giuliani's Segal says agency overstepping authority with 'Utility MACT' plan

THIS WEEK'S MARKUPS AND HEARINGS

CALENDAR: Activity for March 28 - April 1, 2011

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To send a press release, fax 202-737-5299 or e-mail editorial@eenews.net.

ABOUT E&E DAILY

Environment & Energy Daily (E&E Daily) is written and produced by the staff of E&E Publishing, LLC. Designed for policy players who need to know what's happening to their issues on Capitol Hill, from federal agency appropriations to comprehensive energy legislation, E&E Daily is the place insiders go to track their environmental and energy issues in Congress. E&E Daily publishes daily by 7:30 a.m. while Congress is in session.

From: E&E Publishing, LLC <ealerts@eenews.net>
Sent: Monday, March 28, 2011 12:54 PM
To: Virgilio, Martin
Subject: March 28 -- Greenwire is ready

AN E&E PUBLISHING SERVICE

GREENWIRE -- MON., MARCH 28, 2011 -- Read the full edition

1. CLIMATE: Enviro lawyers tied in knots over Calif. emissions ruling

A California court ruling suspending the implementation of the state's landmark climate change law came with a large dose of irony. That's because San Francisco County Superior Court Judge Ernest Goldsmith found that the state had failed to comply with another landmark law, one that is beloved by some of the same environmental groups that are critical of the ruling, the California Environmental Quality Act. Essentially, a major environmental initiative is under threat because the state failed to correctly carry out the appropriate environmental analysis.

TOP STORIES

2. **NATIONAL PARKS:** Supreme Court stays out of Joshua Tree landfill dispute
3. **DOE:** Raise for senior employees rescinded after rule violation
4. **POLITICS:** Ad campaigns take EPA debate to the airwaves

JAPAN EARTHQUAKE

5. **NUCLEAR CRISIS:** Japan disaster sparks push by Calif. port for federal dredging project
6. **DRINKING WATER:** High levels of contamination found in pipe leading out of plant
7. **NUCLEAR:** German companies plan suit over idled plants
8. **NUCLEAR CRISIS:** Japan struggles to keep public updated
9. **NUCLEAR POLICY:** Ties between regulators and industry criticized
10. **NUCLEAR CRISIS:** Reliance on old data left Japan's industry unprepared for disaster

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CONGRESS

11. **EPA:** Rust Belt voters support EPA carbon rules -- poll

POLITICS

12. **GERMANY:** Nuclear fears cost Merkel control of a key state

ENERGY

13. **SMART GRID:** N. Calif. protesters stake out, stalk meter installers
14. **OFFSHORE DRILLING:** BOEMRE approves 6th deepwater permit
15. **NATURAL GAS:** Pa. governor won't budge on gas tax

LAW AND LOBBYING

16. **CLIMATE:** Court considers delaying Texas challenge to EPA takeover
17. **ENDANGERED SPECIES:** 9th Circuit upholds fish protection in Calif. water battle
18. **URANIUM:** Ohio lawsuit over processing plant settled after two decades
19. **GULF RECOVERY:** Ex-FEMA supervisor indicted on fraud related to Katrina relief contract
20. **COAL:** Massey wins case over coal dust at W.Va. school

BUSINESS

21. **FINANCE:** Clean-tech developers fret over witching hour for DOE grants
22. **MARKETING:** 7 companies leave forest-certification program over 'greenwash' claims

AIR AND WATER

23. **COAL:** Scrubbers set to slash FirstEnergy plant's emissions
24. **WATER POLLUTION:** A little burst of energy helps germs break down pollutants

WASTES & HAZARDOUS SUBSTANCES

25. **TOXICS:** Uptick in disease clusters spurs calls for TSCA reform

NATURAL RESOURCES

26. **ENDANGERED SPECIES:** Indian tiger population climbs amid habitat lost to development

27. **PARKS:** Burt's Bees founder plans to donate land for national park

INTERNATIONAL

28. **LEAD:** Chinese plant manager faces environmental charges over poisoning

E&ETV'S ONPOINT

29. **EPA:** Bracewell & Giuliani's Segal says agency overstepping authority with 'Utility MACT' proposal

ABOUT GREENWIRE

Greenwire is written and produced by the staff of E&E Publishing, LLC. The one-stop source for those who need to stay on top of all of today's major energy and environmental action with an average of more than 20 stories a day, Greenwire covers the complete spectrum, from electricity industry restructuring to Clean Air Act litigation to public lands management. Greenwire publishes daily at Noon.

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E&E Publishing, LLC
122 C St., Ste. 722, NW, Wash., D.C. 20001.
Phone: 202-628-6500. Fax: 202-737-5299.
www.eenews.net

Subject:	EDO Alignment for 4/14 & 4/28 CM re: Japanese Earthquake Status - Focus on Health Effects of Radiation & Station Black-Out
Location:	O-17B4
Start:	Mon 3/28/2011 3:00 PM
End:	Mon 3/28/2011 4:00 PM
Recurrence:	(none)
Meeting Status:	Accepted
Organizer:	Borchardt, Bill
Required Attendees:	Virgilio, Martin; Weber, Michael; Ash, Darren; Muessle, Mary; ConferenceRoomO17B4 Resource

When: Monday, March 28, 2011 3:00 PM-4:00 PM (GMT-05:00) Eastern Time (US & Canada).
Where: O-17B4

Note: The GMT offset above does not reflect daylight saving time adjustments.

~~*~*~*~*~*~*~*~*

Rct 2/21

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Subject:	EDO Alignment for 4/14 & 4/28 CM re: Japanese Earthquake Status - Focus on Health Effects of Radiation & Station Black-Out
Location:	O-17B4
Start:	Mon 3/28/2011 3:00 PM
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Recurrence:	(none)
Meeting Status:	Meeting organizer
Organizer:	Borchardt, Bill
Required Attendees:	Virgilio, Martin; Weber, Michael; Ash, Darren; Muessle, Mary; ConferenceRoomO17B4 Resource

Rct 2/21

XX/63

Subject:	Task Force Alignment for 5/5/11 EDO Pre-Brief / Comissioner Briefings
Location:	O-17H10
Start:	Mon 5/2/2011 3:00 PM
End:	Mon 5/2/2011 4:00 PM
Recurrence:	(none)
Meeting Status:	Meeting organizer
Organizer:	Virgilio, Martin
Required Attendees:	Miller, Charles; Holahan, Gary; Sanfilippo, Nathan; Grobe, Jack; Davidson, Cynthia; Cubbage, Amy; Dorman, Dan; ConferenceRoomO17B4 Resource
Optional Attendees:	Ruland, William; NRR_ET_Activity Resource; Westreich, Barry; Cheok, Michael; Schwarz, Sherry
Categories:	Blue Category

4/22/11 Rescheduled from 4/26/11 to 5/2/11 New date for EDO PreBrief 5/5/11 SCianci

4/1/11 Rescheduled. EDO pre-brief rescheduled to 5/2/11 at 3pm Scianci

Purpose: Task Force Alignment for the 5/2/11 EDO Pre-Brief Re: Commission Meeting 5/12/11 30 day Quick Look Following the Events in Japan

*****Please ensure you are prepared to discuss presentation slides and background information with Marty*****

3/29/11

Sandy Cianci
Administrative Assistant to Marty Virgilio, DEDR
Office of the Executive Director for Operations
O-17 H13
301-415-1714
sandra.cianci@nrc.gov

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Subject:	Task Force Alignment for 6/8/11 EDO Pre-Brief
Location:	O-17B4
Start:	Tue 6/7/2011 10:00 AM
End:	Tue 6/7/2011 11:00 AM
Recurrence:	(none)
Meeting Status:	Meeting organizer
Organizer:	Virgilio, Martin
Required Attendees:	Miller, Charles; Sanfilippo, Nathan; Davidson, Cynthia; Holahan, Gary; Grobe, Jack; Cubbage, Amy; Dorman, Dan; ConferenceRoomO17B4 Resource
Optional Attendees:	Cianci, Sandra
Categories:	Blue Category

5/19/11- Rescheduled from 5/31 to 6/7/11 SCianci x1714

4/21/11- Rescheduled to 5/31/11 at 2pm due to Memorial Day Holiday. Thank you

Purpose: Task Force Alignment for the 6/2/11 EDO Pre-Brief Re: Commission Meeting 6/16/11 Task Force Review – 60 Day Quick Look Following the Events in Japan

*****Please ensure you are prepared to discuss presentation slides and background information with Marty*****

3/29/11

Sandy Cianci
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XX/65

From: E&E Publishing, LLC <ealerts@eenews.net>
Sent: Tuesday, March 29, 2011 1:20 PM
To: Virgilio, Martin
Subject: March 29 -- Greenwire is ready

AN E&E PUBLISHING SERVICE

GREENWIRE -- TUE., MARCH 29, 2011 -- Read the full edition

1. BIOFUELS: As algae bloom fades, photosynthesis hopes still shine

Few stories in the energy business are as seductive as that of algae biofuels. Using sunlight, CO2 and little else, many varieties of fast-growing pond scum, when starved of nutrients, quickly build up oil in their cells. They need no external sugar from corn or cane to grow, so they don't compete with food crops. Farmed in ponds or translucent reactors, microalgae can be raised on cheap, sun-splashed land that is unsuitable for crops or much of anything else. That was the idea, anyway, of a host of startups that launched into algae fuels over the past half decade. Often ignorant of algae's biology, these companies stumbled into major physical and engineering hurdles that can derail most of their lofty goals, industry and government experts say. Even the most promising approaches are a decade or more away, experts say. By then, many firms will have failed.

TOP STORIES

2. **CLIMATE:** EPA votes expected tomorrow morning
3. **CLIMATE:** Drafter of California cap and trade stands by analysis
4. **NUCLEAR CRISIS:** Japan lessons might spur call for immediate U.S. reactor changes -- NRC official

JAPAN EARTHQUAKE

5. **NUCLEAR CRISIS:** New concerns for emergency workers as plutonium detected in soil
6. **ELECTRICITY:** Reduced generating capacity in Japan requires rolling blackouts
7. **NUCLEAR CRISIS:** U.S. plants face risk of core damage from extended blackouts
8. **NUCLEAR CRISIS:** Tokyo Electric executive's whereabouts stoke

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confusion, anger

CONGRESS

9. **POLITICS:** Republicans' EPA fight could create problems later, insiders say
10. **OFFSHORE DRILLING:** Hastings offers bills to spur oil and gas development
11. **PESTICIDES:** GOP criticism of salmon bi-ops draws enviro rebuke
12. **RENEWABLE ENERGY:** CEOs urge continued funding for loan guarantee program
13. **LOBBYING:** Former House Science chairman joins law firm

CLEAN TECH

14. **NATIONAL LABS:** New DOE program seeks 'next top energy innovator'
15. **WIND:** Turbine is a teaching tool at Va. school

ENERGY

16. **UTILITIES:** EPA cooling-water proposal disappoints enviro groups

LAW AND LOBBYING

17. **OBITUARY:** Federal judge is remembered for vigorous dissent in mountaintop case
18. **GULF SPILL:** BP managers could face manslaughter charges
19. **OIL AND GAS:** New judge panel appointed to reconsider Chevron suit
20. **OIL AND GAS:** API adds former TV reporter to media shop

FEDERAL AGENCIES

21. **DOE:** Decision to rescind pay raises affected 220 senior executives

AIR AND WATER

22. **AIR POLLUTION:** Calif. court rejects shipping industry challenge of offshore rules
23. **WATER:** Calif. governor to declare drought is officially over

WASTES & HAZARDOUS SUBSTANCES

24. **PESTICIDES:** Court extends deadline for EPA water permitting

NATURAL RESOURCES

25. **ENDANGERED SPECIES:** Judge reverses Interior's decision to delist flying squirrel

26. **FISHERIES:** U.S. blue crab importers agree to size restrictions to curb overfishing

INTERNATIONAL

27. **BIOTECH:** E.U. scraps ban on food from clones

28. **WILDLIFE:** Mexican police net 4,725 wild animals, plants in trafficking bust

E&ETV'S SPECIAL REPORT

29. **ENERGY POLICY:** Lawmakers, analysts discuss challenges to crafting and passing a CES

ABOUT GREENWIRE

Greenwire is written and produced by the staff of E&E Publishing, LLC. The one-stop source for those who need to stay on top of all of today's major energy and environmental action with an average of more than 20 stories a day, Greenwire covers the complete spectrum, from electricity industry restructuring to Clean Air Act litigation to public lands management. Greenwire publishes daily at Noon.

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Phone: 202-628-6500. Fax: 202-737-5299.
www.eenews.net

From: Virgilio, Martin
Sent: Tuesday, March 29, 2011 5:57 PM
To: Sanfilippo, Nathan
Cc: Borchardt, Bill
Subject: FW: Charter memo
Attachments: Task force charter memo.doc

Importance: High

Nathan

Looks good to me. We just need the OK from the chairman on the Charter.

Marty

From: Sanfilippo, Nathan
Sent: Tuesday, March 29, 2011 11:10 AM
To: Virgilio, Martin
Subject: Charter memo
Importance: High

Marty,

Attached is the cover memo for the charter.. We welcome your comment.

Thanks,
Nathan

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MEMORANDUM TO: Martin J. Virgilio
Deputy Executive Director
for Reactor and Preparedness Programs
Executive Director for Operations

Charles L. Miller
Director
Office of Federal and State Materials
and Environmental Management Programs

FROM: R. W. Borchardt
Executive Director for Operations

SUBJECT: AGENCY TASK FORCE TO CONDUCT NEAR-TERM EVALUATION OF THE NEED FOR AGENCY ACTIONS FOLLOWING THE EVENTS IN JAPAN

On March 11th, 2011, Japan experienced a severe earthquake resulting in the shutdown of multiple reactors. It appears that the reactors' response to the earthquake went according to design. At the Fukushima Daiichi site, the earthquake caused the loss of normal AC power. In addition, it appears that the ensuing tsunami caused the loss of emergency AC power at the Fukushima Daiichi site. Subsequent events caused damage to fuel and radiological releases offsite.

The purpose of this memorandum is to task the Deputy Executive Director for Reactor and Preparedness Programs (DEDR) to convene an agency task force of U.S. Nuclear Regulatory (NRC) senior leaders and experts. The task force should conduct a methodical and systematic review of relevant NRC regulatory requirements, programs, and processes, and their implementation, to recommend whether the agency should make near-term improvements to our regulatory system. The task force should also identify a framework and topics for review and assessment for the longer-term effort.

Attached is a charter for the task force. The charter defines the objective, scope, coordination and communication, expected products, schedule, staffing, and EDO interface. The task force should update the Commission on the near-term review at approximately 30 and 60 days, and provide its observations, findings, and recommendations in the form of a written report and briefing at the completion of the near-term effort occurring at approximately 90 days.

The review should be conducted in accordance with Tasking Memorandum – COMGBJ-11-0002, "NRC Actions Following the Events in Japan."

CONTACT: Nathan T. Sanfilippo, OEDO
301-415-3951

DISTRIBUTION:

WDean, RI	VMcCree, RII	MSatorius, RIII	ECollins, RIV
ELeeds, NRR	CHaney, NMSS	SMoore, FSME	MDoane, OIP
BSheron, RES	HBell, OIG	EBrenner, OPA	SBurns, OGC
RSchmidt, OCA	RZimmerman, OE	MJohnson, NRO	JWiggins, NSIR
MWeber, DEDMRT			

ADAMS:

OFFICE:	OEDO/Task Force	FSME/Task Force Lead	EDO/DEDR	EDO
NAME:	NSanfilippo	CMiller	MVirgilio	RWBorchardt
DATE:				

OFFICIAL RECORD COPY

From: Virgilio, Martin
Sent: Tuesday, March 29, 2011 11:37 AM
To: Jaczko, Gregory
Cc: Coggins, Angela; Batkin, Joshua; Miller, Charles; Borchardt, Bill; Loyd, Susan; Brenner, Eliot
Subject: Task Force Charter
Attachments: Draft charter.docx

Importance: High

Chairman

Attached is the final draft of our Task Force Charter. We would appreciate your approval. Should you have any comments or want to discuss this proposal Charlie, Bill or I will make ourselves available.

As an aside, we are working with OPA on a communications plan and roll out strategy.

Marty

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CHARTER FOR THE NUCLEAR REGULATORY COMMISSION TASK FORCE

TO CONDUCT A NEAR-TERM EVALUATION OF THE NEED FOR AGENCY ACTIONS

FOLLOWING THE EVENTS IN JAPAN

Objective

The objective of this task force is to conduct a methodical and systematic review of relevant NRC regulatory requirements, programs, and processes, and their implementation, to recommend whether the agency should make near-term improvements to our regulatory system. This task force will also identify a framework and topics for review and assessment for the longer-term effort.

Scope

The task force review will include the following:

a. A near-term review to:

- Evaluate currently available technical and operational information from the events that have occurred at the Fukushima Daiichi nuclear complex in Japan to identify potential or preliminary near-term/immediate operational or regulatory actions affecting domestic reactors of all designs, including their spent fuel pools. The task force will evaluate, at a minimum, the following technical issues and determine priority for further examination and potential agency action:
    - External event issues (e.g. seismic, flooding, fires, severe weather)
    - Station blackout
    - Severe accident measures (e.g., combustible gas control, emergency operating procedures, severe accident management guidelines)
    - 10 CFR 50.54 (hh)(2) which states, "Each licensee shall develop and implement guidance and strategies intended to maintain or restore core cooling, containment, and spent fuel pool cooling capabilities under the circumstances associated with loss of large areas of the plant due to explosions or fire, to include strategies in the following areas: (i) Fire fighting; (ii) Operations to mitigate fuel damage; and (iii) Actions to minimize radiological release." Also known as B.5.b.
    - Emergency preparedness (e.g., radiological protection, emergency planning zones, dose projections and modeling, protective actions)
    - Incident response (e.g., communications, command and control, roles and responsibilities of NRC, federal, state, local governments, and industry organizations)

- Develop recommendations, as appropriate, for potential changes to NRC's regulatory requirements, programs, and processes, and recommend whether generic communications, orders, or other regulatory actions are needed.

b. Recommendations for the content, structure, and estimated resource impact for the longer-term review.

Coordination and Communications

The near-term task force will:

- Solicit stakeholder input as appropriate, but remain independent of industry efforts.
- Coordinate and cooperate where applicable with other domestic and international efforts reviewing the events in Japan for additional insights.
- Provide recommendations to the Commission for any immediate policy issues identified prior to completion of the near-term review.
- Provide recommendations to program offices for any immediate actions not involving policy issues, prior to completion of the near-term review.
- Identify resource implications of near-term actions.
- Consider information gained from Temporary Instruction 2515/183, "Followup to the Fukushima Daiichi Nuclear Station Fuel Damage Events."
- Develop a communications plan.
- Update and brief internal stakeholders, as appropriate.

Expected Product and Schedule

The task force will provide its observations, conclusions, and recommendations in the form of a written report to the Deputy Executive Director for Reactor and Preparedness Programs at the completion of the 90-day near-term review.

During the development of its report, the task force will brief the Commission on the status of the review at approximately the 30- and 60-day points

The report will be transmitted to the Commission via a SECY paper, and the task force will brief the Commission on the results of the near-term effort at approximately the 90-day point. The report will be released to the public via normal Commission processes.

The task force will recommend a framework for a longer-term review as a part of the near-term report. The longer-term review will begin as soon as the NRC has sufficient technical information from the events in Japan (with a goal of beginning by the end of the near-term review).

Staffing

The task force will consist of the following members:

Leader	Charles Miller	FSME
Senior Managers	Daniel Dorman	NMSS
	Jack Grobe	NRR
	Gary Holahan	NRO
Senior Staff	Amy Cubbage	NRO
	Nathan Sanfilippo	OEDO
Administrative Assistant	Cynthia Davidson	OGC

Additional task force members will be added as needed. For the near-term review, other staff members may be consulted on a part-time basis.

<u>EDO Interface</u>

The task force will keep agency leadership informed on the status of the effort and provide early identification of significant findings. The task force will report to Martin J. Virgilio, Deputy Executive Director for Reactor and Preparedness Programs.

From: E&E Publishing, LLC <ealerts@eenews.net>
Sent: Wednesday, March 30, 2011 1:31 PM
To: Virgilio, Martin
Subject: March 30 -- Greenwire is ready

AN E&E PUBLISHING SERVICE

GREENWIRE -- WED., MARCH 30, 2011 -- Read the full edition

1. ENERGY POLICY: Obama urges expanded U.S. energy production, expresses confidence in nuclear

In a speech packed with pleas to move past Capitol Hill gridlock, President Obama outlined "reasonable, achievable and necessary" plans today for reducing imports of foreign oil. "When I was elected to this office, America imported 11 million barrels of oil a day. By a little more than a decade from now, we will have cut that by one-third. That is something that we can achieve," Obama declared at Georgetown University.

TOP STORIES

2. **CLIMATE:** As Senate prepares to vote, Stabenow adds EPA amendment to the mix
3. **NUCLEAR CRISIS:** Move U.S. spent fuel out of pools -- Feinstein
4. **EPA:** New director plans shakeup of laggard chemical-risk system

CONGRESS

5. **BUDGET:** Democratic senators plead with White House to fight EPA riders
6. **ENERGY POLICY:** Bingaman optimistic about CES despite limited time for Senate action
7. **OFFSHORE DRILLING:** Lawmakers spar over pace of development, funding request
8. **MINING:** Celebrity chefs serve up Bristol Bay salmon to protest Alaska project

JAPAN EARTHQUAKE

9. **NUCLEAR CRISIS:** National Academies warn against earthquake complacency

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10. **NUCLEAR CRISIS:** High radiation detected in seawater near Japan plant

11. **NUCLEAR:** Ariz. plant details disaster preparedness plans

12. **UTILITIES:** Japan considers nationalizing Tokyo Electric

ENERGY

13. **OIL AND GAS:** Industry sends regulatory wish list to Interior

14. **ELECTRICITY:** February cold shut down a quarter of Texas power units

LAW AND LOBBYING

15. **ENDANGERED SPECIES:** Only Indians can use eagle feathers for religious practices, court rules

16. **TOXICS:** Battle over PCBs in NYC schools appears headed for court

17. **AGRICULTURE:** Farmers sue Monsanto over threat of GM crop contamination

AIR AND WATER

18. **AIR POLLUTION:** Mont. to revise oil and gas permitting rules

WASTES & HAZARDOUS SUBSTANCES

19. **CHEMICALS:** Eliminating packaged food can lower BPA levels by 60% -- study

NATURAL RESOURCES

20. **GRAND CANYON:** BLM extends comment period for proposed mining moratorium

21. **GULF SPILL:** Observed dolphin deaths just tip of iceberg -- study

TRANSPORTATION

22. **ELECTRIC CARS:** Tesla sues BBC over alleged fake 'Top Gear' scene

E&ETV'S ONPOINT

23. **ENERGY POLICY:** Pew's Cuttino discusses new research on G-20 clean energy investments

To send a press release, fax 202-737-5299 or e-mail editorial@eenews.net.

ABOUT GREENWIRE

Greenwire is written and produced by the staff of E&E Publishing, LLC. The one-stop source for those who need to stay on top of all of today's major energy and environmental action with an average of more than 20 stories a day, Greenwire covers the complete spectrum, from electricity industry restructuring to Clean Air Act litigation to public lands management. Greenwire publishes daily at Noon.

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Phone: 202-628-6500. Fax: 202-737-5299.
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Subject: Weekly Status Update (Marty, Charlie)
Location: O-17H10

Start: Tue 6/7/2011 9:30 AM
End: Tue 6/7/2011 10:00 AM

Recurrence: (none)

Meeting Status: Meeting organizer

Organizer: Virgilio, Martin
Required Attendees: Miller, Charles

Categories: Green Category

Task Force- Japan Events

3/30/11

Sandy Cianci
Administrative Assistant to Marty Virgilio, DEDR
Office of the Executive Director for Operations
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301-415-1714
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Greenwood, Carol

From: Gibson, Kathy
Sent: Wednesday, March 30, 2011 11:26 AM
To: Lee, Richard; Armstrong, Kenneth
Cc: Wagner, Katie; Tinkler, Charles
Subject: Re: Request for Ops Center RTS support

Resending

From: Gibson, Kathy
To: RST06 Hoc; Lee, Richard
Cc: Wagner, Katie
Sent: Wed Mar 30 06:52:07 2011
Subject: Re: Request for Ops Center RTS support

Richard Lee is our POC with the Ops Center. Please contact him for any assistance you need. I cc'd him on this email.

From: RST06 Hoc
To: Cheok, Michael; Gibson, Kathy
Cc: Ruland, William; Dudes, Laura; Uhle, Jennifer; Hiland, Patrick; Hackett, Edwin; Skeen, David; RST01 Hoc; Hoc, PMT12; McDermott, Brian; Coe, Doug; Scott, Michael; RST01 Hoc
Sent: Tue Mar 29 23:01:43 2011
Subject: RE: Request for Ops Center RTS support

Please see below.

From: Brown, Frederick
Sent: Tuesday, March 29, 2011 10:56 PM
To: Cheok, Michael; Gibson, Kathy
Cc: Ruland, William; Dudes, Laura; Uhle, Jennifer; Hiland, Patrick; Hackett, Edwin; Skeen, David; RST01 Hoc; Hoc, PMT12; McDermott, Brian; Coe, Doug; Scott, Michael; Brown, Frederick; RST01 Hoc
Subject: Request for Ops Center RTS support
Importance: High

Mike, Kathy

First, I'm not sure that you two are the right folks to ask, but I know that you'll know where this should go.

I'd like to have folks with the right skill set look at two issues (the two are inter-related, but the first may be easier to give a quick answer to without the work that the second will take):

1) Given the known, or assumed, status of the three units and four pools, what realistic scenarios exist for energetic dispersion of high quantities of radioactive material that would result in mobile plumes? The point of this question is that there are many clear scenarios that present significant near-area radiological challenges, but given the time since shutdown (for the operating units) and age of much of the fuel (in the SFPs) what are the remaining scenarios of concern with respect to more distant locations (Tokyo with a large concentration of US citizens, Alaska, Hawaii, etc).

2) Given the assumed condition of the three units and four pools, can we generate basic event trees for the coming weeks/months? The point would be to identify key success criteria and to help identify key decision points/risk factors to be balanced (qualitative not quantitative analysis). For instance, take two units, each with

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significant core damage and prior release of volatile fission products, each with primary and secondary containment failure, but one with an intact RPV and the other with a breach of RPV - would there be a difference in potential releases that would lead to different strategies for flooding the primary containment of these two units? This question will make more sense if you look at the assumed conditions below and the attached assessment document where we recommend that TEPCO utilize the SAMG recommendation to flood all 3 units' containments.

Note that the intent is to limit this activity to hours and days, not weeks or years. Once we validate the concept of this evaluation, we can turn it over to US industry for further action/development.

Assumed status (slightly different than the status in the attached assessment):

Unit 1 Rx: Shutdown 3/11. 70% core damage. Cooling with 30 gpm. Significant salt deposits in vessel, core spay plugged. Primary pressure 65 psig. Drywell pressure 25 psig. Secondary containment destroyed. Containment has been vented at least once since fuel damage occurred. Attempting to establish Nitrogen purge prior to resuming venting.

Unit 2 Rx: Shutdown 3/11. 30% core damage. Significant salt deposits in vessel/drywell. Assumed RPV breach, with at least some core ex-vessel that ocurred approximately 3/15. Primary containment breached in the torus. Secondary containment breached. Significant release of volatile fission products has occurred through both airborne release and also via water drainage out of the Rx building.

Unit 3 Rx: same assumptions as Unit 2, but do not assume RPV failure and location of primary containment breach may be the drywell.

SFP 1: 292 bundles. Pool intact. All fuel at least 12 years old. No secondary containment. Rubble on top of pool. Water can be added through external spray. Now at saturation temperature.

SFP 2: 587 bundles. Pool intact. Water added to the point of pool over-flow. Pool had reached saturation temperature at one time.

SFP 3: 548 bundles. ¼ core offload previous refueling. No checker boarding of hotter fuel. Structural damage to pool area suspected. Pool leakage possible. External addition of water has been made repeatedly, but flooding of pool may not be possible due to damage.

SFP 4: 1331 bundles. Full core offload about 120 days ago. No checker boarding of hotter fuel. Structural damage to pool area is known to exist, and structure may not support a full pool weight load. Pool leakage likely, requiring addition of water periodically. Pool was likely dry enough to have cladding/water reaction which produced enough hydrogen to lead to catastrophic explosion that destroyed secondary containment.

Subject:	Weekly Status Update (Marty, Charlie)
Location:	O-17H10
Start:	Mon 6/13/2011 1:30 PM
End:	Mon 6/13/2011 2:00 PM
Recurrence:	(none)
Meeting Status:	Meeting organizer
Organizer:	Virgilio, Martin
Required Attendees:	Miller, Charles
Categories:	Green Category

6/1/11 Rescheduled to Monday 6/13/11 at 4pm Scianci x1714

Task Force – Japan Events

3/30/11

Sandy Cianci
Administrative Assistant to Marty Virgilio, DEDR
Office of the Executive Director for Operations
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XX/72

From:	Sanfilippo, Nathan
Sent:	Thursday, March 31, 2011 3:43 PM
To:	Batkin, Joshua; Bubar, Patrice; Sosa, Belkys; Sharkey, Jeffry; Nieh, Ho
Cc:	Borchardt, Bill; Miller, Charles; Virgilio, Martin; Muessle, Mary; Andersen, James; Landau, Mindy
Subject:	Near-term Task Force Charter
Attachments:	Task Force Memo.pdf; Task Force Charter.pdf
Importance:	High

Commission EAs:

Attached is a copy of the near-term task force memo and charter that was approved by the EDO late yesterday (ADAMS Package ML11089A050). These documents are being declared in ADAMS and will soon be available to the public. Either later today or tomorrow an internal yellow announcement and an external press release will be issued.

Given my role as an ETA and as a member of the task force, I'll likely be a good point of contact for Commission questions about our activities.

Thanks,
Nathan

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March 30, 2011

MEMORANDUM TO: Martin J. Virgilio
Deputy Executive Director
for Reactor and Preparedness Programs
Executive Director for Operations

Charles L. Miller, Director
Office of Federal and State Materials
and Environmental Management Programs

FROM: R. W. Borchardt ***/RA/***
Executive Director for Operations

SUBJECT: AGENCY TASK FORCE TO CONDUCT NEAR-TERM EVALUATION OF THE NEED FOR AGENCY ACTIONS FOLLOWING THE EVENTS IN JAPAN

On March 11th, 2011, Japan experienced a severe earthquake resulting in the shutdown of multiple reactors. It appears that the reactors' response to the earthquake went according to design. At the Fukushima Daiichi site, the earthquake caused the loss of normal AC power. In addition, it appears that the ensuing tsunami caused the loss of emergency AC power at the Fukushima Daiichi site. Subsequent events caused damage to fuel and radiological releases offsite.

The purpose of this memorandum is to task the Deputy Executive Director for Reactor and Preparedness Programs (DEDR) to convene an agency task force of U.S. Nuclear Regulatory (NRC) senior leaders and experts. The task force should conduct a methodical and systematic review of relevant NRC regulatory requirements, programs, and processes, and their implementation, to recommend whether the agency should make near-term improvements to our regulatory system. The task force should also identify a framework and topics for review and assessment for the longer-term effort.

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The review should be conducted in accordance with Tasking Memorandum – COMGBJ-11-0002, "NRC Actions Following the Events in Japan."

Enclosure: As stated

CONTACT: Nathan T. Sanfilippo, OEDO
301-415-3951

March 30, 2011

MEMORANDUM TO: Martin J. Virgilio
Deputy Executive Director
for Reactor and Preparedness Programs
Executive Director for Operations

Charles L. Miller, Director
Office of Federal and State Materials
and Environmental Management Programs

FROM: R. W. Borchardt ***/RA/***
Executive Director for Operations

SUBJECT: AGENCY TASK FORCE TO CONDUCT NEAR-TERM EVALUATION OF THE NEED FOR AGENCY ACTIONS FOLLOWING THE EVENTS IN JAPAN

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Enclosure: As stated

CONTACT: Nathan T. Sanfilippo, OEDO
301-415-3951

ADAMS Package: ML11089A050

OFFICE:	OEDO/Task Force	FSME/Task Force Lead	EDO/DEDR	EDO
NAME:	NSanfilippo	CMiller	MVirgilio (ELeeds for)	RWBorchardt
DATE:	03/30/11	03/30/11	03/30/11	03/30/11

OFFICIAL RECORD COPY

CHARTER FOR THE NUCLEAR REGULATORY COMMISSION TASK FORCE

TO CONDUCT A NEAR-TERM EVALUATION OF THE NEED FOR AGENCY ACTIONS

FOLLOWING THE EVENTS IN JAPAN

Objective

The objective of this task force is to conduct a methodical and systematic review of relevant NRC regulatory requirements, programs, and processes, and their implementation, to recommend whether the agency should make near-term improvements to our regulatory system. This task force will also identify a framework and topics for review and assessment for the longer-term effort.

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a. A near-term review to:

- Evaluate currently available technical and operational information from the events that have occurred at the Fukushima Daiichi nuclear complex in Japan to identify potential or preliminary near-term/immediate operational or regulatory actions affecting domestic reactors of all designs, including their spent fuel pools. The task force will evaluate, at a minimum, the following technical issues and determine priority for further examination and potential agency action:
    - External event issues (e.g. seismic, flooding, fires, severe weather)
    - Station blackout
    - Severe accident measures (e.g., combustible gas control, emergency operating procedures, severe accident management guidelines)
    - 10 CFR 50.54 (hh)(2) which states, "Each licensee shall develop and implement guidance and strategies intended to maintain or restore core cooling, containment, and spent fuel pool cooling capabilities under the circumstances associated with loss of large areas of the plant due to explosions or fire, to include strategies in the following areas: (i) Fire fighting; (ii) Operations to mitigate fuel damage; and (iii) Actions to minimize radiological release." Also known as B.5.b.
    - Emergency preparedness (e.g., emergency communications, radiological protection, emergency planning zones, dose projections and modeling, protective actions)
- Develop recommendations, as appropriate, for potential changes to NRC's regulatory requirements, programs, and processes, and recommend whether generic communications, orders, or other regulatory actions are needed.

b. Recommendations for the content, structure, and estimated resource impact for the longer-term review.

Coordination and Communications

The near-term task force will:

- Solicit stakeholder input as appropriate, but remain independent of industry efforts.
- Coordinate and cooperate where applicable with other domestic and international efforts reviewing the events in Japan for additional insights.
- Provide recommendations to the Commission for any immediate policy issues identified prior to completion of the near-term review.
- Provide recommendations to program offices for any immediate actions not involving policy issues, prior to completion of the near-term review.
- Identify resource implications of near-term actions.
- Consider information gained from Temporary Instruction 2515/183, "Followup to the Fukushima Daiichi Nuclear Station Fuel Damage Events."
- Develop a communications plan.
- Update and brief internal stakeholders, as appropriate.

Expected Product and Schedule

The task force will provide its observations, conclusions, and recommendations in the form of a written report to the Deputy Executive Director for Reactor and Preparedness Programs at the completion of the 90-day near-term review.

During the development of its report, the task force will brief the Commission on the status of the review at approximately the 30- and 60-day points.

The report will be transmitted to the Commission via a SECY paper, and the task force will brief the Commission on the results of the near-term effort at approximately the 90-day point. The report will be released to the public via normal Commission processes.

The task force will recommend a framework for a longer-term review as a part of the near-term report. The longer-term review will begin as soon as the NRC has sufficient technical information from the events in Japan (with a goal of beginning by the end of the near-term review).

Staffing

The task force will consist of the following members:

Leader	Charles Miller	FSME
Senior Managers	Daniel Dorman	NMSS
	Jack Grobe	NRR
	Gary Holahan	NRO
Senior Staff	Amy Cubbage	NRO
	Nathan Sanfilippo	OEDO
Administrative Assistant	Cynthia Davidson	OGC

Additional task force members will be added as needed. For the near-term review, other staff members may be consulted on a part-time basis.

EDO Interface

The task force will keep agency leadership informed on the status of the effort and provide early identification of significant findings. The task force will report to Martin J. Virgilio, Deputy Executive Director for Reactor and Preparedness Programs.

From: E&E Publishing, LLC <ealerts@eenews.net>
Sent: Friday, April 01, 2011 1:13 PM
To: Virgilio, Martin
Subject: April 1 -- Greenwire is ready

AN E&E PUBLISHING SERVICE

GREENWIRE -- FRI., APRIL 1, 2011 -- Read the full edition

1. GULF SPILL: Transocean rejects agency subpoenas for Macondo probe

The owner of the Deepwater Horizon rig that exploded and sank last April, causing the worst oil spill in U.S. history, rejected official requests yesterday to have company employees testify at federal hearings investigating the disaster. Steven Roberts, counsel for the Houston-based Transocean Ltd., told the Bureau of Ocean Energy Management, Regulation and Enforcement that the company is unable to compel employees James Kent and Jay Odenwald to testify and that they would instead be represented by their personal attorneys.

TOP STORIES

2. **SENATE:** No GOP environmental riders allowed in budget deal -- Reid
3. **CLIMATE:** House to vote next week on EPA bill as Senate dithers
4. **WHITE HOUSE:** Obama touts partnership to clean commercial fleets

JAPAN EARTHQUAKE

5. **NUCLEAR CRISIS:** TEPCO will review radiation data after disclosing analysis problem
6. **NUCLEAR CRISIS:** U.S. officials assure that West Coast milk with radiation is safe
7. **NUCLEAR SAFETY:** NRC steps up inspections at 3 reactors

ENERGY

8. **MINING:** Company to open Ore. chromite mine as project foes press lawsuit
9. **NATURAL GAS:** Pa. violation approval policy is only temporary -- state officials
10. **NUCLEAR POWER:** Vt. utility pulls back from power purchase over safety

XX\14

concerns

FEDERAL AGENCIES

11. **EPA:** Environmental justice panel dives into Gulf Coast restoration

AIR AND WATER

12. **AIR POLLUTION:** High levels of lead detected outside of Chicago school
13. **AIR POLLUTION:** EPA to require Pa. plant to curb emissions reaching N.J.
14. **WATER POLLUTION:** Mich. city accepts $26.5M contamination settlement
15. **WATER POLLUTION:** W.Va. judge allows suit against coal companies to continue

NATURAL RESOURCES

16. **NATIONAL PARKS:** Watchdog presses NPS over religious displays at parks
17. **AGRICULTURE:** Death of bats could mean billions in losses for farmers

WASTES & HAZARDOUS SUBSTANCES

18. **E-WASTE:** N.Y. launches sweeping, mandatory recycling program
19. **CHEMICALS:** Jury says Calif. plant contaminated air, water

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Greenwood, Carol

From: Gibson, Kathy
Sent: Friday, April 01, 2011 7:23 PM
To: Tinkler, Charles
Subject: Fw: ACTION: DRAFT PMT request to RES-RST

Baby steps

From: PMT09 Hoc
To: Gibson, Kathy
Cc: Hoc, PMT12
Sent: Fri Apr 01 19:13:06 2011
Subject: RE: ACTION: DRAFT PMT request to RES-RST

Kathy

The MELCOR source term was received and sent to DOE NITOPS and NARAC on March 31, 2011 at 10:12 pm. (NARAC takes direction from NITOPS)

PMT discussed the status of this calculation with DOE at about 5 pm tonight and we learned that the White House had not yet directed that the run be made.

Steve LaVie
Radiological Assessment Assistant Director
Protective Measures Team
U.S. Nuclear Regulatory Commission

From: Hoc, PMT12
Sent: Friday, April 01, 2011 1:51 PM
To: PMT09 Hoc
Subject: FW: ACTION: DRAFT PMT request to RES-RST

From: Gibson, Kathy
Sent: Friday, April 01, 2011 1:50 PM
To: RST01 Hoc; RST07 Hoc; PMT01 Hoc; Hoc, PMT12
Cc: Tinkler, Charles; Schaperow, Jason; Lee, Richard
Subject: Re: ACTION: DRAFT PMT request to RES-RST

Please verify that this source term was received. Also was it sent to NARAC or actually used for any dose projections by PMT or NARAC? We would be interested in the results. Thanks.

From: Schaperow, Jason
To: RST01 Hoc; RST07 Hoc; RST08 Hoc; PMT01 Hoc; Hoc, PMT12
Cc: Tinkler, Charles; Uhle, Jennifer; Gibson, Kathy; Sheron, Brian
Sent: Thu Mar 31 15:37:59 2011
Subject: RE: ACTION: DRAFT PMT request to RES-RST

XX\75

The attached information is provided by RES in response to a PMT request of 3/30/11 to provide a realistic, up-to-date estimation of source terms for dose projections to address future potential radiological releases from the Fukushima Unit 1 reactor and the Unit 4 spent fuel pool.

From: Tinkler, Charles
Sent: Wednesday, March 30, 2011 10:10 AM
To: Schaperow, Jason
Subject: FW: ACTION: DRAFT PMT request to RES-RST
Importance: High

From: PMT01 Hoc
Sent: Wednesday, March 30, 2011 9:39 AM
To: Esmaili, Hossein; Tinkler, Charles; Lee Col
Cc: Lee, Richard; Hoc, PMT12; PMT01 Hoc; PMT11 Hoc; PMT02 Hoc
Subject: ACTION: DRAFT PMT request to RES-RST
Importance: High

Attached for your comment.
Request input ASAP.

Contacts:
Tony Huffert
Rich Clement
PMT – NRC Ops Center
301-816-5402

Greenwood, Carol

From: Gibson, Kathy
Sent: Friday, April 01, 2011 5:56 PM
To: Chang, Richard
Subject: Fw: Good info.
Attachments: Fukuchima_eng_20110320.pps

Richard,
I'm sending info that has timelines of accident progression at Fukushima.

From: Uhle, Jennifer
To: Johnson, Michael; Sheron, Brian; Gibson, Kathy
Sent: Sun Mar 27 02:37:04 2011
Subject: FW: Good info.

From: OST01 HOC
Sent: Saturday, March 26, 2011 11:49 PM
To: Miller, Chris; Uhle, Jennifer; Virgilio, Martin
Cc: FOIA Response.hoc Resource
Subject: FW: Good info.

Gives a good description of the accident progression on all of the units.

Steve Campbell
EST Coordinator

From: Jervey, Richard
Sent: Saturday, March 26, 2011 11:15 PM
To: OST01 HOC; RST02 Hoc
Subject: FW: Good info.

Regards,

R. A. Jervey
RES/DE/RGDB
CS2A07
301/251-7404

XX/76

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The Fukushima Daiichi Incident

1. Plant Design
2. Accident Progression
3. Radiological releases
4. Spent fuel pools
5. Sources of Information

Matthias Braun
PEPA4-G, AREVA–NP GmbH
Matthias.Braun@AREVA.com

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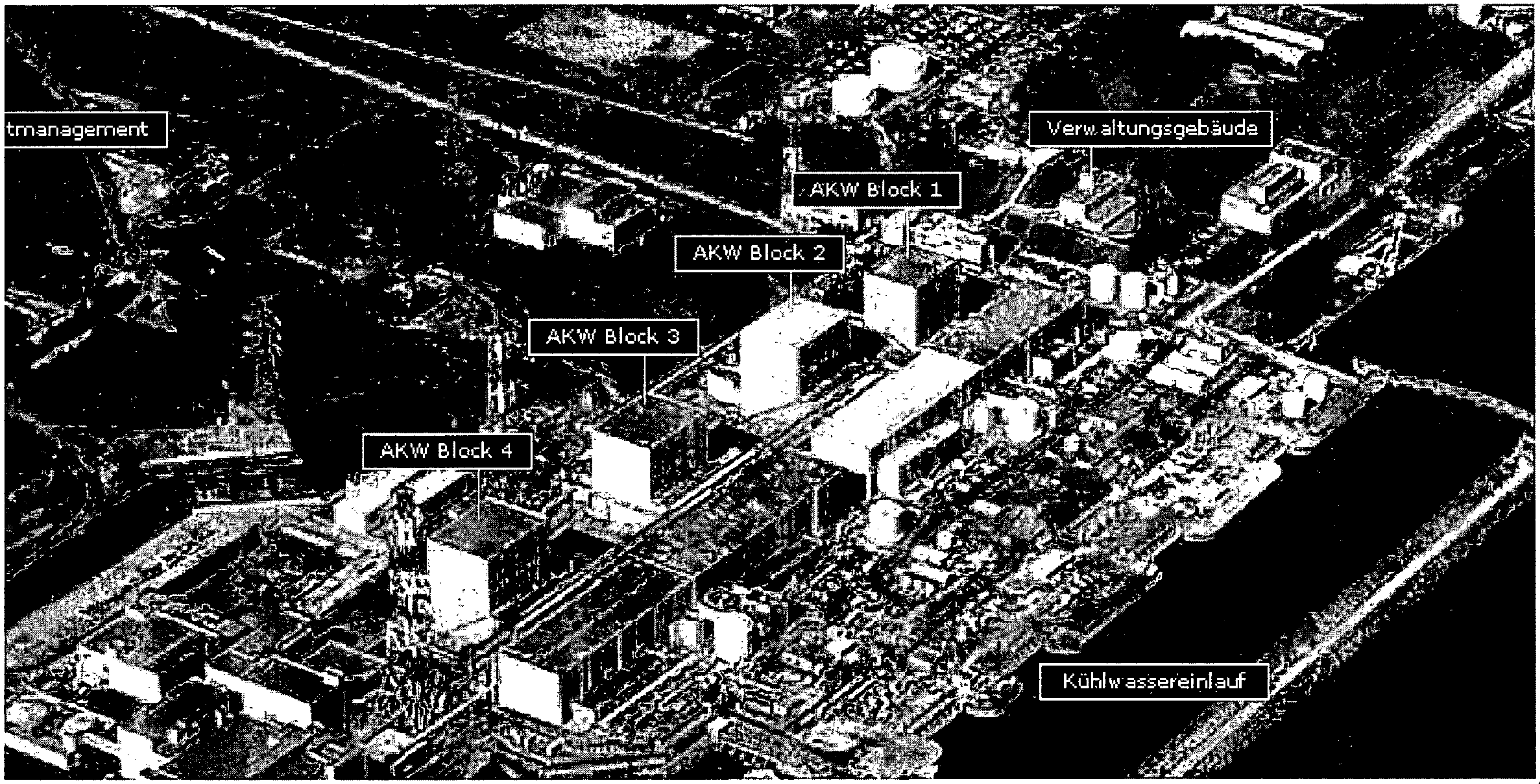
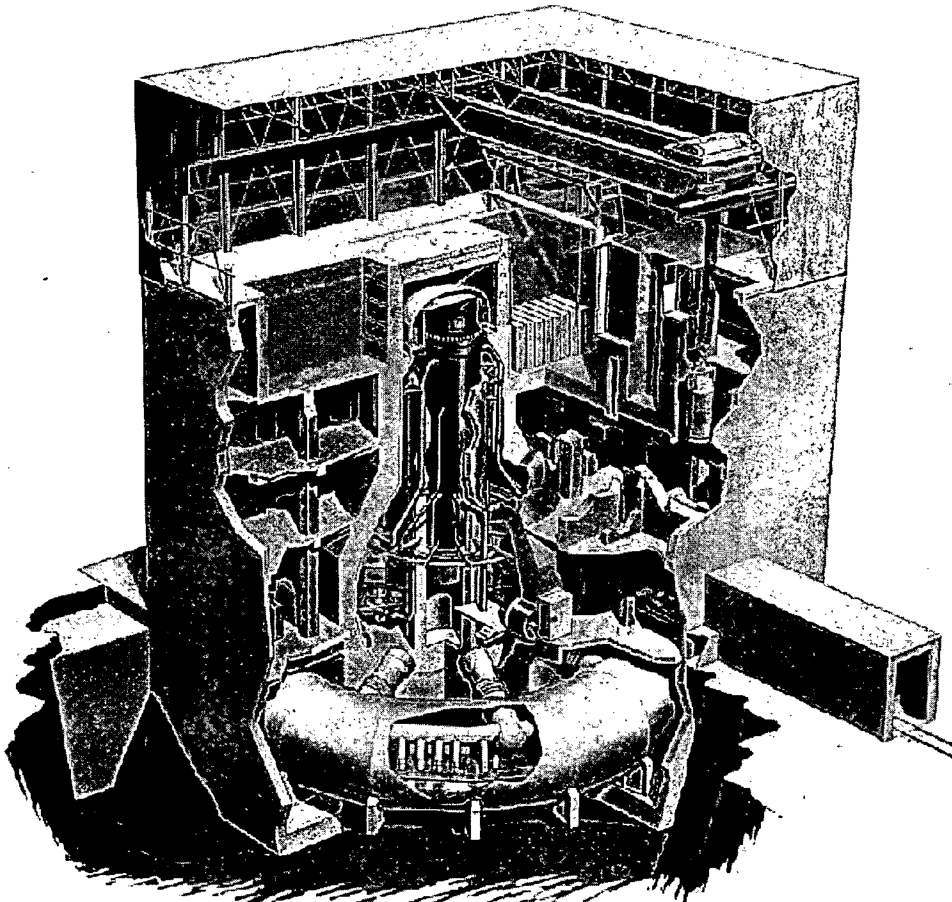
The Fukushima Daiichi Incident
1. Plant Design

- **Fukushima Daiichi (Plant I)**
  - **Unit I - GE Mark I BWR (439 MW), Operating since 1971**
  - **Unit II-IV - GE Mark I BWR (760 MW), Operating since 1974**



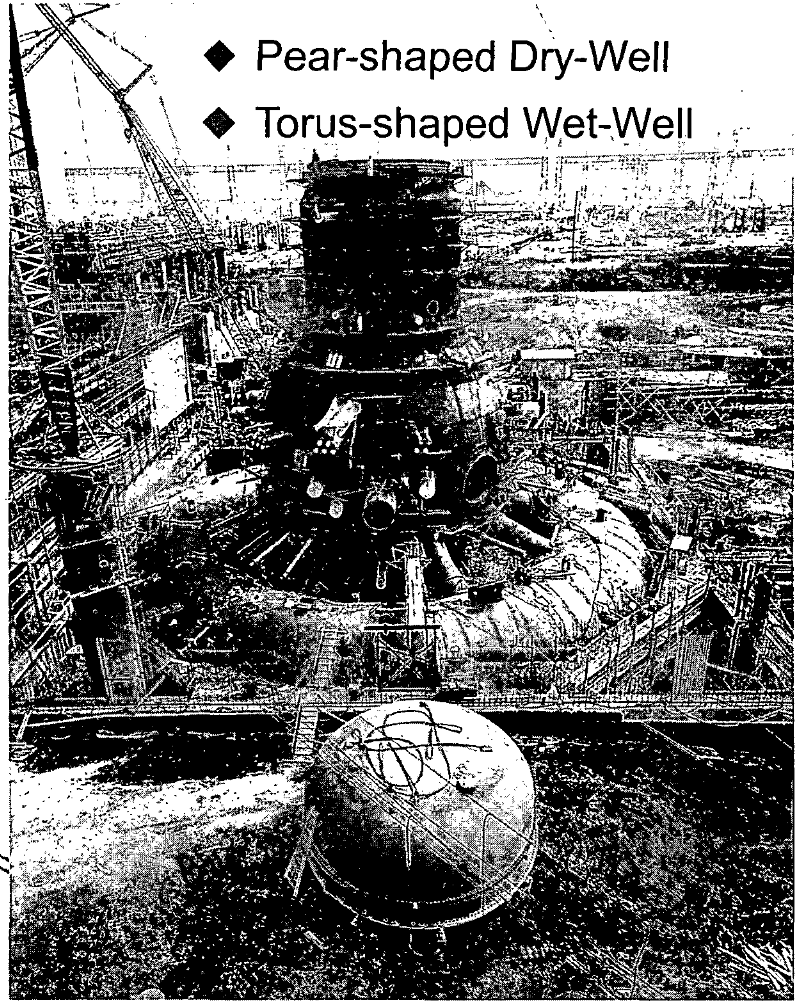
The Fukushima Daiichi Incident
1. Plant Design

- Building structure
  - Concrete Building
  - Steel-framed Service Floor



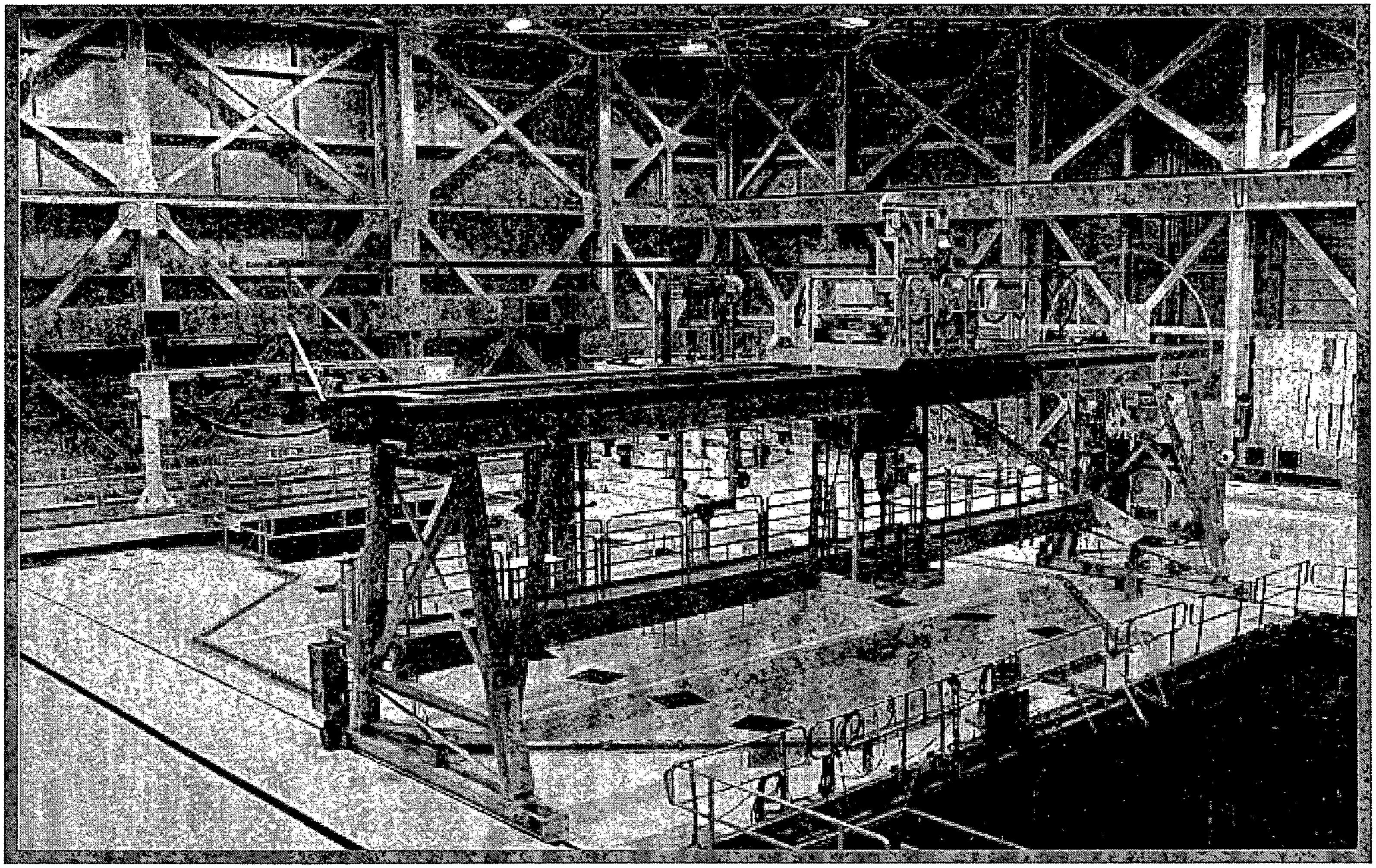
nucleartourist.com

- Containment
  - Pear-shaped Dry-Well
  - Torus-shaped Wet-Well

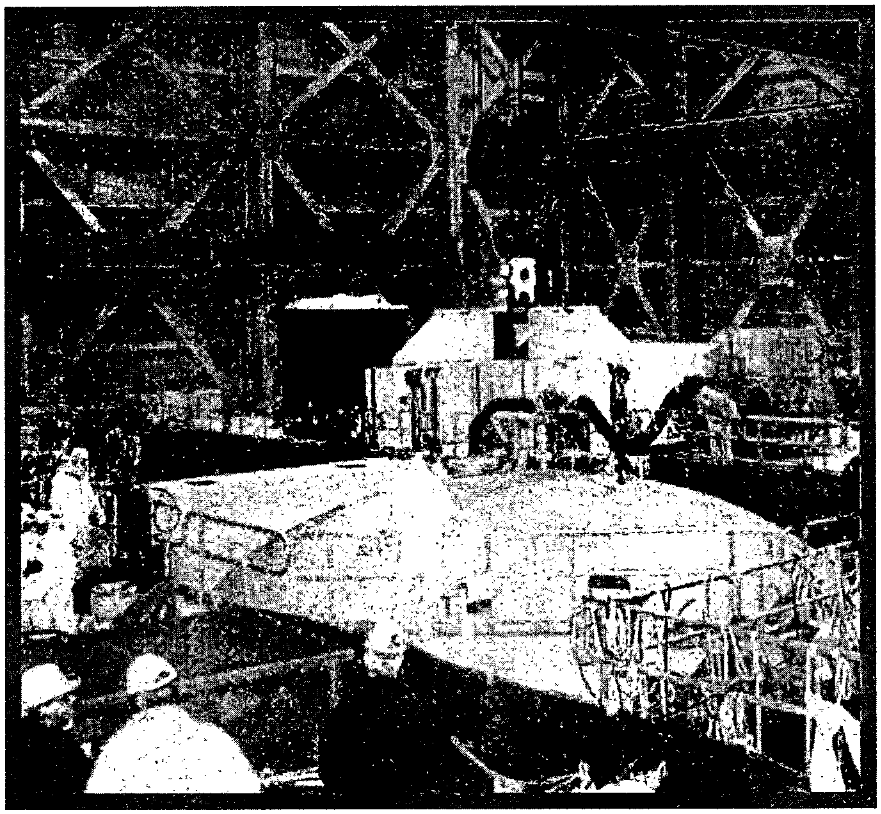


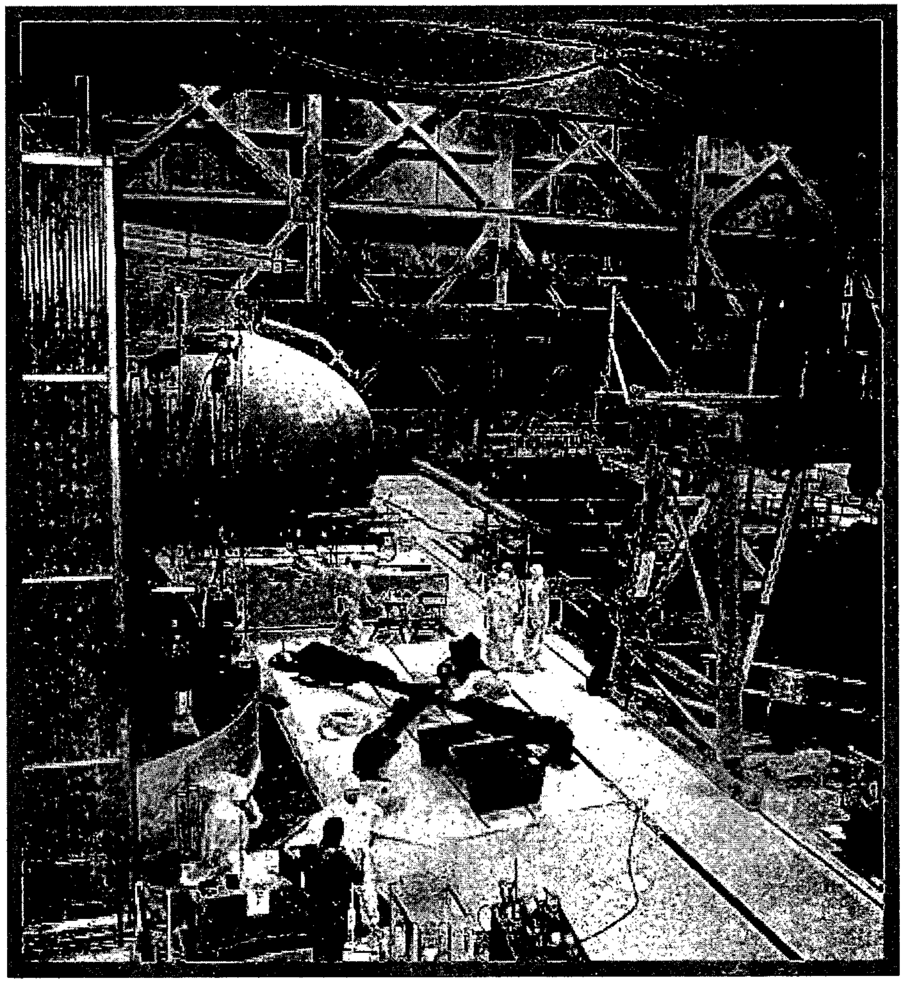
en.wikipedia.org/wiki/Browns_Ferry_Nuclear_Power_Plant

▶ Service Floor



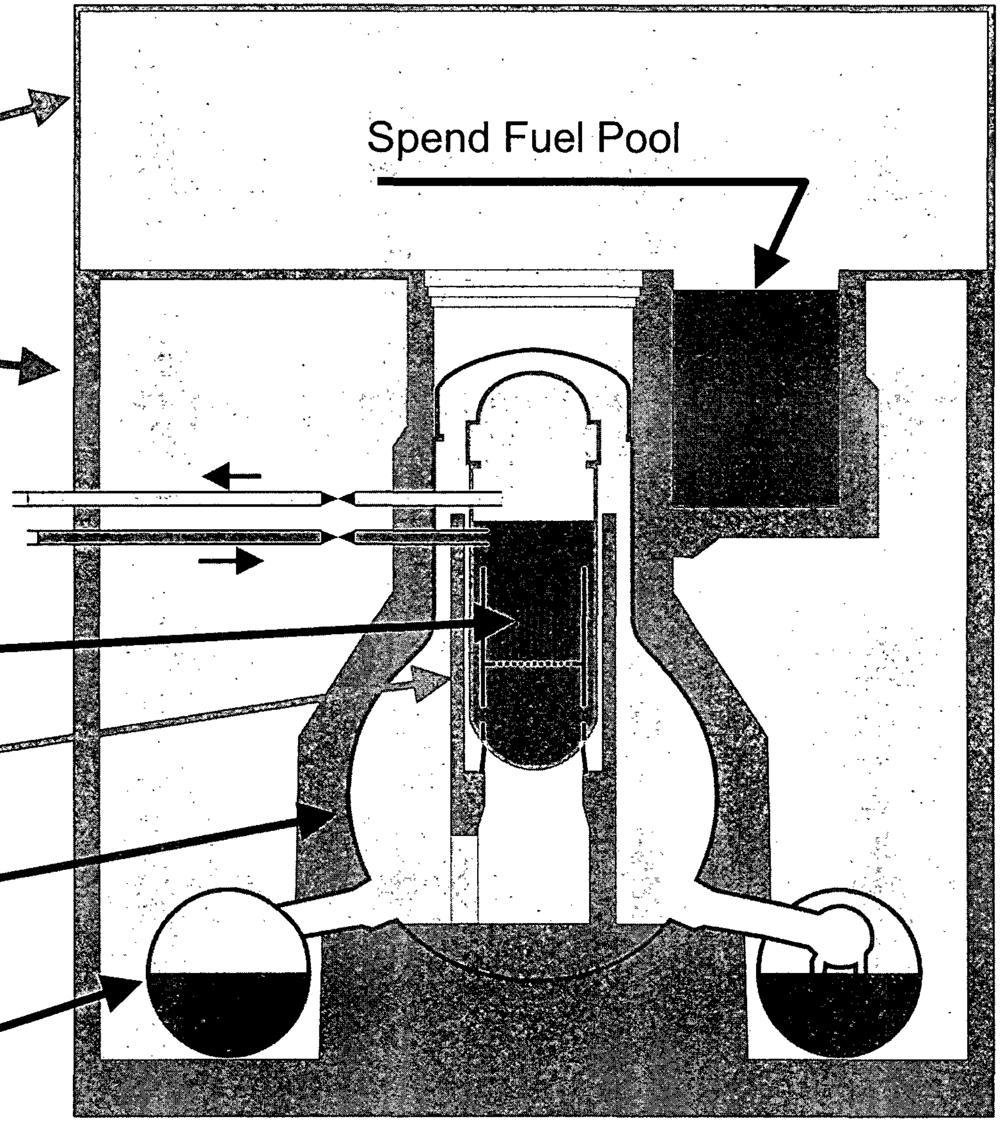
- Lifting the Containment closure head





The Fukushima Daiichi Incident
1. Plant Design

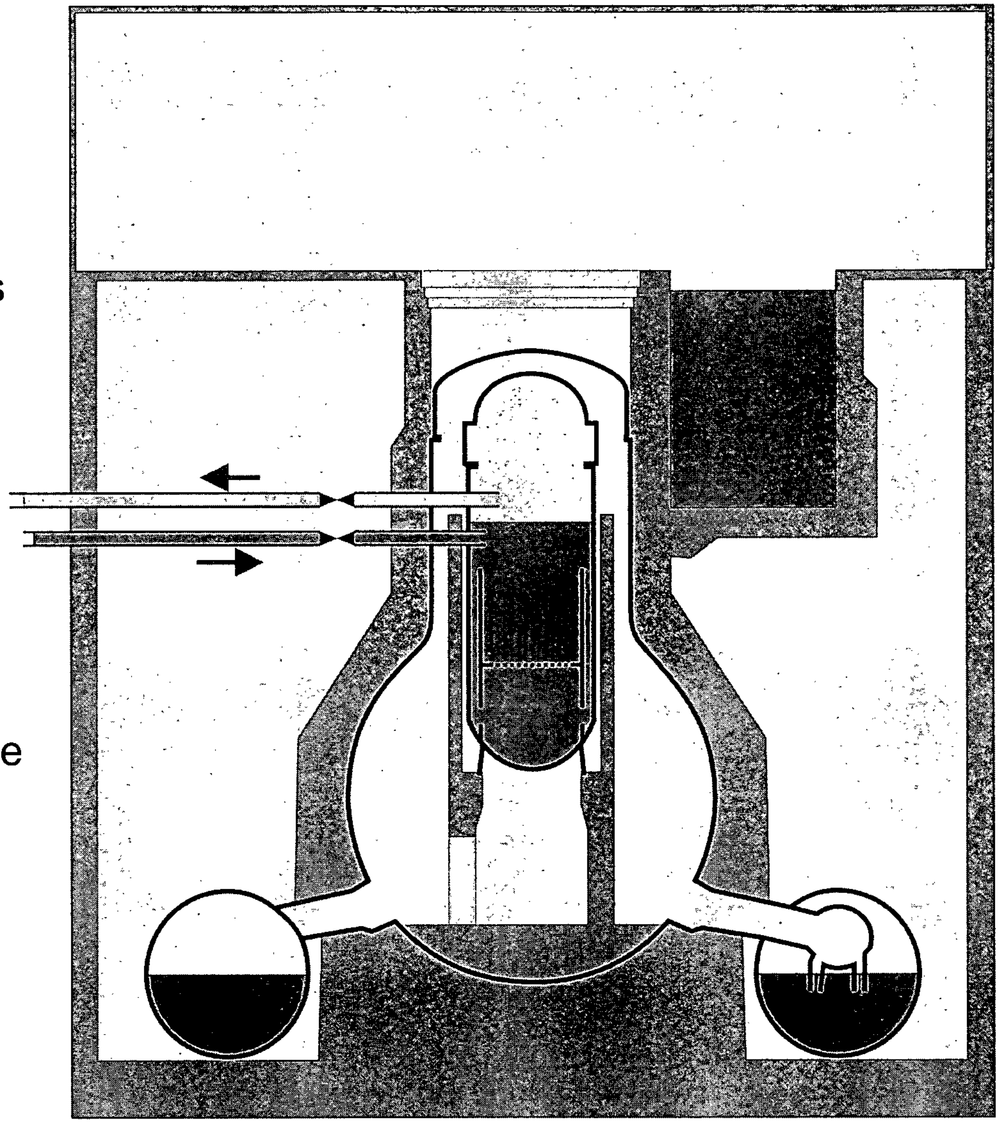
- Reactor Service Floor (Steel Construction)
- Concrete Reactor Building (secondary Containment)
- Reactor Core
- Reactor Pressure Vessel
- Containment (Dry well)
- Containment (Wet Well) / Condensation Chamber



The Fukushima Daiichi Incident
2. Accident progression

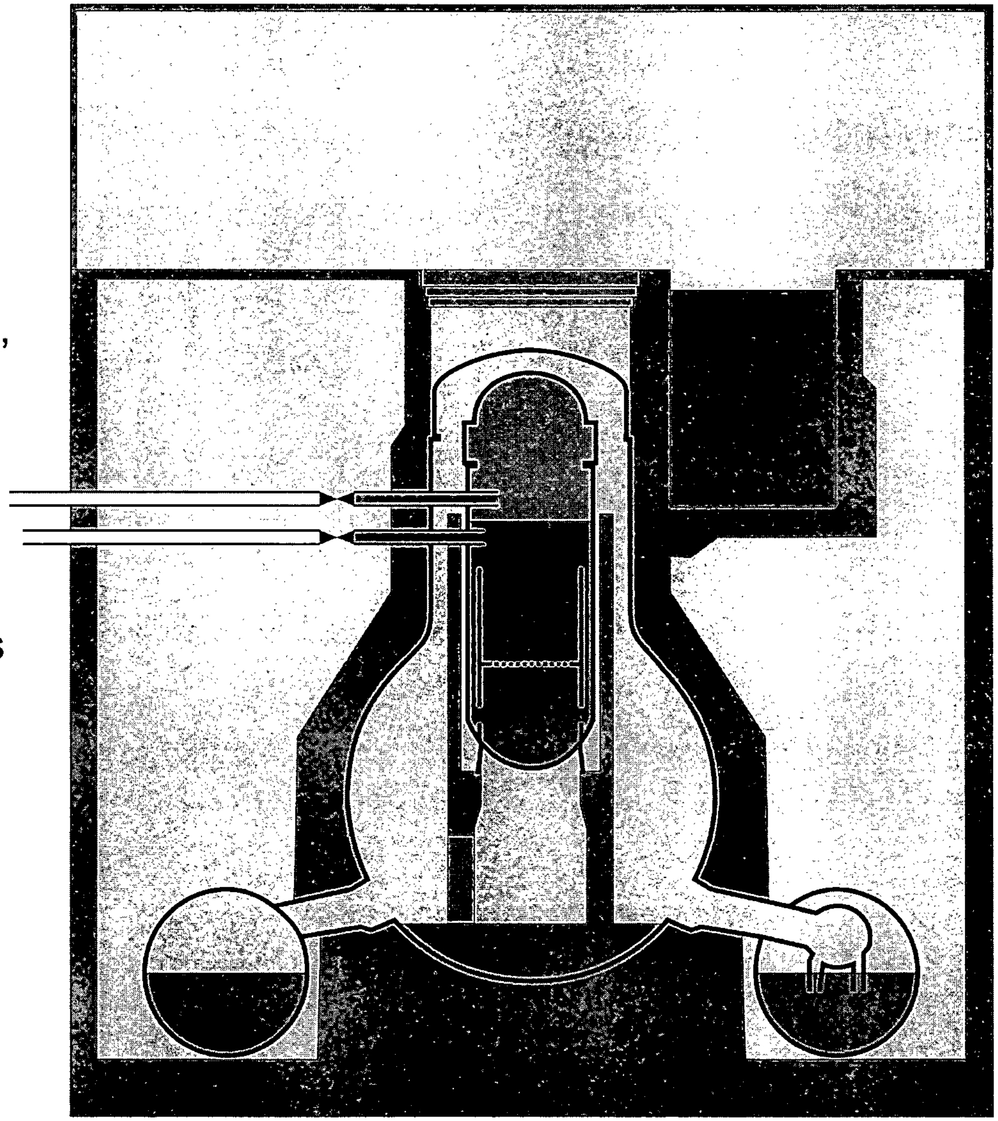
- 11.3.2011 14:46 - Earthquake
  - Magnitude 9
  - Power grid in northern Japan fails
  - Reactors itself are mainly undamaged

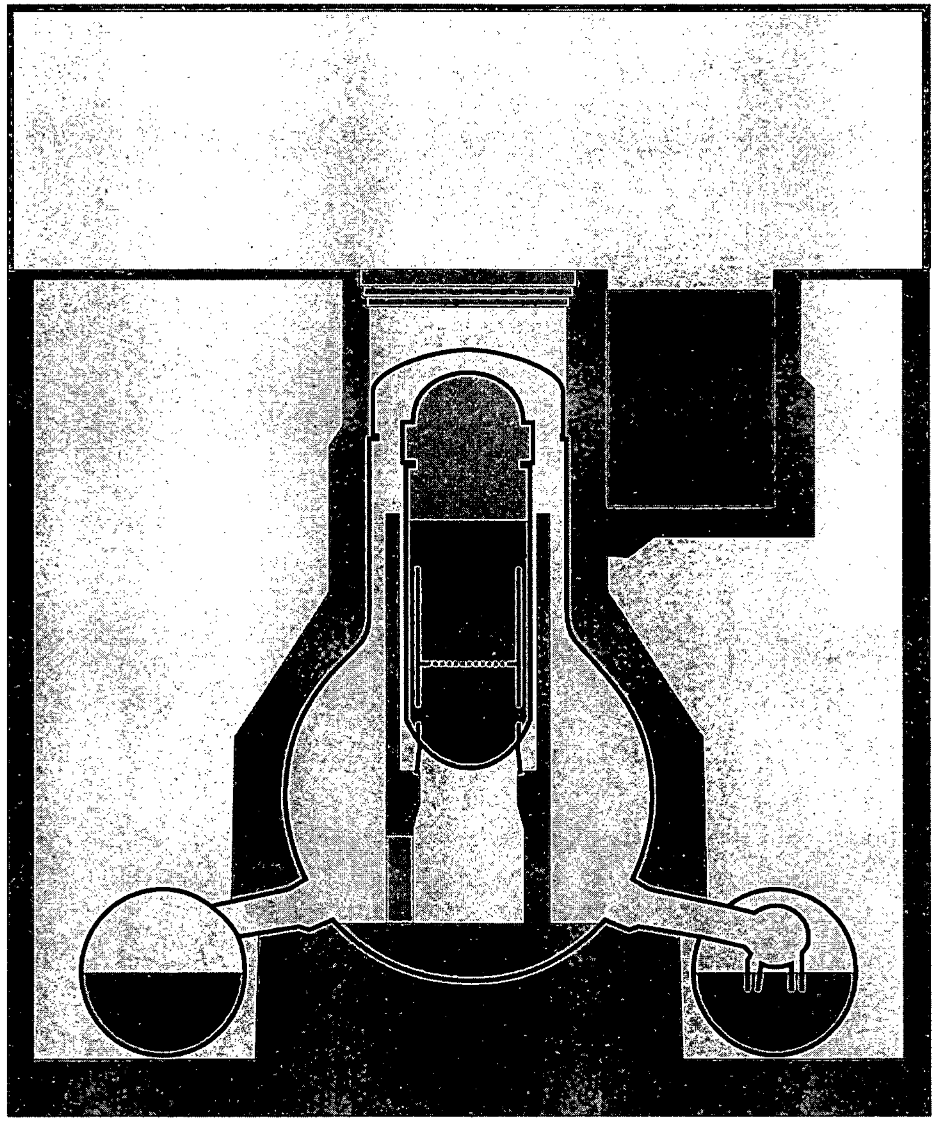
- SCRAM
  - Power generation due to Fission of Uranium stops
  - Heat generation due to radioactive Decay of Fission Products
    - After Scram ~6%
    - After 1 Day ~1%
    - After 5 Days ~0.5%



The Fukushima Daiichi Incident
2. Accident progression

- Containment Isolation
  - Closing of all non-safety related Penetrations of the containment
  - Cuts off Machine hall
  - If containment isolation succeeds, a large early release of fission products is highly unlikely
- Diesel generators start
  - Emergency Core cooling systems are supplied
- Plant is in a stable save state





- 11.3. 15:41 Tsunami hits the plant
  - Plant Design for Tsunami height of up to 6.5m
  - Actual Tsunami height >7m
  - Flooding of
    - Diesel Generators and/or
    - Essential service water building cooling the generators
- Station Blackout
  - Common cause failure of the power supply
  - Only Batteries are still available
  - Failure of all but one Emergency core cooling systems

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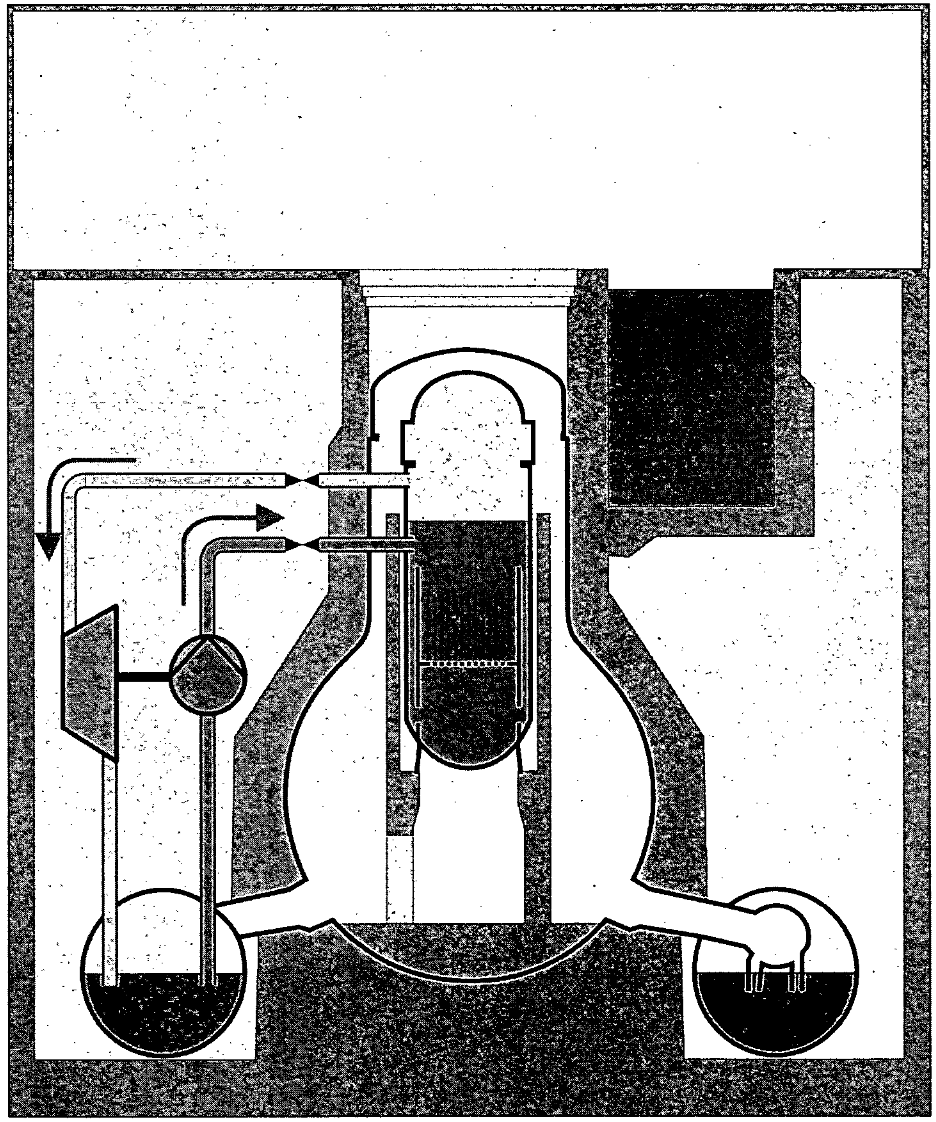
- Reactor Core Isolation Pump still available
  - Steam from the Reactor drives a Turbine
  - Steam gets condensed in the Wet-Well
  - Turbine drives a Pump
  - Water from the Wet-Well gets pumped in Reactor
  - Necessary:
    - Battery power
    - Temperature in the wet-well must be below 100°C

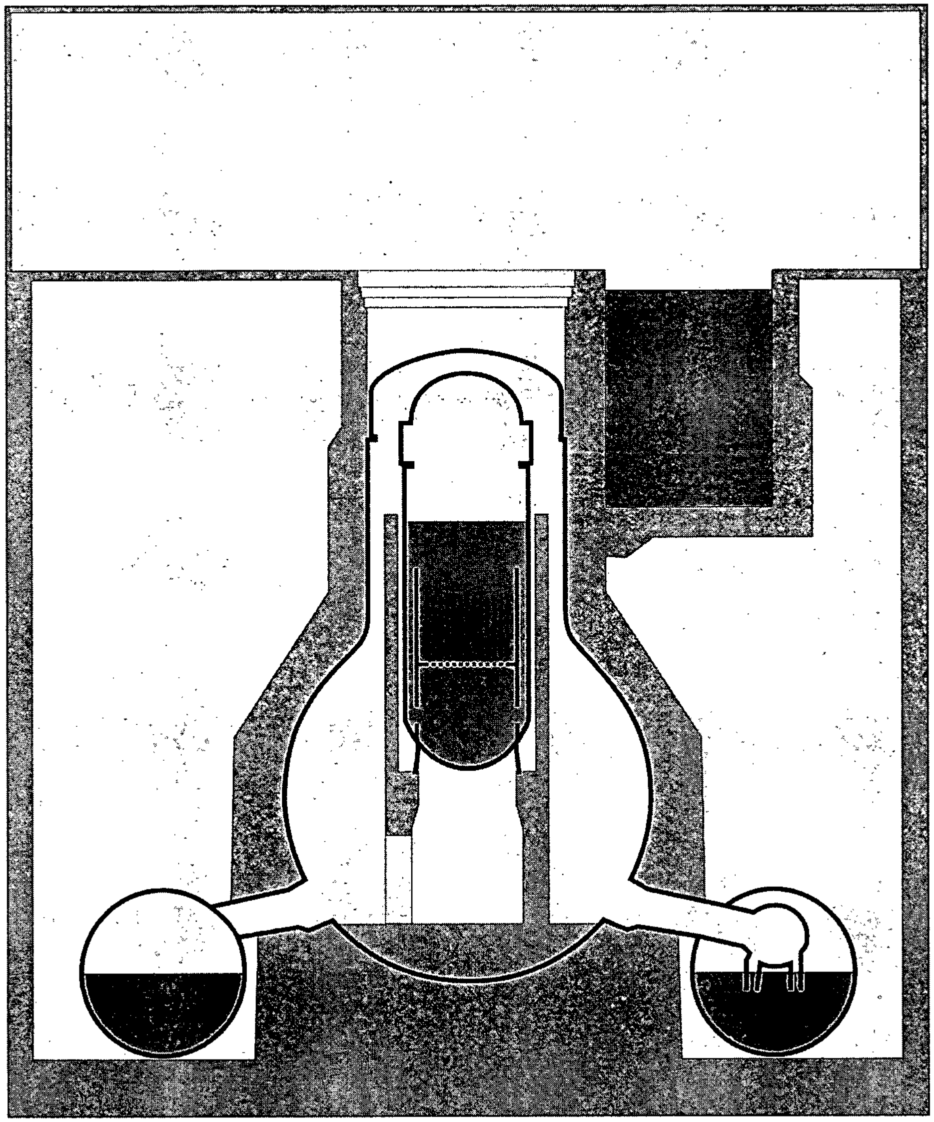
- As there is no heat removal from the building, the Core isolation pump cant work infinitely



AREVA

2. Accident progression

- Reactor Isolation pump stops
  - 11.3. 16:36 in Unit 1 (Batteries empty)
  - 14.3. 13:25 in Unit 2 (Pump failure)
  - 13.3. 2:44 in Unit 3 (Batteries empty)
- Decay Heat produces still steam in Reactor pressure Vessel
  - Pressure rising
- Opening the steam relieve valves
  - Discharge Steam into the Wet-Well
- Descending of the Liquid Level in the Reactor pressure vessel



The Fukushima Daiichi Incident
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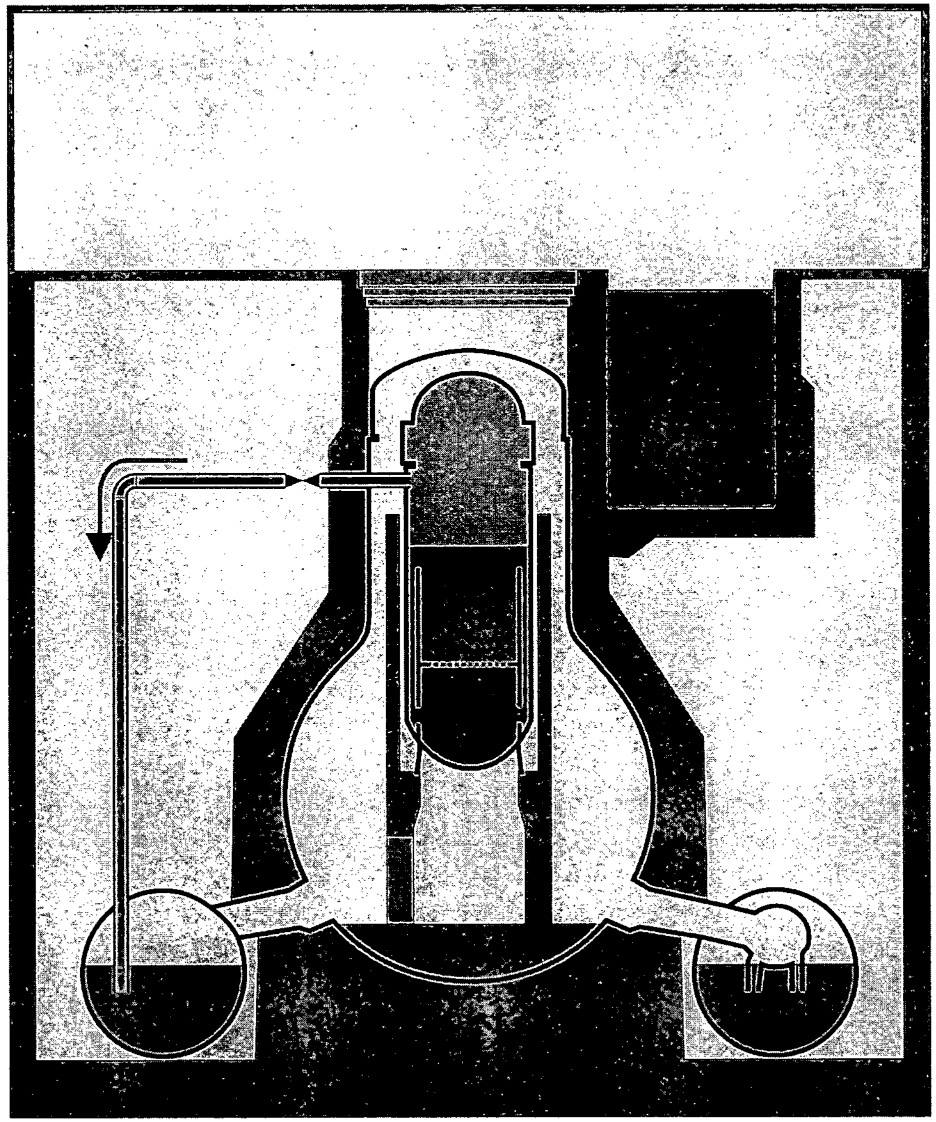

The Fukushima Daiichi Incident
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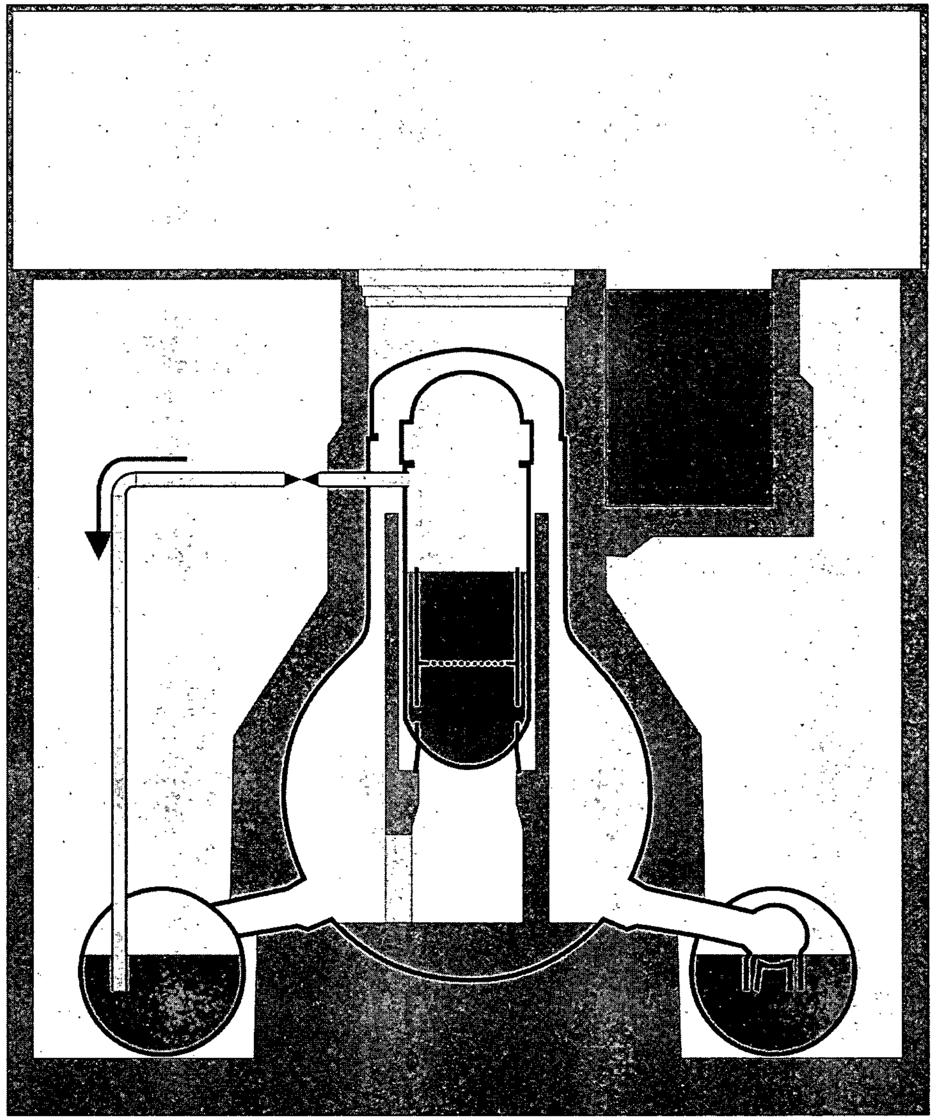

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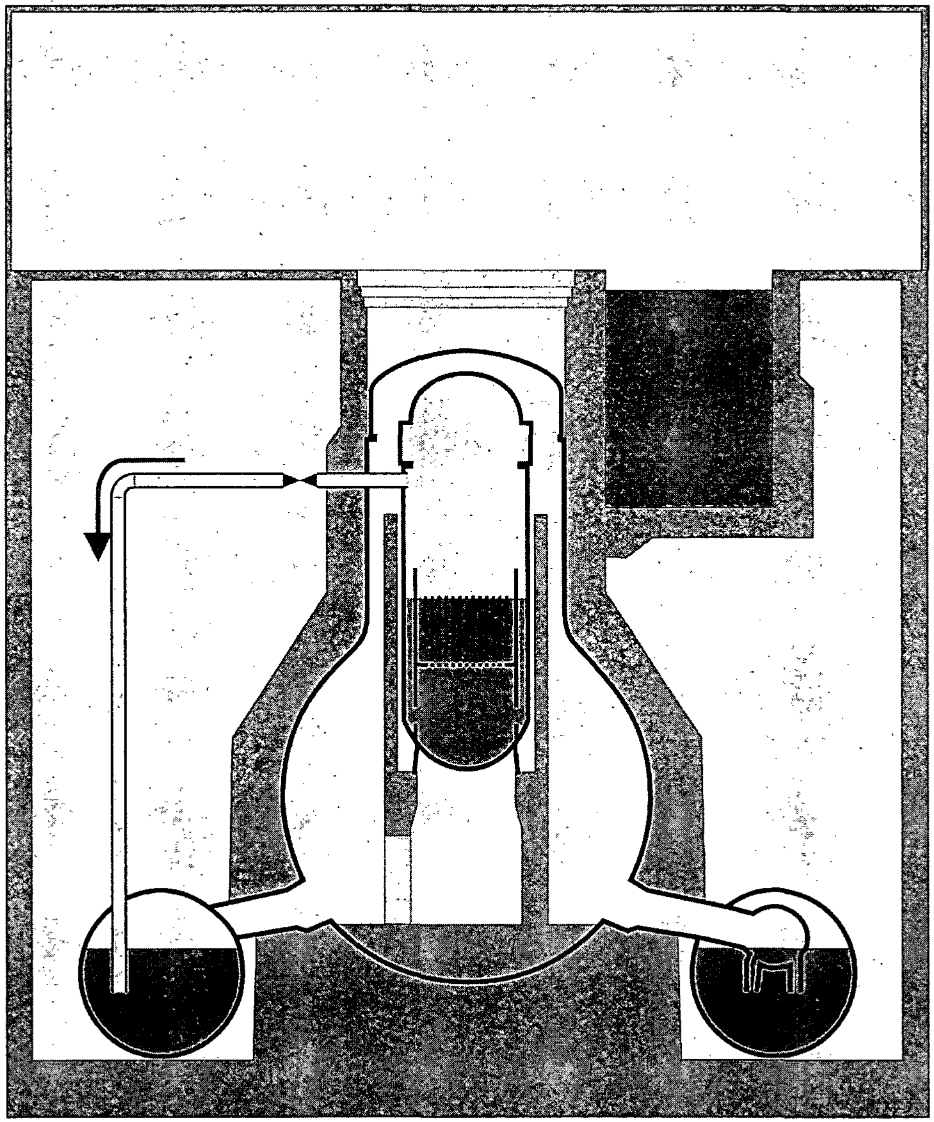

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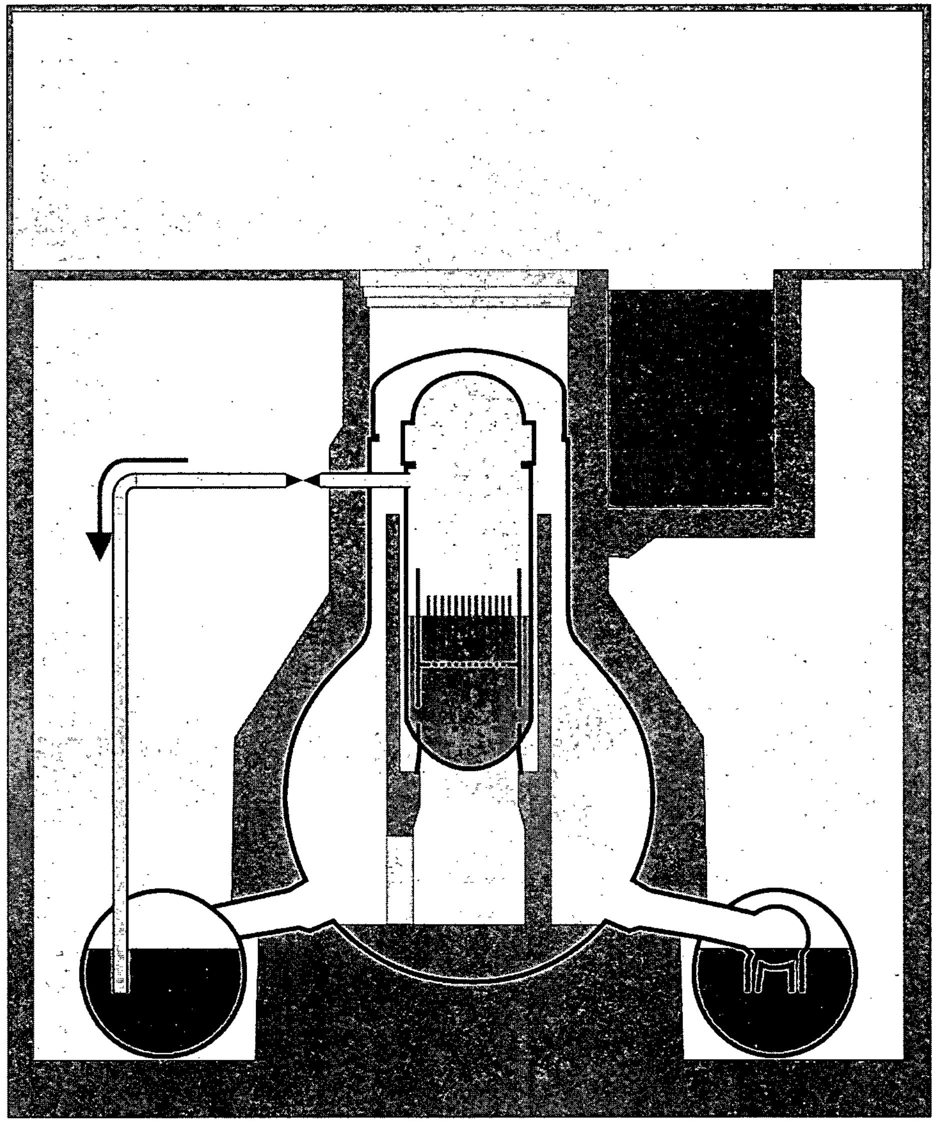
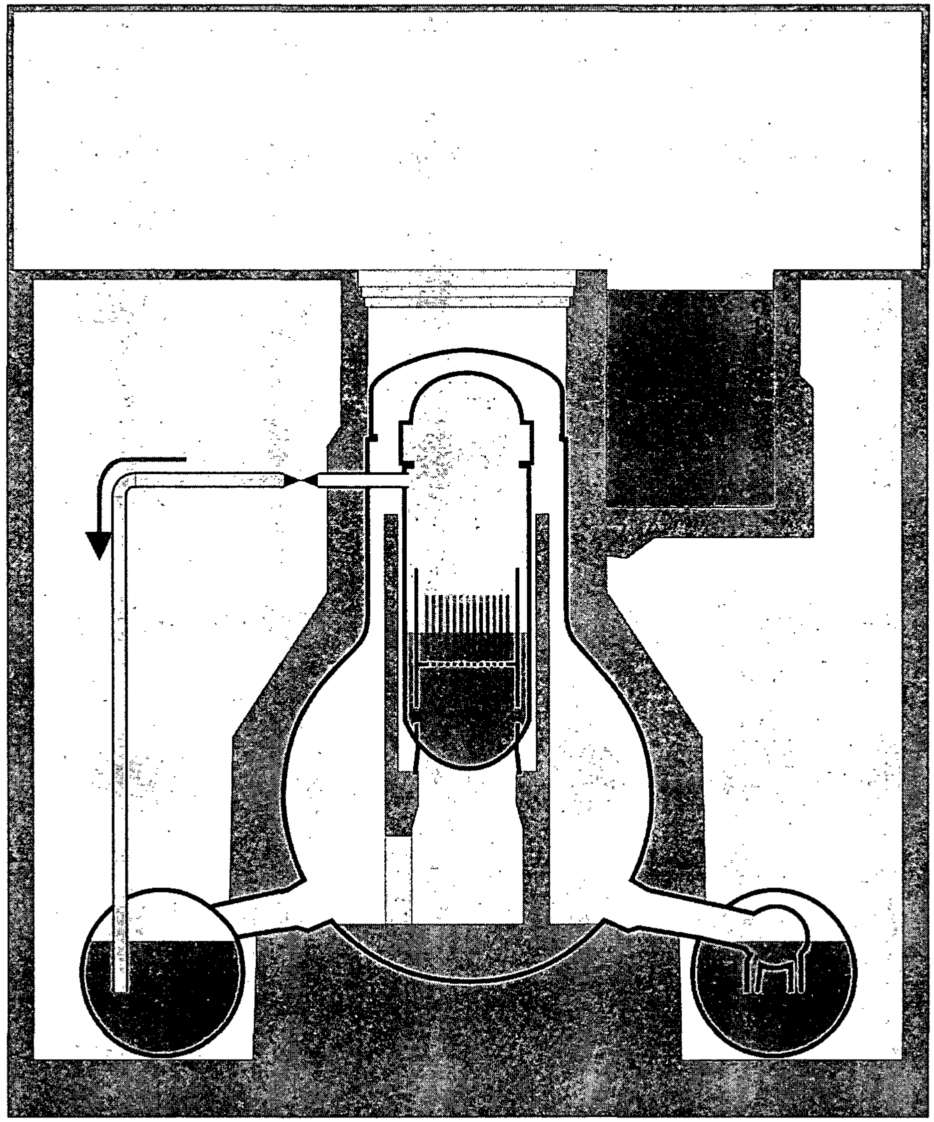


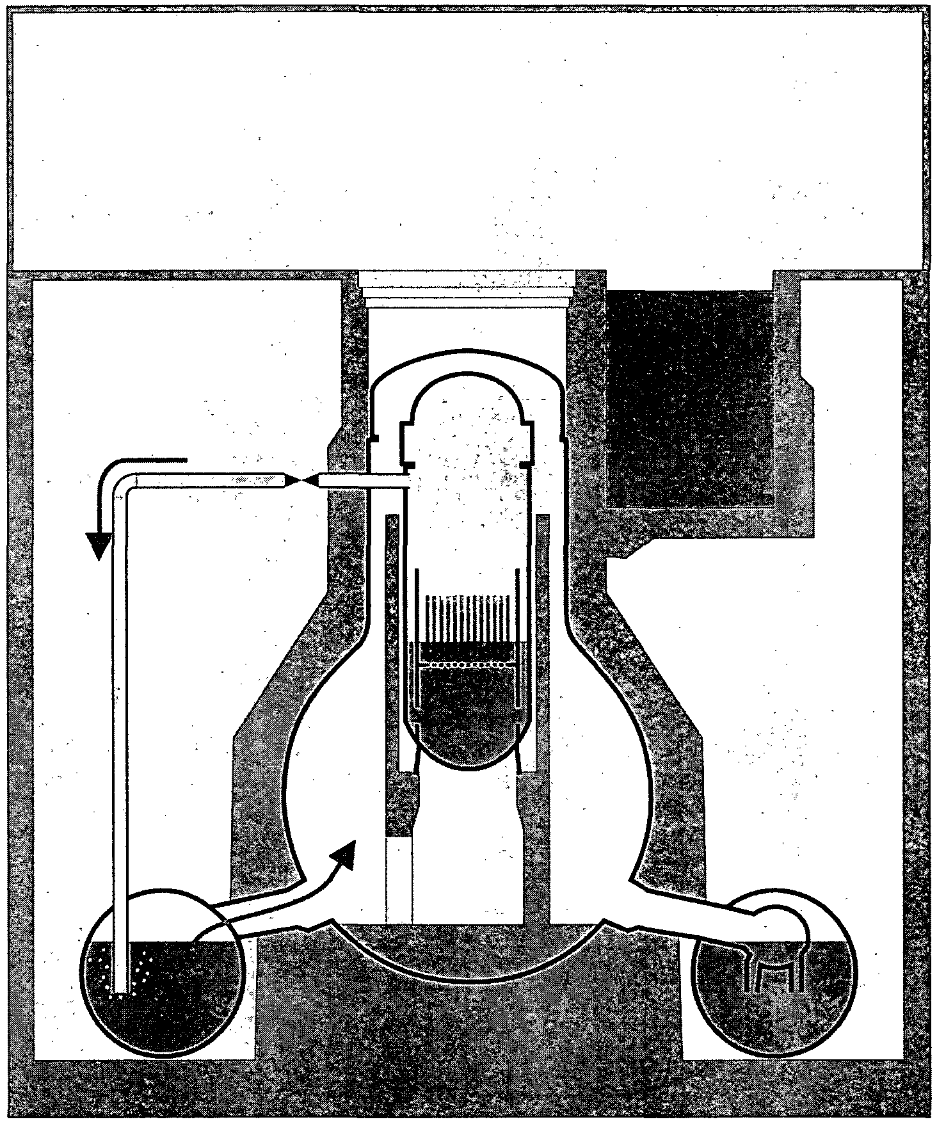
- Measured, and here referenced Liquid level is the collapsed level. The actual liquid level lies higher due to the steam bubbles in the liquid

- ~50% of the core exposed
  - Cladding temperatures rise, but still no significant core damage

- ~2/3 of the core exposed
  - Cladding temperature exceeds ~900°C
  - Balooning / Breaking of the cladding
  - Release of fission products form the fuel rod gaps



- ~3/4 of the core exposed
  - Cladding exceeds ~1200°C
  - Zirconium in the cladding starts to burn under Steam atmosphere
  - **$Zr + 2H_20 \rightarrow ZrO_2 + 2H_2$**
  - Exothermal reaction further heats the core
  - Generation of hydrogen
    - Unit 1: 300-600kg
    - Unit 2/3: 300-1000kg
  - Hydrogen gets pushed via the wet-well, the wet-well vacuum breakers into the dry-well



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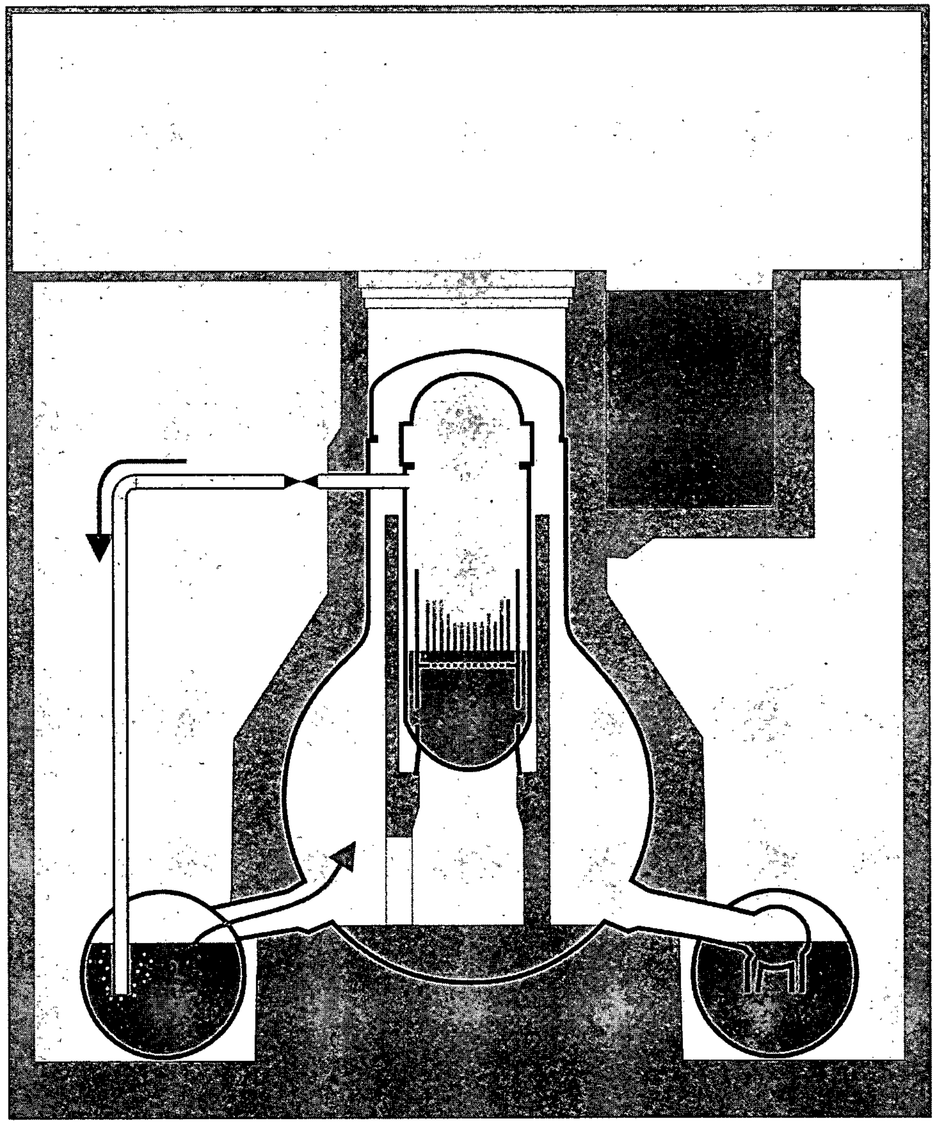
The Fukushima Daiichi Incident
2. Accident progression

- at ~1800°C [Unit 1,2,3]
  - Melting of the Cladding
  - Melting of the steel structures
- at ~2500°C [Block 1,2]
  - Breaking of the fuel rods
  - debris bed inside the core
- at ~2700°C [Block 1]
  - Melting of Uranium-Zirconium eutectics
- Restoration of the water supply stops accident in all 3 Units
  - Unit 1: 12.3. 20:20 (27h w.o. water)
  - Unit 2: 14.3. 20:33 (7h w.o. water)
  - Unit 3: 13.3. 9:38 (7h w.o. water)



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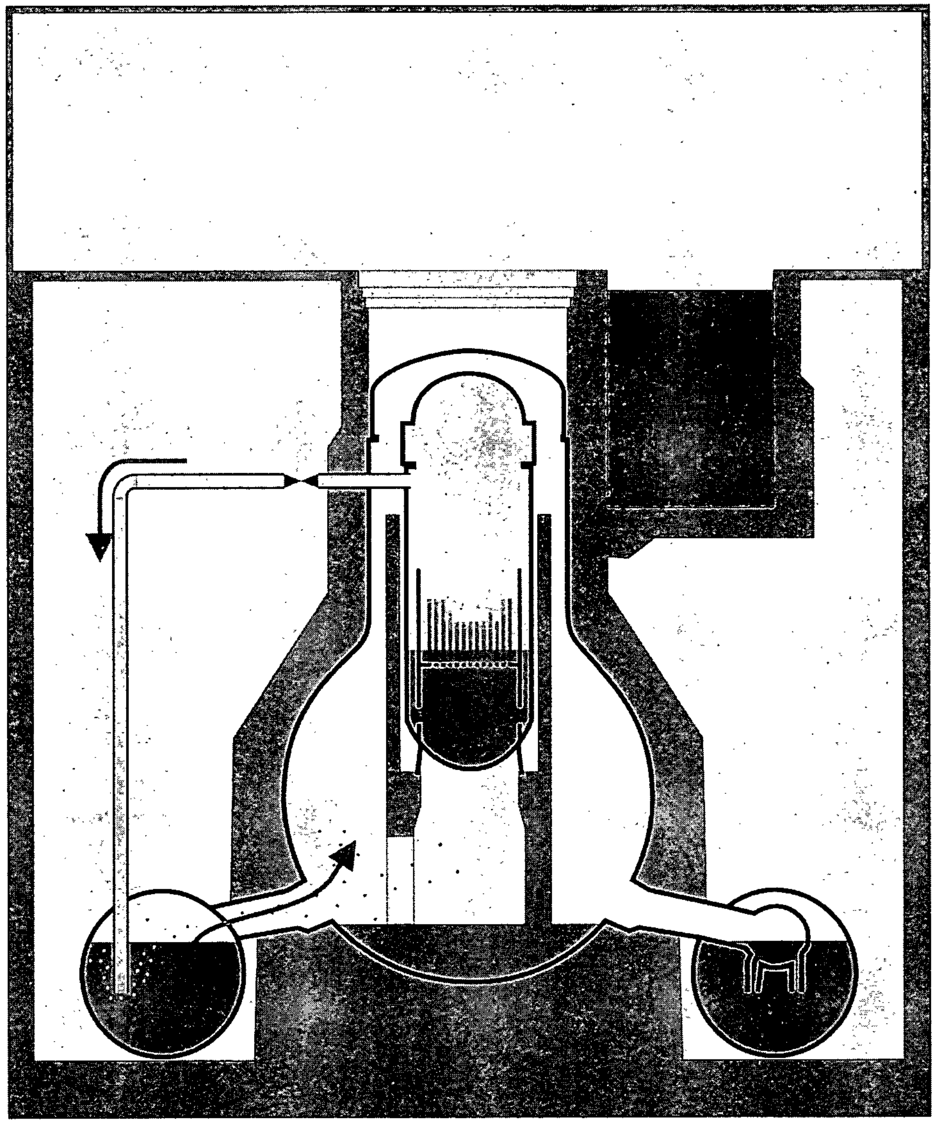
- Release of fission products during melt down
  - Xenon, Cesium, Iodine,…
  - Uranium/Plutonium remain in core
  - Fission products condensate to airborne Aerosols
- Discharge through valves into water of the condensation chamber
  - Pool scrubbing binds a fraction of Aerosols in the water
- Xenon and remaining aerosols enter the Dry-Well
  - Deposition of aerosols on surfaces further decontaminates air



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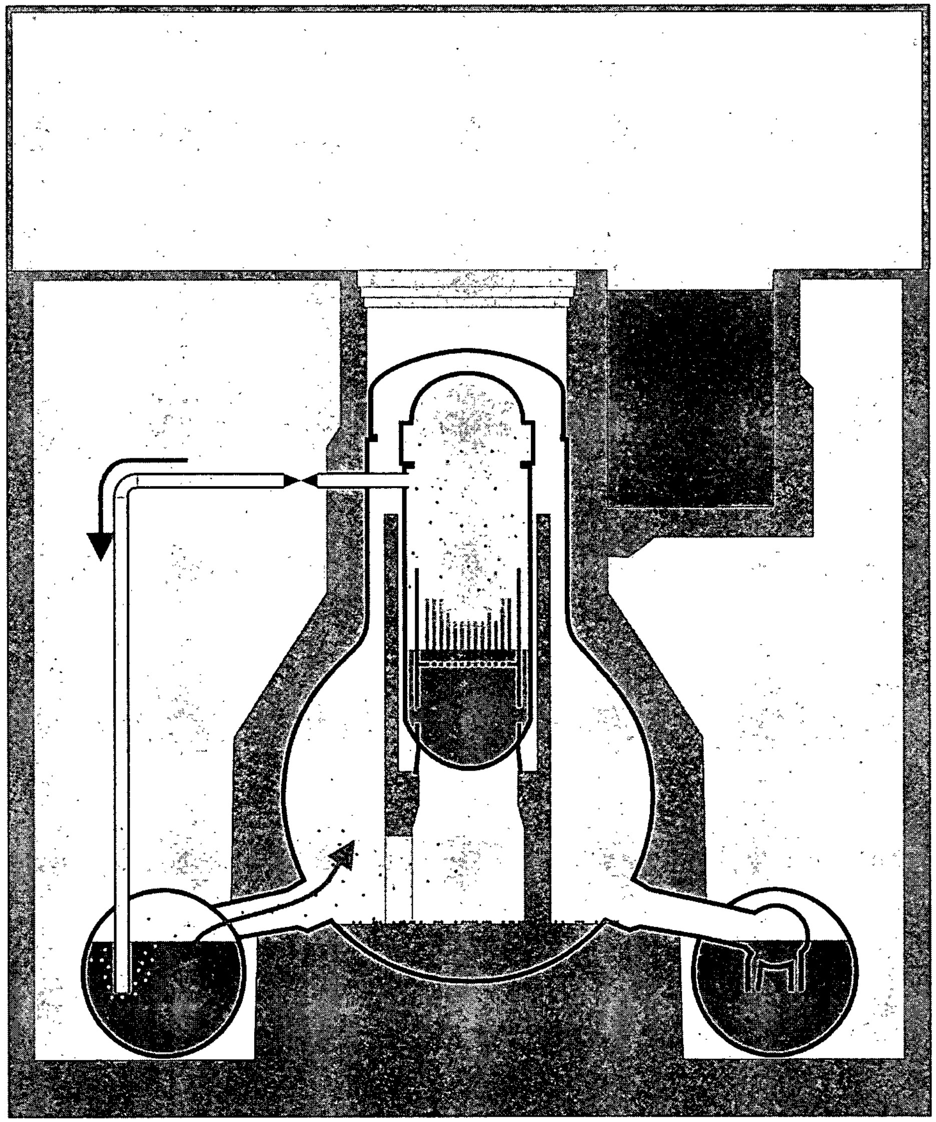
- Containment
  - Last barrier between Fission Products and Environment
  - Wall thickness ~3cm
  - Design Pressure 4-5bar

- Actual pressure up to 8 bars
  - Normal inert gas filling (Nitrogen)
  - Hydrogen from core oxidation
  - Boiling condensation chamber (like a pressure cooker)

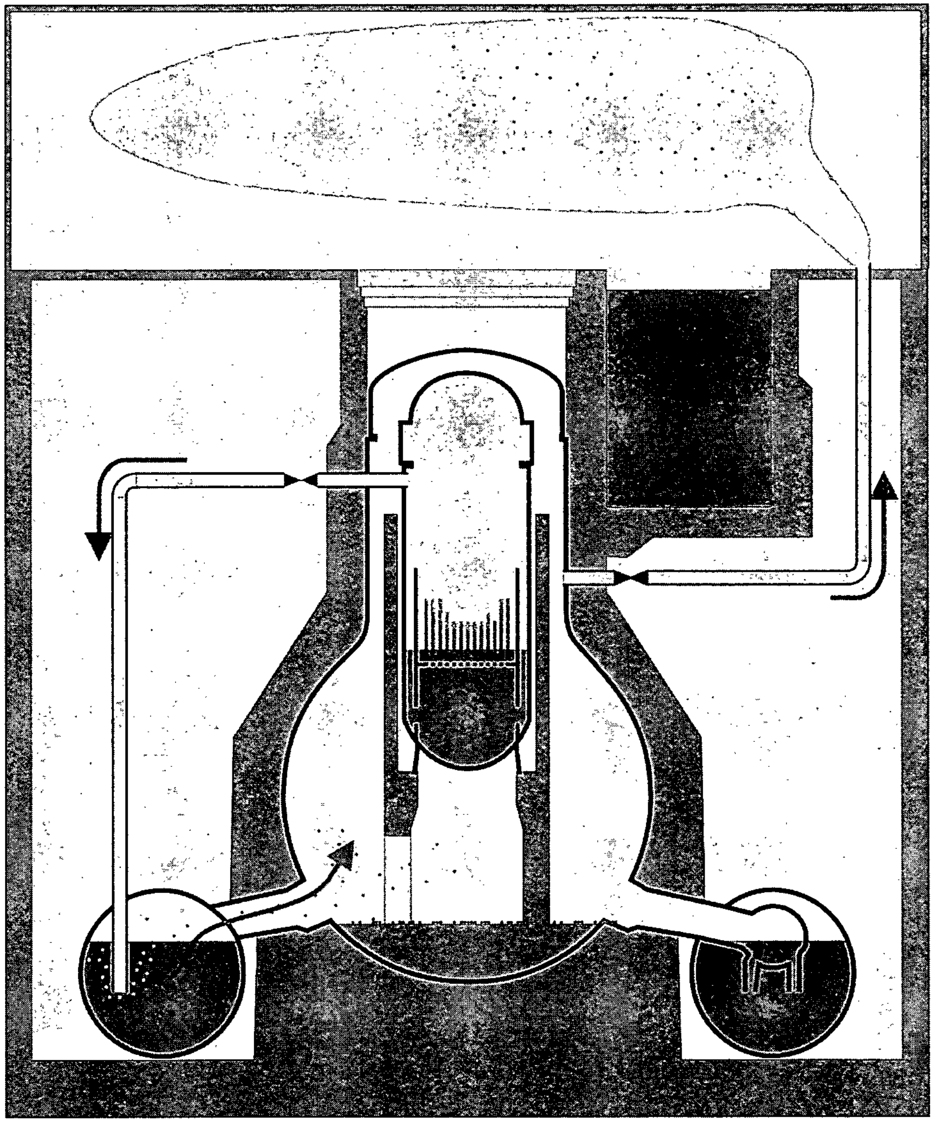
- Depressurization of the containment
  - Unit 1: 12.3. 4:00
  - Unit 2: 13.3 00:00
  - Unit 3: 13.3. 8.41



The Fukushima Daiichi Incident
2. Accident progression

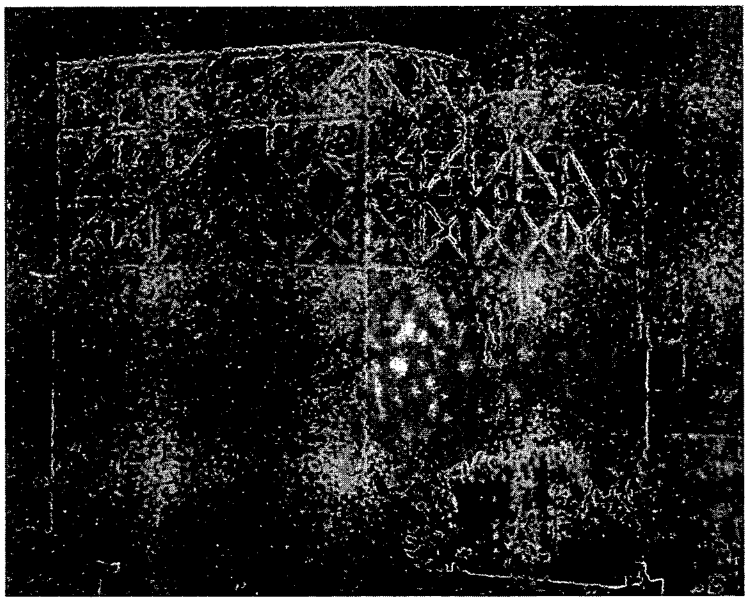
- Positive und negative Aspects of depressurizing the containment
  - Removes Energy from the Reactor building (only way left)
  - Reducing the pressure to ~4 bar
  - Release of small amounts of Aerosols (Iodine, Cesium ~0.1%)
  - Release of all noble gases
  - Release of Hydrogen

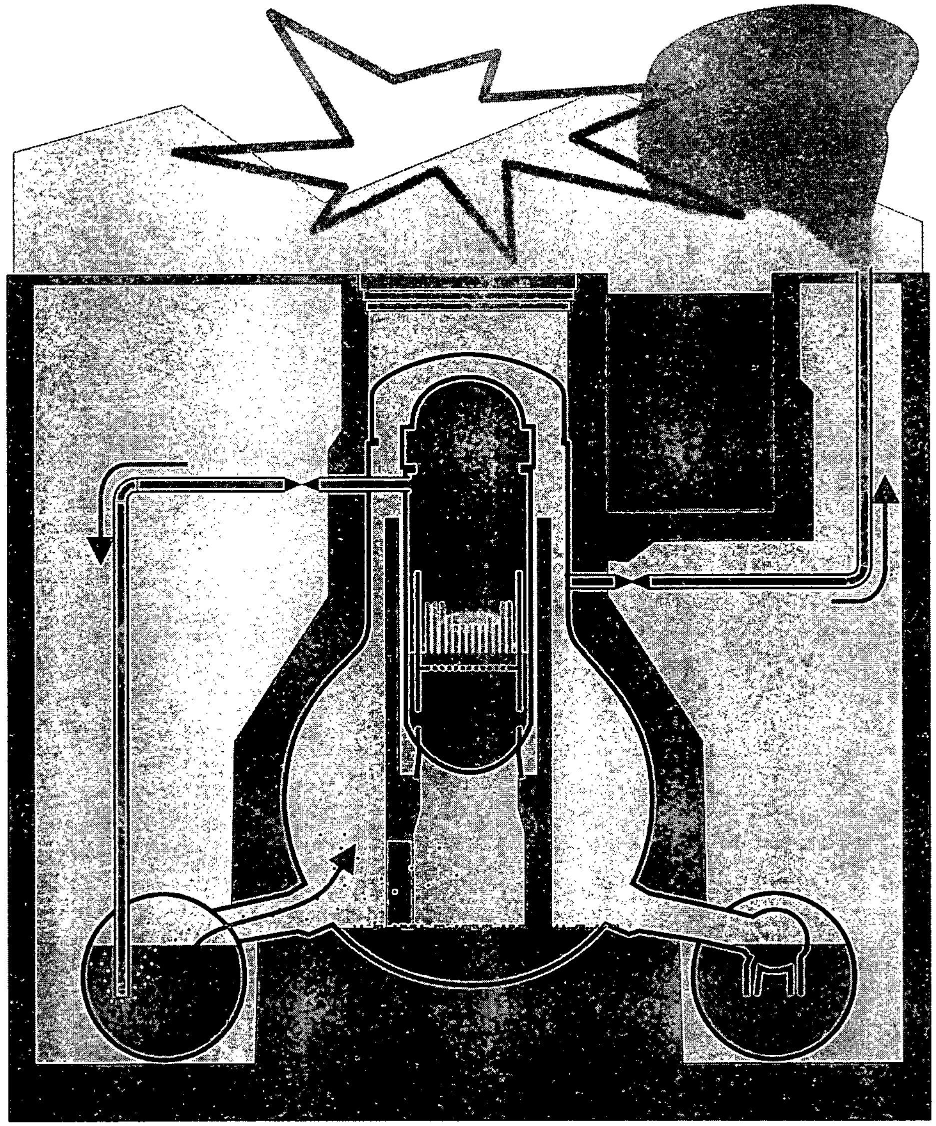
- Gas is released into the reactor service floor
  - Hydrogen is flammable



The Fukushima Daiichi Incident
2. Accident progression

- Unit 1 und 3
  - Hydrogen burn inside the reactor service floor
  - Destruction of the steel-frame roof
  - Reinforced concrete reactor building seems undamaged
  - Spectacular but minor safety relevant





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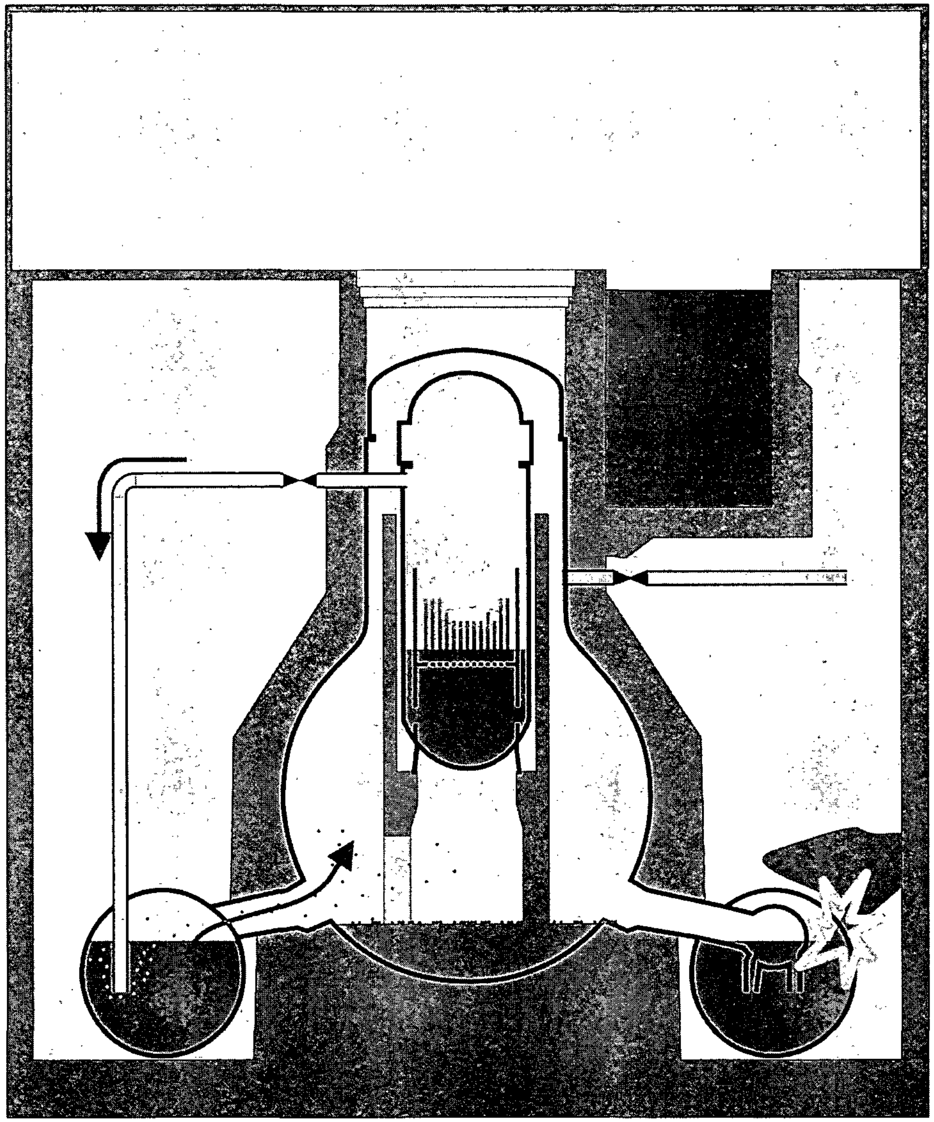
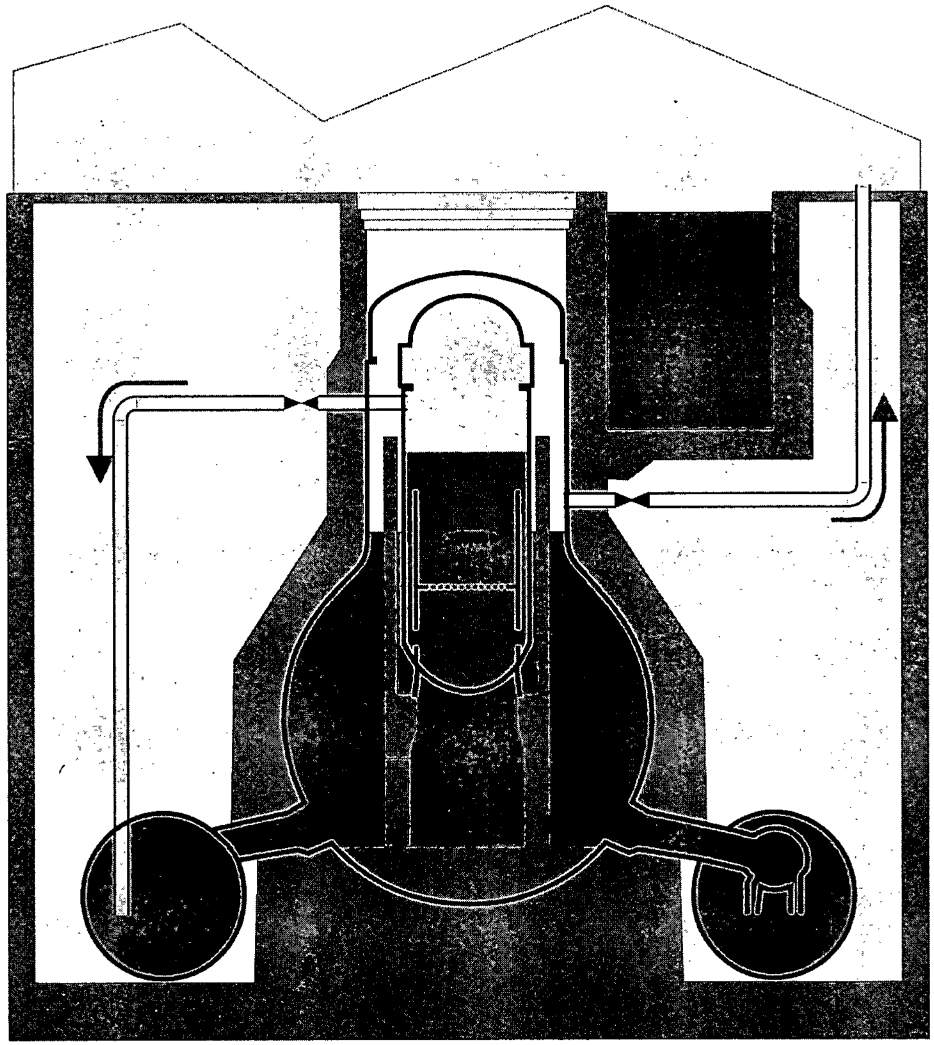
- Unit 2
  - Hydrogen burn inside the reactor building
  - Probably damage to the condensation chamber (highly contaminated water)
  - Uncontrolled release of gas from the containment
  - **Release of fission products**
  - Temporal evacuation of the plant
  - High local dose rates on the plant site due to wreckage hinder further recovery work

- No clear information's why Unit 2 behaved differently



- Current status of the Reactors
  - Core Damage in Unit 1,2, 3
  - Building damage due to various burns Unit 1-4
  - Reactor pressure vessels floode in all Units with mobile pumps
  - At least containment in Unit 1 flooded
- Further cooling of the Reactors by releasing steam to the atmospher
- Only small further releases of fission products can be expected



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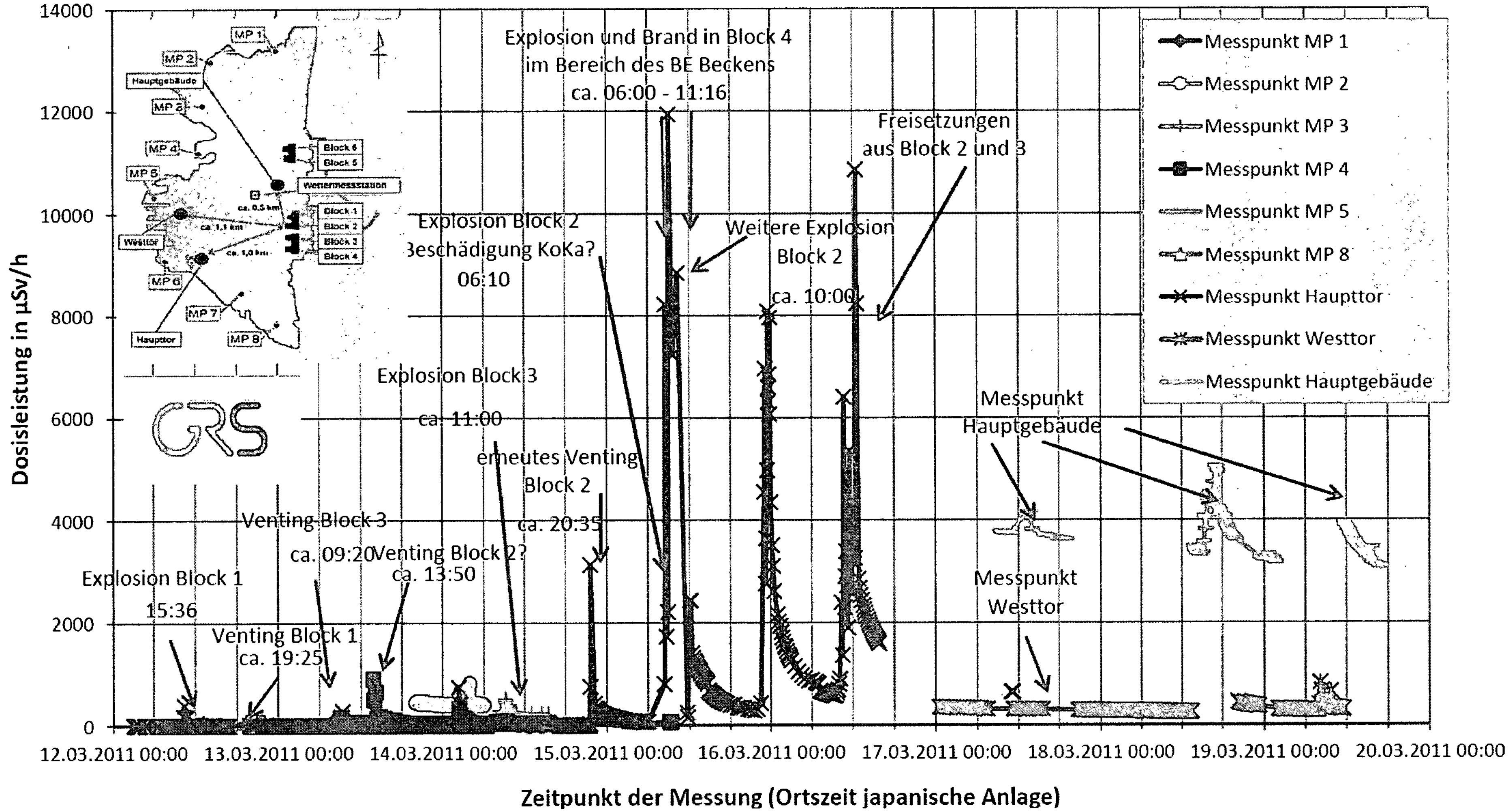
- Directly on the plant site
  - Before Explosion in Unit Block 2
    - Below 2mSv / h
    - Mainly due to released radioactive noble gases
    - Measuring posts on west side. Maybe too small values measured due to wind
  - After Explosion in Unit 2 (Damage of the Containment)
    - Temporal peak values 12mSv / h
    - (Origin not entirely clear)
    - Local peak values on site up to 400mSv /h (wreckage / fragments?)
    - Currently stable dose on site at 5mSv /h
    - Inside the buildings a lot more
  - Limiting time of exposure of the workers necessary

The Fukushima Daiichi Incident
3. Radiological releases



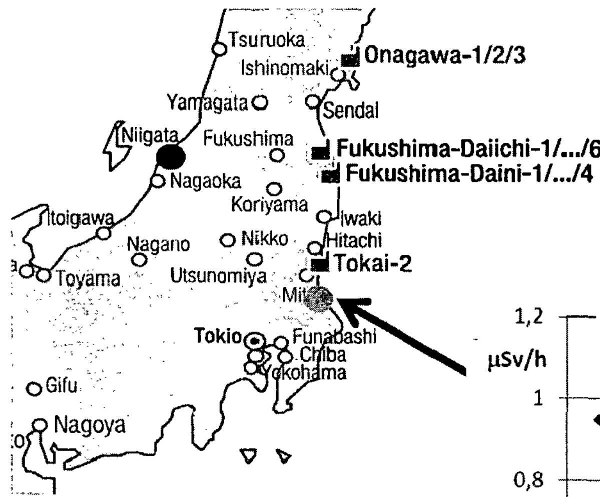
AREVA

- Outside the Plant site
  - As reactor building mostly intact
    => reduced release of Aerosols (not Chernobyl-like)
  - Fission product release in steam
    => fast Aerosol grows, large fraction falls down in the proximity of the plant
  - Main contribution to the radioactive dose outside plant are the radioactive noble gases
  - Carried / distributed by the wind, decreasing dose with time
  - No „Fall-out“ of the noble gases, so no local high contamination of soil

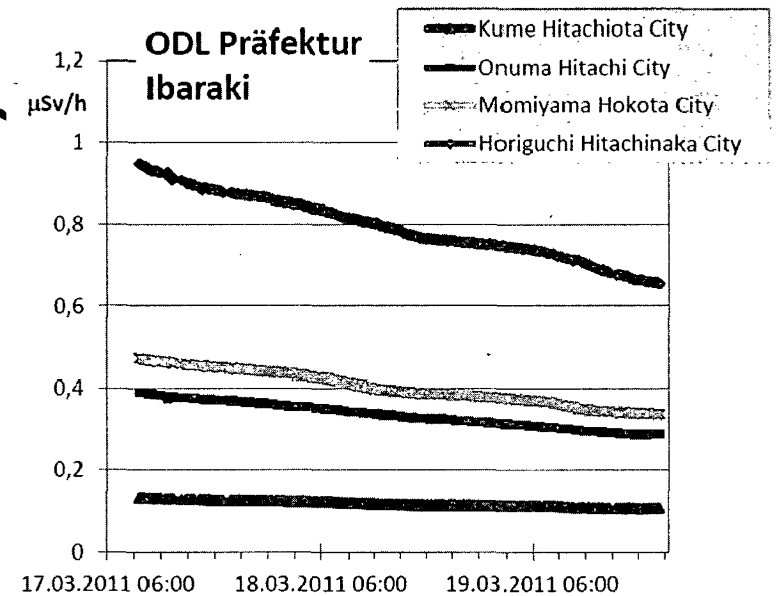
- ~20km around the plant
  - Evacuations were adequate
  - Measured dose up to 0.3mSv/h for short times
  - Maybe destruction of crops / dairy products this year
  - Probably no permanent evacuation of land necessary

AREVA

The Fukushima Daiichi Incident
3. Radiological releases



GRS.de



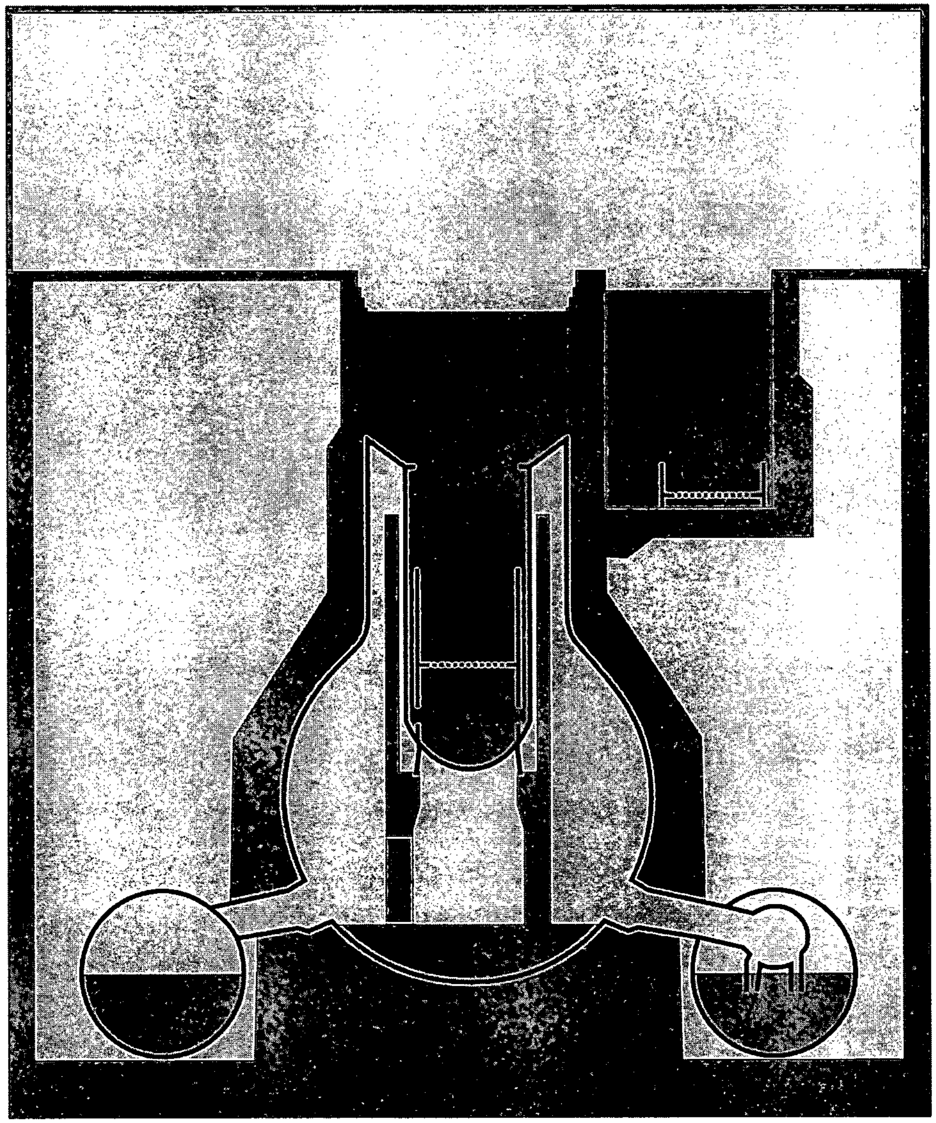
- ~50km around the plant
  - Control of Crop / Dairy products
  - Usage of Iodine pills (Caution, pills can interfere with heart medicine)

AREVA

The Fukushima Daiichi Incident
4. Spend fuel pools

- Spend fuel stored in Pool on Reactor service floor
  - Due to maintenance in Unit 4 entire core stored in Fuel pool
  - Dry-out of the pools
    - Unit 4: in 10 days
    - Unit 1-3,5,6 in few weeks
  - **Leakage of the pools due to Earthquake?**

- Consequences
  - Core melt „on fresh air "
  - Nearly no retention of fission products
  - Large release



AREVA

4. Spend fuel pools

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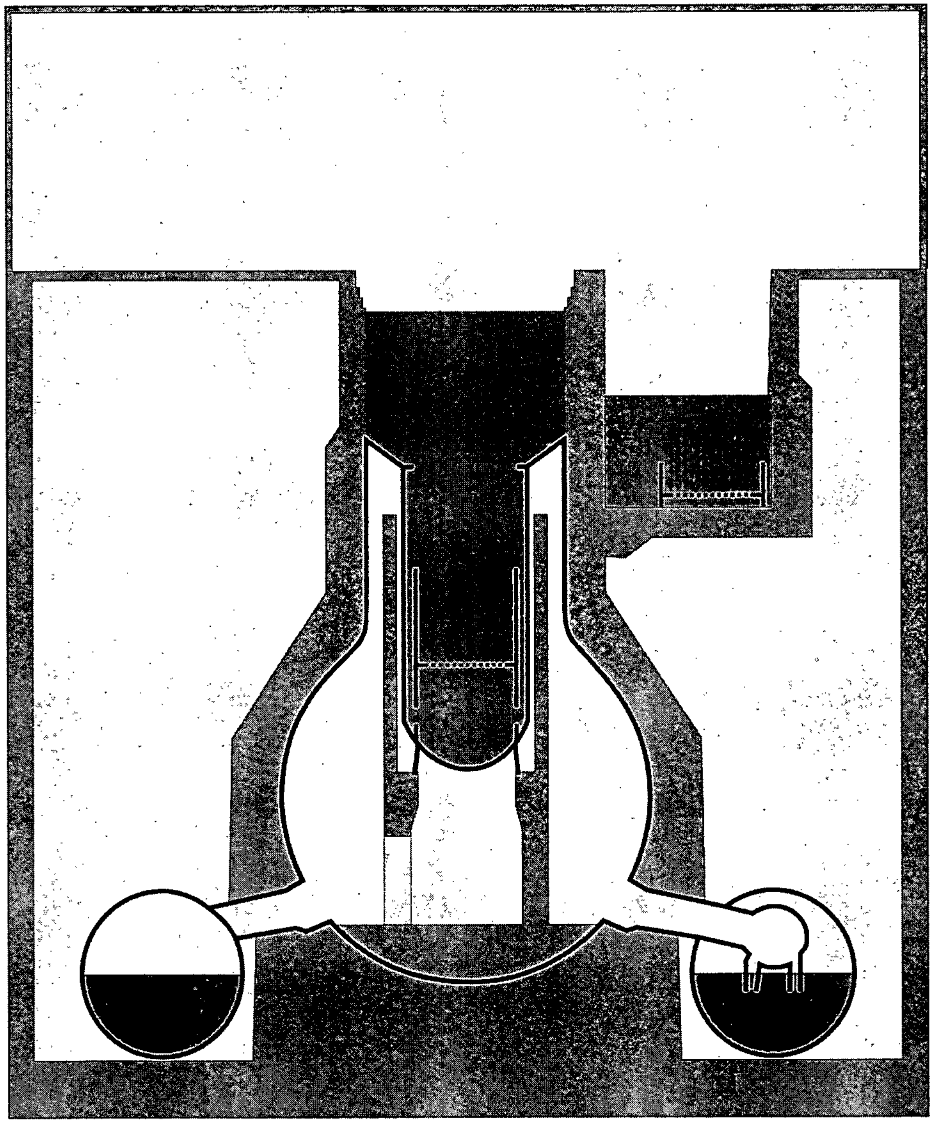

- Consequences
  - Core melt „on fresh air "
  - Nearly no retention of fission products
  - Large release

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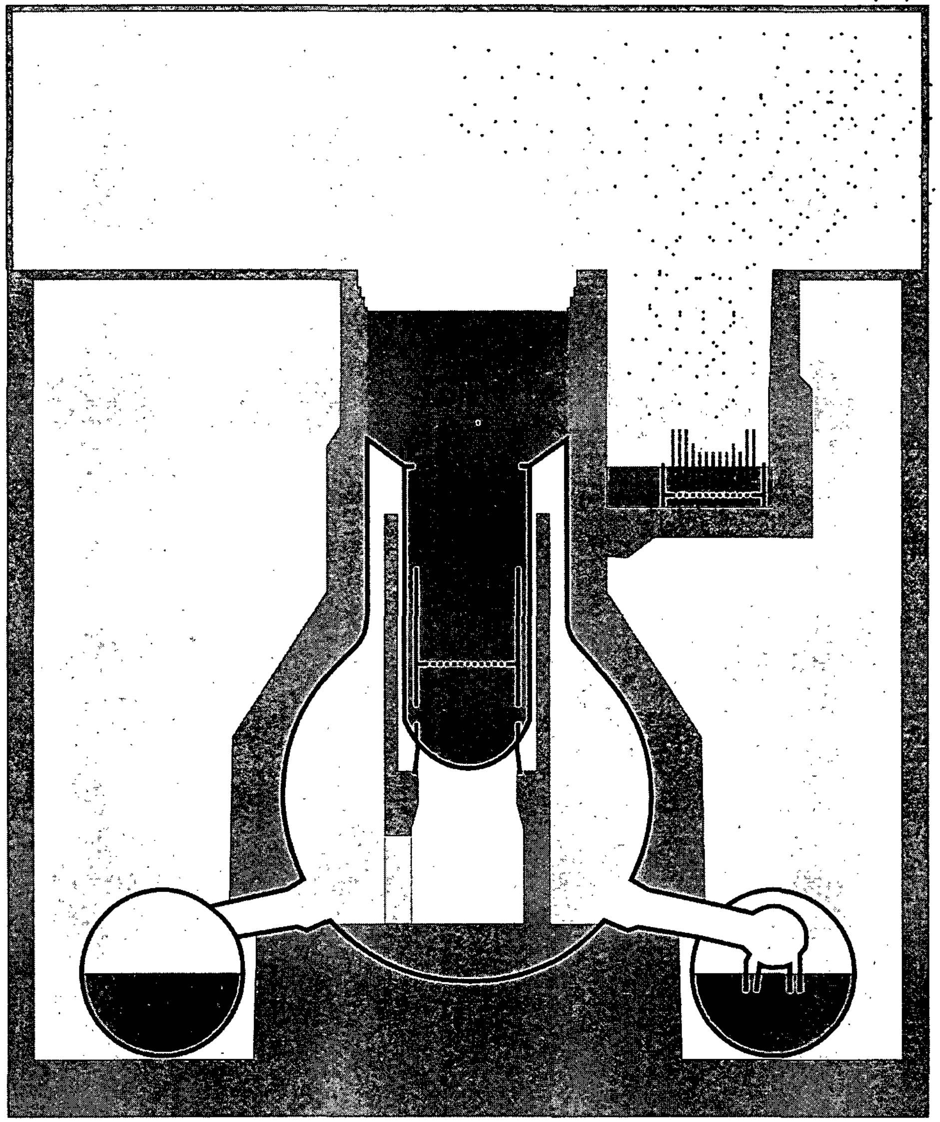
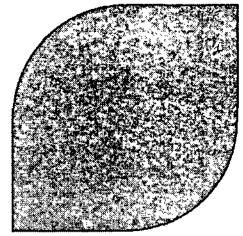
  - Due to maintenance in Unit 4 entire core stored in Fuel pool
  - Dry-out of the pools
    - Unit 4: in 10 days
    - Unit 1-3,5,6 in few weeks
  - **Leakage of the pools due to Earthquake?**
- Consequences
  - Core melt „on fresh air "
  - Nearly no retention of fission products
  - Large release
- **It is currently unclear if release from fuel pool already happened**





- Good sources of Information
  - Gesellschaft für Reaktorsicherheit [GRS.de]
    - Up to date
    - Radiological measurements published
    - German translation of japanese/englisch web pages
  - Japan Atomic Industrial Forum [jaif.or.jp/english/]
    - Current Status of the plants
    - Measurement values of the reactors (pressure liquid level)
  - Tokyo Electric Power Company [Tepco.co.jp]
    - Status of the recovery work
    - Casualties
- May too few information are released by TEPCO, the operator of the plant

AREVA

Greenwood, Carol

From: Gibson, Kathy
Sent: Friday, April 01, 2011 3:14 PM
To: Sheron, Brian; Correia, Richard; Coe, Doug; Scott, Michael
Cc: Uhle, Jennifer
Subject: Re: RESPONSE - SFP DStudy

Rich,
Suggest we add this to our meeting next week since we will have all the right people there.

K

From: Sheron, Brian
To: Correia, Richard; Gibson, Kathy; Coe, Doug; Scott, Michael
Cc: Uhle, Jennifer
Sent: Fri Apr 01 14:27:22 2011
Subject: FW: RESPONSE - SFP DStudy

See below. We've been given the go-ahead to start this comparative risk assessment. Please think about:

1.) Who should have the lead? DSA or DRA?
2.) What staff and/or contractors are available to do the study? Can we rationalize that this work would feed into a future level 3 PRA study?
3.) How much $ do we think it will cost? Can we find the money from within RES?
4.) Will we trip the threshold for Commission notification?
5.) How long will the study take? I do not believe this is something we can do at a leisurely pace. I anticipate the Commission will need to take some sort of action on this issue within a year.

I am planning to take a CWS day Monday, so maybe you can discuss among yourselves Monday and then let's discus Tuesday.

From: Weber, Michael
Sent: Friday, April 01, 2011 2:15 PM
To: Sheron, Brian
Cc: Borchardt, Bill; Virgilio, Martin
Subject: RESPONSE - SFP DStudy

Please proceed with starting the study. This question has arisen in a variety of contexts of the years. We faced it in the 2005-2006 timeframe with the National Academy in their spent fuel study. Now it arises again. Let's get the information; whether we decide to recommend a policy change based on the information is a totally separate decision. Do we anticipate that this will trip the 4 FTE or $500K threshold requiring Commission notification?

From: Sheron, Brian
Sent: Friday, April 01, 2011 2:09 PM
To: Weber, Michael
Subject: SFP DStudy

Mike, I am reading lots of stories about everyone clamoring for the NRC to require licenses to remove as much of the spent fuel from their pools as is technically feasible. I think I mentioned that I anticipated we (the Agency) would get this question, and I said I wanted to start on a study ASAP (rather than wait for the TF 90 day study, then wait for a tasking from the Commission)

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My objective was to do a comparative risk assessment of storing fuel in the pools (as is done now) versus removing all of the fuel that could be air-cooled into dry casks.

About 80% of the SFP heat load comes from the most recent offloads, so removing older fuel does not reduce the SFP heat load that much. However, removing all the old fuel removes mass from the pool that can be replaced by water. Thus, removing older fuel would increase the volume of water available for boiloff in the event all SFP cooling was lost. Both of the above would increase the time available to restore forced convection cooling before the onset of overheating the fuel.

Another potential benefit is that the licensees could then spread the fuel out in the pool, so hot assemblies would not be adjacent to each other. Thus, if pool cooling was lost and the pool boiled down and began to uncover the fuel, heat transfer to the fuel bundle surroundings would be increased because it would be to pool water, rather than to an adjacent hot bundle. This could result in fewer assemblies reaching the runaway oxidation and ignition temperature.

Finally, having fewer assemblies in the SFP means less radioactive material is available for release in the event that SFP cooling could not be restored.

The drawbacks are that removal of all assemblies that are air-coolable in dry casks will increase fuel handling and thus increase the potential for fuel handling accidents and their attendant consequences. Plus, dry storage casks may have their own set of vulnerabilities that need to be considered.

I saw in the Friday edition of "The Energy Daily" that "....Jaczko neither rejected nor embraced the idea of reviewing the NRC's spent fuel policies."

Thus, I am a little hesitant to go off and start this study without having some clear direction from either you, Bill or the Commission. I think that if the Commission eventually either wants to address the issue, or is directed to in legislation, we need to start now. I would imagine such a study will take a while (~ 1 year?), and because of the scrutiny it will probably come under, it will have to be done very carefully.

Any suggestions on if and how to proceed?

From: Cubbage, Amy
Sent: Friday, April 01, 2011 5:03 PM
To: Miller, Charles; Virgilio, Martin; Holahan, Gary; Grobe, Jack; Dorman, Dan; Sanfilippo, Nathan
Subject: RE: press release is out
Attachments: ML11089A030.pdf; ML11089A045.pdf

The charter was finally declared and is available in ADAMS. Copy of memo and charter are attached.

Cynthia – please add the press release (link below) and the attached documents to the communications binder

Thanks,
Amy

From: Cubbage, Amy
Sent: Friday, April 01, 2011 4:35 PM
To: Miller, Charles; Virgilio, Martin; Holahan, Gary; Grobe, Jack; Dorman, Dan; Sanfilippo, Nathan
Subject: press release is out

http://www.nrc.gov/reading-rm/doc-collections/news/2011/11-062.pdf

The charter is attached to the press release. The charter will also be publicly available in ADAMS momentarily.

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March 30, 2011

MEMORANDUM TO:	Martin J. Virgilio Deputy Executive Director for Reactor and Preparedness Programs Executive Director for Operations Charles L. Miller, Director Office of Federal and State Materials and Environmental Management Programs
FROM:	R. W. Borchardt ***/RA/*** Executive Director for Operations
SUBJECT:	AGENCY TASK FORCE TO CONDUCT NEAR-TERM EVALUATION OF THE NEED FOR AGENCY ACTIONS FOLLOWING THE EVENTS IN JAPAN

On March 11th, 2011, Japan experienced a severe earthquake resulting in the shutdown of multiple reactors. It appears that the reactors' response to the earthquake went according to design. At the Fukushima Daiichi site, the earthquake caused the loss of normal AC power. In addition, it appears that the ensuing tsunami caused the loss of emergency AC power at the Fukushima Daiichi site. Subsequent events caused damage to fuel and radiological releases offsite.

The purpose of this memorandum is to task the Deputy Executive Director for Reactor and Preparedness Programs (DEDR) to convene an agency task force of U.S. Nuclear Regulatory (NRC) senior leaders and experts. The task force should conduct a methodical and systematic review of relevant NRC regulatory requirements, programs, and processes, and their implementation, to recommend whether the agency should make near-term improvements to our regulatory system. The task force should also identify a framework and topics for review and assessment for the longer-term effort.

Attached is a charter for the task force. The charter defines the objective, scope, coordination and communication, expected products, schedule, staffing, and Executive Director for Operations interface. The task force should update the Commission on the near-term review at approximately 30 and 60 days, and provide its observations, findings, and recommendations in the form of a written report and briefing at the completion of the near-term effort occurring at approximately 90 days.

The review should be conducted in accordance with Tasking Memorandum – COMGBJ-11-0002, "NRC Actions Following the Events in Japan."

Enclosure: As stated

CONTACT: Nathan T. Sanfilippo, OEDO
301-415-3951

March 30, 2011

MEMORANDUM TO: Martin J. Virgilio
Deputy Executive Director
for Reactor and Preparedness Programs
Executive Director for Operations

Charles L. Miller, Director
Office of Federal and State Materials
and Environmental Management Programs

FROM: R. W. Borchardt ***/RA/***
Executive Director for Operations

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Enclosure: As stated

CONTACT: Nathan T. Sanfilippo, OEDO
301-415-3951

ADAMS Package: ML11089A050

OFFICE:	OEDO/Task Force	FSME/Task Force Lead	EDO/DEDR	EDO
NAME:	NSanfilippo	CMiller	MVirgilio (ELeeds for)	RWBorchardt
DATE:	03/30/11	03/30/11	03/30/11	03/30/11

OFFICIAL RECORD COPY

CHARTER FOR THE NUCLEAR REGULATORY COMMISSION TASK FORCE

TO CONDUCT A NEAR-TERM EVALUATION OF THE NEED FOR AGENCY ACTIONS

FOLLOWING THE EVENTS IN JAPAN

Objective

The objective of this task force is to conduct a methodical and systematic review of relevant NRC regulatory requirements, programs, and processes, and their implementation, to recommend whether the agency should make near-term improvements to our regulatory system. This task force will also identify a framework and topics for review and assessment for the longer-term effort.

Scope

The task force review will include the following:

a. A near-term review to:

- Evaluate currently available technical and operational information from the events that have occurred at the Fukushima Daiichi nuclear complex in Japan to identify potential or preliminary near-term/immediate operational or regulatory actions affecting domestic reactors of all designs, including their spent fuel pools. The task force will evaluate, at a minimum, the following technical issues and determine priority for further examination and potential agency action:
  - External event issues (e.g. seismic, flooding, fires, severe weather)
  - Station blackout
  - Severe accident measures (e.g., combustible gas control, emergency operating procedures, severe accident management guidelines)
  - 10 CFR 50.54 (hh)(2) which states, "Each licensee shall develop and implement guidance and strategies intended to maintain or restore core cooling, containment, and spent fuel pool cooling capabilities under the circumstances associated with loss of large areas of the plant due to explosions or fire, to include strategies in the following areas: (i) Fire fighting; (ii) Operations to mitigate fuel damage; and (iii) Actions to minimize radiological release." Also known as B.5.b.
  - Emergency preparedness (e.g., emergency communications, radiological protection, emergency planning zones, dose projections and modeling, protective actions)
- Develop recommendations, as appropriate, for potential changes to NRC's regulatory requirements, programs, and processes, and recommend whether generic communications, orders, or other regulatory actions are needed.

ENCLOSURE

b. Recommendations for the content, structure, and estimated resource impact for the longer-term review.

Coordination and Communications

The near-term task force will:

- Solicit stakeholder input as appropriate, but remain independent of industry efforts.
- Coordinate and cooperate where applicable with other domestic and international efforts reviewing the events in Japan for additional insights.
- Provide recommendations to the Commission for any immediate policy issues identified prior to completion of the near-term review.
- Provide recommendations to program offices for any immediate actions not involving policy issues, prior to completion of the near-term review.
- Identify resource implications of near-term actions.
- Consider information gained from Temporary Instruction 2515/183, "Followup to the Fukushima Daiichi Nuclear Station Fuel Damage Events."
- Develop a communications plan.
- Update and brief internal stakeholders, as appropriate.

Expected Product and Schedule

The task force will provide its observations, conclusions, and recommendations in the form of a written report to the Deputy Executive Director for Reactor and Preparedness Programs at the completion of the 90-day near-term review.

During the development of its report, the task force will brief the Commission on the status of the review at approximately the 30- and 60-day points.

The report will be transmitted to the Commission via a SECY paper, and the task force will brief the Commission on the results of the near-term effort at approximately the 90-day point. The report will be released to the public via normal Commission processes.

The task force will recommend a framework for a longer-term review as a part of the near-term report. The longer-term review will begin as soon as the NRC has sufficient technical information from the events in Japan (with a goal of beginning by the end of the near-term review).

Staffing

The task force will consist of the following members:

Leader	Charles Miller	FSME
Senior Managers	Daniel Dorman	NMSS
	Jack Grobe	NRR
	Gary Holahan	NRO
Senior Staff	Amy Cubbage	NRO
	Nathan Sanfilippo	OEDO
Administrative Assistant	Cynthia Davidson	OGC

Additional task force members will be added as needed. For the near-term review, other staff members may be consulted on a part-time basis.

EDO Interface

The task force will keep agency leadership informed on the status of the effort and provide early identification of significant findings. The task force will report to Martin J. Virgilio, Deputy Executive Director for Reactor and Preparedness Programs.

Subject: Weekly Status Update (Marty, Charlie)
Location: O-17H10

Start: Mon 4/4/2011 10:00 AM
End: Mon 4/4/2011 11:00 AM

Recurrence: (none)

Meeting Status: Meeting organizer

Organizer: Virgilio, Martin
Required Attendees: Miller, Charles

Categories: Green Category

Task Force – Japan Events

3/30/11

Sandy Cianci
Administrative Assistant to Marty Virgilio, DEDR
Office of the Executive Director for Operations
O-17 H13
301-415-1714
sandra.cianci@nrc.gov

XX/7.9

From: E&E Publishing, LLC <ealerts@eenews.net>
Sent: Monday, April 04, 2011 12:59 PM
To: Virgilio, Martin
Subject: April 4 -- Greenwire is ready

AN E&E PUBLISHING SERVICE

GREENWIRE -- MON., APRIL 4, 2011 -- Read the full edition

1. CLIMATE: Conservative group drafts, promotes anti-EPA bills in state legislatures

A Virginia state lawmaker caused a stir in February when he admitted that his resolution declaring U.S. EPA's effort to curb greenhouse gas emissions a "regulatory train wreck" was written by the coal industry. Republican Delegate Will Morefield's resolution said EPA regulations would have potentially "devastating consequences," called for a "comprehensive study" of their impact on the economy and urged Congress to place a two-year moratorium on new air pollution regulations.

TOP STORIES

2. **OFFSHORE DRILLING:** Salazar denies reports of BP permit talks
3. **MINING:** Judges leaning toward Massey in Upper Big Branch case
4. **DRINKING WATER:** Utilities failed to alert public to presence of likely carcinogen, group says

JAPAN EARTHQUAKE

5. **NUCLEAR CRISIS:** Critics zero in on DOE projects, urge moratorium on new reactors
6. **NUCLEAR CRISIS:** Contaminated water to be dumped into the ocean
7. **NUCLEAR:** GE head defends industry
8. **NUCLEAR CRISIS:** Int'l regulators undertake 'unprecedented' review of industry
9. **SOLID WASTE:** Japan disaster leaves tons of trash -- and dilemmas about what to do with it

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POLITICS

10. **HIGH-SPEED RAIL:** Wis. among states applying for Fla.'s discarded funds

ENERGY

11. **ENERGY MARKETS:** N.Y. officials, grid operator vow to fight FERC power decision

12. **COAL:** World Bank to decrease funding for new power plants

13. **NATURAL GAS:** Utah conservation groups reach deal with drilling company

14. **OIL AND GAS:** Abandoned wells are a growing problem as drilling increases

15. **PIPELINES:** LaHood cracks down on safety with new campaign

FEDERAL AGENCIES

16. **INTERIOR:** IG finds no 'leaderless malaise' at Nat'l Bison Range

17. **EPA:** Watchdog groups bash Office of Civil Rights, despite Jackson's praise

BUSINESS

18. **COAL:** Alpha moves closer to $7B Massey buyout

TRANSPORTATION

19. **AUTOS:** Federal green fleet mandate won't apply to security vehicles

AIR AND WATER

20. **MINING:** EPA delays final guidance for mountaintop water-pollution permits

21. **DRINKING WATER:** GAO decries CDC analysis of D.C. lead contamination

E&ETV'S ONPOINT

22. **ENERGY POLICY:** Third Way's Freed discusses administration's new direction

ABOUT GREENWIRE

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Huffert, Anthony

From: Huffert, Anthony
Sent: Wednesday, April 06, 2011 4:04 PM
To: Ramirez, Annie
Cc: Bush-Goddard, Stephanie
Subject: RE: ACTION: FOIA Request on Japan Events from GREENPEACE (Due date Friday April 8th)

Annie,

For the FOIA request related to the Fukushima Daiichi Nuclear Plant, I'm supporting the NRC Protective Measures Team. The PMT's Dose Assessors have maintained information related to the Japan event from March 11 through 24, 2011, which includes email correspondence and calculations in electronic and hard copy formats.

The PMT Operations Center has created several electronic folders containing files (both draft and final) located on the NSIR's M:\PMT\Fukushima shared computer drive. These folders are named by date/month and/or by topic such as "03162011 Press Release Basis", "Unit 1 14MAR 1600", "16MAR outgoing to NARAC" etc. Some of the files saved in these folders are identified as "Official Use Only". Also, there is incoming/outgoing email correspondence on NSIR's PMT email system and hard copies of certain documents.

It's my understanding that, at this time, the PMT is identifying the location of information that may be subject to this FOIA, but is not providing the documents.

Tony Huffert

From: Ramirez, Annie
Sent: Thursday, March 31, 2011 5:47 PM
To: RES_DSA
Cc: Elkins, Scott; Hoxie, Chris; Gibson, Kathy; Armstrong, Kenneth
Subject: ACTION: FOIA Request on Japan Events from GREENPEACE (Due date Friday April 8th)

DSA Staff,

All TA's are working with PMDA and the agency FOIA group to get a handle on the response to all the FOIAs that we have received and expect to receive. We are trying to push back on the time required to respond and exploring other ways to lessen the work load on you but, for the time being we have to respond to another FOIA request.

A FOIA Request from **GREENPEACE** for the following information:

"...Greenpeace requests that the Nuclear Regulatory Commission provide with any and all documentation regarding the ongoing nuclear crisis in Japan, including but, not limited to any and all information on the status of damage to reactors and spent fuel pools in the Fukushima Daiichi nuclear plant and the resulting release of radiation."

- **Please provide ALL documentation** (This includes all reports, studies, test results, correspondence memoranda, meeting notes, meeting minutes, working papers, graphs charts, diagrams notes form drop in visits and summaries of conversations and interviews, computer records ,e-mail and any other form of written communications including the internal and external NRC memoranda) pertaining to the Japanese event during the period of March 11, 2011 through March 24th,2011.

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- If, for any reason, you think that documentation should not be released to the requester (e.g. official use only material proprietary information, etc.), you must still provide it but, note on the documentation your justifications for not releasing the documents (please also discuss this with your manager). The FOIA Office will determine what will be released considering the staff's recommendations. (See the attached guidance)

- Please use TAC# ZF0001 to record your time in HRMS related to activities in response to a FOIA request.

Provide hard copies only of any records that meet the above criteria to Annie Ramirez by 3:00 PM on Friday, April 8th.

Also, make sure to include in your package the following items and information;

1. All records requested properly labeled/marked (e.g. official use only material proprietary information, etc.). It is extremely important that you follow the attachment guidance.
2. A sheet with your name and the amount of time spend on the task. (in hrs)
3. Proper classification of the documents per category;
    - Releasable All
    - Releasable in Part
    - Not releasable
    - Refer to another agencies entities

Attached is the "*How to Respond to a FOIA Request*" document for more detailed guidance (refer to steps 6 & 7 for exceptions to release). If you have any questions please contact me or Jazel Parks, and we will do our best to address your concerns.

Please let me know if you have any questions, comments, or concerns related to this request.

Thanks!
Annie

From: E&E Publishing, LLC <ealerts@eenews.net>
Sent: Wednesday, April 06, 2011 12:57 PM
To: Virgilio, Martin
Subject: April 6 -- Greenwire is ready

AN E&E PUBLISHING SERVICE

GREENWIRE -- WED., APRIL 6, 2011 -- Read the full edition

1. BUDGET: Shutdown would mean 800K furloughs, EPA permitting halt -- White House

With two days left for Congress to make a budget deal, the White House today began painting a picture of what life would be like under a government shutdown. Among the details offered by a senior administration official on a conference call late this morning was the furloughing of somewhere around 800,000 federal employees, the closure of all national parks, the Smithsonian museums and the canceling of the National Cherry Blossom festival and parade in Washington, D.C.

TOP STORIES

2. **CLIMATE:** Tea party, wonky White House messaging sunk cap and trade -- Van Jones
3. **REGULATIONS:** European study finds noise can kill, as EPA lies dormant
4. **AIR POLLUTION:** EPA overturns Ala. rule on smokestack soot

CONGRESS

5. **NUCLEAR CRISIS:** NRC model reveals U.S. meltdown risks -- Waxman
6. **CLIMATE:** Dems blast anti-EPA bills, riders as House vote looms
7. **OFFSHORE DRILLING:** Industry proponents, skeptics debate Hastings' OCS bills
8. **ENERGY POLICY:** Cantor, in op-ed, renews call for drilling off Va. coast

POLITICS

9. **LOBBYING:** Koch's clout extends far, both publicly and privately
10. **GRAND CANYON:** American Indians urge Interior, Congress to block new hardrock claims

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JAPAN EARTHQUAKE

11. **NUCLEAR:** Regulators propose 'lessons learned' approach for Oyster Creek
12. **NUCLEAR CRISIS:** Report details mounting U.S. concerns; radioactive leak stopped
13. **JAPAN:** Tsunami washed pollutants, debris over northeastern coast

CLIMATE CHANGE

14. **ADAPTATION:** Defense engineer opens his playbook for climate planners
15. **NEGOTIATIONS:** Kyoto Protocol stymies U.N. climate talks

ENERGY

16. **NUCLEAR:** Areva signs MOU for planned Calif. 'clean energy park'
17. **OIL AND GAS:** Alberta conservation plan would revoke some oil sands leases

FEDERAL AGENCIES

18. **CHEMICALS:** EPA shifts to electronic reporting of new materials
19. **ARMY CORPS:** Obama nominates new chief engineer and commanding general

BUSINESS

20. **GULF SPILL:** Transocean execs donate safety performance bonuses
21. **OCEANS:** Richard Branson plots undersea adventure

LAW AND LOBBYING

22. **GULF SPILL:** BP wants fines based on duration of spill, not amount of oil leaked

TRANSPORTATION

23. **AUTOS:** Toyota sells 1M Priuses in U.S.

AIR AND WATER

24. **AGRICULTURE:** Groups petition EPA to regulate ammonia as a criteria pollutant
25. **WATER POLLUTION:** 3 utility officials get fines, probation for Ind. wastewater discharges

26. **WATER POLLUTION:** Bodies of 2 wastewater treatment plant employees found in Tenn.

NATURAL RESOURCES

27. **WILDLIFE:** Mont. reaches agreement to let bison roam free

WASTES & HAZARDOUS SUBSTANCES

28. **CHEMICALS:** Board faults Tesoro in deadly Wash. refinery blast

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Subject:	EDO Pre-brief for 7/19 CM re: Task Force Review for NRC Processes & Regulation Following Events in Japan
Location:	O-17B4 (RGN I & IV calling in)
Start:	Thu 7/7/2011 2:00 PM
End:	Thu 7/7/2011 2:30 PM
Recurrence:	(none)
Meeting Status:	Accepted
Organizer:	Borchardt, Bill
Required Attendees:	Weber, Michael; Virgilio, Martin; Ash, Darren; ConferenceRoomO17B4 Resource; Matakas, Gina; Tannenbaum, Anita; Quayle, Lisa
Categories:	Business

When: Thursday, July 07, 2011 2:00 PM-2:30 PM (GMT-05:00) Eastern Time (US & Canada).
Where: O-17B4 (RGN I & IV calling in)

Note: The GMT offset above does not reflect daylight saving time adjustments.

~~*~*~*~*~*~*~*~*

[redacted]

Rct 4/7

XX\83

From:	E&E Publishing, LLC <ealerts@eenews.net>
Sent:	Thursday, April 07, 2011 1:01 PM
To:	Virgilio, Martin
Subject:	April 7 -- Greenwire is ready

AN E&E PUBLISHING SERVICE

GREENWIRE -- THU., APRIL 7, 2011 -- Read the full edition

1. LOBBYING: Former Hill stars add muscle to nuclear industry's post-Japan push

As a congressman, Rep. Robert Walker extolled the safety of nuclear power, arguing that technology prevented radiation poisoning during the meltdown at Three Mile Island. He's buttressing nuclear again today, this time working from the inside. Retired from the House, the Pennsylvania Republican provides strategic advice to the trade group Nuclear Energy Institute. Walker is one of more than 240 lobbyists for companies with nuclear interests who came through the government-to-industry revolving door.

TOP STORIES

2. **BUDGET:** Environmental cutbacks at heart of Hill shutdown drama -- Reid
3. **BUDGET:** Shutdown plans take shape at EPA, DOE, Interior
4. **DOE:** 'No home run yet' for ARPA-E, but chief says 'motivated' team's on track

CONGRESS

5. **CLIMATE:** Industry, enviro groups rush to spin EPA votes as victory
6. **BUDGET:** Prepare for shutdown, Va. Democrat tells federal workers
7. **AUTOS:** Bills would authorize battery-charging stations at Capitol

POLITICS

8. **HIGH-SPEED RAIL:** Freight railroad chief says he won't support Obama plans

JAPAN EARTHQUAKE

9. **NUCLEAR CRISIS:** New earthquake hits Japan as evacuation zone reconsidered

XX/84

10. **WATER:** Experts unsure what to do with Japanese plant's contaminated water

CLIMATE CHANGE

11. **CLIMATE:** Calif., E.U. plan to link carbon markets

ENERGY

12. **TRANSMISSION:** FERC to probe hurdles facing long-distance projects
13. **ENERGY MARKETS:** Power feud between CFTC, FERC lingers on
14. **OFFSHORE WIND:** N.J. takes first steps toward Atlantic City farm
15. **BIOFUELS:** Rush to reach renewable energy goals is driving up food prices
16. **GULF SPILL:** Blowout preventer did not receive recommended overhaul

FEDERAL AGENCIES

17. **INTERIOR:** Probe finds unsafe conditions at Indian Affairs' detention centers

LAW AND LOBBYING

18. **AIR POLLUTION:** Court weighs EPA role in approval of Ky. power plants
19. **OFFSHORE DRILLING:** La. judge rules in favor of new permit requirements in Gulf
20. **HAZARDOUS WASTE:** Chromium manufacturer pledges to clean up contaminated N.J. property

BUSINESS

21. **SOLAR:** GE plans largest U.S. PV panel plant

AIR AND WATER

22. **WATER POLLUTION:** Enviro groups protest White House review of EPA mining guidance

HEALTH AND SAFETY

23. **GULF SPILL:** Emotional impacts may be worse than health effects -- study

INTERNATIONAL

24. **AMAZON:** Brazil to push for dam despite pressure from human rights groups

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Subject: NRC focus on Fukishima (Marty/Eric)
Location: O-17H10

Start: Fri 4/8/2011 1:30 PM
End: Fri 4/8/2011 2:00 PM

Recurrence: (none)

Meeting Status: Meeting organizer

Organizer: Virgilio, Martin
Required Attendees: Leeds, Eric

Categories: Business

4/8/11

Sandy Cianci
Administrative Assistant to Marty Virgilio, DEDR
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sandra.cianci@nrc.gov

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Subject:	EPW Committee Meeting - Japan Events
Location:	O-17H10 (Conference Call)
Start:	Fri 4/8/2011 3:00 PM
End:	Fri 4/8/2011 4:00 PM
Recurrence:	(none)
Meeting Status:	Meeting organizer
Organizer:	Virgilio, Martin
Required Attendees:	Powell, Amy
Categories:	Orange Category

[redacted]

4/7/11

Sandy Cianci
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sandra.cianci@nrc.gov

XX/86

Subject: Update - Task Force Meeting w/Chairman (Marty/Nathan)
Location: Teleconference (Nathan to call Marty)

Start: Fri 4/8/2011 4:00 PM
End: Fri 4/8/2011 4:30 PM

Recurrence: (none)

Meeting Status: Meeting organizer

Organizer: Virgilio, Martin
Required Attendees: Sanfilippo, Nathan

Categories: Business

4/8/11

Sandy Cianci
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From: E&E Publishing, LLC <ealerts@eenews.net>
Sent: Monday, April 11, 2011 1:03 PM
To: Virgilio, Martin
Subject: April 11 -- Greenwire is ready

AN E&E PUBLISHING SERVICE

GREENWIRE -- MON., APRIL 11, 2011 -- Read the full edition

1. NUCLEAR CRISIS: Hiroshima and Nagasaki cast long shadows over radiation science

The collected medical histories from the survivors of the atomic bombings at Hiroshima and Nagasaki have never been more visible, as another radiation crisis has gripped Japan. With few exceptions, each invocation of the possible cancer risk -- or lack of risk -- poised by the failed reactors at the Fukushima Daiichi nuclear plant has its origins in the lives of atomic bomb survivors. A disaster caused by man has resulted in one of the longest and largest health studies ever conducted, led by Japan's Radiation Effects Research Foundation (RERF). Similar efforts could follow for Fukushima. The science, it seems, has come home to roost.

TOP STORIES

2. **ENERGY POLICY:** Shale gas isn't cleaner than coal, Cornell researchers say
3. **DOE:** Data shortfalls make tracking efficiency grants a tough slog -- GAO
4. **MARKETING:** Forest-certification group battles 'greenwashing' charges

POLITICS

5. **TRANSPORTATION:** DOT chief touts transit programs squeezed by budget deal
6. **LOBBYING:** Law firm snags former senior Energy and Commerce member

ENERGY

7. **TRANSMISSION:** Lines for importing Canadian hydropower draw opposition in N.H.
8. **JAPAN:** Aftershock hits coast, forcing suspension of cooling at plant
9. **NUCLEAR POWER:** Fresh questions about turning weapons plutonium into

XX/88

fuel

10. **NUCLEAR POWER:** Radioactive water leaks in U.S. plants go unchecked

11. **OIL AND GAS:** Canadian firm eyes Utah oil sands extraction

12. **NUCLEAR POWER:** Mo. bill would allow utilities to charge customers for permitting costs

13. **NUCLEAR POWER:** French-owned company must find U.S. partner for Md. project

CLEAN TECH

14. **CLEAN TECH:** Rare earths mining company, DOE lab team up

FEDERAL AGENCIES

15. **GULF SPILL:** Coast Guard was unprepared for cleanup -- report

NATURAL RESOURCES

16. **ENDANGERED SPECIES:** Alaskan waters designated critical habitat for beluga whales

17. **GREAT LAKES:** Chicago pushes Army Corps to speed up Asian carp study

WASTES & HAZARDOUS SUBSTANCES

18. **TOXICS:** Katrina relief groups will gut, rebuild homes with Chinese drywall

STATES

19. **GULF SPILL:** Some BP funds used for expenses distantly connected to cleanup

20. **PENNSYLVANIA:** New development czar spent years fighting enviro regs

21. **FLOODS:** Sandbags seeing competition in flood-prone Fargo

SOCIETY

22. **PEOPLE:** Goldman prize recipient pushed refineries toward cleaner practices

E&ETV'S ONPOINT

23. **NATURAL GAS:** AGA's McCurdy discusses new vehicle legislation

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Subject: Hearing- Review of the Nuclear Emergency in Japan and Implications for the US
Location: 406 Dirksen Senate Office Building

Start: Tue 4/12/2011 2:15 PM
End: Tue 4/12/2011 4:45 PM

Recurrence: (none)

Organizer: Virgilio, Martin

Categories: Red Category

[redacted]

4/11/11

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Subject:	CM - Japanese Earthquake Status
Start:	Thu 4/14/2011 12:00 AM
End:	Fri 4/15/2011 12:00 AM
Show Time As:	Free
Recurrence:	(none)
Organizer:	Borchardt, Bill

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From: E&E Publishing, LLC <ealerts@eenews.net>
Sent: Thursday, April 14, 2011 1:12 PM
To: Virgilio, Martin
Subject: April 14 -- Greenwire is ready

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GREENWIRE -- THU., APRIL 14, 2011 -- Read the full edition

1. AIR POLLUTION: TVA to retire 18 coal boilers in landmark pact

In a move that will transform one of the nation's largest coal-burning utilities, the federally run Tennessee Valley Authority has agreed to shut down 18 of its oldest coal-fired boilers and to spend $3 billion to $5 billion more on air pollution controls for its remaining coal plants. The 10-year plan, which will resolve claims from states and environmental groups that 11 TVA power plants in Alabama, Kentucky and Tennessee violated federal air pollution laws, was approved by the utility's board at a meeting today in Chattanooga, Tenn.

TOP STORIES

2. **POLITICS:** EPA supporters work to snag women with focus on family health
3. **CLIMATE:** Greens prepare for the next EPA battle
4. **ENVIRONMENTAL JUSTICE:** Initiative offers 'opportunity,' not a burden, DOJ tells wary industry

POLITICS

5. **CAMPAIGN 2012:** Congresswoman enters Nev. Senate race

ENERGY

6. **NUCLEAR CRISIS:** Questions, challenges surround Japan's cleanup plans
7. **GULF SPILL:** BP payouts created new class of 'spillionaires'
8. **NATURAL GAS:** Some permits get only minutes of review, Pa. regulators say
9. **OFFSHORE DRILLING:** Salazar, Bromwich tour first rig to receive permit after moratorium
10. **NUCLEAR CRISIS:** High radiation levels at reactor No. 4 likely from

XX/91

outside debris

11. **ENERGY EFFICIENCY:** Air conditioner gaps cost millions in wasted fuel -- report

12. **OIL AND GAS:** Gulf protesters barred as BP shareholders convene

CLIMATE CHANGE

13. **CLIMATE:** Bloomberg, Clinton team up groups to cut emissions

LAW AND LOBBYING

14. **ENDANGERED SPECIES:** Judge considers 'elephant in the room' on polar bear case: greenhouse gases

15. **CHEMICALS:** Appeals court dismisses claims against DuPont over C8 pollution

TRANSPORTATION

16. **AUTOS:** Teams announced for second round of DOE's EcoCar competition

17. **HIGH-SPEED RAIL:** China to slow down its bullet trains amid safety concerns

AIR AND WATER

18. **AIR POLLUTION:** States divided on need for stricter carbon monoxide rules

NATURAL RESOURCES

19. **MINING:** Army Corps tries to assess impacts of sprawling phosphate operations

20. **FISHERIES:** Pacific Coast salmon fishing is back after 3 years

E&ETV'S ONPOINT

21. **EPA:** Air expert Bill Becker assesses impact of EPA's budget cuts on states

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From: E&E Publishing, LLC <ealerts@eenews.net>
Sent: Friday, April 15, 2011 12:42 PM
To: Virgilio, Martin
Subject: April 15 -- Greenwire is ready

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GREENWIRE -- FRI., APRIL 15, 2011 -- Read the full edition

1. WETLANDS: Oil industry threatens Obama admin over Clean Water Act guidance

Some of the biggest names in the oil industry -- Exxon Mobil Corp., Marathon Oil Corp. and the American Petroleum Institute -- have waded into the fight to stop the Obama administration from strengthening Clean Water Act regulation of streams and wetlands. The three oil heavyweights met with White House officials last month and threatened legal warfare if the administration proceeds with issuing new guidance on Clean Water Act rules that would increase the number of wetlands and streams subject to federal pollution regulation and permitting.

TOP STORIES

2. **MINING:** Report says claims threaten national treasures
3. **CALIFORNIA:** Schwarzenegger defends nuclear, sugarcane ethanol
4. **CITIES:** A year after floods, Nashville looks to heal 'naturally'

CONGRESS

5. **DOE:** Senate confirms Lyons to lead nuclear office

ENERGY

6. **MINING:** Duke Energy will avoid mountaintop coal based on cost
7. **NATURAL GAS:** Enviro groups deliver thousands of public comments on fracking regs
8. **COAL:** Minn. Senate paves the way for new plants

CLEAN TECH

9. **DOE:** Rentech negotiating second loan guarantee, shifting strategy on fuels project

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10. **POLITICS:** Young activists say they're frustrated with Obama's energy plans

JAPAN EARTHQUAKE

11. **NUCLEAR CRISIS:** Markey criticizes NRC safety review as limited, secret
12. **NUCLEAR CRISIS:** Obama nuclear backing may not quell investment jitters
13. **NUCLEAR CRISIS:** TEPCO to pay $600M to evacuees from disaster

LAW AND LOBBYING

14. **OIL SPILL:** Citgo not responsible for 2004 Delaware River slick, judge rules
15. **SOLAR:** Calif. court dismisses lawsuit over solar project

BUSINESS

16. **GULF SPILL:** Emails show BP tried to influence research fund
17. **GULF SPILL:** BP chairman reassures shareholders, defends CEO

NATURAL RESOURCES

18. **CHESAPEAKE BAY:** Tree planting is first step in partnership's cleanup efforts

WASTES & HAZARDOUS SUBSTANCES

19. **LEAD:** Baltimore paint removal program transfers agencies

STATES

20. **UTILITIES:** Ind. regulator denies conflict of interest with Duke

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Subject:	Replacement for Chuck Casto in Japan
Location:	O17H10
Start:	Fri 4/15/2011 2:45 PM
End:	Fri 4/15/2011 3:30 PM
Recurrence:	(none)
Meeting Status:	Meeting organizer
Organizer:	Virgilio, Martin
Required Attendees:	Doane, Margaret; Mamish, Nader; Weber, Michael; Leeds, Eric; Evans, Michele; Wiggins, Jim; Holahan, Patricia
Optional Attendees:	Kreuter, Jane

4/15/11 per Marty

[redacted]

Stephanie Garland
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Huffert, Anthony

From: Huffert, Anthony
Sent: Saturday, April 16, 2011 7:06 AM
To: Conatser, Richard
Subject: RE: PAGs and Info for Dose Calcs -- Info Collected So Far

Richard,
Great start.
Some suggestions: consider the Codex Alimentarius values and the '09 ICRP 111 document.
Also, more background info would be greatly appreciated.
Wish I had more for you at this time, but the earthquake this morning did interfere with our review of your draft.
Tony

From: Conatser, Richard
Sent: Friday, April 15, 2011 4:37 PM
To: Huffert, Anthony; Gepford, Heathert.
Cc: Pedersen, Roger; Garry, Steven
Subject: PAGs and Info for Dose Calcs -- Info Collected So Far

Tony, Heather,

Here is what I have collected so far. I have not gotten very far, but it will give us something to work from. I have been using the following references:

1. Accidental Radioactive Contamination of Human Food and Animal Feeds: Recommendations for State and Local Agencies.
2. RG 1.109, US NRC
3. IAEA Safety Standards Series, No. GS-R-2, Preparedness and Response for a Nuclear Radiological Emergency
4. Manual of PAGs and Protective Actions for Nuclear Incidents, EPA

I've attached some other documents as well. Call me when you are ready to talk. 301-247-7172.

Richard L. Conatser
Health Physicist
Nuclear Regulatory Commission
301-415-4039
Richard.Conatser@NRC.gov

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Huffert, Anthony

From: Huffert, Anthony
Sent: Saturday, April 16, 2011 5:19 PM
To: Gepford, Heather; Meighan, Sean
Subject: FW: IAEA ENAC reprt for April 15 , 2011

H&S – Last night I sent Rich a couple of emails with suggestions – let's discuss path forward with Rich soon -
T

From: Conatser, Richard
Sent: Saturday, April 16, 2011 8:03 AM
To: Huffert, Anthony
Subject: RE: IAEA ENAC reprt for April 15 , 2011

Thanks Tony,

I'll add some background information and maybe so Q&A type stuff.

From: Huffert, Anthony
Sent: Saturday, April 16, 2011 7:35 AM
To: Conatser, Richard
Subject: FW: IAEA ENAC reprt for April 15 , 2011

Richard,

Latest IAEA ENAC report which includes info on food monitoring.

Please note the sensitivity of the information.

Tony

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Huffert, Anthony

From: Huffert, Anthony
Sent: Saturday, April 16, 2011 5:16 PM
To: Meighan, Sean; Gepford, Heather
Cc: Reynolds, Steven
Subject: FW: Solid and liquid radwaste criteria

We should consider establishing direct communication with Vince via PMT coordination. Your thoughts?

From: Hoc, PMT12
Sent: Saturday, April 16, 2011 11:05 AM
To: Huffert, Anthony
Subject: FW: Solid and liquid radwaste criteria

From: Holahan, Vincent
Sent: Saturday, April 16, 2011 11:35 AM
To: Hoc, PMT12
Subject: RE: Solid and liquid radwaste criteria

Hi Jessica,

On the 11 am call right now.

There is a periodic conference call with the Office of the Secretary of Defense, PACOM, Naval Reactors, line organizations in Japan and others. NRC has not been participating in these calls. One name that I recognize is Gregg Komp. I believe that NSIR has had multiple contacts with Gregg and may be able to contact him directly next week for additional information. Don't know when the next call will be. Could be as late as Tuesday, but I will let the PMT know the time and phone number when I get it from CDR East in the J44 office. Last week's calls were at 7:30 pm EST. If any minutes for these meetings have been issued, I will see that a copy is forwarded to PMT on Monday.

Good news. PACOM cancelled all meeting for the weekend, so I have the weekend off. Probably will not call into the consortia call tomorrow.

Hope this helps.

Cheers,
Vince

From: Hoc, PMT12
Sent: Saturday, April 16, 2011 5:19 AM
To: Holahan, Vincent
Subject: Solid and liquid radwaste criteria

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Vince,

It is the PMT's understanding that NISA is establishing criteria as to what liquid and solid rad-waste will be allowed to be released into municipal waste systems, and this information will become available on 04-21-2011. Tony Huffert and the Japan Team conveyed to me on our 0300 call that they do not have any further information on the issue but would like to know what your information source is and if you have any values on the rad criteria?

Thanks.

-Jessica Kratchman
PMT

Huffert, Anthony

From: Huffert, Anthony
Sent: Saturday, April 16, 2011 5:11 PM
To: Reynolds, Steven
Subject: RE: re-entry

Steve,
This version is an improvement. I'd like to run it by Heather and Sean (fresh eyes) and compare it to what can be realistically achieved today in areas that are candidate for short term reentry.
Tony

From: Reynolds, Steven
Sent: Saturday, April 16, 2011 3:55 PM
To: Huffert, Anthony
Subject: Fw: re-entry

From: Hoc, PMT12
To: Holahan, Vincent; Garchow, Steve; Gepford, Heather; Mitman, Jeffrey; Moore, Carl; Reynolds, Steven; Lupold, Timothy; Meighan, Sean
Cc: Milligan, Patricia; Moore, Scott; Tracy, Glenn; Zimmerman, Roy
Sent: Sat Apr 16 12:58:39 2011
Subject:

Folks,

Attached for your review is the most current version of our "Guidance for Return (Re-entry) of US Citizens to Areas around Fukushima Daiichi NPP." Please, provide comments by Wednesday, April 20.

Note this document is not approved for release outside the NRC at this time.

Kimberly Gambone
PMT12

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Huffert, Anthony

From: Huffert, Anthony
Sent: Saturday, April 16, 2011 5:23 PM
To: Call, Michel
Cc: Meighan, Sean; Gepford, Heather
Subject: QUERY: Japan PMT presentation materials electronic format

Importance: High

Michel – Would you forward Heather, Sean Meighan, and me the email that provided Japan's PMT presentation material that was discussed last Friday at 2 PM? Thanks - Tony

Huffert, Anthony

From: Huffert, Anthony
Sent: Sunday, April 17, 2011 4:43 AM
To: Sun, Casper; Brock, Terry
Cc: Sherbini, Sami; Schaffer, Steven
Subject: RE: Japanese worker doses - Reuters

Gents,
Please continue to send this type of information from your media perusing. It is helpful and appreciated.
From quaking Tokyo,
Tony

Subject: RE: Japanese worker doses - Reuters

This is what they say based on external radiation dose rates at site.
How about their internal doses and bioassay confirmations?
Time will tell. Radiation doses received among the "50-heroes" will hike in time.

Thanks,
Casper

From: Brock, Terry
Sent: Friday, April 15, 2011 12:55 PM
To: Bush-Goddard, Stephanie; RES_DSA_HEB
Subject: Japanese worker doses - Reuters

28 workers between 10 and 25 rem

http://www.reuters.com/article/2011/04/15/us-japan-nuclear-workers-idUSTRE73E58K20110415

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Huffert, Anthony

From: Huffert, Anthony
Sent: Sunday, April 17, 2011 6:46 AM
To: Casto, Chuck; Reynolds, Steven
Subject: "Bake" REQUEST: embassay monitoring equipment

Chuck and Steve,

At the 3 PM meeting today, I mentioned that Chris Smith thought yesterday that the Marines would take their rad monitoring equipment from the embassy rooftop when they left Tokyo in the near future. This afternoon, I confirmed with Chris that he still thinks that may be the case.

I tried to confirm this item with embassy personnel today, but the contact person (Greg Johnstone) was unavailable. I plan to do so tomorrow morning, but I'm uncertain if I can accomplish this task before your Monday morning meeting with embassy leadership. If I'm unable to complete this task before your meeting, please consider letting this item "bake," as I want to avoid providing you with faulty information.

Tony

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Greenwood, Carol

From: Gibson, Kathy
Sent: Sunday, April 17, 2011 6:26 PM
To: Scott, Michael
Subject: Re: Commission Meeting on Japanese Events

Postponed

From: Scott, Michael
To: Gibson, Kathy
Sent: Sun Apr 17 17:28:33 2011
Subject: RE: Commission Meeting on Japanese Events

Whatever happened with this? Past Apr 14 so guess did not happen.

From: Gibson, Kathy
Sent: Tuesday, March 22, 2011 8:07 AM
To: Sheron, Brian; Uhle, Jennifer; Scott, Michael; Bush-Goddard, Stephanie
Cc: Elkins, Scott
Subject: Re: Commission Meeting on Japanese Events

Yes we should lead (with NSIR/Ops Center support) and we can be ready. As soon as you tell me to launch, I will put a team together to work it.

From: Sheron, Brian
To: Uhle, Jennifer; Gibson, Kathy; Scott, Michael; Bush-Goddard, Stephanie
Sent: Tue Mar 22 07:56:32 2011
Subject: FW: Commission Meeting on Japanese Events

See below. Can we be ready to do this by 4/14? Should we be the lead?

From: Bowman, Gregory
Sent: Tuesday, March 22, 2011 7:51 AM
To: Sheron, Brian; Uhle, Jennifer; Gibson, Kathy; Scott, Michael
Cc: Bush-Goddard, Stephanie; Rini, Brett; Dion, Jeanne; Armstrong, Kenneth
Subject: Commission Meeting on Japanese Events
Importance: High

I just learned that we're working towards scheduling a near-term meeting on the events in Japan, with a focus on radiological consequences and potential health effects. The current thinking is that RES would have the lead for this meeting, which will most likely take place on April 14.

The meeting would involve discussion of (1) status of the event (maybe led by NRR), (2) radiological impacts, and (3) radiological significance. The external panel might involve other Federal agencies (e.g., EPA, DOE), HPS, industry, and/or a representative from one of the labs, although it could end up being a challenge to get participation given the timeframe. We would just need to give SECY suggestions and let them take care of the invitations.

Alan Frazier put together the attached draft scheduling note, but it will need to be revised. My understanding is the SECY will likely need a revised scheduling note back today to get to the Commission. Please let me know

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as soon as you can if you think the lead for this meeting should be assigned to a different office (if that's the case, we'll need to circle back with Mike).

Greg

From: Frazier, Alan
Sent: Monday, March 21, 2011 4:47 PM
To: Bowman, Gregory
Cc: Brock, Kathryn; Andersen, James; Wittick, Brian; Merzke, Daniel
Subject: RE: ACTION: Draft Scheduling Note for New Commission Meeting

Greg,

FSME tells me that last week RES agreed to take the lead in any discussion of rad consequences or health affects if those topics had come up during today's Commission meeting. The Commission would now like to have a Commission meeting in April focused on rad consequences and health effects.

Could you please confirm with RES tomorrow that they should have the lead for the April Commission meeting? Note that it was Jeanne Dion that agreed RES should have the lead last week (see attached email) but I am not aware of any front office interaction on this.

Alan

From: Deegan, George
Sent: Monday, March 21, 2011 4:29 PM
To: Frazier, Alan
Cc: Brock, Kathryn; Andersen, James; Wittick, Brian; Weber, Michael; Miller, Charles; Moore, Scott; Merzke, Daniel
Subject: RE: ACTION: Draft Scheduling Note for New Commission Meeting

Alan- Thanks for forwarding Jim Andersen's email.

When Allen Howe's Working Group was assembled last week to construct an outline for today's Commission briefing, the rad consequences/health effects issue was identified as originally marked as an FSME potential topic, but we later determined that RES would be better to take lead (with SOARCA etc.). I'd think they'd be the best ones to lead any new Commission briefing in April on this topic. I'll forward you that email chain separately.

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Sent: Monday, March 21, 2011 3:42 PM
To: Deegan, George
Cc: Brock, Kathryn; Andersen, James; Wittick, Brian; Weber, Michael; Miller, Charles; Moore, Scott; Merzke, Daniel
Subject: ACTION: Draft Scheduling Note for New Commission Meeting

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Please take a look at Jim's note below from today's agenda planning meeting which was held immediately after the Commission meeting.

Note in particular the highlighted **new Commission meeting in April on the Japan event with additional focus on radiological consequence / health effects** (probably around 4/14). FSME will have the lead for this new Commission meeting. Additionally, I got some feedback from Jim that you should consider having the following elements in the scheduling note.

- Status of event
- Radiological Impacts
- Radiological significance
- External panel

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I do not know when this action will be due but I wanted to give you a head-start. We are still waiting for SECY's official summary of the meeting, which usually contains due dates for the draft scheduling notes.

Please let me know if you have any questions.

Regards,

Alan L. Frazier
Executive Technical Assistant
Office of the Executive Director for Operations
U.S. Nuclear Regulatory Commission
301-415-1763

From: Andersen, James
Sent: Monday, March 21, 2011 1:35 PM
To: EDO_TBPM Distribution
Cc: Muessle, Mary; Weber, Michael; Virgilio, Martin; Ash, Darren; Landau, Mindy
Subject: Agenda Planning Meeting

ETAs,

The Commission held an Agenda Planning Meeting this morning. SECY will provide the formal summary, but I wanted to let you know a couple things as quickly as possible:

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- Status meeting on the Japanese event with additional focus on radiological consequence / health effects; probably around 4/14 **(Brian lead for scheduling note)**

- Status meeting on the Japanese event with additional focus on station blackout; probably around 4/28 **(Brian lead for scheduling note)**

- Stakeholder meeting on the staff's 90 day status report; probably around 7/25 **(Jim A lead for scheduling note)**

Huffert, Anthony

From: Huffert, Anthony
Sent: Sunday, April 17, 2011 7:44 AM
To: Reynolds, Steven
Subject: PMT Request (SNL mtg)

Steve,

Before the SNL staff leave this Wednesday, I need to acquire a better understanding of past and potential future source term release estimates that are based on their latest analyses of each rx and spent fuel pool no. 4.

For this meeting to be productive and efficient, a RST member from the embassy team with severe accident knowledge should participate in the meeting in support of the PMT's objectives.

I'm seeking your guidance on how best to proceed on this item, including whether to seek Chuck's input on what information the PMT should be able to provide in support of our mission.

I'd be glad to discuss this with you further tomorrow morning, before or after the 8 AM mtg.

Tony

XX/102

Subject:	Meeting w/Chairman re: 50 Mile Evacuation and Operations Center
Location:	Chairman's Office
Start:	Mon 4/18/2011 11:00 AM
End:	Mon 4/18/2011 11:30 AM
Recurrence:	(none)
Organizer:	Virgilio, Martin
Categories:	Red Category

4/14/11 per Patti x1820 (Marty's request on 4/13)

Stephanie Garland
Administrative Assistant to Darren Ash, DEDCM
Office of the Executive Director for Operations
O-17 H15
301-415-8704
stephanie.garland@nrc.gov

XX/103

Wittick, Brian

From: Wittick, Brian
Sent: Monday, April 18, 2011 4:14 AM
To: Matheson, Mary
Cc: Mitchell, Reggie; Kaplan, Michele; Mamish, Nader
Subject: RE: Japan support

Rel

Mary,

Surin and I discussed the transition today; I would like to discuss the transition plans with you when you get a chance. Let me know when a good time to call is (Tokyo is 13 hours ahead of DC).

Thanks
Brian

OCFO

From: Matheson, Mary
Sent: Thursday, April 14, 2011 6:18 PM
To: Wittick, Brian
Cc: Mitchell, Reggie; Kaplan, Michele; Mamish, Nader
Subject: Japan support

Hi Brian,

OCFO has been tasked to ensure all elements of support are taken care of when the humanitarian efforts supported by USAID end on April 30, 2011. I was hoping you could take care of a few items while you are still there to support the transition.

USAID currently has the agreement through State/ICASS for reimbursing the US Embassy in Japan for support they have been providing the NRC staff working over in Japan. NRC will need to start funding this effort starting May 1, 2011. This agreement includes embassy support and the translator services. An employee from USAID, I believe her name is Suri, is going to speak to you about the logistics on how to get this done. I have all of the funding information to support the transition, I just need a POC at the embassy that I can work directly with to coordinate the transition. I need cost estimates for these services and I have additional questions relating to lodging. If you could pave the way for me to speak to or e-mail the correct person I could use the help.

I look forward to hearing from you.

Thanks in advance for your help.

Mary
301-415-8748

XX/104

Wittick, Brian

From: Wittick, Brian
Sent: Monday, April 18, 2011 6:07 AM
To: Wittick, Brian; Doane, Margaret; Mamish, Nader
Cc: LIA08 Hoc; LIA02 Hoc; Foggie, Kirk; Abrams, Charlotte; Emche, Danielle
Subject: RE: Read out from 4/18 meetings
Attachments: Meeting results 4-18.docx

rel email

Margie,

Attached please find the results of the Monday meeting. We are also looking to get a feed from Skip of Elizabeth on activities in Japan involving Russia. Hosono mentioned to Chuck that he may ask NRC to assist in cooperation efforts involving Russia in the not to distant future, so it would be good to know what activities they are involved in.

VR/
Brian

XX/105

Summary – 4/18

NSIR ?

NISA/TEPCO Meeting

The NISA/TEPCO meeting focused on plant status and discussions of the TEPCO "Roadmap towards Restoration from the Accident at Fukushima Daiichi Nuclear Power Station," which is a high level guide discussing the big picture steps for bringing the reactors and spent fuel pools to a stable cooling condition, and mitigating the release of radioactive materials. This report was big news in the local media, some applauding TEPCO openly communicating their recovery plan, others criticizing TEPCO for planning to take nine months for their recovery plan.

The meeting began with the RST lead stating the new team (which had changed out over the weekend) had reviewed all of the data and concurred with the previous team's assessment that NRC believed more emphasis was needed on diversity and redundancy for the site cooling systems. Nei countered with a request that NRC provide him detail on exactly what measures and systems we were recommending.

When asked about the level of activity on the site TEPCO provided there were 778 people directly at the site and 150 people at a staging are working support. This was a bit higher than the level of activity most expected. TEPCO also noted they had employed a "U.S. robot" at the site for monitoring activities and some debris clearing and thanked the U.S.

Speaking of thanks, an number of NRC personnel have recently received unsolicited thanks from Japanese citizens for their support and presence in Japan; it happened with me today from a cabbie enroute to a meeting at NISA.

Nei scheduled a special meeting of a PRA subgroup for Tuesday to discuss risk insights and structural assessment of #4 SFP. He said the subgroup is known in NISA as the "Excitement Group" because of their lively discussions.

In a sidebar with Bannai I discussed our efforts to support their request for TMI lessons learned. See separate emails on the subject.

Andersen, James

From: Bavol, Rochelle
Sent: Monday, April 18, 2011 10:29 AM
To: Wilson, George
Cc: Merzke, Daniel; Bowman, Gregory; Andersen, James; Laufer, Richard; Hiland, Patrick; Bowman, Eric
Subject: Updated Scheduling Note for 4/28 Commission Briefing on Japan
Attachments: 110428 Status on Japan-Station Blackout Scheduling Note.docx

\SECY

George,

I understand from Jim Anderson that Pat Hiland will replace Eric Leeds to give the overview for the April 28th Commission briefing on Japan – SBO, and Eric will not be at the table. See attached updated scheduling note.

Rochelle

4X\106

Draft: 4/18/11

SECY

SCHEDULING NOTE

Title: **BRIEFING ON THE STATUS OF NRC RESPONSE TO EVENTS IN JAPAN AND BRIEFING ON STATION BLACKOUT (Public)**

Purpose: To provide the Commission with an update on the status of the events in Japan and to provide an overview of U.S. nuclear plant preparedness to prevent and cope with station blackout.

Scheduled: **April 28, 2011**
9:30 am

Duration: Approx. 1 hour and 45 minutes

Location: Commissioners' Conference Room, 1st floor OWFN

Participants:	**Presentation**
NRC Staff Panel	**50 mins.***
Marty Virgilio, Deputy Executive Director for Reactor and Preparedness Programs Topic: Update on NRC Response to Japanese Events	10 mins.*
Pat Hiland, Director, Division of Engineering, NRR Topic: Station Blackout and Advanced Accident Mitigation (B.5.b) Overview	10 mins.*
George Wilson, Chief of Instrumentation and Control Branch, Division of Engineering, Office of Nuclear Reactor Regulation Topic: Station Blackout Preparedness and Coping	15 mins.*
Eric Bowman, Senior Project Manager, Division of Policy and Rulemaking, Office of Nuclear Reactor Regulation Topic: Advanced Accident Mitigation (B.5.b)	15 mins.*
Commission Q & A	**50 mins.**
Discussion – Wrap-up	**5 mins**

*For presentation only and does not include time for Commission Q & A's.

Documents:
Background material distributed: April 12, 2011.
Slides due to SECY: April 21, 2011.

Greenwood, Carol

From: Gibson, Kathy
Sent: Monday, April 18, 2011 10:01 AM
To: Scott, Michael
Subject: Re: Commission Meeting on Japanese Events

No

From: Scott, Michael
To: Gibson, Kathy
Sent: Mon Apr 18 08:23:34 2011
Subject: RE: Commission Meeting on Japanese Events

Any idea to when?

From: Gibson, Kathy
Sent: Sunday, April 17, 2011 6:26 PM
To: Scott, Michael
Subject: Re: Commission Meeting on Japanese Events

Postponed

From: Scott, Michael
To: Gibson, Kathy
Sent: Sun Apr 17 17:28:33 2011
Subject: RE: Commission Meeting on Japanese Events

Whatever happened with this? Past Apr 14 so guess did not happen.

From: Gibson, Kathy
Sent: Tuesday, March 22, 2011 8:07 AM
To: Sheron, Brian; Uhle, Jennifer; Scott, Michael; Bush-Goddard, Stephanie
Cc: Elkins, Scott
Subject: Re: Commission Meeting on Japanese Events

Yes we should lead (with NSIR/Ops Center support) and we can be ready. As soon as you tell me to launch, I will put a team together to work it.

From: Sheron, Brian
To: Uhle, Jennifer; Gibson, Kathy; Scott, Michael; Bush-Goddard, Stephanie
Sent: Tue Mar 22 07:56:32 2011
Subject: FW: Commission Meeting on Japanese Events

See below. Can we be ready to do this by 4/14? Should we be the lead?

From: Bowman, Gregory
Sent: Tuesday, March 22, 2011 7:51 AM
To: Sheron, Brian; Uhle, Jennifer; Gibson, Kathy; Scott, Michael
Cc: Bush-Goddard, Stephanie; Rini, Brett; Dion, Jeanne; Armstrong, Kenneth

XX/107

Subject: Commission Meeting on Japanese Events
Importance: High

I just learned that we're working towards scheduling a near-term meeting on the events in Japan, with a focus on radiological consequences and potential health effects. The current thinking is that RES would have the lead for this meeting, which will most likely take place on April 14.

The meeting would involve discussion of (1) status of the event (maybe led by NRR), (2) radiological impacts, and (3) radiological significance. The external panel might involve other Federal agencies (e.g., EPA, DOE), HPS, industry, and/or a representative from one of the labs, although it could end up being a challenge to get participation given the timeframe. We would just need to give SECY suggestions and let them take care of the invitations.

Alan Frazier put together the attached draft scheduling note, but it will need to be revised. My understanding is the SECY will likely need a revised scheduling note back today to get to the Commission. Please let me know as soon as you can if you think the lead for this meeting should be assigned to a different office (if that's the case, we'll need to circle back with Mike).

Greg

From: Frazier, Alan
Sent: Monday, March 21, 2011 4:47 PM
To: Bowman, Gregory
Cc: Brock, Kathryn; Andersen, James; Wittick, Brian; Merzke, Daniel
Subject: RE: ACTION: Draft Scheduling Note for New Commission Meeting

Greg,

FSME tells me that last week RES agreed to take the lead in any discussion of rad consequences or health affects if those topics had come up during today's Commission meeting. The Commission would now like to have a Commission meeting in April focused on rad consequences and health effects.

Could you please confirm with RES tomorrow that they should have the lead for the April Commission meeting? Note that it was Jeanne Dion that agreed RES should have the lead last week (see attached email) but I am not aware of any front office interaction on this.

Alan

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Cc: Brock, Kathryn; Andersen, James; Wittick, Brian; Weber, Michael; Miller, Charles; Moore, Scott; Merzke, Daniel
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From: E&E Publishing, LLC <ealerts@eenews.net>
Sent: Monday, April 18, 2011 1:05 PM
To: Virgilio, Martin
Subject: April 18 -- Greenwire is ready

AN E&E PUBLISHING SERVICE

GREENWIRE -- MON., APRIL 18, 2011 -- Read the full edition

1. NATURAL GAS: Instant coffee, nut shells in frack fluid -- but what else?

Turns out, fracking has its own "junk shot." A congressional study made public over the weekend found that companies that perform hydraulic fracturing have blasted into the ground kitchen-table materials such as walnut hulls and instant coffee. They are the surprisingly pedestrian aspects of a controversial chemical brew mixed with water and sand, then injected at high pressure to crack open rock and pry oil and gas from rock formations.

TOP STORIES

2. **WHITE HOUSE:** Congress can't kill advisory posts, Obama declares in signing statement
3. **POLITICS:** Gulf spill didn't change trajectory of La. Senate race
4. **OIL AND GAS:** Updated review of Keystone pipeline fails to silence project's critics

POLITICS

5. **LOBBYING:** EDF hires former journalist to develop climate strategies

CONGRESS

6. **HOMELAND SECURITY:** Bill would let Border Patrol waive enviro laws on public lands

CLIMATE CHANGE

7. **CALIFORNIA:** Carbon traders predict on-time launch of new GHG market

CLEAN TECH

XX\108

8. **BIOFUELS:** DOE report scopes best locations for farming microalgae

ENERGY

9. **ENERGY POLICY:** Economic boom isn't changing minds about Obama in Wyo.

10. **NUCLEAR:** Progress brings troubled fleet into Duke merger

11. **NUCLEAR:** U.S. cranks the power at old plants to boost output

12. **NUCLEAR CRISIS:** TEPCO announces 9-month plan to shut down plant

GULF SPILL ANNIVERSARY

13. **GULF SPILL:** Coast Guard leader says cleanup 'the most political event' he's ever been involved in

14. **OFFSHORE DRILLING:** Despite changes, federal regulators still have 'more to do'

15. **GULF SPILL:** Ecosystem health back to normal, but trouble spots remain

FEDERAL AGENCIES

16. **MINING:** Internal audits reveal federal enforcement lapses

AIR AND WATER

17. **WATER:** N.C. environmental restoration program falls short of goals

NATURAL RESOURCES

18. **FISHERIES:** Little chance Pacific fish have radioactive contamination -- FDA

19. **FISHERIES:** Four fish species added to tainted list along Los Angeles waters

WASTES & HAZARDOUS SUBSTANCES

20. **PESTICIDES:** Wildlife deaths prompt crackdown on most potent rat poisons

INTERNATIONAL

21. **NUCLEAR:** Ukraine seeks more money for Chernobyl as it cuts benefits to cleanup workers

E&ETV'S ONPOINT

22. **OIL & GAS:** Helix CEO Kratz discusses containment solutions for

deepwater spills

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Phone: 202-628-6500. Fax: 202-737-5299.
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Wittick, Brian

Rel email

From:	Wittick, Brian
Sent:	Tuesday, April 19, 2011 7:22 AM
To:	Wittick, Brian; Doane, Margaret; Mamish, Nader
Cc:	LIA08 Hoc; LIA02 Hoc; Foggie, Kirk; Abrams, Charlotte; Emche, Danielle
Subject:	Read out from 4/19 meetings
Attachments:	Meeting results 4-19.docx

Margie,

Attached please find the results of the Tuesday meetings.

VR/
Brian

XX/109

Summary – 4/19

NISA/TEPCO Meeting

The NISA/TEPCO meeting was largely a meeting discussing the equipment schematics for the temporary emergency cooling systems. The group also discussed current status of the three plants and #4 SFP, which remain largely unchanged.

Of note, the Ambassador requested we inquire as to the status of the "Bechtel pumping system" the NRC worked to provide to TEPCO early in the accident. We were informed the pumping system has been placed in a standby status in case they are needed as a backup.

Subgroup Engineering Meeting

The subgroup meeting reviewed the MELCOR results completed by JNES and Sandia Lab. The PRA analysts had a lively discussion debating the finer points of what may have happened during the accident sequences. I guess this is why Nei refers to them as the "Excitement Group." I mostly got a sore neck from my head bobbing

Other Activities:

Nakagawa from JNES requested a luncheon between Chuck Casto and METI's Mitsumata (Director of Nuclear Energy Policy Planning Division). We are working to set that up for early next week.

DOS – DOE legal team arrives Wednesday for Thursday discussion with MOFA on nuclear related assistance. See email forwarded separately.

Merzke, Daniel

From:	Merzke, Daniel
Sent:	Tuesday, April 19, 2011 3:40 PM
To:	Batkin, Joshua; Bradford, Anna; Sharkey, Jeffry; Castleman, Patrick; Thoma, John; Monninger, John; Sosa, Belkys; Baggett, Steven; Bubar, Patrice; Tadesse, Rebecca; Nieh, Ho; Kock, Andrea
Cc:	Virgilio, Martin; Weber, Michael; Milligan, Patricia; Vietti-Cook, Annette
Subject:	RE: EPA guidance on reentry and return

In response to numerous questions surrounding whether or not there is a Deputies meeting at the White House tomorrow concerning re-entry criteria, for Fukushima or the PLE, NSIR queried their contacts with the National Security Staff and as far as anyone on the NSS is concerned, there is no Deputies or Principal meeting scheduled tomorrow. The action request to compare the PLE re-entry document with the NRC generated Fukushima re-entry criteria appears to be an effort to ensure the two documents are consistent in their decision-making basis. The requesting agency mentioned a White House meeting tomorrow, and that got interpreted as a possible Deputies meeting, which is not the case.

Marty is attending a meeting with the EPA on Thursday afternoon to align on the PLE re-entry paper. That meeting is not about the Fukushima re-entry criteria. My understanding is the Fukushima re-entry paper is about ready to go out for inter-agency comment.

I hope this clears up the question. If you have further questions, please let me know.

Dan

From: Kock, Andrea
Sent: Tuesday, April 19, 2011 2:59 PM
To: Milligan, Patricia; Merzke, Daniel
Subject: FW: EPA guidance on reentry and return
Importance: High

Trish/Dan: There is a lot of confusion up here on a potential meeting at the white house tomorrow on the issue below- whether there is a meeting to discuss EPA versus NRC PAGs? Can you call me? I understand Patty Bubar has also been in contact with you- if you call either of us, we will contact each other so you can discuss with us both at the same time.

Thanks

Andrea Kock
United States Nuclear Regulatory Commission
Technical Assistant for Materials
Office of Commissioner Ostendorff
301-415-2896

From: Vietti-Cook, Annette
Sent: Tuesday, April 19, 2011 12:37 PM
To: Kock, Andrea
Subject: FW: EPA guidance on reentry and return
Importance: High

From: Vietti-Cook, Annette
Sent: Tuesday, April 19, 2011 12:34 PM
To: Batkin, Joshua; Monninger, John; Sharkey, Jeffry; Castleman, Patrick; Sosa, Belkys; Snodderly, Michael; Bubar, Patrice; Orders, William; Nieh, Ho; Franovich, Mike
Subject: FW: EPA guidance on reentry and return
Importance: High

As a follow up to a TA request from an Ops Center Briefing a week ago Sunday for reentry and return criteria to evacuation zone, attached is more info.

OE

From: Zimmerman, Roy
Sent: Tuesday, April 19, 2011 12:23 PM
To: Virgilio, Martin; Vietti-Cook, Annette; Milligan, Patricia
Cc: Hoc, PMT12
Subject: FW: EPA guidance on reentry and return
Importance: High

Oh –oh, dueling re-entry guidance we need to get sorted out quickly. Didn't know about the white house mtg tomorrow.....apparently a deputies mtg that will talk on re-entry as one of the topics.

From: Keith, Sam (ATSDR/DTEM/ATB) [mailto:ldk4@cdc.gov]
Sent: Tuesday, April 19, 2011 12:05 PM
To: Hoc, PMT12; RST01 Hoc
Cc: Zimmerman, Roy; LIA08 Hoc
Subject: EPA guidance on reentry and return
Importance: High

Sandy,

This morning, the DHHS lead at the White House sent me the attached EPA draft guidance on population re-entry and return, along with a request to compare the EPA and NRC versions in preparation for a White House meeting tomorrow. I checked and was given the ok to share it here at NRC. Although the NRC version is not yet releasable, perhaps it will be later today.

I would appreciate you sharing this message and attachment with Trish at the earliest. I am copying ET and LIA on this.

Thanks,
Sam Keith
CDC Liaison

Rihm, Roger

From: Rihm, Roger
Sent: Tuesday, April 19, 2011 2:56 PM
To: Landau, Mindy
Subject: FW: QFRs from EW Appopriations Hearing
Attachments: 20110330 QFRs - NRC (Jaczko).doc

Rel

FYI. A Few Qs and As from a Senate hearing. David Decker says we should have ques coming from other hearings as well.

OCA

From: Decker, David
Sent: Tuesday, April 19, 2011 2:33 PM
To: McKelvin, Sheila; Champ, Billie
Cc: Powell, Amy; Schmidt, Rebecca; Rihm, Roger; Rothschild, Trip
Subject: QFRs from EW Appopriations Hearing

One more set of Questions for the Record coming in. This small set is from the March 30th hearing with the Senate Appropriations Subcommittee on Energy and Water Development.

XX/111

OCA

QUESTIONS FOR THE RECORD
FOR THE NUCLEAR REGULATORY COMMISSION
PROPOUNDED BY SENATOR MARY LANDRIEU
SENATE APPROPRIATIONS SUBCOMMITTEE ON
ENERGY AND WATER DEVELOPMENT
Hearing on Nuclear Safety
March 30, 2011

1. What has and will the U.S. Nuclear Regulatory Commission do to ensure that our U.S. reactors are safe and are prepared for the worst case scenario?

2. I know that 23 of the U.S. reactors are a General Electric Mark I design, the same design at the Fukushima Daiichi facility in Japan. Yet, I believe each of these 23 facilities has been retrofitted and modified to address venting and other concerns with this reactor design. Can you please walk me through why the modifications were needed at the U.S. facilities? Can you confirm that all of these reactors have been modified? Does this make our reactors safer than the reactors in Japan?

3. I am told that in the upcoming year, two of the five NRC Commissioners will be up for replacement. Given the events that have taken place over the past month, and the number of U.S. nuclear facilities that will need renewal licenses, can you please speak to the importance of having a full panel as the NRC moves forward to tackle these issues?

Merzke, Daniel

EDO

From: Merzke, Daniel
Sent: Tuesday, April 19, 2011 2:12 PM
To: Dudek, Michael; Milligan, Patricia
Cc: Williams, Kevin; Holahan, Patricia; McDermott, Brian
Subject: RE: ACTION: Review of EPA vs. NRC re-entry guidance documents

Rel

Jason checked with NSS and they are unaware of a Deputies meeting tomorrow. The original e-mail requested the comparison to prepare for a White House meeting tomorrow, and that has been construed to mean Deputies meeting, but it may in fact just be a meeting for the agency requesting the review. We have not gotten any invitation to attend a Deputies meeting tomorrow. Be that as it may, the paper is the draft working group paper for the PLE. I think EPA staff was hoping to align the Fukushima re-entry criteria with the PLE re-entry criteria, which I suspect is the reason for the request.

Dan

NSIR

From: Dudek, Michael
Sent: Tuesday, April 19, 2011 2:05 PM
To: Milligan, Patricia
Cc: Williams, Kevin; Holahan, Patricia; McDermott, Brian; Merzke, Daniel
Subject: ACTION: Review of EPA vs. NRC re-entry guidance documents
Importance: High

Trish,
I have receive this tasking from the ET and I believe that this is in your purview. Due date is ASAP for meeting at the White House tomorrow. Please refer all questions to PMT.

Question to be answered by NSIR:

An EPA drafted re-entry guidance document has come to light. We need this document to be reviewed as soon as possible against our own, noting similarities and disparities in the re-entry criteria. Sounds like there will be a principles meeting tomorrow morning, with the potential to be involved in meeting with National Security Staff at the White House.

This ticket is being tracked in the Japan SharePoint page (http://nsir-ops.nrc.gov/Lists/HOC%20Red%20Tickets/AllItems.aspx) under ticket number **4906.**

Please provide a response to this email to confirm receipt. Thank you,
Michael I. Dudek

Michael Dudek | Technical Assistant | NSIR/Division of Preparedness & Response | U.S. NRC
11555 Rockville Pike, Rockville, MD 20852 | ☎ (301) 415-6500 | ✉: Michael.Dudek@nrc.gov

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NSIR

From: Hoc, PMT12
Sent: Tuesday, April 19, 2011 1:10 PM
To: Dudek, Michael
Subject: ACTION: Review of EPA vs. NRC re-entry guidance documents
Importance: High

Michael,

XX/112

An EPA drafted re-entry guidance document has come to light. We need this document to be reviewed as soon as possible against our own, noting similarities and disparities in the re-entry criteria. Sounds like there will be a principles meeting tomorrow morning, with the potential to be involved in meeting with National Security Staff at the White House.

Please be diligent in assigning this task.

V/r,

Kimberly Gambone
PMT12

Merzke, Daniel

EDO

From: Merzke, Daniel
Sent: Tuesday, April 19, 2011 2:05 PM
To: Virgilio, Martin; Bubar, Patrice
Cc: Cianci, Sandra; Milligan, Patricia
Subject: FW: EPA guidance on reentry and return

Rel

Marty/Patty, I just spoke with Trish, and she is scheduled to arrive at Dulles late this afternoon, early evening. She is unavailable tomorrow morning, but could support a meeting late tomorrow afternoon. Marty, the AARM is tomorrow.

Patty, you are correct, the paper distributed today is the working group paper for the PLE discussion on long-term cleanup criteria. The only paper NRC is working on is the re-entry criteria around Fukushima. My understanding was that EPA staff was hoping to align the two approaches to send a consistent message, which may be the impetus behind the request to compare the two documents. After checking with the NSS, they are unaware of a Deputies meeting tomorrow; it may be a meeting for just one agency. I hope I didn't confuse anyone.

Dan

EDO

From: Virgilio, Martin
To: Bubar, Patrice; Milligan, Patricia; Cianci, Sandra
Sent: Tue Apr 19 13:41:19 2011
Subject: RE: EPA guidance on reentry and return

Rel

Patty

Trish is out of the office but scheduled to return today or tomorrow. Let's get together as soon as she can support a meeting.

Marty

SECY

From: Bubar, Patrice
Sent: Tuesday, April 19, 2011 1:26 PM
To: Virgilio, Martin; Milligan, Patricia; Cianci, Sandra
Subject: FW: EPA guidance on reentry and return
Importance: High

Marty and Trish – the message below causes a bit of confusion – at least to me.

The EPA Re-Entry Guidance mentioned below and attached – was developed after a Feb. meeting on the Principal Level Exercise. It was developed by EPA. Not sure if NRC has officially commented. It was for use in the US.

There is also Re-Entry guidance for Fukushima that was developed by NRC for use in Japan. One could ask why NRC was developing the re-entry guidance in the first place?

At first blush – there are major differences between the NRC developed draft and the EPA developed draft.

Of course – there is another effort ongoing – separate but somewhat related – that is the interagency review process on the EPA PAGs. Commissioner Magwood and I have been talking to senior management in DOE – to see if we could get some alignment within the federal family.

XX/113

I would benefit from a few minutes with both of you to get a better understanding of the lay of the land here.

Marty/Sandy – could I have a few minutes today with you?

Patty Bubar
Chief of Staff
Office of Commissioner William D. Magwood
U.S. Nuclear Regulatory Commission
301-415-1895

Sct

From: Vietti-Cook, Annette
Sent: Tuesday, April 19, 2011 12:34 PM
To: Batkin, Joshua; Monninger, John; Sharkey, Jeffry; Castleman, Patrick; Sosa, Belkys; Snodderly, Michael; Bubar, Patrice; Orders, William; Nieh, Ho; Franovich, Mike
Subject: FW: EPA guidance on reentry and return
Importance: High

As a follow up to a TA request from an Ops Center Briefing a week ago Sunday for reentry and return criteria to evacuation zone, attached is more info.

OE

From: Zimmerman, Roy
Sent: Tuesday, April 19, 2011 12:23 PM
To: Virgilio, Martin; Vietti-Cook, Annette; Milligan, Patricia
Cc: Hoc, PMT12
Subject: FW: EPA guidance on reentry and return
Importance: High

Oh –oh, dueling re-entry guidance we need to get sorted out quickly. Didn't know about the white house mtg tomorrow.....apparently a deputies mtg that will talk on re-entry as one of the topics.

From: Keith, Sam (ATSDR/DTEM/ATB) [mailto:ldk4@cdc.gov]
Sent: Tuesday, April 19, 2011 12:05 PM
To: Hoc, PMT12; RST01 Hoc
Cc: Zimmerman, Roy; LIA08 Hoc
Subject: EPA guidance on reentry and return
Importance: High

Sandy,

This morning, the DHHS lead at the White House sent me the attached EPA draft guidance on population re-entry and return, along with a request to compare the EPA and NRC versions in preparation for a White House meeting tomorrow. I checked and was given the ok to share it here at NRC. Although the NRC version is not yet releasable, perhaps it will be later today.

I would appreciate you sharing this message and attachment with Trish at the earliest. I am copying ET and LIA on this.

Thanks,
Sam Keith
CDC Liaison

Merzke, Daniel

ODO **From:** Merzke, Daniel
Sent: Tuesday, April 19, 2011 7:35 AM
To: Morris, Scott; Wiggins, Jim
Cc: Evans, Michele; McDermott, Brian; Milligan, Patricia
Subject: RE: Issues from Marty

Rel

Scott, I asked Marty to be more specific about how we got outside our process, and he told me that we didn't really. His concern was that we were getting a lot of unsolicited "help" from the White House and OSTP in determining the protective action recommendations. He suspects in a domestic situation, we would probably get even more "help," and it's something we should be prepared to deal with. We should add this to the lessons learned effort.

Dan

NSIR **From:** Morris, Scott
Sent: Friday, April 15, 2011 3:12 PM
To: Merzke, Daniel; Wiggins, Jim
Cc: Evans, Michele; McDermott, Brian; Milligan, Patricia
Subject: RE: Issues from Marty

Dan ... thanks ... can you be a tad more specific about how Marty thinks we got "outside our existing framework" in decision-making? I have some thoughts on this, but I just want to be certain that we understand Marty's specific concerns.

EDO **From:** Merzke, Daniel
Sent: Friday, April 15, 2011 2:31 PM
To: Wiggins, Jim
Cc: Evans, Michele; McDermott, Brian; Morris, Scott; Milligan, Patricia
Subject: Issues from Marty

Rel

Jim, I met with Marty this morning, and he had two things for NSIR. He would like to have the information paper to the Commission done as soon as possible. He mentioned taking it to the April 21st meeting with EPA, but I'm not sure that's realistic. I told him at this point there is no information beyond what was put into the CA Note that was sent up, and that we could just try converting the CA Note into an info paper. He was receptive to that idea. He thinks it's possible that one of the Commissioners will try to turn it into a vote paper. I was waiting to hear from Trish to ticket this so we could assign a realistic due date, but it was clear Marty would like it sooner rather than later.

Second, during the Japan event response, he expressed concern that intervention by the White House and other federal agencies in making the protective action recommendations got us outside our existing framework in decision-making. He would like to explore lessons learned on the ability, or inability, to stick to our established ground rules on PARs during an event with the potential for recommendations coming from outside our framework. I suggested this topic might be appropriate for the Lessons Learned Task Force, but he thinks this is outside their charter.

If you have any questions, feel free to ask.

Dan

XX/114

Rel

Wittick, Brian

From: Wittick, Brian
Sent: Wednesday, April 20, 2011 8:17 PM
To: Matheson, Mary
Cc: Carter, Mary; Reynolds, Steven; Mamish, Nader
Subject: RE: Japan team travel

Mary,

Please see below for answers to your questions, and some additional from me.

Thanks for your support.
Brian

OFO

From: Matheson, Mary
Sent: Wednesday, April 20, 2011 4:04 PM
To: Wittick, Brian
Subject: RE: Japan team travel

Thanks for the e-mail today.

I met with Jim Dyer and Nader Mamish and a few things have been decided.

1) NRC travelers that are in Japan and scheduled to return no later than May 3 will continue to be covered under AID funding. All vouchers and tickets will be done via the AID travel vouchering process. If one of these travelers change reservations and return after May 3 they will have to obtain an NRC ticket and will have to voucher lodging and per diem from May 4 until their return through NRC. We must know of any changes so that we can create NRC Travel authorizations.
   Acknowledged
2) Chuck Casto since he is staying longer will be under an NRC travel authorization starting May 1. His return trip ticket will need to be booked through Mary Carter. I am checking on his charge card situation.
   Who will be setting up Chuck's new orders and how would you like to transition his hotel reservations. I can talk to embassy travel to effect his hotel transition.
3) New travelers that have yet to be identified will travel under NRC authorizations, their reservations should be booked with Mary Carter. All of their expenses will be charged to their individually billed travel card (with the exception of their airfare) They will be booked at the same hotel (Okura) to support the mission and maintain continuity. They will voucher through NRC.
   If Mary is doing reservations does that imply not using the E2 system? Will Mary make both air and hotel reservations?
4) We would like with your help look into utilizing the ICASS process for: (are you able to ask for them to provide an estimate monthly for May – September FY 2011 – 5 Months.
   a. Information Tech Support
   b. Administrative Supply
   c. GOTL Non Residential Building Operations

   I hope to have an estimate and interagency agreement for ICASS available for you later today. There are some additional items we need to consider (which are already becoming an issue) such as mail service support. The estimate we send you should include the necessary support (e.g. phones) for functioning through the end of the year.
5) Can you send me the estimate and I will provide all of the funding information they need?
6) Interpreters – at this stage we will work to get this service billed directly to NRC. I will provide more information as I receive this.

XX/115

I spoke to the financial office. They do not recommend going outside the embassy contracting on this as the embassy gets a good discount on their interpreter contract and there are embassy access issues as well. We are working to try to significantly reduce our usage of interpreters (grouping usage to cut hours, getting the embassy to cover meetings they have lead for, etc), so we hope to bring the costs way down on this.

Are you able to check this with Surin to ensure that we have not missed anything? I look forward to hearing from you.
The estimate will come from Yoriko in the embassy finance office (the ICASS officer) but I am working with Surin as well.

Mary

From: Wittick, Brian
Sent: Wednesday, April 20, 2011 4:06 AM
To: Marshall, Jane; Matheson, Mary
Cc: Holahan, Patricia; Casto, Chuck; Reynolds, Steven; Mamish, Nader; Doane, Margaret
Subject: FW: Japan team travel

Mary/Jane,

I have been working with USAID and the Amembassy to try to effect a smooth transition to NRC funding on 1 May. Please keep me in the loop on transition related issues.

Following is the answer to your questions below, and some additional questions from here.

- Does the team want to (1) stay at the same hotel you are currently in, (2) all choose a different hotel, or (3) allow each traveler to choose their own hotel?
  It is desired that the team stay at the same hotel (Hotel Okura). It is across the street from the Embassy, and is currently providing the best rate to the government, including breakfast. Need to also decide if CFO desires to have travelers book and pay hotels individually on their orders, or have rooms paid for collectively out of an ICASS line item (which results in a 5% cost reduction but could be a management burden).

- What is your current level of translator support (how many translators and how many hours/day)
  We are currently using one translator on average about eight hours per day. It occasionally goes to two translators and the hours sometimes go late. USAID said the burn rate has been about $25K/week, so I am trying to streamline the usage. We are now cutting out weekends and hope to reduce elsewhere.

- To make it easier on travelers, those returning the first few days of May will still be on USAID travel. They should keep in mind that their return tickets will not be able to be changed. Travelers departing the US next week will be on NRC funding for their entire trip. That way folks arriving/departing around May 1 won't have to file two separate vouchers.
  Assuming travelers will be paying their hotel bills individually, need to ensure there is adequate credit limits on their credit cards (figure about $350/day expense rate)

- Your travel will change on May 1 from USAID to NRC funding.
  Please confirm who is doing Chuck's new NRC orders and flights arrangements which go into effect 1 May.

- Your credit card issue should have been resolved. If not, let me know.
  Chuck's government credit card issue is not resolved but he is in good shape handling it himself and has backups.

I sent an email separately with data from USAID showing expenses and services. I will be forwarding another email shortly with an ICASS agreement that needs signature, along with a listing of desired services.

Also, for more long term planning, if we send someone here for longer periods (>90 days) we need to have travelers complete State medical screenings; for a PCS there are many more requirements, such as completion of NSDD 38 mission staffing process completed.

Thanks
Brian

From: Casto, Chuck
Sent: Tuesday, April 19, 2011 7:33 PM
To: Wittick, Brian
Subject: Fw: Japan team travel

From: Marshall, Jane
To: Casto, Chuck
Cc: Holahan, Patricia
Sent: Tue Apr 19 17:14:28 2011
Subject: Japan team travel

Chuck-
NRC will begin to fund the Japan response (instead of USAID) on May 1st. With that is the opportunity for changes to some of the travel situation, and we'd like to get your preferences for the direction we go. There are also a few points to note on travel arrangements:

- Does the team want to (1) stay at the same hotel you are currently in, (2) all choose a different hotel, or (3) allow each traveler to choose their own hotel?
- What is your current level of translator support (how many translators and how many hours/day)?
- To make it easier on travelers, those returning the first few days of May will still be on USAID travel. They should keep in mind that their return tickets will not be able to be changed. Travelers departing the US next week will be on NRC funding for their entire trip. That way folks arriving/departing around May 1 won't have to file two separate vouchers.
- Your travel will change on May 1 from USAID to NRC funding.
- Your credit card issue should have been resolved. If not, let me know.

We are looking into how the team should return documents that have been developed by the team in Japan.

Jane

Jane E. Marshall, Chief
Coordination Branch
Office of Nuclear Security and Incident Response
301-415-7854

Wittick, Brian

From: Wittick, Brian
Sent: Wednesday, April 20, 2011 1:53 AM
To: Meighan, Sean
Subject: FW: OSC: Jiji: High Radiation Detected Inside Fukushima Reactor Buildings

Rel

From: Casto, Chuck
Sent: Monday, April 18, 2011 6:46 AM
To: Wittick, Brian
Cc: Reynolds, Steven
Subject: RE: OSC: Jiji: High Radiation Detected Inside Fukushima Reactor Buildings

Rel

Nice work on these Brian, you might want to think about providing a verbal synopsis every morning or evening of the issues of interest...

Congrats

chuck

From: Wittick, Brian
Sent: Monday, April 18, 2011 7:21 PM
To: Liaison Japan
Subject: FW: OSC: Jiji: High Radiation Detected Inside Fukushima Reactor Buildings

OPEN SOURCE.COM

From: OSCINFO@rccb.osis.gov
Date: April 18, 2011 3:19:47 PM GMT+09:00
Subject: OSC: Jiji: High Radiation Detected Inside Fukushima Reactor Buildings
Reply-To: OSCINFO@rccb.osis.gov

Note: The following OSC material is being emailed to you based on a subscription.

UNCLASSIFIED

Jiji: High Radiation Detected Inside Fukushima Reactor Buildings

JPP20110418969028 Tokyo Jiji Press in English 0605 GMT 18 Apr 11

[Computer selected and disseminated without OSC editorial intervention]

Fukushima, April 18 (Jiji Press) -- Tokyo Electric Power Co. <9501> said Monday that a robot survey showed high levels of radiation inside buildings that house the No. 1 and No. 3 reactors of the crippled Fukushima No. 1 nuclear

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plant.

Maximum radiation levels were at 49 millisieverts per hour on the first floor of the No. 1 reactor building and at 57 millisieverts on the first floor of the No. 3 reactor building.

The radiation levels are within expectations, Hidehiko Nishiyama, a spokesman for the Nuclear and Industrial Safety Agency, said. But the levels are too high for repair workers and therefore should be reduced, he said.

The survey was made by two U.S.-made remote-controlled robots Sunday. A similar survey is conducted for the No. 2 reactor building Monday.

The survey showed that there were no puddles of water in the both buildings.

The robots were controlled by 12 workers in Sunday's three-hour survey. The staff had a maximum radiation dose of 6 millisieverts.

The company said that the level of highly radioactive water in a pit connected to an underground tunnel near the No. 2 reactor rose 3 centimeters over the 24 hours to 82 centimeters below the ground surface as of 7 a.m. Monday (10 p.m.

Sunday GMT).

Tokyo Electric also said workers have almost finished work to repair the plant's nuclear waste disposal facility to be used for storing some 25,000 tons of highly radioactive water.

Work to move the contaminated water from the pit to the waste disposal facility is set to begin in a day or two.

The company continued to inject nitrogen gas into the No. 1 reactor's containment vessel, a move aimed at preventing a hydrogen explosion. As of 6 a.m. Monday, the pressure inside the vessel fell from the previous day.

Officials at the nuclear safety agency said they are considering installing air fin coolers for the No. 1 and No. 3 reactors. The move, if realized, will be the first ever in Japan, Nishiyama said.

Air fin coolers cool the reactors through exchanges of heat between outside and inside. They are already used in French nuclear plants.

[Description of Source: Tokyo Jiji Press in English -- English-language news service of Jiji Press, Ltd., a private press agency]

To access this product and its attachment(s), please visit OpenSource.gov and search using the document ID of JPP20110418969028.

Wittick, Brian

From:	Wittick, Brian
Sent:	Wednesday, April 20, 2011 6:16 AM
To:	Wittick, Brian; Doane, Margaret; Mamish, Nader
Cc:	LIA08 Hoc; LIA02 Hoc; Foggie, Kirk; Abrams, Charlotte; Emche, Danielle
Subject:	RE: Read out from 4/20 meetings
Attachments:	Meeting results 4-20.docx

Margie,

Attached please find the results of the Tuesday meetings.

VR/
Brian

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Summary – 4/20

NISA/TEPCO Meeting

The NISA/TEPCO meeting was largely a review of plant status, which has not changed in some time. Notable issues included a statement from Nei that he is being pushed from above to press TEPCO to remove the fuel from the #4 SFP based on a previous NRC team recommendation, which the current NRC team does not necessarily agree with. Unfortunately, a revised NRC team recommendation is predicated on TEPCO resampling the SFP, which they are refusing to do. Also, given the lack of status changes in almost two weeks, the 1100 meeting frequency is reduced to M-W-F. As this meeting has been the lynchpin of our engagement with NISA/TEPCO I anticipate there will be a marked decrease in activity going forward. Also, there is expected to be no activity this weekend.

Radiological Monitoring Subgroup

The subgroup, led by MEXT and DOE, is now being attended by NRC's site team PMT. Lack of interagency coordination caused some rough moments in the meeting when MEXT was asked for information they had already provided to DOE. It was agreed there would be an interagency alignment meeting before the next meeting with the Japanese.

MEXT presented their priorities and long term monitoring plan. They also indicated they are trying to better focus their efforts due to exhaustion of resources. They mentioned that they appreciate all of the aerial monitoring being done by the U.S. but noted they would prefer to not have to pay for it.

The MEXT DDG arrived an hour into the meeting and expressed interest in seawater sampling in proximity to Fukushima. He indicated that TEPCO is responsible for sampling to 15Km, MEXT is responsible for sampling to 30Km, and expressed a desire for the U.S. to pick up a sector to be responsible for sampling.

Other Activities:

Chuck Casto and METI's Mitsumata (Director of Nuclear Energy Policy Planning Division) are scheduled for lunch on Monday.

DOS – DOE legal team arrived tonight and are conferencing at 2100 for tomorrow's meeting with MOFA. Will provide a readout tomorrow.

Lee, Richard

From: Marksberry, Don
Sent: Thursday, April 21, 2011 3:04 PM
To: RST01 Hoc
Cc: Lee, Richard; Esmaili, Hossein; Salay, Michael
Subject: RE: Plant data

Mike

Joy Rempe, INL (also ACRS member). Can we provide her with the detailed Japanese data sheets on a routine basis (including RES)?

Also, what was the website that was mentioned at the 11:00 call that provided data?

FYI, RES will provide the RST with comments on potential gaps to the TEPCO roadmap (by COB tomorrow). Richard Lee was tasked by the DOE Science Council to provide input.

Thanks,

Don

From: RST01 Hoc
Sent: Thursday, April 21, 2011 2:52 PM
To: Marksberry, Don
Subject: RE: Plant data

Where does the Fukushima Plant Data Charts come from?

Thanks,

Mike

Mike Brown
Reactor Safety Team

From: Marksberry, Don
Sent: Thursday, April 21, 2011 12:45 PM
To: RST01 Hoc
Cc: Lee, Richard; Salay, Michael; Esmaili, Hossein
Subject: Plant data

Mike, Dave

INL through DOE is maintaining spreadsheets of plant parameter data that they extract from the NISA press releases and other public sources. The end product is a daily set of trend plots that I started to forward to RST01 (see attached). They (and us in RES) would like to get on the distribution list for the detailed data tables that are in Japanese (see attached). If INL can get these on a routine basis, they may be willing to share the spreadsheets of raw data, as well as provide an expanded set of plots.

The INL-DOE plots are marked OUO, so a DOE will have to approve the distribution to the Consortium.

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Don

Don Marksberry

Division of Risk Analysis
Office of Nuclear Regulatory Research
U.S. Nuclear Regulatory Commission
21 Church Street
Rockville, Maryland 20850-4207

Phone: 301-251-7593
E-mail: Don.Marksberry@nrc.gov

USPS & Express Mail Address:
Mail Stop: C-4C07M
Washington, D.C. 20555-0001

Rihm, Roger

From:	Rihm, Roger
Sent:	Wednesday, April 20, 2011 2:07 PM
To:	Decker, David
Cc:	Landau, Mindy
Subject:	FW: Post Hearing Questions from the March 31, 2011 Hearing on the FY 2012 Budget Request
Attachments:	Subcommittee on Energy and Water Development Questions from the FY 2012 Budget Request Hearing on 3-31-11.docx

I hadn't tasked these to OCFO, so am forwarding to you. NOTE: OEDO is looking at the answer to #7D (about the cost of the Japan review) and may give you a different answer when we proivide our responses to you.

From: Ojeda, Jennifer
Sent: Wednesday, April 20, 2011 1:37 PM
To: Rihm, Roger; Landau, Mindy; RidsEdoMailCenter Resource
Cc: Golder, Jennifer; Peterson, Gordon; Smolik, George; Allwein, Russell
Subject: Post Hearing Questions from the March 31, 2011 Hearing on the FY 2012 Budget Request

Attached are the questions and answers OCFO was responsible for handling from the March 31, 2011 Hearing on the FY 2012 budget request. Please let me know if you have any questions.

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OCFO

FOLLOW-UP QUESTIONS FROM THE

HOUSE OF APPROPRIATIONS SUBCOMMITTEE ON ENERGY AND WATER DEVELOPMENT

ON THE

FY 2012 BUDGET REQUEST HEARING MARCH 31, 2011

QUESTION 5B: How much funding is in the fiscal year 2012 budget request for the NRC and other U.S. government agencies for legal fees and/or damages resulting from these or expected cases (lawsuits)? What are your estimates for future years?

ANSWER (OCFO/OGC):

The NRC has made no budget request "for legal fees and/or damages from these or expected cases." The pending Yucca Mountain-related lawsuits involving the NRC seek no legal fees or damages. NRC is not directly involved in the pending litigation in the United States Court of Federal Claims seeking damages from the government. Budget requests and estimates for that litigation can be obtained from the Department of Justice or the Department of Energy.

QUESTION 7D: How much funding do you expect the comprehensive review of all nuclear facilities that was charged by the President to cost, and do you expect the 2012 request will need to change in order to accommodate it?

ANSWER (OCFO)::

The cost for both the short and long term lessons review activities is expected to be less than $5M. NRC plans to reprogram funds in FY 2011 to cover the cost of the reviews. FY 2012 Commission reviews and approved costs may require NRC to adjust the budget.

QUESTION 8: Have your plans changed for licensing activities for new plants following the tragedy in Japan that would fund two new combined licenses and continued work on new designs and early site permits?

ANSWER (OCFO/NRO):

No, The NRC plans with regard to new reactor licensing reviews have not changed. NRC has not received any indication from industry or current applicants that their plans to obtain licenses have changed.

QUESTION 12A: What is the estimate of your carryover funds for fiscal year 2010?

ANSWER (OCFO):

Source	X0200		N0200	X0300	Total
	Fee Based[1]	Gen Fund	Nuclear Waste Fund	Office of Inspector General	
Unobligated from FY 2010 Appropriation	$ 6.4	$ 0.6	$ 5.6	$ 0.1	$ 12.7
PY Unobligated prior to FY 2010	15.5	2.2	1.5	1.8	21.0
Prior Year Deobligations	7.9	-	0.0	0.0	7.9
Carryover Allocated for FY 2011 Salaries & Benefits	(2.0)	-	-	-	(2.0)
Total Unobligated[2]	$ 27.9	$ 2.9	$ 7.1	$ 1.9	$ 39.7

[1]NRC's Feebased Funds are 90% recoverable

[2]Total Unobligated includes $24.7M for FY 2011 proposed reprogramming and $1.7M in committed carryover funding.

QUESTION 12B: Do you think the amount of FY 2010 carryover funds is appropriate? If not, what are you doing to "spend down" the funding to an appropriate level?

ANSWER (OCFO):

The NRC plans to submit a request to reprogram $26.4 million in prior-year unobligated funds to support critical mission activities, including emergent work associated with U.S. technical assistance and support to the Japanese government following the earthquake and tsunami at the Fukushima Daiichi nuclear facility in Japan.

QUESTION 12C: Can we expect to see a reprogramming?

ANSWER (OCFO):

Yes, we should see a reprogramming of prior year funds during FY 2011.

QUESTION 13A: What is the total budget request for construction activities of a new office building, and how much has already been spent on these activities?

ANSWER (OCFO/ADM):

The Fiscal Year (FY) 2012 budget request includes $21 million to support the design, construction and outfitting of a 14 story headquarters building for the Nuclear Regulatory Commission (NRC). The General Services Administration leased the building to consolidate NRC headquarters staff at a single location. NRC has allocated approximately $46 million to this project through FY 2011.

QUESTION 13B: What is the projected total cost of construction activities of a new office building?

ANSWER (OCFO/ADM):

The NRC projected total cost is approximately $79 million.

Huffert, Anthony

From:	Gauntt, Randall O [rogaunt@sandia.gov]
Sent:	Thursday, April 21, 2011 7:00 PM
To:	Huffert, Anthony
Cc:	Watson, Bruce; Reynolds, Steven; Garchow, Steve; Gepford, Heather; Meighan, Sean; Hoc, PMT12; PMT_japan Resource
Subject:	Re: Japan source term information

Will do. Have a call scheduled.

From: Huffert, Anthony [mailto:Anthony.Huffert@nrc.gov]
Sent: Thursday, April 21, 2011 04:57 PM
To: Gauntt, Randall O
Cc: Watson, Bruce <Bruce.Watson@nrc.gov>; Reynolds, Steven <Steven.Reynolds@nrc.gov>; Garchow, Steve <Steve.Garchow@nrc.gov>; Gepford, Heather <Heather.Gepford@nrc.gov>; Meighan, Sean <Sean.Meighan@nrc.gov>; Hoc, PMT12 <PMT12.Hoc@nrc.gov>; PMT_japan Resource <PMT_japan.Resource@nrc.gov>
Subject: RE: Japan source term information

Randy,

Below is an email request from the USNRC-HQ PMT (Bruce Watson) re: an updated source term request from NARAC's John Nasstrom. Please reply directly to Mr. Nasstrom.

Thanks,

PMT Embassy
Heather Gepford, Tony Huffert, Sean Meighan

From: Watson, Bruce
Sent: Thursday, April 21, 2011 10:43 AM
To: Huffert, Anthony
Subject: FW: Japan source term information

Tony,

Can you ask (Randy Gauntt) the Sandia representative, to contact John Nasstrom at NARAC, email listed below or phone: 925-423-6738. Rel
NARAC has been asked to perform more runs with any updated release rates re-created from the accidents. They heard Sandia is trying to reassess the source term/release rates.

Thanks, see you when you get back!

C

Bruce A. Watson, CHP
Chief - Reactor Decommissioning Branch
US Nuclear Regulatory Commission
Rockville, MD 20852
301-415-6221 Office

44/120

From: Nasstrom, John S. [mailto:Nasstrom1@llnl.gov]
Sent: Wednesday, April 20, 2011 3:33 PM
To: Watson, Bruce

Cc: Pobanz, Brenda M.; Baskett, Ron
Subject: RE: Japan source term information

Thanks Bruce. Do you have an email and phone number for Randy?

John

From: Watson, Bruce [mailto:Bruce.Watson@nrc.gov]
Sent: Wednesday, April 20, 2011 12:01 PM
To: Nasstrom, John S.
Subject: FW: Japan source term information

John,

Just found out the Sandia contact in Japan is Randy Gauntt. It was not made clear what he was working on and is expected to complete the in country work this week.

Bruce A. Watson, CHP
Chief - Reactor Decommissioning Branch
US Nuclear Regulatory Commission
Rockville, MD 20852
301-415-6221 Office

From: Nasstrom, John S. [mailto:Nasstrom1@llnl.gov]
Sent: Thursday, April 14, 2011 2:15 PM
To: Hoc, PMT12; HOO Hoc; Watson, Bruce
Cc: 'narac'
Subject: Japan source term information

Attention PMT:

Attached is the Japan press release with their source term estimates for Fukushima.

As I discussed with Bruce Watson and Michelle Hart on the phone today, DOE asked us to contact you to see if you could provide any assistance with the following:

- Information the NRC Japan team may have on the basis and details of Japan's source term estimates (including any assumed release times)

- Contacts in NRC (RST, PMT, Japan) that may have information that may help in refined estimates of Fukushima source terms.

Thank you looking into this, and for the invaluable assistance you have already provided for this event.

Sincerely,
John Nasstrom

NARAC Operations
925-422-7627

Huffert, Anthony

From: Huffert, Anthony
Sent: Thursday, April 21, 2011 6:58 PM
To: rogaunt@sandia.gov
Cc: Watson, Bruce; Reynolds, Steven; Garchow, Steve; Gepford, Heather; Meighan, Sean; Hoc, PMT12; PMT_japan Resource
Subject: RE: Japan source term information

Importance: High

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301-415-6221 Office

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John

XX\124

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Sent: Wednesday, April 20, 2011 12:01 PM
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Chief - Reactor Decommissioning Branch
US Nuclear Regulatory Commission
Rockville, MD 20852
301-415-6221 Office

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Sincerely,
John Nasstrom

NARAC Operations
925-422-7627

Subject:	Japan Task Force (Marty, Charlie)
Location:	O-17H10
Start:	Fri 4/22/2011 8:30 AM
End:	Fri 4/22/2011 9:00 AM
Recurrence:	(none)
Meeting Status:	Meeting organizer
Organizer:	Virgilio, Martin
Required Attendees:	Miller, Charles
Categories:	Business

4/21/11

Sandy Cianci
Administrative Assistant to Marty Virgilio, DEDR
Office of the Executive Director for Operations
O-17 H13
301-415-1714
sandra.cianci@nrc.gov

XX/122

Subject:	Discuss EPA Re-entry (Marty, Trish)
Location:	O-17H10
Start:	Thu 4/21/2011 8:30 AM
End:	Thu 4/21/2011 9:00 AM
Recurrence:	(none)
Meeting Status:	Meeting organizer
Organizer:	Virgilio, Martin
Required Attendees:	Milligan, Patricia
Categories:	Business

4/20/11

Sandy Cianci
Administrative Assistant to Marty Virgilio, DEDR
Office of the Executive Director for Operations
O-17 H13
301-415-1714
sandra.cianci@nrc.gov

XX\123

Lee, Richard

From: Salay, Michael
Sent: Monday, April 25, 2011 7:09 PM
To: Marksberry, Don; Lee, Richard; Esmaili, Hossein; Gauntt, Randall O
Subject: U1 seeming stop of DW water level increase

Guys,

Based on this handout (4/23 RPV and PCV level determinations):

It seems that the water level in U1PCV stopped increasing on the afternoon of 4/18 at ~16400mm above reference level. This is probably why they made the calculations for the two lower water level injection rates 2 and 1 m^3/hr. Their initial calculation was ~3 m^3/hr (6 m^3/hr injected - 3 m^3/hr evaporated with the remaining 3 being assumed to contribute to the U1PCV water level increase. The pressure trends for both DW sensors seemed to track the 3m^3/hr curve until the time mentioned above.

It seems that the sensors used for this plot are different from those listed in the daily plots for SC and DW pressures – which both seem to read identical pressure (table on 4/21 7:00 Plant Data handout).

The data seems to suggest that the water level reached the DW pressure tap 15150mm above OP (just under RPV bottom head (15200mm above OP)) but then stopped rising soon after, because:
-the pressure difference between the SC tap and this tap stopped increasing.
-the pressure difference between the SC tap and this upper DW tap (PNL999@ 28650mm above OP) also stopped increasing.
-the pressure difference between this tap and another in the upper DW 28650mm above OP started increasing but then seemed to have stopped soon after
-the absolute pressure in the (assumed to be) submerged tap (PNL925) started trending upwards.

Note that the level readings don't always seem to exactly coincide with pressure readings even thought the same pressure data are being used – I'm guessing that this is due to water and steam density assumptions made in the level calculation.

If water level were continuing to rise after reaching the DW PNL925 pressure tap, the level as indicated by the SC:PNL999 – DW:PNL925 pressure trace would have stabilized whereas the level as indicated by SC:PNL999 – DW:PNL999 would have continued to rise.

I don't know what the leveling off is attributed to – perhaps the water level reached the vessel (hot spots not measured by the reported detector thermocouples) or perhaps the water level reached a leak from the DW. If it reached a leak it would be expected that the absolute pressure from the lower tap would rise somewhat, faster if the covered leak were a significant amount of the total DW leakage. A hot spot on vessel being reached by the water would also increase DW pressure from increased steaming.

Also coincident with this leveling off: a small perturbation in the FW nozzle temperature provided in the daily status plots

I don't know why the absolute DW pressure (DW:PNL925) didn't level off after N2 injection. If they are leaking at 30%/day (calculated before nitrogen injection and recalculated based on pressure increase following loss of N2 injection following the LOOP of 4/11 (or 12 –can't tell from plot)). The pressure seemed to level off about 4/12 – the rate seemed coincident with a 30% per day exchange rate – i.e. ~ 1.5 to 2 day gas composition stabilization half time but the change was perturbed by the earthquake so it could have been affected by that. After the switch to higher purity N2 on April 14, the pressure also started to drop until this level change event.

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After more thought about curves: Why didn't SC:PNL999 – DW:PNL925 curve level off after water level reached the level of DW:PNL925 tap (i.e. 15150 mm above OP)??? Is the elevation of this tap higher or am I incorrectly understanding how it should work (i.e. once water level exceeds that of a tap, the difference in pressure between two submerged taps should be rho-g-dz and should thus remain constant except for changes in water density)? I am basing this on the assumption that they are determining the level by subtracting the pressure from the different DW taps from the one SC tap to get both curves. The labels for the curves seem to indicate this (I can't make out second line other than the words "pressure" and "water level" – I'm guessing it says something to the effect of "pressure difference converted to water level"). Do you think I am doing this wrong? Do any of you interpret this differently? If I am interpreting it correctly, the P tap that they are indicating as DW:PNL925 cannot be at the level indicated.

Do you have any other ideas about what the data are showing – have you heard anything about this?

- Mike

From: Salay, Michael
Sent: Monday, April 25, 2011 2:58 PM
To: Marksberry, Don
Cc: Lee, Richard; Esmaili, Hossein
Subject: RE: RST assessment rev 2

Don,

Attached is another document related to today's and Thursdays industry discussions. I think this is TEPCO's document as they have been using the change in pressure upon nitrogen injection to estimate water levels.

This has already been added to Sharepoint. Another document of interest in the "interesting docs" directory on sharepoint today is the (JNES or JAEA) assessment of plant conditions. This seems to be the document that industry was referring to about the high water levels in the pedestal region. At the time I saw this document (or a very similar one) they wanted to keep their assessment restricted – even from TEPCO or US industry perhaps. pre-decisional, not verified. It seemed that only one individual was putting forth this assessment. Other Japanese expressed disagreement with this. It was partially based on the fact that temperatures on the lower heads were showing low. The pressure differences don't seem to agree with the level indications shown (1 atm is about 10 meters of water).

-Mike

From: Salay, Michael
Sent: Monday, April 25, 2011 1:18 PM
To: Marksberry, Don
Subject: RST assessment rev 2

Don,

Richard does think that we should look at this. The attached looks like latest version (obtained from Japan RST drive). I have added this and about 15 other documents to Fukushima working group sharepoint / interesting docs. (I noticed at least one duplicate – will have to go through and remove other duplicates later)

Tomorrow will go over to the Chernobyl seminar or will have a meeting on steam generator tube ruptures (if that can't be moved earlier) so won't be able to meet/listen in on call.

BTW: Just put some drawings from site team/RST in G:\DSA\FSTB\Fukushima updates\drawings. I don't have time to check/upload to Sharepoint but it seems that some drawings there are not already in Sharepoint. If you find the time to check and upload any additional ones, let me know.

-Mike

From: E&E Publishing, LLC <ealerts@eenews.net>
Sent: Monday, April 25, 2011 1:04 PM
To: Virgilio, Martin
Subject: April 25 -- Greenwire is ready

AN E&E PUBLISHING SERVICE

GREENWIRE -- MON., APRIL 25, 2011 -- Read the full edition

1. OFFSHORE DRILLING: New containment technologies jump-start industry but fail to quell spill concerns

The device credited with reviving U.S. deepwater oil drilling is parked in a lot in northwest Houston. Helix Well Containment Group's containment cap -- two-and-a-half stories tall and 74 tons -- is designed to close off a well during an oil spill and helped restart stalled deepwater drilling following an Obama administration moratorium on such projects in the Gulf of Mexico after last year's devastating blowout of BP PLC's Macondo well.

TOP STORIES

2. **OFFSHORE DRILLING:** Appeals court to hear arguments on pace of U.S. permitting
3. **CLIMATE:** Report prompts debate, soul searching on enviros' cap-and-trade bill tactics
4. **AGRICULTURE:** Food insecurity looms in parched Horn of Africa

GULF SPILL ANNIVERSARY

5. **GULF SPILL:** Delays in BP money could thwart spring research
6. **GULF SPILL:** Coast Guard faults Transocean, Marshall Islands and itself for Deepwater Horizon

POLITICS

7. **CHEMICALS:** Pediatricians urge reform of 1976 toxics law
8. **POLITICS:** Gingrich's support for ethanol raises questions

ENERGY

9. **RENEWABLE ENERGY:** U.S. solar surges, wind stalls -- report

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10. **GASOLINE:** Prices may be peaking below all-time record, analyst says

11. **NATURAL GAS:** Pa. regulator confident that fracking discharges will stop

12. **NATURAL GAS:** States weigh fracking fluid disclosure in light of new website

13. **NUCLEAR CRISIS:** Japanese utility allowed reactor pressure to build beyond design limit

14. **COAL:** Ky. utilities plan to shut down coal units by 2016

FEDERAL AGENCIES

15. **WORKFORCE:** OMB requires agencies to report on time taken to fill vacancies

16. **WILDLIFE:** Federal wolf recovery leader to retire this summer

LAW AND LOBBYING

17. **OFFSHORE DRILLING:** Supreme Court won't hear Gulf leasing case

18. **MINING:** Upper Big Branch families 'may be victim of a federal crime' -- FBI

AIR AND WATER

19. **WATER:** Fla. governor asks EPA to back off on state pollution rules

20. **AIR POLLUTION:** London may face penalties if it falls short of Olympic environmental goals

21. **DRINKING WATER:** Calif. farming town's conditions mirror developing world -- U.N. lawyer

NATURAL RESOURCES

22. **CHESAPEAKE BAY:** Chicken poop finds a new purpose at Del. recycling center

23. **FISHERIES:** Tsunami only added to decline of Japan's seafood industry

24. **WILDLIFE:** After budget rider, states prepare wolf hunts

WASTES & HAZARDOUS SUBSTANCES

25. **SUPERFUND:** Sick and dying workers question safety of Utah site

SOCIETY

26. **OBITUARY:** Hazel Dickens, singer of mining anthems, dies at 75

E&ETV'S ONPOINT

27. **TRANSMISSION:** FERC's Tres Amigas Counsel Raskin discusses outlook for U.S. transmission

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To send a press release, fax 202-737-5299 or e-mail editorial@eenews.net.

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Greenwire is written and produced by the staff of E&E Publishing, LLC. The one-stop source for those who need to stay on top of all of today's major energy and environmental action with an average of more than 20 stories a day, Greenwire covers the complete spectrum, from electricity industry restructuring to Clean Air Act litigation to public lands management. Greenwire publishes daily at Noon.

Huffert, Anthony

From: Gauntt, Randall O [rogaunt@sandia.gov]
Sent: Monday, April 25, 2011 2:10 AM
To: PMT_japan Resource; Hoc, PMT12
Cc: Gepford, Heather; Meighan, Sean; Huffert, Anthony
Subject: RE: RESPONSE: Modification of Source Term; Email Distribution Request

Dear All,

I have been running MELCOR forensic analyses for the past month on the three reactor accidents in order to document and understand what happened. This necessarily generates predictions of fission product release each time we run the analysis, which we have done dozens of times. If this is what one calls a source term, then we are generating source terms several times a week for each reactor in addition to revised simulations of reactor and containment pressure response and estimated core damage fractions. But, I don't think this is what you mean by modifying "The March 24th Source Term".

We will be attempting to finally estimate a range of likely best estimate releases of fission products from the reactors as we gain better understanding of the sequence progressions and root out errors, bad data etc.

I have received a request from two people at the LLNL NARAC group for a guess at what we think is a most likely release profile from the reactors and they are interested from the standpoint of model validation and forensics examinations on measured downwind doses and land depositions given the weather conditions at the time of the accidents.

Concerning the "March 24 Assumptions" - we actually don't make any assumptions about % core damage or containment release rate - this is actually what we are trying to simulate based on more fundamental assumptions such as operability and functioning of reactor systems such as isolation condenser and HPCI function in Unit 1, RCIC function and torus failure in Unit 2 and containment performance and water injections in all three reactors.

Let me know what else you might like to know.

Randy

From: PMT_japan Resource [PMT_japan.Resource@nrc.gov]
Sent: Sunday, April 24, 2011 10:35 PM
To: Hoc, PMT12
Cc: PMT_japan Resource; Gepford, Heather; Meighan, Sean; Huffert, Anthony; Gauntt, Randall O
Subject: RESPONSE: Modification of Source Term; Email Distribution Request

PMT12,

Two items:

1. Please contact Dr. Randy Gauntt directly about the question in your email below. Randy's email address is rogaunt@sandia.gov and phone number is 505-263-6849, and we're cc'ing him on this email to facilitate your request. *[Note to Randy: when responding to PMT12, include the PMT Japan Resource email address also]*

2. For all emails that are sent to the "PMT Japan Resource" address, place Heather Gepford, Tony Huffert, and Sean Meighan on distribution also.

Thanks!

PMT Japan

4/4/126

Heather Gepford, Tony Huffert, Sean Meighan

From: Hoc, PMT12
Sent: Friday, April 22, 2011 11:54 AM
To: PMT_japan Resource
Subject: Modification of the Source Term

PMT Japan,

The question has been asked, are any efforts being taken to modify the source term?

The assumptions from the March 24th source term are as follows:

Unit 1: 70%, 10%/day leak rate
Unit 2: 33%, 5inch hold in containment
Unit 3: 33%, 100% leak rate

To your knowledge are any efforts being made? A simple "no" will suffice, but if the answer is "yes," please define those efforts.

Thank you.

Kimberly Gambone
PMT/PAAD

From: E&E Publishing, LLC <ealerts@eenews.net>
Sent: Tuesday, April 26, 2011 4:32 PM
To: Virgilio, Martin
Subject: April 26 -- E&ENews PM is ready

AN E&E PUBLISHING SERVICE

E&ENEWS PM -- TUE., APRIL 26, 2011 -- Read the full edition

1. ENERGY POLICY: Obama seizes on Boehner's remarks about industry subsidies

House Speaker John Boehner (R-Ohio) today edged away from an hours-old remark that lawmakers "oughta be looking at" a rollback of tax benefits for major oil companies -- but that did not stop the White House and congressional Democrats from pouncing on the issue. Boehner's statement to ABC News that he did not think larger oil companies needed at least one of the subsidies that Democrats want to repeal revved up an otherwise sleepy recess-week news cycle in Washington. President Obama today released a letter to congressional leaders describing himself as "heartened" by the Ohioan's remarks, and House Minority Leader Nancy Pelosi's (D-Calif.) aides fired off a blog post about "a breakup for Speaker Boehner and Big Oil."

THIS AFTERNOON'S STORIES

2. SENATE: Energy Committee Republicans hire special counsel
3. WHITE HOUSE: Pentagon, DOE tout progress in energy security push
4. OFFSHORE DRILLING: Groups urge court to stiffen regulators' resolve
5. FEDERAL AGENCIES: White House accepts nominations for GreenGov awards

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ABOUT E&ENEWS PM

E&ENews PM is written and produced by the staff of E&E Publishing, LLC. A late afternoon roundup providing coverage of all the breaking and developing policy news from

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www.eenews.net

Lee, Richard

From: Sheron, Brian
Sent: Tuesday, April 26, 2011 7:39 AM
To: Lee, Richard
Subject: Science Experts Call

Richard, I got Mike Weber to agree to turn the science experts call over to the IRC ET Director. Can you talk with Briam McDermott in NSIR about this. Can you explain what the science experts are, what the call is about, when it occurs, etc., and give them the phone number to call in.

I will e-mail John Kelly and tell him we are turning the NRC participation in the science experts call over to the IRC ET Director.

44/128

Lee, Richard

From: Salay, Michael
Sent: Thursday, April 28, 2011 2:37 PM
To: Lee, Richard
Cc: Marksberry, Don; Esmaili, Hossein
Subject: RE: Status of Fukushima calculations

We notified the RST that the conclusion was not that the U1 lower head would not fail in the event of loss of cooling. I told them we would provide more detailed clarification via email.

-Mike

From: Lee, Richard
Sent: Thursday, April 28, 2011 12:17 PM
To: Salay, Michael; Marksberry, Don
Subject: FW: Status of Fukushima calculations

I spoke to Randy. The conclusion is not the same that I heard from RST this past two days. Randy is on his way to work. Perhaps, we can chat with him later today.

From: Goldmann, Andrew S [mailto:asgoldm@sandia.gov]
Sent: Thursday, April 28, 2011 12:08 PM
To: Lee, Richard
Cc: Esmaili, Hossein
Subject: FW: Status of Fukushima calculations

Richard and Hossein,

Attached are the latest results I've received. The short email chain might also be useful.

Andrew

From: M.T. Leonard [mailto:mtl@dycoda.com]
Sent: Monday, April 25, 2011 5:31 PM
To: Gauntt, Randall O; Lachance, Jeffrey Lynn
Cc: Goldmann, Andrew S
Subject: RE: Status of Fukushima calculations

Randy et al.,

PLEASE DISCARD the earlier summary of the MELCOR calcs. The 1F1 calculation was so corrupted by the inadvertent MSL creep rupture that it should be ignored. ATTACHED is an updated summary of results, which corrects the 1F1 response to the debris relocation into the lower head. The creep rupture model was deactivated and the subsequent damage progression has been corrected.

Sorry for distributed the earlier flawed results.

Mark

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From: M.T. Leonard [mailto:mtl@dycoda.com]
Sent: Monday, April 25, 2011 2:56 PM
To: Randy Gauntt (SNL); Jeff LaChance (jllacha@sandia.gov)

Cc: Goldmann, Andrew S (asgoldm@sandia.gov)
Subject: Status of Fukushima calculations

Randy, et al.,
Attached is a summary of the current status of the three Fukushima calculations. Problems arose over the weekend in the calculations for Units 1 and 3, which have been at least partially addressed. In the 1F1 calculation, creep rupture of the main steam line occurred which permanently depressurized the RPV when debris relocated into the lower head. There is no evidence this occurred and the model has been de-activated and the calculation restarted to re-run through this period of time. In the 1F3 calculation, seawater injection terminated before level recovery could be completed because the control volume used as the suction source went dry. This was corrected and the calculation was restarted at 42 hrs, which unfortunately is the slowest time frame for the calculation.

I will continue to babysit these calculations to completion, but there are at least two areas of major modeling improvements we should explore before embarking on any further work:

(1) Containment pressure response in Unit 1: A test calculation should be developed to examine the containment pressure response to SRV discharge to the containment atmosphere with no (or minimal) condensation in the pool. This would involve several model changes:
  a. SRV discharge directly into the drywell atmosphere (J. Kelly seems rather insistent that none of the 1F1 SRVs discharge through tailpipes into the torus.)
  b. Rupture of the torus ring header (or stuck-open WW-DW vacuum breaker(s)). This would prevent steam flow from the drywell entering the torus downcomers and reduce steam suppression to only the surface of the pool.
  c. Stratify the control volume model for the torus to separate a thin layer of water on the surface of the pool from the bulk of the pool volume. This would represent poor thermal mixing in the pool and maximize the containment pressure response.

(2) The steam turbine models for RCIC and HPCI should be re-constructed to more accurately represent the steam flow through the turbines when the systems are throttled. This might improve the RPV pressure reponse while the systems operate.

Mark

Lee, Richard

From: Salay, Michael
Sent: Thursday, April 28, 2011 3:02 PM
To: Gauntt, Randall O
Cc: Lee, Richard; Esmaili, Hossein; Marksberry, Don
Subject: integrity of U1 lower head

Randy,

We need some clarification on your Mathcad analysis of the U1 lower head integrity:

What we think we were hearing on the consortium call for the past few days was that, based on the analysis, vessel integrity would be maintained even if water injection was lost. This seemed to imply that containment flooding was not needed to maintain vessel integrity.

What we interpret from your analysis is that vessel integrity would be maintained even if water injection was lost if containment was flooded and skirt wall is cooled. This indicates that, based on the analysis, containment flooding would still be required to maintain vessel integrity.

We realize that this assumes that a high vessel-to-containment pressure differential does not develop.

Would you please let us know which was intended?

Thank you,
-Mike

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From: E&E Publishing, LLC <ealerts@eenews.net>
Sent: Thursday, April 28, 2011 8:13 AM
To: Virgilio, Martin
Subject: April 28 -- ClimateWire is ready

AN E&E PUBLISHING SERVICE

CLIMATEWIRE -- THU., APRIL 28, 2011 -- Read the full edition

1. RENEWABLE ENERGY: Despite decline of nuclear power, wind industry remains in the doldrums

The earthquake and tsunami that crippled the Fukushima Daiichi atomic plant last month resurrected a vociferous anti-nuclear movement in Europe that until recently seemed to have been all but tamed by the fight against global warming. Responding to protests by Greens and public fears that nuclear technology has become too risky, Germany shut down seven reactors, Italy canceled plans to build four, and Switzerland and the United Kingdom are reviewing their plans for new plants.

TODAY'S STORIES

2. **EMISSIONS:** DOE expert sees growth in China's GHG emissions stopping in 2 decades -- if everything goes right
3. **ENERGY EFFICIENCY:** Small New York hospital cuts greenhouse gas emissions by 18%
4. **NATIONS:** South Africa vows to cut use of coal and explores a carbon tax
5. **CALIFORNIA:** State's efficiency law quickly cuts computer energy demands -- report
6. **SCIENCE:** Environmental groups want 13 Arctic areas protected to save fish, wildlife
7. **NATIONS:** China's new five-year development plan favors renewable energy
8. **INDIA:** Nation's biggest private utility plans to raise its renewable energy capacity
9. **NUCLEAR:** Iowa House approves financial framework for new nuclear plant
10. **STATES:** Md. governor under pressure to veto trash-to-energy bill

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E&ETV'S ONPOINT

11. **TECHNOLOGY:** MIT's Moniz discusses 'game changers' for clean energy future

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www.eenews.net

Lee, Richard

From: Powers, Dana A [dapower@sandia.gov]
Sent: Friday, April 29, 2011 12:00 PM
To: Lee, Richard
Subject: RE: Budnitz Garwin Per show

I do not. They probably said, but it went in one ear and out the other. It may be listed in the minutes if they issue a set. Dana

-----Original Message-----
From: Lee, Richard [mailto:Richard.Lee@nrc.gov]
Sent: Thursday, April 28, 2011 5:56 PM
To: Powers, Dana A
Subject: RE: Budnitz Garwin Per show

Thx, Dana:

Do you know who from NRC call in?

Richard

From: Powers, Dana A [dapower@sandia.gov]
Sent: Thursday, April 28, 2011 5:56 PM
To: Lee, Richard
Subject: Budnitz Garwin Per show

NOAA has completed apparently a detailed analysis of the tsunami showing among other things that peak wave heights at some points in Japan were as much as 37 meters! It will be of interest to see the NOAA analysis once it is published. (Garwin is of course suspicious of the analysis). TEPCO is confident that water level in spent fuel pool is well above the top of the active fuel ~6 meters - Garwin is dubious. Per continues his work to do a shaker table test on water sloshing - despite all expert assurances water did not slosh out and no one really cares now. BNL continues to work on the Markov model that I don't even begin to understand - Budnitz has done similar things in the past. Garwin is unpersuaded. They are still looking at phosphate for pH control. They recognize the issue of precipitation. They may not recognize that phosphate will enhance uranium dioxide dissolution in oxygenated systems. Per wants them to handle the contaminated water. Garwin wants to know why we are not getting more definitive information. In other words, you did not miss a thing! Dana

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Lee, Richard

From: Marksberry, Don
Sent: Friday, April 29, 2011 5:35 PM
To: Joy L Rempe
Cc: Lee, Richard
Subject: RE: DOE Trend Plots and plant Data From TEPCO

Hi Joy

Everyone likes your charts. I believe the Consortium would prefer INL to continue so each organization doesn't have to go through the time consuming data entry and checking process. The distribution of information and raw data has not been consistent at our end and the distant end, mainly due to the constant changing of staff in the Ops Center and Site Team. We (RES) have setup a SharePoint page for sharing of info and data inside the NRC firewall, but this is not available outside the firewall.

Can INL setup a hidden, non-public webpage to post basic data and information not OUO (e.g., your charts, chronologies, TEPCO data)? As this become popular, maybe it can convince those in the field to recognize INL as the clearinghouse for data. Marty Sattison's staff should be able to help setup a website.

What do you think?

Don

From: Joy L Rempe [Joy.Rempe@inl.gov]
Sent: Friday, April 29, 2011 2:00 PM
To: Marksberry, Don; Esmaili, Hossein; Brown, Michael; Salay, Michael; Lee, Richard; RST01 Hoc; Alice.Caponiti@nuclear.energy.gov; Peko, Damian; Douglas E Burns; Harold Finley McFarlane; Gauntt, Randall O; Robert W Youngblood; William C Phoenix
Subject: Re: DOE Trend Plots and plant Data From TEPCO

Hi,

I do try to add RSTO1 to the pdfs of plots that I send out daily (Monday through Thursday, but sometimes it's the wee hours of the morning...). I apologize if I left this distribution off one day. I'm also wondering if I'm 'allowed' to send to this distribution list. Can someone who should be getting two copies (e.g., they are individually on my email and on the list) verify that they are getting two copies?

Note that in addition to the plots, I've also been collecting a 'chronology of events' and a document that describes that the location and operational aspects of sensors/sources for this data. The latter two are more draft in nature, and I would appreciated comments. Frankly, we still see changes in the data (so they, also, can change). I send out pdfs. I am willing to send out power point and Excel versions. However, there are problems when we go from MACS to PCs and within different versions of Office products that can affect the date. We've discussed this with helplines, and there are just bugs in the software. As long as we stay on one platform, it isn't a problem.

The data, as Don as noted, are coming from various reports. Frankly, I am guessing that all of the data (except the thermal imaging) really come from TEPCO and their contractors at the site. However, how we obtain these data is not direct. For example, the early data did come from TEPCO but were sent to us 'unofficially'. We do look at the NISA press releases and data from other sources, such as the FEPC. When I was in DC, Richard Lee suggested that DOE and NRC work together on this. I'm glad that my management (and DOE) agreed. It makes more sense if all we are trying to do is understand the information that is available, and I appreciate the help that Don, Jeff, and Carl have provided. Alice asked me to add RST01 to ensure that it is properly distributed. I can take the OUO off (if the proper folks tell me to do it).

I am willing to send out to whatever to whomever. However, I would like to warn those that receive the Excel and /or the PowerPoint versions to be careful. I know that Randy Gauntt told me that his got hosed over the other day.. so I'm sending him a new one.

XX\133

Joy

P.S. Robert Youngblood and Bill Pheonix found an error in our schematic. Please use this updated version for the 28 April plots...

"Marksberry, Don" <Don.Marksberry@nrc.gov>
04/29/2011 10:15 AM

To RST01 Hoc <RST01.Hoc@nrc.gov>, "Brown, Michael" <Michael.Brown@nrc.gov>
cc "Lee, Richard" <Richard.Lee@nrc.gov>, Joy L Rempe <Joy.Rempe@inl.gov>, "Salay, Michael" <Michael.Salay@nrc.gov>, "Esmaili, Hossein" <Hossein.Esmaili@nrc.gov>
Subject DOE Trend Plots and plant Data From TEPCO

Dave, Mike, RST01

Joy added RST01 to the distribution of the INL-DOE charts (see att 1). The INL charts are largely based on the 2-page table of "...major parameters of the plant..." from the NISA press releases (see att 2). The same 2-page table in Japanese can be found on the NISA Japanese webpage (see att 3). I have been sending Joy the full set of the TEPCO data table and charts (in Japanese) whenever someone in RES receives them and uploads to our 1F SharePoint page. Jeff Mitman hooked us up with Carl Moore to add Joy and myself to the daily distribution of the full TEPCO data set (see att 4 for an example of the full TEPCO data set).

Joy's staff at INL can add additional trend charts using the larger scope data from the TEPCO data set, if she can get on a regular distribution. We received a TEPCO data set yesterday, but not today (maybe because of the holiday).

With regards to the Excel spreadsheets, maybe Joy can share her spreadsheets with the NRC and Consortium.

One observation: The INL-DOE charts are marked OUO. I don't know what this means when they are sent to INPO and GEH.

Don

Don Marksberry

Division of Risk Analysis
Office of Nuclear Regulatory Research
U.S. Nuclear Regulatory Commission
21 Church Street
Rockville, Maryland 20850-4207

Phone: 301-251-7593
E-mail: Don.Marksberry@nrc.gov

USPS & Express Mail Address:
Mail Stop: C-4C07M
Washington, D.C. 20555-0001

----- Message from Joy L Rempe <Joy.Rempe@inl.gov> on Thu, 28 Apr 2011 21:42:24 -0400 -----

To: "Caponiti, Alice" <Alice.Caponiti@nuclear.energy.gov>, "Bari, Robert A" <bari@bnl.gov>, "Bill.McCaughey@nuclear.energy.gov" <Bill.McCaughey@nuclear.energy.gov>, "binderjl@ornl.gov" <binderjl@ornl.gov>, "busbyjt@ornl.gov" <busbyjt@ornl.gov>, "cgrandy@anl.gov" <cgrandy@anl.gov>, Christine E White <Christine.White@inl.gov>, "Peko, Damian" <Damian.Peko@nuclear.energy.gov>, "dddixon@lanl.gov" <dddixon@lanl.gov>, "Marksberry, Don" <Don.Marksberry@nrc.gov>, Douglas E Burns <Douglas.Burns@inl.gov>, "Hackett, Edwin" <Edwin.Hackett@nrc.gov>, Elizabeth A Connell <Elizabeth.Connell@inl.gov>, "farmer@anl.gov" <farmer@anl.gov>, "flanagangf@ornl.gov" <flanagangf@ornl.gov>, "gehinjc@ornl.gov" <gehinjc@ornl.gov>, Harold Finley McFarlane <Harold.McFarlane@inl.gov>, "horak@bnl.gov" <horak@bnl.gov>, "james.buelt@pnl.gov" <james.buelt@pnl.gov>, "JohnE.Kelly@nuclear.energy.gov" <JohnE.Kelly@nuclear.energy.gov>, "Flack, John" <John.Flack@nrc.gov>, "kbsoren@sandia.gov" <kbsoren@sandia.gov>, "Kellar, Kenneth" <Kenneth.Kellar@nuclear.energy.gov>, "ks@bnl.gov" <ks@bnl.gov>, Kurt L Davis <Kurt.Davis@inl.gov>, "patrick.schwab@nuclear.energy.gov" <patrick.schwab@nuclear.energy.gov>, "Lee, Richard" <Richard.Lee@nrc.gov>, "Richard.Reister@nuclear.energy.gov" <Richard.Reister@nuclear.energy.gov>, "RobertP.Martin@inl.gov" <RobertP.Martin@inl.gov>, "Robert.Youngblood@inl.gov" <Robert.Youngblood@inl.gov>, "ROB.VERSLUIS@nuclear.energy.gov" <ROB.VERSLUIS@nuclear.energy.gov>, "Rogaunt@sandia.gov" <Rogaunt@sandia.gov>, RST01 Hoc <RST01.Hoc@nrc.gov>, "spburns@sandia.gov" <spburns@sandia.gov>, "tom.miller@nuclear.energy.gov" <tom.miller@nuclear.energy.gov>, "trevor.cook@nuclear.energy.gov" <trevor.cook@nuclear.energy.gov>, "wagnerjc@ornl.gov" <wagnerjc@ornl.gov>, William C Phoenix <William.Phoenix@inl.gov>

Subject: Updated Plots and Timeline

Hi,

Here's the latest set of plots. We are continuing to add more data that we've been receiving from TEPCO. Because of the behavior that we are seeing at earlier time periods (e.g., negative temperature values), we are also starting to label some of the data as 'suspect', such as the feedwater nozzle temperatures reported on Unit 3 (slide 15). We also have generated a sketch (Slide 12) that illustrates the location of various sensors.

Joy

[attachment "Fukushima Chart 28 April 2011.pdf" deleted by Joy L Rempe/YOJ/CC01/INEEL/US] [attachment "2 Fukushima Dai-ichi Nuclear Power Station Major Parameters of the Plant (As of 0600, April 28th.pdf" deleted by Joy L Rempe/YOJ/CC01/INEEL/US] [attachment "3 - Parameter Table in Japanese (see last page).pdf" deleted by Joy L Rempe/YOJ/CC01/INEEL/US]

----- Message from "Moore, Carl" <Carl.Moore@nrc.gov> on Wed, 27 Apr 2011 22:26:32 -0400 -----

To: "Garchow, Steve" <Steve.Garchow@nrc.gov>, "Lupold, Timothy" <Timothy.Lupold@nrc.gov>, "Mitman, Jeffrey" <Jeffrey.Mitman@nrc.gov>, "Norwood, Donald" <Donald.Norwood@nrc.gov>, "Marksberry, Don" <Don.Marksberry@nrc.gov>, "Rempe, Joy" <Joy.Rempe@nrc.gov>

Subject: FW: 1F Plant DATA (4 /28/2011)

-----Original Message-----

From: 遠藤　秀和 [mailto:endou.hidekazu@tepco.co.jp]
Sent: Wednesday, April 27, 2011 10:14 PM
To: Reynolds, Steven; Moore, Carl; GardLA@INPO.org; nei-hisanori@meti.go.jp; oshima-toshiyuki@meti.go.jp; Aleshia D. Duncan
Cc: 堀川　健; 高階　悟志; 白石　哲博; nakamura.mihoko@tepco.co.jp; 横尾　智之; 氏田　修二郎; 佐藤　隆; 二宮　豊; 中野　浩; 伊藤　正裕; 石井　武生; 毒島　康二
Subject: 1F Plant DATA (4/28/2011)

Dear all.

Please find attached plant status of Fukushima Daiichi NPS.

We appreciate your support.

Best regards,

Hidekazu Endou
TEPCO
[attachment "福島第一プラントパラメータ 0428_06時00分.pdf" deleted by Joy L Rempe/YOJ/CC01/INEEL/US]
[attachment "作業予定・現状 0428_0800Fix.pdf" deleted by Joy L Rempe/YOJ/CC01/INEEL/US]

Lee, Richard

From: Marksberry, Don
Sent: Friday, April 29, 2011 5:40 PM
To: Helton, Donald; Salay, Michael; Tinkler, Charles; Schaperow, Jason; Esmaili, Hossein; Lee, Richard
Cc: Demoss, Gary; Coyne, Kevin
Subject: FW: Unit 4 Spent Fuel Pool Movie

Good news (or not)

From: Joy L Rempe [Joy.Rempe@inl.gov]
Sent: Friday, April 29, 2011 3:55 PM
To: corradin@cae.wisc.edu; John Stetkar; Bill Shack; Sam Armijo; dapower@sandia.gov; dc.bley@gmail.com; Hackett, Edwin; Marksberry, Don; Richard B Lee
Subject: Unit 4 Spent Fuel Pool Movie

Unit 4 Spent Fuel Pool Movie

http://www.tepco.co.jp/en/news/110311/index-e.html

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From:	E&E Publishing, LLC <ealerts@eenews.net>
Sent:	Friday, April 29, 2011 8:17 AM
To:	Virgilio, Martin
Subject:	April 29 -- ClimateWire is ready

AN E&E PUBLISHING SERVICE

CLIMATEWIRE -- FRI., APRIL 29, 2011 -- Read the full edition

1. NUCLEAR: Why older nuclear power plants remain 'cash cows' despite Fukushima

There are no new nuclear plants in the foreseeable future for Exelon Corp., the largest U.S. reactor operator. Old plants, though, are a different story. Exelon's proposed acquisition of Baltimore-based Constellation Energy, announced yesterday, would add five nuclear reactors at three plants to the 17 reactors at 10 plants that the Chicago-based company already runs. Exelon's total nuclear capacity would climb from 17,047 megawatts to nearly 19,000 if the projected $7.9 billion deal is completed.

2. ENERGY: Exelon-Constellation deal could create 'clean energy' giant

Exelon Corp.'s $7.9 billion bid to buy Constellation Energy builds on a series of recent deals meant to create profitable electric power companies that burn less coal, use more natural gas and combine existing nuclear fleets.

TODAY'S STORIES

3. **DEFORESTATION:** Study shows how coca production drives deforestation in Colombia
4. **RENEWABLE ENERGY:** Clean energy finance can be thwarted by a lack of structure
5. **EMISSIONS TRADING:** Dutch embassy in Washington blazes a trail for the 'average Joe'
6. **NATIONS:** Russia shuns 'fast-track' climate funds
7. **LOBBYING:** Business Roundtable asks EPA to drop greenhouse gas regulations
8. **NEGOTIATIONS:** Durban climate deal is impossible, say envoys
9. **OFFSHORE WIND:** Fukushima accident quickly turns Germany to wind

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10. **WATER:** Spain's desalination plant stranded amid political firefight

11. **NUCLEAR:** India pushes back approval of four nuclear reactors

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Lee, Richard

From: Skeen, David
Sent: Saturday, April 30, 2011 3:29 PM
To: Correia, Richard; Marksberry, Don; Tracy, Glenn
Cc: Coe, Doug; Demoss, Gary; Lee, Richard; Jackson, Karen; Hogan, Rosemary
Subject: RE: Question from NISA on reporting to the IAEA

I agree we shouldn't just pass along Don's notes as written below.

I will assign a tasker to the LT to provide a final response by Wednesday evening. On Monday, the LT could work with Don and glean the essential information from Don's notes to pass along to Steve Reynolds whatever we know as interim information. They can also reach out to IAEA via OIP.

From: Correia, Richard
Sent: Saturday, April 30, 2011 3:16 PM
To: Marksberry, Don; Skeen, David; Tracy, Glenn
Cc: Coe, Doug; Demoss, Gary; Lee, Richard; Jackson, Karen; Hogan, Rosemary
Subject: Re: Question from NISA on reporting to the IAEA

Thanks Don. This information is very useful.

Dave. Glenn. I would propose to have OIP reach out to IAEA and ask them what historical information that have relative to TMI. It may be faster than searching around NRC for someone that might have different information than what Don has found thus far. I would also recommend we send Steve Reynolds what Don has provided here only as "this is what we know to date but we are continuing to search for more information". Steve can advise NISA as he feels is prudent but I would be careful not to give NISA Don's notes as written.

Thoughts?
Rich

Rich
Richard Correia, Director
Division of Risk Analysis
RES

Sent from a Blackberry

From: Marksberry, Don
To: Correia, Richard
Cc: Coe, Doug; Demoss, Gary; Skeen, David; Lee, Richard; Jackson, Karen; Hogan, Rosemary
Sent: Sat Apr 30 10:01:02 2011
Subject: RE: Question from NISA on reporting to the IAEA

Rich

I don't remember that IAEA was into incident notification and response until post Chernobyl. After TMI-2, an IAEA expert group was formed and establishes international guidelines on emergency planning and response. After Chernobyl, the Convention on Early Notification of a Nuclear Accident and the Convention on Assistance in the Case of Nuclear Accident or Radiological Emergency were established.

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Neither the Kemeny Commission nor the Rogovin reports mention "IAEA" or "international," except for the routine (annual) exchange of operating experience information via IAEA and the international media response to the accident. (Kemeny Commission - Report Of The Public's Right To Information Task Force quoted: "Instead of a regional story, TMI quickly became a national and international story which attracted a worldwide press corps numbering at any one time from 300 to 500 journalists, including reporters from Japan, France, Sweden, West Germany, Italy, Spain, and Great Britain.") In addition, none of the NRC investigations and actions NUREGs (e.g., 0578, 0585, 0600, 0616, 0660, 0737) mentioned IAEA or international.

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Don

(I also found one of the early public statements of core melt at TMI-2---seven year later).

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To: Marksberry, Don; Demoss, Gary; Coe, Doug
Cc: Skeen, David
Subject: Fw: Question from NISA on reporting to the IAEA

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Richard Correia, Director
Division of Risk Analysis
RES

Sent from a Blackberry

From: Reynolds, Steven
To: RST01 Hoc; LIA08 Hoc; LIA07 Hoc
Cc: Casto, Chuck; Mitchell, Matthew; Young, Francis; Skeen, David; Tracy, Glenn; Correia, Richard
Sent: Fri Apr 29 22:05:12 2011
Subject: Question from NISA on reporting to the IAEA

We received the following question from NISA.

After the TMI accident, what was reported to the IAEA about the accident, who reported it (e.g., NRC, TMI operator, other US government agency), when was it reported (how long after the accident), and how was it reported?

Can you have someone get back to us with the answer?

hanks,
Steve

Lee, Richard

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Cc: Coe, Doug; Demoss, Gary; Lee, Richard; Jackson, Karen; Hogan, Rosemary
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XX\137

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Lee, Richard

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Sent: Saturday, April 30, 2011 3:36 PM
To: Skeen, David; Marksberry, Don; Tracy, Glenn
Cc: Coe, Doug; Demoss, Gary; Lee, Richard; Jackson, Karen; Hogan, Rosemary
Subject: RE: Question from NISA on reporting to the IAEA

Thanks Dave. I fully support your recommendations.

thank you Don for responding so quickly and thoroughly!

rich

Rich Correia, PE
Director
Division of Risk Analysis
RES
US NRC

From: Skeen, David
Sent: Saturday, April 30, 2011 3:29 PM
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Rich
Richard Correia, Director
Division of Risk Analysis

XX/138

RES

Sent from a Blackberry

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Don

(I also found one of the early public statements of core melt at TMI-2---seven year later).

From: Correia, Richard
Sent: Saturday, April 30, 2011 7:35 AM
To: Marksberry, Don; Demoss, Gary; Coe, Doug
Cc: Skeen, David
Subject: Fw: Question from NISA on reporting to the IAEA

Don. Can you assist with the Nisa questions below? Don't start answering them but just let me know if you feel you have the information to answer it or you know who would have the information. We'll decide would will answer after that. Many thanks. Rich Richard Correia, Director Division of Risk Analysis RES

Sent from a Blackberry

From: Reynolds, Steven
To: RST01 Hoc; LIA08 Hoc; LIA07 Hoc
Cc: Casto, Chuck; Mitchell, Matthew; Young, Francis; Skeen, David; Tracy, Glenn; Correia, Richard
Sent: Fri Apr 29 22:05:12 2011
Subject: Question from NISA on reporting to the IAEA We received the following question from NISA.

After the TMI accident, what was reported to the IAEA about the accident, who reported it (e.g., NRC, TMI operator, other US government agency), when was it reported (how long after the accident), and how was it reported?

Can you have someone get back to us with the answer?

Thanks,

Steve

Lee, Richard

From: Correia, Richard
Sent: Saturday, April 30, 2011 3:16 PM
To: Marksberry, Don; Skeen, David; Tracy, Glenn
Cc: Coe, Doug; Demoss, Gary; Lee, Richard; Jackson, Karen; Hogan, Rosemary
Subject: Re: Question from NISA on reporting to the IAEA

Thanks Don. This information is very useful.

Dave. Glenn. I would propose to have OIP reach out to IAEA and ask them what historical information that have relative to TMI. It may be faster than searching around NRC for someone that might have different information than what Don has found thus far. I would also recommend we send Steve Reynolds what Don has provided here only as "this is what we know to date but we are continuing to search for more information". Steve can advise NISA as he feels is prudent but I would be careful not to give NISA Don's notes as written.

Thoughts?
Rich

Rich
Richard Correia, Director
Division of Risk Analysis
RES

Sent from a Blackberry

From: Marksberry, Don
To: Correia, Richard
Cc: Coe, Doug; Demoss, Gary; Skeen, David; Lee, Richard; Jackson, Karen; Hogan, Rosemary
Sent: Sat Apr 30 10:01:02 2011
Subject: RE: Question from NISA on reporting to the IAEA

Rich

I don't remember that IAEA was into incident notification and response until post Chernobyl. After TMI-2, an IAEA expert group was formed and establishes international guidelines on emergency planning and response. After Chernobyl, the Convention on Early Notification of a Nuclear Accident and the Convention on Assistance in the Case of Nuclear Accident or Radiological Emergency were established.

Neither the Kemeny Commission nor the Rogovin reports mention "IAEA" or "international," except for the routine (annual) exchange of operating experience information via IAEA and the international media response to the accident. (Kemeny Commission - Report Of The Public's Right To Information Task Force quoted: "Instead of a regional story, TMI quickly became a national and international story which attracted a worldwide press corps numbering at any one time from 300 to 500 journalists, including reporters from Japan, France, Sweden, West Germany, Italy, Spain, and Great Britain.") In addition, none of the NRC investigations and actions NUREGs (e.g., 0578, 0585, 0600, 0616, 0660, 0737) mentioned IAEA or international.

Ops Center transcripts for the first 6 days of Executive Management Team meetings (Commission meetings were recorded in the Ops Center and H-Street) did not mentioned IAEA or international.

Daily Preliminary Notifications (PNs) were issued (see attached), but I'm not sure about the distribution (I've never seen any NRC press releases). I believe that International programs was part of state programs at the time.

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