Bozin, Sunny

From: Franovich, Mike
Sent: Saturday, March 26, 2011 10:51 AM
To: Ostendorff, William
Cc: Nieh, Ho; Kock, Andrea; Zorn, Jason
Subject: UPDATE from 0830 Telecon on Fukushima Daiichi Events
Attachments: NISA Status 3-26-2011 1100.pdf

Dyer led the call

- The LIA/sit report provides significant update on plant parameters/conditions which are stable but challenging. Fresh water being used to cool Units 1, 2, and 3. I have attached the latest NISA report as a supplement to the LIA/sit report. (Note: Cabinet Minster Edano said today that crisis will be ongoing for sometime)

- One of two Navy fresh water barges on its way to the site. Barge #1 delayed by weather but expected by Sunday to arrive at Daiichi.

- The NRC saltwater report and accident management recommendations were provide to NISA and Tepco. Copy sent to the Chairman's office to be sent to Commission offices. This report represents a snap shot in time to what we will see may not reflect conditions.

- Feedback from NRC in-country team is that the NRC/DOE salt water analysis and accident management recommendations are very helpful but may be overtaken by current plant conditions. Example, Unit 2 cannot use nitrogen to purge containment. NRC/RST will need to regroup this morning. Telecon for 0900 EDT today to discuss other approaches.

- Casto and Monninger looking to get to J-village (encampment for rad workers going to Daiichi site). J-village is south of the plant approximately 12.5 miles away. Casto/Monninger likely to stay longer in Japan than originally planned.

- Vincent Holahan (liaison, NRC senior health physicist) departing today to Hawaii to assist Admiral Willard/PAC-COM by providing tech support, conduit to NRC, and insight on NRC organization.

- Japanese SDF wrapping up training on Bechtel pumping system. System will be moved to the Daiichi site from Yokota Air Base. Expected arrival at site by c.o.b. Sunday.

- Zimmerman was on call last night with deputy principals. Appears executive branch agencies beginning to duplicate or overlap NRC activities as actions

Y/279

come out of the White House. NRC to provide roadmap of what NRC roles and activities.

- Finally, as an aside outside the telecon, CNN has a good article on inside a nuke plant (reporter's trip inside Indian Point plant).

From: Csontos, Aladar
To: Klein, Paul; Taylor, Robert
Subject: Re: Stress Corrosion Crack Growth Rates of Stainless Steels in Chloride Solutions.docx
Date: Friday, March 25, 2011 2:27:35 PM

Rob,

I agree with Paul that SCC is a secondary issue and only an issue as it allows the core radionuclides a pathway for release. Also, I agree with Paul that my #3 bullet should be caveated with many assumptions/best estimates, so use with caution. I could be wrong, but I thought the bottom RPV penetrations and SRV interals also use susceptible stainless steels.

Paul, as normal, has done a fantastic job pulling us together.

Al

From: Klein, Paul
To: Taylor, Robert
Cc: Csontos, Aladar
Sent: Fri Mar 25 14:14:57 2011
Subject: RE: Stress Corrosion Crack Growth Rates of Stainless Steels in Chloride Solutions.docx

Rob,

To follow up NRC staff's initial comments on the "Issues with seawater in a BWR" paper, I asked RES to examine the literature to see if the staff could provide a better ballpark estimate of SCC crack growth rates given that we thought the number provided in the paper could underestimate the rate. I am forwarding Al's email below to you since you are in a good position to digest the contents while also understanding there are many uncertainties (e.g., we don't know the actual environment conditions) that can significantly affect stress corrosion crack growth rates. Here's my take on the information:

1. Our best estimate for crack growth rates, considering the scatter in the existing test data and uncertainties associated with the actual environment, is on the order of 0.030 inches per day or 30 times higher than was in the KAPL paper.
2. I have attached a summary of information compiled by Darrell Dunn related to CGRs in chloride solutions.
3. I have included Al's points below for some background information, but we should be cautious about trying to draw too many conclusions given the very limited information available.
4. Overall, I think SCC cracking remains a secondary priority given other current issues. Their plan to switch to freshwater injection as soon as possible is also a beneficial change with respect to SCC.

As to be expected Al, Dave Rudland, and Darrell did a great job pulling together and digesting some relevant crack growth rate data.

From: Csontos, Aladar
Sent: Friday, March 25, 2011 2:30 AM
To: Klein, Paul
Subject: FW: Stress Corrosion Crack Growth Rates of Stainless Steels in Chloride Solutions.docx

Paul,

Here's Darrell's writeup on the CGRs. I think we ought to change the 0.001in/day number that's in your writeup to reflect a more realistic number based on the attached. With residual stresses in welds, a 0.03in/day number seems more realistic from Tamaki's 1991 paper. We should at least send this out to folks to see what they think is reasonable.

Other bullets that I wanted to send to you that you can adjust:

- Boric acid, salt deposits, and 100C saturated brine salt water will lead to degraded piping, RPV, and other primary loop components over time (within weeks of the initial sea water injection).
- Preliminary component integrity calculations with best estimate CGRs found in the peer reviewed literature as a function of stress intensity indicate that throughwall circumferential cracking can occur within 21 days for a 0.5" thick pipe and 30-59 days for 1" thick pipe that is contacting the 100C brine water/hydrated salt precipitates on both ID and OD.
- The calculations also indicate that many circumferential cracks would arrest prior to growing throughwall, but, may grow throughwall during an aftershock seismic event.
- These cracks would lead to some leakage from numerous throughwall cracks and pits, but, without significant pressures, the leaks may be limited. Nevertheless, this is a fast pathway for further radionuclide release into the environment.
- Moving from sea water to fresh water may reduce this degradation, however, further degradation will continue even in diluted salt water.

Nelson, Robert

From: Nelson, Robert
Sent: Friday, March 25, 2011 9:09 AM
To: Weaver, Doug
Cc: Chernoff, Harold
Subject: RE: Fukushima Dai'ichi fuel removal

I've discussed with our BC for TMI licensing..Although not with NRC at the time, he's very familiar with the TMI event and the response. He does not believe that we have any information on special packaging for TMI clean-up. He also notes that the circumstances for the two events are vastly different. I have cc'ed him on this response. Please feel free to call him directly & discuss.

NELSON

-----Original Message-----
From: Weaver, Doug
Sent: Friday, March 25, 2011 8:13 AM
To: Nelson, Robert
Subject: FW: Fukushima Dai'ichi fuel removal

-----Original Message-----
From: Ordaz, Vonna
Sent: Friday, March 25, 2011 7:39 AM
To: Weaver, Doug
Cc: White, Bernard
Subject: Fw: Fukushima Dai'ichi fuel removal

Doug,

Please get this rolling first thing. All requests from Japan are the highest priority.

Thanks
Vonna

----- Original Message -----
From: Dorman, Dan
To: Ordaz, Vonna; Weaver, Doug
Sent: Fri Mar 25 07:28:00 2011
Subject: Fukushima Dai'ichi fuel removal

We are being asked to participate in a WG on planning the post-accident fuel removal. Please have someone shoot me any reference materials and key thoughts on our experience with any special packages used int TMI-2 cleanup. Anything you can get to me by COB today your time will be most helpful to get us started.

Thanks

Dan

Arndt, Steven

From: ANS Broadcasts [broadcasts@ans.org]
Sent: Saturday, March 26, 2011 12:55 AM
To: Arndt, Steven
Subject: ANS Technical Brief: MOX Fuel & Fukushima
Attachments: ANS-Technical-Brief-MOX-Fukushima.pdf

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/

Y/281

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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.

Kock, Andrea

From: Ostendorff, William
Sent: Sunday, March 27, 2011 10:07 PM
To: Franovich, Mike
Cc: Nieh, Ho; Kock, Andrea; Zorn, Jason
Subject: Re: RESEND: UPDATE from 2000 Telecon on Fukushima Daiichi Events

Thanks Mike.

From: Franovich, Mike
To: Ostendorff, William
Cc: Nieh, Ho; Kock, Andrea; Zorn, Jason
Sent: Sun Mar 27 21:54:45 2011
Subject: RE: RESEND: UPDATE from 2000 Telecon on Fukushima Daiichi Events

Sheron led the call

- No significant change in plant conditions. All three units have flooded turbine building basements. (isotopic samples confirm fission products in Unit 2 & 3 Turbine Building Sump water. (Note: reports from Japan indicate that the turbine condensers may used as temporary storage for the contaminated water).
- One Navy water barge arrived at the site.
- Offsite dose rates continue to decline (except for seawater contamination)
- Ambassador Roos wants a USG consensus recommendation that is signed off by all parties on how to proceed from here on regarding severe accident management /next steps. NRC high level approval has occurred today. I asked for a copy the report given our previous request (see attached e-mail and response).
- NRC's white paper summarizing safety assessment of spent fuel pools and dry cask storage went to White House today and will be shared with Commission offices per last night's request from the TAs.
- Casto developed agenda for Chairman's visit. Includes meetings with Amd. Roos, cabinet crisis team, TEPCO Chairman, and USG support team (Casto, et al.).
- Regarding addition of cooling systems and debris cleanup, TEPCO contracted Shaw.

Y/382

Rihm, Roger

From: Rihm, Roger
Sent: Monday, March 28, 2011 9:39 AM
To: Landau, Mindy
Subject: One last read-through?
Attachments: Testimony_Oral__March29_2011.docx

Could you take a last look at Bill's testimony and see if you have any final suggestions?

Y/283

NRC Response to Recent Nuclear Events in Japan and the Continuing Safety of the U.S. Commercial Nuclear Reactor Fleet

The staff of the NRC is deeply saddened by the tragedy in 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

The NRC is mindful that our primary responsibility is to ensure the 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 currently available information. Review of this information, combined with our ongoing inspection and licensing oversight, allows us to say with confidence 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. 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.

Overview of Events and the NRC's immediate and Continuing Response to Events in Japan

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, appears to have caused the loss of normal and 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.

At this time, it is our assessment that Units One, Two, and Three have experienced some degree of core damage, but that they are currently stable and being cooled with fresh water. Units Two and Three appear to have some primary containment damage. There have been releases of radioactivity that are of continuing significant concern, including significant

contamination in the lower levels of the Unit 2 and Unit 3 turbine buildings. The spent fuel pools on Units One through Four have experienced varying water levels, but also have been receiving seawater from helicopters and spray systems. The Unit 2 spent fuel pool has now started receiving fresh water and they are trying to change all the units from fire trucks to normal pumping in the next few days. Tokyo Electric Power Company has restored electric power to the site and the six reactor control rooms, and the situation, in general, continues to further stabilize, although many hurdles remain.

Shortly after 4:00 AM on Friday, March 11th, the NRC Emergency Operations Center made the first call to inform NRC management of the earthquake. We went into the monitoring mode at the Emergency Operations Center and the first concern for the NRC was possible impacts of a tsunami on U.S. plants and radioactive materials on the West Coast, and in Hawaii, Alaska, and U.S. Territories in the Pacific.

On that same day, we began interactions with our Japanese regulatory counterparts and dispatched two experts to Japan to help at the embassy. By Monday, March 14th, we had dispatched a total of 11 staff to Japan. We have subsequently rotated in additional staff to continue our on-the-ground assistance in Japan. The areas of focus for this team are: 1) to assist the Japanese government with technical support as part of the USAID response; and 2) to support the U.S. ambassador. While our focus now is on helping Japan in any way that we can, the experience will also help us assess the implications for U.S. citizens and the U.S. reactor fleet in as timely a manner as possible.

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. We feel confident, based on current data from monitoring at nuclear power plants and through the Environmental Protection Agency's system, that there is no reason for concern in the U.S. regarding radioactive releases from Japan.

Continuing Confidence in the Safety of U.S. Nuclear Power Plants

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 any single level of protection for public health and safety.

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 ensure that the plant is in a high condition of readiness to respond to any scenario.

Beyond this, 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 1979. As a result of those lessons learned, we have significantly revised emergency planning requirements and emergency operating procedures. We have 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 enables the monitoring of radioactive material release and possible fuel degradation. And, one of the most significant changes after Three Mile Island was expansion 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.

As a result of operating experience and ongoing research programs, we have developed requirements for severe accident management guidelines.

Our program of continuous improvement based on operating experience will now include

evaluation of the significant events in Japan. We've already begun enhancing inspection activities through temporary instructions to our inspection staff to look at licensees' readiness to deal with both design basis accidents and beyond-design basis accidents. We've also issued an information notice to licensees to make them aware of the events in Japan, and directing them to verify their capabilities to mitigate conditions that result from severe accidents.

Over the past 20 years, there have been a number of new rulemakings that have enhanced the domestic fleet's preparedness against some of the problems we are seeing in Japan. For example, 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. And then, regarding the type of containment design used by the most heavily damaged plants in Japan, we have had a Boiling Water Reactor Mark I Containment Improvement Program since the late 1980s, which has required installation of hardened vent systems for containment pressure relief, as well as enhanced reliability of the automatic depressurization system.

The Path Ahead

Beyond the initial steps to address the experience from the events in Japan, the Chairman, with the full support of the Commission, directed the NRC staff 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. At the end of the 90-day period, a report will be provided to the Commission.

The task force's longer-term review will begin as soon as the NRC has sufficient technical information from the events in Japan. 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. A report with appropriate recommendations will be provided to the Commission within 6 months of the start of this evaluation. Both the 90-day and final reports will be made publicly available in accordance with normal Commission processes.

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. At the same time, we are undertaking a 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 U.S. nuclear power plants.

Rihm, Roger

From: Rihm, Roger
Sent: Monday, March 28, 2011 10:05 AM
To: Borchardt, Bill; Taylor, Renee
Subject: Revised Tuesday Testimony
Attachments: Testimony_Oral__March29_2011.docx

Here it is, slightly updated from Friday.

Bill, the couple of other items I mentioned that you didn't want specifically included in the testimony (Chairman in Japan, coordinated set of recommendations) are covered in the 3/28/11 Briefing sheet in the Go-To Book.

Renee, please coordinate with Bill re: whether he wants a 14 point version to speak from.

Y/384

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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 ensure that the plant is in a high condition of readiness to respond to any scenario.

Beyond this, 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 1979. As a result of those lessons learned, we have significantly revised emergency planning requirements and emergency operating procedures. We have 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 enables the monitoring of radioactive material release and possible fuel degradation. And, one of the most significant changes after Three Mile Island was expansion 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.

As a result of operating experience and ongoing research programs, we have developed requirements for severe accident management guidelines.

Our program of continuous improvement based on operating experience will now include

evaluation of the significant events in Japan. We've already begun enhancing inspection activities through temporary instructions to our inspection staff to look at licensees' readiness to deal with both design basis accidents and beyond-design basis accidents. We've also issued an information notice to licensees to make them aware of the events in Japan, and directing them to verify their capabilities to mitigate conditions that result from severe accidents.

Over the past 20 years, there have been a number of new rulemakings that have enhanced the domestic fleet's preparedness against some of the problems we are seeing in Japan. For example, 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. Regarding the type of containment design used by the most heavily damaged plants in Japan, we have had a Boiling Water Reactor Mark I Containment Improvement Program since the late 1980s, which has required installation of hardened vent systems for containment pressure relief, as well as enhanced reliability of the automatic depressurization system.

The Path Ahead

Beyond the initial steps to address the experience from the events in Japan, the Chairman, with the full support of the Commission, directed the NRC staff 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. At the end of the 90-day period, a report will be provided to the Commission.

The task force's longer-term review will begin as soon as the NRC has sufficient technical information from the events in Japan. 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. A report with appropriate recommendations will be provided to the Commission within 6 months of the start of this evaluation. Both the 90-day and final reports will be made publicly available in accordance with normal Commission processes.

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. At the same time, we are undertaking a 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 U.S. nuclear power plants.

Rihm, Roger

From: Rihm, Roger
Sent: Monday, March 28, 2011 4:18 PM
To: Weber, Michael
Cc: Landau, Mindy
Subject: Here's Testimony as Trish wants it
Attachments: Testimony_EPP_March 30 2011_Milligan.docx

Importance: High

I spoke to David Decker, who said this "re-arrangement" shouldn't be a problem, but I haven't heard back definitively from Raeann.

David will bring you (directly) a copy of the 3/16 background materials we discussed.

Y/285

STATEMENT
BY MIKE WEBER, DEPUTY EXECUTIVE DIRECTOR FOR
MATERIALS, WASTE, RESEARCH, STATE, TRIBAL AND COMPLIANCE PROGRAMS
UNITED STATES NUCLEAR REGULATORY COMMISSION
TO THE
HOUSE COMMITTEE ON TRANSPORTATION AND INFRASTRUCTURE

MARCH 30, 2011

Good morning, Mr. Chairman and members of the Subcommittee. I am pleased to appear before you on behalf of the United States Nuclear Regulatory Commission to discuss our emergency planning and preparedness programs at nuclear power facilities in the United States, and to discuss the protective action guidance recently issued by the U.S. Ambassador to American citizens in Japan in response to the events at the Fukushima 1 nuclear power plant site.

NRC's primary mission is to regulate nuclear reactors, materials, and waste facilities in a manner that protects the health and safety of the public and promotes the common defense and security. Emergency preparedness is a key element of the "defense in depth" safety philosophy we employ for nuclear power plants. This philosophy ensures high quality in design, construction, and operation of nuclear power plants; requires redundant safety systems that reduce the chances that malfunctions will lead to accidents; and recognizes that in spite of all these precautions, unforeseen events could occur. Through emergency planning and preparedness, mechanisms are in place to protect the public in the unlikely event that these barriers fail.

The NRC emergency preparedness and planning regulations are extensive and require the licensee to develop and demonstrate an effective emergency plan prior to initial startup. The nuclear power plant operator is required to provide extensive emergency response training to

emergency plant workers; for example, severe accident management training to control room operators, and demonstrate personnel response in a rigorous drill and exercise program. This program includes an every-other-year full participation exercise that engages both the onsite and offsite response organizations which include state and local responders as well as FEMA. These exercises are evaluated by both FEMA (offsite) and NRC (onsite) staff. In addition, the NRC performs periodic emergency preparedness inspections of the facility. NRC resident inspectors also observe licensee on-site emergency drills and exercises. It is safe to say that over the 30 plus years of operating history and in 104 operating nuclear power plants, there have been thousands of drills and exercises designed to ensure optimum response to abnormal and emergency conditions.

For planning purposes, we define two planning zones around nuclear power plant sites. The first zone is an area covering a 10 mile radius around a nuclear power plant. This is the area with the greatest potential for exposure from a release. Planning for this area is comprehensive and includes such protective actions as evacuation, sheltering, and potassium iodide, as appropriate, for members of the public.

Consideration of these protective actions is prompted at very low projected dose levels. A second extended planning zone of about 50 miles is also established around each plant to deal with potential lower-level, long-term risks primarily due to exposure from consumption of contaminated food, milk, and water. This comprehensive planning within the 10 and 50 mile EPZ provides a substantial basis for expansion of response efforts in the event that this is necessary.

Let me now address the NRC's recent protective action recommendation for U.S citizens in Japan to evacuate out to 50 miles from the Fukushima Daiichi site. That decision was based on

the best information available during an evolving event. NRC began monitoring the event when the tsunami warning was issued for Hawaii and the west coast of the United States. The information flow from the Fukushima site was often confusing and conflicting. In order to provide timely information to the U.S. Ambassador to Japan, and to best protect the health and safety of U.S. citizens in Japan, we based our assessment on the conditions as we understood them. This is a 6 unit site and 4 of the units were facing extraordinary challenges. Units 1, 2, and 3 appeared to have suffered significant damage as a result of reported hydrogen explosions. We knew that the concrete containment buildings were severely damaged and unable to perform their function of stopping the release of radiation. Unit 4 was in a refueling outage and its entire core had been transferred to the spent fuel pool a little more than 3 months earlier. This means that there was fresh fuel in the spent fuel pool that was in danger of overheating if the water level dropped, and there were indications that was happening. Additionally, radiation monitors were showing very high levels of radiation on the plant site, which would pose challenges to plant crew attempting to stabilize the reactors, and there were offsite readings indicating that fuel damage had occurred. This situation was unprecedented.

In order to determine the proper evacuation distance, the staff performed a series of calculations using our RASCAL computer code to assess possible offsite consequences. These calculations demonstrated that the Environmental Protection Agency's Protective Action Guidelines would be exceeded at a distance of 50 miles from the Fukushima site. We understood that some of our assumptions were conservative, but believed that it was better to err on the side of overprotection, especially in the case of a seemingly rapidly deteriorating situation.

If this situation had occurred in the United States, the NRC has resident inspector staff at the plants that can report back to the Region and Headquarters on conditions as they are evolving.

In addition, we are able to readily access "live-time" plant parameters and radiation monitors, as well as talk directly to our licensee and emergency management officials allowing us to refine our understanding and consequence assessments. The licensee would then make a recommendation to State officials on what protective actions to take. With the Fukushima event we had to make our best decision with what we had available. The Emergency Preparedness framework provides for the expansion of the emergency planning zones as conditions require. Acting in accordance with this framework and with the best information available at the time, the NRC determined that evacuation out to 50 miles for U.S. citizens was an appropriate course of action.

Rihm, Roger

From: Rihm, Roger
Sent: Monday, March 28, 2011 11:43 AM
To: Powell, Amy
Subject: Bill's 3/29 Testimony

Should I be expecting any Commission feedback from you on the statement for the record that would affect Bill's remarks tomorrow?

Y/286

Andersen, James

From: Andersen, James
Sent: Monday, March 28, 2011 12:03 PM
To: Williams, Shawn
Cc: Virgilio, Martin; Cianci, Sandra
Subject: RE: Japan Task Force Commission Meetings

The 60-day is scheduled for June 16th. The AARM Commission meeting is May 27th, so he will miss that one.

Jim A.

From: Williams, Shawn
Sent: Monday, March 28, 2011 11:59 AM
To: Andersen, James
Cc: Virgilio, Martin; Cianci, Sandra
Subject: Japan Task Force Commission Meetings

Jim,
Marty is currently planned to be at the CSS the week of May 22-28th.

I don't know if the 30-60- 90 day Commission meetings have been scheduled yet, but it would be unfortunate if the 60 day was scheduled during the May 22-28th week.

If you have an option, please schedule the 60 day before or after the May 22cd week.

Thanks,
Shawn Williams
Executive Technical Assistant
Office of the Executive Director for Operations
301-415-1009

Y/287

Merzke, Daniel

From: Merzke, Daniel
Sent: Monday, March 28, 2011 12:42 PM
To: Muessle, Mary
Subject: RE: Memo

I sent it to Bill earlier, but Bill just sent me Mike's comments, so I'll take a look at them.

From: Muessle, Mary
Sent: Monday, March 28, 2011 12:23 PM
To: Merzke, Daniel
Subject: Memo
Importance: High

I understand Mike Weber is making significant changes to the memo. Is it already gone to Bill and above?

Mary Muessle
Assistant for Operations - Acting
Office of the Executive Director for Operations
U.S. Nuclear Regulatory Commission
301-415-1703 office
301-415-2700 fax

1/388

Rihm, Roger

From: Rihm, Roger
Sent: Tuesday, March 29, 2011 7:58 AM
To: Shane, Raeann
Subject: RE: Draft Weber Testimony Sent to Commission

Thanks. Mike has some edits I need to review. Will call at some point.

From: Shane, Raeann
Sent: Monday, March 28, 2011 8:12 PM
To: Rihm, Roger
Subject: RE: Draft Weber Testimony Sent to Commission

Roger,

Moved it.....I do not have all the CMR offices comments back yet, but you should be seeing a new version soon. I just want to run it by OCA mgt in the morning.

Raeann

From: Rihm, Roger
Sent: Monday, March 28, 2011 2:48 PM
To: Shane, Raeann
Subject: FW: Draft Weber Testimony Sent to Commission

From: Milligan, Patricia
Sent: Monday, March 28, 2011 2:47 PM
To: Rihm, Roger; Weber, Michael
Cc: Landau, Mindy
Subject: RE: Draft Weber Testimony Sent to Commission

They need to move it. It is the important point and really the reason for the Wed discussion.

From: Rihm, Roger
Sent: Monday, March 28, 2011 2:44 PM
To: Milligan, Patricia; Weber, Michael
Cc: Landau, Mindy
Subject: RE: Draft Weber Testimony Sent to Commission

I noticed that OCA did not have it in where you had placed it and agree with you. I'll check to see why they put it there and discuss moving it.

From: Milligan, Patricia
Sent: Monday, March 28, 2011 2:35 PM
To: Rihm, Roger; Weber, Michael
Cc: Landau, Mindy
Subject: RE: Draft Weber Testimony Sent to Commission

I think this massaged draft needs to be rearranged a bit. I purposely chose to discuss the emergency planning drills, exercises, etc before the planning zones to link together the 10 and 50 mile EPZs and their

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basis for expansion as conditions warrant to the actual discussion that recommends the 50 mile evacuation. It makes the point a bit better that expanding an evacuation is consistent with our EP framework. I don't think we want to bury that point... I think it needs to be highlighted and the dots connected. I have attached the original version I sent along with the OCA massaged version. Please consider rearranging it so that this point is not lost.

Happy to discuss if you want.

Trish

From: Rihm, Roger
Sent: Monday, March 28, 2011 12:03 PM
To: Weber, Michael
Cc: Landau, Mindy; Milligan, Patricia
Subject: Draft Weber Testimony Sent to Commission

Attached is OCA's slightly massaged version of Trish's draft that was sent (by OCA) to the Commission this morning for review.

Caponiti, Kathleen

From: Nuclear Plant Journal [anu@goinfo.com]
Sent: Tuesday, March 29, 2011 5:06 PM
To: Cusumano, Victor
Subject: NPJ E-News March 29, 2011 Fukushima Update

Having trouble viewing this email? Click here

Nuclear Plant Journal
An International Publication
Published in the United States

Nuclear Plant Journal E-News

Japan Update
March 29, 2011

Dear VICTOR,

In this issue of NPJ E-News you'll find an update of the Fukushima Nuclear Plants in Japan. Information is current as of March 29, 2011, 15:00 CDT. All items are directly quoted, without any editing.

In this issue

TEPCO Update

Status Document

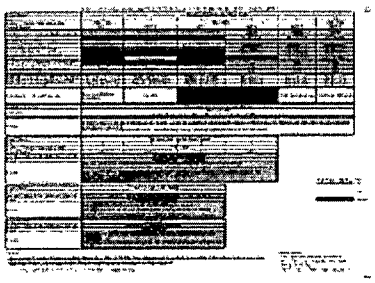
US NRC FAQs

TEPCO Update

From the TEPCO website:

- From 2:17pm to 6:18pm, March 29th, water was injected into Unit 3 from a concrete pumping vehicle. Until March 28th, we had been injecting sea water, however, from March 29th, we started injecting fresh water.
- At Unit 2, seawater had been injected from the fire fighting pump, but at 4:30pm, March 29th, we started injecting fresh water from a temporary motor driven pump instead. The water was injected until 6:25pm, March 29th.

Click for more...



JAIF Status Update

Update 46, March 29, 2011

A PDF document provides a simple summary of each of the units at Fukushima nuclear power plants. This is a multi-page document that also provides a chronology of events and a map

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that details the status of each of the Japanese nuclear units.

Earthquake Update 36.

US NRC FAQs related to Fukushima eatchquake and subsequent events

NRC frequently asked questions related to the March 11, 2011 Japanese Earthquake and Tsunami. Some sample questions:

- Can an earthquake and tsunami as large as happened in Japan also happen here?
- *Did the Japanese underestimate the size of the maximum credible earthquake and tsunami that could affect the* plants?
- How high was the tsunami at the Fukushima nuclear plants?
- Was the damage to the Japanese nuclear plants mostly from the earthquake or the tsunami?

Quick Links...

- NPJ Website
- Cost-free Subscription (to NPJ)
- JAIF
- TEPCO
- NISA
- U.S. NRC Actions on Japan

Like Nuclear Plant Journal's new page on Facebook!

Contact Information
phone: 630-313-6739
email: NPJ@goinfo.com

Rihm, Roger

From: Rihm, Roger
Sent: Tuesday, March 29, 2011 8:31 AM
To: Milligan, Patricia
Subject: FW: RESPONSE - Here's Testimony as Trish wants it
Attachments: Testimony_EPP_March 30 2011_Weber.docx

Did you have any comments on Mike's edits? (I want/need to share with OCA). Regarding concerns with what the invitation says they want....we went on what we were told at the time we started, so can't "re-do" at this point. I guess if you can do any additional Q&A or 2 for Mike, that would be good.

From: Weber, Michael
Sent: Monday, March 28, 2011 5:11 PM
To: Rihm, Roger
Cc: Landau, Mindy; Decker, David; Benowitz, Howard; Milligan, Patricia; Andersen, James; Wittick, Brian; Merzke, Daniel; Muessle, Mary; Virgilio, Martin
Subject: RESPONSE - Here's Testimony as Trish wants it

Looks good. I like the testimony. I only had a couple factual clarifications and minor adjustments. The most sensitive part is the portion that describes the status of the plants and what we "knew" when we were making our protective action recommendations for evacuation out to 50 miles.

Thanks

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Sent: Monday, March 28, 2011 4:18 PM
To: Weber, Michael
Cc: Landau, Mindy
Subject: Here's Testimony as Trish wants it
Importance: High

I spoke to David Decker, who said this "re-arrangement" shouldn't be a problem, but I haven't heard back definitively from Raeann.

David will bring you (directly) a copy of the 3/16 background materials we discussed.

4/291

STATEMENT
BY MICHAELKE WEBER, DEPUTY EXECUTIVE DIRECTOR FOR
MATERIALS, WASTE, RESEARCH, STATE, TRIBAL AND COMPLIANCE PROGRAMS
UNITED STATES NUCLEAR REGULATORY COMMISSION
TO THE
HOUSE COMMITTEE ON TRANSPORTATION AND INFRASTRUCTURE

MARCH 30, 2011

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The NRC emergency preparedness and planning regulations are extensive and require the licensee to develop and demonstrate an effective emergency plan prior to initial startup. The nuclear power plant operator is required to provide extensive emergency response training to

emergency plant workers; for example, severe accident management training to control room operators, and demonstrate personnel response in a rigorous drill and exercise program. This program includes an every-other-year full participation exercise that engages both the onsite and offsite response organizations which include state and local responders as well as FEMA. These exercises are evaluated by both FEMA (offsite) and NRC (onsite) staff. In addition, the NRC performs periodic emergency preparedness inspections of the facility. NRC resident inspectors also observe licensee on-site emergency drills and exercises. It is safe to say that over the 30 plus years of operating history and in 104 operating nuclear power plants, there have been thousands of drills and exercises designed to ensure optimum response to abnormal and emergency conditions.

For planning purposes, we define two planning zones around nuclear power plant sites. The first zone is an area covering a 10 mile radius around a nuclear power plant. This is the area with the greatest potential for exposure from a release. Planning for this area is comprehensive and includes such protective actions as evacuation, sheltering, and administration of potassium iodide, as appropriate, for members of the public.

Consideration of these protective actions is prompted at very low projected dose levels. A second extended planning zone of about 50 miles is also established around each plant to deal with potential lower-level, long-term risks primarily due to exposure from consumption of contaminated food, milk, and water. This comprehensive planning within the 10 and 50 mile EPZ provides a substantial basis for expansion of response efforts in the event that this is necessary.

Let me now address the NRC's recent protective action recommendation for U.S citizens in Japan to evacuate out to 50 miles from the Fukushima-Daiichi site. That decision was based on

the best information available during an evolving event. NRC began monitoring the event when the tsunami warning was issued for Hawaii and the west coast of the United States. The information flow from the Fukushima site was often confusing and conflicting. In order to provide timely information to the U.S. Ambassador to Japan, and to best protect the health and safety of U.S. citizens in Japan, we based our assessment on the conditions as we understood them. This ~~is a 6 unit~~ site has six nuclear power plants and 4 of the plants ~~units~~ are ~~were~~ facing extraordinary challenges. Units 1, ~~2, and~~ 3, and 4 appeared to have suffered significant damage as a result of reported hydrogen explosions. We suspected ~~knew~~ that the concrete containment buildings were severely damaged by the explosions and may not be capable ~~unable~~ to perform their function of stopping the release of radiation. Unit 4 was in a refueling outage and its entire core had been transferred to the spent fuel pool a little more than 3 [check] months earlier. This means that there was ~~fresh~~ irradiated fuel that had been freshly loaded into the spent fuel pool that was in danger of overheating if the water level dropped, and there were indications that was happening. Additionally, radiation monitors were showing very high levels of radiation on the plant site, which would pose challenges to plant crew attempting to stabilize the reactors, and there were offsite readings indicating that fuel damage had occurred. This situation was unprecedented.

In order to determine the proper evacuation distance, the NRC staff performed a series of calculations using our RASCAL computer code to assess possible offsite consequences. These calculations demonstrated that the Environmental Protection Agency's Protective Action Guidelines could ~~would~~ be exceeded at a distance of 50 miles from the Fukushima site, if a large-scale release occurred from the reactors or spent fuel pools. We understood that some of our assumptions were conservative, but believed that it was better to err on the side of ~~over~~protection, especially in the case of a seemingly rapidly deteriorating situation.

If this situation had occurred in the United States, the NRC has resident inspector staff at the plants that can report back to the Region and Headquarters on conditions as they are evolving. In addition, we are able to readily access "live-time" plant parameters and radiation monitors, as well as talk directly to our licensee and emergency management officials allowing us to refine our understanding and consequence assessments. The licensee would then make a recommendation to State or local officials on what protective actions to take. With the Fukushima event we had to make our best decision with what we had available. The Emergency Preparedness framework provides for the expansion of the emergency planning zones as conditions require. Acting in accordance with this framework and with the best information available at the time, the NRC determined that evacuation out to 50 miles for U.S. citizens was an appropriate course of action.

This concludes my testimony. Thank you for the opportunity to present this testimony. I would be happy to answer your questions.

Rihm, Roger

From: Rihm, Roger
Sent: Tuesday, March 29, 2011 8:45 AM
To: Shane, Raeann
Subject: FW: RESPONSE - Here's Testimony as Trish wants it
Attachments: Testimony_EPP_March 30 2011_Weber.docx

Importance: High

Raeann, here are the edits Mike proposes to the testimony (and his explanation below). Note: He was aware of the issue regarding placement of Trish's last piece of text, and I had provided this version to him where I had moved it where she wanted it.

Will you go ahead and incorporate, as appropriate, along with Commission edits you receive? Let me know if I need to do something more. Thx.

From: Weber, Michael
Sent: Monday, March 28, 2011 5:11 PM
To: Rihm, Roger
Cc: Landau, Mindy; Decker, David; Benowitz, Howard; Milligan, Patricia; Andersen, James; Wittick, Brian; Merzke, Daniel; Muessle, Mary; Virgilio, Martin
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MATERIALS, WASTE, RESEARCH, STATE, TRIBAL AND COMPLIANCE PROGRAMS
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This concludes my testimony. Thank you for the opportunity to present this testimony. I would be happy to answer your questions.

Rihm, Roger

From: Rihm, Roger
Sent: Tuesday, March 29, 2011 9:50 AM
To: Sanfilippo, Nathan; Ellmers, Glenn
Subject: RE: Bill's testimony
Attachments: Testimony_Oral__March29_2011.docx

It's possible Bill may have tweaked this last night, but here is what I gave him as the "final" yesterday.

From: Sanfilippo, Nathan
Sent: Tuesday, March 29, 2011 9:36 AM
To: Rihm, Roger; Ellmers, Glenn
Subject: Bill's testimony
Importance: High

Roger, Glen,

Could one of you please send me Bill's testimony for today so the task force can see it?

Thanks!
Nathan

NRC Response to Recent Nuclear Events in Japan and the Continuing Safety of the U.S. Commercial Nuclear Reactor Fleet

The staff of the NRC is deeply saddened by the tragedy in 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

The NRC is mindful that our primary responsibility is to ensure the 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 currently available information. Review of this information, combined with our ongoing inspection and licensing oversight, allows us to say with confidence 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. 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.

Overview of Events and the NRC's Immediate and Continuing Response to Events in Japan

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, appears to have caused the loss of normal and 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.

At this time, it is our assessment that Units One, Two, and Three have experienced some degree of core damage, but that they are currently stable and being cooled with fresh water. Units Two and Three appear to have some primary containment damage. There have been releases of radioactivity that are of continuing significant concern, including significant

contamination in the lower levels of the Unit 2 and Unit 3 turbine buildings. The spent fuel pools on Units One through Four have experienced varying water levels, but also have been receiving seawater from helicopters and spray systems. The Unit 2 spent fuel pool has now started receiving fresh water and they are trying to change all the units from fire trucks to normal pumping in the next few days. Tokyo Electric Power Company has restored electric power to the site and the six reactor control rooms, and the situation, in general, continues to further stabilize, although many hurdles remain.

Shortly after 4:00 AM on Friday, March 11th, the NRC Emergency Operations Center made the first call to inform NRC management of the earthquake. We went into the monitoring mode at the Emergency Operations Center and the first concern for the NRC was possible impacts of a tsunami on U.S. plants and radioactive materials on the West Coast, and in Hawaii, Alaska, and U.S. Territories in the Pacific.

On that same day, we began interactions with our Japanese regulatory counterparts and dispatched two experts to Japan to help at the embassy. By Monday, March 14th, we had dispatched a total of 11 staff to Japan. We have subsequently rotated in additional staff to continue our on-the-ground assistance in Japan. The areas of focus for this team are: 1) to assist the Japanese government with technical support as part of the USAID response; and 2) to support the U.S. ambassador. While our focus now is on helping Japan in any way that we can, the experience will also help us assess the implications for U.S. citizens and the U.S. reactor fleet in as timely a manner as possible.

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. We feel confident, based on current data from monitoring at nuclear power plants and through the Environmental Protection Agency's system, that there is no reason for concern in the U.S. regarding radioactive releases from Japan.

Continuing Confidence in the Safety of U.S. Nuclear Power Plants

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 any single level of protection for public health and safety.

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 ensure that the plant is in a high condition of readiness to respond to any scenario.

Beyond this, 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 1979. As a result of those lessons learned, we have significantly revised emergency planning requirements and emergency operating procedures. We have 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 enables the monitoring of radioactive material release and possible fuel degradation. And, one of the most significant changes after Three Mile Island was expansion 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.

As a result of operating experience and ongoing research programs, we have developed requirements for severe accident management guidelines.

Our program of continuous improvement based on operating experience will now include

evaluation of the significant events in Japan. We've already begun enhancing inspection activities through temporary instructions to our inspection staff to look at licensees' readiness to deal with both design basis accidents and beyond-design basis accidents. We've also issued an information notice to licensees to make them aware of the events in Japan, and advising them to verify their capabilities to mitigate conditions that result from severe accidents.

Over the past 20 years, there have been a number of new rulemakings that have enhanced the domestic fleet's preparedness against some of the problems we are seeing in Japan. For example, 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. Regarding the type of containment design used by the most heavily damaged plants in Japan, we have had a Boiling Water Reactor Mark I Containment Improvement Program since the late 1980s, which has required installation of hardened vent systems for containment pressure relief, as well as enhanced reliability of the automatic depressurization system.

The Path Ahead

Beyond the initial steps to address the experience from the events in Japan, the Chairman, with the full support of the Commission, directed the NRC staff 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. At the end of the 90-day period, a report will be provided to the Commission.

The task force's longer-term review will begin as soon as the NRC has sufficient technical information from the events in Japan. 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. A report with appropriate recommendations will be provided to the Commission within 6 months of the start of this evaluation. Both the 90-day and final reports will be made publicly available in accordance with normal Commission processes.

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. At the same time, we are undertaking a 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 U.S. nuclear power plants.

Rihm, Roger

From: Rihm, Roger
Sent: Tuesday, March 29, 2011 8:50 AM
To: Weber, Michael
Subject: RE: RESPONSE - Here's Testimony as Trish wants it

I have passed these along to Raeann Shane, requesting that she incorporate them along with comments she receives from commission offices.

From: Weber, Michael
Sent: Monday, March 28, 2011 5:11 PM
To: Rihm, Roger
Cc: Landau, Mindy; Decker, David; Benowitz, Howard; Milligan, Patricia; Andersen, James; Wittick, Brian; Merzke, Daniel; Muessle, Mary; Virgilio, Martin
Subject: RESPONSE - Here's Testimony as Trish wants it

Looks good. I like the testimony. I only had a couple factual clarifications and minor adjustments. The most sensitive part is the portion that describes the status of the plants and what we "knew" when we were making our protective action recommendations for evacuation out to 50 miles.

Thanks

From: Rihm, Roger
Sent: Monday, March 28, 2011 4:18 PM
To: Weber, Michael
Cc: Landau, Mindy
Subject: Here's Testimony as Trish wants it
Importance: High

I spoke to David Decker, who said this "re-arrangement" shouldn't be a problem, but I haven't heard back definitively from Raeann.

David will bring you (directly) a copy of the 3/16 background materials we discussed.

Y/294

Rihm, Roger

From: Milligan, Patricia
Sent: Tuesday, March 29, 2011 2:49 PM
To: Weber, Michael
Cc: Rihm, Roger; Wiggins, Jim; Evans, Michele; Virgilio, Martin; Decker, David
Subject: RE: RESPONSE - HEARING INVITATION
Attachments: Risk informed EP background.docx

Mike

A Q & A to address "streamlining Emergency Management Programs" and background .

From: Weber, Michael
Sent: Tuesday, March 29, 2011 8:21 AM
To: Milligan, Patricia
Cc: Rihm, Roger; Wiggins, Jim; Evans, Michele; Virgilio, Martin; Decker, David
Subject: RESPONSE - HEARING INVITATION

How about a backup Q&A? The testimony is essentially complete, once the Commission clears it.

From: Milligan, Patricia
Sent: Tuesday, March 29, 2011 8:15 AM
To: Weber, Michael; Decker, David
Cc: Rihm, Roger; Wiggins, Jim; Evans, Michele; Virgilio, Martin
Subject: RE: QUERY - HEARING INVITATION

I did not know that this was the focus of the hearing. We have been working towards "risk informed, performance based" EP. Do you want something on that?

From: Weber, Michael
Sent: Monday, March 28, 2011 6:52 PM
To: Decker, David
Cc: Rihm, Roger; Milligan, Patricia; Wiggins, Jim; Evans, Michele; Virgilio, Martin
Subject: QUERY - HEARING INVITATION

Is the attached letter the invitation to the hearing that I will be testifying in on Wednesday morning? Not sure that I even touch on suggestions for how we could accomplish emergency preparedness in a more cost-effective and streamlined manner...Please advise.

Tab 'A" 03/23/11 -- Letter from Rep. Jeff Denham, invites Commission testimony at the March 25, 2011 hearing on "Improving the Nation's Response to Catastrophic Disasters: How to Minimize Costs and Streamlining our Emergency Management Programs."

Y/25

Independent Assessment of Nuclear Power Safety in the United States

Chairman Jaczko, I want to thank you and the people of your agency for the hard work and long hours many of you have been putting in since March 11. I further want to say that I believe the women and men of your agency work hard every day to keep our power plants safe. So, in no way do I want you or the workforce of the NRC to take this question as a slight.

* **Do you believe there is value in having an independent assessment of nuclear power safety in the United States?**

The NRC continues working in its mission to license, regulate the Nation's use of byproduct, source, and special nuclear materials in order to protect public health and safety, promote the common defense and security, and protect the environment. I am confident that the NRC's regulatory regime, inspection and oversight, and the proactive efforts of the industry through organizations like INPO will continue to ensure that this nation's reactors are operated safely.

The events in Japan are still unfolding as we speak and, I believe, it will still take some time before we know the full details of the event progression for each unit at the Fukushima Dai-ichi facility, the full extent of damage to structures, systems, and components, and the availabilities, capabilities, and responses of structures, systems and components to the earthquake and resultant tsunami. Until we know the full extent of what happened at the Fukushima Dai-ichi plant in Japan, I believe that it is premature to comment on whether or not there would be value in having an independent assessment of nuclear power safety in the U.S.

Design Basis Reassessment

Chairman Jaczko, in the past four years there has been earthquakes in Japan that have exceeded the design basis for nuclear plants in the vicinity of the earthquakes.

* **How confident are you that our design basis for U.S. plants is sufficient?**

All US nuclear plants are built to withstand environmental hazards, including earthquakes and tsunamis. Even those nuclear plants that are located within areas with low and moderate seismic activity are designed for safety in the event of such a natural disaster. The NRC requires that safety-significant structures, systems, and components be designed to take into account even rare and extreme seismic and tsunami events. In addition to the design of the plants, significant effort goes into emergency response planning and accident management. This approach is called defense-in-depth.

The Japanese facilities are similar in design to some US facilities. However, the NRC has required modifications to the plants since they were built, including design changes to control hydrogen and pressure in the containment. The NRC has also required plants to have additional equipment and measures to mitigate damage stemming from large fires and explosions from a beyond-design-basis event. The measures include providing core and spent fuel pool cooling and an additional means to power other equipment on site.

*** Why were the Japanese so wrong on their assumptions of the possible maximum earthquake and tsunami events?**

Currently we do not have official information. However, it appears that the ground motions (in terms of peak ground acceleration) are similar to the **Review Level Ground Motions** shaking levels, although the causative earthquakes are different. Thus the design basis was exceeded, but the review level may not have been.

*** NOTE There are two shaking levels relevant to the Fukushima plant, the original design level ground motion and a newer **review level ground motion**. As a result of a significant change in seismic regulations in 2006, NISA, the Japanese regulator initiated a program to reassess seismic hazard and seismic risk for all nuclear plants in Japan. This resulted in new assessments of higher ground shaking levels (i.e. seismic hazard) and a review of seismic safety for all Japanese plants. The program is still ongoing, but has already resulted in retrofit in some plants.

OR

The magnitude of the earthquake was somewhat greater than was expected for that part of the subduction zone. However, the Japanese nuclear plants were recently reassessed using ground motion levels similar to those that are believed to have occurred at the sites. The ground motions against which the Japanese nuclear plants were reviewed were expected to result from earthquakes that were smaller, but were much closer to the sites. The NRC does not currently have full information on the maximum tsunami height that was expected at the sites.

Relicensing not including seismic and tsunami

Chairman Jaczko, I understand from my trip to Diablo Canyon that the relicensing process does not include a review of seismic and tsunami threats. Rather that relicensing is focused more on the aging of materials and equipment. The plant operators and NRC personnel on the trip explained that seismic and tsunami issues are considered on a continuing basis and thus do not need to be part of the relicensing.

I find this a little confusing. I understand relicensing should consider aging of materials and equipment as 20 to 40 years have passed since the initial license. But our information relative to seismic and tsunami threats has also changed over this time.

*** If seismic and tsunami issues are not considered during relicensing, what guarantee do we have that the NRC is adequately considering these issues at any other time?**

*** If not considered during relicensing, does the burden fall to the federal government to prove there is a need to modify the license due to seismic or tsunami information or does that burden get put on the plant operator?**

- Seismic information to date is bounded by the current licensing/design basis of the plant. Seismic information is a current plant issue, not a license renewal issue.

- If future seismic information is not bounded by current licensing/design basis, the NRC will take appropriate and timely action irrespective of the license renewal review status.

- The license renewal review is focused on managing the effects of aging and not a re-review of the current licensing basis.

Rihm, Roger

From: Rihm, Roger
Sent: Tuesday, March 29, 2011 4:04 PM
To: Kammerer, Annie
Subject: Is this OK with you?
Attachments: seismic margin.docx

Per conversation

Y/296

Use of Margin in Seismic Analysis

- Currently operating reactors (licensed prior to 1997) had their seismic regulatory basis in the General Design Criteria 2 in Appendix A to Part 50. That standard required that the design bases include "sufficient margin." This was an undefined term that varied across facilities.

- Proposed new reactors (submitted after 1997) have to demonstrate a seismic margin of 1.67 times the 10,000 year ground motion relative to site-specific seismic demands. That is, the minimum high confidence, low probability of failure for a plant should be at least 1.67 times the ground motion acceleration of the design basis safe-shutdown earthquake (SSE).

- Ongoing and planned GS 199 analyses will apply this 1.67 margin to existing facilities.

Rihm, Roger

From: Rihm, Roger
Sent: Tuesday, March 29, 2011 5:51 PM
To: Batkin, Joshua; Schmidt, Rebecca; Powell, Amy
Cc: Shane, Raeann; Muessle, Mary
Subject: Additional Hearing Materials
Attachments: RESPONSE - News Article on SOARCA

Mike Weber became aware earlier today of a new AP article on blackouts and asked the staff to provide him some additional information in advance of his hearing appearance tomorrow. He asked that we share this with the chairman should it come up at the Senate hearing. Attached is an email that includes the AP article in the body of the email and has staff additional information attached.

Y/297

Rihm, Roger

From: Armstrong, Kenneth
Sent: Tuesday, March 29, 2011 5:32 PM
To: Rihm, Roger
Cc: Sheron, Brian; Uhle, Jennifer; Gibson, Kathy; Tinkler, Charles; Burnell, Scott; Wilson, George; Milligan, Patricia
Subject: RESPONSE - News Article on SOARCA
Attachments: Response to questions posed by AP (3-29-11).docx

Roger,

Attached please find our response to the Mike's questions on the recent AP article.

Thanks,
Kenneth

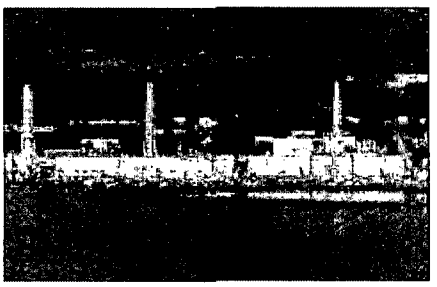
From: Weber, Michael
Sent: Tuesday, March 29, 2011 12:14 PM
To: Sheron, Brian
Cc: Virgilio, Martin; Leeds, Eric; Johnson, Michael; Wiggins, Jim; Rihm, Roger; Milligan, Patricia; Wittick, Brian; Brenner, Eliot; Hayden, Elizabeth; Schmidt, Rebecca; Powell, Amy; Muessle, Mary; Andersen, James; Bowman, Gregory
Subject: RESPONSE - News Article on SOARCA

Thanks, Brian. I'll need to be prepared to respond to this concern in tomorrow morning's hearing and the Chairman will need to be prepared to respond at his hearings tomorrow. Please work with OEDO staff (Roger Rihm/Brian Wittick) to ensure that we develop a short-response by COB today that we can use tomorrow in case this comes up.

David Lochbaum reported at this morning's hearing that 93 of the U.S. plants only had a 4-hour coping capacity for SBO. The rest could cope for 8 hours. Is this valid? Does this taken into consideration the B5b mitigating measures? Was SBO considered among the scenarios that resulted in the U.S. decision to establish the nominal exposure pathway EPZ at 10 miles?

AP IMPACT: Long blackouts pose risk to US reactors

AP Associated Press



AP – Only Unit 2 is covered with white concrete housing, seen on left of an iron tower on right, at the stricken ...

By DINA CAPPIELLO, Associated Press Dina Cappiello, Associated Press – Tue Mar 29, 3:13 am ET

WASHINGTON – Long before the nuclear emergency in Japan, U.S. regulators knew that a power failure lasting for days at an American nuclear plant, whatever the cause, could lead to a radioactive leak. Even so, they have only required the nation's 104 nuclear reactors to develop plans for dealing with much shorter blackouts on the assumption that power would be restored quickly.

In one nightmare simulation presented by the Nuclear Regulatory Commission in 2009, it would take less than a day for radiation to escape from a reactor at a Pennsylvania nuclear power plant after an earthquake, flood or fire knocked out all electrical power and there was no way to keep the reactors cool after backup battery power ran out. That plant, the Peach Bottom Atomic Power Station outside Lancaster, has reactors of the same older make and model as those releasing radiation at Japan's Fukushima Dai-ichi plant, which is using other means to try to cool the reactors.

And like Fukushima Dai-ichi, the Peach Bottom plant has enough battery power on site to power emergency cooling systems for eight hours. In Japan, that wasn't enough time for power to be restored. According to the International Atomic Energy Agency and the Nuclear Energy Institute trade association, three of the six reactors at the plant still can't get power to operate the emergency cooling systems. Two were shut down at the time. In the sixth, the fuel was removed completely and put in the spent fuel pool when it was shut down for maintenance at the time of the disaster. A week after the March 11 earthquake, diesel generators started supplying power to two other two reactors, Units 5 and 6, the groups said.

The risk of a blackout leading to core damage, while extremely remote, exists at all U.S. nuclear power plants, and some are more susceptible than others, according to an Associated Press investigation. While regulators say they have confidence that measures adopted in the U.S. will prevent or significantly delay a core from melting and threatening a radioactive release, the events in Japan raise questions about whether U.S. power plants are as prepared as they could and should be.

"We didn't address a tsunami and an earthquake, but clearly we have known for some time that one of the weak links that makes accidents a little more likely is losing power," said Alan Kolaczkowski, a retired nuclear engineer who worked on a federal risk analysis of Peach Bottom released in 1990 and is familiar with the updated risk analysis.

Risk analyses conducted by the plants in 1991-94 and published by the commission in 2003 show that the chances of such an event striking a U.S. power plant are remote, even at the plant where the risk is the highest, the Beaver Valley Power Station in Pennsylvania.

These long odds are among the reasons why the United States since the late 1980s has only required nuclear power plants to cope with blackouts for four or eight hours, depending on the risk. That's about how much time batteries would last. After that, it is assumed that power would be restored. And so far, that's been the case.

Equipment put in place after the Sept. 11, 2001, terrorist attacks could buy more time. Otherwise, the reactor's radioactive core could begin to melt unless alternative cooling methods were employed. In Japan, the utility has tried using portable generators and dumped tons of seawater, among other things, on the reactors in an attempt to keep them cool.

A 2003 federal analysis looking at how to estimate the risk of containment failure said that should power be knocked out by an earthquake or tornado it "would be unlikely that power will be recovered in the time frame to prevent core meltdown."

In Japan, it was a one-two punch: first the earthquake, then the tsunami.

Tokyo Electric Power Co., the operator of the crippled plant, found other ways to cool the reactor core and so far avert a full-scale meltdown without electricity.

"Clearly the coping duration is an issue on the table now," said Biff Bradley, director of risk assessment for the Nuclear Energy Institute. "The industry and the Nuclear Regulatory Commission will have to go back in light of what we just observed and rethink station blackout duration."

David Lochbaum, a former plant engineer and nuclear safety director at the advocacy group Union of Concerned Scientists, put it another way: "Japan shows what happens when you play beat-the-clock and lose."

Lochbaum plans to use the Japan disaster to press lawmakers and the nuclear power industry to do more when it comes to coping with prolonged blackouts, such as having temporary generators on site that can recharge batteries.

A complete loss of electrical power, generally speaking, poses a major problem for a nuclear power plant because the reactor core must be kept cool, and back-up cooling systems — mostly pumps that replenish the core with water_ require massive amounts of power to work.

Without the electrical grid, or diesel generators, batteries can be used for a time, but they will not last long with the power demands. And when the batteries die, the systems that control and monitor the plant can also go dark, making it difficult to ascertain water levels and the condition of the core.

One variable not considered in the NRC risk assessments of severe blackouts was cooling water in spent fuel pools, where rods once used in the reactor are placed. With limited resources, the commission decided to focus its analysis on the reactor fuel, which has the potential to release more radiation.

An analysis of individual plant risks released in 2003 by the NRC shows that for 39 of the 104 nuclear reactors, the risk of core damage from a blackout was greater than 1 in 100,000. At 45 other plants the risk is greater than 1 in 1 million, the threshold NRC is using to determine which severe accidents should be evaluated in its latest analysis.

The Beaver Valley Power Station, Unit 1, in Pennsylvania had the greatest risk of core melt — 6.5 in 100,000, according to the analysis. But that risk may have been reduced in subsequent years as NRC regulations required plants to do more to cope with blackouts. Todd Schneider, a spokesman for FirstEnergy Nuclear Operating Co., which runs Beaver Creek, told the AP that batteries on site would last less than a week.

In 1988, eight years after labeling blackouts "an unresolved safety issue," the NRC required nuclear power plants to improve the reliability of their diesel generators, have more backup generators on site, and better train personnel to restore power. These steps would allow them to keep the core cool for four to eight hours if they lost all electrical power. By contrast, the newest generation of nuclear power plant, which is still awaiting approval, can last 72 hours without taking any action, and a minimum of seven days if water is supplied by other means to cooling pools.

Despite the added safety measures, a 1997 report found that blackouts — the loss of on-site and off-site electrical power — remained "a dominant contributor to the risk of core melt at some plants." The events of Sept. 11, 2001, further solidified that nuclear reactors might have to keep the core cool for a longer period without power. After 9/11, the commission issued regulations requiring that plants have portable power supplies for relief valves and be able to manually operate an emergency reactor cooling system when batteries go out.

The NRC says these steps, and others, have reduced the risk of core melt from station blackouts from the current fleet of nuclear plants.

For instance, preliminary results of the latest analysis of the risks to the Peach Bottom plant show that any release caused by a blackout there would be far less rapid and would release less radiation than previously thought, even without any actions being taken. With more time, people can be evacuated. The NRC says improved computer models, coupled with up-to-date information about the plant, resulted in the rosier outlook.

"When you simplify, you always err towards the worst possible circumstance," Scott Burnell, a spokesman for the Nuclear Regulatory Commission, said of the earlier studies. The latest work shows that "even in situations where everything is broken and you can't do anything else, these events take a long time to play out," he said. "Even when you get to releasing into environment, much less of it is released than actually thought."

Exelon Corp., the operator of the Peach Bottom plant, referred all detailed questions about its preparedness and the risk analysis back to the NRC. In a news release issued earlier this month, the company, which operates 10 nuclear power plants, said "all Exelon nuclear plants are able to safely shut down and keep the fuel cooled even without electricity from the grid."

Other people, looking at the crisis unfolding in Japan, aren't so sure.

In the worst-case scenario, the NRC's 1990 risk assessment predicted that a core melt at Peach Bottom could begin in one hour if electrical power on- and off-site were lost, the diesel generators — the main back-up source of power for the pumps that keep the core cool with water — failed to work and other mitigating steps weren't taken.

"It is not a question that those things are definitely effective in this kind of scenario," said Richard Denning, a professor of nuclear engineering at Ohio State University, referring to the steps NRC has taken to prevent incidents. Denning had done work as a contractor on severe accident analyses for the NRC since 1975. He retired from Battelle Memorial Institute in 1995.

"They certainly could have made all the difference in this particular case," he said, referring to Japan. "That's assuming you have stored these things in a place that would not have been swept away by tsunami."

RES

From: Chang, Richard
Sent: Tuesday, March 29, 2011 7:35 AM
To: Schaperow, Jason; Tinkler, Charles; Santiago, Patricia; Ghosh, Tina; Armstrong, Kenneth
Subject: FYI- News Article on SOARCA

http://news.yahoo.com/s/ap/20110329/ap_on_re_us/us_us_japan_nuclear_blackouts_2

Richard Chang
Program Manager
RES/DSA/SPB
301-251-7980

NES

Response to questions posed by 3-29-11 AP article "Long blackouts pose risk to US reactors"

1) David Lochbaum reported that 93 of the U.S. plants only have a 4-hour coping capacity for station black out. The rest could cope for 8 hours. Is this valid? (NRR)

The NRC only allows up to a 4 hour coping with batteries, anything longer will require an alternate AC source. The coping time using an alternate AC source ranges from 2 to a maximum of 16 hours. 44 plants are battery coping plants, 60 plants are alternate AC source plants.

The definition of coping is the time until off site power is restored or an emergency diesel generator is restored (i.e. on site or off site power is restored). The following was used to analyze the coping time (specified station black out duration) is based on the following factors:

- The redundancy of the onsite emergency AC power sources
- The reliability of the onsite emergency AC power sources
- The expected frequency of loss of offsite power
- The probable time needed to restore offsite power

Two methods of coping with a SBO event:

- AC independent (relying on Battery power only) plants have to satisfy all the requirements for maintaining a plant in a safe condition for a maximum duration of 4 hours. Hence plants relying on battery power alone have adequate battery capacity for only FOUR HOURS based on the station black out loads and using the existing safety related batteries. 44 plants fall in this category.

- If the configuration of offsite power (the grid system), onsite power (emergency diesel generators), and reliability of these sources could be affected by weather related events, and IF restoration of these sources was not possible within 4 hours, then the plants had to use an alternate AC (AAC) source. Therefore, these plants decided to comply with the station black out rule by using the AAC source. Plants using an AAC source had a variable coping duration between 2 hours and 16 hours. 60 plants fall in this category (4-16 hours).

In summary:

- 44 plants adopted AC independent method and have battery power for 4 hours.
- 43 plants use AAC methodology and can restore AC (EDG or Offsite) power within 4 hours. Hence have a coping duration of 4 hours.
- 14 plants use AAC methodology and can restore AC (EDG or Offsite) power within 8 hours

- 3 plants use AAC and have a 16 hour duration for restoration of AC power. This site (3 units) had originally assumed a 4 hour duration but EDG reliability and LOOP events affected the calculated duration that this plant had to consider.

2) Does the coping capacity addressed by Lochbaum above take into consideration the B5b mitigating measures? (NRR, RES)

No, the station back out rule was made before B5b.

The new, additional B.5.b equipment includes both portable generators (with inverters) and an independent portable diesel driven pump.

3) What power is available for spent fuel pool cooling in US plants? (NRR)

Station black out rule does not address this. But the power supply bus that provides power to the spent fuel pool pumps is normally powered from off-site power and can be backed up or powered by the emergency diesel generators. Additionally, measures have been added to provide water spray capability to the spent fuel pools by a diesel driven pump as part of security enhancements after 9/11 (B.5.b).

4) SOARCA insights relevant to AP article. (RES)

- Probabilistic risk assessments and severe accident research and studies over the last 20 yrs have evaluated US plant response to an event generally similar to the event which occurred at Fukushima (not including similar Tsunami).
- In many respects the Japanese event resembles a severe accident scenario which is known as a long term station blackout, an event in which offsite AC power and emergency onsite AC power is lost. The plant is able to respond safely through the use of turbine driven equipment controlled by emergency DC power (station batteries).
- Recent severe accident studies (SOARCA) for a long term station blackout (seismically initiated) at a US BWR Mark I plant indicate that US plants can safely shutdown during such an event through the use of new, additional equipment, put in place (and inspected) following the terrorist attack of 9/11.
    - Comprehensive security assessments focused on implementing plant changes to enhance plants ability to respond to accidents.

- The new, additional equipment (B.5.b) includes both portable generators (with inverters) and an independent portable diesel driven pump. Additionally procedures have been developed for manual start of turbine driven pump (RCIC).

- These measures combined with existing infrastructure and coordination within the nuclear industry indicates that US plants have capability to successfully respond to a station blackout.
- Also, as a result of our post 9/11 security assessment, additional equipment has been added to improve spent fuel pool cooling.
    - Measures have been added to provide water spray capability to the spent fuel pools by a diesel driven pump.
    - Further, another enhancement has been made to spent fuel pools to enhance coolability of the fuel by distributing fuel within the pool (by locating higher decay power assemblies amongst lower decay power assemblies).
    - These items were also identified by the National Academy of Sciences. [Note an Op-Ed was written which erroneously stated that these measures were not implemented – a retraction was printed in the Washington Post]

5) Was station back out considered among the scenarios that resulted in the U.S. decision to establish the nominal exposure pathway (EPZ at 10 miles)? (NSIR)

The Reactor Safety Study, aka "WASH 1400" NUREG/CR-75 did consider total loss of electrical power as one of the severe accidents analyzed. NRC considered the catastrophic "class 9" accidents such as those analyzed in WASH 1400 when determining the appropriate size of the EPZ. So, a short answer is yes.

6) Do we need a bigger EPZ? (NSIR)

NRC regulations and guidance have always considered the possibility that response actions may need to be expanded beyond the 10/50 mile EPZs and in fact states, "detailed planning within 10 miles would provide a substantial base for expansion of response efforts in the event this proved necessary" similarly for the 50 mile EPZ .

Rihm, Roger

From: Frazier, Alan
Sent: Tuesday, March 29, 2011 5:27 PM
To: Batkin, Joshua
Cc: Schmidt, Rebecca; Rihm, Roger; Andersen, James; Muessle, Mary
Subject: UPDATE: Isotopic make up of spent fuel including MOX

These talking points on MOX should help as well.

MOX Impact on Severe Accident Consequences

Background

- All commercial nuclear reactors produce plutonium from uranium activation chain in the core. By the end of a reactor cycle (about 18 months), plutonium accounts for about 15% (to be finalized) of the generated reactor power.

- Mixed oxide (MOX) fuel refers to nuclear fuel consisting of a mixture of uranium oxide and plutonium oxide. Uranium composes most of the fuel, with an average of ~95% of the total loading. MOX fuel has been used for decades in commercial nuclear reactors.

- MOX has been one way of using surplus weapons-grade plutonium from the US and the former Soviet Union, with a clear non-proliferation benefit.

MOX Safety Impact

- In November 1999, the U.S. Department of Energy, in accordance with the National Environmental Policy Act (NEPA), issued the ***Surplus Plutonium Disposition Final Environmental Impact Statement***
    - The consequence of four severe accident scenarios at three different reactors using MOX fuel were analyzed
    - Each was analyzed with a reference non-MOX core and mixed core with ~40% MOX.
    - The accident consequences ranged from 4% to 20% higher for the MOX core, depending on the accident scenario. Most cases resulted in a ~10% decrease.
    - The differences were not significant compared to the uncertainties generally associated with the consequence calculations.

Fukushima MOX utilization

4/29

- Only one reactor out of the six had MOX fuel in its core. Reactor 3 loaded 32 MOX assemblies out of a total of 548 assemblies in the reactor; this amounts to less 6% of the core fuel.

- The MOX fuel along with the rest of the current core was loaded in November 2010 and resided about four months before the March 11 earthquake and tsunami.

- There is no other MOX fuel in the Fukushima plant beside the 32 assemblies that were loaded in Reactor 3

- Considering that the MOX fuel is typically ~95% uranium – 5% plutonium, the plutonium impact on the core power at the beginning of the reactor cycle is very minor. By the end of the cycle, prior to refueling, plutonium impact will be important (just as in the case of non-MOX reactors)

- Based on the above information, it is concluded that the presence of a small number of MOX fuel assembly in Fukushima Daiichi Unit 3 constitutes an insignificant change from the non-MOX in core operating conditions and accident consequences.

From: Frazier, Alan
Sent: Tuesday, March 29, 2011 4:59 PM
To: Batkin, Joshua; Schmidt, Rebecca
Subject: Iso topic make up of spent fuel

Josh,

I believe this is for typical spent fuel (initially 5 percent enrichment) not MOX. Sorry for the late response.

Alan

From: Rahimi, Meraj
To: Frazier, Alan; Weaver, Doug
Cc: Ordaz, Vonna
Sent: Tue Mar 29 16:53:01 2011
Subject: RE: NEW Deadline 4:30pm !!! Isotopic make up of spent fuel

Here is the inventory for isotopes more than one percent of total. I made a number of assumptions which I can let you know later:

Isotope	Curies/MTHM	%Total
SR 90	8.13e4	7.84
Y 90	8.13e4	7.84
RU106	7.15e4	6.89
RH106	7.15e4	6.90
CS134	9.677e4	9.33
CS137	1.25e5	12.12

BA137M	1.19e5	11.47
CE144	5.882e4	5.67
PR144	5.88e4	5.67
PM147	4.924e4	4.75
EU154	1.29e4	1.24
PU241	1.52e5	14.69
Total	9.79e5	94.42

Meraj Rahimi
Chief of Criticality, Shielding, and Dose Assessment Branch
Division of Spent Fuel Storage and Transportation
Office of Nuclear Materials Safety and Safeguard
U.S. Nuclear Regulatory Commission
6003 Executive Blvd., Suite 301
Rockville, MD 20852
Phone: 301-492-3338
Fax: 301-492-3348
e-mail: meraj.rahimi@nrc.gov

From: Frazier, Alan
Sent: Tuesday, March 29, 2011 3:31 PM
To: Weaver, Doug
Cc: Rahimi, Meraj; Ordaz, Vonna
Subject: NEW Deadline 4:30pm !!! Isotopic make up of spent fuel
Importance: High

New timeline: Chairman's office would like answers by 4:30pm today. Sorry.

Thanks for your help!!!

From: Frazier, Alan
Sent: Tuesday, March 29, 2011 3:29 PM
To: Weaver, Doug
Cc: Rahimi, Meraj; Ordaz, Vonna
Subject: RE: Isotopic make up of spent fuel
Importance: High

Thanks!! If you have the data you may also want to include the difference between regular and MOX fuel.

From: Weaver, Doug
Sent: Tuesday, March 29, 2011 3:02 PM
To: Frazier, Alan
Cc: Rahimi, Meraj; Ordaz, Vonna
Subject: Isotopic make up of spent fuel

Alan,

We can help. Meraj will send you something this afternoon.

Doug

Doug Weaver

Deputy Director
Division of Spent Fuel Storage and Transportation
U.S. Nuclear Regulatory Commission
tel: 301-492-3300
doug.weaver@nrc.gov

Imboden, Andy

From: Imboden, Andy NRR
Sent: Tuesday, March 29, 2011 12:16 PM
To: Mazaika, Michael
Subject: RE: Fukushima - Requesting Guidance on Some Loose Ends Re PMT-Meteorology Activities

R

Another bullet to add: some emails intended for PMT leadership instead go to the PMT Meteorologist (intended for PMT12 but sent instead to PMT01). Whether or not the meteorologist position is staffed, PMT01 should be periodically checked to ensure that no communications go missing.

From: Mazaika, Michael NRO
Sent: Tuesday, March 29, 2011 9:43 AM
To: Quinlan, Kevin; Brown, David; Harvey, Brad; Imboden, Andy
Cc: Galletta, Thomas; Schaaf, Robert
Subject: Fukushima - Requesting Guidance on Some Loose Ends Re PMT-Meteorology Activities

Folks:

As you know, after last Friday's first shift the PMT-Meteorology and GIS positions were placed on an "on-call' status. Here are several items that I'd like to bring to Lou Brandon's attention to get a read on whether and, if so, to what extent he would like us to keep taking the pulse of even though we may not currently have an active function. If you have any additional items, please annotate this e-mail and I will put together a composite list to forward to Lou.

- Correspondence was initiated with the Japan Meteorological Agency (JMA) thru the Japan Embassy Task Force with the good help of the International Liaison staff, requesting data from operational JMA monitoring stations located along the coast to the north and south of the Fukushima reactor site. The intent was to obtain hourly data summaries from March 11 thru about March 18, depending on the observing station, by which time PMT-meteorology were assembling these summaries from the JMA website. There was a request from JMA for clarification of my initial e-mail to which Andy Imboden responded. Since standing down, we are not aware of how (or if) this request was resolved and would like to close the loop on this issue. In the meantime, I have been downloading the daily summaries of hourly data from the JMA website (except for Saturday, March 26).

- Once we began to receive onsite radiation monitoring and meteorological data, I had planned to make a request of TEPCO, again thru the Japan Embassy Task Force with the assistance of the International Liaison team, to obtain details about how the meteorological data were actually collected in addition to other available details about the onsite monitoring programs at the Dai-ichi and Dai-ni sites. If these data are to be used in the future and some indicator of their quality addressed, I would still prefer to start the process of obtaining this info in the near future rather than at some later date. Please advise on how to proceed.

- A process of building an MS Excel data base and plotting the results of mobile radiation measurements for four specific areas (groups) around the Fukushima site was initiated by Kevin Quinlan and David Brown extending thru about last Thursday, March 24. Data were received by e-mail from multiple sources (sometimes duplicate). In some cases data translation / transcription was necessary as part of that process. We have not been advised about whether that process should continue or if it has been picked up by another team. Please advise whether and, if so, to what this info should continue to be processed or, at a minimum archived by PMT-Meteorology.

- On Friday, March 25, several PMT work stations were near or had reached their MS Outlook limit. For PMT-Meteorology, I requested additional storage capacity and was told that for PMT01 that it was increased to 2 GB. As indicated above, we were receiving e-mails providing data summaries or other info

4/2/99

from multiple sources (e.g., onsite and offsite monitoring data, NARAC meteorology files, NOAA HYSPLIT model output) which consumed mailbox capacity. To my knowledge, no one has been attending to the PMT01 since the end of last Friday's first shift. At some point, those e-mails and that information needs to be extracted, organized, and/or archived.

Thanks,

Mike Mazaika on behalf of PMT-Meteorology

Physical Scientist (Meteorologist)
U.S. Nuclear Regulatory Commission
NRO/DSER/RSAC
11545 Rockville Pike, Mail Stop T-7F27
Rockville, MD 20852-2738
(301) 415-6282
michael.mazaika@nrc.gov

Bozin, Sunny

From: Ostendorff, William
Sent: Tuesday, March 29, 2011 10:34 PM
To: Franovich, Mike
Cc: Nieh, Ho; Kock, Andrea; Zorn, Jason
Subject: Re: Two additional items from the 2000 Telecon

Thanks Mike.

----- Original Message -----
From: Franovich, Mike
To: Ostendorff, William
Cc: Nieh, Ho; Kock, Andrea; Zorn, Jason
Sent: Tue Mar 29 21:58:25 2011
Subject: Two additional items from the 2000 Telecon

□ Japanese considering use of spray-on polymer to affix contamination at the plant (Zeolite). I noted the Russians/Ukrainians used a polymer spray during Chernobyl to reduce spread of contamination (according to NRC info)

□ Margie Doane offered OIP services to be coordinating point for support logistics to Japan. No details offered

Y/302

Kock, Andrea

From: Kock, Andrea
Sent: Tuesday, March 29, 2011 7:08 AM
To: Franovich, Mike
Subject: RE: UPDATE from 2000 Telecon on Fukushima Daiichi Events

Mike thanks for the laugh about the rainwater. That was good first thing in the morning! What EPA limit is 3 pCi/L?

Andrea Kock
Technical Assistant for Materials
Office of Commissioner Ostendorff
301-415-2896

From: Franovich, Mike
Sent: Tuesday, March 29, 2011 12:13 AM
To: Ostendorff, William
Cc: Nieh, Ho; Kock, Andrea; Zorn, Jason
Subject: UPDATE from 2000 Telecon on Fukushima Daiichi Events

Zimmerman led the call

- Units 1, 2, 3 on fresh water injection. Note the Unit 3 drywell pressure is 0.97 psig (typo in LIA/sit report).
- Unit 1 remains a top priority to purge containment hydrogen and oxygen with nitrogen.
- Reports of pumping out Unit 1 turbine building basement water into condenser as temporary storage.
- Some reports of trenches outside of turbine building may be filled with contaminated water. Trenches used for electrical or piping runs
- A single train of the Bechtel pumping system is now at J-village. If and how the system is to be used has yet to be determined.
- Reports of plutonium found near plant in soil. Tiny traces believed to be from one of the units and/or residual traces from atomic bomb fallout.
- Japanese requesting specialized evaporator/pumping radioactive waste system and robotics from DOE. Gamma radiation hardened camera/robotics from Sandia/PNNL and other labs may be sent.

Y/301

- Reentry criteria to retrieve personal items of US residents into the 50 mile evacuation zone discussed. ET/PMT resolved EPA comments. Recommendations/criteria sent to the WH. Copy requested by TAs.

- Feedback on Chairman's visit was positive, no specifics provided.

- Dan Dorman will be return to US. Elmo Collins will be his replacement.

- NEI has a secure protected website for licensees to provide radioisotope data from sampling. NRC has access. Info to be shared with EPA.

- Some discussion of a press release from Gov. of Pennsylvania that discussed rain water with I-131 and how it compares with state limits in terms of picocuries. PR states that I-131 at 40-100 picocuries/ liter(?) which is 25 times below limits but say EPA limit is 3 pico curies/liter. Message, don't drink rain water (unless you are Sterling Hayden).

- I asked about the consortium effort and if there is a charter. ET believes one was developed but will look into it. Wanted to find out what role NRC is anticipated to have in long-term efforts.

- Asked about recirc pump seal failure hypothesis and if there is corroborating information other than indicated water level in the RPV. RST looked at fresh water makeup rate and boil-off, differential pressures between RPV and containment (presumably for U2 and 3) and the 10 gpm difference makes some sense to them that the water is going through the seal packages.

Arndt, Steven

From: Wilson, George
Sent: Tuesday, March 29, 2011 12:18 PM
To: Alvarado, Rossnyev; Carte, Norbert; Chung, Pong; Darbali, Samir; Dittman, Bernard; Garg, Hukam; Kemper, William; Mazumdar, Subinoy; Mossman, Timothy; Rahn, David; Singh, Gursharan; Stattel, Richard; Wyman, Stephen
Cc: Manoly, Kamal; Khanna, Meena; Murphy, Martin; Hiland, Patrick; Skeen, David; Arndt, Steven
Subject: FW: Japan event -AREVA Presentation
Attachments: Fukuchima_eng_201103201.pps

fyi

From: Koshy, Thomas
Sent: Tuesday, March 29, 2011 12:03 PM
To: Case, Michael; Richards, Stuart
Cc: Matharu, Gurcharan; Mathew, Roy; Wilson, George
Subject: Japan event -AREVA Presentation

Thomas Koshy, Chief
Mechanical & Electrical Engineering Branch
Division of Engineering
Office of Research
U S Nuclear Regulatory Commission
Tel: (301) 251-7663


AREVA

The Fukushima Daiichi Incident

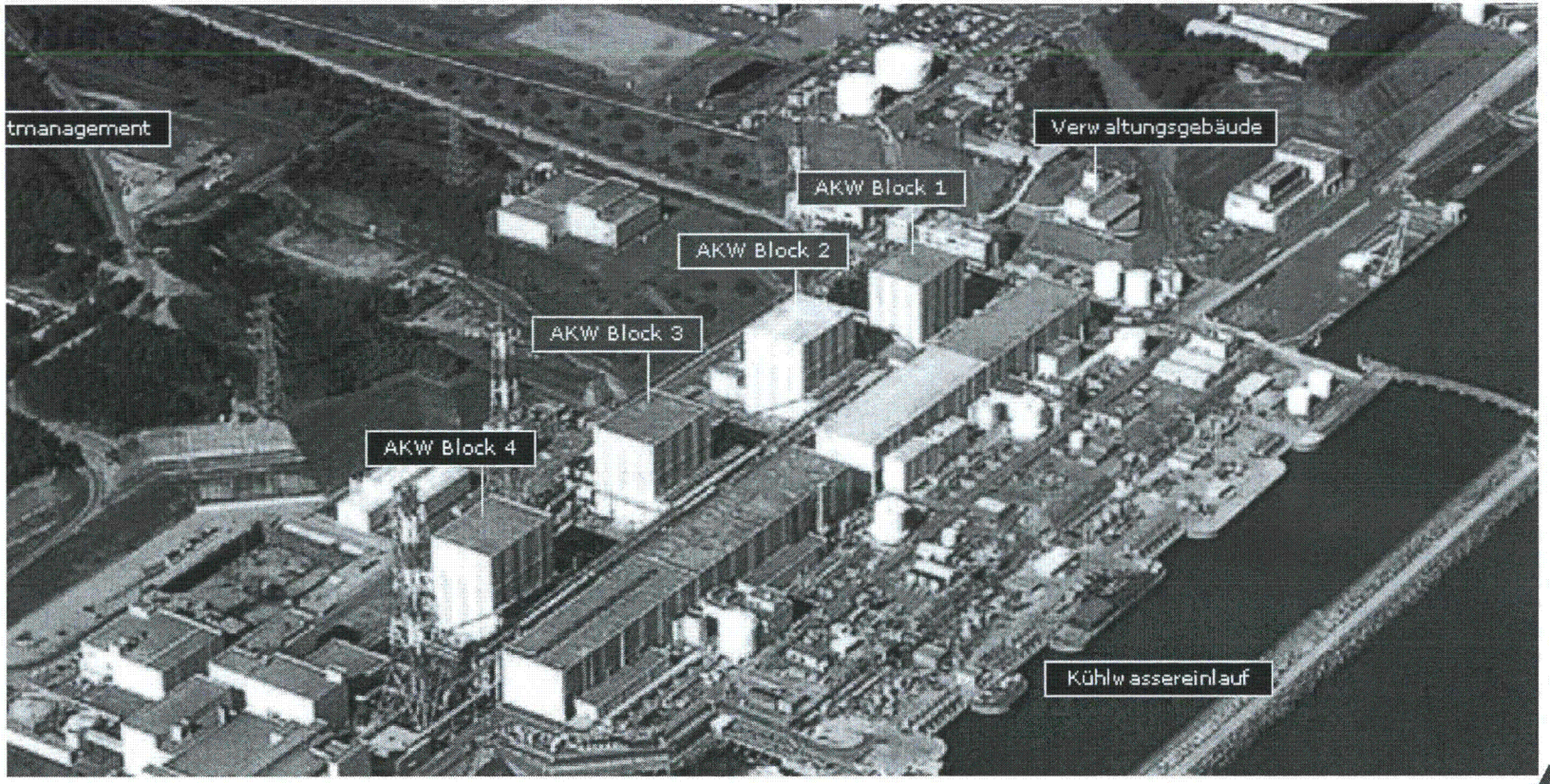
1. Plant Design
2. Accident Progression
3. Radiological releases
4. Spent fuel pools
5. Sources of Information

Matthias Braun
PEPA4-G, AREVA–NP GmbH
Matthias.Braun@AREVA.com

AREVA

The Fukushima Daiichi Incident
1. Plant Design

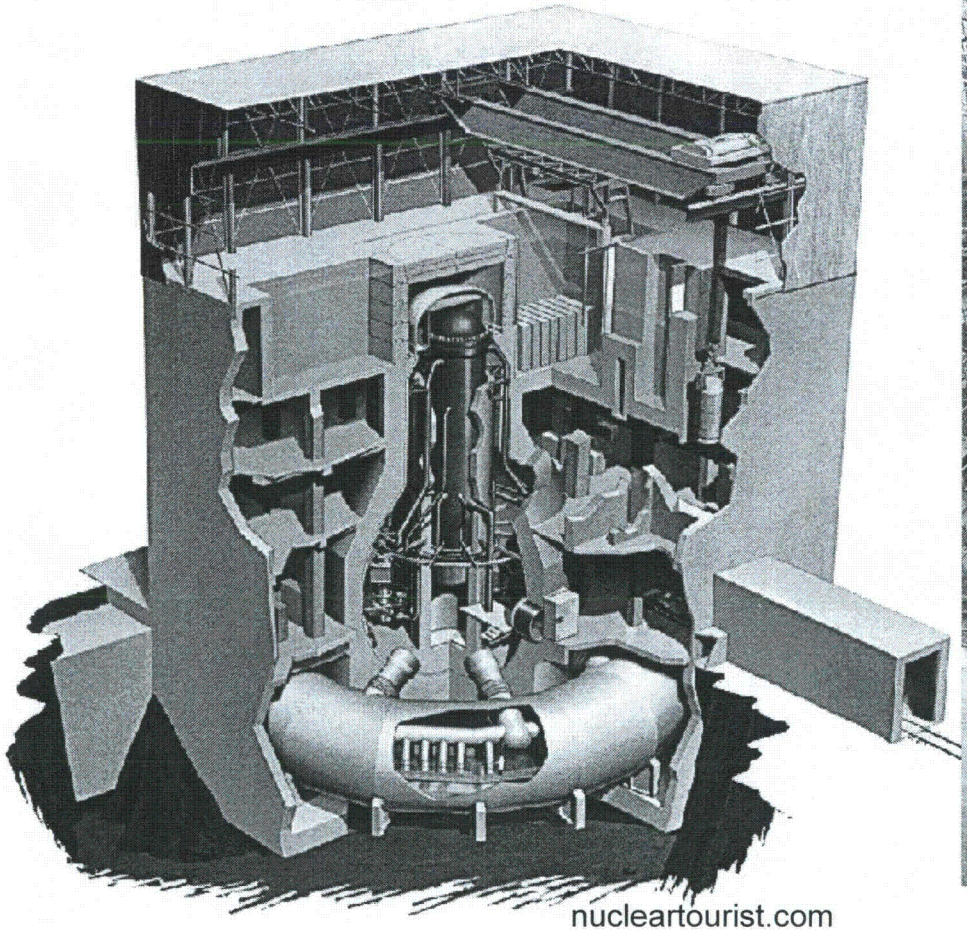
- **Fukushima Daiichi (Plant I)**
  - **Unit I - GE Mark I BWR (439 MW), Operating since 1971**
  - **Unit II-IV - GE Mark I BWR (760 MW), Operating since 1974**



AREVA

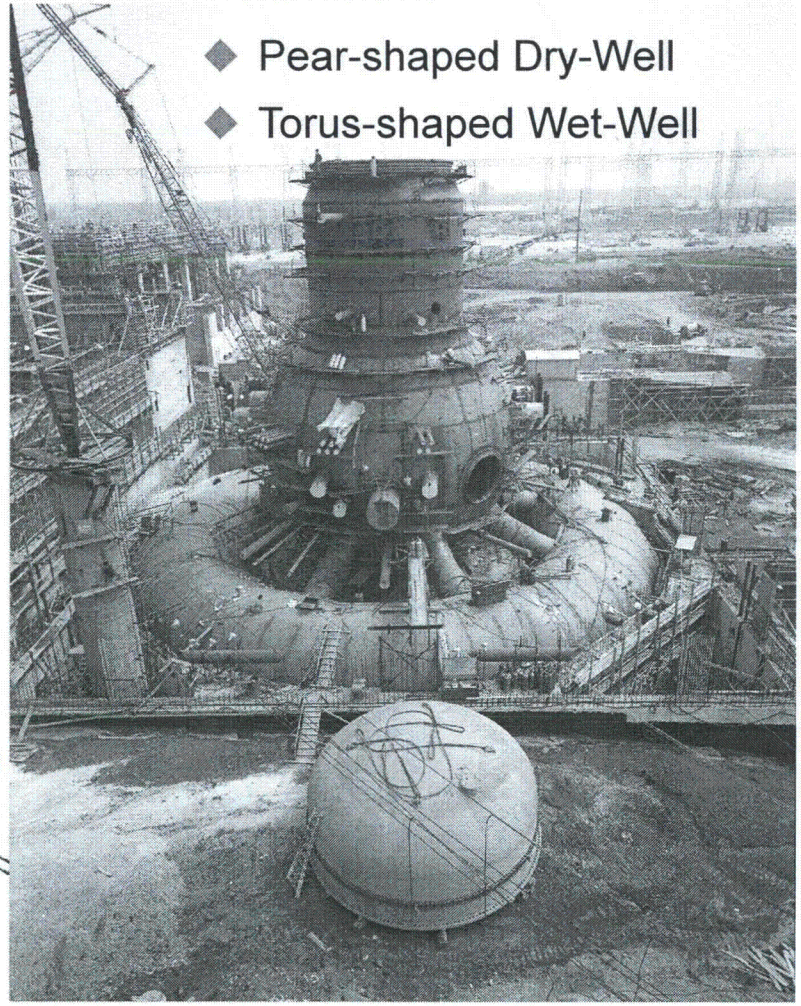
The Fukushima Daiichi Incident
1. Plant Design

- Building structure
  - Concrete Building
  - Steel-framed Service Floor



nucleartourist.com

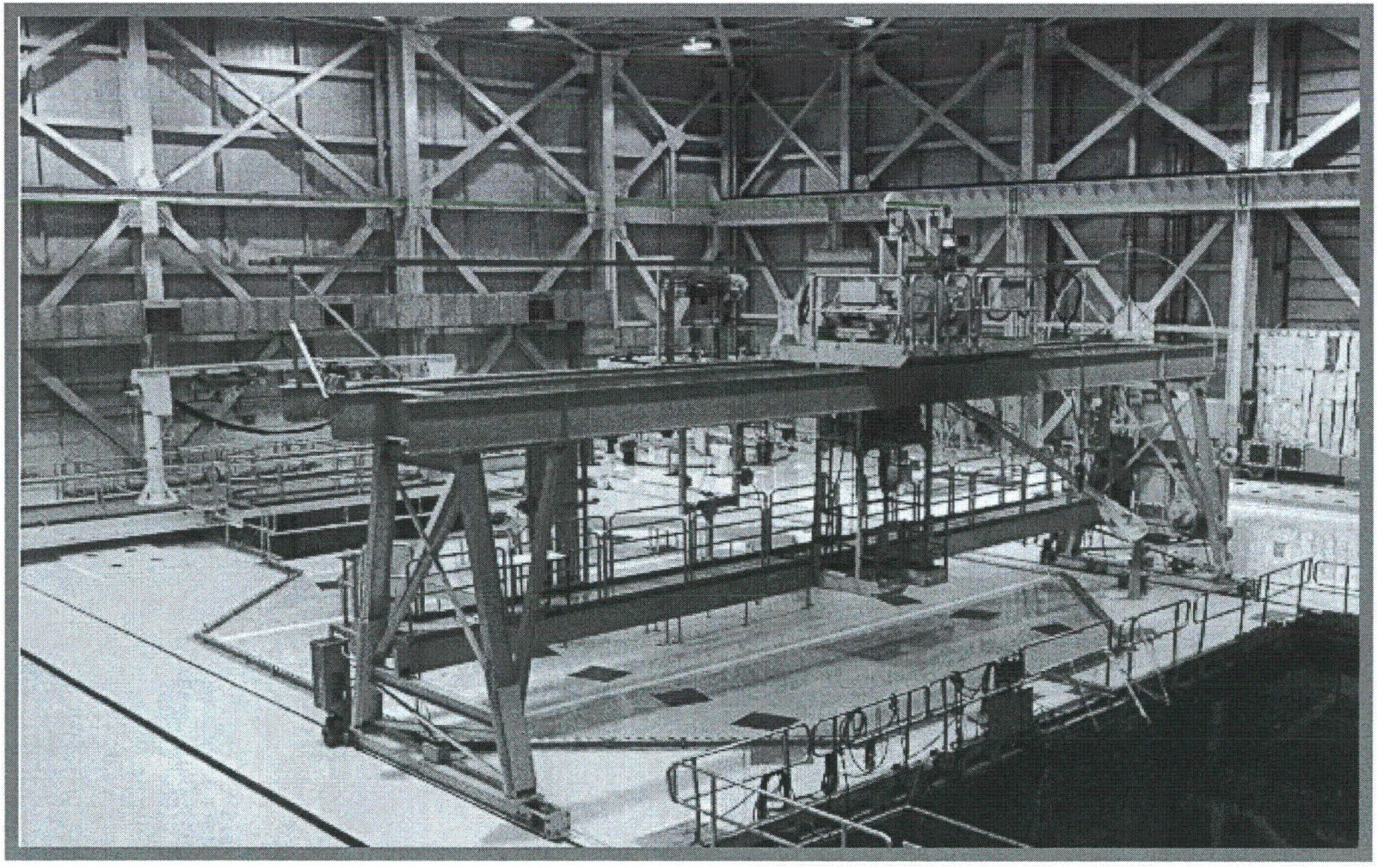
- Containment
  - Pear-shaped Dry-Well
  - Torus-shaped Wet-Well



en.wikipedia.org/wiki/Browns_Ferry_Nuclear_Power_Plant

The Fukushima Daiichi Incident
1. Plant Design

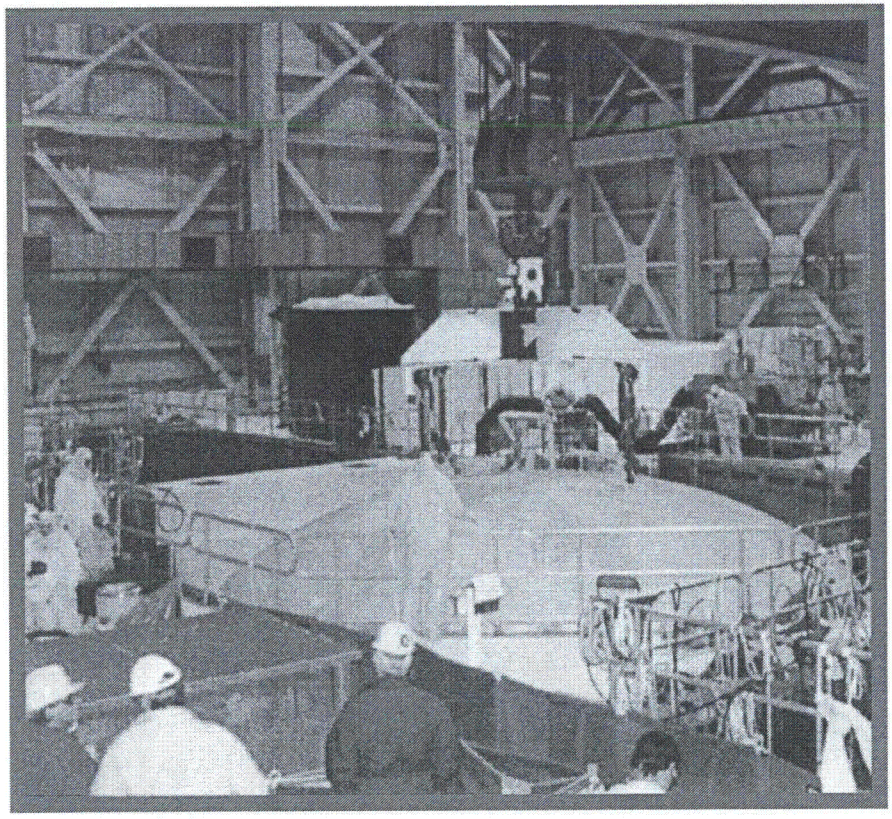
- Service Floor

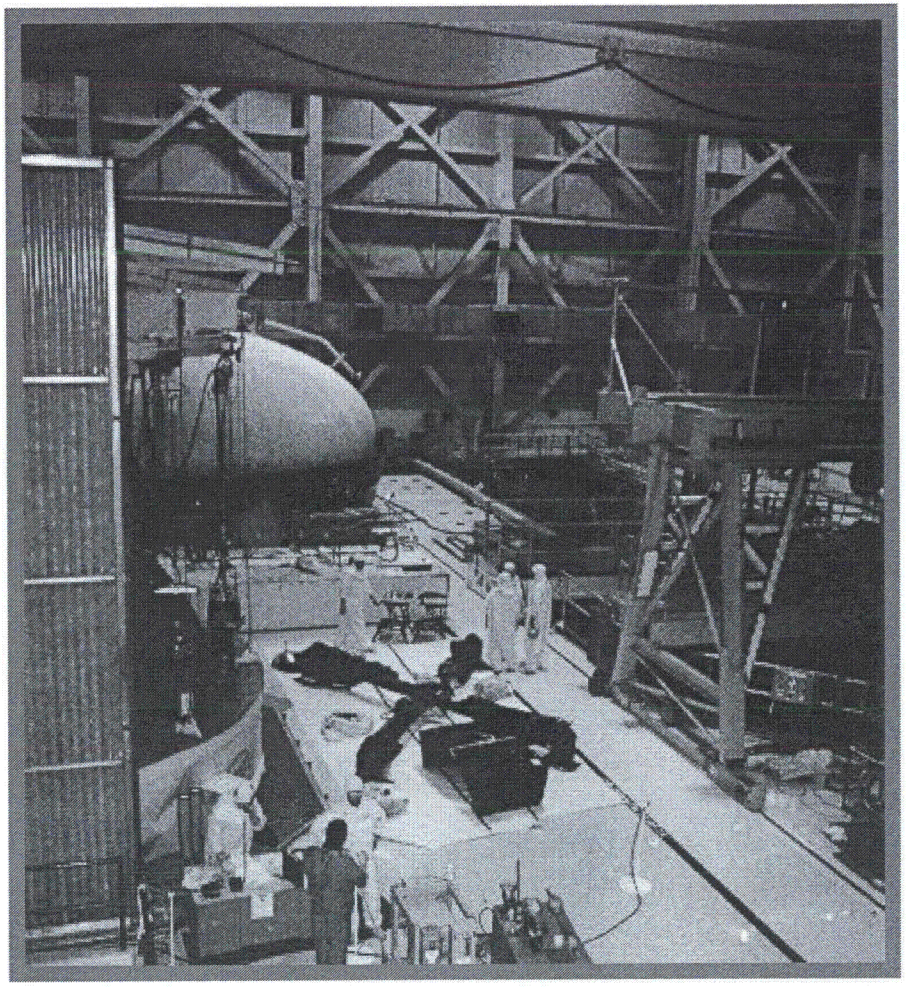


AREVA

The Fukushima Daiichi Incident
1. Plant Design

- Lifting the Containment closure head

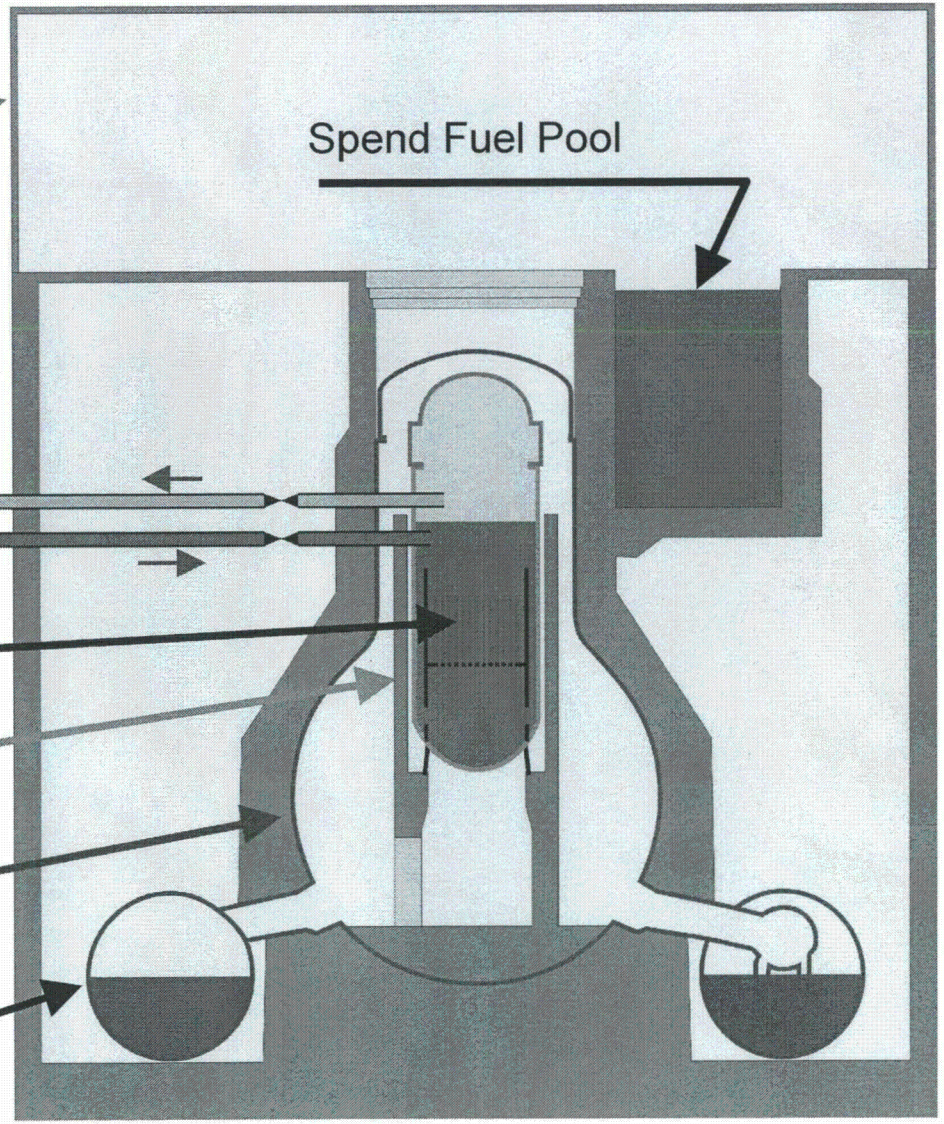




AREVA

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

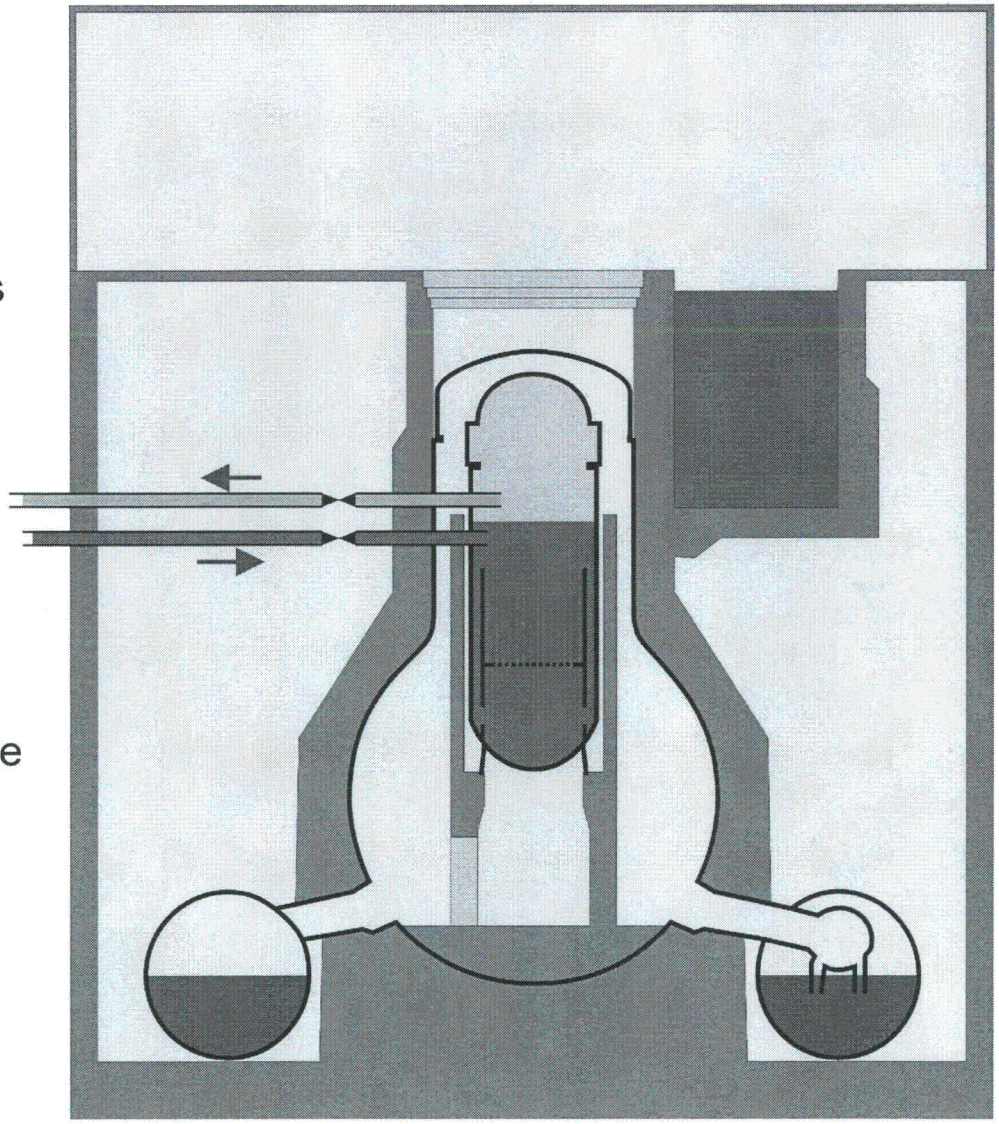


AREVA

The Fukushima Daiichi Incident

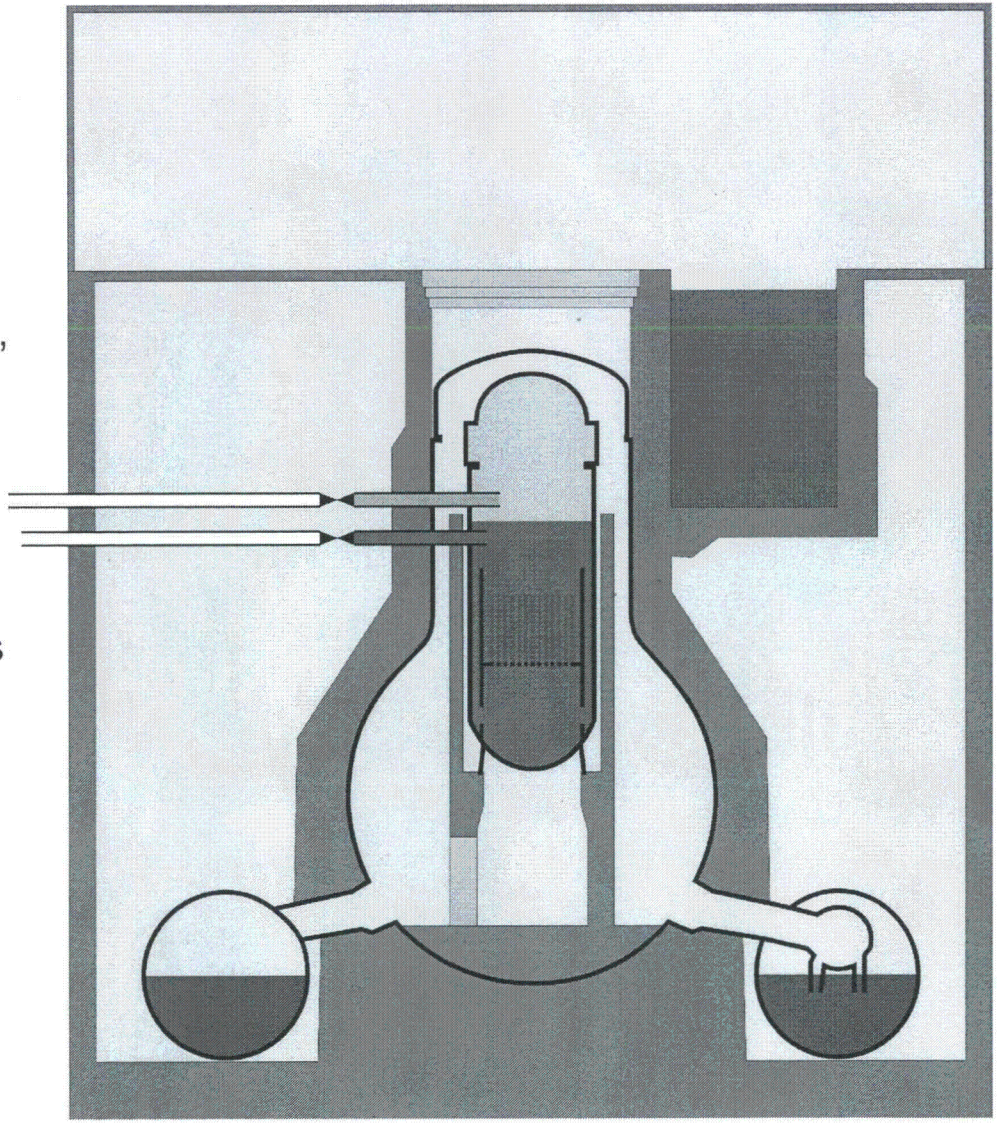
2. Accident progression

- 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

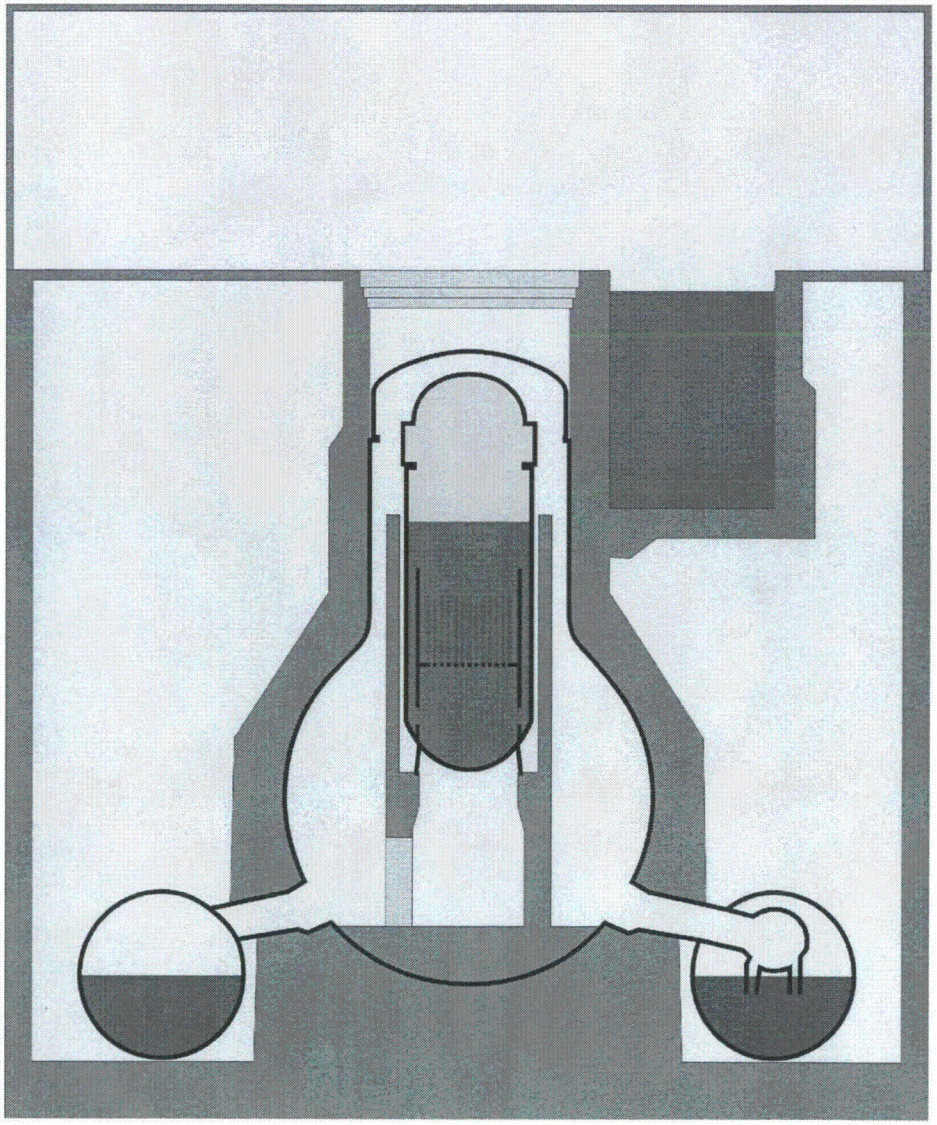
- Containment Isolation
  - Closing of all non-safety related Penetrations of the containment
  - Cuts off Machine hall
  - If containment isolation succeeds, a large early release of fission products is highly unlikely
- Diesel generators start
  - Emergency Core cooling systems are supplied
- Plant is in a stable save state



The Fukushima Daiichi Incident

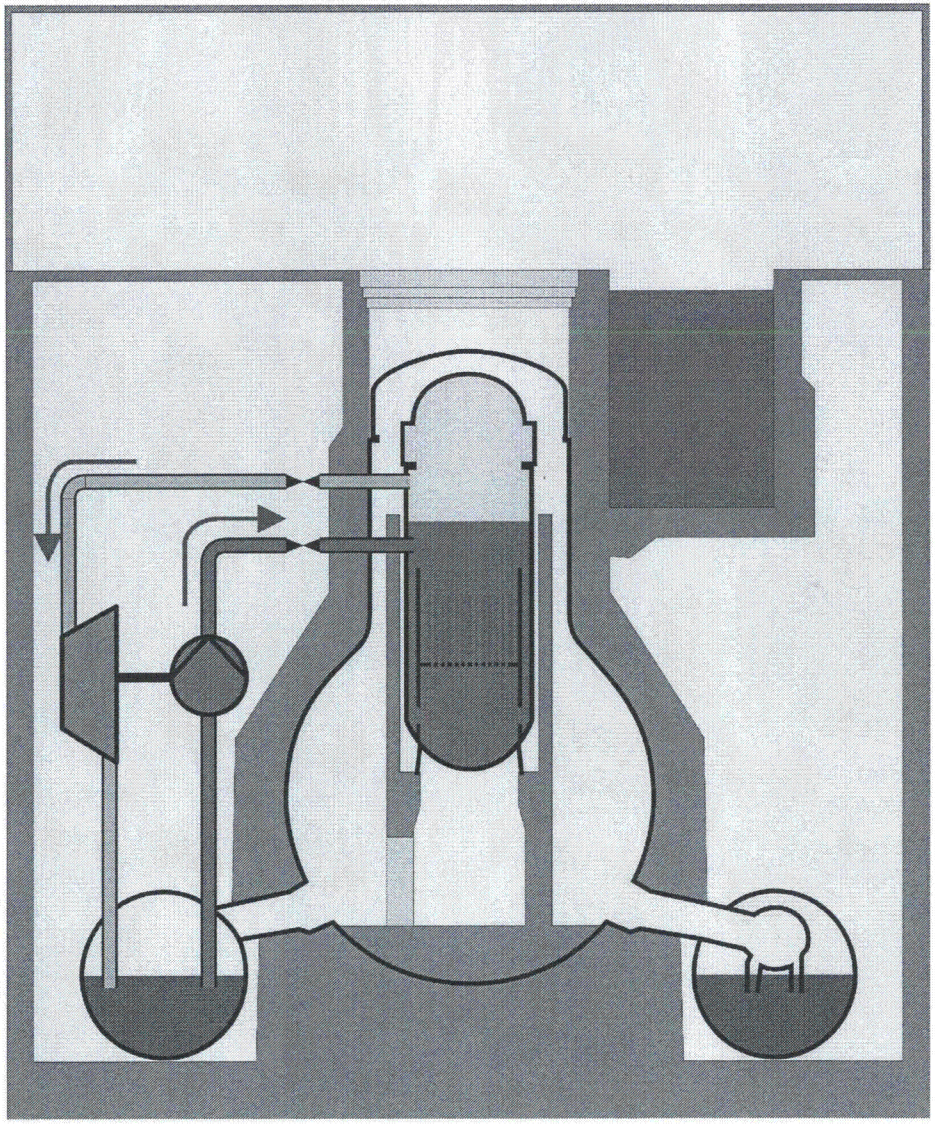
2. Accident progression

- 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



The Fukushima Daiichi Incident
2. Accident progression

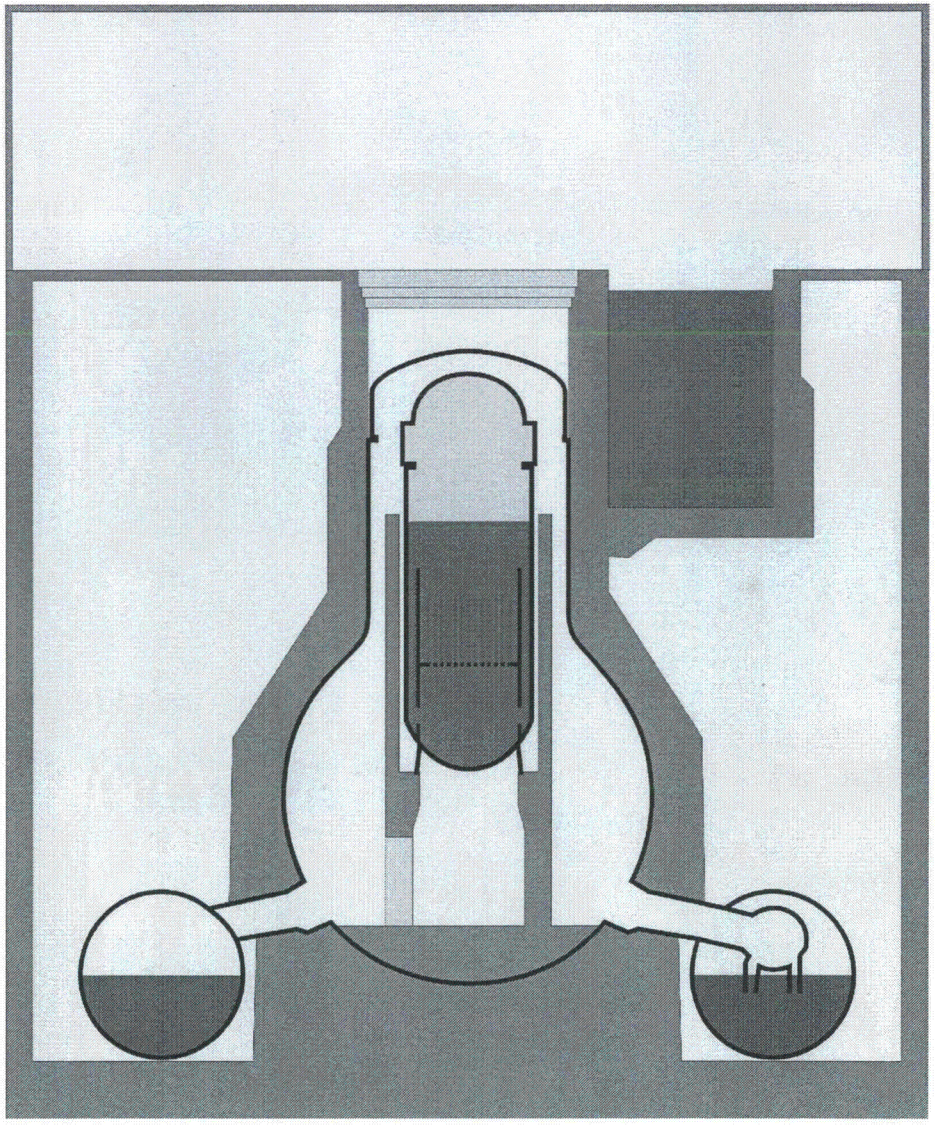
- Reactor Core Isolation Pump still available
  - Steam from the Reactor drives a Turbine
  - Steam gets condensed in the Wet-Well
  - Turbine drives a Pump
  - Water from the Wet-Well gets pumped in Reactor
  - Necessary:
    - Battery power
    - Temperature in the wet-well must be below 100°C
- As there is no heat removal from the building, the Core isolation pump cant work infinitely



AREVA

The Fukushima Daiichi Incident
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



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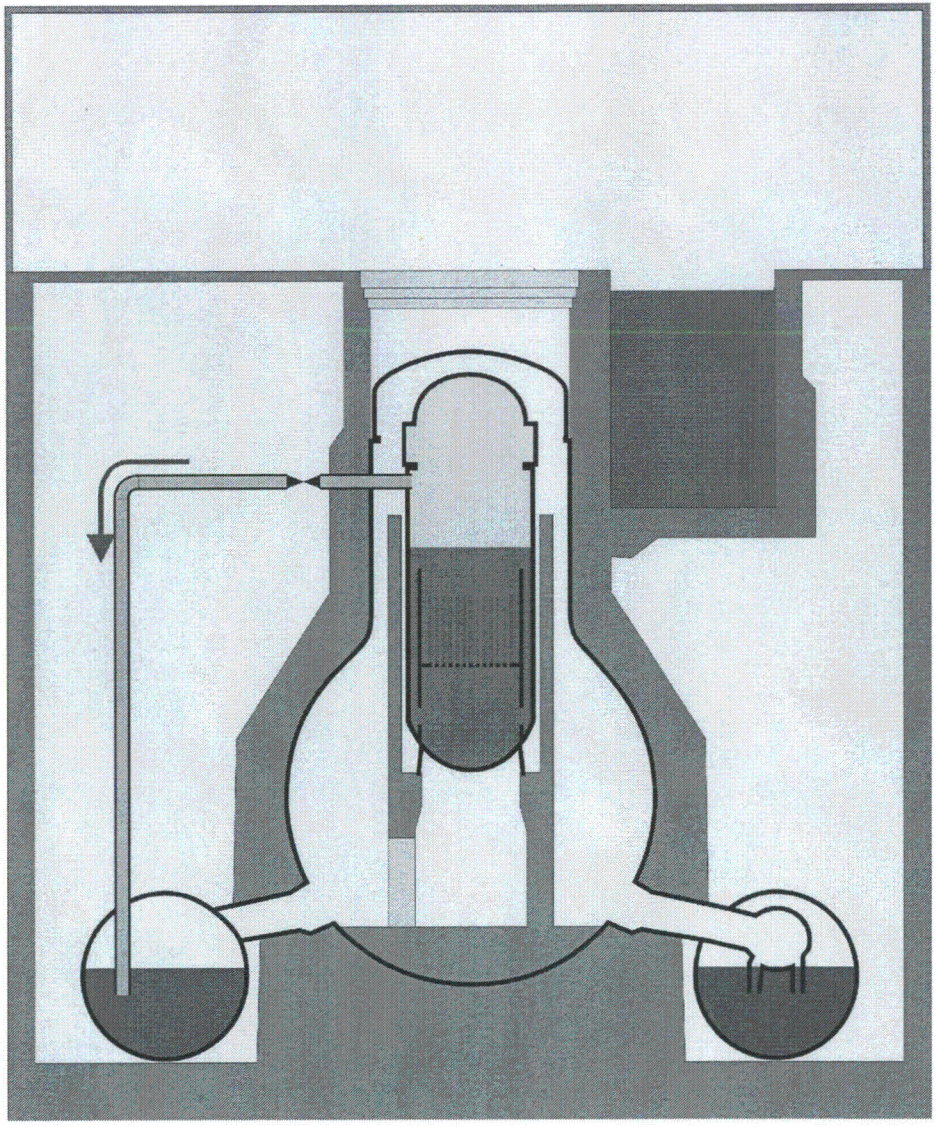

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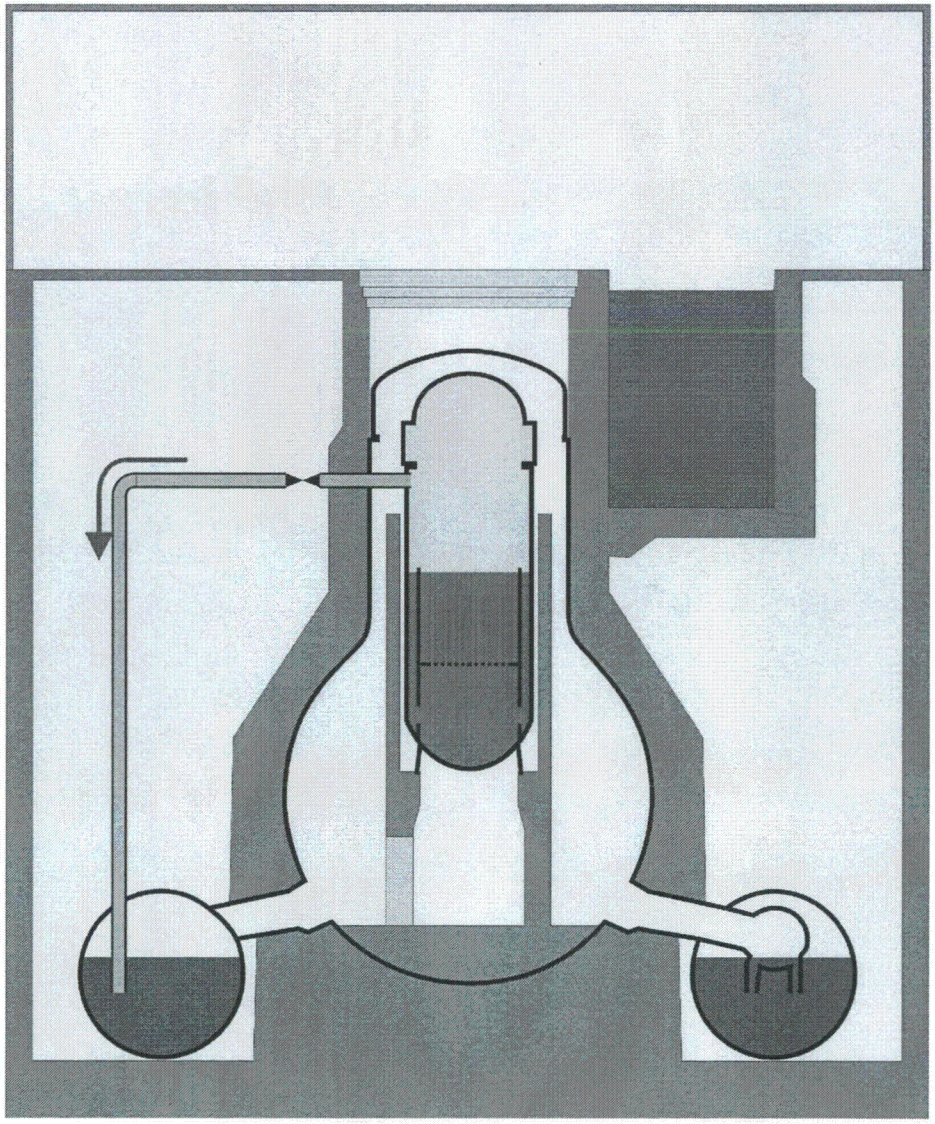

The Fukushima Daiichi Incident
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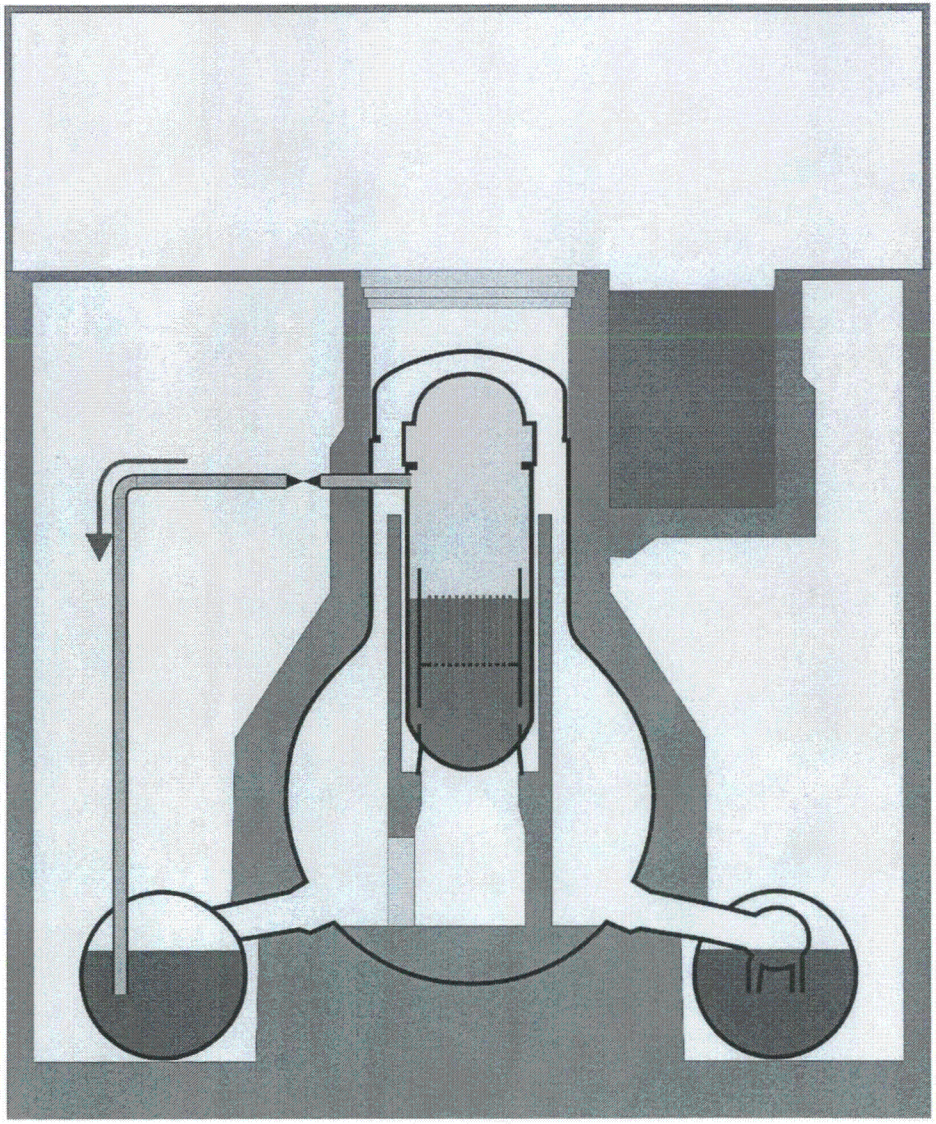

The Fukushima Daiichi Incident
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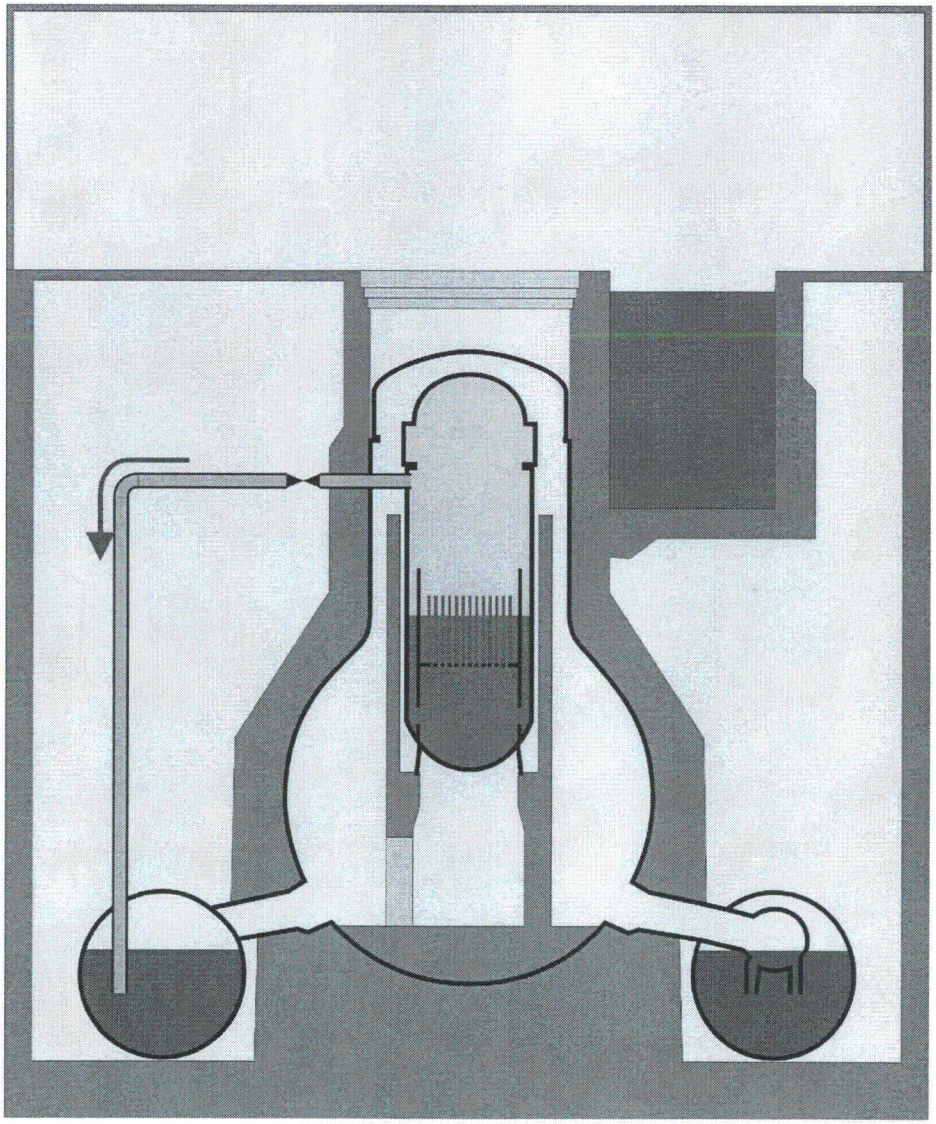
  - Discharge Steam into the Wet-Well
- Descending of the Liquid Level in the Reactor pressure vessel

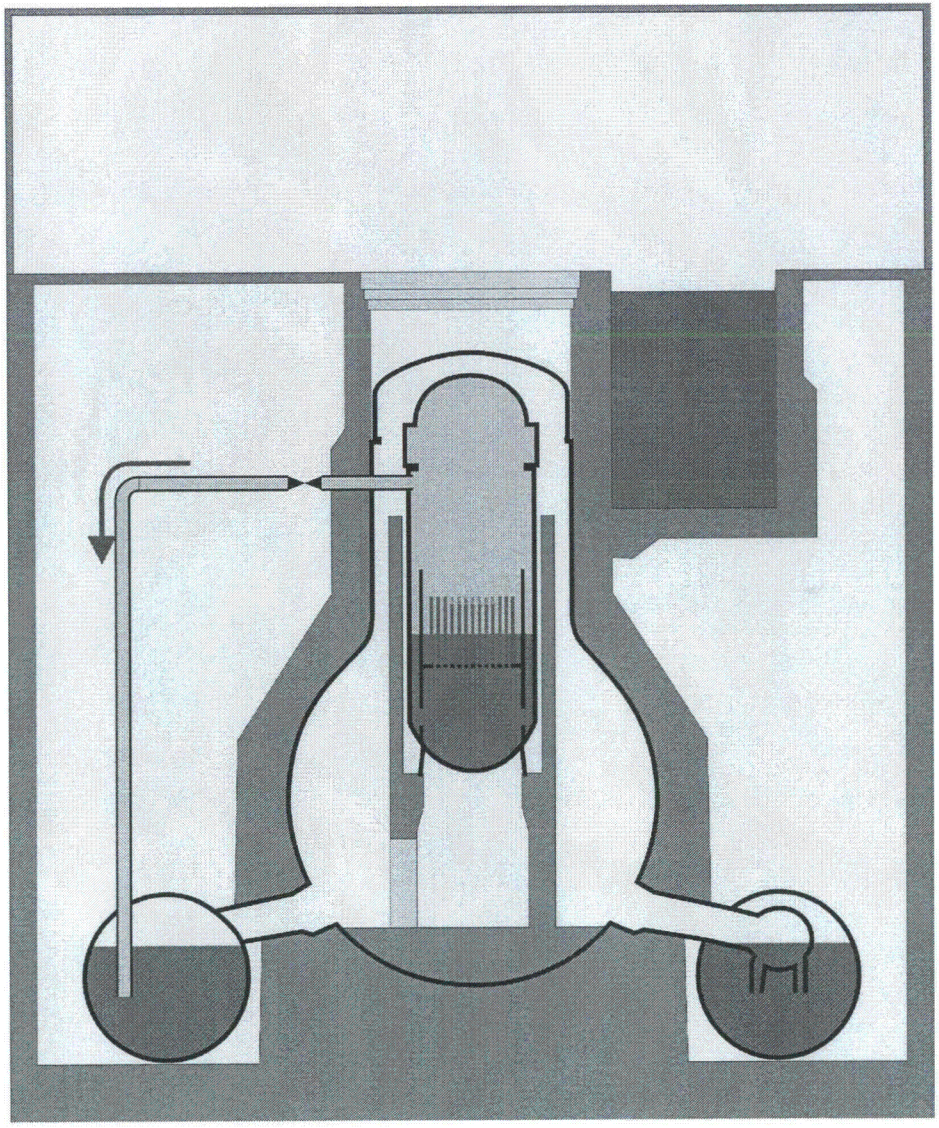


The Fukushima Daiichi Incident
2. Accident progression

- Measured, and here referenced Liquid level is the collapsed level. The actual liquid level lies higher due to the steam bubbles in the liquid

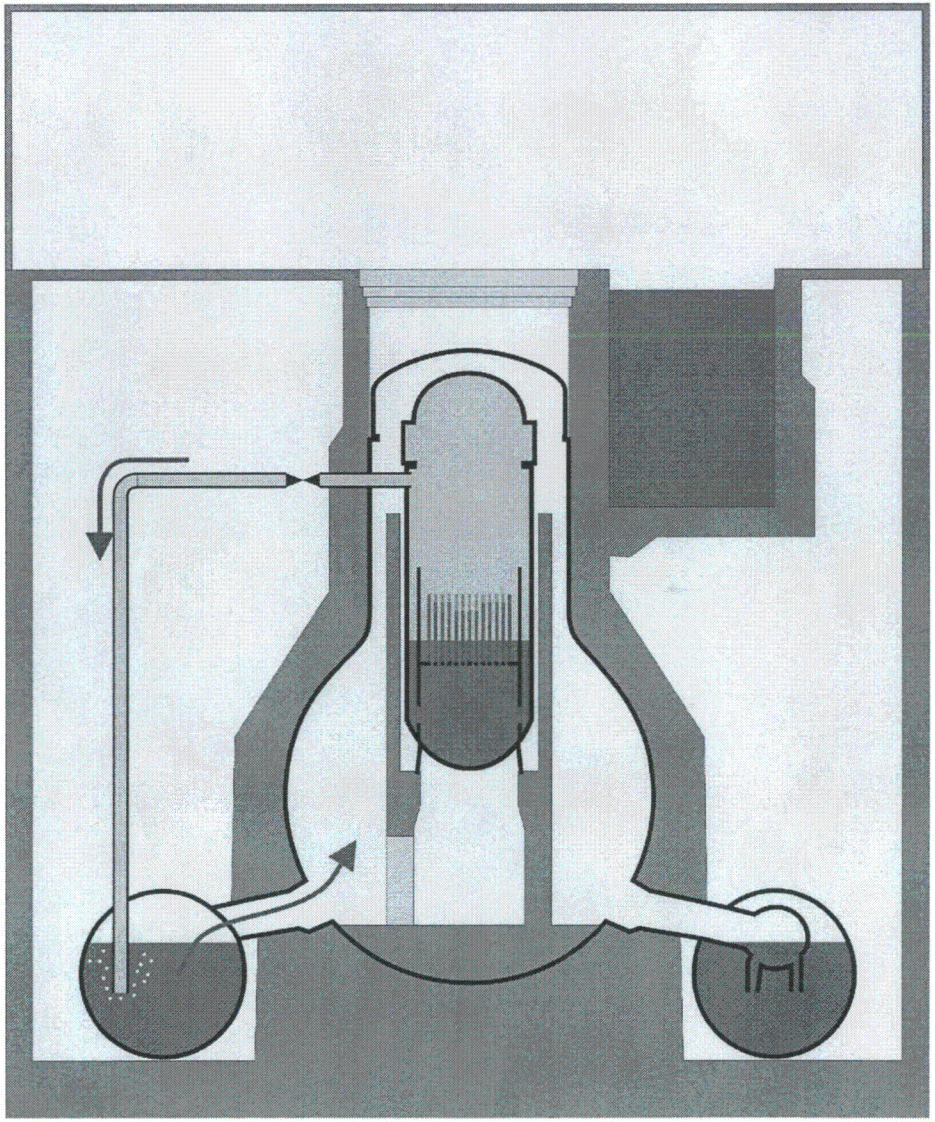
- ~50% of the core exposed
  - Cladding temperatures rise, but still no significant core damage

- ~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



The Fukushima Daiichi Incident
2. Accident progression

- ~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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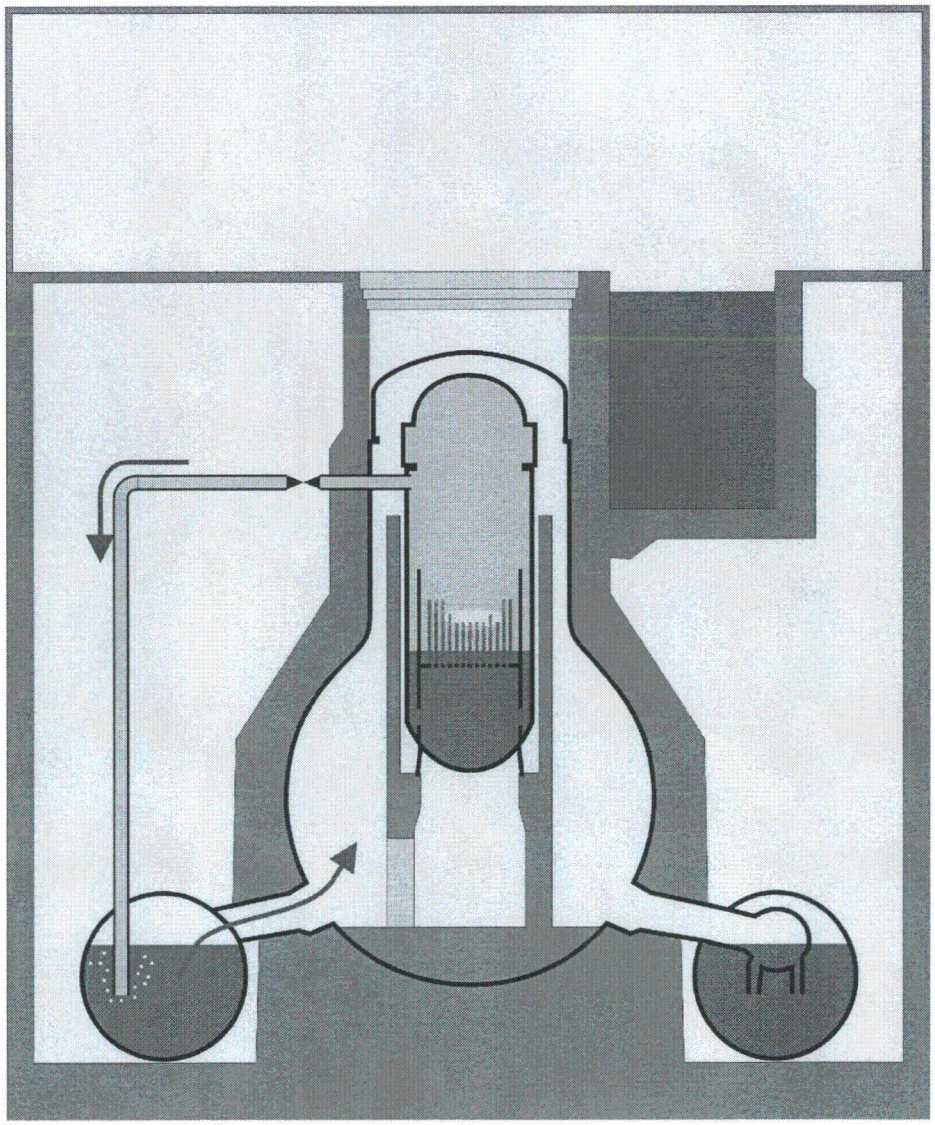
The Fukushima Daiichi Incident

2. Accident progression

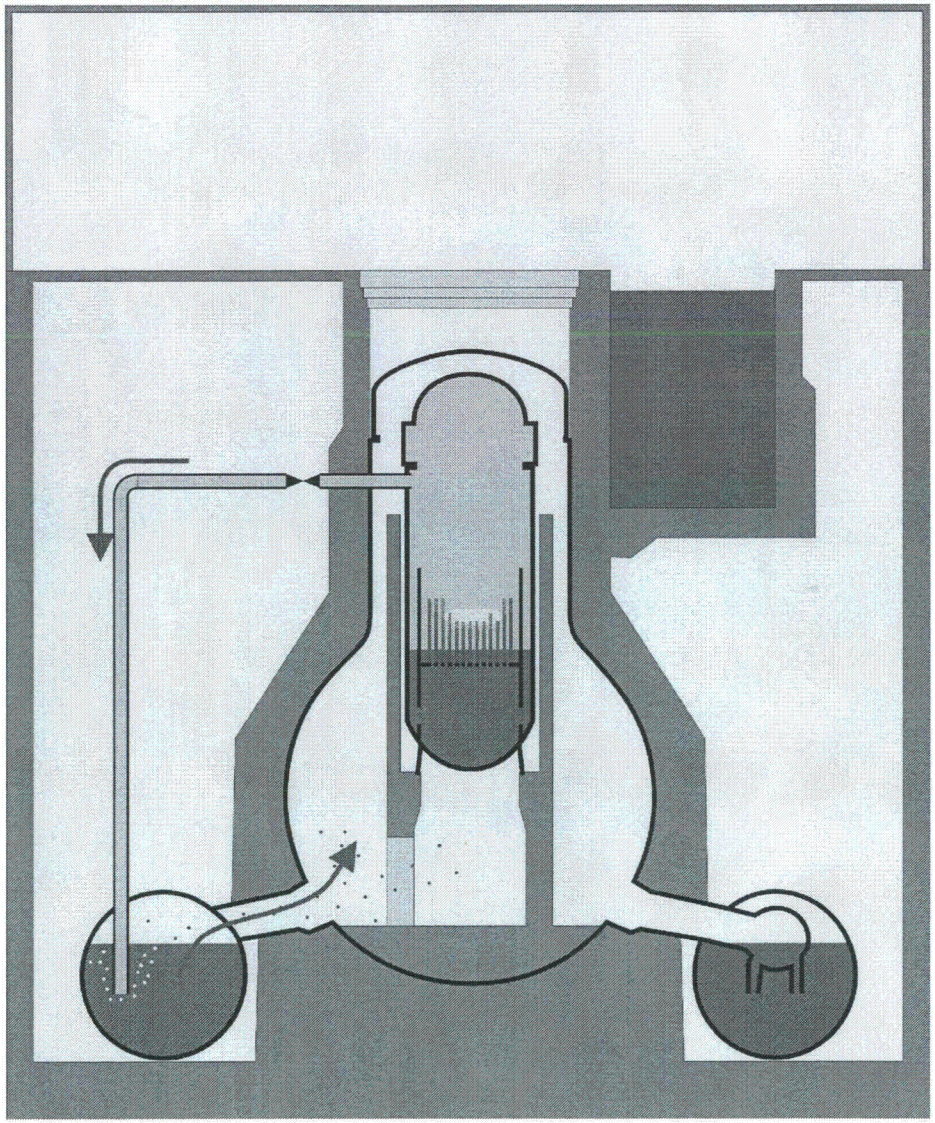
- at ~1800°C [Unit 1,2,3]
  - Melting of the Cladding
  - Melting of the steel structures
- at ~2500°C [Block 1,2]
  - Breaking of the fuel rods
  - debris bed inside the core
- at ~2700°C [Block 1]
  - Melting of Uranium-Zirconium eutectics
- Restoration of the water supply stops accident in all 3 Units
  - 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)



The Fukushima Daiichi Incident

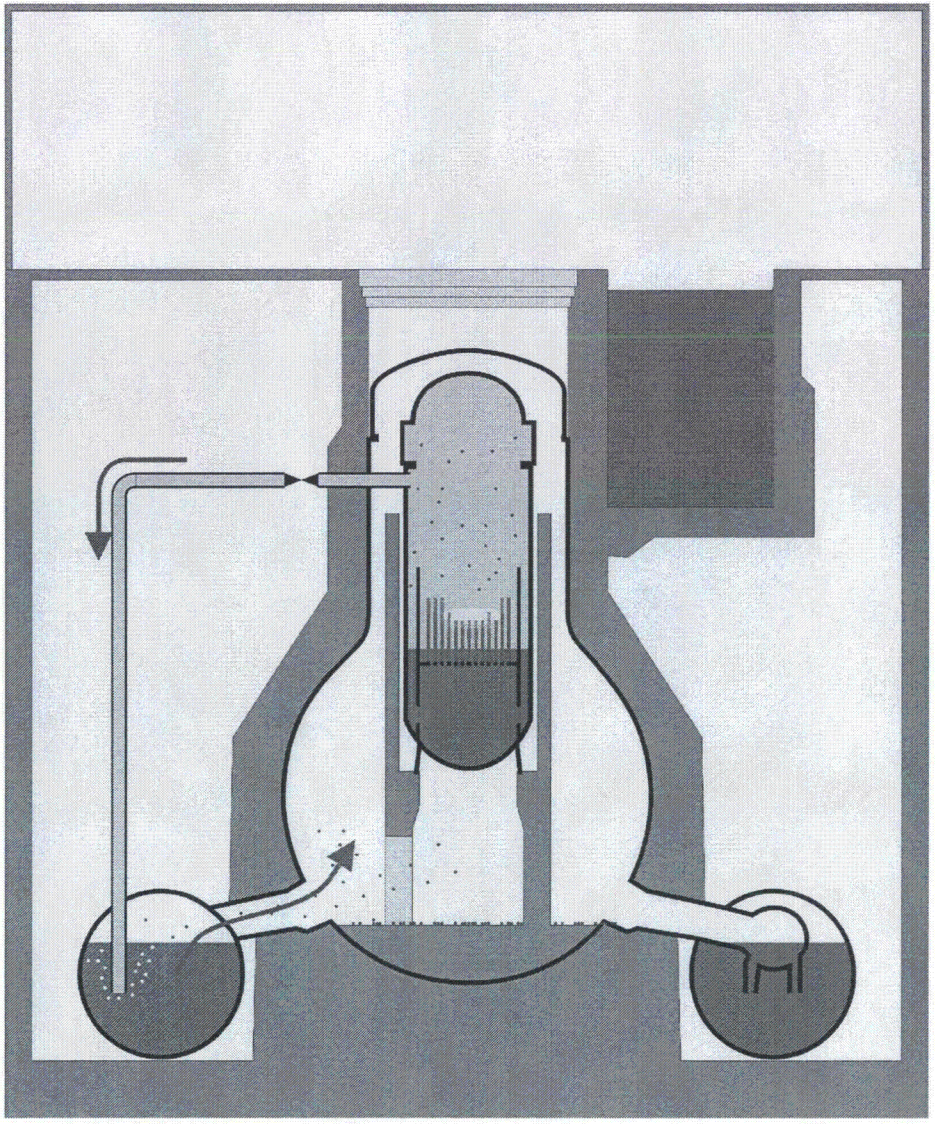
2. Accident progression

- 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



The Fukushima Daiichi Incident
2. Accident progression

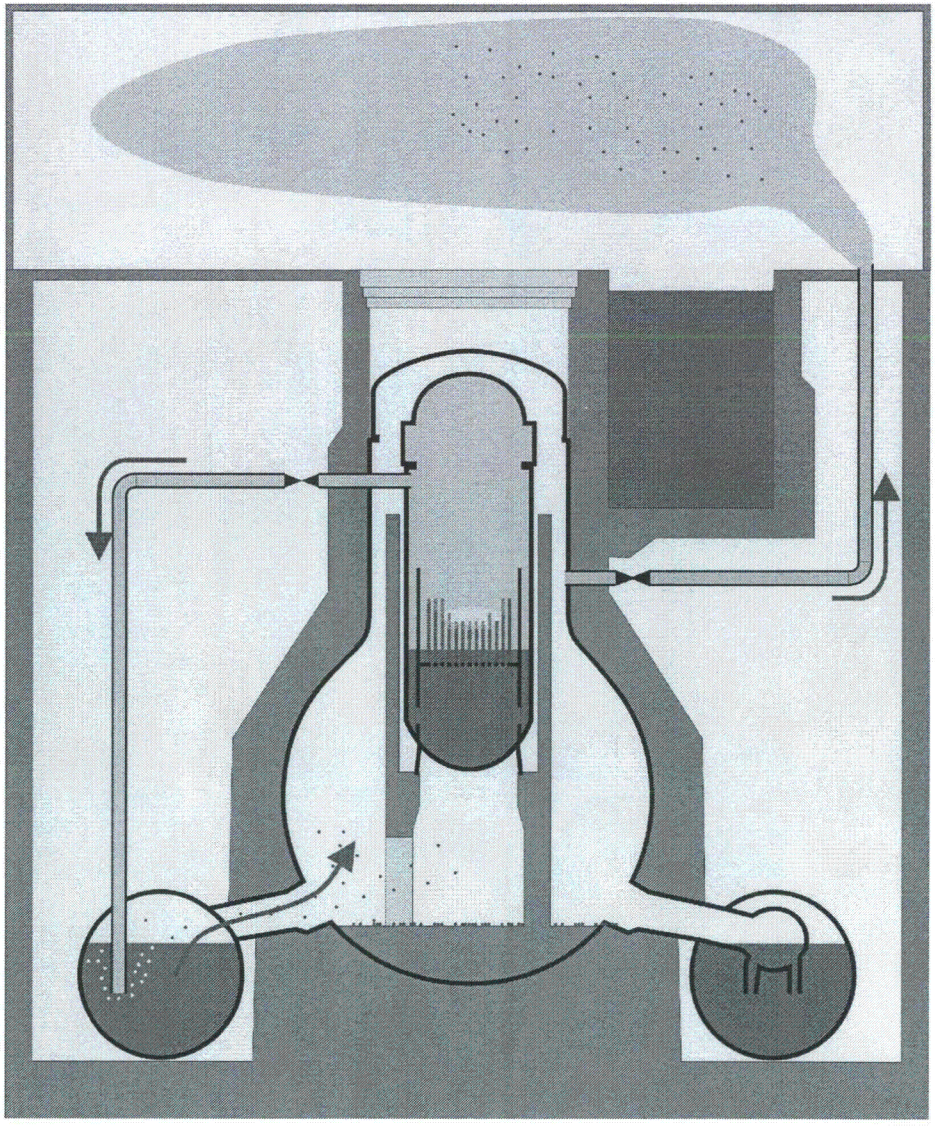
- Containment
  - Last barrier between Fission Products and Environment
  - Wall thickness ~3cm
  - Design Pressure 4-5bar
- Actual pressure up to 8 bars
  - Normal inert gas filling (Nitrogen)
  - Hydrogen from core oxidation
  - Boiling condensation chamber (like a pressure cooker)
- Depressurization 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

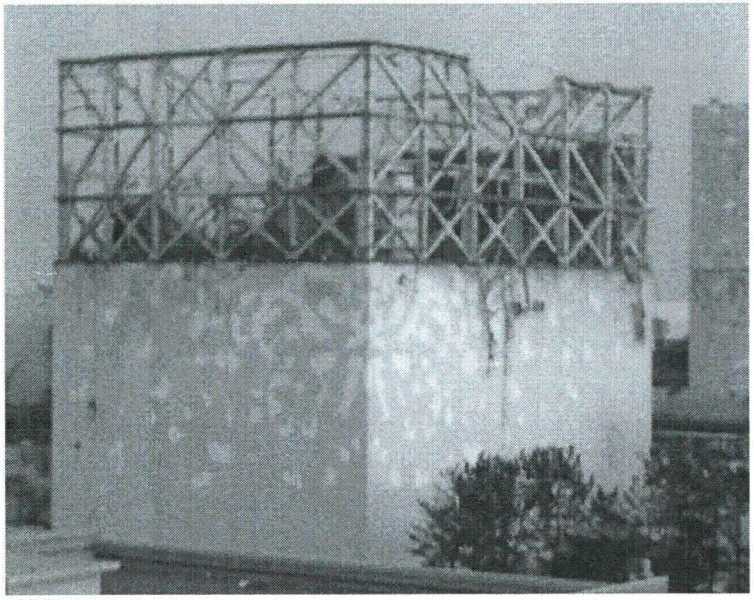
2. Accident progression

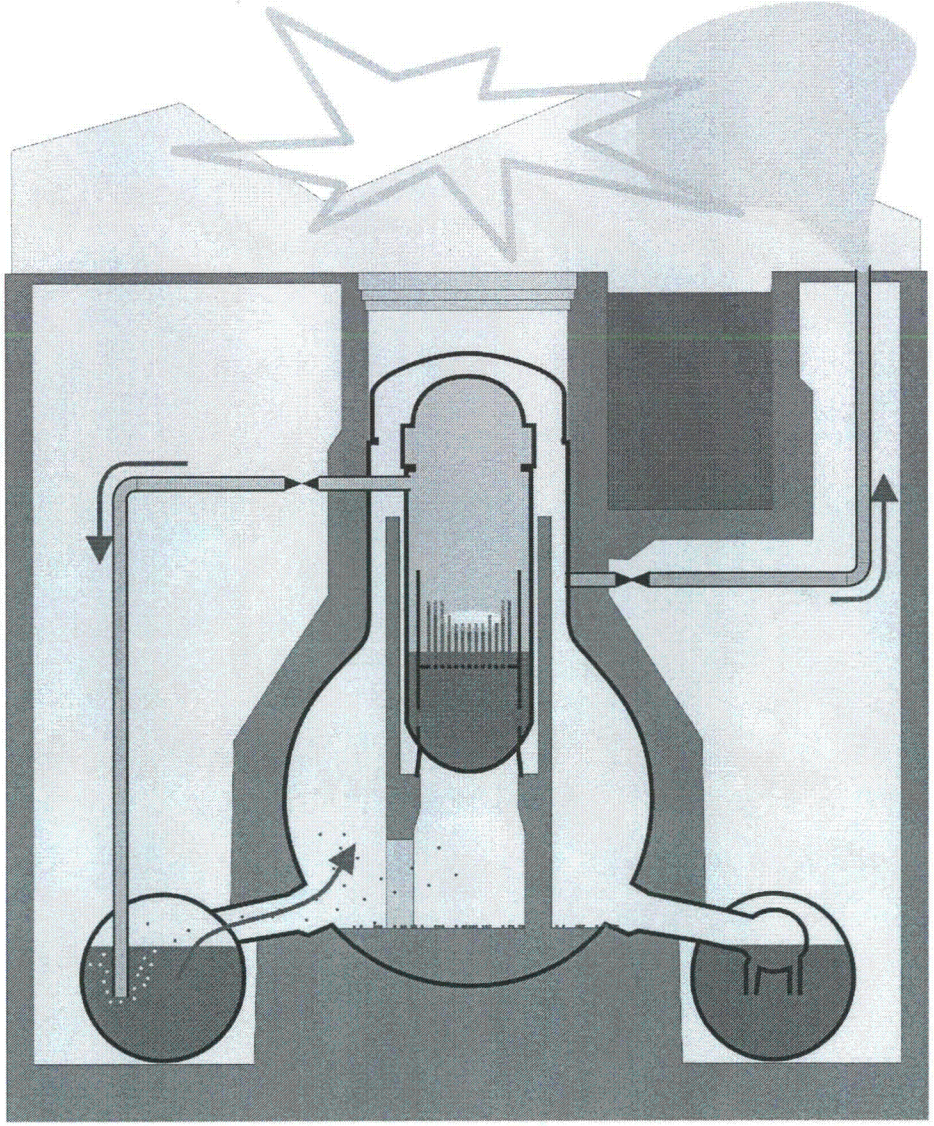
- Positive und negative Aspects of depressurizing the containment
  - Removes Energy from the Reactor building (only way left)
  - Reducing the pressure to ~4 bar
  - Release of small amounts of Aerosols (Iodine, Cesium ~0.1%)
  - Release of all noble gases
  - Release of Hydrogen
- Gas is released into 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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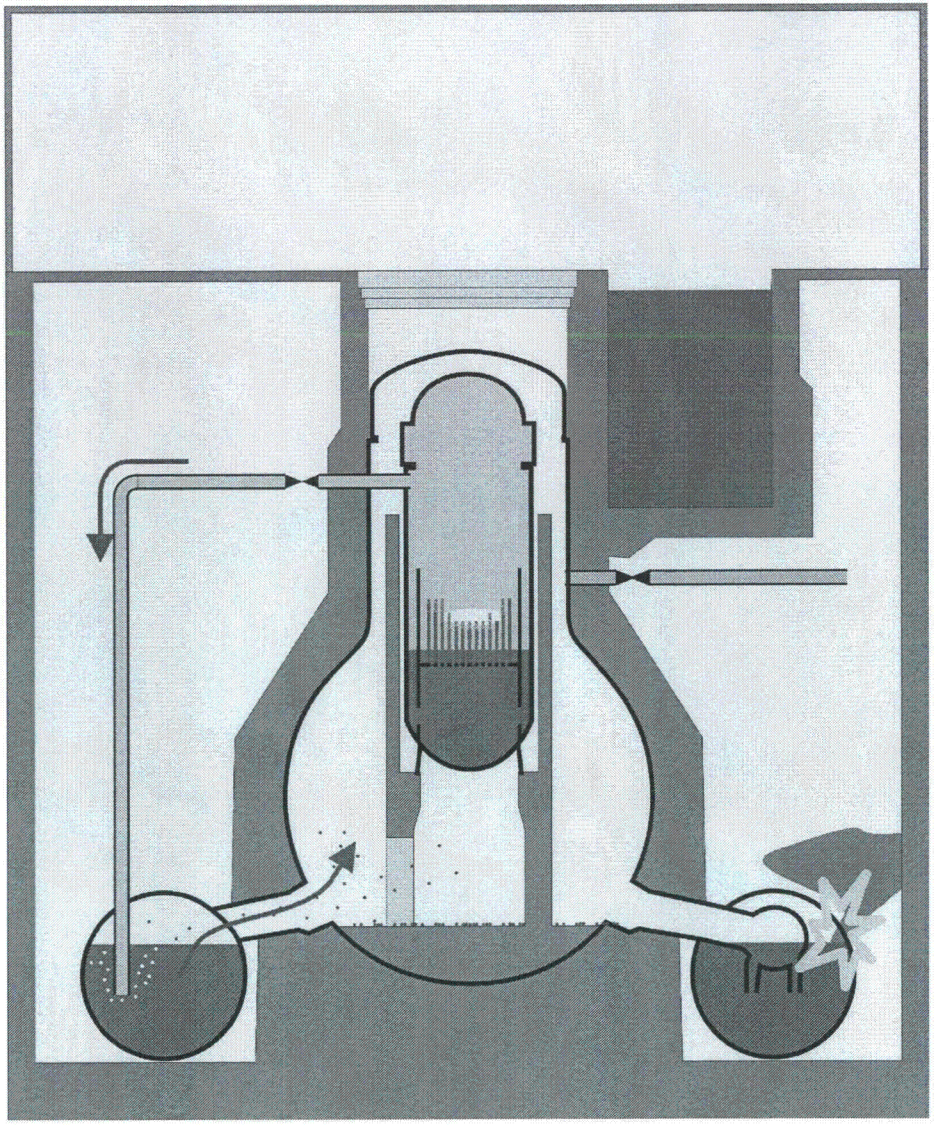
The Fukushima Daiichi Incident
2. Accident progression

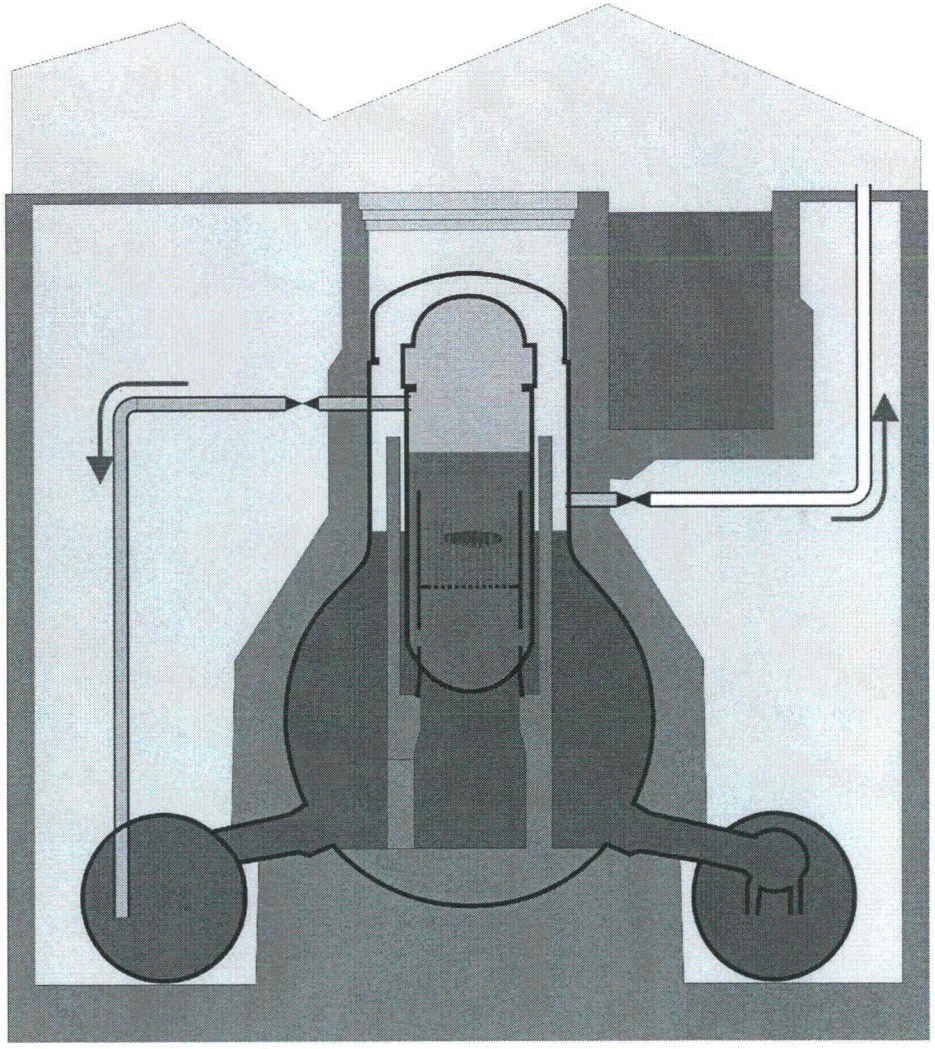
- Unit 2
  - Hydrogen burn inside the reactor building
  - Probably damage to the condensation chamber (highly contaminated water)
  - Uncontrolled release of gas from the containment
  - **Release of fission products**
  - Temporal evacuation of the plant
  - High local dose rates on the plant site due to wreckage hinder further recovery work

- No clear information's why Unit 2 behaved differently



The Fukushima Daiichi Incident
2. Accident progression

- 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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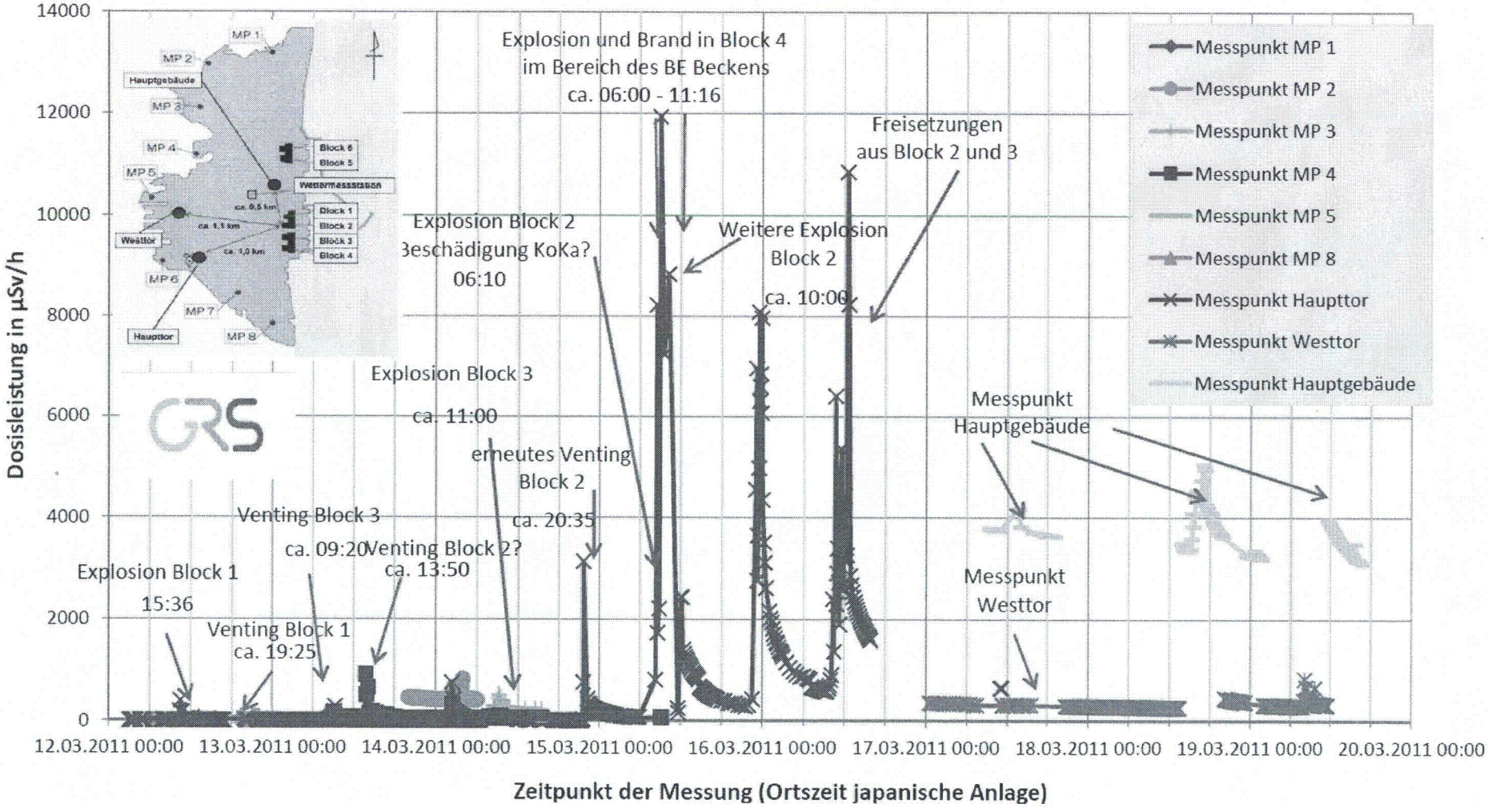
The Fukushima Daiichi Incident
3. Radiological releases

- 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



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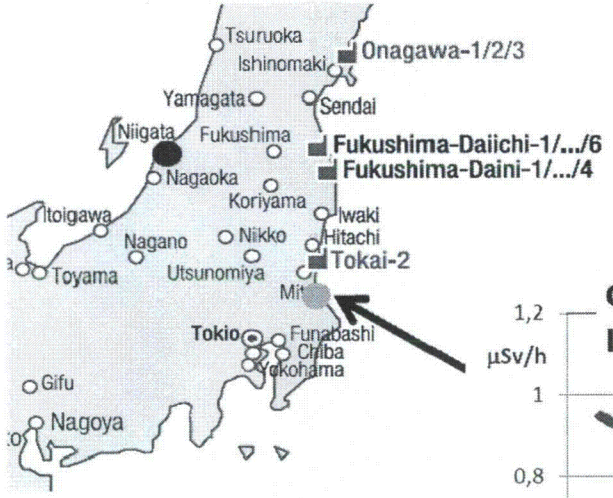
The Fukushima Daiichi Incident
3. Radiological releases

- 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

The Fukushima Daiichi Incident

3. Radiological releases



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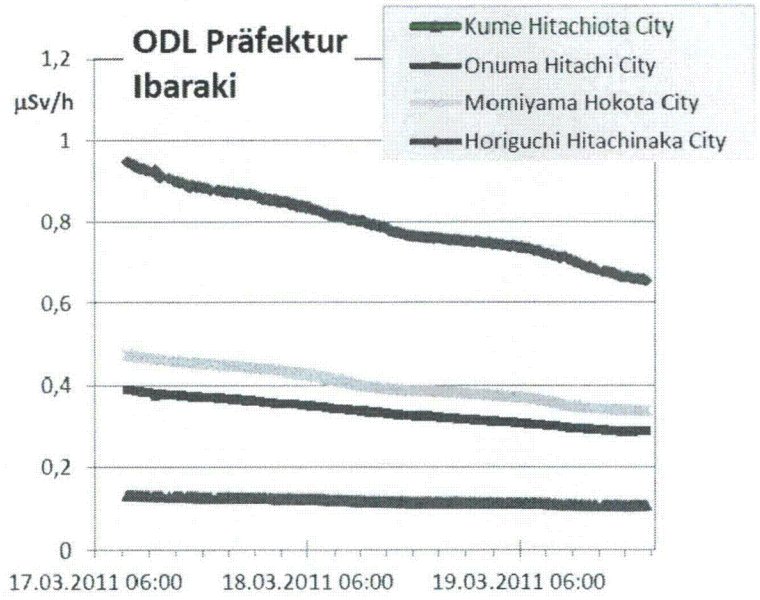

- ~50km around the plant
  - Control of Crop / Dairy products
  - Usage of Iodine pills (Caution, pills can interfere with heart medicine)

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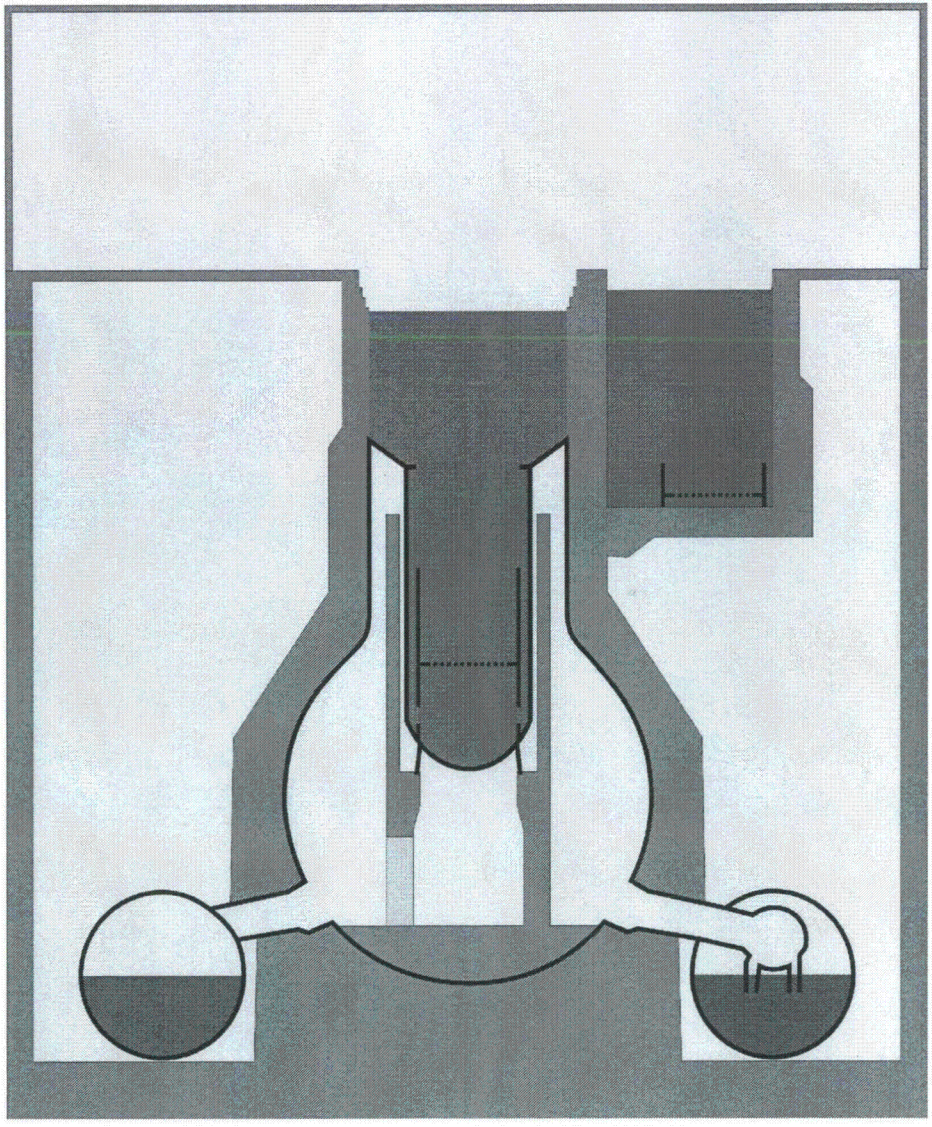
The Fukushima Daiichi Incident
4. Spend fuel pools

- 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



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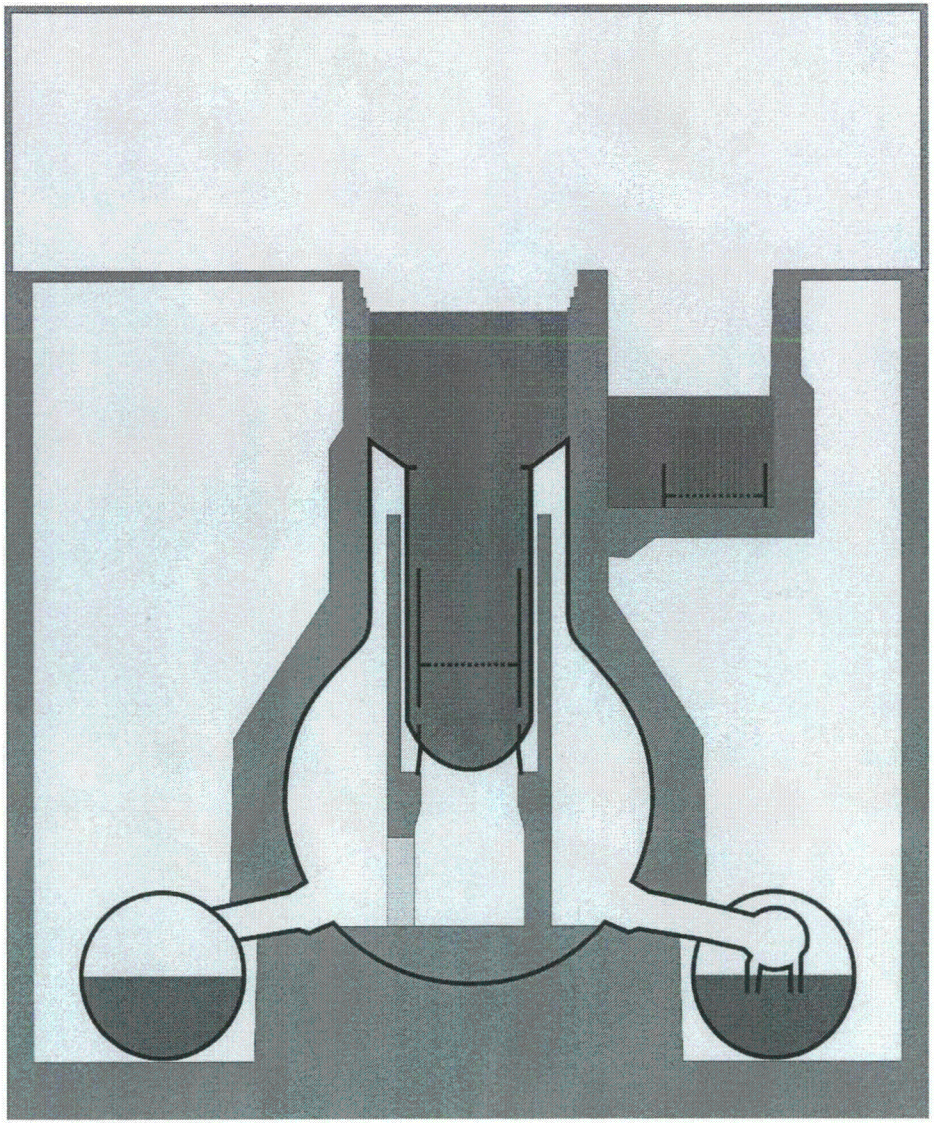
The Fukushima Daiichi Incident
4. Spend fuel pools

- 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



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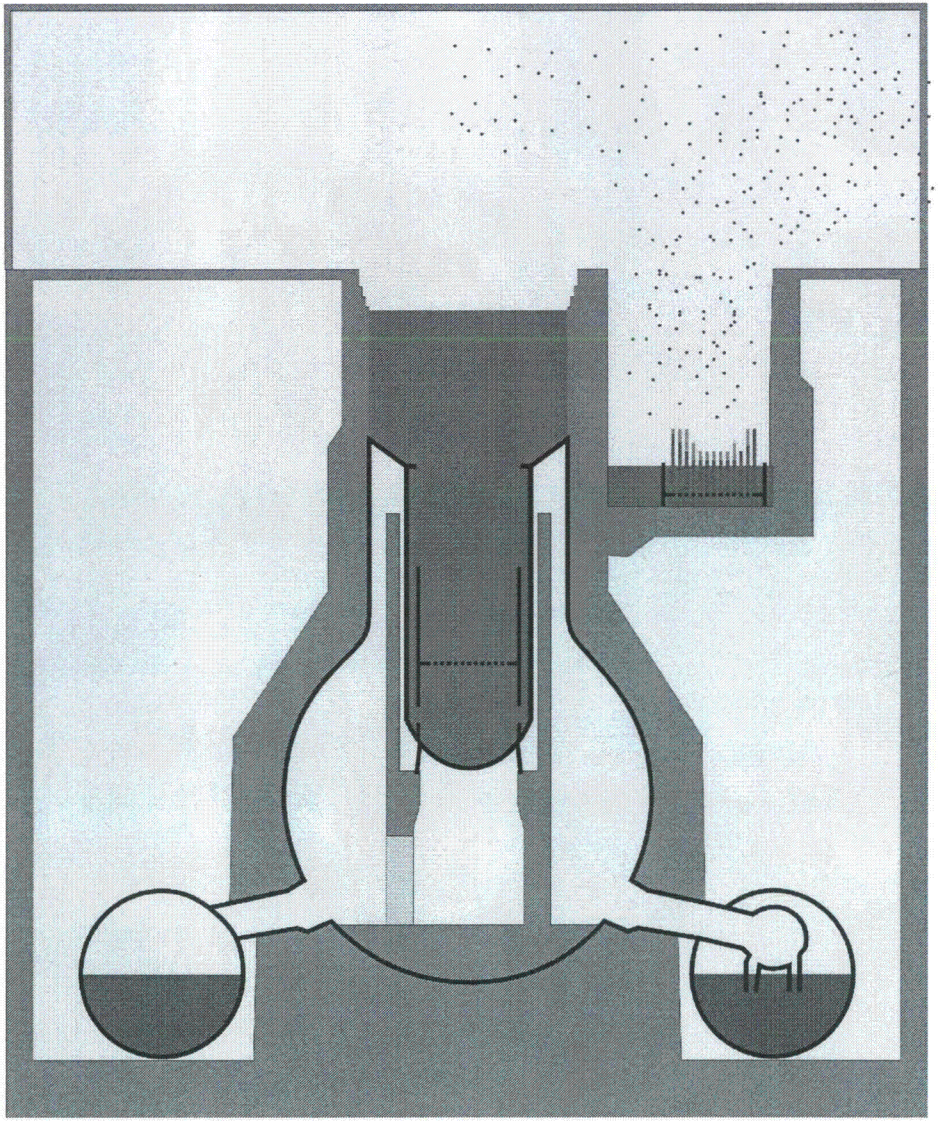
The Fukushima Daiichi Incident

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
- **It is currently unclear if release from fuel pool already happened**



The Fukushima Daiichi Incident
5. Sources of Information

- 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