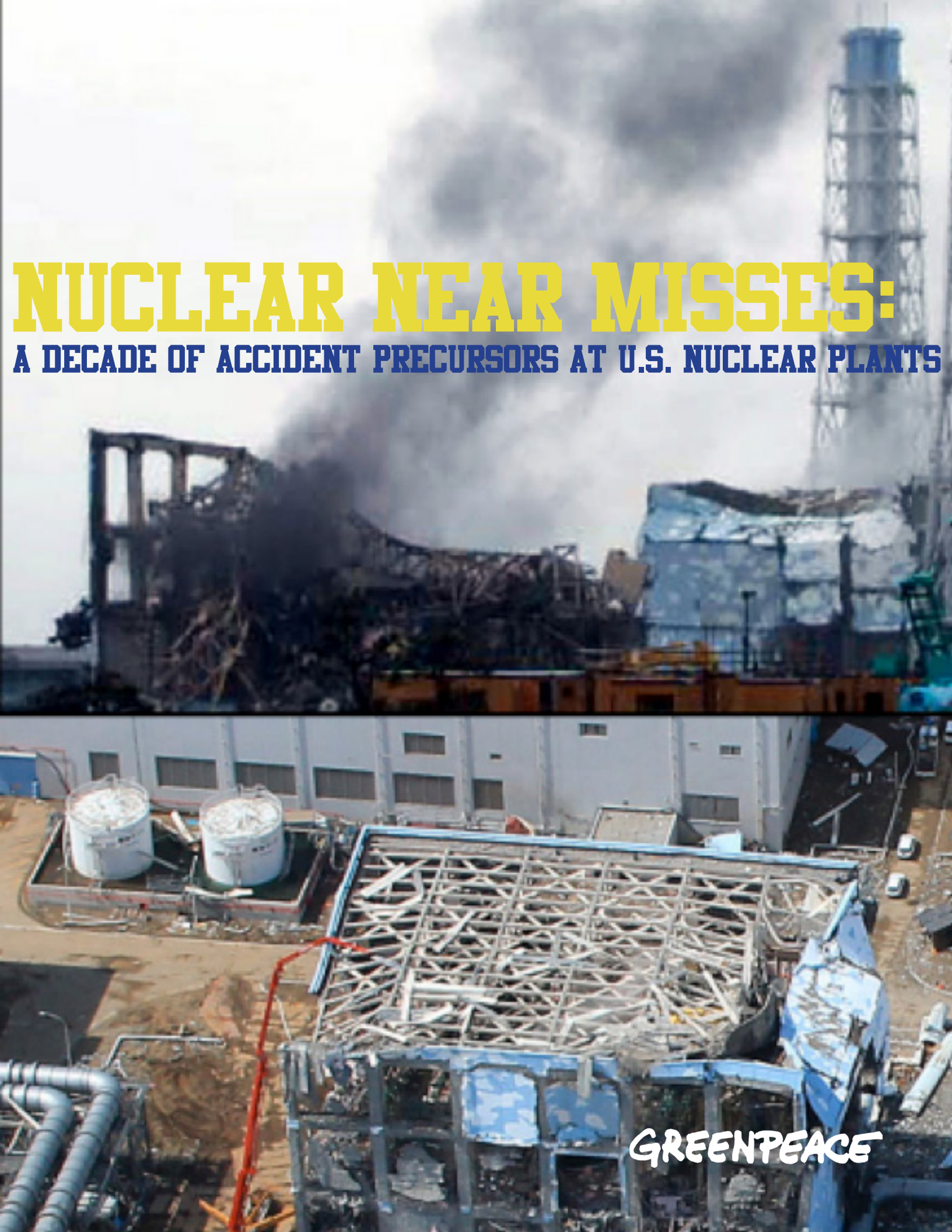

NUCLEAR NEAR MISSES:

A DECADE OF ACCIDENT PRECURSORS AT U.S. NUCLEAR PLANTS

GREENPEACE

Photo Source: U.S. Nuclear Regulatory Commission, Fukushima and Subsequent Lessons Learned Actions, NRC Commissioner William C. Ostendorff, Pennsylvania Society of Professional Engineers September 19, 2014

http://www.nrc.gov/about-nrc/organization/commission/comm-william-ostendorff/comm-ostendorff-20140919-slides.pdf

Greenpeace US would like to dedicate this report to those individuals at the U.S. Nuclear Regulatory Commission (NRC) who have attempted to regulate reactors and reduce the risks they pose to public health and safety. These individuals have risked their careers by speaking truth to power inside the NRC and informing the public of the risks posed by nuclear power plants.

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Executive Summary

Thirty years after Chernobyl and five years after the triple meltdown at Fukushima Daiichi in Japan, U.S. nuclear regulators are claiming that U.S. nuclear power plants are safe and that Fukushima couldn't happen here. Nothing could be further from the truth.

Contrary to these claims, Greenpeace has documented 166 near misses or accident precursors at US nuclear power plants over the past decade that risk analysts have determined are precursors to a meltdown. The U.S. Nuclear Regulatory Commission (NRC) documented 61 events and 102 conditions at US nuclear plants that were near misses to a meltdown.

Unfortunately, NRC's Accident Sequence Precursor program missed three of the most risk significant near misses in the past decade; the triple meltdown threat to Duke Energy's Oconee Nuclear Station in South Carolina. According to NRC's risk analysts, if Jocassee Dam failed all three of the nuclear reactors at Oconee were certain to meltdown. And contrary to the claims of the Nuclear Regulatory Commission, the threat to the Oconee reactors was hundreds of times more probable than the tsunami that struck Japan in 2011. The NRC considers ten of these near misses to be important precursors to a core melt accident.

IMPORTANT NEAR MISSES AT U.S. REACTORS 2004 - 2014

YEAR	NUCLEAR PLANT	NEAR MISS EVENT or CONDITION	NRC RISK
2011	BROWNS FERRY 1	Residual heat removal loop unavailable; valve failure	7 X 10-4
2012	WOLF CREEK	Multiple Switchyard Faults, Reactor Trip & Loss Of Offsite Power	5 x 10 -4
2010	ROBINSON	Fire Causes Partial Loss Of Offsite Power & Reactor Coolant Pump Seal Cooling Challenges	4 X 10 -4
2012	FORT CALHOUN	Fire in safety-related 480 volt electrical breaker due to deficient design control. 8 other breakers susceptible	4 X 10 -4
2012	RIVER BEND	Loss of Normal Service Water, Circulating Water & Feedwater caused by Electrical Fault	3 X 10 -4
2008	OCONEE 1	Failure of Jocassee Dam would result in a meltdown	2.8 X 10 -4
2008	OCONEE 2	Failure of Jocassee Dam would result in a meltdown	2.8 X 10 -4
2008	OCONEE 3	Failure of Jocassee Dam would result in a meltdown	2.8 X 10 -4
2011	NORTH ANNA 1	Dual Loss of Offsite Power Caused By Earthquake AFW Pump out of service & Failure of Unit 2 EDG	2 X 10 -4
2012	BYRON 2	Transformer & breaker failures cause Loss of Off Site Power, reactor trip and de-energizing of safety buses	1 X 10 -4

The three reactors at Duke Energy's Oconee nuclear plant weren't the only ones that were at risk from flooding. The NRC has documented over a dozen other nuclear reactors that were threatened by flooding over the past decade. Many of these near miss vulnerabilities dated back decades and were only identified after the NRC was forced to take a closer look at U.S. nuclear plants in the aftermath of Fukushima. In addition to the flooding vulnerabilities, NRC risk analysts identified a statistically significant trend in Losses of Offsite Power or (LOOPs) at US nuclear plants. This trend is a result of 20 LOOP events in just the last four years.

Equally as disturbing as the 166 accident precursors or near misses is the fact that NRC staff has had to turn whistleblower on four of the top ten near misses in order to get the agency to address the risks in a timely manner.

Contrary to the claims of U.S. regulators and the nuclear industry, nuclear power plants can experience catastrophic failures like those we witnessed at Fukushima Daiichi in Japan. This probability makes nuclear power anything but "safe". The NRC's failure to make public the documents that revealed the flooding threat to all three reactors at Duke Energy's Oconee Nuclear Station has only served to significantly delay the final resolution of nuclear near misses that are even more risk significant than those that caused the fiasco at Fukushima Daiichi in Japan. The NRC's failure to address long standing safety issues at Oconee and other U.S. nuclear plants further serves to undermine public confidence in nuclear power and those that regulate it.

Greenpeace US' report on Nuclear Near Misses finds that despite years of inspections, licensing and relicensing, safety issues continue to be identified at U.S. reactors; many of which date back decades, some vulnerabilities have existed since the nuclear plants were first started. These long standing vulnerabilities make nuclear power anything but safe. Greenpeace has long called for the phase out of nuclear power and this report further supports that determination.

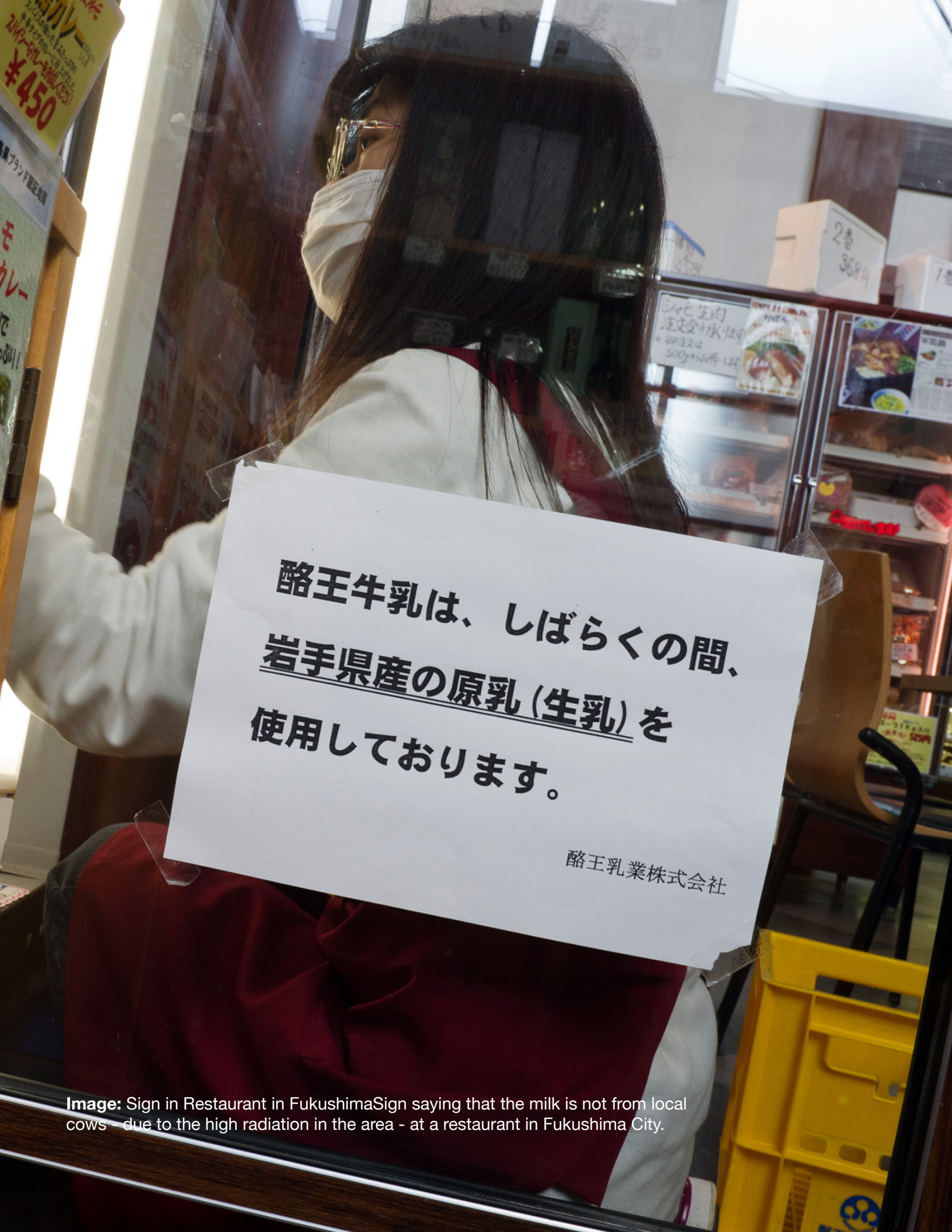


Image: Sign in Restaurant in FukushimaSign saying that the milk is not from local cows - due to the high radiation in the area - at a restaurant in Fukushima City.

Introduction

Ten years ago, Greenpeace published our report *American Chernobyl: Nuclear Near Misses at U.S. Reactors Since 1986* to remind the public and government officials that contrary to the claims made by the nuclear industry lobbyists and U.S. Nuclear Regulatory Commission (NRC) Chairman and Commissioners:

***U.S. reactors can have accidents with consequences equal to or greater than the Chernobyl disaster;**

***U.S. reactors have had and will continue to experience "near misses" that could result in a meltdown;**

***U.S. reactor containments were not designed to withstand a reactor meltdown and the government has little confidence that any of them could.**

Now, thirty years after Chernobyl and five years after the meltdown of three General Electric-designed nuclear reactors[1] at the Fukushima Daiichi nuclear plant in Japan, U.S. NRC Commissioners are again claiming that U.S. reactors are "safe" and that "Fukushima couldn't happen here."[2]

Despite blithe assurances from the NRC Commissioners since the Fukushima fiasco, that "(t)he NRC continues to determine that US nuclear plants are safe,"[3] Greenpeace's review of a decade of nuclear near misses shows that US reactors are still vulnerable to both flooding and losses of off-site power as well as other vulnerabilities to a meltdown that make them anything but "safe."

NRC risk analysts have documented 163 events or conditions at U.S. nuclear power plants in the last decade that could have resulted in a meltdown. In addition to these 163 accident precursors or near misses identified by the NRC, Greenpeace has documented three important near misses that NRC risk analysts failed to review under the NRC's Accident Sequence Precursor Program (ASP).

After Fukushima the nuclear industry and its regulators have been forced to reexamine the holes in the nation's nuclear safety net[4]. But as former NRC Chairman Gregory Jaczko noted "unfortunately, all too often, when faced with tough policy calls, a majority of this current commission has taken an approach that is not as protective of public health and safety as I believe is necessary."[5]

Nuclear Near Misses

In order to compile the last decade of nuclear near misses Greenpeace reviewed the U.S. Nuclear Regulatory Commission's (NRC) program for tracking and evaluating near misses or as the agency terms them "precursors to severe core damage accidents" or "accident precursors." Accident precursors are those actual events or conditions at nuclear reactors that if additional failures had occurred, would have resulted in inadequate cooling of the radioactive fuel and caused it to meltdown.[6] The NRC analyses inspection reports and licensee event reports submitted by the nuclear plant operators to capture those events or conditions that could have led to a meltdown.

For the purpose of analyzing risk, the NRC divides nuclear reactor risks into two categories: initiating events and degraded conditions.[7] Initiating events are actual occurrences such as a loss of offsite power (LOOP) or an automatic or manual shutdown (SCRAM) of the reactor with complications like any additional equipment failures or degradation of safety system function.[8] Degraded conditions are those recognized safety system or equipment degradations or unavailability that came to light without an occurrence of an initiating event.[9]

To analyze initiating events, the NRC calculates a conditional core damage probability or CCDP. CCDP represents the probability that the nuclear reactor would experience core damage or a meltdown of the radioactive fuel rods, given an occurrence of the initiating event and any subsequent equipment failure or degradation.[10]

To analyze degraded conditions, the NRC calculates the increase in core damage probability or CDP. CDP represents the increase in the probability that the reactor would damage the core for the period that safety equipment was unavailable or incapable or performing its function. [11]

Once the NRC has assessed an event, they determine the probability that it could have led to a meltdown. The NRC's Accident Sequence Precursor (ASP) program uses CCDP and CDP interchangeably and uses scientific notation to describe the significance. For example Three Mile Island, Chernobyl and Fukushima the core damage probability was 1 in 1.

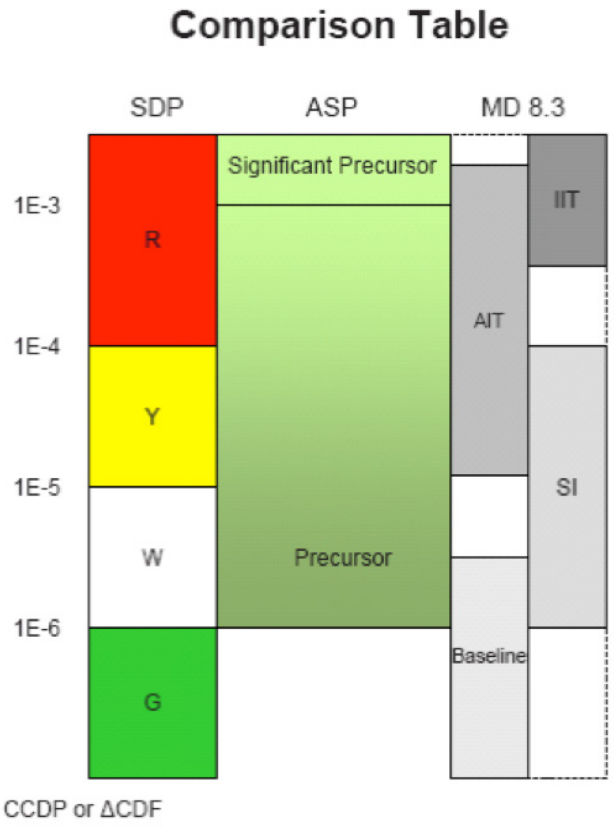
Terminology & Methodology

For those accidents that did not result in core damage the NRC assess a probability expressed as a negative function. For example:

1 X 10-1 = 1/10;
1 X 10-2 = 1/100;
1 X 10-3 = 1/1,000,
1 X 10-4 = 1/10,000,
1 X 10-5 = 1/100,000
1 X 10-6 = 1/1,000,000 [12]

For the purposes of assessing reactor risk the NRC breaks the events into categories based upon their perceived significance. According to NRC, accident precursors with a Conditional Core Damage Probability or CCDP or CDP of 1 in 1000 are considered significant, accident precursors with a CCDP of 1 in 10,000 are considered important and those with a CCDP of greater than 1 in a million are consider precursors.[13]

The chart below demonstrates how NRC's evaluation of nuclear power plant risk relates to NRC's inspection process and the color coding NRC uses in the significance determination process to evaluate near miss conditions at US reactors. [14]



(SDP = Significance Determination Process, ASP = Accident Sequence Precursor, MD = Management Directive, AIT = Augmented Inspection Team. IIT = Incident Investigation Team and SI = Special Inspction) .[15]

Nuclear Power Plant Risk

In the aftermath of the triple meltdown at Fukushima, many, including Greenpeace, have questioned the validity and usefulness of nuclear risk assessments. The nuclear industry's claims regarding the risk of melting down a nuclear reactor do not stand up in the face of the historic record.

As Princeton's MV Ramana pointed out in the Bulletin of Atomic Scientists:

"The lesson from the Fukushima, Chernobyl, and Three Mile Island accidents is simply that nuclear power comes with the inevitability of catastrophic accidents. While these may not be frequent in an absolute sense, there are good reasons to believe that they will be far more frequent than quantitative tools such as probabilistic risk assessments predict."[16]

To claim that nuclear power is safe is little more than atomic hubris. Nuclear power plants will fail, and when they do, the consequences are catastrophic for individuals and society. As the co-discoverer of the DNA molecule once put it, "the idea that the atom is safe is just a public relations trick." [17]

Fukushima has also reminded us that probability will not protect the public when a nuclear reactor melts down. Nassim Nicholas Taleb's book The Black Swan addressed the impact of low-probability, high-consequence events such as Fukushima and he points out the psychological trap of relying on probability to protect us. As Taleb stated after Fukushima:

"I spent the last two decades explaining … why we should not talk about small probabilities in any domain. Science cannot deal with them. It is irresponsible to talk about small probabilities and make people rely on them, except for natural systems that have been standing for 3 billion years (not manmade ones for which the probabilities are derived theoretically, such as the nuclear field for which the effective track record is only 60 years)."[18]

Probability provides cold comfort when reactors are overwhelmed by forces they were never designed to resist—such as the meltdown of the radioactive fuel rods that make up the core of the nuclear reactor. As John Downer points out in his article, "Disowning Fukushima", "What is the purpose of a risk calculation of dubious reliability? It is not useful to say that there is a one on a million chance of a meltdown but an unknowable but nonetheless meaningful chance that that figure is completely wrong …?" [19]

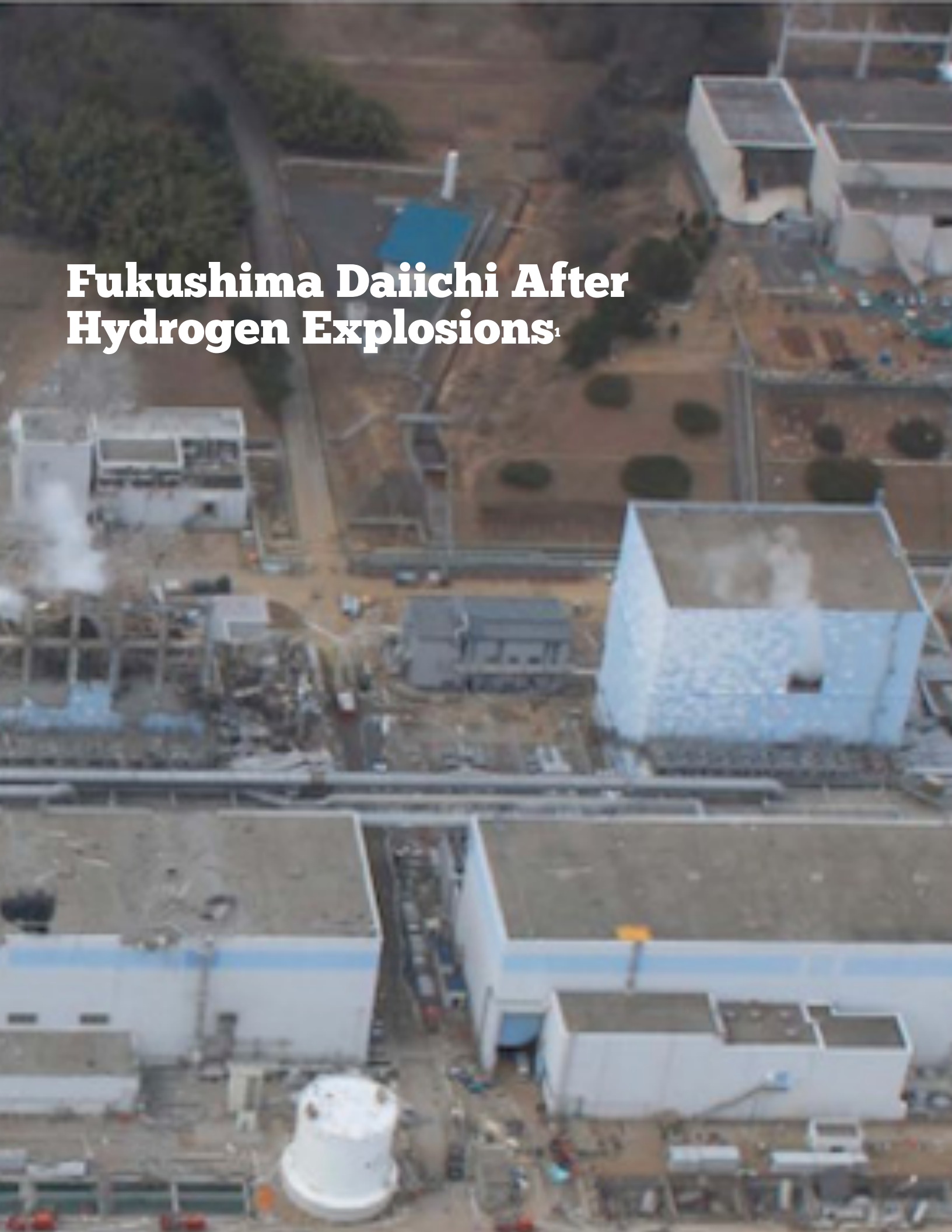
Risk After Fukushima

As Downer states, "The only fact that Fukushima demonstrates absolutely unambiguously is that devastating oversights can exist in what authoritative experts ardently claim to be rigorous, objective and conservative risk calculations." [20]While nuclear risk assessment calculations cannot and should not be taken as gospel, the NRC's Accident Sequence Precursor program could provide useful insights into the gaps in the regulator's approach to preventing meltdowns. As Price Waterhouse Coopers wrote after Fukushima:

"The U.S. nuclear industry must enhance its risk management capabilities in two ways. First, it must strengthen existing risk assessment methodologies to address extremely low-probability, high-consequence risks. This will involve improving existing processes and tools to identify potential risks from a much wider range of uncertainties than the industry has used in the past. Traditional thinking about "known unknowns" must be expanded to include "unknown unknowns." [21]

However, contrary to the PWC's recommendation the U.S. Nuclear Regulatory Commission has ceased to include and acknowledge those potentially risk significant events or conditions that are not modeled in their assessments. The last time NRC acknowledged the blind spot in their nuclear power plant risk models was the year BEFORE Fukushima.[22] From 2001- 2009, "30 percent of the identified precursors involved initiators or failure cases were not explicitly modeled in the associated SPAR (Standardized Plant Analysis Risk) model."[23] The near misses NRC failed to model that are included in this report are contained in the appendix.

As Yale University Professor Emeritus and renowned accident expert Charles Perrow pointed out in the wake of Fukushima, "it is important to ask whether some industrial systems have such huge catastrophic potential that they should not be allowed to exist."[24] One of many reasons Greenpeace has long called for the phase out of nuclear power in the US and around the planet.



Fukushima Daiichi After Hydrogen Explosions[1]

14

A Decade of Nuclear Near Misses at US Nuclear Plants

In compiling the last decade of nuclear near misses at US nuclear plants, Greenpeace has reviewed the U.S. Nuclear Regulatory Commission Accident Sequence Precursor (ASP) reports from 2005 - 2015. The NRC's analysis of risk significant events and conditions at US reactors involves the review of hundreds of potential precursors and this takes time. So the NRC reports released in 2015 cover near misses from 2014. After reviewing a decade of nuclear near misses, Greenpeace has found the good, the bad and the ugly in the NRC's assessment of reactor risk and it's regulation of US nuclear plants.

The Good: There has not been a significant near miss since the 2002 Davis Besse debacle. The reactor vessel head degradation at Davis Besse in Ohio is still the most risk significant near miss since the meltdown at Three Mile Island.[25]

The Bad: Despite NRC's claims that US nuclear plants are "safe," US reactors have experienced 166 near miss events or conditions that were so risk significant that government regulators considered them "precursors" to a meltdown. The NRC's Accident Sequence Precursor program identified 61 events and over 100 conditions at US nuclear plants that could have led to a meltdown; NRC considered seven of these to be "important" precursors. However, the NRC's ASP program failed to capture three of the most risk significant conditions over the past decade; the triple meltdown threat to Duke Energy's Oconee Nuclear Station, 30 miles west of Greenville South Carolina. While the NRC ASP program failed to review the flood risk at Oconee, NRC's risk analysts did identify a statistically significant increase in Loss Of Off-site Power (LOOPs) events over the last decade due to 20 such events in the past four years.

The Ugly: After Fukushima, NRC commissioners testified to Congress that U.S. nuclear plants were "safe" and that a Fukushima couldn't occur in the United States. However, NRC commissioners and staff were aware as early as May of 2008 that Duke Energy had failed to provide "adequate protection" from flooding risks at Duke Energy's Oconee Nuclear Station. The NRC was aware that should the Jocassee dam just 10 miles up stream fail, all three Oconee nuclear reactors were certain to melt down.[26] Despite this knowledge it took NRC until June 2010 to require Duke to install temporary mitigation measures.[27] As of April 2016 permanent flooding fixes to the Oconee site are still not competed.

Almost as disturbing as the Oconee near misses is the fact that NRC staff has had to blow the whistle and go public on four of the near misses in order to force the agency to address long standing safety issues at US nuclear plants. While not as risk significant as the triple meltdown threat at Oconee, the NRC staff has also identified flooding vulnerabilities at over a dozen reactors that were risky enough to be considered accident precursors or near misses. Despite licensing and relicensing these nuclear reactors, the NRC only caught these flooding vulnerabilities AFTER the triple meltdown at Fukushima forced regulators to take a closer look.

Important Near Misses at US Nuclear Plants[28]

YEAR	NUCLEAR PLANT	NEAR MISS EVENT or CONDITION	NRC RISK
2011	BROWNS FERRY 1	Residual heat removal loop unavailable; valve failure	7 X 10-4
2012	WOLF CREEK	Multiple Switchyard Faults, Reactor Trip & Loss Of Offsite Power	5 x 10 -4
2010	ROBINSON	Fire Causes Partial Loss Of Offsite Power & Reactor Coolant Pump Seal Cooling Challenges	4 X 10 -4
2012	FORT CALHOUN	Fire in safety-related 480 volt electrical breaker due to deficient design control. 8 other breakers susceptible	4 X 10 -4
2012	RIVER BEND	Loss of Normal Service Water, Circulating Water & Feedwater caused by Electrical Fault	3 X 10 -4
2008	OCONEE 1	Failure of Jocassee Dam would result in a meltdown	2.8 X 10 -4
2008	OCONEE 2	Failure of Jocassee Dam would result in a meltdown	2.8 X 10 -4
2008	OCONEE 3	Failure of Jocassee Dam would result in a meltdown	2.8 X 10 -4
2011	NORTH ANNA 1	Dual Loss of Offsite Power Caused By Earthquake AFW Pump out of service & Failure of Unit 2 EDG	2 X 10 -4
2012	BYRON 2	Transformer & breaker failures cause Loss of Off Site Power, reactor trip and de-energizing of safety buses	1 X 10 -4

Table 1

The U.S. Nuclear Regulatory Commission's Accident Sequence Precursor Program considers any event or condition with a risk equal to or above 1 in 10,000 as an "important" precursor to a core damage accident.[29] Over the past decade, there have been ten such event or conditions that Greenpeace has documented above. Unfortunately, three of the most risk significant findings in the past decade were not captured by NRC's ASP program; the triple meltdown threat at Duke Energy's Oconee Nuclear Station.

The triple meltdown threat at Duke Energy's Oconee nuclear power plant in South Carolina only became public after the triple meltdown at Fukushima when NRC safety advocates blew the whistle over NRC and Duke Energy's failure to mitigate the threat in a timely manner.[30] According to NRC risk analysts:

"The probability of Jocassee Dam catastrophically failing is hundreds of times greater than a 51 foot wall of water hitting Fukushima Daiichi and, like the tsunami in Japan, the man-made 'tsunami' resulting from the failure of the Jocassee Dam will –- with absolute certainty –- result in the failure of three reactor plants along with their containment structures."[31]

Unfortunately, the triple meltdown threat at Oconee isn't the only important precursor that has caused NRC staff members to risk their careers and turn whistleblower. In March 2016, seven NRC engineers filed a public petition to force the agency to enforce it's own regulations at Exelon's Byron plant. [32]

According to the engineers' petition:

"A design flaw in the electric power systems of all but one of the 100 U.S. nuclear plants. The flaw prevents the detection of certain disruptions on power lines connected to the plants. If a degraded power line were called into service during an emergency, the reactor's motors, pumps and valves could burn out, preventing a safe shutdown."[33]

The NRC engineers point to the fact that this important accident precursor at Byron has occurred thirteen times in the past 14 years. The petition states that in February of 2013, "the staff determined that all nuclear facilities are susceptible to this design vulnerability except one plant and recommended that NRC takes prompt regulatory action." [34]

The fact that the Nuclear Regulatory Commission's own engineers have had to repeatedly break ranks and go public on four of the ten most risk significant events in the past decade reveals serious safety culture issues inside the NRC and the extent to which the Nuclear Regulatory Commission is captured by the industry it claims to regulate.[35]

(**NOTE:** Since Greenpeace first released our compilation of nuclear near misses, the Union of Concerned Scientists (UCS) has conducted an annual review of accident precursors. For detailed descriptions of many of the near misses mentioned in this report see UCS' annual reports.[36] All events and conditions considered accident precursors or nuclear near misses in the last decade are listed in the appendix.)

18 Near Misses at US Nuclear Plants: Flooding

Unfortunately, the three reactors at Duke Energy's Oconee Nuclear Station weren't the only nuclear reactors that were threatened by flooding. While the threat to Oconee certainly posed the greatest risk, NRC's Accident Sequence Precursor (ASP) program identified flooding risks at over a dozen other reactors that were so severe they made NRC's cut as an accident precursor or "near miss". While NRC's ASP program captured these vulnerabilities, it fails to address why the NRC or the nuclear corporations they license failed to identify these long standing safety issues.

Duration of Issue	Nuclear plant	FLOODING VULNERABILITIES FOUND AT US NUCLEAR REACTORS	NRC Rating	Year IDed
40 Years	Arkansas Nuclear 1	Inadequate External Flood Protection	YELLOW	2014
40 Years	Arkansas Nuclear 2	Inadequate External Flood Protection	YELLOW	2014
36 Years	St. Lucie 1	Reactor Auxillary Building Flooding	WHITE	2014
31 Years	Ginna	Potential Flooding of Vital Battery Room	WHITE	2013
31 Years	Sequoyah 1	Diesel Generators Vulnerable to Flooding	WHITE	2013
30 Years	Sequoyah 2	Diesel Generators Vulnerable to Flooding	WHITE	2013
29 Years	Kewaunee	Failed to Protect Safety Related Equipment	YELLOW	2005
21 Years	Dresden 2	Procedure Fails to Address External Flooding	WHITE	2013
21 Years	Dresden 3	Procedure Fails to Address External Flooding	WHITE	2013
17 Years	Point Beach 1	Failed to Protect Safety Related Equipment	WHITE	2013
17 Years	Point Beach 2	Failed to Protect Safety Related Equipment	WHITE	2013
6 Years	Ft Calhoun	Failed to Protect Heat Sink Cooling Water	YELLOW	2010
2 Years	Oconee 1	Failed to Maintain SSF Flooding Boundary	WHITE	2006
2 Years	Oconee 2	Failed to Maintain SSF Flooding Boundary	WHITE	2006
2 Years	Oconee 2	Failed to Maintain SSF Flooding Boundary	WHITE	2006
1 Year	Monticello	Failure to protect Site from External Flooding	YELLOW	2013

Table 2

Near Misses at US Nuclear Plants: Loss of Offsite Power

The NRC and the nuclear industry only captured the majority of flooding vulnerabilities AFTER the triple meltdown at Fukushima forced the agency to take a closer look. These long standing vulnerabilities to flooding represent holes in NRC safety net and call into question the caliber and quality of NRC's licensing and relicensing schemes. How can major safety flaws go undetected through not one but two licensing processes and decades of NRC inspections?

Year	Nuclear Plant	Description	Risk
2014	Millstone 2	Dual Unit LOOP and Reactor Scram	1X10-5
2014	Millstone 3	Dual Unit LOOP and Reactor Scram	2X10-5
2013	Pilgrim	LOOP and Reactor Scram	3X10-5
2013	Pilgrim	LOOP events due to Winter Storm Nemo	8X10-5
2013	LaSalle 1	Dual Unit Loss of Offsite Power due to Lightning Strike	1X10-5
2013	LaSalle 2	Dual Unit Loss of Offsite Power due to Lightning Strike	1X10-5
2013	Arkansas Nuclear 1	Generator Stator Drop Causes Unit 1 LOOP	4X10-6
2013	Arkansas Nuclear 2	Generator Stator Drop Causes Unit 2 Trip	4X10-6
2012	Oyster Creek	Reactor Scram & Loss of Offsite Power	5X10-5
2012	Browns Ferry 3	Reactor Trip & Subsequent Loss of Offsite Power	2X10-5
2012	Byron 2	Transformer & breaker failures cause LOOP & Trip	1X10-4
2012	Wolf Creek	Multiple Switchyard Faults Cause Reactor Trip & LOOP	5X10-4
2011	North Anna 1	Dual Unit Loss of Offsite Power due to earthquake	2X10-4
2011	North Anna 2	Dual Unit Loss of Offsite Power due to earthquake	4X10-5
2011	Browns Ferry 1	Extended Loss of Offsite Power & Shutdown Cooling	1X10-5
2011	Browns Ferry 2	Extended Loss of Offsite Power & Shutdown Cooling	1X10-5
2011	Browns Ferry 3	Extended Loss of Offsite Power & EDG Unavailable	1X10-5
2011	Surry 1	LOOP & Switchyard Damaged by Tornado	9X10-5
2011	Surry 2	LOOP & Switchyard Damaged by Tornado	7X10-5

As the world witnessed at Fukushima, the loss of offsite power to cool the radioactive fuel can lead to a meltdown with devastating consequences. The NRC's web site states that, "the availability of ac power to commercial nuclear power plants is essential for safe operations and accident recovery. A loss of offsite power (LOOP) event, therefore, is considered an important contributor to total risk at nuclear power plants." [37]

The NRC Accident Sequence Precursor program identified a statistically significant increase in Loss of Offsite Power near misses at US reactors. This increase is due to the occurrence of 20 losses of off site power in just the last 4 years.

The U.S. Nuclear Regulatory Commission has long recognized that:

> Loss of offsite power (LOOP) can have a major negative impact on a power plant's ability to achieve and maintain safe shutdown conditions. Risk analyses suggest that loss of all alternating current power contributes over 70% of the overall risk at some U.S. nuclear plants.[38]

According to NRC, typically all loss of off site power events are risky enough to be considered accident precursors or near misses.[39]

NRC's Missing Near Misses

Greenpeace's analysis of the U.S. Nuclear Regulatory Commission's accident sequence precursors or near misses over the past decade reveals that three of the most risk significant conditions discovered by NRC regulators over the past ten years never made it into the NRC accident sequence precursor program. As the chart of Important near misses reveals, only five near misses in the past decade posed more risk than the triple meltdown threat to Duke Energy's Oconee nuclear power plant.

According to NRC's risk analysis the threat to the three reactors at Oconee from flooding caused by failure of Jocassee dam was 2.8 X 10-4.[41] This level of risk makes the threat an important precursor that should have been captured by the NRC's Accident Sequence Precursor program and detailed in the reports NRC issues on an annual basis. The graphic below, only publicly released by the NRC under the Freedom of Information Act, shows the flooding risk at the Oconee nuclear plant compared to the other threats to the nuclear plant that the NRC requires Duke Energy to defend against.

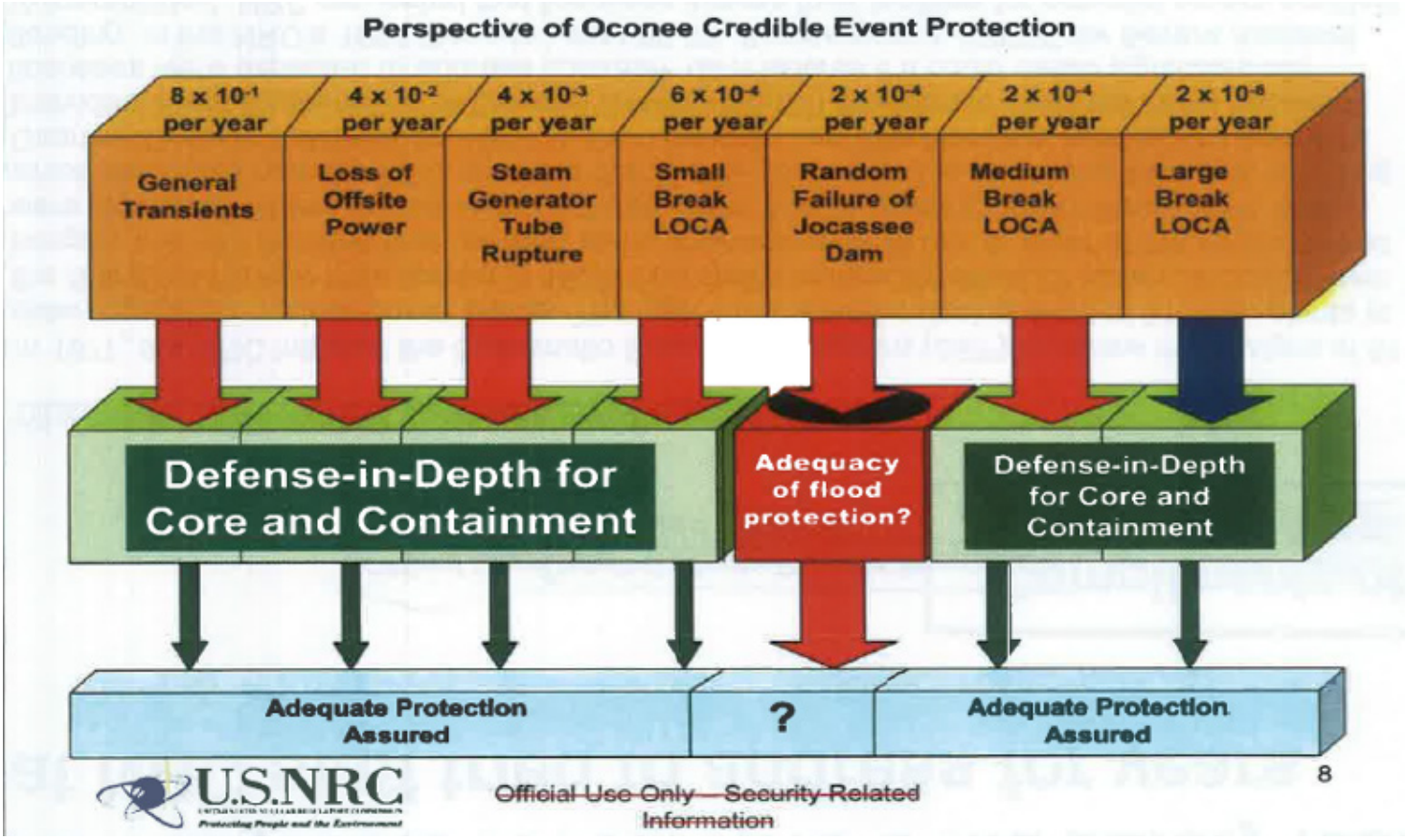


Table 3

While the NRC claims to conduct “its regulatory responsibilities in an open and transparent manner,”[42] the agency has been anything but open and transparent when dealing with the triple meltdown threat at the Oconee nuclear power plant. In fact, the NRC has attempted to withhold information concerning this long standing safety issue by claiming the flooding threat was a security issue. The NRC repeatedly stamped documents:

Limited Internal Distribution Permitted
Official Use Only - Security-Related Information

However according to a September 2012 letter from a NRC Reliability Risk Engineer to then NRC Chairman Alison McFarlane:

“There is nothing in the letter which is classified with regard to national security. There is nothing in the letter which is Safeguards. There is no discussion in the letter about any security related topics. In fact, an electronic word search of the letter only finds the word "security" in the "Security-Related Information"markings.

Why is this document for "Official Use Only"? Why is it "Security-Related Information"? Why is only "Limited Internal Distribution Permitted"? I see nothing in the 2008-08-15 letter from NRR/DORL to Duke Energy which prevents it from being released to the public. Is "transparency" still something we've committed to?”[43]

The NRC even withheld the letter cited above until the NRC Risk Engineer sued the agency for its release.[44] As documents released to Greenpeace under the Freedom Of Information Act detail, Duke Energy & the NRC failed to provide adequate protection against flooding since the plant was licensed. The NRC only began to realize this in 2006, when of the flooding vulnerability of Oconee’s safe shutdown facility made NRC risk analysts take a harder look.[45] If Jocassee dam fails, all three nuclear reactors at Oconee will meltdown; basically a Fukushima in South Carolina.[46]

Image: Children in FukushimaChildren walk along a road which had earlier been assessed by a Greenpeace team for radioactive contamination.

The NRC's report on flooding risks that Greenpeace provided to Huffington Post indicates that:

"The predicted flood would reach (Oconee Nuclear Station) in approximately 5 hours …The Failure scenario results are predicted such that core damage occurs in about 8 to 9 hours following the dam break and containment failure in 59 to 68 hours. When containment failure occurs, significant dose to the public would result."[47]

But rather than order the shut down of the nuclear plant until flooding defenses were in place, NRC entered into negotiations with Duke Energy to justify continued operation.

As the Oconee Timeline[48] reveals, the NRC staff struggled to get NRC senior management to address the flood threat in a timely manner. NRC staff was concerned that forcing Duke Energy to fix the long standing vulnerability would be an admission of NRC's "guilt". The timeline also reveals that NRC Commissioners and their technical assistants were repeatedly briefed on the lack of adequate protection at the Oconee nuclear plant. Despite the recognized threat it took NRC years to order Duke Energy to install temporary flooding mitigation at Oconee.

Excerpts from the seventeen page "Oconee Timeline,"[49] only released to Greenpeace through a 2012 Freedom Of Information Act (FOIA) request, reveal a disturbing pattern of regulatory inaction. The Oconee Timeline details the negotiations between Duke Energy & NRC from March 2008 - May 2009:

3/19/08	Duke Energy removed references to the SSF(Safe Shutdown Facility) wall and Jocassee Dam rupture from the FSAR (Final Safety Analysis Report) via NRC's 50.59 process.
4/10/08	NRC senior managment (Jack Grobe) wanted a full backfit analysis, "given Duke's record of fighting NRC."
4/29/08	NRC staff was concerned that forcing Duke to fix the flooding issue via a backfit was an admission of guilt
5/21/08	NRC Senior management (Jack Grobe) felt NRC "did not have an adequate protection argument" but "couldn't define adequate protection."
6/11/08	Duke claimed that the flooding threat was incorrectly added to the FSAR (Final Safety Analysis Report) so they felt they could remove it.
8/4/08	Questions from Ed Williamson on acceptance of Oconee's license renewal application (it turns out we lack grounds to rescind granting their license renewal)
8/6/08	NSIR(Nuclear Security & Incident Response) classified a meeting on Oconee flood risk as SGI (safeguards information) & had to hang up on NRC region II Vic McCree.
8/12/08	NSIR determined that this is not SGI based on several reasons, one of which was the potential (radioactive) release exceeding 10 CFR 100 guidelines. Can classify as OUO -SRI (official use only - security related information)

8/12/08 NRC Commissioners Technical Assistants were brief on August 12. 2008.

8/13/08 NRC Commissioner Svinicki had questions concerning NRC's 50.54 (f) (demand for information) letter to Duke Energy on August 13, 2008 and NRC staff prepared an Oconee timeline for Commissioner Svinicki the following day.

8/20/08 NRC considered issuing a Confirmatory Action Letter (CAL) to Duke as early as August of 2008. (CAL was only issued to Duke on June 22, 2010)

8/20/08 NRC staff discussed briefing Congress & need to summarize Oconee for Oversight Staffers.

8/27/08 NRC senior management (Jack Grobe) "expressed a desire to soften the message to Duke."

9/10/08 NRC contact to Senator Boxer's Office regarding why NRC did not order Oconee to shut down.

10/6/08 Briefing of NRC senior management "Eric Leeds is set for 10/16/08 with I'm briefing the Chairman on 10/17/08.

10/30/08 NRC senior management (Jack Grobe) "suggested a 6-year allowance to Duke to operate with this vulnerability with a renewal period."

12/23/08 Duke claimed inundation levels might exceed 9 feet.

2/3/09 Commissioner Lyons visit to Oconee and Jocassee sites.

3/6/09 DRA (Division of Risk Assessment) reviewed timeline Jack Grobe prepared for commissioners during the RIC.

5/11/08 Meeting at Duke HQ: Jack Grobe reiterated the NRC position that this is an adequate protection issue not a PRA issue. Duke argued that NRC in the past did not cite Yankee Rowe on not having adequate protection against failure of the Harriman Dam as precedent.[50]

According to NRC documents released to Greenpeace under FOIA, the NRC had prepared a communications plan to to explain to the media, "Why did the Oconee flood issue take so many years to address?"[51] NRC wanted the permanent fixes to the flooding vulnerabilities at Oconee completed by February 2016. Duke Energy wanted to put off permanent mitigation measures until February 2019.[52] As of April 2016, almost a decade after NRC first discovered the triple meltdown threat, permanent flooding fixes to protect Duke's Oconee nuclear plant are still not completed.


Jocassee Dam
Jocassee Dam and
Oconee Nuclear Station [2]
Keowee Dam
Oconee Nuclear
Station
Devils Fork
State Park
Salem
Mile Creek
County Park
Lake
Keowee
Pickens Hwy
Cherokee Foothills Scenic Hwy
Shady Grove Rd
Crow Creek Rd
Stamp Creek Rd
11
130
133
183
188
137

Did the NRC mislead Congress?

Despite the fact that several NRC Commissioners and their technical assistants had been briefed on the threat to Duke's Oconee nuclear power plant in 2008. The NRC testified to Congress that Fukushima couldn't happen here and claimed that US nuclear plants were "safe".

On March 15, 2012, the Senate Environment and Public Works committee conducted a hearing on nuclear safety one year after Fukushima. Senator John Barrasso (R-WY) cited a Union of Concerned Scientists (UCS) report that concluded Fukushima could happen here and asked the NRC's Commissioners if they agreed:

"Commissioner Magwood: I think that our infrastructure, our regulatory approach,our practices at plants, our equipment, our configuration, our design bases would prevent Fukushima from occurring under similar circumstances at a U.S. plant. I ust don't think it would happen.

Commissioner Svinicki: I agree with my colleagues.

Commissioner Apostolakis: I disagree with the statements from UCS.
I don't think that what happened in Fukushima can happen here.
Commissioner Ostendorff: I also disagree with the UCS report."[53]

While only Commissioners Svinicki & Jaczko were on the Commission in the 2008-2009 time frame covered by the Oconee Timeline, Commissioners Magwood, Apostolakis & Ostendorff all served on the Commission at the time NRC sent the Confirmatory Action Letter to Duke Energy in June of 2010.[54] Each of these three commissioners also visited both Oconee and Jocassee dam and were briefed in 2010. [55]

According to the NRC's Inspector General, the NRC knew about the triple meltdown threat at Oconee since at least 2008:

"Based on these concerns, the NRC issued a 10 CFR 50.54 (f) letter in August 2008 requesting information from Duke. Duke responded in September 2008 and after review the NRC found that Duke did not demonstrate that ONS (Oconee Nuclear Station) would be adequately protected from external flooing events."[56]

While the NRC briefed Senate Oversight staff in 2008 to explain why the Commission had failed to required the shutdown of the Oconee reactors until the threat had been mitigated, the NRC never publicly acknowledge that if Jocassee dam failed all three Oconee reactors were certain to melt down. Instead, NRC wrapped the known vulnerability in security clearances and failed to make public the documents that determined that the NRC had failed to meet its statutory duty to adequately protect the public. The 50.54 (f) letter demanding information from Duke Energy, Duke's response, even the NRC's confirmatory action letter to force Duke to install temporary mitigation of the triple meltdown vulnerability, were only made public under the Freedom of Information Act after NRC whistleblowers broke the story in the press.[57]

Contrary to the claims made by the four NRC's Commissioners in Senate testimony, the flooding vulnerabilities at Duke's Oconee Nuclear Station were actually more significant than the risks that resulted in the triple meltdown at Fukushima. In fact, the threat to all three Oconee reactors was hundreds of times more probable than the tsunami that struck Japan and caused the Fukushima meltdowns. [58]
As NRC's risk analysts related to Huffington Post:

"The Nuclear Regulatory Commission staff may be motivated to prevent the disclosure of this safety information to the public because it will embarrass the agency. The redacted information includes discussion of, and excerpts from, NRC official agency records that show the NRC has been in possession of relevant, notable, and derogatory safety information for an extended period but failed to properly act on it. Concurrently, the NRC concealed the information from the public."[59]

After reviewing thousands of pages of NRC documents released under FOIA over the past three years, Greenpeace concurs with this conclusion. The NRC's failure to make public the documents that revealed the threat to all three reactors at Duke Energy's Oconee Nuclear Station has only served to significantly delay the final resolution of nuclear near misses that are even more risk significant than those that caused the fiasco at Fukushima Daiichi in Japan.

Conclusion

Greenpeace's compilation and review of nuclear near misses at US nuclear plants over the last decade found over 160 events or conditions that were so risk significant that the US regulators consider them precursors to a core melt accident or melt down. Contrary to the claims made by NRC Commissioners these risks make nuclear power anything but "safe". Ten of these near misses were considered important precursors yet NRC staff had to blow the whistle and go public on four of the top ten near misses in order to force the U.S. Nuclear Regulatory Commission to address long standing vulnerabilities and safety issues at US nuclear plants.

Despite the fact that NRC Commissioners testified to Congress that "Fukushima couldn't happen here," NRC's own data revealed flooding vulnerabilities at reactors that had existed for years sometime decades but were only identified AFTER the triple meltdown in Japan. Contrary to NRC testimony to Congress, the NRC was aware of the triple meltdown threat to Duke Energy's Oconee nuclear station as early as 2006. By 2008 the NRC Commissioners and was aware that Duke Energy had failed to provide "adequate protection of the public health and safety," at Oconee Nuclear Station. However, NRC allowed the nuclear plant to continue to operate for another two years before requiring temporary mitigation measures be put in place. NRC hid the triple meltdown threat from the public claiming security concerns. However NRC whistleblowers contend and FOIA documents released to Greenpeace support their contention that NRC's withheld safety information to avoid embarrassment. This only served to delay final resolution of a long standing triple melt down threat that was hundreds of times more probable than the events that led to Fukushima. As of April 2016, nearly a decade after NRC first discovered the flooding threat at Oconee, Duke Energy still has not completed the permanent flood mitigation measures to prevent a Fukushima in South Carolina.

Unfortunately, Duke Energy's Oconee nuclear plant wasn't the only one to be threatened by flooding. Over a dozen other nuclear plants had similar vulnerabilities some that dated back decades. Yet the NRC only discovered these long standing flooding vulnerabilities at US nuclear plants after the tragedy at Fukushima forced the agency to take a closer look. By failing to act upon known safety vulnerabilities at US nuclear plants the NRC has only served to further undermined public confidence in government and it's regulation of this most unforgiving technology.

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Appendix A: Nuclear Near Miss Events 2004-2014

YEAR	Reactor	Event Discription	CCDP
5/25/14	Millstone 2	Dual Unit LOOP and Reactor Scram	1X10-5
5/25/14	Millstone 3	Dual Unit LOOP and Reactor Scram	2X10-5
1/21/14	Calvert Cliffs 2	Reactor Trip due to weather related water intrusion	5X10-6
1/14/14	Shearon Harris	Manual Reactor rip due to Indications of a fire	6X10-6
12/9/13	Arkansas Nuclear 2	Fire and Explosion of Unit Auxiliary Transformer	2X10-6
10/14/13	Pilgrim	LOOP and Reactor Scram	3X10-5
4/17/13	La Salle 1	Loss Of Offsite Power due to lightning strike	1X10-5
4/17/13	La Salle 2	Loss of Offsite Power due to lightning strike	1X10-5
3/31/13	Arkansas Nuclear 1	Dropped Generator Stator causing Unit 1 LOOP while shutdown	Yellow
3/31/13	Arkansas Nuclear 2	Dropped Generator Stator caused Unit 2 trip with loss of switchgear	Yellow
2/8/13	Pilgrim	Loss Of Offsite Power due to winter storm NEMO	8X10-5
12/22/12	Browns Ferry 2	Unplanned automatic scram due to loss of power to RPS	2X10-5
7/23/12	Oyster Creek	Turbine generator trip & reactor scram after a Loss of Offsite Power	5X10-5
5/24/12	River Bend	Loss of service water, circulating water & feedwater due to electrical fault	3X10-4
5/22/12	Browns Ferry 3	Reactor trip & Loss of Offsite Power due to failure of station transformer relay	2X10-5
4/4/12	Catawba 1	Reactor trip casued by faulted reactor coolant pump cable & error in relay	9X10-6
1/30/12	Byron 2	Loss of Off Site Power and reactor trip caused by transformer & breaker failures	1X10-4
1/13/12	Wolf Creek	Loss of Offsite Power and reactor trip caused by multiple switchyard faults	5X10-4
9/25/11	Palisades	Reactor Trip caused by loss of 125 volt direct current train	Yellow
8/23/11	North Anna 1	LOOP due to earthquake Aux Feed Water Pump unavailable	3X10-4
8/23/11	North Anna 2	LOOP due to earthquake Aux Feed Water Pump unavailable & EDG failure	4X10-5
5/10/11	Pilgrim	Unrecognized subcriticality and return to criticality with subsequent scram	White
4/27/11	Browns Ferry 1	Extended LOOP due to tornado EDG unavailable & loss of shutdown cooling	1X10-5
4/27/11	Browns Ferry 2	Extended LOOP due to tornado EDG unavailable & loss of shutdown cooling	1X10-5
4/27/11	Browns Ferry 3	Extended Loss of Offsite Power due to tornado with EDG unavailable	1X10-5
4/16/11	Surry 1	Loss of Offsite Power due to switchyard damage by a tornado	9X10-5
4/16/11	Surry 2	Loss of Offsite Power due to switchyard damage by a tornado	7X10-5
9/9/10	H.B. Robinson	Reactor Trip due to degraded circuit board connection	3X10-6
7/16/10	Susquehanna 1	Manual scram due to circulating water system leak & flooding of condenser bay	4X10-6
6/8/10	Surry 1	Reactor Trip due to loss of electrical bus & additioanl complictions	5X10-6
3/28/10	H.B. Robinson	Fire cauases partial LOOP with reator coolant pump seal challenges	4X10-4
2/18/10	Calvert Cliffs 2	Failure of EDG to start during partial Loss Of Offsite Power	2X10-5
8/19/09	Wolf Creek	Loss of Off Site Power due to lightning strike	9X10-6
7/30/09	Braidwood 2	LOOP coincident with a reactor trip due to loss of reactro coolant pumps	4X10-5
7/12/09	Oyster Creek	LOOP with unavailability of isolation condenser due to foreign material	5X10-5

3/26/09	Sequoyah 1	Partial LOOP causes reactor trips & extended LOOP to safety bus in both units	4X10-6
3/26/09	Sequoyah 2	Partial LOOP causes reactor trips & extended LOOP to safety bus in both units	4X10-6
11/3/08	Dresden 3	Inadvetent, uncontrolled control rod withdrawl by non licensed operators.	White
9/11/08	Monticello	Trip with partial loss of off site power due to blown fuse	1X10-5
4/15/08	Oconee 1	Loss of reactor coolant system inventory while shutdown	White
11/1/06	Brunswick 2	Loss of auxiliary transformer causes manual reactor protection system actuation	6X10-6
10/19/06	River Bend	Automatic reactor scram due to inadvertent isolation of main feedwater	3X10-6
10/11/06	Surry 2	Partuial Loss of Offsite Power and subsequent reactor trip	2X10-6
5/20/06	Catawba 1	Loss of Offsite Power to both reactors	9X10-5
5/20/06	Catawba 2	Loss of Offsite Power to both reactors	6X10-5
3/8/06	Turkey Point 3	Loss of Residual Heat Removal while in Mode 5 due to electrical complications	White
2/23/06	Millstone 2	Reactor Trip due to loss of instrument air	8X10-6
8/29/05	Waterford	Loss of Offsite Power caused by Hurricane Katrina while plant was shut down	2X10-6
6/23/05	Columbia	Reactor trip due to feedwater pump trip caused by maintenance error	1X10-5
4/17/05	Millstone 3	Reactor trip & safety injection with failure of turbine driven aux feed water pump	3X10-6
2/22/05	Watts Bar	Low temperature over pressure valve actuations while shut down	7X10-6
12/10/04	River Bend	Reactor trip due to loss of non vital 125V instrument bus	3X10-5
11/20/04	Vogtle 2	Reactor trip with safety injection & full-open demand from steam by pass valves	3X10-6
10/10/04	Hope Creek	Manual reactor scram due to moisture seperator reheater drain line failure	3X10-6
9/25/04	St. Lucie 1	Loss of Offsite Power due to Hurricane Jeane while plant was shut down	1X10-5
9/25/04	St. Lucie 2	Loss of Offsite Power due to Hurricane Jeane while plant was shut down	1X10-5
6/14/04	Palo Verde 1	Grid related LOOP with offsite power recovery complications	9X10-6
6/14/04	Palo Verde 2	Grid related LOOP with an emergency diesel generator unavailable	4X10-5
6/14/04	Palo Verde 3	Grid related LOOP with offsite poweer recovery complications	9X10-6
5/5/04	Dresden 3	Plant centered LOOP due to breaker malfunction	3X10-6
1/4/04	Calvert Cliffs 2	Reactor trip due to loss of main feedwater & complicated by overcooling	2X10-5

Appendix B: Nuclear Near Miss Conditions 2004-2014

Duration of Condition	Nuclear Reactor	Description of Condition	CDP/SDP Color	Citation
Since start up	Kewaunee	Multiplle design deficiencies and potential unavailability of AFW pumps	YELLOW	LER-305/05-002, 006, 008
Since start up	Clinton	Potential air entrapment of HPCS due to incorrect suction source switchover setpoint	WHITE	EA-06-291
Since start up	Kewaunee	Design deficiency could cause unavailability of safety related equipment during postulated internal flood	YELLOW	LER-305/05-004
Since start up	Surry 1	Potential loss of reactor coolant pump seal cooling due to postulated fire damage to switch gear	WHITE	LER-280/-3-005
Since start up	Surry 2	Potential loss of reactor coolant pump seal cooling due to postulated fire damage to switch gear	WHITE	LER-280/-3-005
Since start up	Turkey Point 3	Triennial fire protection issues	WHITE	LER-251/04-007
Since start up	Turkey Point 4	Triennial fire protection issues	WHITE	LER-251/04-007
40 Years	Arkansas Nuclear 1	Inadequate External Flood Protection for Safety Related Equipment Located Below the Design Basis Flood Elevation	YELLOW	EA-14-088
40 Years	Arkansas Nuclear 2	Inadequate External Flood Protection for Safety Related Equipment Located Below the Design Basis Flood Elevation	YELLOW	EA-14-088
39 Years	Fort Calhoun	High Energy Line Break could lead to failure of equipment for safe shutdown	WHITE	EA-14-187
36 Years	St. Lucie 1	Internal Reactor Auxiliary Building Flooding During Heavy Rain Due to degraded conduits lacking internal flood barriers	WHITE	EA-14-131
34 Years	Prairie Island 2	Potential unavailability of component cooling water during HELB due to inadequate design	WHITE	EA-09-167
33 Years	Millstone 2	Un planned reactivity additions during main turbine control valve testing	WHITE	EA-11-047
31 Years	Ginna	Unanalyzed condition for Potential Flood water intrusion into Vital Battery Room	WHITE	EA-13-247
31 Years	Sequoyah 1	Inadequate electrical conduit seals for Essential Raw Cooling Water Pumping Station could result in the loss of diesel generators during a flooding event	WHITE	EA-13-045
31 Years	St Lucie 1	Air intrusion into component cooling water system causes pump cavitation	YELLOW	EA-09-321
30 Years	Sequoyah 2	Inadequate electrical conduit seals for Essential Raw Cooling Water Pumping Station could result in the loss of diesel generators during a flooding event	WHITE	EA-13-045

28 Years	Oconee 1	Failure to maintain design control of standby shutdown facility (SSF) pressure heater breakers	YELLOW	EA-11-226
28 Years	Oconee 2	Failure to maintain design control of standby shutdown facility (SSF) pressure heater breakers	YELLOW	EA-11-226
28 Years	Oconee 3	Failure to maintain design control of standby shutdown facility (SSF) pressure heater breakers	YELLOW	EA-11-226
23 Years	Oyster Creek	Technical Specification Prohibited Condition caused by Two Electromagnetic relief valves inoperable for greater than allowed outage time	YELLOW	EA-14-178
21 Years	Dresden 2	Failure ot establish procedure to address tyler effect of external flooding ont he plant	WHITE	EA-13-079
21 Years	Dresden 3	Failure ot establish procedure to address tyler effect of external flooding ont he plant	WHITE	EA-13-079
18 Years	Browns Ferry 2	Failure to protect cables of redundant safety systems from fire damage	YELLOW	EA-09-307
17 years	Point Beach 1	Flooding Procedure Failed to protect safety related equipment	WHITE	EA-13-125
17 years	Point Beach 2	Flooding Procedure Failed to protect safety related equipment	WHITE	EA-13-125
15 Years	Prairie Island 1	Battery chargers potentially inoperable	WHITE	EA-11-110
13 Years	Cooper	Deficient emergency procedures could lead to operators failing to position valves necessary for core cooling in a postulated fire	WHITE	EA-11-024
13 Years	Browns Ferry 3	Failure to protect cables of redundant safety systems from fire damage	YELLOW	EA-09-307
13 Years	LaSalle 1	Single Failure Vulnerability of 4160 volt bus protective relay	WHITE	LER-373/05-001
13 Years	LaSalle 2	Single Failure Vulnerability of 4160 volt bus protective relay	WHITE	LER-373/05-001
11 Years	Palo Verde 1	Containment sump recirculation potentially inoperable due to pipe voids	WHITE	LER-528/04-009
11 Years	Palo Verde 2	Containment sump recirculation potentially inoperable due to pipe voids	WHITE	LER-528/04-009
11 Years	Palo Verde 3	Containment sump recirculation potentially inoperable due to pipe voids	WHITE	LER-528/04-009
10 Years	Oconee 1	High Cycle Fatigue resulted in Reactor Coolant Leak	WHITE	EA-14-091
10 Years	Cooper	Inadequate post fire procedure could have prevented achieving safe shutdown	WHITE	EA-07-204
10 Years	Crystal River 3	Single Failure Vulnerability of 4160 volt bus protective relay	WHITE	LER-302/05-001

9 Years	Oyster Creek	Technical Specification Prohibited Condition caused by Emergency Deisel Generator inoperable for greater than allowed outage time	WHITE	EA-14-126
9 Years	Calvert Cliffs 1	Degraded EDG due to inadequate feed breaker	WHITE	LER-317/06-001
6 Years	Fort Calhoun	Failure to establish and maintain procedures to protect heat sink cooling water intake and auxiliary building from external floods	YELLOW	EA-10-084
4 Years	San Onofre 2	Deficient electrical connections with potential to affect multiple safety systems	WHITE	EA-08-296
3 Years	Palisades	Failure of service water pump	WHITE	EA-11-241
2 Years	Turkey Point 3	AFW pump inoperable for longer than allowed by tech specs	WHITE	EA-06-027
2 Years	Oconee 1	Failure to maintain design control for safe shutdown facility flooding boundary	WHITE	EA-06-199
2 Years	Oconee 2	Failure to maintain design control for safe shutdown facility flooding boundary	WHITE	EA-06-199
2 Years	Oconee 3	Failure to maintain design control for safe shutdown facility flooding boundary	WHITE	EA-06-199
19 Months	Browns Ferry 1	Failure to establish adequate design control and perform adequate maintenance led to valve failure and residual heat removal loop unavailable	RED	EA-11-018
19 Months	Fort Calhoun	Fire in safety related 480n volt electrical breaker due to deficient design control; 8 other breakers were also susceptible	RED	EA-12-023
19 Months	Browns Ferry 1	Failure to protect cables of redundant safety systems from fire damage	YELLOW	EA-09-307
14 Months	Oconee 2	Standby shutdown facility reactor coolant make up let down line oriface strainer blocked by valve gasket	YELLOW	EA-10-094
454 Days	Fort Calhoun	Faulty maintenance causes inoperability of containment spray	WHITE	EA-07-047
1 Year	Millstone 3	Turbine Driven Auxiliary Feedwater Pump Operability imapcted by Incorrect Bearing	WHITE	EA-14-092
1 Year	Monticello	Failure to maintain flood plan to protect the site against external floods	YELLOW	EA -13-096
1 Year	Byron 1	Corrosion of equipment cooling water system piping	WHITE	EA-08-046
1 Year	Byron 2	Corrosion of equipment cooling water system piping	WHITE	EA-08-046
1 Year	Brunswick 1	All EDG unable to be operated locally due to incorrect relay wiring	WHITE	EA-09-121
1 Year	Brunswick 2	All EDG unable to be operated locally due to incorrect	WHITE	EA-09-121

Appendix C: Nuclear Near Misses Not Modeled in PRA

FY	Plant	Event Description
2009	St. Lucie 1	Air intrusion into component cooling water system causes pump cavitation. ***EA-09-321***
2009	Dresden	Failure to prevent inadvertent, uncontrolled control rod withdrawal by nonlicensed operators. ***EA-09-172***
2009	Browns Ferry 1, 2, 3	Failure to protect cables of redundant safety systems from fire damage. ***EA-09-307***
2008	Prairie Island 2	Potential unavailability of the component cooling water system during a postulated high-energy line break due to inadequate design. ***EA-09-167***
2008	Byron 1 & 2	Corrosion of equipment cooling water system piping. ***EA-08-046***
2008	San Onofre 2	Deficient electrical connections with potential to affect multiple safety systems. ***EA-08-296***
2008	Oconee 1	Procedure error leads to loss of reactor coolant system inventory while shutdown (Mode 6). ***EA-08-324***
2007	Cooper	Inadequate post-fire procedure could have prevented achieving safe shutdown. ***EA-07-204***
2007	McGuire 1 & 2	Potential inoperability of service water strainer backwash system during accident conditions. ***EA-08-220***
2006	Clinton	Potential air entrapment of high-pressure core spray because of incorrect suction source switchover set point. ***EA-06-291***
2006	Oconee 1, 2, 3	Failure to maintain design control for the standby shutdown facility flooding boundary. ***EA-06-199***
2005	Kewaunee	Design deficiency could cause unavailability of safety-related equipment during postulated internal flooding. ***EA-05-176***
2005	LaSalle 1 & 2 Crystal River 3	Single-failure vulnerability of safety bus protective relay schemes caused by common power metering circuits. ***EA-05-103, EA-05-114***
2005	Watts Bar	Component cooling backup line from essential raw cooling water was unavailable because silt blockage. ***IR 50-390/04-05***
2005	Watts Bar	Low-temperature, overpressure valve actuations while shut down. ***EA-05-169***
2004	Calvert Cliffs 2	Failed relay causes overcooling condition during reactor trip. ***LER 318/04-001***
2004	Palo Verde 1, 2, 3	Containment sump recirculation potentially inoperable because of pipe voids. ***LER 528/04-009***

Appendix D: Oconee Timeline

Oconee Timeline

Date	Summary of Events
3/4/08	• Action plan meeting with DORL (Tim McGinty, Melanie Wong, and Lenny Olshan) in Mark Cunningham's office. o Decided on a simultaneous action plan to concentrate on Oconee and generic industry issues. o Compliance backfit was discussed as a possible route. o Mark was to contact RES on the GSI/USI program with a possible memo to Chris Liu. • Reviewed the draft TIA from Region II. Mike Franovich told Region II (Bob Carroll ?) that we will incorporate it into our action plan.
3/18/08	• Kamal Manoly put Raman Pichumani on the team. • Kamal claimed that Oconee was in compliance with licensing basis however, Raman was unable to find any reference to it. • DRA gave guidance to have Raman and Lenny Olshan to speak with Donnie Harrison (then in DSS) and check on the Giambusso letter. • Ken See (NRO) suggested that NRC perform its own flood inundation study.
3/19/08	• Met with Jack Grobe and DORL, DE, and DRA on action plan. o Jack complained that we did little to follow through after the WHITE finding in the ROP (however, he kept putting this meeting off for months). o The meeting turned into a discussion of the exact licensing basis for Oconee. o Explained to Jack how Duke removed the SSF wall and Jocassee Dam rupture from the FSAR using a 50.59 evaluation. o Lenny Olshan suggested that NRC do a flood height calculation without checking the licensing basis. Jack felt that we should know what the basis is for Oconee. o Raman and Lenny had little to show from their investigation of licensing basis outside of what DRA gave them. o Action plan to be completed by 3/21/08. • Met with Melanie Galloway, Mike Franovich, and Melanie Wong. Melanie Galloway wanted DRA to take the lead on this (despite LIC-202 and LIC-400 states that DORL should take the lead).
3/20/08	• Asked Raman to check with RES to try to "piggyback" on any existing contracts to do a flood inundation study. • Asked Mark Rubin regarding backfit. His branch contracts them out and he suggested contacting DPR.
3/21/08	• Initial action plan completed and sent to DORL and DRA management. • Lenny Olshan contacted Joe Golla in DPR on informing Duke of our intent to backfit the license.
3/24/08	• Brian Richter in DPR was tasked with the backfit/reg. analysis. • Melanie Galloway decided that NRC will not do an inundation analysis since she felt it was the responsibility of the licensee. • Raman Pichumani needed a copy of NSAC/60.
3/25/08	• DE concluded that the IPEEE was the licensing basis.
3/26/08	• Completed next revision of the action plan. • DRA entered it into MS Project.

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Oconee Timeline

Date	Summary of Events
3/27/08	• Scheduled next meeting with Jack Grobe. • Pat Hiland suggested to Jack that a 50.54(f) letter should be sent.
3/28/08	• Major comments from Melanie Galloway on action plan o Do not show descriptions. o Add sections from LIC-202. o No mention of flood inundation contract. o Postpone meeting with Jack until she returns to office. • Melanie reiterated that DRA has the lead.
4/1/08	• Action plan is rewritten with digital I&C template. • Discussions with DE on licensing basis and the IPEEE. • DE spoke with Donnie on Oconee licensing basis.
4/2/08	• Action plan written in new format.
4/3/08	• Internal DRA discussion on management direction taken on action plan.
4/7/08	• Further review by Mark Cunningham on action plan. • Melanie asked for all the work from DE done to date on licensing basis before next meeting with Jack.
4/8/08	• Further revision to action plan with new completion dates.
4/9/08	• Met with Melanie Galloway to postpone meeting with Jack. o Requested that DE do more work on licensing basis. o Additional comments on action plan.
4/10/08	• Pre-meeting with DE and DORL. o Raman discussed the 50.59 that Duke had performed removing the wall and Jocassee Dam failure from the FSAR. o Discussed performing a compliance backfit exception vs. a full backfit. o DORL was to check with OE on enforcement options of having Duke restore the wall and Jocassee Dam failure to the FSAR. o DORL was to check with Eileen McKenna on the 50.59 evaluation that Duke performed. o DE was to check with FERC on the flooding analysis. o Checked on whether license renewal SAMA table was still valid. • Met with Melanie Galloway who presented a bulleted list of concerns and additional comments to the action plan. • Met with Jack Grobe (DE, DORL, and DRA). o Jack was satisfied with progress made. o Compliance backfit exception option will be explored by 4/29/08. o Jack expressed that a full backfit should be done given Duke's record of fighting NRC. • Melanie met privately with Jack to further discuss actions and his praise of the team.
4/15/08	• Suggestion from Dave Beaulieu (DPR) that when it was in licensing basis, the SSF 5-ft wall records should maintained as part of Appendix B requirements. Passed on to DE and Region II to check into this.

Oconee Timeline

Date	Summary of Events
4/16/08	• Meeting with Melanie Galloway and Mike Franovich to establish a weekly schedule of separate meetings with responsible NRR management and staff level personnel. • Preparation of a bulleted list of pros and cons for a compliance backfit exception and a full backfit. • DE asked to search for modification package of the 5-ft wall from the licensee.
4/17/08	• Involved Jim Vail on searching for the original modification package for the wall. • Cliff Doutt gave some information on Oconee and the SSF construction. • Looked into pursuing a GL 91-18 (RIS-2005-20) path on operability assessments against the Oconee SSF.
4/18/08	• Gave package of information from Cliff Doutt to Raman to see if there is anything he can use on checking for licensing basis.
4/19/08	• Met with DE, DORL, and DPR. o Discussed proposed table from DORL on how to proceed. o Discussed the 50.59 Duke had done to remove Jocassee Dam failure and the 5-ft wall from the FSAR. Lenny Olshan told the group that Harold Chernoff agreed with him that a risk argument was an acceptable means in a 50.59 (??). o Agreed on getting OGC involved in further actions. o Agreed on a two-prong approach: ▪ Pursue the licensee's incorrect use of 50.59. ▪ Perform the regulatory analysis and backfit. • Mike Franovich did voice concerns that a backfit would be an admission that NRC did not regulate the licensee properly in that a flood protection requirement is a mistake.
4/23/08	• Mike Franovich put together a summary from the meeting of 4/19/08. • Melanie Galloway requested a summary of all backfit items that need to be done. • Had discussions on backfit with DPR.
4/24/08	• Work on backfit analysis plan.
4/28/08	• Put together a proposed schedule for the backfit. • Set-up an Access database of the schedule based on MS Project – Melanie wanted it to be similar to what Mark Cunningham uses. • Raman reviewed Oconee's mod. package on ASW. • DE put together a list of documents review to date for project.
4/29/08	• Met with Jack with DORL, DE, Melanie Galloway, and Mike Franovich. o Jack concluded that a backfit was a better approach to 50.59. o Mike argued over the backfit being an admission of guilt. o Kamal had confused the IPEEE with licensing basis arguing that we cannot change anything since we accepted their IPEEE submittal. o Jack felt that DRA should do the risk analysis portion for the backfit. • Discussed performing part of the backfit PRA analysis with Bob Palla of DRA/APLA.

Oconee Timeline

Date	Summary of Events
4/30/08	• Staff level meeting with DPR, DORL, and DE. o Summarized the meeting with Jack for Jake Zimmerman. o Informed the team that Bob Palla will be doing part of the risk analysis required for the backfit. o Jake suggested that we ask all the PMs in DORL on any plants with flooding vulnerabilities. o Discussed a LIC-504 meeting plan for the end of May 2008. • Walt Rogers (Region II) sent over a SWSOPI inspection report on Oconee which had mention of the discrepancy between the 5-ft wall and the inundation levels.
5/6/08	• Bob Palla completed the averted and replacement power costs for Oconee for both Jocassee Dam failure frequencies. • Staff level meeting where results were given to DPR. • Wrote a POP for Eric Leeds on Oconee flood project progress.
5/14/08	• Staff level meeting with DPR, DORL, DE. o Discussed the backfit analysis and some changes made to the averted costs. o George Wilson sent over some material from FERC on Jocassee Dam. o A discussion of LIC-504 was made. o Kamal reprised his IPEEE and licensing basis argument. • Prepared project flowchart for directors' level meeting on 5/15/08.
5/15/08	• SES level meeting. o Mike Case (DPR) advocated going to the licensee to get cost information – was not feasible due to the restrictions in LIC-202 on contacting licensees prior to backfit. o Pat Hiland wanted to know about leak-before-break and whether the Jocassee Dam inspections were different than other "high hazard" dams. • Asked Region II and the Oconee Resident to put together a package of material to answer the questions.
5/20/08	• Additional flowchart comments from Melanie Galloway.
5/21/08	• Met with Jack Grobe. o Expressed that he felt we did not have an adequate protection argument. Jack couldn't define adequate protection. o He did not want us to use LIC-504 formally. o On the backfit work, Jack wanted to triple radionuclide release fractions. o Jack wanted DORL to put together a 50.54(f) letter by 6/9/08. • Met with Steve Laur over using LIC-504. Steve discussed his experience with Jack using LIC-504 on past issues.
5/22/08	• DRA meeting with Geary Mizuno of OGC on adequate protection. o Geary discussed the history of the term and backfit o Decided that LIC-504 is necessary and expanded to invite directors to the proposed meeting.

Oconee Timeline

Date	Summary of Events
5/30/08	• LIC-504 meeting. o Steve Laur gave a presentation on the process. o Pat Hiland argued against pursuing flood protection on several points and was not convinced of the lack of adequate protection. o None of the developed options for review had the opportunity to be presented. o Andy Hutto (Oconee site Resident) by phone expressed concern over the condition of the roads after floodwaters recede. o Ed Williamson of OGC will work with us on any further actions. o SES concluded that a demand-for-information (50.54(f)) letter should be written and given to Jack for comment soon.
6/3/08	• Directors discussed adequate protection – Pat Hiland stated that he was convinced that there was a lack of adequate protection but, later recanted this. • Spoke with Bruce Boger on Oconee who admitted that although he has had some briefings with this staff, he doesn't understand all the specifics of the case. • Mike Franovich produced a draft flowchart on how to proceed after the LIC-504 meeting. Melanie Galloway advocated the previous parallel approach. Mike wanted complete management approval before proceeding with any approach.
6/4/08	• Met with Pat Hiland with DE, OGC and DORL. o Geary Mizuno discussed adequate protection. o Found out that the licensing basis was in the construction permit for Oconee. Lenny Olshan's argument that there was no flooding licensing basis was incorrect. Oconee is licensed to a draft version of GDC-2. Lenny admitted that he knew this all along but, didn't understand how this would help us in this project. o George Wilson discussed the "high hazard" dam classification and the inspection regime. • Lenny Olshan sent out a draft version of a 50.54(f) letter. • SES level meeting with Jack. o Got authorization to pursue the backfit.
6/11/08	• Further checked into the 50.59 argument Duke used to remove references in the FSAR. Duke claimed that it was incorrectly added to the FSAR so they felt that they can remove them.
6/12/08	• Got a copy of the Federal Register (Volume 32, Number 132, 7/11/67) which contained the draft GDC-2 that Oconee is licensed by.
6/13/08	• DORL presented a further revision to their draft 50.54(f) letter to Duke. o Jack Grobe wanted all licensing basis references removed.
6/18/08	• Discussed with DORL further points, structure, and references to add to the draft 50.54(f) letter.
7/8/08	• Jim Vail working on Information Notice on external flooding. • Planning on meeting with Jack Grobe due to his trip out of the office. • Transition plan on having someone else taking over the project.
7/9/08	• RES-sponsored discussion of flooding analysis and PMP with USBR (John England). • Met with Melanie Wong to discuss planning on OGC sessions with NRR SES on backfitting.

Oconee Timeline

Date	Summary of Events
7/11/08	• IN revised after checking LIC-503.
7/14/08	• Meeting with SES and Geary Mizuno. o Discussion of backfitting. o Discussions on pursuing a compliance backfit exception.
7/15/09	• Follow up meeting with SES (Mike Franovich attended). • Lenny Olshan to look into any 50.59 that was used for construction of the 5-ft wall around the SSF. He found the documentation that Duke stated the wall was built as a result of NSAC/60.
7/28/08	• Met with Eric Leeds and DE, DORL, DPR, and Bruce Boger. o Mike Franovich presented the POP and discussion of Oconee flood. o Kamal reprised his one IPEEE concern.
7/29/08	• Mike discussed a meeting that he and Melanie Galloway had with NSIR and DHS. o Meeting with Eric Leeds and Luis Reyes set for 8/1/08. o Will create a one-page summary.
8/1/08	• Meeting with Eric Leeds and OGC, DE, DORL, OE, and R-II (on videoconference). o Mike Franovich gave presentation on issue. o Eric and Luis decided to issue a 50.54(f) letter. o Eric and Luis will call Dave Baxter (Oconee site V-P).
8/4/08	• Further comments on the 50.54(f) letter draft from OGC. • Questions from Ed Williamson on acceptance of Oconee's license renewal application (it turned out that we lack grounds to rescind granting their license renewal).
8/5/08	• Met with staff to prepare for meeting with Bruce Mallett. o Preparation for telephone call to Duke Management. o Discussed what kind of analysis Duke would have to do. o Discussed possibility of issuing an order. • Mike met with Melanie Galloway regarding her SES meeting where Jim Wiggins expressed doubt that we can pursue this issue with Duke since they have already committed to installing MSIVs, performing HELB and tornado analyses. Joe Giitter learned of the lack of MSIVs during the meeting.
8/6/08	• Met in Bruce Mallett's conference room with NRR SES and Jim Wiggins. o NSIR initially classified meeting as SGI – had to hang up from Region II (Vic McCree). o Mike Franovich made the presentation. o Jim Wiggins was in favor of sending a regular correspondence (non-50.54(f)) to the licensee (this would violate the Paperwork Reduction Act). Jim wanted us to call the licensee only after we issue the letter. o Bruce Mallett was in favor of issuing a 50.54(f) letter based on his past experience with Duke. He was in favor of a pre-issue phone call.
8/7/08	• Met with DORL on preparation of "talking points" for the phone call to Duke. o Discussed Bruce Boger's idea of calling several days before issue of the letter. That idea was disbanded. o We decided to call Duke's compliance manager on the morning of the call with Eric Leeds and Luis Reyes. o Discussed points for the Commissioners' T/A briefing.

Oconee Timeline

Date	Summary of Events
8/8/08	• Further discussions with NSIR on removing this issue as SGI, downgrading it to OUO-SRI. Meeting was set for 8/11/08 cancelled.
8/12/08	• Met with NSIR. o Explained the background of the flooding concern. o NSIR determined that this is not SGI based on several reasons, one of which is the potential release exceeding 10 CFR 100 guidelines. o Can classify this as OUO-SRI. • Lenny Olshan got a call from the Oconee Regulatory Compliance Manager who received a call from local law enforcement asking, from DHS, for the zone security analysis records of Jocassee Dam. Lenny was asked not to speak with the licensee on this matter until Eric and Luis calls them. • Commissioners' T/A briefing. Mike Franovich made the presentation. • Staff meeting with DORL, DPR, and DE. o Despite sending the 50.54(f) letter, we are still continuing with the backfit path as a contingency.
8/13/08	• Jack Grobe had additional comments on the 50.54(f) letter. Had to remove and rewrite one of the questions (Question 2). Mike Franovich worked on it. • Answered simple question from Commissioner Svinicki on sending a 50.54(f) letter.
8/14/08	• Bruce Mallett called the Duke CNO. • Prepared timeline with Region II for Commissioner Svinicki. • Timeline to be used for call between Duke with Eric and Luis.
8/15/08	• Phone call between Duke with Eric and Luis. o Duke response that they were blindsided by this issue (??). o Duke Management expressed desire to fix this problem. • 50.54(f) letter issued to Duke.
8/19/08	• Impromptu meeting in Jack Grobe's office on possible face-to-face meeting with Oconee management. o Jack expressed his concern that he didn't want to engage the licensee in a meeting (being in a listening mode). o Len Wert should come up from Region II. o DRA to make a presentation along with DORL. • Mike Franovich had concerns over Jocasee Dam's seismic fragility. • Raman to work on contingencies to be taken on Duke's response.

Oconee Timeline

Date	Summary of Events
8/20/08	• Briefing with Mark Cunningham on Oconee flood generic aspects. o Discussed how GSI-154 was possibly prematurely closed out. o Jim Vail discussed progress with the Information Notice. o Mark wanted to discuss this directly with Mike Case (after speaking with Marty Murphy). • Mike Franovich received a call from John Zeiler (a rotational Commissioner's T/A from Region II) questioning split fractions Duke used and his concerns that Duke's evaluation of Jocassee Dam is more rigorous than ours. • Met with OPA/OCA and DORL on briefing Congress. o No set threshold for briefing Congress. o Waiting for Congress to reconvene after summer recess. o Need to summarize this for the approximately 14 Oversight Staffers. • Staff meeting with DORL, DE, DPR. o Discussed contingencies on the face-to-face meeting and letter response. o Mike Franovich discussed the possibility of a commitment with a Confirmatory Action Letter (CAL) from Duke. • Phone call to Duke Management on the letter with DORL, and Region II. o Duke claimed that they did not understand the questions in the letter and wanted an extension to the deadline. o We expressed the need for them to concentrate on response to the specific questions in the letter. o Face-to-face meeting within a week. o Duke wanted pre-decisional backfit bases which we refused to give them (LIC-202 and a DHS concern). Duke expressed need for information stating that law enforcement officials told them the NRC requires this information. o Duke stated that they did not understand the adequate protection argument. • Jack Grobe had a follow-up phone call with Duke and Mike Franovich on Duke's concern on dam failure frequency. Mike offered to discuss the details in a call on 8/21/08. • Melanie Galloway and Tim McGinty selected to give presentations during the face-to-face meeting.

Oconee Timeline

Date	Summary of Events

8/21/08	• Met with Craig Ehrlanger (NSIR) on our interface with DHS.
	  o Tentative meeting set with DHS representative to explain the Jocassee Dam concern on 8/25/08.
	  o Further meeting in September with Assistant DHS Secretary.
	  o Discussed very few aspects of the Buffer Zone Protection Plan related to Jocassee Dam but could not share or show us.
	  o Reminded Craig that Mark Cunningham discussed this issue with NSIR on November 2007.
	• Phone call with Duke Oconee Management, Duke Headquarters PRA, Region II, and the site Residents on the dam failure frequency.
	  o Jim Vail discussed the two failures counted for the failure frequency determination.
	  o Duke was not interested in discussing the apparent large discrepancy between our dam-year computations.
	  o Duke claimed that this call will help them put together an interim contingency plan while they concentrate on a long term corrective action.
	• Preparation of tables for the face-to-face meeting with Duke on initiating event frequencies and consequences. Made figures instead of table.

8/25/08	• Duke proposed an Oconee site meeting the week of 9/15/08 to tour the SSF and Jocassee Dam. We declined.
	• DHS meeting was cancelled.
	• Steve Laur to review the draft IN from Jim Vail.
	• Meeting in Melanie Wong's office.
	  o Rich Freudenberger will be in the office and plans a drop-in visit to Joe Giitter.
	  o Suggested briefing for Joe.
	• Discussed the closeout of GSI-157 and the IPEEE review with Gary Demoss in RES.

8/26/08	• Additional comments to the draft IN from Steve Laur for Jim Vail.
	• DORL developed checklist for Duke face-to-face meeting.
	• Staff meeting with DORL and DE.
	  o Comments over draft presentation for the Duke face-to-face meeting.
	  o Schedule meeting with Jack to go over new presentation.

8/27/08	• Pre-meeting with Melanie Galloway on additional comments to the presentation along with contingencies on Duke's response.
	• Met with Jack Grobe.
	  o Jack expressed a desire to soften the message to Duke.
	  o Concentrate only on limited flooding contribution from Jocassee Dam rupture and no other flood source.
	  o Concentrate on random failure of Jocassee Dam only.
	• Further presentation rewriting.

Oconee Timeline

Date	Summary of Events
8/28/08	• Met with Jack and DORL, DE, DPR, and OGC. o Jack underscored the need to listen only. o We should address the FERC study. o Only concentrate on Jocassee as a random-failure-only flood source. o Reassigned presenters for meeting based on comments from OGC. o Last minute major changes to presentation. • Face-to-face meeting with Oconee Management and Duke Headquarters PRA. o Duke expressed their desire to parse out dam failure frequencies into discrete inundation levels based on their two industry failure events. o Duke claimed that they have contracted Dr. David Bowles from Utah State University to perform a dam frequency failure calculation. o Duke discussed the spillway design of Jocassee and that it differs from the other dams in the database. o Duke admitted that they could not reproduce the original NSAC/60 calculation of a 4.71-ft inundation height. o Duke presented the Potential Failure Modes Analysis (PFMA). o Duke briefly brought up a potential engineering solution of installing watertight doors.
9/2/08	• Staff level meeting with DORL, DE, RES. o Raman mentioned that George Wilson spoke with FERC on the PFMA Duke presented during the meeting. o Revised list of milestones required from DRA.
9/3/08	• Met with Dave Decker in OCA o Discussed presentation to Congressional Staffers. o Dave plans on briefing them 9/9/08 or 9/10/08. o DORL to get a copy of the FERC response to Duke Hydro on the 1992 inundation study. o George Wilson to brief FERC before OCA briefs the Congressional Staffers (South Carolina delegations). • Prepared a one-page paper on parsing data for Jack Grobe and why PMP needs to be considered. Based it on R.G. 1.59 and 1.102.
9/4/08	• Prepared a one-page paper on parsing data for Melanie Galloway and why PMP needs to be considered. Based it on R.G. 1.59 and 1.102.
9/9/08	• Staff meeting with DORL, DE o Discussed preparations for NRR LT and ET meeting. o Discussed briefings for management after Duke sends their 50.54(f) response in. o Waiting for responses from NSIR and the Congressional delegations.
9/10/08	• Contact to Dave Decker from Annie Caputo (Senator Boxer's office) regarding why NRC did not order Oconee to shut down. o Prepared a response.
9/11/08	• Further complete rewrite of the draft IN. • Discussions in DRA on how to perform a dam frequency calculation that way that Duke would do.
9/17/08	• Given a letter at Region II which outlined a meeting at NRR regarding Oconee issues from the SWSOPI including the inundation study results and decision not to pass it on to RES for IPEEE submittal review.

Oconee Timeline

Date	Summary of Events
9/20/08	• Mike Franovich met with DHS and NSIR on Jocassee Dam failure and Oconee.

9/23/08	• Discussed the generic issue and possible TI.
	• Prepared bulleted slides for Melanie to use for SES briefing on 9/25/08.
	• Staff level meeting with DORL, DE, and RES.
	  ○ Discussion of DHS meeting.
	  ○ Requests to get additional information from FERC.

9/25/08	• DRA prepared presentation on dam failure frequency for SES meeting.
9/26/08	• DORL received Duke's response to the 50.54(f) letter.

10/1/08	• Staff meeting with DE, DORL, and NRO (Ken See and Goutam Bagchi, a new member).
	  ○ Discussion of the Duke response letter and how to respond.
	  ○ Ken See discussed how a 1-D model can be as detailed as some 2-D models.
	  ○ Possible call with their hydrology engineers after Ken heard from them that NRC would accept 2-D models.
	  ○ Discussed Bob Palla of DRA/APLA to evaluate containment failure time.

10/2/08	• Discussed with Bob Palla containment failure timing. He agreed that it would be 40-50 hours after the onset of core damage. • Further presentation on dam failure frequency distributions.

10/6/08	• Staff meeting with DORL, DE, NRO.
	  ○ Goutam to speak with Jon Ake on an additional beta-factor in the ARES seismic fragility study.
	  ○ Goutam has concerns over rock integrity, soil liquefaction, and impaction.
	  ○ Technical phone call set for 10/9/08 to discuss inundation study modeling with Ken See.
	  ○ A LIC-504 meeting is scheduled for 10/15/08.
	  ○ Briefing for Eric Leeds is set for 10/16/08 with him briefing the Chairman on 10/17/08.

10/14/08	• Staff meeting with DORL, DE, and NRO.
	  ○ Telephone call with Duke scheduled for 10/15/08.
	  ○ DORL cautioned that seismic questions can not be asked during the call.
	• Preparation of briefing for Eric Leeds.
	• Preparation of LIC-504.
	• Dave Skeen in as DD/DE.

Oconee Timeline

Date	Summary of Events
10/15/08	• Phone call with Duke technical personnel, Duke Headquarters PRA with NRO, DE, DORL, and Oconee site Resident. o NRC questions on Duke's choice not to use 2-D analysis and the commitment to extend the SSF wall only by 2.5 ft. o Duke claimed that the existing SSF wall would not be able to handle any additional load. They decided to use 1-D HEC-RAS. o Discussed an engineering solution of installing watertight doors which would solve many of the shortcomings of the design. Ken See expressed his view that this would be the best solution. • LIC-504 meeting (in EBB) with SES representation from DRA, DORL (detailed deputy director from DOE), and DE. o Expressed concerns over seismic fragility. o Large bands of sensitivity of inundation level. o Concerns over the non-conservative breach parameters done in the original 1992 inundation study. o Discussion of the next face-to-face meeting and that it should be a management level one. o Watertight doors with re-engineering the intakes/ventilation appeared to be the best solution to the problem.
10/17/08	• Comments from inside DRA over NRR ET/LT presentations.
10/20/08	• Revised ET/LT presentations with comments from other division SES. o Ken See added the uncertainty in the breach parameters using a text book.
10/21/08	• NRR LT presentation given by Mike Franovich. o DORL wanted to blend the dam failure frequency with deterministic licensing basis. o DE felt that decisions shouldn't be made in this meeting. • Prepared next presentation to the ET.
10/23/08	• NRR ET briefing. o Eric Leeds wanted us to define success for this issue and that it shouldn't be like the others with Oconee. o Discussed allowing Duke to choose how to resolve this. o DE proposed giving Duke one year to perform the work and one year for NRC review. • Concerns of the site Residents that we were not addressing the long 72-hr allowed outage time of the SSF. We told them that this will come later.
10/30/08	• Met with Jack Grobe on presentation for the Duke Management meeting. o Wanted to change direction and not summarize anything up front. o Jack suggested a 6-year allowance to Duke to operate with this vulnerability with a renewal period. o Jack did not initially want a technical solution presented then wanted a short-term and a long-term solution to be presented. o We should allow Duke to perform a more complex inundation study. o Discussed uncertainties involved. • Re-wrote new presentation without technical details for DRA and DE comments. • Started work with DORL on preparing a response to the Duke 50.54(f) response.

Oconee Timeline

Date	Summary of Events
10/31/08	• Contact Ed Williamson in OGC on current efforts and potential backfit. Ed assigned Marcia Simon and Cathy Marco on it. • Met with Jack. o Was not satisfied with the rewritten presentation. o Suggested a more simplified format addressing licensing basis adequacy. o Jack planning on a call with Dave Baxter.
11/3/08	• Discussions with DORL on the allowed outage times for equipment in the SSF. Most of these need to be radically changed in light of the new dam failure frequency. • Starting to work on a JCO which Mike Franovich started on.
11/4/08	• DORL asked Duke about controlling lake levels and maintaining Lake Jocassee at the drought level. Duke claimed that they would not be allowed to do so. • Further concerns voiced by Ken See over the validity of selection of breach parameters from the 1992 FERC inundation study. • Email from Jack that he changed his mind over the presentation material and did not want to use it.
11/5/08	• Met with Jack with DORL, DE, NRO, and OGC. o Discussed the pitfalls of developing a JCO for Oconee based on failure of the SSF. o A risk-informed LAR would not be acceptable since Duke does not have a R.G. 1.200 model of dam failure frequency. o Rewrote the presentation once again. • Met with Duke Oconee Management, DRA, DE, DORL, OE, Region II, Site Residents, Duke Hydro, and Duke HQ PRA. o Presented NRC view that parsing out the dam frequency to guide smaller inundation studies would not solve the adequate protection question. o Questioned Duke over soil compaction and west embankment seepage. o Duke claimed that they "spec'ed out" the watertight doors but, having planned on installing them. o Duke made no commitments outside of more analysis. o Duke erroneously claimed that we approved their seismic fragility study for Jocassee Dam. o Melanie Galloway made NRC point-of-contact for Duke.
11/6/08	• Discussed with NSIR a meeting with DHS.
11/12/08	• Staff meeting with DORL, DE, RES, NRO. o DE sent FERC the 50.54(f) letter. o RES want the foundation records for the dam. o Ken See to contact Ken Fearon at FERC. • Duke contact DORL on the JCO. DRA told DORL that NRC will not write a JCO but, Duke should prepare it for our review.

Oconee Timeline

Date	Summary of Events
11/14/08	• Call with FERC (Dan Mahoney, Ken Fearon, and Wayne King), DORL and DRA. o Discussed the inundation calculations and how NRC views PRA vs. licensing basis. o FERC will pull records on the dam construction. o PRA is in the developmental stage at FERC. o FERC suggested a face-to-face meeting.
11/26/08	• Met with DHS (Craig Conklin and his staff) at their offices with DE, DRA, and NSIR. o Discussed the issue and consequences of dam rupture. o Discussed generic implications at other sites. o DHS discussed some of their insights on infrastructure and requested some additional information from NSIR.
12/1/08	• Met with FERC at their offices (was out of office).
12/4/08	• Met with Duke technical staff (was out of office).
12/16/08	• Meeting with Melanie Galloway with DE, DRA, Region II, and DORL. o Discussed seismic response of the dam and the licensee's use of seismic margins for the IPEEE. • Roy Zimmerman briefed Bruce Mallett on the security aspects of the issue.
12/17/08	• First draft of the response to the Duke 50.54(f) response written.
12/18/08	• Discovered that Jack Grobe has designated Pat Hiland to take the lead on the Oconee flood issue during the past week after Luis Reyes visited the site. • Gave Melanie the response letter with an attachment. • DE was tasked with preparing a JCO. Melanie expressed her desire to support this effort.
12/22/08	• Complete revision of draft letter to Duke on their 50.54(f) response. • Discussion from DE on FERC concerns over NRC being critical of their licensing of Jocassee Dam.
12/23/08	• Call between Duke (Rich Freudenberger) and Melanie Galloway (DRA) on the revised HEC-RAS inundation study progress. o Duke claimed that inundation levels might exceed 9 feet.
12/30/08	• Melanie Galloway discussed preparing a justification of why NRC requires additional dam breach parameters in the inundation calculation.
1/5/09	• Completed paper discussing the NRC vs. FERC breach parameters. • Met with DE on the draft response letter, breach widths, and the JCO. o Discussed not stating breach parameters in the response letter. o Nobody knew the FERC rationale for the 575-ft breach width for Jocassee Dam.
1/6/09	• Melanie Galloway met with Pat Hiland (this is hearsay) o Discussed breach parameters for Jocassee. o Discussed the possibility of issuing a DFI (??)
1/7/09	• Jeff Mitman was added to the team from DRA. • Fernando Ferrante to work with Jim Vail on the dam failure database. • Commissioner Lyons scheduled to visit site in February 2009.
1/8/09	• Melanie Galloway with other SES on visit to Oconee and Jocassee sites.

Oconee Timeline

Date	Summary of Events
1/9/09	• Melanie Galloway wanted overtopping to be considered for dam failure – asked Ken See to write a paragraph on the selection of breach parameters. • Melanie asked Fernando to drop out of training to work on the Oconee flood issue.
1/12/09	• Meeting with DORL, DE, Region II, Oconee Resident. o Discussed the SES trip made on 1/8/09. o New action items created to look into orders, CAL, DFI, arbitration, etc. o Need to finalize JCO. o Perform seismic evaluation. o Do overtopping analysis. o Prepare for meeting with Eric Leeds and Jim Wiggins for 1/14/09. • Allen Howe (and John Stang) concern that we are out of process – Melanie Wong asked Jon Thompson to document this.
1/26/09	• Antonios Zoulis added to the team from DRA to look into backfit analysis and recreate LIC-504. • Meeting with DORL, DE, Region II, and site Resident. o Discussed the ET meeting. ▪ Discussed the JCO. ▪ Update of R.G. 1.59. ▪ Developing an order. o Duke attorneys looking to defend an order. o Discussed the meeting with FERC. ▪ Steep slope of abutments can limit break size. ▪ Largest break size and shortest time is not necessarily the worst-case. • Meeting with Melanie Galloway o Re-open backfit. Melanie to contact DPR for Brian Richter's time. o Fernando Ferrante working on developing definitions from the ANSI standard. o Further rewrite of the IN for Jim Vail.
1/27/09	• Call between DRA and Duke (Oconee site and Headquarters PRA) over the data used for the dam failure frequency calculation.
2/3/09	• Commissioner Lyons visit to the Oconee and Jocassee sites.
2/5/09	• Meeting with SES on Oconee (no information on results). • Meeting with DPR and DRA on the IN o Discussed DPR concerns over the use of data. • Fernando Ferrante discussions with Rex Wescott in NMSS on dam failure and R.G. 1.59. • DRA to produce the adequate protection backfit documented evaluation done.
2/9/09	• Meeting with DE, DORL, and DPR. o DORL to put together communication plan. o Discussed B.5.b. alternatives. • Meeting between DRA and DPR on re-opening backfit.
2/10/09	• Melanie Galloway tasked DRA to prepare a history of the Oconee flood issue. • SES meeting with Jack Grobe and DRA, DE. o DE wishes to consider the FERC 575-ft inundation study break size.

Oconee Timeline

Date	Summary of Events
2/17/09	• Ken See review of FERC PMP calculation found discrepancy on not having a pre-emptive rainfall which would saturate the soil and change the results.
2/20/09	• DRA sent backfit documented evaluation to OGC for review.
2/24/09	• DRA discussions at Oconee site regarding Duke proposed procedure on SSF failure.
2/26/09	• DRA tour of Jocassee Dam site.
3/4/09	• DRA meeting with OGC for further guidance on adequate protection.
3/5/09	• DORL has response to Duke's 50.54(f) response. • Duke sent their guidance for shutting down on flood failure of the SSF (EM5.3) for review.
3/6/09	• DRA reviewed timeline Jack Grobe prepared for commissioners during the RIC.
3/9/09	• Meeting with DE and DORL. o Response letter to Duke is being rewritten by Jack after extensive comments.
3/16/09	• DRA comments on Duke's guidance for flood.
3/23/09	• Melanie Galloway initial non-concurrence package to the response letter to Duke.
3/26/09	• Further comments from Region II and site Residents to Duke's guidance on SSF flood.
3/30/09	• Comments to Duke guidance formally sent out.
4/1/09	• Melanie Galloway rewrote the IN, again.
4/6/09	• Formally sent backfit documented evaluation to OGC for Cathy Marco and Kimberly Sexton to review. • Meeting with DE and DORL. o Duke extended the date of their meeting to 5/1/09. o USBR will review the flood analysis but, won't be immediately available due to internal workload.
4/20/09	• Meeting with DE, DORL, and Region II o Discussed the USBR contract. o Discussion of comments to licensee's proposed procedure EM5.3.
4/23/09	• Meeting between OGC (Kimberly Sexton), DE (Dave Skeen), DRA. o Discussed the adequate protection documented evaluation. o OGC felt that overtopping and seismic can not be used for an adequate protection argument since they are natural phenomena which are part of licensing basis. o OGC required that any information for a backfit be "new" and "significant". o Kimberly to speak with Geary Mizuno on definitions.
4/27/09	• Duke sent advance copy of the HEC-RAS report. • Melanie Galloway call with OGC (Cathy Marco) regarding the backfit documented evaluation. o Melanie reported that Cathy agreed that overtopping and seismic failures can be included in the evaluation.

Oconee Timeline

Date	Summary of Events
4/29/09	• Additional email comments from OGC (Kimberly Sexton) on the backfit documented evaluation. o Reiterated the view that overtopping and seismic failures cannot be considered for the documented evaluation. o Geary Mizuno gave her 4 points which need to be discussed in the backfit documented evaluation. • DORL prepared revised draft letter to Duke.
5/1/09	• Initial DRA review of Duke HEC-RAS analysis.
5/4/09	• Oconee meeting with DE to discuss questions on HEC-RAS analysis (not invited).
5/5/09	• Phone call with Duke, DORL, DE (not invited).
5/7/09	• Met with NRO (Chris Cook) on HEC-RAS review questions.
5/11/09	• Meeting with Duke at HQ. o Duke will present only the initial phase of HEC-RAS runs done to benchmark the 1992 FERC inundation study. o Jack Grobe reiterated the NRC position that this is an adequate protection and not a PRA issue. o Duke had not done any sensitivity calculations to vary breach parameters. o Duke argued that NRC in the past did not cite Yankee-Rowe on not having adequate protection against failure of the Harriman Dam as a precedent. o Discussed lumped answers to the HEC-RAS analysis questions due to time constraints.
5/12/09	• Post-mortem meeting with DE. o Duke told DE and DORL that they will do sensitivity calculations. o FERC questions and comments will be filtered through NRC. o DE will assemble an independent team made up of DE personnel and Rex Wescott from NMSS. o The question of adequate protection will be pursued first. o USBR contract starts on 5/15/09.