PR 52
(76FR10269)

DOCKETED
USNRC

March 14, 2011 (11:00 am)

OFFICE OF SECRETARY
RULEMAKINGS AND
ADJUDICATIONS STAFF

I

As of: March 14, 2011
Received: March 11, 2011
Status: Pending_Post
Tracking No. 80c06047
Comments Due: May 10, 2011
Submission Type: Web

PUBLIC SUBMISSION

Docket: NRC-2010-0131
AP1000 Design Certification Amendment

Comment On: NRC-2010-0131-0001
AP1000 Design Certification Amendment

Document: NRC-2010-0131-DRAFT-0017
Comment on FR Doc # 2011-03989

Submitter Information

Name: Susan Perz
Address:
5387 Rabbit Farm Road
Loganville, 30052

General Comment

I oppose the building of ANY nuclear power plant in Georgia and especially near where I live--or where ANYONE lives. A nuclear power plant is a weapon of mass destruction in that all a terrorist has to do is bomb it and it could release more radiation than any dirty uranium bomb and kill untold numbers of people. I have served my community for 8 years in the public schools and all my life as a therapist with a Ph.D. and am well-educated about the dangers of nuclear energy and its clear link to nuclear weapons. This reactor in particular is even less safe than others. If this reactor is built I will move my family out of the state to an area that is nuclear energy free. I think it's criminal that we are building nuclear reactors instead of investing in safe solar and wind energy--especially in this state when we have so much sunshine. You could harness the public school science and work-study programs to help build lower cost solar panels and save millions of dollars in electricity just by training people in energy-saving changes for their homes and subsidizing solar. Build youth centers and teach them solar technology! The fact is--that you cannot prevent small radiation leaks from this or any nuclear plant--and radiation is there FOREVER. The spent fuel rods are a nightmare to deal with and end up dumped on Native American lands like Yucca Mountain and other areas where they cause cancer in entire communities. Is greed really worth that much to you? I don't believe for one instant that nuclear power is the best or only option we have to meet our energy needs. I expect better integrity and better leadership from our leaders than this. This is not a "FAMILY VALUE" so if you can't walk the walk, don't sling the bull. Either you care about our families NOW and for future generations or you don't deserve to be in office. How DARE you jeopardize our future and waste our time with this project when there are so many important things to be done?

1 2 4 5 3

Template = SECY-067 DS10

Rulemaking Comments

From: Gallagher, Carol
Sent: Monday, March 14, 2011 9:12 AM
To: Rulemaking Comments
Subject: Comment letter on AP1000 Design Certification
Attachments: NRC-2010-0131-DRAFT-0017pdf.pdf

Van,

Attached for docketing is a comment letter from Susan Perz on the above noted proposed rule (76 FR 10269) that I received via the regulations.gov website on 3/11/11.

Carol

DOCKETED
USNRC
April 13, 2011 (12:32 pm)
OFFICE OF SECRETARY
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ADJUDICATIONS STAFF

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(76FR10269)

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PUBLIC SUBMISSION

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Tracking No. 80c24062
Comments Due: May 10, 2011
Submission Type: Web

Docket: NRC-2010-0131
AP1000 Design Certification Amendment

Comment On: NRC-2010-0131-0001
AP1000 Design Certification Amendment

Document: NRC-2010-0131-DRAFT-0020
Comment on FR Doc # 2011-03989

Submitter Information

General Comment

The AP1000 containment interior has an inorganic zinc coating. The DCD discusses the production of hydrogen caused by fuel damage, but does not go into detail on the hydrogen production caused by the interaction of zinc and steam to produce ZnO and H2. Given the recent events in Japan, is it possible to have a station black-out during full power operation lead to the activation of the automatic depressurization system, which fills containment with steam? 1 Given that the hydrogen re-combiners are non-safety systems and we assume thay don't work, will the steam/zinc coating interaction produce enough H2 gas in containment to reach explosive levels between the time the Class 1E batteries can no longer operate the hydrogen ignition system (4 hours) and the 72 hour mark for safety system operation? 2

Template= SECY-067 DS 10

Rulemaking Comments

From: Gallagher, Carol
Sent: Wednesday, April 13, 2011 12:05 PM
To: Rulemaking Comments
Subject: Comment on Proposed Rule - AP1000 Design Certification Amendment
Attachments: NRC-2010-0131-DRAFT-0020.pdf

Van,

Attached for docketing is a comment from an anonymous individual on the above noted proposed rule (3150-AI81; 76 FR 10269) that I received via the regulations.gov website on 4/12/11.

Thanks,
Carol

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(76FR10269)

April 13, 2011 (12:32 pm)

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As of: April 13, 2011
Received: April 12, 2011
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PUBLIC SUBMISSION

Docket: NRC-2010-0131
AP1000 Design Certification Amendment

Comment On: NRC-2010-0131-0001
AP1000 Design Certification Amendment

Document: NRC-2010-0131-DRAFT-0021
Comment on FR Doc # 2011-03989

Submitter Information

General Comment

The AP1000 DCD Chapter 17 states, "Effective March 16, 2007, HQA-1-1994 is the applicable revision of NQA-1 for work performed for the AP1000 project." NRC form 335 on NUREG 0800, section 17.5, states in part, "Section 17.5 is based on a combination of the following guidance previously endorsed by the NRC: ASME Standard NQA-1 (1994 Edition)". When has the NRC endorsed the 1994 edition of NQA-1? According to Regulatory Guide 1.28 Revision 4, the NRC endorses NQA-1-2008 and NQA-1-2009 addenda. According to Regulatory Guide 1.28 Revision 3, the NRC endorses NQA-1-1983 and NQA-1a-1983 addenda. Where is it documented that NQA-1-1994 adequately meets the requirements of Title 10, Code of Federal Regulations, Part 50, Appendix B, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants"? i.e. By implementing NQA-1-1994, does Westinghouse meet all the requirements of 10 CFR Part 50, Appendix B with respect to AP1000 Quality Assurance?

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Rulemaking Comments

From: Gallagher, Carol
Sent: Wednesday, April 13, 2011 12:08 PM
To: Rulemaking Comments
Subject: Comment on Proposed Rule - AP1000 Design Certification Amendment
Attachments: NRC-2010-0131-DRAFT-0021.pdf

Van,

Attached for docketing is a comment from an anonymous individual on the above noted proposed rule (3150-AI81; 76 FR 10269) that I received via the regulations.gov website on 4/12/11.

Thanks,
Carol

Rulemaking Comments PR 52 (76FR10269) 4

From: andrew stevenson [andrewstevenson@sbcglobal.net]
Sent: Thursday, April 21, 2011 4:59 PM
To: Rulemaking Comments
Subject: Stop the AP1000 (Docket ID NRC-2010-0131)

Dear Secretary Vietti-Cook,

In the wake of the crisis at Fukushima, it has become clear that nuclear fission SHOULD NOT ME USED TO BOIL WATER!!!

Do we REALLY have to think about this?
No more. It's over.

andrew stevenson
3274 lynde
oakland, CA 94601

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USNRC

April 27, 2011 (4:35 pm)

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ADJUDICATIONS STAFF

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DS10

From: Keith vonBorstel [keith@keithvb.com]
Sent: Thursday, April 21, 2011 5:00 PM
To: Rulemaking Comments
Subject: Docket ID NRC-2010-0131: Approve the AP1000

Dear Secretary Vietti-Cook,

I encourage you to build the Westinghouse AP1000 as soon as possible.

Nuclear power is the only solution to our energy problems. Do the numbers and see.

For more information go to www.thesciencecouncil.com

Keith vonBorstel
614 Hubble Street
Davis, CA 95616-2723

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April 27, 2011 (4:35 pm)

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PR 52
(76FR10269)

Rulemaking Comments 6

From: Patricia Richard-Amato [prichardamato@gmail.com]
Sent: Thursday, April 21, 2011 5:47 PM
To: Rulemaking Comments
Subject: Docket ID NRC-2010-0131: NO to the AP1000 approval

Dear Secretary Vietti-Cook,

Stop and consider the risks before approving the new Westinghouse AP1000 reactor for construction in Georgia, South Carolina and other states. 1

Haven't we learned anything from the crisis in Japan? How about putting the license application on hold until more research and analysis is done. 1 2

Patricia Richard-Amato
4004 London Rd. Apt. CC23
Duluth, MN 55804

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April 27, 2011 (4:35 pm)

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DS 10

Rulemaking Comments **PR 52 (76FR10269)** 7

From: Gina Thomas [gina@entlebuchers.net]
Sent: Thursday, April 21, 2011 6:53 PM
To: Rulemaking Comments
Subject: Docket ID NRC-2010-0131: Suspend the AP1000 approval

Dear Secretary Vietti-Cook,

How many Fukushima and Chernobls are too many? One. History has already proven that nuclear power is not worth the risk. Stop nuclear power construction and move to solar and wind energy.
Thank you,
Gina

Gina Thomas
PO Box 1377
Veneta, OR 97487

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April 27, 2011 (4:35 pm)

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(76FR10269)

Rulemaking Comments 8

From: David Addison [davashadd@verizon.net]
Sent: Thursday, April 21, 2011 6:53 PM
To: Rulemaking Comments
Subject: Stop the AP1000 (Docket ID NRC-2010-0131)

Dear Secretary Vietti-Cook,

Fast track approval on any new Westinghouse AP1000 reactors is the antithesis of progress. To insure that the Nuclear Regulatory Commission performs its duties as originally intended, I urge you to promptly table any approval of said designs within our nation. 1 2

The safety concerns of the Westinghouse Corporation are either a second thought or a hindrance to the construction of any of its nuclear reactors. The recent crisis in Japan speaks volumes along this line. Yet, Westinghouse's mammoth public relations section speaks of nothing more than the supposed plusses of the new design, while purposely ignoring the obvious. 3

One would hope that the NRC will have second thoughts about any immediate approvals of the proposals. The 75-day comment period in the rule-making period does not seem adequate for the items currently at hand. Promptly reexamine the efficiency of such a short time slot. 4

Thank you for the opportunity to comment on this very important national and international matter.

David Addison
5700 11th St N #10
Apt 10
Arlington, VA 22205

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USNRC

April 27, 2011 (4:35 pm)

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RULEMAKINGS AND
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DS 10

From: A. C. Cantrell [acarolcantrell@gmail.com]
Sent: Thursday, April 21, 2011 7:54 PM
To: Rulemaking Comments
Subject: Docket ID NRC-2010-0131: Suspend the AP1000 approval

Dear Secretary Vietti-Cook,

To all who are in positions of decision-making power:

I am not opposed to nuclear power.

I am extremely opposed to fast-tracking.

Please do not rush into new plants without every question answered truthfully.

Thank you for your service, and your care for the nation.

A. C. Cantrell

27707

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USNRC

April 27, 2011 (4:35 pm)

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Template = SECY-067

DS10

PR 52
(76FR10269)

10

Rulemaking Comments

From: Paul Fretheim [paul@inyopro.com]
Sent: Thursday, April 21, 2011 7:59 PM
To: Rulemaking Comments
Subject: Docket ID NRC-2010-0131: Suspend the AP1000 approval

Dear Secretary Vietti-Cook,

Eternity is a long time. 250,000 ,might as well be eternity as far as human lives are concerned. As you know, that is how long the most poisonous of all substances, Plutonium, must be isolated from the environment to avoid mass disruption of the basic component of live, our chromosomes, DNA itself.

Plutonium and the other horribly deadly substances created by nuclear fission in a reactor do not even exist naturally. If they did, we probably wouldn't be here, and if we create too much of them, our descendants will not be here. 1

There is no way to isolate those substances for eternity.

Eternity is a long time.

We cannot in good conscience create hundreds of tons of these immutable poisons to generate heat to boil water, the energy of which is gone in an instant. Especially when there are perfectly good reactors already going that provided, in the case of the Sun, roughly enough energy to run the entire human economy for 800 years each day.

Al Gore, in his recent book, "It's Up to Us!" estimates that the other source of safe heat from nuclear decay, the geothermal heat from the Earth's core, can provide us with enough energy to power our entire economy for 40,000 years.

We don't need nuclear reactors and we certainly don't want any more of their actual product, the deadly, immutable radioactive poisons. 1

Please try and be reasonable, thoughtful, and well informed. If you are, I don't think you can possibly support the continued use of nuclear fission to boil water. Sunlight can do that very well. 2

Paul Fretheim

Paul Fretheim
219 W Main Street
219 W Main Street
Independence, CA 93526

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USNRC

April 27, 2011 (4:35 pm)

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PR 52
(76FR10269)

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Rulemaking Comments

From: Lynne Mayo [LLEN@usfamily.net]
Sent: Thursday, April 21, 2011 8:44 PM
To: Rulemaking Comments
Subject: Stop the AP1000 (Docket ID NRC-2010-0131)

Dear Secretary Vietti-Cook,

We need to learn how to live well on vastly reduced energy. Nuclear is dangerous. 1

The best intentions cannot beat the statistical chances of a nuke accident.
More nuke reactors means more nuke black markets
There is no way our generation can guarantee the safety of spent fuel rods, etc for generations born into the distant future, the lifetime of some of the deadly radiation produced during fission. It is irresponsible to bequeath radiation poisons they may not have the ability to deal with. The systems that provide backup to avert nuclear meltdown are themselves dependent on fossil fuel systems....how can we guarantee those systems will exist far into the future? 2
They cost too much. 3
The insurance companies will not insure them~~the American public will have to subsidize accident insurance, and we are mostly broke.

Lynne Mayo
2420 17th Ave South
Minneapolis, MN 55404

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April 27, 2011 (4:35 pm)

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PR 52
(76FR10269)

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Rulemaking Comments

From: David Strohm [boomerang@boomkids.com]
Sent: Thursday, April 21, 2011 10:54 PM
To: Rulemaking Comments
Subject: Docket ID NRC-2010-0131: Suspend the AP1000 approval

Dear Secretary Vietti-Cook,

Please. The Japanese experience is not an aberration. Nuclear power is simply too dangerous to pursue. Do the right thing. We are counting on you. 1
David Strohm

David Strohm
13366 pescadero rd
La honda, CA 94020

Template = SECY-067

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Rulemaking Comments

From: J Troy Burns [troy@bohemianimports.com]
Sent: Thursday, April 21, 2011 11:00 PM
To: Rulemaking Comments
Subject: Docket ID NRC-2010-0131: Suspend the AP1000 approval

Dear Secretary Vietti-Cook,

Don't Die ich me. Nuclear power is not clean or safe.

J Troy Burns
2589 Pinewood Dr
Marietta, GA 30068

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USNRC

April 27, 2011 (4:35 pm)

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As of: April 22, 2011
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USNRC

April 27, 2011 (4:35 pm)

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RULEMAKINGS AND
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Docket: NRC-2010-0131
AP1000 Design Certification Amendment

Comment On: NRC-2010-0131-0001
AP1000 Design Certification Amendment

Document: NRC-2010-0131-DRAFT-0022
Comment on FR Doc # 2011-03989

Submitter Information

Name: Matthew Grosso
Address:
San Francisco, 94107
Submitter's Representative: Nancy Pelosi
Organization: private citizen
Government Agency Type: Federal

General Comment

I support the proposed rule. 1

We desperately need to shift the mix of our power generation away from carbon fuels, and this will help.

Recent events in Japan have indicated that even the worse case is not that bad when compared to the coal ash that is fueling cancer and lung disease right now.

Given that there is no political consensus in this country to establish the Pigovian taxes on soot and carbon dioxide emissions that would make renewables competitive, we cannot afford to stand in the way of the cleanest available option.

The passive safety measures and simpler design should make this a much safer reactor in any case. 2

I wish more of my fellow liberals would be willing to look at the facts and support the best solution that can achieve a consensus rather than continue to hold out for things that are getting politically less tenable rather than more.

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Rulemaking Comments

From: Gallagher, Carol
Sent: Friday, April 22, 2011 8:26 AM
To: Rulemaking Comments
Subject: Comment on Proposed Rule - AP1000 Design Certification Amendment
Attachments: NRC-2010-0131-DRAFT-0022.pdf

Van,

Attached for docketing is a comment from Matthew Grosso on the above noted proposed rule (3150-AI81; 76 FR 10269) that I received via the regulations.gov website on 4/21/11.

Thanks,
Carol

From: Margaret Welke [mwelke@tds.net]
Sent: Thursday, April 21, 2011 10:34 PM
To: Rulemaking Comments
Subject: Docket ID NRC-2010-0131: Suspend the AP1000 approval

Dear Secretary Vietti-Cook,

Nuclear reactors are a Faustian bargain. I already have cancer and I've no doubt that seriously rising cancer rates are due in large part to the toxins and radiation pouring into our environment.

No one is safe, not you, your family or your friends. There is no 100% safe containment for radioactive materials and there is no safe way to deal with highly radioactive waste for hundreds if not thousands of years. Things go wrong that we cannot predict. And there are certainly plenty of examples.

I want to hear how you can possibly justify this activity .

Margaret Welke
410 Clemons Avenue
Madison, WI 53704

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Rulemaking Comments PR 52 (76FR10269) 16

From: Ineke Deruyter [ideruyter@hotmail.com]
Sent: Thursday, April 21, 2011 11:41 PM
To: Rulemaking Comments
Subject: Docket ID NRC-2010-0131: Suspend the AP1000 approval

Dear Secretary Vietti-Cook,

Malfunctioning of nuclear reactors will be the death of all of us, including you and your families.
Please focus your attention on the production of energy that is safe for the planet and the population. Thank you,

Ineke Deruyter
9322 N. Oswego Ave
Portland, OR 97203

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USNRC

April 27, 2011 (4:35 pm)

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PR 52
(76FR10269)

Rulemaking Comments

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From: Pete Marshall [pete@mandomafia.com]
Sent: Thursday, April 21, 2011 7:41 PM
To: Rulemaking Comments
Subject: Docket ID NRC-2010-0131: Suspend the AP1000 approval

Dear Secretary Vietti-Cook,

I am opposed to building any more nuclear reactors, especially in light of what has happened recently in Japan. It is the height of folly to fast track the approval of any reactors without at least pausing to learn from the disaster at Fukushima. We pay for these abominable things before they are built, they are hideously expensive, and in the event of another accident, the corporations that build and run them would walk away leaving the rest of us to carry the bag. Speaking as someone who lives less than 40 miles from two nuclear reactors, I say enough! Shut them all down, permanently.

1 2 4 5 3

Pete Marshall
1422 Gentry Lane
Charlottesville, VA 22903

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April 27, 2011 (4:35 pm)

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Rulemaking Comments PR 52 (76FR10269) 18

From: August Cardea [twocrows@tampabay.rr.com]
Sent: Thursday, April 21, 2011 6:38 PM
To: Rulemaking Comments
Subject: Docket ID NRC-2010-0131: Suspend the AP1000 approval

Dear Secretary Vietti-Cook,

The definition of stupidity is to see what happened in Japan and immediately rush into building new, untested nuclear reactors. So, please tell us, are you stupid? We're watching to see what you answer.

August Cardea
1218 N. Cherry Blossom Drive
Clearwater, FL 33764-1049

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USNRC

April 27, 2011 (4:35 pm)

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Rulemaking Comments **PR 52 (76FR10269)** 19

From: Diana and Ken McCracken [flyandwasp@charter.net]
Sent: Thursday, April 21, 2011 7:01 PM
To: Rulemaking Comments
Subject: Stop the AP1000 (Docket ID NRC-2010-0131)

Dear Secretary Vietti-Cook,

It is hubris to take the risks that one tiny miscalculation, act of God or operator error can become an act of devastation so greeat that the earth itself is in danger. The game isn't worth the candle, When you become infallible you can "fast track" nuclean plant approval. In the meantime catch up on what we need to do to make our existing potential disasters less threatening.

Diana and Ken McCracken
241 La Cresta Dr
Arroyo Grande, CA 93420

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April 27, 2011 (4:35 pm)

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Rulemaking Comments **PR 52 (76FR10269)** 20

From: John Edminster [john.edminster@gmail.com]
Sent: Thursday, April 21, 2011 6:36 PM
To: Rulemaking Comments
Subject: Docket ID NRC-2010-0131: Suspend the AP1000 approval

Dear Secretary Vietti-Cook,

The Nuclear Regulatory Commission must take every possible precaution before approving the Westinghouse AP1000 reactor design now being considered for construction. I ask the NRC to put the license application on hold until weaknesses found in the AP1000 design have been considered in light of the recent accident at the Fukushima facility in Japan. 1 2

Do not invite a Chernobyl or Fukushima event to take place on United States soil. The earth belongs to God who created it, and we are all its stewards, not its owners, and must answer to God for how we have done. Don't make yourselves into ones who must flee screaming, because of your bad consciences, from the One who most loves you and wishes your happiness. Powerful-seeming bullies in the nuclear energy industry can neither help nor hurt you without God's consent. My prayer for you all is that God will strengthen you to do what you know is right, and then smile on you for acting prudently. You will feel that smile in your heart.

To ensure transparency, please include this comment and all others in the formal review proceedings and post them in the NRC's online library so the public can see any expressed concerns. 3

John Edminster
37-55 77th St.
Apt. 5G
Jackson Heights, NY 11372

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April 27, 2011 (4:35 pm)

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RULEMAKINGS AND
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From: Joan King [joank@windstream.net]
Sent: Thursday, April 21, 2011 5:27 PM
To: Rulemaking Comments
Subject: Docket ID NRC-2010-0131: Suspend the AP1000 approval

Dear Secretary Vietti-Cook,

No more! No more reactors. No more license extensions.No more subsidies to a technology that should be self supporting by now. No more money spent on anything but rad waste clean up. 1|3|4 5

The Japanese catastrophe wasn't supposed to happen, but it did. 6
One chance in millions still isn't good odds when you are dealing with radiation that won't go away for at least that long. 7

Even if it can be made safe, nuclear power is just too expensive. 2

No more!

Joan King
304 Manor Drive
Sautee, GA 30571

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DS10

From: Tom Jackson [d.eppelsheimer@gmail.com]
Sent: Thursday, April 21, 2011 5:18 PM
To: Rulemaking Comments
Subject: Stop the AP1000 (Docket ID NRC-2010-0131)

Dear Secretary Vietti-Cook,

Nuclear energy is proven to be cheap, efficient, safe, and necessary. By all means build the plant; in fact, built more such plants. Oil and other fossil fuels will exhaust themselves, but with safe, efficient nuclear energy we will be set for thousands of years. 1

By all means, built it. Don't pay attention to the silly eco nuts.

Tom Jackson
6507 Betsy Ross PL
Wauwatosa, WI 53213-2417

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From: Leonard R. Jaffee [ljaffee@comcast.net]
Sent: Thursday, April 21, 2011 5:36 PM
To: Rulemaking Comments
Subject: Docket ID NRC-2010-0131: Terminate the AP1000 approval; do not approve.

Dear Secretary Vietti-Cook,

GO OUT OF BUSINESS.

CLOSE ALL EXISTING NUCLEAR POWER PLANTS AND DO NOT PERMIT MORE. |1|3

NO FAILSAFE IS POSSIBLE.

ALL REACTORS ARE INHERENTLY DANGEROUS. |2

STOP PLAYING GOD WITH OUR LIVES AND HEALTH AND THE LIVES AND HEALTH OF INNOCENT NON-HUMAN CREATURES.

Leonard R. Jaffee
Professor of Law Emeritus

Leonard R. Jaffee
2219 SE Regner Rd
Gresham, OR 97080

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USNRC

April 27, 2011 (4:35 pm)

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ADJUDICATIONS STAFF

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Rulemaking Comments PR 52 (76FR10269) 24

From: Christian Schwoerke [schwoerkec@yahoo.com]
Sent: Friday, April 22, 2011 7:36 AM
To: Rulemaking Comments
Subject: Suspend the AP1000 approval

Dear Secretary Vietti-Cook,

The NRC needs to ensure that it has taken all possible precautions before moving forward with
the new Westinghouse AP1000 reactor design considered for construction in Georgia, South 1
Carolina and other states.

Consider the ongoing crisis in Japan! A thorough review of the Japanese accident has to be 2
conducted and weaknesses in the AP1000 design reviewed in light of the accident. Thus more
than a 75-day rulemaking comment period is required. 3

The Nuclear Regulatory Commission's primary concern should be safety. There is a possibility 4
that the AP1000's shield building could shatter. Also, there is concern that the thin steel
containment shell over the reactor will not be effective during severe accidents. 1

Until these safety issues are fully explored, please do not approve the AP1000 design.

Thank you.

Christian Schwoerke
719 W. Cornwallis Rd.
Durham, NC 27707

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USNRC

April 27, 2011 (4:35 pm)

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Rulemaking Comments **PR 52 (76FR10269)** 25

From: carl mcgarry [mcgarry50@gmail.com]
Sent: Friday, April 22, 2011 9:27 AM
To: Rulemaking Comments
Subject: Docket ID NRC-2010-0131: Suspend the AP1000 approval

Dear Secretary Vietti-Cook,

until we make sure we have voted out all the democrats and republicans and have in place a government that is not bought and sold by corporations who care nothing about the environment or safety regulations and a regulatory commission who is lying through the teeth and is probably in the back pocket of big money i see no reason to allow any further steps going forward for any renewal of license's or permits for new construction. 1 | 2 | 1

carl mcgarry
3742 driftwood drive box b
clinton, WA 98236

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USNRC

April 27, 2011 (4:35 pm)

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RULEMAKINGS AND
ADJUDICATIONS STAFF

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Rulemaking Comments PR 52 (76FR10269) 26

From: michael broughton [mkbroughton@hotmail.com]
Sent: Friday, April 22, 2011 10:40 AM
To: Rulemaking Comments
Subject: Docket ID NRC-2010-0131: Suspend the AP1000 approval

Dear Secretary Vietti-Cook,

We cannot afford to build and use more nuclear reactors because disaster can occur at any nuclear reactor...anywhere! 1

Sun, wind, geothermal...what don't you understand? 2

michael broughton
9936 Jan Drive
St. Louis, MO 63123-6912

DOCKETED
USNRC

April 27, 2011 (4:35 pm)

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DS10

27

Rulemaking Comments **PR 52 (76FR10269)**

From: Paul Crouser [paulcrouser@windstream.net]
Sent: Friday, April 22, 2011 10:52 AM
To: Rulemaking Comments
Subject: Stop the AP1000 Disaster/Ripoff (Docket ID NRC-2010-0131)

Dear Secretary Vietti-Cook,

According to the DOE's landmark report "20 percent wind power by 2030" wind power is not only competitive with fossil fuels, it is the fastest growing source of power in the U.S. today, even without long term subsidies. 1

Ditto for solar. We have been called "the Saudi Arabia of wind", and we have even more solar in our vast deserts and on every rooftop. Certainly South Carolina and Georgia have lots of sun, so why on earth are we building nuclear plants there?? It makes zero sense!

Nuclear power is the most expensive form of power in the world. No nuclear power plant in history has ever been built without massive government funding. It is too expensive and too dangerous to living beings and its waste too long lived. 2 3 3 4

In short, there is no coherent rationale for building nuclear plants beyond simple graft and corruption, which is what this fleecing of taxpayers for $38 Billion is all about in the first place. 2

We can do so much better than that.

Paul Crouser
8876 Belton Drive
North Ridgeville, OH 44039

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USNRC

April 27, 2011 (4:35 pm)

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PR 52
(76FR10269)

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Rulemaking Comments

From: Gene Webb [webby3@gmail.com]
Sent: Friday, April 22, 2011 11:24 AM
To: Rulemaking Comments
Subject: Stop the AP1000 (Docket ID NRC-2010-0131)

Dear Secretary Vietti-Cook,

In the wake of the crisis at Fukushima, it has become clear that using nuclear energy to boil water makes as much sense as using daisy cutter nukes to plant trees and calling it green technology. 1

You are totally batshit insane if you think nuclear energy will lead the world to anything other than extinction!!! 2

Please, let us have the next 20,000 generations babysit this toxic, mutating, cancer causing, waste.

YOU HAVE NO CREDIBILITY CAUSE YOU OBVIOUSLY BEEN BOUGHT AND MUST STEP ASIDE NOW!!!

Independent investigation of your bribe and kickback taking is underway!!!

Keep playing GOD and you won't see him soon enough.

Gene Webb
2 Neame Ave.
San Rafael, CA 94901

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April 27, 2011 (4:35 pm)

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Rulemaking Comments **PR 52 (76FR10269)** 29

From: Dylan Butler [Don_villano@hotmail.com]
Sent: Friday, April 22, 2011 11:37 AM
To: Rulemaking Comments
Subject: Docket ID NRC-2010-0131: Suspend the AP1000 approval

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USNRC

April 27, 2011 (4:35 pm)

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RULEMAKINGS AND
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Dear Secretary Vietti-Cook,

Dear Annette,

My name is Dylan Butler, I am a Canadian, and thus understand I have little if any voice in your country, but sharing a border with your country, and being quite close neighbors, I must
state how concerned I am about the implementation of nuclear power and the building of new 1
highly untested nuclear power reactors. I understand that it is cost efficient, and meets the 2
demand for non-polluting energy production, but the danger that it poses is too great. 3
looking at the recent events in Japan, I think its safe to say, that a scenario that is unforeseeable will occur, causing public and economic hardship, if we rely on a form of energy generation that is so fickle as nuclear power. At this point in time we need to be
looking to the future, and investing in power generation processes that are both safe and sustainable, which in my view Nuclear power is not. Please heed the voice of your people and 4
your cousins to the north, we are asking you, in your stance of power to protect us from this looming threat.

Thank You For Your Time,

Sincerely,

Dylan Butler

(following is a letter pre-written by the group that notified me to this event)

We cannot afford to take any unnecessary risks when building nuclear reactors. Because disaster can occur at any nuclear reactor, the NRC needs to ensure that it has taken all 5
possible precautions before moving forward with the new Westinghouse AP1000 reactor design considered for construction in Georgia, South Carolina and other states.

Especially considering the ongoing crisis in Japan and the review which will take place when 10
the situation is brought under control, the current 75-day public comment period on the reactor design is insufficient for the new AP1000 reactor. I request that the NRC put the license application on hold until a thorough review of the Japanese accident has been conducted and weaknesses in the AP1000 design have been reviewed in light of the accident. To 11
stick with the grossly inadequate 75-day rulemaking comment period would be the height of irresponsibility by the NRC.

Please accept the petition filed by the twelve environmental organizations of the AP1000 12
Oversight Group to suspend rulemaking. To ensure transparency, please include this comment and all others in the formal review proceedings and post them in the NRC's online library so 13
the public can see any expressed concerns.

Addressing safety concerns, not satisfying the industry, should be the Nuclear Regulatory 6
Commission's primary concern. NRC engineer John S. Ma's non-concurrence with the review of

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the reactor raised the possibility that the AP1000's shield building could shatter "like a glass cup." It would be indefensible for the NRC to move forward without further addressing 7
that weakness. Also, Westinghouse has not satisfactorily proved that the thin steel containment shell over the reactor would be effective during severe accidents or that the 8
reactor could be properly cooled in conditions similar to those at Fukushima. 9

Dylan Butler
Laurel Crescent
Cawston, BC v0x1c2

From: Costa Chitouras [cchitouras@alum.mit.edu]
Sent: Friday, April 22, 2011 5:42 PM
To: Rulemaking Comments
Subject: Stop the AP1000 (Docket ID NRC-2010-0131)

Dear Secretary Vietti-Cook,

THE WORLD HAS CARRIED OUT ACTIVITIES WHOSE CONSEQUENCES COULD NOT BE TOLERATED, E.G., FROM THE BURNING OF COAL IN LONDON, USING DDT AND A HOST OF OTHER CHEMICALS, SUCH AS THOSE CAUSING OZONE DEPLETION, ETC., ETC., ETC. BUT WHEN ANY AND ALL OF THESE UNDESIRABLE RESULTS WERE UNDERSTOOD AND ACKNOWLEDGED BY SOCIETY, IT COULD AND DID STOP USING THEM. THE HORRORS OF SUCH USAGE WERE MITIGATED AND EVENTUALLY CEASED TO EXIST.

IN CONTRAST TO THAT SCENARIO, LONG-LIVED RADIATION RELEASED INTO THE ATMOSPHERE AND ELSEWHERE, HOWEVER, UNLIKE ALL PREVIOUS CONTAMINANTS, RADIATION, CANNOT BE RECALLED. IT CAN PERSIST FOR LITERALLY HUNDREDS OF CENTURIES. SUCH A "MISTAKE" CANNOT BE TOLERATED AND NOT ACCEPTABLE UNDER ANY CIRCUMSTANCES.

Costa Chitouras
10 Packard Avenue
Somerville, MA 02144

DOCKETED
USNRC

April 27, 2011 (4:35 pm)

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DS10

From: Eugene c [ecraig98@yahoo.com]
Sent: Friday, April 22, 2011 9:44 PM
To: Rulemaking Comments
Subject: Docket ID NRC-2010-0131: Suspend the AP1000 approval

Dear Secretary Vietti-Cook,

In light of the terrible nuclear disaster at Fukushima, Japan, which has a US model reactor and is a situation that is still not under control, we can no longer afford to take any unnecessary risks with nuclear reactors of any kind. The fact of the matter is that there is no safe disposal of nuclear waste and that unleashed radiation contaminates our world for thousands of years. It cannot be diluted or dispersed as the mythology of the industry would have us believe. 6 1 7

Because disaster can occur at any nuclear reactor, the NRC needs to ensure that it will no longer permit any construction of nuclear plants in Georgia, South Carolina and other states. 2

We want the NRC put all license applications on hold . Nuclear energy is a dangerous and unnecessary source of power in a world that is bright with sunlight, vibrant with winds and energy-rich living waters. There must be safe and renewable sources for all. This is what we need to fund and where to put our research and developmental efforts. 3 4 5

Addressing human and environmental safety concerns, not satisfying industry demands and greed, should be the Nuclear Regulatory Commission's primary concern. 8

Eugene c
5267 Camden Ave #152
San Jose, CA 95124

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DS10

Rulemaking Comments

From: Richard Klotz [rmkjr@centurytel.net]
Sent: Saturday, April 23, 2011 8:53 AM
To: Rulemaking Comments
Subject: Stop the AP1000 (Docket ID NRC-2010-0131)

Dear Secretary Vietti-Cook,

This is the only planet that we humans will ever have. It is on loan to us by our descendants. It is not ours to poison for our own gratification.

Richard Klotz
5089 N Red Ribbon Pt
Beverly Hills, FL 34465-2409

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DS 10

From: dbitter@solerahomes.net
Sent: Saturday, April 23, 2011 6:42 PM
To: Rulemaking Comments
Subject: Docket ID NRC--2010-0131 Westinghouse AP1000 Reactor

Greetings,
Especially since the recent and ongoing events concerning the Japanese reactors (which are an ominous threat to current and future generations of mankind) I have taken a considerable interest in the safety precautions used for reactors close to home.
I understand that the Westinghouse AP1000 reactor is being planned for two new reactors at Plant Vogtle in Georgia.
It surprises me to learn that there are a number of apparently significant safety questions regarding the use of these reactors. 1
In very strong terms I urge you to delay the approval of these reactors until there is sufficient time to address all possible safety concerns relative to their use including any possible concerns that may be learned after a serious study of "lessons learned" relative to the Japanese incident. 2
With Regards,
David Bitter - U.S Citizen and Georgia Resident

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USNRC

April 27, 2011 (4:35 pm)

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DS10

From: Tara Jankovic [tmansion@hotmail.com]
Sent: Saturday, April 23, 2011 9:11 PM
To: Rulemaking Comments
Subject: Suspend the AP1000 approval

Dear Secretary Vietti-Cook,

I am dead set against the building of any new nuclear reactors and would in fact like to see the currently operating ones closed and a renewed focus on alternative fuel sources. Great work is being done in this field and other countries are leading the way. Let's catch up! 1 3|2

Tara Jankovic
7667 N. Wickham Rd. #813
Melbourne, FL 32940

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DS10

Rulemaking Comments PR 52 (76FR10269) 35

From: John Gambardella [johnandnette@westnet.com.au]
Sent: Sunday, April 24, 2011 5:21 PM
To: Rulemaking Comments
Subject: Docket ID NRC-2010-0131: Suspend the AP1000 approval

Dear Secretary Vietti-Cook,

It is glaringly clear that we, as an advanced society, have bitten off much more than we know how to chew. Although nuclear power plants have back-up systems upon back-up systems, the Japanese plant still portends catastrophic consequences. Today, the people who live near Chernobyl are enduring real suffering. Earthquake faults were discovered in places where there were thought to be none. An atomic power plant now operates on top of one.

It is time to admit to ourselves that nuclear energy is a risk too great. It is nonsensical to use this awesome, extremely dangerous, ultimately little understood power to boil water. | 1

The billion dollars or more needed to build and maintain a nuclear powered generator would be smartly and safely spent on supplementing individuals and businesses alike to install personal solar or wind or even geothermal electricity generators. Never reported has such an operating installation caused anyone any harm of any kind. | 2

It is time to advance past the self-deception of nuclear plant safety. It is time to advance towards truly safe energy production. We must redirect our composite energies to alternative sources, to teach conservation of all matters natural, and to respect unequivocally good Mother Earth.

Thank you,
John Gambardella

John Gambardella
6701 Melbourne Dr.
Huntington Beach, CA 92647-2609

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USNRC

April 27, 2011 (4:35 pm)

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Rulemaking Comments **PR 52** **(76FR10269)** 36

From: Hugh Smyser [hsmyser@nyc.rr.com]
Sent: Monday, April 25, 2011 11:51 AM
To: Rulemaking Comments
Subject: Stop the AP1000 (Docket ID NRC-2010-0131)

Dear Secretary Vietti-Cook,

The problem with nuclear reactors is that while the probability of problems is low, the costs and consequences when they occur can become staggeringly, unimaginably high, to the point where they become extremely hard to predict, as we see now in Japan.

Any new nuclear reactors that are built in the US must be held to far higher standards than are applied currently. They must be overbuilt in the extreme, and engineered to clarify their operations, to try to ensure that the extreme consequences of a malfunction never occur. If that changes the economics of nuclear power, so be it. In the worst case, if something goes wrong with a reactor, we're dealing with possible long-term impacts on many thousands of lives, and potentially a serious blow to our economy as well. Please do NOT fast-track the AP 1000's license application.

2

1

Hugh Smyser
538 East 89th St
New York, NY 10128

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USNRC

April 27, 2011 (4:35 pm)

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Rulemaking Comments

PR 52
(76FR10269)

37

From: Kasia Gadek [szarotka@gmail.com]
Sent: Monday, April 25, 2011 10:12 PM
To: Rulemaking Comments
Subject: Docket ID NRC-2010-0131: Suspend the AP1000 approval

Dear Secretary Vietti-Cook,

I don't want any nuclear reactors! Whatever you figure is safe does not give you the go ahead to build what people don't want. People don't want nuclear reactors!!! | 1

Kasia Gadek
705 S 8th Street
Philadelphia, PA 19147

DOCKETED
USNRC

April 27, 2011 (4:35 pm)

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ADJUDICATIONS STAFF

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Rulemaking Comments PR 52 (76FR10269) 38

From: Kris Elletson [kelletson@mac.com]
Sent: Wednesday, April 27, 2011 11:33 AM
To: Rulemaking Comments
Subject: Docket ID NRC-2010-0131: Suspend the AP1000 approval

Dear Secretary Vietti-Cook,

After what happened in Japan all applications for using nuclear power is unwise. We can not afford to build or use nuclear power. Are you willing to be the one who goes into the power plant after what happened in Japan? Say no to AP1000's license application. No to Nuclear power in this country. 1 2 3

Kris Elletson
526 West Fremont Drive
Littleton, CO 80120

DOCKETED
USNRC

April 27, 2011 (4:35 pm)

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Rulemaking Comments

From: John Runkle [jrunkle@pricecreek.com]
Sent: Friday, April 29, 2011 10:38 AM
To: Rulemaking Comments
Subject: DOCKET ID NRC-2010-0131
Attachments: comments on AP1000 containment.pdf

PART 1 of 4

Attached please find the comments by the AP1000 Oversight Group et al. on containment flaws in the AP1000 reactor design with two reports by Fairewinds Associates (and attachements) supporting those comments. Because of your apparent size limits we are sending these comments in four parts.

John D. Runkle
Attorney at Law
Post Office Box 3793
Chapel Hill, NC 27515
919-942-0600
jrunkle@pricecreek.com

DOCKETED
USNRC

April 29, 2011 (2:15 pm)

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Template = SECY-067

DS10

JOHN D. RUNKLE
ATTORNEY AT LAW
POST OFFICE BOX 3793
CHAPEL HILL, N.C. 27515-3793

919-942-0600
jrunkle@pricecreek.com

April 29, 2011

To: Rulemaking on AP1000 Reactor Certification
DOCKET ID NRC-2010-0131

From: AP1000 Oversight Group

Re: CONTAINMENT FLAWS IN AP1000 DESIGN

NOW COME the AP1000 Oversight Group, and its member organizations, Bellefonte Efficiency and Sustainability Team, Blue Ridge Environmental Defense League, Citizens Allied for Safe Energy, Friends of the Earth, Georgia Women's Action for New Directions, Green Party of Florida, Mothers Against Tennessee River Radiation, North Carolina Waste Awareness and Reduction Network, Nuclear Information and Resource Service, Nuclear Watch South, South Carolina Chapter - Sierra Club, and Southern Alliance for Clean Energy with comments on the containment flaws in the proposed Westinghouse-Toshiba AP1000 reactor designs. Because of these flaws, and other significant problems with the AP1000 reactor design and operating procedures, our recommendation is to **DISAPPROVE** the certification for this reactor.

Last year, the AP1000 Oversight Group submitted two reports by Fairewinds

Associates, Inc. and provided testimony to the Advisory Committee on Reactor Safeguards ("ACRS") on design flaws with the containment systems in the proposed AP1000 reactors. Fairewinds Associates, *Post Accident AP1000 Containment Leakage: An Unreviewed Safety Issue*, April 7, 2010, attached to Petition to Initiate 8
Special Investigation on Significant AP1000 Design Defect by the AP1000 Oversight Groups, April 21, 2010; and Fairewinds Associates, *Nuclear Containment Failures: Ramifications for the AP1000 Containment Design*, December 21, 2010, submitted to 9
ACRS on December 21, 2010.[1] The earlier of these reports was presented to the ACRS with a power point presentation, by Mr. Gundersen, Chief Engineer of Fairewinds, on June 25, 2010, as part of the ACRS's review of the AP1000 design.[2]

The fundamental concern expressed in the reports and presentation to the ACRS is that in instances when there were cracks or through-wall holes in the containment structure, excessive amounts of radiation would be released during loss of 2
cooling accidents, as pressurized steam would be forced through the hole and then vented directly into the atmosphere, without any filtering. In his reports and presentation, Mr. Gundersen characterizes the unfiltered venting at the AP1000 design as the "chimney effect." 2
It should be noted that after Mr. Gundersen submitted his reports, preliminary information from the Fukushima accident showed the containments failed during accident conditions, further proving his assertion that containments do not have a zero probability of leaking.

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[1] ATTACHMENTS 1 and 2. Both reports are also available at www.fairewinds.com/reports

[2] www.fairewinds.com/content/ap1000-nuclear-design-flaw-addressed-to-nrc-acrs

Unlike existing reactor designs that have double barriers, the AP1000 containment is only a single barrier. A single failure in the AP1000 design will cause it to fail and release radioactivity. The rationale for this reduced protection is in large part 2 because of its alleged "passive design" by which the containment operates as a heat exchanger following an accident. The AP1000 design uses a large tank of water above the shield building to pour water directly onto the outside of the steel containment shell. After an accident, the falling water is designed to cool the containment shell, which then cools the radioactive steam inside the containment via thermal conduction and convection during which the steel shell evaporates the water that is sprayed from above. However, potential cracks and through-wall holes in the steel containment leads to the venting of unfiltered radioactive gases into the environment in certain accident 2 conditions.[3]

First, it should be reemphasized that containment failures routinely occur, and recently have occurred in all three containments at Fukushima. The NRC however routinely assumes containment failure is a zero probability event despite historical evidence to the contrary. The NRC uses zero probability as the basis for the Severe Accident Mitigation Design Alternatives ("SAMDA") analysis for new reactors, which is in 3 turn reflected in the analysis of severe accidents for the AP1000 reactors. In the AP1000 Design Control Document ("DCD"), Revision 18, Appendix 1B, page IB-3 and IB-8, Westinghouse-Toshiba limits its SAMDA analysis to "late containment

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[3] It appears from the accident at the Fukushima Daiichi reactors in Japan that considerable debris from a damaged or destroyed shield building would impede this recirculation of cooling water. The passive design also fails if an accident, or intentional attack, destroyed the water tanks.

overpressure failures" and dismisses the need for venting into filtered spaces or
employing high-pressure designs.[4] The SAMDA for the AP1000 reactors does not 4
address the containment failures described by Mr. Gundersen.

The NRC has admitted elsewhere it has no database to track containment
failures and has not conducted a complete investigation of the related containment 5
problems at U.S. reactors. In its review of containment liner corrosion after Mr.
Gundersen's presentation to the ACRS, NRC staff conducted a cursory investigation of
containment cracks in several U.S. reactors and found the currently followed coating
and inspection regimens may not be sufficient. NRC Information Notice 2010-12,
Containment Liner Corrosion, June 18, 2010 (ADAMS No. ML100640449). The
information notice reviewed containment flaws at the Beaver Valley 1, Brunswick 1 and
Salem 2 reactors, noting corrosion and through holes undetected by routine inspection.

An earlier study, *Detecting of Aging Nuclear Power Plant Structures*, by NRC
contractors, D.J. Naus of Oak Ridge Laboratory and H.L. Graves III, showed at least 66
separate occurrences of degradation in operating containments and more than 32
reported occurrences of corrosion of steel containments or liners.[5] Two instances 6
where corrosion completely penetrated the line and four additional cases where
extensive corrosion of the line reduced the thickness by nearly one-half. A subsequent
investigation of industry experience through 2008 showed at least eight additional
episodes of containment system degradation. NRC Information Notice 2004-09,

[4] ADAMS No. ML10348043, December 1, 2010.

[5] www.ornl.gov/~webworks/cpr/pres/106157.pdf

Corrosion of Steel Containment and Container Liner, June 27, 2004 (ADAMS No. ML041170480). This investigation documented numerous pits in the D.C. Cook reactor in 1998 and a through-wall hole in the liner in 2001, three through-wall holes in the liner at the Brunswick reactor in 1999, and two through-wall cracks in the steel containment at Hatch 1 and 2.

Mr. Gundersen bases his conclusions in his reports on his more complete compilation of the containment flaws, such as through-wall holes, corrosion and coating flaws. The assessment shows approximately 40 incidents of steel degradations, another 40 concrete degradations, and six through-wall holes in both PWR liner failures and BWR containment failures. Both are relevant to the AP1000 design. Examples of the other reactors that have shown containment flaws are the Salem reactor, corrosion from the inside out; Beaver Valley 1, corrosion from the outside in; FitzPatrick, through-wall cracks; Oconee, coating misapplication and coating failure; and Turkey Point 3, evidence of at least 12 holes from the inside out (with similar problems at Turkey Point 4). The common thread in every case is that the problem has not been identified by visual inspection prior to the liner or containment breach. Each of these shows evidence of failures to meet American Society of Mechanical Engineers ("ASME") inspection standards.

In several of these incidences, the through-wall failures have been in the containments for Boiling Water Reactors ("BWRs"), which are much thicker than the containments for the proposed AP1000 reactors. Our preliminary survey shows that through-wall cracks in BWR containments have occurred on at least three separate times at three different reactors (out of the 44 BWRs in operation in this country).

Unlike other reactors in use, the AP1000 design does not have a secondary containment structure designed to capture and treat any radioactivity that might escape the primary containment.

Over their history, both the Hatch 1 and Hatch 2 BWR reactors have experienced through-wall containment cracks, and there have been numerous reported instances of torus thinning. More closely analyzed, a third BWR containment at the FitzPatrick BWR in upstate New York was shown to have a major crack in the containment to the extent it could not perform its intended function. In 2005, a 4½-inch through-wall crack was discovered in the containment and as a result, it was declared to be "inoperable." NRC Special Inspection Report, December 27, 2005 (ADAMS No. ML053610132) and NRC Information Notice 2006-01, January 6, 2006 (ADAMS No. ML053060311).

Visual inspections may identify cracks or holes, but not always in a timely manner. A FitzPatrick staff member was alerted to the through-wall crack in the containment by a long line of rust at the bottom of the crack. The forensic evidence proved that the through-wall crack had been in existence for years before it was finally detected by visual inspection. Even though the location of the crack was accessible to inspectors, it had not been identified until the telltale sign of rust was belatedly observed.

Again using the FitzPatrick reactor as an example, while the size of the FitzPatrick though wall crack may not be large enough to cause catastrophic containment failure in the event of an accident, this through-wall crack was large enough to allow radiation to leak out of the containment building and into the filtered Reactor Building. If a 4½-inch through-wall crack occurred in the containment of an

AP1000 reactor, the radiation leaking through that crack in the case of an accident would have immediately and continuously been exhausted into the environment via the chimney effect.

As stated in the Petition to Suspend AP1000 Design Certification Rulemaking Pending Evaluation of Fukushima Accident Implications on Design and Operational Procedures and Request for Expedited Consideration filed earlier in this rulemaking record by the AP1000 Oversight Group and its member organizations, it should be apparent that containment integrity will be shown to be of paramount importance in the Fukushima "lessons learned." Rather than backsliding because of cost considerations, a robust AP1000 containment with a system to collect and treat any leakage is necessary. At Fukushima, even after the roofs of the secondary containment buildings were blown off by hydrogen explosions, the primary containment structure at each reactor was intended as the last defense against major radiation releases. Apparently one of more of the reactor containments at Fukushima failed that test and are leaking directly to the environment. A review of the effectiveness of the reactor containments, 7
especially if radiation was released through cracks, through-wall holes or breaches in the containment structure, could have direct implications for containment thickness and material, as well as coating and inspection protocols. The high temperatures already documented at the Fukushima reactors may further impact the effectiveness of the AP1000 design, causing containment degradation, widespread cracks or even major breaches of the containment.

The Staff's acceptance of the AP1000 containment, with its failure to provide 4
adequate SAMDA analysis of containment flaws reverses decades of NRC and industry

advocacy for "defense in depth" and requirements for robust containment. It is evident that instead of having a design that is optimized to provide protection to public health and safety, the AP1000 design has multiple problems that have eluded Westinghouse Toshiba and Staff resolution. These problems were evident before Fukushima, but not addressed by the NRC. After Fukushima, it has become unconscionable that the AP1000 design receive approval without a redesign of its containment structure.

ATTACHMENTS

1. Fairewinds Associates, *Post Accident AP1000 Containment Leakage: An Unreviewed Safety Issue*, April 7, 2010, attached to Petition to Initiate Special Investigation on Significant AP1000 Design Defect by the AP1000 Oversight Groups, April 21, 2010.

2. Fairewinds Associates, *Nuclear Containment Failures: Ramifications for the AP1000 Containment Design*, December 21, 2010

Rulemaking Comments

From: John Runkle [jrunkle@pricecreek.com]
Sent: Friday, April 29, 2011 10:40 AM
To: Rulemaking Comments
Subject: DOCKET ID NRC-2010-0131
Attachments: AP1000 Containment Leakage Report Gundersen, Hausler, 4-7-2010.pdf

PART 2 of 4

Attached please find the comments by the AP1000 Oversight Group et al. on containment flaws in the AP1000 reactor design with two reports by Fairewinds Associates (and attachments) supporting those comments. Because of your apparent size limits we are sending these comments in four parts.

John D. Runkle
Attorney at Law
Post Office Box 3793
Chapel Hill, NC 27515
919-942-0600
jrunkle@pricecreek.com

Post Accident AP1000 Containment Leakage

An Unreviewed Safety Issue

Fairewinds Associates, Inc, April 7, 2010

A Report by Arnold Gundersen, March 26, 2010
Chief Engineer, Fairewinds Associates, Inc

Affidavit by Rudolf H. Hausler, PhD, Corro-Consulta
Re. Post Accident AP1000 Containment Leakage:
An Un-reviewed Safety Issue

<u>Attachments:</u>
Attachment 1 – Curriculum Vitae
Attachment 2 – Table 1 from *<u>Detection of Aging Nuclear Power Plant Structures</u>*
Attachment 3 – Table 35-4 *<u>Summary Of Release Category Definitions</u>*
Attachment 4 – *<u>Declaration Of Arnold Gundersen Supporting Citizen Power's Petition</u>*
Attachment 5 – *<u>Declaration Of Arnold Gundersen Supporting Connecticut Coalition Against Millstone In Its Petition For Leave To Intervene, Request For Hearing, And Contentions</u>*

Post Accident AP1000 Containment Leakage
An Unreviewed Safety Issue

A Report by Arnold Gundersen[1]
March 26, 2010

1. Introduction

The AP1000 design has no secondary containment to provide for fission product control following a design basis accident. The purpose of this report is to describe the basis for concerns regarding an apparently unreviewed safety issue raised by the AP1000 containment system design (Revision 18).

My four concerns are:

- Recent experience with the current generation of nuclear reactors shows that containment corrosion, cracking, and leakage are far more prevalent and serious than anticipated by the U.S. Nuclear Regulatory Commission (NRC) in establishing its regulatory program for the safe operation of nuclear reactors.

- By design, the AP1000 containment has an even higher vulnerability to corrosion than containment systems of current reactor designs because the outside of the AP1000 containment is subject to a high-oxygen and high-moisture environment conducive to corrosion and is prone to collect moisture in numerous inaccessible locations that are not available for inspection.

- By design, the AP1000 containment has an even higher vulnerability to unfiltered, unmonitored leakage than the current generation containment system designs, and it lacks the defense in depth of existing structures. While the AP1000 is called an *advanced passive system*, in fact the containment design and structures immediately outside the containment are designed to create a chimney-like effect and draw out any radiation that leaks through the containment into the

[1] Arnold Gundersen is the Chief Engineer with Fairewinds Associates, Inc., a paralegal and expert witness firm that specializes in nuclear safety, engineering, and reliability issues. Mr. Gundersen holds a bachelor's and master's degree in nuclear engineering and has more than 38 years of experience in nuclear power plant operation, management and design. A copy of his curriculum vitae is attached.

environment. Such a system will also facilitate the more efficient release of unfiltered, unmonitored radiation from any cracks or holes that might develop in the containment.

- Finally, a leakage path exists that is not bounded by any existing analysis and will be more severe than those previously identified by Westinghouse in its AP1000 application and various revisions.

The potential consequences of a radiation release to the environment from a small hole or crack in the AP1000 containment are significant. A containment hole approximately ¾" by ¼", like the one discovered at Beaver Valley in 2009, would create exposure to the public well in excess of the 25 rem limit in 10 CFR 100.11(2) for the entire period of the accident. A hole that is the size of the hole in Beaver Valley's containment is not a low probability event, as several through-wall liner holes have already occurred in existing nuclear containments. Therefore, it is not a concept to be pushed off into the severe accident category. Yet, to my knowledge, neither Westinghouse nor the NRC has adequately analyzed this significant safety issue for the AP1000 design.

2. Background of Containment Design

2.1 General. All nuclear power reactor containment systems are designed to contain the radiation and energy that would be released during a Loss Of Coolant Accident (LOCA). In the absence of a containment system, post accident exposures to the public would be unacceptably high. "A containment building, in its most common usage, is a steel or concrete structure enclosing a nuclear reactor. It is designed to contain the escape of radiation... during any emergency. The containment is the final barrier to radioactive release, the first being the fuel ceramic itself, the second being the metal fuel cladding tubes, the third being the reactor vessel and coolant system."[2]

2.2 Current Reactor Containment Designs. According to H.L. Graves, III, NRC, and D.J. Naus, Oak Ridge National Laboratories, there are two main types of

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[2] http://encyclopedia.thefreedictionary.com/containment+structure

containment designs currently in operation: freestanding containments and concrete containments with liners.[3]

> Freestanding Containments are:
> "freestanding, welded steel structures that are enclosed in a reinforced concrete reactor or shield building. The reactor or shield buildings are not part of the pressure boundary and their primary function is to provide protection for the containment from external missiles and natural phenomena (e.g., tornadoes or site-specific environmental events). Thirty-two of the NPPs licensed for commercial operation in the US employ a metal containment."[4]
>
> Concrete Containments With Liner are:
> "metal lined, reinforced concrete pressure-retaining structures that in some cases may be post-tensioned. The concrete vessel includes the concrete shell and shell components, shell metallic liners, and penetration liners that extend the containment liner through the surrounding shell concrete. The reinforced concrete shell, which generally consists of a cylindrical wall with a hemispherical or ellipsoidal dome and flat base slab, provides the necessary structural support and resistance to pressure-induced forces. Leak-tightness is provided by a steel liner fabricated from relatively thin plate material (e.g., 6-mm thick) that is anchored to the concrete shell by studs, structural steel shapes, or other steel products... Seventy-two of the NPPs licensed for commercial operation in the US employ either a reinforced concrete (37 plants) or post-tensioned concrete (35 plants) containment.[5]"

2.3 AP1000 Containment Design. The proposed AP1000 reactors use concepts common to both types of containment system designs to create a wholly *new hybrid containment* that has had no prior operational history. While the AP1000 is a PWR that uses a dry containment system similar to that which most other existing PWRs use, unlike most currently operating PWRs, the AP1000 design proposes to use a freestanding steel containment and no secondary containment.

2.4 Existing freestanding containment systems are normally surrounded by a reactor building that also acts as a filtered enclosure in the case of a design-basis accident. In the AP1000 design, the freestanding steel containment is surrounded by a

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[3] Naus, D.J. and Graves, III, H.L., *Detection of Aging Nuclear Power Plant Structures*, Proceedings of the OECD-NEA Workshop on the Instrumentation and Monitoring of Concrete Structures, NEA/CSNI/ R(2000)15, Organization for Economic Cooperation and Development – Nuclear Energy Agency, ISSY-les-Moulineaux, France, 2001.
[4] *Id.*, page 3.
[5] *Id.*, pages 3-4.

shield building that is not intended or designed to filter exhaust gases that may leak from the steel containment in the event of an accident.

The AP1000 containment has another unique feature: following an accident it serves a role as a heat exchanger. Unlike any previous containment system ever built, the AP1000 uses a large tank of water above the shield building to pour water directly onto the outside of the steel containment shell. After an accident, the falling water then cools the containment shell, which then cools the radioactive steam inside the containment via two processes known as thermal conduction and convection during which the steel shell evaporates the water that is sprayed from above. As stated in a Westinghouse report:

> "The steel containment vessel provides the heat transfer surface that removes heat from inside the containment and transfers it to the atmosphere. Heat is removed from the containment by the continuous, natural circulation of air. During an accident, air cooling is supplemented by water evaporation. The water drains by gravity from a tank located on top of the containment shield building."[6]

The process of falling water effectively converts the containment into a heat exchanger rather than the passive containment building that is the hallmark of the original PWR containment system design.

2.5 History of NRC Containment Analysis. One of the hallmarks of NRC regulation is that licensees and applicants must apply either *conservative assumptions* or *conservative estimates* in order to meet the NRC's statutory requirement to protect public health and safety. The dictionary defines "*conservative*" *as "Moderate: cautious: a conservative estimate"*. The pattern of recently uncovered weakness in the overall integrity of the current operating containment system design methodology proves that presumptions made for the AP1000 containment system considered in the containment design bases lack the level of prudence and caution as required to protect public health and safety.

3. <u>Discussion</u>

3.1 History of Containment Corrosion and Leakage A recent string of failures in

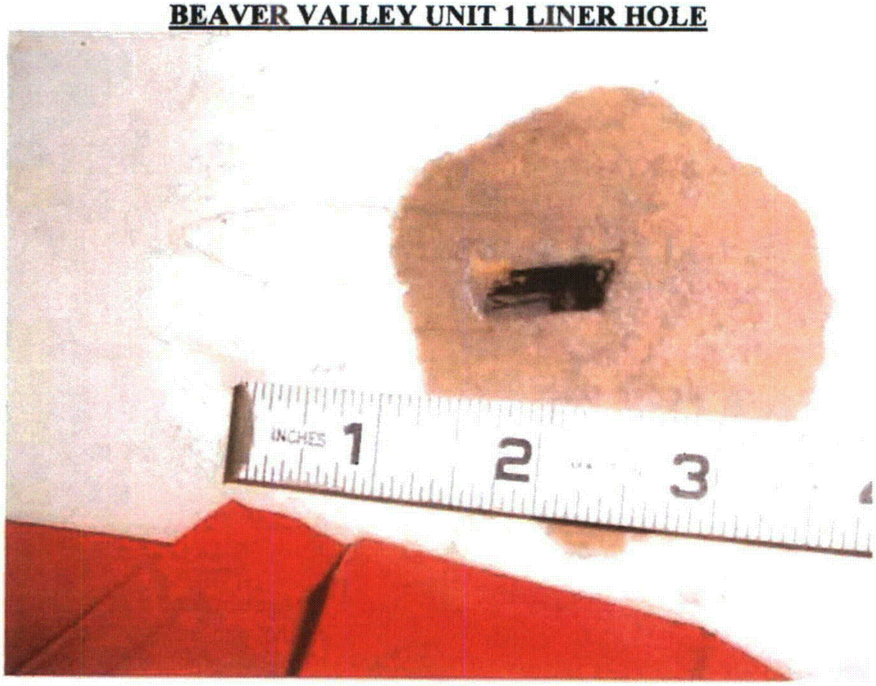
[6] W.E. Cummins, et al, *Westinghouse AP1000 Advanced Passive Plant,* Proceedings of ICAPP '03, Cordoba, Spain, May 4-7, 2003, Paper 3235.

the current generation of containment systems strongly indicates that these current containment systems are not as impervious to the post accident environment as was anticipated and calculated by NRC and the nuclear industry in conducting design basis analysis for nuclear reactors. As discussed below in paragraph 3.1.8, this disturbing trend calls for a new analysis of the potential for containment corrosion and leakage. As further discussed in Section 3.2 below, the need for such an analysis is all the more pronounced with respect to the AP1000 design, which appears to invite corrosion through the establishment of a moist oxygenated environment.

For Example:

3.1.1 Beaver Valley. The NRC and the ACRS have received expert witness testimony concerning three pitting indications at Beaver Valley in 2006 and a through-wall hole at Beaver Valley in 2009 as delineated in the April 23, 2009 NRC Event Notification Report 45015. Moreover, the Beaver Valley NRC Event Notification Report clearly shows that visual inspections have proven inadequate to discover leaks before the leaks penetrate the entire metal surface. Below is a picture taken in April 2009 of a through-wall hole in the Beaver Valley containment that was undetected until complete penetration of the liner had occurred.

BEAVER VALLEY UNIT 1 LINER HOLE



3.1.2 European PWRs. Weld anomalies in the containment liner of the latest generation European Pressurized Reactor at Framanville 3 have caused construction delays and setbacks.[7] Weld anomalies may lead to crevices that create through-wall corrosion if they occurred in the unique AP1000 containment design. While there is a significant amount of European data, the data cited in this report is limited to United States nuclear power plants.

3.1.3 Naus and Graves Study. In their treatise, _Detection of Aging Nuclear Power Plant Structures_, Naus and Graves have created a lengthy and comprehensive list of 66 containment system failures beginning as early as 1970 and following through to the end of their published research in 1999. According to their report:

> "As nuclear plant containments age, degradation incidences are starting to occur at an increasing rate, primarily due to environmental-related factors. There have been at least 66 separate occurrences of degradation in operating containments (some plants may have more than one occurrence of degradation). One-fourth of all containments have experienced corrosion, and nearly half of the concrete containments have reported degradation related to either the reinforced concrete or post- tensioning system. Since 1986, there have been over 32 reported occurrences of corrosion of steel containments or liners of reinforced concrete containments. In two cases, thickness measurements of the walls of steel containments revealed areas that were below the minimum design thickness. Two instances have been reported where corrosion has completely penetrated the liner of reinforced concrete containments. There have been four additional cases where extensive corrosion of the liner has reduced the thickness locally by nearly one-half (10)."[8]

Naus and Graves also report that: "Since the early 1970's, at least 34 occurrences of containment degradation related to the reinforced concrete or post-tensioning systems have been reported."[9]

More disturbingly, Naus and Graves chronicled 32 reported incidences of steel containment or liner degradation that are particularly germane to anticipated problems

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[7] Oliver, Anthony and Owen, Ed, *New Civil Engineer Magazine* June 18, 2009
[8] *Id.*, page 5.
[9] *Id.*, page 6.

with the proposed AP1000 containment system. While some of the problems detailed by Naus and Graves are corrosion or pitting that did not completely penetrate the containment system, *their report also uncovered complete containment system failures of either the liner or the steel containment shell.* Table 1, labeled Attachment 2, from Detection of Aging Nuclear Power Plant Structures identifies through-wall containment cracks that occurred in 1984 at Hatch 2,in 1985 at Hatch 1, and in 1999, North Anna 2 also experienced a through-wall hole in its containment.

Naus and Graves also identify significant problems with containment inspections in locations where inspections are difficult due to inaccessibility. It is stated on Page 18 of their report that:

> **"Inaccessible Area Considerations**
> Inspection of inaccessible portions of metal pressure boundary components of nuclear power plant containments (e.g., fully embedded or inaccessible containment shell or liner portions, the sand pocket region in Mark I and II drywells, and portions of the shell obscured by obstacles such as platforms or floors) requires special attention. Embedded metal portions of the containment pressure boundary may be subjected to corrosion resulting from groundwater permeation through the concrete; a breakdown of the sealant at the concrete-containment shell interface that permits entry of corrosive fluids from spills, leakage, or condensation; or in areas adjacent to floors where the gap contains a filler material that can retain fluids. Examples of some of the problems that have occurred at nuclear power plants include corrosion of the steel containment shell in the drywell sand cushion region, shell corrosion in ice condenser plants, corrosion of the torus of the steel containment shell, and concrete containment liner corrosion. In addition there have been a number of metal pressure boundary corrosion incidents that have been identified in Europe (e.g., corrosion of the liner in several of the French 900 MW(e) plants and metal containment corrosion in Germany). Corrosion incidences such as these may challenge the containment structural integrity and, if through-wall, can provide a leak path to the outside environment." [10]

Not only do Naus and Graves identify inspection problems with containments in the United States, but also in Europe. The data they collected, however, only reflect containment problems in the United States. While their report was written in 1999, the

[10] *Id.*, Page 18

inspection problems have actually accelerated in severity since that time, with the most recent containment problem reviewed occurring at Beaver Valley in April 2009.

3.1.4 Reports in NRC Information Notice. The 66 incidences of containment system degradation occurring between 1970 and 1999 and reported by Naus and Graves appear to be comprehensive for that specific period of time. While my research to date has not uncovered a comprehensive and all-inclusive list for the current decade from 1999 to present, my review of USNRC Information Notice 2004-09 identified another eight additional episodes of containment system degradation including a through-wall hole in the containment liner at D.C. Cook in 2001, three through-wall holes through the liner at Brunswick in late 1999, and 60 areas of pitting at D.C. Cook (Ice Containment) in 1998 where the liner was not penetrated but the thickness of the pitting was below the minimum design value[11].

According to the evidence reviewed, at least 77 instances of containment system degradation have occurred at operating US reactors since 1970, including two through-wall cracks in steel containments (Hatch 1 & 2), six through-wall holes in containment liners (Cook, North Anna 2, Beaver Valley 1, and three at Brunswick), and at least 60 instances of liners pitting to below allowable minimum wall thickness (minimum design value).

3.1.5 Citizens Power Report. In its May 2009 filing regarding Beaver Valley's application for a 20-year license extension, Citizen Power recently informed the NRC's Advisory Committee on Reactor Safeguards (ACRS) of the increased likelihood of containment system leakage failures. The expert witness declaration, entitled *Declaration Of Arnold Gundersen Supporting Citizen Power's Petition* and attached herein as Attachment 3 and contained within Citizen Power's filing to the ACRS, identified the *industry-wide* significance of the containment liner hole at Beaver Valley. The declaration detailed potential causes of containment through-wall liner failure and the currently existing weaknesses in inspection techniques on PWR containment systems.

[11] The minimum standard upon which the licensing design of this specific nuclear power plant was predicated and upon which risk assessment data was factored.

The *Declaration Of Arnold Gundersen Supporting Citizen Power's Petition* also addresses United States patents on containment design that clearly state that concrete containment structures are considered porous to radioactive gases and no credit for retention of radiation in concrete may be allowed.[12]

3.1.6 ACRS 2008 Meeting with Connecticut Coalition Against Millstone. Following my July 9, 2008 testimony to ACRS regarding potential problems with Dominion Nuclear Connecticut Inc.'s Millstone Unit 3's sub-atmospheric *containment system*, the ACRS questioned a *containment specialist staff member of NRC* as to whether the NRC even has the capability to analyze a sub-atmospheric containment. According to the NRC *containment specialist*, the NRC cannot accurately analyze containment systems.

The NRC *containment specialist* and staff member said:

> "It's sort of difficult for us to do an independent analysis. It takes time. We're not really set up to do it. The other thing you have to realize, too, for containment, which isn't as true in the reactor systems area, is that **we don't have the capability**."[13]

To date, the NRC ACRS has met at least twice to discuss Citizen Power's concerns regarding liner failures and the transcripts of those meetings contain key details for containment system failure that should be of concern to the entire nuclear industry.

The most informed discussion of the probability of significant leakage from a PWR containment system may be found in the July 8, 2009 ACRS transcript regarding the Citizen Power petition alerting the NRC to the magnitude and significance of the failure of the containment system. The specific text relating to probability of gross containment leakage is addressed on Page 40 of the July 8, 2009 ACRS transcript:

> "MEMBER RAY: At which point the condition of the concrete can't be taken credit for. So I guess I just think that **the idea that the leakage is**

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[12] According to one of Stone and Webster's patents, "A Sub-atmospheric double containment system is a reinforced concrete double wall nuclear containment structure with each wall including an essentially impervious membrane or liner and **porous concrete** filling the annulus between the two walls." US Patent 4081323 Issued on March 28, 1978 to Stone & Webster Engineering Corp. [Emphasis Added]

[13] ACRS Transcript, July 9, 2008, page 88 lines 6-11 [Emphasis added]

> **going to be small from a small hole, from a hole this size, as small as Dan says, in the design-basis conditions isn't logically supportable because the concrete, you can't – you, yourself said, you can't take credit for the concrete and the reason is because it's condition in the design-basis event can't be predicted, can't be credited. The only thing you can credit is the membrane itself.**
>
> MEMBER SHACK: From a deterministic basis, you're correct. From a probabilistic basis, which is what they use and can take credit based on –
>
> MEMBER RAY: I don't think so.
>
> MEMBER SHACK: Well, that's the way it is.
>
> MEMBER RAY: That's not right."[14]

The July 8, 2009 ACRS discussion between ACRS members Ray and Shack regarding the probability of significant leakage from a PWR containment system occurred after failure of the containment liner at Beaver Valley.

- Ray emphasizes that deterministically the steel containment liner is the only leakage barrier that protects the public.
- Shack implies that the if the liner fails, radiation leaks would be delayed by the concrete containment behind it and therefore a probabilistic risk assessment credit should be given for that reduction in dose release.

My 2008 testimony to ACRS contradicts Shack's assessment and directs one to the original patent delineating the fact that concrete is porous. [See footnote 12]. In the case of the AP1000 design, there is no porous concrete secondary barrier suggested by Shack. Therefore, in regards to the AP1000 design, Ray's position is both deterministically and probabilistically correct.

These ACRS discussions, and further correspondence submitted to the ACRS by Citizen Power indicate that the ACRS has developed an increased awareness of the newly uncovered weaknesses in PWR containment designs. Moreover, a more detailed discussion, including my analysis of the containment issues at Millstone, is detailed within my expert report entitled _Declaration Of Arnold Gundersen Supporting Connecticut Coalition Against Millstone In Its Petition For Leave To Intervene, Request For Hearing, And Contentions,_ herewith filed as Attachment 4.

[14] Transcript, page 40 [emphasis added].

Furthermore, the ACRS wrote a letter to NRC Executive Director for Operation R. W. Borchart on September 21, 2009 entitled *Request By The ACRS For A Future Briefing By NRR On Current Containment Liner Corrosion Issues And Actions Being Taken By The Staff To Address Them* in which the ACRS said:

> "During the 565th meeting of the Advisory Committee on Reactor Safeguards, September 10-12, 2009, the Committee indicated the need for a future briefing by NRR on the topic of containment liner corrosion. **In recent years liner corrosion issues have been identified on a few of the operating nuclear power reactors. The Committee would like to hear from NRR about current staff efforts to address these issues generically.** Please let us know about a proper date and time for this briefing to take place.[15]

3.1.7 Petrangeli Report. The ACRS is not the only organization expressing concern regarding the overall integrity of PWR containments. In his book *Nuclear Safety*, Dr. Gianni Petrangeli, a nuclear engineering professor at the University of Pisa in Italy, also reported his concern regarding the likelihood of *containment* breaches *and the probability of severe post-accident leakage from a PWR containment.* In his book, Dr. Petrangeli noted:

> "There is a tendency in the design phase to specify for the containments a figure for the maximum admissible leakage rate which is close to that which is technically obtainable in ideal conditions... In the course of plant operation however, even if at the start the leak rate was the specified one or lower, a certain deterioration in the containment leak rate takes place and then in the case of an accident, the leak rate would probably be higher than that measured in the last leakage test.... In depth studies ... were performed on the deterioration probability of the leak proofing in real containment systems. The picture that emerges is not very reassuring... The probability of overcoming the specification values in the case of an accident is 15 per cent for BWR's and 46 percent for PWRs"[16].

Using US NRC data gathered from 1965 through 1988 and NUREG-1273 on containment leakage from a variety of sources, Dr. Petrangeli presents the probability that a containment system will exceed its technical specification limits during an accident in Table 14-2 reproduced below.

[15] Meeting Transcript, page 40 [Emphasis Added]

[16] Petrangeli, Gianni, Nuclear Safety, Butterworth-Heinemann, 2006, ISBN 10: 0-7506-6723-0, Page 141.

Table 14-2. Measured containment leaks (USNRC 1988)

Leak measured relative to the specifications	BWRs*	PWRs*
From 1 to 10 times	0.10	0.31
From 10 to 100 times	0.04	0.08
Higher than 100	0.01	0.07

* These columns represent the probability of exceeding the technical specification leakage rates.

In my review of the more comprehensive data from the 1999 Naus and Graves study, as well as significant liner failures between 2000 and 2010 after Naus and Graves collected their data, the leakage rates in Table 14-2 of Dr. Petrangeli's 2006 book may in fact underestimate the post-accident containment system leakage risk.

Dr. Petrangeli further expressed his concerns based on his review of this data as it pertains to the new containment designs including the AP1000 when he said:

> "It is surprising that this issue does not receive much attention in the field of safety studies... This issue has been dealt with here because, for plants now under construction and for future ones, the tendency is to restrict the important consequences of severe accidents to within a very small distance from the plant possibly to avoid the need to evacuate the population. From this perspective, the real leakage of the containment system becomes very important."[17]

Dr. Petrangeli then continues by suggesting as a solution the exact opposite approach to that taken in the AP1000 containment design. Rather than act as a chimney and draw unfiltered gases from the gap between the containment and shield building as the AP1000 does, Petrangeli suggests as a possible solution for severe accident dose mitigation would be "... systems with a double containment with filtering of the effluents from the annulus between the containments..." when a secondary containment can be constructed. I note that the AP1000 shield building is not designed to "contain" any gases, and that Westinghouse has stated, "There is no secondary containment provided for the fission product control following a design basis accident." (AP1000 DCD, Rev. 16, Section 6.5.3.2).

[17] *Id.*, page 142.

3.1.8 Conclusions Regarding Containment Degradation and Leakage. As discussed above, the recent history of nuclear reactor operation shows a disturbing, unanticipated and unanalyzed trend of containment corrosion and leakage. This trend is seen in both standard containments and in containment designs such as the sub-atmospheric design used at Millstone and six other plants, and the ice containment system that has a litany of serious safety related containment failures. And clearly, the newfound containment liner hole at Beaver Valley creates a dilemma for both the industry and regulators in that it shows the increased likelihood of gross leakage by a PWR containment system that would significantly compromise public health and safety.

In my professional opinion, this disturbing trend calls for a new analysis of the potential for containment corrosion and leakage in the existing fleet of operating reactors. As further discussed in Section 3.2 below, the need for such an analysis is all the more pronounced with respect to the AP1000 design, which appears to invite corrosion through the establishment of a moist environment.

3.2 The Unique AP1000 Design Introduces An Unanalyzed Vulnerability

3.2.1 General. In the event the AP1000 containment leaks radioactive material into the annular gap between it and the shield building, the AP1000 is specifically designed to immediately act as a chimney and draw those vapors directly into the environment without filtration. The design of the AP1000 containment also has a greater potential to leak than existing containments with an increased likelihood that the leakage will exceed dose exposure limits at the Low Population Zone.

3.2.2 AP1000 Integrity and Corrosive Attacks. Well before the discovery of pitting (2006) or the through wall leak (2009) at Beaver Valley, the NRC expressed concerns about the integrity of the AP1000 containment to resist a corrosive attack. In 2003 the NRC wrote:

> "The staff's review of the containment shell design identified a concern that the 4.44 cm (1.75 in.) thickness of the cylindrical shell just meets the minimum thickness requirement of 4.4336 cm (1.7455 in.) of the 1998 ASME Code, Section III, Subsection NE, Paragraph NE-3324.3(a), based on a 406.8 kPa (59 psi) design pressure, a 148.9 °C (300 °F) design temperature, allowable stress, S = 182 MPa (26.4 ksi), and a containment vessel radius, R = 1981.2 cm (780 in.). **The staff noted that there is no**

margin in the nominal design thickness for corrosion allowance. Of particular concern is the embedment transition region of the cylinder, which has been prone to corrosion in operating plants. Paragraph NE-3121 specifically requires that the need for a corrosion allowance be evaluated. Consequently, the staff requested the applicant to provide justification for (1) making no provision, in defining the nominal design thickness, for general corrosion of the containment shell over its 60-year design life, and (2) not specifying a corrosion allowance in the embedment transition region. In its response to RAI 220.002 (Revision 1), the applicant submitted the following information to address the corrosion allowance for the AP1000 containment shell:

> The ASME Code of record has been updated to the 2001 Edition including 2002 Addenda. (The applicant has revised the DCD to incorporate this change.) Per the revised Code of record, S = 184.09 MPa (26.7 ksi) and tmin = 4.38 cm (1.726 in.), which provides a nominal margin for corrosion of 0.06 cm (0.024 in.).
>
> The design has been changed to add a corrosion allowance for the embedment transition region, as was provided for the AP600. The nominal thickness of the bottom cylinder section is increased to 4.76225 cm (1.875 in.) and the vertical weld joints in the first course will be post-weld, heat-treated per ASME Code requirements. Design of Structures, Components, Equipment, and Systems
>
> Corrosion protection has been identified as a safety-related function for the containment vessel coating in DCD Tier 2, Section 6.1.2.1.1, "General (Protection Coatings)." The COL applicant will provide a program to monitor the coatings, as described in DCD Tier 2, Section 6.1.3.2, "Coating Program."
>
> On the basis that enough corrosion allowance and proper corrosion protection were provided, the staff found the applicant's response acceptable, pending (1) incorporation of the design change in the cylinder embedment transition region in a future revision, and (2) designation of the "inhibit corrosion" function as "safety" for coatings on the outside surface of the containment vessel in a future revision of DCD Tier 2, Table 6.1-2. This was Confirmatory Item 3.8.2.1-1 in the DSER." [18]

The use of the term *corrosion allowance* refers to situations during which the containment experiences general corrosion over a large area. This general corrosion is a structural problem because it is a broad attack upon the entire structure rather than a pinhole, and therefore the NRC staff concern regarding a general corrosion issue with the

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[18] Page 3-106 AP1000 SER

AP1000 does not address the potential for the through-wall pitting problem reviewed and analyzed in this report. The unique features of the AP1000 exacerbate the likelihood of through-wall pitting corrosion that would increase post accident leakage.

The NRC requirements for increasing the thickness of the AP1000 containment by only one-eighth of an inch and by adding field applied protective coatings do not provide adequate assurance to mitigate potential pitting. The proposed NRC remedies are inadequate in light of industry experience and the unique features of the AP1000 containment design. One needs only to review the 3/8"-thick hole at Beaver Valley which occurred on a field coated surface and other through-wall failures discussed above to conclude that the 1/8 inch corrosion allowance in the AP1000 design is simply not adequate to address pitting.

3.2.3 Vulnerability To Hole Propagation. As discussed in 3.1.3 above, Naus and Graves have already identified the difficulty of thoroughly inspecting inaccessible locations in any containment system. The data reviewed show that such inspections will be more problematic in the AP1000 where abundant air, moisture and corrosive chemicals may allow holes to continue to grow over extended periods of time thereby forming unlimited pockets of corrosion in crevasses at inaccessible locations. This action would likely be especially true in the vicinity of non heat-treated or poorly heat-treated welds of high strength steels. In comparison, the corrosion at Beaver Valley and other existing PWRs has not progressed quite as rapidly as what is projected to occur in the AP1000 because there was no constant replenishment of oxygen and moisture on the outside of the containment liner shell. However, in the event that a corrosion site begins on the outside of the AP1000 containment, unlimited amounts of oxygen, moisture and corrosive chemicals are available for the corrosion to propagate and eventually result in broad weakening of the shell by deep grooves.

The annular gap outside the AP1000 containment is continually subjected to air, is subject to moisture buildup from humidity and condensation in the air, and subject to corrosive chemicals creating the ideal incubator for crack propagation and the creation of holes. The AP1000 containment design effectively continuously "breathes" in air, moisture and contaminants into the annular gap between the shield building and the containment. “Breathing” in this case is what engineers would call natural convection. For example, at Turkey Point and other saltwater sites, that air would also contain salt and other minerals that give ocean air its familiar *ocean smell* and corrosivity of the salt water. On cooling tower sites, the AP1000 would "breath" in cooling tower drift (fine water droplets in the vapor cloud), containing chlorides and biocides and accumulated minerals in the cooling water. The net effect is that these chemicals are corrosive agents traveling immediately next to the outside of the steel containment.

Furthermore, the 8,000,000 gallon (8 million gallon) water tank situated above the containment may leak over extended periods of time thereby providing additional moisture to aid in the propagation of holes.

In addition to the possibility of holes or pitting in the wall of the AP1000 containment due to the factors previously discussed, there is also an additional failure mode due to corrosion that must be addressed. Since concrete cannot bond to steel, a gap or pocket will be formed at the interface between the containment wall and the concrete containment floor. History has proven that over time moisture and contamination will enter this gap and cause corrosion to begin. Once again, as Naus and Graves suggest, it is at just such an inaccessible location that pitting can grow to cause either complete failure of the containment system or deterioration of the containment wall thickness to below the Code Allowable.

A second method of containment integrity failure would also be possible at the junction between the concrete floor and steel wall. In this inaccessible location, it is most likely that corrosion would first form as numerous pits ultimately coalescing into a grove that would present a mechanism of loss of structural integrity called *buckling*. If devolved pitting were to occur at the junction between the concrete floor and steel wall, then the low margin of safety for the overall thickness of the AP1000 containment actually becomes a serious structural issue and not just a hole that causes increased leakage.

The net effect of all these parameters upon the AP1000 design is that through-wall holes or flaws below minimum allowable wall thickness are at least as vulnerable to develop in the new AP 1000 design as compared to the existing PWR containments in which the industry has already witnessed failures.

3.2.4 Inspection Of The AP1000 Containment. Current visual inspections of the containment from easily accessible areas within existing containments have a history of failing to identify any corrosion until the containment barrier itself has been penetrated. Visual inspection on the inside of all containments therefore relies upon a hole fully penetrating the containment in order to be detected.

My experience as a Senior Vice President of an ASME Section XI non-destructive testing division and my review of the AP1000 containment design has led me to conclude that the AP1000 design presents similar obstacles to visual and ultrasonic inspection techniques, and also introduces more locations that are inaccessible to inspection and prone to corrosive attack. Moisture buildup and corrosive agent attack in small crevasses between the containment and the shield building will most likely increase the likelihood of hole-propagation at exactly the locations that are most difficult or impossible to inspect.

3.2.5 Field Welding and Coatings on the AP1000. The AP1000 containment is not a single piece of steel but rather many sheets welded together in the field. These numerous field-welded connections to the containment provide ideal locations both for pitting and crevice corrosion to develop and horizontal surfaces for moisture to collect. In addition, an Idaho National Laboratories Report entitled *Study Of Cost Effective Large Advanced Pressurized Water Reactors That Employ Passive Safety Features* states that, "The containment vessel supports most of the containment air baffle. ...Flow distribution weirs are welded to the dome as part of the water distribution system..."[19]

In addition to field-welds, coatings will also be applied to the containment in the field. According to the Idaho National Labs report, "The containment vessel is coated with an inorganic zinc coating".[20] While coatings can provide some protection when properly applied, there is no assurance that field application can be completely successful and will

[19] Pages 2-11 and 2-12 of an Idaho National Laboratories Report entitled Study Of Cost Effective Large Advanced Pressurized Water Reactors That Employ Passive Safety Features (DOE/SF/22170) dated November 12, 2003
[20] *Id.*, page 2-12.

last for the 40 to 60 years of projected operating life. In fact, field quality assurance problems during the construction of existing containments have been determined to be the root cause of many of the containment degradation issues identified earlier in this report. Moreover, there are oil and gas facilities where components have completely corroded even though they were protected by galvanic coatings. A galvanic coating protects only as long as the zinc is present as a metal. For protection, the zinc corrodes and thereby prevents the underlying iron from corroding. However, when the zinc is gone the iron corrodes.

Given that moisture and corrosive chemicals will be drawn into the gap between the shield building and the containment and that various welded connections will provide locations for pit and crevasse corrosion to initiate, it is possible that intergranular corrosion in weldments could propagate at a rate of 0.15inches per year of faster, and in locations that are under stress, cracks could form. In my opinion a small crack could create a hole that would remain undetected and completely penetrate the AP1000 containment in a through-wall leak within approximately ten years or less.

3.2.6 AP1000 Chimney Effect. The AP1000's containment design is uniquely designed to act like a chimney and draw air and moisture out of the annular gap between the containment and the shield building. In the event a containment hole develops, the pressure inside the containment will push any radioactivity into the annular gap and then that radioactivity will immediately be drawn out into the air above the reactor by this chimney effect.

3.2.7 Increased Radiation Exposure From A Leak Into Annular Gap. Based upon my experience in Integrated Leak Rate Testing, the industry expectation is that a ¼ inch hole in the containment will produce leakage in excess of 100 Standard Cubic Feet per Hour (SCFH) resulting in an off-site exposure of approximately 25-rem at the Low Population Zone (LPZ). The hole at Beaver Valley was significantly larger than the aforementioned industry standard and would have resulted in approximately ten times that exposure, as leakage increases with the square of the hole diameter. However, as noted earlier in the conversation between ACRS members Ray and Shack, the existing steel liner at Beaver Valley was also backed up by a concrete containment. No such redundancy is incorporated in the AP1000 design. A hole the size of Beaver Valley's would clearly exceed the NRC's Low Population Zone (LPZ) dose limits. Admittedly the AP1000 containment is thicker than Beaver Valley's, but hole propagation is not self-limiting in the AP1000 design as previously described.

3.2.8 Implications To The AP1000 Design. The ACRS concern regarding containment integrity following the discovery of the Beaver Valley hole, Dr. Petrangeli's concern with respect to new containment design leakage rates, and the detailed history of at least 77-containment system failures nationwide, demand a wholly new analysis to determine exactly how the newly proposed AP1000 design accommodates leakage through the wall of its unique hybrid containment system.

Containment system leakage from through-wall holes in steel has already occurred at North Anna, Beaver Valley, Hatch 1, Hatch 2, Cook and Brunswick. However, in each of these circumstances ACRS member Shack articulated the fact that there was another potential barrier by which to collect and filter the airborne radiation that leaked from the containment system. Previous freestanding steel containments with holes were enclosed within a reactor building into which the leakage entered and was controlled. The liner failures appeared to be backed up by a concrete containment building.

In the event of an accident at a proposed AP1000 reactor, leakage through the freestanding steel containment will pass directly into the gap between the steel and the shield building. Therefore, the proposed AP1000 containment design is inherently less safe than current reactors presently licensed and operating.

The following four pages contain accident sequence illustrations.

- Figure 1 – AP1000 in normal operation.
- Figure 2 – AP1000 design basis accident begins.
- Figure 3 – AP1000 containment hole opens as containment fills with radioactive gases.
- Figure 4 – AP1000 chimney effect draws radioactivity directly into the environment.

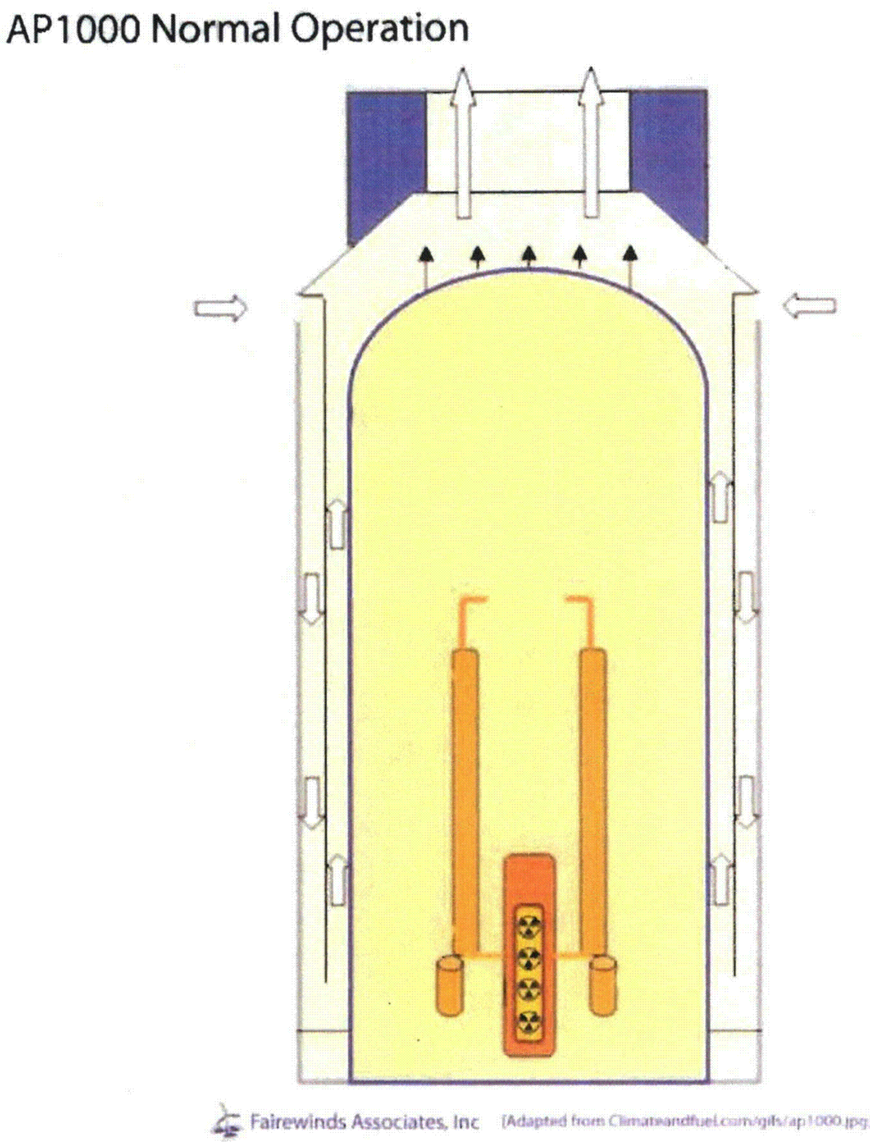
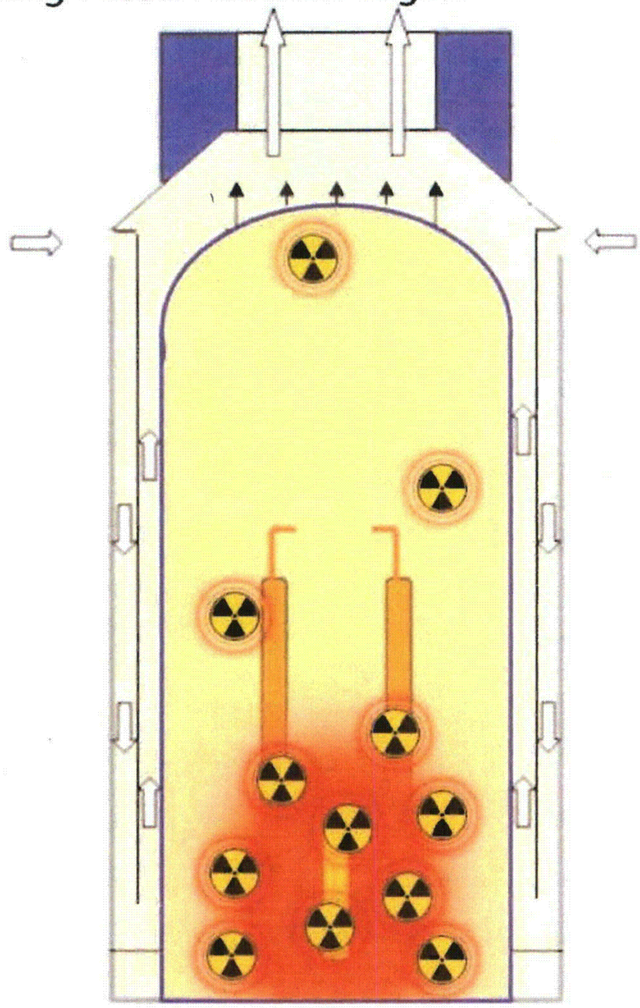

AP1000 Normal Operation
Fairewinds Associates, Inc
(Adapted from Climateandfuel.com/gifs/ap1000.jpg)

Figure 1

AP1000 Design Basis Accident Begins



Fairewinds Associates, Inc (Adapted from Climateandfuel.com/gifs/ap1000.jpg)

Figure 2

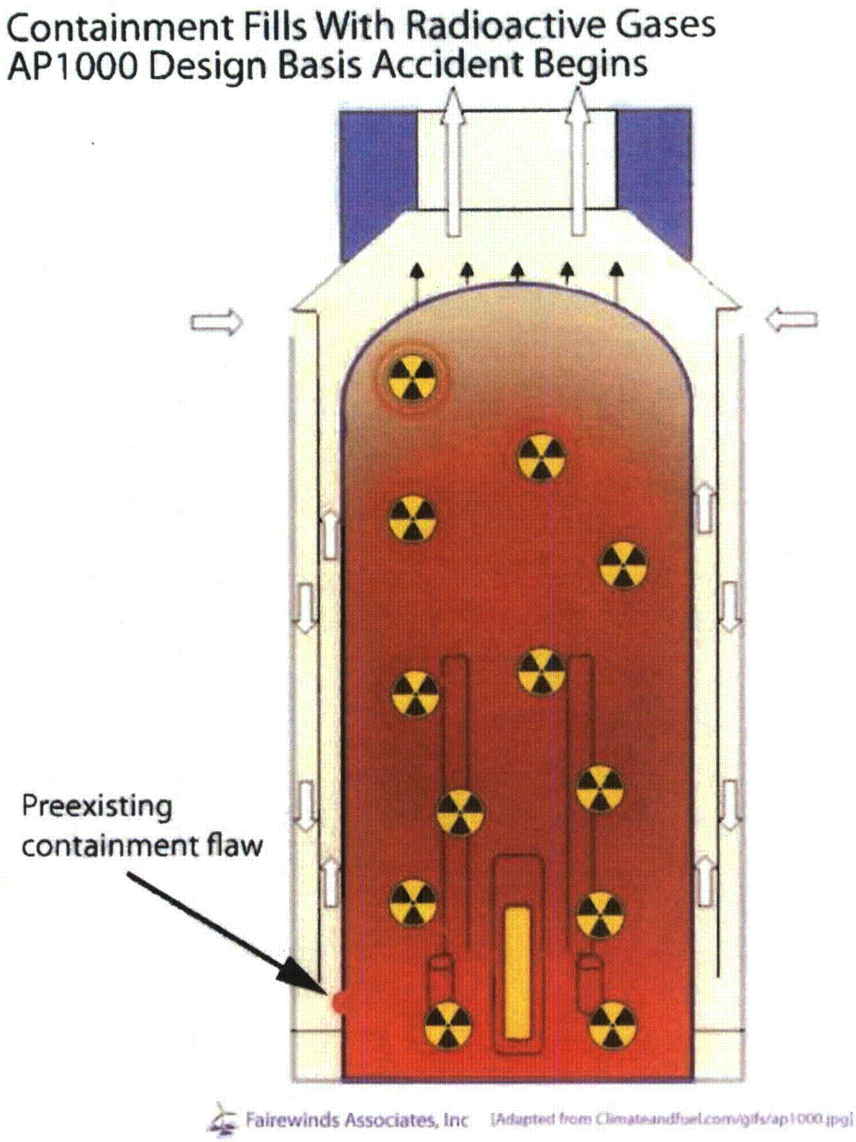

Containment Fills With Radioactive Gases
AP1000 Design Basis Accident Begins
Preexisting containment flaw
Fairewinds Associates, Inc
[Adapted from Climateandfuel.com/gifs/ap1000.jpg]

Figure 3

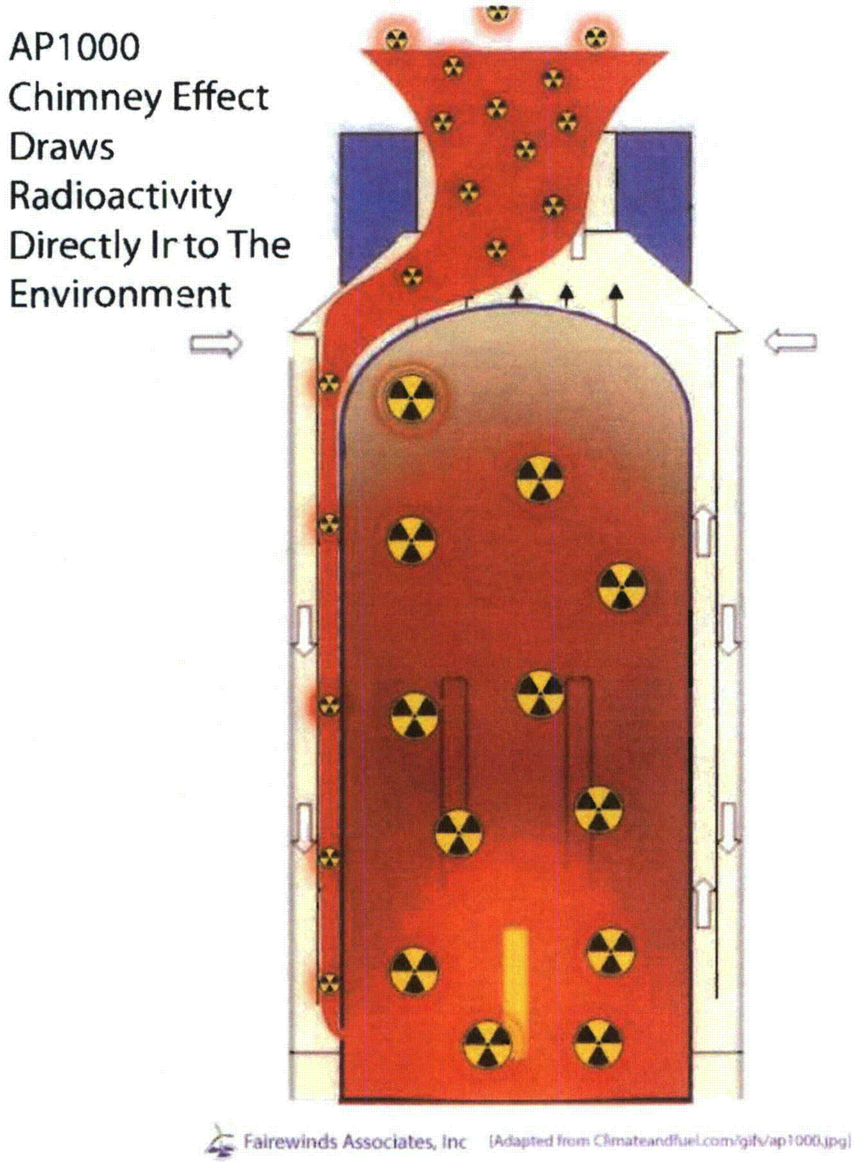

AP1000
Chimney Effect
Draws
Radioactivity
Directly Ir to The
Environment
Fairewinds Associates, Inc (Adapted from Climateandfuel.com/gifs/ap1000.jpg)

Figure 4

Concernedly, the hybrid AP1000 containment system appears to lack any of the redundancy or defense in depth[21] in containment system design that was present in earlier designs reviewed in this report and upon which *design bases events* are predicated.

The hole in the Beaver Valley containment confirms Dr. Petrangeli's analysis about the increased likelihood of severe containment leakage. In his analysis, Dr. Petrangeli shows that there is at least a 10-percent likelihood and potentially a 31-percent likelihood of leakage from the AP1000 containment system being 10-times higher than that specified in the AP1000 Design Basis and Technical Specifications. This significant variation in potential leakage corresponds roughly to the size of the hole in the Beaver Valley Containment. See Table 14-2 on Page 12 for comparative chart.

Incongruously, the purpose of *the gap between the steel and the shield building* in the design has ***NOT*** been created to collect and treat radiation as Dr. Petrangeli suggests would be appropriate, but rather to allow air and moisture to cool the containment itself and then to act as a chimney allowing those gases to be siphoned directly out into the environment.

Consequently, the design of the proposed AP1000 containment and its shield building might actually cause the occurrence of a larger leakage rate and a higher probability of a through-wall leakage than the currently existing containment system failures discussed above due to the active role of the AP1000 shield building in acting as a chimney which draws radioactively contaminated air into the environment.

Specifically, the outside of the containment is designed to be wetted and for that reason it has millions of gallons of water suspended above it in order to provide moisture following an accident. More specifically, containment holes and leaks in existing

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[21] **Defense in depth** is an approach to nuclear power plant safety that builds-in layers of defense against release of radioactive materials so that no one layer by itself, no matter how good, is completely relied upon. To compensate for potential human and mechanical failures, *defense in depth* is based upon several layers of protection with successive barriers to prevent the release of radioactivity to the environment. This approach includes protection of the barriers to avert damage to the plant and to the barriers themselves. It includes further measures to protect the public, workers, and the environment from harm in case these barriers are not fully effective. *Defense in depth* is a hallmark of nuclear regulation and risk assessment to meet the statutory requirements inherent in the NRC responsibility to protect public health and safety.

containment systems were previously self-limiting because they ran out of moisture and oxygen. Moisture, oxygen and corrosive chemicals would be plentiful in the annular gap surrounding the containment and would promote the propagation of holes in normal AP1000 operational scenarios.

Existing data shows that containment system failures occur with moisture and oxygen. Therefore, it is clear that for the AP1000 design, leakage from the water tank, water from testing the tank, and/or atmospheric moisture due to the condensation on the water tank will create a constant environment of moisture and oxygen that may in fact provoke a through-wall containment failure in locations that are difficult and/or impossible to inspect.

Consequently, by looking at the historical record of containment system failures detailed in NRC records and in this report, and given the lack of a bond between the concrete floor and steel containment wall, and the inspection difficulty within crevasses in the annular gap between the AP1000 containment and the shield building, it is very likely that corrosion will develop that will limit the containment's effectiveness in the event of an accident.

4. Severe Accident Scenario or Design Basis Event?

4.2.1 General. Published reports indicate that the NRC already considers a breach of existing containments to be a plausible accident scenario. Emergency planning exercises at Oyster Creek and Callaway have already been based upon containment failure. My concern is that the potential for a breach of the AP1000 containment as discussed in this report is not a remote probability event, and may in fact occur prior to a design basis accident, and may remain undetected until the accident occurs.

4.2.2 AP1000 PRA. According to Chapter 35 of the Westinghouse AP1000 Probabilistic Risk Assessment on file with the NRC, Westinghouse has not assessed the possibility of radioactive gasses moving through the annular gap between the steel containment and the shield building and then directly out into the environment.

In Chapter 35 of the Westinghouse AP1000 probabilistic risk assessment, which is entitled *CONTAINMENT EVENT TREE ANALYSIS*, ***none*** of the seven AP1000 accident scenarios assumed containment leaks into the an annular gap of the shield building that would then move radiation out into the environment without filtration.

Moreover, in Table 35-4 entitled *SUMMARY OF RELEASE CATEGORY DEFINITIONS* on page 35-24 of the report (reproduced as Attachment 5), only seven possible "*Release Categories*" have been defined and identified by Westinghouse as possible candidates for releasing gases into the environment following an accident. None of these release categories identified by Westinghouse include steel containment failure directly into the annular gap created by the shield building.

4.2.3 Severe Accident Mitigation Design Alternatives (SAMDA). As part of the AP1000's *Severe Accident Mitigation Design Alternatives (SAMDA)* analysis, Westinghouse claims to have considered and rejected the need for "Secondary Containment Filtered Ventilation". In its Revision 9 of the AP1000 Design Control Document, Page 1B-6 Westinghouse said:

> **"Secondary Containment Filtered Ventilation**
> This SAMDA consists of providing the middle and lower annulus... of the secondary concrete containment with a passive annulus filter system for filtration of elevated releases. The passive filter system is operated by drawing a partial vacuum on the middle annulus through charcoal and HEPA filters. The partial vacuum is drawn by an eductor with motive flow from compressed gas tanks. The secondary containment would then reduce particulate fission product release from any failed containment penetrations (containment isolation failure). In order to evaluate the benefit from such a system, this design change is assumed to eliminate the CI release category."

I have no understanding of why, in the above quotation, Westinghouse uses the term "*secondary concrete containment*" to refer to the AP1000 Shield Building. The Shield Building is proposed to be of modular construction and will not serve the purpose of containing radiation. It is not designed to contain anything, but rather is designed to disperse air and moisture used to cool the containment. *Westinghouse's use of the term "secondary concrete containment" is a misnomer.*

The starting point (base case) for all the AP1000 containment scenarios is the "Intact Containment". The intact containment is explained as "Release Category IC" on Page 1B-10:

> **"Release Category IC – Intact Containment**
> If the containment integrity is maintained throughout the accident, then the release of radiation from the containment is due to nominal leakage and is expected to be within the design basis of the containment. This is the "no failure" containment failure mode and is termed intact containment. The main location for fission-product leakage from the containment is penetration leakage into the auxiliary building where significant deposition of aerosol fission products may occur."

In addition to this base case scenario, the SAMDA analysis then postulates several extremely low probability events on Pages 1B-10 and 1B-11:

> **"Release Category CFE – Early Containment Failure**
> Early containment failure is defined as failure that occurs in the time frame between the onset of core damage and the end of core relocation. During the core melt and relocation process, several dynamic phenomena can be postulated to result in rapid pressurization of the containment to the point of failure. The combustion of hydrogen generated in-vessel, steam explosions, and reactor vessel failure from high pressure are major phenomena postulated to have the potential to fail the containment. If the containment fails during or soon after the time when the fuel is overheating and starting to melt, the potential for attenuation of the fission-product release diminishes because of short fission-product residence time in the containment. The fission products released to the containment prior to the containment failure are discharged at high pressure to the environment as the containment blows down. Subsequent release of fission products can then pass directly to the environment. Containment failures postulated within the time of core relocation are binned into release category CFE."

> **"Release Category CFI – Intermediate Containment Failure**
> Intermediate containment failure is defined as failure that occurs in the time frame between the end of core relocation and 24 hours after core damage. After the end of the in-vessel fission- product release, the airborne aerosol fission products in the containment have several hours for deposition to attenuate the source term. The global combustion of hydrogen generated in-vessel from a random ignition prior to 24 hours can be postulated to fail the containment. The fission products in the containment atmosphere are discharged at high pressure to the environment as the containment blows down. Containment failures postulated within 24 hours of the onset of core damage are binned into release category CFI."

"Release Category CFL – Late Containment Failure
Late containment failure is defined as containment failure postulated to occur later than 24 hours after the onset of core damage. Since the probabilistic risk assessment assumes the dynamic phenomena, such as hydrogen combustion, to occur before 24 hours, this failure mode occurs only from the loss of containment heat removal via failure of the passive containment cooling system. The fission products that are airborne at the time of containment failure will be discharged at high pressure to the environment, as the containment blows down. Subsequent release of fission products can then pass directly to the environment. Accident sequences with failure of containment heat removal are binned in release category CFL."

"Release Category CI – Containment Isolation Failure
A containment isolation failure occurs because of the postulated failure of the system or valves that close the penetrations between the containment and the environment. Containment isolation failure occurs before the onset of core damage. For such a failure, fission-product releases from the reactor coolant system can leak directly from the containment to the environment with diminished potential for attenuation. Most isolation failures occur at a penetration that connects the containment with the auxiliary building. The auxiliary building may provide additional attenuation of aerosol fission-product releases. However, this decontamination is not credited in the containment isolation failure cases. Accident sequences in which the containment does not isolate prior to core damage are binned into release category CI."

"Release Category BP – Containment Bypass
Accident sequences in which fission products are released directly from the reactor coolant system to the environment via the secondary system or other interfacing system bypass the containment. The containment failure occurs before the onset of core damage and is a result of the initiating event or adverse conditions occurring at core uncovery. The fission-product release to the environment begins approximately at the onset of fuel damage, and there is no attenuation of the magnitude of the source term from natural deposition processes beyond that which occurs in the reactor coolant system, in the secondary system, or in the interfacing system. Accident sequences that bypass the containment are binned into release category BP."

4.2.4 Analysis of SAMDA Assumptions. A brief examination of the SAMDA assumptions Westinghouse applied to the AP1000 containment beyond its design basis (*Intact Containment*) scenario shows many non-conservative assumptions.

- For Release Category CLF (Late Containment Failure), Westinghouse assumes that the postulated containment failure occurs only 24-hours after the accident has begun and that the failure is due to the inability of the containment to remove decay heat. Westinghouse has simply made an arbitrary choice of the 24-hour number and the causative action.

- For Release Category CI (Containment Isolation), Westinghouse first assumes that the containment fails to properly isolate. Secondly, Westinghouse assumes that the isolation failure occurs at a containment penetration from which any additional leakage then enters the auxiliary building. Leakage into another building then provides additional filtration and delay. Westinghouse **does *not* assume** that the failure might occur at a location in the containment that directly exhausts into the annular ring between the containment and the shield building. Any leakage into this annular gap would then leak directly into the environment, which has not been factored into either the Westinghouse assessment or the NRC review of the Westinghouse data.

- For Release Category BP (Containment Bypass) Westinghouse has assumed that the containment is bypassed through an open piping system. Once again, Westinghouse fails to consider or factor in to its analysis that the containment failure might occur at a location in the containment that directly exhausts into the annular ring between the containment and the shield building. Any leakage into this annular gap would then leak directly into the environment. As delineated before, the Westinghouse assessment has not considered all the pertinent data.

Westinghouse has ignored the long history of previous containment and containment liner failures that indicate there is an unacceptably high risk that the AP1000 containment might be in a failed condition at the onset of an accident. Inspection results of existing PWR containments have shown numerous occasions when containment liners have completely failed or experienced holes below minimum allowable wall thickness. Therefore, there is a significant probability that leakage from the AP1000 containment would begin immediately and most likely **will *not* occur** at the site of containment penetration. This potential AP1000 leakage is not related to an extraordinary SAMDA event, but may be anticipated to exist at the beginning of the accident due to uninspected corrosion of the containment as discussed in this report. The leakage problem in the AP1000 design is exacerbated because it is the only containment design that has an annular gap specifically created to act as a chimney and draw air directly into the environment.

4.2.5 SAMDA Summation. In every case Westinghouse chose to analyze, it ignored the likelihood that radioactive leakage would move directly into the annular gap between the containment and the shield building.

Moreover, in the design *features* of the Westinghouse AP1000 reactor, this leakage would *be deliberately* wafted out into the environment. Furthermore, there are several significant and extraordinary assumptions within the Westinghouse analysis that has the net effect of minimizing the AP1000's unique design weakness.

These non-conservative SAMDA assumptions include:

- The likelihood of containment failure is minimized.
- The timing of the failure is delayed, hence reducing radionuclide concentrations.
- The location of the failure is chosen to avoid the annular gap.
- The likelihood of significant leakage is minimized.
- And, the dose consequences are therefore also minimized.

With these five erroneous assumptions, Westinghouse has failed in its efforts to *prove* that there is no need to modify the AP1000 Containment and Shield building in order to eliminate the possibility of releases directly into the environment and to protect public health and safety. In fact, containment failure through only a small hole similar to that at Beaver Valley should not be a SAMDA event, but is likely to exist when the design basis event occurs.

5. Conclusion

Given the newly discovered Beaver Valley containment system failure and a litany of other containment failures identified throughout this report, the facts show that it is unreasonable to assume that the AP1000 containment design for the proposed AP1000 reactors will not leak radiation directly into the annular gap created by the shield building.

In conclusion, the potential for containment leakage directly through holes in the steel shell creates an unanalyzed safety risk to the public from the proposed AP1000 containment design. Releases from this potential leakage path are not bounded by any existing analysis and will be more severe than those previously identified by Westinghouse in its AP1000 applications and various revisions.

Four contributing factors will increase the consequences of an accident in which the containment leaks radiation directly into the annular gap.

- First, more radiation is likely to be released than previously analyzed.
- Second, radiation will be released sooner than in other scenarios because the hole or leakage path exists prior to the accident.
- Third, radioactive gases entering this gap are not filtered or delayed.
- Fourth, moisture and oxygen, routinely occurring between the containment and the shield building in the AP1000 design, exacerbates the likelihood of larger than design basis containment leaks.

Filtration of the air leaving the annular gap between the containment and the shield building was previously rejected by Westinghouse's SAMDA analysis. However, in my opinion, this issue should be reconsidered because it is a design basis event and not a low probability SAMDA occurrence. Finally, because the NRC and Westinghouse have not analyzed the containment system for the design of the proposed AP1000 reactors in light of these flaws, the public is presented with an *unreviewed safety issue* that creates a potential accident with much more severe consequences than previously analyzed.

Attachments:

Attachment 1 – Curriculum Vitae

Attachment 2 – Table 1 from *Detection of Aging Nuclear Power Plant Structures*

Attachment 3 – Table 35-4 *Summary Of Release Category Definitions*

Attachment 4 – *Declaration Of Arnold Gundersen Supporting Citizen Power's Petition*

Attachment 5 – *Declaration Of Arnold Gundersen Supporting Connecticut Coalition Against Millstone In Its Petition For Leave To Intervene, Request For Hearing, And Contentions*

CORRO-CONSULTA
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Mobile 972 824 5871
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Affidavit

Re.

Post Accident AP1000 Containment Leakage: An Un-reviewed Safety Issue

By
Arnold Gundersen, March 26, 2010

I, Rudolf H. Hausler, Corrosion Engineer, NACE Corrosion Specialist, recipient of the NACE Technical Achievement Award, and NACE Fellowship, dipl. Chemical Engineer and PhD in Technical Sciences, hereby assert that I have read subject report in detail.

I agree with the assessment that the construction of the containment building of the AP1000 leaves the reactor containment (carbon steel shell) subject to various modes of corrosion attack. Even though both the inside and the outside of the containment may be coated for corrosion protection (it is not clear that they are because heavy protective paint coat layers will reduce the necessary heat transfer rate) there are always pinholes in any paint layer where corrosion processes may be initiated. Inaccessible areas will be most vulnerable to defects and hence corrosion. 6

In recent years coatings for applications in nuclear energy plants have been given much attention. However, with all the testing in salt spray cabinets supplemented by irradiation, there are no manufacturers who will give assurances beyond the life expectancies based on intuitive extrapolations.

It turns out that the paint manufactures develop paints and perform test procedures according to industry standards but leave the final selection of a paint schedule to the operating engineer at the respective generating plants. Clearly in this case the blind are leading the seeing.

Because of the impossibility of ruling out defects in the protective coating, the uncertainty of the fitness for purpose of coatings beyond the customarily guaranteed 10 years, the further uncertainty of the performance of the natural convection cooling scheme of the AP-1000, it would appear extremely risky to deny and rule out need for secondary containment.

I therefore agree with Arnold Gundersen's assessment in its entirety.

Signed

March 29, 2010

CURRICULUM VITAE
Arnold Gundersen
Chief Engineer, Fairewinds Associates, Inc
April 2010

Education and Training

ME NE	Master of Engineering Nuclear Engineering Rensselaer Polytechnic Institute, 1972 U.S. Atomic Energy Commission Fellowship Thesis: Cooling Tower Plume Rise
BS NE	Bachelor of Science Nuclear Engineering Rensselaer Polytechnic Institute, Cum Laude, 1971 James J. Kerrigan Scholar
RO	Licensed Reactor Operator, U.S. Atomic Energy Commission License # OP-3014

Qualifications – including and not limited to:

- Chief Engineer, Fairewinds Associates, Inc
- Nuclear Engineering, Safety, and Reliability Expert
- Federal and Congressional hearing testimony and Expert Witness testimony
- Former Senior Vice President Nuclear Licensee
- Former Licensed Reactor Operator
- 39-years of nuclear industry experience and oversight
    - Nuclear engineering management assessment and prudency assessment
    - Nuclear power plant licensing and permitting – assessment and review
    - Nuclear safety assessments, source term reconstructions, dose assessments, criticality analysis, and thermohydraulics
    - Contract administration, assessment and review
    - Systems engineering and structural engineering assessments
    - Cooling tower operation, cooling tower plumes, thermal discharge assessment, and consumptive water use
    - Nuclear fuel rack design and manufacturing, nuclear equipment design and manufacturing, and technical patents
    - Radioactive waste processes, storage issue assessment, waste disposal and decommissioning experience
    - Reliability engineering and aging plant management assessments, in-service inspection
    - Employee awareness programs, whistleblower protection, and public communications
    - Quality Assurance (QA) & records

Publications

Co-author — *DOE Decommissioning Handbook, First Edition*, 1981-1982, invited author.

Co-author — *Decommissioning the Vermont Yankee Nuclear Power Plant: An Analysis of Vermont Yankee's Decommissioning Fund and Its Projected Decommissioning Costs*, November 2007, Fairewinds Associates, Inc.

Co-author — *Decommissioning Vermont Yankee – Stage 2 Analysis of the Vermont Yankee Decommissioning Fund – The Decommissioning Fund Gap*, December 2007, Fairewinds

Associates, Inc. Presented to Vermont State Senators and Legislators.
Co-author — *Vermont Yankee Comprehensive Vertical Audit – VYCVA – Recommended Methodology to Thoroughly Assess Reliability and Safety Issues at Entergy Nuclear Vermont Yankee*, January 30, 2008 Testimony to Finance Committee Vermont Senate
Co-author — *Act 189 Public Oversight Panel Report*, March 17, 2009, to the Vermont State Legislature by the Vermont Yankee Public Oversight Panel.
Author — Fairewinds Associates, Inc *First Quarterly Report to the Joint Legislative Committee*, October 19, 2009.
Co-author — The Second Quarterly Report by Fairewinds Associates, Inc to the Joint Legislative Committee regarding buried pipe and tank issues at Entergy Nuclear Vermont Yankee and Entergy proposed Enexus spinoff. See two reports: *Fairewinds Associates 2nd Quarterly Report to JFC* and *Enexus Review by Fairewinds Associates.*

Patents

Energy Absorbing Turbine Missile Shield – U.S. Patent # 4,397,608 – 8/9/1983

Committee Memberships

Vermont Yankee Public Oversight Panel – appointed 2008 by President Pro-Tem Vermont Senate
National Nuclear Safety Network – Founding Board Member
Three Rivers Community College – Nuclear Academic Advisory Board
Connecticut Low Level Radioactive Waste Advisory Committee – 10 years, founding member
Radiation Safety Committee, NRC Licensee – founding member
ANSI N-198, Solid Radioactive Waste Processing Systems

Honors

U.S. Atomic Energy Commission Fellowship, 1972
B.S. Degree, Cum Laude, RPI, 1971, 1st in nuclear engineering class
Tau Beta Pi (Engineering Honor Society), RPI, 1969 – 1 of 5 in sophomore class of 700
James J. Kerrigan Scholar 1967–1971
Teacher of the Year – 2000, Marvelwood School
Publicly commended to U.S. Senate by NRC Chairman, Ivan Selin, in May 1993 – "It is true...everything Mr. Gundersen said was absolutely right; he performed quite a service."

Nuclear Consulting and Expert Witness Testimony

Vermont State Legislature House Natural Resources – April 5, 2010
Testified to the House Natural Resources Committee regarding discrepancies in Entergy's TLG Services decommissioning analysis. See *Fairewinds Cost Comparison TLG Decommissioning* (http://www.leg.state.vt.us/JFO/Vermont%20Yankee.htm).

Vermont State Legislature Joint Fiscal Committee Legislative Consultant Regarding Entergy Nuclear Vermont Yankee – February 22, 2010
The Second Quarterly Report by Fairewinds Associates, Inc to the Joint Legislative Committee regarding buried pipe and tank issues at Entergy Nuclear Vermont Yankee and Entergy proposed Enexus spinoff. See two reports: *Fairewinds Associates 2nd Quarterly Report to JFC* and *Enexus Review by Fairewinds Associates.*
(http://www.leg.state.vt.us/JFO/Vermont%20Yankee.htm).

Vermont State Legislature Senate Natural Resources – February 16, 2010
Testified to Senate Natural Resources Committee regarding causes and severity of tritium leak in unreported buried underground pipes, status of Enexus spinoff proposal, and health effects of tritium.

Vermont State Legislature Senate Natural Resources – February 10, 2010
Testified to Senate Natural Resources Committee regarding causes and severity of tritium leak in unreported buried underground pipes. http://www.youtube.com/watch?v=36HJiBrJSxE

Vermont State Legislature Senate Finance – February 10, 2010
Testified to Senate Finance Committee regarding *A Chronicle of Issues Regarding Buried Tanks and Underground Piping at VT Yankee.*
(http://www.leg.state.vt.us/JFO/Vermont%20Yankee.htm)

Vermont State Legislature House Natural Resources – January 27, 2010
A Chronicle of Issues Regarding Buried Tanks and Underground Piping at VT Yankee.
(http://www.leg.state.vt.us/JFO/Vermont%20Yankee.htm)

Eric Epstein, TMI Alert – January 5, 2010
Expert Witness Report Of Arnold Gundersen Regarding Consumptive Water Use Of The Susquehanna River By The Proposed PPL Bell Bend Nuclear Power Plant In the Matter of RE: Bell Bend Nuclear Power Plant Application for Groundwater Withdrawal Application for Consumptive Use BNP-2009-073.

U.S. Nuclear Regulatory Commission Atomic Safety and Licensing Board (NRC-ASLB)
Declaration of Arnold Gundersen Supporting Supplemental Petition of Intervenors Contention 15: Detroit Edison Cola Lacks Statutorily Required Cohesive QA Program, December 8, 2009.

U.S. NRC Region III Allegation Filed by Missouri Coalition for the Environment
Expert Witness Report entitled: *Comments on the Callaway Special Inspection by NRC Regarding the May 25, 2009 Failure of its Auxiliary Feedwater System,* November 9, 2009.

Vermont State Legislature Joint Fiscal Committee Legislative Consultant Regarding Entergy Nuclear Vermont Yankee
Oral testimony given to the Vermont State Legislature Joint Fiscal Committee October 28, 2009.
See report: *Quarterly Status Report - ENVY Reliability Oversight for JFO*
(http://www.leg.state.vt.us/JFO/Vermont%20Yankee.htm).

Vermont State Legislature Joint Fiscal Committee Legislative Consultant Regarding Entergy Nuclear Vermont Yankee
The First Quarterly Report by Fairewinds Associates, Inc to the Joint Legislative Committee regarding reliability issues at Entergy Nuclear Vermont Yankee, issued October 19, 2009.
See report: *Quarterly Status Report - ENVY Reliability Oversight for JFO*
(http://www.leg.state.vt.us/JFO/Vermont%20Yankee.htm).

Florida Public Service Commission (FPSC)
Gave direct oral testimony to the FPSC in hearings in Tallahassee, FL, September 8 and 10, 2009 in support of Southern Alliance for Clean Energy (SACE) contention of anticipated licensing and construction delays in newly designed Westinghouse AP 1000 reactors proposed by Progress Energy Florida and Florida Power and Light (FPL).

Florida Public Service Commission (FPSC)
NRC announced delays confirming my original testimony to FPSC detailed below. My supplemental testimony alerted FPSC to NRC confirmation of my original testimony regarding licensing and construction delays due to problems with the newly designed Westinghouse AP 1000 reactors in *Supplemental Testimony In Re: Nuclear Plant Cost Recovery Clause By The Southern Alliance For Clean Energy*, FPSC Docket No. 090009-EI, August 12, 2009.

Florida Public Service Commission (FPSC)
Licensing and construction delays due to problems with the newly designed Westinghouse AP 1000 reactors in *Direct Testimony In Re: Nuclear Plant Cost Recovery Clause By The Southern Alliance For Clean Energy*, FPSC Docket No. 090009-EI, July 15, 2009.

Vermont State Legislature Joint Fiscal Committee Expert Witness Oversight Role for Entergy Nuclear Vermont Yankee (ENVY)
Contracted by the Joint Fiscal Committee of the Vermont State Legislature as an expert witness to oversee the compliance of ENVY to reliability issues uncovered during the 2009 legislative session by the Vermont Yankee Public Oversight Panel of which I was appointed a member along with former NRC Commissioner Peter Bradford for one year from July 2008 to 2009. Entergy Nuclear Vermont Yankee (ENVY) is currently under review by Vermont State Legislature to determine if it should receive a Certificate for Public Good (CPG) to extend its operational license for another 20-years. Vermont is the only state in the country that has legislatively created the CPG authorization for a nuclear power plant. Act 160 was passed to ascertain ENVY's ability to run reliably for an additional 20 years. Appointment from July 2009 to May 2010.

U.S. Nuclear Regulatory Commission
Expert Witness Declaration regarding Combined Operating License Application (COLA) at North Anna Unit 3 *Declaration of Arnold Gundersen Supporting Blue Ridge Environmental Defense League's Contentions* (June 26, 2009).

U.S. Nuclear Regulatory Commission
Expert Witness Declaration regarding Through-wall Penetration of Containment Liner and Inspection Techniques of the Containment Liner at Beaver Valley Unit 1 Nuclear Power Plant *Declaration of Arnold Gundersen Supporting Citizen Power's Petition* (May 25, 2009).

U.S. Nuclear Regulatory Commission
Expert Witness Declaration regarding Quality Assurance and Configuration Management at Bellefonte Nuclear Plant *Declaration of Arnold Gundersen Supporting Blue Ridge Environmental Defense League's Contentions in their Petition for Intervention and Request for Hearing*, May 6, 2009.

Pennsylvania Statehouse
Expert Witness Analysis presented in formal presentation at the Pennsylvania Statehouse, March 26, 2009 regarding actual releases from Three Mile Island Nuclear Accident. Presentation may be found at: http://www.tmia.com/march26

Vermont Legislative Testimony and Formal Report for 2009 Legislative Session
As a member of the Vermont Yankee Public Oversight Panel, I spent almost eight months examining the Vermont Yankee Nuclear Power Plant and the legislatively ordered Comprehensive Vertical Audit. Panel submitted Act 189 Public Oversight Panel Report March 17, 2009 and oral testimony to a joint hearing of the Senate Finance and House Natural Resources March 19, 2009. (See: http://www.leg.state.vt.us/JFO/Vermont%20Yankee.htm)

Finestone v FPL (11/2003 to 12/2008) Federal Court
Plaintiffs' Expert Witness for Federal Court Case with Attorney Nancy LaVista, from the firm Lytal, Reiter, Fountain, Clark, Williams, West Palm Beach, FL. This case involved two plaintiffs in cancer cluster of 40 families alleging that illegal radiation releases from nearby nuclear power plant caused children's cancers. Production request, discovery review, preparation of deposition questions and attendance at Defendant's experts for deposition, preparation of expert witness testimony, preparation for Daubert Hearings, ongoing technical oversight, source term reconstruction and appeal to Circuit Court.

U.S. Nuclear Regulatory Commission Advisory Committee Reactor Safeguards (NRC-ACRS)
Expert Witness providing oral testimony regarding Millstone Point Unit 3 (MP3) Containment issues in hearings regarding the Application to Uprate Power at MP3 by Dominion Nuclear, Washington, and DC. (July 8-9, 2008).

Appointed by President Pro-Tem of Vermont Senate to Legislatively Authorized Nuclear Reliability Public Oversight Panel
To oversee Comprehensive Vertical Audit of Entergy Nuclear Vermont Yankee (Act 189) and testify to State Legislature during 2009 session regarding operational reliability of ENVY in relation to its 20-year license extension application. (July 2, 2008 to present).

U.S. Nuclear Regulatory Commission Atomic Safety and Licensing Board (NRC-ASLB)
Expert Witness providing testimony regarding *Pilgrim Watch's Petition for Contention 1 Underground Pipes* (April 10, 2008).

U.S. Nuclear Regulatory Commission Atomic Safety and Licensing Board (NRC-ASLB)
Expert Witness supporting *Connecticut Coalition Against Millstone In Its Petition For Leave To Intervene, Request For Hearing, And Contentions Against Dominion Nuclear Connecticut Inc.'s*

Millstone Power Station Unit 3 License Amendment Request For Stretch Power Uprate (March 15, 2008).

U.S. Nuclear Regulatory Commission Atomic Safety and Licensing Board (NRC-ASLB)
Expert Witness supporting *Pilgrim Watch's Petition For Contention 1: specific to issues regarding the integrity of Pilgrim Nuclear Power Station's underground pipes and the ability of Pilgrim's Aging Management Program to determine their integrity.* (January 26, 2008).

Vermont State House – 2008 Legislative Session

- House Committee on Natural Resources and Energy – Comprehensive Vertical Audit: *Why NRC Recommends a Vertical Audit for Aging Plants Like Entergy Nuclear Vermont Yankee (ENVY)*
- House Committee on Commerce – Decommissioning Testimony

Vermont State Senate – 2008 Legislative Session

- Senate Finance – testimony regarding Entergy Nuclear Vermont Yankee Decommissioning Fund
- Senate Finance – testimony on the necessity for a Comprehensive Vertical Audit (CVA) of Entergy Nuclear Vermont Yankee
- Natural Resources Committee – testimony regarding the placement of high-level nuclear fuel on the banks of the Connecticut River in Vernon, VT

U.S. Nuclear Regulatory Commission Atomic Safety and Licensing Board (NRC-ASLB)
MOX Limited Appearance Statement to Judges Michael C. Farrar (Chairman), Lawrence G. McDade, and Nicholas G. Trikouros for the "Petitioners": Nuclear Watch South, the Blue Ridge Environmental Defense League, and Nuclear Information & Resource Service in support of *Contention 2: Accidental Release of Radionuclides, requesting a hearing concerning faulty accident consequence assessments made for the MOX plutonium fuel factory proposed for the Savannah River Site.* (September 14, 2007).

Appeal to the Vermont Supreme Court (March 2006 to 2007)
Expert Witness Testimony in support of *New England Coalition's Appeal to the Vermont Supreme Court Concerning: Degraded Reliability at Entergy Nuclear Vermont Yankee as a Result of the Power Uprate.* New England Coalition represented by Attorney Ron Shems of Burlington, VT.

State of Vermont Environmental Court (Docket 89-4-06-vtec 2007)
Expert witness retained by New England Coalition to review Entergy and Vermont Yankee's analysis of alternative methods to reduce the heat discharged by Vermont Yankee into the Connecticut River. Provided Vermont's Environmental Court with analysis of alternative methods systematically applied throughout the nuclear industry to reduce the heat discharged by nuclear power plants into nearby bodies of water and avoid consumptive water use. This report included a review of the condenser and cooling tower modifications.

U.S. Senator Bernie Sanders and Congressman Peter Welch (2007)
Briefed Senator Sanders, Congressman Welch and their staff members regarding technical and engineering issues, reliability and aging management concerns, regulatory compliance, waste storage, and nuclear power reactor safety issues confronting the U.S. nuclear energy industry.

State of Vermont Legislative Testimony to Senate Finance Committee (2006)
Testimony to the Senate Finance Committee regarding Vermont Yankee decommissioning costs, reliability issues, design life of the plant, and emergency planning issues.

U.S. Nuclear Regulatory Commission Atomic Safety and Licensing Board (NRC-ASLB)
Expert witness retained by New England Coalition to provide Atomic Safety and Licensing Board with an independent analysis of the integrity of the Vermont Yankee Nuclear Power Plant condenser (2006).

U.S. Senators Jeffords and Leahy (2003 to 2005)
Provided the Senators and their staffs with periodic overview regarding technical, reliability, compliance, and safety issues at Entergy Nuclear Vermont Yankee (ENVY).

10CFR 2.206 filed with the Nuclear Regulatory Commission (July 2004)
Filed 10CFR 2.206 petition with NRC requesting confirmation of Vermont Yankee's compliance with General Design Criteria.

State of Vermont Public Service Board (April 2003 to May 2004)
Expert witness retained by New England Coalition to testify to the Public Service Board on the reliability, safety, technical, and financial ramifications of a proposed increase in power (called an uprate) to 120% at Entergy's 31-year-old Vermont Yankee Nuclear Power Plant.

International Nuclear Safety Testimony
Worked for ten days with the President of the Czech Republic (Vaclav Havel) and the Czech Parliament on their energy policy for the 21st century.

Nuclear Regulatory Commission (NRC) Inspector General (IG)
Assisted the NRC Inspector General in investigating illegal gratuities paid to NRC Officials by Nuclear Energy Services (NES) Corporate Officers. In a second investigation, assisted the Inspector General in showing that material false statements (lies) by NES corporate president caused the NRC to overlook important violations by this licensee.

State of Connecticut Legislature
Assisted in the creation of State of Connecticut Whistleblower Protection legal statutes.

Federal Congressional Testimony
Publicly recognized by NRC Chairman, Ivan Selin, in May 1993 in his comments to U.S. Senate, "It is true...everything Mr. Gundersen said was absolutely right; he performed quite a service." Commended by U.S. Senator John Glenn for public testimony to Senator Glenn's NRC Oversight Committee.

<u>PennCentral Litigation</u>
Evaluated NRC license violations and material false statements made by management of this nuclear engineering and materials licensee.

<u>Three Mile Island Litigation</u>
Evaluated unmonitored releases to the environment after accident, including containment breach, letdown system and blowout. Proved releases were 15 times higher than government estimate and subsequent government report.

<u>Western Atlas Litigation</u>
Evaluated neutron exposure to employees and license violations at this nuclear materials licensee.

<u>Commonwealth Edison</u>
In depth review and analysis for Commonwealth Edison to analyze the efficiency and effectiveness of all Commonwealth Edison engineering organizations, which support the operation of all of its nuclear power plants.

<u>Peach Bottom Reactor Litigation</u>
Evaluated extended 28-month outage caused by management breakdown and deteriorating condition of plant.

***<u>Special Remediation Expertise</u>*:**
Director of Engineering, Vice President of Site Engineering, and the Senior Vice President of Engineering at Nuclear Energy Services (NES).

- NES was a nuclear licensee that specialized in dismantlement and remediation of nuclear facilities and nuclear sites. Member of the radiation safety committee for this licensee.
- Department of Energy chose NES to write *DOE Decommissioning Handbook* because NES had a unique breadth and depth of nuclear engineers and nuclear physicists on staff.
- Personally wrote the "Small Bore Piping" chapter of the DOE's first edition Decommissioning Handbook, personnel on my staff authored other sections, and I reviewed the entire Decommissioning Handbook.
- Served on the Connecticut Low Level Radioactive Waste Advisory Committee for 10 years from its inception.
- Managed groups performing analyses on dozens of dismantlement sites to thoroughly remove radioactive material from nuclear plants and their surrounding environment.
- Managed groups assisting in decommissioning the Shippingport nuclear power reactor. Shippingport was the first large nuclear power plant ever decommissioned. The decommissioning of Shippingport included remediation of the site after decommissioning.
- Managed groups conducting site characterizations (preliminary radiation surveys prior to commencement of removal of radiation) at the radioactively contaminated West Valley site in upstate New York.
- Personnel reporting to me assessed dismantlement of the Princeton Avenue Plutonium Lab in New Brunswick, NJ. The lab's dismantlement assessment was stopped when we uncovered extremely toxic and carcinogenic underground radioactive contamination.

- Personnel reporting to me worked on decontaminating radioactive thorium at the Cleveland Avenue nuclear licensee in Ohio. The thorium had been used as an alloy in turbine blades. During that project, previously undetected extremely toxic and carcinogenic radioactive contamination was discovered below ground after an aboveground gamma survey had purported that no residual radiation remained on site.

Teaching and Academic Administration Experience
Rensselaer Polytechnic Institute (RPI) – Advanced Nuclear Reactor Physics Lab
Community College of Vermont – Mathematics Professor – 2007 to present
Burlington High School
  Mathematics Teacher – 2001 to June 2008
  Physics Teacher – 2004 to 2006
The Marvelwood School – 1996 to 2000
  Awarded Teacher of the Year – June 2000
  Chairperson: Physics and Math Department
  Mathematics and Physics Teacher, Faculty Council Member
  Director of Marvelwood Residential Summer School
  Director of Residential Life
The Forman School & St. Margaret's School – 1993 to 1995
  Physics and Mathematics Teacher, Tennis Coach, Residential Living Faculty Member

Nuclear Engineering 1970 to Present
Vetted as expert witness in nuclear litigation and administrative hearings in federal, international, and state court and to Nuclear Regulatory Commission, including but not limited to: Three Mile Island, US Federal Court, US NRC, NRC ASLB & ACRS, Vermont State Legislature, Vermont State Public Service Board, Florida Public Service Board, Czech Senate, Connecticut State Legislature, Western Atlas Nuclear Litigation, U.S. Senate Nuclear Safety Hearings, Peach Bottom Nuclear Power Plant Litigation, and Office of the Inspector General NRC.

Nuclear Engineering, Safety, and Reliability Expert Witness 1990 to Present
- Fairewinds Associates, Inc – Chief Engineer, 2005 to Present
- Arnold Gundersen, Nuclear Safety Consultant and Energy Advisor, 1995 to 2005
- GMA – 1990 to 1995, including expert witness testimony regarding the accident at Three Mile Island.

Nuclear Energy Services, Division of PCC (Fortune 500 company) 1979 to 1990
  Corporate Officer and Senior Vice President - Technical Services
  Responsible for overall performance of the company's Inservice Inspection (ASME XI), Quality Assurance (SNTC 1A), and Staff Augmentation Business Units – up to 300 employees at various nuclear sites.

Senior Vice President of Engineering
Responsible for the overall performance of the company's Site Engineering, Boston Design Engineering and Engineered Products Business Units. Integrated the Danbury based, Boston based and site engineering functions to provide products such as fuel racks, nozzle dams, and transfer mechanisms and services such as materials management and procedure development.

Vice President of Engineering Services
Responsible for the overall performance of the company's field engineering, operations engineering, and engineered products services. Integrated the Danbury-based and field-based engineering functions to provide numerous products and services required by nuclear utilities, including patents for engineered products.

General Manager of Field Engineering
Managed and directed NES' multi-disciplined field engineering staff on location at various nuclear plant sites. Site activities included structural analysis, procedure development, technical specifications and training. Have personally applied for and received one patent.

Director of General Engineering
Managed and directed the Danbury based engineering staff. Staff disciplines included structural, nuclear, mechanical and systems engineering. Responsible for assignment of personnel as well as scheduling, cost performance, and technical assessment by staff on assigned projects. This staff provided major engineering support to the company's nuclear waste management, spent fuel storage racks, and engineering consulting programs.

New York State Electric and Gas Corporation (NYSE&G) — 1976 to 1979

Reliability Engineering Supervisor
Organized and supervised reliability engineers to upgrade performance levels on seven operating coal units and one that was under construction. Applied analytical techniques and good engineering judgments to improve capacity factors by reducing mean time to repair and by increasing mean time between failures.

Lead Power Systems Engineer
Supervised the preparation of proposals, bid evaluation, negotiation and administration of contracts for two 1300 MW NSSS Units including nuclear fuel, and solid-state control rooms. Represented corporation at numerous public forums including TV and radio on sensitive utility issues. Responsible for all nuclear and BOP portions of a PSAR, Environmental Report, and Early Site Review.

Northeast Utilities Service Corporation (NU) — 1972 to 1976

Engineer
Nuclear Engineer assigned to Millstone Unit 2 during start-up phase. Lead the high velocity flush and chemical cleaning of condensate and feedwater systems and obtained discharge permit for chemicals. Developed Quality Assurance Category 1 Material, Equipment and Parts List. Modified fuel pool cooling system at Connecticut Yankee, steam generator blowdown system and diesel generator lube oil system for Millstone. Evaluated Technical Specification Change Requests.

<u>Associate Engineer</u>
Nuclear Engineer assigned to Montague Units 1 & 2. Interface Engineer with NSSS vendor, performed containment leak rate analysis, assisted in preparation of PSAR and performed radiological health analysis of plant. Performed environmental radiation survey of Connecticut Yankee. Performed chloride intrusion transient analysis for Millstone Unit 1 feedwater system. Prepared Millstone Unit 1 off-gas modification licensing document and Environmental Report Amendments 1 & 2.

Rensselaer Polytechnic Institute (RPI) — 1971 to 1972
<u>Critical Facility Reactor Operator, Instructor</u>
Licensed AEC Reactor Operator instructing students and utility reactor operator trainees in start-up through full power operation of a reactor.

Public Service Electric and Gas (PSE&G) — 1970
<u>Assistant Engineer</u>
Performed shielding design of radwaste and auxiliary buildings for Newbold Island Units 1 & 2, including development of computer codes.

<u>Public Service, Cultural, and Community Activities</u>

2005 to Present – Public presentations and panel discussions on nuclear safety and reliability at University of Vermont, NRC hearings, Town and City Select Boards, Legal Panels, Television, and Radio

2007-2008 – Created Concept of Solar Panels on Burlington High School; worked with Burlington Electric Department and Burlington Board of Education Technology Committee on Grant for installation of solar collectors for Burlington Electric peak summer use

Vermont State Legislature – Ongoing Public Testimony to Legislative Committees

Certified Foster Parent State of Vermont – 2004 to 2007

Mentoring former students – 2000 to present – college application and employment application questions and encouragement

Tutoring Refugee Students – 2002 to 2006 – Lost Boys of the Sudan and others from educationally disadvantaged immigrant groups

Designed and Taught Special High School Math Course for ESOL Students – 2007 to 2008

Featured Nuclear Safety and Reliability Expert (1990 to present) for Television, Newspaper, Radio, & Internet
Including, and not limited to: CNN (Earth Matters), NECN, WPTZ VT, WTNH, VPTV, WCAX, Cable Channel 17, The Crusaders, Front Page, Mark Johnson Show, Steve West Show, Anthony Polina Show, WKVT, WDEV, WVPR, WZBG CT, Seven Days, AP News Service, Houston Chronicle, Christian Science Monitor, New York Times, Brattleboro Reformer, Rutland Herald, Times-Argus, Burlington Free Press, Litchfield County Times, The News Times, The New Milford Times, Hartford Current, New London Day, evacuationplans.org, Vermont Daily Briefing, Green Mountain Daily, and numerous other national and international blogs

NNSN – National Nuclear Safety Network, Founding Advisory Board Member, meetings with and testimony to the Nuclear Regulatory Commission Inspector General (NRC IG)

Berkshire School Parents Association, Co-Founder

Berkshire School Annual Appeal, Co-Chair

Sunday School Teacher, Christ Episcopal Church, Roxbury, CT

Washington Montessori School Parents Association Member
Episcopal Marriage Encounter National Presenting Team with wife Margaret
- Provided weekend communication and dialogue workshops weekend retreats/seminars
- Connecticut Episcopal Marriage Encounter Administrative Team – 5 years

Northeast Utilities Representative Conducting Public Lectures on Nuclear Safety Issues

End

Table 1. Instances of containment pressure boundary component degradation at commercial nuclear power plants in the United States.

Plant Designation (Occurrence Date) Plant Type (Source)*	Containment Description (No. of Similar Plants)	Degradation Description	Detection Method
Vermont Yankee (1978) BWR/4 (Ref. 52)	Mark I Steel drywell and wetwell (22)	Surface cracks in the overlay weld-to-torus base metal heat-affected zone	Visual examination (As part of modifications to restore the originally intended design safety margins)
Hatch 2 (1984) BWR/4 (Refs. 53, 54, and 55)	Mark I Steel drywell and wetwell (22)	Through-wall cracks around containment vent headers within the containment torus (Brittle fracture caused by injection of cold nitrogen into torus during inerting)	Visual examination of torus interior
Hatch 1 (1985) BWR/4 (Ref. 55)	Mark I Steel drywell and wetwell (22)	Through-wall crack in nitrogen inerting and purge line (Brittle fracture caused by injection of cold nitrogen during inerting)	In-service inspection testing. using magnetic particle method
Monticello (1986) BWR/3 (Ref. 56)	Mark I Steel drywell and wetwell (22)	Polysulfide seal at the concrete-to-shell interface became brittle allowing moisture to reach the steel shell	Visual examination (A small portion of the drywell shell was excavated as a part of a life extension study)
Dresden 3 (1986) BWR/3 (Ref. 57)	Mark I Steel drywell and wetwell (22)	Coating degradation due to exposure to fire with peak metal temperatures of 260°C (500°F) and general corrosion of metal shell by water used to extinguish fire	Visual examination (Polyurethane between the drywell shell and concrete shield wall was ignited by arc-air cutting activities producing smoke and heat)
Oyster Creek (1986) BWR/2 (Refs. 58, 59, and 60)	Mark I Steel drywell and wetwell (22)	Defective gasket at the refueling pool allowed water to eventually reach the sand cushion region causing drywell shell corrosion	Visual examination of uncoated areas and ultrasonic inspection
Fitzpatrick (1987) BWR/4 (Refs. 56 and 61)	Mark I Steel drywell and wetwell (22)	Degradation of torus coating with associated pitting	Visual examination of uncoated areas and ultrasonic inspection (Technical specification surveillance performed during outage)
Millstone 1 (1987) BWR/3 (Ref. 61)	Mark I Steel drywell and wetwell (22)	Degradation of torus coating	Visual examination of uncoated areas and ultrasonic inspection (The torus had been drained for modifications)
Oyster Creek (1987) BWR/2 (Ref. 61)	Mark I Steel drywell and wetwell (22)	Degradation of torus coating with associated pitting	Visual examination of uncoated areas and ultrasonic inspection

Table 1. Instances of containment pressure boundary component degradation at commercial nuclear power plants in the United States (cont.).

Plant Designation (Occurrence Date) Plant Type (Source)*	Containment Description (No. of Similar Plants)	Degradation Description	Detection Method
Brunswick 1 (1987) BWR/4 (Ref. 62)	Reinforced concrete with steel liner (9)	Corrosion of steel liner	General visual examination of coated areas
Nine Mile Point 1 (1988) BWR/5 (Ref. 63)	Steel drywell and wetwell (22)	Corrosion of uncoated torus surfaces	Visual examination of uncoated areas and ultrasonic inspection
Pilgrim (1988) BWR/3 (Ref. 61)	Steel drywell and wetwell (22)	Degradation of torus coating	Visual examination of uncoated areas and ultrasonic inspection (Licensee inspection as a result of occurrences at similar plants)
Brunswick 2 (1988) BWR/4 (Ref. 62)	Reinforced concrete with steel liner (9)	Corrosion of steel liner	General visual examination of coated areas
Dresden 2 (1988) BWR/3 (Ref. 64)	Steel drywell and wetwell (22)	Coating, electrical cable, and valve operator component degradation due to excessive operating temperatures	Visual examination of uncoated areas and ultrasonic inspection (Ventilation hatches in the drywell refueling bulkhead inadvertently left closed)
Hatch 1 and 2 (1989) BWR/4 (Ref. 65)	Steel drywell and wetwell (22)	Bent anchor bolts in torus supports (due to weld induced radial shrinkage)	Visual examination
McGuire 2 (1989) PWR (Ref. 66)	Ice Condenser Reinforced concrete with steel liner (4)	Corrosion on outside of steel cylinder in the annular region at the intersection with the concrete floor	General visual examination prior to Type A leakage rate test
McGuire 1 (1989) PWR (Ref. 66)	Ice Condenser Reinforced concrete with steel liner (4)	Corrosion on outside of steel cylinder in the annular region at the intersection with the concrete floor	General visual examination (Inspection initiated as a result of corrosion detected at McGuire 2)
Catawba 1 (1989) PWR (Refs. 66 and 67)	Ice Condenser Steel cylinder (5)	Corrosion on outside of steel cylinder in the annular region	General visual examination (Inspection initiated as a result of corrosion detected at McGuire 2)
Catawba 2 (1989) PWR (Ref. 66)	Ice Condenser Steel cylinder (5)	Corrosion on outside of steel cylinder in the annular region	General visual examination (Inspection initiated as a result of corrosion detected at McGuire 2)

Table 1. Instances of containment pressure boundary component degradation at commercial nuclear power plants in the United States (cont.).

Plant Designation (Occurrence Date) Plant Type (Source)[c]	Containment Description (No. of Similar Plants)	Degradation Description	Detection Method
McGuire 1 (1990) PWR (Ref. 68, 69, and 70)	Ice Condenser Reinforced concrete with steel liner (4)	Corrosion on inside surface of coated containment shell under the ice condenser and between the floors near the cork filler material	Visual examination and ultrasonic inspection (Degradation possibly caused by moisture from the ice condenser or condensation)
Quad Cities 1 (1991) BWR/3 (Refs. 71, 72, and 82)	Steel drywell and wetwell (22)	Two-ply containment penetration bellows leaked due to transgranular stress-corrosion cracking	General visual examination (Excessive leakage detected)
Quad Cities 2 (1991) BWR/3 (Refs. 71 and 72)	Steel drywell and wetwell (22)	Two-ply containment penetration bellows leaked due to transgranular stress-corrosion cracking	General visual examination (Excessive leakage detected)
Dresden 3 (1991) BWR/3 (Ref. 72)	Steel drywell and wetwell (22)	Two-ply containment penetration bellows leaked due to transgranular stress-corrosion cracking	General visual examination (Excessive leakage detected)
Point Beach 2 (1992) PWR (Ref. 73)	Post-tensioned concrete cylinder with steel liner (35)	Liner plate separated from concrete	General visual examination
H. B. Robinson (1992) PWR (Ref. 73)	Post-tensioned concrete cylinder (vertical only) with steel liner (35)	Degradation of liner coating	General visual examination
Cooper (1992) BWR/4 (Ref. 73)	Steel drywell and wetwell (22)	Corrosion of interior torus surfaces and corrosion stains on exterior torus surface in one area	General visual examination
Beaver Valley 1 (1992) PWR (Refs. 73 and 74)	Subatmospheric Reinforced concrete cylinder with steel liner (7)	Corrosion of steel liner, degradation of liner coating, and instances of liner bulging	General visual examination prior to Type A leakage rate test
Salem 2 (1993) PWR (Ref. 75)	Reinforced concrete cylinder with steel liner (13)	Corrosion of steel liner	General visual examination prior to Type A leakage rate test

Table 1. Instances of containment pressure boundary component degradation at commercial nuclear power plants in the United States (cont.).

Plant Designation (Occurrence Date) Plant Type (Source)[a]	Containment Description (No. of Similar Plants)	Degradation Description	Detection Method
Sequoyah 1 (1993) PWR (Ref. 76)	Ice Condenser Steel cylinder with concrete shield building (5)	Degradation of moisture barriers resulting in corrosion of the steel shell	General visual examination and visual examination of coated areas
Sequoyah 2 (1993) PWR (Ref. 76)	Ice Condenser Steel cylinder with concrete shield building (5)	Degradation of moisture barriers resulting in corrosion of the steel shell	General visual examination and visual examination of coated areas
Brunswick 2 (1993) BWR (Refs. 62 and 77)	Reinforced concrete drywell and wetwell with steel liner (9)	Corrosion of steel liner	General visual examination and visual examination of coated areas (Follow-up inspection based on conditions noted in 1988)
Brunswick 1 (1993) BWR/4 (Ref. 77)	Reinforced concrete drywell and wetwell with steel liner (9)	Corrosion of steel liner	General visual examination and visual examination of coated areas (Inspection initiated as a result of corrosion detected at Brunswick 2)
McGuire 1 (1993) PWR (Ref. 78)	Ice Condenser Reinforced concrete with steel liner (4)	Main steam isolation line bellows leakage	Leakage testing conducted on bellows following successful Type A leakage rate test
Braidwood 1 (1994) PWR (Ref. 79)	Post-tensioned concrete cylinder with steel liner (35)	Liner leakage detected but not located	Type A leakage rate test
North Anna 2 (1999) PWR (Ref. 80)	Subatmospheric Reinforced concrete with steel liner (7)	6-mm-diameter hole in liner due to corrosion	General visual examination and visual examination of coated areas
Brunswick 2 (1999) BWR/4 Ref. 81)	Reinforced concrete drywell and wetwell with steel liner (9)	Corrosion of liner ranging from clusters of surface pitting corrosion to a 2-mm-diameter hole	General visual examination and visual examination of coated areas (Inspection initiated as a result of corrosion detected at Surry)

Attachment 3
Summary of Release Category Definitions
Extracted from Chapter 35 AP1000 PRA

Table 35-4

SUMMARY OF RELEASE CATEGORY DEFINITIONS

Release Category	Definition	Release Category Description	Release Magnitude	Release Timing
IC	Intact Containment	Containment integrity is maintained throughout the accident, and the release of radiation to the environment is due to normal leakage.	Normal Leakage	-
BP	Containment Bypass	Fission products are released directly from the RCS to the environment via the secondary system or other interfacing system bypass. Containment failure occurs prior to onset of core damage	Large Release	Time Frame 1
CI	Containment Isolation Failure	Fission-product release through a failure of the system or valves that close the penetrations between the containment and the environment. Containment failure occurs prior to onset of core damage.	Large Release	Time Frame 1
CFE	Early Containment Failure	Fission-product release through a containment failure caused by severe accident phenomenon occurring after the onset of core damage but prior to core relocation. Such phenomena include hydrogen combustion phenomena, steam explosions, and vessel failure.	Large Release	Time Frame 2
CFV	Containment Venting	Fission-product release through a containment vent line during intentional depressurization of the containment	Controlled Release	Time Frame 3
CFI	Intermediate Containment Failure	Fission-product release through a containment failure caused by severe accident phenomenon, such as hydrogen combustion, occurring after core relocation but before 24 hours.	Large Release	Time Frame 3
CFL	Late Containment Failure	Fission-product release through a containment failure caused by severe accident phenomenon, such as a failure of passive containment cooling, occurring after 24 hours.	Large Release	Time Frame 4

DOCKET NOS. 50-334 and 50-412
CITIZEN POWER
EXHIBIT ONE

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

In the matter of

FirstEnergy Nuclear Operating Co.	)	May 25, 2009
Beaver Valley Power Station Unit 1	)	Docket No. 50-334 and 50-412
License Renewal for Beaver Valley Units 1 and 2	)	

DECLARATION OF ARNOLD GUNDERSEN
SUPPORTING CITIZEN POWER'S PETITION

I, Arnold Gundersen, declare as follows:

1. My name is Arnold Gundersen. I am sui juris. I am over the age of 18-years-old.
2. Citizen Power has retained me as an expert witness in the above captioned matter, and my declaration is intended to support the Petition of Citizen Power.
3. I have a Bachelor's and a Master's Degree in Nuclear Engineering from Rensselaer Polytechnic Institute (RPI) cum laude.
4. I began my career as a reactor operator and instructor in 1971 and progressed to the position of Senior Vice President for a nuclear licensee. A copy of my Curriculum Vitae is attached. (*Exhibit 3*)
5. I have qualified as an expert witness before the Nuclear Regulatory Commission (NRC) Atomic Safety and Licensing Board (ASLB) and Advisory Committee on Reactor Safeguards (ACRS), in Federal Court, before the State of Vermont Public Service Board and the State of Vermont Environmental Court.
6. I am an author of the first edition of the Department of Energy (DOE) Decommissioning Handbook.

7. I have more than 35-years of professional nuclear experience including and not limited to: Nuclear Plant Operation, Nuclear Management, Nuclear Safety Assessments, Reliability Engineering, In-service Inspection, Criticality Analysis, Licensing, Engineering Management, Thermohydraulics, Radioactive Waste Processes, Decommissioning, Waste Disposal, Structural Engineering Assessments, Cooling Tower Operation, Cooling Tower Plumes, Consumptive Water Loss, Nuclear Fuel Rack Design and Manufacturing, Nuclear Equipment Design and Manufacturing, Prudency Defense, Employee Awareness Programs, Public Relations, Contract Administration, Technical Patents, Archival Storage and Document Control, Source Term Reconstruction, Dose Assessment, Quality Assurance and Records, Configuration Management, Whistleblower Protection, and NRC Regulations and Enforcement.

8. My declaration is intended to support the Petition by Citizen Power and is specific to issues regarding FirstEnergy Nuclear Operating Company's application to extend Beaver Valley Unit 1 Power Station's operating license for an additional 20 years.

9. Beaver Valley Unit 1 is a Westinghouse three loop Nuclear Steam Supply System with a Stone & Webster designed "sub-atmospheric containment." It received its operating license to generate electricity on July 2, 1976.[1]

10. According to NUREG/CR 5640, the *Nuclear Power Plant System Sourcebook*:

    "Sub-atmospheric containments are only found at seven Westinghouse PWR plants, six 3-loop plants, and one 4-loop plant."

11. Stone & Webster Engineering Corporation designed all sub-atmospheric containment systems. The six three-loop sub-atmospheric units are Beaver Valley 1 and 2, North Anna 1 and 2, and Surry 1 and 2. Stone & Webster's last sub-atmospheric containment is at Millstone Unit 3, a Westinghouse four-loop unit.

12. As a former Northeast Utilities employee who worked on the Millstone Unit 3 engineering, design, and construction, I have personal knowledge of Stone &

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[1] http://www.nrc.gov/info-finder/reactor/bv1.html

Webster's sub-atmospheric design. Moreover, in 2008, I provided written testimony to the NRC regarding Millstone Unit 3 sub-atmospheric containment. *(Exhibit 2)*

13. Furthermore, I briefed the NRC ACRS on the problems and contradictions associated with the NRC's analysis of sub-atmospheric containments.

14. As the lead licensing engineer for Northeast Utilities' Millstone Power Station Unit 3 during the 1970's, I was responsible for coordinating the analysis for the PSAR (Preliminary Safety Analysis Report), which formed the original design basis of the Millstone Power Station Unit 3 including its Containment. This interface was among Millstone's structural mechanical, electrical, construction, and operations personnel as well as the architect Stone & Webster and the NSSS vendor Westinghouse. Millstone Power Station Unit 3 was originally designed to be a "Sub-Atmospheric Containment." [In this instance my testimony is that of a fact witness[2] in addition to my overall testimony as an expert witness in my Millstone Unit 3 Declaration (Exhibit 2).]

15. In my 2008 expert witness report to the NRC ACRS, I identified generic issues with sub-atmospheric containments. The issues of critical concern to both the engineering and operations staff regarding the Sub-Atmospheric Containment were:

15.1. Members of the operations staff, who worked within the Containment, were repeatedly subjected to the adverse effects of high temperature and low oxygen.

15.2. The small size of the Containment Building severely limited space for equipment and also complicated accident analysis.

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[2] According to the Department of Justice United States Attorneys' Manual Title 3, Chapter 3-19.111 An expert witness qualifies as an expert by knowledge, skill, experience, training or education, and may testify in the form of an opinion or otherwise. (See Federal Rules of Evidence, Rules 702 and 703). The testimony must cover more than a mere recitation of facts. It should involve opinions on hypothetical situations, diagnoses, analyses of facts, drawing of conclusions, etc., all which involve technical thought or effort independent of mere facts. And according to Chapter 3-19.112 Fact Witness A fact witness is a person whose testimony consists of the recitation of facts and/or events, as opposed to an expert witness, whose testimony consists of the presentation of an opinion, a diagnosis, etc
http://www.usdoj.gov/usao/eousa/foia_reading_room/usam/title3/19musa.htm#3-19.111

15.3. Significant construction problems relating to the placement of concrete and rebar were caused by the Containment's small size.

15.4. Minimal analytical data regarding the long-term strength of the building's concrete and its continual exposure to the combination of high temperatures, low pressure, and low specific humidity within its sub-atmospheric Containment as it has aged has led to doubts and questions regarding the strength of this critical safety-related structure in the event of a nuclear accident.

16. Following my ACRS testimony, the ACRS questioned a *containment specialist* staff member of NRC as to whether the NRC even has the capability to analyze a sub-atmospheric containment. According to the NRC *containment specialist,* the NRC cannot accurately analyze Containment systems.

The NRC staff member *containment specialist* said,

> "It's sort of difficult for us to do an independent analysis. It takes time. We're not really set up to do it. The other thing you have to realize, too, for containment, which isn't as true in the reactor systems area, is that **we don't have the capability**." (Page 88, ACRS Transcript, July 9, 2008, lines 6-11.) [*Emphasis added*]

17. From 1976 until 2002, Beaver Valley Unit 1 (BV1) was operated with a sub-atmospheric containment building. In my opinion, Stone & Webster's similar patents[3] provide two important considerations that apply directly to Beaver Valley's design. Those two considerations are that concrete is considered

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[3] According to one of S&W's patents, "A Sub-atmospheric double containment system is a reinforced concrete double wall nuclear containment structure with each wall including an essentially impervious membrane or liner and porous concrete filling the annulus between the two walls. The interior of the structure is maintained at sub-atmospheric pressure, and the annulus between the two walls is maintained at a sub-atmospheric pressure intermediate between that of the interior and the surrounding atmospheric pressure, during normal operation. In the event of an accident within the containment structure the interior pressure may exceed atmospheric pressure, but leakage from the interior to the annulus between the double walls will not result in the pressure of the annulus exceeding atmospheric pressure so that there is no net outleakage from the containment structure. US Patent 4081323 Issued on March 28, 1978 to Stone & Webster Engineering Corp.

porous and all boundaries leak to some extent. On page 1 of the footnoted patent, Stone & Webster considers the concrete to be "***porous***", and on page 8 of the cited patent, Stone and Webster stated, "...***all boundaries leak to some extent***...".

18. In a sub-atmospheric containment, the air pressure in the containment is approximately 4 psi[4] below the pressure outside the containment liner.

19. During the past four years the evidence I reviewed shows that several age related corrosion problems have impacted BV1's containment system.

20. According to Beaver Valley Senior Resident Inspector David Werkheiser[5], May 19, 2009, the first documented containment liner problem at BV1 was uncovered during the BV1 2006 steam generator replacement outage.

    20.1. Specifically, NRC Senior Resident Inspector Werkheiser said that when the containment liner was cut and removed to allow the steam generator replacement, Beaver Valley personnel noticed three locations or pockets on the "outside" of the cut portion of the liner where significant corrosion was present.

    20.2. According to Werkheiser, FirstEnergy's BV1 attributed these "pockets" to construction problems dating back to the early 1970's. Werkheiser also noted that in FirstEnergy's analysis, the "pockets" or voids appear to have been caused by improper vibration of the concrete as it was being poured.

    20.3. Furthermore, Werkheiser noted that FirstEnergy's analysis showed that over time these "pockets" had allowed moisture to accumulate and gradually corrode the "outside" of the liner.

    20.4. Finally, Werkheiser confirmed that the three corrosion locations were analyzed and repaired prior to start-up in 2006 in accordance with:

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[4] pounds per square inch

[5] Telephone conversation between Beaver Valley Senior Site Resident Inspector David Werkheiser and Arnold Gundersen, expert witness nuclear engineer, May 19, 2009 12:33 pm.

- Duquesne Light Company Calculation 8700-DSC-156W, 2/26/91;
- Liner Minimum Wall Thickness S&W Calculation 11700-EA-41, 11/3/71;
- Duquesne - Beaver Valley Unit 1 – Reactor Containment Liner Stress Analysis and repaired before the Unit started up in 2006.

21. In my opinion, the data I reviewed from the FirstEnergy BV1 SER and outage report indicates problems with the BV1 inspection techniques. For more than 30-years, BV1's visual, ultrasonic and integrated leak-rate inspection techniques were unable to detect these three voids and their associated corrosion until 2006, though the voids and corrosion clearly existed well before then.

22. When the steam generator was replaced in 2006, the 17' x 21' piece of liner which was removed represents, according to my calculations, approximately three percent of the total containment liner.

22.1. Given that the voids are randomly positioned, when I applied a ratio of the containment surface area to the piece removed, a basic statistical analysis showed that if three voids were found behind a 17'x 21' section, there may be as many as 99 (ninety-nine) more voids that are similarly impacted by corrosion, but remain hidden behind the residual containment liner.

22.2. By failing to reexamine the full liner in 2006 after detecting three corrosion sites, I believe that FirstEnergy and the NRC made analytical errors by not analyzing whether the sampling density is sufficient to make a reasonably valid conclusion. By not inspecting for more corrosion, in other words, not looking for evidence of the corrosion problem does not prove that corrosion does not exist and that the containment system is sound.

23. BV1 documented a second containment liner problem on April 23, 2009, when the company filed event report 45015 with the NRC. According to BVI event report 45015 *Damaged Area In Containment Liner*:

"On April 21, 2009 during the Beaver Valley Power Station Unit No.1

> (BEAVER VALLEY PS-1) refueling outage, an ASME XI Section IWE General Visual examination was performed on the interior containment liner. A suspect area was identified at the 738 foot elevation level of containment. This area was approximately 3 inches in diameter and exhibited blistered paint and a protruding rust product. At approximately 1015 hours on April 23, 2009 after cleaning the area and removal of the corrosion products, a rectangular area approximately 1 inch (horizontal) by 3/8 inch (vertical) was discovered that penetrated through the containment steel liner plate (nominal .375 inch thickness). The BEAVER VALLEY PS-1 containment design consists of an internal steel liner that is surrounded by reinforced concrete."
>
> "With the plant currently shutdown and in Mode 6, the containment as specified in Technical Specification 3.6.1 is not required to be operable. The cause of this discrepancy is currently being evaluated.
>
> "This is reportable pursuant to 10 CFR 50.72(b)(3)(ii)(A) as a condition of the principal safety barrier (i.e., containment) being seriously degraded."

23.1. In my opinion, it is important to note once again that all visual, ultrasonic and integrated leak-rate inspection techniques at BV1 *failed to detect the incipient passive failure of a key safety structure before the full perforation of the steel liner.*

24. FirstEnergy claims that the "root cause" of both the BV1 2006 containment liner corrosion and the 2009 gross containment liner failure may be related to construction problems that occurred more than 33-years ago. However, the evidence I examined shows that this purported *root cause* analysis is simplistic for several reasons:

24.1. In the National Association of Corrosion Engineers (NACE) book[6] *Corrosion Basics,* Pierre R. Roberge defines the electrochemistry of corrosion as resulting "from the overwhelming tendency of metals to react electrochemically with oxygen, water, and other substances in the aqueous environment".

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[6] *Corrosion Basics: An Introduction*, 2nd Edition, by Pierre R. Roberge, 2006 by NACE Press Book, 364 pages, 77 tables, 292 figures hardbound, ISBN: 1-57590-198-0

24.2. Therefore, in order for any corrosion to occur, there must be both moisture and oxygen present during which the corrosion reaction would occur. In my expert opinion, if this corrosion issue were solely due to construction problems that occurred more than 33-years ago, there would not have been enough oxygen to cause the identified corrosion. Thus, there must be a secondary source of oxygen.

24.3. Neither the construction voids between the liner and the concrete, which was the purported BV1 2006 reason for containment corrosion, nor BV1's 2009 claim, that a block of wood left from construction, is the *cause* of this recent gross containment failure, because neither accounts for the significant oxygen and moisture buildup that must have occurred. I believe that both FirstEnergy and the NRC have failed to address the underlying issue, which is how did the accumulated moisture and oxygen infiltrate the containment system for such an extensive period of time as to perpetuate a serious corrosion reaction.

25. No root cause analysis to date has addressed moisture and oxygen buildup behind the liner, or why such a buildup occurred at only four very specific locations. The failure to conduct a root cause analysis implies that the four sites of corrosion identified during the past three years may be an anomaly. Rather, I believe that a root cause analysis must investigate in an in-depth fashion the possibility of systemic corrosion issues which may be even greater than 99 corrosion "pockets" on the "outside" of the containment liner rather than limited to these four recently discovered random sites.

26. As discussed above, BV1's sub-atmospheric containment design is unique. In my opinion, it is possible that the pressure differential between the outside moist air and the sub-atmospheric conditions within the containment could act as the driving force to draw moisture and oxygen through the porous concrete into construction voids and wood adjacent to the liner. Therefore, I believe this sub-atmospheric design may be the *root cause* of the oxygen and moisture buildup behind the liner. A thorough *root cause analysis* must consider what impact the sub-atmospheric containment had upon the accumulation of oxygen and moisture between the liner and the porous concrete.

27. In summation, I found the incomplete analytical evidence in the FirstEnergy BV1 and the NRC assessments of BV1's containment failures to be simplistic and believe such incomplete analysis puts an undue risk on public health and safety. In my opinion, an in-depth analysis of the corrosion problems that exists between the liner and the porous concrete may uncover systemic failure mechanisms.

28. Moreover, I believe the breach of this containment liner with no prior warning following repeated and various types of containment inspections which occurred for more than 33-years has broad nuclear policy and safety ramifications, for BV1, Beaver Valley Unit 2 and the other sub-atmospheric containments nationwide.

29. The evidence I reviewed also shows significant problems, therefore, I believe that corrective actions are appropriate, including, but not limited to:

29.1. The prompt 100% ultrasonic inspection of the entire liner at BV1 due to the fact that more than 33-years of visual inspection and fractional ultrasonic testing failed to detect the 2009 corrosion until the liner failed.

29.1.1. In my opinion, the liner failure implies that visual and partial ultrasonic techniques are inappropriate for liner inspections under any conditions.

29.1.2. In my assessment, the Beaver Valley liner degradation and/or failures of both 2006 and 2009 indicate a gross breakdown in Quality Assurance (QA) procedures during the construction phase of BV1.

29.1.3. Based upon my knowledge of the construction processes involved in pouring a sub-atmospheric containment, the QA process applied during the BV1 construction repeatedly missed opportunities for this piece of wood to have been discovered and removed.

29.1.4. If the failure discovered in 2009 existed in 2006, an Integrated Leak rate Test in 2006 failed to detect incipient failure implying that slow, controlled pressurization of the containment in that test is inadequate to detect incipient failure.

29.2. It is my position that the 20-year life extension of the Beaver Valley Units 1 and 2 should be put on hold until these significant programmatic Aging Management problems have been analyzed and resolved.

29.2.1. The visual, ultrasonic and integrated leak test inspection failures show programmatic weakness in the aging management systems upon which FirstEnergy has relied upon for its Beaver Valley Units' license extensions.

29.3. In my opinion, if the 100% UT inspection process discovers other construction voids, then the containment liner should be reanalyzed to determine the operability BV1 in order to ascertain any overall weakening of the liner.

29.3.1. An analysis of the Containment liner will ascertain its ability to withstand seismic stress and limit radiation releases, and the NRC has informed the ACRS of its inability to perform a containment analysis, I believe that an independent National Lab should perform this analysis.

29.4. Likewise, I believe that Beaver Valley Unit 2 (BV2) should also be inspected using 100% ultrasonic techniques, given that BV1 and BV2 have the same design, were built by the same contractor, have the same inspection program, and the same Aging Management Program.

30. Furthermore, it is my conclusion that these events at BV1 also have critical ramifications for the entire U.S. nuclear industry, but especially for PWRs.

30.1. In my opinion, the Containment Breach at BV1 in 2009 was the *Passive Failure* of one of the most important safety barriers in a nuclear power plant.

30.1.1. The nuclear industry has heretofore considered such containment liner failures virtually impossible.

30.1.2. NRC Risk Informed Decision Making does not take the likelihood of

Passive Failure of the Containment into consideration.

30.1.3. Given the generic nature and risk to public health and safety due to *containment breach*, I believe that the NRC should order 100% Ultrasonic Testing of all PWR containment liners.

31. In my opinion, FirstEnergy's inability to detect the most recent failure (2009) of the containment liner prior to perforation, as well as its inability to detect three other corrosion sites discovered in 2006, may indicate one of two possible failure scenarios.

31.1. If the 2006 and 2009 corrosion events grew slowly and began during construction, I believe this implies that during the 35-years since construction, neither the visual, ultrasonic, nor integrated leak rate testing have been adequate to detect incipient containment liner failure.

31.2. The second possibility is that visual, ultrasonic and integrated leak rate testing do indeed work, but that through wall liner failure can propagate much more quickly than anticipated between inspection intervals.

31.3. Both of these scenarios are equally troubling to me, as one indicates that ANY existing inspection regime has been inadequate, and the second indicates rapid failures are possible between inspections whose corrosion growth mechanisms have yet to be determined.

32. Given either scenario, it is my professional opinion that the NRC must modify the Beaver Valley SER and AMP to include a full ultrasonic inspection and root cause analysis prior to license extension.

I declare under penalty of perjury that the foregoing is true and correct to the best of my knowledge.

Executed this day, May 25, 2009 at Burlington, Vermont.

Arnold Gundersen, MSNE

STATE OF VERMONT)
COUNTY OF CHITTENDEN) ss.

I HEREBY CERTIFY that on this 25th day of May 2009, personally appeared Arnold Gundersen resident of Burlington Vermont, who is personally known to me or who produced the following identification, and he swore, subscribed, and acknowledged before me that he executed the foregoing as his free act and deed as an expert witness of said case, for the uses and purposes therein mentioned, and that he did take an oath.

In witness whereof, I have hereunto set my hand in the County and State aforesaid:

OFFICIAL NOTARY

NOTARY PUBLIC STATE OF VERMONT

MY COMMISSION EXPIRES: 2/2010

Rulemaking Comments

From: John Runkle [jrunkle@pricecreek.com]
Sent: Friday, April 29, 2011 11:35 AM
To: Rulemaking Comments
Subject: Re: DOCKET ID NRC-2010-0131
Attachments: ATT 5 Gundersen Declaration Dominion_Millstone 3-15-08.pdf

PART 3 of 4

Attached please find the comments by the AP1000 Oversight Group et al. on containment flaws in the AP1000 reactor design with two reports by Fairewinds Associates (and attachments) supporting those comments. Because of your apparent size limits we are sending these comments in four parts.

John D. Runkle
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919-942-0600
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EXHIBIT A

UNITED STATES
NUCLEAR REGULATORY COMMISSION

In the matter of
DOMINION NUCLEAR CONNECTICUT INC.)
MILLSTONE POWER STATION UNIT 3.) Docket No. 50-423
LICENSE AMENDMENT REQUEST)
STRETCH POWER UPRATE)

DECLARATION OF ARNOLD GUNDERSEN SUPPORTING CONNECTICUT COALITION AGAINST MILLSTONE IN ITS PETITION FOR LEAVE TO INTERVENE, REQUEST FOR HEARING, AND CONTENTIONS

I, Arnold Gundersen, declare as follows:

1. My name is Arnold Gundersen. I am sui juris. I am over the age of 18-years-old. I have personal knowledge of the facts contained in this Declaration.

2. I reside at 376 Appletree Point Road, Burlington, Vermont.

3. The Connecticut Coalition Against Millstone has retained me as an expert witness in the above captioned matter.

4. I have a Bachelor's and a Master's Degree in Nuclear Engineering from Rensselaer Polytechnic Institute (RPI) cum laude.

5. I began my career as a reactor operator and instructor at RPI in 1971 and progressed to the position of Senior Vice President for a nuclear licensee. I am a vetted expert witness on nuclear safety and engineering issues. My more than 37-years of professional nuclear experience include and are not limited to: nuclear

safety expert witness testimony; nuclear engineering management and nuclear engineering management assessment; prudency assessment; nuclear power plant licensing, licensing and permitting assessment, and review; nuclear safety assessments, public communications, contract administration, assessment and review; systems engineering, structural engineering assessments, cooling tower operation, cooling tower plumes, nuclear fuel rack design and manufacturing, nuclear equipment design and manufacturing, in-service inspection, criticality analysis, thermohydraulics, radioactive waste processes and storage issue assessment, decommissioning, waste disposal, source term reconstructions, thermal discharge assessment, reliability engineering and aging plant management assessments, archival storage and document control technical patents, federal and congressional hearing testimony, and employee awareness programs.

6. My Curriculum Vitae delineating my qualifications is attached.

7. My Declaration is intended to support Connecticut Coalition Against Millstone's Petition For Leave To Intervene, Request For Hearing, and Contentions.

8. The Five Contentions my Declaration supports are:

   A. The proposed power level for which Dominion Nuclear has applied to uprate Millstone Power Station Unit 3 exceeds the NRC Stretch Power Uprate (SPU) regulatory criteria.

B. The design margins for the Millstone Unit 3 Containment, which help to protect public health and safety, have been significantly reduced by license amendments granted in 1991, and Dominion's proposed power increase, if granted, will further reduce Containment margins designed for safety.

C. When compared to all other Westinghouse Reactors, Millstone Unit 3 is an outlier or anomaly. Dominion's proposed uprate is the largest percent power increase for a Westinghouse reactor. Additionally, Millstone Unit 3 also has the smallest Containment for any Westinghouse reactor of roughly comparable output.

D. Construction problems due to the unique Sub-Atmospheric Containment Design, coupled with the impact upon the Containment concrete by the operation of the Containment Building at very low pressure, very high pressure and very low specific humidity, place the calculations used to predict the stress on that concrete Containment in uncharted analytical areas.

E. The impact of flow-accelerated corrosion at Dominion Nuclear's proposed higher power level for Millstone Unit 3 have not been adequately analyzed and addressed.

9. As an expert witness, who happens to hold both a Bachelor's and Master's degree in Nuclear Engineering, have more than 35-years of nuclear industry engineering experience, and as a former Northeast Utilities employee worked on Millstone Nuclear Power Station Unit 3, in my professional opinion the Dominion Nuclear application fails to satisfy *any of the NRC criteria* to be accepted as a Stretched Power Uprate. A thorough review of the evidence presented by Dominion Nuclear and compared and contrasted with NRC Stretched Power Uprate requirements clearly shows that the Dominion Nuclear Stretched Power Uprate application should in fact be treated as an Extended Power Uprate (EPU) application.

10. According to the NRC, there are two criteria[1] that must be met for a licensee to be considered for a Stretch Power Uprate (SPU):

    A. An increase in the reactor power that is "**up to 7 percent**" and

    B. "... **are within the design capacity of the plant**"

    C. Furthermore, the NRC states that achieving a Stretch Power Uprate "**depends on the operating margins included in the design of a particular plant**". [Emphasis added]

11. In my opinion, the magnitude of Dominion Nuclear's proposed power increase, the uniqueness of the initial Millstone 3 Power Plant Containment design, the Containment's unusually small size, and the fact that the design margins of the Containment have already been dramatically reduced by changes made to

[1] www.nrc.gov/reactors/operating/licensing/power-uprates

Millstone 3 in 1990 by Northeast Utilities, makes it necessary for the NRC to conduct the more thorough and intensive Extended Power Uprate review.

12. Dominion Nuclear has characterized this proposed increase in power at Millstone Unit 3 (Millstone Power Station Unit 3) as a Stretch Power Uprate (SPU), and Dominion Nuclear claims that Millstone 3 meets all the criteria for a Stretched Power Uprate. According to Dominion's letter filing for the power increase:

> "DNC developed this LAR utilizing the guidelines in NRC Review Standard, RS- 001, "Review Standard for Extended Power Uprates." In addition, requests for additional information (RAIs) regarding SPU and Extended Power Uprate (EPU) applications for other nuclear units were reviewed for applicability. Information that addresses many of those RAIs is included in this MPS3 SPU LAR. RS-001 states that a SPU is **characterized by power level increases up to 7 percent and does not generally involve major modifications**. Plant modifications are addressed in Section 1.0 of the License Report (LR) (Attachment 5) and are not considered to be major. Since the requested uprate is 7 percent and does not involve major plant modifications, it is considered to be a Stretched Power Uprate."[2]
> [emphasis added]

13. Contention 1: To begin with, the Dominion Nuclear application fails to satisfy the first NRC criteria[3] that the NRC has set the power limit for SPU's at "**... up to 7% ...**". Yet Dominion Nuclear notifies its acceptance of the NRC's specific criteria in stating "**...a SPU is characterized by power level increases up to 7 percent** ... ". Most importantly, Dominion's proposed power increase at Millstone Unit 3 in fact exceeds the seven percent limit established by the NRC and accepted by Dominion Nuclear.

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[2] Letter, Dominion Nuclear to NRC, SPU Filing, February 2007
[3] www.nrc.gov/reactors/operating/licensing/power-uprates

14. Millstone Power Station Unit 3 is currently licensed to operate at 3411 thermal megawatts (MWt). This number signifies how much heat the reactor is generating and is accurate to four significant figures (numbers).

- The proposed power level of 3650, for which Dominion Nuclear has applied, exceeds the NRC 7% limit that would qualify the power uprate for the less rigorous review of a Stretched Power Uprate.

- Dominion Nuclear has applied for a power increase to 3650 MWt, which is a full 300 KW above what is allowable by the NRC regulations for a Stretch Power Uprate.

- Let's look at the math. Multiply the current licensed power by the NRC's maximum allowable 7% SPU increase. The calculation total equals 3649.7 MWt, which is below the reactor power level of 3650 MWt for which Dominion Nuclear has applied. <u>3411 x 1.07 < 3650</u>

- The 7% NRC limit is accurate to two significant figures. When multiplying a two significant figure number by a four significant figure number *mathematical methodology demands the calculation be rounded down <u>not up</u>* as Dominion Nuclear has done in its application.

- By rounding its proposed reactor power level to a higher power level the requested Dominion Nuclear reactor power increase exceeds the regulatory limit for a Stretched Power Uprate (SPU). Thus, this unscientific rounding up of the thermal megawatt power to a higher power level causes the reactor power to exceed the legal Stretched Power Uprate limit of "up to 7 %" by a full 300 KW.

15. The mathematical evidence shows that Dominion Nuclear proposed power level increase for its Millstone Power Station Unit 3 exceeds the 7% regulatory limit clearly established by the NRC. Therefore, it is my opinion that the Dominion Nuclear's Millstone Unit 3 *is disqualified* for a Stretched Power Uprate.

16. Moreover, while on the face, this mathematical discrepancy may not appear to be a huge number, the 300 KW discrepancy between the NRC 7% limit and Dominion Nuclear's application for a 3650 megawatt thermal increase at Millstone 3 is a significant number that will yield approximately an additional $1 Million in profit for each additional electric megawatt produced per year.
    - In other words, industry data[4] shows that the profit from each megawatt of electricity generated from uprated power increases the profit yield to each electric generating corporation by approximately $1,000,000 per year.
    - Therefore the data show us that by rounding up the power level increase at Millstone 3 in excess of 7%, Dominion Nuclear's Millstone Power Station Unit 3 will earn additional profits of approximately $330,000 each year until 2045.
    - Stated in total dollars, the round up to a power increase in excess of 7% will yield Dominion Nuclear an extra $10,000,000 during the

[4] *Condenser Long Term Plan*, Enrico Betti, Vermont Yankee, Memo FILE UND2002-042 07; MSD 2002/002.

uprated license extension to 2045.

17. In the first place, according to the NRC document *Approved Applications for Power Uprates*[5], the NRC has never allowed a Westinghouse reactor to be licensed for a Stretched Power Uprate with a power level increase as great as that proposed for Millstone Unit 3 by Dominion Nuclear. In the second place, no other Dry Containment[6] Westinghouse reactor with a reactor power level greater than 2000 MWt has been granted a Stretched Power Uprate beyond 6.9 percent.

18. Table 1, inserted below, which is entitled Westinghouse Uprates Ranked in Ascending Order, is a list of all Westinghouse Dry Containment reactors whose thermal power exceeds 2000 MWt.

19. Table 1 ranks the Stretched Power Uprate from smallest to largest, and the NRC data provided in Table 1 shows that no other reactor of this type has ever been granted a Stretched Power Uprate in excess of seven percent like Dominion Nuclear has proposed for Millstone Power Station Unit 3.

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5 NRC *Approved Applications for Power Uprates* http://www.nrc.gov/reactors/operating/licensing/power-uprates/approved-applications.html

6 A Dry Containment is a cylindrical structure with a hemispherical dome that relies solely on its large volume to contain the initial release of radioactive steam after an accident, and to reduce the peak accident pressure. It is a robust passive structure without any additional active mechanical means by which to mitigate immediate post accident pressure. Dry Containment does not rely upon ice or water suppression, nor is it maintained at a large sub-atmospheric pressure in order to reduce the peak accident pressure.

Westinghouse Uprates Ranked in Ascending Order

Name	Initial power	Power Uprate %	Current Power
Indian Point 2	2758	1.4	2797
Commanche Peak 1	3425	1.4	3473
Commanche Peak 2	3425	1.4	3473
STP 1	3800	1.4	3853
STP 2	3800	1.4	3853
Diablo Canyon 1	3338	2	3405
Diablo Canyon 2	3338	2	3405
Salem 1	3411	3.4	3527
Salem 2	3411	3.4	3527
Robinson 2	2300	4.5	2403
Shearon Harris	2775	4.5	2900
Vogtle 1	3411	4.5	3564
Vogtle 2	3411	4.5	3564
Wolf Creek	3411	4.5	3564
Turkey Point 3	2200	4.5	2300
Turkey Point 4	2200	4.5	2300
Callaway	3565	4.5	3725
Braidwood 1	3411	5	3581
Braidwood 2	3411	5	3581
Byron 1	3411	5	3581
Byron 2	3411	5	3581
Farley 1	2652	5	2785
Farley 2	2652	5	2785
Indian Point 3	3025	6.2	3213
Seabrook	3411	6.9	3646
Millstone 3	3411	7.01	3650

Table 1

20. Contention 2: The current application by Dominion Nuclear fails to meet the NRC's second criteria for a Stretched Power Uprate application, because the Millstone Power Station Unit 3 already had its design margins dramatically reduced.

21. According to the NRC, achieving a Stretch Power Uprate "...**depends on the operating margins included in the design of a particular plant**."[7] [emphasis added] Dominion has stated that since the Millstone Power Station Unit 3 application "...does not involve major plant modifications, it is considered to be a SPU". Dominion has erroneously neglected to consider the significant reduction in structural **operating margins** already in place at Millstone Unit 3 prior to its application for a power uprate.

22. The Millstone Power Station Unit 3 Containment structure and its requisite systems have already been "stretched" by previous changes to its design basis when the Containment was converted from Sub-Atmospheric Containment to Dry Containment more than a decade ago. I believe that the proposed changes to Containment systems and structures that have already been reanalyzed and fine tuned once over a decade ago constitutes a dramatic decrease in "...the **operating margins** included in the design of a particular plant."

23. The Containment is the safety related building, which houses the nuclear reactor. As such, it "contains", or in other words collects, the steam and

7 NRC *Approved Applications for Power Uprates* http://www.nrc.gov/reactors/operating/licensing/power-uprates/approved-applications.html

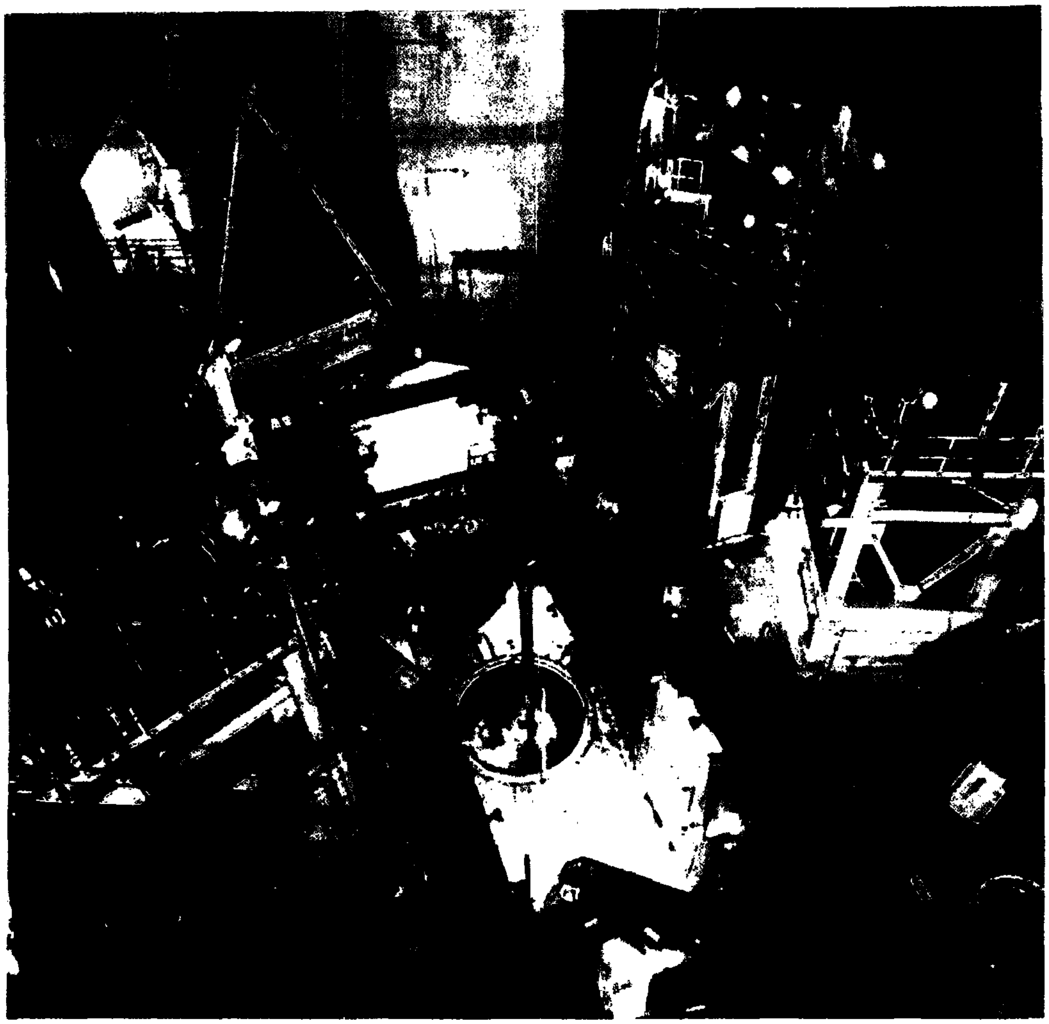
radioactive material that may be released from the reactor after an accident. Please see the photo below of the inside of the Millstone Power Station Unit 3 Containment during initial fuel load in 1986.

24. As the Northeast Utilities lead licensing engineer on Millstone Power Station Unit 3 during the 1970s, I was responsible for coordinating all of the analysis for the PSAR (Preliminary Safety Analysis Report), which formed the original design basis of the Millstone Power Station Unit 3 including its Containment. This interface was among Millstone's structural mechanical, electrical, construction, and operations personnel as well as the architect Stone & Webster and the NSSS vendor Westinghouse. Millstone Power Station Unit 3 was originally designed to be "Sub-Atmospheric Containment." [In this instance my testimony is that of a fact witness[8] in addition to my overall testimony as an expert witness in this Declaration.]

25. The unique design approach of the Sub-Atmospheric Containment maintained the pressure inside the Containment at a "negative pressure" with respect to the atmosphere. Thus the difference between the pressure outside the Containment and inside the Containment (pressure differential) was approximately four pounds. Speaking as an expert witness nuclear engineer, this pressure

[8] According to the Department of Justice United States Attorneys' Manual Title 3, Chapter 3-19.111 An expert witness qualifies as an expert by knowledge, skill, experience, training or education, and may testify in the form of an opinion or otherwise. (See Federal Rules of Evidence, Rules 702 and 703). The testimony must cover more than a mere recitation of facts. It should involve opinions on hypothetical situations, diagnoses, analyses of facts, drawing of conclusions, etc., all which involve technical thought or effort independent of mere facts. And according to Chapter 3-19.112 Fact Witness A fact witness is a person whose testimony consists of the recitation of facts and/or events, as opposed to an expert witness, whose testimony consists of the presentation of an opinion, a diagnosis, etc http://www.usdoj.gov/usao/eousa/foia_reading_room/usam/title3/19musa.htm#3-19.111

differential is quite dramatic for a structure of this size. According to the NRC Sourcebook[9], page 4-26,paragraph B, Sub-atmospheric Containment, Millstone Unit 3 was the only Westinghouse four-loop plant in the nation to have Sub-Atmospheric Containment.



26. Due to critical engineering and operations concerns during my employment as

[9] NRC Sourcebook, page 4-26, paragraph B

the lead licensing engineer for Northeast Utilities on Millstone Power Station Unit 3, both the engineering and operations staff at Northeast Utilities (NU) expressed sincere regret as early as 1975 regarding NU's decision to design and build this unique Sub-Atmospheric Containment.

27. Critical issues of concern to both the engineering and operations staff regarding the Sub-Atmospheric Containment were:

  A. The operations staff working within the Containment was repeatedly subjected to the adverse effects of the high temperature and low oxygen.

  B. The small size of the Containment Building severely limited space for equipment and also complicated accident analysis.

  C. Significant construction problems relating to the placement of concrete and rebar were caused by the Containment's small size.

  D. Minimal analytical data regarding the long-term strength of the building's concrete and its continual exposure to the combination of high temperatures, low pressure, and low specific humidity within the sub-atmospheric Containment as it aged lead to doubts and questions regarding the strength of this critical safety-related structure in the event of a nuclear accident.

28. Despite these major concerns, NU decided in 1976 to continue with the licensing process for Millstone Unit 3 as a Sub-atmospheric Containment rather than risk delaying the license by changing the design. At the same time, the company made the strategic decision to modify Millstone Unit 3's license to

operate, by converting the Containment to a standard "Dry" Containment, but only after the nuclear power plant became operational because it is easier to amend a power plant license after a plant is operational.

29. Millstone Power Station Unit 3 began generating power in 1986, and at that time had Sub-Atmospheric Containment. However, Millstone Unit 3's original design basis with its one-of-a-kind four loop Sub-Atmospheric Containment was modified after it became operational in 1986.

30. The purpose of this one-of-a-kind four loop Sub-Atmospheric Containment was to lower peak design pressure[10] in case of a nuclear accident and to rapidly reduce out-leakage[11] after an accident.

   A. More specifically, the Containment Building is designed to capture steam, energy, and radiation after an accident. In order to capture this post-accident energy, the Containment pressure increases. Thus, Containment Buildings are designed to specific pressure levels that must be considered during all power level design changes.
   B. At Millstone Unit 3 the 1975 initial peak Containment design pressure was 39.4 psig[12].
   C. However, prior to Millstone Unit 3's start-up[13], NU reanalyzed the peak pressure and dropped it to 36.1 psig.
   D. Then on February 26, 1990, NU applied to modify the Millstone Power

[10] Maximum pressure inside the Containment after a design basis accident
[11] Leakage out of the Containment
[12] psig - pounds per square inch, gauge
[13] Amendment 17 to FSAR

Station Unit 3 license by changing the design basis pressure of the Containment from 9.8 psia to 14.0 psia[14].

31. When NU applied for the 1990 license change, it claimed that the sole basis for the change was to reduce the risk of injury to operations personnel who struggled to work at the reduced pressures inside this unique Containment. Such an environment is roughly equivalent to working at the top of the Grand Teton Mountains in temperatures in excess of 100 degrees.

    A. On page 2 of the initial application, NU stated, "… very little is known about the health effects of people working in high-temperature, low pressure environments."

    B. While it is true that this was indeed a staff concern dating back to 1975, it was only ONE of other equally important concerns.

    C. Another major staff concern was the fact that the Containment concrete is being exposed to these very same conditions and there is no data to review regarding the ability of concrete to withstand such a unique high-temperature low-pressure environment. Disturbingly, NU was silent on this major concern throughout its application to modify its license and convert the Sub-Atmospheric Containment to Dry Containment.

32. These changes to the design of Millstone Unit 3's one-of-a-kind Containment actually changed the design basis for the plant.

    A. From the time the initial PSAR was filed with the NRC, the peak accident pressure of Millstone Unit 3 was repeatedly *fine tuned* by NU.

[14] psia - pounds per square inch, absolute

B. From a nuclear engineering standpoint, the critical concern in my mind is that each time a new Containment pressure analysis was derived, NU applied less conservative assumptions in order to achieve more operational flexibility and decidedly increasing public exposure to radiation if there were an accident.

C. In order to accomplish the 1990 modification of Millstone Unit 3, NU changed numerous design criteria and further reduced design margins by taking further credits for systems that were in the original accident scenario design basis.

33. On page 5 of the application to increase Millstone Unit 3's Containment pressure, Northeast Utilities acknowledged that these modifications to the original design "...constitute an Unreviewed Safety Question."[15]

A. In this February 26, 1990 application to the NRC, NU requested to increase the design basis for the normal pressure inside the Containment from 9.8 psia to 14.0 psia, which resulted in the increase of the post-accident peak Containment pressure from 36.0 to 38.57 psig.

B. Since Millstone Unit 3 was originally designed with this unique Sub-Atmospheric Containment Design, in the event of an accident the Containment was designed to leak radiation to the environment for only an hour until it was able to drop the pressure back down and once again

[15] An unreviewed safety question means a change which involves any of the following: (1) The probability of occurrence or the consequences of an accident or malfunction of equipment important to safety previously evaluated in the safety analysis report may be increased; (2) A possibility for an accident or malfunction of a different type than any evaluated previously in the safety analysis report may be created; or (3) The margin of safety as defined in the basis for any technical safety requirement is reduced. *http://www.nuclearglossary.com*

contain any radiation releases inside the Containment Building.

C. The 1990 modifications changed the ability of the Containment Building to release radiation for only an hour and instead allowed the Containment to leak at 0.65 weight percent per day after an accident.

D. Bypass leakage was also increased from 0.01 to 0.042 weight percent per day as a result of the change, and the modification to the Containment pressure increased the calculated exposure to a person at the Exclusion Area Boundary from 16.8 rem to 19.5 rem.

34. Contention 3: Earlier in this Declaration, I also mentioned that the Millstone Power Station Unit 3 Containment has what is considered a *small* Containment. To illustrate the fact that Millstone Unit 3's Containment is small in comparison to other Westinghouse designed nuclear reactors, I evaluated data from the publicly available "NRC Sourcebook" and compiled information regarding 25 Westinghouse Reactors, which all have "Dry" Atmospheric Containment[16].

35. Table 2, inserted below, shows, in ascending order by size, the frec Containment volume (in millions of cubic feet) of these 25 Westinghouse Reactors.

A. The Containment for Millstone Unit 3 clearly stands out as one of the smallest such Containment Buildings in the country.

[16] Since they are not comparable with Dominion Nuclear's Millstone Power Station Unit 3, I have not included the Westinghouse Reactors with Ice Containments, or several three-loop Reactors with Sub-Atmospheric Containment in the compilation. Also, not included for the same reason are decommissioned reactors and reactors whose thermal power is less than 2000 MWt.

B. For that matter, the only nuclear power plants with a Reactor Containment that is smaller than Millstone Power Station Unit 3 have power outputs that are 800 to 1200 MWt less than the power output of Millstone Unit 3 *prior to the Dominion's proposed uprate.*

C. Moreover, of the 11 identical 3411 MWt Westinghouse four-loop Reactors, Millstone is smaller by as much as half a million cubic feet.

36. The ratio of the initial licensed power level to the Containment Volume at each of the same 25 nuclear reactors is clearly shown in Table 3. This ratio comparison is the real indicator of Millstone Unit 3's small Containment. By applying these ratio criteria in comparison with all 25 reactors, Table 3 clearly shows that Millstone Power Station Unit 3 has the smallest Power to Volume ratio of any Dry Containment Westinghouse reactor in the nation.

37. Dominion Nuclear's proposed 7+% power increase to Millstone Power Station Unit 3 widens even further the size gap between Millstone Unit 3 and the other reactors, thus making Millstone Power Station Unit 3's Containment even "smaller" in comparison to every other Dry Containment Westinghouse reactor in the country.

38. Table 4 shows how the initial licensed power levels of all 25 reactors adjusted as a result of NRC approved "stretch" increases.

A. Accordingly, I have adjusted the power level number for Millstone Unit 3 in order to reflect the amount proposed by Dominion Nuclear's application to uprate Millstone 3's power.

Ascending Comparison of Containment Volumes

Name	Volume xE6	Initial power
Turkey Point 3	1.55	2200
Turkey Point 4	1.55	2200
Farley 1	2.03	2652
Farley 2	2.03	2652
Robinson 2	2.1	2300
Millstone 3	2.35	3411
Shearon Harris	2.5	2775
Wolf Creek	2.5	3411
Callaway	2.5	3565
Indian Point 2	2.6	2758
Indian Point 3	2.6	3025
Salem 1	2.6	3411
Salem 2	2.6	3411
Vogtle 1	2.7	3411
Vogtle 2	2.7	3411
Seabrook	2.7	3411
Diablo Canyon 1	2.83	3338
Diablo Canyon 2	2.83	3338
Braidwood 1	2.9	3411
Braidwood 2	2.9	3411
Byron 1	2.9	3411
Byron 2	2.9	3411
Commanche Peak 1	2.98	3425
Commanche Peak 2	2.98	3425
STP 1	3.3	3800
STP 2	3.3	3800

Table 2

Containment Volume Compared to Initial Power

Name	Volume xE6	Initial power	Initial Power/ Volume
Indian Point 2	2.6	2758	1,060.8
Robinson 2	2.1	2300	1,095.2
Shearon Harris	2.5	2775	1,110
Commanche Peak 1	2.98	3425	1,149.3
Commanche Peak 2	2.98	3425	1,149.3
STP 1	3.3	3800	1,151.5
STP 2	3.3	3800	1,151.5
Indian Point 3	2.6	3025	1,163.5
Braidwood 1	2.9	3411	1,176.2
Braidwood 2	2.9	3411	1,176.2
Byron 1	2.9	3411	1,176.2
Byron 2	2.9	3411	1,176.2
Diablo Canyon 1	2.83	3338	1,179.5
Diablo Canyon 2	2.83	3338	1,179.5
Vogtle 1	2.7	3411	1,263.3
Vogtle 2	2.7	3411	1,263.3
Seabrook	2.7	3411	1,263.3
Farley 1	2.03	2652	1,306.4
Farley 2	2.03	2652	1,306.4
Salem 1	2.6	3411	1,311.9
Salem 2	2.6	3411	1,311.9
Wolf Creek	2.5	3411	1,364.4
Turkey Point 3	1.55	2200	1,419.4
Turkey Point 4	1.55	2200	1,419.4
Callaway	2.5	3565	1426
Millstone 3	2.38	3411	1,433.2

Table 3

Containment Volume Compared to Uprate License Power

Name	Volume xE6	Initial power	Power Uprate %	Current Power	Current Power/V
Indian Point 2	2.6	2758	1.4	2797	1,075.76923
Robinson 2	2.1	2300	4.5	2403	1,144.28571
Shearon Harris	2.5	2775	4.5	2900	1,160
Commanche Peak 1	2.98	3425	1.4	3473	1,165.43624
Commanche Peak 2	2.98	3425	1.4	3473	1,165.43624
STP 1	3.3	3800	1.4	3853	1,167.57576
STP 2	3.3	3800	1.4	3853	1,167.57576
Diablo Canyon 1	2.83	3338	2	3405	1,203.18021
Diablo Canyon 2	2.83	3338	2	3405	1,203.18021
Braidwood 1	2.9	3411	5	3581	1,234.82759
Braidwood 2	2.9	3411	5	3581	1,234.82759
Byron 1	2.9	3411	5	3581	1,234.82759
Byron 2	2.9	3411	5	3581	1,234.82759
Indian Point 3	2.6	3025	6.2	3213	1,235.76923
Vogtle 1	2.7	3411	6.2	3564	1,320
Vogtle 2	2.7	3411	6.2	3564	1,320
Seabrook	2.7	3411	6.9	3646	1,350.37037
Salem 1	2.6	3411	3.4	3527	1,356.53846
Salem 2	2.6	3411	3.4	3527	1,356.53846
Farley 1	2.03	2652	5	2785	1,371.92118
Farley 2	2.03	2652	5	2785	1,371.92118
Wolf Creek	2.5	3411	4.5	3564	1,425.6
Turkey Point 3	1.55	2200	4.5	2300	1,483.87097
Turkey Point 4	1.55	2200	4.5	2300	1,483.87097
Callaway	2.5	3565	4.5	3725	1,490
Millstone 3	2.35	3411	7.01	3650	1,553.19149

Table 4

39. An examination of Table 4, inserted above, shows that the new Power to Volume ratio created by the proposed uprate indicates that Millstone Unit 3's Containment would be even "smaller" if Dominion's proposed power increase is approved.

40. A smaller Containment does not mean that the physical Containment has shrunk in size, but rather that more reactor power, and, in the case of an accident, more radioactive releases are being squeezed by volume into the same small Containment Building as a result of this proposed power increase.

41. If approved, Dominion's power increase to Millstone Unit 3 would be the largest ever power uprate approved to Millstone 3's unique Containment with the "smallest" volume ever licensed as discussed above.

42. What is the net effect of increasing the reactor power in this unique very small Sub-Atmospheric designed Containment? I believe that the proposed power increase at Millstone Power Station Unit 3 means that in the event of a nuclear accident at Unit 3, more than 7% additional energy must be absorbed into this one-of-a-kind Containment.

43. I believe that Core samples from within the Containment should be analyzed to assure that the Containment's integrity has not been jeopardized by operating Millstone Unit 3 under these conditions during the first four years of its operational life during the time period while concrete curing shrinkage is

known to occur.

44. In addition to my concerns regarding Millstone Unit 3's operation beyond its design basis due to the analytical tweaking of its one-of-a-kind Sub-Atmospheric Containment, I am also concerned about the reactor power level Dominion has applied in its new analysis in order to support the proposed increase application.

A. Specifically, Dominion Nuclear used a 7.01 percent increase as the basis for energy added to the Containment during an accident. As I have already shown in this Declaration, that 7.01 percent exceeds the NRC limits for consideration for a Stretched Power Uprate.

B. More importantly, Millstone Power Station Unit 3 already has a history of exceeding its licensed reactor power. According to the NRC Integrated Inspection Report on Millstone[17], Dominion Nuclear was cited for:

> "failure to maintain reactor core thermal power less than or equal to 3411 megawatts thermal (MGTH). Specifically, during performance of turbine overspeed protection system testing, the Unit 3 reactor's four minute power average exceeded 3479 MWTH." [Unit 3's license limit is 3411 MGTH also written MWt]

C. This higher power level, for which Dominion Nuclear was cited, is a full 2% higher than level of power Millstone Unit 3 is licensed to produce.

[17] Inspection Report on Millstone, ML 080380599, February 7, 2008 for the period 10/012007 to 12/31/2007, Pages 4, 5, 21, and 22

D. Such a power level increase would also increase the energy available in an accident scenario by the same additional two percent.

E. Given Dominion's history of exceeding its licensed power level, it is my opinion that any analysis of Millstone Unit 3's Containment should use a 9% additional power level in order to most accurately reflect the condition of this one-of-a-kind Containment to withstand any additional pressures during an accident.

45. Contention 4: In its 1990 licensing application to change its Containment pressure, NU never mentioned its staffs' previous concerns about possible stress to the Containment's concrete due to the impact of its operation at high temperatures, low pressures, and low specific humidity. While it is a well known fact throughout the industry that concrete continues to shrink for up to 30-years as it matures after being poured, I was unable to uncover any NU or Dominion studies the long term impact Millstone Unit 3's concrete Containment due to its unique high temperature, low pressure, and low specific humidity environment.

46. Since nothing about this proposed change is either simple or standard, it is therefore my professional opinion that an Extended Power Uprate (EPU) review is more appropriate than a Stretched Power Uprate (SPU) review.

47. Furthermore, the Containment analysis for Millstone Unit 3 is further complicated by the fact that for the first four years of its operation, Millstone Power Station Unit 3 operated at the high, temperature, low pressure, low specific humidity unique to its Sub-Atmospheric Containment and therefore which may have compromised the structural integrity of the concrete.

48. In addition to being the lead licensing engineer at for NU at its Millstone Unit 3 nuclear plant during the 1970s, I have also been both a vice president and the senior vice president of a company that provided goods and services to Millstone 3 during the 1980s.

   A. In my capacity as an officer of the firm contracted to conduct structural analytical support to Millstone Unit 3 during its construction phase, I oversaw a group of sixty structural engineers at the Millstone Unit 3 site in 1984.

   B. Engineers reported to me during the construction phase informed me of other structural problems involving Millstone Unit 3's unique Containment.

   C. Due to the design of this Containment, the size and amount of rebar near major Containment penetrations created strategic geometry problems in the ability of the construction contractors to pour adequate amounts of concrete around the rebar in this tight configuration.

   D. This unique Containment design placed an enormous amount of rebar in several different directions around the Containment penetrations[18], making it extraordinarily difficult for concrete to slip by the rebar. Concrete voids between the rebar were a major concern. To "solve" this problem, NU qualified a procedure for the construction workers to apply long vibrating shafts into the rebar to get the concrete to slide around the rebar and create a heterogeneous block without voids.

E. This vibration method caused the sand to separate from the concrete if applied too long, and would create voids if applied for too short of a time.

F. While the procedure was qualified and construction workers were trained in how to operate the vibrating rods, my structural engineers were concerned that there was no way to test the Containment penetrations after the concrete had hardened to assure there where no voids.

G. The complex geometry at penetrations and the presence of concrete and steel intertwined made any ultrasonic exam impossible.

H. Core drilling was, of course, impossible, as it would weaken the Containment.

I. Given the structural limitations of the original design, and given that licensing changes in 1990 modified the Containment, it is imperative that this license modification be given a more thorough investigation than what is normally provided during a *Stretch* Power Uprate approval

[18] Containment penetrations - Locations through the Containment wall where pipes like steam lines and feedwater lines enter and exit the Containment.

process.

49. Contention 5: Flow Accelerated Corrosion is another critical issue that should be considered the review of Dominion's proposed power increase application.

A. Dominion's proposed power uprate will change Millstone Power Station Unit 3's reactor coolant flow by approximately 7%.

B. It will impact the flow in and out of the reactor and the steam and condensate/feedwater flow on the secondary side of the plant will also be increased by 7%.

C. These flow increases in turn increase "Flow Accelerated Corrosion" thus causing pipes to wear out much faster.

D. This Flow Accelerated Corrosion is a non-linear phenomenon, and in my opinion is a significant risk due to the application of a 7% power increase on a plant that is already in the second-half of its engineered design life.

E. Disturbingly, in its application, Dominion did not propose hiring any new personnel at Millstone Power Station Unit 3 to deal with *flow accelerated corrosion* following the unit's proposed power uprate. This despite the fact that components will require more inspections because an uprate will cause those components to wear out much faster.

F. In general, Flow Accelerated Corrosion increases the likelihood of pipe failure.

G. Equally important, given Millstone Power Station Unit 3 exceeded licensed power less than a year ago, is the concern that pipe already worn thin by the seven percent power increase might break when power is increased further.

H. I saw no evidence that the Containment has been analyzed to withstand this increased energy.

50. I believe that Millstone Unit 3's program for assessing Flow Accelerated Corrosion in Dominion's proposed uprate of the plant fails to comply with 10 CFR50 Appendix B, XVI which states:

<u>10 CFR Appendix B to Part 50</u> – Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants, XVI. Corrective Action that reads:

> "Measures shall be established to assure that conditions adverse to quality, such as failures, malfunctions, deficiencies, deviations, defective material and equipment, and nonconformances are promptly identified and corrected. In the case of significant conditions adverse to quality, the measures shall assure that the cause of the condition is determined and corrective action taken to preclude repetition. The identification of the significant condition adverse to quality, the cause of the condition, and the corrective action taken shall be documented and reported to appropriate levels of management."

51. The power increase at Millstone Power Station Unit 3 will be accomplished by increasing the flow of water through both the primary and secondary sides of

the power plant. This increased flow through the pipes causes pipes to wear out faster by a phenomenon called Flow Accelerated Corrosion (FAC).

52. The basic two causes of FAC are erosion-corrosion of the pipe walls and cavitation- corrosion of the pipe wall. Electrolytic attack may also occur. Wall thinning from FAC is non-linear and is a local issue, caused by local geometry like Elbows and flow restrictions, local turbulence, and local metallurgical conditions (welds and impurities) in the pipe. Once local corrosion has started, changes in turbulence in the local area can intensify the corrosive attack. This localized nature of the corrosion is evident in a FAC pipe failure at the Surry plant in 1986. There a feed-water elbow had holes in one area, yet the nearby pipe wall was much less worn. Similar FAC piping failures have occurred at San Onofre in 1991 and 1993, Fort Calhoun in 1997, and Mihama in Japan in 2004. While this is an *old issue*, it has not been resolved, and instead has continued to plague the nuclear industry for more than three decades.

53. Due to the localized nature of the FAC, it is difficult to predict where and when a piping component might fail. The difficulty in developing accurate predictive models for FAC is the reason why, as recently as 2004, several workers were killed at Japan's Mihama I nuclear power plant. While prediction of what might fail is difficult, it is certain, however, to say that the rate at which piping components will wear out as a result of the proposed increase in power at Millstone 3 will exceed the 7 percent power increase due to the non-linear nature of FAC.

54. In my opinion, Dominion's application does not adequately address the guidance of NRC NUREG-1800, which requires that a FAC program address the scope, analytical tools, benchmarking of the computer model, preventative activities, what is monitored, what is inspected, trend analysis, acceptance criteria, operating experience, inspection techniques as well as data collection.

55. Furthermore, I believe Dominion's proposed License amendment for Millstone Power Station Unit provides inadequate information to determine if Millstone Nuclear Power Station Unit 3 has the management systems and staff in place to properly evaluate FAC if NRC approves Dominion's proposed power increase to the plant.

    A. The application did not discuss the increases in staff necessitated in order to maintain the plant in a safe condition if the proposed power increase is approved.

    B. Clearly the increase in the increased corrosion rates caused by the proposed 7% power level increase will require extra analysis, extra inspection, and extra maintenance, yet the application is silent on the need to increase Millstone Unit 3's inspection and maintenance staff.

56. Without such programmatic and staffing information, I am unable to further assess the adequacy of any actions Dominion Nuclear might have to mitigate

the consequences of Flow Accelerated Corrosion caused by the proposed power uprate at Millstone Nuclear Power Station Unit 3.

57. In conclusion: following a complete review of the evidence presented and by relying upon my nuclear safety and nuclear engineering experience in my review of the documents referenced herein above, it is my professional opinion that the issues discussed above are serious safety considerations germane to the subject of the license application in this case. Similarly after reviewing all the evidence presented, it is my professional opinion that Dominion Nuclear is ill prepared to increase the power at Millstone Nuclear Power Station Unit 3. Finally, since Dominion's proposed power increase is above NRC regulatory criteria and given the new stresses upon the one-of-a-kind formerly Sub-Atmospheric Containment, I believe that the evidence clearly shows the entire application should be given the more rigorous review of the Extended Power Uprate License Evaluation.

I declare under penalty of perjury that the foregoing is true and correct.

Executed this day, March 15, 2008 at Burlington, Vermont.

____

Arnold Gundersen, MSNE

Rulemaking Comments

From: John Runkle [jrunkle@pricecreek.com]
Sent: Friday, April 29, 2011 10:41 AM
To: Rulemaking Comments
Subject: DOCKET ID NRC-2010-0131
Attachments: Fairewinds AP1000 Supplemental Report 12-21-2010.pdf

PART 4 of 4

Attached please find the comments by the AP1000 Oversight Group et al. on containment flaws in the AP1000 reactor design with two reports by Fairewinds Associates (and attachements) supporting those comments. Because of your apparent size limits we are sending these comments in four parts.

John D. Runkle
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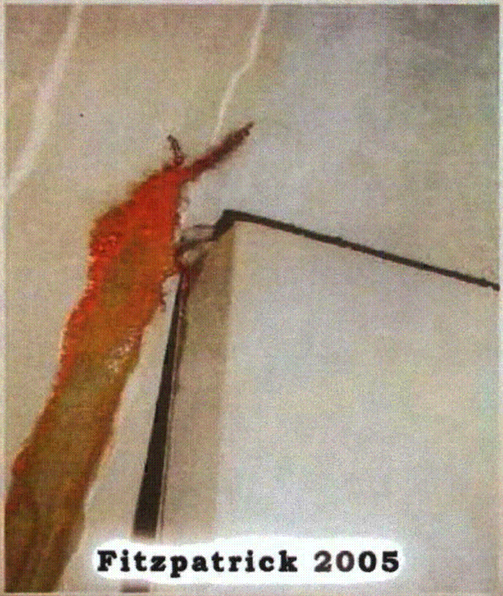
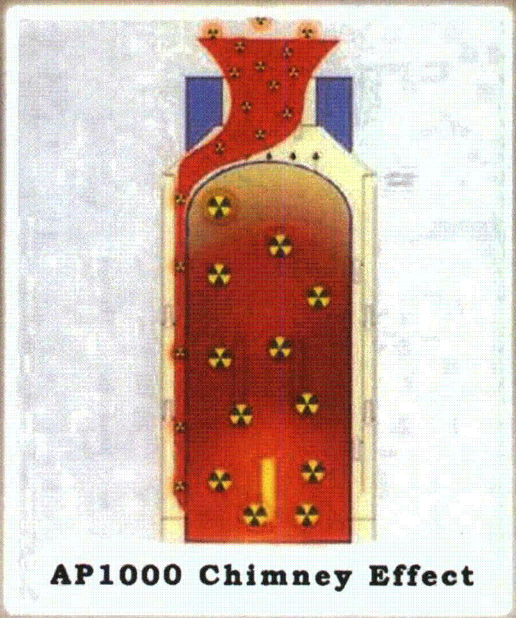
Post Office Box 3793
Chapel Hill, NC 27515
919-942-0600
jrunkle@pricecreek.com

NUCLEAR CONTAINMENT FAILURES:
Ramifications for the AP1000 Containment Design


Fitzpatrick 2005

Beaver Valley 2009


AP1000 Chimney Effect

Fairewinds Associates, Inc
December 21, 2010

Table of Contents

Introduction and Background

During the fall of 2009, Fairewinds Associates, Inc was retained by the AP1000 Oversight Group to independently evaluate the proposed design of the Westinghouse AP1000 nuclear power plant. Following six-months of research and peer review, Fairewinds Associates prepared and submitted an expert report entitled *Post Accident AP1000 Containment Leakage, An Unreviewed Safety Issue* to the AP1000 Oversight Group. In response to Fairewinds Associates' expert report, the AP 1000 Oversight Group sent the report to the NRC and the ACRS April 28, 2010.

As a result of Fairewinds Associates' expert report regarding the unreviewed safety issues of significant potential containment leakage in the event of a design basis accident in an AP1000 nuclear power plant, the ACRS invited Fairewinds Associates' chief engineer Arnie Gundersen and AP1000 Oversight Group Attorney John Runkle to make a formal presentation to the ACRS June 25, 2010. The concerns raised by Fairewinds Associates, Inc regarding the unreviewed safety issues contained in the design of the Westinghouse AP1000 are delineated in its expert report and additional supplemental information is contained in the Power Point presentation Mr. Gundersen and Attorney Runkle made June 25, 2010 to the NRC ACRS.

Fairewinds Associates, Inc wrote *Nuclear Containment Failures: Ramifications for the AP1000 Containment Design*, December 21, 2010, in order to:

1. Reference and combine the conclusions, produced in its previous *AP 1000 Containment Leakage* Report, the June 2010 Power Point, and Mr. Gundersen's oral testimony to NRC ACRS.
2. Add new evidence in the form of additional failure data and new failure modes that Fairewinds Associates has recently reviewed.
3. Address the erroneous information provided to the ACRS by the NRC Staff at the October 2010 ACRS meeting.
4. Address the application of protective coatings in light of new evidence.
5. Address misconceptions relating to <u>all known</u> failure modes of existing containments and their applicability to the AP1000 design.

The Chimney Effect

The *Post Accident AP1000 Containment Leakage, An Unreviewed Safety Issue* Report identified a problem in the AP1000 containment design that Fairewinds Associates, Inc named the *Chimney Effect.* To summarize briefly, in the event of only a small failure in the containment system of the AP1000, the radioactive gasses inside the AP1000 would leak directly into the environment, because the gasses would be sucked out the hole in the top of the AP1000 Shield Building via the *chimney effect.* The *AP 1000 Containment Leakage* Report shows at least 40 occasions when significant corrosion and other failures had developed on containments of all types, and yet this is only a partial picture of all the containment failure data now available.

Failure Modes Causing Containment Malfunction

At least five different failure modes have caused containment failures in existing thick-walled containment vessels or their liners. These failure modes were identified and discussed in the aforementioned *AP1000 Containment Leakage* Report and are identified by the following means:

1. Pitting of the liner from the outside to the inside at the area where the liner is in direct contact with the concrete. (Example: DC Cook)
2. Failure of the liner from the outside to the inside due to construction debris erroneously left in the finished containment that then came in contact with both the concrete and the containment liner. (Example: Beaver Valley 1)
3. Failure of thick walled containments due to expansion and contraction. (Example: Hatch 1 and 2)
4. Inadequacies associated with ASME visual inspections. (Numerous)
5. Inadequate coating application. (Oconee)

Based upon these five types of very diverse failure modes, the initial report concluded that the Westinghouse analysis of SAMDA failure probabilities and consequences must be reevaluated. Moreover, if a complete and proper SAMDA analysis had been conducted, it would show that Filtered Vents would be required on the Westinghouse AP1000 design in order to reduce accident exposures in the scenario postulated in the Fairewinds Associates *Post Accident AP1000 Containment Leakage Report*. Finally, it appears that both the NRC staff and the ACRS are focusing their attention on items 1 and 2 and ignoring items 3, 4, and 5 that are also directly applicable to the AP1000 design. The NRC staff and the ACRS have not initiated an analysis of Filtered Vents as a mitigation measure.

Fairewinds Associates June 25, 2010 AP1000 Power Point presentation to ACRS from June 2010 incorporated and expanded upon the earlier Fairewinds Associates' Report. In addition, it also provided new information that clearly showed that both the NRC and its licensees have ignored:

1. Significant coating degradation information and findings. (Oconee)
2. Clearly evident inadequacies in ASME visual inspections for containment Aging Management Programs. (Beaver Valley)
3. Significant inadequacies in ASME inspections of the joint where the containment wall meets the floor. (Salem)

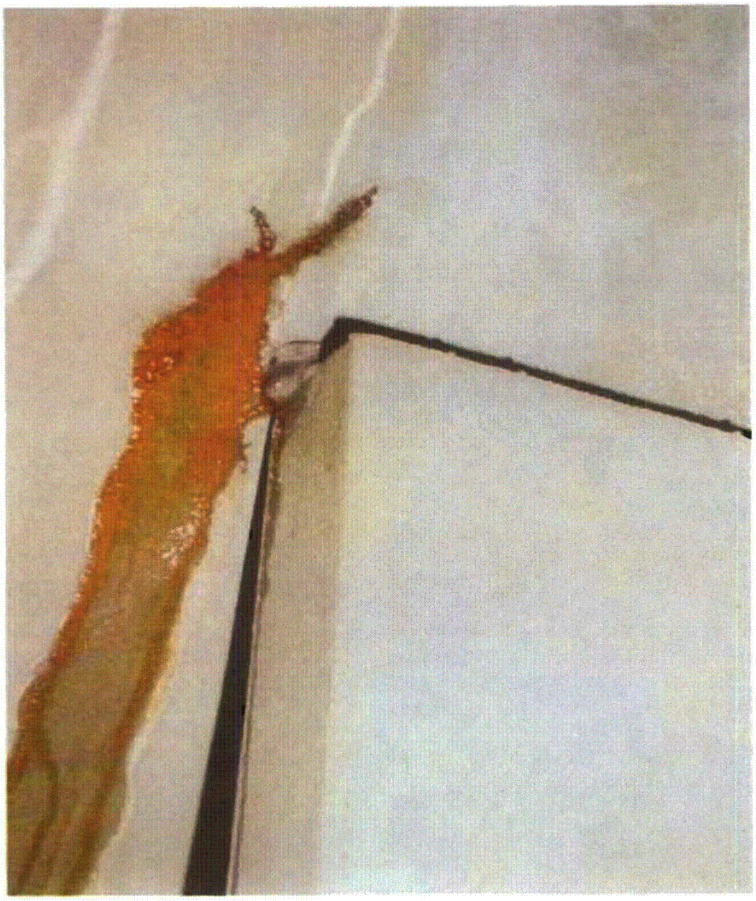
Containment Corrosion

Only a few days prior to the release of Fairewinds Associates' June 25, 2010 Power Point presentation to the ACRS, the NRC staff released Information Notice 2010-12 identifying additional unreported containment failures. Fairewinds Associates was not aware of these additional and newly reported containment failures at the time of its initial report. Moreover, an industry-wide or NRC sponsored database is not available to track such containment failures, like the containment corrosion issue recently reported at Salem. The containment condition that occurred at Salem began inside the containment liner and progressed outward eventually exceeding ASME Code minimum wall thickness. The Salem containment failure is particularly relevant to Fairewinds Associates' AP1000 contention because:

1. Salem's corrosion is from the inside progressing outward.
2. A boric acid leak that occurred during a period of 30-years caused the corrosion.
3. The corrosion remained undetected by all forms of ASME visual inspections *even though* it occurred on the inside of Salem's containment, which was allegedly visually accessible.
4. The Salem containment corrosion was found to be located in the joint between the wall and the floor.
5. More troubling is that this is the specific location Fairewinds Associates pinpointed in its April 2010 report as being problematic to the Westinghouse design of the AP1000.

Containment Cracks

On June 28, 2010, three days after the ACRS meeting, Fairewinds Associates, Inc informed the ACRS of *yet another containment failure*, this time at the Fitzpatrick nuclear power plant in 2005. The photo below of the 4 ½" crack was taken in 2005 from the outside of the containment torus at the Fitzpatrick nuclear power plant in Oswego, NY.



As a result of questions during the ACRS discussion period relating to BWR thick containment designs like the through wall cracks at Hatch 1 and 2, Fairewinds researched additional failures and found that the Fitzpatrick nuclear power plant developed a large though-wall leak that was not due to corrosion. Once again, here is a unique violation of the BWR containment system that is directly applicable to the Westinghouse design of the AP1000.

The Fitzpatrick crack is due to differential expansion in a thick containment that is of similar thickness to the proposed AP1000 design and like the cracks previously uncovered at Hatch 1 and Hatch 2. Thus to date, three thick containments have experienced complete through-wall failures that remained undetectable by ASME visual techniques until each through-wall crack actually appeared.

Protective Coating Failures

Fairewinds Associates clearly showed in its June 25, 2010 presentation to the ACRS that the application of protective coatings throughout the nuclear industry has been proven to be prone to repeated failures (Oconee). The proposed AP1000 containment design relies upon, and indeed requires, the successful application of protective coatings to prevent rust and through-wall holes from developing. Since Fairewinds Associates' presentation to the ACRS, a broader coating concern has arisen involving the integrity of the very contractors who attempt to apply those coatings. Examples of whistleblower suppression in the coatings application industry show us that the application of coatings in the AP1000 cannot be expected to be failsafe.

More disturbingly, in September 2010, the NRC issued a significant decision against the Shaw Group because its management staff harassed and intimidated a foreman who had expressed concerns about protective coating applications.[1] At the time the AP1000 Oversight Group identified the coating issue to the ACRS, this intimidation by the Shaw group had not been publicized or decided. While we commend the NRC for its decision against the Shaw Group, the issue does not stop there for it serves to highlight the significance of our report to the ACRS.

Inadequate and untimely NRC review

Once again the NRC staff has downplayed significant safety issues in its review regarding the AP1000 design. The October 2010 presentation to the ACRS ignored critical containment safety issues in the AP1000 design that were delineated by Fairewinds Associates, Inc in its April 2010 report and its June 2010 ACRS presentation. Instead of conducting a thorough analysis of the data presented, the NRC staff cherry-picked the design failures and only focused on one type of containment failure mode in its October 2010 presentation to ACRS. Additionally, the NRC staff simply chose to focus on and then dismiss as an anomaly the leakage from outside inward due to construction debris associated corrosion like the 2009 through-wall containment hole uncovered at Beaver Valley.

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[1] http://www.kmblegal.com/2010/09/21/u-s-nuclear-regulatory-commission-orders-shaw-group-to-protect-whistleblowers/

NRC staff chose to ignore five other key areas of containment failure in its presentation to ACRS in October 2010. The key failure modes ignored by NRC staff are:

1. Pitting on the outside not associated with debris (DC Cook, Beaver Valley 2006),
2. Rust associated with corrosive attack (boric acid) from the inside out as at Salem and now Turkey Point, and
3. Through-wall cracks in thick containments due to thermal stresses like Fitzpatrick and Hatch 1 & 2.
4. Poor coating application and threats against those who try to apply coatings properly
5. The common theme is that ASME XI inspections missed all of them until through wall cracking or corrosion holes occurred.

NRC never mentioned the additional corrosion and cracking failure modes in their October 2010 presentation to the ACRS. Additionally, it appears that the NRC Staff simply pre-judged these AP1000 design concerns as insignificant in its rush to fast track the design in its accelerated certification process. It appears that the NRC staff once again ignored significant safety related issues.

More New Unreviewed Containment Failures

Yet another through-wall hole in the liner of a containment system was experienced in October 2010 in the sump liner at Turkey Point 3. Like the corrosion at the Salem nuclear plant this hole emerged from the inside of the containment to the outside, and once again, it was generated in an area that was readily accessible to ASME visual inspections. Why was it missed by the ASME inspections? Once more we have another failure mode directly related to Fairewinds Associates' concerns regarding the inadequacy of the AP1000 design.

Rush To Certify AP1000 Design Without Adequate Review

In its rush to certify the AP1000 design and continue the COLA fast-track demanded by the nuclear industry, the NRC staff and NRC committees continue to ignore legitimate safety concerns and significant design flaws that fly in the face of nuclear power probabilistic risk assessment upon which the construction of nuclear power plants was predicated. The AP1000 Chimney Effect identified by Fairewinds is not the only significant technical issue that the NRC appears to be downplaying in order to issue final design approval before the end of 2011. In a closed session ACRS meeting on December 3, 2010, NRC engineer John Ma, discussed his concern that the AP1000 shield building lacks flexibility and could crack in the event of an earthquake or aircraft impact. A cracked shield building would cause the AP1000 passive "chimney effect" airflow to fail, creating an accident scenario even worse than that postulated by Fairewinds Associates, Inc. Furthermore, NRC engineer Ma stressed his concern that the AP1000 shield building design does not even meet American Concrete Institute (ACI) standards and the design also failed required shear test certifications. In a continuation of its rush for approval of the AP1000 design, some of the NRC staff agreed with Westinghouse that the existing approach was adequate, while still acknowledging that the shield building design did not meet ACI criteria.

The NRC's complete failure to address Fairewinds Associates' legitimate technical safety-related issues and concerns and the new admission by NRC's own engineers that the AP1000 has failed tests and does not meet ACI criteria are indicative of NRC capitulation to industry-wide pressure for NRC to certify the AP1000 prior to the end of 2011. The passive cooling approach of the proposed Westinghouse AP1000 design poses unique problems requiring significant NRC technical review and safety hearings, even at the expense of delaying the certification.

Conclusion

In conclusion, while corrosion from the outside inward is certainly an AP1000 issue, the inside outward corrosion problems uncovered at Salem and Turkey Point and the thermal cracking at Hatch and Fitzpatrick are equally damning concerns illustrated to the ACRS by the AP1000 Oversight Group June 25, 2010. Fairewinds Associates, Inc remains convinced that the application of a protective coating and reliance on the ASME visual inspection will not and cannot address the Chimney Effect matter of contention we discussed with the ACRS in June 2010.

The AP1000 has a design post accident containment leak rate of one tenth of one percent per day for the first day of an accident and five hundredths of one percent thereafter[2]. In the Fairewinds

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[2] *Final Safety Evaluation Report Related to Certification of the AP1000 Standard Design (NUREG-1793), SER, Chapter 15, Transient And Accident Analysis, Table 15.3-7: Assumptions Used to Evaluate the Radiological Consequences of the Loss-of-Coolant Accident,* Page 15-98.

Associates' April report, the evidence reviewed shows three major matters in question that differentiate Fairewinds Associates' review from the non-conservative assumptions assembled to facilitate certification of the AP1000 design. These differences are:

1. First, Fairewinds' report shows that the leakage through a rust hole is much larger than one-tenth of one-percent per day.
2. Second, Fairewinds' report shows that the leakage through the rust hole would not decrease as the accident progresses.
3. Third, Fairewinds' report shows that the leakage progresses directly into an unfiltered area. And, because the annular area is unfiltered, radioactive iodine is not eliminated and therefore thyroid doses are a factor of 100 times higher than they would be if filtration were to occur.

The net effect of all these non-conservative assumptions in the AP1000 design by Westinghouse its NRC review is that post accident radiation doses to the public could be several orders of magnitude higher (one hundred to one thousand times higher) than those assumed by Westinghouse in its AP1000 design. Such calculational flaws quite seriously impact emergency planning over a much broader area than that presently assumed in the Westinghouse SAMDA analysis and NRC staff review.

Fairewinds Associates' Recommendation

In order to rectify the problems that Fairewinds has identified, Westinghouse and the NRC Staff must revise the AP1000 SAMDA analysis that presently ignores the large number of existing containment failures. Industry failure data does not substantiate the erroneous assumption that there is not a possibility that leakage from the AP1000 could exceed one-tenth of one-percent. The SAMDA analysis must include a realistic containment failure rate in conjunction with its associated increase in radiation exposure to the public.

Arnie Gundersen, Chief Engineer
Fairewinds Associates, Inc
December 21, 2010

Green America

DOCKETED
USNRC

May 2, 2011 (4:30 pm)

OFFICE OF SECRETARY
RULEMAKINGS AND
ADJUDICATIONS STAFF

40

May 2, 2011

The Honorable Greg Jaczko
Chairman
Nuclear Regulatory Commission
11555 Rockville Pike
Rockville, MD 20852

Re: AP1000 Design Certification, Docket ID: NRC-2010-0131

Dear Chairman Jaczko:

On behalf of Green America and our members, I write to strongly urge the Commission to immediately
suspend rulemaking for the Westinghouse AP1000 nuclear reactor design certification. It is clear from 1
statements from engineers and other experts that the new reactor, especially its shield building, pose
significant safety concerns.

Founded in 1982, Green America is a national membership organization that works to harness economic power—the strength of consumers, investors, businesses, and the marketplace—to create a socially just and environmentally sustainable society. Our 150,000 individual members and 4,000 business members are deeply concerned about our nation's energy needs and the importance of securing safe, renewable energy sources. Clearly, creating a clean energy economy, that protects public and environmental health, must be a national priority.

In the wake of last month's Fukushima nuclear tragedy, the fact that a new reactor design is moving
forward should require greater scrutiny than ever. We are aware that the current design proposal includes 2
a single, thin containment layer to block the escape of radiation. We share the concern expressed by
Congressman Markey in his March 7, 2011 letter to the Commission that a natural disaster or terrorist
attack on the AP1000 "could result in catastrophic core meltdown." The Congressman also notes that the 3
material comprising 60% of the shield building has not passed important physical safety tests and is
therefore too brittle. It is unconscionable that any design certification plans would proceed in light of such
very real danger.

Approval of the AP1000 design, currently being considered for construction in Georgia, South Carolina,
and elsewhere would have profound implications for human and environmental safety. Safety issues 4
need to drive the Commission's decision-making. Green America supports the petition filed by a dozen 6
environmental organizations to suspend rulemaking on the AP1000 until we have definitive analysis of the 5
Fukushima nuclear disaster.

In closing, Green America urges the Nuclear Regulatory Commission to suspend rulemaking on the
AP1000 nuclear reactor design and to await the findings on the Fukushima nuclear crisis so that they can 1
inform our nation's nuclear policies going forward. We owe this to our citizens and future generations.

Sincerely yours,

Alisa Gravitz, Executive Director

1612 K Street NW, Suite 600 Washington, DC 20006 T. 800.58.GREEN F 202.331.8166 www.GreenAmerica.org

Rulemaking Comments

From: Fran Teplitz [fteplitz@greenamerica.org]
Sent: Monday, May 02, 2011 2:51 PM
To: Rulemaking Comments
Subject: Docket ID: NRC-2010-0131
Attachments: NRC AP1000.pdf

ATTN: NRC Rulemaking

Attached please find a letter from Green America related to rulemaking for the AP1000 nuclear power plant.

Thank you for posting this online and for considering our concerns as part of the public comment period that is open through May 10, 2011.

Sincerely,
Fran Teplitz

Fran Teplitz
Director, Social Investing & Strategic Outreach
Green America
1612 K St., NW #600
Washington, DC 20006
202-872-5326
www.GreenAmerica.org

PR 52
(76FR10269)

41

Westinghouse

DOCKETED
USNRC

May 3, 2011 (10:30 am)

OFFICE OF SECRETARY
RULEMAKINGS AND
ADJUDICATIONS STAFF

Westinghouse Electric Company
Nuclear Power Plants
1000 Westinghouse Drive
Cranberry Township, Pennsylvania 16066
USA

Ms. Annette L. Vietti-Cook
Secretary
U S Nuclear Regulatory Commission
One White Flint North
11555 Rockville Pike
Rockville, MD 20852-2738

Direct tel: 412-374-2035
Direct fax: 724-940-8505
e-mail: ziesinrf@westinghouse.com

Your ref: Docket No. 52-006
Our ref: DCP_NRC_003166

May 2, 2011

Attention: Rulemakings and Adjudications Staff

Subject: "Emergency Petition to Suspend All Pending Licensing Decisions and Related Rulemaking Decisions Pending Investigation of Lessons Learned from Fukushima Daiichi Nuclear Power Station Accident" ("Emergency Petition")

Dear Ms. Vietta-Cook,

Westinghouse Electric Company is responding to the Order of the U.S. Nuclear Regulatory Commission, dated April 19, 2011 ("Order"), inviting any person to file an answer to the Emergency Petition, or a brief *amicus curiae*, no later than May 2, 2011.

Westinghouse opposes any suspension of pending licensing decisions and related rulemakings. Such suspension is unwarranted, unnecessary, and undesirable. The Emergency Petition provides no legitimate factual or legal basis for the Commission to take such an extraordinary step. Westinghouse supports the current Commission approach to continue ongoing licensing proceedings and design certification reviews while conducting, in parallel, a comprehensive review of the Fukushima events in Japan. The positive approach of the Commission, both short term and long term, to evaluate the technical and policy issues related to those events, and identify what, if any, regulatory actions should be pursued by the Commission in light of that review and evaluation, is sound from both a technical and a regulatory standpoint.

The Nuclear Energy Institute ("NEI"), of which Westinghouse is a member, has submitted today to the Commission a "Brief of the Nuclear Energy Institute as *Amicus Curiae* in Opposition to the Emergency Petition to Suspend All Pending Reactor Licensing Decisions and Related Rulemaking Decisions" ("NEI Brief"). Westinghouse endorses the NEI Brief.

Template = SECY-067

DS 10

Apart from the Emergency Petition to which this letter is a response, several petitions have been filed in the AP1000 Design Certification Amendment (10 C.F.R. Part 52) rulemaking (NRC-2010-0131; RIN-3150-A18) requesting that the NRC "immediately suspend" that rulemaking and/or extend the comment period in that rulemaking. Westinghouse will be filing comments in response to those petitions during the comment period in that AP1000 rulemaking proceeding.

Very truly yours,

R. F. Ziesing

R. F. Ziesing
Director, U.S. Licensing

From: Julian, Emile
Sent: Monday, May 02, 2011 5:13 PM
To: Giitter, Rebecca; Ngbea, Evangeline
Subject: FW: Westinghouse Electric Company Response to the Emergency Petition
Attachments: Emergency Petition to Suspend All Pending Licensing Decisions DCP_NRC_003166 05-02-11.pdf

Attached is the response of Westinghouse to the petition. We can discuss tomorrow. It should be actioned.

Emile

From: Loza, Paul G. [mailto:lozapg@westinghouse.com]
Sent: Monday, May 02, 2011 4:57 PM
To: Julian, Emile
Cc: Vietti-Cook, Annette; Ziesing, Rolf F.; Bugle, Linda J
Subject: Westinghouse Electric Company Response to the Emergency Petition

Attached please find the Westinghouse Electric Company response dated May 2, 2011 to the Emergency Petition. A paper copy of the original will arrive via FedEx.

Thank you,

Paul G. Loza
Senior Engineer, US Licensing

Westinghouse Electric Company, 520E Suite 115
1000 Westinghouse Drive, Cranberry Township, PA 16066 USA
Phone: +1 (412) 374-5138, Cell: +1 (973) 903-8100, Fax: +1 (724) 940-8505
Email: lozapg@westinghouse.com Home Page: www.westinghousenuclear.com

PR 52
(76FR10269)

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Rulemaking Comments

From: Charlene Eblen [maceblen@cfu.net]
Sent: Wednesday, May 04, 2011 2:42 PM
To: Rulemaking Comments
Subject: Stop the AP1000 (Docket ID NRC-2010-0131)

DOCKETED
USNRC

May 5, 2011 (10:45 am)

OFFICE OF SECRETARY
RULEMAKINGS AND
ADJUDICATIONS STAFF

Dear Secretary Vietti-Cook,

Nuclear energy is NOT safe for people and the planet. Preserving our planet and protecting public health must take precedence over profit.

Damage from Three Mile Island and Chernobyl continue through this day with no end in sight. Damage from the Fukushima disaster is immeasurable and will continue through any foreseeable future.

I live in Iowa, many miles from South Carolina and Georgia, yet adding new reactors in southern states threatens me -- and the world. The very name of the Nuclear Regulatory Commission is a lie: NUCLEAR POWER CANNOT BE REGULATED. It is a force we have neither the wisdom nor the power to tame.

Charlene Eblen
5311 Hyacinth Dr. #63
Cedar Falls, IA 50613

Template = SECY-067 DS 10

PR 52
(76FR10269)

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Rulemaking Comments

From: Philip Stoddard [MayorStoddard@gmail.com]
Sent: Wednesday, May 04, 2011 9:53 PM
To: Rulemaking Comments
Subject: Docket ID NRC-2010-0131: Suspend the AP1000 approval

DOCKETED
USNRC

May 5, 2011 (10:45 am)

OFFICE OF SECRETARY
RULEMAKINGS AND
ADJUDICATIONS STAFF

Dear Secretary Vietti-Cook,

The chimney effect and narrow space between the reactor vessel and containment structure give me serious pause. I beg you, in the name of my constituents, to stop the license process on the AP1000 until these problems can be corrected. 1 2

Thank you for your consideration.

Philip Stoddard, PhD, Mayor
City of South Miami

Philip Stoddard
6820 SW 64 CT
South Miami, FL 33143

Template = SECY-067 DS 10

PR 52
(76FR10269)

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Rulemaking Comments

From: Susan Stantejsky [sstansky3@comcast.net]
Sent: Wednesday, May 04, 2011 10:28 PM
To: Rulemaking Comments
Subject: Stop the AP1000 (Docket ID NRC-2010-0131)

DOCKETED
USNRC

May 5, 2011 (10:45 am)

OFFICE OF SECRETARY
RULEMAKINGS AND
ADJUDICATIONS STAFF

Dear Secretary Vietti-Cook,

Three Mile Island, Chernobyl, Fukushima.

Three reasons not to allow an untested, unlicensed reactor design -- the Westinghouse AP1000 in Georgia, South Carolina and other states. 1

Once again, a powerful industry has bought their way into our politicians hearts, and have influenced preferential laws and treatment. This must stop here.

Nuclear accidents are not on the same scale as coal mine collapses or oil well explosions. Instead of a limited number of workers killed in the case of coal or oil accidents, nuclear accidents affect local residents, the food and water supply, and wildlife for years and years to come. Increased cancer incidence, containinated and unusable food, and toxic clouds are a few of the problems. And then there is the unsolved issue of waste storage. 3 4

The best course of action is to have the power industry spend their dollars developing clean energy -- sun and wind. 2

Thank you.

Susan Stantejsky
5001 E 12TH AVE
Denver, CO 80220

Template = SECY-067 **DS 10**

PR 52
(76FR10269)

45

Rulemaking Comments

From: Mighty Xee [mightyxee@yahoo.com]
Sent: Thursday, May 05, 2011 6:35 AM
To: Rulemaking Comments
Subject: Docket ID NRC-2010-0131: Suspend the AP1000 approval

DOCKETED
USNRC

May 5, 2011 (10:45 am)

OFFICE OF SECRETARY
RULEMAKINGS AND
ADJUDICATIONS STAFF

Dear Secretary Vietti-Cook,

One mistake and we dirtied the Earth
and effected countless generations

AND CAUSED CANCER IN INNUMERABLE HUMANS

We should be using your funding to create solar panels on every roof top in America, and harness perpetual wave, wind and solar energy.

CHERNOBYL CAUSED OVER 985,000 DEATH... NOT 4000 WHAT WILL FUKASHIMA CAUSE?

THINK OF YOUR OWN GRANDCHILDREN
YOU CANNOT UNDO A GAMBLE LIKE THIS
plutonium will kill for 24,000 years!!!!!!

Mighty Xee
791 RT 214
Chichester, NY 12416

Template = SECY-067 **DS 10**

PR 52
(76FR10269)

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Rulemaking Comments

From: Hal Hazen [id4hkh@gmail.com]
Sent: Thursday, May 05, 2011 8:07 AM
To: Rulemaking Comments
Subject: Stop the AP1000 (Docket ID NRC-2010-0131)

DOCKETED
USNRC

May 5, 2011 (10:45 am)

OFFICE OF SECRETARY
RULEMAKINGS AND
ADJUDICATIONS STAFF

Dear Secretary Vietti-Cook,

Until the country implements a way to deal with the existing nuclear waste no new plants should be buillt. Further, Japan proved that existing storage methods are absolutely unsafe. 2 1

For our children. please consider the realities of these two issues.

Hal Hazen
32 Emile Drive
Milton, VT 05468

Template = SECY-067 DS 10

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(76FR10269)

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Rulemaking Comments

From: Chris Crescioli [Chris@TristarSoftware.com]
Sent: Thursday, May 05, 2011 6:00 PM
To: Rulemaking Comments
Subject: Docket ID NRC-2010-0131: Suspend the AP1000 approval

DOCKETED
USNRC

May 9, 2011 (8:50 am)

OFFICE OF SECRETARY
RULEMAKINGS AND
ADJUDICATIONS STAFF

Dear Secretary Vietti-Cook,

I can not understand why a nuclear power plant would be given any consideration until a solution to the waste products are created. It is clear that each time we build one, we permanently destroy part of our land, simply for the profit of a few people. This is immoral and in my opinion, criminally negligent. The risk is now clear, nuclear power plants will fail and there is nothing to prevent release of radiation. Slowly poisoning our planet bodes ill for the future of our children. Because there are alternatives, it only makes sense to stop and solve the problems rather than cave to money.

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Chris Crescioli
2374 Flora Street
San Luis Obispo, CA 93401

Template = SECY-067 **DS 10**

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(76FR10269)

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American Sustainable Business Council

DOCKETED
USNRC

May 9, 2011 (1:30 pm)

OFFICE OF SECRETARY
RULEMAKINGS AND
ADJUDICATIONS STAFF

1401 New York Ave., N.W., Suite 1225
Washington, D.C. 20005
202-595-9302
www.asbcouncil.org

May 9, 2011

The Honorable Greg Jaczko
Chairman
Nuclear Regulatory Commission
11555 Rockville Pike
Rockville, MD 20852

Re: AP1000 Design Certification, Docket ID: NRC-2010-0131

Dear Chairman Jaczko:

We write as members of the American Sustainable Business Council (ASBC) to urge the Nuclear Regulatory Commission to immediately suspend rulemaking for the 1
Westinghouse AP1000 nuclear reactor design certification in light of the safety concerns this reactor raises.

The American Sustainable Business Council is a national coalition of 33 business networks and over 70,000 businesses and 300,000 individual business leaders committed to advancing policies that stimulate our economy, benefit our communities, and preserve our environment. Our business members and NGO partners are active on energy issues and have taken public positions in support of investment in renewable energy options as well as environmental protection. Developing a clean energy economy, that protects human and environmental health, is a major concern of the business networks we represent.

As we await further information and analysis of the current nuclear crisis in Japan, we believe it is all the more incumbent on the Nuclear Regulatory Commission to deeply 2
examine the safety issues facing U.S. reactors. For example, public documents reveal that the current design proposal for the AP1000 reactor includes a single, thin
containment layer to block the escape of radiation. We are concerned that NRC 3
engineer Dr. John Ma asserts in his November 4, 2010 statement of dissent to the NRC that the reactor's building shield could shatter under certain conditions. We also share
Congressman Edward Markey's concern expressed in his March 7, 2011 letter to the 4
NRC that a natural disaster or terrorist attack on the AP1000 "could result in catastrophic core meltdown."

As business leaders and citizens, we cannot emphasize strongly enough the need to 5
ensure that solutions to our nation's energy needs are safe for the long term.

Approval of the AP1000 design would have serious implications for human and 6
environmental safety, especially if the design is replicated nationally. As business
leaders who take a long-term view of economic and environmental sustainability, we 7
know that safety needs to be a top priority. We therefore urge the NRC to suspend
rulemaking on the AP1000 until the lessons from the Fukushima nuclear crisis are fully 2 | 1
understood.

Thank you for your attention to our concerns during this public comment period on the AP1000 reactor design.

Sincerely yours,

Richard Eidlin, Director of Campaigns

Rulemaking Comments

From: Scott Fenn [sfenn@asbcouncil.org]
Sent: Monday, May 09, 2011 12:10 PM
To: Rulemaking Comments
Subject: RE: AP1000 Design Certification, Docket ID: NRC-2010-0131
Attachments: NRC AP 1000.doc

Please find attached a comment letter from the American Sustainable Business Council on the AP-1000 Design Certification.

Thank you.

Scott Fenn
American Sustainable Business Council
sfenn@asbcouncil.org
office: 202-595-9302 x 103
cell: 202-489-5090
www.asbcouncil.org

DOCKETED
USNRC

May 9, 2011 (3:30 pm)

OFFICE OF SECRETARY
RULEMAKINGS AND
ADJUDICATIONS STAFF

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PUBLIC SUBMISSION

As of: May 09, 2011
Received: May 08, 2011
Status: Pending_Post
Tracking No. 80c428c4
Comments Due: May 10, 2011
Submission Type: Web

Docket: NRC-2010-0131
AP1000 Design Certification Amendment

Comment On: NRC-2010-0131-0001
AP1000 Design Certification Amendment

Document: NRC-2010-0131-DRAFT-0027
Comment on FR Doc # 2011-03989

Submitter Information

Name: Christopher Lish
Address:
Olema, CA,

General Comment

See attached file(s)

Attachments

NRC-2010-0131-DRAFT-0027.1: Comment on FR Doc # 2011-03989

Template = SECY-067 **DS 10**

Sunday, May 8, 2011

Secretary Annette L. Vietti-Cook
Nuclear Regulatory Commission
ATTN: Rulemakings and Adjudications Staff
11555 Rockville Pike
Rockville, MD 20852

Subject: Stop the AP1000 -- AP1000 Design Certification Amendment (Document ID NRC-2010-0131)

Dear Secretary Vietti-Cook and members of the Nuclear Regulatory Commission,

In the wake of the Fukushima disaster in Japan, the US government should thoroughly 1
review the safety of nuclear reactors in the United States. I am, therefore, deeply disturbed
to learn that the Nuclear Regulatory Commission (NRC) is moving forward with a 75-day 2
comment for the proposed AP1000 reactor before any review has been completed.

> "It is horrifying that we have to fight our own government to save the environment."
> -- Ansel Adams

It has become clear that we cannot afford to take any unnecessary risks when building
nuclear reactors. Because disaster can occur at any nuclear reactor, the NRC needs to
ensure that it has taken all possible precautions before moving forward with the new 3
Westinghouse AP1000 reactor design considered for construction in Georgia, South
Carolina, and other states.

> "Our duty to the whole, including to the unborn generations, bids us to restrain an unprincipled present-day minority from wasting the heritage of these unborn generations. The movement for the conservation of wildlife and the larger movement for the conservation of all our natural resources are essentially democratic in spirit, purpose and method."
> -- Theodore Roosevelt

Addressing safety concerns, not satisfying the industry, should be the Nuclear Regulatory
Commission's primary concern. The NRC's own expert, John S. Ma, has made clear that
there are serious concerns surrounding the safety of the AP1000 reactor, including its ability 8
to survive a natural or man made impact or an earthquake. Ma's non-concurrence with the
review of the reactor raised the possibility that the AP1000's shield building could shatter
"like a glass cup." It would be indefensible for the NRC to move forward without further
addressing that weakness.

> "As we peer into society's future, we—you and I, and our government—must avoid the impulse to live only for today, plundering for our own ease and convenience the precious resources of tomorrow. We cannot mortgage the material assets of our grandchildren without risking the loss also of their political and spiritual heritage. We want democracy to survive for all generations to come, not to become the insolvent phantom of tomorrow."
> -- Dwight D. Eisenhower

In addition, concerns have been raised about the capability of the reactor's cooling 4
mechanism to function in a disaster. These concerns are particularly relevant considering
the failure to cool or contain the Fukushima reactors after a major natural disaster, resulting
in widespread radioactive contamination. Westinghouse has not satisfactorily proved that
the thin steel containment shell over the reactor would be effective during severe accidents 5
or that the reactor could be properly cooled in conditions similar to those at Fukushima. In
Japan, we can clearly see the devastating effects of design flaws, and the serious concerns 6
being raised about the AP1000 reactor need to be thoroughly addressed.

> "Then I say the Earth belongs to each generation during its course, fully and in its own right, no generation can contract debts greater than may be paid during the course of its own existence."
> -- Thomas Jefferson

Considering the ongoing crisis in Japan and the review which will take place when the
situation is brought under control, the current 75-day public comment period on the reactor 2
design is insufficient for the new AP1000 reactor. I request that the NRC put the license
application on hold until a thorough review of the Japanese accident has been conducted
and weaknesses in the AP1000 design have been reviewed in light of the accident. To stick
with the grossly inadequate 75-day rulemaking comment period would be the height of
irresponsibility by the NRC.

> "A thing is right when it tends to preserve the integrity, stability, and beauty of the biotic community. It is wrong when it tends otherwise."
> -- Aldo Leopold

Also, please accept the petition filed by the twelve environmental organizations of the 7
AP1000 Oversight Group to suspend rulemaking. To ensure transparency, please include
this comment and all others in the formal review proceedings and post them in the NRC's 9
online library so the public can see any expressed concerns.

> "Do not suffer your good nature, when application is made, to say 'Yes' when you should say 'No'. Remember, it is a public not a private cause that is to be injured or benefited by your choice."
> -- George Washington

The safety of the public should take precedence over the desire of industry to move forward 10
quickly on a new reactor, especially when there are significant concerns over that reactor's
safety. Again, I urge the NRC to engage in a thorough review process of the AP1000 that
protects the public's safety. 1

Thank you for your consideration of my comments. Please do NOT add my name to your mailing list. I will learn about future developments on this issue from other sources.

Sincerely,
Christopher Lish
Olema, CA

Rulemaking Comments

From: Gallagher, Carol
Sent: Monday, May 09, 2011 2:56 PM
To: Rulemaking Comments
Subject: Comment on Proposed Rule - AP1000 Design Certification Amendment
Attachments: NRC-2010-0131-DRAFT-0027pdf.pdf

Van,

Attached for docketing is a comment from Christopher Lish on the above noted proposed rule (3150-AI81; 76 FR 10269) that I received via the regulations.gov website on 5/8/11.

Thanks,
Carol

PR 52
(76FR10269)

DOCKETED
USNRC

May 9, 2011 (3:30 pm)

OFFICE OF SECRETARY
RULEMAKINGS AND
ADJUDICATIONS STAFF

50

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Comments Due: May 10, 2011
Submission Type: Web

PUBLIC SUBMISSION

Docket: NRC-2010-0131
AP1000 Design Certification Amendment

Comment On: NRC-2010-0131-0001
AP1000 Design Certification Amendment

Document: NRC-2010-0131-DRAFT-0028
Comment on FR Doc # 2011-03989

Submitter Information

Name: Joseph Resnick
Address:
206 Freedom Lane
Natrona Heights, 15065
Submitter's Representative: Airwars Defense Corp., LLC
Organization: NxGenUSA Corporation

General Comment

To the Ladies and Gentlemen at NRC and to the Good Peoples of the General Public of the United States of America, I send Greetings. I offer the following comment and request posting/submission to NRC Public Comments Page re NRC-2010-0131 proposed regulation changes as follows. I am part of a team leading advancement of improved safety scenarios at all NRC-regulated facilities under NRC jusrisdiction in view of recent events at Fukuhima-Diachi Power Station Japan which utilize the AP1000 Nuclear Reactor. This recommendation centers upon recommending integration of a pateneted nitrogen-gas assist technology called, CryoRain, along with ability to remotely monitor reactor core components in order to insure improved worker safety and prevent possible reactor core meltdowns as proposed in the following article published on April 13, 2011 and viewable at URL: http://www.clubdoconline.com/news/press-release/scientists-propose-use-of-cryorainorie-technology-at-great-lakes-and-candu-corridor-nuclear-sites/

Prior to NRC's granting final approval for licensure of the AP1000 units at any current or future Nuclear generation sites in North America, this team is calling for and requestion Congressional Hearing to address the instant, proposed safety upgrade which was demonstrated to be effective in halting the meldown at the Fukushima disaster in Japan. The Nitrogen assist mitigation technology should be given serious consideration for deployment at any and all nuclear sites under US Jurisdiction and should be mandated by Congress for deployment particularly in view of the Fulushima incident. Respectfully Submitted, Dr. Joseph A. Resnick, Professor Emeritus

Attachments

NRC-2010-0131-DRAFT-0028.1: Comment on FR Doc # 2011-03989

Template = SECY-067 **DS 10**

TITLE: **Liquid Nitrogen Enabler**

INVENTOR: Denyse DuBrucq EdD, 100 W. Elm Street, Cedarville OH 45314-8575 USA

ASSIGNED TO: AirWars Defense LP, a Colorado Limited Partnership registered 7/26/02 #20021204951, a small business.

SECTION 3744 Class 62-050.1 PRIOR ART: Searched, but none found relevant.
Examiner: William Doerrler (571) 272-4807; FAX: (571) 273-4807

DATE: May 14, 2003 APPLICATION NUMBER: 10/437,538; USP 20040226301

Background: Nitrogen as a molecule, N_2, comprises 78% of the atmospheric gas throughout the earth. Extreme cooling isolates oxygen, another molecule, O_2, comprising about 21% of atmospheric gas, the process can liquefy either N_2 or O_2. Nitrogen molecular gas is as inert as Helium or other Noble gases, whereas Oxygen molecular gas is explosive, oxidizing anything it contacts. Therefore, in volatile situations, where something is likely to burn or explode, Nitrogen is preferred, even to Noble gases since Noble gases are rare, and thus expensive, compared to Nitrogen. Liquid Nitrogen is stable between -210° and -195.8° Centigrade, mighty cold. Liquid Oxygen is stable between -218.79° and -182.97° Centigrade. Viewing Liquid Nitrogen in a dewar, it looks as clear as water. If one pours it out on a tile or cement floor, droplets of it rise above the floor and skitter in all directions gathering loose dust and dirt. When it is fully evaporated, the dust and dirt are at the spot of its extinction. This use has no function.

The skittering droplets of Liquid Nitrogen happen because the liquid has a very high surface tension making its shape at rest a sagging ball. It rises from the floor, which is warm, because the warmth causes the Liquid Nitrogen to evaporate. This levitation is the result of the jet-like gas production caused by this warming. It is hard to balance on a point to stay in place, so as the drop becomes off-center of the gas jet, it leans in a direction and the gas jet then propels it in that direction as it warms to the temperature of the atmosphere and the floor beneath it. Since Liquid Nitrogen is so very cold, and the gas jet is cold as well, even dirt stuck on the floor freezes and flakes off the floor as it freezes coating the droplet. Since it freezes and reaches the temperature of the Liquid Nitrogen, it can adhere to the cold droplet without causing the liquid around it to gasify or evaporate. Thus, the dirt and dust flow with the droplet at the same speed and essentially polluting the droplet until it is dissipated.

Evaporating it goes from a liquid density of 19.54 pounds per cubic foot to gas at -195.8° C. boiling point at 0.083 pounds per cubic foot, indicating an expansion of 235 times in the process of evaporating and cooling to -147° C. and to 0.078 pounds per cubic foot warming to 17.7° C., an expansion of 250 times the liquid volume. If it enters a fire, there is further expansion as it heats to the burn temperature. Thus, non-fire applications of Liquid Nitrogen would have a liter of Liquid Nitrogen evaporate into 250 liters of molecular Nitrogen gas. The volume change would be from 1 cube unit as Liquid Nitrogen to 6.3 units cubed. In a fire situation, the heat of the fire will expand the gaseous Nitrogen even further. For this reason, it is well to guage the size of the task and use only as much Liquid Nitrogen as needed to "do the job."

To raise the temperature from -195.8° C. to 17.7° C. pulls considerable heat from the region. Thus if the Liquid Nitrogen could be controlled or at least pause in the area where a fire needs controlling long enough to draw the heat energy from the fire, it is hard to sustain the burning. Add to that the inertness of the gas, the fact that a Nitrogen atmosphere will not sustain a fire. Thus there are two components of Liquid Nitrogen, which, when it evaporates, would prevent a fire from continuing to burn.

Another function of the Liquid Nitrogen is the fact that chemical reactions are temperature dependent and can be slowed and even stopped by lowering the temperature. Therefore, it would be most useful to find a means to control the locality of Liquid Nitrogen while it evaporates to concentrate the purity of the Nitrogen atmosphere and the heat loss caused by evaporation of Liquid Nitrogen and its heating to 17.7° C. This patent application addresses this capability.

All work with Liquid Nitrogen here described should be done with breathing air for people and animals supplied if close to the area affected and intake air for combustion engines. Electric motor driven units are not affected by the atmospheric content change.

The Discovery: To slow the flow from the origin of the Liquid Nitrogen, the origin being, for example, the spot where the Liquid Nitrogen goes as it is poured from a dewar, one can use an elevated trough pierced with holes to shower the Liquid Nitrogen down in many narrow streams or drip lines. This will give maximum exposure of the Liquid to warm gases in the atmosphere as it falls causing much of it to gasify. This cools the air, but the burst of the cool, dense Nitrogen gas will push other gases from the location where it is raining Liquid Nitrogen. What does not evaporate hits the surface and will skitter if the surface is smooth and dry. If it is gravel or sand it may dig itself into the ground with its weight and liquidness making the ground extremely cold and effervescent with gaseous Nitrogen boiling to the surface. This both increases the amount of inert Nitrogen gas and lowers the ambient temperature considerably freezing water and attracting frost.

Descriptions of Figures:

Figure 1 - Design of the trough or gutter.

Figure 2 - Nozzle design for varying the number of flow points from a dewar or other Liquid Nitrogen source as a insulated truck or trailer.

Figure 3 - One circular design using multiple curved units and a two-outlet source with applications to surround single point fires of large size.

Figure 4 - Fire quelling in a residence fire at window entry of equipment and Nitrogen dissipation.

Figure 5 - Fire quelling in a slab structure and on floor fires in tall buildings.

Figure 6 - Fire quelling and preventing collapse in vehicle, plane and rocket attacks on buildings by inserting a trough and pouring Liquid Nitrogen into it.

Figure 7 - Shows means to increase pressure in an active tornado using Liquid Nitrogen and questions if it could apply to hurricanes.

Figure 8 - A circular trough design with hydraulic inner leg sections, which expand when in place undercuts and lifts an explosive unit as a bomb or mine.

Figure 9 - Shows hydraulically expandable sections of the legs.

Figure 10 - Shows leg sections hydraulically expanded and Liquid Nitrogen in the trough and raining down to the surface cooling the mine and freezing leg sections.

Figure 11 -Shows the detonation device, now inert, lifted with trough unit and shoveled by undercutting it below the hydraulically inflated leg sections allowing the whole structure including mine to be moved in the Liquid Nitrogen cooled state.

Figure 12 - shows Liquid Nitrogen used to postpone detonation of underground ordinance and saving of the integrity of the system the ordinance was to destroy.

Figure 13 - Lava flow arresting can create a plateau, which can be plumbed for use and in preparation for a dam holding back stream water forming a mountainside lake. *Figure 13a* shows the preparation apparatus. *Figure 13b* shows the lava cooled and covering grid. *Figure 13c* shows resulting area with dam on high side of plateaus with lake. The Lake will stop future lava flows from destroying this area by cooling it.

The Method: One way to apply Liquid Nitrogen to a limited region is to use galvanized gutter material forming a circle if one has a point fire as a burning oil well or chemical volatility that must be diminished as with a mine, an explosive unit that detonates with a touch or touch sequence, or forming linear trough with the circumstance of a raging fire line moving to cross a line that would endanger lives or property. The gutter is pierced with holes at a size as, but not limited to, a quarter inch (1/4") diameter in an area pattern as zigzag so that when the Liquid Nitrogen is poured into the gutter it flows to fill the gutter and leaks out of the holes making an area of raining Liquid Nitrogen flowing onto the ground or surface below. The purpose is to expose the Liquid Nitrogen to generate the most gaseous Nitrogen and produce the greatest cooling.

Figure 1 shows the design of the trough or gutter with *Figure 1a* representing a cross section of the trough (**1**) showing a spike (**2**), which enters the ground leaving a gap between the surface (**4**) and the gutter outer skin (**3**) at the height needed to make the raining Liquid Nitrogen evaporate most efficiently for the particular application. The roll or core edge (**5**) gives the trough strength to retain its shape during use. *Figure 1b*, the top view, shows the holes (**6**) are patterned (**7**) to give a thickness to the rain of Liquid Nitrogen. *Figure 1c*, the side view, shows the trough with the holes (**6**) on the side showing and the spikes (**2**) with the selected distance between the surface (**4**) and the outer skin (**3**) of the trough. The roll or core edge (**5**) stiffens the trough structure.

In practice, the trough would be leveled such that the end or part of the structure where the Liquid Nitrogen Source pours into is the highest and, with gradual slope, the final or end of flow section is the lowest. The dewar can be the source outlet for a straight trough as for stopping the circular airflow and burning of the leading edge of a forest fire. The dewar with a "T" nozzle is recommended for a circular trough where the base of the "T" is sealed to the dewar and the two ends of the top of the "T" pour the Liquid Nitrogen out into the trough in both directions at once.

Figure 2 shows this configuration with the dewar (**10**) having the "T" (**8**) base (**8a**) sealed to the dewar outlet (**10a**) and the two ends of the top of the "T", (**8b** and **8c**) form the outlets for the Liquid Nitrogen (**9**).

Figure 3 shows a three unit circular ring (**1a**, **1b**, **1c**) as might be used for encircling a well fire (**20**). The dewar (**10**) with a "T" nozzle (**8**) pours Liquid Nitrogen in both directions into the circular trough (**1**) flowing from the highpoint (**12**) where the Liquid Nitrogen (**9**) is introduced, to the opposite side of the circle (**13**) where the Nitrogen (**9**) flows while leaking through the holes (**6**) and raining down on the ground in a wide line (**7**) on the surface surrounding the fire. The dynamics of fire convection is that the heat of the fire heats the air above and radiating out from the fire, while the air near the ground is cooler and drawn into the fire, heated and flows upward pulling more cool ground air toward the fire making a rolling action surrounding the point of the fire.

Figure 3a shows how to optimize the trough height in fire conditions. The wind input draft (**30**) has a height limit which is determined by a wind pole (**31**) with light weight fabric strips tied around it with long ends left to blow in the wind. The strips above this draft **(32)** are limp, whereas the strips in the draft **(33)** extend out in the direction of the wind flow. The break height between strips **(32)** and **(33)** is the optimum height of the stakes **(2)** holding the trough in place. This is the height of the stakes used in *Figure 3* apparatus where the nitrogen **(9)** pours from the trough **(1)** through this flow which super cools the air and floods it with nitrogen gas faster than it can be drawn into the fire. This disrupts the wind draft by becoming the gas source; cools it, thus reducing the fire energy; and floods the space of the fire with Nitrogen stopping the burning.

Figure 4 shows the use of the wind pole **(31)** in treating a house fire to determine if the window, which was opened by whatever means including breaking the glass is in the fire draw. If, when the window is opened, the strips go from pointing down **(32)** to blown horizontal **(33)**, that window can be used for the Liquid Nitrogen treatment. If not, try another window until you find one that becomes the air intake for the fire. Place a half-circular pan **(11)** inside the window **(14)** with stakes **(2)** that attach to the pan rim **(5)** and rest on the windowsill **(15)** and pouring receptacle **(11a)** outside the window so Liquid Nitrogen **(9)** can be poured into the pan **(11)** from outside. The pan **(11)** has holes **(6)** in a pattern **(7)** that allow the Liquid Nitrogen **(9)** to shower down to the floor **(4)** past the window **(14)** with a wide path **(7)** for the draft to pass through the Liquid Nitrogen streams before it goes to the fire. Shortly, the Wind pole **(31)** ties will all droop **(32)** because the pull of air to the fire is coming from the Nitrogen gas **(9)** coming from the streams of Liquid Nitrogen rather than the air from outside the window. When the Nitrogen is gone and the draft does not start again, the fire is out. This is a quick process. Immediately rescuers wearing air tank breathing apparatus and carrying extra oxygen rich air tank breathing equipment should enter the building to find people or animals in the building. Once they have the breathing equipment in place, artificial respiration may be needed to resuscitate those in the fire since the Nitrogen atmosphere can render them unconscious. This must be done immediately. The procedure prevents much of the burning of those rescued had this technique not been used to quickly quell the fire.

Figure 5 illustrates fires in slab building structures or floor isolated fires in tall buildings, the strip trough method should be used which is recommended above for stopping the leading edge of a forest or grass fire. The trough with a center Liquid Nitrogen pouring location (**12**) should be set up in the central hall with an entry of the dewar tube from the storage dewar or tank truck (**10**). The "T" configuration of the tube end (**8**) is required so Liquid Nitrogen pours in both directions into the trough. The level of the trough should be highest at the Liquid Nitrogen entry (**12**) and slant, say one inch per foot of trough, to the ends (**13**). Stakes (**2**) need to be planted in flag stand type boots so the trough does not fall down with the flow of Liquid Nitrogen. Seal the entry of the dewar tube to prevent air from entering. Start the Nitrogen flow. The raised trough with holes (**6**) in patterns (**7**) will let the Nitrogen drop through the holes so it will evaporate into super cool air during the fall. The Liquid Nitrogen left hitting the floor will skitter all over the floor distributing the Nitrogen to all parts of that floor of the building, and, where there are passages as stairwells and elevator shafts, to other floors of the building. After the prescribed amount of Nitrogen, say a barrel a foot of trough plus a barrel per two to five linear feet of floor space beyond that depending on the volume of that floor of the building. This will flood the floor, floor to ceiling with Nitrogen gas stopping the burn and markedly cooling the air and physical structure. Once applied, again get rescuers into the area wearing air tank breathing apparatus and carrying oxygen rich air tank breathing equipment for those found, resuscitating those who have stopped breathing immediately at the place they are found. Keeping the breathing with equipment over the nose and mouth of those needing rescue, move them or help them walk to safety.

Figure 6 illustrates the case of an assault on a building with an external vehicle, truck, aircraft, rocket, one can deliver a trough, say 200 feet long, made of, for example, 33-foot sections with the sixty six feet closest to the building having patterned **(7)** holes **(6)** and an open end **(13-16)**, and the other end having a closed end **(12-17)**. If on the ground floor this can be carried into the burning building **(21)** on a truck bed and rammed in the pathway under or aside the attack vehicle **(22)**. If an airborne missile, rocket or plane **(22)**, hit the building and lodged inside, two helicopters will raise the assembled trough **(1)** to the proper height to match the entry and then fly towards the building from above the roof level sliding the trough in along the side of the plane, not in through the fuselage. The ties to the trough for the helicopter closest to the building **(24)** should be just building-side of the center so it puts some weight on the outside end. This strap is released to the roof to be tied around the elevator shack or other secure roof feature. Those on the roof should tie it securely. The outer helicopter **(25)** has two straps around the end area of the trough. It lets one fall onto the roof, which is secured to the looped feature as the outer end is lifted **(12)** to insure that the Liquid Nitrogen **(9)** will flow into the building down the trough **(13)**, and then the second strap is released to again hook into and be tied securely to the roof feature.

Then the helicopters pick up dewars **(10)** of Liquid Nitrogen **(9)** with a dropped dewar tube **(10a)** to allow flow of Liquid Nitrogen into the trough outside the building and flowing down the trough raining Liquid Nitrogen from the inside end of the trough with patterned holes **(6)** and with any remaining in the trough flowing across the floor cooling and evaporating as it goes. This will oxygen-starve the fire, even of jet fuel, and cool the building structures from the "hot floor." To supplement the cooling and increase the Nitrogen affect on fire elsewhere in the building, like burning fuel running down the elevator shaft, dewars (**10**) of Liquid Nitrogen that empty into a round pan (**1**) affixed to the dewar (**10**), with patterns (**7**) of holes (**6**) will give the fastest dispersal of Nitrogen gas and greatest cooling rate for the interior structural units of the building preventing the meltdown that occurred when the World Trade Center was attacked by two airliners on September 11, 2001. This method, if applied quickly, may have prevented the collapse of the buildings by stopping the petroleum burn and cooling the entire structure. To save the people traveling in the stairwells, buffers, like a row of sandbags, should encircle the entrance to the stairwell so the Nitrogen gas does not asphyxiate those using these escape routes. Rescuers wearing air tank breathing apparatus, again should enter the fire area with oxygen rich air tank equipment to rescue survivors. The fire put out this quickly will save the people from further burning, but precaution must be taken to not re-ignite remaining jet fuel or other fire fueling substances. Centers of beams, external metal and other hot places can ignite the fuel if it contacts these spots. Vacuuming up explosive liquids as quickly as possible can prevent this re-ignition.

This illustrates the purpose of this technology for fire control.

Figure 7 shows this same concept of shower application of Liquid Nitrogen (**9**) can be applied to dissipating tornados. Having a cargo plane carrying one or more trailer dewars (**10**) of Liquid Nitrogen (**9**) with dispersion dewar tubes (**10a**) leading to a sprinkler head nozzle (**8**), they can fly to the clouds suspected of producing tornados because of the buildup of extremely low atmospheric pressure and unload the Liquid Nitrogen (**9**) which, as it cools, evaporates into about 250 times is liquid volume. The cooling may exacerbate the hail from the clouds, but it should increase the air-pressure in the cells that create the twisters. This is the same concept as putting the Liquid Nitrogen in the rolling, leading edge of an advancing fire to stop the destructive airflow pattern. The volume of Liquid Nitrogen needed for hurricane taming needs to be calculated and hail increase figured before this method can apply in this circumstance.

Figure 8 starts a series of illustration to stop the explosion of ordinance needing to be cleared. A small circle surrounding a mine in the dirt or sand can be made before removing it from its location. A trough **(1)** the same size with slit holes **(6)** so the Liquid Nitrogen pours down faster than for fire applications since the preferred function of the Liquid Nitrogen here is cooling the mine to make the explosive material inert long enough to move the mine **(26)** from its location to a detonation chamber. This unit has a second feature, double sectioned legs **(27)** with a structural support section **(28)** on the outside and an inflatable inner section **(29)**. This figure shows the top view of the mine with the cap on top defined.

Figure 9 shows this inner leg section **(29)** filled hydraulically with water or oil expanding it in the lower section to extend from the leg **(28)** to under the mine **(26)** allowing the mine to be lifted from the surface **(4)** a small distance. The mine **(26)** is shown in *Figure 9a*. *Figure 9b* shows the expanded hydraulic section **(29)** from the front and side. *Figure 9c* shows the trough unit **(1)** in side view with the leg sections **(29)** expanded to slide under the mine. *Figure 9d* shows the structure, bottom view, from the surface looking up with the leg sections **(29)** extending under the mine **(26)** in equal spaced segments enabling the whole unit, trough and mine, to be lifted once the whole area is Liquid Nitrogen cooled.

Figure 10 shows the mine cooling trough **(1)** with the mine **(26)** cooled by the Liquid Nitrogen **(9)** here being poured into the trough with a single nozzle dewar **(8)**. A

"T" nozzle would be used on a larger circular trough or where linear troughs are applied and the Liquid Nitrogen is brought in at a center location rather than from one end. With the Liquid Nitrogen (**9**) poured in, it fills the trough (**1**) and flows from the holes (**6**). One would keep the flow going at a rate that retains the Liquid Nitrogen in the trough, yet not overflowing its gunnels (**5**), the rolled or core edge, though it will splash over as the Liquid Nitrogen is introduced to the warm trough. This splashing will slow as the trough reaches Liquid Nitrogen temperature. The inner leg (**29**) components flooded with oil or water become rock-hard with cooled to below freezing temperatures enabling the tough-mine unit to be transported with the mine held in place by the inflated units (**29**).

Figure 11 shows the next step in the mine (**26**) transfer. Once cooled to near Liquid Nitrogen temperature, the mine becomes inert and can be shoveled from its location and placed in a detonation chamber. A proper robotic design will have a lifting device (**19**) as this hook unit serves and a shoveling (**18**) unit with attachments to the carrying device (3**8**) to allow the shovel to be pushed under the trough (**1**) and mine (**26**) lifting these as a unit. The lift will separate the trough and mine unit from the surface (**4**) either at the surface or at the depth where the ground is not frozen solid.

The mine removal method can save life and limb and tools, which are ruined by explosions. It can be used on big pot mines as the Iraqi's left on the bridge over the Tigris River in April 2003 during the Iraq War, or the small Pop Mines buried shallow in the ground. Once a mine is found, this technique will make its removal safer protecting those doing this tenuous job. During this work, one must supply breathing air for those working directly at the scene of Liquid Nitrogen use and for combustion engines.

To extend the application of the inertness of the explosive in an ordinance device when cooled, the transport of these un-detonated units can be done safely if they are retained at Liquid Nitrogen temperatures as putting them in Liquid Nitrogen or in a trailer cooled and maintained at Liquid Nitrogen temperature until it is stored or exploded.

For point-fire control, as putting out the fire in oil well-fires or even surrounding a burning storage tank of petroleum or other combustible material, the large, multi-unit trough is chosen with smaller holes so the longer track of the trough filled with a "T" nozzle can be flooded around the whole circumference with a reasonable volume and flow rate of Liquid Nitrogen.

Predicted Liquid Nitrogen volumes to realize the goal of these techniques are a liter or two of Liquid Nitrogen for the mine cooling technique and about a barrel or two of Liquid Nitrogen for quelling a well fire. For a huge storage tank, a barrel for every ten feet of circumference will probably quell the blaze and lower the temperature of the flammable liquid or solid so it will not readily re-ignite. Linear applications can use a barrel every ten feet to have a Nitrogen gas volume sufficient to extinguish the leading edge of a forest fire stopping its progress.

Figure 12 shows another use of Liquid Nitrogen in this discovery, with detonators (**21**) deep in the ground as with oil wells in northern Iraq, which have detonators 20' below the surface. Using a dewar pipe (**10a**) formed inside a drill bit (**10b**) long enough to probe near the detonator, one sprays Liquid Nitrogen at the level of the detonator to freeze it solid and cool the immediate vicinity to Liquid Nitrogen temperatures. Retaining the explosives at Liquid Nitrogen temperature, dig to the frozen volume and remove the whole section while cold. If the explosive is tied to the well pipe (**34**), a water cutter (**37**) directed parallel to the pipe at the pipe outer skin cuts the explosive loose. Also if the pipe is banded to hold the explosive against it, the water cutter can be directed to cut in a path from the pipe wall outward on the side of the pipe away from the explosives. One swipe downward next to the pipe wall will cut the band. The water cutter can also be used to cut away a segment of the oil well pipe to be removed with the explosive since the oil in the pipe just below the cooled section is solid, cooled by the Liquid Nitrogen. In that case, after the explosive chunk is brought up, the drill pipe should remain in place keeping the oil in the remaining pipeline solid until the petroleum engineers can have it plumbed back into the repaired wellhead. Before the oil is allowed to warm up to flow, the reconstructed wellhead must be in place and the valve closed preventing oil flow. The valve can be opened when the pipeline system is ready to transport the oil.

Figure 13 shows how the cooling effect of Liquid Nitrogen can control the lava flow in volcanos or any other uncontrolled flow of material, even water in a flood or a mudslide. A threatening lava flow can be stopped. It also can be part of planned construction in the place it cools. One places the straight trough **(1)** with patterned holes defining the stop line for the width of the lava flow **(35)**. Pouring in the Liquid Nitrogen **(9)** will cause the rain of the Liquid Nitrogen cooling the flow into rock and the nitrogen gas atmosphere will prevent burning of vegetation and structures. Were there time to prepare an area for the approaching lava flow, a grid **(36)**, forming a level horizontal plane, can be laid across the flow path with air vents **(36a)** at intersections in the grid going upward an long enough to be above the lava rock level expected, and end points in the grid with extended pipe **(36c)** beyond the expected lava rock volume will have temporary ends of either the funnels **(36b)** for pouring in the Liquid Nitrogen or with temporary air vents again at the height of other air vents. Pipe diameters should be such that whatever use these tunneling pipes are to be put to can be done, as water, electric, telephone and sewage lines. A second level grid, same as the first, can be placed to catch overflow of lava to make a second tier. After that, the flow stopping trough delivery of Liquid Nitrogen is used.

As the lava **(35)** approaches, the grid pipes should be filled with Liquid Nitrogen so the pipes are cold enough to solidify lava around them into solid rock. If the integrity of the grid is lost, the lava will continue its flow and the grid pipes will melt into the flow. Thus it is important to retain the Liquid Nitrogen availability for this process to work. Once rock has formed around the pipes and the lava flow stopped, a dam **(39)** can be built on the upward side to hold back water flowing down the mountain as a stream making a lake. Later eruptions may have lava flow in the direction of this plateau rock and lake **(40)**, but it should stop as it enters the lake, being cooled by the lake water.

Therefore I claim:

Cancel claims **1 - 57**.

58. Means of dispensing Liquid Nitrogen to enable its effectiveness against many events caused by nature, accident, or malicious intent, which need curtailing for safety and property preservation.

59. The method, according to Claim **58**, using a spaced hole sieve produces a field of Liquid Nitrogen in drops forming a Nitrogen gas cloud at low temperature originating below the sieve location.

60. The method, according to Claim **59**, using the spaced-hole sieve at or slightly above the fire draft into the fire height floods the fire at the draft with cold, inert gaseous Nitrogen.

61. The method, according to Claim **60**, using the spaced-hole sieve at or above the fire draft height, in troughs surrounding a large fire, and having the fire draft blocked by solid materials to the fire draft height at obstructions to surrounding the fire, applying Liquid Nitrogen to contain the fire and to quell the burn.

62. The method, according to Claim **59**, using the spaced-hole sieve inside the building at a single, external wall location in a building, as a house, upon application of Liquid Nitrogen to flood the entire structure with Nitrogen gas, to extinguish a fire, to put down personnel and chemical explosions in a suspected Methanphenamine lab or hostage crisis.

63. The method, according to Claim **59**, using a closed pipe or solid trough to feed Liquid Nitrogen to the spaced-hole sieve as a long trough to rapidly flood a single story structure as a floor of a tall building, warehouse, or office structure with Nitrogen gas to contain a fire or other crisis.

64. The method, according to Claim **59**, using a portable spaced-hole sieve to apply Liquid Nitrogen directly on the crisis-causing agent as small fire stopping the burn, broken pipe, spewing canister or aerosole can preventing further release of its contents, solidify organic materials spilled on water or the ground solidifying or gelling it for efficient pickup, ordnance as landmine or Experiemental Ordnance Device (EOD) delaying its explosion.

65. The method, according to Claim **58**, using thermal conductive solid walled tubing, cools water to ice and other liquids, including lava and petroleum products, to solids or gels on the tubing surface and, if in a lattice, throughout the inter-tube structure.

66. The method, according to Claim **65**, using thermal conductive tubing, where one pre-empts a crisis by placing the matrix of conductive tubing before the crisis, and when crisis is predicted as imminent, applying the Liquid Nitrogen to freeze the structure in time for it to be effective in the crisis.

67. The method, according to Claim **65**, using thermal conductive solid walled tubing, one can plan the structure of the cooled material by designing the matrix form of the tubing so as to make a post-lava flow area useful or an ice structure sufficient in width and depth to serve as a dam against flooding water torrents.

68. The method, according to Claim **58**, using a crop-duster type dispersion device from an aircraft allows inserting a significant volume of Liquid Nitrogen into a weather system that threatens to create tornados by disrupting its pattern of formation and air currents by adding molecules to raise the barometric pressure and providing coldness to infuse temperature change to prevent or delay or disrupt funnel cloud formation.

69. The method, according to Claim **58**, using a hollowed drill bit enables feeding Liquid Nitrogen to the underground spot where the cold and inert gas is needed insuring the hole to the location is open and intact.

Summary: This invention is a means to quell uncontrolled fires, dissipate low-pressure cells in tornado-producing clouds and make ordinance as mines, old bombs and the like inert and provide a design opportunity for lava flows. For each operation, one applies unique means of distribution of Liquid Nitrogen, either above the surface sufficiently to allow it to rain down from holes in a trough forming a pattern in the bottom of an encircling or linear trough held up with stakes or legs of a length optimum for maximum evaporation before hitting the surface, or underground with drilling means or preparatory piping or well placed air drops of Liquid Nitrogen. This produces local cooling and expansion of inert gas supplanting the general atmosphere with a nitrogen atmosphere reducing significantly the amount of oxygen available and increasing the atmospheric pressure. Both cooling and flooding with inert gas quickly quell of fires. The expansion of gas sprayed in tornado-producing clouds raises the atmospheric pressure. Cooling renders inert fused ordinance as mines and bombs. They cannot explode or detonate at these extremely low temperatures. Liquid Nitrogen can control both lava flows and flooding making the flowing liquid a solid by lowering its temperature.

Declaration: I, Denyse Claire DuBrucq, am the sole inventor of the technology of the patent application, 10/437,538 filed May 14, 2003, titled, LIQUID NITROGEN ENABLER. I am a United States Citizen residing in Milwaukee, Wisconsin USA with correspondence address of P. O. Box 26292, Wauwatosa WI 53226-0292.

The patent has 13 figures and 12 claims, of which six are independent and six dependent.

date

Denyse DuBrucq
P. O. Box 26292
Wauwatosa WI 53226-0292

Figure 1

Figure 1a *Figure 1b* *Figure 1c*

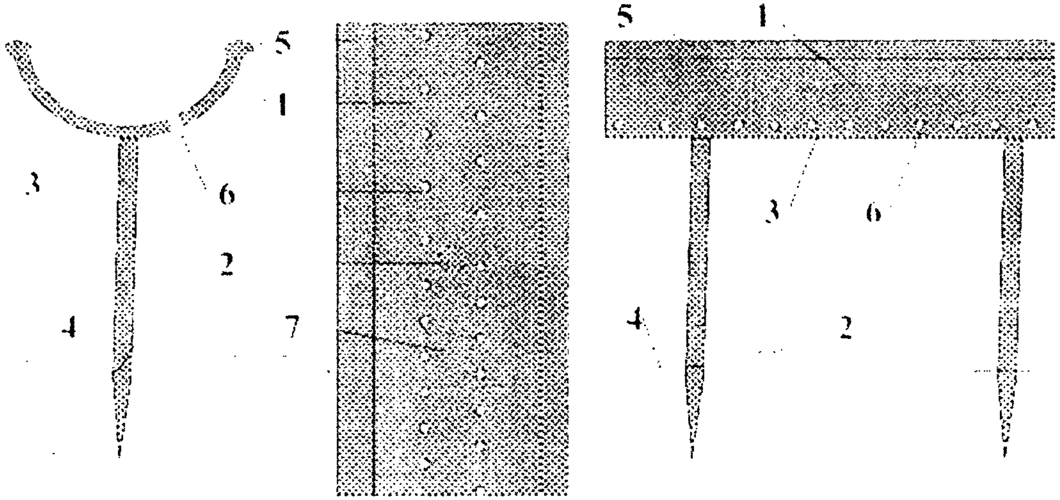
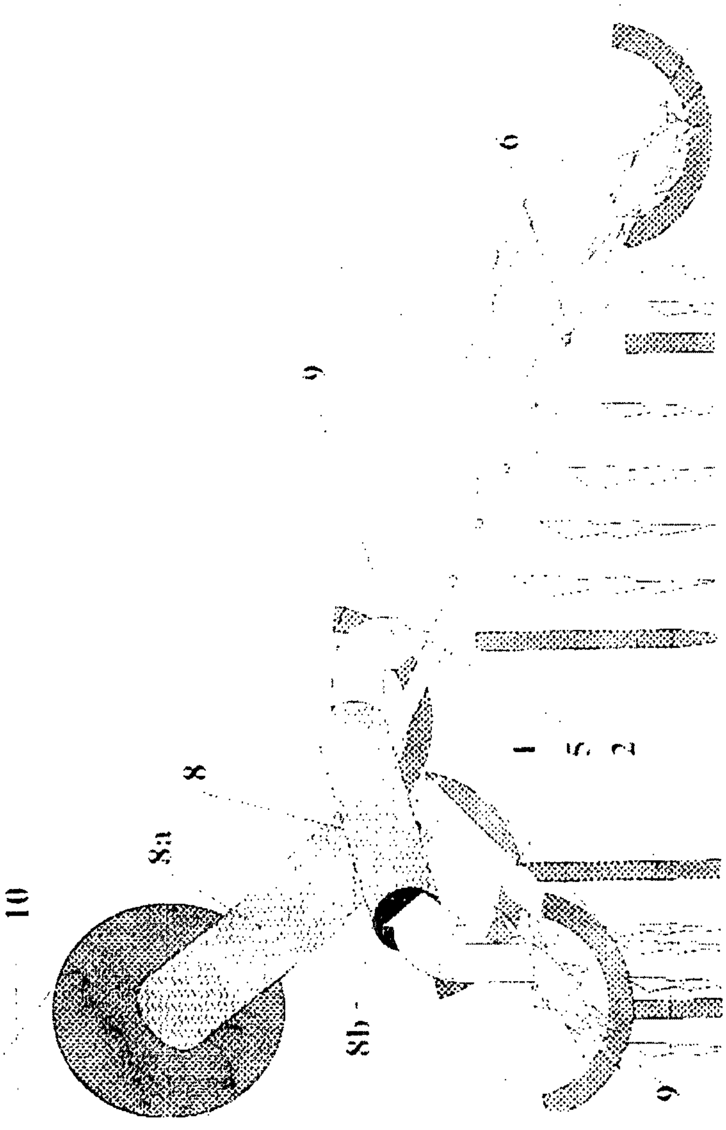


Figure 2



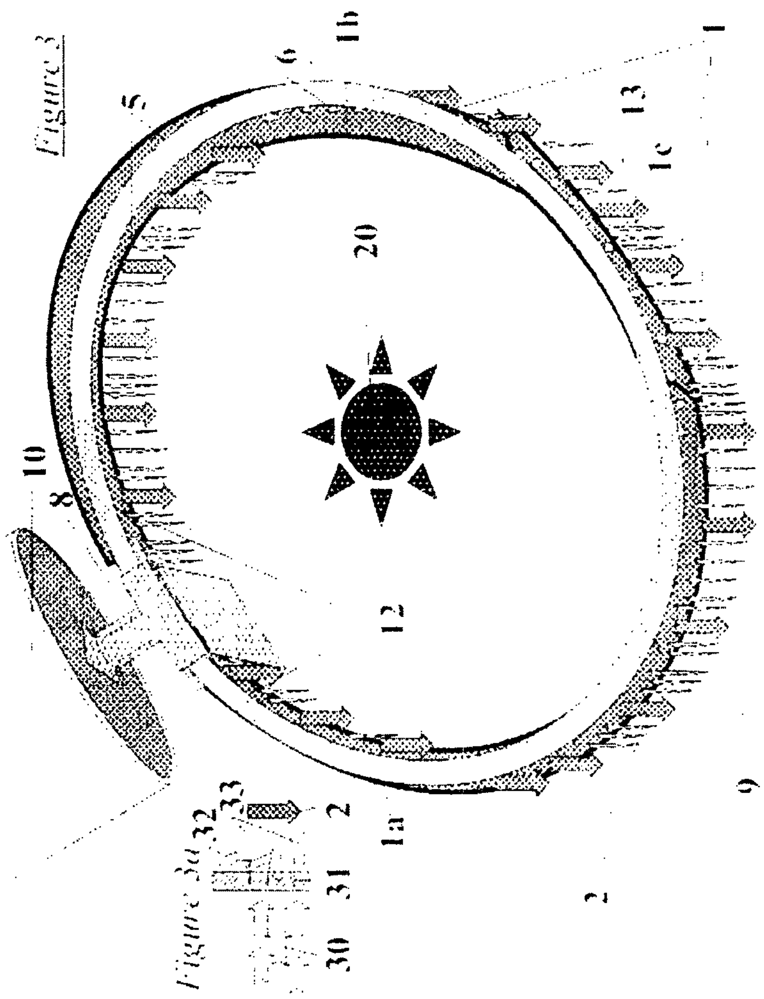


Figure 3
Figure 3a
10
8
5
6
1b
1
13
1c
20
12
9
1a
2
32
33
30
31
2

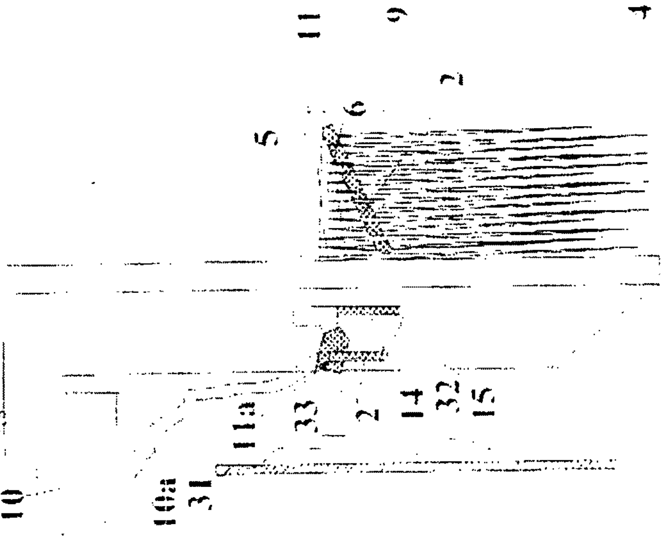


Figure 4

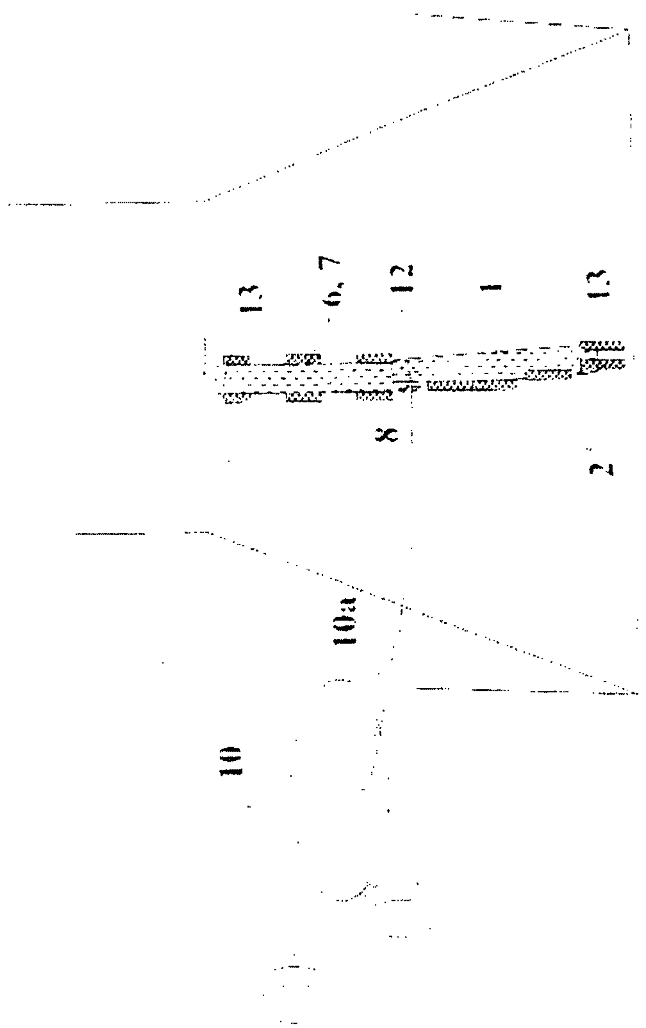


Figure 5

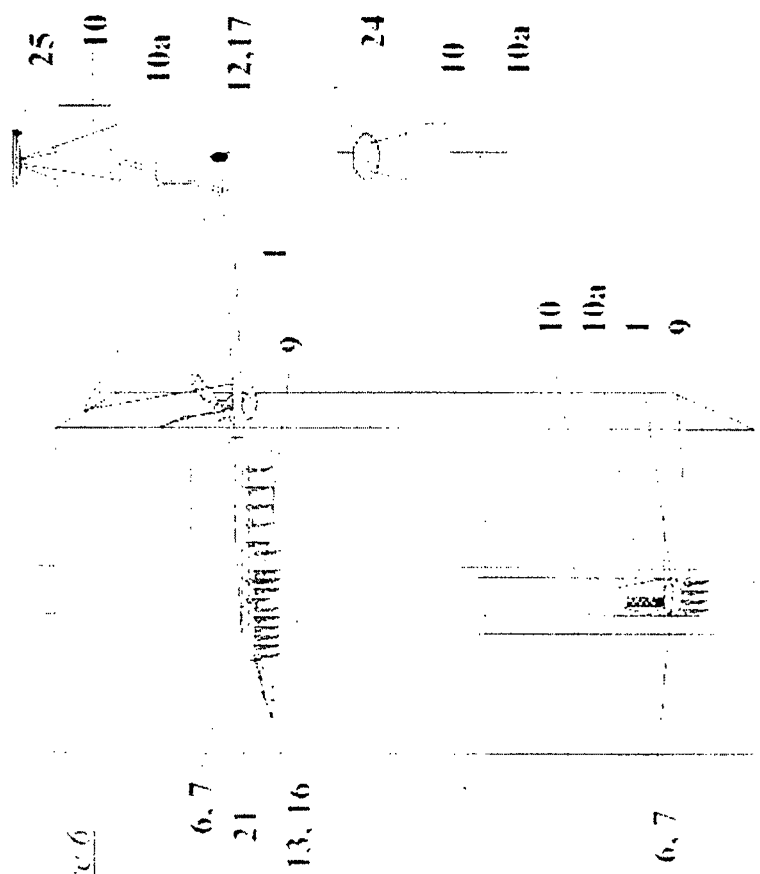


Figure 6

Figure 7

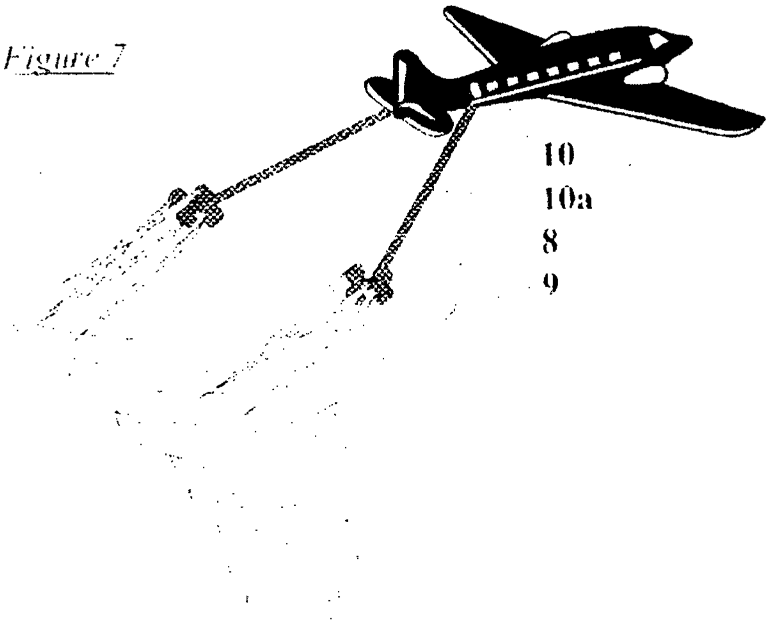


Figure 8

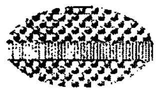


Figure 8a

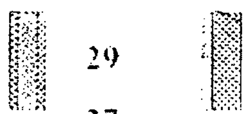
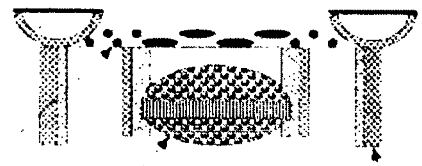


Figure 8b

Figure 8c



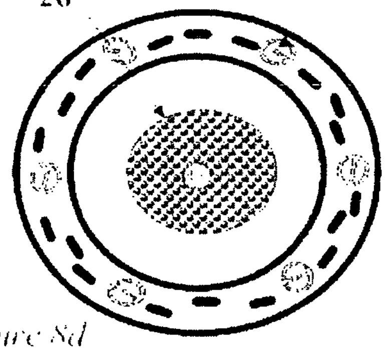


Figure 8d

Figure 9

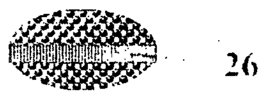


Figure 9a

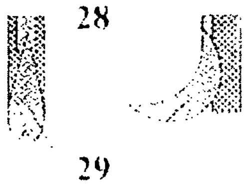
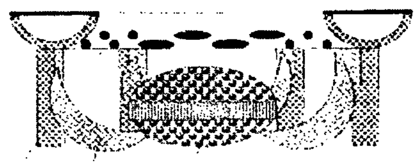


Figure 9b

Figure 9c



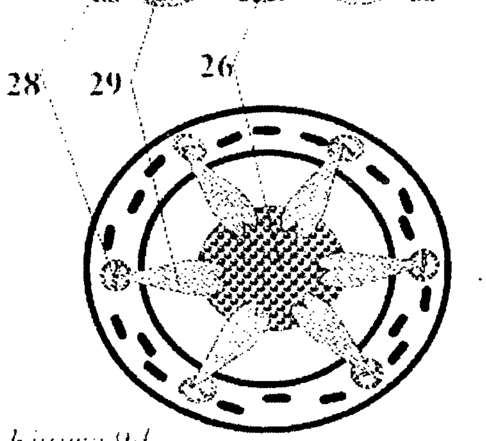


Figure 9d

Figure 10

Figure 10a

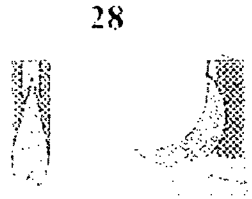
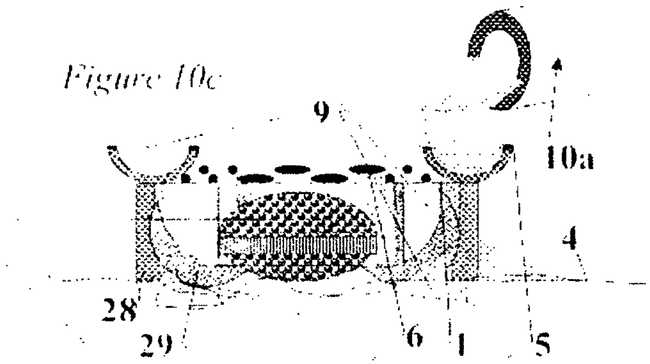


Figure 10b

Figure 10c



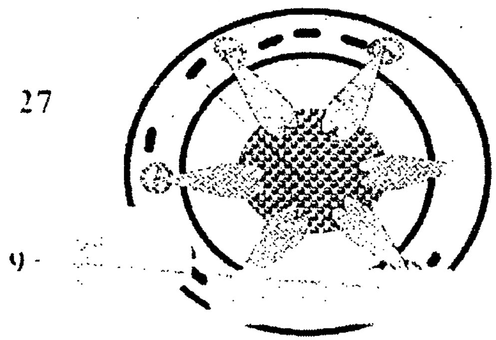


Figure 10d

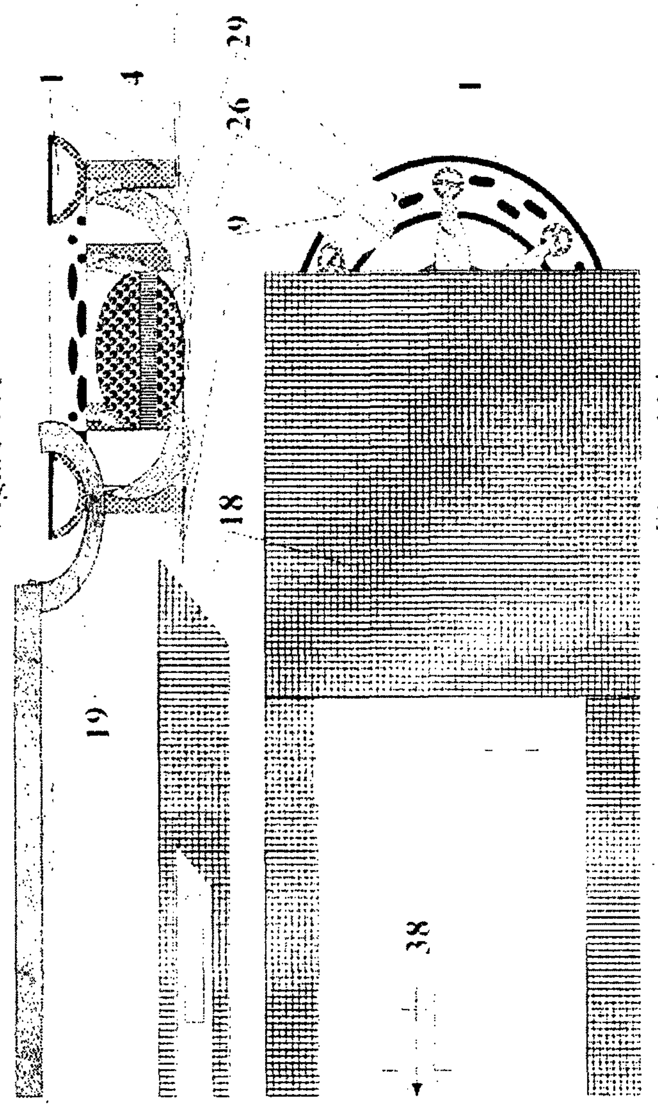


Figure 11

Figure 11c

Figure 11d

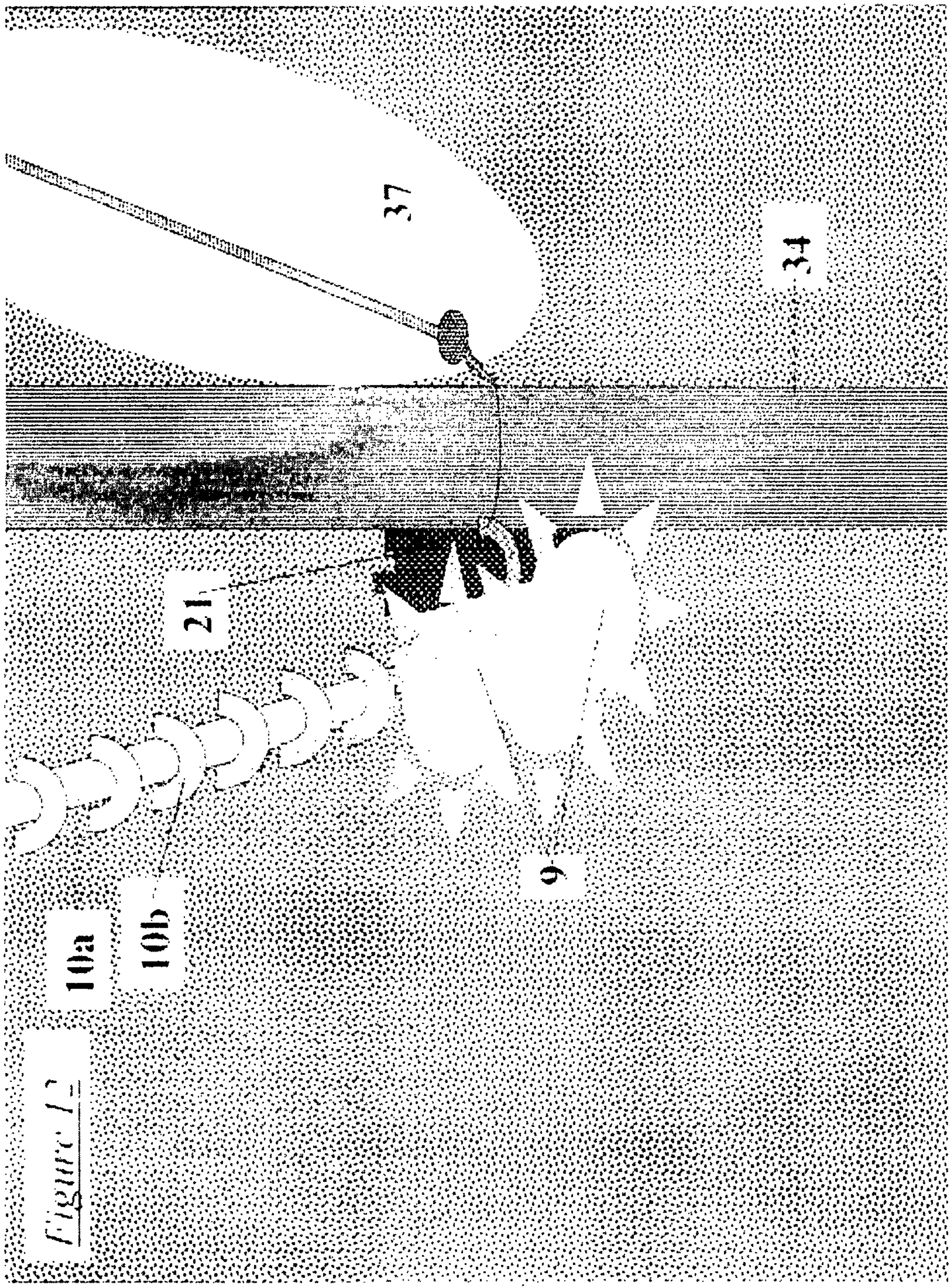
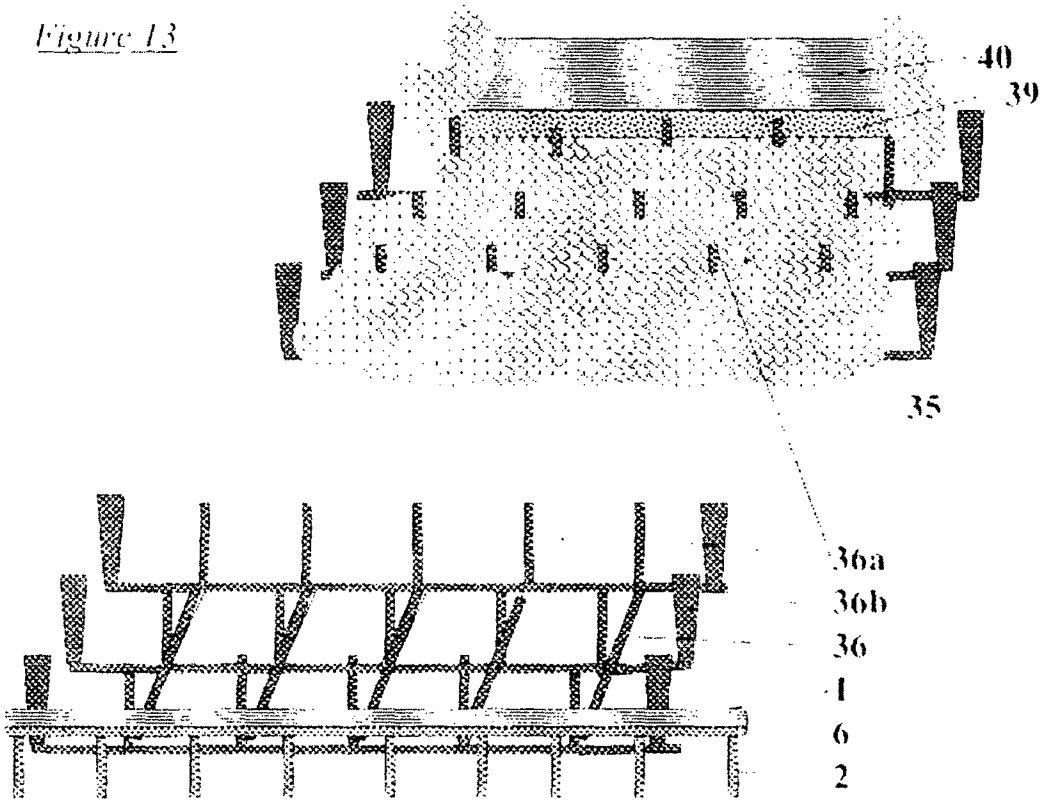


Figure 12

Figure 13



Rulemaking Comments

From: Gallagher, Carol
Sent: Monday, May 09, 2011 3:05 PM
To: Rulemaking Comments
Subject: Comment on Proposed Rule - AP1000 Design Certification Amendment
Attachments: NRC-2010-0131-DRAFT-0028.pdf

Van,

Attached for docketing is a comment from Joseph Resnick on the above noted proposed rule (3150-AI81; 76 FR 10269) that I received via the regulations.gov website on 5/9/11.

Thanks,
Carol

51

Rulemaking Comments

From: John Runkle [jrunkle@pricecreek.com]
Sent: Monday, May 09, 2011 5:47 PM
To: Rulemaking Comments
Subject: DOCKET ID NRC-2010-0131
Attachments: Petitioners Motion for Modification of Order to Allow Reply 5-5-11.pdf; Petitioners Reply to Petition to Suspend 5-6-11.pdf

May 9, 2010

Attached please find the PETITIONERS' MOTION FOR MODIFICATION OF THE COMMISSION'S APRIL 19, 2011, ORDER TO PERMIT A CONSOLIDATED REPLY and the PETITIONERS' REPLY TO RESPONSES TO EMERGENCY PETITION TO SUSPEND ALL PENDING REACTOR LICENSING DECISIONS AND RELATED RULEMAKING DECISIONS PENDING INVESTIGATION OF LESSONS LEARNED FROM FUKUSHIMA DAIICHI NUCLEAR POWER STATION ACCIDENT filed in various rulemaking and licensing dockets.
Together they provide additional support the AP1000 Certification rulemaking should be postponed or significantly extended to allow the NRC to develop and implement lessons learned from the Fukushima accident.

John D. Runkle
for the AP1000 Oversight Group

DOCKETED
USNRC

May 10, 2011 (11:30 am)

OFFICE OF SECRETARY
RULEMAKINGS AND
ADJUDICATIONS STAFF

Attorney at Law
Post Office Box 3793
Chapel Hill, NC 27515
919-942-0600
jrunkle@pricecreek.com

Template = SECY-067 DS 10

May 6-9, 2011

UNITED STATES OF AMERICA
U.S. NUCLEAR REGULATORY COMMISSION
BEFORE THE COMMISSION

In the Matter of

	)	
Amerenue (Callaway Plant Unit 2)	)))	Docket No. 52-037-COL
AP1000 Design Certification Amendment 10 CFR Part 52	)))	NRC-2010-0131 RIN 3150-A18
Calvert Cliffs 3 Nuclear Project, L.L.C. (Calvert Cliffs Nuclear Power Plant, Unit 3)	)))	Docket No. 52-016-COL
Detroit Edison Co. (Fermi Nuclear Power Plant, Unit 3)	)))	Docket No. 52-033-COL
Duke Energy Carolinas, L.L.C. (William States Lee III Nuclear Station, Units 1 and 2)	))))	Docket Nos. 52-018 and 52-019
Energy Northwest (Columbia Generating Station)	)))	Docket No. 50-397-LR
Entergy Nuclear Generation Co. And Entergy Nuclear Operations, Inc. (Pilgrim Nuclear Power Station)	))))	Docket No. 50-293-LR
Entergy Nuclear Operations, Inc. (Indian Point Nuclear Generating Station, Units 2 and 3)	))))	Docket Nos. 50-247-LR and 50-286-LR
ESBWR Design Certification Amendment 10 CFR Part 52	)))	NRC-2010-0135 RIN-3150-AI85
FirstEnergy Nuclear Operating Co. (Davis-Besse Nuclear Power Station, Unit 1)	))))	Docket No. 50-346-LR
Florida Power & Light Co. (Turkey Point Units 6 and 7)	)))	Docket Nos. 52-040-COL and 52-041-COL

Luminant Generation, Co., L.L.C. (Comanche Peak Nuclear Power Plant, Units 3 and 4)	))))	Docket Nos. 52-034-COL and 52-035-COL
Nextera Energy Seabrook, L.L.C. (Seabrook Station, Unit 1)	)))	Docket No. 50-443-LR
Pacific Gas and Electric Co. (Diablo Canyon Nuclear Power Plant, Units 1 and 2)	))))	Docket Nos. 50-275-LR and 50-323-LR
PPL Bell Bend, L.L.C. (Bell Bend Nuclear Power Plant)	)))	Docket No. 52-039-COL
Progress Energy Carolinas, Inc. (Shearon Harris Nuclear Power Plant, Units 2 and 3)	))))	Docket Nos. 52-022-COL and 52-023-COL
Progress Energy Florida, Inc. (Levy County Nuclear Power Plant, Units 1 and 2)	))))	Docket Nos. 52-029-COL and 52-030-COL
South Carolina Electric and Gas Co. And South Carolina Public Service Authority (Also Referred to as Santee Cooper) (Virgil C. Summer Nuclear Station, Units 1 and 2)	)))))	Docket Nos. 52-027-COL and 52-028-COL
Southern Nuclear Operating Co. (Vogtle Electric Generating Plant, Units 3 and 4)	))))	Docket Nos. 52-025-COL and 52-026-COL
South Texas Project Nuclear Operating Co. (South Texas Project, Units 3 and 4)	))))	Docket Nos. 52-012-COL and 52-013-COL
Tennessee Valley Authority (Bellefonte Nuclear Power Plant, Units 1 and 2)	))))	Docket Nos. 50-438-CP and 50-439-CP
Tennessee Valley Authority (Bellefonte Nuclear Power Plant, Units 3 and 4)	))))	Docket Nos. 52-014-COL and 52-015-COL

Tennessee Valley Authority (Watts Bar Unit 2)	)))	Docket No. 50-0391-OL
Virginia Electric and Power Co. d/b/a/ Dominion Virginia Power and Old Dominion Electric Cooperative (North Anna Unit 3)	))))	Docket No. 52-017-COL

PETITIONERS' MOTION FOR MODIFICATION OF THE COMMISSION'S APRIL 19, 2011, ORDER TO PERMIT A CONSOLIDATED REPLY

I. INTRODUCTION

Petitioners respectfully request the U.S. Nuclear Regulatory Commission ("NRC" or "Commission") to modify its April 19, 2011, Order setting forth a schedule for further briefing on Petitioners' Emergency Petition to Suspend All Pending Reactor Licensing Decisions and Related Rulemaking Decisions Pending Investigation of Lessons Learned From Fukushima Daiichi Nuclear Power Station (April 14-18, 2011, corrected April 18, 2011) ("Emergency Petition"), for the purpose of allowing Petitioners to file a single consolidated reply to the twenty responses that have been filed in opposition to the Emergency Petition. As discussed below, satisfy the NRC's standard for allowing a reply because this case involves compelling circumstances. 10 C.F.R. § 2.323(c).

I. FACTUAL BACKGROUND

Between April 14, 2011, and April 18, 2011, Petitioners submitted to the Commission an Emergency Petition requesting that the Commission exercise its supervisory jurisdiction to suspend all pending decisions regarding the issuance of construction permits, new reactor licenses, combined construction permit and operating licenses, early site permits, license renewals, and standardized design certification rulemakings for nuclear reactors, to suspend licensing decisions on those applications while it evaluated new and significant information regarding the safety and environmental implications of the ongoing catastrophic radiological accident at the Fukushima Daiichi Nuclear Power Station, Units 1-6 ("Fukushima"), in Okuma, Japan. On April 19, 2011, Petitioners submitted an amended and corrected version of the Emergency Petition, along with a supporting declaration by Dr. Arjun Makhijani.

On April 19, 2011, the Commission issued an Order acknowledging its receipt of both the original and corrected petitions and set a deadline of May 2, 2011, for responses and amicus briefs. The Order did not provide for a reply.

Approximately twenty separate responses have been filed in opposition to the Emergency Petition, including briefs from the NRC Staff, the Nuclear Energy Institute, and license applicants in nineteen separate proceedings.[1]

---

[1] In addition to the NRC Staff and NEI, the following new reactor license applicants and license renewal applicants submitted Responses in opposition to the Emergency Petition: Calvert Cliffs 2 Nuclear Project, L.L.C. and Unistar Nuclear Operating Services, L.L.C. (Docket No. 52-016); the Detroit Edison Co. (Docket No. 52-033); Duke Energy Carolinas, L.L.C. (Docket Nos. 52-018 and 52-019); Energy Northwest (Docket No. 50-397); Entergy Nuclear Generation co. and Entergy Nuclear Operations, Inc. (Docket No. 50-203); Entergy Nuclear Operations, Inc. (Docket Nos. 50-247 and 50-286); FirstEnergy Nuclear Operating Co. (Docket No. 50-346); Florida Power & Light Co. (Docket Nos. 52-040 and 52-041); Luminant Generation Co. (Docket Nos. 52-034 and 52-035); NextEra Energy Seabrook, L.L.C. (Docket No. 50-443); Nuclear Innovation North America L.L.C. (Docket Nos. 52-012 and 52-013); Pacific Gas & Electric Co. (Docket Nos. 50-275 and 50-323); PPL Bell Bend, L.L.C. (Docket No. 52-039); Progress Energy Carolinas, Inc. (Docket Nos. 52-022 and 52-023); Progress Energy Florida, Inc. (Docket Nos. 52-029 and 52-030); South Carolina Electric and Gas Co. and South Carolina Public Service Authority (a.k.a. Santee Cooper) (Docket Nos. 52-027 and 52-028); Southern Nuclear Operating Co. (Docket Nos. 52-025 and 52-026); Tennessee Valley Authority (Docket Nos. 50-391, 52-014 and 52-015); and Dominion Virgina Power, et al. (Docket No. 52-017).

The Commonwealth of Massachusetts (Docket No. 50-293) also filed a Response in support of Petitioners.

III. DISCUSSION

Petitioners respectfully submit that there are two important respects in which this case presents compelling circumstances warranting the granting of leave to reply to the Responses filed in opposition to their Emergency Petition under 10 C.F.R. § 2.323(c).

First, the occurrence of the Fukushima accident, as the first severe radiological accident involving reactors and spent fuel pools with designs used in the U.S., raises unprecedented technical and legal issues for which there is very little precedent in NRC jurisprudence. The accident also raises unprecedented safety and environmental concerns for members of the public who are neighbors of proposed or existing reactors, and who seek to exercise their rights under the Atomic Energy Act ("AEA") and the National Environmental Policy Act ("NEPA") to ensure that the lessons of the Fukushima accident are adequately considered in all prospective licensing decisions. It is therefore appropriate to allow a thorough debate regarding the regulatory significance of the Fukushima accident under the AEA and NEPA and what procedural measures must be imposed to protect the public's right to participate in a meaningful way in the consideration of Fukushima-related issues licensing decisions.

Second, Petitioners could not have anticipated that many of the Responses would mischaracterize the nature of their Emergency Petition or misinterpret the governing law. For example, virtually all of the Responses mischaracterize Petitioners' Emergency Petition to suspend licensing decisions as a "motion" to suspend licensing "proceedings." They then rely on that mischaracterization to contend that the Petition is subject to a host of procedural regulations which are simply irrelevant, and with which Petitioners did not comply. Because the Commission's acceptance of their mischaracterization would result in the dismissal of the Petition, the Commission should consider their Reply.

Petitioners also could not have anticipated the numerous technical arguments that the Responses have made in challenging the validity of Dr. Makhijani's supporting declaration regarding the new and significant information demonstrated by the Fukushima accident, or that the Responses would fail to provide expert support for their technical arguments.

Finally, the Petitioners could not have anticipated the numerous ways in which the opponents misinterpret NEPA's requirement for consideration of new and significant information in NRC licensing decisions. They ascribe to the NRC a level of discretion that simply does not exist in the statute. They also fail to recognize that to the limited extent that NEPA does give agencies discretion to avoid public participation on some issues, the AEA nevertheless requires the NRC to allow the public to participate. Given that to date, the Commission has provided no guidance regarding how it will apply NEPA to the lessons of the Fukushima accident, Petitioners believe it is extremely important to have a thorough discussion of NEPA that provides for their reply.

Pursuant to 10 C.F.R. 2.323, the undersigned have conferred with other parties to this proceeding. All parties consulted stated that they would oppose this motion, except for the Commonwealth of Massachusetts. Separate certificates of counsel are being submitted in each separate proceeding.

IV. CONCLUSION

For the foregoing reasons, Petitioners' Motion should be granted.

Signed (electronically) by:
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Counsel to Southern Alliance for Clean Energy in Watts Bar Unit 2 Operating License Proceeding

Signed (electronically) by:
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Counsel to Center for a Sustainable Coast, Georgia Women's Action for New Directions, Savannah Riverkeeper, and the Southern Alliance for Clean Energy in Vogtle Units 3 and 4 COL proceeding.
Counsel to Dan Kipnis, Mark Oncavage, National Parks Conservation Association, and the Southern Alliance for Clean Energy in Turkey Point Units 6 and 7 COL proceeding.

Signed (electronically) by:
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May 6-9, 2011

May 6-9, 2011

UNITED STATES OF AMERICA
U.S. NUCLEAR REGULATORY COMMISSION
BEFORE THE COMMISSION

In the Matter of

	)	
Amerenue (Callaway Plant Unit 2)	))	Docket No. 52-037-COL
	)	
AP1000 Design Certification Amendment 10 CFR Part 52	))	NRC-2010-0131 RIN 3150-A18
	)	
Calvert Cliffs 3 Nuclear Project, L.L.C. (Calvert Cliffs Nuclear Power Plant, Unit 3)	))	Docket No. 52-016-COL
	)	
Detroit Edison Co. (Fermi Nuclear Power Plant, Unit 3)	))	Docket No. 52-033-COL
	)	
Duke Energy Carolinas, L.L.C. (William States Lee III Nuclear Station, Units 1 and 2)	)))	Docket Nos. 52-018 and 52-019
	)	
Energy Northwest (Columbia Generating Station)	))	Docket No. 50-397-LR
	)	
Entergy Nuclear Generation Co. And Entergy Nuclear Operations, Inc. (Pilgrim Nuclear Power Station)	)))	Docket No. 50-293-LR
	)	
Entergy Nuclear Operations, Inc. (Indian Point Nuclear Generating Station, Units 2 and 3)	)))	Docket Nos. 50-247-LR and 50-286-LR
	)	
ESBWR Design Certification Amendment 10 CFR Part 52	))	NRC-2010-0135 RIN-3150-AI85
	)	
FirstEnergy Nuclear Operating Co. (Davis-Besse Nuclear Power Station, Unit 1)	)))	Docket No. 50-346-LR
	)	
Florida Power & Light Co. (Turkey Point Units 6 and 7)	))	Docket Nos. 52-040-COL and 52-041-COL
	)	

Luminant Generation, Co., L.L.C. (Comanche Peak Nuclear Power Plant, Units 3 and 4)	))))	Docket Nos. 52-034-COL and 52-035-COL
Nextera Energy Seabrook, L.L.C. (Seabrook Station, Unit 1)	)))	Docket No. 50-443-LR
Pacific Gas and Electric Co. (Diablo Canyon Nuclear Power Plant, Units 1 and 2)	))))	Docket Nos. 50-275-LR and 50-323-LR
PPL Bell Bend, L.L.C. (Bell Bend Nuclear Power Plant)	)))	Docket No. 52-039-COL
Progress Energy Carolinas, Inc. (Shearon Harris Nuclear Power Plant, Units 2 and 3)	))))	Docket Nos. 52-022-COL and 52-023-COL
Progress Energy Florida, Inc. (Levy County Nuclear Power Plant, Units 1 and 2)	))))	Docket Nos. 52-029-COL and 52-030-COL
South Carolina Electric and Gas Co. And South Carolina Public Service Authority (Also Referred to as Santee Cooper) (Virgil C. Summer Nuclear Station, Units 1 and 2)	)))))	Docket Nos. 52-027-COL and 52-028-COL
Southern Nuclear Operating Co. (Vogtle Electric Generating Plant, Units 3 and 4)	))))	Docket Nos. 52-025-COL and 52-026-COL
South Texas Project Nuclear Operating Co. (South Texas Project, Units 3 and 4)	))))	Docket Nos. 52-012-COL and 52-013-COL
Tennessee Valley Authority (Bellefonte Nuclear Power Plant, Units 1 and 2)	))))	Docket Nos. 50-438-CP and 50-439-CP
Tennessee Valley Authority (Bellefonte Nuclear Power Plant, Units 3 and 4)	))))	Docket Nos. 52-014-COL and 52-015-COL
Tennessee Valley Authority (Watts Bar Unit 2)	)))	Docket No. 50-0391-OL

Virginia Electric and Power Co.)
d/b/a/ Dominion Virginia Power and) Docket No. 52-017-COL
Old Dominion Electric Cooperative)
(North Anna Unit 3))

PETITIONERS' REPLY TO RESPONSES TO EMERGENCY PETITION TO SUSPEND ALL PENDING REACTOR LICENSING DECISIONS AND RELATED RULEMAKING DECISIONS PENDING INVESTIGATION OF LESSONS LEARNED FROM FUKUSHIMA DAIICHI NUCLEAR POWER STATION ACCIDENT

I. INTRODUCTION

Petitioners hereby reply to the responses filed in the above-captioned proceedings (collectively, the "Responses") by the U.S. Nuclear Regulatory Commission ("NRC") Staff, the license applicants and the Nuclear Energy Institute ("NEI"), to Petitioners' Emergency Petition to Suspend All Pending Reactor Licensing Decisions and Related Rulemaking Decisions Pending Investigation of Lessons Learned from Fukushima Daiichi Nuclear Power Station Accident (April 14-18, 2011, corrected April 18, 2011) ("Emergency Petition").[1] The Responses are based on mischaracterizations of the

[1] In addition to the NRC Staff and NEI, the following new reactor license applicants and license renewal applicants submitted Responses in opposition to the Emergency Petition: Calvert Cliffs 2 Nuclear Project, L.L.C. and Unistar Nuclear Operating Services, L.L.C. (Docket No. 52-016); the Detroit Edison Co. (Docket No. 52-033); Duke Energy Carolinas, L.L.C. (Docket Nos. 52-018 and 52-019); Energy Northwest (Docket No. 50-397); Entergy Nuclear Generation co. and Entergy Nuclear Operations, Inc. (Docket No. 50-203); Entergy Nuclear Operations, Inc. (Docket Nos. 50-247 and 50-286); FirstEnergy Nuclear Operating Co. (Docket No. 50-346); Florida Power & Light Co. (Docket Nos. 52-040 and 52-041); Luminant Generation Co. (Docket Nos. 52-034 and 52-035); NextEra Energy Seabrook, L.L.C. (Docket No. 50-443); Nuclear Innovation North America L.L.C. (Docket Nos. 52-012 and 52-013); Pacific Gas & Electric Co. (Docket Nos. 50-275 and 50-323); PPL Bell Bend, L.L.C. (Docket No. 52-039); Progress Energy Carolinas, Inc. (Docket Nos. 52-022 and 52-023); Progress Energy Florida, Inc. (Docket Nos. 52-029 and 52-030); South Carolina Electric and Gas Co. and South Carolina Public Service Authority (a.k.a. Santee Cooper) (Docket Nos. 52-027 and 52-028); Southern Nuclear Operating Co. (Docket Nos. 52-025 and 52-026); Tennessee Valley Authority

Petition, incorrect representations regarding the NRC's response to the Three Mile Island accident, and incorrect interpretations of the law. Therefore they should be rejected and the Petition should be granted.

II. DISCUSSION

A. The Petition is Not a Motion to Suspend all Licensing Proceedings.

The Responses raise a host of procedural criticisms that are based on a concerted mischaracterization of the Petition: almost without exception, they characterize the Petition as a "motion" to suspend "licensing proceedings." *See, e.g.*, NRC Staff Response at 9. Thus, the Responses argue, Petitioners have violated several of the NRC's regulations in Subpart C of 10 C.F.R. Part 2, which govern motions in NRC adjudications. These regulations include the requirement to consult opposing parties before filing a motion (10 C.F.R. § 2.323(b)), the requirement to file a motion within ten days of the precipitating event (10 C.F.R. § 2.323(a)), requirements for motions by parties to stay adjudicatory proceedings (10 C.F.R. § 2.342), and requirements for motions to re-open closed records of adjudicatory proceedings (10 C.F.R. § 2.326).

Contrary to the mischaracterizations by the Responses, however, the Emergency Petition does not constitute a motion that can be brought in an adjudication; nor does it seek suspension of licensing proceedings.

(Docket Nos. 50-391, 52-014 and 52-015); and Dominion Virgina Power, et al. (Docket No. 52-017).

The Commonwealth of Massachusetts (Docket No. 50-293) also filed a Response in support of Petitioners.

1. The Emergency Petition is not a motion.

First, Petitioners' Emergency Petition cannot be characterized as a motion or the equivalent of a motion that is subject to the regulations in Subpart C of 10 C.F.R. Part 2, because the relief it seeks could not be granted in an adjudication. Petitioners seek to suspend all licensing *decisions,* which are relegated by the Commission to the NRC Staff pursuant to 10 C.F.R. § 2.340. As further explained below, the regulations in Subpart C of 10 C.F.R. Part 2 regarding adjudications are simply not applicable to these licensing decisions. *See Cincinnati Gas and Electric Co.* (William H. Zimmer Nuclear Station), LBP-79-24, 10 NRC 226, 232 (1979) (noting that duty of licensing boards in adjudications is to "resolve discrete contentions or issues" and that "[g]eneral responsibility for operating licenses rests with the Staff. . .")[2]

2. The Emergency Petition seeks blanket suspension of licensing decisions, not licensing proceedings.

Second, despite the Responses' persistent mischaracterization of the Emergency Petition, Petitioners do not seek a blanket suspension of all licensing *proceedings.* Instead, they seek suspension of all licensing *decisions.* As discussed above, only the Commission has the authority to issue a blanket suspension of all licensing decisions in order to ensure the lawful and orderly consideration of the lessons learned from the Fukushima accident. While Petitioners also seek suspension of those aspects of contested

[2] In order to give notice to interested parties, including applicants and the NRC Staff, the Petition was submitted in pending licensing proceedings, including adjudications; however, it was not described as or intended to be a motion in any adjudication. In fact, the Petition was submitted in several proceedings in which no adjudication is pending, including the design certification rulemakings for the AP1000 and Economic Simplified Boiling Water Reactor ("ESBWR"), the Callaway combined construction permit/operating license ("COL") proceeding, the Bell Bend COL proceeding, and the Columbia license renewal proceeding.

proceedings which concern Fukushima-related issues, this relief is incidental to the primary action requested of the Commission, which is to hold in abeyance the NRC's ultimate decisions to license or re-license reactors or certify designs.

Petitioners essentially seek the same measures that the Commission imposed in the aftermath of the Three Mile Island Accident: suspension of all licensing decisions and establishment of procedures for the meaningful and orderly consideration of the lessons learned from the accident, including provision of public participation. *See Statement of Policy: Further Commission Guidance for Power Reactor Operating Licenses*, CLI-80-42, 12 NRC 654 (1980) ("TMI Policy Statement"). Just as the Commission did not broadly suspend its licensing proceedings after the Three Mile Island accident, Petitioners do not seek a blanket suspension of licensing proceedings, but rather the establishment of procedures to ensure that contested proceedings will include the consideration of lessons learned from the accident.

Thus, as explained above, the general procedural requirements for motions made in the course of adjudications do not apply;[3] nor is the Petition subject to the regulations governing motions for stays or re-opening of closed records. The cases cited in the Responses do not hold otherwise, because they all concern petitions or motions to suspend licensing *proceedings*. *See, e.g., Duke Energy Corp.* (McGuire Nuclear Station Units 1 & 2); Catawba Nuclear Station, Units 1 & 2), CLI-01-27, 54 NRC 385, 389-90

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[3] Before filing this Reply, Petitioners consulted opposing counsel to ask if they would object to a motion to modify the Commission's April 19, 2011 Order to permit such a reply. Petitioners did so because they believed that once the Commission had issued an order in this matter, it was appropriate to consult opposing counsel before seeking to modify the order. By consulting opposing counsel in this limited instance, however, Petitioners do not concede that they were required to do so in filing their Petition in the first instance.

(2001); *Private Fuel Storage, L.L.C.* (Independent Spent Fuel Storage Installation), CLI-01-26, 54 NRC 376, 380 (2001); *AmerGen Energy Co., L.L.C.* (Oyster Creek Nuclear Generating Station), CLI-08-23, 68 NRC 461, 484 (2008)); *Pacific Gas & Electric* Co. (Diablo Canyon Power Plant Independent Spent Fuel Storage Installation), CLI-02-23, 56 NRC 230 (2002); *Amergen Energy Co., et al.* (Oyster Creek Nuclear Generating Station) CLI-08-23, 68 NRC 461 (2008). In all of those decisions, the Commission was responding to requests for suspension of licensing proceedings, which is not the case here.

The one NRC case that is clearly applicable here is the 1980 TMI Policy Statement, where the Commission records its determination, in the aftermath of the Three Mile Island accident, that all licensing decisions should be suspended while the Commission studied the lessons to be learned from the accident. As the Commission summarized in that Policy Statement:

> After the March 1979 accident at Three Mile Island, Unit 2, the Commission directed its technical review resources to assuring the safety of operating power reactors rather than to the issuance of new licenses. Furthermore, the Commission decided that power reactor licensing should not continue until the assessment of the TMI accident had been substantially completed and comprehensive improvements in both the operation and regulation of nuclear power plants had been set in motion.

12 NRC at 656. While NEI cites numerous licensing-related "decisions" that were made while the Commission studied the lessons of the Three Mile Island accident, NEI nevertheless admits that no decision authorizing the operation of a new reactor was made until August of 1980, 17 months after the accident. NEI Response at 7, n.15. Similarly, while the Staff cites the TMI Policy Statement for the proposition that the Commission "issued several licenses while it continued to study that accident" (NRC Staff Response

at 11), the Policy Statement states that the Commission waited to issue two full power licenses until *after* initial drafts of the Three Mile Island Action Plan had been prepared. 12 NRC 658.[4]

B. Suspension of Licensing Decisions is Necessary to Ensure Compliance With the National Environmental Policy Act.

1. No showing of immediate or irreparable harm is required.

Most of the Responses argue that the Emergency Petition should be rejected because it does not show immediate or irreparable harm to public health and safety or the environment. In making these arguments, however, they miss the central point of the Petition, which is to invoke the Commission's responsibility to comply with the National Environmental Policy Act ("NEPA") by considering new and significant information relating to the Fukushima accident. 10 C.F.R. § 51.92; *Marsh v. Oregon Natural Res. Council*, 490 U.S. 360, 373-74 (1989). The NRC's duty to consider new and significant information before making licensing decisions is nondiscretionary. *Calvert Cliff's Coordinating Commission v. AEC*, 449 F.2d 1109, 1112 (D.C. Cir. 1971) (federal agencies are held to a "strict standard of compliance" with NEPA's requirements). *See also Silva v. Romney*, 473 F.2d 287, 292 (1st Cir. 1973). Therefore it is inappropriate to apply a discretionary stay standard to answer the basic question of whether NEPA must be complied with in a timely fashion.[5]

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4 The NRC Staff and some of the applicants also argue that the Commission did not suspend licensing proceedings while it studied the Three Mile Island accident. Petitioners do not seek that relief, however. The only relief sought by Petitioners with respect to ongoing licensing proceedings is to request the Commission to establish procedures for the consideration of Fukushima-related issues in adjudications and design certification rulemakings.

5 "NEPA's instruction that all federal agencies comply with its requirements –'to the fullest extent possible,'...is neither accidental nor hyperbolic. Rather the phrase is a

2. The NRC's existing EISs are inadequate because they do not address new and significant information arising from the Fukushima accident.

A number of Responses argue that because the NRC has already prepared final environmental impact statements in some of the proceedings, and these documents already analyze the environmental impacts of the respective licensing decisions, nothing more is required. *See, e.g.*, Southern Nuclear Operating Company's Response at 17-18. This argument, however, ignores the continuing obligation agencies have to consider new information that comes to light throughout the NEPA process, even after a final EIS has been issued. 10 C.F.R. § 51.92(a); *Marsh v. Oregon Natural Res. Council*, 490 U.S. at 373-74.

3. The existing process is not adequate to ensure prior consideration of new and significant information arising from the Fukushima accident.

Other Responses argue that the existing NRC process for consideration of new and significant information is sufficient to ensure that any new and significant information emerging from the Fukushima accident will be considered. *See, e.g.*, Energy Northwest Response at 21. But this argument ignores the real potential that the NRC may not complete its investigation before it issues or renews licenses for reactors. For instance, during the Fukushima accident, the NRC re-licensed the Vermont Yankee and Palo Verde reactors, completely failing to consider the implications of the accident for those re-licensing decisions in violation of NEPA. In order to comply with NEPA, the Commission must establish measures to ensure that it will not take licensing actions

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deliberate command that the duty NEPA imposes upon the agencies to consider environmental factors not be shunted aside in the bureaucratic shuffle." *Flint Ridge Development Co. v. Scenic Rivers Association of Oklahoma*, 426 U.S. 776 (1976).

without first taking a "hard look" at the environmental implications of the Fukushima accident. *Friends of the Clearwater v. Dombeck*, 222 F.3d 552, 557-58 (9th Cir. 2000) (quoting *Marsh v. Oregon Natural Res. Council*, 490 U.S. at 373-74.

The argument that existing procedures are sufficient also ignores NEPA's directive that federal agencies must "integrate the NEPA process with other planning at the earliest possible time to insure that planning and decisions reflect environmental values, to avoid delays..., and to head off potential conflicts." 40 C.F.R. §1501.2. *See also* 40 C.F.R. § 1500.2 ("Federal agencies shall to the fullest extent possible: Integrate the requirements of NEPA with other planning and environmental review procedures required by law or by agency practice so that all such procedures run concurrently rather than consecutively"). Given that the NRC has decided to evaluate whether the Fukushima accident conveys lessons that must be accounted for in its safety regulations, it now has an obligation to explain how the lessons will be integrated into its environmental decision-making process.

Finally, the argument that existing procedures are sufficient fails to recognize the fact that the NRC and license applicants, in the first instance, bear the burden of analyzing environmental issues, not the public. Just as environmental reports by applicants and draft EISs by the NRC Staff must address known environmental issues before they are presented to the public, so they should be required to address the environmental significance of the events in Japan before the public is required to challenge them in comments or hearing requests.

4. Petitioners are not required to prove that new and significant information from the Fukushima accident is certain to affect the outcome of EISs.

Still other Responses argue that Petitioners have not established that an analysis of the Fukushima accident will, in fact, affect the outcome of EISs for U.S. reactors. *See, e.g.*, Energy Northwest Response at 22-23. But that is not the standard for consideration of new and significant information. "NEPA requires that the agency take a 'hard look' at the new information to determine *whether* a [Supplemental] EIS is necessary." *Blue Mountains Biodiversity Project v. United States Forest Service*, 229 F.Supp.2d 1140, 1148 (D. Or. 2002) (emphasis added). *See also Warm Springs Dam Task Force v. Gribble*, 621 F.2d 1017, 1025 (9th Cir. 1980). By undertaking an investigation of the regulatory implications of the Fukushima accident from a safety standpoint, the Commission has effectively conceded that it has potential significance from an environmental standpoint. *See* discussion in Section C below.

Entergy argues that Petitioners err in claiming that the NRC must at least prepare an environmental assessment to determine the significance of the Fukushima Daiichi information. Entergy Response at 27 (citing *N. Idaho Cmty. Action Network v. DOT*, 545 F.3d 1147, 1154 (9th Cir. 2008), *price Rd. Neighborhood Ass'n v. DOT*, 113 F.2d 1505, 1509-10 (9th Cir. 1997) (holding that NEPA permits agencies to establish their own methods for evaluating new and significant information.) Petitioners respectfully submit, however, that the cases cited by Entergy do not involve the NRC, a unique agency whose organic statute requires it to offer an opportunity for public participation in its licensing decisions. *See* Section 189a of the Atomic Energy Act ("AEA"), 42 U.S.C. § 2239(a). To the extent that the NRC considers whether to incorporate lessons from the Fukushima accident into its environmental licensing decisions, Section 189a of the AEA requires it to include the interested public in that decision-making process by offering an opportunity for a hearing. In any event, regardless of whether public participation is required in the NRC's analysis of the environmental significance of the Fukushima accident, to date the NRC has not even attempted the requisite "hard look" at the issue. *Friends of the Clearwater*, 222 F.3d at 557-58. Petitioners are not obligated to carry out that task for the NRC.

5. NEPA is not retroactive.

A number of the Responses suggest that the Commission may address the lessons of the Fukushima accident by applying them retrospectively after licenses have been issued or renewed. To do so, however, would violate NEPA's signal requirement that environmental impacts must be considered *before* licensing actions are taken and the "die is cast." *Robertson v. Methow Valley Citizens Council*, 490 U.S. 332, 349 (1989). *See also Protect Key West v. Cheney*, 795 F. Supp. 1552, 1562 (S.D. Fla. 1992) (citing *Sierra Club v. Lujan*, 716 F. Supp. 1289 (D. Ariz. 1989); *Cady v. Morton*, 527 F.2d 786, 795 (9th Cir. 1975)) (rejecting the federal government's argument that studies, surveys, and investigations conducted after the decision was made to proceed with a project could "cure" any defects in the original EA).

Moreover, once a license is issued, environmental considerations that were non-discretionary prior to licensing also become matters of pure discretion, in which the public has no right of participation. *See, e.g., Safe Energy Coalition of Michigan v. NRC*, 866 F.2d 1473 (D.C. Cir. 1989). Thus, in an enforcement context, the public will be deprived of any right to challenge the adequacy of post-Fukushima measures to protect the human environment, thereby undermining NEPA's purpose of encouraging public participation in environmental decisions. *See Robertson*, 490 U.S. at 348-49 (a key purpose of an EIS is to make environmental information "available to the larger audience that may also play a role in the decisionmaking process and implementation of that decision.")[6]

6. NEPA applies to the Japan events because the Commission has conceded that they have potential regulatory significance in the U.S.

Finally, several Responses maintain that NEPA does not apply to the Fukushima accident because the NRC is not undertaking a major federal licensing action for reactors in Japan and that the events in Japan do not constitute information that should be incorporated into any future draft or final EIS. *See, e.g.*, NRC Staff Response at 25, 30. The argument is frivolous. Petitioners do not contend that the NRC is undertaking a major federal licensing action for reactors in Japan, any more than the NRC has done so by creating the Task Force. Just as the Task Force is considering the implications of the Fukushima accident with respect to NRC safety regulations for U.S. reactors and spent fuel pools, so Petitioners are rightfully insisting that the NRC must consider the environmental implications of the Fukushima accident for U.S. reactors and spent fuel pools.

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[6] For this reason, NEI's suggestion that Petitioners' concerns are satisfied by the right to file post-licensing enforcement petitions under 10 C.F.R. § 2.206 is utterly devoid of merit. *See* NEI Response at 14.

C. The Occurrence of the Fukushima Accident and the Commission's Acknowledgement of its Potential Regulatory Significance Demonstrate the Existence of New and Significant Information That Must be Considered in Licensing Decisions.

In their Emergency Petition, the Petitioners contend that in forming the Task Force and identifying issues whose significance for the NRC regulatory process must be studied, the NRC effectively acknowledged that it has new information that could have a significant effect on its environmental decisions for licensing and re-licensing of reactors. Emergency Petition at 3. Petitioners assert that by establishing the Task Force and charging it with the task of investigating the implications of the Fukushima Daiichi accident with respect to its regulatory program, the Commission has, as a matter of law, bound itself to evaluate the significance of the information yielded by its investigation under NEPA and to analyze any information that is new and significant in supplemental environmental impact statements for all pending licensing decisions. *Id.* at 4 n.2. Even if the NRC ultimately concludes that the information does not have a significant effect on its licensing decisions, it must nevertheless follow NEPA's procedures for considering the information, including preparation of an environmental assessment. *Id.* at 27 (citing *Marsh,* 490 U.S. at 385 ("NEPA's mandate applies "regardless of [the agency's] eventual assessment of the significance of [the] information."))

This argument is effectively ignored in the Responses to the Petition. Instead, the Responses attack Dr. Makhijani's supporting declaration as if the Petitioners were required to *prove* the existence of significant new information that affects the outcome of the NRC's environmental analyses. Dr. Makhijani's declaration, however, is more than adequate to serve its purpose of demonstrating that the new and significant information revealed by the Fukushima accident has the *potential* to affect the outcome of NRC licensing decisions with respect to consideration of environmental impacts. *See* Makhijani Declaration, par. 5.[7]

The Responses also contain technical arguments that are not supported by any expert declarations or affidavits. For instance, Entergy Nuclear Generating Co. et al. challenge Dr. Makhijani's analysis of severe accident probabilities, without providing any countervailing expert analysis.[8] Entergy Response at 22-23. *See also* NEI Response at 17-18. Those arguments must be rejected out of hand for lack of technical support.

In any event, the Responses' challenges to the technical merit of Dr. Makhijani's declaration are without merit. The Staff claims, for instance, that Dr. Makhijani contradicts himself by arguing that the Fukushima accident presents new and significant information, even at the same time that he concedes that the causes, evolution and consequences of the accident are "not yet fully clear." NRC Staff Response at 27. Dr.

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[7] The NRC Staff makes the irrelevant argument that Dr. Makhijani's declaration is insufficient to support the Petition because it does not show the "immediate threat to public safety" that is necessary for a suspension of a licensing proceeding. NRC Staff Response at 28. As discussed above, however, Petitioners do not seek the suspension of all licensing proceedings. Instead, they ask the Commission to delay issuance of all licensing *decisions* until it has completed its study of the lessons of the Fukushima accident and applied those lessons to those licensing decisions, as required by NEPA and the AEA. Thus, it is not necessary for Petitioners to show an immediate threat to public safety, only that the NRC would not be in compliance with NEPA and the AEA if it were to issue licenses without considering the environmental and safety implications of the Fukushima accident for those licensing decisions.

[8] Some Responses cite NUREG-1437, the NRC's 1996 Generic Environmental Impact Statement for License Renewal of Nuclear Plants, for the proposition that the environmental impacts of severe accidents are small because the risk of a severe accident has been determined to be small. *See, e.g.*, NRC Staff Answer at 26. However, as Dr. Makhijani's Declaration demonstrates, the Fukushima accident calls into question the NRC's previous assumptions about the risks of severe accidents. The very occurrence of a severe accident at Fukushima presents "readily available" information that calls into question the validity of the fifteen-year-old GEIS for license renewal. *See Blue Mountains Biodiversity Project*, 229 F.Supp.2d at 1148 (ordering supplementation of an EIS on summary judgment, where a fourteen-year-old EIS failed to address new and significant information developed over the intervening years).

Makhijani does not contradict himself. He relies on factual statements made to the public by the NRC and the French Government. Makhijani Declaration, pars. 6-10. In Dr. Makhijani's expert opinion, that factual information is sufficient for purposes of concluding that it is both new and significant to the regulatory process. He is not alone in that assessment; merely by assigning the Task Force to study the regulatory implications of the Fukushima accident, the Commission has effectively conceded that the information has regulatory significance. As Commissioner Svinicki stated during a recent Commission briefing on station blackout issues, "although . . . we're still working to gain knowledge of the events in Japan, station blackout certainly identifies itself as an important issue that we need to be looking at . . ." Transcript of Commission briefing on NRC Response to Events in Japan and Briefing on Station Blackout at 5 (April 28, 2011) (http://www.nrc.gov/reading-rm/doc-collections/commission/tr/2011/20110428a.pdf).[9] As Dr. Makhijani attests, station blackout is one of a number of major topics on which the Fukushima accident has revealed new and significant information, including the following:

- Unanticipated compounding effects of simultaneous accidents at multiple co-located reactor units, including spent fuel pools.
- Unanticipated risks of spent fuel pool accidents, including explosions.
- Frequency of severe accidents and explosions.
- Inadequacy of safety systems to respond to long-duration accidents.
- Nuclear crisis management with contaminated control and turbine buildings that have lost power.
- Unanticipated aggravating effects of some emergency measures.

[9] The profound gap between conditions covered by the NRC's regulations and actual potential accidents was highlighted during the discussion. As Commissioner Apostolakis observed during the April 28, 2011 briefing, the four-hour period that is required for recovery from a station blackout is conservative only for "routine failures of the grid" and does not cover "major external events." Commission briefing on Transcript of Briefing on NRC Response to Events in Japan and Briefing on Station Blackout at 48. *See also id.* at 19.

- Health effects and costs of severe accidents.
- The hydrogen explosions at Fukushima and their implications for aircraft crash evaluations.

In addition, the Staff accuses Dr. Makhijani of "prejudging the results of the Task Force's review" by concluding that the issues identified above should be studied before the NRC makes any further licensing decisions. NRC Staff Response at 28. But Dr. Makhijani has not prejudged the results of the Task Force study any more than has Commissioner Svinicki by acknowledging that station blackout is an "important issue" that deserves further study. Tr. of April 28 Briefing at 5.[10]

Florida Power and Light ("FP&L"), several other applicants, and the NEI also attack Dr. Makhijani's declaration. FP&L argues that Dr. Makhijani's concern regarding the risk of hydrogen explosions in spent fuel pools is unfounded because "the Commission's studies bound and do not ignore hydrogen explosions as a potential mechanism." FP&L Response at 22. *See also* Entergy's Response at 24, which makes a similar argument. But FP&L and Entergy provide no actual support for this novel argument. Their Responses contains no citation to any discussion of hydrogen explosions in an NRC spent fuel pool study (or any other study for that matter), and the Federal Register notice on which FP&L relies does not even mention the word "hydrogen." *See* FP&L Response at 22 n.17 (citing 73 Fed. Reg. 46,204 (August 8, 2007)). Nor do FP&L and Entergy supply an expert declaration in support of their argument. Because the NRC's risk analyses for spent fuel pool accidents do not include

[10] Bizarrely, the Staff accuses Dr. Makhijani of advocating the "bypassing of the near-term review by the Task Force based on the information currently available." In no respect has Dr. Makhijani advocated the abandonment of any study of the Fukushima accident that is now being conducted by the NRC. What he disagrees with is the hasty issuance of licensing decisions before those studies are complete.

hydrogen explosions, there is no way to compare the NRC's scenarios with hydrogen explosion scenarios in U.S. spent fuel pools until the studies of the Fukushima accident are complete. Thus, FP&L's and Entergy's argument is unfounded and must be rejected.

FP&L also disputes Dr. Makhijani's assertion that the uncovering of spent fuel at Fukushima, which was accompanied by boiling of the water in the pools and a destructive hydrogen explosion, demonstrates that the NRC's probability estimates for spent fuel pool fires are far too low. FP&L Response at 23 (citing Makhijani Declaration, par. 22). According to FP&L, "there have been no reports of fire at any of the Fukushima spent fuel pools, and the loss of cooling events at all three units were precipitated by the same event – station blackout." *Id.* In making this argument, FP&L ignores the fact that loss of cooling to a spent fuel pool and boiling off of the water is a recognized precursor to a pool fire. *See* 73 Fed. Reg. at 46,210. The fact that fuel was uncovered at three of the Fukushima pools thus demonstrates that the precursors to a pool fire are more likely than previously envisioned by the NRC.

FP&L, Dominion Virginia Power, et al, ("DVP"), and Duke Energy Carolinas, L.L.C. ("Duke") also claim that Dr. Makhijani has failed to show the relevance of the Fukushima accident to spent fuel pool storage at the proposed Turkey Point, North Anna and W.S. Lee new reactors because they are not BWR plants like Fukushima. FP&L Response at 21-22, VPC Response at 11-12, Duke Response at 11. But these applicants do not deny that AP1000 design on which their proposed reactors rely calls for storage of spent fuel in high-density pools. As pointed out in a recent legal petition to suspend the AP1000 design certification rulemaking, between Revision 15 and Revision 18 of the Design Control Document for the AP1000 design, Westinghouse increased the fuel density in storage pools from 619 fuel assemblies to 884 assemblies, an increase of 42.8%. *See* Petition to Suspend AP1000 Design Certification Rulemaking Pending Evaluation of Fukushima Accident Implications on Design and Operational Procedures and Request for Expedited Consideration at 17 (April 6, 2011) (citing AP1000 DCD, Section 9.1.2.1). As Dr. Makhijani states in his declaration, the Japanese store spent fuel at lower density than in the U.S., and therefore the use of high-density pool storage for spent fuel must be re-examined.

Finally, FP&L states that "The only specific claim regarding severe reactor accidents is Dr. Makhijani's assertion that the occurrence of accidents at three reactors should change the underlying frequency data that go into computing the probability of a severe accident at a given reactor." FP&L cites Dr. Makhijani's Declaration at pars. 16-19 and asserts that this statement is "erroneous." FP&L Response at 21 n.16. However, the cited paragraphs do not discuss the issue of the frequency of the accidents at all. Paragraph 16 is a listing of the issues analyzed in Dr. Makhijani's expert declaration, while paragraphs 17-19 only point to the fact that the NRC allows collocation of new reactors at existing sites without analyzing the problem of multi-reactor accidents. The question of the frequency of accidents and related probabilistic analysis is addressed elsewhere, in paragraphs 22 to 24 of the Makhijani Declaration. Specifically, his statement that three of the Fukushima reactors "appear to have had core damage" is simply a reiteration of the facts as they are best known at the present time. Makhijani Declaration at 22. His inference regarding the need to revisit reactor accident probabilities derives directly from this. FP&L's statement is a misreading of Dr.

Makhijani's Declaration, refers to the wrong paragraphs, and is without factual foundation.

D. The Opponents of the Petition Would Put an Unfair Burden on Interested Members of the Public and Invite Chaos into NRC Adjudications.

Numerous Responses argue that the NRC's existing procedures for the raising of contentions in licensing cases is sufficient for the raising of Fukushima-related issues. *See, e.g.*, NRC Staff Response at 18, NEI Response at 15, FirstEnergy Response at 18. But a "business-as-usual" approach is entirely inadequate for these circumstances, where the Fukushima accident has raised so many questions about the adequacy of the NRC's regulatory program and prior environmental analyses and where the Commission itself has undertaken a systematic investigation of the accident's regulatory significance. If the Commission does not yet have enough information to judge the adequacy of its regulatory program in light of the Fukushima accident, then it would be unreasonable to require members of the public to perform that task. Yet, given that intervenors in NRC licensing cases must raise new information within 30 days of obtaining it, and given that some licensing proceedings may be finished before the NRC issues any lessons learned report, that is exactly what members of the public would be forced to do if they wished to have their concerns addressed before a licensing decision was made.

Furthermore, none of the Responses addresses the logistical difficulty of applying standard NRC procedures to the raising of new Fukushima-related contentions without some guidance from the Commission. How will an interested member of the public know when there is enough information from the Fukushima accident to justify the raising of a contention? The Response filed by Energy Northwest in the Columbia

Generating Station license renewal proceeding illustrates the potentially absurd result of failing to establish a schedule for submitting contentions on new Fukushima-related information. The Energy Northwest Response suggests no less than four "potential trigger events" that "could have prompted the Petition: the earthquake on March 11, the March 18 issuance of NRC Information Notice 2011-05, the Commission's March 23 approval of an action plan to review the implications of the Fukushima accident, and the April 1 release of the Task Force Charter." Energy Northwest Response at 9. If the Commission fails to provide any guidance regarding when enough information has been generated as a result of the Fukushima accident to support timely contentions, members of the public will have no choice but to submit new or amended contentions every time that some marginal new piece of information becomes available, in order to comply with the 30-day deadline for raising new information in contentions. The result would not only be chaotic and wasteful of the parties' resources, but would divert NRC resources away from investigation of the Fukushima accident, where they should be focused. The Commission should avoid such an unproductive and wasteful outcome by providing clear procedures for the raising of issues related to the Fukushima accident after the NRC's long-term investigation has been completed.

III. CONCLUSION

For the foregoing reasons, the Emergency Petition should be granted.

Respectfully submitted,

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May 6-9, 2011

From: tomclements329@cs.com
Sent: Tuesday, May 10, 2011 10:45 AM
To: Rulemaking Comments; Rulemaking Comments
Subject: Docket ID NRC-2010-0131, AP1000 Design Certification Amendment

May 10, 2011

DOCKETED
USNRC

May 10, 2011 (4:30 pm)

OFFICE OF SECRETARY
RULEMAKINGS AND
ADJUDICATIONS STAFF

Secretary
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

ATTN: Rulemakings and Adjudications Staff

Re: Docket ID NRC-2010-0131, AP1000 Design Certification Amendment

I hereby submit the following article by Dr. Akira Tokuhiro (Department of Mechanical Engineering, University of Idaho) - **Initial look at lessons learned from Fukushima, A review of what went wrong, why, and what should be done in the future -** as part of the AP1000 Design Certification Amendment docket. 1

In response to comments submitted as part of the rulemaking, each point raised by Dr. Tokuhiro must be considered concerning design certification review of the AP1000 design. The NRC staff must respond to each point in writing and explain how Dr. Tokuhiro's recommendations are being taken into account concerning the AP1000 design.

Dr. Tokuhiro's comments underscore the need for the impacts of the Fukushima accident to be fully considered in the licensing of new reactors, including the AP1000. Proceeding with the AP1000 licensing certification without taking into account "lessons learned" from the Fukushima disaster is a dangerous approach which could undermine not only safety of the design but could damage the NRC's credibility by revealing a lack of will or inability to thoughtfully incorporate important lessons learned in the design of the AP1000. 2

In regard to the impact of the Fukushima accident on NRC licensing activities, Commissioner Jaczko on May 6, 2011 stated before the American Association for the Advancement of Science (AAAS): "A longer term review will begin as soon as we have sufficient information from Japan and will be completed in six months from the beginning of the evaluation. During this longer term review, we expect to be able to engage key stakeholders in a way that the time constraints of the short-term review do not allow. Both the 90-day and final reports will be made publicly available."

It is imperative that the "longer term review" and engagement of stakeholders in that process be a part of the AP1000 design review. If the long-term review and lessons learned from it is not going to be taken into account in advance of issuing a final rule on the AP1000, a full explanation and justification as to this decision must be provided in response to this comment. 3 2

I request that this comment be made a part of Docket ID NRC-2010-0131 (AP1000 Design Certification Amendment) and be posted in ADAMS.

Sincerely,

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April 25, 2011

Initial look at lessons learned from Fukushima

A review of what went wrong, why, and what should be done in the future

Guest Blog Post by: Akira T. Tokuhiro Ph.D *

Following a magnitude 9.0 earthquake and as high as ~14 meter tsunami, the Fukushima Dai-ichi (D1) and Dai-ni (D2) Nuclear Power Plants (NPPs, Units 1-4[U1-4] at D1, U5-6-2 at D2i) experienced a series of multiple incidents caused by inadequate cool down of decay heat in both the reactor and in the co-located spent fuel pool (SFP).

The reactors at D1, U1-6 were constructed as part of a GE/Hitachi/Toshiba collaboration and began commercial operation, during 1971-1979; U1-5 are GE-BWR, Mark-I, U6 is a Mark-II. Two GE ABWRs are due to start construction in April 2012.

Impact of loss of power

Although the Units at D1 and D2 automatically shutdown at the onset of the quake and with near immediate loss of off-site power, the back-up diesel generator operated (~30minutes) until the tsunami inflicted considerable (unknown) damage to auxiliary and back-up systems (most prominently the back-up diesel general and batteries).

This initiated the onset of lack of decay heat cooling. Additional aftershocks continued for about one-week. During initial week, March 11-18, there were up to three larger (likely H2 explosion) explosions, vapor/steam jets and fires that further stressed the RPV, the containment and (weather) confinement buildings.

Damage to primary containment?

One of the later explosions conceivably damaged the primary (coolant) containment and thus, water found in the adjacent basement of the turbine building pointed to high-levels of radiation including fission products. Additional large volumes of contaminated water were found in the U-shaped electrical conduit 'trenches' off of U1-3 and spreading into other areas such as beneath the reactor site.

Outline of lessons learned

This paper outlines the initial list of lessons learned from the multiple sequence of events, some interpretations of the news releases and the aspects of safety culture that contrast Japan and the U.S. during crisis management.

It is based largely on events of the first three weeks and professional interpretation of publically accessible information. It is being released without peer review and in this summary form. Only the provisionally conclusive lessons learned are noted below.

1) Nuclear R&D institutions must consider alternatives to zirconium-based and zircaloy cladding so that chemical reactions that generate hydrogen is prevented. We (as an industry) need to accelerate development and deployment of non-hydrogren producing cladding materials; that is, assuming that the coolant/ moderator/ reflector remains (light) water. 1a

2) Having multiple (reactor) units at one site, having more than two units on site needs critical review in terms of post-accident response and management. We must consider the energetic events at one unit exacerbating the situation (safe shutdown) at the other. 1b

3) Further, there is a definite need for a backup (shielded) reactor plant control center that is offsite (remote) so that the accidents can be managed with partial to full extent of reactor plant status (P, T, flowrates, valve status, tank fluid levels, radiation levels). 1c

4) There is a need for standby back-up power, via diesel generator and battery power, at a minimal elevation (100feet/31m) above and some distance from the plant (thus remotely located). This is needed to offset loss of off-site power for plants subject to environmental water ingress (foremost tsunami). Spare battery power should also be kept off-site and in a confirmed 'charged' state. 1d

5) It is clear that the spent fuel pool (SFP) cannot be in proximity of the reactor core, reactor pressure vessel or containment itself. The SFP, in current form, is essentially an open volume subcritical assembly that is not subject to design requirements generally defining a reactor core. 1e
Yet, unless thermohydraulic cooling is maintained, it is subject to the similar consequences as a reactor core without adequate cooling. Therefore, we need new passive designs of the SFP, away from the actual plant's reactor core.

6) Thus needs to be a re-definition of the spent fuel pool. A new standard and design requirement is needed for the spent fuel pool. It should be 'reclassified' as a subcritical assembly with a potential to go critical with no active or passive control (rod or soluble 'poison') mechanism. Further it needs to be some distance from the reactor plant. 1f

7) We need to identify key valves for emergency core cooling and require them to be non-electrically activated. Otherwise these valves need a secondary means of open and closed status that is remotely located. 1g

8) If an 'in-containment' SFP is maintained, then the fuel transfer crane system must be designed so that it is available to remove the fuel during a post-accident phase. OR a second means such as a robotic arm needs to be available. 1h

9) There needs to be a volumetric guidance analysis for ultimate (decay heat) cooling contingency plans so that not only limitations on volume are understood but also transfer of liquids from one volume to another. 1i

Spare tanks and water-filled tanks need to be kept on site as uptake tanks for 'runoff' in case of addition of cooling during accident management phases. Spare means to produce boric acid needs to be available off-site. Earthquake-proof diesel generator housing also need to be water-proof. Remote diesel generators are also needed with access to equally remote diesel fuel tanks (also see 4).

10) For nuclear power plants located in or near earthquake zones, we cannot expect structural volumes and 'channels' to maintain structural integrity. We should also expect the immediate ground underneath these structures to be porous (earth). Thus design of these volumes and channels should be such that they minimize connections to other (adjacent) volumes from which contaminated (liquid) effluents can flow. 1j

11) Color-code major components so that in case of an accident such as the Fukushima NPP accident, we will be able to quickly identify the major components from digital images. 1k

12) An international alliance of nuclear reactor accident first responders and thereafter, a crisis management team is needed. This does not seem to be available at any significant level at this time. We (the global nuclear industry) cannot wait 3 weeks for international participation. 1l

13) We should consider and work toward international agreement on standards for regulated levels of radiation (activity) and radiation exposure to the general public and separately, those under emergency and extended 'recovery' phases. 1m

We should also be consistent in definition and practice of evacuation zoning. We should also strongly encourage acceptance and use of SI unit for activity and exposure and not use culturally-based numbering customs (in Japan, one counts in orders of ('man')104, ('oku')108, 1012 etc.) Im

14) Under emergency and crisis management, wider access roads are needed to and from NPPs. The access roads need to be clear of debris and of such width to accommodate large-scale trucks needed as first response and thereafter. A means to access the plant via water, such as ocean, calls for infrastructure (boats, water-containing barge, jet-skis etc) is needed as part of a contingency plan for those plants located near bodies of water. In

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Article above is on line at:
http://djysrv.blogspot.com/2011/04/initial-look-at-lessons-learned-from.html?utm_source=feedburner&utm_medium=feed&utm_campaign=Feed%3A+blogspot%2FYiuo+%28Idaho+Samizdat%29

http://theenergycollective.com/dan-yurman/56372/initial-look-lessons-learned-fukushima

PR 52
(76FR10269)

53

Rulemaking Comments

From: Danny Dyche [tolarian@juno.com]
Sent: Tuesday, May 10, 2011 1:03 AM
To: Rulemaking Comments
Subject: Docket ID NRC-2010-0131: Suspend the AP1000 approval

Dear Secretary Vietti-Cook,

We cannot afford to build nuclear reactors. Because disaster can occur at any nuclear 1
reactor, the NRC needs stop the new Westinghouse AP1000 reactor design considered for
construction in Georgia, South Carolina and other states. 2
I demand that the NRC reject the license application.
Addressing safety concerns, not satisfying the industry, must be the Nuclear Regulatory 3
Commission's primary concern. NRC engineer John S. Ma's non-concurrence with the review of 4
the reactor raised the possibility that the AP1000's shield building could shatter "like a
glass cup". It would be indefensible for the NRC to move forward without further addressing
that weakness. Also, Westinghouse has not satisfactorily proved that the thin steel 5
containment shell over the reactor would be effective during severe accidents or that the
reactor could be properly cooled in conditions similar to those at Fukushima. 6

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DOCKETED
USNRC

May 10, 2011 (4:30 pm)

OFFICE OF SECRETARY
RULEMAKINGS AND
ADJUDICATIONS STAFF

Template = SECY-067 **DS 10**

PR 52
(76FR10269)

NEI

NUCLEAR ENERGY INSTITUTE

54

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May 10, 2011 (4:30 pm)

OFFICE OF SECRETARY
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May 10, 2011

Ms. Annette L. Vietti-Cook
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ATTN: Rulemakings and Adjudications Staff

Subject: Comments on AP1000 Design Certification Amendment; Docket ID NRC–2010–0131; *Federal Register* Notice 76 FR 10269

Project Number: 689

Dear Ms. Vietti-Cook:

The Nuclear Energy Institute (NEI)[1], on behalf of the nuclear industry, is pleased to provide these comments in response to the subject *Federal Register* Notice 76 FR 10269, *AP1000 Design Certification Amendment*.

As described in the proposed rule published for comment on February 24, 2011, the purpose of this amendment is "to replace the combined license (COL) information items and design acceptance criteria (DAC) with specific design information, address the effects of the impact of a large commercial aircraft, incorporate design improvements, and increase standardization of the design." The applicant for the amendment to the certified design is Westinghouse Electric Company LLC (Westinghouse). Upon NRC rulemaking approval of the amendment to the AP1000 design, an applicant seeking an NRC license to construct and operate a nuclear power reactor using the AP 1000 design need not demonstrate in its application the safety of the certified design.

[1]NEI is the organization responsible for establishing unified nuclear industry policy on matters affecting the nuclear energy industry, including the regulatory aspects of generic operational and technical issues. NEI's members include all utilities licensed to operate commercial nuclear power plants in the United States, nuclear plant designers, major architect/engineering firms, fuel fabrication facilities, materials licensees, and other organizations and individuals involved in the nuclear energy industry.

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DS 10

On April 6, 2011, a "Petition to Suspend AP1000 Design Certification Rulemaking Pending Evaluation of Fukushima Accident Implications on Design and Operational Procedures and Request for Expedited Consideration" (the "Petition") was filed with the Commission. Petitioners asked the Commission to "exercise its supervisory authority to order the immediate suspension of any AP1000-related rulemaking while it conducts a thorough and open investigation of the implications of the Fukushima accident." Petitioners sought expedited consideration because the comment period for the rulemaking ends on May 10, 2011.

In brief, both Commission precedent and sound public policy support the NRC's approach of *continuing its ongoing licensing and design certification reviews and associated decision making processes.* On this important point, see the May 2, 2011, "NRC Staff Answer to Emergency Petition to Suspend All Pending Reactor Licensing Decisions and Related Rulemaking Decisions Pending Investigation of Lessons Learned from Fukushima Daiichi Nuclear Power Station Accident. "In that filing, the NRC Staff argued that the April 19, 2011, Emergency Petition should be denied because (among other reasons), the Petitioners failed to meet Commission requirements to suspend or stay all licensing decisions and related rulemakings. "The Petition simply has not provided an adequate basis to support such emergency relief . . ." noted the NRC Staff (NRC Staff Answer, p.1).

On March 21, 2011, the Commission announced the creation of a Task Force specifically to study lessons learned from the March 2011 earthquake, tsunami and resulting nuclear emergency at the Fukushima Daiichi nuclear plant. That NRC Task Force is taking appropriate steps to identify the near-term and long-term lessons from that event and apply those lessons, as appropriate, to licensed reactors and as part of pending licensing and design certification reviews. Conducting the agency's comprehensive review of the implications of the Fukushima Daiichi Nuclear Power Station accident in Japan in parallel with ongoing Commission activities is appropriate.

Additionally, the Atomic Energy Act and NRC regulations provide for public participation in connection with any future agency actions that may result from the evaluation of lessons learned from the Fukushima event. To the extent a petitioner believes that new information from the lessons-learned reviews is relevant to any particular NRC decision, existing NRC regulations provide adequate processes for seeking relief. However, consistent with the actions taken after Three Mile Island and September 11, 2001, the Commission should deny the Petitioners' request to suspend the ongoing AP1000 design certification rulemaking. Any regulatory action or environmental analyses necessitated by the Fukushima accident will be addressed in due course, following established administrative procedures.

In sum, this Petition, to our knowledge, provides no viable basis for asking the Commission to take the extraordinary step of suspending or extending the rulemaking. The additional remedy sought the agency's "comprehensive review;" (see Petition, p. 23) is already underway and will be provided by the NRC Task Force. Thus, the Commission should deny the relief requested by Petitioners.

These and other reasons supporting NEI's opposition to Petitioners' request are discussed in more detail in NEI's May 2, 2011, "Brief of the Nuclear Energy Institute as *Amicus Curiae* in Opposition to the Emergency Petition to Suspend All Pending Reactor Licensing Decisions and Related Rulemaking Decisions," which was filed with the Commission.

If you have any questions, please do not hesitate to contact me at or Kimberly Keithline at 202.739-8121 or kak@nei.org.

Sincerely,

Russell J. Bell

c: Mr. William F. Burton, NRO/DNRL/DDIP/NR, NRC
Mr. Earl R. Libby, NRO/DNRL/DDIP/NR, NRC
NRC Document Control Desk

Rulemaking Comments

From: BELL, Denise [dxb@nei.org] on behalf of BELL, Russ [rjb@nei.org]
Sent: Tuesday, May 10, 2011 2:52 PM
Subject: Comments on AP1000 Design Certification Amendment; Docket ID NRC-2010-0131; Federal Register Notice 76 FR 10269
Attachments: 05-10-11_NRC_Comments on AP1000 Design Certification Amendment.pdf

May 10, 2011

Ms. Annette L. Vietti-Cook
Secretary
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001
ATTN: Rulemakings and Adjudications Staff

Subject: Comments on AP1000 Design Certification Amendment; Docket ID NRC–2010–0131; *Federal Register* Notice 76 FR 10269

Project Number: 689

Dear Ms. Vietti-Cook:

The Nuclear Energy Institute (NEI)[1], on behalf of the nuclear industry, is pleased to provide these comments in response to the subject *Federal Register* Notice 76 FR 10269, *AP1000 Design Certification Amendment*.

As described in the proposed rule published for comment on February 24, 2011, the purpose of this amendment is "to replace the combined license (COL) information items and design acceptance criteria (DAC) with specific design information, address the effects of the impact of a large commercial aircraft, incorporate design improvements, and increase standardization of the design." The applicant for the amendment to the certified design is Westinghouse Electric Company LLC (Westinghouse). Upon NRC rulemaking approval of the amendment to the AP1000 design, an applicant seeking an NRC license to construct and operate a nuclear power reactor using the AP 1000 design need not demonstrate in its application the safety of the certified design.

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Russell J. Bell
Director, New Plant Licensing
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Putting Clean Air Energy to Work.

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[1]NEI is the organization responsible for establishing unified nuclear industry policy on matters affecting the nuclear energy industry, including the regulatory aspects of generic operational and technical issues. NEI's members include all utilities licensed to operate commercial nuclear power plants in the United States, nuclear plant designers, major architect/engineering firms, fuel fabrication facilities, materials licensees, and other organizations and individuals involved in the nuclear energy industry.

Rulemaking Comments

From: tomclements329@cs.com
Sent: Tuesday, May 10, 2011 3:21 PM
To: Rulemaking Comments
Subject: Docket ID NRC-2010-0131 - AP1000 Comments by Friends of the Earth, May 10
Attachments: Gundersen_FOE_Report_5-10-2011-2.pdf

May 10, 2011

**DOCKETED
USNRC**

May 10, 2011 (4:30 pm)

**OFFICE OF SECRETARY
RULEMAKINGS AND
ADJUDICATIONS STAFF**

Secretary
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

ATTN: Rulemakings and Adjudications Staff

Re: Docket ID NRC-2010-0131, AP1000 Design Certification Amendment

I am here by submitting comments prepared by Fairewinds Associates, Inc. for Friends of the Earth. Those comments are attached. Please confirm that you have received them.

I request that each point raised in these comments be responded to by NRC staff in writing.

In addition to being posted into the docket for the AP1000 rulemaking, I request that the comments also be placed in ADAMS.

We continue to hold thee opinion that the rulemaking was announced before reactor design problems and safety questions have been resolved and in advance of any pertinent input from the Fukushima disaster. Due to this and the refusal of the NRC to honor the request by over 14,000 people to indefinitely extend the comment period, we believe that the rulemaking and license review must now be put on hold.

Sincerely,

Tom Clements
Southeastern Nuclear Campaign Coordinator
Friends of the Earth
1112 Florence Street
Columbia, South Carolina 29201

Comment to the proposed rule on the
AP1000 Design Certification Amendment
Docket ID NRC-2010-0131
As noticed in the Federal Register on February 24, 2011

Report Prepared for Friends of the Earth
By Chief Engineer Arnie Gundersen
Fairewinds Associates, Inc
May 10, 2011

Table of Contents

Introduction and Background

This report, prepared by Fairewinds Associates, Inc for Friends of the Earth, is being submitted as a comment to the proposed rule on the *AP1000 Design Certification Amendment*, Docket ID NRC-2010-0131 as noticed in the Federal Register on February 24, 2011[1]. Fairewinds' comments, which are of a technical nature and merit close scrutiny, support the position that issuance of a notice of rulemaking is premature and that approval of the design certification of the AP1000 reactor is not warranted. 12

Prior to the nuclear power plant accidents at Japan's Fukushima Boiling Water Reactors (BWR's), intervenors, NGO's, expert witnesses, industry insiders, and staff members within the Nuclear Regulatory Commission (NRC) had expressed significant doubts about the integrity and rigor of the proposed AP1000 design. To this date, the NRC has not adequately addressed the issues raised.

During the fall of 2009, Fairewinds Associates, Inc was retained by the AP1000 Oversight Group to independently evaluate the proposed design of the Westinghouse AP1000 nuclear power plant. Following six months of research and peer review, Fairewinds Associates prepared and submitted an expert report entitled *Post Accident AP1000 Containment Leakage, An Unreviewed Safety Issue*[2] to the AP1000 Oversight Group, which in turn submitted that report to the NRC. Subsequently, Fairewinds' Chief Engineer Arnie Gundersen and AP1000 Oversight Group Attorney John Runkle were invited to present their concerns to the NRC's Advisory Committee on Reactor Safeguards (ACRS) June 25, 2010. Subsequently, the AP1000 Oversight Group submitted the Nuclear Containment Failures: Ramifications for the AP1000 Containment Design supplemental report December 21, 2010. The two reports, the associated power point, and the June 25, 2010 presentation to the NRC coordinated with the NRC meeting audio may be found at Fairewinds Website under the reports and multi-media tabs.

Is Zero Percent Leakage Reasonable?

Both the NRC in its regulatory role and Westinghouse as the design engineer have declined to adequately scrutinize or calculate the reality of containment failure and leakage in the single-wall

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[1] *AP1000 Design Certification Amendment*, Docket ID NRC-2010-0131 http://edocket.access.gpo.gov/2011/2011-3989.htm

[2] Fairewinds Associates' website: fairewinds.com

containment structure upon which the proposed AP1000 design is predicated. Nuclear power industry operating experience during the past 40 years indicates repeated instances where containments have developed failures. Despite these repeated incidents, the Nuclear Regulatory Commission assumes that the probability of containment failure or leakage during operation of the AP1000 design is zero. In complete defiance of more than 40 years of actual nuclear power industry operating experience, the Nuclear Regulatory Commission perpetuates the myth that nuclear power plant containments do not fail and leak radioactivity. Thereby the regulatory agency continues to approve the faulty design features of the highly touted and fast-tracked AP1000 design by claiming that such containment failure never occurs. 2

Well before the proven inadequacy and even possible complete rupture of at least three separate nuclear power plant containment systems at Japan's troubled Fukushima nuclear power plant, the NRC's assumption of a zero failure rate diametrically opposes all historical data and sound engineering analysis on record. Fairewinds Associates has analyzed containment probabilities dating back more than 40 years and has detailed the history of containment failure and leakage in several reports submitted to the NRC and presented in person to the NRC Advisory Committee on Reactor Safeguards (ACRS). We have attached those reports to this filing, and while we will not currently review them in detail, we are submitting the following conclusions as part of this evidentiary report.

Five Containment Failure Modes:

1. There are numerous instances of containment failure where rust has
developed on the outside of the containment building and progressed all the 3
way from its outside origin through the wall to the inside of the containment.
None of these failures were identifiable during any visual examination until the
holes had propagated completely through the containment wall.

2. There are numerous instances of containment failure at which time rust developed on the inside and progressed from inside-out all the way through the wall to the outside of the containment. Once again, these actual containment breakdowns and failures could not be identified by any method of visual examination until the actual hole had propagated completely through the

containment system.

3. Fairewinds' analyses has shown that these phenomena are not just limited to through-wall rust and holes. The nuclear power industry data has numerous examples of containment failure where actual cracks have developed and 4
propagated completely through the containment. These cracks were not identified by visual examinations, and instead were only uncovered when the actual crack propagated completely through the containment system.

4. Protective coatings are often touted by the nuclear power industry as a solution to containment cracking, holes, and leakage, but protective coatings do 5
not perform as well as the nuclear power industry claims. Instead, there are numerous instances in which protective coatings have failed and were not identified by inspection personnel for significant periods of time, thus not protecting the public from containment leakage. Additionally, personnel who apply protective coating have been harassed and intimidated by industry executives for bringing their coating concerns to management's attention.

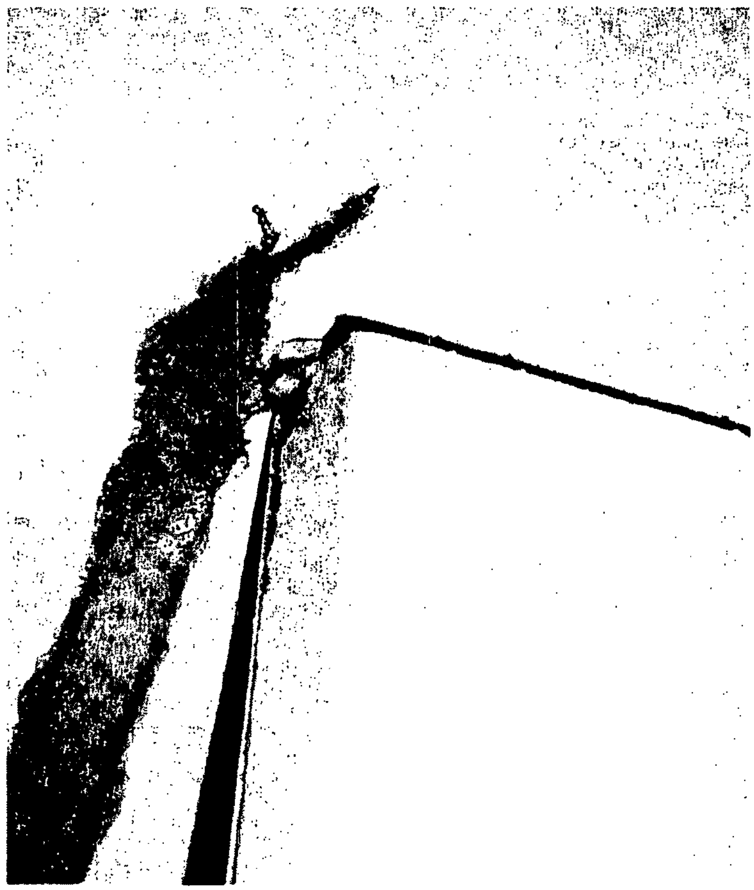
5. The nuclear power industry also claims that the visual inspection technique upon which the industry relies assures complete containment integrity. In 6
actuality, the inspection procedures heralded by the nuclear power industry have repeated failed to identify cracks, holes and containment coating deterioration until gross degradation has already occurred.

NRC Uses Flawed Data

Based upon a thorough analysis containment failure and degradation as delineated in this report in points 1 to 5 listed above, Fairewinds concludes that there is a finite probability of a containment failure or containment leakage in the AP1000 design. Fairewinds' conclusion was reported to the NRC and ACRS prior to the very real containment failure and leakage evidenced 7
at Japan's Fukushima nuclear power plants. Yet, despite actual evidence to the contrary, the Nuclear Regulatory Commission continues to allow Westinghouse to assume and calculate a zero percent (0%) probability of containment degradation leading to failure or leakage even 8

without an accident scenario, let alone from additional stress during a LOCA (Loss of Coolant
Accident). Such claims are not based upon sound scientific analysis and engineering review, 8
but appear instead to be based upon the mythical dreaming of an aggressive industry and its
captive regulator. Moreover, throughout the AP1000 docket there is no supporting
documentation proving Westinghouse's SAMDA analysis and the NRC's endorsement of that 7
SAMDA claiming that there is a zero percent probability of containment failure.

On June 28, 2010, three days after the ACRS meeting, Fairewinds Associates, Inc informed the ACRS of *yet another containment failure*, this time at the Fitzpatrick nuclear power plant in 2005. The photo below of the 4 ½" crack was taken in 2005 from the outside of the containment torus at the Fitzpatrick nuclear power plant in Oswego, NY.



As a result of questions during the ACRS discussion period relating to BWR thick containment designs like the through wall cracks at Hatch 1 and 2, Fairewinds researched additional failures and found that the Fitzpatrick nuclear power plant developed a large though-wall leak that was not due to corrosion. Once again, here is a unique violation of the BWR containment system that is directly applicable to the Westinghouse design of the AP1000.

The Fitzpatrick crack is due to differential expansion in a thick containment that is of similar thickness to the proposed AP1000 design and like the cracks previously uncovered at Hatch 1 and Hatch 2. Thus to date, three thick containment systems have experienced complete through-wall failures that remained undetectable by ASME visual techniques until each through-wall crack actually appeared. Similar stresses resulting in cracks could also occur in an AP1000 nuclear power plant if it is constructed to the current inadequate specifications.

Immediately after Fairewinds provided these photos and detailed analysis of the AP1000 design to the ACRS and without detailed analysis of any kind, either the NRC staff or members of the ACRS itself leaked their opinion to pro-nuclear bloggers stating that Fairewinds analysis was incorrect. While Fairewinds has never had the privilege of a detailed NRC response, the NRC used its typical backchannel communications with its friends in the nuclear industry in an attempt to discredit the veracity of the Fairewinds report. When Fairewinds issued its report discussing the critical safety flaw of *the chimney effect,* Westinghouse immediately issued a press release ignoring all of Fairewinds peer-reviewed data and instead attempted to impugn integrity of Fairewinds Associates. And, rather than analyze the Fairewinds report, the NRC apparently read the Westinghouse press release and simply parroted those words to back to the pro-nuclear bloggers. The April 29, 2010 edition of *Nuclear Engineering International* quotes the Westinghouse cover-up:

> Westinghouse spokesman Vaughn Gilbert responded vigorously to the claims:
>
> We disagree completely and unequivocally with every conclusion that was put forward. We are certainly never surprised when an antinuclear group with an antinuclear agenda puts forth antinuclear comments. The reality is that the steel in question is 1.75 inches thick, it is corrosion-resistant, and it is highly unlikely corrosion would ever be an issue. Contrary to what they reported, if corrosion were to begin, it would be quickly discovered in a manner that is prompt and appropriate, and it would be remedied before it would come close to being a problem. The announcements were plain and simple wrong.[3]

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[3] April 29, 2010 edition of *Nuclear Engineering International*
http://www.neimagazine.com/story.asp?storyCode=2056229

In its jaundiced statement to *Nuclear Engineering International,* Westinghouse attempts to ignore the real findings of Fairewinds' analysis by attempting to obfuscate the truth. By mischaracterizing accurate scientific analysis and thorough engineering review by trying to label it as anti-nuclear comments, Westinghouse follows the 60-year-old pattern of the nuclear industry. Whenever it is confronted with engineering errors and debacles, the industry shouts to the rooftops that whoever criticizes them is a rabid anti-nuke. The acceptance of such innuendo and slander by the NRC staff and the ACRS rather than doing what it is chartered to do by Congress and conduct a thorough overall safety analysis of the AP1000 design shows its industry 2
bias and capitulation to industry pressure for a fast-tracked process of a new and inadequately reviewed AP1000 design.

Despite historical data and reams of analysis indicating that containment failures do in fact occur, the NRC has repeatedly ignored these facts and has not responded to Fairewinds' analysis 1
delineating existing containment failures. Fairewinds requests a complete and thorough review of this critical design-basis safety flaw.

As Fairewinds has already stated, the NRC has not adequately analyzed the *unreviewed safety issue* Mr. Gundersen identified on the AP1000 regarding containment leakage. The current 9
AP1000 design is not consistent with very basic "defense in depth" and "multiple barrier" principles to which the NRC must adhere by statute. Information available to Fairewinds shows that the NRC appears not to understand that unlike on current PWRs, the shield building on the AP1000 *does NOT* function as a secondary containment. Quite simply, the AP1000 shield building does not prevent the release of radiation to the environment; it is not a secondary containment building.

The December 10, 2010 *Nuclear Engineering International*, indicates just how widespread the false belief is throughout the entire nuclear industry that the AP1000 has both a primary and a secondary containment system.

> The amended design includes a redesigned AP1000 Shield Building, a massive armored structure made of concrete and steel that protects the containment vessel from external forces, such as tornado-driven objects, earthquakes and aircraft

> impact. It also acts as a secondary radiation barrier... [4]

The *Nuclear Engineering International* article emphasizes the factually incorrect conclusion that the shield building "also acts as a secondary radiation barrier".

As Fairewinds stressed to the NRC more than one year ago, not only does the shield building not serve as a secondary radiation barrier during a severe accident, which is when it would be critically needed to perform that function, but also through the "chimney effect", it actually aids dispersal of any radioactivity that leaks from the primary containment. 9 21

That this prestigious nuclear magazine could so visibly misunderstand the purpose of the shield building is an indication why so many engineers working on this project or reviewing the AP1000 for licensure have not understood this basic safety flaw. Once again, for the record, the AP1000 shield building does not function as an additional radiation barrier in the event of an accident. 9

Issues Proven by Fukushima Accidents

Given the failure of three containment systems at Japan's stricken Fukushima nuclear power plants, it is imperative that the NRC reevaluates the new AP1000 design in light of its potential for containment failure. The AP1000 shield building vents directly to the outside environment and was never designed to be a secondary containment system. As Fairewinds Associates notified the NRC more than one year ago, the AP1000 shield building was never designed as a secondary containment system. Moreover, not only will the shield building not contain any radioactivity in the case of an accident, the shield building creates what Fairewinds has named *the chimney effect*, and actually wafts radiation out into the environment, which will significantly compromise the surrounding population during an accident. 10 9 21

Although final data from the multiple Fukushima nuclear power plants are not yet available, it is readily apparent that the Fukushima nuclear plants, which are the same BWR Mark 1 model as many US plants, are suffering cataclysmic containment failure and leakage.

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[4] December 10, 2010 *Nuclear Engineering International*
http://www.neimagazine.com/story.asp?storyCode=2058414

- Fukushima Unit 2 has a containment system that has failed completely and is allowing highly radioactive releases from inside the containment to freely enter the environment.

- Fukushima Unit 1 has also suffered a loss of containment integrity as evidenced by Tokyo Electric Power Company's (TEPCO's) continuous addition of gaseous nitrogen in an effort to reestablish containment integrity and pressure without success.

- While data from Fukushima Unit 3 is inconclusive, there is also evidence that Unit 3's containment has also been breached.

Consequently, during just the last two months, three allegedly robust nuclear containment systems have failed entirely. If such a containment breach, failure, or leakage were to occur in
the new AP1000 design, the results would be catastrophic for the surrounding communities. In 22
prior reports and testimony, Fairewinds Associates has already identified the AP1000 chimney effect that would waft enormous amounts of radiation out of the reactor and into the surrounding communities. Given that there is 40 years of data indicating a bevy of containment failures in nuclear power plants operating within the United States, and given that there are now three Japanese nuclear power plants that have failed containment systems in Fukushima, it is obvious
that the NRC's acceptance of a zero percent (0%) probability of containment failure is not only 7
mathematically and historically incorrect, but appears to prove that the NRC is failing in its regulatory role.

Furthermore, it is now evident that a detonation shock wave (not deflagration) occurred at Fukushima Unit 3, destroying much of the structure. The AP1000 containment is not designed
to withstand a detonation shock wave. Until the cause of the detonation is determined, design 11
approval of the AP1000 containment should not be granted. Once again, Fairewinds reiterates
that the "issuance of a notice of rulemaking is premature and that approval of the design 12
certification of the AP1000 reactor is not warranted".

AP1000 Is Only A Simulated Design

Fairewinds has great concern regarding the AP1000 design that has only been simulated on a
limited Computer Aided Design (CAD) program. Neither the shield building nor the 13
containment building have been constructed in verification of the their computer simulated

design analysis. In fact, the AP1000 shield building technique has never been used in the United States on any comparable structure. Previously, the NRC demanded full scale testing of the Mark 3 BWR containment in the mid-1970's due to its unique design. However, the NRC has 13 required no full-scale tests on the unique AP1000 containment design. Furthermore, Fairewinds Associates' review has uncovered analytical problems with the containment design computer codes applied to both the AP1000 containment analysis and the analysis of the AP1000 shield building.

Careful analysis by Fairewinds of significant containment defects at Progress Energy's Crystal River nuclear power plant (NPP) illustrate the deficiencies in its similar containment analysis via state-of-the-art computer programs simulating containment performance. Beginning in 2009, in order to uprate the power (increase the power output) at the Crystal River NPP, contractors cut into the containment in order to replace the steam generators so that the power output could be increased. The contractors at the Crystal River NPP used concrete-cutting saws to cut into the nuclear power plant's containment, and in the process unwittingly created a 60foot long delamination (splitting apart into layers) of the containment.

Fairewinds notes that this was allegedly a carefully analyzed quality-assured process. In spite of the fact that the CAD simulation program had allegedly thoroughly analyzed containment design at the Crystal River NPP prior to any concrete cuts by contractors, the simulation erroneously predicted no damage to the containment structure.

Following the erroneous CAD analysis and subsequent damage to the nuclear power plant's vital containment system in 2009, Crystal River NPP and the NRC have proclaimed that Crystal River engineers and contractors have applied sophisticated computer codes to thoroughly reanalyze Crystal River's containment building in order to create a new methodology for rebuilding and resealing the nuclear power plant's containment in order to seal up and restart the nuclear power plant.

Despite assurances by the NRC and Progress Energy regarding the veracity of the computer code analysis the CAD program once again failed dramatically leaving the Crystal River containment building with a new and large delamination. Allegedly, thousands of hours of analysis by

Progress Energy and review by the NRC occurred before these repairs were implemented. Yet once again the Crystal River containment repair was a failure and the plant remains shutdown.

Fairewinds believes that this second failure of the allegedly rigorous CAD program proves the 13
total inadequacy of the current computer code in analyzing and predicting containment integrity. The Crystal River containment analysis and design was likely the most heavily analyzed containment design in the world, yet sophisticated computer programs specifically built to analyze containment structures failed to prevent not only one but two significant delamination to Crystal River's containment building. The containment integrity debacle evidenced at Progress Energy's Crystal River NPP establishes and validates the complete failure of the nuclear industry computer code and computer aided design programs to accurately assess or calculate shield building and containment integrity.

Dr. John Ma, the NRC's lead structural engineer for the AP1000 has already been rebuffed when he stated his concerns about the NRC's analysis of the AP1000 shield building. The evidence of the marked failure of the containment integrity computer code analysis and CAD programs at Crystal River unequivocally proves the weakness in the fast-track design and analysis of both the AP1000 Shield and Containment buildings. The evidence shows that the computer models created to conceptualize and design the nuclear power plant containment system are undeniably flawed.

Moreover, the NRC is given its authority to regulate and license nuclear power plants based upon its primary responsibility to protect public health and safety as it grants permits for the design, construction and operation of all U.S. nuclear power plants. The utter failure of the CAD computer code to correctly analyze containment integrity at Crystal River and other operating
nuclear plants clearly demonstrates the inability of the computer code and CAD program to 13
analyze even the rudimentary containment integrity and shield building stability of the proposed AP1000.

Numerous Single Points of Vulnerability in the AP1000 Design

Historically the Nuclear Regulatory Commission has evaluated single points of vulnerability on active, not passive, containment systems. However, the three accidents at Fukushima clearly indicate the need to evaluate all single points of vulnerability. Fairewinds review shows that the AP1000 design has at least two such single points of vulnerability and that given the tragedy at Fukushima, a viable airtight secondary containment system is vital to any new reactor design.

1. The first single point of vulnerability is the possibility of a leak or failure in large water tank balanced atop the reactor's shield building.

    - Should this tank fail to perform its intended function, the AP1000 design will not adequately remove heat from the containment building during a design basis 23 accident that would lead to a meltdown. This single source of cooling water perched atop the shield building is unique to the AP1000 design and Westinghouse's reliance upon it creates a single point of vulnerability that has not been thoroughly evaluated by industry regulator NRC due to the rush for AP1000 certification and licensure.

    - While Westinghouse, the AP1000 nuclear power plant vendor, has allegedly completely evaluated the 8-million-pound water tank perched atop the containment and claims the design is robust, the computer codes used to analyze 13 this tank are similar to the codes used to repeatedly analyze the Crystal River 3 containment that has repeatedly failed despite NRC review and approval.

    - The tragic nuclear plant accidents at Fukushima prove the travesty of an inadequate design like the Mark 1 BWR that GE pressured regulators to approve[5]. Westinghouse is applying the same pressure to the NRC in 2011. Events at Fukushima corroborate the necessity of proactive design integrity of mechanical structures designed to withstand anticipated and unanticipated forces of nature.

    - Therefore, the evidence collected from the Fukushima accidents clearly demonstrate the absolute necessity of the Nuclear Regulatory Commission to 23 reevaluate the unique and unprecedented AP1000 NPP design that uses a single water tank perched atop the shield building design as its primary and only source

5 NRC Internal Memo: *Joseph Hendrie to John O'Leary*, September 22, 1972.

of emergency cooling. Should there be a design basis accident and the tank fails, all capacity for cooling the AP1000 nuclear power plant will be lost as 23
emergency cooling capacity was lost at Fukushima by the single point of vulnerability of the weather-caused destruction of the intake cooling pumps. Computer codes approved by the NRC predicted the Crystal River containment would be robust and were proven wrong. Computer codes claim to show that the AP1000 water tank will be robust as well. In light of Crystal River and Fukushima, that trust has no basis in the actual record.

- Moreover, this tank is subject to wind loads from hurricanes or tornadoes as well as seismic loads. Fairewinds believes that the Fukushima nuclear power plant accidents clearly show that what was previously identified as a maximum 24
credible design basis accident must be reevaluated.

- Furthermore, this 8-million-pound water tank must be refilled within 3days after an accident. The nuclear accidents at Fukushima have also publically unveiled the nightmare of water demand during a design basis accident caused by hurricanes, tornadoes, floods, tsunamis, or earthquakes. It is scientifically 25
impossible to suggest that such an unreasonably short time frame could be fulfilled in the midst of a national disaster that has damaged access to the nuclear power plant. The evidence reviewed clearly reveals this single point of vulnerability inherent in the AP1000 shield building design, and such a significant safety flaw demands regulatory attention and AP1000 redesign.

2. Second, Fairewinds is not alone in its belief that the new AP1000 design features must be reevaluated in light of the three Fukushima nuclear power accidents. To date, Dr. Akira T. 26
Tokuhiro, Associate Professor of Nuclear Engineering at the University of Idaho, has identified *at least* five vulnerable areas that must be reevaluated prior to any new reactor design certification following the Fukushima tragedy. These single points of vulnerability include, but are not limited to:

2.1. **Zirconium-based fuel cladding.** The use of zirconium-based fuel cladding has created hydrogen explosions 5 times during the past 40 years. The Three Mile Island nuclear 14 power plant accident in 1979 and four of the six Fukushima nuclear reactors have had experienced hydrogen explosions as a direct result of zirconium-based fuel cladding.

2.1.1. Yet the AP 1000 design once again relies upon the flawed and accident-prone zirconium-based fuel cladding. 14

2.1.2. Given the likelihood that a hydrogen-induced explosion will occur, as now has happened 5 times during the past 35 years, it should be mandatory that non-zirconium-based fuel cladding be evaluated for any new reactor design prior to design certification and licensure.

2.2. **The Danger of Multiple Nuclear Power Plants on the Same Site.** Events at the Fukushima nuclear power plant site have shown the dangerous implication of placing multiple reactors on the same site. Should a design basis event occur, Fukushima demonstrates the necessity for reevaluating all multi-reactor sites for their ability to withstand multiple design basis accidents and for the region's ability to sustain services 15
and power in the event of a natural disaster like a hurricane, tornado, earthquake, or flood.

2.2.1. Currently operating nuclear reactors on a multi-unit nuclear power plant site have not been evaluated in terms of how a multi-unit site functions during an accident or LOCA. This process must be expanded to evaluate how a multi-unit site operates during an accident or LOCA for the new AP1000 design. Fairewinds believes this is especially important for multi-unit sites for which the new AP1000 is under consideration on the same site as multi-unit older generation reactors.

2.2.2. Two AP1000 nuclear power plants are already proposed for construction and licensure at the Vogtle site, and separately two AP1000 reactors are proposed for the Turkey Point site both of which already have other nuclear reactors presently in operation. Additionally, at V.C. Summer, two AP1000 reactors are planned for that single reactor site. The older reactors have different, lower design basis event designs that could fail before the AP1000 yet increase the likelihood of an AP1000 failure as part of a sequence of cascading failures similar to Fukushima. For example Fukushima Unit 1 had lower design bases than the other reactors and was the first to explode. This compounded recovery efforts at the other reactors. 15

2.2.3. The multi-nuclear power plant accident scenario that played out in Japan at the Fukushima multi-unit site demonstrates the critical importance of evaluating the real vulnerability of multi-unit sites as part of any new power plant licensing process.

2.3. **Abandonment of Reactor Control.** The Fukushima accident has also demonstrated the necessity of standby control rooms that are accessible during accidents in which reactor containment leakage and high radiation releases have compromised normal operating control room designs. 16 While costly backfits should be examined for all currently operating reactors, it is imperative that the new AP1000 design be corrected to reflect control room compromise in the event of a design basis accident by locating a standby control room at some distance from the plant within a filtered hermetically sealed containment building so that reactor operators are protected from radiation and may continue to monitor and operate the reactor in the event of a design-basis accident.

2.4. **Additional Power Supplies Necessary.** The Fukushima accidents also reveal the necessity of adding the evaluation of alternating current and direct current power 17 supplies to the AP 1000 design and licensure process.

2.5. **Spent Fuel Pool.** Finally, since the AP1000 design calls for a spent fuel pool to be built within the containment, Fairewinds recommends that no spent fuel should be stored within the reactor containment due to the obvious risk of heat, fire, and explosion as well as the extensive radioactive dose risk to personnel attempting to operate the reactor itself during a natural disaster and subsequent design-basis accident. Additionally, all spent fuels pools should be required to have back-up control and moderating systems in the event that a natural disaster creates a rack distortion and inadvertent criticality. Fukushima clearly shows that fuel should be moved to dry cask storage as soon as 18 possible, which eliminates the need for high-density racks for the AP1000 design.

The net effect of all these non-conservative assumptions in the Westinghouse AP1000 design is that post accident radiation doses to the public could be several orders of magnitude higher (one 20 hundred to one thousand times higher) than those assumed by Westinghouse in its AP1000 design. Such calculational flaws quite seriously impact emergency planning over a much broader area than that presently assumed in the Westinghouse SAMDA analysis and NRC staff 20 review.

Safety Concerns Submitted by AP1000 Engineer Never Addressed

In addition to the specific concerns expressed by Fairewinds Associates and submitted to the NRC, Dr. Susan Sterrett, a former Westinghouse design engineer assigned to the AP1000 project, made repeated attempts to discuss AP1000 design concerns and apprehensions with both the NRC staff and the ACRS from 2003 to 2005.

The AP1000 design is similar in many respects to the AP600. While Dr. Sterrett was employed by Westinghouse, she determined that Westinghouse had ignored its own internal quality assurance design procedures created to ensure design integrity by maintaining a database of similarities and differences for reactor designs receiving upgraded power levels. These specific internal monitoring procedures were created by Westinghouse to address the unexpected consequences of power increases, and they were not applied to the AP1000 design analysis.

More specifically, the Power Capability Working Group is an organization in place at Westinghouse whose purpose it is to analyze and address such unexpected consequences, yet Westinghouse did not apply the expertise of this group for its new AP1000 reactor design. Furthermore, Westinghouse also has in place additional processes and procedures designed as an oversight process for new reactor design, and Westinghouse also did not implement these 19 internal procedures during its development of the fast-tracked AP1000 design.

Presentations and design submissions by Westinghouse to the NRC and the ACRS clearly lay out the firm's engineering reliance upon the AP600 design in the conception and development of the AP1000 nuclear power plant. Moreover, a significant number of Design Control Documents (DCD's) presented by Westinghouse to the Nuclear Regulatory Commission claim to be based upon NRC AP600 approval. Dr. Sterrett first brought her concerns to the NRC ACRS in 2003, and instead of giving such serious allegations a thorough review, the ACRS discounted and ignored considerable sound scientific and engineering analysis, and continues to do so eight years later. It appears that the ACRS and NRC have done a woefully inadequate review of both

Dr. Sterrett's and Fairewinds Associate AP1000 legitimate safety and engineering concerns in order to meet industry demand for an accelerated review process and fast-track licensure of a woefully unreviewed and untested new reactor design.

In her thorough engineering analysis for the NRC ACRS, Dr. Sterrett noted several other considerations in need of critical analysis and thorough engineering review. For example, Dr. Sterrett observed numerous conditions under which the AP1000 design was inappropriately based upon the previous AP600 design calculations. Astonishingly, the NRC never required proof of design calculations from Westinghouse during the design certification process. 19 Instead of calculation proof during the design evaluation and sufficiency assessment process, the NRC has delayed such rudimentary engineering requirements until the actual Construction Operating License (COL) stage of the AP1000 licensing process.

- Specifically, Dr. Sterrett informed the NRC that post-accident steam pressures would be lower on the AP1000 than in the AP600 design because pipe size would be bigger. 19 The NRC chose not to review this legitimate engineering safety concern.

- More specifically, Dr. Sterrett also outlined problems with the temperature of the ultimate heat sink. In AP600 and AP1000 design the ultimate heat sink is ambient atmosphere. However, as Dr. Sterrett acknowledged, the impact of solar radiation on the slanted roof and on the water tank perched on atop the shield building have not been 19 adequately addressed by the Nuclear Regulatory Commission it its design review of the AP1000.

- Additionally, the effect of a heat wave upon the AP1000 cooling system has not been calculated, especially in view of global warming compared to the historical record of 19 temperatures.

- Furthermore Dr. Sterrett believes that the concerns expressed by Dr. John Ma in his non-concurrence should also receive further consideration by the Nuclear Regulatory Commission in light of the temperature of the ultimate heat sink and the effect of solar 19 radiation on the top of the shield building.

The broad issues delineated above are discussed in some detail below, but Dr. Sterrett has informed Fairewinds that she believes that none these concerns received adequate review and assessment by either the NRC or the ACRS. A chronology of Dr. Sterrett's concerns with references to the ADAMS database follows:

1. Prior to the first meeting of the ACRS at which Dr, Sterrett's concerns were discussed in April of 2003, she provided the ACRS with written material concerning the level of design detail and design control for the power output increase from the AP600 design the AP1000 design.[6]

2. Prior to approaching the NRC's ACRS, Dr. Sterrett had tried to work directly with NRC staff in order to remedy these AP1000 design deficiencies. It appears that the project manager for the AP1000 review, Larry Burkhart, finally understood Dr. Sterrett's apprehension regarding design detail, and he had promised to get back to her to further discuss her concerns. After not hearing back from Mr. Burkhart, Dr. Sterrett was informed that Mr. Burkhart had been removed as the AP1000 review manager and was unavailable for contact. After Mr. Burkhart left, there was no more correspondence by NRC regarding the design flaws enumerated by Dr. Sterrett.

3. According to the transcript of the *501st Summary Report 4/10-12/03*[7]

> 5. Subcommittee Report on AP1000 Design Certification Matters
> The Vice Chairman of the Thermal-Hydraulic Phenomena Subcommittee provided a report to the Committee highlighting the matters associated with AP1000 that were discussed at the Subcommittee meeting on March 19-20, 2003. Also, Dr. Susan G. Sterrett (Assistant Professor, Department of Philosophy/Duke University) presented and submitted a statement regarding the level of detail of the AP1000 design review. Dr. Sterrett expressed concern regarding whether the NRC verifies or asks for proof that the system fluid parameters reported in the AP1000 design certification application (and used in the analyses reported in topical reports) are actually justified by design details, as opposed to the system designs [being] at the conceptual stage.

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[6] *Meeting Minutes of the 501st ACRS Meeting, April 10 - 12, 2003* ML081820102. See the Meeting Handout that is attached to the minutes: *Draft of Remarks by Dr S. G. Sterrett 501st ACRS Meeting April 11, 2003, Rockville, MD.*

[7] *501st Summary Report 4/10-12/03*, Pages 4-5, ML031270683

4. Next, in July 2003, Dr. Sterrett met with the ACRS Future Plant Designs Subcommittee where she raised the issues of AP1000 Design and Quality Assurance Procedures and the Heat of solar radiation and the AP1000 Ultimate Heat Sink.[8] *Meeting Minutes of the ACRS Future Plant Designs Subcommittee, July 17-18, 2003*, ML081630184. The two letters written by Dr. Sterrett and attached to those minutes are import evidentiary reference points. At this meeting the ACRS asked the staff how they would respond to Dr. Sterrett's earlier concerns about the level of design detail, and Ms Joelle Starefos, one of the NRC's AP1000 co-project managers, replied that the staff would reply in a letter in some sort of public forum. However, shortly thereafter Ms. Starefos transferred to another position within the NRC, and the NRC never fulfilled its commitment for a review and public comments.

5. On January 28, 2004, Dr. Sterrett received a voicemail[9] alerting her to the NRC response to some of her concerns. Dr. Sterrett had requested a formal reply to her earlier discussions with the ACRS and the NRC staff had committed to a formal reply in a letter in a public forum. Instead it appears that the NRC attempted to respond to these critical safety issues by using an undocumented phone call.

6. On February 11, 2004, Dr. Sterrett then appeared before the ACRS. Fairewinds has excerpted some key points in Dr. Sterrett's testimony before the Thermal-Hydraulic Phenomena Subcommittee Meeting[10].

    On pages 641–645 of the 2/11/04 transcript, Dr. Sterrett's previously referenced concerns regarding the inadequacies of the AP1000 Quality Assurance design process were discussed. At this time, the ACRS explicitly stated that the NRC is NOT treating the AP1000 as an uprating of the AP600, but as a NEW design. Westinghouse and the NRC have repeatedly relied upon the fact that the AP1000 grew out of and is an extension of the AP600 design process. Fairewinds believes that NRC has made a critical analytical

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[8] *Meeting Minutes of the ACRS Future Plant Designs Subcommittee, July 17-18, 2003*, ML081630184. The two letters written by Dr. Sterrett and attached to those minutes are import evidentiary reference points.
[9] ML090820064 *Email from Dr. S. Sterrett - Your Voice Mail Re: AP1000 Design Certification*
[10] ML040760488 *Transcript of ACRS Thermal-Hydraulic Phenomena Subcommittee Meeting in Rockville, MD*, pp 639 – 661.

error in basing the AP1000 design upon the AP600 calculations, and never reviewing the AP600 calculations and determining their application as those calculations have been carried forward and applied to the AP1000 design and certification process.

Dr. Sterrett gets to the heart of the matter regarding the design inconsistencies and lack of appropriate QA on page 648 of the transcript

> Hence, the question identified above about whether there was a procedure and if so, which procedure it was that covered the overarching process of determining which features, calculations, and documents of the AP600 apply to the AP1000 unchanged and which are impacted by the new design, shall we say, remains. The reason I focus on this is that it can't be done piecemeal. Many calculations use the results of other calculations, either directly by using values of parameters that are computed by other calculations or indirectly by involving design features or values of parameters based upon other design calculations. The order in which things are done matters. [lines 7-21]

This essential process of knowing the exact history of calculations and building upon those calculations in a scientific manner is a basic tenet of engineering mathematics. This process has never been adequately reviewed or acknowledged by the NRC Staff or the ACRS.

7. On April 20, 2004, the NRC finally provided a written response to Dr, Sterrett entitled *Response to Dr Susan Sterrett Concerns on AP1000 Design Certification*[11]. In an interview with Fairewinds, Dr Sterrett stated that the NRC reply simply did not address the referenced concerns she had raised during the previous year. What this NRC letter did do was acknowledge that the NRC planned to implement such a review process after design certification and during the Combined Operating License (COL) stage, concerning what the NRC would do when a license application (e.g., for a COL) referencing the AP1000 was received.

8. Both Dr. Sterrett and Fairewinds Associates agree that the structural integrity of the shield building is a significant issue for the upcoming rulemaking due to Dr. John Ma's non-concurrence report. More importantly, it is possible that the distribution of temperatures in

[11] *Response to Dr Susan Sterrett Concerns on AP1000 Design Certification* (dated April 20, 2004) ML040550366.

the shield building due to the heat of solar radiation that originally worried Dr. Sterrett so much that she contacted the NRC in 2004 might have an even larger importance given Dr. Ma's analysis. As Dr. Sterrett notified the NRC, temperature differences in a structure can induce stresses, depending upon how the building is constrained.

9. On July 7, 2004, Dr. Sterrett again attended an ACRS meeting on the AP1000. The transcript[12] beginning on Page 97 details Dr. Sterrett's discussion with the ACRS during which she called into question the lack of NRC staff response regarding the AP1000 design issues and concerns she had raised previously and that those specific issues and concerned still remained unaddressed and unresolved.

10. According to Dr. Sterrett, following the July 7, 2004 ACRS meeting, Jim Lyons of the NRC informally discussed Dr. Sterrett's concerns with her. When Fairewinds spoke with Dr. Sterrett, she recalled two important statements from that conversation:

    10.1 Lyons was adamant that the surface of the concrete could not exceed the surrounding air temperature. Dr. Sterrett notes that this NRC statement is unquestionably false, as any good engineering reference on roof design will reveal.

    10.2 Lyons stated that if an AP1000 plant had to shut down during a heat wave because of temperature constraints on the ultimate heat sink, and thousands of people died as happened in France in 2003, that that would be a great human tragedy, but that it was not the NRC's role to prevent such incidents.

    10.3 Lyons stated that the NRC licenses plants along with setting limits for plant operation.

11. Lastly, on July 8, 2004 Dr. Sterrett again met with the ACRS[13] where only one of her issues was reviewed because it was determined that two of the three issues Dr. Sterrett had raised belonged to the NRC staff for review and were outside purview of the ACRS. The one issue the ACRS did discuss at this meeting was the technical issue that the heat of solar radiation had not been considered as part of the design and analysis of the AP1000 safety systems and

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[12] *Transcript of 514th ACRS Meeting*, July 7, 2004. ML042080082.
[13] *Transcript of 514th ACRS Meeting, July 8, 2004,* Pages 104 ff. ML042080030.

structures. Dr. Sterrett was not asked to participate in the discussion of the concerns she had raised, and when the findings of the meeting were reported, she did not concur with the comments made or the conclusions drawn by the ACRS.

The AP1000 safety and design concerns remain unaddressed. Fairewinds believes these legitimate safety concerns must be fully addressed by the NRC staff prior to any licensing review 12
and design certification moving forward. Furthermore, given the gravity of these safety issues, the NRC must hold a public meeting to discuss these concerns and publicly issue its technical resolution.

Fairewinds Associates' Conclusion

This report delineates that four reputable engineers with significant experience in reviewing and analyzing the AP1000 design (Dr. Ma, Dr. Sterrett, Dr. Tokuhiro, and Mr. Gundersen) have approached the NRC with significant design-basis safety problems. Those problems have been completely ignored by the NRC it its headlong rush to meet industry demands and satisfy Westinghouse's pursuit of fast-track licensure for its AP1000 design. 2
The publication of the rulemaking notice is completely premature. The review of the AP1000 design must be completely suspended until all the prior safety issues have been resolved and the impact of the tragic Fukushima accidents are analyzed and incorporated
into this untested design. 12
A new rulemaking may commence only when successful resolution of these design-basis dilemmas has been completed. Without complete and successful resolution to these design-basis safety issues, the AP1000 certification will be vulnerable to legal challenge and the AP1000 itself will be a veritable safety threat to public health and safety.

Arnie Gundersen, Chief Engineer
Fairewinds Associates, Inc
May 10, 2011

PR 52
(76FR10269)

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USNRC

Westinghouse

May 10, 2011 (4:30 pm)

OFFICE OF SECRETARY
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Your ref: Docket No. NRC-2010-0131
Our ref: DCP_NRC_003168

May 10, 2011

Subject: Westinghouse Comments in the AP1000® Design Certification Amendment Rulemaking in Response to Petitions to Suspend Rulemaking

Westinghouse is submitting the enclosed comments on the AP1000® Design Certification Amendment rulemaking docket (Docket No. NRC-2010-0131) per the February 24th, 2011 Federal Register notice (76 Fed. Reg. 10269). These comments respond to the "Petition to Suspend AP1000 Design Certification Rulemaking Pending Evaluation of Fukushima Accident Implications on Design and Operational Procedures and Request for Expedited Consideration" and the "Emergency Petition to Suspend All Pending Licensing Decisions and Related Rulemaking Decisions Pending Investigation of Lessons Learned from Fukushima Daiichi Nuclear Power Station Accident".

Very truly yours,

R. F. Ziesing
Director, U.S. Licensing

/Enclosure

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	C. Pierce	-	Southern Company
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	G. Zinke	-	NuStart/Entergy
	R. Grumbir	-	NuStart

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

May 10, 2011

Before the Commission

In the Matter of	)	
	)	NRC-2010-0131
AP1000 Design Certification Amendment	)	RIN 3150-A181
	)	
10 CFR Part 52	)	

I. INTRODUCTION

Westinghouse Electric Company files these comments in the AP1000® Design Certification Amendment rulemaking docket in response to a petition dated April 6, 2011, entitled "Petition to Suspend AP1000 Design Certification Rulemaking Pending Evaluation of Fukushima Accident Implications on Design and Operational Procedures and Request for Expedited Consideration" (the "Petition"). The Petition requests that the NRC "immediately suspend the AP1000 design certification rulemaking which was noticed on February 24, 2011, at 76 Fed. Reg. 10,269." (Petition, p. 1).

These Westinghouse comments also respond to a petition dated "corrected" April 18, 2011, entitled "Emergency Petition ..." (the "Emergency Petition"). The Emergency Petition requests, in addition to suspension of the AP1000 rulemaking, that the rulemaking process be extended for at least six months or, in the alternative, that the comment period in the rulemaking be extended for at least six months. (The Petition and Emergency Petition are collectively referred to in these comments as the "Petitions.")[1]

Westinghouse opposes any suspension of the AP1000 design certification amendment rulemaking and any extension of the rulemaking process or the rulemaking comment period. The Petitions provide no new information and raise no legitimate factual or legal basis for the Commission to take the extraordinary step of suspending or extending the rulemaking. Further, there is no "emergency" that requires such action by the Commission. 3

Westinghouse supports the current Commission approach to continue ongoing licensing proceedings and design certification reviews while conducting, in parallel, a comprehensive review of the Fukushima events in Japan. The positive approach of the Commission, both short term and long term, to evaluate the technical and policy issues related to those events, and identify what, if any, regulatory actions should be pursued by the Commission in light of that review and evaluation, is sound from both a technical and a regulatory standpoint. 2

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1 In addition to the Petitions, other comments have been filed in the AP1000 Design Certification Amendment rulemaking docket. This includes additional comments dated April 29, 2011 filed by the AP1000 Oversight Group and others. These additional comments generally repeat claims made in the Petitions, and amount to another attempt to raise issues previously considered and resolved by the NRC staff in the rulemaking docket. They present no additional support for the requested suspension of, or extension of the comment period for, the rulemaking.

In 1978, the Commission denied a petition (by the Union of Concerned Scientists) to halt all licensing, suspend all construction activities, and shut down all operating reactors because of issues relating to fire protection for electrical cables and environmental qualification of electrical components in nuclear power plants. *Petition for Emergency and Remedial Action*, CLI-78-6, 7 NRC 400 (1978), *aff'd* CLI-80-21, 11 NRC 707 (1980). (This decision is cited in the Petition (p. 8)). In its decision denying the petition, the Commission stated (7 NRC at 404):

> "Three actions which the petitioner requests are styled 'emergency relief.' The Commission was asked to shut down immediately all operating power reactors, to order immediately cessation of all construction involving connectors and electrical cables conducted under permits previously issued, and to impose immediately a moratorium on all power plant license issuances until licensees and applicants could demonstrate compliance with applicable regulations. Emergency actions, such as those requested, are procedures which obviously 'can radically and summarily affect the rights and interests of others, including licensees and those who depend on their activities. Our emergency powers must be responsibly exercised.'"[citation omitted] (emphasis added)

Imposition of the suspension or extension of the rulemaking process sought by the petitioners would have a major adverse impact on Westinghouse as well as on any future course of action of Westinghouse and the nuclear industry. This impact would extend well beyond any period that a suspension may last, and could call into question the viability of new nuclear power plants in the United States. Thus, Westinghouse urges the Commission to deny the Petitions.

II. THE CRITERIA FOR SUSPENSION OR EXTENSION OF THE AP1000 RULEMAKING ARE NOT MET

The questions which the Commission previously has addressed in deciding whether to continue ongoing regulatory actions or suspend or delay such actions are: (1) will continuing the regulatory action jeopardize the public health and safety; (2) will continuing the regulatory action prove an obstacle to fair and efficient decision-making; and (3) will continuing the regulatory action prevent appropriate implementation of any pertinent rule or policy changes that might emerge from ongoing Commission evaluations. See *In the Matter of Private Fuel Storage LLC* (Independent Spent Fuel Storage Installation), CLI-01-26, 54 NRC 376 (2001).

In the present situation with regard to the AP1000 rulemaking, the answer to each of these three questions is "no." Moving forward with the AP1000 rulemaking will not jeopardize the public health and safety. When completed, the AP1000 rulemaking will not authorize the construction or operation of any nuclear power plant. Thus, there is no need or "emergency" with regard to the AP1000 rulemaking proceeding that requires a suspension or delay in the ongoing rulemaking.

Continuation of the rulemaking is not an obstacle to fair and efficient decision-making. If changes to the AP1000 design are determined to be necessary as a result of lessons learned and to be learned from the Fukushima accident, NRC procedures provide an appropriate and adequate process for incorporating such changes on a plant-specific basis or by amendment to the certified design, including appropriate opportunity for public comment. For the same reason, moving forward will not prevent implementation of any new rule or policy change that may result from the Commission evaluation of the Fukushima accident.

III. CLAIMS IN THE PETITIONS

The Petitions are replete with misunderstandings of the Part 52 process and NRC regulations, misunderstandings about the design of the AP1000, and misrepresentations about what has occurred to date in the AP1000 rulemaking. Moreover, numerous statements in the Petitions commenting on technical matters relating to the AP1000 and on the NRC staff review of the AP1000 design are misleading or untrue. Set forth in Attachment 1 to these comments are specific comments on some of the misstatements contained in the Petition.

After calling for the NRC to postpone both the certification process and the licensing process "until the Fukushima lessons learned are investigated and resolved," the Petition then states that "... the debate over lessons to be learned from Japan will surely extend for months, if not years...." (Petition, p. 10, emphasis added). For reasons discussed elsewhere in these comments, there is no "emergency" in connection with the AP1000 rulemaking process or in connection with current licensing actions that requires, as suggested by the quotation, that these proceedings be shut down "for months, if not years."

In the Petitions, there also are a number of false statements that malign the integrity of the NRC regulatory staff. For example, the Petition alleges (pp. 12-13):

> "...the NRC apparently allowed industry's increasing pressure for DCD approval to cause it [the NRC] to bypass safety-based regulations ...."

The Petition also claims in several places that review of the AP1000 by the NRC regulatory staff was inadequate, and has not resolved safety issues. For example, the Petition states (Petition, p. 20):

> "In our opinion, several unresolved design and operational issues have not been given adequate review, and certainly have not been resolved safely. ... [the AP1000] design and operational procedures [were] so deficient that it [the AP1000] should have been sent back for further review." (emphasis added) [2]

Westinghouse submits that, contrary to these outrageous statements in the Petition about the bypass of safety regulations and the inadequacy of the NRC staff review, the NRC staff and the ACRS carefully reviewed the application for amendments to the AP1000 design, including the technical issues raised in the Petitions, before concluding that "there is reasonable assurance that the revised design can be built and operated without undue risk to the health and safety of the public" (SECY-11-0002, "Proposed Rule: AP1000 Design Certification Amendment (RIN 3150-A181)," dated January 3, 2011, p. 6).

[2] Similar statements are made in the Emergency Petitions and in other comments filed in the AP1000 rulemaking docket, including a filing by the AP1000 Oversight Group and other organizations, dated April 29 2011. For the same reasons as stated herein, these statements should be discounted.

The fact that several members of NRC staff filed non-concurrence statements does not change the fact that there was a careful and complete review of the application by the NRC staff. The concerns raised in the non-concurrence statements were reviewed fully both by the NRC staff and the ACRS, which resulted in a higher level of scrutiny and independent review of the issues as part of dispositioning the non-concurrences. The Petitions attempt to turn the non-concurrences into a charge that the review of the AP1000 was deficient should be rejected by the Commission.

IV. TMI PRECEDENT

In arguing that there should be an immediate halt to all new plant regulatory and licensing activities, both Petitions refer to the actions taken by the NRC after the Three Mile Island (TMI) accident as precedent for the proposed suspension of the AP1000 rulemaking docket. The Petition claims that the Commission *Statement of Policy: Further Commission Guidance for Power Reactor Operating Licenses*, CLI-80-42, 12 NRC 654 (1980) ('TMI Statement of Policy") describes "the NRC's decision to suspend all licensing activities while the [TMI] accident was being investigated" (Petition, p. 2.). Similarly, citing the same TMI Statement of Policy, the Emergency Petition asserts that the NRC "suspended all licensing decisions until conclusions of the [TMI] lesson learned process." The Emergency Petition further chastises the Commission for not describing its TMI "suspension" in the Commission's Memorandum dated April 4, 2011filed with the United States Court of Appeals for the Third Circuit in connection with the case of *New Jersey Environmental Federation et al. v. NRC* (No. 09-2567).[3] (Emergency Petition, pp. 21-22)

These and other statements in the Petitions demonstrate a misunderstanding of the actions of the NRC after the TMI accident and the directions in the TMI Statement of Policy. The Commission did not suspend licensing proceedings after the TMI accident. Nothing in the TMI Statement of Policy called for a "suspension" of "all licensing decisions" while the Commission investigated the TMI accident. It is noteworthy that the Union of Concerned Scientists and the Shoreham Opponents Coalition filed a request for a stay of the TMI Statement of Policy because the NRC did not suspend all of the then-pending licensing proceedings. The stay was denied by the NRC.[i]

In an Oversight Hearing on the accident at TMI, conducted on May 21 and 24, 1979, by the Subcommittee on Energy and the Environment of the Committee on Interior and Insular Affairs, U.S. House of Representatives on the accident at TMI, Commissioner Peter Bradford denied that a moratorium on operating licenses and construction permits had been imposed by the NRC. Congressman Edward Markey, who was chairing the hearing, asked for the views of NRC Chairman Joseph Hendrie on the statement by Commissioner Bradford. Chairman Hendrie responded: "... I would not feel that everything ought to come to a dead stop ...." Congressman Markey then remarked: "I want to say I am completely, 180 degree, [at] diametrical odds with your position ...." (Transcript, p. 52)

The status of NRC licensing actions after TMI was described by Harold R. Denton, Director, Office of Nuclear Reactor Regulation, NRC, on September 19, 1979, at a hearing before the

[3] This case involves the NRC's decision to relicense the Oyster Creek reactor, where the U.S. Court of Appeals for the Third Circuit directed the NRC to "advise the Court what impact, if any, the damages from the earthquake and tsunami at the Fukushima Daiichi Nuclear Power Station have on the propriety of granting the license on the renewal application for the Oyster Creek Generating Station."

Subcommittee on Energy Research and Production of the Committee on Science and Technology, U.S. House of Representatives on "Plans for Improved Safety of Nuclear Power Plants Following the Three Mile Island Accident" (Transcript, pp. 63-64)

- "... I presented the status of the various [NRC] task forces efforts and my recommendations with respect to near-term licensing actions to the NRC Commissioners. In response, the Commissioners directed that:

  1. Commission approval be obtained prior to issuance of any operating license or construction permits.
  2. ...
  3. ...
  4. The staff should continue licensing reviews and continue to present evidence at hearings on non-TMI related areas. The Commission deferred a decision on presentation of evidence related to TMI issues in hearings.

  Within the framework of these directives, it is my intention to proceed with licensing activities."

It should be noted that the NRC focus after TMI was on the operating reactors and the then-ongoing operating license proceedings.[4] In contrast, the Petitions seek to suspend or extend an ongoing rulemaking for amendments to the certification of the reactor design for the AP1000. 1
This is a completely different situation than was involved in Commission actions after TMI. As stated above, any lessons learned or to be learned from the Fukushima accident applicable to the AP1000 design can be factored into the design and AP1000 plants under construction, if appropriate, at a later time.

V. CONCLUSION

Westinghouse believes that the lessons learned and to be learned from the Fukushima accident must be understood and properly factored into NRC regulatory decisions. The approach currently being taken by the Commission to perform a systematic and methodical review of that accident to determine if there are changes that should be made to NRC programs and regulations is the 2
proper approach. The April 8, 2011 response of NRC Chairman Gregory Jaczko to Senator Barbara Boxer's letter of March 17, 2011, appropriately sets forth the very positive approach and plans of the NRC, both short term and long term, to review the events of Fukushima, evaluate the technical and policy issues related to those events, and identify what regulatory actions should be pursued by the NRC in light of that review and evaluation.

Westinghouse does not believe the Commission should suspend the AP1000 design certification 2
amendment rulemaking, extend the comment period for the rulemaking, or halt new plant certification and licensing activities to await the outcome of its review of the Fukushima

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[4] In response to a Commission Order dated April 19, 2011 inviting any person to file an answer to an Emergency Petition to suspend all pending licensing and related rulemaking decisions, Westinghouse filed a letter with the Commission on May 2, 2011, opposing any such suspension and endorsing the brief *amicus curiae* filed by the Nuclear Energy Institute opposing such suspensions.

accident. Such a suspension is unwarranted, unnecessary, and undesirable. Thus, the Commission should deny the request in the Petitions to suspend the AP1000 design certification amendment rulemaking, and should deny the request in the Emergency Petition to extend the rulemaking.

Attachment 1

The following are Westinghouse comments on some of the inaccurate or untrue statements in the Petitions.[5]

1. "The AP1000 design approval process should be suspended while the NRC investigates the implications of the ongoing catastrophic accident in Fukushima, Japan, and decides what 'lessons learned' must be incorporated into the AP100 design to ensure that they do not pose an undue risk to public health and safety or unacceptable environmental risks. (Petition, pp. 1-2, emphasis added)

Westinghouse Comment: There is no statutory or regulatory requirement in connection with the adoption of a design certification rule that the NRC must find that there is no "unacceptable environmental risk." NRC regulations on design certification do not require preparation or submittal of an environmental report in connection with an application for design certification, and Part 51 – the NRC's environmental protection regulations – does not identify design certifications in § 51.20(b) when setting forth the types of actions which require an environmental impact statement.

As stated in the Federal Register notice, 76 Fed. Reg. 10269 at 10280:

> "The Commission has determined under NEPA, and the Commission's regulations ... that this proposed DCR, if adopted, would not be a major Federal action significantly affecting the quality of the human environment and, therefore, an environmental impact statement (EIS) is not required. The basis for this determination, as documented in the EA, is that the Commission has made a generic determination under 10 CFR 51.32(b)(2) that there is no significant environmental impact associated with the issuance of an amendment to a design certification. This amendment to 10 CFR Part 52 would not authorize the siting, construction, or operation of a facility using the amended AP1000 design; it would only codify the amendment to the AP1000 design in a rule."

Even if such a requirement were applicable to a design certification rulemaking, there is no "emergency" relating to the implementation of such a requirement that would require suspension of the design certification amendment proceeding, or, indeed, any licensing proceeding.

2. "The implications [of the Fukushima accident] that must be studied cover a wide spectrum of regulatory issues, including, but not limited to, adequacy of backup measures for loss of offsite power, emergency core cooling, spent fuel storage risks, sufficiency of emergency planning and adequacy of containment and shield structures." (Petition, p. 2, emphasis added)

Westinghouse Comment: There are two different misunderstandings in the quoted statement: (1) the adequacy of backup measures for loss of offsite power is not within the scope of the rulemaking for a certified design; and (2) emergency planning and the sufficiency of emergency

[5] Westinghouse is not commenting on the technical aspects of the Petitions and other filings due to the fact that it believes that all such technical matters have been addressed previously in the AP1000 rulemaking docket, including reviews by the NRC staff and the ACRS.

planning are not within the scope of the rulemaking for a certified design. Even if these items were within the scope of the design certification rulemaking, there is no "emergency" that would require suspension or extension of the design certification amendment rulemaking or, indeed, any licensing proceeding.

3. "... the Commission issued a final rule certifying the AP1000 design in January 2006. However, at the time of the rulemaking approval, a significant number of major Tier 1 items had not been completed by Westinghouse or reviewed by the NRC staff." (Petition, p. 4)

Westinghouse Comment: This statement is inaccurate. When the Commission certified the AP1000 design (71 Fed. Reg. 4464, January 27, 2006), the Commission determined that the applicable requirements of 10 CFR 52.54, "Issuance of Standard Design Certification," were met. Thus, the Commission determined, among other things, that "Issuance of the standard design certification will not be inimical to the common defense and security or to the health and safety of the public" (10 CFR 52.54(a)(6)). Clearly, to the extent necessary for this determination to be made, all Tier 1 items were complete and the designs of such Tier 1 items were reviewed by the NRC staff.

As noted in SECY-11-0002, "Proposed Rule: AP1000 Design Certification Amendment (RIN 3150-A181)," dated January 3, 2011 (p. 3):

> "Many of the proposed changes relate to the satisfactory completion [by Westinghouse] of COL information items and the resolution of DAC and other design changes resulting from detailed design efforts. The staff SER provides the safety basis for acceptability of changes."

The fact that there has been completion of COL information items, resolution of DACs, and further detailed design efforts by Westinghouse does not mean, contrary to the statement in the Petition, that Tier 1 items had not been completed or reviewed by the NRC staff to the extent necessary to make the requisite finding for issuance of the AP1000 design certification rule in 2006.

4. "... the NRC Staff has repeatedly found serious deficiencies in the design [of the AP1000] requiring new revisions." (Petition, p. 5)

Westinghouse Comment: The implication of this statement is that Westinghouse design efforts have shown serious deficiencies. This implication is not true. During NRC staff review of the proposed amendments to the AP1000 certified design, the NRC staff, on occasion, did not accept certain of the original design changes proposed by Westinghouse. In response, Westinghouse conducted additional analysis, reviews and in some cases, testing, and where appropriate made modifications to the AP1000 design. This process is normal in connection with NRC staff review of applications for certified designs, as well as in connection with NRC staff review of license applications.

5. "A notable example of a design issue that has not been resolved is the shield building." (Petition, p. 5)

Westinghouse Comment: This statement is not true. The NRC Staff issued its approval of the shield building in the Advanced Final Safety Evaluation Report dated December 28, 2010. (The report is referenced in the Petition.) Further, SECY-11-0002, in which the NRC staff requests "Commission approval to publish for public comment a proposed rule that would certify an amendment to the AP1000 standard design," the NRC staff approved the proposed design for the shield building. Moreover, the ACRS agreed with the staff as to the adequacy of the shield building design – a fact not mentioned in the Petition. Thus, SECY-11-0002 states (p. 6):

> "During the ACRS full committee meeting held on December 2-4, 2010, the staff presented its shield building design safety evaluation and the non-concurrence was discussed. The ACRS agreed with the staff's safety evaluation position on the shield building design and concluded that the proposed changes in theAP1000 amendment maintain the robustness of the certified design and that <u>there is reasonable assurance that the revised design can be built and operated without undue risk to the health and safety of the public.</u>" (emphasis added)

6. In the Petition (p. 6), there is an attempt, by referencing the non-concurrence of Dr. John Ma to reopen the shield building approval. Thus, after erroneously asserting that the design issue involving the shield building has not been resolved (see item 5 above), the Petition sets forth four alleged concerns of Dr. Ma. The Petition later elaborates on the issue of the shield building (Petition, pp. 12-14).

Westinghouse Comment: Omitted from the Petition is the fact that both the NRC staff and the ACRS agreed that the design of the shield building is sufficient to provide adequate protection of the public health and safety.

7. "In the related January 24, 2011 report on the safety aspects of the Vogtle COL ... the ACRS also indicated that the DCD was not ready for review, noting 'the staff should review with us the changes in design or commitments that are not yet incorporated in the COLA or referenced in the Design Control Document (DCD), which significantly deviate from those presented during our review." (Petition, p. 6)

Westinghouse Comment: This statement in the Petition is a misrepresentation of the conclusion reached by the ACRS in its January 24, 2011 report on Vogtle, Units 3 and 4. In the introductory paragraph of its report, the ACRS states that it had reviewed the NRC staff's Advanced Safety Evaluation Report (ASER) for the pending COLA for Vogtle, which incorporates by reference, the AP1000 Design Certification Amendment application and the Vogtle Early Site Permit. The ACRS further states that "This report [the ACRS report of January 24, 2011] fulfills the requirement of 10 CFR 52.53 that the ACRS report on those portions of the application which concern safety."

Under the heading "CONCLUSION AND RECOMMENDATIONS," the ACRS report states:

> "1. There is reasonable assurance that VEGP, Units 3 and 4, can be built and operated without undue risk to the health and safety of the public."

It is only in that context that the ACRS report says:

> "5. The staff should review with us the changes in design or commitments that are not yet incorporated in the COLA or referenced in the Design Control Document (DCD), which significantly deviate from those presented during our review.

Nowhere does the ACRS state that the DCD was not ready for review. Rather, the ACRS was recognizing that there could be further changes in the design or commitments, and requesting that, if there were such changes and they significantly deviated from those presented in the ACRS review leading to its statement of reasonable assurance, the ACRS wanted those future changes presented to it for its review.

PR 52
(76FR10269)

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Rulemaking Comments

From: John Runkle [jrunkle@pricecreek.com]
Sent: Tuesday, May 10, 2011 6:19 PM
To: Rulemaking Comments
Subject: DOCKET ID NRC-2010-0131
Attachments: Safer Storage of Spent Nuclear Fuel.pdf; lochbaum-senate-energy-3-29-2011.pdf; Thompson Storage Study.pdf; Alverez et al Princeton Study.pdf

DOCKETED
USNRC

May 11, 2011 (9:00 am)

OFFICE OF SECRETARY
RULEMAKINGS AND
ADJUDICATIONS STAFF

Part 1 of 2

May 10, 2010

Attached please find the following

1. Union of Concerned Scientists, "Safer Storage of Spent Nuclear Fuel: The Problems of Spent Fuel Pools," revised March 24, 2011 8

2. Statement of David Lockbaum, Director, Nuclear Safety Project, before the U.S. Senate Energy and Natural Resources Committee, March 29, 2011 9

3. Alvarez et al., "Reducing the Hazardous from Stored Spent Power-Reactor Fuel in the United States," January 2003 10

4. Thompson, "Robust Storage of Spent Nuclear Fuel: A Neglected Issue of Homeland Security," January 2003. 11

5. National Academies of Science, "Safety and Security of Commerical Spent Nuclear Storage (Public Report)," 2006 12

Because of you size limitations, I am including document 5 in a separate email.

Together these document provide additional support that the AP1000 Certification rulemaking should be DENIED because of the inadequate spent fuel pools, and/or postponed or significantly extended to allow the NRC to develop and implement lessons learned from the Fukushima accident. As stated in the PETITION TO SUSPEND AP1000 DESIGN CERTIFICATION RULEMAKING PENDING EVALUATION OF FUKUSHIMA ACCIDENT IMPLICATIONS ON DESIGN AND OPERATIONAL PROCEDURES AND REQUEST FOR EXPEDITED CONSIDERATION, there was a significant backsliding from Revision 15 to Revision 18 by increasing the density of the spent fuel pools. 1 2 1

It is also readily apparent that some of the lessons learned from the Fukushima accident are:

a. spent fuel pools should not be densely packed b. there should be a robust containment around the fuel pools c. there should be redundant cooling systems for the fuel pools d. the build up of hydrogen in the fuel pools needs to be addressed e. there should be back up power for pumps, cooling systems and monitoring systems 1 2 3 4

Other lessons regarding the spent fuel pools may be learned after investigation. 5

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Template = SECY-067

DS 10

Union of Concerned Scientists

Safer Storage of Spent Nuclear Fuel

The Problems with Spent Fuel Pools

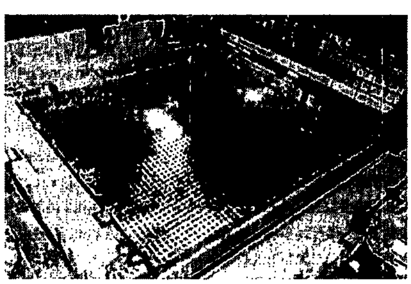
When fuel rods in a nuclear reactor are "spent," or no longer usable, they are removed from the reactor core and replaced with fresh fuel rods. The spent fuel rods are still highly radioactive and thus continue to generate heat for years. The fuel assemblies, which consist of dozens of fuel rods, are moved to pools of water to cool. They are on kept on racks in the pool, and water is continuously circulated to draw heat away from the rods.

Because no permanent repository for spent fuel exists in the United States (or elsewhere), reactor owners have kept spent fuel at the reactor sites. As the amount of spent fuel has increased, the Nuclear Regulatory Commission has authorized many power plant owners to increase the amount in their storage pools to as much as five times what they were designed to hold. As a result, virtually all U.S. spent fuel pools have been "re-racked" to hold spent fuel assemblies at densities that approach those in reactor cores. In order to prevent the spent fuel from going critical, the spent fuel assemblies are placed in metal boxes whose walls contain neutron-absorbing boron.

If a malfunction, a natural disaster, or a terrorist attack causes the water to leak from the pool or the cooling system to stop working, the rods will begin to heat the remaining water in the pool, eventually causing it to boil and evaporate. If the water that leaks or boils away cannot be replaced, the water level will drop, exposing the fuel rods.

Once the fuel is uncovered, it could become hot enough to suffer damage, which in turn could release large amounts of radioactive gases, such as cesium-137, into the environment. A typical spent fuel pool in the United States holds 1,000 or more tons of fuel, so a radioactive release could be very large.

Spent Fuel Pool Vulnerabilities



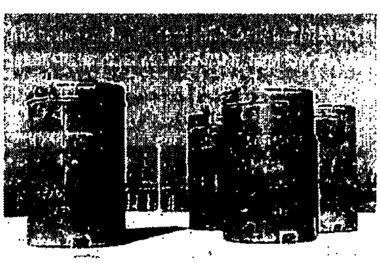
The spent fuel pools are located only within the secondary containment of the reactor—the reactor building—and not within the more robust primary containment that is designed to keep radiation released from the reactor vessel during an emergency event from escaping into the environment. Thus, any radiation released from a spent fuel pool is more likely to reach the outside environment than is radiation released from the reactor core. Moreover, because it is outside the primary containment, the spent fuel pool is more vulnerable than the reactor core to terrorist attack.

Continuing to add spent fuel to these pools compounds this problem by increasing the amount of radioactive material that could be released into the environment. A large radiation release from a spent fuel pool could result in thousands of cancer deaths and hundreds of billions of dollars in decontamination costs and economic damage. The amount of land contaminated by a release from a spent fuel pool could be significantly greater than that contaminated by the Chernobyl disaster.

Like the cooling system for the reactor core, the cooling system for the spent fuel pools is powered by the electric grid. However, the reactor core cooling system has two back-up power supplies—diesel generators and either a four- or eight-hour DC battery—whereas the spent fuel pool system typically has none. More generally, the industry and the NRC have given little thought to spent fuel pool accidents, and there is virtually no operator training for handling such accidents.

Advantages of Dry Cask Storage

The risks from spent fuel in storage pools can be reduced by placing some of it in dry casks. Dry casks are made of steel and concrete, with the concrete providing shielding from radiation, and are stored outdoors on concrete pads. To become cool enough to be placed in the dry casks currently licensed and used in the United States, the spent fuel must first spend about five years in a spent fuel pool. By then it is cool enough that further cooling can be accomplished by natural convection—air flow driven by the decay heat of the spent fuel itself.



By transferring fuel from spent fuel pools to dry casks, plants can lower the risk from spent fuel in several ways:

First, with less spent fuel remaining in the pools, workers will have more time to cope with a loss of cooling or loss of water from the pool, because the amount of heat released by the spent fuel is lower. With less heat, it takes longer for the water to heat up and boil away.

Second, if there is less fuel in the pool, it can be spread out more, making it easier for water to cool the fuel. When fuel is densely packed, less water flows past each fuel assembly.

Third, because there is less fuel in the pool, if workers are unable to prevent an accident, the amount of radioactive gas emitted from the pool will be much lower than it would be otherwise.

The combination of reducing the likelihood of an event and reducing the consequences of an event significantly reduces the risk from a spent-fuel accident. In contrast to spent fuel pools, dry casks are not vulnerable to loss of coolant because their cooling is passive.

While dry casks are still vulnerable to safety and security hazards, those risks are reduced. In contrast to the large amount of fuel in a single spent fuel pool, each dry cask only holds about 15 tons of spent fuel. Thus, it would require safety failures at many dry casks to produce the scale of radiological release that could result from a safety failure at one spent fuel pool. Likewise, terrorists would have to break open many dry casks to release as much radioactivity as a single spent fuel pool could release. Therefore, an attack on a dry cask storage area would, in most circumstances, result in a much smaller release of radioactivity than an attack on a storage pool.

UCS recommendations

- All spent fuel should be transferred from wet to dry storage within five years of discharge from the reactor core. This can be achieved with existing technologies.
- The NRC should upgrade existing regulations to require that dry cask storage sites be made more secure against a terrorist attack.
- The NRC should significantly upgrade emergency procedures and operator training for spent fuel pool accidents.

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ROBUST STORAGE OF SPENT NUCLEAR FUEL: A Neglected Issue of Homeland Security

by

Gordon Thompson

January 2003

A report commissioned by

Citizens Awareness Network

About IRSS

The Institute for Resource and Security Studies (IRSS) is an independent, non-profit corporation. It was founded in 1984 to conduct technical and policy analysis and public education, with the objective of promoting international security and sustainable use of natural resources. IRSS projects always reflect a concern for practical solutions to resource, environment and security problems. Projects include detailed technical studies, participation in public education and debate, and field programs that promote the constructive management of conflict.

About the author

Dr. Gordon Thompson is the executive director of IRSS and a research professor at Clark University. He received an undergraduate education in science and mechanical engineering in Australia and a doctorate in applied mathematics from Oxford University. Thompson has extensive experience in assessing the safety and security hazards associated with nuclear facilities, and in identifying alternative designs and modes of operation that can reduce a facility's hazard potential.

Acknowledgements

This report was commissioned by Citizens Awareness Network (CAN). The author thanks Deb Katz of CAN for her courtesy and assistance during this project. During preparation of the report, important insights and perspectives were contributed by Robert Alvarez, Diane Curran, Robert Goble, Paula Gutlove and Jim Warren. The author, Gordon Thompson, is solely responsible for the content of this report.

Abstract

The prevailing practice of storing most US spent nuclear fuel in high-density pools poses a very high risk. Knowledgeable attackers could induce a loss of water from a pool, causing a fire that would release to the atmosphere a huge amount of radioactive material. Nuclear reactors are also vulnerable to attack. Dry-storage modules used in independent spent fuel storage installations (ISFSIs) have safety advantages in comparison to pools and reactors, but are not designed to resist a determined attack. Thus, nuclear power plants and their spent fuel can be regarded as pre-deployed radiological weapons that await activation by an enemy. The US government and the Nuclear Regulatory Commission seem unaware of this threat.

This report sets forth a strategy for robust storage of US spent fuel. Such a strategy will be needed whether or not a repository is opened at Yucca Mountain. This strategy should be implemented as a major element of a defense-in-depth strategy for US civilian nuclear facilities. In turn, that defense-in-depth strategy should be a component of a homeland-security strategy that provides solid protection of our critical infrastructure.

The highest priority in a robust-storage strategy for spent fuel would be to re-equip spent-fuel pools with low-density, open-frame racks. As a further measure of risk reduction, ISFSIs would be re-designed to incorporate hardening and dispersal. Preliminary analysis suggests that a hardened, dispersed ISFSI could be designed to meet a two-tiered design-basis threat. The first tier would require high confidence that no more than a small release of radioactive material would occur in the event of a direct attack on the ISFSI by various non-nuclear instruments. The second tier would require reasonable confidence that no more than a specified release of radioactive material would occur in the event of attack using a 10-kilotonne nuclear weapon.

Table of Contents

1. Introduction

> "One fact dominates all homeland security threat assessments: terrorists are strategic actors. They choose their targets deliberately based on the weaknesses they observe in our defenses and our preparations. They can balance the difficulty in successfully executing a particular attack against the magnitude of loss it might cause."
> National Strategy for Homeland Security[1]

It is well known that nuclear power plants and their spent fuel contain massive quantities of radioactive material. (Note: Irradiated fuel discharged from a nuclear reactor is described as "spent" because it is no longer suitable for generating fission power.) Consequently, thoughout the history of the nuclear power industry, informed citizens have expressed concern that a substantial amount of this material could be released to the environment. One focus of concern has been the possibility of an accidental release caused by human error, equipment failure or natural forces (e.g., an earthquake). In response to citizens' demands and events such as the Three Mile Island reactor accident of 1979, the US Nuclear Regulatory Commission (NRC) has taken some actions that address this threat.

To date, citizens have been much less successful in forcing the NRC to address a related threat -- the possibility that a release of radioactive material will be caused by an act of malice or insanity. The citizens' failure is not for lack of effort. For many years, citizen groups have petitioned the NRC and engaged in licensing interventions, seeking to persuade the NRC to address this threat. Yet, the agency has responded slowly, reluctantly and in limited ways, even after the terrorist attacks of 11 September 2001. This limited response is not unique to the NRC. The US government in general seems unwilling to address the possibility that an enemy, domestic or foreign, will exploit a civilian nuclear facility as a radiological weapon.

The terrorist attacks of September 2001 demonstrated the vulnerability of our industrial society to determined acts of malice, and cruelly validated long-neglected warnings by many analysts and concerned citizens. In response, the United States employed its military capabilities in Afghanistan and has signaled its willingness to use those capabilities in Iraq and elsewhere. Yet, nothing significant has been done to defend US nuclear power plants and their spent fuel against attack. There is much discussion in the media about "dirty bombs" that disperse radioactive material, but decision makers seem

[1] Office of Homeland Security, 2002, page 7.

largely unaware that civilian nuclear facilities contain massive quantities of radioactive material and are vulnerable to attack.

What is Robust Storage?

This report addresses robust storage of spent fuel from nuclear power plants. Here, the term "robust" means that a facility for storing spent fuel is made resistant to attack. The provision of robust storage would substantially reduce the potential for a maliciously-induced release of radioactive material from spent fuel, and would thereby enhance US homeland security. Robust storage of spent fuel should be viewed as a component of a national strategy for reducing the vulnerability of all civilian nuclear facilities, within the context of homeland security. This report takes such a view.

A spent-fuel-storage facility can be made resistant to attack in three ways. First, the facility can be made passively safe, so that spent fuel remains in a safe state without needing electrical power, cooling water or the presence of an operating crew. Second, the facility can be "hardened", so that the spent fuel and its containment structure are protected from damage by an instrument of attack (e.g., an anti-tank missile). For a facility at ground level, hardening involves the provision of layers of concrete, steel, gravel or other materials above and around the spent fuel. Third, the facility can be "dispersed", so that spent fuel is not concentrated at one location, but is spread more uniformly across the site. Dispersal can reduce the magnitude of the radioactive release that would arise from a given attack.

At present, all but a tiny fraction of US spent fuel is stored at the nation's nuclear power plants. Most of this fuel is stored at high density in water-filled pools that are adjacent to, but outside, the containments of the reactors. This mode of storage does not meet any of the above-stated three conditions for robustness. High-density spent-fuel pools are not passively safe. Indeed, if water is lost from such a pool, which could occur in various ways, the fuel will heat up, self-ignite and burn, releasing a large amount of radioactive material to the environment. Spent-fuel pools are not hardened against attack, and a pool concentrates a large amount of spent fuel in a small space, which is the antithesis of dispersal.

A growing fraction of US spent fuel, now about 6 percent of the total inventory, is stored in dry-storage facilities at nuclear power plants. The storage is "dry" in the sense that the spent fuel is surrounded by a gas such as helium, rather than by water. The NRC describes a spent-fuel-storage facility, other than a spent-fuel pool at a nuclear power plant, as an independent spent fuel storage installation (ISFSI).[2] All but two of the existing ISFSIs are at the sites of nuclear power plants, either operational plants or plants undergoing decommissioning.[3] Future ISFSIs could be built at nuclear-power-plant sites or at away-from-reactor sites. An application to build an ISFSI at an away-from-reactor site -- Skull Valley, Utah -- is awaiting decision by the NRC. It should be noted that the nuclear industry is building dry-storage ISFSIs not as an alternative to high-density pools, but to accommodate the growing inventory of spent fuel as pools become full.

Dry-storage ISFSIs meet one of the above-stated three conditions for robust storage of spent fuel. They are passively safe, because their cooling depends on the natural circulation of ambient air. However, none of the existing or proposed ISFSIs is hardened, and none of them is dispersed across its site.

A Broader Context

This report describes the need for robust storage of all US spent fuel, whether in pools or dry-storage ISFSIs, and sets forth a strategy for meeting this need. As discussed above, a productive discussion of these issues must occur within a broader context, which is is addressed in this report. The provision of robust storage of spent fuel must be viewed as a component of a national strategy for defending the nation's civilian nuclear industry, including all of the nuclear power plants and all of their spent fuel. That strategy must in turn be viewed as a component of homeland security in general. Finally, homeland security must be viewed as a key component of US strategy for national defense and international security.

The various levels of security, ranging from the security of nuclear facilities to the security of the nation and the international community, are linked in surprising ways. If our nuclear facilities and other parts of our infrastructure -- such as the airlines -- are poorly defended, we may feel compelled to use military force aggressively around the world, to punish or pre-empt attackers. Such action poses the risk of arousing hostility and promoting anarchy, leading to new attacks on our homeland. The potential exists for an escalating spiral of violence. If, however, our nuclear facilities and other critical items of infrastructure are strongly defended, we can gain a double benefit. First, the communities around each facility will receive direct protection. Second, we can take a more measured approach to national defense, with a greater prospect of detecting, deterring and apprehending potential attackers without undermining civil liberties or international

[2] One wet-storage ISFSI exists in the USA, at Morris, Illinois. All other existing ISFSIs, and all planned ISFSIs, employ dry storage.

[3] The existing ISFSIs that are not at nuclear-power-plant sites are the small wet-storage facility at Morris and a facility in Idaho that stores fuel debris from Three Mile Island Unit 2.

security. Thus, a decision about the level of protection to be provided at a nuclear facility has wide-ranging implications.

The Need for Further Investigation

The investigation leading to this report has identified a number of technical issues that could not be resolved within the scope of the investigation. Issues of this kind are flagged in relevant parts of the report. Also, this report has a broad focus. It sets forth a strategy for providing robust storage of US spent fuel, and outlines a design approach for hardened, dispersed, dry storage. Additional analysis, supported by experiments, would be needed to test and refine this design approach and to determine the feasibility of implementing hardened, dispersed, dry storage at particular sites. That work would, in turn, set the stage for detailed, engineering-design studies that could lead to site-specific implementation. Moreover, a variety of governmental actions would be needed to support nationwide implementation of robust storage. For example, the NRC would need to develop new regulations and guidance. Also, the implementation program would require new financing arrangements, which would probably require new legislation.

Sensitive Information

An attack on a nuclear facility could be assisted by detailed information about the facility's vulnerability and the measures taken to defend the facility. Thus, certain categories of information related to a facility are not appropriate for general distribution. However, experience shows that secrecy breeds incompetence, complacency and conflicts of interest within the organizations that are shielded from public view.[4] Thus, in the context of defending nuclear facilities, protection of the public interest requires that secrecy be limited in two respects. Firstly, the only information that should be withheld from the public is detailed technical information that would directly assist an attacker. Second, stakeholder groups should be fully engaged in the development and implementation of measures for defending nuclear facilities, through processes that allow debate but protect sensitive information.[5] It should be noted that this report does not contain sensitive information and is suitable for general distribution.

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[4] Thompson, 2002a, Section X.
[5] Thompson, 2002a, Sections IX and X.

Robust Storage and Related Concepts

Issues addressed in this report have been the subject of public debate around the United States, and this debate has been framed in a number of ways. One approach has been to speak of "risk reduction", whereby robust storage of spent fuel and related measures are used to reduce the risk of a maliciously-induced release of radioactive material from nuclear facilities. This approach explicitly recognizes that the risk can be reduced but, given the continued existence of radioactive material, cannot be eliminated. Another approach has been to speak of "hardened on-site storage" as a strategy for managing US spent fuel. This approach advocates the robust storage of all spent fuel, but only at the sites of nuclear power plants. A related but distinct approach is "nuclear guardianship", whose supporters argue that radioactive materials should be contained in accessible, monitored storage facilities for the foreseeable future. The robust-storage strategy that is outlined in this report is compatible with all three approaches, and with a prudent assessment of the likelihood and timeframe for development of a radioactive-waste repository at Yucca Mountain.

Structure of this Report

The remainder of this report begins, in Section 2, with the provision of some basic information about US nuclear power plants and their spent fuel. Then, Section 3 discusses the potential for attacks on nuclear facilities, describes the US government's response to this threat, and outlines a balanced response. Section 4 addresses the vulnerability of nuclear facilities to attack, describes the potential consequences of an attack, outlines a defense-in-depth strategy for a nuclear facility, and sets forth a national strategy for robust storage of spent fuel. Elaborating upon this proposed strategy for robust storage, Section 5 discusses the various factors that must be considered in planning hardened, dispersed, dry storage of spent fuel. Section 6 offers a design approach that accounts for these factors. A set of requirements for nationwide implementation of robust storage is described in Section 7. Conclusions are set forth in Section 8, and a bibliography is provided in Section 9. Documents cited in this report are, unless indicated otherwise, drawn from this bibliography.

2. Nuclear Power Plants and Spent Fuel in the USA

2.1 Status and Trends of Nuclear Power Plants and Spent Fuel

There are 103 commercial nuclear reactors operating in the USA at 65 sites in 31 states.[6] Of these 103 reactors, 69 are pressurized-water reactors (PWRs), 9 with ice-condenser containments and 60 with dry containments. The remaining 34 reactors are boiling-water reactors (BWRs), 22 with Mark I containments, 8 with Mark II containments and 4 with Mark III containments. In addition there are 27 previously-operating commercial reactors in various stages of storage or decommissioning. As of December 2000, all but 2 of the 103 operating reactors had been in service for at least 9 years, and 55 reactors had been in service for at least 19 years.[7] Thus, the reactor fleet is aging. The nominal duration of a reactor operating license is 40 years.

Four of the 103 operating reactors have design features intended to resist aircraft impact. The Limerick Unit 1, Limerick Unit 2 and Seabrook reactors were designed to withstand the impact of an aircraft weighing 6 tonnes, while the Three Mile Island Unit 1 reactor was designed to withstand the impact of an aircraft weighing 90 tonnes. No other US reactor was designed to withstand aircraft impact.[8]

Wet and Dry Storage of Spent Fuel

The core of a commercial nuclear reactor consists of several hundred fuel assemblies.[9] Each fuel assembly contains thousands of cylindrical, uranium-oxide pellets stacked inside long, thin-walled tubes made of zirconium alloy. These tubes are often described as the "cladding" of the fuel. After several years of use inside an operating reactor, a fuel assembly becomes "spent" in the sense that it is no longer suitable for generating fission power. Then, the fuel is discharged from the reactor and placed in a water-filled pool adjacent to the reactor but outside the reactor containment. This fuel, although spent, contains numerous radioactive isotopes whose decay generates ionizing radiation and heat.

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[6] In addition, Browns Ferry Unit 1, a BWR with a Mark I containment, is nominally operational. However, it is defueled and not in service.
[7] Data from the NRC website (www.nrc.gov), 24 April 2002.
[8] Markey, 2002, page 73.
[9] The number of fuel assemblies in a reactor core ranges from 121 (in some PWRs) to 764 (in some BWRs).

After a period of storage in a pool, the thermal power produced by a fuel assembly declines to a level such that the assembly can be transferred to a dry-storage ISFSI. Current practice is to allow a minimum cooling period of 5 years before transfer to dry storage. However, this cooling period reflects an economic and safety tradeoff rather than a fundamental physical limit. Fuel cooled for a shorter period than 5 years could be transferred to dry storage, but in that case fewer assemblies could be placed in each dry-storage container. Alternatively, older and younger spent fuel (counting age from the date of discharge from the reactor) could be co-located in a dry-storage container. The major physical limit to placement of spent fuel in dry storage is the maximum temperature of the cladding, which the NRC now sets at 400 degrees C. This temperature limit constrains the allowable heat output of the fuel, which in turn constrains the cooling period.

Development of ISFSIs

At present, there are 20 ISFSIs in the USA, of which 15 are at sites where commercial reactors are in operation.[10] More ISFSIs will be needed, because the spent-fuel pools at operating reactors are filling up. Analysis by Allison Macfarlane of MIT shows that, by 2005, almost two-thirds of reactor licensees will face the need to acquire onsite dry-storage capacity, even if shipment of spent fuel away from the reactor sites begins in 2005.[11] NAC International, a consulting firm and vendor of dry-storage technology, reaches similar conclusions. NAC estimates that, at the end of 2000, about 6 percent of the US inventory of commercial spent fuel was stored in ISFSIs at reactor sites, whereas about 30 percent of the inventory will be stored in ISFSIs by 2010.[12] New ISFSIs entering operation by 2010 will generally be at reactor sites, although some might be at new sites. At present, only one proposed ISFSI at a new site -- Skull Valley, Utah -- seems to be a plausible candidate for operation by 2010.

Shipment of Spent Fuel from Reactor Sites

If spent fuel is shipped away from a reactor site, the fuel could have three possible destinations. First, fuel could be shipped to another reactor site, which Carolina Power and Light Co. is now doing, shipping fuel from its

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[10] Data from the NRC website (www.nrc.gov), 24 April 2002.
[11] Macfarlane, 2001a.
[12] NAC, 2001. NAC estimates that the end-2000 US inventory of spent fuel was 42,900 tonnes, of which 2,430 tonnes was in ISFSIs. Also, NAC estimates that the 2010 US inventory will be 64,300 tonnes, of which 19,450 tonnes will be in ISFSIs.

Brunswick and Robinson reactors to its Harris site.[13] Second, fuel could be shipped to an ISFSI at an away-from-reactor site, such as Skull Valley. Third, fuel could be shipped to a repository at Yucca Mountain, Nevada. At Yucca Mountain, the fuel would be emplaced in underground tunnels. Under some scenarios for the operation of Yucca Mountain, emplacement would be preceded by a period of interim storage at the surface.

There seems to be no current planning for shipment of spent fuel to any reactor site other than Harris. Also, there are factors that argue against shipping fuel to an away-from-reactor ISFSI. First, such shipment would increase the overall transport risk, because fuel would be shipped twice, first from the reactor site to the ISFSI, and then from the ISFSI to the ultimate repository. Second, an away-from-reactor ISFSI would hold a comparatively large inventory of spent fuel, creating a potentially attractive target for an enemy.[14] Third, shipment to an away-from-reactor ISFSI would not free most reactor licensees from the obligation to build some ISFSI capacity at each reactor site.[15] Fourth, there is a risk that a large, away-from-reactor ISFSI would become, by default, a permanent repository, despite having no long-term containment capability. Finally, storage of spent fuel in reactor-site ISFSIs could be cheaper than shipping fuel to away-from-reactor ISFSIs.[16] Time will reveal the extent to which these factors affect the development of away-from-reactor ISFSIs at Skull Valley or elsewhere.

Yucca Mountain

The Yucca Mountain repository project will not free reactor licensees from the obligation to develop ISFSI capacity, for three reasons. First, the Yucca Mountain repository may never open. This project is politically driven, does not have a sound scientific basis, and is going forward only because previously-specified technical criteria for a repository have been abandoned.[17] These deficiencies add weight to the determined opposition to this project by the state of Nevada and other entities. That opposition will also be fueled by concern about the risk of transporting fuel to Yucca Mountain. Second, decades will pass before fuel can be emplaced in a repository at Yucca Mountain. The US Department of Energy (DOE) claims that it can open the repository in 2010, but the US General Accounting Office has determined that

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[13] The Harris site features one reactor and four spent-fuel pools, and thus has more pool-storage capacity than other reactor sites. Spent fuel that is shipped to Harris is placed in a pool, and there is no current plan to build an ISFSI at Harris.
[14] The proposed Skull Valley ISFSI could hold 40,000 tonnes of spent fuel, according to the Private Fuel Storage website (www.privatefuelstorage.com), 4 October 2002.
[15] Macfarlane, 2001a.
[16] Macfarlane, 2001b.
[17] Ewing and Macfarlane, 2002.

several factors, including budget limitations, could extend this date to 2015 or later.[18] DOE envisions that, after the repository is opened, emplacement of fuel will occur over a period of at least 24 years and potentially 50 years.[19] This vision may prove to be optimistic. Third, under present federal law the Yucca Mountain repository will hold no more than 63,000 tonnes of commercial spent fuel.[20] Yet, the cumulative amount of commercial spent fuel to be generated during the lifetimes of the 103 currently-licensed reactors is likely to exceed 80,000 tonnes.[21] Reactor licensees have shown strong interest in obtaining license extensions which, if granted, would lead to the production of a substantial additional amount of spent fuel.

Summary

To summarize the preceding paragraphs, it is clear that thousands of tonnes of spent fuel will be stored at reactor sites for several decades to come, in pools and/or ISFSIs. Similar amounts of fuel might be stored at away-from-reactor ISFSIs. Moreover, it is entirely possible that the Yucca Mountain repository will not open, with the result that the entire national inventory of spent fuel will be stored for decades, perhaps for 100 years or more, at reactor sites (in pools and/or ISFSIs) and/or at away-from-reactor ISFSIs. It is therefore imperative that each ISFSI is planned to allow for its possible extended use. The NRC has begun to recognize this need, by performing research to determine if dry storage of spent fuel can safely continue for a period of up to 100 years.[22]

2.2 Present Practice for Storing Spent Fuel

The technology that is currently used for storing spent fuel was developed without consideration of the possibility of an attack. Nor was there any consideration of the possibility that spent fuel would be stored for many decades. Instead, the technology has developed incrementally, in response to

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[18] Jones, 2002b.

[19] DOE, 2002. DOE contemplates the construction of a surface facility for interim storage of spent fuel at Yucca Mountain, especially if emplacement of fuel occurs over a period of 50 years. However, given the cost of this surface facility, a more likely alternative is that fuel would remain in ISFSIs until it could be emplaced in the repository.

[20] DOE, 2002. The Nuclear Waste Policy Act limits the total amount of waste that can be placed in a first repository to 70,000 tonnes until a second repository is in operation. DOE plans to use 63,000 tonnes of this capacity for commercial spent fuel. DOE has studied the possible expansion of Yucca Mountain's capacity to include 105,000 tonnes of commercial spent fuel together with other wastes.

[21] Macfarlane, 2001a.

[22] "Radioactive Waste Safety Research", from NRC website (www.nrc.gov), 23 September 2002.

changing circumstances. Throughout this process, cost minimization has been a top priority.

When the present generation of nuclear power plants was designed, the nuclear industry and the US government both assumed that spent nuclear fuel would be reprocessed. Thus, spent-fuel pools were designed to hold only the amount of spent fuel that a reactor would discharge over a period of a few years. This was accomplished by equipping the pools with low-density, open-frame racks. However, in the mid-1970s the US government banned reprocessing, and the industry faced the prospect of an accumulating inventory of spent fuel.

High-Density Spent-Fuel Pools

Industry's response to growing spent-fuel inventories has been to re-rack spent-fuel pools at progressively higher densities, so that more fuel can be stored in a given pool. Now, pools across the nation are equipped with high-density, closed-frame racks that, in many instances, fill the floor area of the pool from wall to wall. The NRC has allowed this transition to occur despite the fact that a loss of water from a pool equipped with high-density racks can cause the zirconium cladding of the spent fuel to heat up, spontaneously ignite and burn, releasing a large amount of radioactive material to the atmosphere. This hazard is discussed further in Section 4.2.

Dry Storage as a Supplement to High-Density Pools

Consistent with the focus on cost minimization, the nuclear industry has turned to alternative methods of fuel storage only when pools have begun to fill up. Preventing a pool fire has not been a consideration. Thus, dry-storage ISFSIs have not been introduced as an alternative to high-density pool storage. Instead, standard industry practice is to fill a pool to nearly its maximum capacity, then to transfer older spent fuel from the pool to an ISFSI at a rate just sufficient to open up space in the pool for fuel that is discharged from the reactor.[23]

As a part of this strategy, each ISFSI has a modular design. One or more concrete pads are laid in the open air. Each pad supports an array of identical fuel-storage modules that are purchased and installed as needed, so that the ISFSI grows incrementally. Additional pads can be laid as needed.

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[23] In standard practice, the maximum storage capacity of a spent-fuel pool is less than the number of fuel-assembly slots in the pool, to allow for the possibility of offloading a full reactor core. However, preserving the capacity for a full-core offload is not a licensing requirement.

This modular approach to the development of ISFSIs has functional and cost advantages. However, the present implementation of the approach is not driven by security considerations, and is therefore proceeding slowly. Pools remain packed with fuel at high density, and can therefore be readily exploited as radiological weapons. Moreover, the ISFSIs themselves are not designed to resist attack.

Types of Dry-Storage Module

The NRC has approved 14 different designs of dry-storage module for general use in ISFSIs.[24] In each of these designs, the central component of the module is a cylindrical, metal container whose interior is equipped with a metal basket structure into which spent fuel assemblies can be inserted. This container is filled with spent fuel while immersed in a spent-fuel pool. Then, the container's lid is attached, the container is removed from the pool and sealed, its interior is dried and filled with an inert gas (typically helium), and it is transferred to the ISFSI.

Available designs of dry-storage modules for ISFSIs fall into two basic categories. In the first category, the metal container has a thick wall, and no enclosing structure is provided. This type of module is commonly described as a "monolithic cask". In the second category, the metal container has a thin wall and is surrounded by an overpack. Different overpacks are used during the three phases of spent-fuel management. First, during the initial transfer of fuel from a spent-fuel pool to an onsite ISFSI, the metal container is surrounded by a transfer overpack. Second, during storage in an ISFSI, the metal container is surrounded by a storage overpack. Third, if fuel is eventually shipped away from the site, the metal container would be placed inside a transport overpack. The second category of module is described here as an "overpack system".

A Typical Monolithic Cask

One example of a monolithic cask is the CASTOR V/21, which was approved by the NRC in 1990 for general use and is employed at the Surry ISFSI. This cask is about 4.9 meters long and 2.4 meters in diameter, and can hold 21 PWR fuel assemblies. In the storage position the cask axis is vertical. The cask body is made of ductile cast iron with a wall thickness of about 38 cm. Circumferential fins on the outside of the cask body facilitate cooling by natural circulation of ambient air. Fully loaded, this cask weighs about 98 tonnes.[25] The NRC has approved this cask for storage but not for transport,

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24 "Dry Spent Fuel Storage Designs: NRC Approved for General Use", from NRC website (www.nrc.gov), 20 September 2002.

25 Raddatz and Waters, 1996.

although CASTOR casks are widely used in Europe for both purposes. CASTOR casks have not been popular in the US market.

Examples of Overpack Systems

One example of an overpack system is the NUHOMS design, which the NRC approved for general use in 1995. In this design, the metal container that holds the spent fuel is about 4.7 meters long and 1.7 meters in diameter, and has a wall thickness of 1.6 cm. This container, which is placed horizontally inside its storage overpack, is made of stainless steel and can hold 24 PWR fuel assemblies or 52 BWR fuel assemblies. The storage overpack is a reinforced-concrete box about 6.1 meters long, 4.6 meters high and 2.7 meters wide, with walls and roof 91 cm thick.[26] Ambient air passes into and out of this structure through vents, and cools the metal container by natural convection. NUHOMS modules are in use at the Davis-Besse site and some other reactor sites.

A second example of an overpack system is the NAC-UMS, which the NRC approved for general use in 2000. In this instance, the metal container is about 4.7 meters long and 1.7 meters in diameter, and has a wall thickness of 1.6 cm. This container, which is made of stainless steel, can hold 24 PWR fuel assemblies or 56 BWR fuel assemblies. The storage overpack is a vertical-axis reinforced-concrete cylinder about 5.5 meters high and 3.5 meters in diameter. The wall of this overpack consists of a steel liner 6.4 cm thick and a layer of concrete 72 cm thick. Ambient air passes into and out of the overpack through vents, and cools the metal container by natural convection. At the Maine Yankee nuclear power plant, which is being decommissioned, sixty NAC-UMS modules are being installed. Most of the modules will be used to store spent fuel discharged from the plant. Some modules will store pieces of the reactor core shroud, which is classified as greater-than-Class C (GTCC) waste.[27]

Monolithic Casks versus Overpack Systems

The two categories of dry-storage module employ distinct design approaches. In a monolithic cask such as the CASTOR, spent fuel is contained within a thick-walled metal cylinder that is comparatively robust.[28] In an overpack system the fuel is contained within a thin-walled metal container that has a

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26 Ibid.

27 Stone and Webster, 1999.

28 The vendor of the CASTOR cask has developed a cheaper type of monolithic cask that is made as a steel-concrete-steel sandwich. This cask, known as CONSTOR, was developed for storage and transport of spent fuel from Russian reactors. The vendor states that the CONSTOR cask could be used in the USA. See: Peters et al, 1999.

limited capability to withstand impact, fire or corrosion. The storage overpack employs concrete -- a cheap material -- as its primary constituent. The transfer and transport overpacks can be used multiple times. Thus, an overpack system can be substantially cheaper -- about half as expensive per fuel assembly, according to some reports -- than a monolithic cask.

ISFSI Configuration

At ISFSIs in the USA, dry-storage modules are placed on concrete pads in the open air. This approach contrasts with German practice, where dry-storage modules -- usually CASTOR casks -- are placed inside buildings. These buildings are designed to have some resistance to attack from outside using anti-tank weapons. This aspect of their design has been informed by tests conducted in the period 1979-1980. At one German reactor site -- Neckarwestheim -- the ISFSI is inside a tunnel built into the side of a hill.[29]

Another feature of the US approach to ISFSI design, consistent with the high priority assigned to cost minimization, is that dry-storage modules are packed closely together in large numbers. In illustration, consider the ISFSI that is proposed for the Diablo Canyon site in California. This facility would hold up to 140 of Holtec's HI-STORM 100 dry-storage modules, whose design is similar to the NAC-UMS system described above. These modules would sit on concrete pads, 20 casks per pad in a 4 by 5 array. Initially, two pads would be built. Ultimately, as the ISFSI expanded, seven pads would be positioned side by side, covering an area about 150 meters by 32 meters. Each module would be a vertical-axis cylinder about 3.7 meters in diameter and 5.9 meters high. The center-to-center spacing of modules would be about 5.5 meters, leaving a gap of 1.8 meters between modules. A security fence would surround the area needed for this array, at a distance of about 15 meters from the outermost modules. That fence would in turn be surrounded by a second fence, at a distance of about 30 meters from the outermost modules.[30]

2.3 Present Security Arrangements

One could reasonably expect that the defense strategy for a nuclear-facility site would be a component of a strategy for homeland security, which would itself be a component of an overall strategy for national security. Moreover, one could expect that the site-level strategy would provide a defense in depth. (See Section 4.4 of this report for an explanation of defense in depth.) Logical planning of this kind may eventually occur. However, at present, the security

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29 Janberg, 2002.
30 PG&E, 2001a.

arrangements for US nuclear facilities are not informed by any strategic vision.

Differing Positions on the Threat of Attack

For several decades it has been clear to many people that nuclear power plants and other commercial nuclear facilities are potential targets of acts of malice or insanity, including highly destructive acts. The NRC has repeatedly rebuffed citizens' requests that this threat be given the depth of analysis that would be expected, for example, in an environmental impact statement (EIS).[31] This history is illustrated by a September 1982 ruling by the Atomic Safety and Licensing Board (ASLB) in the operating-license proceeding for the Harris plant. The intervenor, Wells Eddleman, had proffered a contention alleging, in part, that the plant's safety analysis was deficient because it did not consider the "consequences of terrorists commandeering a very large airplane.....and diving it into the containment." In rejecting this contention the ASLB stated:[32]

> "This part of the contention is barred by 10 CFR 50.13. This rule must be read *in pari materia* with 10 CFR 73.1(a)(1), which describes the "design basis threat" against which commercial power reactors *are* required to be protected. Under that provision, a plant's security plan must be designed to cope with a violent external assault by "several persons," equipped with light, portable weapons, such as hand-held automatic weapons, explosives, incapacitating agents, and the like. Read in the light of section 73.1, the principal thrust of section 50.13 is that military style attacks with heavier weapons are not a part of the design basis threat for commercial reactors. Reactors could not be effectively protected against such attacks without turning them into virtually impregnable fortresses at much higher cost. Thus Applicants are not required to design against such things as artillery bombardments, missiles with nuclear warheads, or kamikaze dives by large airplanes, despite the fact that such attacks would damage and may well destroy a commercial reactor."

In this statement, the ASLB correctly described the design basis for US nuclear power plants. However, other design bases are possible. In the early 1980s the

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[31] In illustration of this continuing policy, on 18 December 2002 the NRC Commissioners dismissed four licensing interventions calling for EISs that consider the potential for malicious acts at nuclear facilities. One intervention, by the state of Utah, addressed the proposed ISFSI at Skull Valley. The other three interventions, by citizen groups, addressed: a proposed spent-fuel-pool expansion at Millstone Unit 3; a proposed MOX-fuel-fabrication facility; and proposed license renewals for the McGuire and Catawba nuclear power plants.

[32] ASLB, 1982.

reactor vendor ASEA-Atom developed a preliminary design for a commercial reactor known as the PIUS reactor. The design basis for the PIUS reactor included events such as equipment failures, operator errors and earthquakes, but also included: (i) takeover of the plant for one operating shift by knowledgeable saboteurs equipped with large amounts of explosives; (ii) aerial bombardment with 1,000-pound bombs; and (iii) abandonment of the plant by the operators for one week.[33] It seems likely that this design basis would also provide protection against a range of other assaults, including the impact of a large, fuel-laden aircraft. Clearly, ASEA-Atom foresaw a world in which acts of malice could pose a significant threat to nuclear facilities. The NRC has never exercised an equivalent degree of foresight.

A Brief History

Some US nuclear facilities have been specifically designed to resist attack. For example, in the early 1950s five heavy-water reactors were built at the Savannah River site in South Carolina, to produce plutonium and tritium for use in US nuclear weapons. In order to resist an attack by the USSR using nuclear weapons, the reactors were dispersed across a large site and hardened against blast. The reactor buildings were designed to withstand an external blast of 7 psi, the overpressure that could be experienced at about 2 miles from a 1-megatonne surface burst. However, the purpose was to preserve the reactors' ability to produce weapons material after an attack, rather than to protect the public from a release of radioactive material. Indeed, these reactors had minimal safety systems when they first entered service. Safety systems were added over the years, but the reactors' safety standards never approached the level that is expected for commercial reactors.[34]

In 1950, the Reactor Safeguards Committee of the US Atomic Energy Commission (AEC) produced a report -- designated WASH-3 -- that considered the potential for reactor accidents and estimated the offsite effects of an accident. This report gave special attention to sabotage as a potentially important cause of reactor accidents. About 16 years later, during the construction license proceedings for Turkey Point Units 3 and 4 in Florida, an intervenor raised the question of an attack on these nuclear power plants from a hostile country (i.e., Cuba). The AEC held that it was not responsible for providing protection against such an attack.[35] This position remains enshrined in the NRC's regulation 10 CFR 50.13, which states:[36]

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33 Hannerz, 1983.
34 Thompson and Sholly, 1991.
35 Okrent, 1981, pp 18-19.
36 NRC Staff, 2002.

> "An applicant for a license to construct and operate a production or utilization facility, or for an amendment to such license, is not required to provide for design features or other measures for the specific purpose of protection against the effects of (a) attacks and destructive acts, including sabotage, directed against the facility by an enemy of the United States, whether a foreign government or other person, or (b) use or deployment of weapons incident to US defense activities."

Pursuant to this regulation, the NRC's licensees are not required to design or operate nuclear facilities to resist enemy attack. However, events have forced the NRC to progressively modify this position, so as to require greater protection against acts of malice or insanity. A series of incidents, including the 1993 bombing of the World Trade Center in New York, eventually forced the NRC to introduce, in 1994, regulations requiring licensees to defend nuclear power plants against vehicle bombs. The terrorist events of 11 September 2001 forced the NRC to require additional, interim measures by licensees to protect nuclear facilities, and are also forcing the NRC to consider strengthening its regulations in this area. Nevertheless, present NRC regulations require only a light defense of nuclear facilities.

NRC Regulations for Defending Nuclear Facilities

Present NRC regulations for the defense of nuclear facilities are focused on site security. As described in Section 4.4, below, site security is one of four types of measure that, taken together, could provide a defense in depth against acts of malice or insanity. The other three types of measure are, with some limited exceptions, ignored in present NRC regulations and requirements.[37]

At a nuclear power plant or an ISFSI, the NRC requires the licensee to implement a set of physical protection measures. According to the NRC, these measures provide defense in depth by taking effect within defined areas with increasing levels of security. In fact, these measures provide only a fraction of the protection that could be provided by a comprehensive defense-in-depth strategy. Within the outermost physical protection area, known as the Exclusion Area, the licensee is expected to control the area but is not required to employ fences and guard posts for this purpose. Within the Exclusion area is a Protected Area encompassed by physical barriers including one or more fences, together with gates and barriers at points of entry. Authorization for unescorted access within the Protected Area is based on background and behavioral checks. Within the Protected Area are Vital

[37] For information about the NRC's present regulations and requirements for nuclear-facility defense, see: the NRC website (www.nrc.gov) under the heading "Nuclear Security and Safeguards", 2 September 2002; Markey, 2002; Meserve, 2002; and NRC, 2002.

Areas and Material Access Areas that are protected by additional barriers and alarms; unescorted access to these locations requires additional authorization.

Associated with the physical protection areas are measures for detection and assessment of an intrusion, and for armed response to an intrusion. Measures for intrusion detection include guards and instruments whose role is to detect a potential intrusion and notify the site security force. Then, security personnel seek additional information through means such as direct observation and closed-circuit TV cameras, to assess the nature of the intrusion. If judged appropriate, an armed response to the intrusion is then mounted by the site security force, potentially backed up by local law enforcement agencies and the FBI.

The Design Basis Threat

The design of physical protection areas and their associated barriers, together with the design of measures for intrusion detection, intrusion assessment and armed response, is required to accommodate a "design basis threat" (DBT) that is specified by the NRC in 10 CFR 73.1. The DBT for an ISFSI is less demanding than that for a nuclear power plant. At a nuclear power plant, the dominant sources of hazard are the reactor and the spent-fuel pool(s). In theory, both of these items receive the same level of protection, but in practice the reactor has been the main focus of attention. At present, the DBT for a nuclear power plant has the following features:[38]

> "(i) A determined violent external assault, attack by stealth, or deceptive actions, of several persons with the following attributes, assistance and equipment: (A) Well-trained (including military training and skills) and dedicated individuals, (B) inside assistance which may include a knowledgeable individual who attempts to participate in a passive role (e.g., provide information), an active role (e.g., facilitate entrance and exit, disable alarms and communications, participate in violent attack), or both, (C) suitable weapons, up to and including hand-held automatic weapons, equipped with silencers and having effective long range accuracy, (D) hand-carried equipment, including incapacitating agents and explosives for use as tools of entry or for otherwise destroying reactor, facility, transporter, or container integrity or features of the safeguards system, and (E) a four-wheel drive land vehicle used for transporting personnel and their hand-carried equipment to the proximity of vital areas, and

[38] 10 CFR 73.1, Purpose and Scope, from the NRC web site (www.nrc.gov), 2 September 2002.

(ii) An internal threat of an insider, including an employee (in any position), and

(iii) A four-wheel drive land vehicle bomb."

For an ISFSI, the DBT is the same as for a nuclear power plant except that it does not include the use of a four-wheel-drive land vehicle, either for transport of personnel and equipment or for use as a vehicle bomb. This is true whether the ISFSI is at a new site or a reactor site. Thus, an ISFSI at a reactor site will be less protected than the reactor(s) and spent-fuel pool(s) at that site. At a reactor site or a new site, an ISFSI will be vulnerable to attack by a vehicle bomb. (Note: An NRC order of October 2002 to reactor-site ISFSI licensees, as discussed below, might require vehicle-bomb protection at reactor-site ISFSIs. Measures required by this order have not been disclosed.)

Interim, Additional Requirements by the NRC

After the events of 11 September 2001, the NRC concluded that its requirements for nuclear power plant security were inadequate. Accordingly, the NRC issued an order to licensees of operating plants in February 2002, and similar orders to licensees of decommissioning plants in May 2002 and reactor-site ISFSI licensees in October 2002, requiring "certain compensatory measures", also described as "prudent, interim measures", whose purpose is to "provide the Commission with reasonable assurance that the public health and safety and common defense and security continue to be adequately protected in the current generalized high-level threat environment".[39] The additional measures required by these orders have not been publicly disclosed, but the NRC Chairman has stated that they include:[40]

(i) increased patrols;
(ii) augmented security forces and capabilities;
(iii) additional security posts;
(iv) vehicle checks at greater stand-off distances;
(v) enhanced coordination with law enforcement and military authorities;
(vi) additional restrictions on unescorted access authorizations;
(vii) plans to respond to plant damage from explosions or fires; and
(viii) assured presence of Emergency Plan staff and resources.

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[39] The quoted language is from page 2 of the NRC's order of 25 February 2002 to all operating power reactor licensees. Almost-identical language appears in the NRC's orders of 23 May 2002 to all decommissioning power reactor licensees and 16 October 2002 to all ISFSI licensees who also hold 10 CFR 50 licenses.
[40] Meserve, 2002.

In addition to requiring these additional security measures, the NRC has established a Threat Advisory System that warns of a possible attack on a nuclear facility. This system uses five color-coded threat conditions ranging from green (low risk of attack) to red (severe risk of attack). These threat conditions conform with those used by the Office of Homeland Security. Also, the NRC is undertaking what it describes as a "top-to-bottom review" of its security requirements. The NRC has stated that it expects that this review will lead to revision of the present DBT. The review is not proceeding on any specific schedule.

Limitations of the Design Basis Threat

A cursory examination of the present DBT reveals significant limitations. For example, this threat does not include aircraft bombs (e.g., fuel-laden commercial aircraft, light aircraft packed with high explosive) or boat bombs.[41] This threat does not include lethal chemical weapons as instruments for disabling security personnel. This threat allows for one vehicle bomb, but not for a subsequent vehicle bomb that gains access to a vital area after the first bomb has breached a security barrier. Also, this threat envisions a small attacking force equipped with light weapons, rather than a larger force (e.g., 20 persons) equipped with heavier weapons such as anti-tank missiles. In sum, the present DBT is inadequate in light of the present threat environment. The compensatory measures required by the NRC's recent orders do not correct this deficiency.[42]

3. The Potential for Attacks on Nuclear Facilities

3.1 A Brief History

There is a rich history of events which show that acts of malice or insanity pose a significant threat to nuclear facilities around the world.[43] Consider some examples. Nuclear power plants under construction in Iran were repeatedly bombed from the air by Iraq in the period 1984-1987. Yugoslav Air Force fighters made a threatening overpass of the Krsko nuclear plant in Slovenia -- which was operating at the time -- a few days after Slovenia declared independence in 1991. So-called research reactors in Iraq were destroyed by aerial bombing by Israel in 1981 and by the United States in 1991. In 1987, Iranian radio threatened an attack by unspecified means on US nuclear plants if the United States attacked launch sites for Iran's Silkworm anti-ship missiles. Bombs damaged reactors under construction in Spain in

[41] An NRC Fact Sheet (NRC, 2002) mentions new measures "against water-borne attacks", but it does not appear that these measures provide significant protection against boat bombs.
[42] POGO, 2002.
[43] Thompson, 1996.

1977 and in South Africa in 1982. Anti-tank missiles struck a nuclear plant under construction in France in 1982. North Korean commandos were killed while attempting to come ashore near a South Korean plant in 1985. These and other events illustrate the "external" threat to nuclear plants. Numerous crimes and acts of sabotage by plant personnel illustrate the "internal" threat.

Vehicle Bombs

The threat posed to nuclear facilities by vehicle bombs became clearly apparent from an October 1983 attack on a US Marine barracks in Beirut. In a suicide mission, a truck was driven at high speed past a guard post and into the barracks. A gas-boosted bomb on the truck was detonated with a yield equivalent to about 5 tonnes of TNT, destroying the building and killing 241 Marines. In April 1984 a study by Sandia National Laboratories titled "Analysis of Truck Bomb Threats at Nuclear Facilities" was presented to the NRC. According to an NRC summary:[44] "The results show that unacceptable damage to vital reactor systems could occur from a relatively small charge at close distances and also from larger but still reasonable size charges at large setback distances (greater than the protected area for most plants)." Eventually, in 1994, the NRC introduced regulations that require reactor licensees to install defenses (gates, barriers, etc.) against vehicle bombs. The NRC was spurred into taking this action by two incidents in February 1993. In one incident, a vehicle bomb was detonated in a parking garage under the World Trade Center in New York. In the other incident, a man recently released from a mental hospital crashed his station wagon through the security gate of the Three Mile Island nuclear plant and rammed the vehicle under a partly-opened door in the turbine building.

Suicidal Aircraft Attack

The threat of suicidal aircraft attack on symbolic or high-value targets became clearly apparent from three incidents in 1994.[45] In April 1994 a Federal Express flight engineer who was facing a disciplinary hearing was travelling as a passenger on a company DC-10. He stormed the cockpit, severely wounded all three members of the crew with a hammer, and tried to gain control of the aircraft. The crew regained control with great difficulty. Federal Express employees said that the flight engineer was planning to crash into a company building. In September 1994 a lone pilot crashed a stolen single-engine Cessna into the grounds of the White House, just short of the President's living quarters. In December 1994 four Algerians hijacked an Air France Airbus 300, carrying 20 sticks of dynamite. The aircraft landed in

44 Rehm, 1984.
45 Wald, 2001.

Marseille, where the hijackers demanded that it be given a large fuel load -- three times more than necessary for the journey -- before flying to Paris. Troops killed the hijackers before this plan could be implemented. French authorities determined that the hijackers planned to explode the aircraft over Paris or crash it into the Eiffel Tower.

The Insider Threat

The incident involving the Federal Express flight engineer illustrates the vulnerability of industrial systems, including nuclear plants, to "internal" threats. That vulnerability is further illustrated by a number of incidents. In December 2000, Michael McDermott killed seven co-workers in a shooting rampage at an office building in Massachusetts. He had worked at the Maine Yankee nuclear plant from 1982 to 1988 as an auxiliary operator and operator before being terminated for exhibiting unstable behavior.[46] In 1997, Carl Drega of New Hampshire stockpiled weapons and killed four people -- including two state troopers and a judge -- on a suicide mission. He had passed security clearances at three nuclear plants in the 1990s.[47] In October 2000 a former US Army sergeant pleaded guilty to assisting Osama bin Laden in planning the bombing of the US embassy in Nairobi, which occurred in 1998.[48] In June 1999, a security guard at the Bradwell nuclear plant in Britain hacked into the plant's computer system and wiped out records. It emerged that he had never been vetted and had two undisclosed criminal convictions.[49] These and other incidents demonstrate clearly that it is foolish to ignore or downplay the "internal" threat of acts of malice or insanity at nuclear plants.

The General Threat of Terrorism

The events mentioned in the preceding paragraphs occurred against a background of numerous acts of terrorism around the world. Many of these acts have been highly destructive. US facilities have been targets on many occasions, as illustrated by the bombing of the US embassy in Beirut in 1983, the embassies in Nairobi and Dar es Salaam in 1998, and the USS Cole in 2000. There have been repeated warnings that the threat of terrorism is growing and could involve the US homeland. For example, in 1998 three authors with high-level government experience wrote:[50]

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46 Barnard and Kerber, 2001.
47 Ibid.
48 Goldman, 2000.
49 Maguire, 2001.
50 Carter et al, 1998.

> "Long part of the Hollywood and Tom Clancy repertory of nightmarish scenarios, catastrophic terrorism has moved from far-fetched horror to a contingency that could happen next month. Although the United States still takes conventional terrorism seriously, as demonstrated by the response to the attacks on its embassies in Kenya and Tanzania in August, it is not yet prepared for the new threat of catastrophic terrorism."

Some years ago the US Department of Defense established an advisory commission on national security in the 21st century. This commission -- often known as the Hart-Rudman commission because it was co-chaired by former Senators Gary Hart and Warren Rudman -- issued reports in September 1999, April 2000 and March 2001. The findings in the September 1999 report included the following:[51]

> "America will become increasingly vulnerable to hostile attack on our homeland, and our military superiority will not entirely protect us.............States, terrorists and other disaffected groups will acquire weapons of mass destruction and mass disruption, and some will use them. Americans will likely die on American soil, possibly in large numbers."

It is clear that the potential for acts of malice or insanity at nuclear facilities -- including highly destructive acts -- has been foreseeable for many years, and has been foreseen. However, the terrorist attacks on the World Trade Center and the Pentagon on 11 September 2001 provided significant new information. These attacks conclusively demonstrated that the threat of highly-destructive acts of malice or insanity is a clear and present danger, and that no reasonable person can regard this threat as remote or speculative. According to press reports, US authorities have obtained information suggesting that the hijackers of United Airlines flight 93, which crashed in Pennsylvania on 11 September 2001, were planning to hit a nuclear plant.[52] This may be true or false, or the truth may never be known. Whatever the truth is, it would be foolish to regard nuclear plants as immune from attack.

Estimating the Probability of an Attack on a Nuclear Facility

The NRC has a longstanding policy of dismissing citizens' concerns about nuclear-facility accidents if the probability of such accidents is, in the agency's judgement, low. A body of analytic techniques known as probabilistic risk

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[51] Commission on National Security, 1999.
[52] Rufford et al, 2001.

assessment (PRA) has been developed to support such judgements.[53] However, the NRC Staff has conceded that it cannot provide a quantitative assessment of the probability of an act of malice at a nuclear facility. In a memo to the NRC Commissioners, the Staff has stated:[54]

> "The staff, as a result of its ongoing work with the Federal national security agencies, has determined that the ability to quantify the likelihood of sabotage events at nuclear power plants is not currently supported by the state-of-the-art in PRA methods and data. The staff also believes that both the NRC and the other government stakeholders would need to conduct additional research and expend significant time and resources before it could even attempt to quantify the likelihood of sabotage events. In addition, the national security agencies, Intelligence Community, and Law Enforcement Agencies do not currently quantitatively assess the likelihood of terrorist, criminal, or other malevolent acts."

To date, there has been no determined attack on a US civilian nuclear facility. At present, we cannot quantitatively estimate the probability of such an attack in the future. However, from a qualitative perspective, it is clear that the probability is significant.

3.2 The Strategic Context

In considering the need to defend civilian nuclear facilities, one is obliged to take a broad view of the security environment. An ISFSI, for example, may remain in service for 100 years or more. During that period the level of risk will vary but the cumulative risk will continue to grow. Thus, the ISFSI's designer should take a conservative position in specifying a DBT. That position should be informed by a sober assessment of the range of threats that may be manifested over coming decades.

A Turbulent World?

A number of strategic analysts have warned that world affairs may become more turbulent over the coming decades. Analysts have pointed to destabilizing factors that include economic inequality, poverty, political grievances, nationalism, environmental degradation and the weakening of international institutions. For example, a 1995 RAND study for the US Department of Defense contains the statement:[55]

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[53] The state of the art of PRA can be illustrated by: NRC, 1990. For a critique of PRA, see: Hirsch et al, 1989.
[54] Travers, 2001.
[55] Kugler, 1995, page xv.

> "If the worst does transpire, the world could combine the negative features of nineteenth-century geopolitics, twentieth-century political passions, and twenty-first century technology: a chronically turbulent world of unstable multi-polarity, atavistic nationalism, and modern armaments."

As another example, the Stockholm Environment Institute (SEI) has identified a range of scenarios for the future of the world over the coming decades, and has studied the policies and actions that will tend to make each scenario come true. In summarizing this work, SEI states:[56]

> "In the critical years ahead, if destabilizing social, political and environmental stresses are addressed, the dream of a culturally rich, inclusive and sustainable world civilization becomes plausible. If they are not, the nightmare of an impoverished, mean and destructive future looms. The rapidity of the planetary transition increases the urgency for vision and action lest we cross thresholds that irreversibly reduce options -- a climate discontinuity, locking-in to unsustainable technological choices, and the loss of cultural and biological diversity."

SEI has specifically considered the implications of the September 2001 terrorist attacks, concluding:[57]

> "Certainly the world will not be the same after 9/11, but the ultimate implications are indeterminate. One possibility is hopeful: new strategic alliances could be a platform for new multinational engagement on a wide range of political, social and environmental problems. Heightened awareness of global inequities and dangers could support a push for a more equitable form of global development as both a moral and a security imperative. Popular values could eventually shift toward a strong desire for participation, cooperation and global understanding. Another possibility is ominous: an escalating spiral of violence and reaction could amplify cultural and political schisms; the new military and security priorities could weaken democratic institutions, civil liberties and economic opportunity; and people could grow more fearful, intolerant and xenophobic as elites withdraw to their fortresses."

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[56] Raskin et al, 2002, page 11.
[57] Ibid.

Nuclear Facilities as Symbolic Targets

In view of the range of possibilities for world order or turbulence over the coming decades, it would be prudent to assume that any US civilian nuclear facility could be the subject of a determined attack. Moreover, civilian nuclear facilities may be especially prime targets because of their symbolic connection with nuclear weapons. The US government flaunts its superiority in nuclear weapons and rejects any constraint on these weapons through international law.[58] At the same time, the government has signaled its willingness to attack Iraq because that country might acquire a nuclear weapon. It would be prudent to assume that this situation will motivate terrorist groups to search for ways to attack US nuclear facilities. For example, a terrorist group possessing a crude nuclear weapon might choose to use that weapon on a US civilian nuclear facility for two reasons. First, because the target would be highly symbolic. Second, because the radioactive fallout from the weapon would be greatly amplified.

The Domestic Threat

There is a natural tendency to look outside the country for sources of threat. However, an attack on a nuclear facility could also originate within the United States. The national strategy for homeland security contains the statement:[59]

> "Terrorist groups also include domestic organizations. The 1995 bombing of the Murrah Federal Building in Oklahoma City highlights the threat of domestic terrorist acts designed to achieve mass casualties. The US government averted seven planned terrorist acts in 1999 -- two were potentially large-scale, high-casualty attacks being organized by domestic extremist groups."

3.3 The US Government's Response to this Threat

The preceding discussion shows that there is a significant potential for a determined attack on a US civilian nuclear facility. Such an attack could employ a level of sophistication and violence that is characteristic of military operations. However, in most attack scenarios the attacking group would have a negligible capability for direct confrontation with US military forces. Thus, it is appropriate to think of an attack of this kind as a form of asymmetric warfare. The attacking group, be it domestic or foreign, will have

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[58] Deller, 2002; Scarry, 2002.
[59] Office of Homeland Security, 2002, page 10.

a set of political objectives. For symbolic and practical reasons, the attackers will prefer to obtain their weapons and logistical resources inside the USA.

US Strategy for National Security and Homeland Security

The White House has recently articulated a national security strategy for the United States.[60] This strategy rests primarily on the use of military force outside the country, to deter, disrupt or punish potential attackers. In support of this concept, the strategy asserts the right to conduct unilateral, pre-emptive attacks around the world, and repudiates the International Criminal Court. Homeland security is regarded as a secondary form of defense, as illustrated by the statement:[61]

> "While we recognize that our best defense is a good offense, we are also strengthening America's homeland security to protect against and deter attack."

A strategy for homeland security has been articulated by the White House.[62] This document contains a section titled "Defending against Catastrophic Threats", and that section begins with an aerial photograph of a nuclear power plant. Yet, the section does not mention civilian nuclear facilities or the NRC. Thus, at the highest levels of strategic planning, the US government has nothing to say about the potential for an attack on a nuclear facility, or about the measures that could be taken to defend against such attacks. In fact, the US government seems largely unaware of this threat, and has delegated its responsibility to the NRC. As described in Section 2.3 of this report, the NRC's response to the threat has been limited and ineffectual.

Imbalance in National Security and Defense Planning

Inattention to the vulnerability of nuclear facilities is symptomatic of a larger imbalance in national security and defense planning. As another example of imbalance, consider the threat of attack on the United States by inter-continental ballistic missiles (ICBMs). Large expenditures are devoted to the development of technologies that might, ultimately, allow missile warheads to be intercepted. Yet, in considering the respective risks of attack by missiles or other means, the US National Intelligence Council has stated:[63]

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[60] White House, 2002.
[61] Ibid, page 6.
[62] Office of Homeland Security, 2002.
[63] National Intelligence Council, 2001, page 18.

> "Nonmissile means of delivering weapons of mass destruction [WMD] do not provide the same prestige or degree of deterrence and coercive diplomacy associated with ICBMs. Nevertheless, concern remains about options for delivering WMD to the United States without missiles by state and nonstate actors. Ships, trucks, airplanes, and other means may be used. In fact, the Intelligence Community judges that US territory is more likely to be attacked with WMD using nonmissile means, primarily because such means:
>
> - Are less expensive than developing and producing ICBMs.
> - Can be covertly developed and employed; the source of the weapon could be masked in an attempt to evade retaliation.
> - Probably would be more reliable than ICBMs that have not completed rigorous testing and validation programs.
> - Probably would be much more accurate than emerging ICBMs over the next 15 years.
> - Probably would be more effective for disseminating biological warfare agent than a ballistic missile.
> - Would avoid missile defenses."

The defense analyst John Newhouse has contrasted the high level of attention given to the ICBM threat with the lack of effort in other areas of defense. He notes that the State Department advised US embassies in early 2001 that the principal threat to US security is the use of long-range missiles by rogue states, and comments:[64]

> "This dubious proposition -- an article of faith within parts of the defense establishment -- obscured existing and far more credible threats from truly frightful weapons, some of which are within the reach of terrorists. They include Russia's shaky control of its nuclear weapons and weapons-usable material; the vulnerability of US coastal cities and military forces stationed abroad to medium-range missile systems, ballistic and cruise; the vulnerabilities of all cities to chemical and biological weapons, along with so-called suitcase weapons and other low-tech delivery expedients. Vehicles that contain potentially destructive amounts of stored energy are a major source of concern, as is one of their most attractive potential targets, a nuclear spent-fuel storage facility."

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[64] Newhouse, 2002, page 43.

Nuclear Facilities as Targets

It is clear that US civilian nuclear facilities are candidates for attack under conditions of asymmetric warfare. They are large, fixed targets that are, at present, lightly defended. In the eyes of an enemy, they can be regarded as pre-deployed radiological weapons. They can be attacked using comparatively low levels of technology. Given the United States' overt reliance on nuclear weapons as offensive instruments, civilian nuclear facilities offer highly symbolic targets. In light of these considerations, it is remarkable that the US government has largely ignored this threat.

The Danger of an Offense-Dominated Strategy

At present, US policy for national security assigns a higher priority to offensive actions worldwide than to defensive actions within the homeland. This is a tradition of many years' standing. However, in the contemporary era of asymmetric warfare, this policy can be dangerous.[65] If our vulnerable infrastructure -- including nuclear facilities, the airlines, etc. -- is poorly defended, we may feel compelled to use military force aggressively around the world, in order to pre-empt or punish attackers. Such action poses the risk of arousing hostility and promoting anarchy, leading to new attacks on our homeland. The potential exists for an escalating spiral of violence. Strategic analysts have warned of this danger, both before and after the terrorist events of September 2001.[66]

3.4 A Balanced Response to the Threat

The United States needs a balanced, mature strategy for national defense and international security. Within that strategy, it needs a balanced strategy for homeland security. Finally, as a part of homeland security, the nation needs a defense-in-depth strategy to protect its civilian nuclear facilities. At present, all three levels of strategy are deficient.

The Role of Protection in a Balanced Response

Articulation of a balanced strategy at all three levels is a task beyond the scope of this report. However, this report does articulate, in Sections 4.4 and 4.5

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65 A recent essay (Betts, 2003) argues that US decision makers have neglected the risk that Iraq's leaders will strike back at the US homeland if we attack Iraq. Betts' essay focusses on the potential for Iraq to use chemical or biological weapons on US territory, but the same general arguments apply to the potential for an attack on a US civilian nuclear facility.

66 See, for example: Sloan, 1995; Martin, 2002 (see especially the chapter by Conrad Crane in this volume); Mathews, 2002; Conetta, 2002; Crawford, 2003; and Newhouse, 2002.

respectively, a defense-in-depth strategy for nuclear facilities and a national strategy for robust storage of spent fuel. As an illustration of how these protective measures could fit within a higher-level strategy, consider Carl Conetta's suggestion of a four-pronged campaign against the terrorist group al-Qaeda. The four prongs would be:[67]

> "(i) squeeze the blood flow of the organization -- its financial support system;
> (ii) throw more light on the organization's members and components through intelligence gathering activities;
> (iii) impede the movement of the organization by increasing the sensitivity of screening procedures at critical gateways -- borders, financial exchanges, arms markets, and transportation portals; and
> (iv) improve the protection of high-value targets."

The importance of protecting high-value targets is emphasized in the recent report of a high-level task force convened by the Council on Foreign Relations and chaired by former Senators Gary Hart and Warren Rudman. One of the report's major findings is:[68]

> "*Homeland security measures have deterrence value:* US counterterrorism initiatives abroad can be reinforced by making the US homeland a less tempting target. We can transform the calculations of would-be terrorists by elevating the risk that (1) an attack on the United States will fail, and (2) the disruptive consequences of a successful attack will be minimal. It is especially critical that we bolster this deterrent now since an inevitable consequence of the US government's stepped-up military and diplomatic exertions will be to elevate the incentive to strike back before these efforts have their desired effect."

The Need for Proactive Planning

Other findings by the Council on Foreign Relations' task force also deserve attention. For example, their report points out that proactive planning will yield better protection at lower cost than reacting after each new attack.[69] This point is especially important in an era of asymmetric warfare, when opponents will employ unfamiliar tactics. Planning techniques such as "competitive strategies" and "net assessment" have been developed to accommodate such situations. In discussing net assessment, one author has stated:[70]

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67 Conetta, 2002, page 3.
68 Hart et al, 2002, pp 14-15.
69 Ibid, page 16.
70 Hoffman, 2002, pp 3-4.

> "One of the advantages of such an approach is that it credits the opponent with having a brain and a will, which Clausewitz suggested is also fundamental to war. Rarely do US strategists credit adversaries with being as cunning or adaptive as they usually turn out to be. It is well to be reminded on occasion that any opponent has strategies and options at his disposal too. The essence of the homeland security challenge is based on this consideration."

4. Defending Nuclear Power Plants and Spent Fuel

4.1 Potential Modes and Instruments of Attack

It is not appropriate to publish a detailed discussion of scenarios whereby a nuclear power plant or a spent-fuel-storage facility might be successfully attacked. However, it must be assumed that attackers are technically sophisticated and possess considerable knowledge about individual nuclear facilities. For decades, engineering drawings, photographs and technical analyses have been openly available for every civilian nuclear facility in the USA. This material is archived at many locations around the world. Thus, a public discussion, in general terms, of potential modes and instruments of attack will not assist attackers. Indeed, such a discussion is needed to ensure that appropriate defensive actions are taken.

Safety Systems and their Vulnerability

The safe operation of a US commercial reactor or a spent-fuel pool depends upon the fuel in the reactor or the pool being immersed in water. Moreover, that water must be continually cooled to remove fission heat or radioactive decay heat generated in the fuel. A variety of systems are used to ensure that water is available and is cooled, and that other safety-related functions -- such as shutdown of the fission reaction when needed -- are performed. Some of the relevant systems -- such as the switchyard -- are highly vulnerable to attack. Other systems are located inside reinforced-concrete structures -- such as the reactor auxiliary building -- that provide some degree of protection against attack. The reactor itself is inside a containment structure. At some plants, but not all, the reactor containment is a concrete structure that is highly reinforced and comparatively robust. Spent-fuel pools have thick concrete walls but are typically covered by lightweight structures.

Attack through Brute Force or Indirectly?

A group of attackers equipped with highly-destructive instruments could take a brute-force approach to attacking a reactor or a spent-fuel pool. Such an approach would aim to directly breach the reactor containment and primary cooling circuit, or to breach the wall or floor of a spent-fuel pool. Alternatively, the attacking group could take an indirect approach, and many such approaches will readily suggest themselves to technically-informed attackers. Insiders, or outsiders who have taken over the plant, could obtain a release of radioactive material without necessarily employing destructive instruments. Some attack scenarios will involve the disabling of plant personnel, which could be accomplished by armed attack, use of lethal chemical weapons, or radioactive contamination of the site by an initial release of radioactive material.

Vulnerability of ISFSIs

Dry-storage ISFSIs differ from reactors and spent-fuel pools in that their operation is entirely passive. Thus, each dry-storage module in an ISFSI must be attacked directly. To obtain a release of radioactive material, the wall of the fuel container must be penetrated from the outside, or the container must be heated by an external fire to such an extent that the containment envelope fails. The attack could also exploit stored chemical energy in the zirconium cladding of spent fuel inside the module. Combustion of this cladding in air, if initiated, would generate heat that could liberate radioactive material from the fuel to the outside environment. A knowledgeable attacker could combine penetration of the fuel container with the initiation of combustion.

Relevance of Site-Security Barriers

In some attack scenarios that involve the use of destructive instruments, the attackers may need to carry these instruments, by hand or in a vehicle, to the point of application. Such an action would require the overcoming of site-security barriers. In other scenarios, the instruments could be launched from a position outside some or all of these barriers.

Commercial Aircraft as Instruments of Attack

One instrument that an attacking group will consider is a fuel-laden commercial aircraft. As indicators of the forces that could accompany the impact of such an aircraft, consider the weights and fuel capacities of some typical jetliners.[71] The Boeing 737-300 has a maximum takeoff weight of 56-63 tonnes and a fuel capacity of 20-24 thousand liters. The Boeing 747-400 has a maximum takeoff weight of 363-395 tonnes and a fuel capacity of 204-217 thousand liters. The Boeing 757 has a maximum takeoff weight of 104-116 tonnes and a fuel capacity of 43 thousand liters. The Boeing 767 has a

[71] Jackson, 1996.

maximum takeoff weight of 136-181 tonnes and a fuel capacity of 63-91 thousand liters.

Commercial jet fuel typically has a heat of combustion of about 38 MJ per liter. For comparison, 1 kilogram of TNT will yield 4.2 MJ of energy. Thus, complete combustion of 1 liter of jet fuel will yield energy equivalent to that from 9 kilograms of TNT. Complete combustion of 100 thousand liters of jet fuel -- about half the fuel capacity of a Boeing 747-400 -- will yield energy equivalent to that from 900 tonnes of TNT. Thus, the impact of a fuel-laden aircraft could lead to a violent fuel-air explosion. Fuel-air munitions have been developed that yield more than 5 times the energy of their equivalent weight in TNT, and create a blast overpressure exceeding 1,000 pounds per square inch.[72] A fuel-air explosion arising from an aircraft impact will be less efficient than a munition in converting combustion energy into blast, but could generate a highly-destructive blast if fuel vapor accumulates in a confined space before igniting.

Explosive-Laden, General-Aviation Aircraft

The attacking group might choose to use an explosive-laden, general-aviation aircraft as an instrument of attack. Such an aircraft could be much easier to obtain than a large commercial aircraft. In 1999, about 219,000 general-aviation aircraft were in use in the USA.[73] Of these, about 172,000 had piston engines, 5,700 were turboprops, 7,100 were turbojets and 7,400 were helicopters.[74] In the piston-engine category, about 21,000 aircraft had two engines, the remainder having one engine. The general-aviation fleet in 2002 must be similar to that in 1999.

It is clear that terrorist groups can readily obtain and use explosive materials. Such use is a tragic accompaniment to political disputes around the world. Moreover, explosives are easily obtainable within the USA. In 2001, about 2.4 million tonnes of explosives were sold in the USA. Most of this material consisted of blasting agents and oxidizers used for mining, quarrying and construction. Much of the blasting material consisted of mixtures of ammonium nitrate and fuel oil, which are readily-available materials. It is also noteworthy that current law in many US states allows high explosives to be purchased without a permit or a background check.[75]

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72 Gervasi, 1977.
73 Data from the website of the General Aviation Manufacturers Association (www.generalaviation.org), 30 September 2002.
74 The remainder of the fleet consisted of gliders, balloons/blimps and experimental aircraft.
75 Information from the website of the Institute of Makers of Explosives (www.ime.org), 30 September 2002.

Anti-Tank Missiles

Another instrument of attack that could be used is an anti-tank missile. Large numbers of these missiles exist around the world, and they can be obtained by many terrorist groups. As an example, consider the tube-launched, optically-tracked, wire-guided (TOW) anti-tank missile system, which is now marketed by Raytheon.[76] This system is said to be the most successful anti-tank missile system in the world. It first entered service with the US Army in 1970 and is currently in use by more than 40 military forces. As of 1991, more than 460,000 TOW missiles had been produced, and the cumulative production up to 2002 must be substantially higher. The TOW missile has a maintenance-free storage life of 20 years, and all versions of the missile can be fired from any TOW launcher. TOW systems have been sold to countries such as Colombia, Iran, Lebanon, Pakistan, Somalia, Yugoslavia and South Yemen, so it must be presumed that they can be obtained by terrorist groups. There is no indication from available literature that the TOW missile or launcher is self-disabling if it passes into inappropriate hands. In connection with the availability of systems of this kind, it is interesting to note that, in August 2002, federal agents seized more than 2,300 unregistered armor-piercing missiles from a private, counter-terrorism training school in New Mexico.[77]

Modern anti-tank missiles are reliable, accurate and easy to use. They are capable of penetrating considerable thicknesses of armor plate using a shaped-charge warhead that is designed for this purpose. Some types of missile can also be equipped with a general-purpose warhead that would be used for attacking targets such as fortified bunkers and gun emplacements. All types can be set up and reloaded comparatively quickly. Consider the TOW missile system as an example. The launcher can be mounted on a light vehicle or carried a short distance and mounted on the ground on a tripod. A late-model TOW launcher weighs about 93 kilograms, the guidance set about 24 kilograms and each missile about 22 kilograms. A rate of fire of about two rounds per minute can be sustained, and the missile has a range in excess of 3,000 meters. It is reported that an early-model TOW missile can blow a hole as much as two feet in diameter in the armor of a Soviet T-62 tank, or cut through three feet of concrete. Later-model TOW missiles are more capable.[78]

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[76] Information from: Hogg, 1991; Gervasi, 1977; Raytheon website (www.raytheon.com), 26 September 2002; US Marine Corps website (www.hqmc.usmc.mil), 26 September 2002; and Canadian Army website (www.army.forces.gc.ca), 27 September 2002.

[77] Reuters, 2002.

[78] Information from: Hogg, 1991; Gervasi, 1977; Raytheon website (www.raytheon.com), 26 September 2002; US Marine Corps website (www.hqmc.usmc.mil), 26 September 2002; and Canadian Army website (www.army.forces.gc.ca), 27 September 2002.

Nuclear Weapons

A nuclear weapon could be used to attack a civilian nuclear facility. This possibility was a source of concern during the Cold War, and there is a body of technical and policy literature on this subject.[79]. Russia retains the capability to attack US nuclear facilities using ICBMs with thermonuclear warheads, and might be motivated at some future date to threaten or implement such an attack. A greater concern in the current period is that a sub-national group, with or without the assistance of a government, might use a comparatively low-yield fission weapon -- perhaps one with an explosive yield in the vicinity of 10 kilotonnes of TNT equivalent -- to attack a US nuclear facility. The means of delivery might be a land vehicle or a general-aviation aircraft. Such a weapon would be difficult to obtain, but many knowledgeable experts have warned that the fissionable material for a simple nuclear weapon could be diverted from poorly-secured stocks in Russia and elsewhere.[80] There is even the possibility that a complete nuclear weapon will be diverted. A high-level group advising the US government has examined the security of nuclear weapons and fissile material in Russia, concluding:[81]

> "The most urgent unmet national security threat to the United States today is the danger that weapons of mass destruction or weapons-usable material in Russia could be stolen and sold to terrorists or hostile nation states and used against American troops abroad or citizens at home. This threat is a clear and present danger to the international community as well as to American lives and liberties."

Summary

Table 1, on the following page, briefly summarizes the characteristics of some potential modes of attack on civilian nuclear facilities, and the present defense against each mode. Other modes of attack can be identified, and an attacking group might use several modes simultaneously or in sequence. The characteristics of each mode are, of course, more complex and varied than is shown in Table 1. Nevertheless, this table shows that determined, knowledgeable attackers have a range of options available to them.

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[79] See, for example: Fetter, 1982; Fetter and Tsipis, 1980; Ramberg, 1984; and SIPRI, 1981.
[80] See, for example: Baker, Cutler et al, 2001; Bunn et al, 2002; and Sokolski and Riisager, 2002.
[81] Baker, Cutler et al, 2001, first page of Executive Summary.

MODE OF ATTACK	CHARACTERISTICS	PRESENT DEFENSE
Commando-style attack	• Could involve heavy weapons and sophisticated tactics • Successful attack would require substantial planning and resources	Alarms, fences and lightly-armed guards, with offsite backup
Land-vehicle bomb	• Readily obtainable • Highly destructive if detonated at target	Vehicle barriers at entry points to Protected Area
Anti-tank missile	• Readily obtainable • Highly destructive at point of impact	None if missile launched from offsite
Commercial aircraft	• More difficult to obtain than pre-9/11 • Can destroy larger, softer targets	None
Explosive-laden smaller aircraft	• Readily obtainable • Can destroy smaller, harder targets	None
10-kilotonne nuclear weapon	• Difficult to obtain • Assured destruction if detonated at target	None

TABLE 1

SOME POTENTIAL MODES OF ATTACK ON CIVILIAN NUCLEAR FACILITIES

4.2 Vulnerability to Attack

The preceding section of this report describes, in deliberately general terms, the potential modes and instruments of attack on a nuclear power plant or an ISFSI. No sensitive information is disclosed. In discussing the vulnerability of nuclear facilities to such attacks, one must be similarly careful to avoid disclosing sensitive information. In this context, the word "vulnerability" refers to the potential for an act of malice or insanity to cause a release of radioactive material to the environment. At the site of a nuclear power plant or an ISFSI, most of the radioactive material at the site is in the reactor(s), the spent-fuel pool(s) and the ISFSI modules.

Requirements for a Vulnerability Study

Every US commercial reactor has been subjected to a PRA-type study by the licensee. This study addressed the reactor's potential to experience accidents, but did not consider acts of malice or insanity. No spent-fuel pool or ISFSI has been subjected to a PRA-type study or a study of its vulnerability to acts of malice or insanity. Indeed, there has never been a comprehensive, published study of the vulnerability of any US nuclear facility to acts of malice or insanity. Spurred by the terrorist events of September 2001, the NRC has sponsored secret, ongoing studies on the vulnerability of nuclear facilities to impact by a large commercial aircraft. Available information suggests that these studies are narrow in scope and will provide limited guidance regarding the overall vulnerability of nuclear facilities.

A comprehensive study of a facility's vulnerability would begin by identifying a range of potential attacks on the facility. The probability of each potential attack would be qualitatively estimated, with consideration of the factors (e.g., international events, changing availability of instruments of attack) that could alter the probability over time. Site-specific factors affecting the feasibility and probability of attack scenarios include local terrain and the proximity of coastlines, airports, population centers and national symbols. A variety of modes and instruments of attack would be considered, of the kind discussed in Section 4.1.

After identifying a range of potential attacks, a comprehensive study would examine the vulnerability of the subject facility to those attacks. This could be done by adapting and extending known techniques of PRA, with an emphasis on the logical structure of PRA rather than the numerical probabilities of events. The analysis would consider the potential for interactions among facilities at a site. For example, a potentially important interaction could be the prevention of personnel access at one facility (e.g., a spent-fuel pool) due to a release of radioactive material at another facility (e.g., a reactor). Attention would be given to the potential for "cascading" scenarios in which attacks at some parts of a nuclear-power-plant site (e.g., control room, switchyard, diesel generators) lead to releases from reactors and/or spent fuel pools that were not directly attacked.

Working with Partial or Misleading Information

In the absence of any comprehensive study of vulnerability, one is obliged to rely upon partial information. Also, one must contend with misleading information disseminated by the nuclear industry. An egregious example is a recent paper in Science, a journal that is usually sound.[82] Two points illustrate the low scientific quality of this paper. First, the paper cites an experiment performed at Sandia National Laboratories as proof that an aircraft cannot penetrate the concrete wall of a reactor containment. In response, Sandia officials have stated that the test has no relevance to the structural behavior of a containment wall, a fact that is readily evident from the nature of the test.[83] Second, the paper states, in connection with the vulnerability of spent-fuel shipping casks, that "there is virtually nothing one could do to these shipping casks that would cause a significant public hazard".[84] A report prepared by Sandia for the NRC is cited in support of this statement.[85] Yet, examination of the Sandia report reveals that it considers only the effects on a shipping cask of impact and fire pursuant to a truck or train accident. The Sandia report does not address the effects of, for example, attack by a TOW missile, a vehicle bomb, or a manually-placed charge.

Aircraft Impact

A rough, preliminary indication of the vulnerability of a nuclear power plant to aircraft impact can be obtained from the PRA for the Seabrook reactor. This reactor is a 4-loop Westinghouse PWR with a large, dry containment, and is one of only four US reactors that were specifically designed to resist impact by an aircraft, a 6-tonne aircraft in the case of Seabrook.[86] The Seabrook PRA finds that any direct impact on the containment by an aircraft weighing more than 37 tonnes will lead to penetration of the containment and a breach in the reactor coolant circuit. Also, the Seabrook PRA finds that a similar impact on the control building or auxiliary building will inevitably lead to a core melt.[87] All of the typical, commercial aircraft mentioned in Section 4.1 of this

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[82] Chapin et al, 2002.
[83] Jones, 2002a.
[84] Chapin et al, 2002, page 1997.
[85] Sprung et al, 2000.
[86] Markey, 2002, page 73.
[87] PLG, 1983, pp 9.3-10 to 9.3-11.

report weigh considerably more than 37 tonnes. Moreover, the Seabrook PRA does not consider the effects of a fuel-air explosion and/or fire as an accompaniment to an aircraft impact. Finally, this PRA, like other PRAs, does not consider malicious acts. Thus, it does not consider, for example, an attack on the Seabrook reactor by an explosive-laden, general-aviation aircraft.

Analytic techniques are available for estimating the effects that aircraft impact will have on the structures and equipment of a nuclear facility. Two recent studies illustrate the use of such techniques. First, the Nuclear Energy Institute (NEI), an industry lobbying organization, has released some preliminary findings from an analysis of aircraft impact on reactor containments and spent-fuel facilities.[88] The analysis itself will not be published, so the findings cannot be verified. Second, a group at Purdue University has released the results of its simulation of the aircraft impact on the Pentagon that occurred on 11 September 2001.[89] A simulation of this kind could be performed for aircraft impact on a nuclear facility. The Purdue group employs commercially-available software and, in contrast to NEI, seems willing to publish its analysis.

The analytic techniques discussed in the preceding paragraph focus on the kinetic energy of the impacting aircraft and its contents. Effects of an accompanying fuel-air explosion and/or fire are given, at best, a crude analysis. A 1982 review by Argonne National Laboratory of the state of the art for aircraft-impact analysis stated:[90]

> "Based on the review of past licensing experience, it appears that fire and explosion hazards have been treated with much less care than the direct aircraft impact and the resulting structural response. Therefore, the claim that these fire/explosion effects do not represent a threat to nuclear power plants has not been clearly demonstrated."

Examination of PRAs and related studies for nuclear facilities shows that the Argonne statement remains valid today. Indeed, in view of the large amount of energy that can be liberated in a fuel-air fire or explosion, previous analyses of aircraft impacts may have substantially underestimated the vulnerability of nuclear facilities to such impacts.

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88 NEI, 2002.
89 Purdue, 2002; Sozen et al, 2002.
90 Kot et al, 1982, page 78.

Vulnerability of Spent-Fuel Pools

The vulnerability of spent-fuel pools deserves special attention because these pools contain large amounts of long-lived radioactive material that could be liberally released to the atmosphere during a fire.[91] The potential for such a fire exists because the pools have been equipped with high-density racks. In the 1970s, the spent-fuel pools of US nuclear power plants were typically equipped with low-density, open-frame racks. If water were partially or totally lost from such a pool, air or steam could circulate freely throughout the racks, providing convective cooling to the spent fuel. By contrast, the high-density racks that are used today have a closed structure. To suppress criticality, each fuel assembly is surrounded by solid, neutron-absorbing panels, and there is little or no gap between the panels of adjacent cells. In the absence of water, this configuration allows only one mode of circulation of air and steam around a fuel assembly -- vertically upward within the confines of the neutron-absorbing panels.

If water is totally lost from a high-density pool, air will pass downward through available gaps such as the gap between the pool wall and the outer faces of the racks, will travel horizontally across the base of the pool, will enter each rack cell through a hole in its base, and will rise upward within the cell, providing cooling to the spent fuel assembly in that cell. If the fuel has been discharged from the reactor comparatively recently, the flow of air may be insufficient to remove all of the fuel's decay heat. In that case, the temperature of the fuel cladding may rise to the point where a self-sustaining, exothermic oxidation reaction with air will begin. In simple terms, the fuel cladding -- which is made of zirconium alloy -- will begin to burn. The zirconium-alloy cladding can also enter into a self-sustaining, exothermic oxidation reaction with steam. Other exothermic oxidation reactions can also occur. For simplicity, the occurrence of one or more of the possible reactions can be referred to as a pool fire.

In many scenarios for loss of water from a pool, the flow of air that is described in the preceding paragraph will be blocked. For example, a falling object (e.g., a fuel-transfer cask) might distort rack structures, thereby blocking air flow. As another example, an attack might cause debris (e.g., from the roof of the fuel handling building) to fall into the pool and block air flow. The presence of residual water in the bottom of the pool would also block air flow. In most scenarios for loss of water, residual water will be present for significant periods of time. Blockage of air flow, for whatever reason, will lead to ignition of fuel that has been discharged from a reactor for long

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[91] The NRC has published a variety of technical documents that address spent-fuel-pool fires. The most recent of these documents is: Collins et al, 2000.

periods -- potentially 10 years or longer.[92] The NRC Staff failed to understand this point for more than two decades.[93]

Loss of Water from a Pool

Partial or total loss of water from a spent-fuel pool could occur through leakage, evaporation, siphoning, pumping, displacement by objects falling into the pool, or overturning of the pool. These modes of loss of water could arise, directly or indirectly, through a variety of attack scenarios. As a simple example, consider leakage as a direct result of aircraft impact on the wall of a pool. This example represents a brute-force attack on the model of 11 September 2001. Other attack options will suggest themselves to knowledgeable attackers.

An NRC Staff study includes a crude, generic analysis of the conditional probability that aircraft impact will cause a loss of water from a spent fuel pool.[94] The pool is assumed to have a 5-ft-thick reinforced-concrete wall. Impacting aircraft are divided into the categories "large" (weight more than 5.4 tonnes) and "small" (weight less than 5.4 tonnes). The Staff estimates that the conditional probability of penetration of the pool wall by a large aircraft is 0.45, and that 50 percent of penetration incidents involve a loss of water which exposes fuel to air. Thus, the Staff estimates that, for impact of a large aircraft, the conditional probability of a loss of water sufficient to initiate a pool fire is 0.23 (23 percent).

Facility Interactions and Cascading Scenarios

An earlier paragraph in Section 4.2 of this report mentions the potential for interactions among facilities on a site, and points out that a potentially important interaction could be the prevention of personnel access at one facility (e.g., a spent-fuel pool) due to a release of radioactive material at another facility (e.g., a reactor). This type of interaction was partially addressed during a licensing proceeding for the Harris nuclear power plant. In that proceeding, the NRC Staff conceded that a fire in one spent-fuel pool would preclude the provision of cooling and makeup to nearby pools, thereby leading to evaporation of water from the nearby pools followed by fires in those pools.[95] This situation would arise mostly because the initial fire would contaminate the site with radioactive material, generating high radiation fields that preclude personnel access. An analogous situation could

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92 The role of residual water in promoting ignition of old fuel is discussed in: Thompson, 1999, Appendix D.
93 Thompson, 2002a, Section II.
94 Collins et al, 2000, page 3-23 and Appendix 2D.
95 Parry et al, 2000, paragraph 29.

arise in which the release of radioactive material from a damaged reactor precludes the provision of cooling and makeup to nearby pools. For example, an attack on a reactor could lead to a rapid-onset core melt with an open containment, accompanied by a raging fire. That event would create high radiation fields across the site, potentially precluding any access to the site by personnel. One can envision a variety of "cascading" scenarios, in which there might eventually be fires in all of the pools at a site, accompanied by core-melt events at all of the reactors.

Progression of a Pool Fire

A pool fire could begin comparatively soon after water is lost from a pool. For example, suppose that most of the length of the fuel assemblies is exposed to air, but the flow of air to the base of the racks is precluded by residual water or a collapsed structure. In that event, fuel heatup would be approximately adiabatic. Fuel discharged for 1 month would ignite in less than 2 hours, and fuel discharged for 3 months would ignite in about 3 hours. The fire would then spread to older fuel. Once a fire has begun, it could be impossible to extinguish. Spraying water on the fire could feed an exothermic zirconium-steam reaction that would generate flammable hydrogen. High radiation fields could preclude the approach of firefighters.

Vulnerability of Dry-Storage Modules

The dry-storage modules used at ISFSIs are passively safe, as discussed in Section 4.1 of this report. Thus, an attacking group that seeks to obtain a radioactive release from an ISFSI must attack each module directly. To obtain a release of radioactive material, the wall of the fuel container must be penetrated from the outside, or the container must be heated by an external fire to such an extent that the containment envelope fails. In addition, a technically-informed and appropriately-equipped attacker could exploit stored chemical energy in the zirconium cladding of the stored spent fuel. Such an attacker would arrange for penetration of the container to be accompanied by the initiation of combustion of the cladding in air. Combustion would generate heat that could liberate radioactive material from the fuel to the outside environment. Initiation of combustion could be facilitated by the presence of zirconium hydride in the fuel cladding, which is a characteristic of high-burnup fuel. The NRC Staff has noted that zirconium hydride can experience auto-ignition in air.[96] This point had been brought to the Staff's attention by the NRC's Advisory Committee on Reactor Safeguards.[97]

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[96] Collins et al, 2000, page A1B-3.
[97] Powers, 2000, page 3.

There is a body of literature that addresses aspects of the vulnerability of dry-storage modules for ISFSIs. Consider some examples. First, NAC International has analyzed the impact of a Boeing 747-400 aircraft on a NAC-UMS storage module of the type discussed in Section 2.2 of this report.[98] According to NAC, this analysis shows that failure of the fuel container would not occur, either from impact or fire. Second, analyses of aircraft impact have been done in Germany in connection with the licensing of ISFSIs that employ CASTOR casks. In Germany, ISFSIs are typically located inside buildings to provide some protection against anti-tank missiles, a practice which creates the potential for pooling of jet fuel following an aircraft impact. As a result, the intensity and duration of fire has become a key issue in technical debates about the release of radioactive material following an aircraft impact.[99] Third, in a test done in Germany in 1992, a shortened CASTOR cask containing simulated fuel assemblies made from depleted uranium was penetrated by a static, shaped charge, in order to simulate attack by an anti-tank missile.[100] The metal jet created by the shaped charge caused a small amount of finely-divided uranium to be released from the cask, but this test did not account for several important factors that are discussed in the following paragraph. Fourth, analyses of aircraft, cruise-missile and dummy-bomb impact on a dry-storage module have been done in connection with the licensing of the proposed Skull Valley ISFSI. The accompanying technical debate suggests that the magnitude of the radioactive release following penetration of a fuel container would be sensitive to the fraction of a fuel assembly's inventory of radionuclides, such as cesium-137, that would be present in the pellet-cladding gap region.[101]

Requirements for a Comprehensive Study of Dry-Storage Vulnerability

The literature that is exemplified in the preceding paragraph addresses only some of the attack scenarios and physical-chemical phenomena that would be addressed in a comprehensive assessment of the vulnerability of dry-storage modules. Such an assessment would consider a range of instruments of attack, including anti-tank missiles, manually-placed charges, a vehicle bomb or an aircraft bomb. Modes of attack that promote zirconium ignition would be considered. Factors that would be accounted for include: (i) the presence of zirconium hydride in fuel cladding; (ii) radioactive-decay heat in fuel pellets; (iii) a pre-attack temperature characteristic of an actual, operating module; and (iv) source-term phenomena (such as the gap inventory of radionuclides) that are characteristic of high-burnup fuel. There is no evidence from

98 McCough and Pennington, 2002.
99 Hirsch, 2002.
100 Lange et al, 2002.
101 Resnikoff, 2001.

published literature that a comprehensive vulnerability assessment of this kind has been made. Some components of a comprehensive assessment may have been performed secretly. For example, there are rumors of NRC-sponsored tests that have combined penetration of a fuel container with incendiary effects. Given the information that is available, it is prudent to assume that a variety of modes and non-nuclear instruments of attack could release to the atmosphere a substantial fraction of the radioactive inventory of a dry-storage module.

Attack Using a Nuclear Weapon

As indicated in Section 4.1 of this report, it is prudent to assume that a low-yield nuclear weapon (with a yield of perhaps 10 kilotonnes of TNT equivalent) might be used as an instrument of attack at a nuclear power plant or an ISFSI. A thorough assessment of the vulnerability to such an attack of the reactor(s), spent-fuel pool(s) and ISFSI modules at a site would require detailed analysis. Absent such an analysis, rough judgements can be made.

Consider, for example, a 10-kilotonne ground burst at an unhardened, surface-level ISFSI of the usual US type. It seems reasonable to assume that any module within the crater area would, as a result of blast effects and heating by the fireball, become divided into fragments, many of them small enough to travel downwind for many kilometers before falling to earth. A 10-kilotonne ground burst over sandstone, which is perhaps representative of an ISFSI, would yield a crater about 68 meters in diameter and 16 meters deep.[102]

As an indication of the potential release of radioactive material following a nuclear detonation at an ISFSI, consider a 10-kilotonne groundburst at an ISFSI that employs vertical-axis fuel-storage modules with a center-to-center distance of 5.5 meters, as would be the case for the proposed Diablo Canyon facility. Given a large, square array of such modules, about 120 modules would fall within the 68-meter diameter of the anticipated crater. Thus, it is plausible to assume that 100 percent of the volatile radionuclides (such as cesium-137) in 120 modules, together with a lesser fraction of the non-volatile radionuclides, would be carried downwind in a radioactive plume. This quantity could be an over-estimate, because the ISFSI has finite dimensions and is not an infinite array, or it could be an under-estimate, because damage to modules outside the crater is not considered. Note that a NAC-UMS module, as used at Maine Yankee, can hold 24 PWR fuel assemblies or 56

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[102] Glasstone, 1962, Chapter VI.

BWR fuel assemblies.[103] The HI-STORM 100 modules that would be used at the proposed Diablo Canyon ISFSI can each hold 32 PWR fuel assemblies.[104]

Comparative Risks of Attack Options

Section 4.1 of this report shows that a determined, knowledgeable group has available to it a range of options for attacking reactors, spent-fuel pools and ISFSIs. The preceding paragraphs of Section 4.2 provide a brief discussion of the vulnerability of reactors, pools and ISFSI modules to such options. These topics could be discussed more comprehensively, but that task was beyond the scope of this report. A comprehensive assessment -- whose underlying technical analysis should not, for obvious reasons, be openly published -- would identify a wide range of attack scenarios and would estimate their outcomes. Such an assessment could provide a perspective on the comparative risks of attack options.

As an illustration of comparative risk, consider three potential options for obtaining a release of radioactive material. Option I would be an attack on an ISFSI using a 10-kilotonne nuclear weapon delivered by a general-aviation aircraft. Delivery of the weapon could be straightforward, given the lack of air defense at ISFSIs, but the weapon would be difficult to obtain. Thus, this attack option seems to have a comparatively low probability. However, it would yield a large release of radioactive material. Option II would be a commando-style attack in which the attackers seize control of a nuclear power plant, initiate a reactor-core melt, breach the reactor containment, and initiate the removal of water from the spent-fuel pool(s) by siphoning and/or breaching the pool(s). Such an attack is feasible but would require substantial planning and resources and might be repulsed. Thus, this attack option may have a comparatively low probability. It would, however, yield a large release of radioactive material. Option III would be an attack on one or more ISFSI modules using anti-tank missiles fired from one or more offsite locations. In a plausible time window the attackers might, for example, be able to obtain 10 hits. The probability of this option is presumably substantially greater than the probability of Options I and II, but the release of radioactive material would be considerably smaller.

4.3 Consequences of Attack

The offsite radiological consequences of a potential attack on a nuclear facility can be estimated with widely-used, computer-based models. In order to apply such a model, one must have an estimate of the accident "source term". The

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103 Stone and Webster, 1999.
104 PG&E, 2001a.

source term is a set of characteristics -- magnitude, timing, etc. -- that describe a potential release of radioactive material to the atmosphere. Using this source term, together with weather data for the release site, the model can estimate the magnitude of each of a range of radiological impacts at specified locations downwind.

Cesium-137 as an Indicator

A full analysis of this type is beyond the scope of this report. Instead, some scoping calculations are presented here, focussing on one radioactive isotope -- cesium-137. This isotope is a useful indicator of the potential, long-term consequences of a release of radioactive material. Cesium-137 has a half-life of 30 years, and accounts for most of the offsite radiation exposure that is attributable to the 1986 Chernobyl reactor accident, and for about half of the radiation exposure that is attributable to fallout from nuclear weapons tests in the atmosphere.[105] Cesium is a volatile element that would be liberally released during nuclear-facility accidents or attacks. For example, an NRC study has concluded that a generic estimate of the release fraction of cesium isotopes during a spent-fuel-pool fire -- that is, the fraction of the pool's inventory of cesium isotopes that would reach the atmosphere -- is 100 percent.[106] It is reasonable to assume such a high release fraction because cesium is volatile, because a fire in a high-density pool, once initiated, would eventually involve all of the fuel in the pool, and because pool buildings are not designed as containment structures.

Inventories of Cesium-137 at Indian Point

The Indian Point site provides an illustration of the inventories of cesium-137 at nuclear facilities. Three nuclear power plants have been built at this site. Unit 1 had a rated power of 590 MW (thermal) and operated from 1962 to 1974.[107] Unit 2 has a rated power of 2,760 MW (thermal), commenced operating in 1974, and remains operational. Unit 3 has a rated power of 2,760 MW (thermal), commenced operating in 1976, and remains operational. Unit 2 and Unit 3 each employ a four-loop Westinghouse PWR with a large, dry containment. The reactor cores of Unit 2 and Unit 3 each contain 193 fuel assemblies.[108]

Unit 2 and Unit 3 are each equipped with one spent-fuel pool. The capacity of the Unit 2 pool is 1,374 fuel assemblies, while the capacity of the Unit 3 pool is

[105] DOE, 1987.
[106] Sailor et al, 1987.
[107] Thompson and Beckerley, 1973, Table 4-1.
[108] Larson, 1985, Table A-2.

1,345 fuel assemblies.[109] Both pools employ high-density racks. As of November 1998, the Unit 2 pool contained 917 fuel assemblies, while the Unit 3 pool contained 672 fuel assemblies.[110] It can be assumed that the number of fuel assemblies in each pool has increased since November 1998.

The inventory of cesium-137 in the Indian Point pools can be readily estimated. Three parameters govern this estimate -- the number of spent fuel assemblies, their respective burnups, and their respective ages after discharge. Assuming a representative, uniform burnup of 46 GW-days per tonne, one finds that the 917 fuel assemblies that were in the Unit 2 pool in November 1998 now contain about 42 million Curies (460 kilograms) of cesium-137. The 672 fuel assemblies that were in the Unit 3 pool in November 1998 now contain about 31 million Curies (350 kilograms) of cesium-137. Additional amounts of cesium-137 would be present in any fuel assemblies that have been added to these pools since November 1998.

For comparison, the cores of the Indian Point Unit 2 and Unit 3 reactors each contain about 6 million Curies (67 kilograms) of cesium-137. Also, it should be noted that the Chernobyl reactor accident of 1986 released about 2.4 million Curies (27 kilograms) of cesium-137 to the atmosphere. That release represented 40 percent of the Chernobyl reactor core's inventory of 6 million Curies (67 kg) of cesium-137.[111] Also, atmospheric testing of nuclear weapons led to the deposition of about 20 million Curies (220 kilograms) of cesium-137 across the land and water surfaces of the Northern Hemisphere.[112]

As another comparison, consider a HI-STORM 100 dry-storage module that contains 32 PWR fuel assemblies. Assuming that these fuel assemblies have an average post-discharge age of 20 years, this module would contain about 1.3 million Curies (14 kilograms) of cesium-137.

Inventories of Cesium-137 at Vermont Yankee

The Vermont Yankee site provides a second illustration of the inventories of cesium-137 at nuclear facilities. At this site there is a single BWR with a rated power of 1,590 MW (thermal) and a Mark I containment. This plant commenced operating in 1972 and remains operational. The reactor core contains 368 fuel assemblies.[113] One spent-fuel pool is provided at this plant.

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109 "Reactor Spent Fuel Storage", from NRC website (www.nrc.gov), 30 May 2001.
110 Ibid.
111 Krass, 1991.
112 DOE, 1987.
113 Larson, 1985, Table A-1.

The pool is equipped with high-density racks and has a capacity of 2,870 fuel assemblies, with a possible recent increase in this capacity.[114]

In 2000, the Vermont Yankee pool contained 2,439 fuel assemblies.[115] Licensee projections done in 1999 showed the pool inventory increasing to a maximum of 2,687 assemblies in 2004, after which the inventory would decrease until the pool would be empty in 2017. These projections assumed continuing operation of the plant until 2012, transfer of spent fuel from the pool to an on-site ISFSI beginning in 2004, and shipment of fuel to Yucca Mountain beginning in 2010.[116] To date, there has been no license application for an ISFSI at Vermont Yankee. Thus, transfer of fuel to an on-site ISFSI in 2004 is unlikely. As discussed in Section 2.1 of this report, shipment of fuel to Yucca Mountain in 2010 is unlikely.

The inventories of cesium-137 in the Vermont Yankee pool and reactor can be estimated as described above for Indian Point. One can assume that the Vermont Yankee pool now (in January 2003) contains 2,639 fuel assemblies, which have been discharged from the reactor during refuelling outages since 1972.[117] Thus, the pool now contains about 35 million Curies (390 kilograms) of cesium-137. The Vermont Yankee reactor contains about 2.3 million Curies (26 kilograms) of cesium-137.

Land Contamination by Cesium-137 After a Pool Fire

Now consider the potential for a spent-fuel-pool fire at Indian Point or Vermont Yankee. As explained above, it is reasonable to assume that 100 percent of the cesium-137 in a pool would be released to the atmosphere in the event of a fire. The cesium-137 would be released to the atmosphere in small particles that would travel downwind and be deposited on the ground and other surfaces. The deposited particles would emit intense gamma radiation, leading to external, whole-body radiation doses to exposed persons. Cesium-137 would also contaminate water and foodstuffs, leading to internal radiation doses.

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114 According to information compiled by licensee staff in February 1999 (Weyman, 1999), the licensed storage limit for the Vermont Yankee pool was 2,870 fuel assemblies in 1999, and was projected to increase to 3,355 fuel assemblies in 2001. According to information compiled by the NRC, the capacity of the Vermont Yankee pool in November 1998 was 2,863 assemblies; see "Reactor Spent Fuel Storage", from NRC website (www.nrc.gov), 30 May 2001.

115 Vermont Yankee, 2000.

116 Weyman, 1999.

117 Ibid.

One measure of the scope of radiation exposure attributable to deposition of cesium-137 is the area of land that would become uninhabitable. For illustration, one can assume that the threshold of uninhabitability is an external, whole-body dose of 10 rem over 30 years. This level of radiation exposure, which would represent about a three-fold increase above the typical level of background (natural) radiation, was used in the NRC's 1975 Reactor Safety Study as a criterion for relocating populations from rural areas.

A radiation dose of 10 rem over 30 years corresponds to an average dose rate of 0.33 rem per year.[118] The health effects of radiation exposure at this dose level have been estimated by the National Research Council's Committee on the Biological Effects of Ionizing Radiations.[119] This committee has estimated that a continuous lifetime exposure of 0.1 rem per year would increase the incidence of fatal cancers in an exposed population by 2.5 percent for males and 3.4 percent for females.[120] Incidence would scale linearly with dose, in this low-dose region.[121] Thus, an average lifetime exposure of 0.33 rem per year would increase the incidence of fatal cancers by about 8 percent for males and 11 percent for females. About 21 percent of males and 18 percent of females normally die of cancer.[122] In other words, in populations residing continuously at the threshold of uninhabitability (an external dose rate of 0.33 rem per year), about 2 percent of people would suffer a fatal cancer that would not otherwise occur.[123] Internal doses from contaminated food and water could cause additional cancer fatalities.

The increased cancer incidence described in the preceding paragraph would apply at the boundary of the uninhabitable area. Within that area, the external dose rate from cesium-137 would exceed the threshold of 10 rem over 30 years. At some locations, the dose rate would exceed this threshold by orders of magnitude. Therefore, persons choosing to live within the uninhabitable area would experience an incidence of fatal cancers at a level higher than is set forth above.

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[118] At a given location contaminated by cesium-137, the resulting external, whole-body dose received by a person at that location would decline over time, due to radioactive decay and weathering of the cesium-137. Thus, a person receiving 10 rem over an initial 30-year period would receive a lower dose over the subsequent 30 -year period.

[119] National Research Council, 1990.

[120] Ibid, Table 4-2.

[121] The BEIR V committee assumed a linear dose-response model for cancers other than leukemia, and a model for leukemia that is effectively linear in the low-dose range. See National Research Council, 1990, pp 171-176.

[122] National Research Council, 1990, Table 4-2.

[123] For males, 0.08 x 0.21 = 0.017. For females, 0.11 x 0.18 = 0.020.

Area of Uninhabitable Land
After a Pool Fire at Indian Point or Vermont Yankee

For a postulated release of cesium-137 to the atmosphere, the area of uninhabitable land can be estimated from calculations done by Dr Jan Beyea.[124] Four releases of cesium-137 are postulated here. The first postulated release is 42 million Curies, representing the fuel that was present in the Indian Point Unit 2 pool in November 1998. The second postulated release is 31 million Curies, representing the fuel that was present in the Indian Point Unit 3 pool in November 1998. (Actual, present inventories of cesium-137 in the Unit 2 and Unit 3 pools are higher than these numbers, assuming that fuel has been added since November 1998.) The third postulated release is 35 million Curies, representing the present (January 2003) inventory of fuel in the Vermont Yankee pool. The fourth postulated release is 1 million Curies, representing the cesium-137 inventory in a dry-storage ISFSI module that contains 32 PWR fuel assemblies. This fourth release does not represent a pool fire or a predicted release from an ISFSI. Instead, it is a notional release that provides a scale comparison.

For typical weather conditions, assuming that the radioactive plume travels over land rather than out to sea, a release of 42 million Curies of cesium-137 would render about 95,000 square kilometers of land uninhabitable. Under the same conditions, a release of 31 million Curies would render about 75,000 square kilometers uninhabitable, and a release of 35 million Curies would render about 80,000 square kilometers uninhabitable. A release of 1 million Curies would render uninhabitable about 2,000 square kilometers. For comparison, note that the area of New York state is 127,000 square kilometers, while the combined area of Vermont, New Hampshire and Massachusetts is 70,000 square kilometers. The use of a little imagination shows that a spent-fuel-pool fire at Indian Point or Vermont Yankee would be a regional and national disaster of historic proportions, with health, environmental, economic, social and political dimensions.

Cesium-137 Fallout From a Nuclear Detonation

For attack scenarios involving the use of a nuclear weapon on a spent-fuel-storage facility, it is instructive to compare the long-term radiological significance of the nuclear detonation itself with the significance of the release that the detonation could induce. For example, detonation of a 10-kilotonne fission weapon would directly generate about 2 thousand Curies (21

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[124] Beyea et al, 1979.

grams) of cesium-137.[125] Yet, this weapon could release to the atmosphere tens of millions of Curies of cesium-137 from a spent-fuel pool or an unhardened, undispersed ISFSI.

4.4 Defense in Depth

Four types of measure, taken together, could provide a comprehensive, defense-in-depth strategy against acts of malice or insanity at a nuclear facility. The four types of measure, which are described in the following paragraphs, are in the categories: (i) site security; (ii) facility robustness; (iii) damage control; and (iv) emergency response planning. The degree of protection provided by these measures would be greatest if they were integrated into the design of a facility before its construction. However, a comprehensive set of measures could provide significant protection at existing facilities.

Site Security

Site-security measures are those that reduce the potential for implementation of destructive acts of malice or insanity at a nuclear site. Two types of measure fall into this category. Measures of the first type would be implemented at offsite locations, and the implementing agencies might have no direct connection with the site. Airline or airport security measures are examples of measures in this category. Measures of the second type would be implemented at or near the site. Implementing agencies would include the licensee, the NRC and, potentially, other entities (e.g., National Guard, Coast Guard). The physical protection measures now required by the NRC, as discussed in Section 2.3 of this report, are examples of site-security measures of the second type. More stringent measures could be introduced, such as:

(i) establishment of a mandatory aircraft exclusion boundary around the site;
(ii) deployment of an approaching-aircraft detection system that triggers a high-alert status at facilities on the site;
(iii) expansion of the DBT, beyond that now applicable to a nuclear power plant, to include additional intruders, heavy weapons, lethal chemical weapons and more than one vehicle bomb; and
(iv) any ISFSI on the site to receive protection equivalent to that provided for a nuclear power plant.

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125 SIPRI, 1981, page 76.

Facility Robustness

Facility-robustness measures are those that improve the ability of a nuclear facility to experience destructive acts of malice or insanity without a significant release of radioactive material to the environment. In illustration, the PIUS reactor design, as discussed in Section 2.3, was intended to withstand aerial bombardment by 1,000-pound bombs without suffering core damage or releasing a significant amount of radioactive material to the environment. An ISFSI could be constructed with a similar degree of robustness. At existing facilities, a variety of opportunities are available for enhancing robustness. As a high-priority example, the spent fuel pool(s) at a nuclear power plant could be re-equipped with low-density racks, so that spent fuel would not ignite if water were lost from a pool. As a second example, the reactor of a nuclear power plant could be permanently shut down, or the reactor could operate at reduced power, either permanently or at times of alert. Other robustness-enhancing opportunities could be identified. For a nuclear power plant whose reactor is not permanently shut down, robustness could be enhanced by an integrated set of measures such as:

(i) automated shutdown of the reactor upon initiation of a high-alert status at the plant, with provision for completion of the automated shutdown sequence if the control room is disabled;
(ii) permanent deployment of diesel-driven pumps and pre-engineered piping to be available to provide emergency water supply to the reactor, the steam generators (at a PWR) and the spent fuel pool(s);
(iii) re-equipment of the spent fuel pool(s) with low-density racks, excess fuel being stored in an onsite ISFSI; and
(iv) construction of the ISFSI to employ hardened, dispersed, dry storage.

Damage Control

Damage-control measures are those that reduce the potential for a release of radioactive material from a facility following damage to that facility due to destructive acts of malice or insanity. Measures of this kind could be ad hoc or pre-engineered. One illustration of a damage control measure would be a set of arrangements for patching and restoring water to a spent fuel pool that has been breached. Many other illustrations can be provided. It appears, from the list of additional measures set forth in Section 2.3 of this report, that the NRC's recent orders have required licensees to undertake some planning for damage control following explosions or fires. Additional measures would be appropriate. For example, at a site housing one or more nuclear power plants and an ISFSI, the following damage-control measures could be implemented:

(i) establishment of a damage control capability at the site, using onsite personnel and equipment for first response and offsite resources for backup;
(ii) periodic exercises of damage-control capability;
(iii) establishment of a set of damage-control objectives -- to include patching and restoring water to a breached spent fuel pool, fire suppression in the ISFSI, and provision of cooling to a reactor whose support systems and control room are disabled -- with accompanying plans; and
(iv) provision of equipment and training to allow damage control to proceed on a radioactively-contaminated site.

Offsite Emergency Response

Emergency-response measures are those that reduce the potential for exposure of offsite populations to radiation, following a malice- or insanity-induced release of radioactive material from a nuclear facility. Measures in this category would in many respects be similar to emergency planning measures that are designed to accommodate "accidental" releases of radioactive material arising from human error, equipment failure or natural forces (e.g., earthquake). However, there are two major ways in which malice- or insanity-induced releases might differ from accidental releases. First, a malice- or insanity-induced release might be larger and begin earlier than an accidental release.[126] Second, a malice- or insanity-induced release might be accompanied by deliberate degradation of emergency response capabilities (e.g., the attacking group might block an evacuation route). Accommodating these differences could require additional measures of emergency response. Overall, an appropriate way to improve emergency-response capability at a nuclear-power-plant site could be to implement a model emergency response plan that was developed by a team based at Clark University in Massachusetts.[127] This model plan was specifically designed to accommodate radioactive releases from spent-fuel-storage facilities, as well as from reactors. That provision, and other features of the plan, would provide a capability to accommodate both accidental releases and malice- or insanity-induced releases. Major features of the model plan include:[128]

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[126] Present plans for emergency response do not account for the potential for a large release of radioactive material from spent fuel, as would occur during a pool fire. The underlying assumption is that a release of this kind is very unlikely. That assumption cannot be sustained in the present threat environment.
[127] Golding et al, 1992.
[128] Ibid, pp 8-13.

(i) structured objectives;
(ii) improved flexibility and resilience, with a richer flow of information;
(iii) precautionary initiation of response, with State authorities having an independent capability to identify conditions calling for a precautionary response[129];
(iv) criteria for long-term protective actions;
(v) three planning zones, with the outer zone extending to any distance necessary[130];
(vi) improved structure for accident classification;
(vii) increased State capabilities and power;
(viii) enhanced role for local governments;
(ix) improved capabilities for radiation monitoring, plume tracking and dose projection;
(x) improved medical response;
(xi) enhanced capability for information exchange;
(xii) more emphasis on drills, exercises and training;
(xiii) improved public education and involvement; and
(xiv) requirement that emergency preparedness be regarded as a safety system equivalent to in-plant systems.

4.5 A Strategy for Robust Storage of Spent Fuel

The preceding section of this report sets forth a defense-in-depth strategy for nuclear facilities. This strategy could be implemented at every civilian nuclear facility in the United States. Within the context of that strategy, it would be necessary to establish a nationwide strategy for the robust storage of spent fuel. The strategy must protect all spent fuel that has been discharged from a reactor but has not been emplaced in a repository. Available options for storing this fuel are wet storage in pools and dry storage in ISFSIs.

Timeframe for a Robust-Storage Strategy

As pointed out in Section 2.1 of this report, thousands of tonnes of US spent fuel will remain in interim storage for decades, even if a repository opens at Yucca Mountain. If a repository does not open, the entire national inventory of spent fuel will remain in interim storage for many decades. Thus, the robust-storage strategy for spent fuel must minimize the overall risk of interim storage throughout a period that may extend for 100 years or longer.

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[129] A security alert could be a condition calling for a precautionary response.

[130] The inner and intermediate zones would have radii of 5 and 25 miles, respectively. As an example of the planning measures in each zone, potassium iodide would be predistributed within the 25-mile zone and made generally accessible nationwide.

Moreover, this interim storage strategy must be compatible with the eventual emplacement of the spent fuel in a repository in a manner that minimizes long-term risk.

Reactor Risk and Spent-Fuel Risk

This report focusses on the risk of a radioactive release from spent fuel. It also, by necessity, discusses the risk of a similar release from a reactor. These risks are closely intertwined in two practical ways. First, many scenarios for a spent-fuel-pool fire involve interactions between the affected pool(s) and the reactor(s) on the site. Second, the security of an at-reactor ISFSI is an adjunct to the security of a nuclear-power-plant site.

A robust-storage strategy for spent fuel could substantially reduce the risk of a radioactive release from spent fuel, at a comparatively low cost. Given the design of US nuclear power plants, there is no obvious strategy for achieving a comparable reduction in reactor risk. Thus, even if a defense-in-depth strategy is implemented for every reactor, a substantial fraction of the present reactor risk will continue to exist as long as the reactors continue to operate.

What should be the risk target for a robust-storage strategy? There are three major considerations that argue for seeking a spent-fuel risk that is substantially lower than the reactor risk. First, measures are available for substantially reducing the spent-fuel risk at a comparatively low cost. Second, storing spent fuel creates no benefit to offset its risk, whereas reactors generate electricity. Third, spent fuel may be in interim storage for 100 years or longer, whereas the present reactors will operate for at most a few more decades.

Elements of a Robust-Storage Strategy

From Sections 4.2 and 4.3 of this report, it is evident that storing spent fuel in high-density pools poses a very high risk. Dry storage of spent fuel, even employing the present practice that is described in Section 2.3, poses a lower risk. Thus, a robust-storage strategy must assign its highest priority to re-equipping each spent fuel pool with low-density racks, in order to reduce the pool's inventory of fuel and to prevent self-ignition and burning of fuel if water is lost from the pool.[131] The excess fuel, for which space would no longer be available in pools, would be transferred to ISFSIs. When a nuclear power plant is shut down, the fuel remaining in its pool(s) would be transferred to an ISFSI after an appropriate period of cooling. These steps would dramatically reduce the overall risk of spent-fuel storage. A further,

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131 Further protection of the spent fuel that remains in pools could be provided by a variety of site-security, facility-robustness and damage-control measures of the kind that are described in Section 4.4 of this report.

substantial reduction of the overall risk would be obtained by employing hardened, dispersed, dry storage at every ISFSI.

Figure 1, on the following page, shows how a robust-storage strategy for spent fuel would operate in a larger context. The robust-storage strategy would have the three elements represented by the three boxes at the base of the figure: low-density pools; hardened dry-storage modules; and dispersed dry-storage modules. In turn, the robust-storage strategy would be one of the elements of facility robustness, which itself would be one of four components of a defense in depth for US civilian nuclear facilities. This defense would contribute to homeland security and national security.

Away-from-Reactor ISFSIs

In a robust-storage strategy, any ISFSI would employ hardened, dispersed dry storage. The essential principles would be the same whether the ISFSI is at a nuclear-power-plant site or at another site such as Skull Valley.

Section 2.1 of this report discusses factors that argue against shipping spent fuel to an away-from-reactor ISFSI. Some of these factors are economic in nature. However, three factors affect the overall risk of interim storage. First, shipment to an away-from-reactor ISFSI would increase the overall transport risk, because fuel would be shipped twice, first from the reactor site to the ISFSI, and then from the ISFSI to the ultimate repository. Second, an away-from-reactor ISFSI would hold a comparatively large inventory of spent fuel, creating a potentially attractive target for an enemy. Third, there is a risk that a large, away-from-reactor ISFSI would become, by default, a permanent repository, despite having no long-term containment capability. These three factors must be considered in minimizing the overall risk of interim storage.

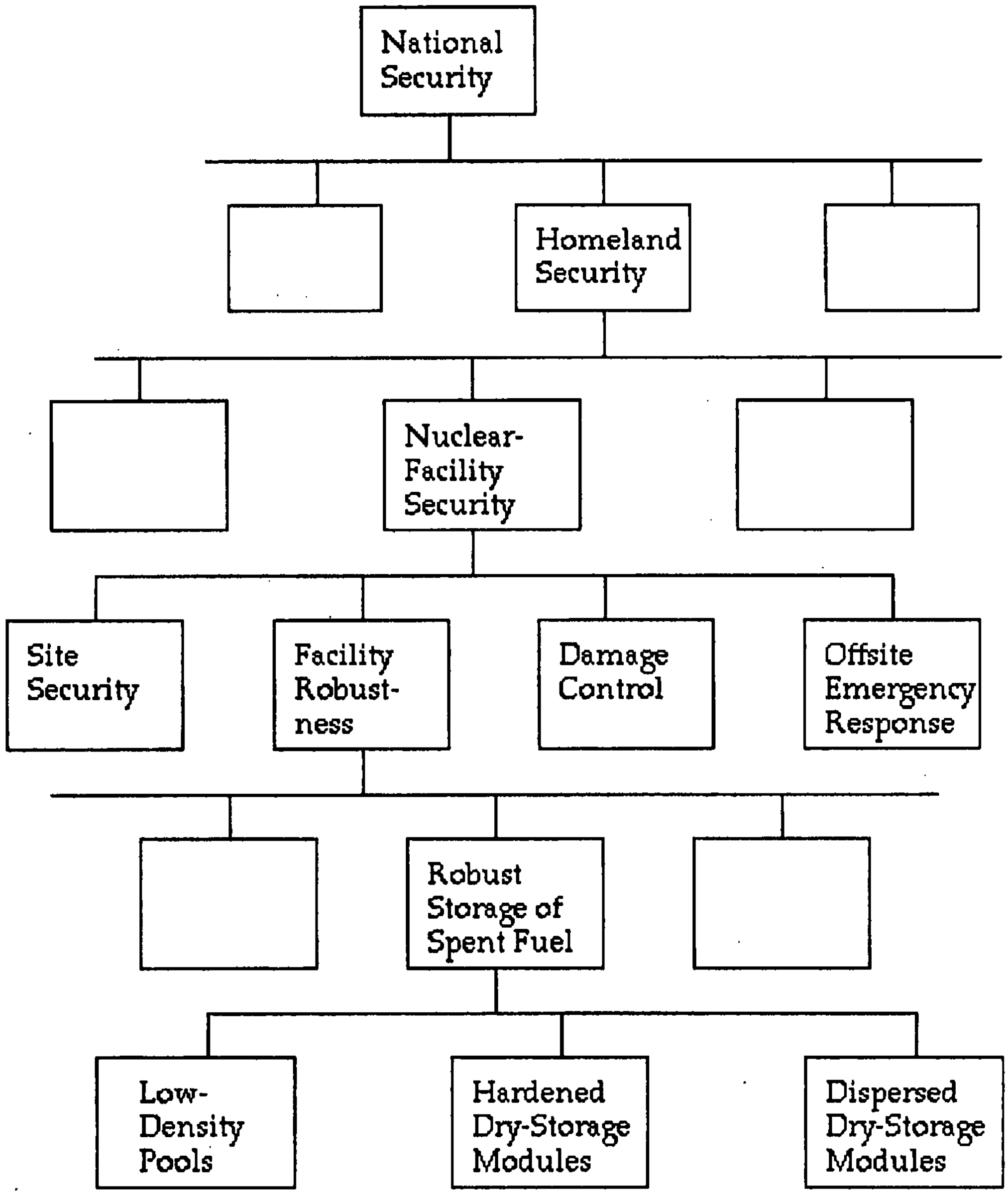

FIGURE 1

ROBUST STORAGE OF SPENT FUEL IN THE CONTEXT OF NATIONAL SECURITY

5. Considerations in Planning Hardened, Dispersed, Dry Storage

5.1 Balancing Short- and Long-Term Risks

Interim storage of spent fuel could lead to eventual emplacement of the fuel in a repository at Yucca Mountain. In this case, fuel would remain in interim storage for several decades. That period is long enough to require action to reduce the very high risk that is posed by pool storage, and the smaller but still significant risk that is posed by unhardened, undispersed ISFSIs. However, in this case the long-term risk posed by spent-fuel management would not be relevant to interim storage. The long-term risk, which will be significant for many thousands of years, would be associated with the Yucca Mountain repository.

Avoiding a Repository by Default

If a repository does not open, a different problem will arise. That problem is the possibility that society will extend the life of interim-storage facilities until they become, by default, repositories for spent fuel. These facilities would function poorly as repositories, and the environment around each facility would become contaminated by radioactive material leaking from the facility. This outcome would pose a substantial long-term risk. The prospect of society acting in this improvident manner may seem far-fetched, but becomes more credible when one examines the history of the Yucca Mountain project. That project is politically driven, and is going forward only because previously-specified technical criteria for a repository have been abandoned.[132]

Any current planning for the implementation of interim storage must account for the possibility that a repository will not open at Yucca Mountain. Thus, the design approach that is adopted for a hardened, dispersed, dry-storage ISFSI must balance two objectives. The first objective is that the facility should be comparatively robust against attack. The second objective is that the facility should not have features that encourage society to allow the facility to become, by default, a repository.

Consideration of the second objective dictates that the ISFSI should not, unless absolutely necessary, be located underground. Therefore, the first objective should be pursued through a design in which the ISFSI modules are stored at grade level (i.e., at the general level of the site). Hardening would then be achieved by placing steel, concrete, gravel or other materials above

[132] Ewing and Macfarlane, 2002.

and around each module. The remaining protection would be provided by dispersal of the storage modules.

5.2 Cost and Timeframe for Implementation

As discussed in Section 2.1 of this report, forecasts show a rapid expansion in dry-storage capacity across the USA over the coming years. NAC International predicts that about 30 percent of US commercial spent fuel will be in dry-storage ISFSIs by 2010, as compared with 6 percent at the end of 2000. Vendors have developed a comparatively cheap technology for these ISFSIs, in response to to industry preferences. This technology -- the overpack system -- involves the placement of spent fuel into thin-walled metal containers that are stored inside overpacks made primarily from concrete. The resulting modules are placed close together in large numbers on concrete pads in the open air. A preference for vertical-axis modules seems to be emerging.

Required Properties of Dry-Storage Modules

Re-equipping US spent fuel pools with low-density racks would create a large additional demand for dry-storage modules. This demand should be met as quickly as possible, in view of the very high risk that is posed by high-density pool storage. Also, the cost of the additional storage capacity should be minimized, consistent with the achievement of performance objectives. Thus, it is desirable that module designs already approved by the NRC be used. However, any module that is used for a hardened, dispersed ISFSI must be capable, when hardened, of resisting a specified attack. This requirement did not exist when module designs were approved by the NRC. Also, it is desirable that modules be capable of retaining their integrity for 100 years or more, which was not a requirement when module designs were approved by the NRC. A module that does not have a long-life capability may need to be replaced at some point if it is used in an ISFSI that serves for an extended period. Finally, the design of a module should allow for the eventual transport of spent fuel from an ISFSI to a repository.

Meeting the Requirements:
Monolithic Casks versus Overpack Systems

Of the module designs already approved by the NRC, monolithic casks such as the CASTOR are probably more capable of meeting attack-resistance and long-life requirements than are modules that employ a thin-walled metal container inside a concrete overpack. However, monolithic casks are more expensive. Thus, it would be convenient if some of the cheaper and more widely-used module designs proved to be capable of meeting attack-resistance and long-life requirements. This outcome would minimize the cost of offloading fuel from pools to hardened, dispersed dry storage, and would expedite this transition.

The development of detailed requirements for attack resistance and long life is a task beyond the scope of this report. Section 7 of the report sets forth a process for developing attack-resistance requirements, drawing upon experiments. When that process is completed, it will be possible to determine which of the already-approved module designs can be used for hardened, dispersed, dry storage.

5.3 Design-Basis Threat

The specification of a DBT for a nuclear facility inevitably reflects a set of tradeoffs. In the case of a hardened, dispersed, dry-storage ISFSI, five major considerations must be balanced. First, the ISFSI must protect spent fuel against a range of possible attacks. Second, the cost of the ISFSI should not be dramatically higher than the cost of an ISFSI built according to present practice. Third, the timeframe for building of the ISFSI should be similar to the timeframe for building an ISFSI according to present practice. Fourth, the ISFSI should not, unless absolutely necessary, be built underground. Fifth, it should be possible to construct an ISFSI of this kind at every US nuclear-power-plant site.

These considerations suggest a two-tier DBT for a hardened, dispersed, dry-storage ISFSI. This DBT might have the following structure:

Tier I

There should be high confidence that the release of radioactive material from the ISFSI to the environment would not exceed a small, specified amount in the event of a direct attack on any part of the ISFSI by:

(i) a TOW missile;
(ii) a specified manually-placed charge;
(iii) a specified vehicle bomb;
(iv) a specified explosive-laden general-aviation aircraft; or
(v) a fuel-laden commercial aircraft.

Tier II

There should be reasonable confidence that the release of radioactive material from the ISFSI to the environment would not exceed a specified amount in the event of a ground burst, at any part of the ISFSI, of a 10-kilotonne nuclear weapon. .

5.4 Site Constraints

At each ISFSI site there will be a site-specific set of constraints on the development of a hardened, dispersed ISFSI. Some constraints will be political, financial or in some other non-physical category. Other constraints will be physical, reflecting the geography of the site. Of the physical constraints, the most significant will be the land area required for dispersal of dry-storage modules.

At many nuclear-power-plant sites, ample land area will be available for dispersal. At some, smaller sites, it may not be possible to achieve the desired degree of dispersal, but this deficiency might be compensated by increased hardening. At the smallest sites, it might be necessary to relax the requirement that the ISFSI should not be built underground. This step would allow a substantial increase in hardening, to offset the limited degree of dispersal that could be achieved. At especially-constricted sites, it might be necessary to ship some spent fuel from the site to an ISFSI elsewhere.

6. A Proposed Design Approach for Hardened, Dispersed, Dry Storage

An ISFSI design approach that offers a prospect of meeting the above-specified DBT involves an array of vertical-axis dry-storage modules at a center-to-center spacing of perhaps 25 meters. Each module would be on a concrete pad slightly above ground level, and would be surrounded by a concentric tube surmounted by a cap, both being made of steel and concrete. This tube would be backed up by a conical mound made of earth, gravel and rocks. Further structural support would be provided by triangular panels within the mound, buttressing the tube. The various structural components would be tied together with steel rods. Air channels would be provided, to allow cooling of the dry-storage module. These channels would be inclined, to prevent pooling of jet fuel, and would be configured to preclude line-of-sight access to the dry-storage module. Figure 2, on the following page, provides a schematic view of the proposed design.

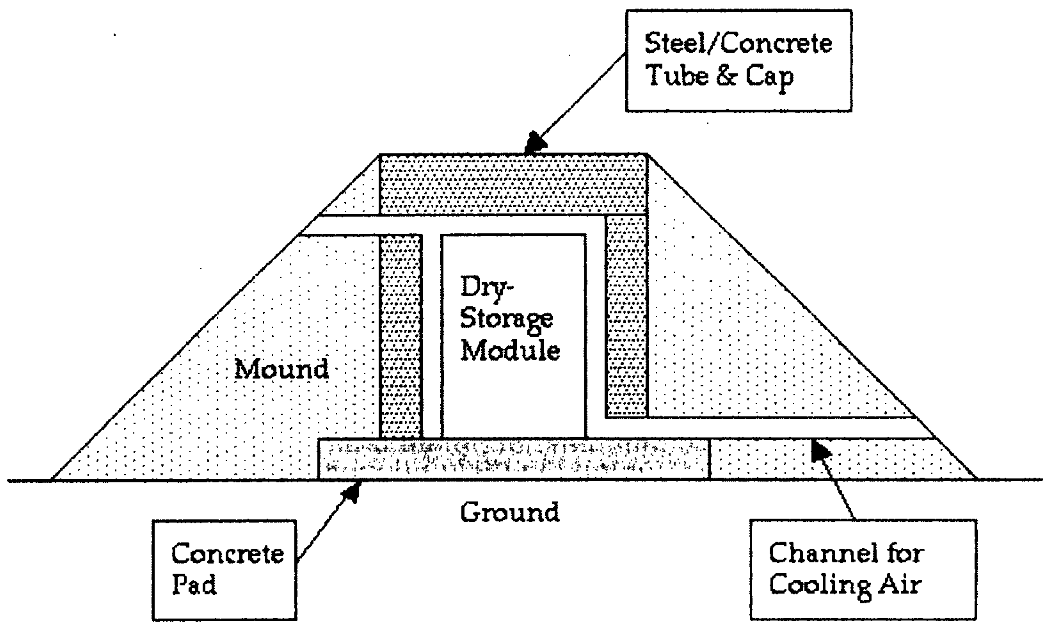

FIGURE 2

SCHEMATIC VIEW OF PROPOSED DESIGN
FOR HARDENED, DRY STORAGE

Notes

1. Cooling channels would be inclined, to prevent pooling of jet fuel, and would be configured to preclude line-of-sight access to the dry-storage module.
2. The tube, cap and pad surrounding the dry-storage module would be tied together with steel rods, and spacer blocks would prevent the module from moving inside the tube.
3. The steel/concrete tube could be buttressed by several triangular panels connecting the tube and the base pad.

Further analysis and full-scale experiments would be needed to determine whether this design approach, or something like it, could meet the DBT and other requirements that are set forth in Section 5, above. Ideally, these requirements could be met while using dry-storage modules that are approved by the NRC and are in common use. Another objective would be that the hardening elements (concentric tube, cap, tie rods, mound, etc.) could be built and assembled comparatively quickly and cheaply. These elements would not be high-technology items.

The Benefits of Dispersal

As an illustration of the benefits of dispersal, consider an attack on an ISFSI involving a ground burst of a 10-kilotonne nuclear weapon. In Section 4.2 of this report, it was noted that this attack could excavate a crater about 68 meters in diameter and 16 meters deep. If dry-storage modules had a center-to-center spacing of 5.5 meters, as is typical of present practice, about 120 modules could fall within the crater area and suffer destruction. However, if the center-to-center spacing were 25 meters, as is proposed here, only 6 modules could fall within the crater area and suffer destruction.

Site-Specific Tradeoffs

Within this design approach it would be possible to trade off, to some extent, hardening and dispersal. As suggested in Section 5.4, above, dispersal could be reduced and hardening could be increased at smaller sites. Detailed, site-specific analysis is needed to determine how such tradeoffs might work.

An alternative design approach might be used at a few sites where space is insufficient to allow wide dispersal. In this approach, a number of dry-storage modules would be co-located in an underground, reinforced-concrete bunker. Similar bunkers would be dispersed across the site to the extent allowed by the site's geography. At an especially-constricted site, it might be necessary to reduce the overall inventory of spent fuel in order to meet design objectives. Thus, some spent fuel from the site would be shipped to an ISFSI elsewhere.

7. Requirements for Nationwide Implementation of Robust Storage

7.1 Experiments on Vulnerability of Dry-Storage Options

Section 5.3 of this report outlines a DBT for hardened, dispersed, dry storage of spent fuel. Section 6 describes a design approach that offers a prospect of meeting a DBT of this kind, together with other requirements that are set forth in Section 5. Further investigation is needed to determine the extent to which the various requirements can be met. This determination would be made at two levels. First, the investigation would determine if the DBT and other requirements set forth in Section 5 are broadly compatible with the proposed design approach or something like it. Second, assuming an affirmative determination at the first level, the investigation would go into more detail, exploring the various tradeoffs that could be made.

An essential part of this investigation would be a series of full-scale, open-air experiments. These experiments would be sponsored by the US government, and would be conducted at US government laboratories and testing centers. The experiments would involve a range of non-nuclear instruments of attack, including anti-tank missiles, manually-placed charges, vehicle bombs and aircraft bombs. Each instrument of attack would be tested against several test specimens that would simulate alternative design approaches for a hardened, dispersed ISFSI.

A separate set of experiments would be conducted in contained situations. These experiments would study the potential for release of radioactive material following penetration or prolonged heating of a fuel container.[133] Factors discussed in Section 4.2 of this report, such as the presence of zirconium hydride in fuel cladding, would be accounted for. The potential for auto-ignition of hydrided cladding when exposed to air deserves special attention in the experimental program, because this potential is relevant not only to the vulnerability of dry-storage modules, but also to the initiation of a fire in a spent-fuel pool.[134]

7.2 Performance-Based Specifications for Robust Storage

The investigation called for in Section 7.1 would establish the technical basis for a set of performance-based specifications for hardened, dispersed, dry storage of spent fuel. These specifications would include a detailed, precise formulation of the DBT. Also included would be design guidelines for meeting the DBT, and an allowable range of design parameters within which tradeoffs could be made. The specifications would apply not only to the design of external, hardening elements, but also to dry-storage modules. Thus, some modification of the licensing basis for currently-licensed dry-storage modules may be required.

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[133] The proposed experiments would simulate, among other events, an attack in which penetration of a fuel container is accompanied by incendiary effects.

[134] At the higher fuel burnups now commonly achieved, zirconium hydride forms in the fuel cladding. A potential for auto-ignition of zirconium hydride in air has been identified. See: Powers, 2000, page 3; Collins et al, 2000, page A1B-3.

Specifications for Low-Density Pool Storage

Performance specifications would also be required for the nationwide reversion to low-density pool storage. A primary objective would be to prevent the initiation of a pool fire in the event of a loss of water from a pool. This would be accomplished by reverting to low-density, open-frame racks that allow convective cooling of fuel by air or steam in the event of water loss, as discussed in Section 4.2. (Note: Low-density, open-frame racks would not necessarily preclude a pool fire after water loss if auto-ignition of zirconium hydride, as discussed in Section 7.1, could occur. Thus, it is important to empirically resolve the auto-ignition issue.)

At nuclear power plants with larger pools, reverting to low-density, open-frame racks will not conflict with other objectives. At plants with smaller pools, the pursuit of low density may conflict with other objectives, including: (i) preserving open spaces in the racks to allow offloading of the reactor core; (ii) allowing fuel to age for at least 5 years before transferring it to an ISFSI; and (iii) suppressing criticality of fresh or low-burnup fuel without relying on soluble boron in the pool water. Tradeoffs and technical fixes could resolve many of these conflicts.[135] New analysis, perhaps supplemented by some experiments, would establish the technical basis for performance specifications that include the necessary tradeoffs.

Establishing the Specifications

Establishing a comprehensive set of specifications for robust storage would call for the exercise of judgement. There is no purely objective basis for deciding upon one level of required performance as opposed to another. However, judgement must be exercised with full awareness of the wide-ranging implications of a particular choice. As discussed in Section 3 of this report, the defense of US nuclear facilities should be seen as a key component of homeland security and international security.

In view of the national importance of the needed set of specifications, these should be developed with the full engagement of stakeholders. Relevant stakeholders include citizen groups, local governments and state

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[135] Examples of possible tradeoffs and technical fixes include: (i) relaxing the requirement to offload a full core; (ii) providing some high-density rack spaces for fresh fuel and core offload; (iii) relying on soluble boron in normal operation, with limited addition of unborated water if borated water is lost; (iv) adding some solid boron to rack structures while preserving an open-frame configuration; (v) relaxing the 5-year cooling period by partially filling some dry-storage modules or mixing younger fuel with older fuel in dry-storage modules; and (vi) shipping some fuel to plants with larger pools.

governments. Processes are available that could allow full engagement of stakeholders while protecting sensitive information.[136]

7.3 A Homeland-Security Strategy for Robust Storage

A robust-storage strategy for US spent fuel would involve two major initiatives. The first initiative would be to re-equip the nation's spent-fuel pools with low-density racks and to provide other defense-in-depth measures to protect the pools. The second initiative would be to place all spent fuel, other than the residual amount that would then be stored in low-density pools, into hardened, dispersed, dry-storage ISFSIs.

Fast, effective implementation of this strategy would require decisive action by the US government. It would require expenditures that are comparatively small by national-security standards but are nonetheless significant. At present, there is no sign that the needed action will be taken. The US government in general seems largely unaware of the threat posed by the present practice of storing spent fuel. The NRC appears to be paralyzed, perhaps through fear of being criticized for its previous inattention to the threat of attack on nuclear facilities.

A new paradigm is needed, in which spent-fuel-storage facilities are seen as pre-deployed radiological weapons that await activation by an enemy. Correcting this situation is an imperative of national defense. If the NRC continues to undermine national defense, it should be bypassed. Citizens should insist that Congress and the executive branch promptly initiate a strategy for robust storage of spent fuel, as a key element of homeland security.

8. Conclusions

The prevailing practice of storing most US spent fuel in high-density pools poses a very high risk because knowledgeable attackers could induce a loss of water from a pool, causing a spent-fuel fire that would release a huge amount of radioactive material to the atmosphere. Nuclear reactors are also vulnerable to attack. Dry-storage modules used in ISFSIs have safety advantages in comparison to pools and reactors, but are not designed to resist a determined attack.

Thus, nuclear power plants and their spent fuel can be regarded as pre-deployed radiological weapons that await activation by an enemy. The US government in general and the NRC in particular seem unaware of this

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[136] Thompson, 2002a, Sections IX and X.

threat. US nuclear facilities are lightly defended and are not designed to resist attack. This situation is symptomatic of an unbalanced US strategy for national security, which is a potentially destabilizing factor internationally.

A strategy for robust storage of US spent fuel is needed, whether or not a repository is opened at Yucca Mountain. This strategy should be implemented as a major element of a defense-in-depth strategy for US civilian nuclear facilities. In turn, that defense-in-depth strategy should be a component of a homeland-security strategy that provides solid protection of our critical infrastructure.

The highest priority in a robust-storage strategy for spent fuel would be to re-equip spent-fuel pools with low-density, open-frame racks. As a further measure of risk reduction, ISFSIs should be re-designed to incorporate hardening and dispersal. These measures should not be implemented in a manner such that an ISFSI may become, by default, a repository. Therefore, a hardened ISFSI should not, unless absolutely necessary, be built underground. Also, the cost and timeframe for implementing hardening and dispersal should be minimized. These considerations argue for the use, if possible, of dry-storage modules that are already approved by the NRC and are in common use.

Preliminary analysis suggests that a hardened, dispersed ISFSI meeting these criteria could be designed to meet a two-tiered DBT. The first tier would require high confidence that no more than a small release of radioactive material would occur in the event of a direct attack on the ISFSI by various non-nuclear instruments. The second tier would require reasonable confidence that no more than a specified release of radioactive material would occur in the event of attack using a 10-kilotonne nuclear weapon.

Three major requirements must be met if a robust-storage strategy for spent fuel is to be implemented nationwide. First, appropriate experiments are needed. Second, performance-based specifications for robust storage must be developed with stakeholder involvement. Third, robust storage for spent fuel must be seen as a vital component of homeland security.

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