Rulemaking1CEm Resource

From: RulemakingComments Resource
Sent: Thursday, December 26, 2013 9:41 AM
To: Rulemaking1CEm Resource
Subject: FW: Comments on Waste Confidence Generic Environmental Impact Statement from IPSEC

From: Mermelstein, Richard [mailto:Richard.Mermelstein@wilsonelser.com]
Sent: Friday, December 20, 2013 4:29 PM
To: RulemakingComments Resource
Subject: Comments on Waste Confidence Generic Environmental Impact Statement from IPSEC

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December 19, 2013

RE: **Comments on Waste Confidence Generic Environmental Impact Statement (GEIS) Draft Report, Docket ID No: NRC–2012–0246**

Secretary
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001
ATTN: Rulemakings and Adjudications Staff

Via mail and e-mail *Rulemaking.Comments@nrc.gov*

Preliminary Statement

Dear Public Servants:

This precedes the formal Comments of the Indian Point Safe Energy Coalition and represents an entreaty from the individual undersigned members of the coalition's Leadership Council.

We write here as citizens in the hope that this message will reach individuals who see themselves, not just as actors in a bureaucracy, but as servants of the People.

In candor, we fear that your agency has lost perspective as to what is at stake.

If the NRC goes forward with implementation of this GEIS, it will do something that no agency in the history of America has ever done.

It will enable the vast expansion of a threat that will be visited upon thousands of future generations.

Make no mistake, this GEIS will be used to assure policy makers and the public that materials with the potential to unleash vast destruction can be allowed to continue to accumulate and remain controllable forever.

The buildup of hundreds of tons of nuclear waste at sites throughout the nation – some 70,000 tons of high-level spent fuel plus even larger quantities of other nuclear waste product – is a serious problem that absolutely must be dealt with. It is a problem created by many men of good will, but insufficient foresight. Whether due to hubris or excessive confidence, ton after ton of nuclear waste has been generated and now we must deal with the toxic mess we have made.

There is no wondrous solution. There is no clean solution. There is no solution that will not impose a massive financial burden upon the nation's treasury.

Keeping the nuclear waste on the sites where it was produced is very probably the optimal choice at this point, especially if the plan were to include expeditious transfer of spent fuel into casks protected by berms or other hardened supra-structural systems. However, this represents the *least bad* option, not a desirable outcome.

An honorable and honest GEIS would make these points clear. And it would not bury the reality that very serious – potentially catastrophic – consequences could ensue if current NRC calculations are wrong.

Whether significant amounts of radioactivity will be released into the environment is not a question of if, but of *when*, and *where* and *with what impact*? The Sept 11 and Fukushima disasters put such questions into stark relief. Further they show why it is critical to understand the impact the GEIS will have at the global level.

This is a point which must be stressed: In the area of nuclear safety, the nations of the world look to the NRC for leadership and guidance. You, as decision makers at the NRC, will set the standards for spent fuel safety. Your assessment will be used to make security determinations worldwide.

You may not have sought it when you assumed the job, but an enormous historic responsibility has been leveled upon you.

For these reasons we implore drastic revision of the GEIS. The current draft utterly fails to appreciate or honestly convey the level of risk. Worse, it sets a course that may be unalterable.

Please be worthy of your public trust.

Sincerely,

Leadership Council of the Indian Point Safe Energy Coalition

Judy Allen
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December 19, 2013

Comments of the Indian Point Safe Energy Coalition (IPSEC) Expressing No Confidence on Waste Confidence Generic Environmental Impact Statement (GEIS) Draft Report, Docket ID No: NRC–2012–0246 (aka Draft NUREG-2157) dated Sep 2013

Secretary
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

ATTN: Rulemakings and Adjudications Staff

Via mail and e-mail Rulemaking.Comments@nrc.gov

The Indian Point Safe Energy Coalition (IPSEC) asserts vigorous objection to the methodology, assumptions and core conclusions advanced by the Nuclear Regulatory Commission (NRC) in the Sep 2013 Waste Confidence Generic Environmental Impact Statement Draft Report (hereafter referred to as the "GEIS").[1]

Simply put: Our vote is: NO CONFIDENCE.

1. UNDISPUTED FACTS

There are certain facts that are established and need to be simply stated.

Nuclear waste is among the most hazardous materials on the planet.

A man exposed to a spent fuel rod which has come out of a reactor will be delivered a fatal dose of radiation within a matter of seconds.

Nuclear waste remains highly toxic for hundreds of thousands of years.[2]

Since the very inception of the nuclear age – our democracy has struggled, unsuccessfully, to reach consensus on how to dispose of nuclear waste.

The taxpayers of this nation have been forced to assume costs and liability for this waste that runs in the hundreds of billions.

The safety, security, health and environmental dangers involved in nuclear power are of such potential magnitude, that neither the commercial nuclear industry, nor the insurance industry, will accept more than a fraction of the potential liability. And thus through laws like the Price-Anderson Act of 1957 and the Nuclear Waste Policy Act of 1982, most of the risk burden has been placed on the American public.

The NRC itself has taken the position that it cannot be held responsible for cleanup in the event of a major accident.

The NRC has allowed nuclear power plants to be owned and run by LLCs, limited liability corporations and other legal constructs which would allow the multi-billion parent corporations to walk away from a major liability, not just in the future, but today.

All nuclear power plants release radiation and other pollutants into the environment as a matter of course throughout operation.

Accidental releases of radiation into environment have already occurred at the majority of nuclear plant sites.

Two nuclear power installations have had severe accidents involving explosions, fires, meltdowns and massive releases of radiation. The Chernobyl disaster, in 1986, resulted in the permanent relocation of 300,000 people, the severe contamination of over 1000 square miles of land, and a sizable geographical region being deemed uninhabitable for centuries. The Fukushima accident, in 2011, resulted in the evacuation of over 150,000, with ultimate numbers of displaced uncertain. But both Chernobyl and Fukushima accidents occurred in relatively unpopulated areas.

In the U.S., there are nuclear plants and nuclear waste sites such as Indian Point which sit in densely and highly populated areas.

The majority of climate scientists around the globe have warned that climate change is occurring and that it brings risks of warming and extreme weather.
Regardless of whether the “cause” is anthropogenic activity or not, events in recent decades such as hurricanes Katrina, Irene and Sandy, the prolonged droughts and forest fires that have plagued the Southwestern U.S., powerful tornadoes, earthquake activity, flooding, and numerous severe wind and snow storms, which have severely stressed the nation’s infrastructure.

Many of these events have caused prolonged and wide-scale electric outages due to downed power lines, substation flooding and transformer explosions. Difficulties in power recovery have resulted in areas challenged by downed trees, flooding, damaged bridges, impaired rail lines and obstructed roads. Deteriorated infrastructure conditions add other challenges.

Nuclear power stations and spent fuel pools need electricity for safe operation. Indeed the root cause of the Fukushima disaster was loss of electric power.

Over 67,500 metric tons of high-level nuclear waste (or MTU) are being stored at commercial nuclear power plants and that amount is expected to increase at a rate of approximately 2,000 a year or 20,000 MTU each decade.

The typical spent fuel pool at a light water reactor now holds the equivalent of about 6 reactor core loads of spent fuel, about 700 MTU.

Low-burnup fuel can be transferred from cooling pools into dry casks after 5 years, but high-burnup fuel may need to remain within pool cooling for over 20 years, and the use of high-burnup fuel has been increasing.

Transfer of fuel from pool to pad or from wet to dry storage (and back and forth) is an abrupt change of environment for used spent fuel assemblies.

Transfer of fuel also involves varying degrees of mechanical stress and dropping risk.

Aging effects/mechanisms include: degradation of toughness and strength of materials due to irradiation, including degradation of neutron absorber materials; changes in a mechanical property of materials, including change in dimensions or reconfiguration due to creep and effects of freeze-thaw; loss of preload due to stress relaxation; crack initiation and growth; loss or weakening of material due to corrosion; loss of strength and modulus due to elevated temperature.

Aging effects/mechanisms applicable to high-burnup fuel remain to be determined, but the current engineering consensus is that high-burnup fuel is more subject to cladding radial hydride formation and embrittlement 20-25 years after the high-burnup fuel assemblies are placed in dry storage. And casks for high-burnup fuel are still under development.

America's existing nuclear fleet and the on-site spent fuel pools where most of the high-level spent fuel waste remains stored are aging.

It is a fundamental of engineering that as machines and structures age they become subject to age-related deterioration.

Aging effects/mechanisms apply to spent fuel pools and their associated structures.

When the spent fuel pools were originally constructed they were planned to hold spent fuel for a very short term – less than a year.

Unlike the reactors, the spent fuel containments are not hardened. The roofs are similar to the roofs commonly built at box top stores.

The spent fuel pool structures at nuclear plant sites were never designed, nor built, with the intention of holding large quantities of nuclear material for a decade, much less a century.

Data on dry cask performance has been collected for a matter of decades.

All attestations as to the containment of large quantities of nuclear waste for 60 years, 70 years, a century, and beyond are hypothetical, based on limited collections of experiential data, and untested by reality.

The U.S. government, intelligence and security experts have identified nuclear power plants to be terrorist targets.

2. IMACTS DEEMED FOREVER "SMALL"

The above noted facts are beyond serious dispute.

And yet, the NRC in this GEIS has determined that the above and all other major risks attendant to high level nuclear waste should be entirely discounted, written out of the equation, because each is unlikely and the foresight and powers of the NRC are so remarkable, that it will be able to prevent the occurrence of any and all major problems.

With knowledge of the future that is vast and precise, the NRC has determined that continued storage of nuclear waste in aging spent fuel pools for the next 100 years is nothing to worry about. And holding large amounts of nuclear waste at dozens, perhaps even hundreds of sites throughout the nation for 200 years is no problem either.

Indeed, the NRC's omniscience is such that, rest assured, having large amounts of high level nuclear waste on these sites is safe for millennia.

For 100 years, 200 years, tens of thousands of years: All environmental and human health impacts the NRC proclaims in the GEIS will be "SMALL."

Impacts from major natural disasters, major earthquakes, raging wildfires, floods and massive storm surges, with all the possible consequences that could ensue, are also "SMALL."

Impacts relating to accidents, the GEIS attests, will be "SMALL."

Even impacts from terrorist attack directed at nuclear sites or materials in transport, the GEIS assures, will be "SMALL"!

How, we wonder, did the NRC arrive at these patently preposterous conclusions?

For purposes of clarity and efficiency, we will here focus on solely the most critical and systemic underlying flaws of the GEIS

3. FLAWED TIME CONSTRUCT

Ironic Exclusion of Time from Time Analysis

The conceit advanced in the GEIS is that a protective scheme for nuclear waste can be broken down, into the following three (almost incandescently euphemistic) categories:

- "Short Term" - referring to storage in spent fuel pools for the period of the next 100 years;
- "Long-Term" - referring to storage in dry casks for the coming 200 years; and
- "Indefinite Storage" - an indefinitely defined term, presumably to be for effectively forever.

Putting the problems of hubris and absurdity aside for the moment, the entire GEIS suffers from the following fatal flaw: It does not incorporate *time* into its time analysis.

Yes, there are lots of iterations of “aging management” plans (which, incidentally, are *plans*, not realities). True too, there is acknowledgement of population growth, and climate scientists’ warnings of climate change bringing droughts, rising sea levels and sundry other altered climate conditions.

However there is no actual analysis of the effects of time. Nor is there recognition that long durations of time bring into play factors and events that cannot be anticipated.

Reflection upon the past provides perspective.

Berengia

Between 11,000 and 23,000 years ago, the Bering Strait – also known as the lost continent of Berengia – formed a land bridge between Asia and North America which people crossed during the Ice Age to form some of the founding populations of Native Americans.[3]

(Interesting aside, Native American tribal lands are among the areas most ravaged by 20th Century uranium mining and Native American lands are identified in the GEIS as a place for large long-term nuclear waste storage! But we digress.)

The half-life of Plutonium 239 (Pu-239)[4] is 24,100 years. So, if Upper Paleolithic cultures had come up with nuclear power, we would still be dealing with their nuclear waste.

Luckily for us, they were just spearing mammoths.

The point which we hope is not being too subtly made is that the NRC’s assertion that it can surmise the impacts of nuclear waste tens of thousands of years – hundreds of thousands of years, or whatever the notion of “indefinite “ is – is simply ludicrous.

It is so absurd that it casts serious doubt on the credibility of the GEIS in its entirety.

Two Centuries in Perspective

Less inane, but also implausible, is the assertion the NRC can predict the situation over the “Long-Term Storage” period of 200 years hence.

Again, reflection upon the past provides perspective.

Two hundred years ago, Napoleon Bonaparte was battling Prussia, James Madison was president, and America was fighting the War of 1812 against England. In fact in December 2013, the British burned Buffalo, New York.

Two hundred years ago America still had slavery.

Two hundred years ago, the population of the United States was 7.5 million. The petroleum industry did not yet exist. Sperm whale oil was still a major source of energy. There was, of course, no automobile pollution (although horse manure droppings were evidently an issue), there were no Superfund sites. Rivers were still clean enough to drink and fisheries were barely imperiled. (See, *e.g.*, Daniels.)

Thus, while it may be reasonable to believe that dry casks and independent spent fuel storage installations (ISFSs) have the technological capacity under specified conditions to contain nuclear waste for that duration, there is no reasoned basis to conclude that prevailing environmental, political, or social conditions will properly support enduring containment.

One Hundred Years From Now

The upcoming 100 years throughout which the NRC claims spent fuel may merrily sit in spent fuel pools of repeatedly relicensed reactors is also a duration that, NRC jargon aside, is neither "short," nor certain.

What is reasonably predictable is that these pools will leak and that the total burden of radiation being released into the environment will increase sizably.

The evidence comes from an expansive library of studies and reports documenting these leaks. A few of these investigations are dutifully referenced in the GEIS "References" sections. However this GEIS suggests little tends to be learned from "Lessons Learned" reports.

As these already past-their-prime spent fuel pools continue to age, they will continue to experience age-related deterioration, and leak more. This is the most plausible sequel scenario.

Other radiation effluents which have been disgorged onto the reactor sites and the groundwater must also be taken into calculation.

Environmental and biological systems do not abide by the artifice of separately evaluating the impacts of radiation as does the NRC.

The problem – given the century of leakings which await us – is that the radiation will be chronically delivered into the environment. The combined and multiplicative effects of the continual delivery of short and long-lived radionuclides + the past, present, and future bioaccumulation of long-lived radionuclides pose untenable risks to humans and other biological beings.

Add to the calculus the uncertain, but very real, risk of large accidental releases, and the impacts of "Short-Term Storage" storage hardly merit the label: "SMALL."

Which brings us to the topic of risk models.

4. FLAWED RISK CONSTRUCT

Flawed Risk Model

The GEIS suffers at its very foundation from a flawed risk model.

The GEIS states:

"NRC's concept of risk combines the *probability* of an accident with the *consequences of that accident*. In other words, the NRC examines the following questions:

- What can go wrong?

- How likely is it?
- What would be the consequences?"

(GEIS, at xxx).

"What can go wrong?" begs the answer: Fukushima and Chernobyl.

And this illuminates the reality that embodied in any evaluation is a value system.

The value system expressed in the GEIS clearly does not elevate human health, the protection of the environment, or the security of the nation above the goal of enabling the additional accumulation of high level nuclear waste.[5]

It is exceptionally disingenuous for the risk formulation in the GEIS to be proffered as if some sort of objective mathematical equation drives the analysis.

Each of the three bullet point questions posited involves human beings making judgment evaluations based on what they subjectively deem worthy of attention and consideration.[6] Each involves a subjective decision as to what specific selection of sets of data to use and how to weight each component of available evidence. And, with respect to very long term holding of nuclear waste, each step involves – at best – an educated guess based on limited data.

The following point mandates emphasis: Models are models, not reality.

A model's equations are a limited and partial representation of a limitlessly complex series of systems. And when dealing with extraordinarily complex systems that interact with multiple other highly complex systems – as is the case here, where nuclear installations with massive numbers of constituent parts interact with complex, constantly changing, ambient environmental conditions, weather behaviors, geologic events, human actions (both benign and malevolent), and the behaviors and capabilities of other infrastructure – modeling is a particularly inadequate mechanism of prediction.

The very best a model can do is pick out some relevant variables relating to the machine and its structures and tie them through different algorithms to dynamic equations relating to selected sets of models for other systems.

Probabilistic risk modeling may be useful and acceptable for NRC institutional use in assessing the odds of certain specified outcomes for certain specific systems, components, or dangers. But it is an invalid and unacceptable model to use when, as here, a vast number of factors are unknown, and the potential outcomes are catastrophic.

Misapplied Application of Probabilistic Risk

It must also be pointed out that the NRC does not even apply its own absurdly reductive probabilistic risk formulation correctly.

Firstly, by determining every serious event with negative consequences to be "unlikely," the GEIS unceremoniously excises a key factor out of the formula upon application.

Secondly, despite using the word “consequences,” the analysis wholly ignores the likely consequences of a severe accident such as a major spent fuel pool fire at Indian Point which could render the New York Metropolitan area uninhabitable for centuries.

5. FLAWED METHODOLOGY

The GEIS utterly fails to integrate even the information it contains.

Systems, conditions, effects, and impacts all get divided into various categories and then each is treated as if each operates within some imaginary bubble.

Simply from the elementary perspective of basic math, even if one were to accept the preposterous assertions that every possible individually identified impact classification would be – to use the GEIS’s favorite word, “SMALL” – that by no means indicates the total sum of various impacts would be small.

And – again, just using third grade math here – it certainly does not mean that the multiplicative impacts are small.

Elevation of Radiation Release Risk

The NRC cannot seriously contend, for example, that climate change would not exert a multiplier effect on the aging mechanisms applicable to spent fuel assemblies, spent fuel pools, or ISFSIs. Yet such analysis is absent.

For a wide assortment of risks – flooding risk, dam failure risk, earthquake risk, site structure hazard risk, construction accident risk, landslide risk, hurricane risk, tornado risk, site fire risk, wildfire risk, malevolent insider risk, terrorism risk, human error, acts of nature, you name it – small risks can grow pretty exponentially when combined and when the time periods are long.

Take just seismic risk. Accepting that the seismic risk is numerically (albeit not qualitatively) small for any given year to the current *existing* nuclear plant infrastructure, that does not mean risk will remain small as more spent fuel is created, more nuclear sites are built, and the decades and centuries pass. Not only does the GEIS not consider this, but IPSEC is aware of no existing seismic study which has conducted such analysis.

Most astonishingly, given the nuclear events of recent years,[7] there is no analysis which connects the potential consequences of a protracted station blackout (or SBO) to the risks presented by extreme weather, other infrastructure vulnerabilities, earthquakes, terrorism, sabotage, the aging transmission grid and just plain inept operation.[8]

The entirety of problems which may impact spent fuel both during and after reactor license periods is particularly relevant to sites with multiple reactors where continuing reactor operation overlaps with the “short-term” storage period. Sites with more than one spent fuel pool also mandate scrutiny because of the multiplier effects which inevitably result should several pools be affected by one event.

The methodology employed in the GEIS thus disregards the entire discipline of disaster science.

More astoundingly, the GEIS also appears to have no institutional memory of nuclear accident and incident history.

(To jog memory – and hopefully induce reflection – the *References & Sources* section of these IPSEC Comments includes some summaries of findings and quote excerpts.[9] These are hardly exhaustive. In addition, some discussion of potential waterway impacts applicable specifically to Indian Point – as Indian Point is IPSEC's prime purview – is contained in the Comments filed in October 2013 with the New York State, Department of State, reproduced herein as Appendix A.)

We urge GEIS analysis be reformulated to consider all risks and include rare yet credible events including: internal and external hazards, during all modes of plant operation, evaluated in a risk-informed manner. This approach should include consideration of so-called "cliff-edge" events – those for which a small incremental increase in severity can yield a disproportionate increase in consequences.

This argument was made in ASME Technical Report which resulted from a task force set up at the direction of the president of the American Society of Mechanical Engineers (ASME). The ASME task force was co-chaired by the former Chairman of your agency, Dr. Nils Diaz, and the former Senior Vice President and Chief Technology Officer at Westinghouse Electric Company, Regis A. Matzie. The report observes:

- The Fukushima accident "has indicated that the events now needing to be protected against include large fires and explosions, extreme natural phenomena, station blackouts of indefinite duration, and combinations of internal failures that can cause the loss of normal and backup core cooling…" (ASME Technical Report, p. 39)

- Fukushima shows the risks of not preparing "for the possibility that the safety-related electrical distribution system, and many of the plant safety systems, could be rendered inoperable by a single event. Also, the possibility of losing all AC power for an extended period of time, and the resulting depletion of the plant batteries (i.e., all DC power) was not considered in preparations for accident management….They also had to deal with spent fuel pool cooling and potential damage to the spent fuel pools." (ASME Technical Report, pp. 50-51; see also NRC Special Inspection Report, 2003)

- "Many recent examples exist of the occurrence of highly improbable events with unforeseen loss of control, where human actions and decisions have contributed to, or ultimately led to, unacceptable consequences. Recent examples include the Deepwater Horizon fire, explosion, and oil leak in the Gulf of Mexico; inundation of New Orleans following Hurricane Katrina; crashes of the Space Shuttle Columbia and Concorde aircraft; and collapse of the World Trade Center buildings after terrorist actions on September 11, 2001. It is presently not possible to predict the occurrence of such events; furthermore, attempts to predict such events even if information is available will encounter significant uncertainty. The capability to predict and control an event becomes increasingly more difficult as the frequency of occurrence of the event decreases. " (ASME Technical Report, p. 40)

- "The probability of any action is represented and weighted or adjusted by situational multipliers representing stress, environment, and time pressures. It is practically impossible to describe the nuances, permutations, and possibilities behind individual and collective human decision-making, so the human-technological system must be treated as an integral system." (ASME Technical Report, p. 40)

America has had numerous nuclear power plant safety and security lapses. America has also endured a sobering series of terrorist and criminal events (9/11, Boston Marathon, etc.) and extreme weather events since commencement of the current century.

So far we have dogged the bullet of a concurrent nuclear emergency, grid failure, and extreme weather and/or security crisis. But at what point do the odds change for that bullet to connect?

Elevation of Human Health and Environmental Damage Risk

The same failure to look at additive and multiplicative and accelerative factors infects all aspects of the NRC's analysis of human health and environmental damage impacts.

After a long, laborious slog through hundreds of pages of the GEIS, one comes to the "Cumulative Impacts" section.

At last, calculus would be made of all the risks to health and environment from decades of radioactive effluent releases from the entire nuclear operations (military, civilian, medical, etc) and the nuclear waste stream (military, civilian, medical, devise, etc), from the beginning of the nuclear age, through the decades of extended (and new) nuclear power operation, and then for the envisioned centuries ahead.

One would anticipate a thorough analysis, to incorporate the most current medical research and environmental studies.

The realities of water source depletion, dwindling fisheries, polluted and heated waterways, algae growth….the list goes on and on. Surely the GEIS would evaluate the added burdens of heat and radioactive effluents into the groundwater and surface water as an added stressor that might well constitute a tipping point to major environmental crisis. Added too would be the estimation of more accidental releases – large and/or small – during regular nuclear power operation, since that would be just the starting point for analysis. No?

Without a doubt, the findings of the National Academy of Sciences and all the other studies attesting to the additional vulnerabilities of environmental justice populations and of women, adolescents, children, babies and babies in utero will be given due consideration.

And, most assuredly, the analysis would carefully examine the totality of all the cumulative effects of the hundreds of different radionuclides (with so many different pathways and effects) that have been, are being, and will ineluctably be, disgorged.

Increased human populations and exposures would, of course, be calculated. After all, there will be thousands of tons more waste and millions more people.

Alas, we are still waiting.

6. FLAWED ASSUMPTIONS

The number of flawed assumptions in the GEIS is mindboggling. We focus here solely on a few which are systemic and render the entire analysis defective.

Nothing Will Ever Go Really Wrong

The level of denial that things can go wrong in the GEIS borders on the level of delusion.

Sept 11th, Katrina, BP, now Fukushima. How many more examples do we need of the way events can aggressively overwhelm human-engineered systems? How many failures of "fail safe" structures must destroy the lives of thousands?

Somebody at the NRC, pick up a newspaper. Read it. Please.[10]

Government Oversight is Flawless

At the top of the list of overoptimistic assumptions is the GEIS's repeated assertion that if there is a problem, the NRC will catch it in time.

There is, of course, a vast library of documentation of past NRC failures. (See, e.g., GAO; NRC; Lochbaum; and UCS.)

Allowing the possibility that the current NRC is comprised of omniscient and perfect actors, the GEIS still cannot assert that this state of affairs will continue for hundreds (or thousands) of years.

Alas, as a matter of pure logic, the current NRC cannot reliably depend upon the *future* NRC being as fabulous as the present.

The GEIS also postulates that other agencies will step in as needed, as needed. The same logical flaw applies here as well.

Perhaps the most silly assertion is that Congress will step in to help as needed with just the right legislation. Do we even need to respond to that one?

Corporations Always Clean Up their Messes

Really?

Gee, if that's the case how come the industry is so intent on wrapping itself up in multiple protection layers of LLCs? (Schlissel)

And why do we have so many statutes like the Price-Anderson Act of 1957 and the Nuclear Waste Policy Act of 1982, which shift the financial risk burden from the nuclear industry onto the shoulders of the public (i.e., taxpayers)?

And how come corporate giants like Entergy seem to forever be seeking to "optimize" the value for shareholders? (King; Hakim)

Prioritization of profit and shareholder value is, of course, what corporations seek. Corporations are not biological beings with heart and soul, they are legal constructs devised to promote profit and reduce liability. That is actually what corporate law and corporate tax law allows. What the NRC has allowed, is for the behemoth nuclear corporations to wrap themselves in additional layers of "protection" that enable the parent corporations to cut loose at risk subsidiaries, should they pose a substantial threat to profitability. The primary responsibility is to corporate bond holders and stock holders, not to the citizens of a community where a reactor is shut, and waste is seeping from spent fuel pools into the groundwater. (Cooper; Schlissel; Tidmore)

Further, today's viable and well-operated company can become tomorrow's failed corporation. This does not require a nuclear accident, just a financial disaster. (Enron.)

In fact, the NRC regulatory scheme seems to have given no thought to what would or could happen if an operator goes bankrupt. This is exactly what has led to the nation's numerous (and desperately underfunded) Superfund sites. Who will be left footing the bill for all this waste?[11]

If the NRC really believes that nuclear operators who will no longer be pumping profits out of their old machines in 10 or 20 years will stick around to spend the following 100 or 200 years maintaining and cleaning up their defunct operations, we have a wonderful deal for you: Mars condo, ready for move-in, river view.

Radiation is Not a Major Health Risk

This assumption is implicit. Reading the GEIS, if one did not know what spent fuel was, the reader would conclude the material was a minor pollutant presenting minimal health risk.[12]

Plans and Laws on the Books Suffice

Over and over again the GEIS notes a potential hazard or impact and then just waves it away with the wand that the NRC/ industry has a plans or will have plan to deal with the issue.

Similarly, again and again, the GEIS cites legislation or postulates that laws will be passed to deal with potential problems.

But having plans and laws does not constitute evidence of either adequate protection or lack of major impact.

To put it as a math equation: Plans + Laws ≠ SMALL impact.

7. CRUCIAL OMMISSION OF COST TO PUBLIC

One would think that somewhere in the GEIS would be a frank acknowledgement of the estimated costs to the American public of the whole shebang.

These costs include all the federal, state, and locality costs entailed in safety and security.
The costs include government management and oversight of all the massive construction activities and all the transportation-related activities the GEIS notes.

The costs include publically financed R&D for things such as trying to find out what the heck to do with the high-burnup fuel.

The costs include all the potential financial and risks transferred to the public.

The costs include all the potential remediation costs for past, present, and future toxic effluents.

One would think. But one would think wrong.

8. CRUCIAL OMMISSION OF CYBER

Even putting everything noted above aside, there is one astonishing omission that renders the entire GEIS fatally flawed:

The GEIS completely fails to look at cyber.[13]

The GEIS it ignores cybersafety issues, cybersecurity issues, complications that can result from interactions between computer networks.

This area is scopic and critical.

Were space and copyright law not at issue, we would insert the complete contents of the book *America the Vulnerable* by Joel Brenner, former head of counterintelligence for the director of National Intelligence here. Somebody at the NRC should read it, with special attention to the chapter "Dancing in the Dark" about vulnerabilities to nuclear power installations and the grid in general.[14]

The NRC also needs to review the government findings on the Davis-Besse boric acid corrosion fiasco with attention to the fact that the same nuclear operator was implicated in setting off the East Coast and Canada blackout of 2003, and recall that Davis-Besse turned out to also be infected with the malicious virus known as the Slammer worm. Connect some dots and add in a storm like Sandy.

9. ILLICIT ALTERATION OF REGULATORY SCHEME

Deep within the pages of the GEIS is this little ditty:

"As described in Section 1.4 of this draft GEIS, the proposed action is for the Commission to issue a revised rule, 10 CFR 51.23, that generically addresses the environmental impacts of continued storage. This revision would adopt into regulation the environmental impact analyses in this draft GEIS. Further, the revision would state that because the impacts of continued storage have been generically assessed in the draft GEIS and codified in a rule, the NEPA analyses for future reactor and ISFSI licensing actions would not need to separately consider the environmental impacts of continued storage." (GEIS, 8-10)

This is a highly suspect attempt to use a limited-scope (and severely flawed) GEIS to drastically alter the nuclear regulatory scheme.

It has the *appearance* of an attempt to promote nuclear power and effectively shackle the nation to continued nuclear power as an energy source and the endless buildup of nuclear waste.

CONCLUSION

The Draft GEIS is based on poor evaluation of inadequate criteria. It promulgates hypotheses as evidence, unrealistically bounds scenarios, disregards likely malfunctions, discounts human error, minimizes all risks, and shows profound indifference to the effects of radiation upon human health and the environment.

The GEIS conclusions of "SMALL," "SMALL," "SMALL," for every time scale imaginable defy both experience and reason.

That such a simplistic load of bunk would be presented by the nuclear regulator of the United States after 50 years of nuclear plant “near-misses” and leaks, following 9/11, and in the wake of the Fukushima disaster is unconscionable.

This is willful denial.

Please, we know there are people within the NRC who do care and work every day to protect the environment and the citizens of our great nation. We need you to speak up and act more forcefully within your agency.

We need you to present an honest picture to the public.

Sincerely,

The Indian Point Safe Energy Coalition

By its Leadership Council

Judy Allen
Allegra Dengler
Marilyn Elie
Michel Lee, Esq.
Ken Okin
Maureen Ritter
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APPENDIX A
IPSEC COMMENTS FILED OCTOBER 29, 2013 WITH THE NEW YORK STATE DEPARTMENT OF STATE

Indian Point Safe Energy Coalition (IPSEC)
PO Box 131
Ossining, NY 10562-0131
1 (888) 474-8848

October 29, 2013

RE: **Expanded Comments On New York State DOS Public Notice F-2012-1028: The Indian Point Safe Energy Coalition Opposes Coastal Consistency Certification for Indian Point**

New York State Department of State
Office of Coastal, Local Government and Community Sustainability
99 Washington Ave, Suite 1010
Albany, NY 12231-0001

Via mail and e-mail depprmt@gw.dec.state.ny.us

Dear Public Servants:

We, the undersigned Members of the Leadership Council of the Indian Point Safe Energy Coalition, are writing to strongly urge the New York State Consistency Review Panel to withhold a Coastal Consistency Certification for Entergy Nuclear Indian Point 2, LLC, Entergy Nuclear Indian Point 3, LLC, and Entergy Nuclear Operations, Inc., and any other Entergy Corporation affiliated entity (collectively, Entergy) in connection with power generation at the Indian Point nuclear power plant now called the Indian Point Energy Center (Indian Point).

Indian Point has disgorged radiation and other pollutants into the environment – both accidentally and as part of daily operations – now for decades. Every day for 40 years (or over half a century, if one includes operation of the defunct Indian Point 1 reactor) Indian Point has degraded the quality of Hudson River water and Hudson River Valley air. In addition to the isotopes and chemicals emitted, the plant destroys many billions of fish and other aquatic life through its water intake systems, and emits a massive plume of thermal pollution.

As it ages, this degrading industrial plant presents an escalating, and, in fact, incalculable level of risk.

Continued operation of Indian Point runs afoul of every core policy category of the NY Coastal Management Program. In the broadest possible sense, Indian Point puts in jeopardy the protection of water, air, wildlife, fish, agricultural land, and humans. More specifically (as enumerated within a set 44 coastal policies), the nuclear industrial facility constitutes a threat to every single treasured natural, historical, scenic, and recreational site in the lower Hudson Valley.

And, while there are surely other industrial entities which pollute New York's waterways and disrupt natural habitats, Indian Point, singularly, holds the potential of catastrophically devastating a vast region of New York State overnight. Indian Point, singularly, presents a risk to human health, wildlife and ecosystems for centuries. These risks must be taken into the calculus.

With the desire not to waste the time of the dedicated public servants of the NYS DOS, we do not wish here to simply iterate the set of 44 coastal policies. Nor do we want to redundantly proffer points concurrently being advanced by the environmental watchdog organizations Riverkeeper, Inc (Riverkeeper) and Hudson River Sloop Clearwater, Inc. (Clearwater). So please deem the IPSEC comments to incorporate and heartily support the comments of both Riverkeeper and Clearwater in opposition to the issuance of a Coastal Consistency Certification.

However, we do wish to draw the attention of DOS Staff to three key contentions:

The first is that past and current Indian Point operations clearly contravene desirable environmental objectives.

The second is that strong evidence suggests that continued operation of Indian Point for 20 more years will present a marked and increasingly elevated threat to the environment and human health.

The third contention is that the unique site characteristics of Indian Point present an untenable risk to New York. In this regard, we plead that the Department of State view itself as a protector of the life, health and property of the tens of millions of people who live, work, travel and recreate within 50 miles of the site.

FIRST CONTENTION: Past and Current Indian Point Operations Clearly Contravene Desirable Environmental Objectives

Indian Point has clearly, and over an extended duration, despoiled the Hudson River, and has not served the interests of the protection, preservation, and restoration of significant coastal fish and wildlife habitats.

Indian Point has ongoing regulatory level releases of radiologic emissions and has had numerous unplanned releases from ruptured underground pipes and leaks in the spent fuel storage structures.

Indian Point's antiquated cooling water intake structure, located in the vicinity of the designated significant fish and wildlife habitat of Haverstraw Bay, slaughters over a billion fish and other aquatic organisms in Hudson River every year.

In concert, decades of releases of hazardous and toxic effluents, the killing of tens of billions of fish and other aquatic organisms and the massive thermal pollution of the Hudson cannot be reasonably excluded as a material contribution to the identified decline of 10 out of 13 key species in the Hudson River.

Radioactive Leaks

Indian Point's abysmal record of "accidental" leaks of radiation into the air and water is extensively documented. For example, years of stress corrosion cracking in a tube of the Indian Point Unit 2 steam generator resulted in tube rupture, explosion, the release of radiation into the environment, and the declaration of a site emergency in Feb 2000. The accident resulted in the shutdown of Unit 2 for nearly a year. An investigation by the Office of the Inspector General of the Nuclear Regulatory Commission (NRC) revealed that operating conditions at the plant had deteriorated substantially throughout the 1990s. The litany of problems included broken and malfunctioning equipment, failure to implement correction action programs, and lax training. Despite the NRC's awareness of the problem conditions, the NRC did not place Indian Point 2 on its watch list for heightened oversight until *after* the nuclear accident. (Bell, 2003.)

Moreover, while the public was initially assured that radioactive water had been contained and only some radioactive steam had been released into the atmosphere during the Feb 2000 accident, an investigation by the journalist Roger Witherspoon revealed in 2002 that hundreds of gallons of radioactive water from Indian Point 2 had in fact leaked into the Hudson River and the Buchanan water system within days of the accident. (Witherspoon, 2002.)

Subsequently, there were public disclosures of other "unplanned" releases of radioactive tritium, strontium, cesium, cobalt and nickel, and it was revealed that some leaks had persisted, undiscovered or inadequately assessed for many years.

The leaks at Indian Point (and others) have been extensively detailed in a series of reports by the Government Accountability Office (GAO), a NRC Leak Task Force and the hydrogeology firm GZA GeoEnvironmental, Inc., which Entergy was forced to hire to try to determine the root causes and extent of the Indian Point leaks. We strongly urge NY DOS staff to review these reports in their entirety. In combination, what they reveal is: (1) Leaks can take a decade or more before they become recognized. (2) Determination of the source, root cause, and pathway of leaks can be a lengthy, complex and arduous task. (3) By the time the problem is found, it is often too late to prevent contamination of the environment. (4) Leaks on site are not necessarily mandated to be prevented or cleaned up before full plant decommissioning (i.e., cleanup may be delayed for half a century or more). (GAO, 2011; GZA, 2008; NRC Liquid Radioactive Release Lessons Learned Task Force, Final Report, 2006.)

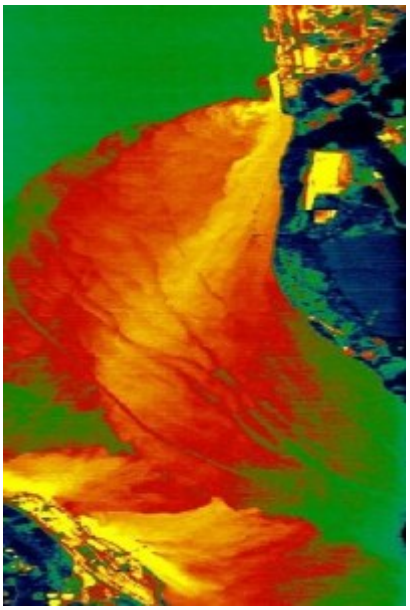
It is worthy of note that other aging nuclear reactors operated by Entergy have also had radiation leaks. As one press report succinctly put it: “Vermont Yankee has had operational and physical plant problems over the last decade, including a water tower collapse, a transformer fire, tritium leaks, missing fuel rods and condenser issues.” (Galloway, 2013. See also UCS Report, 2011 at pp 39-41.) (In August of this year, Entergy announced it would close Vermont Yankee in 2014.) And Entergy’s Palisades nuclear power plant has had over half a dozen reported radiation leaks since 2012, including a May 2013 leak into Lake Michigan which, investigators discovered, resulted from cracking of a tank nozzle in the plant’s 300,000 gallon injection and refueling tank located over the control room. The injection and refueling tank floods and cools the reactor with borated water during refueling and would serve as an emergency safety cooling system for removal of heat from the reactor in the event of a loss of coolant accident. The May 2013 incident caused the ninth shutdown of the plant since Sep 2011, the sixth shutdown as a result of leaks. (Coffey, 2013; Lydersen, 2013; RT, 2013.) In June 2013, the same tank leaked again, allowing water to leak through the ceiling of the plant control room. During repair, workers reportedly discovered that part of the foundation support for the tank had not been installed during the plant’s initial construction.

Non-Radiation Leaks

In addition to leaks of radiation, Indian Point has also released other toxins into the environment, both as a result of normal operation and as a result of poor facility maintenance. For example, in 2010, Entergy was fined $1.2 million for a release of oil into the Hudson when a transformer at Indian Point Unit 2 exploded. The same transformer model and the very same part (bushings) had exploded 3 years earlier at Indian Point Unit 3. This “no lessons learned” approach evidences a reckless disregard for the protection of fish and wildlife habitats.

Thermal Pollution

The thermal pollution from heat dumped into the Hudson River by Indian Point is tremendous. At Indian Point the discharge into the Hudson River varies in temperature from 90 to 100 degrees Fahrenheit. (Riverkeeper.) Thermal pollution, in addition to heating the water, reduces the oxygen level of water and increases bacteria and algae populations.
In terms of physics: Indian Point dumps about 30 billion BTUs of heat into the Hudson, thermal energy roughly equivalent to the heat which would be generated by exploding a Hiroshima sized nuclear bomb in the waters of the Hudson River. (Witherspoon, 2011.) A satellite photo of the Hudson River heat plume is below.



(Indian Point appears at the upper right of the image, its thermal plume is the upper plume.)

SECOND CONTENTION: Strong Evidence Suggests Continued Operation of Indian Point for 20 More Years Presents a Marked and Increasingly Elevated Threat to the Environment and Human Health

<u>High Level Nuclear Waste (Spent Fuel) – Continued Threat and Build-Up of Dump</u>

Some 1,500 to 2,000 tons of high level nuclear waste – also called "spent fuel" – generated by Indian Point to date currently sits by the east bank of the Hudson River.

If Indian Point is allowed to continue operating for 20 more years, the plant is estimated to add approximately 1,000 additional tons of waste to what has become, effectively, an indefinitely extended duration nuclear waste dump site.

So long as Indian Point continues operation as a power plant, massive amounts of spent fuel will sit in overfilled, tightly packed, highly radioactive waste storage pools, which are already degraded.

<u>Aging Nuclear Facility With Previous History of Degradation</u>

The likelihood of future hazardous release is elevated due to the operational history of the site.

In its first 40 years of operation, Indian Point has had fires; explosions; cooling system malfunctions; emergency sump pump defects; clogged water intakes; safety injection system degradation; boric acid corrosion; nitrogen gas accumulation; hydrogen gas buildup; steam generator accidents; reactor control rod malfunctions, electrical failures; backup generator failures; security system malfunctions; emergency communication system collapses; computer software problems; pipe breaks; and a series of radiation leaks. Just this summer, Indian Point's Unit 2 shut down after its two main boiler feed pumps stopped working.

Assurances that aging can be managed – what might be called the "don't worry, be happy" plan – defy common sense. Such optimism is also belied by the literature. Experts warn that the structural integrity of safety-related and other underground piping systems are especially susceptible to corrosion as plants age.

The GAO reports: “NRC officials … noted that the pressure and flow tests NRC currently requires do not provide information about the structural integrity of an underground pipe, such as whether the pipe has degraded to the point that the thickness of its wall could hinder the pipe’s future performance. One stakeholder voiced concern that not having structural integrity information about safety-related underground piping systems could create a very significant risk to public health and safety if such pipes were to unexpectedly fail due to corrosion.” (GAO Report, 2011, at p 19.)

The GAO then noted that the guided wave – or ultrasonic – technology used in the oil and gas industry is not readily adapted to nuclear industry site conditions because “the underground piping at nuclear power plants tends to include many bends and turns, which can distort the wave energy and interfere with the inspection test results.” Thus, “NRC and licensees cannot be assured that underground safety-related pipes remain structurally sound without having information about degradation that has occurred. Without such assurance, the likelihood of future pipe failures cannot be as accurately assessed, and this increases the uncertainty surrounding the safety of the plants.” (GAO Report, 2011, at p 19.)

Astonishingly, the NRC does not even deem piping and other components which could release radiation into the environment to be “safety-related” unless they relate specifically to safe operation or reactor shutdown. This is one reason why radiation leaks are inevitable deemed not to create “a risk to public health and safety.” The other reason is that any individual leak into a waterway which is not huge is always deemed dilutable. In, other words, the solution to pollution is dilution. (See, e.g., GZA report, at p 134, noting “remedial objectives” for Indian Point’s leaks of strontium and tritium into the Hudson, *et al*, include “natural attenuation processes” like “dispersion, and sorption.”)

Seismic Risk

In recent years it has also come to light that Indian Point sits virtually at the intersection of two earthquake faults and the NRC has identified the Indian Point Unit 3 reactor to be at the highest risk of core damage from an earthquake of any nuclear power plant in the nation.

The quake faults, experts at the Lamont-Doherty Earth Observatory of Columbia University have concluded, could generate a magnitude 7 quake on site at any time. Indian Point was not designed with that magnitude in mind, nor was it designed for the kind of gravitational acceleration that might be brought by a lower level on-site seismic event. (Sykes, 2008.) Lynn R. Sykes, the lead author of a study on this risk, stated: “Indian Point is situated at the intersection of the two most striking linear features marking the seismicity and also in the midst of a large population that is at risk in case of an accident… This is clearly one of the least favorable sites in our study area from an earthquake hazard and risk perspective.” John Arbruster, a co-author, said: “You could debate whether a magnitude 6 or 7 is possible, but we’ve already had three magnitude fives, so that is very realistic.” (Sykes, 2008, quoting from press release.)

Notably, the seismic design basis for the plant does not incorporate the multitude of risk factors attendant to the aging.

Revelations which emerged a few years ago regarding degradation of Indian Point’s refueling cavity liner are is illustrative of the problems which keep cropping up at the plant. The subject was the focus of a section in a 2011 report of the Union of Concerned Scientists (UCS) titled “The NRC and Nuclear Power Plant Safety in 2010: A Brighter Spotlight Needed.” To refuel Indian Point’s reactor, the refueling cavity is flooded with water. This removes decay heat from the fuel assemblies and helps protect the workers from excess radiation exposure. The original operating license application for Unit

2 assured that the refueling cavity was “designed to withstand the anticipated earthquake loadings,” and that “the liner prevents leakage in the event the reinforced concrete develops cracks.” This leakage prevention function of the liner became part of the licensing basis for the plant. “However, NRC inspectors at Indian Point recently found that the liner has been leaking 2 to 20 gallons per minute since at least 1993 (NRC 2010v), and that the plant owner has not yet delivered on repeated promises to fix the leak. That means the device installed to prevent leakage after an earthquake is leaking before an earthquake even occurs.” The problem of degrading refueling cavity liners for pressurized water reactors, the UCS report notes, was revealed in 1996, upon discovery that the Millstone nuclear plant in Connecticut had a non-conforming liner. The NRC then developed specific guidance giving plant owners 3 options on what they were supposed to do when they found degraded or nonconforming conditions. “However, the Indian Point owner has chosen option 4: to do absolutely nothing to resolve the safety nonconformance, daring the NRC to respond. That was the very same option the Millstone owner chose in the early 1990s – which led to the reactor shutdown and the NRC’s efforts to prevent such a situation from ever happening again.” (UCS Report, 2011 at pp 37-39.)

Gas Lines Pose Additional Risk

Another site hazard exposed in recent years is that Indian Point was built in close proximity to two large underground gas pipelines which are half-a-century old. (Blanch, 2010.) They could rupture, initiating an explosion and conflagration that could obviously spread.

A related – and virtually unanalyzed – threat is posed by the advent of a gas explosion, a small quake, or some other event, which emits enough vibration to further weaken pipes, fray wires, loosen welds, or create fissure cracks in some component or another. (Problems like these have repeatedly occurred at Indian Point without discovery through ordinary maintenance and inspection.) Degraded systems could then operate seemingly fine for years, but then fail if stressed by accident conditions.

Flooding Risk – Storms and Dam Failure

In the absence of the continual flow of cooling water, the super-hot radioactive fuel contained in the reactor core or the spent fuel pools will overheat. This can lead to both meltdowns and hydrogen explosions and fire.

If cooling is not resumed in time, in spent fuel pools, this could initiate an exothermic reaction and fire which could release the full inventory of radioactivity in the pool. (Alvarez, 2011; Alvarez, 2003; Thompson, 2007.)

If cooling is lost and not timely or adequately restored in a reactor, the nuclear fuel will overheat, potentially leading to core damage, containment failure, and the release of its radioactive contents into the environment.

Somewhat ironically, one of the greatest risks to cooling systems is from flooding. This is because flooding can disable cooling mechanisms by wrecking equipment or knocking out electrical systems. It was this loss of electrical power that led to the meltdowns at Fukushima. (UCS, 2012.)

The flooding risks at Indian Point are likely to rise significantly due to the increased precipitation and severe storms experts predict from climate change. Hurricane Irene and Superstorm Sandy stand as unpleasant recent examples of the phenomena.

Indeed storm-related floods have caused problems at several U.S. nuclear power plants in recent years. Flooding from Sandy caused the Salem and Oyster Creek plants in New Jersey to shut down when high water levels threatened their water intake and circulation systems. In June 2012, just a few weeks after a fire briefly shut down a cooling system for spent fuel rods, flood waters inundated the Fort Calhoun plant in Nebraska. (Funk, 2012.)

Flooding can also result from dam failure. Dam failures in the U.S. are not rare. Over 700 have occurred since 1975 and the American Society of Civil Engineers gives dams a "D" grade on its 2013 Report Card. (ASME Report Card, 2013.) The dams upstream from Indian Point are aging infrastructure and both Indian Point units made the list of the top 34 U.S. reactors at heightened risk of flood damage from dam failure in a 2011 NRC report. (Perkins, 2011.) The public, incidentally, only became informed of this risk after an engineer at the NRC Division of Risk Analysis pressed the issue. (See Perkins, 2012.)

Climate Change and Severe Weather Add Additional and Multiplicative Risks

Heavy precipitation and wide temperature swings in the region will likely take a further toll on the aging plant, accelerating corrosion and rusting in buried pipes and cables. It is only logical to believe that issuing a new 20-year license to a plant that could not be sited where it currently sits will develop more toxic leaks as it ages.

Drought, as well as flooding, can challenge plant cooling systems.

Severe storms present exceptional challenges because they can result in wide-spread regional power losses, cutting off off-site electric power which is needed to operate critical plant systems and result in a station blackout (or SBO); e.g., the Fukushima scenario. The loss of emergency diesel generators and SBO are unequivocally recognized to be a primary accident risk factor. (ASME Technical Report, 2013.)

Indian Point's back-up emergency diesel systems have limited duration capability and have been linked to numerous problems over the years. Indeed, in July 2013, federal criminal charges were filed against the Indian Point Chemistry Manager for falsifying chemical test results of diesel fuel used to power the plants emergency generators. (Complaint, 2013.)

An incident which occurred at Entergy's Arkansas Nuclear One plant on March 31, 2013, shows how rapidly sequences of events involving the loss of off-site power can occur even during pleasant weather – and thus reveals the far greater problems that can emerge under storm conditions. As noted in a June 2013 NRC Report: "At approximately 7:50 a.m. (CDT) on March 31, 2013, while lifting and transferring the Arkansas Nuclear One Unit main generator stator to the train bay, the temporary overhead crane collapsed, causing the 525-ton stator to fall on and extensively damage portions of the turbine deck and subsequently to fall over 30 feet into the train bay. The impact of the stator and crane components on the turbine deck damaged the electrical non-vital buses supplying offsite power to Unit 1 and caused the supply breaker to Unit 2 reactor coolant pump B to open. The damage to the electrical buses resulted in a loss of offsite power to Unit 1, and the trip of reactor coolant pump B resulted in the Unit 2 reactor trip from 100 percent power." (NRC Augmented Inspection Team Report, 2013, at p 3.) The collapse of the temporary crane resulted in the rupture of an eight-inch fire main in the turbine building train bay. (NRC Augmented Inspection Team Report, 2013 at p 3.) "At 9:23 a.m. offsite power to Unit 2 from startup transformer 3 was lost after water from the ruptured fire main caused an electrical fault inside the Unit 2 nonsafety-related switchgear in the turbine building. The loss of power from startup transformer 3 resulted in a trip of the running reactor coolant pumps and charging pump on Unit 2, and a trip of the running instrument air compressors maintaining

instrument air header pressure for both units." (NRC Augmented Inspection Team Report, 2013 at pp 3-4.) "At 10:33 a.m., the licensee declared a Notification of Unusual Event because the electrical fault inside the switchgear appeared to have resulted in a small explosion in the breaker cubicle." (NRC Augmented Inspection Team Report, 2013 at p 4.) The report continues: "The loss of offsite power resulted in the loss of power to both decay heat removal trains. Since the plant was in Mode 6, the decay heat removal pumps were not aligned to automatically restart following the emergency diesel generator starting and connecting to the Class 1E160 volt buses." (NRC Augmented Inspection Team Report, 2013 at p 5.) During the course of the incident, decay heat removal from the reactor fuel briefly ceased, power to a spent fuel cooling pump was disrupted, and an emergency diesel generator did not automatically start up. The loss of cooling was brief, and so the accident did not lead to a meltdown or radiation release. But the accident caused significant structural damage to site, killed a worker and sent 8 others to the hospital. The point of emphasis here is that this kind of incident occurred at an Entergy-run facility on a pleasant weather morning during daylight hours.

Bioaccumulation of Contaminants in the Environment is a Serious Hazard Ignored by Both the Operator and the NRC

Effluents from Indian Point since the 1970s have resulted in sizable discharges of highly toxic radionuclides that are known to bioaccumulate in aquatic organisms and interfere with human health.

The operation of Indian Point for two more decades will result in substantial continued releases of radioactivity and other chemicals into the air and Hudson River simply as a matter of course. Many of these contaminants remain poisonous for long durations and are well known to bioaccumulate in the environment. The long-term risks include not only continued accumulation, but synergistic interaction with other contaminants. Of particular concern over the long term are long-lived isotopes such as cesium-137 and strontium-90, which both remain radioactive for approximately 300 years. Then there is plutonium-239, with a half-life of 24,110 years.

Even a non-catastrophic accident would severely affect swimming and fishing and would degrade water quality. The near proximity of reservoirs also puts drinking water quality in jeopardy.

Other Public Health Risks

The U.S. National Academies of Science Committee to Assess Health Risks from Exposure to Low Levels of Ionizing Radiation (a/k/a, Committee on the Biological Effects of Ionizing Radiation) issued a study in 2005 – known as the BEIR VII study – that concluded there is no level of radiation which can be considered harmless. (NAS BEIR VII Study, 2005.) "Additionally, effects that may occur as a result of chronic exposures over months to a lifetime at dose-rates below 0.1 mGy per minute, irrespective of the total dose, are thought to be most relevant." (NAS BEIR VII Study, 2005, at p 21.) Current science shows long term cumulative effects of all radiation exposures must be taken into account in the assessment of risk. Women, adolescents, children (especially girls), toddlers, infants, and babies in utero are, respectively, increasingly more vulnerable to the effects of radiation. Moreover dose standards very narrowly look at cancer and not the number of overall illnesses such as an increasing weakening of the immune system, premature aging, cardiovascular diseases, chronic diseases of the stomach, thyroid and pancreas, neurological disorders, birth defects, and infant death. (Cf. IPPNW Report, 2011 at pp 22-24; Mangano, 2013.)

Since publication of the BEIR VII study, research has increasingly supported the link between ionizing radiation released during ordinary operation by nuclear power plants and human illness. The link is

especially strong with respect to thyroid cancer and childhood leukemia. (Baker, 2007; KiKK Studies, 2008; Nussbaum, 2009.)
Specifically with respect to Indian Point, analyses by Joseph Mangano, Director of the Radiation and Public Health Project (RPHP), and colleagues have raised serious concerns of health risks to residents of the lower Hudson Valley region should the plant remain operational for 20 more years. (Mangano, 2013; Mangano, 2007; Mangano, 2002.)

THIRD CONTENTION: Indian Point Presents an Untenable Risk to New York

> *"I think it is insane to have a three unit reactor on the Hudson River in Westchester County, 40 miles from Times Square, 20 miles from the Bronx. And if you describe that 50 mile circle…you've got 21 million people."* – Robert Ryan, Director of the Office of State programs for the Nuclear Regulatory Commission in 1979 sworn testimony.

It is beyond dispute that Indian Point could not be sited in the location it sits, were it to be built today.

So long as Indian Point continues operation as a power plant, massive amounts of spent fuel will sit in overfilled, tightly packed, highly radioactive waste storage pools, which are already degraded. Spent fuel rods give off about 1 million rems of radiation per hour – at a distance of one foot, enough to kill a man in a matter of seconds. In an Institute for Policy Studies report authored by Robert Alvarez, a former senior advisor to the U.S. Secretary of Energy, the radioactive inventory in Indian Point's spent fuel pools was estimated to be 233,641,800 curies, as of May 2011. (Alvarez, 2011.) Even with some of that having been moved to dry cask storage, the amount of radioactivity contained in the plant's pools is in the order of 100 times that released by the atomic bombing of Hiroshima.

Accordingly, continued operation presents not just a likely continued release of radioactivity into the environment, but the potential exceptional risk of accident and attendant large scale release of radiation to the surrounding coastal area. (See Appendix A.)

Numerous studies point to the morbidity and mortality risks of a major accident at Indian Point. (Alvarez, 2003; Lyman, 2004; Yablokov, 2009.)

Fallout from a major nuclear power plant accident was demonstrated in fact by the Chernobyl disaster. Radioactive fires at Chernobyl burned fiercely for nearly 10 days. Changes in wind direction and rainfall resulted in an uneven and spotty distribution of radionuclides that is more comparable to a Jackson Pollack painting than the neat little pie plumes depicted in NRC graphics. Three of most highly contaminated areas were the 20 miles surrounding the reactor; the Bryansk, Russia and the Gomel and Mogilev regions of Belarus 120 miles N-NE; and the Kaluga-Tula-Orel area of Russia 300 miles NE of the reactor. (A detailed description of the Chernobyl plume behavior is set forth in Yablokov, 2009.) Chernobyl resulted in over 1000 (noncontiguous) miles being severely contaminated. An area of some 100 square miles became a Dead Zone, which is estimated to remain uninhabitable for centuries.

From the perspective of plume behavior – as opposed to the mechanical cause of the disaster – Chernobyl is actually more relevant to the risks presented by Indian Point than Fukushima. This is because, at Fukushima, winds blew 80 percent of the radiation released during the actual accident out to the Pacific Ocean.

Indian Point, of course, sits on the Hudson River. The plume would thus fall virtually completely upon the Hudson River and the densely populated communities of the Lower Hudson Valley.

Still, it is worth noting that – even with plumes blowing out to sea – over 150,000 thousand people had to evacuate their homes as a result of Fukushima. And Fukushima well demonstrated the fallacy of expecting air flow to stay within a 10 mile Emergency Planning Zone. Evacuations were needed well beyond planned zones, and continued well past anticipated duration. As with Chernobyl, winds and precipitation kept altering plume behavior, forcing some populations to evacuate multiple times. And some towns were evacuated *to* emergency centers directly under the plume. A May 2013 Report by the United Nations Special Rapporteur on the human rights crisis which has followed in the wake of the Fukushima accident notes: "Evacuation orders for some areas with high radiation doses were not issued until one month later. On 22 April 2011, the Government issued evacuation orders for areas up to 50km north-west of the plant, including Katsurao, Iitate, Namie, and parts of Minami-soma and Kawamata, due to high-dose radiation detected in the area brought by winds carrying radioactive material from the plant. People in these areas thus remained exposed to high-dose radiation for a significant period." (UN Special Rapporteur Grover Report, 2013.)

As virtual daily continuing reports from Fukushima show, the aftermath of a reactor accident may well involve years of continuing leaks into the waterways. (Fackler, 2013.)

It goes without saying that a nuclear accident is not in the interest of the protection of NYS coastal resources from hazardous pollutants.

CONCLUSION

The Indian Point Safe Energy Coalition urges the New York State Department of State to deny Entergy and Indian Point certification. A 20 year license extension is inconsistent with NYS's Coastal Management Program and in contravention of enforceable NYS coastal zone policies.

Indian Point is an outdated, unsafe, and environmentally destructive nuclear plant. And if it continues to operate for an additional 20 years, it will continue to degrade the environment and pose an untenable and ever-expanding risk to NYS coastal areas.

And we advocate for a determination that comprehensively considers *all* long-term risks.

As citizens and mothers and fathers and grandparents, we implore upon you here: **Please do everything in your power to safeguard the natural, historic and cultural resources of our beautiful state for all future generations.**

Thank you for your consideration.

The Indian Point Safe Energy Coalition,
Leadership Council

Judy Allen
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Michel Lee
Ken Okin
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Margo Schepart
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[References and Appendix omitted as all are included in References and Sources to IPSEC Comments to NRC Draft. Appendix A in Comments to New York State Department of State herein retitled Appendix B to avoid confusion]

APPENDIX B
INDIAN POINT ACCIDENT STUDIES

Voluminous studies in the U.S. indicate that the effects of a major radiation release accident at Indian Point would be of historic proportion.

A **2004 study by Dr. Edwin Lyman**, **senior staff scientist in the Global Security Program at the Union of Concerned Scientists** on the Health and Economic Impacts of a Terrorist Attack at Indian Point concluded that such an event could cause as many as 44,000 near-term deaths from acute radiation poisoning and 518,000 long term deaths from cancer. These deaths, the report states, could occur among people living as far as 60 miles downwind of Indian Point. (Dr Lyman performed his calculations using the same computer models and methodology employed by the NRC and the Department of Energy to analyze radiological accident impacts.)

A **2003 study by an eight institution team led by the physicist Dr. Frank Von Hippel, Director of the Program on Science and Global Security at Princeton University** (and including Alison McFarlane of the Securities Studies Program at M.I.T. and Robert Alvarez, the former Senior Advisor to the U.S. Secretary of Energy), concluded that a successful terrorist attack on the spent fuel storage pool at Indian Point could have consequences "significantly worse than Chernobyl." Specifically, the study determined that a catastrophic spent fuel fire could release a radiation plume that could contaminate 8 to 70 times more land than the area affected by Chernobyl. (This, of course, would include the entire New York Metropolitan Region.)

A **January 2003 study by Dr. Gordon Thompson, Director of the Institute for Resource and Security Studies** (entitled “Robust Storage of Spent Nuclear Fuel: A Neglected Issue of Homeland Security”) reviewed the ways in which spent fuel pools are vulnerable to attack**.** Dr. Thompson concluded that a nuclear fire in the spent fuel pool of Indian Point Unit 2 would release enough cesium-137 “to render about 95,000 square kilometers of land uninhabitable," which would cover about 75% of New York State. (Given the geography, this would, more likely translate into, segments of NY, NJ, and CT.)

A **2000 special report prepared by experts within the NRC and the Sandia National Laboratories** (designated as an official NRC planning regulation in 2001) determined that a catastrophic meltdown in the spent fuel pool of a nuclear power plant could cause fatal radiation-induced cancer in thousands of people as far as 500 miles from the site.

A **1997 Brookhaven National Laboratory report** (entitled "A Safety and Regulatory Assessment of Generic BWR and PWR Permanently Shutdown Nuclear Power Plants") calculated that a disaster

from a spent fuel pool could cause up to 143,000 cancer deaths and render an area of up to 2,790 square miles uninhabitable.

Interestingly, the National Oceanic & Atmospheric Administration years ago did a study on the threat to the US posed by the Juragua reactors (880 mw – 440mw each) in Cuba and concluded that radiation from an accident there could contaminate areas as far away as Washington, D.C.

The truth is, no one knows what the precise geographical scope of a major incident at the Indian Point reactors would be or what number of casualties would occur. Much would depend on the nature of the underlying accident. A spent fuel pool fire would likely be much more catastrophic than a reactor core meltdown accident. But clearly the vast underestimates of corporate actors who have a massive financial interest in keeping Indian Point operational are more informed by wishful thinking than evidence.

RADIUS CALCULATIONS in SQUARE MILES

The EPZ surrounding Indian Point
10 miles = 314 sq. mi.

The "Peak Fatality Zone"
17.5 miles = 962 sq. mi.

The Chernobyl "Dead Zone"
18 miles = 1017 sq. mi.

The Radiation Ingestion Zone
50 miles = 7850 sq. mi.

~ Photo Fukushima Reactor No. 4

Associated Press Photo

REFERENCES & SOURCES

NOTE: For ease of review, reference citations are distinguished using color and bolding. Derived information and excerpts follow citations and are bracketed.

A

Alvarez, Robert, Spent Nuclear Fuel Pools in the U.S.: Reducing the Deadly Risks of Storage, Report, Institute for Policy Studies (IPS), May 2011. Accessible via summary article and link to study at http://www.ips-dc.org/reports/spent_nuclear_fuel_pools_in_the_us_reducing_the_deadly_risks_of_storage**.** [The author of this report, Robert Alvarez, is a former Senior Advisor to the U.S. Secretary of Energy.

Over the past 30 years, there have been at least 66 incidents at U.S. reactors in which there was a significant loss of spent fuel water. Ten have occurred since the Sep 11 attacks. Over several decades, significant corrosion has occurred of the barriers that prevent a nuclear chain reaction in a spent fuel pool — some to the point where they can no longer be credited with preventing a nuclear chain reaction.

The NRC depends largely on the industry self-reporting problems. Strains are being placed on crowded spent fuel pools of old reactors. Systems for keeping pools cool and clean are being overtaxed, as reactors generate hotter, more radioactive, and more reactive spent rods. Increases of the level of fissionable uranium-235 to enable longer operating periods can cause the protective cladding around a spent fuel rod, to thin and become brittle. It also builds higher pressure from

hydrogen and other radioactive gases within the cladding, all of which adds to the risk of failure. The cladding is less than one millimeter thick (thinner than a credit card) and is a crucial barrier to the escape of radioactive material.]

Alvarez R, Beyea J, Janberg K, Kang J, Lyman E, Macfarlane A, Thompson G, and von Hippel FN, Reducing the Hazards from Stored Spent Power-Reactor Fuel in the United States, Science and Global Security (2003); 11: 1-51. [This study was conducted by an eight institution team led by the physicist Dr. Frank Von Hippel, Director of the Program on Science and Global Security at Princeton University. The group included including Dr. Alison McFarlane of the Securities Studies Program at M.I.T. (prior to her appointment as NRC Chairman) and Robert Alvarez, former Senior Advisor to the U.S. Secretary of Energy.

The study discusses the risks and consequences of spent fuel pool fires. It states that a successful terrorist attack on the spent fuel storage pool at Indian Point could have consequences "significantly worse than Chernobyl." Specifically, the study determined that a catastrophic spent fuel fire could release a radiation plume that could contaminate 8 to 70 times more land than the area affected by Chernobyl.]

Alvarez R, What about the Spent fuel? Bulletin of the Atomic Scientists (2002); 58 (1): 45-47. http://www.nirs.org/radwaste/atreactorstorage/alvarezarticle2002.pdf.

[While concerns about attacks on commercial nuclear power plants have focused mainly on the vulnerability of reactor containment buildings, spent fuel pools are a “weaker link”. On average, spent fuel pools hold 5 to 10 times more long-lived radioactivity than a reactor core, with the large amount of cesium 137 being particularly worrisome. “According to the NRC, as much as 100 percent of a pool’s cesium 137 would be released into the environment in a fire.” In comparison, the 1986 Chernobyl accident released only 40% percent of the core’s 6 million curies of C-137. “A single spent fuel pond holds more cesium 137 than was deposited by all atmospheric nuclear weapons tests in the Northern Hemisphere combined.”

“In 1982, the NRC’s Atomic Safety and Licensing Board ruled that reactor owners ‘are not required to design against such things as…kamikaze dives by large airplanes. Reactors could not be effectively protected against such attacks without turning them into virtually impregnable fortresses at much higher cost.’ This view is buttressed by NRC’s long-standing policy blocking consideration of terrorist attacks in licensing proceedings. Because acts of terrorism are unpredictable, the NRC reasons, they are not germane to safety requirements.”

“Equipment installed to make high-density ponds safe actually exacerbates the fire danger, particularly with aged spent fuel. In high-density pools at pressurized water reactors, fuel assemblies are packed about nine to 10.5 inches apart –slightly more than the spacing inside a reactor. To compensate for the increased risk of criticality, pools have been retrofitted with enhanced water chemistry controls and neutron-absorbing panels between assemblies. The extra equipment restricts water and air circulation, creating vulnerability to systemic failures. If the equipment collapses or fails, as might occur during a terrorist attack, for example, air and water flow to exposed fuel assemblies would be obstructed, causing a fire, according to the NRC report. Heat would turn the remaining water into steam, which would interact with the zirconium, making the problem worse by yielding flammable and explosive hydrogen. As a result, the NRC concluded that ‘it is not feasible, without numerous constraints, to define a generic decay heat level (and therefore decay time) beyond which a zirconium fire is not physically possible.’”

In June 2001 the NRC staff reported that terrorist threats against spent fuel pools are credible and cannot be ruled out "'Until recently, the staff believed that the [design basis threat] of radiological sabotage could not cause a zirconium fire. However, [NRC's safety policy for spent fuel storage] does not support the assertion of a lesser hazard to the public health and safety, given the possible consequences of sabotage.'"]

ASME Report Card, 2013: 2013 Report Card for America's Infrastructure, American Society of Civil Engineers, 2013. http://www.infrastructurereportcard.org/a/#p/overview/executive-summary.

ASME Technical Report, 2012: Forging a New Nuclear Safety Construct, Technical Report American Society of Mechanical Engineers Presidential Task Force on Response to Japan Nuclear Plant Events, Jun 14, 2012. http://files.asme.org/asmeorg/Publications/32419.pdf. [The reference to "presidential" in the name of the task force refers to the president of the ASME, not the President of the U.S.]

AP, 2010: More than one quarter of U.S. nuclear plants have leaked tritium, Associated Press interactive diagram, 2010.
http://hosted.ap.org/specials/interactives/_national/leaking_nukes/index.html?SITE=AP. [The diagram identifies nuclear sites which have leaked tritium with red dots and shows the vast majority to be located in the Northeast/East coast.]

AP, 2009: Not enough money to dismantle old nuclear plants, Associated Press interactive diagram, 2009.
http://hosted.ap.org/specials/interactives/_national/nuclear_decommission/index.html?SITE=AP. [The diagram features links to 2008 data on the amounts in decommissioning funds for nuclear plants compared to the 2008 estimates of decommissioning cost. At Indian Point 2 & 3 (*no data is provided for the defunct reactor no 1*), the decommissioning funds are indicated to be short $114,430,000. At Calvert Cliffs, the funds are indicated to be short $417,308,000. At Limerick, the funds are indicated to be short $716,200,000.]

B

Baker PJ, Hoel D, Meta-analysis of standardized incidence and mortality rates of childhood leukemias in proximity to nuclear facilities, European Journal of Cancer Care (2007); 16: 355–363. http://www.ncbi.nlm.nih.gov/pubmed/17587361. [Researchers from the Department of Biostatistics and Epidemiology at the Medical University of South Carolina, conducted a meta-analysis of 17 studies covering 136 reactor sites in the U.S., Canada, France, Germany, Japan, Spain and the U.K. While studies varied in methods, there was evidence that leukemia in children under age 9 living near nuclear sites was elevated by 14 to 21 percent, and death rates from cancer were higher by 5 to 24 percent, depending upon proximity to the nuclear facilities.]

Batlle, JVi, International Commission on Radiological Protection, slide presentation 2012.
http://www.icrp.org/docs/Jordi%20Vives%20Modelling%20Exposures%20and%20Effects%20in%20the%20Marine%20Environment%20after%20the%20Fukushima%20Accident.pdf.

Behrens E, Schwarzkoph FU, Lübbecke JF, and Böning CW, Model simulations on the long-term dispersal of ^{137}Cs released into the Pacific Ocean off Fukushima, Environmental Research Letters (2012); 7 (3): 034004. http://iopscience.iop.org/1748-9326/7/3/034004/article. [Review by scientists from GEOMAR Helmholtz Centre for Ocean Research Kiel (Germany) and NOAA/PMEL (US).

Samples of sea water collected from the Pacific Ocean near Fukushima by TEPCO and the Japanese Ministry of Technology (MEXT) in the weeks after the incident showed extremely high levels of radioactivity, as far as 30 km (18.6 miles) offshore. Radioisotopes discharged from the plant included both short-lived isotopes like Iodine-131 (half-life 8 days) and long-lived isotopes such as Cesium-137 (half-life 30 years). Estimates of the total amount of Cs-137 directly discharged during the period of March 12 – April 30, 2011 in the ocean range widely (e.g., 4 PBq -36.6 PBq), reflecting a "significant uncertainty of currently estimated release rates". Some percentage of the long-lived isotopes are particles which can accumulate in the food chain with as yet unknown consequences for marine organisms. A substantial amount of the Cs-137 is expected to be carried by the swift near-coastal currents and dispersed over broader regions.

The Pacific Ocean is vast and stirred by energetic, fluctuating currents on various scales. The goal of Behrens and colleagues in this study is to provide a clearer perspective of the spatio-temporal evolution of that dilution process throughout the Pacific over a decadal time span for a tracer dye corresponding to Cs-137 injected over a near-coastal region off northeastern Japan. The simulations have limitations. For instance they ignore possible effects of biological processes which could lead to bioaccumulation of radiation in areas of high biological productivity. However tracer evidence adds to the understanding of the use of global ocean circulation models with different representations of mesoscale eddies to address the question of the long-term dispersion of long-lived radionuclides in the Pacific on timescales of years to a decade.

The fate of that dye (with a half-life corresponding to Cs-137) is evaluated under a host of simulations with a set of ocean circulation models differing in the representation of mesoscale eddy fluxes. With caution given to the various idealizations (unknown actual oceanic state during release, unknown release area, no biological effects included), the evidence indicates, among other things, a rapid decrease of radioactivity levels in the vicinity of Fukushima during the first 2 years followed by strong lateral dispersion, related to the vigorous eddy fields in the mid-latitude western Pacific. After 6–9 years, the tracer cloud is expected to span almost the entire North Pacific, with peak concentrations off the North American coast an order-of-magnitude higher than in the western Pacific.]

Bell HT, NRC Enforcement of Regulatory Requirements and Commitments at Indian Point, Unit 2, Office of the Inspector General, U.S. Nuclear Regulatory Commission, Memorandum to NRC Chairman Diaz (Apr 25, 2003), Case No. 01-01S.
http://pbadupws.nrc.gov/docs/ML0312/ML031200172.pdf. {See ref to NRC Inspector General Report, 2003.}

Billone, 2013: Billone MC, Burtseva TA, and Liu YY, Effects of drying and storage on high-burnup cladding ductility, Conference Paper, 14th International High-Level Radioactive Waste Management Conference, IHLRWMC 2013: Integrating Storage, Transportation, and Disposal (2013); 2: 1106-1113. http://www.scopus.com/record/display.url?eid=2-s2.0-84886884479&origin=inward&txGid=5FB4D61C836A9B562E30191367ACA154.N5T5nM1aaTEF8rE6yKCR3A%3a7. [From Abstract: "Pre-storage drying-transfer operations and early stage storage can subject cladding to high enough temperatures and hoop stresses to induce radial-hydride precipitation during long-term dry-cask cooling. These radial hydrides could provide and additional embrittlement mechanism in response to hoop-stress loading during post-storage fuel retrieval and cask transport." Paper discusses the protocol Argonne National Laboratory proposes for study of high-burnup cladding embrittlement.]

Billone, 2012: Billone MC, Burtseva TA, and Yan Y, Ductile-to-Brittle Transition Temperature for High-Burnup Zircaloy-4 and ZIRLO™ Cladding Alloys Exposed to Simulated Drying-

Storage Conditions, Report of Argonne National Laboratory, Sep 28, 2012. http://pbadupws.nrc.gov/docs/ML1218/ML12181A238.pdf. {NOTE: Results in this report were used to generate the article: Billone MC, Burtseva TA, and Einziger RE, Ductile-to-brittle transition temperature for high-burnup cladding alloys exposed to simulated drying-storage conditions, Nuclear Materials (2013); 433 (1-3): 431-448. http://www.sciencedirect.com/science/article/pii/S0022311512005181.}

[Compared to lower burnup rods, "high-burnup fuel rods are characterized by increased: decay heat following reactor discharge, internal gas pressure, cladding corrosion layer thickness, and cladding hydrogen content." During cooling, under tensile hoop stress, some dissolved hydrogen may precipitate across the cladding. After cooling to about 200° C, most of the dissolved hydrogen re-precipitates as hydrides and additional cooling during storage could result in radial-hydride-induced embrittlement. Both this embrittlement and the corresponding ductile-to-ductile transition temperature "may have a significant effect on cladding mechanical properties used in structural analyses for storage and transport casks." (p. 1.)

The report presents numerous photos of test results, including images of cracked cladding rings. (See, e.g., image of through-wall cracking at p. 16 and image of crack extending through 70% of the wall of ring, at p. 62.) The behavior of cladding materials depends, in part, on the microstructure of the alloy materials (i.e., orientation of grains and grain boundaries.) Residual tensile hoop stresses from fabrication and irradiation can also impact radial hydride precipitation. Overall, evidence suggests high-burnup ZIRLO™ be more susceptible than high-burnup Zry-4 to radial-hydride precipitation both during reactor shut down and during simulated drying storage conditions. Data are not publically available for the behavior of MF® (p. 69.)

Authors conclude additional data will be needed to determine ductile-to-ductile transition temperature. However "the trend of the data generated in the current work clearly indicates that failure criteria for high-burnup cladding need to include the embrittling effects of radial-hydrides for drying-storage conditions that are likely to result in significant radial-hydride precipitation." (p. 71.)]

Blanch, Paul 10 CFR 2.206 Petition regarding Inadequacy of Entergy's Management of Spectra/Algonquin Energy Natural Gas Transmission Lines within the site Boundary at Indian Point Nuclear Power Plants, submission letter to William Borchardt, Executive Director for Operations, U.S. Nuclear Regulatory Commission, Oct 25, 2010. http://pbadupws.nrc.gov/docs/ML1030/ML103020293.pdf. [Describing exceptional level of danger at Indian Point arising from an aging – over 100 years old – gas pipeline in close proximity to key plant structures. Explosion and fires could overwhelm the nuclear plant's safety systems.]

Brenner, Joel, *America The Vulnerable: Inside the New Threat Matrix of Digital Espionage, Crime, and Warfare*, Penguin Press, New York (2011). [Joel Brenner, served as head of counterintelligence for the U.S. Director of National Intelligence, and before that, as Inspector General of the National Security Agency. The book exhaustively details and appraises the cybersafety and cybersecurity risks to the nation. The book reveals intrusions into the Pentagon, NASA, national laboratories, national infrastructure systems, and numerous corporate giants including major engineering, internet and computer security firms. Chapter 5, "Dancing in the Dark" (pp. 93-115) describes nuclear plant and electrical grid vulnerability.]

Brown, Jovana J, PhD and Lori Lambert, PhD, Blowing in the Wind: The Navajo Nation and Uranium, Evergreen State College (2010). http://nativecases.evergreen.edu/collection/cases/blowing-in-the-wind.html. [The material in the monograph was based upon work supported by the National Science Foundation under a grant. The following are two excerpts:

"On July 16, 2009 an early morning prayer walk was held in Church Rock, New Mexico on the Navajo Nation to remember the largest radioactive accident in the United States. This accident occurred thirty

years earlier when a retaining dam at the United Nuclear Corporation's Church Rock Uranium Mill broke, spilling 90 million gallons of radioactive waste into the Rio Puerco. (Giusti, *Farmington Daily Times* 9/16/09) This disaster involved more radioactivity than Three Mile Island which occurred in March of 1979 and the ranks second only to the 1986 Chernobyl reactor meltdown in the amount of radiation released (SW Research & Information Center) The radioactive waste water flowed downstream ultimately killing entire herds of cattle and sheep. The Navajo people could not market their meat or wool after this disaster. (Yazzie-Lewis & Zion, p. 4 in Brugge et al). The spill flooded the alluvial water layer forcing contamination into the deeper aquifers. The groundwater was polluted for 70 miles. (Hugate, pp. 171-173) The spill deposited waste in nearby river and stream beds which is still present. (Giusti) Though there is a higher than usual cancer rate among the residents of the area, it is unclear if this has been caused by this horrendous spill or contamination from 1) working in the uranium mines and mills during the 1950's and 1960's, 2) contamination from abandoned mines and tailings and/or 3) contamination of the aquifers."

The Navajo Nation (NN) and other tribes have paid a terrible price for the uranium boom of the 1950's-1980's. Situated on the Colorado Plateau, the NN's 16 million acres of land are rich in mineral resources. The Colorado Plateau contains 55% of the uranium deposits in the western United States. During the period 1944 to 1986 nearly four million tons of uranium ore were extracted from Navajo Nation lands. (EPA, *Addressing uranium contamination in the NN*) This has resulted in tragedy for the people and the land of the Navajo Nation. Uranium miners, mill workers and their families have high rates of cancer. There are over 1,200 abandoned mines on NN land. Aquifers have been contaminated with radioactive waste and heavy metals. Some dwellings and other buildings constructed from mill tailings are contaminated."]

Brummitt CD, Hines PDH, Dobson I, Moore C, and Souza RMD, Transdisciplinary electric power grid science (with Supporting Information) Proceedings of the National Academy of Sciences (PNAS) (2013); 110 (30): 12159. http://arxiv.org/pdf/1307.7305.pdf. [Paper by scientists from the Departments of Mathematics, Mechanical and Aerospace Engineering, and Computer Science, and the Complexity Sciences Center at the University of California, Davis; the School of Engineering at the University of Vermont, ECpE Department, Iowa State University, Ames, and the Santa Fe Institute, describes the need to produce new risk models for power grids and infrastructure. The focus is on cascading failures, such as the blackout which affected Northeastern North America in 2003 and widespread grid failures triggered by Superstorm Sandy. Such events involve detailed feedbacks of multiple systems. The complexity of web interacts resembles an ecosystem.

The authors note: "Power grids comprise more than physical infrastructure…they are also social and market systems, and challenges span all three of the physical, human and market layers. At the center lies what engineers understand best: the electrical infrastructure. Next, information and communication systems monitor and control the electrical infrastructure at increasing levels of detail using new technology. Novel capabilities … risk introducing privacy concerns, security vulnerabilities, and dependence between electricity and information infrastructure."

Modeling must incorporate the feedback loops between climate change, power systems, infrastructure, and human behavior. Examples of the many complicated mechanisms involved, for example in blackouts, include thermal overloads, relay failure, voltage collapse, dynamic instability and operator error. Risk spreads also among infrastructures, such as via computer viruses.

"The National Academy of Sciences report on robustness and resilience of the electric power system in the United States highlights dangers from the power system's age, inadequate guards against malicious attack, and interdependence with other infrastructure (like wireless communication), all of

which exacerbate risks…caused by extreme weather or by terrorist attack." The risks include blackouts lasting months because of damage to hard-to-replace transformers.

Current state-of-the-art models capture only a subset of failure mechanisms. Tackling problems with large-scale feedbacks among different systems requires a incorporation of transdisciplinary knowledge, which may be called "multiple disciplinary."]

Buesseler K, Aoyama M, and Fukasawa M, Impacts of the Fukushima Nuclear Power Plants on Marine Radioactivity, Environmental Science & Technology (2011); 45: 9931-9935. http://pubs.acs.org/doi/pdf/10.1021/es202816c. [Early analysis of releases of Cesium 134 and Cesium 137 following Fukushima by scientists from Woods Hole Oceanographic Institution (MA, US), the Meteorological Research Institute (Tsukuba, Japan) and Japan Agency for Marine-Earth Science and Technology (Yokosuka, Japan).

Venting of gases, hydrogen explosions, and the fire in the spent fuel pool of Unit 4 resulted in the primary atmospheric releases of radiation. In addition cooling of the reactors and release of highly contaminated water from the damaged reactor buildings led to large radioactive discharges directly into the sea. (p. 9931)

"What are significant are not just the elevated concentrations, but the timing of peak release approximately one month after … the earthquake. This delayed release is presumably due to the complicated pattern of discharge of seawater and fresh water used to cool the reactors and spent fuel rods, interactions with groundwater, and intentional and unintentional releases of mixed radioactive material from the reactor facitilty." (p. 9932.)

Concentration of cesium in sediments and biota near Fukushima may continue to remain quite large for at least 30 to 100 years due to the long half-life of the radionuclide which is still detected in marine and lake sediments from 1960 fallout sources. (pp. 9932-9933.)

By July 2011, levels of Cs-137 were still more than 10,000 times higher than levels measured in the coastal waters off Japan in 2010.

Whether the releases of radiation into the ocean will translate into a health issue is unknown. Dose assessment made by the World Health Organization, for example, does not consider bioaccumulation and consumption of seafood and seaweeds. Locally elevated marine sediment could provide additional pathways for assimilation in the biota near shore. That being said, a significant amount of field data will need to be collected to estimate the ocean radionuclide inventories, the full range of isotopes released, the aerial extent of contamination, the fraction delivered as coastal runoff vs atmospheric fallout, the sedimentary burden near the nuclear power plant and the biological uptake in the marine food chain and it will take some time before results are available to fully evaluate the impacts of the accident upon the ocean. (pp. 9934-9935.)

Bunn M, Morozov CY, Mowatt-Larssen R, Saradzhyan, Tobey William, Yesin VI, and Zolotarev PS, The U.S.-Russia Joint Threat Assessment On Nuclear Terrorism, Joint Report of the Belfer Center for Science and International Affairs at Harvard University and the Institute for U.S. and Canadian Studies Institute of the Russian Academy of Sciences, May 2011. http://belfercenter.hks.harvard.edu/files/Joint-Threat-Assessment%20ENG%2027%20May%202011.pdf. [International group of security and military experts warns nuclear terrorism is a real and urgent threat. Terrorists will certainly be searching for the "weakest link" in an otherwise well-defended nuclear establishment. "Moreover, the dramatic developments associated with the Fukushima disaster might awaken terrorist interest in this path to nuclear terrorism." (p. 20.)

"One important lesson of the Chernobyl and Fukushima accidents is that what can happen as a result of an accident can also happen as a result of a premeditated action. Indeed, today's high levels of nuclear safety are dependent on the high reliability of components such as cooling systems; if these are intentionally destroyed, the probability of a large release would increase greatly." (p. 20.)

“Overfilled spent fuel pools may also be potential sabotage targets; in some cases, if terrorists managed to drain the cooling water – as occurred without human intervention at Fukushima – a zirconium fire and large-scale dispersal of radioactivity could potentially result.” (p. 21.)

Transportation of spent nuclear fuel or high-level waste is a sabotage window. A “scenario of a radiological terrorism act could involve hijacking a vehicle or vessel that is transporting radioactive material and threatening to blow it up.” (p. 21.)]

Bunn, George and Fritz Steinhausler, Guarding Nuclear Reactors and Material From Terrorists and Thieves, Paper, Arms Control Association, Oct 2001.

http://www.armscontrol.org/act/2001_10/bunnoct01. [Paper authored by George Bunn, who served on the U.S. delegation that negotiated the nuclear Non-Proliferation Treaty, is a consulting professor at Stanford University’s Center for International Security and Cooperation, and Fritz Steinhausler, a professor at the Salzburg Institute in Austria and (at the time) visiting professor at the Center for International Security and Cooperation.

Modern threats include “terrorists who want to blow up nuclear reactors with high explosives to kill civilians and create chaos, thieves who want to steal weapons-usable nuclear material to sell to states or terrorists seeking nuclear weapons, and disgruntled employees who want to steal material and sell it on the black market.”

“The threat that a terrorist might try to blow up a U.S. nuclear facility is frighteningly plausible. Even before the September 11 attacks, conventional high-explosive bombs delivered by car, truck, or boat had been used in numerous terrorist attacks on U.S. facilities: a U.S. Marine barracks in Lebanon in 1983, the World Trade Center in New York City in 1993, the Federal Building in Oklahoma City in 1995, a U.S. military housing complex in Saudi Arabia in 1996, two American embassies in Africa in 1998, and a U.S. naval vessel in a port in Yemen in 2000.”

“If such an attack against a nuclear plant were successful, the number of casualties could be extremely high because of the resulting spread of radioactive material. In 1981, an environmental impact statement prepared by the U.S. Nuclear Regulatory Commission (NRC) estimated that a large truck bomb used against a nuclear reactor in a highly populated area could produce 130,000 fatalities. In effect, a simple conventional explosive used against a nuclear facility would serve as a large radiological weapon.”]

C

Chopra OK, Diercks D, Ma D, Shah VN, Tam S-W, Fabian RR, Han Z, and Liu YY, Managing Aging Effects on Dry Cask Storage Systems for Extended Long-Term Storage and Transportation of Used Fuel Rev. Argonne National Laboratory Study for Department of Energy, FCRD-UFD-2013-000294 ANL-13/15, Sep 30, 2013.

http://www.ipd.anl.gov/anlpubs/2013/10/77650.pdf. [Operating experience with respect to structures, systems, and components (SSCs) and dry cask storage systems (DCSS) is more limited than experience in operating reactors. (p. v)

“Significant” aging mechanisms include: Abrasion; aggressive chemical attack, corrosion of carbon steel storage overpack components; corrosion of embedded steel; deterioration of seals, gaskets, and moisture barriers (caulking, flashing, and other sealants); elastomer degradation; elevated temperature and radiation; freeze-thaw and frost action; galvanic corrosion; general corrosion (uniform erosion, pitting and crevice corrosion); hydride reorientation; leaching of calcium hydroxide and carbonation; microbiologically induced corrosion; reaction with aggregates; settlement; stress corrosion cracking; thermal effects, gasket creep, and self-loosening; thermal fatigue; weathering, and wind-induced abrasion). (part II at pp. 5-1 – 5-3)

“Metal and concrete structures and components in independent Spent Fuel Storage Installations (ISFSIs) and dry cask storage systems (DCSSs) are subject to degradation and failure due to fatigue under cyclic loading conditions, such as may occur under temperature an/or pressure cycling or vibrational loading. Such failures can occur at stress amplitudes significantly below the design static

loads. Fatigue in metals typically occurs through a process of crack initiation and subsequent growth through the thickness of the affected component. Plain concrete, when subject to repeated loads may exhibit excessive cracking and may eventually fail after a sufficient number of cycles at load levels less than the static strength of the material." (part III p. 2-1)

Chun, Rene, The China Syndrome 2003, Playboy, May 1, 2003. http://business.highbeam.com/137462/article-1G1-101447287/china-syndrome-2003-millions-people-live-shadow-indian. [Investigative report detailing security problems at Indian Point nuclear plant as described by whistleblower Foster Zeh and collaborated by others. Zeh is a former Marine who worked as security supervisor at Indian Point for 5 and a-half years. In 2000 he received the commendation of Supervisor of the Millennium from Wackenhut Nuclear Security. He trained guards, plotted strategy and ran mock assault drills.

"Over the years, Zeh has become increasingly concerned about the rickety, inept defense' that protects America's most lethal 'soft targets.' In this case, the target is 35 miles from Times Square." Zeh reports "on dangerous conditions at Indian Point's spent-fuel pools that until now have been hidden from the public, denied by Indian Point officials and whitewashed by the Nuclear Regulatory Commission. Zeh's allegations are convincing to many in the industry, and his assessments put New York City closer to a nuclear disaster than most people could imagine."

"'It's one of the worst,' says Pete Stockton when asked about Indian Point. Stockton was a special assistant to the secretary of energy in the Clinton administration and now works with a watchdog group called the Project on Government Oversight. 'It's a lack of thought in their defensive plan, it's fatigued guards who work too much overtime, it's the training of the guards, everything. Few of our plants are ready for a real terrorist attack.'
Security at nuclear plants now is comparable to security at the nation's airports before September 11--a weak government agency sets the standards, and the utilities hire the cops themselves."]

Clarke, Richard, Forward to Edition on Cyber Security in International Relations, Strategic Insights (2011); 10 (1) 1-3. http://www.dtic.mil/dtic/tr/fulltext/u2/a541955.pdf.

Coffey, Chris and Lisa Capilanni, Residents Express Concern Over Aging Nuclear Plant, NBC Chicago, Aug 29, 2013. http://www.nbcchicago.com/investigations/palisades-nuclear-power-plant-chicago-219870131.html; http://www.nbcchicago.com/investigations/palisades-nuclear-power-plant-chicago-219870131.html.

Cole, William J, Global Atomic Agency Confesses Little Can Be Done to Safeguard Nuclear Plants, Associated Press, Sep 19, 2001. [Reporting that a Sep 2001 IAEA statement acknowledged that most nuclear power plants are not strong enough to withstand attack by "a large jumbo jet full of fuel" without dispersion of "large amounts" of radioactive material.]

Cooper M, Renaissance in Reverse: Competition Pushes Aging U.S. Nuclear Reactors to the Brink of Economic Abandonment, Report, Institute for Energy and the Environment at Vermont Law School, Jul 2013. http://216.30.191.148/071713%20VLS%20Cooper%20at%20risk%20reactor%20report%20FINAL1.pdf. {Also at http://will.illinois.edu/nfs/RenaissanceinReverse7.18.2013.pdf.} [Report by Mark Cooper, Senior Fellow for Economic Analysis at the Institute for Energy and the Environment at Vermont Law School, provides a critical analysis of the economic and safety hazards of the nation's fleet of aging nuclear reactors. According to his study, over three dozen reactors in the US are at risk of poorly planned for early retirement due mostly to safety problems and the high costs of retrofitting aging plants to accommodate emerging evidence of risk and age related deterioration.

Cooper uses 11 risk factors – including competition from lower-cost energy sources, falling demand, safety retrofit expenses, significant repair costs, and rising operating costs – identified in analyses

from Moody's, UBS, and Credit Suisse. The 12 reactors Cooper flagged as being at highest risk of abandonment were (listed alphabetically): Clinton (selling into a tough market); Davis-Besse (large number of risk factors); Fitzpatrick (high cost but offset by high market clearing price); Ft. Calhoun (outage, poor performance); Ginna (single unit with negative margin, existing contract); Indian Point (license extension, NY state opposition); Millstone (tax issues); Nine Mile Point (site size saves it, existing contract); Oyster Creek (already set to retire early); Palisades (repair impending, local opposition) Pilgrim (large number of risk factors, local opposition); and Vt. Yankee (tax issue and state opposition).

The report notes the poor performance of nuclear reactors resulting in early retirements in 2012 and 2013 has existed throughout the history of the commercial nuclear sector in the U.S. and the problems are endemic to the technology and the sector.

The principal underlying economic stresses of the escalating costs needed to maintain an aging fleet plus the availability of lower cost alternatives are likely to continue for the next couple of decades. And market conditions are making aging nuclear plants increasingly uneconomic. For example, in May 2013, as a result of price competition, Dominion announced the closure of its Kewaunee nuclear plant in Wisconsin, despite the fact it had just been granted a 20 year license extension. The difficulties faced by the industry in executing major capital improvements and repairs is evidenced by operator decisions to abandon Crystal River in Florida and San Onofre in California after repairs went very badly. The experience with major uprates since 2009 exhibits exactly the same problems that have plagued nuclear construction projects throughout the history of the commercial sector: abandonments, cancellations and large cost overruns.]

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http://www.vermontlaw.edu/Documents/PublicRiskPrivateProfit_Cooper.pdf. [Report by Mark Cooper, Senior Fellow for Economic Analysis at the Institute for Energy and the Environment at Vermont Law School.]
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http://csis.org/files/media/csis/pubs/081208_securingcyberspace_44.pdf. [Report prepared under the auspices of the Washington-based Center for Strategic and International Studies, by a project involving over 60 government and industry computer security specialists. The report followed a series into government computer systems. "The damage from cyber attack is real," the report states, "cybersecurity is now a major national security problem for the United States" and even secure systems are vulnerable...the Departments of Defense, State Homeland Security, and Commerce, NASA and the National Defense University all suffered major intrusions by unknown foreign entities." The report stresses that all infrastructure and industries are vulnerable, and that SCADA systems are prime targets.]

D

Daitz, Ben, MD, A Doctor's Journal: Navajo Miners Battle a Deadly Legacy of Yellow Dust, New York Times Contributing Column, May 13, 2003. http://www.nytimes.com/2003/05/13/health/a-doctor-s-journal-navajo-miners-battle-a-deadly-legacy-of-yellow-dust.html:http://www.nytimes.com/2003/05/13/health/a-doctor-s-journal-navajo-miners-battle-a-deadly-legacy-of-yellow-dust.html. [Ben Daitz, a physician and professor at the University of New Mexico School of Medicine describes his visit to a Navajo reservation and a clinic serving Navajo suffering from the ravages of uranium mining:

"The Diné (pronounced dee-NAY) or 'the People,' as the Navajo call themselves, have many stories about their origins. One says that as they emerged from the fourth world into the fifth and present world, they were given the choice of two yellow powders. One yellow powder was corn pollen, and that was the one they chose."

The other was the color of the yellowcake, uranium oxide.

"The Spirits said it had to be left alone. But from the late 1940's through the mid-80's, yellowcake was picked and shoveled and blasted and hauled in open-bed trucks, and then dried in mountainous piles at multiple sites in the American West. The Navajo, whose lands extend over western New Mexico, eastern Arizona and southern Utah, were at the epicenter of the uranium-mining boom, and thousands of Navajos worked in the mines. More than 1,000 abandoned mine shafts remain on Navajo land.

"The consequences are measured today, decades after the mines closed, in continuing health problems and degraded land.

"Under the Radiation Exposure Compensation Act of 1990, people exposed to radiation through uranium mining and milling or through weapons testing are eligible for government compensation."

"More than 500 uranium miners died of lung cancer from 1950 to 1990. Hundreds more will die of lung cancer in the coming years, a study by the Public Health Service predicts. A majority of the deaths stemmed from exposure to radiation from the breakdown of uranium products. These so-called radon daughters attach to dust particles, and when workers inhale the dust, the particles lodge in their lungs, where they release high doses of radiation."

One patient, John James 67, who was on oxygen and sought attention at a clinic for coughing up blood, had started mining in 1956 in Utah. "'We brought dust home on our clothes,' he told the doctors. 'We contaminated our families. I saw the yellowcake there. It looked like it was burning.'"

"The doctors saw six patients that morning. Most of the old miners drove at least 100 miles to get there, and they will keep returning for testing, betting that the sad chapter of their past will somehow compensate them for the present, before they die."

Mitchell Capitan, a former mining technician president of the Crownpoint chapter of the Eastern Navajo Agency, founded Endaum, Eastern Navajo Diné Against Uranium Mining. The group was battling against a plan for uranium mining using a leeching using water from the Westwater Canyon Aquifer under Crownpoint, the sole source of drinking water for the Crownpoint area providing for 15,000 people. Capitan says: "'People come here from all over these parts, from 50 miles away, to

truck this water back to their houses, to drink it, because it's the only pure supply. Their own water is bad -- contaminated….'This uranium impacts on our water, our air and our cultural identity,'" he said. "'We've already had enough uranium.'" At a gathering Mr. Capitan stood under an Endaum banner which said in Navajo and English: "One Mind, One Voice, One Prayer, One People."]
Damveld H and Bannick D, Management of Spent Fuel and Radioactive Waste: State of affairs – A worldwide overview, NIRS Nuclear Monitor, 746/7/8, May 2, 2012.
http://www.nirs.org/mononline/nm746_48.pdf.

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http://warp.da.ndl.go.jp/info:ndljp/pid/3856371/naiic.go.jp/en/report/. A Summary of the report is available at**:** http://www.nirs.org/fukushima/naiic_report.pdf and http://cryptome.org/2012/07/daiichi-naiic.pdf. [In late 2011 Japan enacted the Fukushima Nuclear Accident Independent Investigation Commission (NAIIC Act) and the Diet (one of the three branches of the Japanese government) established a Commission independent of the parties involved in the accident, with powerful investigative authority, including the legal power to demand documents and obtain testimony. The report is sometimes called the "NAIIC Report, but is most commonly referred to as the "Diet Report." The Diet Commission investigation included more than 900 hours of hearings, interviews of 1,167 people, and 3 town hall meetings to hear firsthand the experiences of evacuees.]

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http://energy.gov/sites/prod/files/2013/07/f2/20130716-Energy%20Sector%20Vulnerabilities%20Report.pdf. [The report assesses the vulnerability of U.S. critical energy and electricity infrastructure to the impacts of climate change. In recent years, widespread and long droughts, extreme heat waves, more severe and prevalent wildfires, and intense storms that caused power and fuel disruptions for millions have occurred and these trends are expected to continue. Increasing risks include temporary partial or full shutdowns at nuclear power plants because of decreased water availability for cooling and higher ambient and air water temperatures. Risk to infrastructure located along the coast is increasing due to sea level rise, increasing intensity of storms, and higher storm surge and flooding. Water levels of rivers may be affected by both drought and flooding. Distribution systems for gasoline may be disrupted. Climate change, additionally, poses increasing risk of physical damage to power lines, transformers and electricity distribution systems from hurricanes, storms and wildfires that are growing more intense and more frequent.]

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http://energy.gov/sites/prod/files/igprod/documents/IG-0846.pdf. ["Security over the Nation's power grid remains a critical area of concern. Recent testimony before Congress disclosed various issues,

including the existence of significant vulnerabilities tin the power grid's infrastructure and many utilities that were not in compliance with the standards." (p. 1)

"Without improving its authority and oversight process related to protecting the Nation's power grid, the Commission may be unable to ensure that cyber security vulnerabilities are mitigated or that the effects of weaknesses are minimized. The current Administration and intelligence officials have expressed concerns over security for the Nation's power grid, noting that intruders have probed the power grid and cyber attacks have occurred against electrical and other critical infrastructure elsewhere. In addition, industry representatives indicated that, although becoming more streamlined, both the current standards and those in development cannot address advanced persistent threat attacks against the power grid." (p. 10)

"In addition, the Department of Energy's (Department) Idaho National Laboratory, in conjunction with the Department of Homeland Security, recently illustrated that a cyber attack upon a power grid generator could potentially cause it to self-destruct. This experiment, called the Aurora Project, demonstrated how efforts to transfer control of generation and distribution equipment from internal networks to systems that could be accessed through the Internet have opened the power grid to additional cyber security vulnerabilities. Furthermore, a Department report recently identified many vulnerabilities with systems supporting the Nation/s critical infrastructure, including weaknesses ...such as missing software security patches and weak password management." (pp. 10-11)

"In addition, as noted in a recent survey conducted by industry and the Center for Strategic and International Studies, more than half of the operators of power plants and other 'critical infrastructure' components reported that their computer networks had been infiltrated by sophisticated adversaries. Furthermore, during recent testimony to Congress, the Director of National Intelligence stated that the cyber security threat was growing at an unprecedented rate ....[Cyber security vulnerability] was recently highlighted by the discovery of sophisticated malwre within various industrial control systems. An industry expert also noted that there have been more than 125 industrial control system incidents resulting in impacts ranging from environmental and equipment damage to death." (p. 11)]

Donn, Jeff, Old age is catching up with the nation's nuclear plants, Associated Press, Jun 27, 2011. http://www.ap.org/company/awards/part-i-aging-nukes. [Brittle vessels, leaky valves, cracked tubing, and corroded piping, are among the aging problems repeatedly arising at the nation's aging fleet of nuclear plants. Nuclear operators have failed to stop an epidemic of leaks in pipes and other underground equipment in damp settings. The Union of Concerned Scientists, in Sep 2010, noted that the country's nuclear sites have sustained more than 400 accidental radioactive leaks.]
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http://www.nytimes.com/2013/10/25/world/asia/with-a-plants-tainted-water-still-flowing-no-end-to-environmental-fears.html?_r=0.

Fahey, Jonathan, Concerns Raised Over Pipeline Near Indian Point, Associated Press, Oct 25, 2010. http://www.huffingtonpost.com/huff-wires/20101025/us-indian-point-gas-line/ [Paul Blanch, a nuclear operations engineer and former utility executive who spent 20 years at Northeast Utilities, has raised strong concerns about the presence of two large underground natural gas pipelines that cross within a few hundred feet of the Indian Point nuclear facility in Buchanan, N.Y. In Sep 2010, a large pipeline in San Bruno, Calif. ruptured and exploded in September, killing eight people and destroying 37 homes. The owner of the NY pipeline, Spectra, reports 1.45 billion cubic feet of gas per day flows in the lines near Indian Point, or about 1 million cubic feet per minute, double the rate of gas flow that escaped in the San Bruno disaster.
Blanch's fear is that similar explosion and subsequent fire at Indian Point could damage or destroy the cooling and safety systems at the site and lead to a catastrophic nuclear accident. "'It's a low probability event," said Blanch of a rupture of one of the pipes. 'But the consequences are unimaginable.'"

The gas pipelines were installed in the 1950s and 1960s, and predate construction of the nuclear plant. Blanch suspects that changes to the pipelines since their safety was first studied in the late 1960s have not been properly evaluated. The NRC claims a study shows the siting is safe, but will not release details of the study. David Lochbaum, director of the nuclear safety program at the Union of Concerned Scientists, agrees with Blanch that the pipeline issue needs to be explored. "Lochbaum says he find it 'curious' that the NRC is withholding details of the study. He wrote in an email that if the Entergy evaluation showed that if the pipeline was not a threat, 'one would think the NRC would want the world, both good guys and bad guys, to know it.' 'Either the alleged expert evaluation does not exist (and therefore cannot be made public),' Lochbaum wrote in another email. 'Or it does exist but identifies a hazard to the plant (and therefore cannot be made public).'"

"[I]n the past the commission itself has raised concerns about natural gas near nuclear facilities. In 1991 it alerted all nuclear power plant operators to potential hazards after it discovered that natural gas wells were drilled and pipes installed near the Fort St. Vrain nuclear facility in northern Colorado without being properly studied. The plant was closed in 1992."

Jim Hall, a pipeline safety expert who formerly served as Chairman of the National Transportation Safety Board said "[I]t should be unacceptable to have pipelines there that are 50 or 60 years old."]

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Ferguson, Charles D and William C. Potter, "The Four Faces of Nuclear Terrorism," Routledge Taylor & Francis Group, New York and London (2005). [Book by Charles D. Ferguson, Science and Technology Fellow at the Council on Foreign Relations, and William C. Potter, Institute Professor and Director of the Center for Nonproliferation Studies at the Monterey Institute of International Studies, also had contributors Amy Sands, Leonard S. Spector and Fred L Wehling of The Center for Nonproliferation Studies. The Forward by Richard G. Lugar, Chairman, U.S. Senate Foreign Relations Committee and Sam Nunn, Co-Chairman and Chief Executive Officer of the Nuclear Threat Initiative, notes "more likely terrorism dangers come from attacks on nuclear facilities...not designed to resist the level of terrorist threat that materialized on September 11"and that spent fuel pools are among the facilities "with weaker levels of or nonexistent containment structures."

Among the "four faces" of nuclear terrorism upon which Ferguson and Potter focus are are attacks against and sabotage of nuclear facilities, in particular nuclear power plants. (Theft of fissile material is another significant risk.)

The authors note that the formula of quantifying risk by the equation: probability of event X consequences = probability is not a good way to conduct risk analysis when the issue is nuclear terrorism or sabotage. The data set is inadequate and the magnitude of threat is devastating. (p. 5.) Further, the "Design Basis Threat" used by the NRC "does not fully reflect the magnitude of the September 11th attack: 19 motivated and well-trained assailants operating in four separate teams." (p. 10.) Moreover "terrorist organizations have openly declared their hopes of wreaking massive destruction on the United States, and others may well follow suit." (p. 8.) Among the examples of nuclear power plants being an alluring target for terrorists is the Aug 2003 arrest in Ontario, Canada of 19 individuals – the same number of attackers involved in Sep 11 – on charges of conspiring to attack a nuclear power plant on the shore of Lake Ontario. (p. 2.)

Among "the nuclear facilities of greatest concern as potential terrorist targets" are those with significant inventories of radioactivity, including nuclear power reactors and "spent fuel storage facilities at these reactor sites". (p. 190.) The authors review the vulnerabilities of commercial nuclear plants in detail. (See, esp. pp. 210-258) and specifically address issues identified at Indian Point. "Attack modes include airplane crashes; commando raids by land, water, or air; or cyberterrorism." (p.192.) In the case of aerial attack, terrorists could precisely target "vital plant safety systems" such as the reactor's "spent fuel pools in order to generate substantial off-site release of radioactivity." (p. 194.) "If a terrorist attack or sabotage caused the spent fuel to be uncovered, its zirconium cladding might ignite, which might result in the release of radioactivity. The dense packing in most U.S. spent fuel pools restricts cooling flow, increasing the risk that temperatures could climb to high levels in the event that the spent fuel becomes uncovered." (p. 205.)]

Foderaro, Lisa W, Cleaning Up Radiation In Park May Take Years, New York Times, Nov 26, 2013. http://www.nytimes.com/2013/11/26/nyregion/radiation-cleanup-at-staten-island-park-to-take-years.html. [In Nov 2013, officials said that the level of radioactive contamination is more extensive than previously thought and cleanup likely to take years. Garbage with trace amounts of radium was dumped into the wetlands at Great Kills Park on Staten Island in the 1940s and 1950s. Contamination was first detected in 2005 when a police flyover of New York City detected a positive reading for radioactive material. In the years since, investigations by the city's Department of Health and Mental Hygiene, the EPA and the United States Army Corps of Engineers turned up more hot spots and a more disturbing picture.

"'As we're getting through this tough job, we're finding that the contamination is not only in these discrete pockets, but is dispersed in the soil and also at the surface,'" said Kathleen Cuzzolino, an environmental protection specialist for the Park Service." In late 2013, after another flyover and years of excavations, "the Park Service acknowledged that the contamination was more extensive than had originally been believed. Indeed, more than half of the park has shown some degree of radioactivity

— virtually the entire area containing the historic fill." Park officials have fenced off 260 acres and started the lengthy process of mapping the contamination and devising a cleanup plan. "[T]he National Park Service, with help from the Army Corps of Engineers, is now surveying every square foot of the 260 acres. Radiation technicians have so far scanned three-fourths of the park with detectors, a painstaking job that entailed clearing vegetation in the survey area so that the detectors could come within six inches of the ground…the Park Service will remove at least 30 hot spots with the highest levels of radiation in the coming months. …The federal government will also undertake a 'human health and ecological risk assessment,' in which soil and ground water samples will be analyzed. Then comes the eventual cleanup, which will involve a feasibility study and a public comment period. 'It's going to be several years,' [the Park Service's Kathleen] Cuzzolino said. 'It's not going to be an easy task to remediate contamination across 260 acres.'"]

Fountain, Henry, Disposal Halted at Well After New Quake in Ohio, New York Times, Jan 2, 2012. http://www.nytimes.com/2012/01/02/science/earth/youngstown-injection-well-stays-shut-after-earthquake.html?_r=3&. [Reporting on a string of earthquakes in Ohio. Eleven quakes occurred in 2011. The first 10 were temblors ranging between a 2.1 and a 2.7-magnitude. But less than 24 hours after a minor quake on Dec 24, 2011, a 4.0 quake occurred in Youngstown Ohio, centered near a hydraulic fracturing waste disposal well. Seismologists suspected that some of the wastewater migrated into deeper rock formations, allowing an ancient fault to slip. "[T]he events in Youngstown — and a string of mostly small tremors in Arkansas, Oklahoma, Texas, British Columbia and other shale-gas-producing areas — suggest that the technique may lead, directly or indirectly, to a dangerous earthquake."

Fox News staff reporting, Guards raise concerns about security at Indian Point, Nov 14, 2013. http://www.myfoxny.com/story/23975312/guards-raise-concerns-about-security-at-indian-point. {*Paragraphs consolidated for space saving*.} [Fox 5 News interviewed five current and former security guards of Indian Point, and "all of them offered disturbing details about security at the plant that seems, at best, lax and, at worst, potentially deadly." (The station protected the identities of the current employees interviewed.) In response to the question "Is the plant safe?" posed by reporter Ben Simmoneau to one current security employee, the worker said: "Sometimes." "Skip Travis and Jason Hettler are both former security lieutenants at Indian Point who are now suing the plant's owner, Entergy. Tom Nicolosi, a third former lieutenant, is considering a lawsuit. They all say security is a mess, yet they say they were punished for raising concerns. Hettler quit after being put on leave without pay. Travis and Nicolosi were fired. 'Based upon what you know about the security of this plant, should it be allowed to continue operating?' Simmoneau asked Hettler. 'Absolutely not,' he said. 'I think people need to know. People need to know how serious this is,' Nicolosi told us. 'It doesn't get any more serious in regards to security,' Travis said.

"One of those investments was a new computer system which controls alarms and cameras in the area around the reactors. But the lawsuits say that system was plagued by false alarms and has crashed hundreds of times. Fox 5's sources claim it can take a few minutes or several hours to restore, which they say can cut off alarms and some cameras."

"Fox 5 obtained an internal Nuclear Regulatory Commission document which shows that Entergy was cited for the crashes, and for failure to track, trend and correct the computer malfunctions. Another complaint in one of the lawsuits is that Indian Point has falsified records submitted to the NRC showing how many hours guards work. "The facility is understaffed in security officer ranks and even more in security supervisory ranks," said one of the current employees. Security guards say they were routinely asked to work long hours, in some cases 24 hours straight. And over the summer, sources say three guards were even caught sleeping on the job."

"Perhaps most concerning, our sources say the security force at Indian Point often fails practice drills, which simulate a terrorist attack."]

Funk, Josh, Nebraska nuclear plant not restarting soon, Bloomberg Businessweek News (report from AP), Jul 18, 2012. http://www.businessweek.com/ap/2012-07-18/nebraska-nuclear-plant-not-restarting-soon. [The Fort Calhoun nuclear power plant in Nebraska was shut down for more than a year due to safety problems. Fort Calhoun was initially shut down in April 2011 for routine refueling maintenance, but flooding along the Missouri River and the safety violations regulators identified forced it to remain offline. Problems included a small electrical fire in June 2011, and deficiencies in flood planning (discovered before extended flooding along the Missouri River). In May 2012, workers found a crack in the steel shield surrounding one of the heaters that help maintain the temperature of the water used to generate steam. A key electrical part had also failed during a 2010 test.]

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Galloway, Anne, Entergy Replaces Radiation Monitors; State Asks the NRC to Investigate "Spurious" Radiation Spikes at Vermont Yankee, Vermont Digger, Jul 28, 2013. http://vtdigger.org/2013/07/28/entergy-replaces-radiation-monitors-state-asks-the-nrc-to-investigate-spurious-radiation-spikes-at-vermont-yankee/.

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GAO Report, 2011: Nuclear Regulatory Commission Oversight of Underground Piping Systems Commensurate with Risk, but Proactive Measures Could Help Address Future Leaks, Report of the Government Accountability Office, Jun 2011, GAO-11-563. http://www.gao.gov/new.items/d11563.pdf. [GAO investigation was initiated after revelations of recurrent leaks from America's aging nuclear plants. NRC has been collecting data primarily since 2008 on "unplanned and uncontrolled releases of radioactive material".

Common sources of leaks that have resulted in groundwater contamination include underground piping systems, spent fuel pools, storage tanks, including radioactive waste storage tanks, sumps and vaults (p. 5)

"Based on these data, NRC has concluded that all 65 reactor sites in the United States have experienced a leak or spill of radioactive material into groundwater." (p. 5)

Data suggests that "groundwater contamination events have been more prevalent during the last several years" but this may be because of less monitoring previously. (p. 5)

NRC's schema prioritizes oversight and inspections of structures and systems needed to prevent a nuclear accident during the course of normal operations; and these are the ones classified as "safety-related". In contrast, most of the structures, components and systems that discharge radioactive materials are not classified by the NRC as "safety-related". (pp. 6-7)

An experts consulted by GAO noted that "any construction on-site can significantly modify how groundwater flows through the subsurface" and "experts noted that industry currently lacks

standardized data across nuclear power plants to characterize the impacts of leaks and that data used to inform assessments of risk are limited to the locations where samples are collected." (p. 11)
"Another expert observed that the groundwater reports prepared voluntarily by industry typically oversimplify presented data. In addition, experts expressed concern that there is no process for an agency or third party to review licensses' groundwater monitoring programs. For example, one expert observed that licesnsees, with their consultants, independently develop their voluntary groundwater monitoring programs, collect the data and report the results without a formal opportunity for NRC or others to comment on he specifics of the programs such as the number, location, and depth of monitoring wells." (p. 12)
"NRC relies on licensees to initially determine whether a leak presents a health risk." (p. 12)
NR..[andtpp.. In addition, experts also said that it was very impconstrusssa, or groundwater v that three-quarters of America's 65 nuclear plant sites have leaked radioactive tritium, sometimes into groundwater. The report finds that nuclear power plant operators have not figured out how to quickly detect leaks of radioactive water from aging pipes that snake underneath the sites. The leaks often remain undetected for years. Leaks from aging nuclear plants will likely continue.] ADD QUOTE
GAO Report, 2011: Commercial Nuclear Waste: Effects of a Termination of the Yucca Mountain Repository Program and Lessons Learned, Report of the Government Accountability Office, Apr 2011, GAO-11-229. http://www.gao.gov/assets/320/317627.pdf. [" Spent nuclear fuel – considered very hazardous – is accumulating at commercial reactor sites in 33 states." The Nuclear Waste Policy Act of 1982 put the responsibility for creating a waste dispository on the government. " DOE decided to terminate the Yucca Mountain repository program because, according to DOE officials, it is not a workable option...." and the Yucca Mountain program was to be dismantled by September 30, 2010. "Because successfully resolving the issue of what to do with spent commercial nuclear fuel will likely be a decades-long, costly, and complex endeavor, which can be disrupted by changing views and unpredictable funding, Congress may wish to consider whether a more predictable funding mechanism would enhance the federal government's future efforts to develop and implement a disposal solution for the nation's spent nuclear fuel."

"However, there is no guarantee that a more acceptable or less costly alternative [to Yucca Mountain] will be identified; termination could instead restart a costly and time-consuming process to find and develop an alternative permanent solution. It would also likely prolong the need for interim storage of spent nuclear fuel at reactor sites, which would have financial and other impacts. For example, the federal government bears part of the storage costs as a result of industry lawsuits over DOE's failure to take custody of commercial spent nuclear fuel in 1998, as required. These costs exceed $15.4 billion and could grow by an additional $500 million a year after 2020."

"....it is important that a waste management strategy have consistent policy, funding, and leadership, especially since the process will likely take decades... GAO suggests that Congress consider whether a more predictable funding mechanism would enhance future efforts...."]

GAO Report, 2011: Cybersecurity: Continued Attention Needed to Protect Our Nation's Critical Infrastructure and Federal Information Systems, Testimony of Gregory C. Wilshusen, Director Information Security Issues, before the Subcommittee on Cybersecurity, Infrastructure Protection, and Security Technologies, Committee on Homeland Security, House of Representatives, Mar 16, 2011, GAO-11-463T. http://www.gao.gov/new.items/d11463t.pdf.
[Pervasive and sustained cyber attacks against the United States continue to pose a potentially devastating impact on federal and nonfederal systems and operations…in the past year, there has been a dramatic increase in malicious cyber activity targeting U.S. computers and networks…." (p. 1)
Electrical infrastructure has already been targeted. Threats to the nation's critical infrastructure include actions by not just foreign nations engaged in espionage and information warfare, but criminals, hackers, virus writers, and disgruntled employees and contractors. (p. 3)]

GAO Report, 2008: Nuclear Safety: NRC's Oversight of Fire Protection at U.S. Commercial Nuclear Reactor Units Could Be Strengthened, Report of the Government Accountability Office, Jun 2008, GAO-08-747. http://www.gao.gov/assets/280/277814.pdf. [NRC has failed to enforce its own fire protection safety regulations. Federal requirements mandate operators install and maintain qualified fire barriers to protect critical electrical circuits. Even after the NRC found that industry actors were failing to fix fire barriers found defective, and had given the NRC misinformation, the NRC continued to failed to enforce fire safety mandates. Evidence shows plants were out of compliance with fire safety for over 30 years.]

GAO Report, 2004: Nuclear Regulation: NRC Needs to More Aggressively and Comprehensively Resolve Issues Related to the Davis-Besse Nuclear Power Plant's Shutdown, Report of the Government Accountability Office, May 2004, GAO-04-415. http://www.gao.gov/assets/250/242286.pdf. [In March 2002, during shutdown for inspection and refueling, FirstEnergy, the operator of the Davis-Besse nuclear plant in Ohio "removed about 900 pounds of boric acid crystals and powder form the reactor vessel head, and subsequently discovered three cracked nozzles.... First Energy also discovered that corrosion had caused discovered a pineapple-sized cavity in the plant's carbon steel reactor vessel head." (p. 16) The reactor vessel head is an 18' diameter, 6" thick, 80 ton cap that is bolted to the reactor vessel and functions as an integral part of the coolant pressure barrier for protecting the environment from any release of radiation from the reactor core. At Davis-Besse, vertical tubes had cracked that penetrate the reactor vessel head that contain boric acid-laced cooling water, and also drive mechanisms used to lower and raise the fuel. This allowed boric acid to leak, which corroded the vessel head to a thin stainless steel lining.

"NRC's inspection team also concluded, among other things, that this corrosion had gone undetected for an extended period of time – at least 4 years – and significantly compromised the plant's safety margins. (pp. 18-19)

The lining is less than 1/3 in. Thick and is not designed as a pressure barrier, already had a bulge with evidence of cracking. "Had this lining given way, the water within the reactor vessel would have escaped, triggering a loss-of-coolant accident, which – if back-up safety systems had failed to operate – likely would have resulted in the melting of the radioactive core and a subsequent release of radioactive materials into the environment."

"NRC should have but did not identify or prevent the vessel head corrosion at Davis-Besse because both its inspections at the plant and its assessments of the operator's performance yielded inaccurate and incomplete information on plant safety conditions. With respect to inspections, NRC resident inspectors had information revealing potential problems, such as boric acid deposits on the vessel head and air monitors clogged with boric acid deposits, but this information did not raise alarms about the plant's safety. NRC inspectors did not know that these indications could signal a potentially significant problem and... did not fully communicate their observations to other NRC staff... Furthermore, NRC's assessments of Davis-Besse... did not provide complete and accurate information on FirstEnergy's performance. For example, NRC consistently assessed Davis-Besse's operator as a 'good performer' during those years when the corrosion was likely occurring, and the operator was not correctly identifying the source of boric acid deposits. NRC had been aware for several years that corrosion and cracking were issues that could possibly affect safety, but did not view them as immediate safety concerns and therefore had not fully incorporated them into its oversight process." (p. 5)

"NRC's process for deciding whether Davis-Besse could delay its shutdown to inspect for nozzle cracking lacks credibility..." NRC did not always follow its own guidance and generally did not document how it applied the guidance. The risk estimate NRC used to help decide whether the plant should shut down was also flawed and underestimated the amount of risk that Davis-Besse posed. (pp. 5-6)

GAO's expert consultants "concluded that NRC's estimate of risk was incorrectly too small, primarily because the calculation did not consider corrosion of the vessel head. In reviewing how NRC

developed and used its PRA estimates .....[the experts] noted that the calculated risk was smaller than it should have been because the calculaions did not consider corrosion of the reactor vessel from the boric-acid coolant leaking through cracks in the nozzles." (p. 40)
"NRC ...has no plans to address three systemic weaknesses underscored by the incident. Specifically, NRC has proposed no actions to help it better (1) identify early indications of deteriorating safety conditions at plants, (2) decide whether to shut down a plant, or (3) monitor actions taken in response to incidents at plants. Both NRC and GAO had previously identified problems in NRC programs that contributed to he Davis-Besse incident, yet these problems continue to persist." (Highlights summary)
GAO states it is "concerned that NRC is misusing basic quantitative mathematics". NRC's calculation on annual average change in the frequency of core damage "artifically reduced NRC's risk estimate to a level that is acceptable under NRC's guidance. By this logic, our consultants stated, risks can always be reduced by spreading them over time; by assuming another 10 years of plant operation (or even longer) NRC could find that its calculated 'risks' are completely negligible...NRC's approach is akin to arguing that an individual, who drives 100 miles per hour 10 percent of the time, with his car otherwise garaged, should nto be cited because his time-average speed is only 10 miles per hour." (pp 123-124).]

GAO Report, 2003: Nuclear Regulation: Emergency Preparedness Issues at the Indian Point 2 Nuclear Power Plant, Testimony of Jim Wells, Director Natural Resources and Environment, United States General Accounting Office, before the Subcommittee on National Security, Emerging Threats and International Relations, Committee on Government Reform, House of Representatives, Mar 10, 2003, GAO-03-528T. http://www.gao.gov/assets/110/109695.pdf. {Discussed below under Wells.}

GAO Report, 2001: Nuclear Regulation: Progress Made in Emergency Preparedness at Indian Point 2, but Additional Improvements Needed, Government Accounting Office, Jul 2001, GAO-01-605. http://www.gao.gov/assets/240/231903.pdf. ["Over the years, NRC had identified a number of emergency preparedness weaknesses at Indian Point 2 that had gone largely uncorrected. For example, in 1998 and again in 1999, NRC identified several communication weaknesses, including delays in activating pagers used to alert the utility's staff about an emergency."
The GAO investigation followed failures in operation and emergency response at Indian Point 2 in Feb 2000 when the plant experience a shutdown due to the rupture of a tube in a steam generator. Emergency problems that occurred during the accident included: (1) operator did not activate its emergency operation facilities within the required 60 min primarily because of the complex process used to page the emergency response staff; (2) operator did not keep track of emergency response personnel as they entered the plant site and could not account for them within the mandated 30 min. (3) operator failed to properly communicate information about whether a radiation release had occurred or its magnitude; (4) operator's technical reps arrived late at emergency centers; and (5) the emergency response data system – the real-time link between Indian Point and the NRC – was inoperable for the first several hours of the accident because of a preexisting equipment problem. The GAO 2001 investigation found that some of the problems had been finally been acted upon, but more needed to be done.]

Geocap Study, 2012: Sermage-Faure C, Laurier D, Goujon-Bellec S, Chartier M, Guyot-Goubin A, Rudant J, Hémon D, and Clavel J, Childhood leukemia around French nuclear power plants—The geocap study, 2002–2007, International Journal of Cancer (2012); 131 (5): E769–E780. http://onlinelibrary.wiley.com/doi/10.1002/ijc.27425/full [In a study published in January 2012, French research teams from the Institut National de la Santé et de la Recherche Médicale (INSERM), the Institut de Radioprotection et de Sûreté Nucléaire (IRSN), and the National Register of hematological diseases of children in Villejuif, France, demonstrated that childhood leukemia rates are significantly elevated in children living near nuclear power reactors in France. The study established a clear correlation between the frequency of acute childhood leukemia and proximity to nuclear power stations. The researchers could not identify any other environmental factor besides

nuclear plant radioaction emissions that could produce the excess cancers. Looking at the period from 2002-2007, the scientists found a doubling of childhood leukemia incidence, with an increase up to 2.2 among children younger than five.]

Giurgiutiu V and Torres AEM, Opportunities and Challenges for Structural Health Monitoring of Radioactive Wast Systems and Structures, Paper published in Proceedings of the ASME 15th International Conference on Environmental Remediation and Radioactive Waste Management, ICEM2013-96195, Brussels, Belgium, Sep 8-12, 2013. http://www.me.sc.edu/research/lamss/pdfnew/Conferences/C226_ICEM2013-96195.pdf.

Gray, Mike and Ira Rosen, *The Warning: Accident at Three Mile Island*, Norton, New York (1982). [This book by Ira Rosen, a reporter who later became a CBS *60 Minutes* producer, and Mike Gray an engineer. The reporting was based on reconstruction of the events from government reports, hearings and deposition transcripts, and extensive interviews of all the principal figures in the event, from plant maintenance personell to the governor of Pennsylvania, which yielded another 200 hours of transcripts. (p. 8) The story of events that led up to the Three Mile Island nuclear accident in Apr 1979 begins in Dec 1968. The story that begins

Gronlund L, Lochbaum D, and Lyman E, Nuclear Power in a warming world: Assessing the Risks, Addressing the Challenges, Report of the Union of Concerned Scientists (UCS), Dec 2007. http://www.ucsusa.org/assets/documents/nuclear_power/nuclear-power-in-a-warming-world.pdf. [This report by UCS nuclear experts extensively details safety problems at nuclear plants and oversight failures at the NRC. Noting dozens of cases where plants were forced to shut down for long durations in order to restore compliance with safety standards, UCS concludes: "NRC has been doing a poor job of regulating the safety of power reactors. An effective regulator would be neither unaware nor passively tolerant of safety problems so extensive that a year or more is needed to fix them." (p. 3)

The NRC has also failed to remedy problems with its own safety culture. "For example, in a 2002 survey by the agency's Office of the Inspector General, nearly 50 percent of NRC staffers reported feeling unable to raise concerns about safety at nuclear power plants without fear of retaliation. In the inspector general's 2005 survey, this unease remained a significant problem. …These assessments of the NRC safety culture are consistent with the calls UCS has received from NRC staffers. We have heard numerous accounts of NRC managers instructing inspectors not to find and safety problems during upcoming visits to nuclear plants, telling inspectors not to write up safety problems that they do find, and ignoring the written objections of the agency's own experts when making safety decisions." (p. 20)

"Another symptom of the NRC's poor safety culture is its failure to enforce its own regulations, with the result that safety problems have remained unresolved for years at reactors that have continued to operate." (p. 21)

"Another indication of the NRC's poor safety culture is its inappropriate emphasis on maintaining arbitrary schedules rather than safety." (p. 21)
The "NRC does not conduct periodic inspections of non-targeted equipment and structures, which could either confirm that the scope boundaries are properly drawn or detect degradation before it manifests as a problem," (p. 23)

"The NRC and the nuclear industry use probabilistic risk assessments (PRSs) for a variety of purposes. PRAs are calculations first developed in the NRC's Reactor Safety Study of 1975 (a.k.a. in the Rasmussen report.)… Used appropriately, PRAs can be a valuable tool. However, the NRC, its

inspector general and Advisory Committee on Reactor Safeguards (ACRS), the Government Accountability Office (GAO), and UCS have documented serious problems with the agency's risk assessments, including omission of key data, inconsistent assumptions and methodology, and inadequate quality standards. The ACRS pointed out in 2003 that a survey of NRC staff found that 'most staff interviewees believe that the reluctance of the industry to improve the scope and quality of the PRAs is a major impediment to the advancement of risk-informed regulation.'" (pp. 24-25)

"Even in the wake of the 9/11 attacks, the NRC has also universally dismissed terrorism from consideration in environmental impact studies, on the grounds that terrorist acts are too remote and speculative. These studies apply to licenses for expanding onsite spent fuel storage, 20-year extensions to operating licenses for nuclear plants, and site permitting for new reactors." (p. 32)

"The NRC also continues to disregard the risk of an attack on spent fuel pools at reactor sites." (p 32)

"[N]o containment buildings protect these pools, and an accident or terrorist attack that allows the water in a densely packed pool to rapidly drain away could cause the zirconium cladding on the fuel rods to catch fire and the spent fuel to melt, resulting in a significant release of hightly radioactive isotopes such as cesium-137…Adding more spent fuel to these pools only compounds this potential problem, and increases the amount of radioactive material that could be released into the environment." (p. 47)

"Although the dry casks would present less of a hazard than spent fuel pools if attacked, they remain vulnerable to weapons such as rocket-propelled grenades. These weapons could penetrate most dry casks and their vaults, igniting a zirconium fire and resulting in the release of significant amounts of radioactive material." (p. 47) However, interim storage of spent fuel in hardened dry casks with berm protection is a relatively safe option for 50 years. (p. 47)]

Gunter P, Leak First, Fix Later: Uncontrolled and Unmonitored Radioactive Releases from Nuclear Power Plants, Report of Beyond Nuclear, Apr 2010. http://www.beyondnuclear.org/storage/documents/LeakFirst_FixLater_BeyondNuclear_April182010_FINAL.pdf. [Report by Paul Gunter, Director of the Reactor Oversight Project at Beyond Nuclear, reviews the uncontrolled releases from nuclear power plants. The report begins with the observation:

"Water is necessary to sustain all life. Water is a natural cycle of vapor, liquid and solid. New water is not created; it is recycled. This continuous cycle takes each water molecule through the processes of evaporation, condensation, precipitation and collection. Clouds, rain, snow, ice, fog and water vapor all converge into the collection of surface water in streams, rivers, lakes, and oceans, as well as within the movement of groundwater in deep and shallow aquifers to begin the cycle anew. Today's groundwater is tomorrow's drinking water. It is a vital rsource for sustaining habitats, food and agriculture and recreation.

"However, long-lived manmade radioactive toxins are being deliberately and accidentally released from nuclear power plants and are incrementally poisoning this natural water cycle." (p. 5)

The report also reviews NRC's denial of jeopardy of public health, noting: "The Nuclear Regulatory Commission has consistently trivialized any concern for the public health and safety in its public statements in the aftermath of buried pipe leaks." (p. 28)

GZA GeoEnvironmental, Inc., Hydrogeologic Site Investigation Report for the Indian Point Energy Center, Jan 7, 2008. http://pbadupws.nrc.gov/docs/ML0803/ML080320540.pdf.

H

Hakim, Danny, Nuclear Operator Seeks to End Revenue Deal With State, New York Times, Jul 21, 2008. http://www.nytimes.com/2008/07/21/nyregion/21indian.html?pagewanted=print&_r=0. [Entergy Nuclear attempt to structure spinoff of nuclear plants. NY officials fear the plan could free Entergy from several hundred million dollars in costs associated with decommissioning the Indian Point and FitzPatrick plants.]

Halstead, Robert J, Lindsay Audin, James David Ballard, Merritt Birky, Fred C. Dilger, Jim Hall, and Martin Resnikoff, Comment, Aug 14, 2003.
http://www.energy.ca.gov/nuclear/yucca/documents/AG-155-2007-000066.pdf.

Halstead, Robert J. Testimony on Behalf of the State of Nevada Before the Subcommittees on Highways and Transit and Railroads of the Committee on Transportation and Infrastructure U.S. House of Representatives, Apr 25, 2002.
http://www.state.nv.us/nucwaste/news2002/nn11678.pdf. [Robert J. Halstead, Transportation Advisor, Agency for Nuclear Projects for the State of Nevada testifies on the vulnerability of shipments to sabotage and terrorist attack and on the radiological consequences of severe highway and rail accidents. For one repository, should it go forward, there would be more than 108,500 cross-county truck shipments of spent nuclear fuel and high level radioactive waste over 38 years. That works out to 2,855 truckloads per year every year. By comparison, over the prior 40 years,k there have been fewer than 100 shipments a year in the U.S. The combined truck and rail total of commercial spent nuclear fuel shipments would be 36,400 (p.2). The combined total of truck and rail shipments from 72 utility sites + 5 DOE sites woud be 42,100 to 47,00 over 38 years, an average of 1,200 to 1,240 per year. A mostly rail scenario would invove 3,000 barge shipments (p. 3). The significant increase in the volume and weight of nuclear cargo changes the manner in which the waste itself acts within the cask in the event of an impact accident. It is impossible to accurately predict this role through scale model accident simulation.]

Henry, Terrence, How Fracking, Drilling and Earthquakes Are Linked, npr State Impact Texas, Feb 8, 2012. http://stateimpact.npr.org/texas/2012/02/08/how-fracking-drilling-and-earthquakes-are-linked/. [Excerpted quotes from npr interview of Cliff Frohlich, PhD, Associate Director of and Senior Research Scientist at the Institute of Geophysics at the University of Texas at Austin: "A year ago, I would have told you that fracking never caused earthquakes. However, in the last year there have three well-documented earthquakes that occurred during the frack job and were probably related to fracking. They were all small earthquakes – of a magnitude of 2 or 3... So we generally think that [quakes happen where] there is already a fault that's stressed, and injection allows it to slip, rather than causing it to slip from scratch. The misconception that the public might have is that earthquakes only occur in places like California. The truth is that there are little faults everywhere… The earthquakes are occurring more frequently now because there's so much more fluid injection due to the fracking and the development of unconventional gas. This unconventional gas boom is huge. The Fort Worth basin covers 15 counties, and the Marcellus Shale covers vast portions of Pennsylvania, West Virginia, and New York. The Bakken Shale covers one-third of North Dakota. These have the potential to provide enormous amounts of energy. So what's happened is that we have a lot more injection going on in a lot more places, where we're producing more gas and earthquakes."]

Hirsch H, Becker O, Schneider M, and Froggatt A, Nuclear Reactor Hazards: Ongoing Dangers of Operating Nuclear Technology in the 21st Century, Report for Greenpeace International, Apr 2005. http://www.greenpeace.org/seasia/th/PageFiles/106897/nuclearreactorhazards.pdf. [The report authors are Helmut Hirsch, PhD, founder and staff scientist of Gruppe Ökologie Hannover and a member of numerous expert commissions providing advice on nuclear and spent fuel storage safety and security issue to European groups in Germany and Austria Dr Hirsch also participating in a study of possible hazards pertaining to dry cask storage at Skull Valley, Utah. Oda Becker, PhD, a

physicist, specializes in nuclear power and spent fuel safety and has been a consultant to the government of Austria. She contributed to studies of the vulnerability of nuclear facilities to air plane crashes and terror attack. Mycle Schneider is a Paris-based nuclear power, environmental and energy planning expert who has consulted for governmental bodies of France and Belgium, the European Commission, and the International Atomic Energy Agency (IAEA). This report describes the inherent flaws of nuclear power plants. Separate chapters are devoted to assessment of risks associated with the management of spent nuclear fuel, the aging of operational plants, the terrorist threat to nuclear power and the risks associated with climate change.

"The main conclusions are:

- All operational reactors have very serious inherent safety flaws which cannot be eliminated by safety upgrading;

- A major accident in a light water reactor – the large majority of the reactors – can lead to radioactive releases equivalent to several times the release at Chernobyl and about 1000 times that released by a fission weapon. Relocation of the population can become necessary for large areas (up to 100.000 km^2). The number of cancer deaths could exceed 1 million;

- New reactor lines ...would require enormous sums for their development, with uncertain outcome;

- The average age of the world's reactors is 21 years and ...[extending the original design lifetime] leads to the degradation of critical components and the increase of severe incidents. The age-related degradation of critical components and the increase of severe incidents. The age-related degradation mechanisms are not well understood and difficult to predict;

- De-regulation (liberalization) of electricity markets has pushed nuclear utilities to decrease safety-related investments and limit staff. Utilities are also upgrading their reactors by increasing reactor pressure and operational temperature and the burn-up of the fuel. This accelerates aging and decreases safety margins. Nuclear regulators are not always able to fully cope with this new regime;

- Highly radioactive spent fuel mostly is stored employing active cooling. If this fails, this could lead to a major release of radioactivity, far more important than the 1986 Chernobyl accident;

- Reactors cannot be sufficiently protected against a terrorist threat. There are several scenario's – aside from a crash of an airliner on the reactor building – which could lead to a major accident;

- Climate change impacts, such as flooding, sea level rises and extreme droughts, seriously increase nuclear risks."

(Executive summary, p. 5).

Hirsch, Daniel, The NRC: What, me worry? Bulletin of the Atomic Scientists (2002); 58 (1): 3.
http://www.thebulletin.org/issues/2002/jf02/jf02hirsch.html [Overview of NRC historic disinclination to appreciate the risks of sabotage and terrorism.]

Hsu H-H and Tsay L-W, Effect of hydride orientation on fracture toughness of Zircaloy-4 cladding, Nuclear Materials (2011); 408 (1): 67-72. http://www.sciencedirect.com/science/article/pii/S0022311510006628. [From Abstract: Researchers at the Institute of Nuclear Energy Research (INER) and the Institute of Materials Engineering at National Taiwan Ocean University (both in Taiwan) observe findings that hydrogen embrittlement is one of the major degradation mechanisms for high burnup fuel cladding during reactor service and spent fuel dry storage, which is related to the hydrogen concentration, morphology and orientation of zirconium hydrides. In this study they measure samples with different hydride orientations to evaluate the fracture toughness of Zircaloy-4 (Zry-4) cladding and find toughness values for Zry-4 cladding with various percentages of radial hydrides to be significantly smaller than those with circumferential hydrides only in the same hydrogen content level at 25 °C. "The fractograghic features reveal that the crack path is influenced by the orientation of zirconium hydride."]

I

Illinois Press Release, 2006: Governor Blagojevich signs new law requiring nuclear plants to report radioactive releases, State of Illinois Press Release, Jun 11, 2006. http://www3.illinois.gov/PressReleases/ShowPressRelease.cfm?SubjectID=1&RecNum=4978. [Announcing signing of Illinois state requiring nuclear plants to report releases of radioactive contaminants into the soil, surface water or groundwater to the state. The law was in response to a series of leaks of tritium from the Dresden, Braidwood and Byron nuclear power plants. "The state became aware of the spills only after being informed by local officials near the Exelon Braidwood nuclear facility. After that, information about additional spills at the Braidwood plant and other nuclear facilities was revealed."]

IPPNW Report, 2011: Calculated Fatalities from Radiation – Officially Permissible Limits for Radioactively Contaminated Food in the European Union and Japan, Foodwatch Report based on study by Thomas Dersee and Sebastian Pflugbeil of the German Society for Radiation Protection, in cooperation with the German Section of the International Physicians for the Prevention of Nuclear War (IPPNW), Sep 2011. http://www.fukushima-disaster.de/fileadmin/user_upload/pdf/english/calculated_fatalities_from_radiation_report_foodwatch-IPPNW.pdf. ["[I]n contrast to chemical toxins, there is no threshold below which radioactivity is harmless." Thus allowance is basically a decision about "how many fatalities or cases of illness will be acceptable in a given situation." (at p 6) "Given that the acceptance of any permissible radiation limits consciously tolerates illness and fatality, the protection of health must not be compromised by trade or commercial interests. A significant reduction in current limits is needed to reduce the risk of health problems." (at p 7.) "Children and teenagers up to the age of 17 are much more sensitive to doses of radiation than adults are, and therefore need special protection." (fn 2.)]

J

Julian J. Bommer JJ, Challenges of Building Logic Trees for Probabilistic Seismic Hazard Analysis, Earthquake Spectra (2012); 28 (4): 1723-1735. http://dx.doi.org/10.1193/1.4000079 [Logic trees in probabilistic seismic hazard analysis are often used to represent and capture epistemic uncertainty {scientific uncertainty in the model of the process due to limited data and knowledge}. These need to include alternative models or parameter values with assigned weight which capture both the best estimates of what is known and the potential range of alternatives given what is not known. A most serious challenge facing the field is a shortage of suitably qualified and experienced experts.]

Justini AH, Stumpa B, Hayward C, and Frohlich C, Analysis of the Cleburne, Texas, Earthquake Sequence from June 2009 to June 2010, Bulletin of the Seismological Society of America (2013): doi 10.1785/01201 20336. http://www.bssaonline.org/content/early/2013/10/03/0120120336.abstract. [Researchers at Southern

Methodist University and the University of Texas at Austin, Institute for Geophysics analyze a group of over 50 earthquakes that hit the area of Cleburne Texas in 2009 and 2010. Injection of wastewater into the ground from fracking at the Barnett Shale began in 2005. Before 2008, the Worth Basis of Texas had no record of quakes. The researchers concluded: "Because there were no known previous earthquakes, and the located events were close to the two injection wells and near the injection depth, the possibility exists that earthquakes may be related to fluid injection."]

K

Katovsky, Bill, Flying the deadly skies: Whistle-blower thinks the state of U.S. aviation security invites another attack, SFGate, Jul 9, 2006. http://www.sfgate.com/opinion/article/Flying-the-deadly-skies-Whistle-blower-thinks-2532016.php. [Reporting on Bogdan Dzakovic revelations. Dzakovic is a former counter-terrorism expert with the Federal Aviation Administration and was in charge of the FAA's Red Team, an elite squad who conducted mock undercover raids to test preparedness against hijackers and terrorists. On May 22, 2003, Dzakovic testified before the 9/11 Commission. "'The Red Team was extraordinarily successful in killing large numbers of innocent people in these simulated attacks, he told the commissioners. 'We breached security up to 90 percent of the time. The FAA suppressed these warnings. Instead, we were ordered not to write up our reports and not to retest airports where we found particularly egregious vulnerabilities, to see if the problems had been fixed. Finally, the agency started providing advance notification of when we would be conducting our "undercover" tests and what we would be "checking." What happened on 9/11 was not a failure in the system. Our airports are not safer now than before 9/11. The main difference between then and now is that life is now more miserable for passengers.'"]

Keranen KM, Savage HM, Abers GA, and Cochran ES, Potentially induced earthquakes in Oklahoma, USA: Links between wastewater injection and the 2011 M_w 5.7 earthquake sequence, Geology (2013); 41 (6): 699-702. http://profile.usgs.gov/myscience/upload_folder/ci2013May3015351271984Keranen%20etal%20Geology%202013.pdf. [Research team from the ConocoPhillips School of Geology and Geophysics at the University of Oklahoma, the Lamont-Doherty Earth Observatory of Columbia University, and the U.S. Geological Survey, observe that significant earthquakes are increasingly occurring within the continental interior of the United States, including five of moment magnitude ≥ 5.0 in 2011 alone. In recent years, the volume of fracking waste fluid injected into the subsurface also continues to rise.

The focal point of this study is on the nexus between injection wells and a magnitude 5.7 earthquake in Oklahoma in Nov 2011. The earthquake was felt in at least 17 states and caused damage in the epicentral region. It occurred in a sequence, with 2 earthquakes of magnitude 5.0 and a prolific sequence of aftershocks. Analysis of the aftershocks indicate the sequence of the faults rupture. Subsurface data indicates that fluid was injected into effectively sealed compartments.

The authors interpret that a net fluid volume increase after 18 years of injection lowered effective stress on reservoir-bounding faults. "Significantly, this case indicates that decades-long lags between the commencement of fluid injection and the onset of induced earthquakes are possible, and modifies our common criteria for fluid-induced events. The progressive rupture of three fault planes in this sequence suggests that stress changes from the initial rupture triggered the successive earthquakes, including one larger than the first."]

Kesler, Brent, Cyber Attacks Against Nuclear Facilities, Edition on Cyber Security in International Relations, Strategic Insights (2011); 10 (1) 15-25. http://www.dtic.mil/dtic/tr/fulltext/u2/a541955.pdf.

KiKK Studies, 2008: (Companion studies).

Kaatsch P, Spix C, Schulze-Rath R, Schmiedel S, and Blettner M, Leukaemia in young children living in the vicinity of German nuclear power plants, International Journal of Cancer (2008); 122 (4): 721-726. http://onlinelibrary.wiley.com/doi/10.1002/ijc.23330/full.

Spix C, Schmiedel S, Kaatsch P, Schulze-Rath R, and Blettner M, Case-control study on childhood cancer in the vicinity of nuclear power plants in Germany 1980-2003, European Journal of Cancer (2008); 44 (2): 275-284.
http://www.sciencedirect.com/science/article/pii/S0959804907008556. [German scientists from the Institute for Medical Biostatistics, Epidemiology and Informatics and the German Childhood Cancer Registry, University Mainz, reviewed data from on 25 years of research on childhood cancer near nuclear plants in two journals: the International Journal of Cancer and the European Journal of Cancer. (The studies are known as the "KiKK studies" because KiKK is the German acronym for "Childhood Cancer in the Vicinity of Nuclear Power Plants.") The researchers found higher levels of cancer and a stronger association with nuclear reactor installations than previously known. The evidence showed a 117 percent increase in leukemia among young children living near all 16 large German nuclear facilities between 1980 and 2003 as well as a 60 percent increase in solid cancers.]

King, Rita, Entergy Holds New Orleans for Ransom, Special to Corp Watch, May 10, 2006.
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http://blogs.utexas.edu/nppp/files/2013/08/NPPP-working-paper-1-2013-Aug-15.pdf. [Report of the Nuclear Proliferation Prevention Project at the University of Texas, commissioned by the U.S. Department of Defense, identifies Indian Point in New York, as well as other nuclear sites in the U.S., to be vulnerable to terrorist attack that could result in reactor core damage or a spent fuel pool fire and a major radioactive release. NRC Design Basis Threat rules fail to ensure safeguards of reactors and spent fuel pools against terrorist attack of even the type and scale as that which occurred on Sep 11, 2001. Security rules do not require defense against aircraft attack or against waterborne attack of any size. "…None of the 104 commercial nuclear power reactors in the United states is protected against a maximum credible terrorist attack, such as the one perpetrated on Sept. 11, 2001," the study reports. "More than a decade after the worst terrorist attack in U.S. history, operators of existing nuclear facilities are still not required to defend against the number of terrorist teams or attackers associated with 9/11, nor against airplane attacks, nor even against readily available weapons such as high-power sniper rifles."]

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http://www.ldeo.columbia.edu/news-events/distant-quakes-trigger-tremors-us-waste-injection-sites-says-study. [Reporting on the van der Elst study published in the July 2013 issue of Science:

Large earthquakes from distant parts of the globe waste-fluid injection wells in the central United States. Furthermore, such triggering of minor quakes by distant events could be precursors to larger events at sites where pressure from waste injection has pushed faults close to failure.

Sites where seismic activity has occurred include areas proximate to injection wells in central Oklahoma and southern Colorado. Most notably, an 8.8 magnitude earthquake in Chile on Feb. 27, 2010 triggered a mid-size quake in the U.S. less than a day later, followed by months of smaller tremors which culminated in a magnitude 5.7 earthquake in Prague, OK on Nov. 6, 2011. Earthquakes off Japan in 2011, and Sumatra in 2012, similarly set off mid-size tremors around injection wells in Texas and Colorado.

Lead author Nicheolas van der Elst, PhD, stated, "The fluids are driving the faults to their tipping point." Coauthor Heather Savage, a geophysicist, stated, "These passing seismic waves are like a stress test [and if] the number of small earthquakes increases, it could indicate that faults are becoming critically stressed and might soon host a larger earthquake."

A 2012 report by the National Academy of Sciences observed that "government agencies and research institutions may not have sufficient resources to address unexpected (seismic) events" and called for further research to "understand, limit and respond [to]" seismic events induced by human activity.
The idea that seismic activity can be triggered by separate earthquakes taking place faraway was controversial until the 1990s. In 2004 and 2008 studies {*see article for details*} found that a magnitude 7.9 Denali earthquake in Alaska in 2002 triggered a series of earthquakes in California nearly 2,000 miles away.]

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http://www.ucsusa.org/assets/documents/nuclear_power/NRC-nuclear-safety-2012-report.pdf.
[Detailed review of significant safety lapses at U.S. nuclear power plants in 2012. The report documents special inspections following 14 "near-misses" the NRC conducted in response to safety equipment problems and security shortcomings. Many of the near-misses involved problems that had been developing for years, even decades. The report also documents inadequacies of NRC enforcement and oversight. For example the NRC routinely fails to enforce its regulations governing reactor coolant leaks.]

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http://www.ucsusa.org/assets/documents/nuclear_power/nrc-nuclear-safety-2011-full-report.pdf. .
[Detailed review of significant safety lapses at U.S. nuclear power plants in 2011. The report documents special inspections following 15 "near-misses " the NRC conducted in response to serious problems involving safety equipment, worker error, security practices, and other troubling events. Four of the special inspections occurred at plants owned by Entergy. The report also documents inadequacies of NRC enforcement and oversight. For example the NRC has allowed 47 reactors to operate despite known violations of fire-protection regulations dating back to 1980. The NRC is also allowing 27 reactors to operate even though their safety systems are not designed to protect against earthquake-related hazards identified in 1996. Eight reactors suffer from both afflictions.]

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[Detailed review of significant safety lapses at U.S. nuclear power plants in 2010. The report documents special inspections following 14 "near-misses " the NRC conducted in response to serious problems involving safety equipment, worker error, security practices, and other troubling events. The report also documents lax NRC oversight and enforcement. In addition, negative outcomes from NRC oversight included a leaking refuelling cavity liner at Indian Point, slow control rods at Peach Bottom, and the illegal release of radioactive effluents.]

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"Imagine fuel without fear. No climate change. No oil spills, dead coal miners, dirty air, devastated lands, lost wildlife. No energy poverty. No oil-fed wars, tyrannies, or terrorists. Nothing to run out. Nothing to cut off. Nothing to worry about. Just energy abundance, benign and affordable, for all, for ever." (p. XI)]

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In a calculation using NRC methodology, Dr. Lyman estimates economic damages (2004 dollars) could exceed $1.1 trillion.]

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http://ieer.org/resource/carbon-emissions/carbon-free-and-nuclear-free/. [Arjun, Makhijani, PhD., President of the Institute for Energy and Environmental Research is a esteemed expert on nuclear engineering, nuclear waste and energy policy. He was the principal author of the first technical assessment of the energy efficiency potential of the U.S. economy (1971) and served on the EPA's advisory panel on high-level radioactive waste repository regulations in the 1980s. In 2007, he was awarded a prestigious fellowship in the American Physical Society. This treatise lays out a very detailed roadmap for transformation to a sustainable clean energy economy.]

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Mangano JJ, Public Health Risks Of Extending Licenses Of The Indian Point 2 and 3 Nuclear Reactors, Radiation and Public Health Project Report (2007).
http://www.radiation.org/spotlight/071112_IndianPoint.html. [This report was authored by Joseph Mangano, Director of the RPHP. Listed advisors to the project were: Rosalie Bertell PhD, founder of the International Institute of Concern for Public Health; Marci Culley PhD, associate professor of psychology, Georgia State University; Samuel Epstein MD, professor emeritus of public health, Univ. of Illinois-Chicago; Sam Galewsky PhD, associate professor of biology, Millikin (IL) University; Donald Louria MD, professor of preventive medicine, New Jersey Medical School; Kay Kilburn MD,

retired professor of medicine, University of Southern California; and Janette Sherman MD, adjunct professor, Environmental Institute, Western Michigan University.

The report covers two subjects: (potential and actual) radioactive contamination from the Indian Point reactors in the local environment, and potential health risks to local residents. The local area near Indian Point was defined as the counties within 20 miles (Orange, Putnam, Rockland, and Westchester). The report notes that historic federal records of comparative nuclear plant radioactivity emissions indicated Indian Point emitted greater amounts of radioactivity into the environment than most U.S. plants, releasing the 5th greatest amount of airborne radioactivity of 72 U.S. nuclear plants. These emissions, the federal record shows, are unpredictable, with wide variations in radioactivity levels near the site over time. (For example, 2006 airborne radioactivity was three times as high in late fall, as in late spring.) During some periods, releases were up to 100 times greater than normal. Also, radioactivity levels in the Hudson River near Indian Point have been found to be over 10 times greater than those in Albany. In the analysis conducted by RPHP, levels of Sr-90 in baby tooth samples was evaluated by a lab, and cancer data derived from the U.S. Centers for Disease Control (cancer mortality from 1979-2004) and the New York State Cancer Registry, Department of Health, Albany NY (cancer incidence from 2000-2004).
http://nyhealth.gov/statistics/cancer/registry/zipcode/index.htm.

The evidence described in the RPHP analysis indicates that environmental contamination from Indian Point during its first few decades of operation may have already caused harm. Among the key findings: (1) Childhood cancer incidence in the local area was among the highest in New York State and exceeded the U.S. rate by 22%. (2) Thyroid cancer incidence in the local area was 70% above the U.S. rate. (3) The breast cancer incidence rate in the local area exceeds that of the state and the nation, and the excess is growing over time. (4) Incidence of the 4 most common types of cancer in the 6 towns within 5 miles of Indian Point was 20% greater than the rest of Rockland and Westchester Counties. (5) Levels of Strontium-90 in local baby teeth are the highest of any area near 7 U.S. nuclear plants analyzed. Local children born in the 1990s had an average Sr-90 level 38% higher than those born a decade earlier. (6) There is a statistical link between average levels of Strontium-90 in local baby teeth and local childhood cancer rates. The report concluded that, if closing Indian Point resulted with the same decrease in cancer mortality as that found following closure of the Rancho Seco, CA plant, some 5000 fewer cancer deaths would occur in the Indian Point area over 20 years. RPHP published five medical journal articles on its findings.]
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http://www.ncbi.nlm.nih.gov/pubmed/16524167. [Previous research has documented a short latency of cancer onset in young children exposed to low doses of radioactivity. The standard mortality ratio (SMR) for cancer in children dying before age 10 rose in the period 6-10 years following the accidents at both Three Mile Island and Chernobyl n populations most exposed to fallout. Further SMRs near most nuclear power plants were elevated 6-10 years after startup, especially in children with leukemia. Cancer incidence in children under age 10 living near New York and New Jersey nuclear plants increased 4-5 years after increases in average strontium-90 in baby teeth, and declined 4-5 years after Sr-90 averages dropped. The correlation between Sr-90 and childhood cancer is most strongly supported for a supralinear dose-response, meaning the greatest per-dose risks are at the lowest doses. These findings indicate that the very young are particularly susceptible to adverse effects of radiation exposure, even at relatively low doses.]

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McClelland, Joseph Testimony, 2012: Testimony of Joseph McClelland, Director, Office of Electric Reliability Federal Energy Regulatory Commission Before the Committee on Energy and Natural Resources, United States Senate, Jul 17, 2012.
http://www.energy.senate.gov/public/index.cfm/files/serve?File_id=142d2c6c-e7e3-4b3b-9084-c7ef4ab4b88c. [The Federal Energy Regulatory Commission (FERC) does not have sufficient jurisdiction or authority to address the full spectrum of identifies vulnerabilities of or threats to the nation's electrical infrastructure.

Notably, the current interpretation of "bulk power system" is limited and, for instance, "excludes some transmission and all local distribution facilities, including virtually all of the grid facilities in certain large cities such as New York, thus precluding Commission action to mitigate cyber or other national security threats to reliability that involve such facilities and major population areas." (p. 2)

The current regulatory process operates too slowly to address emerging cyber threats and procedures "do not provide an effective and timely means of addressing urgent cyber or other national security risks to the bulk power system, particularly in emergency situations." (p. 4)

"The existing reliability standards do not extend to physical threats to the grid, but physical threats can cause equal or greater destruction than cyber attacks …. One example of a physical threat is an electromagnetic pulse (EMP) event. EmP events can be generated from either naturally occurring or man-made causes. In the case of the former, solar magnetic disturbances periodically disrupt the earth's magnetic field which in turn, can generate large induced ground currents. This effect, also termed the 'E3' component of an EMP, can simultaneously damage or destroy bulk power system transformers over a large geographic area." (p. 5)

The power grid is vulnerable to major solar storm such as those which occurred in 1859, 1921, and 1960. A March 2010 study from Oak Ridge National Laboratory and Metatech, commissioned by federal regulators, detailed the risks involved. "The results of the study support the general conclusion that EMP event pose substantial risk to equipment and operation of the Nation's power grid and under extreme conditions could result in major long term electrical outages. In fact, solar magnetic disturbances are inevitable with only the timing and magnitude subject to variability. The study assessed the 1921 solar storm, which has been termed a 1-in-100 year event, and applied it to today's power grid. The study concluded that such a storm could damage or destroy up to 300 bulk power system transformers interrupting service to 130 million people for a period of years." (p. 6)

EMP can also be generated by weapons. "Equipment and plans are radily available that have the capability to generate high-energy bursts, termed 'E1', that can damage or destroy electronics such as those found in control and communication systems on the power grid. These devices can be portable and effective, facilitating simultaneous coordinated attacks, and can be reused, allowing use against multiple targets." (p.5)]

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http://www.nrdc.org/nuclear/indianpoint/files/NRDC-1336_Indian_Point_FSr8medium.pdf. [The very large population around Indian Point in Buchanan, NY, puts millions at risk of exposure to radiation in the event of a major accident and leave a large part of the New York metropolitan area uninhabitable for generations. A Chernobyl-scale release would make Manhattan too radioactively contaminated to live in if the city fell within the plume.

Ambient weather would determine in what direction, how far, and how fast radioactive fallout would travel from Indian Point following a major accident. NRDC looked at a HPAC database of historical

weather from a world-wide network of weather stations and examined wind rose data for the nearby Poughkeepsie/Dutchess County Airport. Analysis showed probabilities of plume behavior depending upon different winds behavior over a 10 year period. “Northerly and westerly winds are predominant at Indian Point. Winds in the Hudson Valley are most often channeled by the terrain into a north-south axis. In other words, the predominant northerly winds at Indian Point blow south down the Hudson Valley to New York City.” (p.3.)

Real estate and economic activity within the New York metropolitan area is among the most valuable in the world.]

N

National Commission on Terrorist Attacks Upon the United States: The 9/11 Commission Report, W.W. Norton & Company, New York, London, Jul 2004. http://www.9-11commission.gov/report/911Report.pdf. [The 9/11 Commission Report, of course, provides an exhaustive and authoritative narrative of the events which led up to the terrorist attack of Sep 11, 2001. It describes multiple failures at multiple levels of government, as well as lax security at commercial airports and in commercial airlines. It famously notes a “failure of imagination.”

The 9/11 Commission Report also attests that America’s nuclear power plants are viewed as terrorist targets. The original plan, as described by Khalid Sheikh Mohammed (SDM), the Pakistani mastermind of the attack, was “a total of ten aircraft to be hijacked, nine of which could crash into targets on both coasts – they included those eventually hit on September 11 plus CIA and FBI headquarters, nuclear power plants, and the tallest buildings in California and the state of Washington.” (p. 154)

Two of the terrorists who ultimately piloted the planes, did practice and training flights down the Hudson Corridor, a low-altitude hallway along the Hudson River. (p. 242.)

A planning meeting for the attacks took place in Madrid on July 8, 2001. Mohamed Atta, the Egyptian tactical leader of the plot and pilot of the lead plane, American Airlines Flight 11, was in attendance. “During the Spain Meeting, Atta also mentioned that he had considered targeting a nuclear facility he had seen during familiarization flights near New York – a target they referred to as ‘electrical engineering.’” (p. 245)

National Research Council, 2002: *Nuclear and Radiological Threats*, National Academies Press, Washington, DC (2002), at p. 47. [Spent fuel generates orders of magnitude less heat than an operating reactor, so that “emergency cooling of the fuel in the case of attack could probably be accomplished using low-tech measures that could be implemented without significant exposure of workers to radiation.”]

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http://energy.gov/sites/prod/files/High-Impact%20Low-

Frequency%20Event%20Risk%20to%20the%20North%20American%20Bulk%20Power%20System%20-%202010.pdf.

NIRS, 2008: False Promises, Report of the Nuclear Information and Resource Service (NIRS), May 2008. http://www.nirs.org/falsepromises.pdf. [Report provides broad overview of key issues relating to nuclear power. Chapter 7 focuses on waste risks.]
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NRC, 2013: NRC ANO Augmented Inspection Team Report, 2013: U.S. Nuclear Regulatory Commission Augmented Inspection Team Report 05000313/2013011 and 05000368/2013011, Jun 7, 2013. http://www.nucpros.com/content/arkansas-nuclear-one-nrc-augmented-inspection-team-report-june-7-2013
http://pbadupws.nrc.gov/docs/ML1315/ML13158A242.pdf. [NRC Augmented Inspection Team Report on the March 31, 2013 accident at Arkansas Nuclear One Units 1 and 2 operated by Entergy Operations Inc under the aegis of Entergy Arkansas, Inc. During a refueling outage, a temporary overhead crane being used to move a 525 ton stator fell. The accident heavily damaged structures, killed a worker and injured 8 others. All offsite power to Unit 1 was lost due to damage from the fallen stator. The loss of offsite power led to the loss of power to both decay heat removal trains (which were then restored manually. Spent fuel pool cooling was lost (but then restored manually). The impact of the crane components on the turbine deck caused electrical breakers to open, removing power from a reactor cooling pumps at Unit 2. A fire main ruptured. Water pouring from the fire main rupture caused a short circuit and small explosion inside an electrical breaker cabinet at Unit 2. This, in turn, led to the loss of an offsite power source to Unit 2. The inspectors – reporting here on a May 9, 2013 inspection – noted damage to "Unit 1 and Unit 2 Structures, Systems and Components" but said structural damage was still being assessed and a "root cause" was not yet established.]

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http://pbadupws.nrc.gov/docs/ML1118/ML111861807.pdf.

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NRC, 2006: NRC Leak Task Force Report, 2006: NRC Liquid Radioactive Release Lessons Learned Task Force, Final Report, Sep 1, 2006.
http://pbadupws.nrc.gov/docs/ML0626/ML062650312.pdf.

NRC, 2003: NRC Inspector General, 2003: NRC's Oversight of Davis-Besse Boric Acid Leakage and Corrosion during the April 2000 Refueling Outage, Report of the NRC Office of the Inspector General Hubert T. Bell, Oct 17, 2003, 03-02S. http://www.nrc.gov/reading-rm/doc-collections/insp-gen/2004/03-02s.pdf. Photos of the corrosion: Click here to view slides**.** [The Office of Inspector General was informed that, after a 1990 NRC review of PWR licensee boric acid corrosion prevention programs, the NRC decided not to proactively inspect licensee implementation of their programs. Consequently, the Region did not conduct any inspections to follow up on licensee's implementation of its boric acid control program.]

NRC, Special Inspection Report, 2003: Indian Point Nuclear Generating Units 2 and 3 – NRC Special Inspection Report 05000247/2003013 and 05000286/2003010, Dec 22, 2003. http://www.nrc.gov/NRR/OVERSIGHT/ASSESS/REPORTS/inp3_2003010.pdf. [The report describes maintenance problems and lax oversight of contractor as contributors to seven sudden shutdowns at Indian Point over a period of 18 months. The main focus is failures which occurred during the 2003 blackout which began on August 14, 2003, when emergency communications systems at Indian Point failed to properly operate and backup diesel generators at both units were inoperable. A significant amount of emergency response equipment needed to implement regional emergency plans was also offline. Excerpts follow.

"[N]umerous balance of plant equipment problems [were] caused by the lack of offsite power. The Unit 2 Technical Support Center and Operations Support Center (TSC/OSC) was staffed early in the event, but not formally activated." Offsite power was lost at the station for about 1.5 hours. (p. 23)

"[B]oth TSC diesel generators failed to operate during the August 14 loss of offsite power event. In addition, a number of un-interruptible power supplies (UPSs) in the EOF [emergency offsite facility] (located in the Training Center) did not function. These UPSs are important because the EOF does not have a back-up AC power source, by design. The UPSs provide short-term DC battery back-up power to dedicated ERO [emergency response organization] communications and data transmission systems." (p. 23)

Lost or shut down systems during the blackout included: lost control room air cooling; computer room air conditioning, the Plant Information Computer of Unit 2; the Plant Information Computer of Unit 3; the Critical Function Monitoring System of Unit 3; Local Area Network for both units; the Safety Assessment System/Emergency Data Display System of Unit 2; the Digital Radiation Monitoring System of Unit 2; and the Safety Assessment System of Unit 2." (p. 24)

At Unit 2, no facsimile or copy machines were functional and "no computer terminals Other than one set of PICs terminals) were available to communicate data or electronic messaging." (p. 24)

"Unit 2 and Unit 3 Local Government Radios were not functional because the Emergency Offsite Facility (EOF) transmitter UPS did not operate." "Unit 2 and Unit 3 Radiological Emergency Communications System (RECS) were not functional due to the failure of the associated EOF UPS." "Five-Way and Three-Way Direct telephone lines did not function due to UPS failures. These direct telephone systems are automatic ringing between the TSC/OCS, Control Rooms, EOF/Alternate EOF, JNC, and White Plains office. The meteorological tower back-up diesel power supply failed (started and tripped) …(p. 24)

"Unit 2 and Unit 3 Operations Department Radios were not functional." "Personal computer-based MEANS (Modular Emergency Assessment Notification System) was without electrical power in the control room (lap-top computer). This lap-top driven PC-based software is used to access and enter data for three emergency management forms: NYS Radiological Emergency Data Forms (INForms); Dose Assessment and Protective Action Recommendations (DAPARS); and Emergency Action Level Computerized Information System (EALCIS). Hard-copy forms are used for back-up, but on August 14, 2003, no copy machines were functional in the control room." (p. 25)

"[T]he EOF computer data acquisition and modem was without power because its associated UPS failed." Several commercial telephone lines were not functional. (p. 25)

Some of the emergency operations staff were never contacted because of segments of Entergy's pager system did not function due to the lack of power and back-up supplies, and because of regional cell phone service disruption. (p. 25)

"A significant amount of TSC/OSC emergency response equipment, necessary to implement the Emergency Plan, was either de-energized by the Entergy staff because of the loss of sufficient air conditioning to ensure emergency response equipment would not be damaged due to overheating or was without AC power because the diesel was non-functional." (pp. 26-27)

The problems with the backup generator at Unit 2 had been identified as early as Feb 2000 and the problem with the generator at Unit 3 was discovered in Apr 2003. The problems remained uncorrected and then surfaced during the blackout. The report further found that Entergy did not have a preventative maintenance in plan in place to ensure that backup power was available for regional emergency-response equipment.]

NRC, 2002: NRC Inspector General, 2002: NRC's Regulation of Davis-Besse Regarding Damage to the Reactor Vessel Head, Report of the NRC Office of the Inspector General, Dec 30, 2002, O2-03S. [NRC's Office of the Inspector General released a report for its inquiry into how the NRC staff handled FirstEnergy's response to Bulletin 2001-01 in fall 2001. Among other findings, the Inspector General reported: "OIG found that Federal regulations authorize NRC to initiate enforcement action whenever it lacks 'reasonable assurance' that the licensee can operate safely. However, many NRC staff expressed to OIG their unwillingness to pursue enforcement action against a licensee without absolute proof of a regulatory violation."]

NRC, 1996: Briefing On Spent Fuel Pool Study, Nuclear Regulatory Commission, Public Meeting, Nov 14, 1996. www.nrc.gov/reading-rm/doc-collections/commission/tr/1996/19961114a.html, at p. 27 [Estimating, if a core had been loaded into the spent fuel pool 5 days after shutdown, it could take about 8 hours for the cooling pool water to fully boil down.]

NSA, 2011: The Accident at TEPCO's Fukushima Nuclear Power Stations, Report of Japanese Government to the IAEA Ministerial Conference on Nuclear Station, Jun 2011. http://www.kantei.go.jp/foreign/kan/topics/201106/iaea_houkokusho_e.html. Chapter IV. http://www.kantei.go.jp/foreign/kan/topics/201106/pdf/chapter_iv_all.pdf.

Nuclear Street, Entergy Details Company-Wide Job Cuts, Nuclear Street News, Jul 31, 2013. https://nuclearstreet.com/nuclear_power_industry_news/b/nuclear_power_news/archive/2013/07/31/entergy-details-company_2d00_wide-job-cuts-073102.aspx#.UjnZKJ3D8gE. [Reporting Entergy citing disappointing earnings as reason for decision to cut 800 positions across its organization. The New Orleans Times-Picayune reported the company will trim 240 positions in Louisiana, 165 in Arkansas, 115 in Texas, 80 in Mississippi and the remainder in Massachusetts, Michigan, New York and Vermont. "The effects of cost cutting are likely to be felt across the organization's nuclear fleet, which provides about a third of Entergy's electrical generation. It is made up of 11 reactors at Arkansas Nuclear One, Grand Gulf, River Bend, Waterford, Palisades, Indian Point, Fitzpatrick, Pilgrim and the Vermont Yankee." Entergy "cited higher tax, operation, maintenance and depreciation expenses in its justification for a company-wide reorganization expected to save between $200 million and $250

million over the next few years." Also Entergy has filed suit against contractor companies at Arkansas Nuclear One, where a crane accident took the life of a worker in 2013.]

Nussbaum RH, Childhood Leukemia and Cancers Near german Nuclear Reactors: Significance, Context, and Ramifications of Recent Studies, International Journal of Occupational and Environmental Health (2009); 15 (3): 318-323(6).
http://www.ingentaconnect.com/content/maney/oeh/2009/00000015/00000003/art00012

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Odenwald, Sten F and James L. Green, Bracing the Satellite Infrastructure for a Solar Superstorm, Scientific American Magazine, Jul 28, 2008.
http://www.scientificamerican.com/article.cfm?id=bracing-for-a-solar-superstorm. Graphics depicting how the entire East Coast and much of the rest of the country would lose power under conditions from a severe store like that of 1921 is at: http://www.scientificamerican.com/article.cfm?id=solar-storms-effects-on-power. [A recurrence of the 1859 major solar storm would be a cosmic Katrina, causing billions of dollars of damage to satellites, power grids and radio communications. The 1859 solar storm caused significant shifts of the Earth's magnetic fields. Telegraphs were rendered useless and several telegraph stations burned down. Were such a storm to happen today, it could "severely damage satellites, disable radio communications, and cause continent-wide electrical black-outs that would require weeks or longer to recover from." Although storms of such magnitude are rare, storms and flares of lesser intensity occur more often. Storms about half the intensity of the 1859 event occur approximately every 50 years, with the last such storm occurring in November 1960.
The 1960 storm led to world-wide geomagnetic disturbances and radio outages. The power grid is especially at risk from such events because transformers are electrically grounded to the Earth and vulnerable to geomagnetically-induced currents. The damage or destruction of numerous transformers across the country would damage grid functionality. Thus even storms that occur about every 50 years" could fry satellites, jam radios and cause coast-to-coast blackouts."]

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Pasternak, Judy, *Yellow Dirt: An American Story of a Poisoned Land and a People Betrayed,* Free Press (2010).

Perkins, 2012: Perkins, Richard H, Letter to Hubert T. Bell, Office of the Inspector General of the NRC. http://big.assets.huffingtonpost.com/igletter.pdf. [In this letter, Richard L. Perkins, an engineer with the NRC Division of Risk Management, alleges:

"[T]he Nuclear Regulatory Commission (NRC) has intentionally mischaracterized relevant and noteworthy safety information as sensitive, security information in an effort to conceal the information from the public. This action occurred in anticipation of, in preparation for, and as part of the NRC's response to a Freedom of Information Act request for information concerning the *generic* issue investigation on *Flooding of U.S. Nuclear Power Plants Following Upstream Dam Failure*. Specifically requested was the completed screening analysis report for this issue, of which I am the lead author. Portions of the publically released version of this report are redacted citing security sensitivities, however, the redacted information is of a general descriptive nature or is strictly relevant to the safety of U.S. nuclear power plants, plant personnel, and members of the public. The Nuclear Regulatory Commission staff has engaged in an effort to mischaracterize the information as security sensitive in order to justify withholding it from public release using certain exemptions... The Nuclear Regulatory Commission staff may be motivated to prevent the disclosure of this safety information to the public because it will embarrass the agency. The redacted information includes discussion of, and excerpts from, NRC official agency records that show the NRC has been in possession of relevant, notable, and derogatory safety information for an extended period but failed to properly act on it. Concurrently, the NRC concealed the information from the public."]

Perkins, 2011: Perkins RH, Bensi MT, Philip J, and Sancaktar S, Screening Analysis Report for the Proposed Generic Issue on Flooding of Nuclear Power Plant Sites Following Upstream Dam Failure, Report to U.S. Nuclear Regulatory Commission Office of Nuclear Regulatory

Research Division of Risk Analysis, Jul 2011.
http://pbadupws.nrc.gov/docs/ML1218/ML12188A239.pdf. [Report identifies 34 nuclear plants as being at heightened risk of flood damage due to upstream dam failures; Indian Point Units 2 and 3, among the plants at risk.]
PSR, 2012: Radioactivity and Health, Environmental Health Policy Institute, Physicians for Social Responsibility (PSR), Oct 31, 2012. http://www.psr.org/environment-and-health/environmental-health-policy-institute/radioactivity-and-health.html. [Issue devoted to Radioactivity and health with contributors, Ira Helfand, MD, Andrew S. Kanter, MD, MPH, JeffreyJ Patterson, DO, John W. Rachow, MD, PhD, Steven Starr, Director of the Clinical Laboratory Science Program, University of Missouri-Columbia.]

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Resnikoff M, Radiation Consequences http://www.state.nv.us/nucwaste/news2001/nn11459.pdf.
Resnikoff Testimony, 2001: Testimony of Marvin Resnikoff, PhD, on behalf of Radioactive Waste Management Associates (RWMA) to the U.S. House of Representatives Committee on Transportation & Infrastructure, Apr 25, 2002.
http://www.yuccamountain.org/leg/resnikoff042502.html.
Riverkeeper, Inc. www.Riverkeeper.org.
Romm, Joe, How Much of a Subsidy is the Price-Anderson Nuclear Industry Indemnity Act?, ThinkProgress, Aug 7, 2008, http://thinkprogress.org/romm/2008/08/07/202962/how-much-of-a-subsidy-is-the-price-anderson-nuclear-industry-indemnity-act/
[Article authored by Joseph Romm, PhD, a physicist who received his doctorate from M.I.T., a Fellow of the American Association for the Advancement of Science and a former acting assistant secretary at the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy. In this article, he points out "the obvious — that nuclear is a mature source of power that has benefited disproportionately from government support" and noted further that (by 2008), the commercial nuclear industry had enjoyed some $300 billion worth in taxpayer subsidization from the Price-Anderson Nuclear Industries Indemnity Act alone. Price-Anderson caps both operator and nuclear industry liability for claims arising from nuclear incidents. It reduces the insurance nuclear power plants need to buy and requires taxpayers to cover all claims in excess of the cap. At the time the Act was originally enacted, in 1957, it was deemed necessary because investors and insurers were unwilling to accept the then unquantified risk. But extending the act through 2025 is hard to justify. "If investors aren't willing to accept the risks of nuclear energy now, without taxpayers liable for any major catastrophe, perhaps the technology no longer deserves government support."]

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http://rt.com/usa/entergy-nuclear-plant-leak-447/ .

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https://pincdn.s3.amazonaws.com/assets/5F7uHwbKhTsl_oc6mfPtfg/RadioactiveRoadsandRails.pdf.
[Inherent dangers in the transportation of nuclear waste evidenced by series of documented cases of radioactive material leakage from casks resulting in contamination both within and beyond the transportation vehicles. Incidents involved rail and truck transport modes.] Synopsis at: Sadik, Pierre, Nuclear Waste Transportation Accidents in the U.S., U.S. Public Interest Research Group fact sheet, 2002. http://www.nuclearactive.org/graphix/transport_accidents.pdf.
Schlissel D, Peterson P, and Biewald B, Financial Insecurity: The Increasing Use of Limited Liability Companies and Multi-Tiered Holding Companies to Own Nuclear Power Plants, Report of Synapse Energy Economics, Cambridge, MA for STAR Foundation and Riverkeeper,

Inc., Aug 7, 2002. http://www.riverkeeper.org/wp-content/uploads/2011/03/SYNAPS2.pdf. [Report shows how Limited Liability Companies (LLCs) are used by large nuclear energy firms to simultaneously maximize corporate profits and shield operators from liability. The allowance of such structures by the NRC allows such parent corporations to discard assets with impunity and shifts responsibility to the public of financial and other consequences of accidents and any major nuclear catastrophe. A prime example of the risk to the public is Indian Point nuclear plant in New York, where the nuclear installation is comprised of multiple levels of "shell" companies.]

Schumer, Charles, Press Release, Recent Reports Reveal Dangerous Gaps in Indian Point Waterfront Security, Nov 25, 2013. http://www.schumer.senate.gov/record.cfm?id=348127&. [Senator Urges Dept. of Homeland Security to conduct to conduct a top-to-bottom review of Indian Point Energy Center's maritime security, in light of recent reports that indicate Indian Point vulnerability to waterborne attack. Press Release includes letter to U.S. Coast Guard Admiral Papp.]

Smith, Brice, Insurmountable Risks: The Dangers of Using Nuclear Power to Combat Global Climate Change, IEER Press, Takoma Park, Maryland, and RDR Books, Muskegon, Mich / Berkeley, Calif (2006, repr. 2007). Link at: http://ieer.org/resource/climate-change/insurmountable-risks-dangers-nuclear/#download.

Solomon, Gina M, MD, MPH, Testimony in Oversight Hearing on Disease Clusters and Environmental Health, Committee on Environment and Public Works, United States Senate, Mar 29, 2011. http://www.nrdc.org/health/files/gsolomon_health_20110329.pdf. [Gina M. Solomon, MD, MPH, is Senior Scientist at the Natural Resources Defense Council and Director, Occupational and Environmental Medicine Residency Program and Associate Clinical Professor of Medicine, at the University of California, San Francisco. Her testimony is on the inadequacies of research on environmental toxins, the problem of chemical interactions, and the failure of the scheme, overall, to protect the public from toxins. She writes: "The bib problem is that the rates of some cancers – including childhood cancers – and other diseases, are rising, so we don't have the luxury of a lot of time. People are getting sick and suffering, so we need to move quickly and use whatever clues we can to understand what'sgoing on." (p. 6)]

Sykes, 2008: Skykes LR, Armbruster JG, Kim W-Y, and Seeber L, Observations and Tectonic Setting of Historic and Instrumentally Located Earthquakes in the Greater New York City-Philadelphia Area, Bulletin of the Seismological Society of America (2008); 98 94): 1695-1719. http://www.bssaonline.org/content/98/4/1696.short. ["Two nuclear power plants at Indian Point (near Peekskill in Fig. 2) are located closer to more people at any given distance than any other similar facilities in the United States…Indian Point is situated at the intersection of the two most striking linear features marking the seismicity (Fig. 3) and also in the midst of a large population that is at risk in case of an accident of an accident to the plants. This is clearly one of the least favorable sites in our study area from an earthquake hazard and risk perspective." (at p.1717.) See also, Earthquakes May Endanger New York More Than Thought, Says Study: Indian Point Nuclear Power Plant Seen As Particular Risk, Press Release on Sykes Report, Aug 21, 2008. http://www.earth.columbia.edu/sitefiles/file/pressreleases/1696.pdf. ["The researchers found concrete evidence for one significant previously unknown structure: an active seismic zone running at least 25 miles from Stamford, Conn., to the Hudson Valley town of Peekskill, N.Y., where it passes less than a mile north of the Indian Point nuclear power plant."]

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Taxpayers for Common Sense, 2008: Nuclear Subsidies Past and Present, Taxpayers for Common Sense Fact Sheet, Dec 12, 2008. http://www.taxpayer.net/library/article/nuclear-subsidies-past-and-present.

[As of 2008, more than $85,870,000,000 in direct federal subsidies, tax breaks and loan guarantees was given to the nuclear industry. (All valuations are in 2007 dollars.)

Table 1 shows a summary of historical subsidies to the nuclear industry (excluding the Price-Anderson Act), with data sourced from the Office of Management and Budget, "Public Budget Database", http://www.whitehouse.gov/omb/budget/fy2009/db.html; Nuclear Energy Research Initiative, FY2007 annual report; Congressional Research Service Issue Brief, Energy Efficiency: Budget, Oil Conservation, and Electricity Conservation Issues.
Yet, despite these sums, the nuclear power industry continues to demand subsidies and is "unable to stand on its own two feet in the marketplace."
In addition to the specified subsidies, Congress has significantly limited the liability of individual nuclear plant operators and the industry as a whole for more than half-a-century. This has been done via the Price-Anderson Act, a 1959 law that has been repeatedly extended. Thus the cost of an accident is a liability which would be primarily borne by American taxpayers. (One analysis, for example, has estimated one nuclear reactor accident could result in 143,000 cancer deaths and $599 billion in property damage.)
Table 2 shows the projected impacts of 2005-2015 subsidies, tax breaks and loan guarantees (primarily from the Energy Policy Act of 2005) to amount to more than $24,000,000,000. This estimate excludes awards for research and development. The data is compiled from the Joint Committee on Taxation, "Estimated budget effects of the conference agreement for Title XIII of H.R. 6, the "energy tax incentives act of 2005"", July 2005; Public Law 109-58, "Energy Policy Act of 2005", August 2005; Department of Energy Loan Guarantee Program, "Title XVII 2008 Omnibus Report Language."
High level nuclear waste deposition is also a cost. The estimated cost from 2007 through permanent closure and decommissioning of the Yucca Mountain repository is $83 billion. *{IPSEC NOTE: The estimate of $83 billion noted here by Taxpayers for Commons Sense was made before the Yucca project was put on hold and does not include the potential for billions of dollars sought by the industry for the costs of nuclear waste disposal.}*
"The potential risk the US government bears with nuclear power is a cost well beyond any other federal subsidy." The US has also invested far more funds in Research and Development for nuclear than for any other energy source.
The paper concludes: "For decades the nuclear industry has heavily benefited from subsidies provided by U.S. taxpayers and they continue to ask for billions more. With a growing economic crisis and federal deficits and debt mounting, taxpayers, now more than ever, cannot afford to shoulder the burden of nuclear subsidies. It is time to end handouts to a mature energy industry that has already received billions from taxpayers."]

Tepco, 2010: Sustainability Report 2010, Tokyo Electric Power Company (TEPCO) Group Report for year ending Mar 31, 2010. http://www.tepco.co.jp/en/challenge/environ/pdf-1/10report-e.pdf. [TEPCO report cites much lessons learned from a large scale blackout in 2006 and the accident at the Kashiwazaki-Kariwa Nuclear Power Station caused by the Niigata-Chuctsu-oki earthquake in 2007. TEPCO asserts strong "commitment" to deliver electricity to society in a safe and stable manner and asserts the capability to respond to any accident.]

Thompson GR, Risk-Related Impacts from Continued Operation of the Indian Point Nuclear Power Plants, Report of the Institute for Resource and Security Studies, Cambridge, MA, for Riverkeeper, NY, Nov 28, 2007. http://pbadupws.nrc.gov/docs/ML1209/ML120970089.pdf. [Gordon Thompson, PhD, Director of the Institute for Resource and Security Studies in Cambridge, Massachusetts, is an internationally-recognized expert in the safety issues and security hazards associated with nuclear facilities. He has worked on committees advising the NRC, and was also associated with the fusion research program of the UK Atomic Energy Authority.]

Thompson G , Robust Storage of Spent Nuclear Fuel: A Neglected Issue of Homeland Security, Report of Institute for Resource and Security Studies for the Citizens Awareness Network, January 2003. http://www.nirs.org/reactorwatch/security/sechossrpt012003.pdf. [Gordon Thompson, PhD, is Director of the Institute for Resource and Security Studies. In this study he reviewed the ways in which spent fuel pools are vulnerable to attack**.** Dr. Thompson concluded that a

nuclear fire in the spent fuel pool of Indian Point Unit 2 would release enough cesium-137 “to render about 95,000 square kilometers of land uninhabitable," which would cover about 75% of New York State. *{IPSEC NOTE: Given the geography, this would, more likely translate into, segments of NY, NJ, and CT.}*

Tidmore, Chrisopher, Is Entergy New Orleans Out of Power? Bayou Buzz, Mar 23, 2006. http”//www.bayoubuzz.com/articles.aspx?aid=6576 . [Entergy reportedly streatening to walk away from its New Orleans subsidiary if multi hundred million federal bailout money not provided to help rebuild utility systems damaged by Katrina.]

TMI President’s Commission Report: The Accident at Three Mile Island – The Need For Change: The Legacy Of TMI, Report of The President’s Commission, Oct 1979. http://www.threemileisland.org/downloads/192.pdf

Travers J, Alexandrova E, and Resnikoff M, An Assessment of Los Alamos National Laboratory Waste Disposal Inventory Los Alamos, New Mexico, Radioactive Waste Management Associates (AWMA) Study, Nov 2009. http://www.rwma.com/LANL%20Waste%20Disposal%20Inventory%2011.18.09.pdf.

Tsai H, Liu YY, Nutt M, and Shuler J, Advanced Surveillance Technologies for Used Fuel Long-Term Storage and Transportation, Paper published in the Proceedings of the 14th International Conference on Environmental Remediation and Radioactive Waste Management ICEM2011, Reims, France, Sep 25-29, 2011. http://www.dis.anl.gov/pubs/68880.pdf.

[Paper authored by scientists from the Argonne National Laboratory and the U.S. Department of Energy. “With the prospect looming for extended long term storage – possibly over multiple decades – and deferred transport, condition-and performance-based aging management of cask structures and components is now a necessity that requires immediate attention. From the standpoint of consequences, one of the greatest concerns is the rupture of a substantial number of fuel rods that would affect fuel retrievability. Used fuel cladding may become susceptible to rupture due to radial-hydride-induced embrittlement caused by water-side corrosion during the reactor operation and subsequent dryin/transfer process, through early state of storage in a dry cask, especially for high burnup fuels.”(p. 1)

“Of the numerous potential cask degradation processes, aside from those caused by severe nature or man-made disasters, air/moisture ingress into the cask is possibly the one with the gravest concern. The displacement of the more-conductive helium cover gas by air/moisture would cause the canister interior temperature to rise. Air and moisture could also cause the zirconium-based fuel rod cladding to oxidize if the system temperature is sufficiently elevated. The released hydrogen from zirconium/moisture interaction could form a contamination in the canister or cask.” (p. 2)

“Currently, the dry cask storage systems are not required to have instrumentation to monitor heat loads or radiation leaks on a continuous basis... [Periodic inspections and other routine surveillance] may not be sufficient in the long term, particularly when fuel retrievability is an issue.” (p. 2)

The authors then posit use of a surveillance technology called “ARG-US,” developed by Argonne, noting “[s]oftware provides the vital link between the technology and the end user and is a key component in the development and implementation of ARG-US. The ARG-US software package consists of a program called ARG-US OnSite, local and central databases, and web applications. ARG-US OnSite, the basic building block, controls the readers via the control computer and provides a graphicaluser interface (GUI) to operate the hardware.” (p. 4)

“To perform in-canister monitoring, numerous enabling technologies have to be developed.” (p.6)

While casts have been shown in tests to meet regulatory requirements “under storage and accident transport conditions, the integrity of the used fuel rods in the cask is not assured in such tests.” (p.6)

“While research is underway to study drying/transfer conditions that could mitigate radial-hydride-induced cladding embrittlement for high-burnup fuels, there is presently insufficient data to confidently project rod integrity beyond even the short term.” (p.7)

The authors' conclude: "The integrity of canisters/casks and that of the used fuel rods in them are vital for the safe operation of DCSS {dry cask storage systems} during extended long-term storage and deferred transportation. The present surveillance programs...may not be sufficient for extended long term storage, which can span multiple decades. Likewise, present practices fo not ensure the integrity of the used fuel rods in the canister/casks." (p.7)]

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UCS, 2012: Flood Risk at Nuclear Plants, Union of Concerned Scientists, web page Nov 28, 2012, at http://www.ucsusa.org/nuclear_power/making-nuclear-power-safer/preventing-nuclear-accidents/flood-risk-at-nuclear-power-plants.html. [Flooding is a risk to safe operation of nuclear plants because flooding can damage equipment, knock out electrical systems, and disable cooling mechanisms. This is what happened at Fukushima as a result of the tsunami flooding. Natural weather events that can lead to flooding include heavy rain or snows that can cause rivers to overflow, and nor'easters and tropical storms can cause storm surges that threaten coastal plants. "Floods from such natural weather events have caused problems at several U.S. nuclear power plants in recent years. In June 2011, unusually high water on the Missouri River, caused by a combination of heavy spring rains and Rocky Mountain snowmelt, inundated the Fort Calhoun plant in Nebraska. And in October 2012, flooding from Hurricane Sandy caused two New Jersey nuclear plants, Salem and Oyster Creek, to shut down when high water levels threatened their water intake and circulation systems."

Nuclear plants downstream from dams also face threat. In dam failure, flooding is sudden and can be catastrophic. "Unlike river overflows or hurricanes, dam failures are likely to occur with little or no advance warning, leaving plant operators scrambling to protect their facilities before the floodwaters arrive within hours." There have been 700 dam failures in the U.S. since 1975.

In July 2011, a report released by the NRC identified 34 nuclear plants as being at heightened risk of flood damage due to upstream dam failures; Indian Point Units 2 and 3, among the plants at risk.]

UCS, 2011: Response to the NRCD Near-Term Task Force Report *Recommendations for Enhancing Reactor Safety in the 21st Century*, Aug 1, 2011.
http://www.ucsusa.org/assets/documents/nuclear_power/UCS-Response-to-NRC-90-day-recs-8-1-11.pdf.

UCS, 2003: Davis- Besse, Union of Concerned Scientists Webpage accessed Dec 3, 2013.
http://www.ucsusa.org/assets/documents/nuclear_power/davis-besse-ii.pdf.

["Davis-Besse was shut down on February 16, 2002, to enter a refueling outage. The refueling outage had been scheduled to start in late March, but it was moved up to accommodate the NRC's concerns about potential cracking of the control rod drive mechanism (CRDM) nozzles. Workers inspecting the CRDM nozzles identified crack indications in five of the 69 CRDM nozzles with through-wall leak indications at three nozzle locations. During the attempted repair to one of the cracked, leaking nozzles, workers discovered significant damage to the reactor vessel head. Borated water leaking from the cracked CRDM nozzle had formed boric acid that corroded the carbon steel head down to its stainless steel liner. Ensuing inquiries into that serious problem identified many other hardware problems, each stemming from a poor safety culture at the plant."

"Prior to the discovery of the gaping hole in the reactor head, the NRC had considered Davis-Besse to be among the best, if not the best, performing plant in Region III. The Institute for Nuclear Power Operations was somewhat less enamored with Davis-Besse, but still rated the overall performance as good. The gaping hole in the reactor head symbolized the gap between perception and reality. The perception that Davis-Besse was a top performer prevented the NRC from looking for evidence to the contrary and to dismiss evidence that it did see."]

UN IPCC, 2013: Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaption, Special Report of the Intergovernmental Panel on Climate change (IPCC), Cambridge University Press, 2012 http://www.ipcc-wg2.gov/SREX/images/uploads/SREX-All_FINAL.pdf. AIPCC, 2012: Summary for Policymakers (Field CB, Barros TF, Stocker D, Qin DJ,

Dokken KL, Ebi MD, Mastrandrea KJ, Mach G-K, Plattner SK, Allen M, Tignor, and Midgley PM eds of Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change, at pp 1-19. summary of the report for policymakers is at: http://www.ipcc-wg2.gov/SREX/images/uploads/SREX-SPMbrochure_FINAL.pdf. [It is very likely that mean sea level rise will contribute to upward trends in extreme coastal high water levels in the future and there is high confidence that locations currently experiencing adverse impacts such as coastal erosion and inundation will continue to do so in the future due to rising sea levels.

While it is not currently possible to reliably project specific changes at the catchment scale, there is high confidence that changes in climate have the potential to seriously affect water management systems.

Climate-related extremes are also expected to produce large impacts on infrastructure. A changing climate leads to changes in the frequency, intensity, spatial extent, duration, and timing of extreme weather and climate events, and can result in unprecedented extreme weather and climate events.

Changes in extremes can be linked to changes in the mean, variance, or shape of probability distributions, or all of these things. Extremes can themselves result from an accumulation of climate events that in and of themselves are not severe. Climate extremes includes extended periods of altered climate, persistent climate events and extreme weather events. The severity of effects depend not only on the events themselves but on extent of exposure and pre-existing vulnerabilities.

Disasters can be triggered when extreme climate produces widespread damage and stresses human, ecological, or physical systems and natural ecosystems. Extreme impacts can also result from a compounding of events. For example, the increased risk of wildfire caused by drought, coupled with extreme heat and low humidity. The cumulative effects of disasters at sub-national levels can also substantially affect the capability of communities to respond to events. Vulnerability is dynamic, varies across temporal and spatial scales and depends upon many geographic, demographic, institutional, and environmental factors. Nonetheless, all countries face challenges in assessing, understanding and responding to such projected changes.]

UN Special Rapporteur Report, 2013: Grover A, Report of the Special Rapporteur on the right of everyone to the enjoyment of the highest attainable standard of physical and mental health, Anand Grover to the United Nations Human Rights Council (23rd Session, May 2, 2013). http://www.ohchr.org/Documents/HRBodies/HRCouncil/RegularSession/Session23/A-HRC-23-41-Add3_en.pdf [Reporting on the Fukushima disaster: "Mandatory evacuation zones were periodically altered from a radius of three kilometers from the Daiichi plant to ten and later to 29km. Voluntary evacuation was eventually endorsed within a 20-30km radius area. Evacuation orders for some areas with high radiation doses were not issued until one month later. On 22 April 2011, the Government issued evacuation orders for areas up to 50km north-west of the plant, including Katsurao, Iitate, Namie, and parts of Minami-soma and Kawamata, due to high-dose radiation detected in the area brought by winds carrying radioactive material from the plant. People in these areas thus remained exposed to high-dose radiation for a significant period."

"573 deaths have been certified by the Government as 'nuclear disaster-related deaths.'" (p. 8)

Significantly, the report clarifies the inadequacy of international radiation safety standards which are based on the principles of optimization and justification: "Such a risk-benefit analysis is not in consonance with the right to health framework, as it gives precedence to collective interests over individual rights. Under the right to health, the right of every individual has to be protected. Moreover, such decisions, which have a long-term impact on the physical and mental health of people, should

be taken with their active, direct and effective participation." (p. 16) On cumulative risk, the report observes: "Furthermore, epidemiological studies monitoring the health effects of long-term exposure to low-iodinizing radiation conclude that there is no low-threshold limit for excess radiation risk to non-solid cancers such as leukaemia. The additive radiation risk for solid cancers continues to increase throughout life with a linear dose-response relationship." (p. 16)]

U.S.-Canada Power System Outage Task Force, 2004: August 14th Blackout: Causes and Recommendations, Report of the U.S.-Canada Power System Outage Task Force, Apr 2004. http://www.nrcan.gc.ca/sites/www.nrcan.gc.ca/files/energy/pdf/eneene/pdf/outpan-eng.pdf.

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van der Elst NJ, Savage HM, Keranen KM, and Abers GA, Enhanced Remote Earthquake Triggering at Fluid-Injection Sites in the Midwestern United States, Science (2013); 341 (6142): 164-167. http://www.sciencemag.org/content/341/6142/164.full. [Dramatic increases in seismicity in the mid-western U.S. in recent years is believed linked to increases in deep wastewater injection. In this study, seismologists from Columba University's Lamont-Doherty Earth Observatory the University of Oklahoma determined that areas with suspected anthropogenic earthquakes appear also to be more susceptible to natural transient stresses generated by the seismic waves of large remote earthquakes. Sensitivity to remote triggering is most clearly seen in sites having a long delay period between the start of waste injection and the onset of seismicity and in regions which had moderate magnitude quakes within 6 to 20 months. This is an indicator that fluid injection brought the fault system to a critical state.]

W

Wald, Matthew L, Heat Shuts Down a Coastal Reactor, New York Times Aug 13, 2012. http://green.blogs.nytimes.com/2012/08/13/heat-shuts-down-a-coastal-reactor/?_r=1. ["A reactor at the Millstone nuclear plant in Waterford, Conn., has shut down because of something that its 1960s designers never anticipated: the water in Long Island Sound was too warm to cool it." Reactors in inland locations have also had to reduce their power output or shut down because of warm cooling water in the past. "Power plants in the Midwest have also experienced problems as temperatures soared in recent weeks. In some cases, reactors shut down because the cooling water was too warm; in others, the ongoing drought had shrunken the body of water from which the cooling water is drawn, and the plant's intake pipes were above the surface."]

Wald, Jul 2012: Wald, Matthew L, So, How Hot Was It? New York Times, Jul 17, 2012. http://green.blogs.nytimes.com/2012/07/17/so-how-hot-was-it/?_r=0. [In July 2012 the twin-unit Braidwood nuclear plant in Illinois needed special permission to keep operating because its cooling water pond reached 102 degrees as a result of low rainfall and high air temperatures. Braidwood was designed to run at temperatures up to 98 degrees. Asked whether he viewed Braidwood's difficulties as a byproduct of global warming Craig Nesbit, a spokesman for the plant operator, Exelon, said: "'I'm not a climatologist. But clearly the calculations when the plant was first operated in 1986 are not what is sufficient today, not all the time.' Braidwood is not alone in facing a difficult summer; a spokeswoman for the Midwest Independent System Operator, which operates the regional grid, said that another plant had shut down because its water intake pipes were now above the water level of the body from which it draws its cooling water. Another is "partially curtailed." The spokeswoman, Jennifer June Lee, said she could not identify the plants because the information was considered competitive." David Lochbaum, a nuclear engineer at the Union of Concerned Scientists, said the NRC was supposed to grant exemptions from its rules if there was no increase or only a minor increase in risk, and if the situation could not have been foreseen. "The safety argument 'is likely solid and justified,' he wrote in an e-mail, but 'it is tough to argue (rationally) that warming water conditions are unforeseen.' That is a predictable consequence of global warming, he said. Mr. Lochbaum

pointed out that in 2010, both Hope Creek in New Jersey and Limerick in Pennsylvania had to reduce power levels because the intake water was too warm, and that some reactors in France have faced the same problem."]

Wald, Matthew L, As Nuclear Waste Languishes, Expense to U.S. Rises, New York Times, Feb 17, 2008. http://www.nytimes.com/2008/02/17/us/17nuke.html?_r=0 [With waste sitting at reactor sites with no long term repository, the federal government may need to pay damages that could reach $35 billion. "The payments come from an obscure and poorly understood government account that requires no new Congressional appropriations, and will balloon in size…." The money comes out of the Treasury, not the Energy Department from a fund called the "Judgment Fund."

"The government is also running up extra expenses on its own wastes. Some of the waste that is supposed to go to Yucca, left over from nuclear weapons production, is sitting in storage that is expensive to maintain."]

Wald, Apr 2003: Wald, Matthew, Nuclear Reactor in Texas Leaking Cooling Water, New York Times, Apr 18, 2003. http://www.nytimes.com/2003/04/18/national/18CND-NUKE.html. [Reporting on a leak of cooling water discovered in the giant vessel of the South Texas 1 plant. "The leak is unexpected and, so far, unexplained. 'This is the first time it's been seen, either here or abroad,' said Victor Dricks, a spokesman for the Nuclear Regulatory Commission." The vessel is 14.4 ft wide and 46 ft high, made of steel about 6 in thick. The leaks were discovered during a refueling outage at 2 of the 58 bottom penetrations, where instruments are inserted to measure the flow of neutrons. "Water inside the vessel is at a temperature of more than 500 degrees and a pressure of more than 2,000 pounds per square inch, so even a small hole could release large volumes of radioactive water into the containment building. …A problem for repair is that the radiation field under the reactor is about 500 millirem per hour [Ed Halpin, the plant general manager] said. At that rate, a worker would absorb in four hours the radiation dose that most reactor operators set as a limit for a full year."]

Wells, Jim, Nuclear Regulation: Emergency Preparedness Issues at the Indian Point 2 Nuclear Power Plant, Testimony of Jim Wells, Director Natural Resources and Environment, United States General Accounting Office, before the Subcommittee on National Security, Emerging Threats and International Relations, Committee on Government Reform, House of Representatives, Mar 10, 2003, GAO-03-528T. http://www.gao.gov/assets/110/109695.pdf. [Well states: "Since our 2001 report, NRC inspection reports have continued to show emergency preparedness weaknesses. For example, NRC reported that, during an emergency exercise in the fall of 2002, the facility gave out unclear information about the release of radioactive materials, as it did during the February 2000 event. Similarly, in terms of NRC and FEMA communicating with the surrounding jurisdictions, little has changed, according to county officials. County officials told us [the GAO] that a videoconference system – promised to ensure prompt meetings and better communication between the plant's technical representatives and the counties – had not been installed."]

Werner, JD, May 24, 2012. U.S. Spent Nuclear Fuel Storage, Report of the Congressional Research Service, 7-5700; R42513, May 24, 2012. https://www.fas.org/sgp/crs/misc/R42513.pdf. [As of Dec 2011 more than 67,000 metric tons of spent fuel in more than 174,000 assemblies is stored at 77 sites (including 4 DOE facilities) in 35 states, increasing at the rate of about 2,000 metric tons per year. About 73% (67,450 metric tons) of spent fuel continues to be in spent fuel pools, which are becoming filled to capacity. At 27 sites there is no current dry cask storage capability. (Summary.) The 5 states with the largest total amount of spent nuclear fuel measured by metric tons of heavy metal content are: Illinois; Pennsylvania; South Carolina; New York; and North Carolina. The

top five states with the largest amount of spent nuclear fuel in pools are Illinois: Pennsylvania; New York; North Carolina; and Alabama. (p. 24.)

“In fact, virtually every site that has ever hosted a commercial nuclear reactor is currently also a storage site for SNF.” (p. 17.) Approximately 80% of commercial spent nuclear fuel, measured by mass, is stored east of the Mississippi River. (p. 23.)
“Notwithstanding the mandate in the Nuclear Waste Policy Act (NWPA) and various contracts that DOE begin accepting SNF for disposal in 1998, no disposal repository has been completed or licensed.” Even if the Yucca Mountain program – terminated in 2009 – were to be resumed quickly, the time required to ship nuclear waste would require an extended period of storage, with interim storage being needed until at least 2056. The current quantity of nuclear waste in the nation (at commercial and government sites) exceeds the legal capacity of the proposed Yucca Mountain repository. (p. 5.)

A survey of spent fuel storage in 10 nations with significant nuclear operations found that all store substantial amounts of spent fuel in pools or dry casks. France – with 13,500 metric tons of spent fuel and 2,229 cm of vitrified high level waste as of 2007 – has not yet selected a disposal site for high level waste. Finland (with 4 nuclear reactors) is the only country where a commercial nuclear waste repository site has been selected with local government support. (p.7.)

The U.S. federal government has already paid out about $1 billion in claims and faces significant and growing liability arising from contracts DOE signed in 1983 and the 1987 Nuclear Waste Policy Act whereby the government was supposed to assume nuclear waste from commercial nuclear utilities. “The future estimated costs for storage of commercial SNF are approximately $500 million per year.” (pp. 7-8.)
The Department of Energy took possession of the spent fuel and debris from the 1979 Three Mile Island plant accident . (p. 25.)

“In the 1970s a relatively small amount (248.7 MTU of commercial SNF was shipped from commercial reactors, including utilities in Michigan and New York, to the West Valley site in New York, which reprocessed SNF for about six years (1966 to 1972). The resulting high-level waste and contaminated facilities remain at the site. DOE has estimated that decommissioning and environmental remediation of the contamination at the West Valley site will continue until at least 2020, cost $3.7 billion, and require indefinite long-term stewardship thereafter.” (pp. 25-26.)

In addition to the releases of tritium contamination from spent fuel pools and other structures to groundwater at 38 commercial nuclear sites, “tritium contamination was found in groundwater from spent fuel storage pools at DOE sites, including the Brookhaven National Laboratory in New York, Hanford in Washington State, and the Savannah River Site in South Carolina….Tritium is inherently difficult to remediate, once released, because it is simply a radioactive form of hydrogen that substitutes freely with hydrogen in water and decays at a rate of about 5% per year (12.32 year half life). (p. 34.)

The inherent hazards of spent nuclear fuel can result in a variety of risks. “A variety of forces or ‘threats’ acting on spent fuel could result in containment being breached, resulting in potential exposures and risks, generally: (1) loss of power for water supply, circulation, or cooling, which can have significant consequences for SNF in wet pool storage; (2) external threats, like hydrogen explosions from adjacent reactors, or an airplane crashing into an SNF storage facility; (3) long-term degradation of SNF through chronic corrosion of cladding (e.g., hydride corrosion); and (4) leakage of contaminated water from wet pools to groundwater.” (p. 30.) In contrast to the U.S. “Germany explicitly requires protection against risks, including ‘external events’ such as an attack on SNF

storage, and this has resulted in construction of hardened storage buildings for dry cask storage of SNF." (p. 32.)

"Another potential threat to SNF storage safety is degradation of the cladding and fuel elements." The potential for degradation of SNF cladding has been well known for decades. (p. 33.) "'Zirconium has a high affinity for hydrogen. Absorption of hydrogen leads to hydrogen embrittlement, which can lead to failure of the zirconium tubing used as cladding for nuclear fuel. In addition, zirconium also reacts with oxygen, which can lead to corrosion.'" (p. 33, fn 142, quoting Kok, Kenneth D, *Nuclear Engineering Handbook*, CRC press, 2009, at p. 287)]

Witherspoon, Roger, NRC Probes Indian Point Security, Energy Matters, Nov 21, 2013. http://spoonsenergymatters.wordpress.com/2013/11/21/are-terrorists-training-at-nuclear-plant-nrc-probes-indian-point-security/. [Reprting on serious security lapses at Indian Point. "Records show that for more than a decade, official at Indian Point have largely ignored instances where their internal security communications system was compromised and blocked by outside individuals. Whether the deliberate jamming of security communications is a decade-long prank or the result of individuals or groups using Indian Point safety drills as opportunities to test their own ability to cause mayhem during a terrorist attack is not known." Deliberate jamming was first reported in 2003 by James Lee With in an analysis of emergency planning for New York State. The problem forced cancellation of emergency drills in November 2012.

"Indeed, those who have hacked into Indian point's security have lately become so brazen that they have recorded instructions made by plant security officials at the beginning of drills, and then jammed the network's receivers by replaying those instructions over and over, according to participants, thus blocking any further use of the compromised security network. And the electronic intruders were apparently operating within a mile or two of the plant site."

Allegations of security failures at Indian Point have been made in a suit filed by two former security officers – Lt. Skip Travis and Lt. Jason Hettler –filed in U.S. District Court in August 2013 against Entergy include:

- "The falsification of work logs and fitness for duty reports, thus allowing security personnel to exceed the maximum permitted work hours per week despite being fatigued.
- "Jeopardizing the effectiveness of Force on Force drills by informing the security personnel of what routes the "invaders" would take to attack the plant.
- "A faulty perimeter detection system, which made it impossible for defenders to know where "terrorists" were breaking into the plant site and where they were on the grounds. As a result of being technologically blind during a drill monitored by the NRC on October 11, 2011, the suit states "all of the 'terrorists' successfully breached the perimeter and the identified target sets located inside of Indian Point and succeeded in causing a total nuclear meltdown. Not one terrorist was killed by any security personnel during the drill."
- "A combination of faulty detection equipment and internal communications allowed "terrorists" to succeed in in reaching all of their targets in an NRC-monitored, Force on Force drill in April, 2013. Hettler and Travis contend that had the April drill "been an actual terrorist attack, the 20 million individuals who live and work in the 50-mile radius meltdown zone would have perished."

- "An absence of backup power for the internal communications system. As a result, the security force could not communicate during station blackout conditions."

Witherspoon, Roger, NRC Probes Indian Point Security, Energy Matters, Nov 21, 2013. http://spoonsenergymatters.wordpress.com/2013/11/21/are-terrorists-training-at-nuclear-plant-nrc-probes-indian-point-security/
Witherspoon, Roger, Indian Point vs. Hudson River: hearings begin on cooling system impacts, Newsroom Jersey, Oct 17, 2011. http://www.newjerseynewsroom.com/science-updates/indian-point-vs-hudson-river-hearings-begin-on-cooling-system-impacts.
Witherspoon, Roger, Report critical of Indian Point 2, 3, Journal News, Dec 24, 2003. http://www.rogerwitherspoon.com/pdfs/energy/ipshutdowns.pdf.
Witherspoon, Roger, Nuclear water leaked into Hudson, Journal News, May 10, 2002. http://www.rogerwitherspoon.com/pdfs/energy/radioactivewaterintohudson.pdf.

Witt Report: Review of Emergency Preparedness of Areas Adjacent to Indian Point and Millstone, Report of James Lee Witt Associates, LLC, 2003.
http://www.nirs.org/reactorwatch/emergency/epwittrpt2003.pdf. [Report – commonly referred to as the "Witt Report" – results from the only comprehensive and independent review of emergency preparedness for Indian Point. It was commissioned by the State of New York at the direction of Governor George E. Pataki. James Lee Witt is a former Director of FEMA. The report describes in extensive detail, emergency planning inadequacies for Indian Point. "Plans are built on compliance with regulations, rather than a strategy that leads to structures and systems to protect from radiation exposure." "The plans do not consider the possible additional ramifications of a terrorist caused event." "The plans to not consider the reality and impacts of spontaneous evacuation." (p. vi) The report concludes emergency plans in the event of a major, especially fast, release of radiation from Indian Point "are not able to protect the public from an unacceptable dose of radiation." Interviews with first responders described in detail reveal a substantial lack of trust in the viability of evacuation. The report notes that planning problems are particularly and uniquely serious at Indian Point because of the large population concentrations near the plant and the area logistics. The report states: the "implications of a release faster or larger than those now being addressed also need to be considered. The low end of the time range specified in NUREG 0654 (as low as one-half hour) is not being sufficiently exercised." (p. x)
XY
Yablokov, 2009: Yablokov AV, Nesternenko VB, and Nesternenko AV., Chernobyl: Consequences of the Catastrophe for People and the Environment, New York Academy of Sciences (2009). [This study, published by the New York Academy of Sciences, estimated Chernobyl to be accountable for over 800,000 deaths, with morbidities expected to continue for several generations. The study is a monograph compiled from tens of thousands of Slavic and other non-English language studies. It constitutes the largest and most complete collection of data on the public health catastrophe resulting from the 1986 Chernobyl nuclear power plant disaster. The list of literature incorporated into the volume includes some 1,000 titles and reflects over 5,000 papers published primarily in the Slavic languages. Janette D. Sherman-Nevinger, MD, of the Environmental Institute at Western Michigan University, served as consulting editor of the English translation.

The lead author of the study, Alexey Vladimirovich Yablokov of the Russian Academy of Sciences in Moscow, served as a consultant to both Gorbachev and Yeltzin. Prof. Alexey Vassil'evich Nesterenko, was a member of the Russian Academy of Sciences in Moscow, Russia. The third author, Vassily B. Nesternenko), served at the Institute of Radiation Safety (BELRAD) in Belarus, Minsk. Trained as a nuclear design engineer, and prior to the Chernobyl disaster, he was Director of the Belarussian Nuclear Center.

In the forward to the volume, Prof. Dimitro M. Grodzinsky, Chairman of the Department of General Biology, Ukrainian National Academy of Sciences, and Chairman of the Ukrainian National Commission on Radiation Protection, writes: "The biological efficiency of cytogenic effects varies depending on whether the radiation is external or internal: internal radiation causes greater damage…With the passage of time, oncological diseases with loner latency periods, in particular breast and lung cancers', become more frequent. From year to year there has been an increase in nonmalignant diseases, which has raised the incidence of overall morbidity in children in areas affected by the catastrophe, and the percent of *practically healthy* children has continued to decrease. For example, in Kiev, Ukraine, where before the meltdown, up to 90% of children were considered healthy, the figure is now 20%. In some Ukrainian Poles' territories, there are no healthy children and morbidity has essentially increased for all aged groups." (p. viii)

Dr. Grodzinsky sums up the findings thusly: "The present volume probably provides the largest and most complete collection of data concerning the negative consequences of Chernobyl on the health of people and on the environment. Information…shows that these consequences do not decrease, but, in fact, are increasing and will continue to do so into the future….Over the next several future generations the health of people and of nature will continue to be adversely impacted." (p. ix)

Yablokov and colleagues begin the study with a review of the estimates of contamination through both time and geographic space, specify the primary radionuclides involved (e.g., Table 1.5, p. 19) and find the three most important determinants of affecting the environment and public health to be: (1) spotty/uneven deposits of contamination, (2) "hot" particle impacts, and (3) bioaccumulation of radionuclides. As to the spotty deposits, aerogamma studies, upon which most maps of contamination are based, give only average values of radioactivity for fairly large areas, thereby missing small, local, highly radioactive hot spots. An example given was the findings of the public health services of the French department Vosges on a "glowing" hog hit by a local hunter. Monitors then discovered that the entire mountain where the dead hog had run was radioactive at a level from 12,000 to 24,000 Bq/$m^{2.}$ (p. 19)

The epidemic of cancers is exhaustively reviewed.

The Yablokov study also – and uniquely – details the increase in *nonmalignant* diseases in radiation contaminated regions. Primary morbidities include increased cardiovascular disease; central nervous system disorders; immune deficiencies (including significant changes in cellular immunity, and findings of decreased T lymphocyte, T suppressor, and T helper cells); high incidences of eye problems; and accelerated aging.

The study stresses recognition of what is known as "Chernobyl AIDS," the overall increased incidence and seriousness of a complex array of multi-systemic morbidities, many of which have the characteristics of accelerated aging.]

Z

Zeller, Tom Jr., Nuclear Agency Is Criticized as Too Close to Its Industry, New York Times, May 8, 2011. http://www.nytimes.com/2011/05/08/business/energy-environment/08nrc.html?pagewanted=all ["In the fall of 2007, workers at the Byron nuclear power plant in Illinois were using a wire brush to clean a badly corroded steel pipe — one in a series that circulate cooling water to essential emergency equipment — when something unexpected happened: the brush poked through. The resulting leak caused a 12-day shutdown of the two reactors for

repairs. The plant's owner, the Excelon Corporation, had long known that corrosion was thinning most of these pipes. But rather than fix them, it repeatedly lowered the minimum thickness it deemed safe. By the time the pipe broke, Exelon had declared that pipe walls just three-hundredths of an inch thick — less than one-tenth the original minimum thickness — would be good enough."

"[S]afety experts say that if enough pipes had ruptured during a reactor accident, the result could easily have been a nuclear catastrophe at a plant just 100 miles west of Chicago."

No documented inspection of the pipes was made by anyone from the NRC for at least 8 years preceding the leak, and the NRC failed to notice that Exelon kept lowering the acceptable standard, a subsequent investigation by the NRC Inspector General found.

The NRC then gave a Exelon a reprimand for two low-level violations — "a tepid response all too common at the N.R.C., said George A. Mulley Jr., a former investigator with the inspector general's office who led the Byron inquiry. 'They always say, "Oh, but nothing happened,'" Mr. Mulley said. 'Well, sooner or later, our luck — you know, we're going to end up rolling craps.'"

"Critics have long painted the commission as well-intentioned but weak and compliant, and incapable of keeping close tabs on an industry to which it remains closely tied. …The Byron pipe leak is just one recent example of the agency's shortcomings, critics say. It has also taken nearly 30 years for the commission to get effective fireproofing installed in plants after an accident in Alabama. The N.R.C.'s decision to back down in a standoff with the operator of an Ohio plant a decade ago meant that a potentially dangerous hole went undetected for months. And the number of civil penalties paid by licensees has plummeted nearly 80 percent since the late 1990s — a reflection, critics say, of the commission's inclination to avoid ruffling the feathers of the nuclear industry and its Washington lobbyists…. The promise of lucrative industry work after officials leave the commission probably doesn't help, critics say, pointing to dozens over the years who have taken jobs with nuclear power companies and lobbying firms."

Congress created the NRC in the mid-1970s to try to remedy the inherent conflict that plagued its predecessor, the Atomic Energy Commission (AEC). "'It wasn't much of a change,' said Peter A. Bradford, a former N.R.C. commissioner…. ''The N.R.C. inherited the regulatory staff and adopted the rules and regulations of the A.E.C. intact.'"]

Zhang, H, Radiological Terrorism: Sabotage of Spent Fuel Pools. INESAP: International Network of Engineers and Scientists Against Proliferation (2003); 22: 75-78.
http://belfercenter.hks.harvard.edu/publication/364/radiological_terrorism.html.
[This paper is authored by Hui Zhang of the Project on Managing the Atom at the the Project on Managing the Atom at the Belfer Center for Science and International Affairs, Harvard Kennedy School.

"A 400 t PWR pool holds about 10 times more long-lived radioactivity than a reactor core. A radioactive release from such a pool would cause catastrophic consequences. One major concern is the fission product cesium-137 (Cs-137), which made a major contribution (about three quarters) to the long-term radiological impact of the 1986 Chernobyl accident. A spent fuel pool would contain tens of million curies of Cs-137. Cs-137 has a 30 year half-life; it is relatively volatile and a potent land contaminant. In comparison, the April 1986 Chernobyl accident released about 2 Mega Curies (MCi) Cs-137 into the atmosphere from the core of the 1,000 MWe unit 4. It is estimated that over 100,000 residents were permanently evacuated because of contamination by Cs-137.The total area of the radiation-control zone is about 10,000 km², in which the contamination level is greater than 15 Ci/km² of Cs-137."

"Assuming a 50-100% Cs137 release during a spent fuel fire, the consequence of the Cs-137 exceed those of the Chernobyl accident 8-17 times (2MCi release from Chernobyl). Based on the wedge model, the contaminated land areas can be estimated. For example, for a scenario of a 50% Cs-137 release from a 400 t SNF pool, about 95,000 km² (as far as 1,350 km) would be contaminated above 15 Ci/km² (as compared to 10,000 km² contaminated area above 15 Ci/km² at Chernobyl)."

The greatest concern is the possibility of significant release of radioactivity in a spent fuel fire, especially in the case of densely packed pools. "The most serious risk is the loss of pool water, which could expose spent fuel to the air, thus leading to an exothermal reactions of the zirconium cladding, which would catch fire at about 900 °C. Thus, the Cs-137 in the rods could be dispersed into the surrounding atmosphere. Based on a *Technical Study of Spent Fuel Pool Accident Risk at Decommissioning Nuclear Power Plant* in 2000, the US Nuclear Regulatory Commission (NRC) conceded that 'the possibility of a zirconium fire cannot be dismissed even many years after a final reactor shutdown.'"]

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[1] IPSEC does not want to waste the time of NRC staff by redundantly proffering points previously or concurrently being advanced in filings by other citizen and public interest groups and watchdog organizations. Accordingly, please deem these IPSEC Comments to incorporate and heartily support the comments of the following groups: Alliance for Nuclear Accountability; Beyond Nuclear; Blue Ridge Environmental Defense League; Center for a Sustainable Coast; Citizens Allied for Safe Energy; Citizens Environmental Alliance; Don't Waste Michigan; Ecology Party of Florida; Friends of the Earth; Georgia Women's Action for New Directions; Hudson River Sloop Clearwater; Institute for Energy and Environmental Research; Missouri Coalition for the Environment; NC WARN; Nevada Nuclear Waste Task Force; New England Coalition; Nuclear Information and Resource Service; Nuclear Watch South; Physicians for Social Responsibility; Public Citizen; Riverkeeper, Inc; San Luis Obispo Mothers for Peace; SEED Coalition; Sierra Club Nuclear Free Campaign; Southern Alliance for Clean Energy; and Union of Concerned Scientists.

[2] Certain radioactive isotopes like Iodine 129 (I-129) have half-lives of millions of years. Both Cesium 137 (Cs-137) and Strontium 90 (Sr-90) remain radioactive for hundreds of years, with half-lives of approximately 30 years. After a few half-lives of Cs-137 and Sr-90, the heat load in spent nuclear fuel is dominated for over 50 years by Americium 241 (Am-241), with a half-life of approximately 432 years. Am-241 is a precursor to Neptunium 237 (Np-237) which has a half-life of over 2 million years and is highly mobile in water.

[3] About 12,000 years ago, a major outbreak occurred on Lake Agassiz, which some experts estimate was as large as the current Black Sea. And 14,800 years ago, areas of the current Sahara desert were wet and fertile with full aquifers. Some 25,000 years ago the area now occupied by New York City was covered with ice roughly a mile high. These facts are noted to illustrate that dramatic natural events occur which dramatically transform waterways and landscapes.

[4] Plutonium emits alpha particles that can be inhaled into the lungs. If it enters the bloodstream, plutonium moves throughout the body and into the bones, liver, or other body organs. Plutonium that reaches body organs usually stays in the body for decades and continues to expose the surrounding tissue to radiation.

[5] A value system that focuses on public health, preserving the integrity of essential natural systems, averting climate change, making energy generation more democratic, and reducing homeland security risks and geopolitical conflict would, in contrast, promote expansion of efficiency technologies, advance transmission system modernization, and strive towards transition to energy systems which are renewable and sustainable. Energy policy encompasses a host of policy objectives.

[6] The very quirky exception made in the GEIS findings of no impact being "LARGE" is the area of "Historic and Cultural Resources." Apparently the GEIS authors view the potential destruction of things like a historic graveyard to be more problematic than the despoliation of the lands of a Native American reservation or the pollution of a National Heritage river. In the GEIS, the impact of loss of historic buildings and cultural assets is admitted may be "LARGE" with the explanation that such loss is permanent. Yet the impacts of "Public and Occupational Health" (i.e., illness and loss of human life due to radiation exposure) is deemed "SMALL." One would think death to also be a rather permanent condition. The sole additional finding of other than small is the concession that nonradioactive waste might have impacts that are "MODERATE." This is rather bizarre, given the determination that all impacts relating to highly radiotoxic material are "SMALL."

[7] Fukushima at least had emergency generators designed to operate for 8 hours. The NRC has allowed Indian Point and many other plants in the U.S. to operate with generators designed for only 4 hours. Notably, just this year, a supervisor, the Chemical Manager, at Indian Point was indicted and pled guilty on charges of falsifying tests relating to emergency diesel operation.

[8] The large-scale, broad geographic region power outages in the U.S. include those from Superstorm Sandy and the nor'easter which struck 3 days later in 2012 and the East Coast-Canada blackout of 2003 (during which, incidentally, Indian Point's emergency communications systems and emergency diesel generators failed. See NRC, Special Inspection Report, 2003).

[9] As noted, we have assayed to not to clutter up the body of these GEIS Comments with references and quotes. So supporting evidence is in the *References & Sources*.

[10] And for newer staffers at the agency, we have helpfully included some examples of what can go wrong in our *References & Sources*.
[11] Answer: The American taxpayers. (See Taxpayers for Common Sense; Wald, 2008)

[12] It is worthy of note that none of the individuals in the GEIS Table 9-1 List of Preparers put forth as having public and occupational health expertise are medical doctors. It is also perplexing that the GEIS determines nonradiological waste to be more of a health concern than radiological waste. Moreover, as earlier noted, the GEIS concedes that the impacts of nuclear waste might be "LARGE" with respect to historic and cultural resources, because the effects could be permanent, yet deems the impacts upon public and occupational health to be "SMALL." This is a rather bizarre given the fact that chronic illnesses and certainly loss of human life caused by radiation exposure would normally be seen as pretty permanent conditions.

[13] In fact, we found only one mention of the word "cyber" in the entire GEIS.

[14] Incidentally, aside from being informative, the book is a terrific read. (Brenner)

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