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Subject: Did Holian/Pham undermine NRC's Integrity? #2.

Attachments: NRC EQM Article.pdf

Staff,

The attached article is circulating around to the public, NGOs, and public interest groups. Is it true that some NRC staff claim that the project manager was removed from his PM position twice, only to be promoted to Branch Chief by the DLR division manager? No wonder staff report that DLR has the highest turnover in the agency. This is embarrassing.

JD

The Nuclear Regulatory Commission and NEPA Review

Why we need a new oversight and assessment process following Fukushima

Charles H. Eccleston

It's etched into our minds: A devastating earthquake in Japan, followed by a crushing tsunami. Then even more terrifying pictures as the Fukushima Dai-ichi nuclear power station went into meltdown mode.

When the tsunami hit Fukushima, it severed the power plant's connection to the electrical grid and flooded its backup generators, leaving the plant with no means to cool its nuclear fuel rods. The reactors at the plant began to overheat, causing hydrogen gas to build up. Then a series of explosions occurred, spewing massive amounts of radiation into the air.

The disaster at Fukushima Dai-ichi released 15,000 terabecquerels of highly radioactive cesium 137,[1] along with other radioactive material. The release of radiation forced officials to institute a 20-kilometer "exclusion zone" around the plant—most of which continues to be uninhabited more than a year after the accident. Radiation from the Fukushima incident has crept into Japan's food sources, including rice, fish, and beef. Cesium 137 and 139 have been found in baby milk formula.[2]

What we witnessed in Japan could happen elsewhere—including the United States, where 104 antiquated commercial nuclear reactors currently are operating. A severe accident could be triggered by an earthquake or other chance event, such as a major solar storm (a large solar event could disable much of the US power grid, cutting off the electricity required to cool reactors).

Despite these potential hazards, the United States Nuclear Regulatory Commission (referred to here as "NRC" or "the Commission") has failed to adequately evaluate the impact of serious nuclear accidents under the National Environmental Policy Act (NEPA).[3]

About This Article

This article explains why NRC needs to overhaul its NEPA review policy in light of the accident at Fukushima. It begins with some background on the Commission and its approach to regulating the commercial nuclear industry in the United States, with particular emphasis on how NRC handles its responsibilities under NEPA.

As the discussion makes clear, NRC policy is geared toward ensuring continued operation of nuclear power plants—despite a growing body of

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evidence about the risks and hazards facing the country's aging nuclear fleet. The Commission's focus on relicensing nuclear reactors on a highly aggressive schedule creates incentives to inadequately evaluate serious threats.

The Commission assumes that nuclear power plants are very unlikely to suffer severe accidents—an assumption that allows them to characterize the likely impacts of such accidents as being of "small" significance. But this assumption is unjustified and in fact cannot be scientifically supported, especially in light of the disaster at Fukushima.

NEPA was designed to prevent federal agencies from ignoring environmental impacts. As such, it offers a valuable tool for analyzing the risks associated with nuclear power plants. But the Commission gives little attention to the purpose and intent of NEPA review—essentially treating it as "window dressing." As this article makes clear, that needs to change.

NRC policy is geared toward ensuring continued operation of nuclear power plants—despite a growing body of evidence about the risks and hazards facing the country's aging nuclear fleet. The Commission's focus on relicensing nuclear reactors on a highly aggressive schedule creates incentives to inadequately evaluate serious threats.

Background: A Failed Response to Catastrophe

Before discussing the specifics of NEPA, it is useful to provide some background on how NRC has responded thus far to the Fukushima disaster. The meltdown at Fukushima shocked observers around the world—and forced many regulators and policymakers into action. On the heels of Fukushima, officials in Germany, Italy, and Switzerland declared their intent to transition away from nuclear power altogether and to accelerate reliance on renewable energy.[4] Japan has shut down all of its remaining nuclear power plants;[5] the country's last operating reactor went off-line in May 2012 for maintenance and may not be allowed to restart.[6]

By contrast, the response of NRC has been muted. In fact, the Fukushima disaster does not appear to have fundamentally changed the Commission's approach to NEPA and risk assessment. In the wake of the accident in Japan, NRC convened an agency task force to review policy and regulatory issues in the United States. But the Commission's handling of the task-force recommendations has drawn pointed criticism.

The task force recommended some broad-based changes at NRC, such as "clarifying the regulatory framework." But the Commission has paid little attention to this overarching concern, which many consider to be the key to more effective regulation of the nuclear industry. Rather, the Commission has focused on several of the more narrow task-force recommendations, which seek to address the specific types of failures that arose at Fukushima.[7]

Even on these narrow issues, NRC has made limited regulatory progress. Instead, the nuclear industry has stepped forward with a voluntary approach called the "FLEX strategy," which seeks to address "the loss of cooling capability and electrical power resulting from a severe natural event" such as the earthquake and tsunami that hit Fukushima. According to the Nuclear Energy Institute, an industry group, this strategy will rely on dispersing portable equipment among various locations at nuclear power plants and in "offsite support centers."[8]

Informed observers question whether the industry's FLEX strategy will be adequate to protect the American public. For instance, Dave Lochbaum and Edwin Lyman of the Union of Concerned Scientists note that nuclear power plants will simply be supplementing and dispersing equipment, without upgrading it to withstand

natural disasters such as earthquakes or floods. They note, "The industry is banking that enough equipment will be around so that some of it would be available in a catastrophe."[9]

Moreover, the emergence of a narrowly focused industry program as America's main policy response to Fukushima points up the inadequacies at NRC. Lochbaum and Lyman conclude:

> The NRC is downplaying its task force's most important recommendation and potentially undermining efforts to improve U.S. reactor safety. . . . All the while, the nuclear industry is outpacing the agency with a low-budget, voluntary and potentially ineffective plan.
>
> For the 116 million Americans who live within 50 miles of a nuclear plant, that's cold comfort.[10]

It is useful to keep this regulatory response in mind as we discuss the Commission's ongoing failure to meet the expectations of NEPA.

NEPA Requirements

Pursuant to NEPA, an environmental impact statement (EIS) must be prepared for any federal action that may significantly affect the quality of the human environment.[11] NEPA Section 102(2) states that an EIS must include, among other things:

- the environmental impact of the proposed action,
- any adverse environmental effects that cannot be avoided if the proposed action is implemented, and
- alternatives to the proposed action.

The purpose of an EIS is to evaluate potential environmental impacts, and then identify and assess alternatives for avoiding or reducing those impacts. NEPA is virtually the only "universal" mechanism that allows the public to provide input into the federal decision-making process.

NRC, NEPA, and a History of Controversy

NRC is an "independent agency," meaning that it operates outside the usual hierarchy of the federal government's executive branch. The Commission is not accountable to a cabinet secretary. Instead, it operates under statutory authority, as spelled out in the Energy Reorganization Act of 1974,[12] which created NRC.

The Commission referenced this independent status in the regulations it adopted regarding NEPA. Noting statutory language stating that "all agencies of the Federal Government shall comply with the procedures in section 102(2) of NEPA except where compliance would be inconsistent with other statutory requirements," the Commission states that it "recognizes a continuing obligation to conduct its domestic licensing and related regulatory functions in a manner which is both receptive to environmental concerns and consistent with the Commission's responsibility as an independent regulatory agency for protecting the radiological health and safety of the public."[13] As detailed in the next section, NRC and its predecessor have a long history of flouting NEPA's congressional intent.

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Calvert Cliffs: The First NEPA Challenge

The Commission has faced a number of challenges under NEPA over the years. In fact, actions taken by NRC's predecessor agency, the

Atomic Energy Commission (AEC), triggered the first major NEPA lawsuit, *Calvert Cliffs' Coordinating Committee v. United States Atomic Energy Commission.*[14]

The case involved a challenge to the Commission's NEPA implementation rules, which in effect treated the requirements of NEPA as mere formalities. Among other things, the rules provided that, when considering an application for a nuclear power plant construction permit or operating license, the Commission's hearing board did not even need to consider environmental concerns unless an outside party or staff member affirmatively raised them. As the court noted, the Commission was arguing that "it is enough that environmental data and evaluations merely 'accompany' an application through the review process, but receive no consideration whatever from the hearing board."

Among other things, the rules provided that, when considering an application for a nuclear power plant construction permit or operating license, the Commission's hearing board did not even need to consider environmental concerns unless an outside party or staff member affirmatively raised them.

The court strongly rejected the Commission's position, characterizing its approach as a "crabbed interpretation of NEPA" that "makes a mockery of the Act." Quoting from NEPA, the court said:

> Section 102 duties are qualified by the phrase "to the fullest extent possible." We must stress as forcefully as possible that this language does not provide an escape hatch for footdragging agencies; it does not make NEPA's procedural requirements somehow "discretionary." Congress did not intend the Act to be such a paper tiger. Indeed, the requirement of environmental consideration "to the fullest extent possible" sets a high standard for the agencies, a standard which must be rigorously enforced by the reviewing courts.

Throughout its decision, the court was highly critical of the Commission, noting for example that the "Commission's approach to statutory interpretation is strange indeed—so strange that it seems to reveal a rather thoroughgoing reluctance to meet the NEPA procedural obligations in the agency review process, the stage at which deliberation is most open to public examination and subject to the participation of public intervenors."

Moreover, in language that seemed to presage the Commission's response to Fukushima, the court noted, "It seems an unfortunate affliction of large organizations to resist new procedures and to envision massive roadblocks to their adoption."

The *Calvert Cliffs* case firmly established that NEPA requirements are binding and nondiscretionary. As the court noted, "Section 102 of NEPA mandates a particular sort of careful and informed decisionmaking process and creates judicially enforceable duties." Some 40 years later, critics counter that NRC is continuing to essentially ignore NEPA. More information on this landmark case can be found in two books by the author of this article: *NEPA and Environmental Planning: Tools, Techniques, and Approaches for Practitioners* and *Global Environmental Policy: Concepts, Principles, and Practice.*[15]

A Dubious Legacy

NRC and its predecessor, the AEC, have a long history of involvement with dubious and potentially dangerous projects. For example, in the late 1950s, the AEC approved plans to create an artificial harbor along the coastline of Alaska by detonating multiple nuclear devices. The initiative was dubbed Project Chariot.

In response to concerns raised about Project Chariot, Congress took the then-unprecedented step of ordering the AEC to prepare an "environmental report" for the proposal. As one commentator has noted, "Chariot was possibly the first government project challenged on ecological grounds, and occasioned the first integrated bioenvironmental study—the progenitor of the modern [NEPA] environmental impact statement."[16] In effect, the AEC was forced to produce the world's first *de facto* EIS.[17] Project Chariot was abandoned in 1962 after serious protests.

NEPA and Reactor Relicensing

Commercial nuclear reactors in the United States originally were licensed for operating periods of 40 years. These licenses are now nearing their expiration dates. As their licenses expire, nuclear reactors must go through a process of relicensing (technically referred to as "license renewal"). Whenever a reactor license is up for renewal, NRC prepares an environmental impact statement (technically, a supplemental EIS).

An Aging Reactor Fleet

NRC's Division of License Renewal (DLR), directed by Brian Holian, is responsible for relicensing (i.e., "license renewal") on the fleet of aging nuclear reactors. Bo Pham has managed DLR's project branch (RPB1), which prepared many of the safety evaluations and EISs for re-licensing these aging reactors. This license renewal process is intended to extend the operating licenses of nuclear reactors for an additional 20-year period, thus enlarging their operating window to 60 years. Serious attention is being given to further extending the operating period of nuclear reactors to 80 years or more.

Unfortunately, these existing reactors were based on outdated and antiquated technological designs, some of which are severely flawed. Let me note here that I am not necessarily against nuclear power if it is generated safely and responsibly. But it is clear that reactors now operating in the United States will encounter a growing number of potentially dangerous problems as they operate beyond their anticipated lifespan.

Here is how some experts have explained the problems posed by aging nuclear reactors, making a comparison with automobiles: Modern cars have safety belts, air bags, collision bumpers, computer-assisted controls, and antilock brakes, and are honeycombed with reinforced steel and modern carbon composites. Automobiles from the 1960s and 1970s lack most of these safety features. Moreover, a 40- or 50-year-old car has exceeded its lifespan and can be expected to break down frequently, increasing the chance of a serious accident. As with cars, there is a world of difference between a new generation of modern nuclear reactors and those built in the 1960s and 1970s.

It is clear that reactors now operating in the United States will encounter a growing number of potentially dangerous problems as they operate beyond their anticipated lifespan.

The United Nations' International Atomic Energy Agency (IAEA) recently prepared a draft report on aging nuclear reactors, noting that about 80 percent of nuclear power plants around the world are over 20 years old. The draft report noted, "There are growing expectations that older nuclear reactors should meet enhanced safety objectives, closer to that of recent or future reactor designs." But it warned, "There is a concern about the ability of the ageing nuclear fleet to fulfill these expectations. . . ."[18]

The report went on to state that those who wish to extend the operating lifetime of nuclear power plants "must thoroughly analyze the safety aspects related to the ageing of 'irreplaceable' key components."[19] It is important to ask how the IAEA's findings square with NRC's handling of re-

actor license renewals—particularly (as discussed below) the Commission's refusal to consider many of the safety and environmental issues brought up in public NEPA comments.

Prioritizing License Renewal

By any measure, it is clear that nuclear power plants rely on one of the most perilous technologies ever developed. So the standards that regulate these plants must make safety a priority issue. But critics charge that safety is being compromised in an effort to keep America's aging nuclear fleet operating as long as possible.

Consider the following key fact: Not a single nuclear reactor in the United States has ever been denied a renewed operating license. As one NRC staff member grudgingly acknowledged, "No licensing application has been rejected, and I will be surprised if one is ever rejected."[20]

It has become clear that NRC is following a fast-paced and carefully choreographed process designed to relicense aging nuclear reactors as expeditiously as possible.

What most concerns critics and informed members of the public is how the Commission is handling the license renewal process. It has become clear that NRC is following a fast-paced and carefully choreographed process designed to relicense aging nuclear reactors as expeditiously as possible.

NRC management has mandated that all relicensing applications are to be completed within 18 months. Project managers are scrutinized on their ability to complete relicensing within this 18-month window, regardless of the complexity of the issues involved. Senior-level NRC management routinely monitors the progress of relicensing project schedules.

Japan's experience clearly illustrates what can happen when schedules and sloppiness trump quality, environmental concerns, and safety issues. These problems are precisely what Congress was trying to avoid when it passed NEPA: The idea was to ensure that agency schedules, funding, management goals, and political factors did not lead decision makers to ignore environmental and safety concerns.

Management and Morale Problems

DLR, which is responsible for relicensing nuclear reactors in the United States, has been plagued by morale problems. Even its own project managers have complained about management, environmental, and safety-related issues. DLR staff members report that the division has experienced the highest turnover rate of the entire NRC.[21]

The morale and management issues at DLR became so significant that a decision was made to hold employee focus-group meetings with staff and project managers to determine the root cause of these problems. DLR personnel were not shy about voicing critical comments.[22] Particularly disconcerting were statements such as the following, which were made during the project managers' focus-group meeting:[23]

- DLR is "sacrificing quality for schedule."
- "Managers are schedule-driven and have dominant personalities."
- DLR managers are "bypassing the regulatory process and compromising the safety mission to impress upper management."
- "Poor management decisions" are being made.
- There are "strained relations between project managers and management" (because management places pressure on project managers to shortcut the process).
- DLR "managers don't listen—they act like know-it-alls."
- DLR "managers are arrogant."
- Some DLR managers are "very condescending."[24]

Particularly troubling was the fact that these comments were not lodged by outside "anti-nuclear" critics, but by the very project managers responsible for preparing the EISs and safety evaluations required for nuclear plant relicensing.

Perhaps most troubling are comments such as those charging that DLR management is "sacrificing quality for schedule" and "bypassing the regulatory process and compromising the safety mission." This observation captures a key concern with the license renewal process at NRC.

Failure to Consider Alternatives to License Renewal

As noted earlier, NRC prepares an EIS whenever a nuclear reactor license is up for renewal. The purpose of the EIS is to evaluate environmental and safety impacts of continued operation and to identify and assess alternatives to renewing the operating license for an additional period of 20 years.

Each EIS includes a chapter on alternatives to the proposed action of license renewal. Under NEPA, alternatives analysis is supposed to play a critical role in informing decision makers about possible alternative courses of action (including the option of taking no action). This requirement has been reinforced by decades of NEPA case law. However, the public is often bewildered to learn that alternatives to reactor license renewal have never been given serious consideration by NRC decision makers. The entire chapter on alternatives is written solely to satisfy NEPA's legal requirement to identify alternatives so that the NRC cannot be challenged on the basis that it does not address alternatives in its EISs.

DLR's own staff members have publicly admitted that the Commission does not seriously consider alternatives beyond the option of relicensing nuclear power plants. For instance, at a public meeting on renewing the operating license for the Cooper Nuclear Station in Nebraska, the NRC project manager discussed the consideration of alternatives. When asked about the choice of taking no action or shutting down the reactor, Bennett Brady, the project manager, candidly and publicly admitted, "that option wasn't even considered because of the important role which Cooper Nuclear Station plays in providing energy."[25]

In other words, the project manager in charge of relicensing the reactor openly admitted in a public meeting that while the no-action alternative (in addition to all the other alternatives) was described in the EIS, it would not even be considered by the final decision maker—a stance that would appear to violate years of NEPA case law. One is left to wonder what the point of preparing the EIS even was.

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Neglecting Stakeholder Concerns

Members of the public are invited to comment on applications for nuclear reactor license renewal. However, many public comments are simply dismissed, often because NRC argues that they fall outside the plant's "licensing basis." (For additional information on this topic, readers are referred to the author's book *Inside Energy*.[26])

For instance, in connection with one license renewal application, an electrical engineer for the US Department of Energy submitted a public comment voicing concern that a giant solar flare could destroy the plant's cooling capability, resulting in a catastrophic meltdown.[27] This individual was an expert on the subject, and the comment actually pertained to all commercial nuclear reactors in the United States, not just to the particular reactor being reviewed for license renewal. His concern was real and tangible, not simply a theoretical exercise.

Nonetheless, RPB1's management response was to dismiss the consequence as "mitigatable," without offering any solid evidence that such an event could in fact be properly mitigated.[28] The DLR dismissed this concern during an informal meeting, and no study or assessment of any kind was performed to support NRC's conclusion. NRC made no effort to alert the operators of the nuclear reactor so that they could study the problem and perhaps institute mitigation measures. In addition, the project manager was chided for spending too long addressing the issue and warned not to let the project schedule slide. This appears to be the way the Commission routinely handles the bulk of their public NEPA comments.[29]

NRC clearly places more emphasis on completing the relicensing of nuclear reactors on schedule than on taking the time to adequately investigate and evaluate potentially catastrophic impacts and how they might be mitigated.

Those who are familiar with the history of the Fukushima nuclear reactors may find this story particularly troubling. They will recall that Japanese officials similarly dismissed concerns about the potential damage from a giant tsunami. Like NRC, Japan's regulators conducted no detailed studies to substantiate their conclusion but instead simply issued a memo stating that the concern was essentially a nonissue.

DLR/RPB1 management has routinely dismissed EIS comments on the potential effects of earthquakes, hurricanes, tsunamis, and flooding, frequently arguing that they fall outside the nuclear reactor's "licensing basis." Unless required to do so by courts, the Commission has also consistently refused to evaluate the potential impacts of terrorist attacks (it maintained that stance even following the tragic events of 9/11). How many other serious safety and environmental issues have been ignored?

NRC clearly places more emphasis on completing the relicensing of nuclear reactors on schedule than on taking the time to adequately investigate and evaluate potentially catastrophic impacts and how they might be mitigated. The Commission's "assembly line" approach to relicensing approvals is preventing it from seeking valuable input that might help identify and prevent a future nuclear calamity like Fukushima.

Flawed Risk Analysis: Dismissing the Dangers

NRC routinely dismisses concerns about the risks posed by events such as earthquakes and hurricanes, arguing that nuclear reactors are capable of withstanding most such events that are likely to occur. The Commission's conclusions frequently are adopted by courts. For example, in the mid-1980s, the US Court of Appeals for the District of Columbia Circuit ruled against opponents of the Diablo Canyon nuclear plant, accepting NRC's argument that the risks posed to the plant by earthquakes were "negligible."[30]

Since that time, however, geologists have discovered that seismic risks pose a much more serious danger than previously recognized. For instance, recent evidence "indicates that the single worst earthquake likely to happen in a 10,000-year period in Chattanooga, [Tennessee,] would be nearly twice as damaging to structures as previously calculated."[31]

Accordingly, in early 2012, NRC announced that it will require the operators of 96 reactors in the eastern and central United States to re-evaluate whether their plants could withstand the risks posed by seismic events.[32] The new requirement was issued partly in response to a recent report that reassessed seismic risks in these areas of the United States.[33]

The need for this new analysis was reinforced by events in August 2011, when an earthquake

hit the Mid-Atlantic coast and "knocked two Virginia nuclear reactors offline." A preliminary finding by the Commission indicated that this "earthquake was more severe than the reactors were built to withstand."[34]

Although the Commission's new requirement is a welcome development, observers might ask why it has taken NRC so long to act in this area. Many of the plants that are being told to reevaluate their seismic risk have already been relicensed to continue operating for another 20 years. Even if these plants install upgrades in response to their required reassessment of risk, many experts fear that the changes will be insufficient to ensure safety at some reactors, especially older units that suffer from inherent design flaws. Moreover, if past experience offers any guide, we might expect that both plant operators and NRC will conclude that the risks identified by the required reassessment are "small" or "acceptable."

The concerns about risk expressed in NEPA comments often are dismissed as far-fetched or extreme. But Fukushima shows that unforeseen catastrophes can and do happen. Events that many assume to be extremely unlikely have in fact occurred repeatedly at nuclear power plants, including plants in the United States. For example, in describing two nuclear incidents from the early 1980s, the *New York Times* noted:

> American nuclear safety regulators, using a complex mathematical technique, determined that the simultaneous failure of both emergency shutdown systems that are designed to prevent a core meltdown was so unlikely that it would happen once every 17,000 years.
>
> But 20 years ago, it happened twice in four days at a pair of nuclear reactors in southern New Jersey.[35]

As these incidents make clear, nuclear power plants need to "expect the unexpected" and be prepared for multiple system failures. At the Fukushima Dai-ichi complex, the nuclear reactors managed to survive the initial magnitude 9.0 earthquake. However, the quake severed all the power lines connecting the plant to the electrical grid. At that point, 12 onsite diesel generators automatically kicked on to provide backup power for the emergency cooling system. But only a few minutes later, a massive tsunami struck, flooding the backup generators and leaving the reactors with no source of power for cooling. The end result: three nuclear meltdowns and emission of highly radioactive contaminants over a large area of the island.

The concerns about risk expressed in NEPA comments often are dismissed as far-fetched or extreme. But Fukushima shows that unforeseen catastrophes can and do happen.

Reactors at Risk

The US nuclear reactor fleet faces a range of hazards and risks, as the following discussion outlines. Yet NRC has failed to seriously consider most of these critical issues in its NEPA analyses. As a result, the public is largely unaware of the potential risks.

Fukushima-Style Technology in the United States

The reactors that melted down at Fukushima relied on outdated "boiling water" technology. In this type of reactor, the nuclear core heats water to the boiling point, turning it to steam. The energy created by this steam then powers turbines that generate electricity. Like many older reactors of this type, those at Fukushima relied on a form of containment known as "Mark I."

The United States has 23 boiling-water nuclear reactors that depend on the same type of containment used at Fukushima.[36] Given the past

track record, all of these reactors will likely receive renewed operating licenses. But the dangers posed by Mark I design have never been seriously addressed in a relicensing EIS—even though the Commission has been aware of problems with this design since the early 1970s.[37]

Transcripts of NRC emergency meetings held as the Fukushima disaster was unfolding reveal concerns by officials about Mark I. In an audio file from March 16, 2011, the Commission's Deputy Regional Administrator for Construction in Region II, Charles Casto, was quoted as saying that Mark I is "the worst one of all the containments we have." He went on to say that "in a station blackout, you're going to lose containment [resulting in release of highly radioactive material]. There's no doubt about it." Casto further observed that "the one thing the [NRC crisis guide for boiling-water reactors] doesn't really do is tell you how to stop [a meltdown], how to mitigate it, other than keeping water on it."[38]

NRC's license renewal EISs have failed to even acknowledge or consider the hazards posed by renewing the licenses for flawed designs such as the Mark I. Not surprisingly, the public is left in the dark, unaware of the potential risks.

NRC was fully aware of this safety issue in part because of computer modeling studies that it had already conducted.[39] To determine the consequences of a serious nuclear accident, the Commission has used computer models to evaluate reactors at two nuclear power plants that it considers to be representative: the Surry Power Station in Virginia (which uses a pressurized-water reactor) and the Peach Bottom Atomic Power Station in Pennsylvania (which uses boiling-water reactors similar to those at Fukushima).

The computer model has considered a range of scenarios, including one in which an earthquake cuts off all electrical power at the plants. The model predicted that if the Peach Bottom plant lost both primary and backup power, its reactor core could begin to melt down within 9 to 16 hours, and that the Mark I containment would fail within about 20 hours. Reports about the modeling study indicated that the "breached reactor would then spew '16 percent of the core inventory'—'inventory' meaning cesium 137, along with 68 other radioactive isotopes in the hot nuclear fuel. The consequences of the release, the analysis concluded, 'could be serious.'"[40]

The actual impacts of an accident would likely be even greater than those predicted by the model, however. NRC's modeling scenarios considered only one reactor at each of the locations studied, even though both plants operate dual reactors. As one author noted, "Multiple reactors might be expected to be similarly troubled by shared challenges, as seen during the Fukushima crisis."[41]

NRC's modeling studies seem to have had little influence on its relicensing decisions. In fact, on March 10, 2011—the day before disaster struck in Japan—the Commission voted to relicense the Vermont Yankee Nuclear Power Station, which uses boiling-water reactors similar to those at Fukushima. The renewed license would allow the plant to operate until 2032.[42] NRC's license renewal EISs have failed to even acknowledge or consider the hazards posed by renewing the licenses for flawed designs such as the Mark I. Not surprisingly, the public is left in the dark, unaware of the potential risks.

Cooling and Backup Power

Nuclear reactors require constant power to cool them and prevent a meltdown. They continue to generate large amounts of heat even after they have been shut down. Electrical power is required to run the cooling system and prevent this residual heat from building up. If a reactor's main electrical power supply is lost, backup batteries or diesel generators are designed to kick in.

The US nuclear regulations generally assume that backup batteries will need to be used for only a short time. Currently, reactors in the United States are required to have only two hours of battery power. The Commission is planning to revise this rule, but it is clear that even significantly longer battery backup could prove inadequate in the event of a serious emergency. At Fukushima, backup batteries had enough power to last for eight hours, but they were quickly depleted once other sources of electricity failed.[43] Contrary to NEPA's intent, DLR's license renewal EISs do not acknowledge or consider such issues. Consequently, most of the public is unaware of the danger.

Spent Fuel Dangers

Nuclear power plants in the United States (like those in Japan) typically store their spent fuel on-site, usually in large pools. A catastrophic accident could impact this spent fuel, with potentially devastating consequences. At Fukushima, explosions that occurred as the reactors melted down

> tore open reactor buildings, damaging the 12-meter-deep pools where [spent] nuclear fuel is kept cool, potentially setting off another meltdown in the fuel there as the surrounding water drained away or boiled off. Densely packed spent fuel without water can heat enough to burst its zirconium cladding and, ultimately, set the cladding ablaze.[44]

This could result in a catastrophic release of highly radioactive waste that may be more serious than the meltdown of the reactor itself.

DLR's relicensing EISs fail to devote any serious consideration to the spent fuel issue, let alone evaluating possible alternatives or mitigation measures. One alternative might involve requiring plant operators to remove spent fuel from pools after it has cooled down and place it in more secure storage using concrete and steel casks, thus significantly reducing the amount of "radioactive inventory" that would be released to the environment in the event of an accident.[45] But this alternative (like other potential measures) has been ignored. Again the general public has yet to learn of the impending risks.

Catastrophic Flooding

At Fukushima, the power plant's sea wall was only 5.7 meters high—and it was quickly overwhelmed when a 15-meter tsunami struck.[46] The giant wave knocked out backup generators, leaving the plant with no power except for batteries, which lasted only hours.

DLR's relicensing EISs fail to devote any serious consideration to the spent fuel issue, let alone evaluating possible alternatives or mitigation measures.

At the time the Fukushima reactors were built, a significant body of evidence already pointed to the potential for massive tsunamis along the coast of Japan. For example, a wave 38 meters high had been recorded north of the Fukushima site.[47] The engineers who built Fukushima Daiichi should have been aware that their sea wall protection was inadequate. Clearly, those who made the decision to build the sea wall were either negligent for not taking the risk into consideration or incompetent for not having understood the potential safety and environmental consequences.

Tsunamis or floods pose major risks to many nuclear reactors around the world, including in the United States. How many US reactors may suffer from similar design flaws in terms of their ability to withstand catastrophic floods, tsunamis, or dam failures? Yet DLR has routinely

dismissed EIS comments concerning events such as tsunamis and natural events by stating, "The issue does not fall within the plant's 'licensing basis.'" The public has yet to be informed about the true nature of the risks they are facing.

Are the Consequences of a Nuclear Meltdown Really "Small"?

Chapter 5 of the license renewal EIS, entitled "Environmental Impacts of Postulated Accidents," evaluates the consequences of "severe accidents" (accidents such as a nuclear meltdown) at nuclear facilities. Among the scenarios that could lead to such accidents are sabotage and "beyond design-basis" earthquakes (i.e., earthquakes the reactor is not designed to withstand).

We must assume that severe accidents at nuclear power plants are not only likely but probable, especially as reactors grow older and operate well beyond their designed lifespan. Thus, DLR's conclusion that the effects of an accident are "small" cannot be justified scientifically.

Most experts would consider serious accidents at nuclear power plants to be among the most catastrophic events that might occur anywhere in the world. However, the EISs produced by DLR typically conclude with a statement such as "the probability-weighted consequences of atmospheric releases, fallout onto open bodies of water, releases to ground water, and societal and economic impacts of severe accidents are of small significance. However, alternatives to mitigate severe accidents must be considered for all plants that have not considered such alternatives."

Stakeholders might wonder how DLR could reach such a counterintuitive conclusion. How does the Commission justify assigning a "small" impact to a potentially catastrophic nuclear meltdown?

The answer is simple: NRC employs mathematical trickery. They recognize that the consequences of a meltdown would be enormous. But they multiply these consequences by what they assume to be the probability of an accident occurring—which they argue is very small. So they rationalize that when something "catastrophic" is multiplied by something "very small," then the result must be "small." In effect, the Commission concludes that the human, environmental, and socioeconomic impacts of a catastrophic accident would be "small" because the probability of their occurrence is remote.

When the public and stakeholders hear about NRC's reasoning, many are baffled. After all, a serious nuclear accident might require tens or hundreds of thousands of people to evacuate their homes, facing possible permanent dislocation. It could lead to radiation deaths, birth defects, and property damage in the hundreds of billions of dollars. Sizable areas of land could suffer long-term contamination. Direct costs of cleanup and indirect costs from evacuation and disrupted business might run into the tens or even hundreds of billions of dollars. And of course those affected would suffer significant psychological trauma.

Clearly, the only way the Commission can arrive at its finding of "small significance" is by assuming that the possibility of a severe accident is extremely remote—in fact, close to zero. NRC has always maintained that the risk of a severe nuclear accident is low. And yet we know from experience that serious accidents are not remote events. They can and do occur at nuclear power plants.

In the few decades that nuclear power plants have been in operation around the world, we have already witnessed major disasters at Three Mile Island, Chernobyl, and Fukushima. Moreover, the United States has witnessed four other near nuclear catastrophes:

- Browns Ferry nuclear reactor incident,
- Vogtle nuclear reactor incident,
- Davis-Besse nuclear reactor incident, and
- Salem nuclear reactor incident.

While a full-scale nuclear reactor accident was averted in each case, all four incidents came perilously close to disaster. The public is often surprised to learn that one of these near misses, the Davis-Besse Nuclear Power Station incident, occurred as recently as 2002.

An interdisciplinary team led by the Massachusetts Institute of Technology has estimated that, given the projected growth in nuclear power from 2005 to 2055, at least four serious nuclear accidents would be likely to occur within that period.[48,49] To date, there have been five serious accidents around the globe since 1970 (one at Three Mile Island in 1979, one at Chernobyl in 1986, and three at Fukushima Dai-ichi in 2011). This suggests an average of one serious accident happening every eight years worldwide.[50]

In view of this history, we must assume that severe accidents at nuclear power plants are not only likely but probable, especially as reactors grow older and operate well beyond their designed lifespan. Thus, DLR's conclusion that the effects of an accident are "small" cannot be justified scientifically. According to the international firm UBS AG, the Fukushima disaster has cast doubt on whether even an advanced economy like Japan can safely master nuclear safety.[51]

Slighting NEPA

NRC's approach sidesteps the serious consideration called for by NEPA. A typical EIS prepared by the Commission runs for hundreds of pages and examines every conceivable impact of nuclear power plant operation, from air emissions to water usage. Then, when it comes to the real issue that everyone worries about—the concern that lies at the heart of the entire licensing process—the Commission provides nothing but a cursory dismissal of potential impacts and a curt conclusion that the consequences of a large-scale accident or meltdown would be of "small significance."

Clearly, NRC is going to great lengths to dismiss the only real consideration that could prevent the issuance of a renewed reactor operating license. For more information on the details of the Commission's flawed significance assessments, see the author's book *Preparing NEPA Environmental Assessments*.[52]

"Significant New Information" After Fukushima

For years, DLR's "mathematical magic" has convinced many observers among the media and the public that the risk of a nuclear accident is "small" and extremely unlikely to happen. But in light of the Japanese experience, it is now clear that the risk of a catastrophic accident is real, and that the impacts can be enormously destructive.

Rather than using NEPA as a scientific assessment process to honestly and publicly evaluate impacts and weigh alternatives, NRC seems to view it simply as another hurdle to jump over in its accelerated mission to relicense the nation's fleet of aging reactors.

The Fukushima disaster has revealed significant new information about several issues of relevance to the United States. It has made clear that many reactors now operating in this country (especially boiling-water reactors) have serious design flaws that make catastrophic meltdown much more likely than previously recognized. It has also shown how devastating a severe accident can be in terms of its impacts on health, the environment, and the economy of the area affected.

The NEPA regulations state that agencies must prepare new EISs when significant new information is discovered. The relevant provision states that agencies "[s]hall prepare supplements to either draft or final environmental impact statements if . . . [t]here are significant new circumstances or information relevant to environmental concerns and bearing on the proposed action or its impacts."[53]

After Fukushima, it is clear that "significant new information" regarding the consequences

of a catastrophic accident now exists. This new information affects license renewal EISs now under preparation, as well as those previously issued by DLR. Under the applicable regulations, this significant new information demands that supplemental EISs be prepared for every nuclear power plant license renewal granted to date. EISs currently in preparation also need to be revised to reflect this new information.

Moreover, the new information now available should force the Commission to change its conclusion that the consequences of a severe nuclear accident are of "small significance." It would be more appropriate for NRC to assign a finding of "large" or perhaps even "catastrophic" to such impacts.

After Fukushima, it is clear that NRC's approach is misleading and inadequate. Like the EU, it should comprehensively reevaluate its license renewal EISs and safety assessments.

Of course, tsunamis and flooding are not the only hazards that can affect nuclear power plants. The Commission should carry out a comprehensive reassessment of all possible hazards, while also rigorously evaluating alternatives and mitigation measures.

Understanding What Is at Stake

Rather than using NEPA as a scientific assessment process to honestly and publicly evaluate impacts and weigh alternatives, NRC seems to view it simply as another hurdle to jump over in its accelerated mission to relicense the nation's fleet of aging reactors. But a process that rubber stamps nuclear operating license renewals on the shortest possible schedule will ultimately leave major questions for society—and especially for stakeholders who must live with the consequences of the Commission's decisions.

What does NRC's approach say about nuclear power plant licenses that have already been renewed? Do stakeholders fully appreciate the extent to which public concerns are routinely dismissed? Do they realize that regulators have gone through a cursory process of noting alternatives and mitigation measures without affording them serious attention?

Does the public understand that the true cumulative risk posed by nuclear power plants has never been fully examined, and that they are at greater risk of an accident than each individual EIS would lead them to believe?[54] Do they know how the Commission has arrived at its conclusion that the risk from a nuclear reactor accident is of "small significance"? Would such knowledge affect the way they might react to renewals of nuclear power plant licenses?

Chip Lagdon, chief of nuclear safety with the US Department of Energy, has been quoted as saying, "You always worry about what you haven't analyzed."[55] The European Union has taken this lesson to heart. The EU has already ordered its member states to perform a comprehensive reassessment of all their nuclear power plants. They must evaluate how well these plants could withstand threats and hazards of all types "from earthquakes and floods to plane crashes and even terrorist attacks."[56]

Yet NRC fails to even seriously address EIS public comments that they deem to be outside a nuclear power plant's "original licensing basis." Likewise, the Commission is reluctant to evaluate scenarios such as terrorist attacks unless a federal court within the affected jurisdiction has already ruled that it must do so.

Fulfilling the Promise of NEPA

It is important to note that the problems outlined in this article are not a reflection on DLR's technical staff. Instead, as indicated earlier, these problems are a result of systemic mismanagement.

After Fukushima, it is clear that NRC's approach is misleading and inadequate. Like the EU, it should comprehensively reevaluate its license renewal EISs and safety assessments. Edwin Lyman

of the Union of Concerned Scientists has suggested that nuclear energy firms should "undertake a detailed threat analysis for each plant with 'a set of severe accident scenarios.'"[57] This is also exactly what license renewal EISs should be doing.

Accomplishing such full-scale reassessment will be no small feat. It will require substantial time and effort to prepare supplemental EISs for every license renewal application granted to date. In the meantime, the status of operating plants that have already received renewed licenses will remain uncertain.

Moreover, fully complying with NEPA will force NRC to seriously consider imposing more stringent (and perhaps costly) mitigation requirements on nuclear power plants. It might even mean that the Commission will refuse to grant operating license renewals to some plants that pose particularly grave threats.

But doing so will mean that the Commission is finally implementing NEPA as originally intended. EIS preparation will become a true planning and decision-making process, rather than an exercise in going through the motions.

As the disaster at Fukushima taught us, a catastrophic meltdown can occur with frightening rapidity. Some experts warn that the impacts from a major accident could be so severe that a major city (or even the better part of an entire state) could be "lost" to human habitation. Fulfilling the promise of NEPA could be costly—but far less costly than the impacts from a preventable nuclear accident.

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