Union of Concerned Scientists

POLICY BRIEF

Nuclear Goldilocks

The Nuclear Regulatory Commission (NRC) strives to be a nuclear Goldilocks, establishing and enforcing regulations that are neither too harsh nor too lax but just right. An unnecessarily harsh regulator imposes undue burdens on nuclear plant owners by forcing them to devote resources to measures above and beyond those needed to adequately protect workers and the public. An unnecessarily lax regulator exposes workers and the public to undue risks from reactors operating with insufficient safety margins. A regulator that is "just right" is fair to one and all.

Harshness Checks

The NRC employs numerous tools to guard against harsh regulatory oversight. For example, the backfit rule[1] and associated regulatory analysis[2] prevent the agency from issuing or revising regulations unless they are either cost-beneficial or clearly warranted for safety. The NRC's staff prepares a formal regulatory analysis and issues it for public comment to allow stakeholders ample opportunity to express their views whether the proposed regulation is "just right" or not.

> ***The NRC's formal checks against harsh or lax regulatory oversight guide the agency towards its "just right" goal. But they are not enough. They fail to consider cumulative effects that could detour the agency to "just plain wrong."***

Revisions to the NRC's emergency planning regulations following the tragic events of 9/11 illustrate this harshness check. The NRC's evaluation of that tragedy recommended changes to its regulations covering preparations for and response to nuclear plant accidents. Because terrorist attacks happen on a different timescale and are of a different nature than accidents, the NRC determined that existing emergency planning provisions needed to be upgraded. The NRC finalized revisions to the emergency planning regulations in April 2011.[3] The 60-page regulatory analysis prepared by the NRC concluded that the proposed regulatory changes would cost slightly under $500,000 to implement at each nuclear plant, but concluded the benefits derived from the changes justified these costs. Thus, the backfit rule and regulatory analysis are not barriers to new and revised regulations—they are barriers to new and revised regulations that unjustly impose costs outweighing their benefits.

The NRC can, and does, impose regulatory requirements outside its rulemaking process. For example, the NRC issues generic communications[4] requiring owners to implement, revise, or supplement maintenance, training, operations, or engineering practices. In this case, the NRC uses its Committee to Review Generic Requirements (CRGR)[5] to avoid imposing unjustified requirements on plant owners. CRGR formally evaluates proposed generic communications to determine if all requirements they impose are properly justified.

CRGR's annual report to the NRC Commissioners[6] illustrates this harshness check. In the prior year, the CRGR reviewed ten proposed generic communications and two draft technical reports. Among the former was a draft generic letter regarding protection of in-plant electrical circuits against under-voltage. Among the latter was a draft revision to NUREG-1022[7] conveying the agency's expectations for plant owners reporting safety and security problems. The CRGR determined that no new or revised regulatory requirements would be imposed on plant owners by these documents.

Laxness Checks

The NRC similarly uses tools before waiving regulatory requirements. For example, the NRC will prepare a formal Notice of Enforcement Discretion (NOED)[8] before allowing a reactor to continue operating outside the requirements specified in its license.

The NOED issued on October 5, 2011, by the NRC to the owner of the Monticello nuclear plant in Minnesota demonstrated this laxness check in action.[9] Monticello has two emergency diesel generators that are normally in standby mode but can rapidly start within seconds to power essential safety equipment during an accident. At least once every 24 months, workers are required by the operating licensed issued by the NRC to start each emergency diesel generator, have it supply electricity to the largest load it would need to power during an accident, and then turn off the diesel generator to verify that no damage results to it or its load. Workers at Monticello discovered a flaw in the testing procedure they had been using for years. They had been connecting the largest electric motor to each emergency diesel generator for the tests, but that motor had not been operated as hard as it might during an accident. Consequently, the tests had been conducted with the load on the emergency diesel generators about 20 percent below the electricity demand that would be present during an accident. The deficient testing procedure compelled the owner to invalidate all past tests and declare both emergency diesel generators inoperable. The operating license required the reactor to be shut down within 12 hours when both emergency diesel generators were inoperable. The NOED allowed the reactor to remain operating for up to five days while workers first fixed the procedural error and then conducted the corrected test on each emergency diesel generator. The NOED formally evaluated the risk from the reactor continuing to operate during the additional 4½ days and concluded it was both small and justified.

Cumulative Effects

The NRC's formal checks against harsh or lax regulatory oversight guide the agency towards its "just right" goal. But they are not enough. They fail to consider cumulative effects that could detour the agency to "just plain wrong." How could regulatory requirements properly judged "just right" individually be anything but "just right" in aggregation? Consider a bee sting. Most people can survive a single bee sting without more than a little pain and discomfort for a short while. That outcome could easily change if one disturbs a bee hive and experiences dozens of stings. Likewise, while an individual regulatory requirement may be neither too harsh or too lax, a combination of them could potentially stray off-target.

CUMULATIVE EFFECT OF REGULATION CAMPAIGN

Recognizing this possibility, the NRC embarked on a campaign to consider the potential harmful impacts from the cumulative effects of regulation. In October 2012, the NRC outlined the potential adverse consequences its campaign sought to avoid:

> *Cumulative Effects of Regulation describes the challenges that licensees, or other impacted entities (such as State partners) face while implementing new regulatory positions, programs, or requirements (e.g., rules, generic letters, backfits, inspections). Cumulative Effects of Regulation is an organizational effectiveness challenge that results from a licensee or impacted entity implementing a number of complex regulatory positions, programs or requirements within a limited implementation period and with available resources (which may include limited available expertise to address a specific issue). Cumulative Effects of Regulation can potentially distract license or entity staff from executing other primary duties that ensure safety or security.*[10]

The NRC's campaign is worthwhile because the agency should avoid overly harsh regulatory oversight whether achieved by one large step or several smaller steps.

CUMULATIVE DEFECT OF NON-REGULATION NON-CAMPAIGN

Unfortunately, the NRC lacks comparable means to guard against potentially adverse consequences from the cumulative effects of non-regulation. The Davis-Besse debacle from a decade ago illustrates the problem, which consists of two parts.

(1) In spring 2001, workers at the Oconee nuclear plant in South Carolina discovered that cooling water had leaked through a crack in one of the vertical metal tubes, called control rod drive mechanism nozzles, passing through the top of the reactor vessel. Leaks from this location had not previously occurred at the nation's 69 pressurized water reactors (PWRs), including the three at Oconee. Inspection protocols in place at that time did not even examine those portions of the tubes. If cracks grew larger, the more rapid loss of cooling water could pose the risk of reactor core damage caused by from overheating. The NRC examined the situation and concluded it was not unique to Oconee. The NRC identified nearly a dozen highly vulnerable reactors, including Davis-Besse. In August 2001, the NRC ordered inspections of the metal tubes at these dozen reactors by the end of the year. Some reactors were scheduled to be shut down for refueling that fall.[11] Others, like Davis-Besse, had no pre-existing plans to shut down but would need to do so in order to perform the inspections. The NRC justified allowing these vulnerable reactors to continue operating for months despite this hazard based on the highly reliable emergency core cooling system. Each reactor had an array of pumps that could provide ample makeup water to the reactor vessel to more than compensate for water inventory lost through a completely severed metal tube. The NRC relied on this safety net to let Davis-Besse and

TABLE 1. FAIR as of 3/11/2014

	Acme Nuclear One	Springfield Unit 1	Springfield Unit 2
Earthquake design	✓		
Fire protection		✓ (04/2016)	✓ (11/2015)
Flooding protection	✓		
NOED		✓ (03/21/2014)	
NRC violation			✓ (09/2014)
PWR containment sump	✓ (03/2015)		
ROP Column 4	✓		
ROP Column 3		✓	

the other reactors continue operating. Considered alone, this regulatory decision seemed "just right."

(2) In September 1996, the NRC staff initiated what it termed Generic Safety Issue 191, also called the PWR sump performance issue.[12] The emergency core cooling systems for PWRs feature a two-phase approach. If a pipe connected to the reactor vessel breaks to allow cooling water to escape, the emergency core cooling system pumps first react by transferring water from large storage tanks into the vessel. This makeup water flows through the reactor core protecting the nuclear fuel from overheating, then spills from the broken pipe into the containment building. The spilled water flows by gravity into the basement and collects in a concrete pit called the sump. Before the storage tanks empty, the emergency core cooling pumps swap over to take water from the containment sump. This second phase has the emergency core cooling system pumps recirculating from the sump through the reactor vessel to cool the core. The problem the NRC identified in fall 1996 involved the high velocity fluid jetting from the broken pipe scouring paint off walls, coatings off equipment, and insulation from piping. The water will then transport some of this debris with it into the sump. If the debris blocked the flow of water to the emergency core cooling system pumps, the reactor core could overheat. The NRC justified allowing the PWRs, including Davis-Besse, to continue operating based on the high quality standards and extensive inspection regime for piping connected to the reactor vessel that minimized the chances of a rupture. The NRC would prefer the PWR containment sump safety net be in place, but recognized it was highly unlikely that Davis-Besse and the other PWRs would need it. Considered alone, this regulatory decision seemed "just right."

The problem is that the NRC formally evaluated each of these safety problems individually. In 2001, the NRC permitted Davis-Besse to continue operating despite elevated risk of a pipe rupture based on the high reliability of the emergency makeup pumps. Earlier, the NRC permitted Davis-Besse to continue operating despite elevated risk that the emergency makeup pumps would fail based on the low risk of a pipe rupture. As a result, Davis-Besse operated for months with both heightened threat of pipe rupture and reduced protection against it. Researchers at the Oak Ridge National Laboratory estimated that the metal tube at Davis-Besse would have severely ruptured in as little as two more months of operation. Had it ruptured with the containment sump problem unresolved, the accident would likely have been worse than Three Mile Island but not as bad as Fukushima—two bad events to be bracketed within.

A decade later, the NRC continues to evaluate safety problems individually and has no campaign or effort underway to evaluate the cumulative effects of non-regulation. Some PWRs still have not resolved the PWR containment sump problem raised more than 17 years ago. Nearly half of the reactors in the U.S. have never complied with the NRC's fire protection regulations. Nearly a third of the reactors in the U.S. may not be properly protected against flooding should an upstream dam fail. Nearly a quarter of the reactors in the U.S. may not be properly protected against damage caused by an earthquake.[13] But the NRC assesses each of these and numerous other afflictions in isolation and fails to evaluate their cumulative effect. It is simply impossible to connect-the-dots to see the entire picture by focusing on a single dot.

Parity is "Just Right"

UCS in no way faults the NRC for its harshness checks or its cumulative effects of regulation campaign. Such efforts reap a safety dividend because every dollar spent unnecessarily represents a dollar unavailable for prudent safety investment.

UCS faults the NRC for not matching its cumulative effect of regulation campaign with similar efforts intended to protect against the cumulative defect from non-regulation. If nuclear Goldilocks warrants a campaign to protect owners against an aggregation of individually justified measures collectively being overly harsh, then comparable measures must be employed to protect the public from overly lax conditions created by the accumulation of individually justified unresolved safety problems.

FAIR is Fair

The NRC could develop and maintain a list of Factors Adversely Impacting Risk (FAIR) for each operating reactor. The FAIR lists would include all safety problems known to be unresolved along with any applicable target resolution dates. When new problems emerged and old problems got fixed, the FAIR lists would be updated accordingly.

The FAIR approach would not necessarily change NRC's decisions. For example, consider a case like that shown in the table above. The NRC might grant an NOED for Acme Nuclear One despite its having four pre-existing safety issues. The NRC could determine that the NOED is independent from the other issues and therefore does not undermine any of the NRC's previous justifications. The NRC could therefore determine that a fifth safety issue is still "just right."

The FAIR approach might change NRC's decisions. It might determine the NOED coupled with another pre-existing safety issue creates too large a vulnerability. In that case, the NRC might decline to issue the NOED. Alternatively, the NRC might decide to issue the NOED conditional on additional measures that adequately compensate for the synergistic effects from multiple safety issues.

Equipped with and informed by these lists, NRC's regulatory decisions could be "just right" individually and collectively. The FAIR lists could also help the NRC allocate prioritize resolution of safety issues by clearly indicating those efforts that, when completed, would take the most X's off the chart.

ENDNOTES

1 See *http://www.nrc.gov/reading-rm/doc-collections/cfr/part050/part050-0109.html.*
2 See *http://www.nrc.gov/reading-rm/doc-collections/nuregs/brochures/br0058/br0058r4.pdf.*
3 See *http://www.nrc.gov/reading-rm/doc-collections/commission/secys/2011/2011-0053scy.pdf.*
4 See *http://www.nrc.gov/reading-rm/doc-collections/gen-comm.*
5 See *http://www.nrc.gov/about-nrc/regulatory/crgr.html.*
6 See *http://adamswebsearch2.nrc.gov/webSearch2/main.jsp?AccessionNumber='ML13240A188'.*
7 See *http://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr1022.*
8 See *http://www.nrc.gov/reading-rm/doc-collections/enforcement/notices/noedreactor.html.*
9 See *http://pbadupws.nrc.gov/docs/ML1127/ML11278A176.pdf*
10 See *http://www.nrc.gov/reading-rm/doc-collections/commission/secys/2012/2012-0137scy.pdf.*
11 See *http://www.nrc.gov/reactors/operating/ops-experience/pressure-boundary-integrity/overview.html#five.*
12 See *http://www.nrc.gov/reactors/operating/ops-experience/pwr-sump-performance.html.*
13 See *http://www.ucsusa.org/nuclear_power/reactor-map/embedded-flash-map.html* to see which reactors have which afflictions.

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