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On U.S. Commercial Nuclear Reactor Safety and Security

Before the

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Chairman Barrasso, Ranking Member Carper, and other distinguished members of the Committee on Environment and Public Works:

Good morning. My name is Edwin Lyman. I am the acting director of the Nuclear Safety Project at the Union of Concerned Scientists (UCS) and a senior scientist with the UCS Global Security Program. On behalf of UCS, I greatly appreciate the opportunity to provide testimony on the important subject of nuclear power reactor safety and security.

The Union of Concerned Scientists (UCS) has half a million supporters united by a central concern: that we need sound scientific analysis to create a healthy, safe, and sustainable future. UCS, while neither pro- nor anti-nuclear power, has served as a nuclear safety and security watchdog for fifty years. Combating the threat of global climate change is one of our priorities, and we believe the operating nuclear reactor fleet should continue to play a role in a low-carbon economy—but only if it meets high standards of safety and security.[1] The Nuclear Regulatory Commission (NRC) plays an essential role in protecting public health and safety from accidents and terrorist attacks at nuclear reactors. And stringent Congressional oversight is critical to ensure that the NRC does its job well.

We agree with the assessment of Dr. Peter Lyons and two other former NRC chairmen, published in *The Hill* earlier this year, that the "secret ingredient" of a successful nuclear power

[1] Union of Concerned Scientists, "The Nuclear Power Dilemma," October 9, 2018. Online at https://www.ucsusa.org/resources/nuclear-power-dilemma

program is "high-quality, independent regulation."[2] The credibility of the NRC depends on its ability to remain independent from the industry that it regulates, and to demonstrate its integrity to the public through its actions rather than its words. Unfortunately, this independence is under threat. Over the last few years I have heard an increasing number of complaints by NRC staff from different offices that the agency's independence is being compromised by undue influence by the nuclear industry. And this influence is increasingly apparent in the NRC's actions. The NRC openly seeks to achieve alignment with industry positions in public meetings before moving forward with regulatory actions. And the majority of recent decisions by the agency's political leadership have been in the industry's favor, often at the expense of safety and security. Below, I discuss our concerns regarding some recent NRC activities that could have a profound effect on public health and safety going forward.

Stripped-down post-Fukushima regulations

A good example of a decision detrimental to safety is the Commission's 3-2 vote earlier this year to significantly scale back a new rule intended to address safety gaps in the NRC's regulatory framework uncovered after the 2011 Fukushima nuclear accident in Japan. A root cause of that accident was severe tsunami-driven flooding that inundated the site to a height far greater than the peak level the plant owner had assumed could occur. This resulted in a near-complete loss of electrical power, the failure of essential nuclear fuel cooling systems, and ultimately the meltdown of three reactor cores. The ensuing radiation release to the environment—the second worst after Chernobyl—contaminated thousands of square miles with long-lived radioisotopes,

[2] Dale Klein, Peter Lyons and Richard Meserve, "Secret ingredient of nuclear success: independent regulation." *The Hill*, July 23, 2019. Online at https://thehill.com/opinion/energy-environment/454381-secret-ingredient-of-nuclear-success-independent-regulation

displaced 160,000 individuals from their homes, and seriously damaged the Japanese economy and nuclear power sector. Estimates of the accident's total cost range from $200 billion to more than $700 billion.[3]

The new NRC rule would have required nuclear reactor owners to upgrade their plans for protecting their plants from Fukushima-type accidents to account for the most recent information regarding flooding and seismic hazards at their sites. Such upgrades are critical because most nuclear plants are not protected against the hazards they are known to face today, much less the increasingly severe challenges they are likely to encounter in the future as a result of climate change. However, the majority of commissioners voted to not require such upgrades, leaving most plants needlessly vulnerable to catastrophic natural disasters. (UCS greatly appreciates the letter that Senators Carper and Whitehouse sent to the NRC in response to this irresponsible decision.)

Weakened reactor safety oversight

In addition to establishing requirements, the NRC is also responsible for ensuring those requirements are met through inspecting nuclear facilities, assessing the safety significance of any regulatory violations or performance issues that it finds, and taking appropriate enforcement actions so that violations are corrected. In 2000, the NRC instituted a program called the Reactor Oversight Process (ROP), in part to create a framework for more consistent and transparent safety and security oversight.

[3] Atsushi Komori, "Think tank puts cost to address nuclear disaster up to 81 trillion yen," *Asahi Shinbun*, March 10, 2019. Online at http://www.asahi.com/ajw/articles/AJ201903100044.html

The U.S. nuclear reactor fleet is facing major challenges that could negatively impact safety in the absence of rigorous oversight. For one thing, it is getting older. The average age of the 96 operating US power reactors is 38 years, according to the Energy Information Administration, and the NRC has extended nearly all their operating licenses from 40 to 60 years. Six reactors have applied for additional 20-year extensions to 80 years, and many more such applications are planned. At the same time, stiff competition from low-cost natural gas has placed many plants under financial strain and at risk of early closure. This is putting pressure on reactor owners to slash operating costs.

As reactors get older, they require more intensive and frequent monitoring and maintenance to detect and correct aging-related degradation of structures and safety equipment before it can cause major problems. Thus they need more attention from the regulator, not less. But the NRC is now considering making significant changes to the Reactor Oversight Process (what it calls "enhancements"), which would scale back its inspections of the aging reactor fleet and weaken its regulatory responses to safety violations. These changes would take the program in the wrong direction.

The NRC has not taken up the worst ideas that the industry has floated, such as replacing certain NRC inspections with self-inspections by reactor owners (perhaps with the recent Boeing 737 MAX 8 fiasco in mind). However, the commissioners are currently considering staff recommendations that include reducing the hours and sample sizes of many critical reactor safety inspections, including fire protection, and reducing the frequencies of others, such as the "problem identification and resolution" inspection. While the NRC staff claims these changes

would increase efficiency, NRC Commissioner Jeff Baran has called these "very bad proposals that would roll back safety and security standards and weaken NRC's oversight of our licensees."[4] Commissioner Annie Caputo has also said that she agrees in "a lot of ways" with Commissioner Baran's concerns.[5] However, the Commission has not yet voted on these proposals.

The nuclear industry is also pressing the NRC to make changes in how it assesses the significance of safety violations, which determines the level of oversight the NRC will apply to each reactor, including the number of inspections it will conduct. Inspection findings and other indicators of plant performance are assigned colors (Green, White, Yellow or Red) that denote their safety significance, with Green denoting "very low safety significance" and Red denoting "high safety significance." The numbers and colors of violations within each of seven "cornerstones of safe operation" governs the placement of reactors on a five-column "Action Matrix" and the corresponding regulatory responses.[6] Plant owners do not like to receive color findings that are greater than Green, and they often spend considerable time and resources to contest them (which some call "fighting the White"). The industry would like to get rid of the

[4] U.S. Nuclear Regulatory Commission, "Meeting on Transformation at the NRC – Becoming a Modern, Risk-Informed Regulator," October 29, 2019. Transcript at https://www.nrc.gov/docs/ML1930/ML19305D098.pdf

[5] U.S. Nuclear Regulatory Commission, "All Employees' Meeting," September 9, 2019. Transcript at https://www.nrc.gov/docs/ML1925/ML19255E449.pdf

[6] The Action Matrix is a scorecard that ranks overall nuclear reactor safety and security performance in one of five categories, ranging from best (Column 1) to worst (Column 5). Each quarter, the position of each plant in the matrix is updated. Plants that end up in Columns 2 and higher are subject to progressively more intensive oversight, including supplemental inspections.

category of White findings altogether. While the NRC is not currently planning to go that far, it is considering other ways to diminish its response to greater-than-Green findings.

It's important to note that the NRC has already changed the Reactor Oversight Process to make it harder for reactors to receive greater-than-Green findings and be shifted to higher Action Matrix columns. On October 3, 2007, the Clean Air and Nuclear Safety Subcommittee of EPW held a hearing on the Reactor Oversight Process, chaired by Senator Carper and attended by several current members of this committee. Senator Carper pointed out that at the time of the hearing, ten reactors were in Column 3 of the Action Matrix (one degraded safety cornerstone), and one was in Column 4 (multiple degraded safety cornerstones). Also, at the time there were nineteen reactors in Column 2 (regulatory response). This left seventy-four reactors, or 71 percent of the 104-reactor fleet, in Column 1 (licensee response).

Today, there is only one reactor—Grand Gulf in Mississippi—in Column 2. The remaining 95 operating reactors—99 percent—are in column 1. At first glance, this appears to signify a major increase in safety of the nuclear fleet over the last 12 years. But it is not possible to directly compare these assessments because of numerous changes that the NRC made over that time, in response to industry complaints, that redefined the meanings of the various columns. In particular, these changes raised the bar for issuing White findings and for moving plants to higher columns in the Action Matrix, reducing the level of regulatory oversight for safety violations.[7] This has made it more difficult for the public to see how nuclear safety is changing

[7] U.S. Nuclear Regulatory Commission, "Staff Requirements Memorandum—Recommendation to Revise the Definition of Degraded Cornerstone as Used in the Reactor Oversight Process," SRM-SECY-15-0108, December 2, 2015. Online at https://www.nrc.gov/docs/ML1533/ML15335A559.pdf

over time. In fact, the NRC staff itself doesn't fully understand the impacts of some of the changes it has made to the assessment process.

Other metrics do not support the notion that nuclear safety has significantly improved in recent years. Key safety indicators, such as the average number of sudden, unplanned shutdowns (known as "scrams"), have not shown statistically significant improvements over the period from fiscal year 2006 to fiscal year 2015 (the last time that the NRC publicly released such an analysis).[8] And in the last few years, the number of scrams across the fleet has been increasing—from 39 in 2017 to 46 in 2018 to about 48 (according to a UCS tally) so far in 2019 —even as the number of operating reactors has decreased. Meanwhile, the number of safety inspection "findings," or violations, dropped 42 percent from 2015 to 2018—a reduction that the NRC was not able to associate with a corresponding improvement in performance over that period. Instead, the decrease may be partly due to industry pushback against potential findings, as well as an increase in the threshold for reportable findings set by NRC management.[9]

The NRC should not continue to weaken the Reactor Oversight Process and make it even harder for the agency to detect safety problems and mandate fixes at aging reactors in a timely manner.

[8] U.S. Nuclear Regulatory Commission, "Fiscal Year 2015 Results of the Industry Trends Program for Operating Power Reactors," SECY-16-0044, April 5, 2016. Online at https://www.nrc.gov/docs/ML1605/ML16050A462.pdf

[9] U.S. Nuclear Regulatory Commission, "Analysis of Inspection Findings Trend at Nuclear Power Reactors Between 2015 and 2018." August 15, 2019. Online at https://www.nrc.gov/docs/ML1922/ML19225D281.pdf

Diminished security inspections[10]

Protection of nuclear plants against terrorist attacks is another area where the NRC is weakening its standards and oversight in response to industry complaints about cost. This is a mistake. Nuclear plants must have robust physical security. A terrorist sabotage attack could cause enough damage to nuclear reactor or spent fuel pool safety systems to cause a meltdown and radiation release as severe as Fukushima or even Chernobyl.

The NRC requires nuclear reactor owners to protect their facilities from attacks by adversaries with a set of assumed characteristics called the "design basis threat." Experience has shown that security plans that look acceptable on paper have weaknesses in practice. Consequently, those plans need to be tested through performance-based inspections. The NRC assesses security force performance through triennial "force-on-force" inspections that are required by law (Section 651 of the Energy Policy Act of 2005). These NRC-run inspections utilize mock commando-style attacking forces to test the performance of the armed response forces at nuclear power plants. Every year, the NRC conducts these inspections at about one-third of nuclear plant sites, and since 2012 the annual failure rate has been about 5 percent. That number should be zero.

Nuclear power reactor licensees, as represented by the Nuclear Energy Institute (NEI), have complained for years that force-on-force inspections are unrealistic and an undue burden, and have consistently pressured the NRC to make the inspections less challenging or even to eliminate them entirely in favor of licensee-run exercises.

[10] E. Lyman, "Update on the Decline of the NRC's Security Inspection Program," 60th Annual Meeting of the Institute of Nuclear Materials Management, Palm Desert, CA, July 14-18, 2019. Online at https://www.dropbox.com/s/o1jdphpcvce69hb/inmm2019paper%20lyman-219.pdf?dl=0

And the NRC has listened. In 2014, the agency reduced the number of force-on-force exercises per inspection from three to two, reducing the quantity of information they provide to the agency for assessing security performance. And in 2018, the NRC further reduced the number of exercises per inspection to a single one. In lieu of the second NRC-run exercise, the NRC would inspect an exercise run by the plant owners themselves. In such exercises, the owner chooses the attack scenario, and all the players are drawn from the plant security force. But these self-run exercises are simply not adequate substitutes for NRC-run force-on-force inspections, given the potential conflict of interest.

The NRC is considering even more changes that could weaken nuclear plant security, including giving credit for assumed off-site law enforcement response. This would relieve plant owners from the sole responsibility of defending their facilities from the design basis threat adversary, allowing them to reduce the size and quality of their own armed response forces. At the same time, the NRC has decided not to update the design basis threat to require plant owners to consider the additional tactical capabilities that rapid advances in drone technology could provide to terrorists.[11]

Safety and security of spent fuel storage

While spent nuclear fuel in principle can be managed safely and securely at reactors, the NRC has failed to take steps to remediate a dangerous situation that exposes millions of Americans to needless risk: the potential for fires in dangerously overloaded spent fuel pools. If an earthquake

[11] Union of Concerned Scientists, "NRC Decision Leaves Nuclear Plants Vulnerable to Terrorist Drones," November 4, 2019. https://www.ucsusa.org/about/news/nrc-decision-leaves-nuclear-plants-vulnerable-terrorist-drones

or a terrorist attack were to damage a spent fuel pool at a reactor, causing it to rapidly lose its cooling water, the spent fuel could heat up and burn, releasing a large fraction of its highly radioactive contents into the environment. This risk is present as long as spent fuel remains in storage pools, even at decommissioning plants.

The consequences of such an event would be truly disastrous. A Princeton University study calculated that a spent fuel pool fire at the Peach Bottom nuclear plant in Pennsylvania could heavily contaminate over 30,000 square miles with long-lived radioactivity and require the long-term relocation of nearly 20 million people.[12] Depending on the wind direction and other factors, the plume could reach anywhere from Maine to Georgia. The impact on the American economy would be profound.

The consequences of such a fire would be greatly reduced if nuclear plants thinned out their spent fuel pools by transferring older fuel to dry storage casks. Yet the NRC has refused to require nuclear plants to do so, insisting that the risk is tolerable. And the industry will not voluntarily spend the money to buy additional dry casks, despite their modest cost in relation to the potential economic damages from a pool fire.

Also, the NRC routinely grants exemptions to decommissioning reactors from important safety and security requirements, such as the need to maintain a 10-mile emergency planning zone and a cyber security plan, even before all spent fuel is transferred out of the pool and the fire risk is

[12] https://wws.princeton.edu/news-and-events/news/item/us-nuclear-regulators-greatly-underestimate-potential-nuclear-disaster

eliminated completely. Recently, NRC commissioner Jeff Baran objected to granting an emergency planning exemption to the Pilgrim plant in Massachusetts, citing concerns by the Federal Emergency Management Agency (FEMA).[13]

While the risk of a large radiological release is greatly reduced when spent fuel is moved from high-density pools to dry casks, it does not go down to zero. One must also be concerned about sabotage attacks on dry storage casks. Indeed, during security reviews following the 9/11 attacks, the NRC discovered ways to sabotage dry storage casks that could cause significant radiological releases. Accordingly, a decade ago agency staff began developing upgraded requirements for protecting dry cask storage facilities from sabotage—whether at operating reactor sites, decommissioning sites, or consolidated sites. However, the NRC delayed development of these new requirements, citing resource constraints, and is now likely to terminate the rulemaking altogether, leaving spent nuclear fuel in dry casks vulnerable to known terrorist threats.

These issues represent only a few of the safety and security concerns we have with the NRC's current regulatory approach. UCS encourages Congress to continue to exercise close oversight over the agency so that nuclear power will remain a safe and secure option for U.S. low-carbon energy in the future.

Thank you for your attention. I would be happy to answer your questions.

[13] U.S. Nuclear Regulatory Commission, Commission Voting Record, "Request by Entergy Nuclear Operations, Inc. for Exemptions from Certain Emergency Planning Requirements for the Pilgrim Nuclear Power Station," CVR-SECY-19-0078, November 4, 2019. Online at https://www.nrc.gov/docs/ML1930/ML19308A042.pdf