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Congress of the United States
House of Representatives
Washington, DC 20515–2107

December 1, 2011

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

Dear Chairman Jaczko:

I am writing to you in response to the recent release of the results of a Nuclear Regulatory Commission (NRC) investigation of an August 9, 2011 shutdown of the Palisades Nuclear Power Plant[1]. The circumstances surrounding this shutdown, which was due to a service water (SW) pump failure, led the NRC to issue a preliminary White enforcement finding yesterday. I am concerned that this failure is the latest in a string of similar incidents at Palisades and other nuclear power plants over the last two decades, and may be related to the continued use of types 410 and 416 martensitic stainless steel (410SS and 416SS), which are used in components of SW pumps at nuclear power plants.

As you know, 410SS and 416SS steels have been employed in the coupling mechanism for joining pump shafts in SW systems in a number of nuclear power plants for decades. SW systems include vertical deep draft pumps that provide cooling water to safety related equipment such as component cooling water, containment air coolers, diesel generators, and control room coolers. The pumps are critical to reactor safety, and I am concerned that despite a well-known history of problems related to the vulnerability of these metals to intergranular stress corrosion cracking (IGSCC), they continue to be used and continue to cause failures in U.S. nuclear power plants.

As the NRC has noted[2], there is a collection of scientific literature and industry operating experience describing the vulnerability of 410SS and 416SS steels to IGSCC degradation, in which cracks form, propagate as stress opens cracks that are subject to corrosion, which are then corroded further, weakening the metal through further cracking.

Three simultaneous conditions must be present for such corrosion and cracking to occur: susceptible material, tensile stress, and a harsh environment. 410SS and 416SS steels are inherently susceptible to IGSCC due to embrittlement from the tempering and hardening process in its manufacture. In SW pump couplings, the nature of the coupling function ensures tensile stress. However, it was assumed that these stainless steel grades could safely be used in SW

[1] Palisades Nuclear Plant, NRC Inspection Report 05000255/2011016; Preliminary White Finding
[2] Palisades Nuclear Plant - NRC Special Inspection Team (SIT) Report 05000255/2011012

pumps because they are rated to operate without corrosion in fresh water. Nonetheless, a number of pump failures from this type of corrosion have been reported to the NRC since at least 1991. In the following documented pump failure events, the failure mechanism was IGSCC in 410SS or 416SS components:

- June 20, 1991 Beaver Valley Power Station[3]
- September 22, 1993 Indian Point Energy Center[2]
- May 2001 VC Summer Nuclear Station[4]
- September 1, 2003 Perry Nuclear Power Plant[5]
- May 21, 2004 Perry Nuclear Power Plant[6]
- June 14, 2005 Columbia Generating Station[7]
- September 29, 2009 Palisades Nuclear Power Plant[8]
- July 2010 Prairie Island Nuclear Generating Plant[2]
- August 9, 2011 Palisades Nuclear Power Plant[2]

NRC's licensees have also been alerted to these problems by the NRC and others on several occasions:

- On September 1, 1993, the NRC issued an Information Notice[3] informing licensees of problems stemming from temper embrittlement of 410SS supplied by Byron-Jackson, referring to the 1991 Beaver Valley pump coupling failure.
- In 2006, the Institute of Nuclear Power Operations released a communication[9] that discussed SW pump shaft, coupling and impeller failures occurring in the industry. The report noted that 12 failures occurred between 1998 and 2006, with the most frequent including corrosion causing coupling separation.
- On February 9, 2007, the NRC issued a second Information Notice[7] referencing the 410SS pump coupling failures due to IGSCC that occurred at the Columbia Generating Station. The operating experience review identified at least 23 essential SW pump shaft and coupling failures since 1983 involving more than six different manufacturers. Many of these pump failures involved IGSCC as a primary cause.

The purpose of such communications is ostensibly to alert licensees to these potential safety problems, presumably so that they can take measures to prevent their recurrence. However, these failures evidently have continued, and I believe that is at least in part because licensees have not been required to take any action or even report back to the NRC regarding what they are doing to identify, mitigate or prevent this corrosion cracking.

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[3] Information Notice 93-68: Failure of Pump Shaft Coupling Caused by Temper Embrittlement During Manufacture
[4] NRC Inspection Report No. 50-395/02-06
[5] Final Significance Determination for a White Finding (NRC Inspection Report 50-440/2004-005)
[6] Perry Nuclear Power Plant NRC Special Inspection Report 05000440/2004011
[7] NRC Information Notice 2007-05: Vertical Deep Draft Pump Shaft and Coupling Failures
[8] Licensee Event Report 2010-001, Potential Loss of Safety Function Due to a Service Water Pump Shaft Coupling Failure Palisades Nuclear Plant, Docket 50-255, License No. DPR-20
[9] Operating Experience Digest 2006-02, Institute of Nuclear Power Operations

In the most recent pump failure due to IGSCC in a 416SS coupling, which resulted in the November 30, 2011 NRC preliminary White enforcement finding, the pump in question had also failed two years prior. The NRC found that "...the licensee failed to take into consideration significant operating experience from as early as 1993 and as late as 2010 that linked IGSCC susceptibility of 410 and 416 stainless steels to temper embrittlement."[1] This demonstrates that merely making available information about the problem to licensees is not enough to assure that the appropriate steps will be taken.

This lack of a requirement for action is particularly alarming considering how the NRC's 2007 Information Notice characterizes the IGSCC problems in pumps: "These failures might not be detected by commonly employed condition monitoring, during routine operations, or from surveillance test or IST results. Pump shaft and coupling failures can challenge operability even though performance degradation over time may appear consistent with normal wear. Operating experience also shows that pump shaft failures and coupling failures can result in sudden total loss of flow before standard performance monitoring techniques alert plant staff to the impending failure."

The NRC General Design Criterion 1 requires that all components, such as pumps and valves, that are necessary for safe operation be tested to demonstrate that they will perform satisfactorily in service. The failures outlined above clearly show that pump components made with 410SS and 416SS do not rise to the standard of performing satisfactorily in service, and I believe that further mandatory NRC action is in order. Therefore, I ask that you address the following:

1. Please provide copies of of any licensee voluntary responses to the NRC's 1993 and 2007 Information Notices.
2. Please provide a list of all U.S. nuclear power plants currently using 410SS and 416SS components.
3. Please provide a list of all the known uses of 410SS and 416SS steels in nuclear power plants.
4. In April 2005, NRC published a review of the performance of steel Alloy 600 in nuclear power plants across the fleet[10]. The impetus for collecting information on Alloy 600 cracking was in part the discovery in March 2002 of vessel head penetration flaws, leaks, and pressure boundary corrosion at the Davis-Besse plant. This review found that Alloy 600 and its associated welds are susceptible to crack nucleation and growth in a wide range of applications. NRC staff concluded that additional inspections beyond one-time inspections were warranted, and industry developed inspection and evaluation guidelines to manage degradation. Will you initiate a similar review for the 410SS and 416SS steels used in pump components? If not, why not?
5. What regulatory actions will the Commission undertake in order to assess, require licensee reporting and inspection of, and address the IGSCC problems involved in 410SS and 416SS pump components? If no such actions are planned, why not?

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[10] "U.S. Plant Experience With Alloy 600 Cracking and Boric Acid Corrosion of Light-Water Reactor Pressure Vessel Materials", NRC Office of Nuclear Regulatory Research

Thank you very much for your consideration of this important matter. Please provide your response no later than close of business Friday, January 6, 2012. If you have any questions or concerns, please have your staff contact Dr. Makenzie Lystrup or Dr. Michal Freedhoff of my staff at 202-225-2836.

Sincerely,

Edward J. Markey

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