September 25, 2003

Ms. Debbie B. Grinnell
C-10 Research & Education Foundation, Inc.
44 Merrimac Street
Newburyport, MA 01950

Dear Ms. Grinnell:

I am responding to your August 27, 2003, letter to Chairman Diaz of the U.S. Nuclear Regulatory Commission. In your letter you expressed concern about the presence of cracks in the steam generator (SG) tubes at the Seabrook Nuclear Power Station (Seabrook). You also asked several specific questions regarding the inspection of SG tubes.

In a letter to Chairman Diaz dated June 30, 2003, you expressed concern over the possibility of a SG tube rupture resulting in offsite doses that could be harmful to the public. In your August 27, 2003, letter you reiterated those concerns. The Enclosure to this letter provides answers to the specific questions that you posed in your August 27, 2003, letter. You should soon receive a separate response addressing the concerns you raised in your June 30, 2003, letter.

We understand the concerns raised in your letter and have reevaluated our activities in light of these concerns. Although we agree on the facts, we appear not to agree on the implications of these facts. We will, however, remain open to new technical information that will help us assure the health and safety of the public. If you have any further questions, please contact the Seabrook Project Manager, Victor Nerses, at (301) 415-1484.

Sincerely,

/RA/

Cornelius F. Holden, Director
Project Directorate I
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Docket No. 50-443

Enclosure: As stated

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NRC STAFF RESPONSE TO REQUEST FOR INFORMATION

1. You stated that the Seabrook Nuclear Power Station (Seabrook) was in violation of Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50 because 11 tubes exceeded the 40% degradation limit at the end of cycle. You asked what steps the U.S. Nuclear Regulatory Commission (NRC) has taken, and will in the future take, to ensure steam generator (SG) tube integrity. You asked if the NRC planned on requiring the plugging of SG tubes with any crack indication whatsoever.

Response: Finding flaws at the end of cycle that exceed the 40% through-wall repair limit specified in the Technical Specifications (TSs) is not a violation of 10 CFR Part 50. In fact, the TS limit recognizes that licensees may find flaws that exceed 40% through-wall during their inspections. The 40% limit is based on analysis conducted in accordance with the methodology described in Regulatory Guide 1.121. This methodology accounts for flaw growth.

Licensee's TSs impose specific SG tube inspection requirements that they must follow to remain in compliance with NRC regulations. In order to ensure that licensees comply with their TSs, the NRC conducts inspections of its own. These inspections may be done either by the Resident Inspectors, who are permanently assigned to the plant, or by specialists from either the Regional Offices or NRC Headquarters. Ongoing inspection is the primary method that the NRC uses to ensure licensee compliance with our regulations, and to give reasonable assurance of the adequacy of each licensee's SG inservice inspection.

With respect to the previous steps the NRC has taken, we conducted an onsite inspection during the 2002 outage at Seabrook, discussed SG findings with the licensee during several phone calls, and held a public meeting to discuss the results of the licensee's SG inspections. The staff further documented its findings, conclusions, and concerns in two Information Notices. Details of these interactions can be found in the NRC's Agencywide Documents Access and Management System (ADAMS), under Accession Numbers: ML021760352 (Inspection Report); ML021770094 (Information Notice); ML030900517 (Information Notice supplement); ML023300457 (Root Cause Report); ML023240524 (Root Cause Report); ML031970605 (June 2003 phone call summary); ML021800003 (May 2002 phone call summary); ML022590328 (August 2002 phone call summary); ML023300041 (October 2002 phone call summary); and ML023300457 (November 2002 meeting summary).

During these interactions, the licensee provided their assessment of the SG inspection results. Based on this information, the NRC did not identify any concerns with respect to the ability of the licensee to ensure that the tubes will not fail under normal, transient, and postulated accident conditions. In fact, the tubes in which flaws were detected had significant margin to failure under normal, transient, and postulated accident conditions. The affected tubes were taken out of service by plugging them before the plant returned to power operation, and sections of two of the tubes were removed from the SG for further testing. The normal differential pressure during power operation is about 1400 pounds per square inch (psi). The maximum pressure expected during a postulated design-basis accident is approximately 2600 psi. The tube with the largest crack was pressure-tested to 7000 psi without leakage, well above the pressure required by the regulations. This indicates that, even with the cracks, the tubes retained significant structural integrity. Based on our inspections and evaluations, we consider that the licensee remained in compliance with their TSs and, as a result, remained in compliance with the regulations.

The NRC plans to conduct an onsite inspection during the upcoming outage. We plan to send experts from either our Regional office or from NRC headquarters, or both, to examine the licensee's SG tube inspection results.

As for whether or not the NRC intends to require Seabrook to plug any tube with a crack indication, we do not believe that such a requirement is justified. We have carefully considered your views on the adequacy of the current regulatory requirements, and consider the current requirements adequate to provide reasonable assurance of public health and safety. In excess of NRC requirements, however, the Seabrook licensee's practice has been to plug tubes upon the detection of cracks, regardless of the depth of the crack.

2. You asked what steps the NRC takes when it discovers that a plant has been operating with a tube that has degraded beyond the plugging criteria.

Response: As discussed in response to question 1, exceeding the plugging criterion at the end of cycle, in and of itself, is not a concern. We recognize that flaws may exceed the 40% through-wall plugging criterion at the end of cycle.

In the event that an inspection reveals a flaw that was of sufficient size that it approached the point where it was not within the margins-to-failure consistent with the design and licensing basis, the NRC (and the licensee) would evaluate what actions would be necessary. All of the tubes with flaws at Seabrook, even the tubes that were greater than 40% through-wall at the end of cycle, had sufficient margin to failure under normal operating, transient, and postulated accident conditions. A margin of safety of three is needed to guard against failure during normal operating conditions. The margin of safety during normal operation for the Seabrook tube with the largest crack was on the order of five, despite the tube having a crack that exceeded 40% through-wall at the end of cycle.

In summary, the finding of cracks in SG tubes does not, by itself, pose a safety concern; rather, it is the size of the cracks that is important. As long as the licensee has an inspection program that can detect cracks early enough in their development, such that they will not grow too large (i.e., adequate structural and leakage integrity will be maintained), the existence of cracks does not necessarily pose a problem. Just because a flaw's depth exceeds the plugging limit at the end of cycle does not imply that it is a safety concern. As discussed above, the cracks at Seabrook were not of sufficient size (length and depth) at the end of cycle to challenge the integrity of the tubes, the licensee has an inspection program that adequately identified the flaws, and the licensee plugged all of the tubes with detected cracks before return to operations.

3. You asked why highly stressed tubes were not detected and reported earlier.

Response: The elevated stresses were identified during the process of trying to determine what caused the first cracks to appear following the 2002 inspection. It is important to note that the elevated stress, in and of itself, does not necessarily pose a safety concern. The elevated stress levels, however, can result in earlier initiation of stress corrosion cracks. This is what was observed at Seabrook. Despite these elevated stresses, and the resultant development of flaws at these locations, the flaws observed at Seabrook were not safety significant. Nonetheless, the Seabrook experience demonstrates the importance of inspecting the tubes for flaws and taking appropriate corrective actions when flaws are detected. The licensee detected

the flaws using 100% bobbin coil inspections, and only used a rotating coil probe to characterize the flaws more completely.

4. You asked why the six tubes with high residual stresses were not removed from service in 2002.

Response: The elevated residual stresses in these six tubes were not identified until after the 2002 inspections were complete. None of these six tubes exhibited any tube degradation in 2002 (that is, cracks were not detected in these tubes); therefore, the licensee was not required to, nor did the staff consider it necessary to, remove these tubes from service. These tubes had adequate integrity at the time of the 2002 inspections. There is no data to suggest that these six tubes will not retain adequate integrity until their next inspection in 2003. As discussed above, the elevated residual stress levels, such as that observed at Seabrook, in and of themselves, do not pose a safety concern. The licensee does plan to preventively plug these tubes during their 2003 outage, regardless of whether they detect any flaws in these tubes.

5. You asked what assessment the NRC performed regarding loose parts in the SG. You cited a 56% through-wall indication from a 1997 inspection.

Response: With respect to your characterization of the 1997 results, it is important to note that the 56% through-wall indication was a result of mechanical contact between the tube and an antivibration bar (AVB), a support structure in the SG. This wear was not caused by loose parts.

The NRC staff did not perform any specific assessment as a result of the 56% through-wall indications at the end of cycle since the reporting of an indication of tube wear of 56% through-wall at the end of cycle does not pose a safety concern. As discussed above, the finding of a flaw that exceeds the tube plugging limits at the end of cycle does not necessarily pose a safety concern. That is, even a tube with a flaw exceeding the plugging limit can still have more than the required margin of safety against failure. In addition, even if the tube could only sustain the required margins of safety, it would still have margin to failure during normal operation, transient, and postulated accident conditions. The licensee plugged the tube following identification of the indication.

Although the 56% through-wall indication was not attributed to a loose part, loose parts have been detected at Seabrook. With respect to your comments on loose parts damage, the NRC (and the industry) recognize the potential for loose parts to affect the integrity of a tube. Licensees take measures to prevent the introduction of loose parts into the SG. In addition, when loose parts are detected in the SG, licensees take corrective action. These corrective actions can include removing the part, moving the part to a region of the SG where it is not expected to move (and, therefore, won't affect tube integrity), or performing analysis to indicate that leaving the part in service will not affect tube integrity. This latter analysis does not ensure that wearing of the tube will not occur, but rather that any wear that does occur will not be safety significant. Licensees' actions to address loose parts have been effective, as evidenced by recent operating experience.

With respect to your concern that a loose part would lodge on a tube affected by stress corrosion cracking, the staff recognizes the potential for this situation to occur; however, such a situation is not likely because of the small number of loose parts present in SGs, and the relatively small number of tubes affected by stress corrosion cracking. Based on operating experience, the potential that this would occur and cause safety significant tube degradation is considered even more remote. In the unlikely event that a tube rupture were to occur, regardless of the reason, the plant is designed to cope with such an accident. Two tube ruptures associated with loose parts have occurred in the U.S. (the most recent was over 20 years ago), and the plant and operator actions were effective at mitigating the events.

6 and 7. You asked why the NRC allowed Seabrook to operate with loose parts in the SGs. You asked whether or not we were going to request that all identified loose parts be removed during this outage.

Response: The presence of a loose part in the SG may have no bearing on safe operation of the SG; therefore, the NRC does not explicitly address loose parts in its regulations. However, as discussed earlier, licensees must ensure that tube integrity is being maintained consistent with their design and licensing basis. As a result, if licensees detect loose parts, their guidance directs them to assess what, if any, impact these loose parts have on tube integrity and to take corrective action as appropriate. Our regulations do require licensees to monitor and maintain tube integrity, regardless of what factors might cause degradation. We do not believe it is necessary, therefore, to revise these regulations to address loose parts specifically. We consider the current regulations and required licensee actions to address loose parts to be adequate; therefore, the NRC is not going to request that all identified loose parts be removed from the SG.

8. You stated that highly stressed tubes with degradation would be allowed to remain in service following the October outage and asked what assessments had been done to determine the risk and effects of a tube failure. You also stated that there was an unknown failure mechanism in action and asked whether or not we would require 100% rotating probe inspection of the SG tubes.

Response: As we stated earlier, the presence of high residual stresses in SG tubes does not, in itself, present a problem. No specific assessments were conducted to determine the risk of tube failures as a result of the 2002 inspections at Seabrook, since the findings were not significant (i.e., the number of tubes affected was small and the severity of the degradation was minor). A generic assessment of the risk associated with tube failures is discussed in NUREG-1570, “Risk Assessment of Severe Accident-Induced Steam Generator Tube Rupture.” This document references a number of previous studies. SG tube ruptures are rare. As we stated before, however, when they have occurred the experience is that both plants and operators have been able to cope with such events without any adverse effect on the public.

Based on the findings at Seabrook during 2002, there is no safety reason for the NRC to require a 100% rotating probe inspection. In addition, the licensee’s previous inspections using bobbin coil probes adequately identified the tube cracking. The mode of failure observed at Seabrook was outside diameter stress corrosion cracking and, although this is the first time it has been observed in thermally treated Alloy 600 tubes, it is a known degradation mechanism affecting SG tubes.

Plants with mill annealed Alloy 600 SG tubes (Seabrook has thermally treated Alloy 600 tubes) have experienced this degradation mechanism and some of these plants leave flawed tubes in service in accordance with an NRC-approved tube repair criteria. This tube repair criteria is discussed in NRC Generic Letter 95-05, "Voltage-Based Repair Criteria for Westinghouse Steam Generator Tubes Affected by Outside Diameter Stress Corrosion Cracking" and is a statistically-based approach. It has been safely implemented at numerous plants since the early 1990s.

Given the operating experience at Seabrook and other plants with outside diameter stress corrosion cracking, as well as the adequacy of the bobbin coil inspections to identify the flaws, the 2002 inspection results at Seabrook do not raise any safety concerns that would warrant the NRC to specifically require a 100% rotating probe inspection at that station.