North Atlantic

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The Northeast Utilities System

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United States Nuclear Regulatory Commission
Washington, D.C. 20555

Attention: Document Control Desk

References:
(a) Facility Operating License No. NPF-86, Docket No. 50-443

(b) North Atlantic Letter NYN-94111 dated September 30, 1994, "Service Water System Pump Bolt Degradation," T. C. Feigenbaum to USNRC

(c) North Atlantic Letter NYN-94136 dated December 2, 1994, "Licensee Event Report (LER) 94-017-00: Service Water System Pump Bolt Degradation," T. C. Feigenbaum to USNRC

Subject: Service Water System Pump Bolt Degradation

Gentlemen:

As described in Reference (b), North Atlantic Energy Service Corporation (North Atlantic) had previously identified a number of degraded 316 austenitic stainless steel alloy (SA-193-B8M) column flange bolts on Seabrook Station Service Water System pumps. North Atlantic tested a number of the subject bolts and determined that they were sensitized as a result of improper heat treatment, hence allowing intergranular corrosion to take place. Reference (b) also described the basis for operability of the Service Water System, the repair plan, and the potential need for increased surveillance activities. In the same letter, North Atlantic committed to apprise the NRC of the bolt failure mechanism and vendor information, when it was available. Accordingly, the following describes the aforementioned requested information, the results found during the pump repair process, and the evaluation of cause and potential generic implications.

North Atlantic has replaced the suspect bolts on all six installed Service Water System pumps, which includes two Cooling Tower pumps and four Ocean pumps. Review of the bolts removed indicates that for the four Ocean Service Water Pumps, 22 out of a total of 560 1x4" column flange bolts, exhibited some degree of intergranular corrosion. However, only one of these bolts exhibited significant intergranular corrosion. The balance of column flange bolts, column flange nuts, column to bowl bolts and nuts, bowl studs and nuts, stuffing box cap screws, and impeller thrust ring retainer cap screws did not exhibit any evidence of intergranular corrosion and were evaluated to be in good condition except for some minor crevice corrosion and pitting, which is expected for this application.



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For the two Cooling Tower Service Water Pumps, 76 out of a total of 288 1x4" column flange bolts exhibited intergranular corrosion, 62 of which were considered to be significantly corroded. Eight out of a total of 48 1x4½" column to bowl bolts also exhibited intergranular corrosion, two of which were considered to be significantly corroded. The balance of bolting material in these pumps did not exhibit any evidence of intergranular corrosion and were evaluated to be in good condition except for some minor crevice corrosion and pitting, which is expected for this application.

North Atlantic performed metallurgical analyses on samples of the bolting material from all Service Water pumps and determined that the 1x4" column flange bolts, 1x4½" and 1⅛"x4½" column to bowl bolts, and ⅞"x2½" impeller cap screws marked "B8M," or "SB B8M," were sensitized. Sensitization is caused by an improper, or lack of, carbide solution annealing heat treatment during the fabrication of the bolting material. Specifically, when austenitic stainless steels are heated in the approximate temperature range of 950 to 1450 °F, they become sensitized or susceptible to intergranular corrosion. In this temperature range, chromium carbide ($Cr_{23}C_6$) precipitates out of solid solution at the grain boundaries if the carbon content is approximately 0.02% or higher (for SA-193-B8M the maximum carbon content is 0.08%). Due to the formation of chromium carbide, the areas immediately adjacent to the grain boundaries are left with a lower chromium content relative to the balance of the microstructure. SA-193-B8M 316 stainless steel material relies upon alloying elements, namely chromium, nickel and molybdenum, to derive its corrosion resistance. The formation of a chromium depleted zone near the grain boundary reduces corrosion resistance and creates the potential for intergranular corrosion if exposed to an aggressive environment. Grain boundary decay and loss of grain structure results in deterioration of the base metal and exposure of fresh grains to the aggressive environment. This, in turn, causes more grain boundary decay and progressive base metal loss. This can be observed as a "sandy" texture in the area affected by intergranular attack.

Not all sensitized bolting materials exhibited intergranular corrosion. North Atlantic believes that crevice corrosion caused localized degradation of the protective surface oxide layer thereby exposing the bolting internal base metal to the aggressive aqueous chloride environment. This then allowed intergranular corrosion to take place.

The sensitized bolting materials were supplied by Johnston Pump Company, Glendora, California, as part of the original pump fabrication. Johnston Pump Company no longer utilizes this location, and is currently located in Chattanooga, Tennessee. It is North Atlantic's understanding that Johnston Pump Company procured the subject bolting as ASME Code material from California Nut and Bolt, Anaheim, California. North Atlantic believes that some bolting material may also have been provided to California Nut and Bolt by Southern Bolt and Screw Company, Montebello, California, since some bolting materials were marked with "SB", the manufacturer's identification symbol for Southern Bolt and Screw Company. North Atlantic believes that both California Nut and Bolt and Southern Bolt and Screw Company are no longer in operation and hence, was unable to identify the suppliers who provided the raw material or manufactured the cap screws, other than Southern Bolt and Screw Company. North Atlantic has also concluded that documentation and some markings for these bolting materials as well as other California Nut and Bolt provided bolting materials were not in full compliance with the ASME Code.

North Atlantic confirmed that California Nut and Bolt was approved by Johnston Pump Company as a supplier. North Atlantic also confirmed that California Nut and Bolt and Southern Bolt and Screw Company did not have an ASME Quality System Certificate as Material Suppliers or Material Manufacturers. In lieu of this provision, the 1974 edition of the ASME Section III, Division I, Code permitted an ASME "N" Certificate Holder, such as Johnston Pump Company, to approve a material supplier's or material manufacturer's Quality Assurance (QA) program provided Code requirements were met. Discussion with Johnston Pump Company (Chattanooga, TN) indicated that Johnston Pump Company (Glendora, CA) did approve the QA program of California Nut and Bolt to ASME NCA 3800 requirements, although North Atlantic does not possess any such documentation.

As part of the review for generic implications, North Atlantic evaluated the 10 CFR 50 Appendix B Quality Assurance program controls that were applied to the procurement of the Service Water System pumps. This included a review of purchase orders, Certificates of Compliance, Certified Material Test Reports, audits of Johnston Pump, and surveillance of pump fabrication activities. In addition, North Atlantic tested additional safety related bolting material to determine compliance with material specifications. This included originally supplied, spare, and replacement SA-193-B8M and SA-194-8M bolting material. Finally, North Atlantic reviewed other pumps provided by Johnston Pump Company to determine if similar bolt degradation exists.

Based on these reviews, North Atlantic determined that the generic implications of this issue are limited to the subset of bolting material provided as part of the original pump fabrication. Specifically, North Atlantic concluded that the Architect Engineer and Constructor [United Engineers and Constructors (UE&C)] Quality Assurance Program was properly implemented regarding vendor controls and surveillances of the Johnston Pump Company activities associated with the original pump fabrication. Johnston Pump Company was also found to have a documented QA Program, however, the implementation of this program was not totally effective in detecting subsupplier bolt marking and documentation deficiencies. North Atlantic also performed metallurgical testing on a representative sample of spare and replacement bolting material and the results did not indicate evidence of sensitization. The review of the operating history of other pumps supplied by Johnston Pump Company did not indicate similar bolt degradation concerns. Finally, North Atlantic confirmed that North Atlantic and UE&C had not procured any bolting materials directly from California Nut and Bolt, or Southern Bolt and Screw Company.

Based on the foregoing, North Atlantic concludes that the primary cause of the bolt material degradation was improper heat treatment. California Nut and Bolt, and Southern Bolt and Screw Company did not provide bolting materials that met ASME Section III as required. A contributing cause was determined to be a lack of sufficient oversight during receipt inspection of the subject bolting materials by Johnston Pump Company to identify and correct bolting material marking and documentation deficiencies. The aforementioned reviews also provide confidence that the generic implications of this issue are limited to the specified subset of bolting material.

Due to the aforementioned lack of sufficient oversight during receipt inspection by Johnston Pump Company, North Atlantic will perform an additional review of the Quality Assurance program that Johnston Pump Company uses to procure and supply ASME Code material. The North Atlantic plans for this review were previously reported to the NRC on December 2, 1994 via Licensee Event Report (LER) 94-017-00 [Reference (c)].

Should you have any questions concerning this response, please contact Mr. James M. Peschel, Regulatory Compliance Manager, at (603) 474-9521, extension 3772.

Very truly yours,

Ted C.Feigenbaum

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