A Preliminary Report on a Meeting Concerning the Nine Mile Point Core Spray Nozzles and Related Piping Systems - May 1, 1970

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Introduction

At the request of the Division of Compliance, Washington, the author attended a meeting at the USAEC Phillips Building in Bethesda, Maryland on May 1, 1970. This meeting was scheduled for the purpose of reviewing the current status of the leaking West Core Spray Nozzle (N6B) in the Nine Mile Point Reactor system, operated by the Niagara Mohawk Power Corporation, Syracuse, New York. Those attending this meeting included representatives from GE-APED, particularly Dolf Hubbard and representatives from the Niagara Mohawk utility, in addition to USAEC-Regulatory Personnel. The specific areas covered were the following:

1. The GE-APED metallurgical analysis of the material failure in the subject West Core Spray Nozzle (N6B)
2. A review of the other furnace sensitized stainless steel parts in the system
3. The proposed method of repair of the two (East and West) Core Spray Nozzles, and their current progress
4. A review of the details related to a piping system stress analysis being performed by Teledyne Material Research, Waltham, Mass.
5. A review of the USAEC-Compliance metallurgical analysis of the East Core Spray Nozzle (N6A)
6. A review of the preliminary results of the GE-APED metallurgical analysis of the East Core Spray Nozzle (N6A).

Discussion

The following is an accounting of the information obtained by the author from the discussions of various people in attendance at the May 1, 1970 meeting. No attempt is made here to fully analyze the comments obtained. The comments and recommendations which are considered appropriate will be given after sufficient time allows a thorough analysis of the situation and will take the form of a subsequent report.

Mr. H. H. Pratt, Vice President and Executive Engineer, NMPC opened the meeting in behalf of the licensee. The complete metallurgical analysis of the West Core Spray Nozzle (N6B) conducted by General Electric was presented to the group in the form of an NMPC document entitled "Reactor Primary System Investigation at Nine Mile Point Nuclear Station," dated May 1, 1970. This document supercedes and replaces the "Preliminary Report Core Spray Nozzle Safe End Nine Mile Point Power Station" dated March 27, 1970. In addition, this report contains the NMPC/GE position as to cause of the cracking, metallurgical analysis of the remaining piping system, stress analysis of the piping system, and the proposed method of repair (Items 1-4, above). The author is currently in the process of thoroughly reviewing this report.

During the briefing given by the Niagara Mohawk and GE people the following points were made:

1. The GE metallographic study revealed that the type 304 stainless steel safe end and thermal sleeve are fully sensitized. Cracking was seen to occur in both the safe end and the thermal sleeve in an intergranular mode.
2. Chemical analysis of the metals did not reveal any abnormalities; however, an analysis of the oxide covering the pipe/sleeve internal surfaces did indicate the presence of fluoride.
3. The Teledyne stress analysis of the subject nozzle, piping system, and hanger system revealed the stress near the failure to be approximately 90,000 psi. In general, it was stated that these studies showed longitudinal stresses of 45,000 psi and 22,000 psi on the West (N6B) and East (N6A) Core Spray Nozzle, respectively. This stress analysis indicated the piping system to be generally underhung.

Mr. Dolf Hubbard briefly reviewed the progress of the metallurgical studies currently being performed on the non-leaking, East Core Spray Nozzle (N6A). To date these studies only include investigations of the surface of this piping section. These studies have the following preliminary results:

1. Intergranular cracks were found in the thinned area of the safe end I.D. from the 12-to 6-o'clock positions (12 o'clock is straight up).
2. Additional I.D., intergranular cracks were found in the thicker sections of the safe end, specifically in the 12-to 3-o'clock positions.
3. It was stated that this pipe was about one-half full of water when cut, even though this pipe section had never been used to pass water to the reactor system.
4. It was stated by GE that the oxide coating on the I.D. of this East Nozzle was different than that which was found in the West Nozzle.
5. The East Nozzle safe end O.D. showed indications at the 1-to 3-o'clock and 6-o'clock positions. Some of these indications appeared to be transgranular in nature.

The AEC-Compliance section was given a sample of this East Nozzle to study. These investigations were conducted by W. J. Collins, Technical Support Branch - AEC Compliance. The AEC sample was cut longitudinally along the pipe axis between the 10:30-11:30-o'clock positions and contained about 1 in. of the pipe, the field weld, about 2 in. of the thermal sleeve, and about 4 in. of the safe end. The following is a brief statement of the findings of this investigation.

1. The safe end was observed metallographically to be fully sensitized and contained numerous, gross transgranular cracks.
2. The thermal sleeve contained numerous transgranular cracks but did not exhibit a sensitized microstructure.
3. The pipe section exhibited a partially sensitized microstructure, but no cracks were observed. The microstructure of the adjacent field weld showed a spheroidized δ-ferrite phase, indicating that this weld had received some degree of thermal stress relieving. This was further supported by the appearance of a recrystallized/grain growth microstructure on the O.D. of the safe end about 1 in. from the field weld fusion line, outside the heat-affected zone.

4. The thermal sleeve exhibited a microstructure containing geometric-shaped precipitates. An electron beam microprobe analysis of these precipitates revealed them to be exceedingly rich in titanium. This information yielded the conclusion that these precipitates were a titanium carbonitride and that this thermal sleeve material might be AISI 321 material instead of AISI 304 stainless steel.
5. Samples were taken of the residue found on the I.D. of the AEC-East Nozzle specimen for chemical analysis. A sample was prepared from this residue by extruding electrodes, using graphite as a binder, to allow an analysis using mass spectrographic techniques. Based on the assumption that this residue was essentially Fe_2O_3 (supported by a comparison with a standard using a scanning electron microscope) the analysis results revealed approximately 13 ppm of chlorine. It was stated that this analysis was believed to be conservative, considering the necessary method of analysis.

No information was provided by NMPC/GE personnel pertaining to the metallurgical analysis being performed on the GE portion of the East Nozzle. Mr. Harold Denton, Technical Support Branch-AEC Compliance, did provide the following information concerning this investigation, as provided by an AEC on-site inspector, Mr. Uldis Potapovs.

1. Sensitized material was found in the safe end.
2. Three (3) intergranular cracks were found 1/4 in. long and 1/4 in. from the field weld root on the I.D. of the safe end. The cracks were aligned axially.
3. Metallographic sectioning lost one crack but this analysis revealed the remaining two cracks to be 0.090 and 0.040 in. long.

The NMPC/GE personnel reviewed the planned repairs for replacing the removed core spray nozzle. These statements are briefly presented below.

1. The West nozzle is presently being repaired using Type 304L stainless steel material and incorporating slight redesigns to the thermal sleeve

and piping system. The redesigned thermal sleeve now provides a drain system through the attachment weld to reduce the possibility of static conditions. The redesign of the piping system entails the use of more 6 in. piping to reduce the stress situation existing in the previous design.

2. A new hanger system for the core spray nozzles has been designed and installed.
3. Ultrasonic testing of all pipe welds up to the vessel wall is being performed.
4. Similar repairs are being initiated on the East nozzle.
5. It is proposed that ultrasonic and penetrant inspections be performed in 1 year on all furnace sensitized material still existing in the system.
6. Prior to current reactor start-up it is proposed that tests be performed (with Teledyne assisting) which indicate that proper expansion tolerance can be maintained. Further, it is proposed that similar testing be performed after each cool-down.

At a private meeting between AEC and GE personnel discussions were held concerning the optimum repair method for furnace sensitized stainless steel safe end materials in many BWR reactor systems. GE related the results of their research on stainless steel material. These investigations included welds, annealed material, and sensitized material and essentially revealed that sensitized material will fail prematurely (18-20 hr. vs. over 400 hr.) when uniaxially stressed to 125% of yield in environments of air/chlorine atmosphere (room temperature to 180°F) or pure water plus 100 ppm oxygen (550°F). If the material is sensitizedit fails in about two (2) hours. Other discussions centered around the advantages and/or disadvantages of overlaying and whether this is an equal or better repair method to a complete changeout, or replacement, of non-sensitized material. No clear-cut conclusion was found to these questions, although the repair of Oyster Creek should provide some sound background on overlay repair methods.

Conclusions

The purpose of this report was to attempt to assemble the major facts outlined and discussed at the May 1, 1970 meeting at AEC Compliance Headquarters. No conclusion will be stated until a complete statement of the results of the many investigations can be obtained and reviewed.

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