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SUBJECT: Provides responses to NRC staff questions provided during 970410,11 & 24 telcons re core shroud cracks & repair.

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April 27, 1997
NMP1L 1210

U. S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, DC 20555

RE: Nine Mile Point Unit 1
Docket No. 50-220
DPR-63

*Subject:* *Responses to NRC Staff Questions Provided During Telephone Conversations of April 10, 11 and 24, 1997, on Core Shroud Cracks and Repair*

Gentlemen:

By letter dated April 8, 1997, Niagara Mohawk Power Corporation (NMPC) submitted to the NRC the results of the inspection of Nine Mile Point Unit 1 (NMP1) Core Shroud and Stabilizer Assemblies conducted during the Spring 1997 refueling outage. In that letter it was stated that final verification and NMPC QA approval of the core shroud inspection data was pending.

Following the submittal of April 8, 1997, the staff requested additional information from NMPC pertaining to the core shroud inspection results and the proposed stabilizer assembly modifications (during telephone conversations on April 10 and 11, 1997). NMPC provided responses to the requests for additional information by letter dated April 23, 1997, except for the responses to questions 1 and 2 of Enclosure 1. The response to questions 1 and 2 were withheld pending verification of the ultrasonic testing results.

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The final review of the data has been completed and was used to revalidate the analysis contained in Enclosure 1 of the April 8, 1997 submittal. The analysis was found to be still bounding (i.e., 10,600 operating hours), however, certain values within the analysis have changed.

The attached responses describe: the use of BWRVIP guidelines in establishing uncertainties for length and depth sizing in VT and UT inspection, the use of those uncertainties in the crack growth analyses for vertical shroud welds, and the bounding analysis.

By telephone conversation on April 24, 1997, the staff also requested clarification to Required Response #3 of the April 23, 1997, submittal. The responses to questions 1, 2 and the additional information for question 3 are provided in the attachment to this letter.

Sincerely,

M. J. McCormick Jr.

Martin J. McCormick Jr.
Vice President - Nuclear Engineering

MJM/MSL/lmc
Enclosures

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<u>ATTACHMENT</u>

**REQUEST FOR ADDITIONAL INFORMATION REGARDING CORE SHROUD WELD CRACKING NINE MILE POINT NUCLEAR STATION UNIT 1**

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*<u>Request for Information #1</u>*

*Please discuss how the uncertainty factors used in crack growth calculations (UT and VT measurements of flaw length and depth) for the vertical welds were determined and also address how the BWRVIP guidelines on inspection uncertainties were met.*

<u>Required Response #1</u>

The vertical weld inspection used the GE suction cup scanner delivery device described in the BWRVIP-03 Section 4.7.2, page 4-42. The transducer package used included a 45° shear, 60° longitudinal, and OD creeping wave probes. The scan type was type 1 (0.036 increment normal to weld, 0.18 parallel to weld). As required by Section 4.7.2 of BWRVIP-03, an application dependent length evaluation factor was derived for the multiple placements of the suction cup scanner since the scanner covers approximately 10.5" per placement. The multiple placement length evaluation factor contains two uncertainties, 1) End Point Placement Uncertainty and 2) Multiple Placement Uncertainty, and was derived as follows:

*1) End Point Placement Uncertainty*

The inspection of the V9 and V10 vertical welds used the H4 weld toe and H5 weld toe as landmarks consistent with the discussion on page 4-42 Section 4.7.2 of BWRVIP-03. These landmarks were used to establish the initial placement, end point, and total weld inspection length. The distance between these landmarks was measured using a measurement tool which is judged to have an underwater uncertainty of less than ±0.5" (nominally considered to be 0.25").

The suction cup scanner was placed as close to the H4 weld toe as possible. The geometry of the scanner and transducer package allows for the transducer package to be butted up to the weld toe. After visual verification, this scan is then defined to start at a known position relative to the H4 weld toe. This position was defined as approximately 1.5" relative to H4. The first scan for V9 established unflawed metal based on the OD creeping wave for the initial placement up to 7.3". The V10 initial placement established unflawed metal up to 7.05". The EVT ID/OD visual examination identified the first visual indication on V9 at approximately 7 1/8" (±1") from the weld toe, using a ruler measurement. The first visual indication on V10 was at approximately 7 3/4" (±1").

The H5 placement of the scanner was performed similarly by placing the transducer package as close to the H5 weld toe as possible. The final scan at this location was then defined based on the distance of the OD creeping wave probe from the scanner package end point for the V9 weld location. The relative location at the H5 location was defined as follows:

- The H4 to H5 distance was measured as 88 11/16" or 88.7"
- Creeping wave located 0.55" from end of package
- H5 end point 88.7" - 0.55 (V9 creeping wave) = 88.15"
- Placement for the V10 weld ws performed in a similar manner except for the end point which was a 45° shear wave

The UT data was then compared to the EVT data to correlate relative location of indications. The UT V9 data showed unflawed metal from 83.25" to 88.15" which is approximately 5.5" up from the H5 toe. The visual data showed that the first vertical indication was at 5.5"±1" up from H5. The UT V10 data showed unflawed metal from 83.4" to 88.15" which is approximately 5.25". The visual data showed that the first vertical is approximately 6 1/2" above H5 with a ±1.5" on this visual location.

The end point placement uncertainty is therefore essentially 1.00". Since the multiple placement uncertainty is 1.08", the value 1.08" was also conservatively used for end point placement uncertainty.

2) *Multiple Placement Uncertainty*

The suction cup was moved in approximate 9" to 10.5" increments starting from the H4 weld endpoint placement. A total of 9 placements were used to scan the entire length of the V9 weld. This increment established an approximate overlap range of ±1.5" between each placement. The analysis of the UT data from each scan established recognizable characteristics that were used as ultrasonic landmarks. The results of this data, based on three independent analyses of the data, have established that this method results in a positional accuracy of 1.08" on either side of the reported location.

After the multiple placement length evaluation factor is developed, a total UT length uncertainty is calculated for use in the analysis. The total UT Length Uncertainty, comprised of the multiple placement length evaluation factor and N.D.E. technique uncertainty, is applied to the analysis as described in BWRVIP-03.

Section 4.1 page 4-3 of BWRVIP-03 states that, "The evaluation factor to be used by utilities in fracture mechanics calculations is the sum of the evaluation factors for the NDE technique and the delivery system. ... the depth evaluation factor will be added to the measured depth of flaws detected in the field, and the length evaluation factor will be added to each end of detected flaws."

Evaluation factor for NDE technique:

1) 60° longitudinal probe UT length evaluation factor = 0.364" (maximum of the 3 probes scan type 1 from table 4.4.17-2, BWRVIP-03, Pg 4-30)
2) 60° longitudinal probe UT depth evaluation factor = 0.108 (chosen since this probe was used to define depth, scan type 1, from Table 4.4.17-Z. BWRVIP-03, Pg 4-30).
3) Creeping wave probe UT length evaluation factor = 0.190" (scan type 1 from Table 4.4.17.Z BWRVIP-03, Pg. 4-30)

Evaluation factor for delivery system:

1) Length evaluation factor = 0.25% of 10.5" scan length = 0.026"
2) Length evaluation factor for multiple placement = 1.08" (NMP1 specific factor)
3) Length evaluation factor for end point placement = 1.08" (NMP1 derived factor)
4) No depth factor is required for delivery device

The method for combining uncertainty in analysis:

This NDE technique length evaluation factor of 0.364" applied in the analysis is conservative since the UT data length sizing used the creeping wave probe, which has a length evaluation factor of 0.190".

Length uncertainty = 0.364 + 0.026 + 1.08 = 1.47" (The value used in final analysis increases the crack length by 2 x 1.47 = 2.94"≈3". Depending on remaining ligament assumptions, the 1.47" is added to each end point to ensure conservative assumptions are maintained.)

Depth uncertainty = 0.108"

In summary, the uncertainty factors are applied such that the critical crack length is increased by 2.94" (i.e. 1.47" to each end) and the depth of all indications was increased by 0.108" before performing the analysis. Depth and length were then increased based upon the bounding crack growth rate of $5 \times 10^{-5}$ in/hr. The final analysis considered a bounding minimum ligament and determined the acceptable operating interval of 10,600 hours.

***Request for Information #2***

*It appears that the indication maps for vertical welds V10 and V9 are not consistent with the corresponding flaw data plots. In the flaw data plots, the uncracked areas are much larger than that shown on the corresponding indication maps. Please explain the discrepancy and discuss its impact on the determination of reinspection interval.*

## Required Response #2

The indication maps were diagrammatic and not drawn to exact dimensions. Use of the revised and verified flaw data plots is discussed in Required Response #3.

As indicated in the NMP1 response of April 23, 1997, the final NDE data analysis has been completed and is summarized as follows:

The review has established the required uncertainty which needs to be applied to the UT data analysis regarding the required length and depth evaluation factors. The derivation of these evaluation factors used in the fracture mechanics calculations was discussed in response to question 1. The analysis accounted for these revised evaluation factors consistent with the core shroud evaluation guidelines in that the crack length and depth were increased by both crack growth rate and uncertainty.

The final data review also included a more detailed breakdown of the UT data for the V9 and V10 welds in 0.25" to 0.5" increments. This breakdown resulted in small variations in the depth and relative location of the cracks which necessitated revised fracture mechanics analysis cases (see Chart 1 attached). A segment of weld was determined to be uninspected by UT on V9 (0.86") and V10 (1.61"). These locations were therefore assumed to be through-wall in the analysis. The results of this final data review and analysis have concluded that the 10,600 hour inspection interval is appropriate.

The final review of the vertical weld V3, V4, V15, and V16 UT data, considering overlapping coverage by three transducers, has determined that the 10,600 hour interval is not impacted. The final data review concluded that the available equivalent uncracked ligament lengths quoted in column 6, table 5-2, page 32, are changed. The revised values are shown in Table 1.

**TABLE 1**
**Summary of Results**

| Weld # | Available Area ($in^2$) | Available Eq. Ligament (in.) | L min (inc) |
|---|---|---|---|
| V15 | 4.1 | 2.73 | 2.46 |
| V16 | 4.5 | 3 | 2.46 |
| V3 | 8.784 | 5.86 | 1.28 |
| V4 | 2.044 | 1.363 | 1.28 |

The overall conclusion is that the required reinspection interval for the ISI of the shroud vertical welds is 10,600 hours of hot operation.

*Request for Information #3*

*Information provided by letter dated April 23, 1997 is unclear. Specifically in Figure 5-6, only the crack growth in the wall thickness (depth) direction was considered. Please provide justification for not considering the crack growth in the axial direction (parallel to vertical weld) and the potential crack initiation and growth in the uncracked areas. If we assume that cracks will initiate and grow in the uncracked areas, what would be the acceptable reinspection interval for vertical weld V9? The bounding case would be assuming the uncracked areas to be cracked with zero depth.*

Required Response #3

Crack growth, both in the length and depth direction, was considered in the evaluation of the limiting crack. The evaluation also considered potential crack initiation and growth in the unflawed areas.

The data shown in Figure 1 is the detailed 0.25" breakdown of the V9 UT data which defines the bounding through-wall analysis case. After considering crack growth for 10,600 hours at 5E-5 in/hr plus the UT depth uncertainty of 0.108" the assumed through-wall conditions starts at 11.73" and is assumed to be a continuous through-wall crack until 50.97" relative to the H4 location for a preliminary total through-wall crack of 39.24". After considering the required crack growth in the length direction at a rate of 5E-5 in/hr (5E-5 in/hr * 10,600 hr = 0.53") plus the required UT uncertainty on length (1.47" derived in the response to RAI #1), the assumed through-wall starts at 9.73" and ends at 52.97" for a total through-wall length of 43.24". This value was utilized in determining the length of operating time before re-inspection is required.

As is evident from the attached Chart 1, significant margin remains in the available ligament assumption of 0.15" used in the fracture mechanics analysis after considering 10,600 hours of operation and assuming a crack growth rate of 5E-5 in/hr.