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SUBJECT: Provides final evaluation of ER308L weld metal acceptability for use in plant safety sys,per IR 50-316/88-12.

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Donald C. Cook Nuclear Plant Unit No. 2
Docket No. 50-316
License No. DPR-74
NRC INSPECTION REPORT NO. 50-316/88012 (DRS);
FINAL REPORT ON WELD ROD SUBSTITUTIONS

U.S. Nuclear Regulatory Commission
Document Control Desk
Washington, D.C. 20555

Attn: A. B. Davis

December 9, 1988

Dear Mr. Davis:

This letter provides the final report of our evaluation of the acceptability of welds made in Cook Nuclear Plant safety-related systems using type ER308L weld material. This evaluation was performed as an expansion of the investigations conducted in response to the Notice of Violation contained in Inspection Report No. 50-316/88012 (DRS). Our previous submittals (AEP:NRC:1060D dated June 24, 1988, and AEP:NRC:1060E dated August 17, 1988) addressed the specific issue of the adequacy of the engineering reviews performed to confirm the acceptability of substituting ER308L weld rod for ER316 in welds made during our Chemical and Volume Control System cross-tie modification, as well as the general issue of the actions taken to strengthen our design change control process overall. The attachment to this letter provides the results of the reviews and engineering evaluations completed subsequent to our August 17, 1988, submittal.

This document has been prepared following Corporate procedures that incorporate a reasonable set of controls to ensure its accuracy and completeness prior to signature by the undersigned.

Sincerely,

M. P. Alexich
Vice President

IE01
1/1

MPA/eh

Attachment

cc: D. H. Williams, Jr.
W. G. Smith, Jr. - Bridgman
R. C. Callen
G. Charnoff
G. Bruchmann
NRC Resident Inspector - Bridgman

ATTACHMENT TO AEP:NRC:1060J

EVALUATION OF ER308L WELD METAL ACCEPTABILITY FOR USE IN COOK NUCLEAR PLANT SAFETY SYSTEMS

Background

NRC Inspection Report 50-316/88012 (DRS) contained a Notice of Violation regarding the substitution of ER308L filler metal for ER316 filler metal in welds made on the Chemical and Volume Control System (CVCS) cross-tie between the discharge headers of the respective unit's centrifugal charging pumps. Our original response to the violation (AEP:NRC:1060D dated June 14, 1988) addressed the specific issue of lack of documentation for the acceptability of the CVCS cross-tie welds and the technical adequacy of the CVCS welds themselves. A subsequent submittal (AEP:NRC:1060E dated August 17, 1988) addressed additional NRC concerns regarding engineering review of deviations from approved design documents and described our plans to conduct additional reviews of welding job orders and problem reports. The following discussion provides the results of our engineering evaluation of the ER308L weld rod substitution and our expanded review of welding documentation.

Engineering Evaluation of ER308L Weld Rod Substitutions

The ASME Boiler and Pressure Vessel and ANSI/ASME B31.1 Codes set allowable stresses at ambient and elevated temperatures for cast and wrought product forms, pipe, tube, plate, fittings, etc., but do not set allowable stresses for weld metals. Weld metal selection by ASME code design sections and B31.1 piping code is based on qualifying the weld to ASME Section IX.

A requirement of Section IX qualification is ambient temperature tensile testing, where the tensile strength of the welded specimen must be not less than the minimum tensile strength of the base metal. Weld metal qualification by ambient temperature tensile testing qualifies that material to an equivalent base material with allowable stresses established at elevated temperatures. There is no requirement to recalculate minimum wall thickness or make other design calculations if the ambient temperature tensile strength of the weld metal is equal to or greater than that of the base metal. The base metal allowable stresses are used in the stress analyses. This is based on code recognition that both the base metal and the weld material maintain the same relative strength and follow the same trend line as temperature is increased up to the creep range (approximately 1100^{o}F for type 316 stainless steel and type ER308L weld filler).

However, other properties of the weld metal have to be considered. In this instance, the lack of molybdenum in ER308L, compared to 316, must be evaluated in determining weld metal compatibility. For systems at the Cook Nuclear Plant where ER308L was used, the additional corrosion resistance imparted by 2-3% molybdenum in 316

is not needed. On this basis, the use of ER308L to weld Type 316 base metal satisfies code requirements for material selection and does not present a design or safety concern.

Although ER308L weld metal manufactured to meet ASME SFA-5.9 is acceptable to join 316 pipe based solely on a P-8 to P-8 weld qualification, we recently prepared a sample for weld qualification using ER308L weld metal from the Cook Nuclear Plant storeroom. Using the gas tungsten arc welding process, SA-312, Type 316 pipe was joined with ER308L weld metal. Both tension specimens had a tensile strength of 90 ksi, which is above the specified minimum tensile strength of 75 ksi for Type 316 in SA-312.

In discussions with NRC Region III concerning use of ER308L, it was suggested that ASME III, Article, III-3000, which describes the code basis for setting allowable stresses, be used in obtaining allowable stresses for ER308L. Article III-3000 states that the mechanical properties considered and factors applied to provide the maximum allowable stresses are the lowest of:

(1) one-fourth of the specified minimum tensile strength at room temperature;
(2) one-fourth of the tensile strength at temperature;
(3) two-thirds of the specified minimum yield at room temperature; or
(4) 90% of the yield strength at temperature, but not to exceed two-thirds of the specified minimum yield strength at room temperature.

The minimum room temperature tensile strength specified in ASME Section II, Part C, SFA-5.9, for ER308L is 75 ksi. In order to obtain elevated temperature tensile and yield properties for ER308L weld metal, the Edison Welding Institute, at our request, conducted a computer search of their welding literature database. The search did not identify any relevant material property information at elevated temperatures for ER308L weld metal. However, as mentioned previously, selection of weld metal for code design is based on ambient temperature tensile properties and the assumption that similar product forms with the same relative strength will follow the same trend line at temperatures up to the creep range. On this basis, the allowables for Type 316 would be appropriate for ER308L weld metal, although as an added conservatism, the ASME Section III, Appendix I, Table I-7.2 allowable stresses for Type 304L material were used in our calculations of minimum wall thickness. This approach is conservative since the ASME Code specified minimum tensile strength for Type 304L material is 5 ksi lower than for ER308L filler material. Also, the allowable stress trend line for ER308L

at elevated temperatures is expected to follow the Type 316 trend line and not the lower trend line of Type 304L. This approach is consistent with ASME Section III, Article III-3000, and resulted in the use of the following 304L allowable stresses:

	Ambient Tensile	100°F	200°F	300°F	400°F	500°F	600°F	650°F	
ER308L	75	NONE AVAILABLE-------------------------							
TP 316	75	18.8	18.8	18.4	18.1	18.0	17.0	16.7	(ksi)
TP 304L	70	15.7	15.7	15.3	14.7	14.4	14.0	13.7	(ksi)

Calculations were performed using the lower allowables of Type 304L for all sizes of Non-NSSS piping in stainless steel safety related systems at Cook Nuclear Plant, taking into account the maximum pressures and temperatures that would exist in these systems during plant operation. These calculations indicated code-acceptable pipe wall thickness in all cases.

In conclusion, the use of ER308L to weld Type 316 base material is consistent with ASME Code and design requirements. Calculations were performed using conservative allowable stresses which show that for Non-NSSS piping installed in safety related systems the use of ER308L is acceptable, and no design or service concerns exist.

Review of Welding Job Orders

In view of the lack of documentation of the acceptability of deviating from the welding procedure specification (WPS) for the CVCS cross-tie welds, actions were taken to assess the extent to which this same documentation deficiency existed in welding records for other welds. As described in our August 17, 1988 submittal, an engineering evaluation was performed by the AEPSC Cognizant Engineer-Welding, and the Cognizant Engineer from the Piping, HVAC and Fire Protection Section. This evaluation concluded that all of the ER308L filler metal substitutions are acceptable as-is in the systems in which they are installed.

Subsequent to our August 17, 1988 submittal, an expanded review of more than 700 additional weld records was completed. This review was performed by extracting a statistically significant number of weld records from among those reviewed that showed apparent discrepancies between the documentation of weld performance and the applicable WPS. These discrepancies were then evaluated to determine if the discrepancies created any engineering or design concerns. With one exception, the discrepancies were determined

to be administrative in nature, such as transcription errors, transposition of numbers, etc. The exception was a case where ER316 filler metal was substituted for the type ER308 specified by the WPS.

Where the substitution of type ER316 for ER308 filler metal is concerned, ER316 and ER308 are both F-number 6 rods and could be covered by the same Procedure Qualification provided consideration is given to metallurgical properties, post-weld heat treatment, design and service requirements, and mechanical properties. With regard to these considerations, our engineering evaluation found the following:

a. <u>Metallurgical Properties</u> - There are slight chemical differences between ER308 and ER316; however, the compositions are balanced between ferrite formers and austenite formers to yield a substantially austenitic alloy with similar corrosion resistance. Weldability characteristics are also similar between the two rods.

b. <u>Post-weld Heat Treatment</u> - No post-weld heat treatment requirements exist for either ER308 or ER316.

c. <u>Design and Service Requirements and Mechanical Properties</u> - The calculation discussed under the ER316/308L weld rod substitution was performed with allowable stresses for Type 304L material, which are lower than either ER308 or ER316. This calculation bounds the use of ER316 filler metal for all pipe sizes in non-NSSS safety related stainless steel systems at Cook Nuclear Plant, and thus there are no design and service or mechanical property concerns with the substitution.

On the basis of the above, it is concluded that there are no technical or design concerns with the associated welds as a result of the substitution of ER316 for ER308 filler metal. In addition, it is concluded that in no case do the identified discrepancies in welding documentation lead to a concern over system performance in Cook Nuclear Plant safety related systems where these welds are installed.

<u>Review of Problem Reports</u>

As a follow-up to our actions to strengthen our design change control process, a review was performed of closed Problem Reports (PRs) to identify those that were dispositioned "use as is" for deviations from design documents. The PRs dispositioned "use as

is" were then reviewed to ensure that a properly documented engineering evaluation existed to support close-out of the PR.

Our review identified 37 PRs dispositioned "use as is", of which in 5 instances although the appropriate engineering evaluation had been performed, the written documentation of the evaluations was judged to be insufficient from an auditability standpoint. No technical concerns existed for any of the PRs, and the documentation deficiencies for the 5 PRs mentioned above were corrected in September, 1988. In addition, our corrective action procedure has been revised to ensure that engineering reviews performed in the future are properly documented.