AmerGen

AmerGen Energy Company, LLC
200 Exelon Way
Suite 345
Kennett Square, PA 19348

www.exeloncorp.com

An Exelon/British Energy Company

September 12, 2001
5928-01-20239

U.S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, DC 20555-0001

Subject: THREE MILE ISLAND, UNIT 1 (TMI UNIT 1)
OPERATING LICENSE NO. DPR-50
DOCKET NO. 50-289

ASME SECTION XI RELIEF REQUESTS ASSOCIATED WITH REACTOR VESSEL HEAD REPAIR (REVISION 2)

References:

1. Letter number 5928-01-20188, dated July 2, 2001 from AmerGen Energy Company to U.S. Nuclear Regulatory Commission, "ASME Section XI Relief Requests Associated With Reactor Vessel Head Repair."

2. Letter number 5928-01-20214, dated August 9, 2001 from AmerGen Energy Company to U.S. Nuclear Regulatory Commission, "ASME Section XI Relief Requests Associated With Reactor Vessel Head Repair."

Dear Sir or Madam:

By letter dated July 2, 2001, AmerGen Energy Company submitted four (4) relief requests (RR-01-14 through RR-01-17), pursuant to 10 CFR 50.55a(a)(3)(i) and 10 CFR 50.55a(a)(3)(ii), from portions of the ASME Code, Section XI, Rules for Inservice Inspection of Nuclear Power Plant Components, 1995 Edition through 1996 Addenda. Revision 1 to this letter was submitted on August 9, 2001. In a telephone conference with AmerGen on August 21, 2001, the NRC requested additional information concerning these requests. This letter provides the requested information as Revision 2 and replaces in its entirety our previous submittals. Changes from the August 9, 2001 submittal are indicated with revision bars.

As stated in our previous submittals, visual inspections for leakage/boric acid deposits of all Reactor Vessel Head Thermocouple (TC) nozzles and Control Rod Drive Mechanism (CRDM) nozzles will be conducted during the upcoming TMI Unit 1 Cycle 14 Refueling Outage (T1R14). Nozzles showing evidence of leakage will be repaired.

In order to conduct the repairs efficiently and insure personnel exposure is kept to a minimum, the attached relief requests and alternatives from ASME Section XI requirements must be approved.

A001

The repair plans seek to significantly reduce exposures by instituting machine remote processes for CRDM repair similar to that used at the Oconee Nuclear Station – Unit 2. Based on the Oconee Nuclear Station – Unit 2 experience of repairing manually verses repairing with machine remote processes, it is estimated that at TMI Unit 1, a significant radiological dose savings of 11 REM will be realized for each CRDM nozzle repaired. There are 69 CRDM nozzles and 8 TC nozzles on the TMI Unit 1 reactor vessel head. If repairs are necessary, approval of these requests are required in order to realize the above radiological dose savings.

Approval of these requests will allow repairs to TC and CRDM nozzles utilizing alternatives to the use of material, welding processes and examination requirements of several ASME Code sections for the repair of Class A Reactor Vessel head components. The relief requests have been evaluated and determined that the alternatives described in each relief request provide an acceptable level of quality and safety. Thermocouple nozzle repairs, if required, will be performed manually, with the majority of the work being performed from the top side of the Reactor Vessel head, such that worker dose is minimized. The repair will consist of either nozzle plugging or nozzle sleeving, depending on replacement of individual nozzle functional requirements.

The new pressure boundary welds will be added to the Augmented Inservice Inspection Program. These welds will be inspected during the third Inservice Inspection Interval for TMI Unit 1 which began on April 20, 2001.

Attachment A and its enclosures contain information proprietary to Framatome ANP (FRA-ANP). The proprietary information is identified in the table of contents. An affidavit from FRA-ANP is included which sets forth the basis on which the information may be withheld from public disclosure by the NRC pursuant to 10 CFR 2.790. Attachment B provides a non-proprietary version of this request.

We request that relief be approved prior to the upcoming TMI Unit 1 Cycle 14 Refueling Outage (T1R14) which is currently scheduled for October 9, 2001.

Very truly yours,

Michael P. Gallagher
Director – Licensing
Mid-Atlantic Regional Operating Group

Enclosure: Summary of AmerGen Energy Company Commitments

Attachments: A) Proprietary Version
B) Non-Proprietary Version

cc: H. J. Miller, USNRC, Regional Administrator, Region I
T. G. Colburn, USNRC, Senior Project Manager, TMI Unit 1
J. D. Orr, USNRC, Senior Resident Inspector, TMI Unit 1
File No. 01055

SUMMARY OF AMERGEN ENERGY COMPANY COMMITMENTS

The following table identifies commitments made in this document by AmerGen Energy Company. Any other actions discussed in the submittal represent intended or planned actions by AmerGen Energy Company. They are described to the NRC for the NRC's information and are not regulatory commitments.

Commitment	Committed Date
1. The new pressure boundary welds will be added to the Augmented Inservice Inspection Program. These welds will be inspected during the third Inservice Inspection Interval for TMI Unit 1 which began on April 20, 2001.	These welds will be inspected during the third Inservice Inspection Interval for TMI Unit 1.

5928-01-20239

ATTACHMENT B
(Non-Proprietary Version)

TMI UNIT 1
ASME Section XI Relief Requests Associated With Reactor Vessel Head Repair

Table of Contents

TMI UNIT 1
ASME Section XI Relief Requests Associated With Reactor Vessel Head Repair

Enclosure 1

Machine Repair Process

The Alloy 600 partial penetration welds used to attach Control Rod Drive Mechanism (CRDM) nozzles to the reactor pressure vessel (RPV) closure head are susceptible to failure by primary water stress corrosion cracking (PWSCC). Visual inspections for leakage/boric acid deposits of all Reactor Vessel Head Thermocouple (TC) nozzles and CRDM nozzles will be conducted at TMI Unit 1. Nozzles showing evidence of leakage will be repaired. The most recent repairs at Oconee Nuclear Station – Unit 2 involved the use of the Framatome-ANP full circumference inner diameter temper-bead (IDTB) weld repair process. The repair plans seek to significantly reduce exposures for CRDM repair by instituting machine remote processes similar to those used at the Oconee Nuclear Station – Unit 2.

Thermocouple nozzle repairs, if required, will be performed manually, with the majority of the work being performed from the topside of the Reactor Vessel head, such that worker dose is minimized. The repair will consist of either nozzle plugging or nozzle sleeving, depending on replacement of individual nozzle functional requirements.

The existing CRDM nozzle will be removed to approximately mid Reactor Vessel Head wall thickness by machining with a bottom-up machine tool. The machining process will remove the entire lower portion of the CRDM nozzle. The machine tool will also form the CRDM nozzle repair weld prep. The machine surface will be clean prior to PT with a top-down tool. The repair weld will be performed with a remotely operated GTAW weld head using the temper-bead process. The weld head will be mounted and operated from under the Reactor Vessel Head. The final weld face will be ground using a remote bottom-up grind tool. The final weld will be UT and PT examined with top-down inspection tools. The final inside diameter surface of the CRDM nozzle and new weld will then be conditioned by abrasive water-jet machining to produce a final surface that is in compression to produce optimum resistance to primary water stress corrosion cracking. Figure 1 illustrates the CRDM nozzle repair configuration.
Figure 2 details the new CRDM pressure boundary welds and shows that a portion of the CRDM nozzle bore in the low alloy steel RPV head will be exposed to the reactor coolant. The low alloy steel will be subject to general corrosion during operating and shutdown conditions. A materials evaluation has been performed to determine the maximum corrosion rate of the exposed RPV head low alloy steel (Reference 1). The estimated corrosion rate was used in a detailed stress analysis to establish the minimum life expectancy (Reference 2). The proposed repair involves leaving a portion of the original nozzle in place. A roll expansion is used to hold the nozzle in place. A life assessment was performed to evaluate residual stresses from the roll expansion and welding relative to PWSCC (Reference 3).

In addition, a fracture mechanics flaw evaluation was performed to evaluate the life expectancy of the repair with assumed flaw sizes and locations. This analysis considered sub-critical growth of presumed pre-existing PWSCC cracks in the original Alloy 182 J-groove weld (Reference 4).

Enclosure 1

Machine Repair Process

The materials evaluation addressed the potential corrosion concerns associated with the weld repairs planned for the TMI Unit 1 thermocouple and CRDM nozzles. The PWSCC and general corrosion of Alloy 52/152 (Alloy 690 type) weld metals were addressed. It was concluded that Alloy 52/152 type weld metals are the best commercially available material for this application.

The corrosion concerns of the RPV closure head low alloy steel include: general, galvanic, crevice, SCC, and hydrogen embrittlement. Galvanic corrosion, crevice corrosion, SCC, and hydrogen embrittlement of the RPV head low alloy steel are not considered to be significant concerns. The general corrosion rate for the RPV head low alloy steel, under the anticipated exposure conditions, is 0.0030 in/year. This corrosion rate is based on a 24 month operating cycle followed by a 2 month refueling cycle.

The detailed stress and fatigue analysis of the IDTB CRDM weld repair was performed, taking into account a more conservative corrosion rate of 0.0032 in./year from Reference 1. The primary stress analysis showed that the Primary General Membrane Stress Intensity (Pm) would be within the allowable limits set by ASME Code, Section III for at least 25 years. The conservative fatigue analysis concludes that the repair has a minimum life expectancy of 25 years.

The life expectancy of the IDTB CRDM weld repair was also evaluated with respect to PWSCC of the entire weld repair zone. This includes the roll expanded portion of the original nozzle and the HAZ in the nozzle and Alloy 52 weld. The entire weld repair zone will be subjected to an abrasive water jet machining (AWJM) process, which produces a continuous layer of compressive stress in these surfaces. The life expectancy of the IDTB CRDM weld repair relative to PWSCC is conservatively shown to be 14.6 effective full power years (EFPYs).

The fracture mechanics analysis performed for the as-left J-groove weld, demonstrated that even if a radial flaw had propagated through the Alloy 182 weld and butter by PWSCC and a small flaw initiated in the low alloy steel RPV head, subsequent fatigue crack growth of the combined radial corner flaw would be minimal. It was determined for Oconee Nuclear Station – Unit 2 that a 1.455" corner flaw would grow to about 1.48" in 12 EFPYs of operation at 6 cycles per year. The stress intensity factor associated with this final flaw size satisfied the acceptance criteria of Section XI using an upper shelf value of 200 ksi$\sqrt{\text{in}}$ for the fracture toughness of the low alloy steel RPV head. Since the height of the J-groove weld (and therefore the postulated flaw size) increases from the center nozzle to the outmost row of nozzles, the acceptable flaw size only includes nozzles 1 through 37 (equivalent to nozzle 30 analyzed for Oconee Nuclear Station – Unit 2). The postulated flaw size in nozzles 38 through 69 would have to be reduced to at least 1.455" by removing a portion of the weld. Due to the extremely small growth of this flaw in the low alloy steel RPV head material, it can easily be shown that such a flaw would be acceptable for even 20 EFPYs of operation. From Reference 4, the stress intensity factor at the initial flaw size of 1.455" is 62.14 ksi$\sqrt{\text{in}}$. In 12 EFPYs, the flaw would grow to about 1.48" and

Enclosure 1

Machine Repair Process

the stress intensity factor would be 62.5 ksi√in. The flaw depth and stress intensity factor at 12 EFPYs can be linearly extrapolated to account for operation at 20 EFPYs, as follows:

The flaw size at 20 EFPYs of operation would be about

$$1.455" + (20/12)\,(1.48" - 1.455") = 1.50"$$

And the stress intensity factor would be about

$$62.14\ \text{ksi}\sqrt{\text{in}} + (20/12)\ (62.5\ \text{ksi}\sqrt{\text{in}} - 62.14\ \text{ksi}\sqrt{\text{in}}) = 62.8\ \text{ksi}\sqrt{\text{in}}$$

And the safety margin on fracture toughness would be

$$(200\ \text{ksi}\sqrt{\text{in}}) / (62.8\ \text{ksi}\sqrt{\text{in}}) = 3.18$$

Which is slightly greater than required value of √10, or 3.16.

It is clear that the postulated flaw in the J-groove weld would be acceptable for at least 14.6 EFPYs of operation.

Based on the analyses and evaluations summarized above, the minimum life expectancy of the proposed IDTB full circumference CRDM nozzle weld repair is 14.6 EFPYs. This exceeds the current TMI Unit 1 operating license which expires on April 19, 2014.

REFERENCES

6. Framatome ANP Inc. Document 51-5013861-00, "Corrosion Evaluation of TMI-1 RV Head Penetration Repair."

7. Framatome ANP Inc. Document 32-5012424-03, "CRDM Temper-bead Bore Weld Analysis."

8. Framatome ANP Inc. Document 51-5012772-00, "ONS-2 CRDM Nozzle Temper-bead Repair Lifetime Assessment."

9. Framatome ANP Inc. Document 32-5012649-01, "CRDM Nozzle J-Groove Weld Flaw."

10. Framatome ANP Inc. Document 02-5012151E-05, "CRDM Nozzle ID Temper-bead Weld Repair Boring Option B&W 177 FA Plants."

Figure 1

TMI Unit 1 CRDM Machining

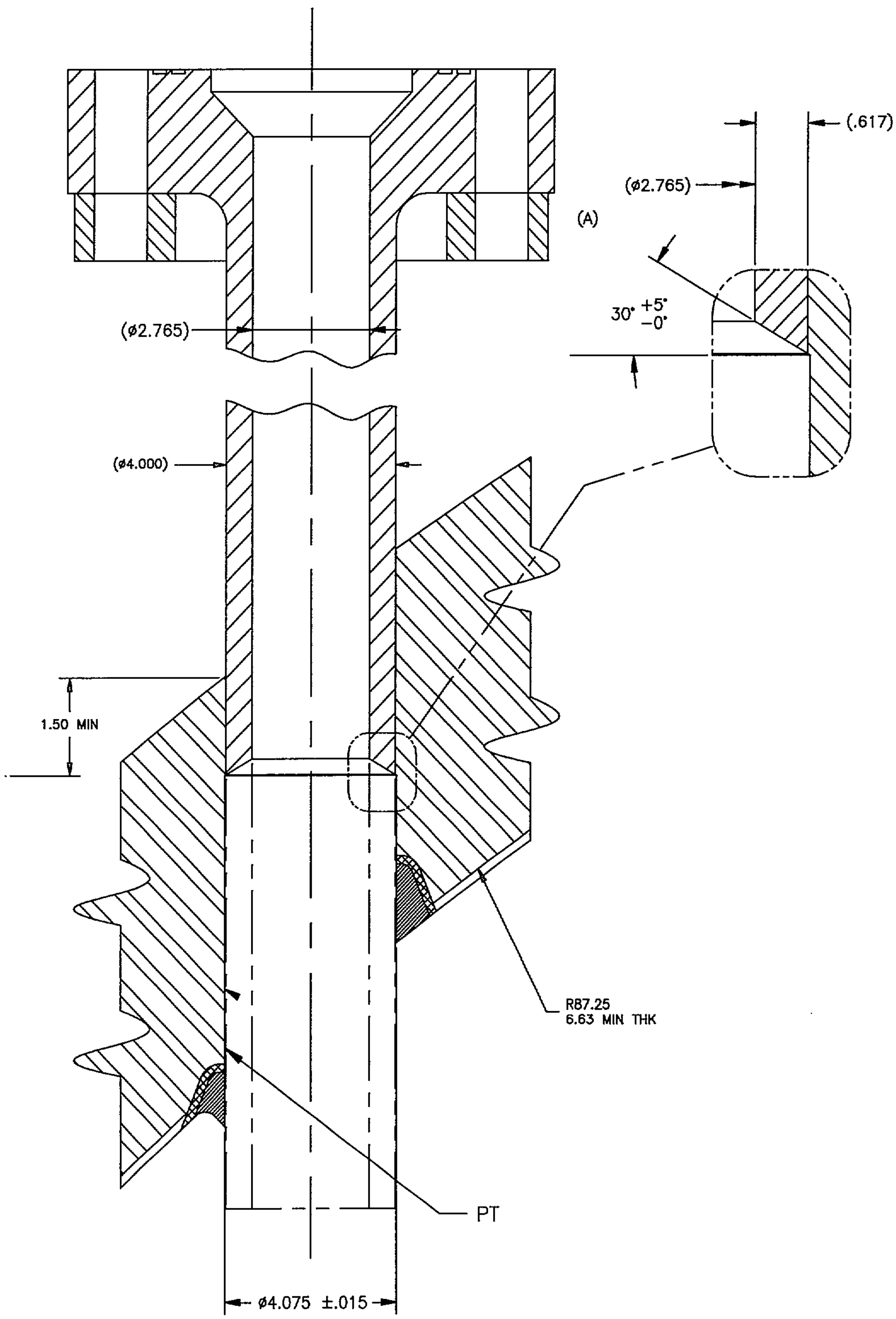
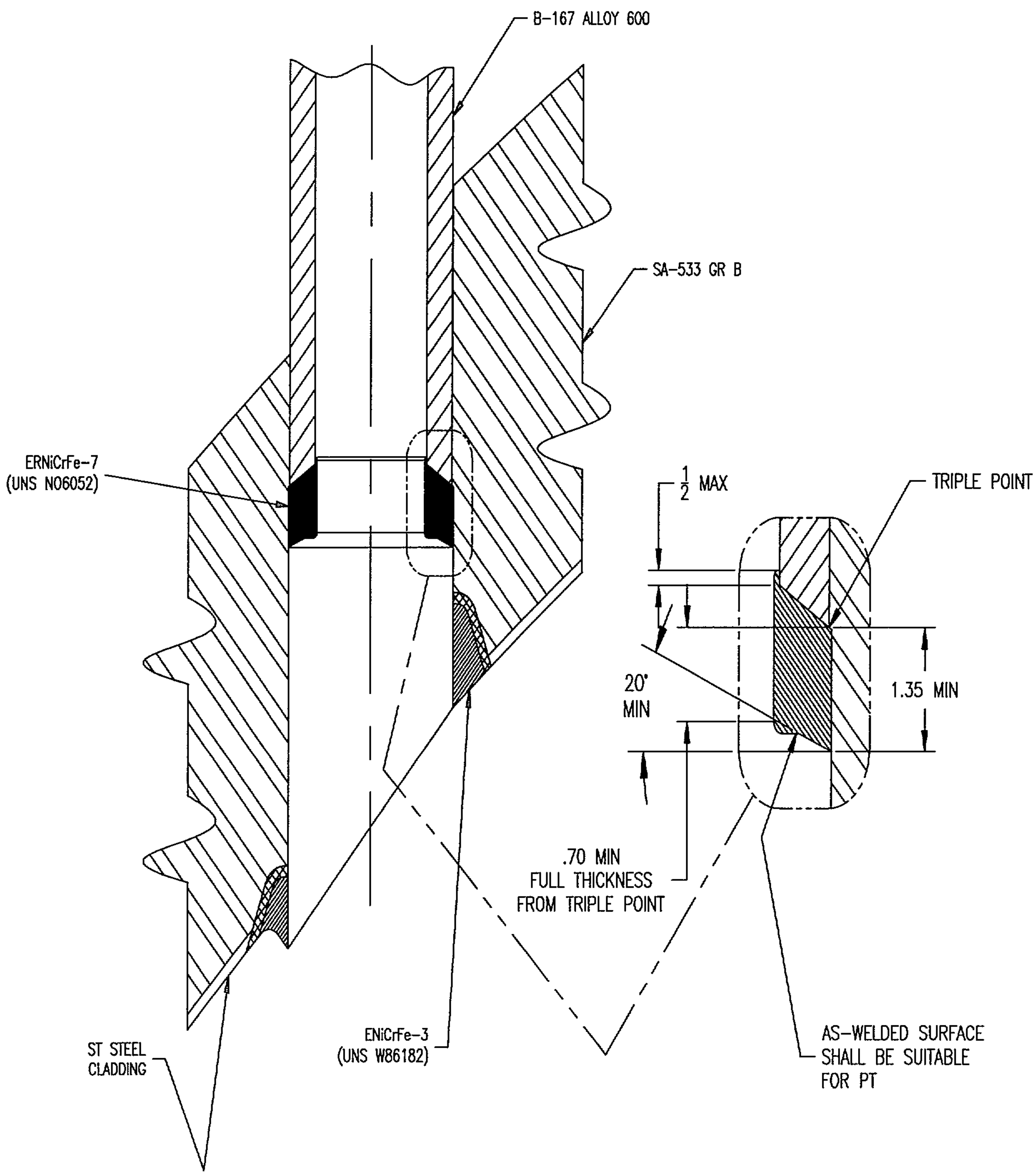


Figure 2

TMI Unit 1
New CRDM Pressure Boundary Welds



Three Mile Island Unit 1
Request for Relief RR-01-14
"Use of Alloy 690 Based Weld Filler Material"

COMPONENT IDENTIFICATION

Code Class:	Class 1
Reference:	ASME, Section XI; 1995 Edition through 1996 Addenda
Examination Categories:	B-O (Section XI)
Item Number:	B14.10 (Section XI)
Description:	Use of Alloy 690 (Alloy 52/152) welding filler material
Component Numbers	All as necessary

CODE REQUIREMENTS FROM WHICH AN ALTERNATIVE IS REQUESTED

The Code to be utilized for the repairs to Thermocouple (TC) nozzles and Control Rod Drive Mechanism (CRDM) nozzles is ASME Code, Section XI, Rules for Inservice Inspection of Nuclear Power Plant Components, 1995 Edition through 1996 Addenda.

ASME Code, Section XI, Rules for Inservice Inspection of Nuclear Power Plant Components, 1995 Edition through 1996 Addenda allows, by reference, the use of Alloy 600 based weld filler material (Alloy 82/182) but does not include the use of Alloy 690 (Alloy 52/152) based weld filler material (Alloy 52/152).

BASIS FOR ALTERNATIVE

Alloy 690 (Alloy 52/152) weld materials possess a high resistance to primary water stress corrosion.

Alloy 690 (Alloy 52/152) material has been shown to be superior to Alloy 600 (Alloy 82/182) material in resisting Primary Water Stress Corrosion Cracking (PWSCC). The NRC approved the use of Alloy 690 (Alloy 52/152) material in the construction of the replacement steam generators to be installed at Oconee, McGuire Nuclear Station Units 1 & 2, and Catawba Nuclear Station Unit 1. The NRC also approved requests for use of Alloy 690 (Alloy 52/152) material in the repairs of the Oconee Unit 1 thermocouple and CRDM nozzles, and the Unit 3 CRDM nozzles. At TMI Unit 1, Alloy 690 (Alloy 52/152) has been approved for use for steam generator plugs and sleeves.

Three Mile Island Unit 1
Request for Relief RR-01-14
"Use of Alloy 690 Based Weld Filler Material"

ASME Code Cases 2142-1 and 2143-1 establish the uniform chemical and material properties and the classification of the weld material with respect to its welding characteristics. Code Case 2142-1 establishes the F-No. for the American Welding Society (AWS) specification AWS A5.14 and Unified Numbering System (UNS) designation UNS N06052 (Alloy 52) as F-No. 43 for both procedure and performance qualification purposes. Code Case 2143-1 establishes the F-No. for AWS A5.11 and UNS designation W86152 (Alloy 152) for a coated electrode as F-No. 43 for procedure and performance qualification purposes. These sets of specifications and F-No. assignments completely describe this material for welding purposes as similar in their welding characteristics to other Code approved nickel based weld metals.

In conclusion, the use of Alloy 690 (Alloy 52/152) welding filler material (Alloy 52/152) and the associated ASME Code Cases 2142-1 and 2143-1 for the repairs to TMI Unit 1 TC and CRDM nozzles will provide superior corrosion protection over that provided by Alloy 600 (Alloy 82/182) material. The use of Alloy 690 (Alloy 52/152) has been previously authorized for new construction and other repair activities. Therefore, the proposed alternative provides an acceptable level of quality and safety.

PROPOSED ALTERNATIVE PROVISIONS

In lieu of the Code requirement, the use of Alloy 690 (Alloy 52/152) weld filler material is proposed for the repair of all TC nozzles and CRDM nozzles located on the TMI Unit 1 Reactor Vessel (RV) head.

Pursuant to 10 CFR 50.55a(a)(3)(i), an alternative is requested on the basis that the proposed alternative provides an acceptable level of quality and safety.

ASME Code, Section XI, Rules for Inservice Inspection of Nuclear Power Plant Components, 1995 Edition through 1996 Addenda allows, by reference, the use of Alloy 600 based weld filler material (Alloy 82/182) but does not include the use of Alloy 690 (Alloy 52/152) based weld filler material (Alloy 52/152).

Code cases 2142-1 and 2143-1 introduce and classify new nickel based weld metals that closely match Alloy 690 (Alloy 52/152). Code Case 2142-1 establishes welding classifications and other requirements for bare wire filler metal (UNS N06052 Ni-Cr-Fe). Code Case 2143-1 establishes welding classifications and other requirements for a coated electrode (UNS W86152 Ni-Cr-Fe). These two Code cases have not been incorporated by reference into the regulations; therefore, their use requires NRC approval.

Three Mile Island Unit 1
Request for Relief RR-01-15
"Eliminate 5 Inch Band Examination"

COMPONENT IDENTIFICATION

Code Class:	Class 1
Reference:	ASME, Section XI; 1995 Edition through 1996 Addenda
Examination Categories:	B-O (Section XI)
Item Number:	B14.10 (Section XI)
Description:	Examination Requirements
Component Numbers	All as necessary

CODE REQUIREMENTS FROM WHICH AN ALTERNATIVE IS REQUESTED

The Code to be utilized for the repairs to the Control Rod Drive Mechanism (CRDM) nozzles is ASME Code, Section XI, Rules for Inservice Inspection of Nuclear Power Plant Components, 1995 Edition through 1996 Addenda.

IWA-4634 of ASME Code, Section XI, Rules for Inservice Inspection of Nuclear Power Plant Components, 1995 Edition through 1996 Addenda states, "The weld as well as the preheated band shall be examined by the liquid penetrant method after the completed weld has been at ambient temperature for at least 48 hours. The weld shall be volumetrically examined."

The first sentence of IWA-4610(a) of ASME Code, Section XI, Rules for Inservice Inspection of Nuclear Power Plant Components, 1995 Edition through 1996 Addenda states, "The area to be welded plus a band around the area of at least 1-1/2 times the component thickness or 5 in., whichever is less, shall be preheated and maintained at a minimum temperature of 350 degrees F for the SMAW process and 300 degrees F for the GTAW process during welding."

BASIS FOR ELIMINATION

The configuration of the new pressure boundary welds limits the ability to examine the band area as defined by IWA-4610(a). For the repairs, the GTAW process will be utilized. Due to the thickness of the RV head, the 5-inch minimum is utilized for definition of the band area.

Three Mile Island Unit 1
Request for Relief RR-01-15
"Eliminate 5 Inch Band Examination"

The 5-inch band area is not directly applicable to the interior surfaces of the RV head CRDM bores that are to be repaired. It is proposed that in lieu of inspecting the 5 inch band, the surfaces of the new pressure boundary weld receive both the UT and PT inspections.

UT inspections of the RV head base material above the new weld through the nozzle would not be effective due to the interface between the nozzle and RV head low alloy steel. Thus, no UT inspections will be attempted above the new weld. The UT coverage volumes are shown in Figures 1 through 6 for the various scans and the transducers to be used are shown in Table 1. The UT transducers and delivery tooling are capable of scanning from cylindrical surfaces with inside diameters near 2.75 in. The UT equipment is not capable of scanning from the face of the taper. Approximately 70% of the weld surface will be scanned by UT. Approximately 83% of the closure head ferritic steel HAZ will be covered by the UT.

The effectiveness of the UT techniques to detect and characterize flaws in the inner diameter temper-bead (IDTB) repair weld have been qualified by demonstration on a mockup of the IDTB involving the same materials used for repair. Notches were machined into the mockup with depths of 0.10", 0.15", and 0.25" in order to quantify the ability to characterize the depth of flaw penetration through the nozzle wall and weld thickness. The depth characterization is done using tip diffraction UT techniques that have the ability to measure the depth of a reflector relative to the nozzle bore. Each of the notches in the mockup could be measured using the 45-degree transducer. During the examination, longitudinal wave angle beams of 45 degrees and 70 degrees are used. These beams are directed along the nozzle axis looking up and down. The downward looking beams are effective at detecting flaws in the weld root area because of the impedance change at the ferritic low alloy steel head, Alloy 600 CRDM nozzle and the Alloy 52 weld. The 45-degree transducer is effective at depth characterization by measuring the time interval to the tip of the reflector relative to the transducer contact surface. The 70-degree longitudinal wave provides additional qualitative data to support information obtained with the 45-degree transducer. Together, these transducers provide good characterization of detected flaws. These techniques are routinely used for examination of austenitic welds in the nuclear industry for flaw detection and sizing. In addition to the 45 and 70-degree beam angles described above, the weld is also examined in the circumferential direction using 45-degree longitudinal waves in both the clockwise and counterclockwise directions to look for transverse flaws. A 0-degree transducer is also used to look radially outward to examine the weld and adjacent material for evidence of under bead cracking in the low alloy steel weld HAZ. Detection of flaws has also been demonstrated on mockups fabricated during the welding qualification activities.

Due to the unique geometry of the CRDM penetration modification, it is not practical to perform a surface examination of the band area. Space restrictions and the final configuration do not allow liquid penetrant examination of the ferritic steel 5 inch band.

Three Mile Island Unit 1
Request for Relief RR-01-15
"Eliminate 5 Inch Band Examination"

The exposed ferritic steel portion of the CRDM penetration plus the weld preparation bevel on the lower end of the remaining portion of the CRDM nozzle as well as the adjacent portion of the CRDM nozzle ID, 1/2 inch above the weld preparation, will be liquid penetrant examined prior to welding. This examination provides assurance that no flaws exist on the surface in the bore and remaining portion of the CRDM nozzle in the region to be welded.

The final weld surface and adjacent base material at least 1/2 inch above the toe of the weld at the nozzle and 1/2 inch below the toe of the weld (Figure 8) in the ferritic steel closure head base material will be liquid penetrant examined after welding. The liquid penetrant examination below the bottom toe of the weld will cover all the exposed closure head base material weld heat affected zone. This examination provides assurance that no flaws exist on the surfaces in the bore and remaining portion of the CRDM nozzle in the region affected by welding as well as the weld. Figure 7 shows the PT coverage area prior to welding and Figure 8 shows the PT coverage area subsequent to welding.

The requirement for the band NDE is specified to assure all unacceptable flaws in the area of the repair have been removed or addressed, since these flaws may be associated with the original flaw and may have been overlooked. The original rules were written within the context of repairing a detected flaw in base metal. As such, there was a concern for other existing flaws in the immediate area. Another purpose of the examination is to detect unacceptable flaws that may be revealed as a result of the repair. This examination extent is consistent with the Construction Code requirements.

Remote enhanced video will be used during the welding operation to insure welding quality. The remote inner diameter temper-bead welding system has two built-in camera systems. One camera is set to view the weld puddle from above and one from below. Using filters and camera iris controls, the remote vision systems are used for both molten puddle, "hot" viewing and as-deposited, solidified, "cold" viewing. This provides an excellent means for assuring good quality weld beads have been placed appropriately during and after each weld pass. The combination of the UT and PT examinations on the weld surfaces and weld procedure qualification will provide an acceptable level of quality and safety.

Compliance with the post-repair examination areas to the requirements of IWA-4634 of ASME Code, Section XI, Rules for Inservice Inspection of Nuclear Power Plant Components, 1995 Edition through 1996 Addenda presents a hardship due to the unique geometry of the CRDM nozzle to RV head interface in the bore region.

Three Mile Island Unit 1
Request for Relief RR-01-15
"Eliminate 5 Inch Band Examination"

PROPOSED ALTERNATIVE PROVISIONS

Pursuant to 10 CFR 50.55a(a)(3)(ii), Compliance with the requirements of IWA-4634 and IWA-4610(a) of ASME Code, Section XI, Rules for Inservice Inspection of Nuclear Power Plant Components, 1995 Edition through 1996 Addenda would result in hardship and unusual difficulty without a compensating increase in the level of quality and safety. An alternative is requested on the basis that the proposed alternative provides an acceptable level of quality and safety. Due to the unique geometry of the CRDM inside Reactor Vessel (RV) head repair, it is not practical to volumetrically examine, as required by IWA-4634, the 5 inch band around the weld area as defined by IWA-4610(a). The repairs to the CRDM nozzles involve severing the existing J-groove partial penetration weld from the CRDM nozzle, removal of the lower portion of the nozzle and relocating the pressure boundary attachment weld up into the bore of the RV head. Post-repair inspections of the repaired areas will be done by a combination of remote and manual methods. In lieu of inspecting the Code required band area, the proposed alternative is that the repair area be inspected by UT and PT.

The UT coverage volumes are shown in Figures 1 through 6 for the various scans. Approximately 70% of the weld surface will be scanned by UT. Approximately 83% of the closure head ferritic steel HAZ will be covered by the UT.

The exposed ferritic steel portion of the CRDM penetration plus the weld preparation bevel on the lower end of the remaining portion of the CRDM nozzle as well as the adjacent portion of the CRDM nozzle ID, 1/2 inch above the weld preparation, will be liquid penetrant examined prior to welding. This examination provides assurance that no flaws exist on the surface in the bore and remaining portion of the CRDM nozzle in the region to be welded.

The final weld surface and adjacent base material at least 1/2 inch above the toe of the weld at the nozzle and 1/2 inch below the toe of the weld (Figure 8) in the ferritic steel closure head base material will be liquid penetrant examined after welding. The liquid penetrant examination below the bottom toe of the weld will cover all the exposed closure head base material weld heat affected zone. Figure 7 shows the PT coverage area prior to welding and Figure 8 shows the PT coverage area subsequent to welding.

The proposed alternative will also utilize remote enhanced video during the welding operation to insure welding quality. The remote inner diameter temper-bead welding system has two built-in camera systems. One camera is set to view the weld puddle from above and one from below. Using filters and camera iris controls, the remote vision systems are used for both molten puddle, "hot" viewing and as-deposited, solidified, "cold" viewing. This provides an excellent means for

Three Mile Island Unit 1
Request for Relief RR-01-15
"Eliminate 5 Inch Band Examination"

assuring good quality weld beads have been placed appropriately during and after each weld pass.

The combination of the UT and PT examinations and weld procedure qualification will provide an acceptable level of quality and safety.

RR-01-15

Table 1

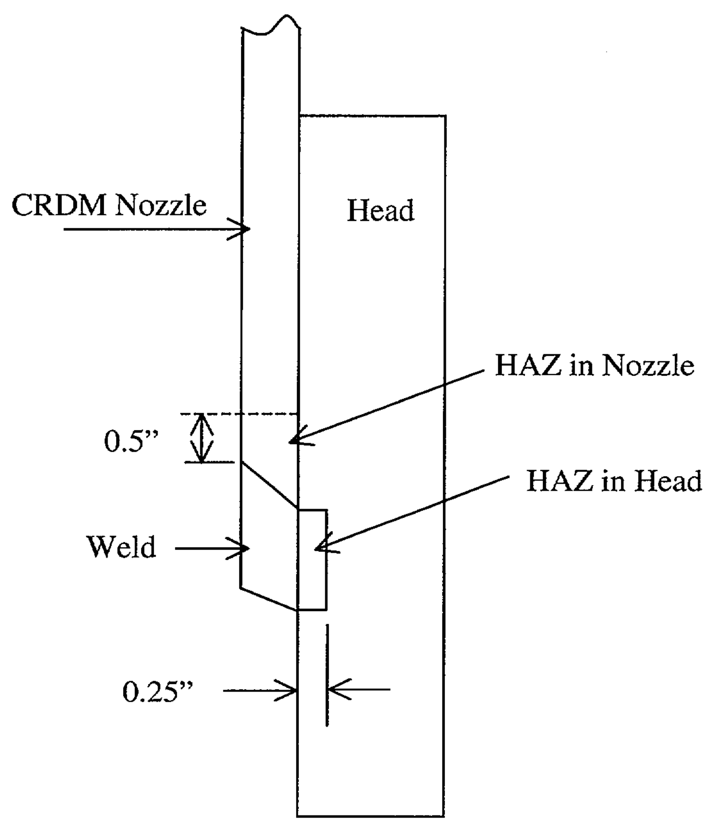
TMI Unit 1 CRDM Replacement Weld
UT Search Unit Transducer Characteristics

Search Unit Selection						
Angle/Mode	**Freq.**	**Model**	**Mfg.**	**Size**	**Focal Depth**	**Beam Direction**
0° L-wave	2.25 MHz	2077	Sigma	.15" x .30"	0.45"	N/A
45° L-wave	2.25 MHz	2118	Sigma	.30" x .20"	0.45"	Axial
70° L-wave	2.25 MHz	2370	Sigma	.72" x .21"	0.69"	Axial
45° L-wave (effective)	2.25 MHz	2117	Sigma	.30" x .20"	0.45"	Circ.

RR-01-15

Figure 1

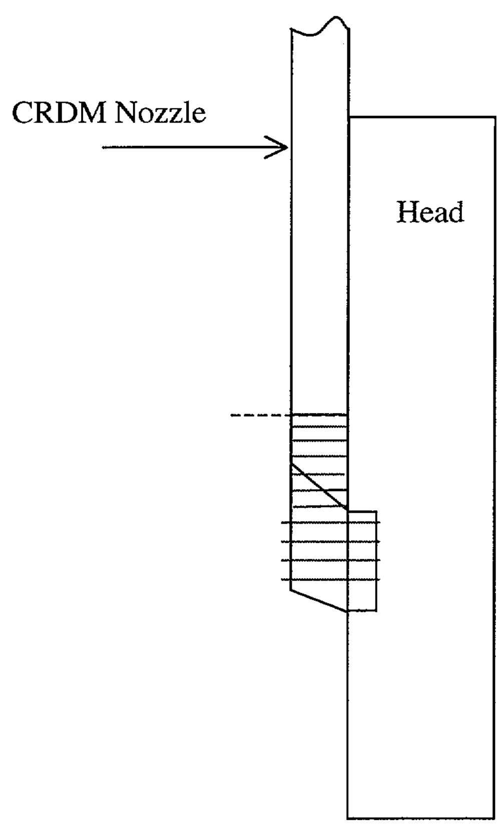
TMI Unit 1 CRDM Temper-Bead Weld Repair
Areas to be Examined



RR-01-15

Figure 2

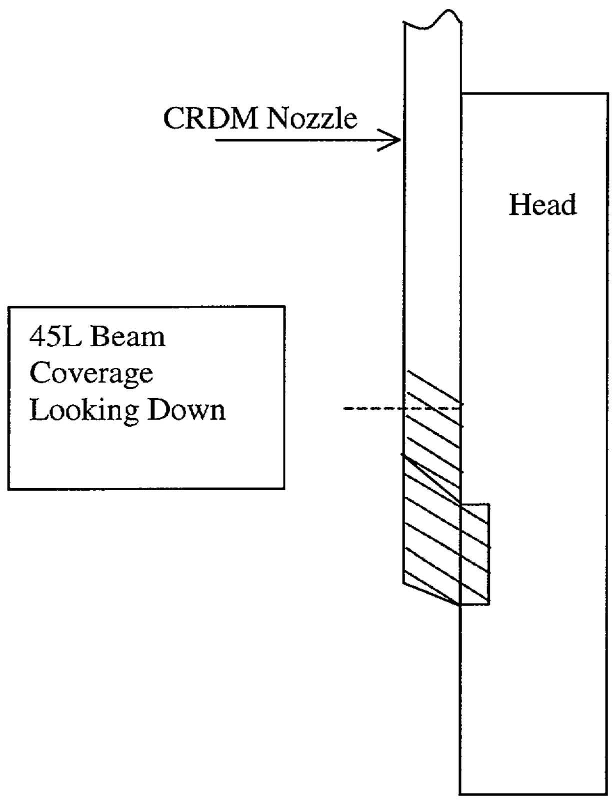
TMI Unit 1 CRDM Temper-Bead Weld Repair
UT 0 degree and 45L Beam Coverage
Looking Clockwise and Counter-clockwise



RR-01-15

Figure 3

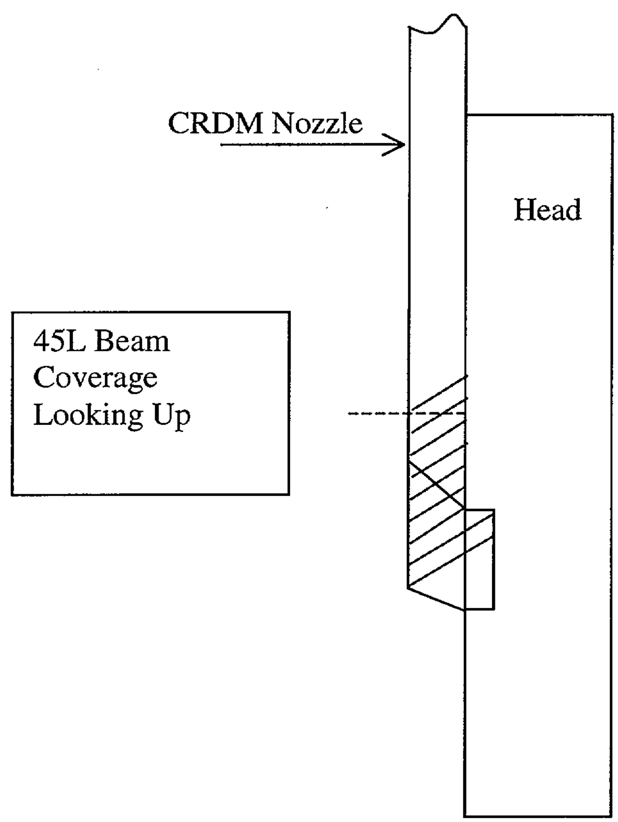
TMI Unit 1 CRDM Temper-Bead Weld Repair
45L UT Beam Coverage Looking Down



RR-01-15

Figure 4

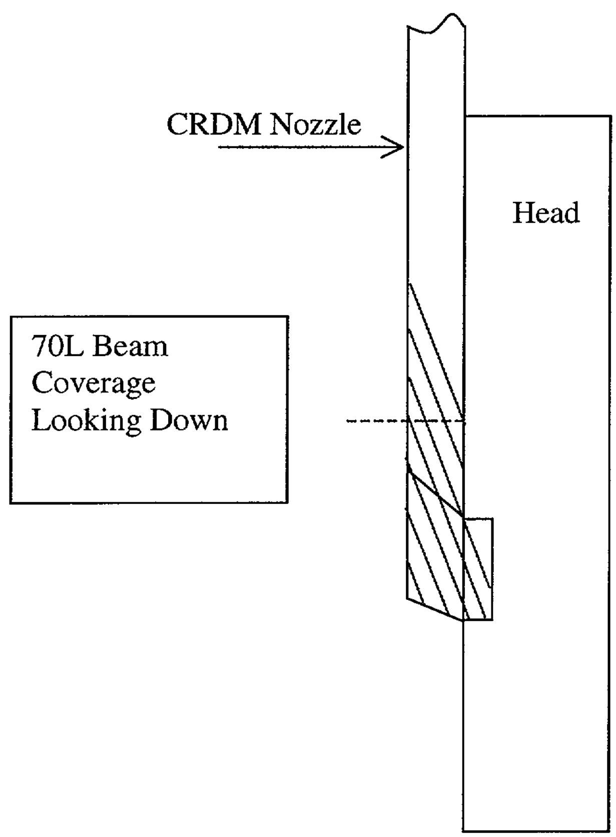
TMI Unit 1 CRDM Temper-Bead Weld Repair
45L UT Beam Coverage Looking Up



RR-01-15

Figure 5

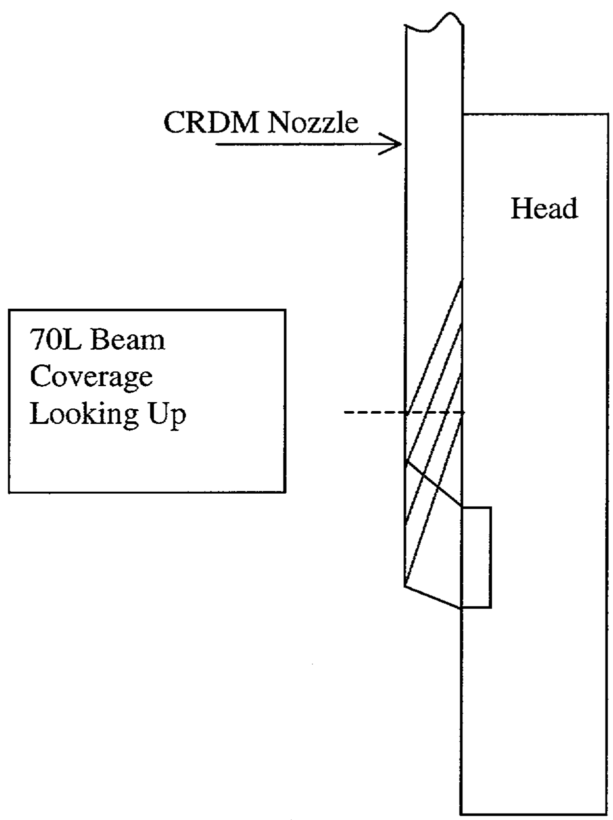
TMI Unit 1 CRDM Temper-Bead Weld Repair
70L UT Beam Coverage Looking Down



RR-01-15

Figure 6

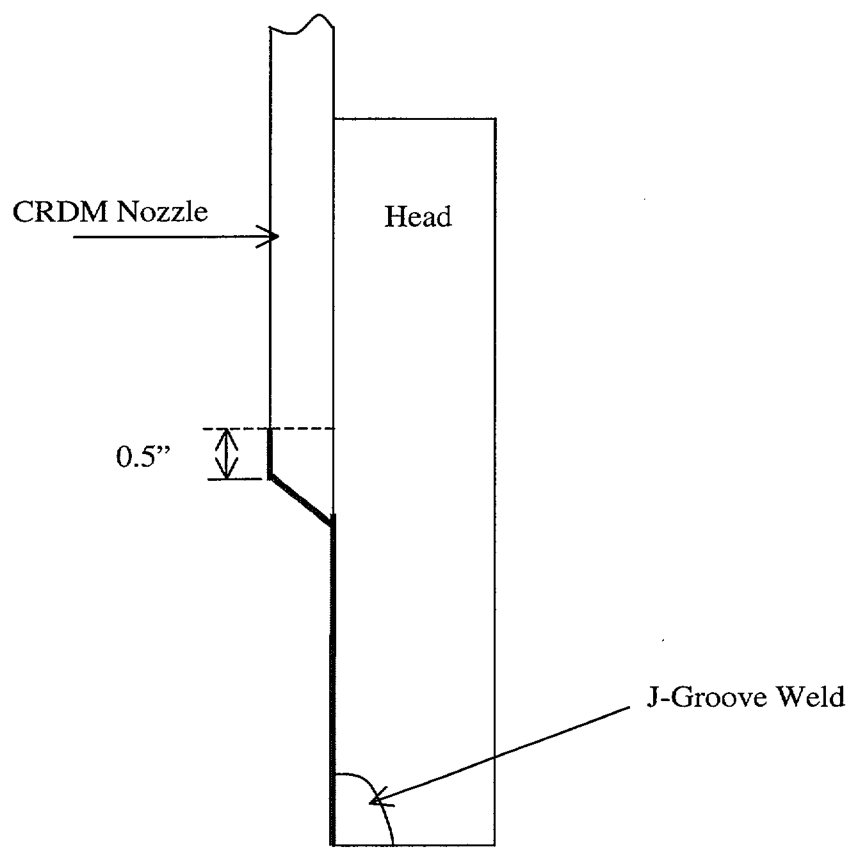
TMI Unit 1 CRDM Temper-Bead Weld Repair
70L UT Beam Coverage Looking Up



RR-01-15

Figure 7

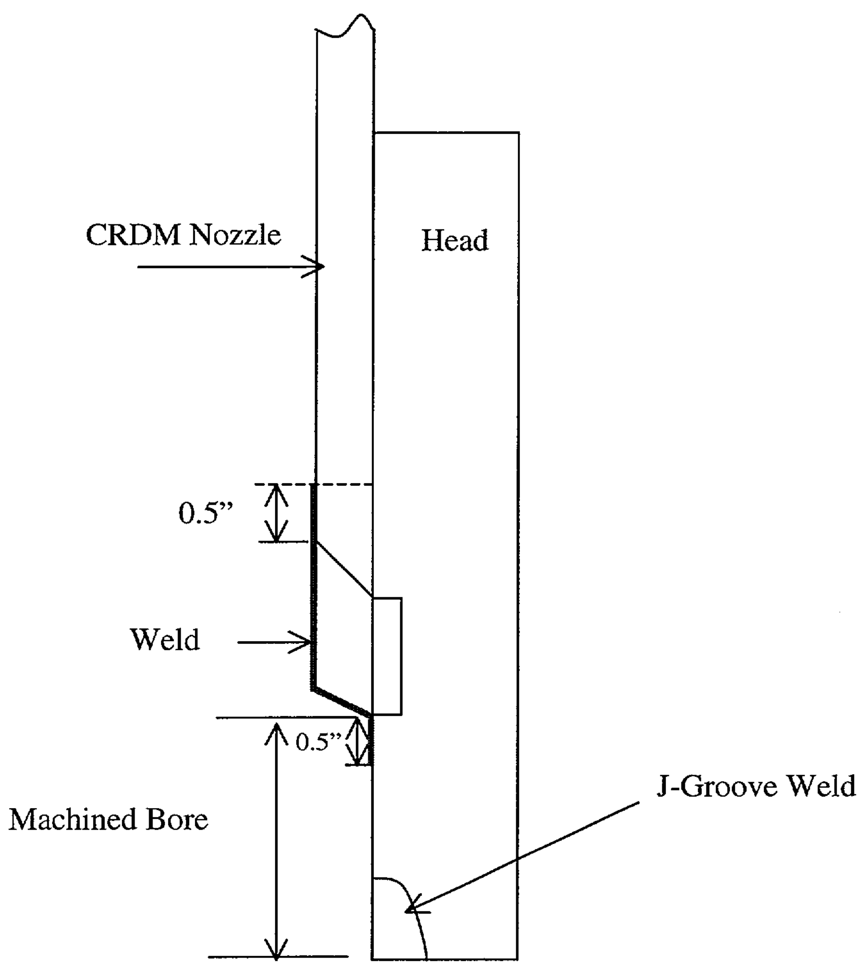
**TMI Unit 1 CRDM Temper-Bead Weld Repair
PT Coverage Prior to Welding**



RR-01-15

Figure 8

TMI Unit 1 CRDM Temper-Bead Weld Repair
PT Coverage after Welding



Three Mile Island Unit 1
Request for Relief RR-01-16
"Eliminate 48 Hour Hold Time"

COMPONENT IDENTIFICATION

Code Class:	Class 1
Reference:	ASME, Section XI; 1995 Edition through 1996 Addenda
Examination Categories:	B-O (Section XI)
Item Number:	B14.10 (Section XI)
Description:	Examination Requirements
Component Numbers	All as necessary

CODE REQUIREMENTS FROM WHICH AN ALTERNATIVE IS REQUESTED

The Code to be utilized for the repairs to the Control Rod Drive Mechanism (CRDM) nozzles is ASME Code, Section XI, Rules for Inservice Inspection of Nuclear Power Plant Components, 1995 Edition through 1996 Addenda.

IWA-4634 of ASME Code, Section XI, Rules for Inservice Inspection of Nuclear Power Plant Components, 1995 Edition through 1996 Addenda states, "The weld as well as the preheated band shall be examined by the liquid penetrant method after the completed weld has been at ambient temperature for at least 48 hours. The weld shall be volumetrically examined."

BASIS FOR ELIMINATION

IWA-4634 of ASME Code, Section XI, Rules for Inservice Inspection of Nuclear Power Plant Components, 1995 Edition through 1996 Addenda specifies that the weld region shall undergo volumetric examination after the weld repair area has been at ambient temperature for a minimum of 48 hours. The 48-hour hold is specified to assure that no delayed cold cracking in the ferritic steel Heat Affected Zone (HAZ) has occurred. The weld consumables to be used in the new pressure boundary weld consist of bare wire with no flux. The welding will be performed at 300 degrees F minimum preheat temperature using the GTAW process, as required by IWA-4610(a).

The preheat temperature of 300 degrees F and the post soak heat treatment (PSHT) requirement of IWA-4633.2(d) is to assure that no delayed cold cracking in the ferritic steel HAZ occurs. Elevated preheat is intended to eliminate moisture and contaminants (hydrocarbons) that could

Three Mile Island Unit 1
Request for Relief RR-01-16
"Eliminate 48 Hour Hold Time"

be introduced into the molten metal during welding. The PSHT requirement, initiated immediately after welding is completed, allows the hydrogen potentially trapped in the HAZ and weld metal an extended time period to diffuse out of the HAZ and weld metal. The weld consumables to be used will consist of bare wire with no flux. The preheat temperature of 300 degrees F will be maintained during the post-weld soak for four hours in accordance with IWA-4633.2(d) of ASME Code, Section XI, Rules for Inservice Inspection of Nuclear Power Plant Components, 1995 Edition through 1996 Addenda. The combination of the low moisture absorbing GTAW weld process and maintaining the post-weld soak temperature at 300 degrees F for four hours will eliminate the possibility of hydrogen induced cracking.

The anticipated ambient temperature for the reactor vessel head will be in the 70 degree F to 80 degree F range by the time a CRDM location would be designated for a repair. Varying plant conditions can affect the temperature of the head. The ambient temperature range for a typical repair is determined by taking an actual measurement and applying a +50 degree F tolerance.

Given a nominal ambient temperature of 75 degree F, a single repair location on the head would take approximately 8 hours to reach the upper end of the 125 degree F ambient temperature range from the 300 degree F minimum PSHT temperature. The time between the end of the welding operations and the beginning of the UT and PT examinations may vary, however, the elapsed time between the end of the welding operation and the beginning of the examinations is estimated to be approximately 12 hours with an ambient temperature no greater than 125 degree F. This estimate includes the PSHT period and the cool-down period.

The PSHT period will not have any significant effect on the microstructure of the base metal, weld metal or Heat Affected Zone (HAZ). Its only purpose is to enhance hydrogen evolution through the matrix.

The reactor vessel base material SA-533 Grade B, Class 1 is a low alloy steel material. This ASME P3 material requires preheat and post weld heat treatment for most applications due to its higher carbon equivalence. The formation of untempered martensite can be expected in the HAZ of this material for welds performed using standard (non temper-bead) welding techniques. The untempered martensite formation in the HAZ will result in reduced mechanical properties in the HAZ. The Code required 1150 degree F stress relief that is typically applied after welding reduces the localized residual stresses from the weld. This required stress relief has little effect on the microstructure and restoration of the mechanical properties of the HAZ but removes the high-localized residual stresses that are one of the components responsible for hydrogen cracking. The temper-bead welding technique through the use of controlled heat input and specified bead placement produces tempered martensite in the HAZ. The tempered martensite will not adversely affect mechanical properties in the ferritic base metal HAZ. This is verified

Three Mile Island Unit 1
Request for Relief RR-01-16
"Eliminate 48 Hour Hold Time"

with the required impact testing comparison of the HAZ and unaffected base material in the welding procedure qualification. Attachment 1 to this relief request provides PQR-7109 (Reference 5), which contains the impact data in the mechanical testing section.

The Inconel 690 weld metal will display superior impact properties and a dendritic microstructure typical of GTAW deposits. PQR–7109 shows the mechanical test data for the weld metal.

PQR-7001 (Reference 5) is provided as Attachment 3. This PQR was one of the first full size temper-bead PQRs utilizing SA-533 Grade B, Class 1 material that Framatome performed using the machine GTAW process. The base material had received 60 hours of stress relief prior to welding. A considerable amount of microhardness testing and metallographic examinations were performed to characterize the HAZ. Microhardness traverses, using a Knoop indenter with a 500g load (HK_{500}) were performed to evaluate the HAZ for potential locations of untempered martensite. Microhardness traverses were performed on three (3) PQR-7001 metallographic specimens from the weld metal to the unaffected base metal at three locations. The results of this testing are summarized in Table 1 of PQR-7001.

Metallographic examination was performed on the same three specimen cross sections that were subjected to microhardness evaluation to determine if any untempered martensitic structure or cracking existed. Metallographic examinations were conducted throughout the entire cross section, but primarily at the HAZs, with emphasis on the locations where microhardness testing was performed. For this class of steels, the microhardness of a bainitic structure is expected to be approximately the same as tempered martensite, therefore, microhardness alone cannot be used to judge the existence of tempered martensite.

The microstructure of tempered martensite is expected to generally consist of carbide precipitation and (in some cases) ferrite formation in the matrix martensite. In general, the degree of carbide and ferrite formation is time and temperature dependent. The criterion to consider a martensitic microstructure to be "tempered" was any evidence of carbide precipitation or ferrite formation. For comparison, an untempered martensitic base metal specimen was also prepared from each weld assembly base material by heat treatment.

The specimen HAZs were carefully examined up to 500X magnification in the optical microscope. Metallographic examination revealed no evidence of untempered martensitic structure or microcracking in the HAZ of any of the samples, especially in the areas where microhardness readings were questionable. HAZ regions of all cross sections exhibited a fine grained structure comprised of a complex conglomerate of microstructure typically found in the HAZs of multiple-pass welds.

Three Mile Island Unit 1
Request for Relief RR-01-16
"Eliminate 48 Hour Hold Time"

Delayed hydrogen cracking tends to occur in carbon and alloy steel welds produced by processes which use a flux, e.g. shielded metal arc welding (SMAW), submerged arc welding (SAW), and flux cored arc welding (FCAW). The flux in these processes can pick up moisture that breaks down during welding to produce atomic hydrogen. The atomic hydrogen is partially absorbed by the weld metal and HAZ. Absorption of hydrogen, in sufficient quantity in low ductility material, may cause delayed hydrogen cracking. The GTAW process uses Argon gas as the shielding medium.

Moisture contaminated shielding gas or high humidity environments may introduce hydrogen into GTAW welds. The Electric Power Research Institute (EPRI) performed tests (Reference 1) where argon shielding gas was bubbled through a cylinder of water and then mixed with welding grade argon having a dew point of –70 degrees F to produce gas mixtures with dew points from –60 degrees F to +60 degrees F. At +60 degrees F dew point (an unrealistically high dew point), the measured hydrogen concentration in test welds was 4.6 ml/100g of as deposited weld metal. This value falls in the extra low hydrogen range specified by American Welding Society (AWS). The EPRI study also measured the hydrogen content of bare filler material and found it to be less than 1 ml/100g of as deposited weld metal.

The EPRI work further showed that a 450 degrees F PSHT would reduce the already low hydrogen content to infinitesimally small values. Work by Coe and Moreton, as documented in table 2-6 of Reference 1 determined that it takes only 0.3 hours at 450 degrees F to remove 95% of any hydrogen present. At 300 degrees F, the diffusivity rate measurements showed that only 0.7 hours is required to remove 95% of any hydrogen that is present.

The EPRI work shows that, if the weld joint receives proper shielding, cleaning and drying, the primary sources of dissolvable hydrogen will not be present during GTAW welding. The Framatome field repairs utilizing temper-bead welding will be performed with procedures that require cleaning and visual inspection of the weld joint and surrounding area for contaminants (hydrocarbons). Framatome weld operating procedures specify shielding gas flow rates, pre-purge and post purge gas shielding requirements. The shielding gas will be procured to a TMI site specification specifying the minimum dew point and gas purity. Shielding curtains are also erected, when needed, for weld locations that are subject to drafts to prevent a loss of shielding gas during welding.

In addition to the compelling data promulgated in the EPRI report, FRA-ANP has qualified the GTAW temper-bead process in support of ASME approval of Code Case N-606-1, "Similar and Dissimilar Metal Welding Using Ambient Temperature Machine GTAW Temper-Bead Technique for BWR CRD Housing/Stub Tube Repairs" (Reference 2).

Three Mile Island Unit 1
Request for Relief RR-01-16
"Eliminate 48 Hour Hold Time"

The supporting welding PQR's for this work, PQ7109-00 (Reference 3) and PQ7153-00 (Reference 4), are given in Attachment 1 and 2 respectively. These qualifications were performed at room temperature with cooling water to limit the maximum interpass temperature to a maximum of 100 degrees F. These noted qualifications were performed on the same P-3 Group-3 base material as proposed for the CRDM repairs, using the same filler material, i.e. Alloy 52 AWS Class ERNiCrFe-7, with similar low heat input controls as will be used in the repairs. The qualifications did not include a PSHT. As noted above, the repairs described herein will be made to the ASME Code, Section XI, Rules for Inservice Inspection of Nuclear Power Plant Components, 1995 Edition through 1996 Addenda. ASME has recognized that the 48-hour hold period is unnecessary for temper-bead weld repairs using the GTAW welding process with 300°F minimum preheat through the approval of Code Case N-432, Revision 1[1].

Compliance with the requirement for a post-weld 48-hour hold period prior to performing the NDE is not necessary considering that the NDE that could be performed in a shorter time period following the repair and would provide an acceptable level of assurance of the quality and safety of the weld repairs. Any weld defects or cracking would be identified by the NDE performed before the 48-hour hold time. The proposed approach will provide assurance of the structural integrity of the CRDM nozzles as demonstrated by a Section III analysis of the new weld configuration, in addition to the above described low hydrogen producing welding process, weld procedure qualification, and NDE procedures and processes.

As previously described: (1) the purpose of the 48-hour hold period is to assure that no undetected delayed hydrogen induced cold cracking in the ferritic steel HAZ has occurred; and (2) the welding process used (GTAW) avoids delayed cold cracking. Accordingly, the proposed elimination of the 48-hour period prior to performing NDE is based on the: 1) use of bare wire with no flux with the 300 degree F preheat such that delayed hydrogen induced cracking is eliminated; 2) the weld procedure qualification provisions described above and welding procedures that ensure the weld joint receives proper shielding, cleaning and drying; 3) Any weld defects or cracking would be identified by the UT and PT examinations; and, 4) the recently approved Code case that allows elimination of the 48-hour hold period. The above assures an acceptable level of quality and safety which meets the NRC's criteria per 10 CFR 50.55a(a)(3)(i).

---

[1] *Approved by the ASME Main Committee (Action No. ISI-99-34) on February 16, 2001.*

Three Mile Island Unit 1
Request for Relief RR-01-16
"Eliminate 48 Hour Hold Time"

PROPOSED ALTERNATIVE PROVISIONS

Pursuant to 10 CFR 50.55a(a)(3)(i), an alternative is requested to the requirements of IWA-4634 of ASME Code, Section XI, Rules for Inservice Inspection of Nuclear Power Plant Components, 1995 Edition through 1996 Addenda on the basis that the proposed alternative provides an acceptable level of quality and safety.

The 48-hour hold is specified to assure that no delayed cold cracking in the ferritic steel Heat Affected Zone (HAZ) has occurred. In lieu of the 48-hour hold time, the proposed alternative will maintain the preheat temperature of 300 degrees F during the post-weld soak for four hours in accordance with IWA-4633.2(d) of ASME Code, Section XI, Rules for Inservice Inspection of Nuclear Power Plant Components, 1995 Edition through 1996 Addenda. The time between the end of the welding operations and the beginning of the UT and PT examinations is estimated to be approximately 12 hours with an ambient temperature no greater than 125 degree F. This estimate includes the PSHT period and the cool-down period.

The weld consumables to be used in the new pressure boundary weld consist of bare wire with no flux. The welding will be performed at 300 degrees F minimum preheat temperature using the GTAW process, as required by IWA-4610(a). The supporting welding PQR's for this work, PQ7109-00 (Reference 3) and PQ7153-00 (Reference 4), are given in Attachment 1 and 2 respectively.

The Framatome field repairs utilizing temper-bead welding will be performed with procedures that require cleaning and visual inspection of the weld joint and surrounding area for contaminants (hydrocarbons). Framatome weld operating procedures specify shielding gas flow rates, pre-purge and post purge gas shielding requirements. The shielding gas will be procured to a TMI site specification specifying the minimum dew point and gas purity. Shielding curtains will also be erected, when needed, for weld locations that are subject to drafts to prevent a loss of shielding gas during welding.

The combination of the low moisture absorbing GTAW weld process/procedures and maintaining the post-weld soak temperature at 300 degrees F for four hours will eliminate the possibility of hydrogen induced cracking.

The proposed alternative, as described above, provides an acceptable level of quality and safety.

Three Mile Island Unit 1
Request for Relief RR-01-16
"Eliminate 48 Hour Hold Time"

REFERENCES

6. Electric Power Research Institute (EPRI), Document TR103354, "Temper-bead Welding Repair of Low Alloy Pressure Vessel Steels: Guidelines," December 1993, Section 2, "Diffusible Hydrogen in Low Alloy Steel Gas Tungsten-arc Welds" D. Gandy & S. Findlan.

7. ASME Code Case N-606-1, "Similar and Dissimilar Metal Welding Using Ambient Temperature Machine GTAW Temper-Bead Technique for BWR CRD Housing/Stub Tube Repairs."

8. Framatome-ANP Welding Procedure Qualification Record PQ7109-00, dated February 23, 2000 (See Attachment 1).

9. Framatome-ANP Welding Procedure Qualification Record PQ7153-00, dated May 8, 2001 (See Attachment 2).

10. Framatome-ANP Welding Procedure Qualification Record PQ7001-04, dated August 24, 1999 (See Attachment 3).

Attachment 1

PQ7109-00

Attachment 2

PQ7153-00

Attachment 3

PQ7001-04

Three Mile Island Unit 1
Request for Relief RR-01-17
"Eliminate Monitoring of Interpass Temperature"

COMPONENT IDENTIFICATION

Code Class:	Class 1
Reference:	ASME, Section XI; 1995 Edition through 1996 Addenda
Examination Categories:	B-O (Section XI)
Item Number:	B14.10 (Section XI)
Description:	Examination Requirements
Component Numbers	All as necessary

CODE REQUIREMENTS FROM WHICH AN ALTERNATIVE IS REQUESTED

The Code to be utilized for the repairs to Control Rod Drive Mechanism (CRDM) nozzles is ASME Code, Section XI, Rules for Inservice Inspection of Nuclear Power Plant Components, 1995 Edition through 1996 Addenda.

IWA-4610(a) of ASME Code, Section XI, Rules for Inservice Inspection of Nuclear Power Plant Components, 1995 Edition through 1996 Addenda states, "The area to be welded plus a band around the area of at least 1-1/2 times the component thickness or 5 in., whichever is less, shall be preheated and maintained at a minimum temperature of 350 degrees F for the SMAW process and 300 degrees F for the GTAW process during welding. The maximum interpass temperature shall be 450 degrees F. Thermocouples and recording instruments shall be used to monitor the process temperatures. Their attachment and removal shall be in accordance with Section III."

BASIS FOR ALTERNATIVE

Due to the difficulty in placing thermocouples adjacent to the new pressure boundary welds inside the CRDM bore in the RV head, direct monitoring of the interpass temperature is a hardship and is physically impossible. The remote welding machine will be fitted into the CRDM nozzle from below the RV head. The machine is then clamped into position against the removed CRDM nozzle bore by expanding mandrels. Placing thermocouples within the small space to monitor interpass temperature is physically impossible. In lieu of monitoring the interpass temperature via adjacent thermocouples, a calculation has been performed justifying the actual interpass temperature at the weld location based on a maximum allowable welding heat input; weld bead placement travel speed, and conservative preheat temperature assumptions.

Three Mile Island Unit 1
Request for Relief RR-01-17
"Eliminate Monitoring of Interpass Temperature"

This calculation is provided as Attachment 1 to this relief request. The calculation supports the conclusion that using the maximum heat input through the third layer of the weld, the interpass temperature returns to the preheat temperature. Heat input beyond the third layer will not have a metallurgical affect on the low alloy steel Heat Affected Zone (HAZ).

The calculation is based on a typical inter-bead time interval of five minutes. The five minute inter-bead interval is based on the time:

3) required to explore the previous weld deposit with the two remote cameras housed in the weld head,
4) to shift the starting location of the next weld bead circumferentially away from the end of the previous weld-bead, and
3) to shift the starting location of the next bead axially to insure a 50% weld bead overlap required to properly execute the temper-bead technique.

A welding mockup on the full size Midland RV closure head was used to demonstrate the welding technique described herein. During the mockup, thermocouples were placed to monitor the resistance heating of the head. These locations will be retained for the actual repairs. During the mockup, thermocouples were placed on the outside diameter of the RV head within a 5-inch band surrounding the CRDM nozzle. Three other thermocouples were placed on the RV head inner diameter. One of the three thermocouples was placed 1-1/2 inches from the CRDM penetration, on the lower hillside. The other inner diameter thermocouples were placed at the edge of the 5-inch band surrounding the CRDM nozzle, one on the lower hillside, the second on the upper hillside. During the mockup, all thermocouples fluctuated less than 15 degrees F throughout the 18-hour welding cycle. Based on past experience, it is believed that the temperature fluctuation was due more to the resistance heating variations than the low heat input from the welding process.

Controlling the parameters determined by the referenced calculation will assure that the maximum interpass temperature is not exceeded and thus provides an acceptable level of quality and safety.

The Code requirement for monitoring the weld interpass temperature is to prevent excessive local heat input into the low alloy steel. The control of the heat input; weld head travel speed, and the calculation of the dissipation of the heat into the large thermal mass of the RV head will insure that the heat input is prevented from exceeding Code limitations. The conclusions of the referenced calculation have been validated in demonstrations on the Midland RV head. These measures will provide an acceptable level of quality and safety compared to Code requirements.

Compliance with IWA-4610(a) of ASME Code, Section XI, Rules for Inservice Inspection of Nuclear Power Plant Components, 1995 Edition through 1996 Addenda constitutes a hardship

Three Mile Island Unit 1
Request for Relief RR-01-17
"Eliminate Monitoring of Interpass Temperature"

per 10 CFR 50.55a(a)(3)(ii). It is physically impossible to locate thermocouples adjacent to the new pressure boundary weld region for the purposes of monitoring interpass temperature. The alternatives described will provide an acceptable level of quality and safety when compared to the Code requirements to directly monitor weld interpass temperature.

PROPOSED ALTERNATIVE PROVISIONS

Pursuant to 10 CFR 50.55a(a)(3)(ii), compliance with the requirement of IWA-4610(a) of ASME Code, Section XI, Rules for Inservice Inspection of Nuclear Power Plant Components, 1995 Edition through 1996 Addenda would result in hardship without a compensating increase in the level of quality and safety. Due to the location of the new pressure boundary weld in the CRDM bore of the RV head, it is physically impossible to directly monitor interpass temperature. It is proposed that the requirement for monitoring of the welding interpass temperature be eliminated.

In lieu of monitoring the interpass temperature via adjacent thermocouples, a calculation has been performed justifying the actual interpass temperature at the weld location based on a maximum allowable welding heat input; weld bead placement travel speed, and conservative preheat temperature assumptions. This calculation is provided as Attachment 1 to this relief request.

The control of the heat input; weld head travel speed, and the calculation of the dissipation of the heat into the large thermal mass of the RV head will insure that the heat input is prevented from exceeding Code limitations. These measures will provide an acceptable level of quality and safety compared to Code requirements.

Attachment 1

Weld Interpass Temperature Evaluation
Revision 2