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TXX-15139

Ref. # 10CFR50.55a(z)(2)

October 15, 2015

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

SUBJECT: COMANCHE PEAK NUCLEAR POWER PLANT
DOCKET NO. 50-445
REVISION TO RELIEF REQUEST 1B3-3 FOR UNIT 1 INSERVICE INSPECTION FOR APPLICATION OF AN ALTERNATIVE TO THE ASME BOILER AND PRESSURE VESSEL CODE SECTION XI EXAMINATION REQUIREMENTS FOR REACTOR PRESSURE VESSEL COLD LEG WELD INSPECTION FREQUENCY
(2007 EDITION OF ASME CODE, SECTION XI, 2008 ADDENDA
THIRD INTERVAL START DATE: AUGUST 13, 2010
THIRD INTERVAL END DATE: AUGUST 12, 2020)

REFERENCE: Letter logged TXX-15056 dated April 20, 2015 from Rafael Flores to the NRC submitting Relief Request 1B3-3 for Unit 1 Inservice Inspection for Application of an Alternative to the ASME Boiler and Pressure Vessel Code Section XI Examination Requirements for Reactor Pressure Vessel Cold Leg Weld Inspection Frequency

Dear Sir or Madam:

Pursuant to 10 CFR 50.55a(z)(2), Luminant Generation Company, LLC (Luminant Power) is submitting a Relief Request 1B3-3 (see attachment) for Comanche Peak Unit 1 for the third ten year inservice inspection interval. Luminant Power is requesting an alternative for the reactor pressure vessel cold leg weld inspection frequency as specified in Code Case N-770-1 from a period of not to exceed 7 years to a period not to exceed 9 years. Compliance with the ASME Boiler and Pressure Vessel Code Section XI cold leg weld inspection frequency requirements would result in a hardship without a compensating increase in the level of quality and safety.

Relief Request 1B3-3 was originally submitted via the referenced letter on April 20, 2015. Per discussion with our NRC Project Manager on October 1, 2015, we are revising our relief request in order to cite 10CFR50.55a(z)(2) for approval rather than 10CFR50.55a(z)(1).

Luminant Power requests approval of this relief request by December 15, 2015, to support the upcoming CPNPP Unit 1 refueling outage.

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NRR

This communication contains no new licensing basis commitments regarding Comanche Peak Unit 1. Should you have any questions, please contact Mr. Jack Hicks at (254) 897-6725.

Sincerely,

Luminant Generation Company LLC

Rafael Flores

By: ______________________
Thomas P. McCool
Vice President, Engineering and Support

Attachment – Relief Request 1B3-3 for Code Case N-770-1 Reactor Pressure Vessel Cold Leg Weld Inspection Frequency Extension

c - Marc L. Dapas, Region IV
Balwant K. Singal, NRR
Resident Inspectors, Comanche Peak
Robert Free, TDLR
Jack Ballard, ANII, Comanche Peak

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Relief Request Number 1B3-3
Code Case N-770-1 RPV Cold Leg Weld Inspection Frequency Extension
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1. ASME Code Component Affected:

The affected components are the Comanche Peak Nuclear Power Plant Unit 1 (CPNPP1) reactor vessel cold leg nozzle-to-safe-end welds (TBX-1-4100-14, TBX-1-4200-14, TBX-1-4300-14 and TBX-1-4400-14), which are Alloy 600 welds covered by Code Case N-770-1, Table 1, Inspection Item B. [Reference 1]

Examination Category	Inspection Item	Description
CC N-770-1 B		TBX-1-4100-14, Loop 1 cold leg nozzle-to-safe-end weld
CC N-770-1 B		TBX-1-4200-14, Loop 2 cold leg nozzle-to-safe-end weld
CC N-770-1 B		TBX-1-4300-14, Loop 3 cold leg nozzle-to-safe-end weld
CC N-770-1 B		TBX-1-4400-14, Loop 4 cold leg nozzle-to-safe-end weld

CPNPP1 reactor vessel cold legs operate at an average temperature of 555.74°F

2. Applicable Code Edition and Addenda:

CPNPP1 is currently using the 2007 Edition through 2008 Addenda of the ASME Section XI Boiler and Pressure Vessel Code. However, Code Case N-770-1, as referenced in 10CFR50.55a(g)(6)(ii)(F), is the applicable code document for this Relief Request.

3. Applicable Code Requirement:

Table 1 of Code Case N-770-1 requires volumetric examination of essentially 100% of Inspection Item B pressure retaining welds once every second inspection period not to exceed 7 years.

4. Reason for Request: Acceptable level of quality and safety (10CFR50.55a(z)(2)).

Relief is being requested at this time due to the NRC imposition of Code Case N-770-1 through rulemaking and the scheduling aspects of the new requirement conflicting with the current plans at CPNPP1. Due to this conflict, Luminant is requesting an extension as compliance with the ASME Boiler and Pressure Vessel Code Section XI cold leg weld inspection frequency requirements would result in a hardship without a compensating increase in the level of quality and safety.

Examination of Code Case Item A-2 (hot leg) and Code Case Item B (cold leg) welds are performed from the inside diameter (ID) of the pipe at CPNPP1 due to extremely limited access provisions from the outside surface of the pipe. The CPNPP1 Item A-2 and Item B welds are located inside a "sandbox," which was installed during original plant construction after all welding was completed. The inspection of the Item A-2 (hot leg) welds from the ID does not require removal of the reactor vessel (RV) lower internals (core barrel), while the inspection of the Item B (cold leg) welds from the ID requires that the core barrel be removed for access. The cold leg weld examination, under ASME Section XI inspection requirements, occurs once per interval, which normally is scheduled to coincide with the inspection of the RV shell welds, thus minimizing core barrel removal evolutions. Inspection of these RV cold leg nozzle welds on a six- or seven-year interval requires removal of the core barrel solely for the purpose of performing these dissimilar metal (DM) weld nozzle

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inspections. Removal of the core barrel should be minimized for a variety of reasons as explained in Section 5.

Baseline inspections of Code Case N-770-1 Inspection Item B welds, TBX-1-4100-14, TBX-1-4200-14, TBX-1-4300-14 and TBX-1-4400-14 were performed in the Spring of 2010 (1RF14). The ultrasonic examinations performed in 2010 met Section XI, Appendix VIII requirements, including examination volume of essentially 100%. Table 1 of Code Case N-770-1 requires the successive examination of these welds to be performed by the Spring of 2017. Therefore, inspection of these welds would require removal of the core barrel during the Spring of 2016 (1RF18) refueling outage.

Since inspection of these welds requires that the core barrel be removed from the reactor vessel, these inspections had previously been planned to be performed concurrently with the reactor vessel shell weld inspections. Rescheduling the Code Case N-770-1 Inspection Item B weld inspections from the Spring of 2016 (1RF18) refueling outage to the Spring of 2019 (1RF20) refueling outage would allow the Code Case N-770-1 inspections and the vessel shell weld inspections to be performed during the same refueling outage. This would eliminate the need to remove the core barrel during the Spring of 2016 (1RF18) refueling outage resulting in the elimination of an additional core barrel removal, reduce radiation exposure and elimination of a critical lift in containment .

5. <u>Proposed Alternative and Basis for Use:</u>

10CFR50.55a(z) states:

> "Alternatives to the requirements of paragraphs (b) through (h) of this section or portions thereof may be used when authorized by the Director, Office of Nuclear Reactor Regulation, or Director, Office of New Reactors, as appropriate. A proposed alternative must be submitted and authorized prior to implementation. The applicant or licensee must demonstrate that:
>
> (1) The proposed alternative would provide an acceptable level of quality and safety; or
>
> (2) Compliance with the specified requirements of this section would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety."

Luminant believes that compliance with the ASME Boiler and Pressure Vessel Code Section XI cold leg weld inspection frequency requirements would result in a hardship without a compensating increase in the level of quality and safety.

CPNPP1 proposes a one-time extension to the Code Case N-770-1, Table 1, Inspection Item B, volumetric examinations from a period of not to exceed 7 years to a period of not to exceed 9 years. The inspections which are currently required to be performed by the Spring of 2017 will be performed in the Spring of 2019 (1RF20) refueling outage. The basis for this extension is provided below.

Review of the industry service experience shows that cracking has only been observed in the hot leg piping locations with DM welds, and the cold leg locations continue to exhibit very reliable service.

<u>Core Barrel Removal</u>: Due to the limited access to the RV nozzles preventing the automated inspection from the outside diameter (OD), the RV cold leg nozzles are inspected remotely from the

ID. This requires that the core barrel be removed for access. However, due to the design of the reactor vessel, core barrel removal is only required for cold leg examination. Previously, these examinations occurred under ASME Section XI inspection requirements once per interval, which coincided with the inspection of the RV shell welds, thus core barrel removal evolutions were minimized. Inspection of these RV cold leg nozzles on a six- or seven-year interval requires removal of the core barrel solely for the purpose of performing these DM weld nozzle inspections. Removal of the core barrel should be minimized for a variety of reasons. As with any heavy lift operation, there are inherent risks to the personnel involved in the lift activities. Experience has shown that there are also risks associated with equipment damage including damage to the lift rig, guide studs, or the lower internals and reactor vessel itself. Damage to these items has the potential to put plant personnel in further adverse situations along with significantly increasing outage time and dose. Removal of the reactor vessel lower internals assembly is considered to be a high risk, infrequently performed, critical lift due to the weight of the component, the tight clearances involved, and the radiation emitted by the assembly. For these reasons, only the personnel directly involved with the movement of the internals are allowed in containment during the evolution. Remote cameras, lasers, pulleys, and ropes are utilized to allow the personnel involved with the lift to be outside of the refueling cavity area to minimize personnel radiation exposure to the extent achievable. Most of the lower internals lifts are performed solely by viewing cameras. The Polar Crane operator(s) is instructed to remain behind shielding for ALARA purposes. Communications are via portable radios. Prior to lifting the lower internals, a "dry run" is typically performed where the crane is attached to the lifting rig and placed onto the guide studs in the reactor cavity. Temporary markings are then made to provide alignment references for the reactor vessel. These markings are used by the crane operator and the crew to align the crane to the vessel. The lifting rig is then moved to the storage location and a second set of markings made. Following completion of the "dry run," the lifting rig is installed onto the guide studs and the lower internals are latched onto the rig. The internals are then lifted until full load is achieved. This position is maintained for 10 minutes. Following the 10-minute hold, the internals are lifted out of the reactor vessel and moved onto their storage stand in the refueling cavity. For CPNPP removing the core barrel requires that it be partially raised approximately 10.5 feet above the refueling cavity water level in order to obtain a minimal clearance over the reactor vessel flange during transfer from the reactor vessel to the storage stand location. As can be expected, the radiation exposure levels for this activity are high and necessitate unrelated work to stop for evacuation of personnel from containment and a reliance on shielding for the polar crane operator. The dose received during the last CPNPP1 core barrel removal and re-installation was approximately 60 millirem with the implementation of the dose saving actions described above.

Flaw Tolerance: Westinghouse has performed a generic flaw tolerance evaluation to determine the maximum flaw sizes in the reactor vessel cold leg DM welds that would support continued operation for a period of 10 years. This evaluation was performed consistent with the evaluations performed for the Reactor Coolant Pump (RCP) nozzles, which were performed in accordance with the ASME Section XI guidelines for flaw tolerance as contained in paragraph IWB-3640. Along with the normal operating steady state piping loads, the impact of welding residual stresses under different safe end lengths and the various extent of inside surface weld repairs during the initial weld fabrication process were considered in the evaluation. These residual stresses were also calculated using finite element analysis techniques that are consistent with recent industry guidance as seen in MRP-287 [Reference 3]. A parametric study was performed to evaluate the residual stresses for the different weld and safe-end configurations present in the Westinghouse fleet. Based on a comparison of the various residual stress distributions from the parametric study, it was concluded that a long (Length > 4.5") safe end with either a 25% or 50% inside surface weld

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repair would produce limiting PWSCC crack growth results. A high and a low cold leg operating temperature were also considered in the evaluation to represent the range of operating temperatures in the fleet. Based on the circumferential crack growth results, even for the most conservative case (high temperature with a 25% weld repair), a flaw with a depth of 15% of the wall thickness would not grow to the maximum allowable ASME flaw size in less than 10 years of continued operation. It should be noted that the results are not representative of a single plant. These results were based on the limiting thickness in the Westinghouse PWR fleet combined with the limiting piping loads from another plant in the Westinghouse PWR fleet and, therefore, these results are conservative. All of the flaw tolerance analyses performed to date have shown that the critical crack sizes in large diameter butt welds operating at cold leg temperatures are very large. Assuming that a flaw initiates, the time required to grow to through wall is in excess of 20 years in most cases analyzed. The time to grow from a through wall leak to a crack equal to the critical crack size can be in excess of 40 years. Furthermore, the chances of a flaw initiating in a colder location are very low. [Reference 2]

Probability of Cracking: Probabilistic fracture mechanics (PFM) evaluations were performed by Westinghouse to address the identified degradation mechanisms of Primary Water Stress Corrosion Cracking (PWSCC) and Fatigue Crack Growth (FCG) on alloy 82/182 dissimilar metal butt welds. The evaluations performed considered the limiting butt welds in large diameter pipes and smaller diameter pipes based on the deterministic evaluations for the Westinghouse, CE, and B&W NSSS designs. The RV inlet nozzle and RCP welds were not specifically evaluated because they were not the limiting locations in the deterministic evaluations. Evaluations for each of the limiting locations considered the small axial leak and small circumferential leak failure modes. The circumferential leak probabilities at 40-years are small. It must be noted that all of these probabilities are for cases evaluated at hot leg or pressurizer operating temperatures. Though not explicitly evaluated, the probabilities for locations at cold leg temperatures would be less. A statistical analysis was performed by Westinghouse to assess the susceptibility of the RCP nozzle welds to PWSCC. The analysis considered available industry experience data for the locations of Alloy 82/182 DM welds. More specifically, the data analyzed included Alloy 82/182 DM welds in large diameter pipes. The collected service experience data was fit to a Weibull distribution, which was then used to calculate the probability of cracking as a function of Effective Full Power Years (EFPY). This was done for three different temperatures with the intent of covering the range of temperatures on the cold leg nozzle DM weld locations (548°F to 556°F), as well as a representative hot leg nozzle DM weld location (615°F). Three different cases were evaluated based on the data to which the Weibull distribution was fit. Case 1 is based on all the available inspection results, for reactor vessel nozzles, steam generator nozzles, pump nozzles, and pressurizer surge nozzles. Case 2 includes all the nozzles, except the pressurizer nozzles, and Case 3 includes only the reactor vessel and RCP nozzles. The results show there is no discernable difference between the cases at the cold leg temperatures. Furthermore, the predicted probability of cracking for the pump nozzle DM welds, operating at cold leg temperatures, is extremely low, even at 60 EFPY. The results of the Weibull fitting for the three cases indicate that even though DM welds have had flaws at hot temperature locations, none have been found at cold temperature butt weld locations, and this gives a very low probability of flaws existing in cold temperature locations. Results show the highest probability of an indication at cold leg temperatures was only 1.42%, at 60 EFPY (Case 1 at 556°F). In comparison, the probability (60 EFPY) at hot leg temperatures is 23.71% (Case 1 at 615°F). Analyses have been performed to calculate the probability of failure for Alloy 82/182 welds using both PFM and statistical methods. Both approaches, statistical and PFM have shown that the likelihood of either cracking or through-wall leaks, in large diameter cold leg welds, is very small. Furthermore, sensitivity studies performed using PFM have shown that even for the more limiting high

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temperature locations, an inspection frequency greater than that required by Section XI, such as that in MRP-139 [Reference 4] or Code Case N-770-1 has only a small benefit in terms of risk. Though past service experience may not be an absolute indicator of the likelihood of future cracking, the experience does give an indication of the relative likelihood of cracking in cold leg temperature locations versus hot leg temperature locations. While there is a significant amount of PWSCC service experience in hot leg locations, the number of indications is still small relative to the number of potential locations. Also, all indications have been detected before they were a safety concern. Therefore, if hot leg PWSCC is a leading indicator for cold leg PWSCC, and the higher frequency of inspections will be maintained for the hot leg locations, it is reasonable to conclude that a moderately less rigorous inspection schedule would be capable of detecting any cold leg indications before they became large enough to be a concern. [Reference 2]

Operating experience on PWSCC of Alloy 82/182 welds show that weld repairs performed during original plant construction are a significant contributor in the initiation and propagation of cracking. A review of the construction records and a weld repair search performed for the CPNPP1 Reactor Vessel nozzle Alloy 82/182 welds did not identify any weld repairs performed on these welds during original plant construction. Additionally, CPNPP1 began elevated pH operation of 7.4 at temperature to aid in source term and dose reduction. A statistical evaluation of PWSCC tests in 2005 (*Materials Reliability Program: Effects of Hydrogen, pH, Lithium, and Boron on Primary Water Stress Corrosion Crack Initiation in Alloy 600 for Temperatures in the Range 320-330°C (MRP-147)* [Reference 5] revealed that elevated pH also has a beneficial effect on mitigating PWSCC.

Examination of Code Case Item A-2 (hot leg) and Code Case Item B (cold leg) welds are performed from the ID at CPNPP1 due to extremely limited access provisions from the outside surface of the pipe. The CPNPP1 Item A-2 and Item B welds are located inside a "sandbox" which was installed during original plant construction after all welding was completed. The inspection of the Item A-2 (hot leg) welds from the ID does not require removal of the reactor vessel core barrel, while the inspection of the Item B (cold leg) welds from the ID does require removal of the reactor vessel core barrel.

In the Fall of 2008 (1RF13), ultrasonic (volumetric) and eddy current (surface) exams were performed on the Code Case N-770-1 Inspection Item A-2 (hot leg) welds, with no indications identified. Also, in the Spring of 2013 (1RF16), ultrasonic (volumetric) and eddy current (surface) exams were performed on the Code Case N-770-1 Inspection Item A-2 (hot leg) welds, with no indications identified. In the Fall of 2017, ultrasonic (volumetric) and eddy current (surface) exams are scheduled to be performed on the Code Case N-770-1 Inspection Item A-2 (hot leg) welds. Since PWSCC is temperature dependent, it would be expected that Inspection Item A-2 (hot leg) welds would show evidence of crack initiation before Inspection Item B (cold leg) welds. Therefore, the lack of any indications in the Inspection Item A-2 (hot leg) welds provides added assurance that the one-time extension of the inspection of the Inspection Item B (cold leg) welds by three years provides an acceptable level of quality and safety.

The baseline inspection of the Code Case N-770-1 Inspection Item B (cold leg) welds, as required by Code Case N-770-1, was performed in the Spring of 2010. At that time, in addition to the ultrasonic (volumetric) examination, an additional surface examination utilizing an eddy current technique was performed. Both the ultrasonic (volumetric) and eddy current (surface) examinations were performed from the ID surface and confirmed the absence of any indications after approximately 20 years of operation. The ultrasonic examinations performed in 2010 met Section XI, Appendix VIII requirements, including examination volume of essentially 100%. Since PWSCC initiates from the

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inside wetted surface of the pipe and propagates radially, an internal surface examination is the preferred inspection technique for this failure mechanism. The use of eddy current examination in addition to the Code Case N-770-1 required ultrasonic examination provides a higher probability of detection of smaller flaws than an ultrasonic examination alone. Since the Code Case N-770-1 inspection frequency is based on flaw sizes associated with ultrasonic examination, the proposed alternative provides an equivalent protection against unacceptable PWSCC as does the Code Case N-770-1 exam schedule.

Conclusion: While there has been a large amount of service experience with PWSCC of Alloy 82/182 welds, this experience has been limited to those welds operating at hot leg temperatures or higher. There have been no incidents of cracking in welds operating at cold leg temperatures that can be attributed to PWSCC. Though the MRP-139 and Code Case N-770-1 requirements for more frequent inspections were taken as proactive measures, the accumulation of more positive service experience indicates that this increased inspection frequency for cold legs, in particular, is not necessary to maintain an acceptable level of safety and quality. Furthermore, it has been realized that accessing these cold leg weld locations for inspection may present an increased risk due to the complications associated with removal of the reactor vessel core barrel. There have been numerous studies performed to evaluate the likelihood of through-wall cracking and flaw tolerance in cold leg Alloy 82/182 welds. The analyses performed as the original basis for MRP-139 showed that the large diameter cold leg welds had high flaw tolerance and a very low probability of failure. More recent analyses, which considered design specific residual stress distributions, have confirmed the original conclusions that the flaw tolerance is high. Furthermore, the more recent analyses have shown that even large circumferential flaws, with a high likelihood of being detected during inservice inspection, will not grow to the maximum depth allowed by ASME Section XI in 10 years. These analyses have been performed based on the assumption that a flaw has initiated, which as shown by more recent probabilistic analyses based on service data is unlikely at the present time. It is therefore concluded that an interval of 10 years for re-examination of large diameter cold leg Alloy 82/182 locations will provide a more than adequate level of safety and quality. Furthermore, this will reduce the risks associated with movement of the reactor vessel core barrel. In summary, no weld repairs were documented on these welds during plant construction, elevated pH operation which decreases the probability of PWSCC crack initiation has been implemented at CPNPP1 since 2005, the hot leg DM examinations including both ultrasonic and eddy current inspections were performed in 2008 and 2013 with no indications identified, and the cold leg examinations including both ultrasonic and eddy current inspections were performed from the ID in 2010 with no indications identified. Based on the above facts, the one-time alternative inspection frequency of every 9 years instead of every 7 years provides an acceptable level of quality and safety. Compliance with the ASME Boiler and Pressure Vessel Code Section XI cold leg weld inspection frequency requirements would result in a hardship without a compensating increase in the level of quality and safety. This eliminates the need to remove the core barrel during the Spring of 2016 (1RF18) refueling outage.

6. Duration of Proposed Alternative:

This request is applicable to Luminant's Inservice Inspection program for the third interval for Comanche Peak Unit 1.

7. Precedents:

1. Indian Point Unit 2 Fourth Inspection Interval Relief Request IP2-ISI-RR-14.

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"Code Case N-770-1 Reactor Coolant System Cold Leg Nozzle Weld Inspection Frequency Extension", as approved by the NRC in a letter dated February 2, 2012 (ADAMS Accession No. ML120260090)

2. Indian Point Unit 3 Fourth Inspection Interval Relief Request IP3-ISI-RR-07. "Reactor Vessel Cold Leg Nozzle to Safe-end Weld Examinations", as approved by the NRC in a letter dated August 4, 2014 (ADAMS Accession No. ML14199A444)

8. <u>**Reference:**</u>

1. *Code Case N-770-1,* Alternative Examination Requirements and Acceptance Standards for Class 1 PWR Piping and Vessel Nozzle Butt Welds Fabricated with UNS N06082 or UNS W86182 Weld Filler Material With or Without Application of listed Mitigation Activities Section XI, Division 1.

2. *PVP2011-57829,* Changing the Frequency of Inspections for PWSCC Susceptible Welds at Cold Leg Temperatures

3. *MRP-287,* PWSCC Flaw Evaluation Guidance

4. *MRP-139,* Primary System Piping Butt Welds Inspection and Evaluation Guideline

5. *MRP-147,* Materials Reliability Program: Effects of Hydrogen, pH, Lithium, and Boron on Primary Water Stress Corrosion Crack Initiation in Alloy 600 for Temperatures in the Range 320-330°C