WOLF CREEK
NUCLEAR OPERATING CORPORATION

Jaime H McCoy
Site Vice President

July 23, 2018

WO 18-0031

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

Subject: Docket No. 50-482: Inservice Inspection (ISI) Program Relief Request from the Requirements of American Society of Mechanical Engineers (ASME) Code Case N-666-1, "Weld Overlay of Class 1, 2, and 3 Socket Welded Connections, Section XI, Division 1"

To Whom It May Concern:

Pursuant to 10 CFR 50.55(z)(2), Wolf Creek Nuclear Operating Corporation (WCNOC) hereby requests Nuclear Regulatory Commission (NRC) approval of relief from the American Society of Mechanical Engineers (ASME) Code Case N-666-1, "Weld Overlay of Class 1, 2, and 3 Socket Welded Connections, Section XI, Division 1," Specifically, WCNOC would like to propose an alternative to the weld overlay carbon content requirement to repair a Class 3 component. Compliance with the specified requirement of this section would result in hardship and unusual difficulty without a compensating increase in the level of quality or safety. The attachment to this letter provides the reason for the request and the proposed alternative.

This letter contains no commitments. If you have any questions concerning this matter, please contact me at (620) 364-4156, or Cynthia R. Hafenstine at (620) 364-4204.

Sincerely,

Jaime H McCoy

Jaime H. McCoy

JHM/rlt

A047
NRR

Attachment: Relief Request from ASME Code N-666-1

P.O. Box 411 / Burlington, KS 66839 / Phone: (620) 364-8831

cc: K. M. Kennedy (NRC), w/a
B. K. Singal (NRC), w/a
N. H. Taylor (NRC), w/a
Senior Resident Inspector (NRC), w/a

RELIEF REQUEST FROM ASME CODE N-666-1

1. ASME Code Component Affected

The affected components are the Component Cooling Water (CCW) Heat Exchanger (EEG01A), an NPS 2 drain line (upstream of valve EGV0029), and the Essential Service Water System (ESW). The CCW heat exchanger (HX) and NPS 2 line are designed and constructed to the ASME Code, Section III, Class 3. The heat exchanger is to the 1974 with Addenda Summer 1975 and the piping is to the 1974 Edition with Summer 1975.

2. Applicable Code Edition and Addenda

ASME Code, Section XI, 2007 Edition with 2008 Addenda

3. Applicable Code Requirement

ASME Code Case N-666-1, Paragraph 1(b):

Use of this Case is limited to Class 1, 2, or 3, NPS 2 (DN 50) and smaller socket welded connections with base material of P-No. 1 Group 1 and P-No. 1 Group 2, or P-No. 8. For water backed welding, the carbon content of P-No. 1 Group 2 materials shall be limited to 0.30% maximum.

Relief is requested for the maximum carbon content of the P-No. 1 Group 2 material during water backed welding. The requested change is to allow using P-No. 1 Group 2 material with a carbon content of 0.32%.

4. Reason for Request

Wolf Creek has attempted to isolate A ESW from the A CCW HX utilizing isolation valves near the heat exchanger. These attempts have been unsuccessful. In order to remove water from the tube side of the A CCW HX, A ESW will have to be drained to below the 2026' elevation which will render the A ESW train completely non-functional. With A ESW train completely non-functional, Wolf Creek will be placed into an elevated, undesirable risk condition.

ESW is the safety related cooling medium for most safety related systems at Wolf Creek. The following equipment would be affected if the A train ESW system was rendered non-functional because some form of cooling is provided by ESW:

a) Emergency Core Cooling System (ECCS) (room coolers)

b) Containment Spray and Cooling (CSP room cooler and Containment Coolers)

c) Auxiliary Feedwater A Motor Driven Aux Feed Pump Room Cooler and emergency makeup to A Motor driven Feedpump and one supply to the Turbine Driven Feedpump)

d) Component Cooling Water (HX and Emergency Makeup)

e) Control Room Air Conditioning system (Condenser cooling)

f) Emergency Diesel Generator (Intercooler, Jacket Water and Lube Oil cooling)

g) Class IE Air Conditioning (Condenser cooling)

h) Electrical Penetration Room Cooler

i) Spent Fuel Pool Cooling (SFP) HX is cooled via CCW which is cooled by ESW)

j) Residual Heat Removal (Cooled by CCW which is cooled by ESW)

One alternative is to place the plant in Cold Shutdown (Mode 5) prior to draining the ESW system. Inherent risk is assumed when maneuvering the power plant from 100% power to Mode 5 and then back to 100%. Additionally, only one train of Residual Heat Removal would be available for shutdown cooling if the A ESW system were drained.
Wolf Creek proposes that establishing the condition of ESW drained to complete the weld overlay will result in a hardship without a compensating increase in quality and safety.

5. Proposed Alternative and Basis for Use

Background:

A leak was detected through an NPS 2 (Schedule 80) socket weld drain line attached to the Component Cooling Water (CCW) system heat exchanger (EEG01A). The connecting drain line (SA-106 Gr B) and coupling material (SA-105) are P-No. 1 Group 1 and P-No. 1 Group 2, respectively [1, 2]. The system design temperature and pressure are 200 deg F and 200 psig, respectively and normal operating temperature and pressure are 95 F and 40 psig, respectively.

Attempts to isolate the heat exchanger and drain line to perform the replacement were not successful. Accordingly, the use of Code Case N-666-1 will be implemented to perform a Code and NRC approved repair. However, in review of the Case there is a limitation on the carbon content P-No.1 Group 2 materials of 0.30%. From review of the original manufacturer's Certified Mill Test Report, the lot for 100 pieces shows a carbon content of 0.32% [3, 4]. Thus, the elevated carbon content places the coupling outside the general requirements of Case N-666-1. The chemical composition of the coupling is found in Table 1, as well as the Carbon Equivalent (CE). The carbon equivalent is being used because it helps compare and contrast hardenability of different materials and their chemistry via a single value.

Table 1 Chemistry and Carbon Equivalents for selected materials

Material	C%	Mn %	Mo%	Ni%	Cr%	Cu%	Carbon Equivalent*
SA-105	0.32	0.74	-	-	-	-	0.44

*CE = C + Mn/6 + (Cr+Mo+V)/5 + (Ni+Cu)/15

This write-up is intended to evaluate if the elevated carbon content is thought to have a detrimental effect compared to similar materials.

<u>Degradation Mechanism:</u>

Due to the leakage identified on the NPS 2 drain line and socket weld coupling associated with Heat Exchanger EEG01A, radiography (RT) and vibration reading were performed. These were performed in order to characterize the flaw and determine the degradation mechanism.

Review of the RT shows general wall loss on the piping ID and in the location of the socket weld. The wall loss may be attributed to corrosion due to the carbon steel material in a raw water system. In addition, the vibration readings show that during normal operations, there is an element of fatigue.

Based on the RT and the vibration readings, it is most likely that the corrosion initiated the flaw and reduced the wall thickness to a point where fatigue propagated the flaw through wall.

<u>Potential Concerns:</u>

There are believed to be two potential technical concerns related to elevated carbon content which are listed below with each evaluated separately.

1. Brittle Microstructure
2. Hydrogen Induced Cracking (HIC)

Brittle Microstructure

P-No. 1 Group 2 materials are considered to be low hardenable materials. This does not mean that a high hardness cannot be achieved with these materials, but that the ability to form martensite across a span of cooling rates is less. Thus, it is observed that the hardness decreases faster than more hardenable materials with similar cooling rates. This can be seen via Jominy End Quench data for various P-No. materials of varying carbon equivalents. The use of Jominy End Quench data for various P number materials is provided in Figures 1 and 2 reproduced from EPRI research [4]. Of particular importance is P-No. 1 Group 2 data that all had higher CE values than the coupling in question. Figures 1 and 2 show that the P-No. 1 materials have the lowest hardenability of the groups tested and do not sustain their hardness compared to other P-Numbers. Note that CE values are provided in the Figures for each material and the coupling CE is lower than all the materials tested.

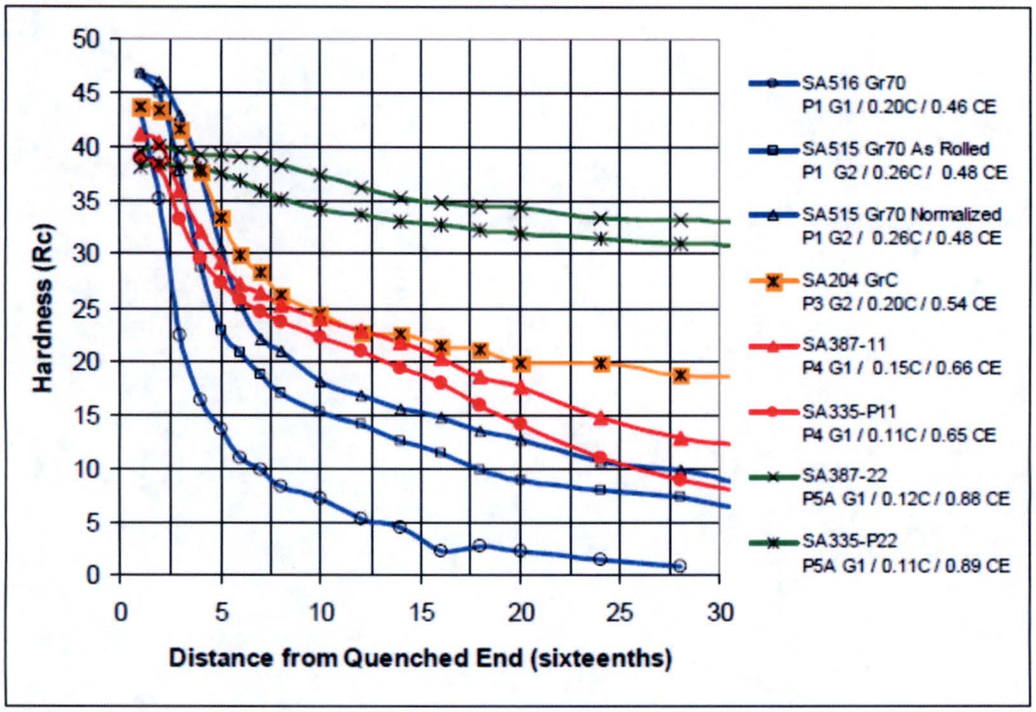

Figure 1 Jominy End Quench Hardness Curves (1/16 to 1-3/4 inches) [5]

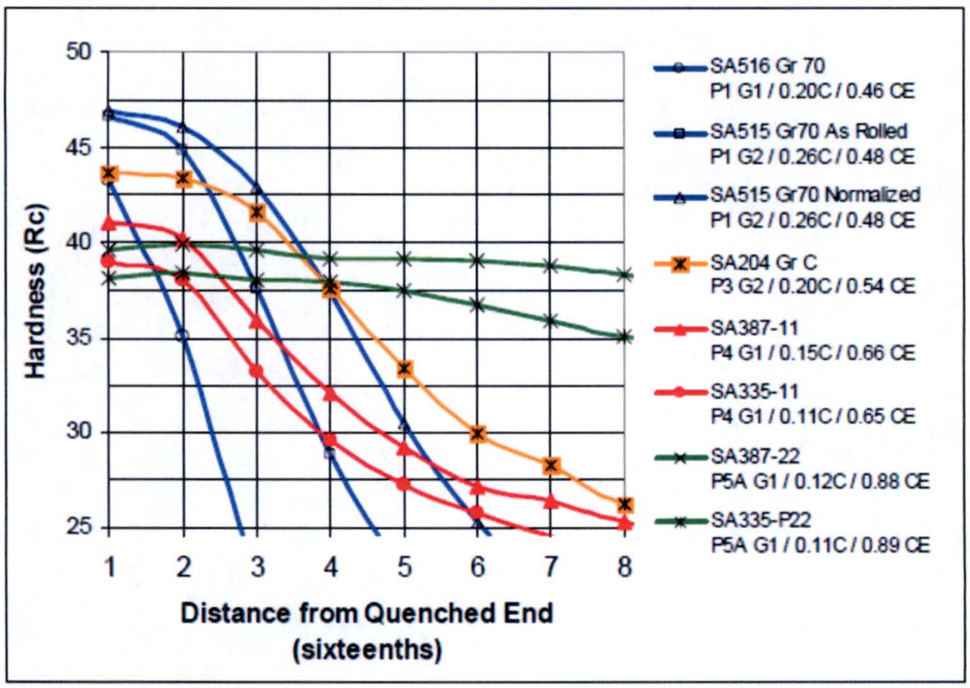

Figure 2 Jominy Hardness Curves Close to Quenched End (1/16 to 1/2 inches) [5]

The expectation is that the coupling will follow a similar behavior trend to the other P-No. 1 Group 2 materials with high hardness dropping rapidly.

The same research also shows the effect of multiple weld passes and layers to the hardness of the Heat Affected Zone (HAZ) microstructure. Once more, of particular importance is the work on 1.5 inch SA-516 Grade 70 base material (P-No 1 Group 2 material). As shown in Figure 3, three hardness plots were developed for 1 layer, 2 layer, and 3 layer weld beads on plate. The hardness traverses were then plotted as presented in Figure 4. The main observation from this research is for multiple weld layers a tempering effect is achieved. This same effect would be expected from a socket weld overlay per N-666-1 because the requirements specify a minimum of 2 layers be deposited.

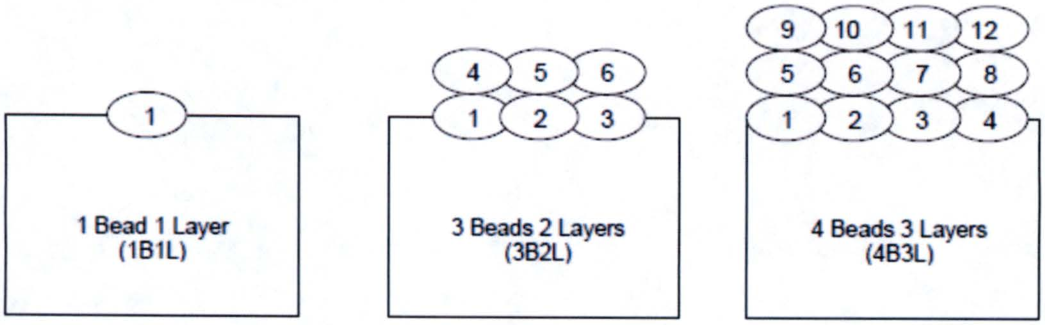

Figure 3 Bead-on-Plate/Bead-on-Pipe Configuration with Typical Bead Placement [5]

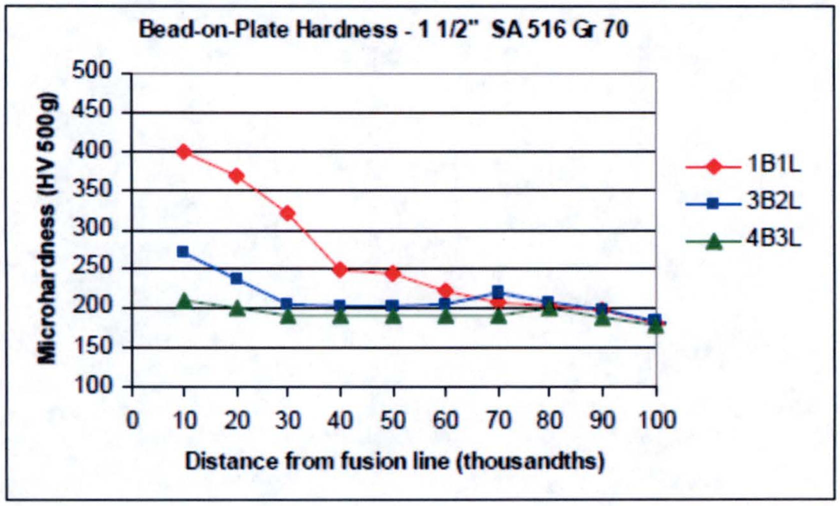

Figure 4 SA-516-70 Bead-on-Plate Hardness Curves for 1-1/2" Plate [5]

While the CE value is thought to bound the behavior of the coupling as previously described, the main effect of higher carbon content is the potential for higher peak hardness. This was observed via past research where it was found that a shift of carbon content of 0.30% to 0.32% shifts the peak hardness from approximately 500 to 540 Vickers [6, Figure 5]. While the 0.32% carbon content coupling could achieve a higher peak hardness, this is a relatively minor shift when comparing the two levels. Consideration should also be taken that welding on the coupling and drain line will not be an ideal quench as the water inside is not ambient (due to leak by of the isolating valves to the heat exchanger); therefore, this level of hardness is not expected.

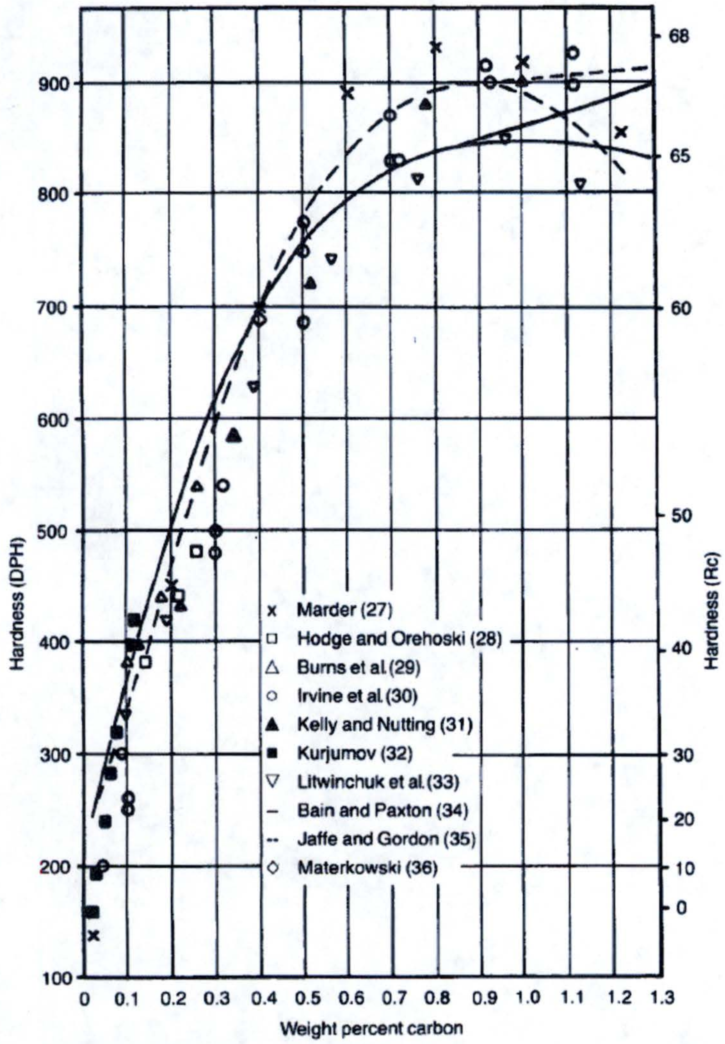

Figure 5 Summary of Hardness of Martensite as a Function of Carbon Content in Fe-C alloys and steels [5]

Hydrogen Induced Cracking (HIC) Susceptibility:

The welding plan for repairing the socket weld via N-666-1 included sealing the leak via SMAW and then using low hydrogen electrode, E7018 (SMAW), or ER70S-2 or ER70S-6 (GTAW), for the weld overlay. The plan includes instructions for stringer weld beads (no weaving) thus promoting beneficial tempering effect of the coupling. Thus, the weld will be dry once the actual layers of the overlay are applied for structural credit. The use of low hydrogen electrodes and the minimum of 2 layers of weld metal should provide two means at eliminating HIC. The use of low hydrogen electrodes will reduce the amount of hydrogen available via the welding process and multiple weld layers will soften the HAZ. Thus, it is formation of HIC to be a concern since the consumables and Code Case are followed as described above.

Examination and Testing:

All examinations and testing are in accordance with N-666-1. Walk downs will be used to identify leakage post installation.

Conclusion:

This evaluation finds that the coupling with carbon content of 0.32% is expected to behave in a similar manner to other P-No. 1 group 2 materials with regards to hardness. In addition, the two potential concerns with a brittle microstructure and HIC do not appear to be justified when the welding plan and Code Case N-666-1 are followed. Specifically, even with very rapid cooling rates the P-No. 1 group 2 materials can have high peak hardness but quickly diminish compared to high hardenability materials. Additionally, hardness was seen to drop with multiple weld layers which will be done per N-666-1. Hydrogen Induced Cracking is also not believed to be an issue because low hydrogen consumables and practices will be used, as well as multiple weld layers that will have a tempering effect on the HAZ. There does not appear to be the concurrent factors necessary for HIC to occur. Thus, the concerns associated with welding on the coupling with 0.32% carbon does not seem to be warranted.

6. Duration of Proposed Alternative

The duration for the proposed activity is though refueling outage 23, scheduled for the fall of 2019

7. Precedent

None

8. References

a) ASME Section IX, 2017 Edition
b) ASME Code Case N-666-1, Weld Overlay of Class 1, 2, and 3 Socket Welded Connections Section XI, Division 1, ASME Approved March 13, 2012
c) CMTR 106-1-77, The Colonial Machine Company Inc.
d) Welding and Repair Technology Center: Evaluation of Post Weld Heat Treatment (PWHT) Exemption Thickness Limitations. EPRI, Palo Alto, CA: 2009. 1019171.
e) Steels: Processing, Structure, and Performance, by George Krauss, ASM International, 2005