ENCLOSURE 9

STRUCTURAL INTEGRITY ASSOCIATES, INC. REPORT 130415.402, REVISION 0

REVIEW OF TRIVIS INC. WELDING PROCEDURES USED FOR FIELD WELDS ON THE TRANSNUCLEAR NUHOMS 61BTH TYPE 1 & 2 TRANSPORTABLE CANISTER FOR BWR FUEL

3 pages follow

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Quality Program: ☐ Nuclear ☒ Commercial

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Subject: Review of TRIVIS INC Welding Procedures used for Field Welds on the Transnuclear NUHOMS 61BTH Type 1 & 2 Transportable Canister for BWR Fuel

References:
1. Transnuclear Drawing Number NUH61BTH-4008, Sheet 1 of 1, dated 3/23/10
2. TriVis Inc.WPS SS-8-A-TN Rev 8 Manual GTAW P8 to P8, dated 4/27/2011
3. TriVis Inc.WPS SS-8-M-TN Rev 10 Automatic GTAW P8 to P8, dated 4/27/2011
4. TriVis Inc. Procedure Qualification Record N.1 Rev. 2, dated 8/4/2010
5. TriVis Inc. Welding Program QP-9.0 Rev 8
6. TriVis Inc. Control of Welding and Brazing Procedure Specifications-WAP-1 R4
7. TriVis Inc. Control of Welding and Welding Operator Qualification-WAP-2 R5
8. TriVis Inc. Welding Administrative Procedure Control of Filler Metal-WAP-3 R4
9. Transnuclear Drawing Number NUH61BTH-3001 Rev 1, Sheet 1 of 3, 3/15/2011
10. Transnuclear Drawing Number NUH61BTH-3000 Rev 1, Sheet 1 of 3, 3/15/2011

Dear Jim:

In accordance with your request for me to review the welding procedures to determine if the welding associated with the closure welds of the subject storage canisters at Monticello Nuclear Generating Plant produced suitable quality welds, I have reviewed the available information to evaluate what can be stated with particular focus on the top cover plate closure welds. I had indicated that a full determination was not possible because neither weld data sheets nor signed weld travelers were available for review to document how the individual welds were performed. However, I have reviewed the available documentation that addresses 1) the materials welded (References 9 & 10), the welding procedures (References 2 & 3) and supporting PQR (Reference 4), the welding program (Reference 5), the programmatic information describing control of the welding specifications (Reference 6), welding consumables (Reference 8), and the welder/operator qualifications (Reference 7). Reference 1 provides the identification of the field welds, the weld joints and the required inspections.

The above documentation controls the welding of stainless steel to stainless steel joints (both partial penetration and fillet welds). The procedures and documentation is specific to austenitic stainless steel, and in most cases the material is SA 240 Type 304 stainless steel plate and welding consumable is called out as SFA 5.9 ER308 solid wire using gas tungsten arc welding (GTAW). Both manual and machine welding is qualified. Typically, the weld root would be tack welded using manual techniques with the remainder of the weld being applied using machine controls. There are small portions around the circumference of the Top Cover Plate where the closure weld must be manipulated around penetrations that permit evacuating and inerting the canisters. In addition, there are small closure lids that seal these penetrations. Manual welding techniques are likely used for these locations.

GTAW is generally known as a high quality process typically having fewer oxides and pores in the weld deposit than is produced with other welding processes such as flux cored, shielded metal arc, gas metal arc, submerged arc, etc. It is recognized that the welding techniques have a significant bearing, but there was nothing found in the welding controls documentation that would suggest the welders and welding operators would have been anything other than competent. In addition, the machine process is repetitive, and unless fusion issues occur due to poor weld bead placement, should produce consistent results. It is also noted that when fusion issues do occur, the extent will typically be significant and readily identified when surface inspections are performed (i.e. liquid dye penetrant, LPT). Even with LPT techniques outside of specifications, fusion issues of this type would develop highly visible dye penetrant indications due to the lengths and the surface breaking nature of fusion defects. Since none of these types of indications were reported, the results suggest that no significant fusion defects would have been produced even with a less than optimum LPT inspection.

The welding consumable used was ER308 stainless steel. This filler metal is characterized as readily weldable with the GTAW process so long as a reasonable inert shielding cover gas is maintained. For these applications 100% welding grade argon is normally used; however, the welding procedure specification only specified use of 100% argon (Reference 3). It was noted that the Procedure Qualification Record (Reference 4) used to support the manual and machine Welding Procedure Specifications specifically identified the use of "Welding Grade" argon. Additionally, there were no records provided that suggested the inert gas was not maintained. ER308 filler metal is commonly used to weld Type 304 stainless steel substrates because it contains ample delta ferrite to avoid cracking issues such as hot cracking or ductility dip cracking (microfissures). The welding characteristics of ER308 filler metal are considered excellent displaying good fluidity and tie-in.

The welding procedures themselves are very detailed and provide sufficient ranges of volts, amps, wire feed rate, and travel speed to weld stainless steel effectively. The manual WPS technique (Reference 2) has a more restricted range of welding currents when compared to the permitted range in the machine procedure WPS (Reference 3). However, this difference is correct and shows an understanding of the GTAW welding process, because the machine process facilitates the necessary control to balance the wire feed, the travel speed, the current and the arc length (voltage) to achieve a quality weld. Both manual and machine welding procedures prohibit autogenous (no filler wire added) welds and this also will help to minimize microfissures. The requirement to apply a minimum of two weld passes is known to help the welder insure complete root and sidewall fusion for both partial penetration and fillet welds. In fact the large top closure plate weld requires more than two passes to complete the required designed groove weld.

It is impossible to estimate the welding residual stresses that might be produced without the benefit of detailed welding techniques. A good estimate of a typical groove weld is something near yield strength of the substrate material – Type 304 plate or forging material.

The maximum welding interpass temperature is 350°F, and this is used to insure that the cooling rates will be sufficiently fast so as to minimize grain boundary sensitization of the weld heat affected zone. This is a typical requirement for welding austenitic stainless steels and likely will not affect the weld quality one way or the other. It is not stated in the documentation, but intergranular stress corrosion cracking is apparently not a concern for the canisters since low carbon grade stainless steels were not specified. It is noted that modern steelmaking often produces plates and forgings that are dual certified (i.e. meets the tensile strength requirements of regular grade but has the lower carbon content of L-grades). The ER308 welding consumables also are typically dual certified.

In conclusion, the information reviewed above indicates that the GTAW welds in the subject spent fuel canisters can reasonably be expected to be of good quality and free of injurious defects. This expectation is based on the characteristics of the GTAW weld, the excellent controls outlined for the welding program, and the fact that the welds and base materials are austenitic stainless steel. Also the welding consumables are compatible with the structural materials used in the design. No weld data sheets nor welding travelers were available for evaluation and the inspections applied were found to have used dwell times that were inconsistent with the procedures (at least on canister No. 16), but the welding program controls are well structured and suggest the proper application of a quality welding process – Gas Tungsten Arc Welding (machine).

Best regards,

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