To WEKessler, GO-107A

From AJBirkle, HH-930

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Subject Midland Plant
Steam Generator Weld Records

Consumers Power Company

Internal Correspondence
Birk 18-73

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The Babcock & Wilcox Company Topical Report (BAW-1402) was reviewed to ascertain if there was adequate data available to fulfill the intent of the documentation requirements of the ASME Boiler and Pressure Vessel Code, Section III (1968). Welding electrodes used with the manual metal arc welding process to repair weld, weld pad buildups and weld some nozzle attachment welds on steam generators for B&W nuclear steam systems had unsatisfactory documentation of mechanical properties. This discrepancy was noted initially on my July 14, 1972 QA audit at Barberton on the Midland steam generators. In one case both the chemical and mechanical property documentation was missing but this batch of electrodes; ie, Type 7018 - lot number 51052A, was not used for the Midland steam generator fabrication. Furthermore, the Type 8015 and 11018 types were not involved on the Midland steam generator, Units 1 and 2.

The Type 7015 electrode which was involved has, based on data on 74 lots of B&W manufactured welding electrodes, a minimum Charpy V-notch energy absorption of 45 ft-lbs at 10F. Although this value is entirely adequate, the typical values ranged from 80 to 110 ft-lbs at +10F with a normal distribution of values both higher and lower than these values. The minimum energy absorption required by the ASME Boiler and Pressure Vessel Code is 20 or 30 ft-lbs at +40F depending on the electrode type. At temperatures in excess of +10F it is known that the fracture toughness increases rapidly so it can be reasonably expected that at the operating temperature and pressure we will have values which are substantially higher than the 45 ft-lb minimum obtained from that one lot of welding electrode B&W tested at +10F. The tensile strength of all of the 73 lots of welding electrodes exceeded to the required minimum. The "carbon equivalent" of the weld deposit from the actual welding electrodes used for the welding on the Midland steam generators was shown through correlation with the lots of electrodes with known chemistry and tensile properties to exceed the minimum required tensile strength. This method of correlation using "carbon equivalents" has been shown to be technically acceptable if all other parameters such as weld heat input, joint configuration, etc, parameters are duplicated closely. In a check with Barberton personnel I have been assured that they hold these parameters to tights limits so their laboratory tensile and Charpy V-notch test results will indeed be indicative of actual shop welds. In a subsequent QA audit at Barberton I will review welding procedures to verify that welding electrode qualification welding parameters do simulate actual repair welds.

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On Unit 2 the 7018 welding electrode was used in addition to the 7015 type already discussed. For this filler metal type the B&W Company has 11 lots of Type 7018 welding electrodes where the tensile, Charpy V-notch, and chemistry is known. "Carbon equivalents" of the lot numbers 818-026931 and 10784 show that the tensile strength of the electrode lots used on the Midland Unit 1 steam generator is above the 70,000 psi minimum required. These 11 lots of Type 7018 welding electrodes with known chemistry, tensile strength, and Charpy V-notch properties the Charpy V-notch energy absorption at 40F exceeds the 20 ft-lb required by the ASME Boiler and Pressure Vessel Code by a large margin. The lowest value of the known Type 7018 Charpy V-notch energy absorption is 43 ft-lbs at +10F with typical values which exceed 100 ft-lbs consistantly.

From the viewpoint of experiencing a failure due to rapid fracture of the Midland steam generators I have used linear elastic fracture mechanics calculations to show that the lack of documentation of the 7015 and 7018 welding electrodes will not adversely affect the safety of the plant. The 43 and 45 ft-lb Charpy V-notch energy absorption values at +10F (the minimum values obtained from the welding electrodes with known mechanical properties) are approximately equivalent to a critical stress intensity factor of 180 K si $\sqrt{\text{inch}}$ which, at the yield strength of the material, results in a flaw size for failure which exceeds one-half the wall thickness. At higher temperatures than +10F this calculated critical flaw size for failure will increase rapidly to a still larger value because ferritic steels undergo a transition in fracture toughness with a change in temperature. At service stresses which are much lower than the yield-strength of the material (ASTM 516, Grade 70) used in the comparison and at the operating temperature flaws required to cause failure would correspondingly be greatly in excess of one-half the thickness, and a leak-before-break criteria would be valid.