Enclosure (2)
to P-82430

PUBLIC SERVICE COMPANY OF COLORADO

FORT ST. VRAIN

INSERVICE INSPECTION AND TESTING PROGRAM

ADDITIONAL SURVEILLANCE REQUIREMENTS FOR THE STEAM GENERATOR

Supplement to Report EE-22-0002 Rev. 1
(Enclosure 4 to PSC Letter P-80064)

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EXAMINATION OF STEAM GENERATOR TUBE BIMETALLIC WELDS

1. INTRODUCTION

The Fort St. Vrain steam generator design includes a bimetallic weld in each crossover tube in the transition region between the EESHI bundle and the SH2 bundle. These bimetallic welds, which are subject to elevated temperatures, are not accessible for examination. Inservice inspection and testing of the Fort St. Vrain steam generator was originally reviewed by PSC in letter P-80064. In their report Q-13:82:5, LANL/ASTA requested that data be supplied which describe material tests performed to date to assure the long term thermal performance of the crossover tube bimetallic welds. These data and further references were provided in PSC letter P-82061. At a meeting between NRC, LANL, ASTA, and PSC held at Fort St. Vrain on July 29, 1982, NRC requested that PSC investigate the possibility of examining other bimetallic welds located in the steam header external to the PCRV steam generator penetration which would be representative of the tube bimetallic welds. This report includes the results of PSC's investigation.

2. CROSSOVER TUBE BIMETALLIC WELDS

The crossover tube bimetallic welds are between Incoloy and 2-1/4Cr-1Mo materials. Tube dimensions are approximately 1 in. OD and 0.20 in. wall thickness. They operate with steam at SH1 outlet conditions in the inside, and primary helium on the outside. The primary helium is for all practical purposes stagnant in the weld region thus limiting heat transfer, so that there is only a relatively samll temperature gradient from the outside surface to the inside surface.

3. EXTERNAL INCOLOY/2-1/4CR-1MO BIMETALLIC WELDS

The same material combination as the steam generator crossover tube bimetallic welds is found in various accessible steam generator bimetallic welds located below the PCRV penetration secondary closure. These welds are illustrated in the attached Figure 1, and are located at the connection of:

a) the main steam subheader thermal sleeves with the secondary closure (weld No. 5 in Figure 1),

b) the main steam ring header to the main steam piping (weld No. 2 in Figure 1) and,

c) the main steam ring header collector to the header drain line (weld No. 3 in Figure 1).

The first weld listed above is not representative of the crossover tube bimetallic welds due to its very different operating conditions as a part of the secondary closure boundary rather than steam piping.

The second and third welds are subject to main steam outlet conditions on the inside, and their outside surface is enclosed in thermal insulation. However, the drain line weld is geometrically much more similar to the crossover tube weld than the large, thick wall, main steam pipe weld. Therefore, the main steam ring header collector drain bimetallic weld would be the first choice for monitoring examination. Its temperature is higher than the crossover tube bimetallic weld temperature. Due to its protection by thermal insulation, the heat transfer is also small resulting in a low temperature gradient from inside to outside. A comparison of weld characteristics is included in Table 1.

The differences between the crossover tube bimetallic welds and the main steam ring header collector drain bimetallic welds appear to be small enough so that the latter welds can be considered representative of the former welds with respect to such phenomena as carbon migration at the fusion line and differential thermal expansion of dissimilar metals.

It should be noted, however, that due to the very different configurations of the steam generator tube bundle, and of the main steam ring header and drain line, operating stresses in the two welds may be quite different. Therefore, should indications be found by examination of the drain weld, the nature and significance of these findings for the crossover tube bimetallic welds will have to be thoroughly investigated before it can be concluded that a similar problem exists in those welds.

The potential effects of differential thermal expansion on bimetallic weld structural integrity would appear to be more accentuated for a large diameter than for a small diameter bimetallic weld, i.e. at the main steam ring header collector to pipe junction than at the collector to drain line junction. Operating temperatures of these two welds are identical, so that potential temperature/time dependent phenomena (such as carbon migration) would be expected to affect both welds in the same fashion. Therefore, if examination of steam generator bimetallic welds is to be performed to alleviate potential concerns about their long term behaviour, then the large collector to pipe weld should also be examined.

4. RECOMMENDED EXAMINATION

Examination of bimetallic welds is performed to monitor the behavior of these welds over time. Not all welds need to be

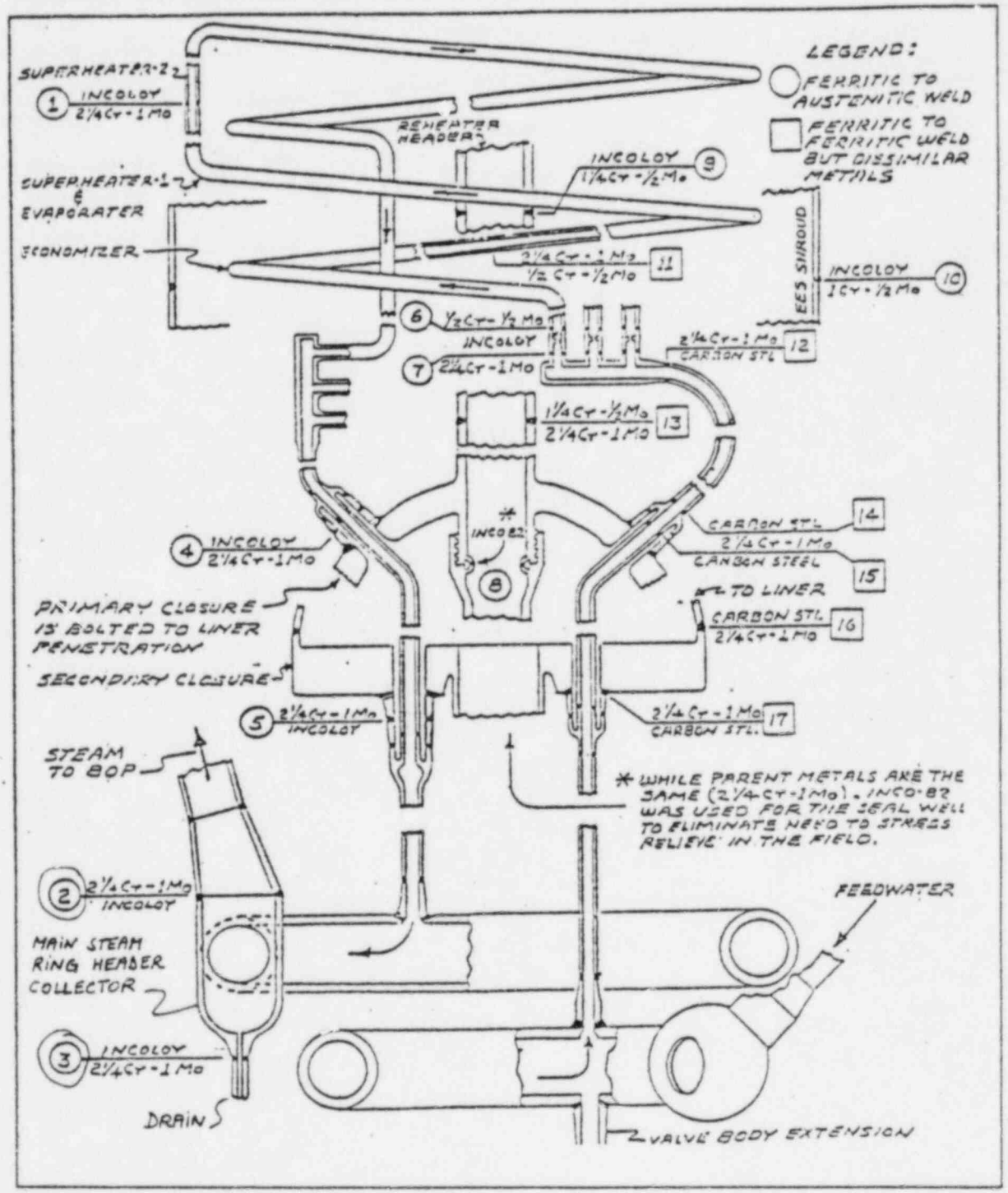
examined, and it is recommended that two main steam ring header collectors be selected for repetitive volumetric examination of the collector to main steam pipe weld and of the collector to drain line weld at five calendar year intervals. It is also recommended that two additional collectors in each loop (8 welds) be volumetrically examined at the first examination, to establish a base line which could be used, should indications be found in the course of the examination program and additional examinations subsequently be required.

	OD (inch)	ID (inch)	Weld Spec	Max Weld Code Allowable	Temperature Operating
Crossover Tube	1.0	0.6	WS-S-205	1015°F	750°F-950°F
Main steam ring header collector/ drain	1.5	0.75	WS-S-173	1025°F	1008°F
Main steam ring header collector/ pipe	8.7	5.9	WS-S-173	1025°F	1008°F

TABLE 1 - STEAM GENERATOR BIMETALLIC WELD CHARACTERISTICS

FIGURE 1

FORT ST. VRAIN STEAM GENERATOR BIMETALLIC WELDS



ATTACHMENT 1

Specification 5.3.11 - Steam Generator Bimetallic Welds, Surveillance

The accessible portions of steam generator bimetallic welds shall be volumetrically examined for indications of subsurface defects as follows:

a) The main steam ring header collector to main steam piping weld for one steam generator module in each loop at five (5) calendar year intervals.

b) The main steam ring header collector to collector drain piping weld for one steam generator module in each loop at five (5) calendar year intervals.

c) The same two steam generator modules initially selected shall be re-examined at each interval.

d) The bimetallic welds described in (a) and (b) shall also be inspected for two other steam generator modules in each loop during the initial examination.

Basis for Specification 5.3.11

The steam generator crossover tube bimetallic welds between Incoloy 800 and 2-1/4Cr-1Mo materials are not accessible for examination. The bimetallic welds between the steam generator ring header collector, the main steam piping and the collector drain piping are accessible, involve the same materials and operate at conditions not significantly different from the crossover tube bimetallic welds. The collector drain piping weld is also geometrically similar to the crossover tube weld. Examination of selected bimetallic welds that are accessible will provide additional assurance concerning the continued integrity of steam generator bimetallic welds. Although no degradation is expected to occur, this specification allows for detection of defects which might result from conditions that can uniquely affect bimetallic welds made between these materials. Additional collector welds are inspected at the first examination to establish a baseline which could be used, should defects be found in later inspections and additional examinations subsequently be required.