MIURA BOILER STEAM GENERATORS

The Miura steam generator is an unfamiliar design to most inspectors in the field. The purpose of this paper is to address common questions and familiarize the inspector with the Miura steam generator through a general overview of the design and operational characteristics.

The Miura boiler design consists of straight water tubes between upper and lower annular headers (rectangular for some models). Both headers are encased in a castable refractory leaving only the tubes exposed to combustion gases. There is very little water and consequently very little energy stored in the steam generator (see chart for comparison of BHP vs. water content). Water volume is exclusively in the tubes with only incidental bubbling in the upper header. Therefore the design has no natural circulation such as a riser, down comer effect common to natural circulation boilers.

Water is forced into the bottom header and tubes by means of a feed water pump. The water is flashed into steam in the tubes, forming a dynamic bubbling system which cools the tubes. This bubbling action may be best described as a "steam gradient", with more steam at the top of the tubes than at the bottom. Steam is accumulated in the upper header with a final separation in the external separator. Condensate dropped by the external separator is fed back into the lower header.

Because of the steam gradient, there is no water level and special modifications are incorporated into the boiler construction and safety system to accommodate this.

First, probes are inserted directly into the top of the tubes. One probe is long, for low water cut out; and one probe is short for feed water control. This water volume control relies on electrical resistance and the bubbling action is what cool's the tubes. As the volume of water in the steam generator is consumed, there is less bubbling at the top of the tubes- increasing the amount of electrical resistance. Once the effective electrical resistance reaches a pre-determined level, a ten second-time delay is tripped after which the feed water pump is turned on. It continues to run until the bubbles re-establish effective contact with the probe. Should the water volume ever become so low as to lose effective contact with the low water cutout probe, the boiler will shut down.

Secondly, probes are inserted into a water column on the side of the boiler. This water control system relies on a more conventional, electrical conductance system - when water contacts a probe, a circuit is formed. Three probes control the boiler feed with the long probe as low water cutout and the other two probes controlling pump on or off. This safety can be confusing for the inspector who encounters the Miura steam generator in the field for the first time, because a water column typically equals a "fixed water level". This is not true however for the Miura steam generator because of the low water content and the fierce cooling action of the steam gradient. This dynamic system is controlled only by a special modification of the water column to create an artificial level. The flanged

pipe leading from the boiler body runs through the column with three holes drilled in the pipe to create an orifice effect. Yet even with this orifice effect, the artificial "level" formed is not necessarily the level on the boiler; and oscillates - especially with load swings on the system. Without this orifice effect, this safety would be useless.
Either of these feed water control systems can operate without the other for proper feed water control, however the combination of these two systems provide for double low water safety and is called the "two-way water volume control system".

Thirdly, thermocouples are attached directly to the tubes. The thermocouples measure the temperature of the tube and will shut the boiler down either by low water volume (insufficient bubbling/ dry fire) or by scale build-up.

The boiler will not operate should any of these low water safeties fail. Only through tampering could the boiler operate without these safeties and develop a dry fire condition. Even in the unlikely event this condition should ever be created, by the time the tubes superheat enough to destroy the tensile strength of the metal, the amount of energy contained in the remaining water is so small that the possibility of a pressure explosion is negligible[1].

Steam is produced within five minutes from cold start-up and selected tubes can be visually inspected through two inch openings located on the top and bottom headers. A complete inspection is typically accomplished in a thirty-minute period.

All Miura steam generators are notated as a forced flow steam generator (with no fixed steam or water level) on the pressure vessel's P-3 form and registered with the National Board. The complete packaged steam generator is listed with UL as a standard and meets IRI, FM and/or ASME-CSD1.

Miura is dedicated to reliable and safe operation of its steam generators through sound engineering principles and years of on the field experience. Please contact us at our Chicago office at (847) 465-0001 should you have any further questions or comments.

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1 The Miura Steam Generator design has been used over twenty years with over 200,000 units presently in operation world-wide. There is no record of ANY pressure vessel explosions.