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EVALUATION OF ASME PRESSURE VESSEL CODE PROHIBITIONS ON ROD AND BAR STOCK AND POTENTIAL REMEDIES

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ABSTRACT

The ASME Codes and referenced standards provide industry and the public the necessary rules and guidance for the design, fabrication, inspection and pressure testing of pressure equipment. Codes and standards evolve as the underlying technologies, analytical capabilities, materials and joining methods or experiences of designers improve; sometimes competitive pressures may be a consideration. As an illustration, the design margin for unfired pressure vessels has decreased from 5:1 in the earliest ASME Code edition of the early 20th century to the present day margin of 3.5:1 in Section VIII Division 1. Design by analysis methods allow designers to use a 2.4:1 margin for Section VIII Division 2 pressure vessels.

Code prohibitions are meant to prevent unsafe use of materials, design methods or fabrication details. Codes also allow the use of designs that have proven themselves in service in so much as they are consistent with mandatory requirements and prohibitions of the Codes. The Codes advise users that not all aspects of construction activities are addressed and these should not be considered prohibited. Where prohibitions are specified, it may not be readily apparent why these prohibitions are specified. The use of "forged bar stock" is an example where use in pressure vessels and for certain components is prohibited by Codes and standards.

This paper examines the possible motive for applying this prohibition and whether there is continued technical merit in this prohibition, as presently defined. A potential reason for relaxing this prohibition is that current manufacturing quality and inspection methods may render a general prohibition overly conservative. A recommendation is made to better define the prohibition using a more measurable approach so that higher quality forged billets may be used for a wider range and size of pressure components.

Jurisdictions with a regulatory authority may find that the authority is rigorous and literal in applying Code provisions and prohibitions can be particularly difficult to accept when the underlying engineering principles are opaque. This puts designers and users in these jurisdictions at a technical and economic disadvantage.

This paper reviews the possible engineering considerations motivating these Code and standard prohibitions and proposes modifications to allow wider Code use of "high quality" forged billet material to reflect some user experiences.

INTRODUCTION

When the first edition of the ASME Boiler and Pressure Vessel Code was published in 1914, it contained an expression for determining the maximum allowable working pressure [MAWP] of a vessel by means of a formula that used the ultimate tensile strength [TS] of the selected material and a factor of safety [1]. For clarity, the expression is given here as

$$MAWP = (TS \cdot t \cdot E) / (R \cdot FS) \quad (1)$$

wherein t, is the thickness of the plate; E, the efficiency of the longitudinal joint; R, the radius of the component and FS is the factor of safety. The FS was prescribed to be 5.

During the Second World War, the FS value, now referred to as a material design factor, was reduced to 4 in response to wartime material shortages and justified on the basis of "great improvements in the art of welding". It appears that two other changes were also made about this time; the allowable material stress incorporated a factor on material yield strength, YS, also more specifically referenced as the specified minimum yield strength, SMYS and the hydrostatic test pressure. The allowable material stress to be used to determine the minimum pressure design thickness was set to the lower of one quarter of

