ABSTRACT

For over three decades, the long seam-welded low alloy steel, Grades 11 and 22, high energy piping in fossil power plants has been considered at risk of premature damage and failure. The experience with piping damage and failures has been documented and extensively studied, but there remains a lack of perspective on how the overall experience with such piping, including that of the large “survivor” population, compares with what one may expect with the design rules used in their construction. Such a perspective can be useful in helping decide on suitable design rules for this class of piping. This paper focuses on an aggregate, global, semi-quantitative evaluation of the damage and failure experience in fossil plant low alloy steel long seam-welded piping in terms of a rate of failure measured against the performance of the overall population. A key aspect of the evaluation is the consideration of the survivor population, particularly important since the documented cases of failure and damage represent a very small fraction of the population of relevant components. The damage and failure rates have been derived from the Electric Power Research Institute database, using an exposure parameter represented by the product of operating time and length of piping. The rates are viewed against the backdrop of the statistical scatter band of base metal stress rupture data used in development of the ASME Code design allowable stresses and against the weld strength reduction factors recently adopted by the ASME Boiler Pressure Vessel Code, Section I and the Power Piping Code, B31.1.

INTRODUCTION

The damage and failure experience of Grades 11 and 22 low alloy CrMo steel long seam weldment piping in fossil power plants as documented by the Electric Power Research Institute (EPRI) has potentially quantifiable implications with regard to what weld strength reduction factors (WSRFs) may be appropriate for design of this class of weldments.

Given (a) that there have been numerous cases of long seam-welded piping failures that have occurred in a fraction of the lifetime that is expected for all-base metal piping (<15%); (b) that these failures have occurred at nominal operating pressure stress levels well below a level that would be expected to cause failure in all-base metal piping in these service durations (50-70% of expected stress); and (c) that the mode of failure can be catastrophic, an immediate inference drawn is that these failures reflect a need for imposition of a WSRF in this class of components. However, since the documented cases of failure and damage represent a very small fraction of the population of relevant components, it is important that the overall experience, including the “survivor” population, be considered in assessing the implications to WSRFs. This paper and analysis focuses on an aggregate, global, semi-quantitative evaluation of the damage and failure experience in fossil plant low alloy CrMo steel long seam-welded piping in terms of a rate of failure measured against the performance of the overall population. The experience has been analyzed as a lumped aggregate and no attempt has been made here to establish the effects of the multitude of possible contributors to premature failure.

THE DAMAGE AND FAILURE EXPERIENCE

Following the catastrophic failure of a hot reheat pipe long seam weld at the Mohave power station in 1985, EPRI has been actively engaged in documenting experience with use of long seam-welded piping at elevated temperatures, and in developing and helping implement guidelines for their in-