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**Abstract:** Demand for power is growing everyday, mainly due to emerging economies in countries such as China, Russia, India, and Brazil. During the last 50 years steam pressure and temperature in power plants have been continuously raised to improve thermal efficiency. Recent efforts to improve efficiency leads to the development of a new generation of heat recovery steam generator, where the Benson once-through technology is applied to improve the thermal efficiency. The main purpose of this paper is to analyze the mechanical behavior of a high pressure superheater manifold by applying finite element modeling and a finite element analysis with the objective of analyzing stress propagation, leading to the study of damage mechanism, e.g., uniaxial fatigue, uniaxial creep for life prediction. The objective of this paper is also to analyze the mechanical properties of the new high temperature resistant materials in the market such as 2Cr Bainitic steels (T/P23 and T/P24) and also the 9-12Cr Martensitic steels (T/P91, T/P92, E911, and P/T122). For this study the design rules for construction of power boilers to define the geometry of the HPSH manifold were applied.

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