

STP-NU-020

VERIFICATION OF ALLOWABLE STRESSES IN ASME SECTION III SUBSECTION NH FOR ALLOY 800H



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FOREWORD

This document is the result of work resulting from Cooperative Agreement DE-FC07-05ID14712 between the U.S. Department of Energy (DOE) and ASME Standards Technology, LLC (ASME ST-LLC) for the Generation IV (Gen IV) Reactor Materials Project. The objective of the project is to provide technical information necessary to update and expand appropriate ASME materials, construction and design codes for application in future Gen IV nuclear reactor systems that operate at elevated temperatures. The scope of work is divided into specific areas that are tied to the Generation IV Reactors Integrated Materials Technology Program Plan. This report is the result of work performed under Task 1 titled “Verification of Allowable Stresses in ASME Section III, Subsection NH with Emphasis on Alloy 800H and Grade 91 Steel (a.k.a., 9Cr-1Mo-V or ‘Modified 9CR-1Mo’).”

ASME ST-LLC has introduced the results of the project into the ASME volunteer standards committees developing new code rules for Generation IV nuclear reactors. The project deliverables are expected to become vital references for the committees and serve as important technical bases for new rules. These new rules will be developed under ASME’s voluntary consensus process, which requires balance of interest, openness, consensus and due process. Through the course of the project, ASME ST-LLC has involved key stakeholders from industry and government to help ensure that the technical direction of the research supports the anticipated codes and standards needs. This directed approach and early stakeholder involvement is expected to result in consensus building that will ultimately expedite the standards development process as well as commercialization of the technology.

ASME has been involved in nuclear codes and standards since 1956. The Society created Section III of the Boiler and Pressure Vessel Code, which addresses nuclear reactor technology, in 1963. ASME Standards promote safety, reliability and component interchangeability in mechanical systems.

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ABSTRACT

Part I Base Metal - Databases summarizing the creep-rupture properties of alloy 800H and its variants were reviewed and referenced. For the most part, the database was judged to be adequate to meet the needs for time-dependent properties in the extension of alloy 800H in ASME Section III Subsection NH (III-NH) to 900°C (1650°F) and 600,000 hours. Procedures for analyzing creep and stress-rupture data for III-NH were reviewed and compared to the current procedure endorsed by the ASME Section II on Materials. The stress-rupture database for alloy 800H in the temperature range of 750 to 1000°C (1382 to 1832°F) was assembled and used to estimate the average and minimum strength for times to 600,000 hours.

Part II Weldments - Databases summarizing the tensile and creep-rupture properties of deposited weld metal and weldments for alloy 800H were reviewed and referenced. Procedures for analyzing creep-rupture data for temperatures of 750°C (1382°F) and higher were reviewed and used to estimate the weld strength reduction factors (SRFs) as a function of time and temperature for temperatures to 900°C (1650°F). The database was judged to be inadequate to meet the needs for the extension of the use of filler metal for alloy 800H in ASME Section III Subsection NH to 900°C (1650°F). Five appendices were included that 1) listed the data used in the evaluation of the SRFs, 2) provided the values for parametric constants in the models, 3) provided an example of the calculated SRFs for alloy 82, 4) recommended supplemental creep-rupture testing to expand the database and improve the estimation of SRFs for long-time service and 5) provided a summary of a parametric Finite Element Analysis (FEA) study of cross-weld samples.