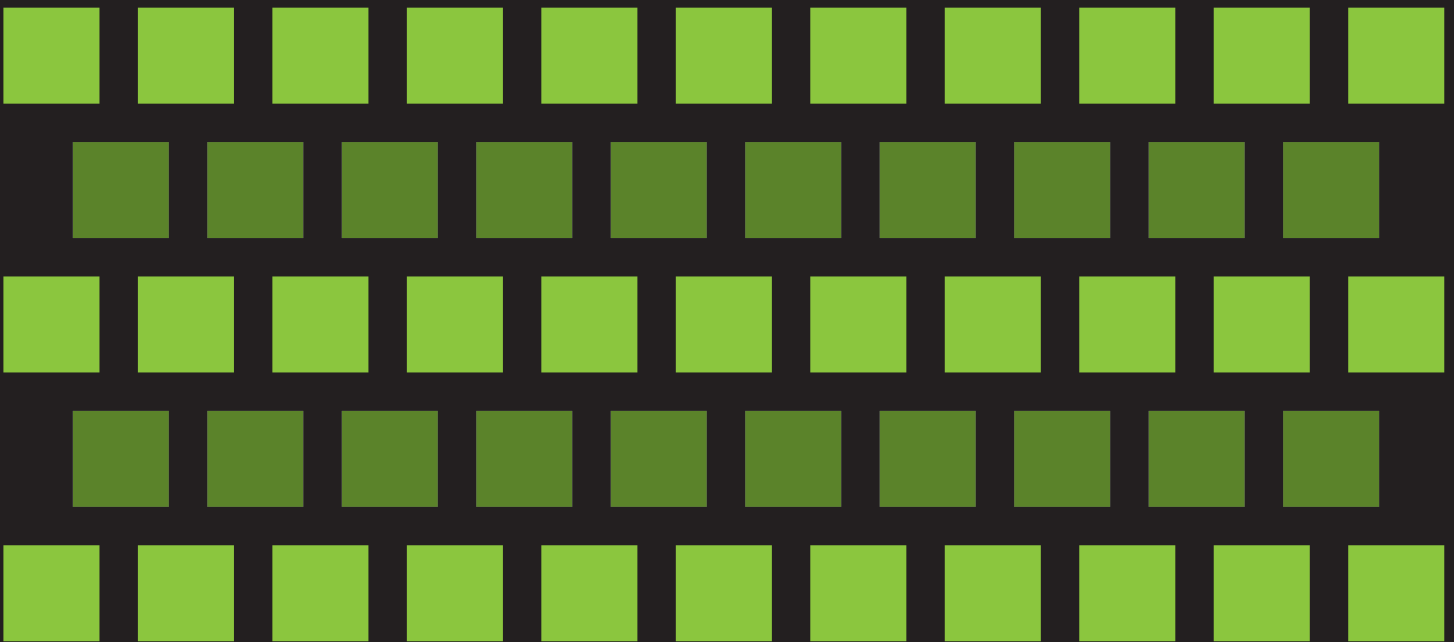


STP-PT-027

# EXTENDED LOW CHROME STEEL FATIGUE RULES



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## FOREWORD

This document was developed under a research and development project which resulted from ASME Pressure Technology Codes & Standards (PTCS) committee requests to identify, prioritize and address technology gaps in current or new PTCS Codes, Standards and Guidelines. This project is one of several included for ASME fiscal year 2008 sponsorship which are intended to establish and maintain the technical relevance of ASME codes & standards products. The specific project related to this document is project 07-04 (BPVC#2), entitled, “Extend Low Chrome Steel Fatigue Rules.”

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**ABSTRACT**

In this report material models were examined for hardening/softening and creep behavior based on available material data sources. Creep and multi-axial effects will be considered. Analytical studies will be explored for typical components using these models. Based on the results, recommendations for an approach to develop fatigue design rules and suitable design factors will be made. Investigation should include consideration of 1-1/4, 2-1/4 and 9 to 12 Cr alloys.

A recommendation was made for developing a technical program for extending the current ASME Section VIII fatigue rules to higher temperatures to address fatigue design aspects for components operating at temperatures approaching the creep range. Vessels where this is commonplace occur in the refining industry; therefore, this development work is of high interest to the petrochemical industry.

## 1 INTRODUCTION

The impetus for this activity arises because the new ASME B&PV Code, Section VIII, Division 2 rules permit high strength materials of the type enumerated to be used to temperatures above 700°F and into their respective creep ranges. A life limiting failure mode is potentially the phenomenon of “creep-fatigue.” We shall define a “creep-fatigue” failure as one in which life is shorter than that expected due to either creep or fatigue acting on a structure independently. This occurs in those regimes of stress, strain-rate, time and temperature where the damage mechanisms due to creep and fatigue can be expected to damage the same microstructure and property characteristics. Creep-fatigue is of concern especially where there may be time-dependent straining and where varying stresses (loads, including start-up and shut down) are among the design conditions.

Comprehensive and correct creep-fatigue design rules are needed now for the aforementioned alloys because, under the new Section VIII, Division 2 rules, as the respective creep ranges of the materials are approached, in many cases the allowable stresses are significantly higher than those for which there is applicable service experience that would permit exempting design details from fatigue analysis based on documented “years of relevant experience.” The same must be said for any new alloys and applications for which there is literally no relevant service experience.

In summary then, the combination of new materials and applications for advanced energy systems with higher allowable stresses and increased design temperatures requires an understanding of creep-fatigue not now available, analytical models to explain and express damage accumulation and relevant test data in order that new, justifiable and correct rules may be developed.