

Safe Long-Term Operation in the Context of Environmental Effects on Fracture, Fatigue and Environmentally-Assisted Cracking

Final Report of the SAFE-I Project

Hans-Peter Seifert, Stefan Ritter, Philippe Spätig, Juxing Bai and Supratik Roychowdhury

Paul Scherrer Institut (PSI) Nuclear Energy and Safety Research Department Laboratory for Nuclear Materials (LNM) 5232 Villigen PSI, Switzerland

> PSI Bericht Nr. 15-03 October 2015

TABLE OF CONTENTS

ABSTRACT ii
INTRODUCTION iii
EXECUTIVE SUMMARY v
ABBREVIATIONS AND SYMBOLS x
PART I: Literature survey on hydrogen and high-temperature water effects on the fracture behaviour of low-alloy steels1
PART II: Effect of hydrogen and high-temperature water on the mechanical and fracture behaviour of a low-alloy RPV steel19
PART III: Environmentally-assisted fatigue in austenitic stainless steels under LWR conditions
PART IV: Mean stress effect investigation on the fatigue behaviour of 316L austenitic steel in air and high-temperature water environment75
PART V: SCC behaviour in the transition region of Alloy 182/low-alloy reactor pressure vessel steel dissimilar metal weld joints in LWR environments
PART VI: Chloride effects on EAC initiation in low-alloy steel under BWR conditions 127
PART VII: Effect of hydrogen on the SCC initiation behaviour in Alloy 182 weld metal under BWR/HWC conditions
ACKNOWLEDGEMENT 197