TECHNOLOGY TRENDS ASSESSMENT

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Code of practice for creep/fatigue testing of cracked components

Code de bonne pratique pour les essais de fluage/fatigue des composants fissurés

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The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

To respond to the need for global collaboration on standardization questions at early stages of technological innovation, the ISO Council, following recommendations of the ISO/IEC Presidents' Advisory Board on Technological Trends, decided to establish a new series of ISO publications named 'Technology Trends Assessments' (ISO/TTA). These publications are the results of either direct cooperation with prestandardization organizations or ad hoc Workshops of experts concemed with standardization needs and trends in emerging fields.

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ISO/TTA 5 was prepared by VAMAS TWA25 and published under a memorandum of understanding concluded between ISO and VAMAS.

This second edition cancels and replaces the first edition (ISO/TTA 5:2006), which has been technically revised.

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Code of practice for creep/fatigue testing of cracked components

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1 EXECUTIVE SUMMARY

Following a brief description of the mechanism for creep and creep/fatigue this document details testing methods and analysis procedures needed for creep and creep/fatigue crack growth testing of generic geometries containing cracks. Use of the terms 'generic geometries', 'component' or 'feature component', 'feature specimens' in testing assumes that the test geometry is non-standard as compared to standard laboratory fracture mechanics geometry such as the Compact Tension (C(T)). These tests maybe needed when the users need additional validation of results and in cases where excessive costs, unavailability of pedigree material, and other testing constraints would allow nominal numbers of tests can be carried out. So far as available, specific advice and additional reference material is given throughout the document in order to assist the user in carrying out a programme of testing and analysis of the data. Specific geometries are identified and appropriate fracture mechanics parameters are presented for each of them.

This document takes into account the experience gained in testing techniques from previous Standards and Codes of Practice [[a]-[kk]] and integrates early advances in the field of high temperature fracture mechanics [1-23] with the more recent findings [24-80] to give advice on testing, measurement and analysis of CCI, CCG and CFCG data for a range of creep brittle to creep ductile materials using a very wide range of pre-cracked geometries. In quantitative terms the information from these tests can be used to consider the individual and combined effects of metallurgical, fabrication, operating temperature, and loading variables on creep crack growth life of a component.

This document, by the very nature of the subject's diversity, cannot go into detail on every issue relating to the methods of testing and the type of geometry that could be tested. Rather it identifies common grounds in the procedures and highlights the sensitivity of the various parameters in completing a validated programme to derive material 'basis' data. Attempts have been made to simplify the procedures whilst at the same time not compromise the overall accuracy that is required in a test programme. Finally advice and recommendations are given to identify the limitations of test results and/or analysis for any specific condition.

2 SCOPE

The scope of this document is to recommend and establish standardized techniques for measuring and analysing Creep Crack Initiation (CCI), Creep Crack Growth (CCG), and Creep Fatigue Crack Growth (CFCG) characteristics using a wide range of pre-cracked standard and non-standard 'feature' geometries. Specimens considered in this document are shown in APPENDIX I. The list of geometries is not by any means complete and the user is advised to use appropriate information from other databases for other geometries to derive the relevant fracture mechanics parameters (see Section **11**) to use in the analysis. The validation of the parameters that are to be used however is important,

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especially where concern exists regarding the compatibility of test geometry with the actual component in terms of size, the type of loading and stress state. This document allows increased flexibility and a wider choice of geometries than previously were made available without comprising on the important issues such as accuracy of testing and data measurements and the appropriate derivation of the correlating parameter. Less emphasis and detail has been placed on cycle dependent fatigue test methods compared to time dependent creep test methods as fatigue testing has been comprehensively dealt with in other standards [g] and the parameters needed for its analysis are linear elastic in nature and therefore simpler than the non-linear time dependent creep regime.

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3 SPECIFIC OBJECTIVES

Availability of Creep Crack Initiation (CCI) and Creep Crack Growth (CCG) and Creep/Fatigue Crack Growth (CFCG) properties are essential for defect assessments of components operating at elevated temperatures. Methods for deriving the uniaxial creep properties are well established. The following identifies the specific objectives for this CoP

1 The user is given advice and information on specific test geometries, techniques, testing methods to allow obtain the maximum amount of verifiable test information for creep and creep/fatigue tests.
2 The information presented has been derived from collaborative experiments on a range of geometries forming the basis for the validation of results in this CoP.
3 Maximum flexibility has been introduced in test techniques without compromising accuracy. Hence the advice will also be relevant to geometries that are not identified specifically in the appendices
4 Advice is given on specimen selection and the appropriateness of fracture mechanics parameters for use in the analysis taking into account the creep properties of the material.
5 Without compromising overall accuracy simplifications of parameters have been introduced and the appropriate variability due to the method of analysis is estimated.
6 The results for the geometries listed in APPENDIX I have been compared and validated and the analysis methods standardized so that testing variability between different laboratories can be reduced to a minimum.
7 The CoP sets out to identify the commonality in the wide variety tests and provides the user with sufficient advice to devise, carry out and analyse a test.

In effect the overall objective of this CoP is to unify, as far as possible, testing and analysis methods between different laboratories. This is in order that subsequent or future analysis of the data or its use in life assessment analysis could be performed with confidence and increased overall accuracy.

4 INTRODUCTION

The Versailles Project on Advanced Materials and Standards (VAMAS) supports trade in high technology products through International collaborative projects aimed at providing the technical basis for drafting codes of practice and specifications for advanced materials. The scope of the collaboration embraces all agreed aspects of enabling science and technology which are required as a precursor to the drafting of standards for advanced materials. The VAMAS activity emphasizes collaboration on pre-standards measurement research, inter-comparison of test results, and consolidation of existing views on priorities for standardization action.

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