

Probabilistic Aspects of **LIFE PREDICTION**

STP 1450

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ASTM Stock Number: STP1450



ASTM International
100 Barr Harbor Drive
PO Box C700
West Conshohocken, PA 19428-2959

Printed in the U.S.A.

Library of Congress Cataloging-in-Publication Data

(To come)

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Foreword

The Symposium on *Probabilistic Aspects of Life Prediction* was held in Miami, FL on 6–7 November 2002. ASTM International Committee E8 on Fatigue and Fracture served as sponsor. Symposium chairmen and co-editors of this publication were W. Steven Johnson, Georgia Institute of Technology, Atlanta, GA and Ben Hillberry, Purdue University, West Lafayette, IN.

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Overview

As fatigue and fracture mechanics approaches are used more often for determining the useful life and/or inspection intervals for complex structures, realization sets in that all factors are not well known or characterized. Indeed, inherent scatter exists in initial material quality and in material performance. Furthermore, projections of component usage in determination of applied stresses are inexact at best and are subject to much discrepancy between projected and actual usage. Even the models for predicting life contain inherent sources of error based on assumptions and/or empirically fitted parameters. All of these factors need to be accounted for to determine a distribution of potential lives based on a combination of the aforementioned variables, as well as other factors. The purpose of this symposium was to create a forum for assessment of the state-of-the-art in incorporating these uncertainties and inherent scatter into systematic probabilistic methods for conducting life assessment.

This is not the first ASTM symposium on this subject. On 19 October 1981 ASTM Committees E9 on Fatigue and E24 on Fracture Testing (today they are combined into Committee E8 on Fatigue and Fracture) jointly sponsored a symposium in St. Louis, MO. The symposium resulted in an ASTM STP 798, *"Probabilistic Fracture Mechanics and Fatigue Methods: Applications for Structural Design and Maintenance."* The STP contained 11 papers. Both of the editors of this current STP were present. At that time, we were very involved with deterministic crack growth predictions under spectrum loading, trying to be as accurate as possible. We had little use for the statistics and probability. One thing that stood out in my listening to the speakers was the level of probability that they were predicting using the ASME boiler and pressure vessel code (author was G. M. Jouris). Some of their estimated probabilities of failure were on the order of 1×10^{-11} . A member of the audience noted that the inverse of this number was greater than the number of atoms in the universe. The audience laughed.

As time went by, a greater appreciation was developed for all the uncertainties in real world applications (as opposed to a more controlled laboratory testing environment). This confounded by needs to assure safety, avoid costly litigation suits, set meaningful inspection intervals, and establish economic risks, have brought more emphasis to the need to use probability in the lifing of components. Since the aforementioned symposium was almost 20 years ago, ASTM Committee E8 agreed to sponsor this symposium. The response was outstanding.

On 6–7 November 2002, in Miami, FL, 29 presentations were given. Lively discussions followed essentially all the talks. The presentations collectively did a great job on assessing the current state of the art in probabilistic fatigue life prediction methodology. We would like to take this opportunity to recognize and thank our session chairs: Dr. Christos Chamis, Dr. Duncan Shepherd, Dr. James Larsen, Prof. Wole Soboyejo, Mr. Shelby Highsmith, Jr., Dr. Fred Holland, and Mr. Bill Abbott. A special thanks to Dr. Chamis for organizing a session.

Due to a number of factors, including paper attrition and a tough peer review process, only 17 papers have made it through the process to be included in this Special Technical Publication. The 17 papers have been divided into three topical groups for presentation in this publication: four papers are

in the section on *Probabilistic Modeling*; seven papers are in the section on *Material Variability*; and six papers are in the section on *Applications*.

We sincerely hope that you find this publication useful and that it helps make the world a safer place.

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ISBN: 0-8031-3478-9

Stock No.: STP1450