

ASME PCC-3-2007

Inspection Planning Using Risk-Based Methods

AN AMERICAN NATIONAL STANDARD



The American Society of
Mechanical Engineers



This page intentionally left blank.

Currently in preview, click buy full version

ASME PCC-3-2007

Inspection Planning Using Risk-Based Methods

AN AMERICAN NATIONAL STANDARD



The American Society of
Mechanical Engineers



Date of Issuance: June 30, 2008

The 2007 edition of this Standard is being issued with an automatic addenda subscription service. The use of addenda allows revisions made in response to public review comments or committee actions to be published as necessary; revisions published in addenda will become effective 6 months after the Date of Issuance of the addenda. This Standard will be revised when the Society approves the issuance of a new edition.

ASME issues written replies to inquiries concerning interpretations of technical aspects of this Standard. The interpretations will be included with the above addenda service.

ASME is the registered trademark of The American Society of Mechanical Engineers.

This code or standard was developed under procedures accredited as meeting the criteria for American National Standards. The Standards Committee that approved the code or standard was balanced to assure that individuals from competent and concerned interests have had an opportunity to participate. The proposed code or standard was made available for public review and comment that provides an opportunity for additional public input from industry, academia, regulatory agencies, and the public-at-large.

ASME does not “approve,” “rate,” or “endorse” any item, construction, proprietary device, or activity.

ASME does not take any position with respect to the validity of any patent rights asserted in connection with any items mentioned in this document, and does not undertake to insure anyone utilizing a standard against liability for infringement of any applicable letters patent, nor assumes any such liability. Users of a code or standard are expressly advised that determination of the validity of any such patent rights, and the risk of infringement of such rights, is entirely their own responsibility.

Participation by federal agency representative(s) or person(s) affiliated with industry is not to be interpreted as government or industry endorsement of this code or standard.

ASME accepts responsibility for only those interpretations of this document issued in accordance with the established ASME procedures and policies, which includes the issuance of interpretations by individuals.

No part of this document may be reproduced in any form,
in an electronic retrieval system or otherwise,
without the prior written permission of the publisher.

The American Society of Mechanical Engineers
Three Park Avenue, New York, NY 10016-5990

Copyright © 2008 by
THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS
All rights reserved
Printed in U.S.A.

CONTENTS

Foreword	iv
Committee Roster	v
1 Scope, Introduction, and Purpose.....	1
2 Basic Concepts.....	1
3 Introduction to Risk-Based Inspection.....	5
4 Planning the Risk Analysis.....	9
5 Data and Information Collection	13
6 Damage Mechanisms and Failure Modes	15
7 Determining Probability of Failure	17
8 Determining Consequence of Failure	20
9 Risk Determination, Analysis, and Management	27
10 Risk Management With Inspection Activities	32
11 Other Risk Mitigation Activities	34
12 Reanalysis	35
13 Roles, Responsibilities, Training, and Qualifications	36
14 Documentation and Record Keeping	38
15 Definitions and Acronyms.....	39
16 References	40
Figures	
2.1 Risk Plot	2
2.3 Management of Risk Using RBI	3
3.3.1 Continuum of RBI Approaches	5
3.3.4 Risk-Based Inspection Planning Process	7
4.4.1 Relationship Among Component, Equipment, System, Process Unit, and Facility	11
8.5 Determination of Consequence of Failure	26
9.2.1 Example of Calculating the Probability of a Specific Consequence	29
9.5.1 Example Risk Matrix Using Probability and Consequence Categories	31
Tables	
2.3 Factors Contributing to Loss of Containment	4
8.3.5-1 Three-Level Safety, Health, and Environmental Consequence Categories	22
8.3.5-2 Six-Level Safety, Health, and Environmental Consequence Categories	22
3.3.4 Six-Level Table	23
16 References	41
Nonmandatory Appendices	
A Damage Mechanism Definitions	47
B Damage Mechanism and Defects Screening Tables	58
C Table of Inspection/Monitoring Methods	65
D Quantitative Methods Including Expert Opinion Elicitation	71
E Examples of Risk-Based Inspection Program Audit Questions	79

FOREWORD

ASME formed an Ad Hoc Task Group on Post Construction in 1993 in response to an identified need for recognized and generally accepted engineering standards for the inspection and maintenance of pressure equipment after it has been placed in service. At the recommendation of this Task Group, the Board on Pressure Technology Codes and Standards (BPTCS) formed the Post Construction Committee (PCC) in 1995. The scope of this committee was to develop and maintain standards addressing common issues and technologies related to post-construction activities, and to work with other consensus committees in the development of separate, product-specific codes and standards addressing issues encountered after initial construction for equipment and piping covered by Pressure Technology Codes and Standards. The BPTCS covers non-nuclear boilers, pressure vessels (including heat exchangers), piping and piping components, pipelines, and storage tanks.

The PCC selects standards to be developed based on identified needs and the availability of volunteers. The PCC formed the Subcommittee on Inspection Planning and the Subcommittee on Flaw Evaluations in 1995. In 1998, a Task Group under the PCC began preparation of Guidelines for Pressure Boundary Bolted Flange Joint Assembly, and in 1999 the Subcommittee on Repair and Testing was formed. Other topics are under consideration and may possibly be developed into future guideline documents. The subcommittees were charged with preparing standards dealing with several aspects of the inservice inspection and maintenance of pressure equipment and piping.

This Standard provides guidance on the preparation and implementation of a risk-based inspection plan. Flaws that are identified during inspection plan implementation are then evaluated, when appropriate, using the procedures provided in the API 579-1/ASME FFS-1, Fitness for Service. If it is determined that repairs are required, guidance on repair procedures is provided in ASME PCC-2, Repair of Pressure Equipment and Piping.

This Standard is based on API 580, Risk-Based Inspection. By agreement with the American Petroleum Institute, this Standard is closely aligned with the RBI process in API 580, which is oriented toward the hydrocarbon and chemical process industries. In the standards development process that led to the publication of this Standard, numerous changes, additions, and improvements to the text of API 580 were made, many of which are intended to generalize the RBI process to enhance applicability to a broader spectrum of industries.

This Standard provides recognized and generally accepted good practices that may be used in conjunction with Post-Construction Codes, such as API 510, API 570, and NB-23.

ASME PCC-3-2007 was approved as an American National Standard on October 4, 2007.

ASME COMMITTEE ON PRESSURE TECHNOLOGY POST CONSTRUCTION

(The following is the roster of the Committee at the time of approval of this Standard.)

STANDARDS COMMITTEE OFFICERS

D. A. Lang, Sr., *Chair*
J. R. Sims, Jr., *Vice Chair*
S. J. Rossi, *Secretary*

STANDARDS COMMITTEE PERSONNEL

G. A. Antaki, Becht Nuclear Services
J. E. Batey, The Dow Chemical Co.
C. Becht IV, Becht Engineering Co., Inc.
D. L. Berger, PPL Generation LLC
P. N. Chaku, ABB Lummus Global, Inc.
P. Hackford, Utah Labor Commission
W. J. Koves, UOP LLC
D. A. Lang, Sr., FM Global
C. R. Leonard, Life Cycle Engineering
K. Mokhtarian, Consultant
C. C. Neely, Becht Engineering Co., Inc.

T. M. Parks, The National Board of Boiler and Pressure Vessel Inspectors
J. T. Reynolds, Consultant
S. C. Roberts, Shell Global Solutions US, Inc.
C. D. Rodery, BP North America Products, Inc.
S. J. Rossi, The American Society of Mechanical Engineers
C. W. Rowley, The Wesley Group
M. E. G. Schmidt, Consultant
J. R. Sims, Jr., Becht Engineering Co., Inc.
C. D. Cowfer, *Contributing Member*, Consultant
E. Michalopoulos, *Contributing Member*, City of Kozani, Greece

POST CONSTRUCTION SUBCOMMITTEE ON INSPECTION PLANNING

C. R. Leonard, *Chair*, Life Cycle Engineering
D. A. Lang, Sr., *Vice Chair*, FM Global
D. R. Sharp, *Secretary*, The American Society of Mechanical Engineers
L. P. Antalfy, Fluor Daniel
J. L. Arnold, Structural Integrity Associates
J. E. Batey, The Dow Chemical Co.
D. L. Berger, PPL Generation LLC
F. L. Brown, The National Board of Boiler and Pressure Vessel Inspectors

P. N. Chaku, ABB Lummus Global, Inc.
C. D. Cowfer, Consultant
F. R. Duvic III, Vessel Statistics
G. A. Montgomery, Progress Energy Fossil Generation
C. C. Neely, Becht Engineering Co., Inc.
D. T. Peters, Structural Integrity Associates
J. T. Reynolds, Consultant
M. E. G. Schmidt, Consultant
J. R. Sims, Jr., Becht Engineering Co., Inc.
G. M. Tanner, M & M Engineering
H. N. Titer, Jr., Mirant Mid-Atlantic

Currently in preview, click buy full version

INTENTIONALLY LEFT BLANK

INSPECTION PLANNING USING RISK-BASED METHODS

1 SCOPE, INTRODUCTION, AND PURPOSE

1.1 Scope

The risk analysis principles, guidance, and implementation strategies presented in this Standard are broadly applicable; however, this Standard has been specifically developed for applications involving fixed pressure-containing equipment and components. This Standard is not intended to be used for nuclear power plant components; see ASME BPV, Section XI, Rules for Inservice Inspection of Nuclear Power Plant Components. It provides guidance to owners, operators, and designers of pressure-containing equipment for developing and implementing an inspection program. These guidelines include means for assessing an inspection program and its plan. The approach emphasizes safe and reliable operation through cost-effective inspection. A spectrum of complementary risk analysis approaches (qualitative through fully-quantitative) should be considered as part of the inspection planning process.

1.2 Introduction

This Standard provides information on using risk analysis to develop and plan an effective inspection strategy. Inspection planning is a systematic process that begins with identification of facilities or equipment and culminates in an inspection plan. Both the probability¹ of failure and the consequence of failure should be evaluated by considering all credible damage mechanisms that could be expected to affect the facilities or equipment. In addition, failure scenarios based on each credible damage mechanism should be developed and considered.

The output of the inspection planning process conducted according to these guidelines should be an inspection plan for each equipment item analyzed that includes

- (a) inspection methods that should be used
- (b) extent of inspection (percent of total area to be examined or specific locations)
- (c) inspection interval (timing)
- (d) other risk mitigation activities
- (e) the residual level of risk after inspection and other mitigation actions have been implemented

¹ *Likelihood* is sometimes used as a synonym for *probability*; however, *probability* is used throughout this Standard for consistency.

1.3 Purpose

This Standard presents the concepts and principles used to develop and implement a risk-based inspection (RBI) program. Items covered are

- (a) an introduction to the concepts and principles of RBI

- 1 Scope, Introduction, and Purpose
- 2 Basic Concepts
- 3 Introduction to Risk-Based Inspection

- (b) individual sections that describe the steps in applying these principles within the framework of the RBI process

- 4 Planning the Risk Analysis
- 5 Data and Information Collection
- 6 Damage Mechanisms and Failure Modes
- 7 Determining Probability of Failure
- 8 Determining Consequence of Failure
- 9 Risk Determination, Analysis, and Management
- 10 Risk Management With Inspection Activities
- 11 Other Risk Mitigation Activities
- 12 Reanalysis
- 13 Roles, Responsibilities, Training, and Qualifications
- 14 Documentation and Record Keeping

1.4 Relationship to Regulatory and Jurisdictional Requirements

This Standard does not replace or supersede laws, regulations, or jurisdictional requirements.

2 BASIC CONCEPTS

2.1 Risk

Everyone lives with risk and, knowingly or unknowingly, people are constantly making decisions based on risk. Simple decisions such as whether to drive to work or walk across a busy street involve risk. Bigger decisions such as buying a house, investing money, and getting married all imply an acceptance of risk. Life is not risk-free and even the most cautious, risk-averse individuals inherently take risks.

For example, when driving a car, an individual accepts the possibility that he or she could be killed or seriously injured. The risk is accepted because the probability of being killed or seriously injured is low while the benefit realized (either real or perceived) justifies the risk taken.