ASME PHM-1–2025

Guideline for Manufacturing Prognostics and Health Management (PHM): Determining PHM Inclusion in Factory Operations

AN AMERICAN NATIONAL STANDARD

The American Society of Mechanical Engineers

ASME PHM-1–2025

Guideline for Manufacturing Prognostics and Health Management (PHM): Determining PHM Inclusion in Factory Operations

AN AMERICAN NATIONAL STANDARD

The American Society of Mechanical Engineers

Two Park Avenue • New York, NY • 10016 USA

Date of Issuance: February 18, 2025

This Standard will be revised when the Society approves the issuance of a new edition.

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 ensure that individuals from competent and concerned interests had an opportunity to participate. The proposed code or standard was made available for public review and comment, which provided an opportunity for additional public input from industry, academia, regulatory agencies, and the public-at-large.

ASME does not "approve," "certify," "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 does ASME assume 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 representatives or persons 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 precludes the issuance of interpretations by individuals.

The endnotes and preamble in this document (if any) are part of this American National Standard.



ASME Collective Membership Mark

All rights reserved. "ASME" and the above ASME symbol are registered trademarks of The American Society of Mechanical Engineers. No part of this document may be copied, modified, distributed, published, displayed, or otherwise reproduced in any form or by any means, electronic, digital, or mechanical, now known or hereafter invented, without the express written permission of ASME. No works derived from this document or any content therein may be created without the express written permission of ASME. Using this document or any content therein to train, create, or improve any artificial intelligence and/or machine learning platform, system, application, model, or algorithm is strictly prohibited.

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

Copyright © 2025 by
THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

CONTENTS

Foreword iv

Committee Roster v

Correspondence With the MAM Committee vi

1 Introduction 1
2 Goal and Scope 1
3 Definitions 2
4 References 5
5 Abbreviations 6
6 PHM Exploration Drivers 7
7 Asset Screening Process 12
8 PHM Feasibility Assessment 17
9 General Framework for Applying PHM 20

Nonmandatory Appendices

A List of Existing Standards for Maintenance Metrics and KPIs 29
B Business Case Workflow 30
C Real Manufacturing Case Studies 33
D How Might ASME PHM-1 Have Helped? 40
E Existing Maintenance Strategies 44
F Other Data Considerations 45
G Health-Readiness Capability Levels 46

Figures

2-1 Steps to Assess PHM Implementation 3
6-1 Overview of the PHM Exploration Drivers 8
6.3-1 Functional Hierarchy From ANSI/ISA-S95.00.01-2000 10
6.3-2 Overlap in Physical Models of ISA-88 and ISA-95 From ISA-TR-88.95.01-2008 11
7-1 Overview of the Asset Screening Process 14
8-1 Overview of the PHM Feasibility Assessment Process 18
9-1 Stepwise Overview of a PHM Deployment Workflow 21
9-2 Overview of the PHM Application Process 22
9.1.2-1 Example Risk Matrix 24
B-2-1 Business Case Workflow 31

Tables

7.3.3-1 Representative PHM Data Catalog Format 16
G-2-1 Health-Readiness Capability Levels 46

FOREWORD

ASME PHM-1 began with a workshop on advanced monitoring, diagnostics, and prognostics operations held in June 2017 at the University of Southern California hosted by the American Society of Mechanical Engineers (ASME) and the National Institute of Standards and Technology (NIST). Over two days, the goal was to identify areas where ASME might be able to develop guidelines and standards that would make it more efficient, cost-effective, and profitable for manufacturers to monitor the overall health of their factories.

At this workshop, several areas were highlighted that might be ready for standardization. From this effort, the PHM Subcommittee on Monitoring, Diagnostics, and Prognostics was created. A second workshop was help from May 7 to 11, 2018, at NIST entitled "Moving From 'React and Repair' to 'Predict and Prevent'" to gather more information in this space.

From these two efforts, the ASME Board on Standardization and Testing voted to approve the formation of the PHM Subcommittee on Monitoring, Diagnostics, and Prognostics for Manufacturing Operations on July 2, 2018. The charter of the subcommittee is to develop standards and guidelines that advance the design and implementation of monitoring, diagnostic, and prognostic capabilities, along with ways of verifying and validating their performance, to enhance adaptive maintenance and operational control strategies within manufacturing.

ASME PHM-1 is part of a planned series to help manufacturers continue to monitor the health of their systems. This Standard was approved by the ASME Manufacturing and Advanced Manufacturing Standards Committee on February 14, 2024. ASME PHM-1 was approved by the American National Standards Institute (ANSI) Board on Standards Review on January 29, 2025.

ASME MAM COMMITTEE
Manufacturing and Advanced Manufacturing

(The following is the roster of the committee at the time of approval of this standard.)

STANDARDS COMMITTEE PERSONNEL

D. Alonzo, *Secretary,* The American Society of Mechanical Engineers
E. Boesiger, Lockheed Martin Corp.
B. He, Shanghai University
J. Marvel, National Institute of Standards and Technology
R. Pavel, Techsolve, Inc.
E. F. Piatti, D2K Technologies
I. J. Van Rooyen, Pacific Northwest National Laboratory
M. Walker, D2K Technologies
B. Weiss, University of Maryland Applied Research Lab for Intelligence and Security
P. Witherell, *Contributing Member*, National Institute of Standards and Technology

PHM SUBCOMMITTEE ON MONITORING, DIAGNOSTICS, AND PROGNOSTICS FOR MANUFACTURING OPERATIONS

R. Pavel, *Co-Chair*, Techsolve, Inc.
A. Salour, *Co-Chair*, The Boeing Co.
D. Alonzo, *Secretary*, The American Society of Mechanical Engineers
M. Brundage, University of Maryland Applied Research Lab for Intelligence and Security
N. Diaz-Elsayed, University of South Florida
X. Hu, GE Digital
S. Lukens, Logistics Management Institute
E. F. Piatti, D2K Technologies
R. Rajamani, DRR2 Consulting
A. Rodriguez-Prieto, Universidad Nacional de Educación a Distancia
M. Seale, U.S. Army
B. Weiss, University of Maryland Applied Research Lab for Intelligence and Security
T. C. Falls, *Contributing Member*, Mississippi State University
L. Hernandez, *Contributing Member*, Global Strategic Solutions, LLC
V. N. Manivannan, *Contributing Member*, U.S. Navy

CORRESPONDENCE WITH THE MAM COMMITTEE

General. ASME codes and standards are developed and maintained by committees with the intent to represent the consensus of concerned interests. Users of ASME codes and standards may correspond with the committees to propose revisions or cases, report errata, or request interpretations. Correspondence for this Standard should be sent to the staff secretary noted on the committee's web page, accessible at https://go.asme.org/MAMcommittee.

Revisions and Errata. The committee processes revisions to this Standard on a periodic basis to incorporate changes that appear necessary or desirable as demonstrated by the experience gained from the application of the Standard. Approved revisions will be published in the next edition of the Standard.

In addition, the committee may post errata on the committee web page. Errata become effective on the date posted. Users can register on the committee web page to receive email notifications of posted errata.

This Standard is always open for comment, and the committee welcomes proposals for revisions. Such proposals should be as specific as possible, citing the paragraph number, the proposed wording, and a detailed description of the reasons for the proposal, including any pertinent background information and supporting documentation.

Cases

(a) The most common applications for cases are

(1) to permit early implementation of a revision based on an urgent need

(2) to provide alternative requirements

(3) to allow users to gain experience with alternative or potential additional requirements prior to incorporation directly into the Standard

(4) to permit the use of a new material or process

(b) Users are cautioned that not all jurisdictions or owners automatically accept cases. Cases are not to be considered as approving, recommending, certifying, or endorsing any proprietary or specific design, or as limiting in any way the freedom of manufacturers, constructors, or owners to choose any method of design or any form of construction that conforms to the Standard.

(c) A proposed case shall be written as a question and reply in the same format as existing cases. The proposal shall also include the following information:

(1) a statement of need and background information

(2) the urgency of the case (e.g., the case concerns a project that is underway or imminent)

(3) the Standard and the paragraph, figure, or table number

(4) the editions of the Standard to which the proposed case applies

(d) A case is effective for use when the public review process has been completed and it is approved by the cognizant supervisory board. Approved cases are posted on the committee web page.

Interpretations. Upon request, the committee will issue an interpretation of any requirement of this Standard. An interpretation can be issued only in response to a request submitted through the online Inquiry Submittal Form at https://go.asme.org/InterpretationRequest. Upon submitting the form, the inquirer will receive an automatic email confirming receipt.

ASME does not act as a consultant for specific engineering problems or for the general application or understanding of the Standard requirements. If, based on the information submitted, it is the opinion of the committee that the inquirer should seek assistance, the request will be returned with the recommendation that such assistance be obtained. Inquirers can track the status of their requests at https://go.asme.org/Interpretations.

ASME procedures provide for reconsideration of any interpretation when or if additional information that might affect an interpretation is available. Further, persons aggrieved by an interpretation may appeal to the cognizant ASME committee or subcommittee. ASME does not "approve," "certify," "rate," or "endorse" any item, construction, proprietary device, or activity.

Interpretations are published in the ASME Interpretations Database at https://go.asme.org/Interpretations as they are issued.

Committee Meetings. The MAM Standards Committee regularly holds meetings that are open to the public. Persons wishing to attend any meeting should contact the secretary of the committee. Information on future committee meetings can be found on the committee web page at https://go.asme.org/MAMcommittee.

INTENTIONALLY LEFT BLANK

GUIDELINE FOR MANUFACTURING PROGNOSTICS AND HEALTH MANAGEMENT (PHM): DETERMINING PHM INCLUSION IN FACTORY OPERATIONS

1 INTRODUCTION

Manufacturers are constantly challenged to optimize their maintenance activities. Improvement targets typically include reducing downtime, waste, and costs while increasing profits, efficiency, and overall competitiveness. The manufacturing industry, including technology integrators and developers, is turning to advanced monitoring, diagnostic, and prognostic capabilities to enhance equipment maintenance strategies within factory operations. Collectively known as prognostics and health management (PHM), monitoring, diagnostic, and prognostic capabilities are becoming more powerful with the advancement of computing systems, networked communications, sensors, data storage, and analytics. PHM is not only applied to individual equipment, it is also applied to work cells, production lines, and potentially even an enterprise's entire manufacturing ecosystem.

Operational safety, productivity, efficiency, and asset availability have a direct impact on the competitiveness of organizations. Unscheduled or frequent downtime can create significant obstacles to the implementation of management strategies known to improve productivity and reduce production costs. With increasing functional complexity of industrial processes and systems, there is now an increasing demand for system-level health assessment, fault diagnosis, and failure prognosis. Through the proper use of PHM technologies, an organization can achieve increased manufacturing asset availability, reduced turnaround time for production, improved process consistency and part quality, and increased safety and environmental preservation.

Numerous challenges face the manufacturing community as manufacturers attempt to design, adopt, integrate, and maintain PHM technologies within their operations. One critical hurdle is not having sufficient reference documentation that can guide them in a practical and effective way to leverage PHM technologies.

ASME PHM-1 is expected to be the first in a series of guidelines developed by the ASME PHM Subcommittee on Monitoring, Diagnostics, and Prognostics for Manufacturing Operations aimed at enhancing the manufacturing community's ability to design, implement, verify, and validate PHM capabilities. Additionally, the guidelines are intended to stimulate feedback and discussion from the manufacturing community to ensure priority needs and challenges continue to be identified and addressed through this subcommittee's efforts.

2 GOAL AND SCOPE

The goal of ASME PHM-1 is to present an approach applicable to almost any manufacturing organization of any size to investigate the implementation and adoption of PHM technologies. More specifically, the intention is to assist manufacturers in making decisions about when and where to integrate monitoring, diagnostic, and prognostic tools and systems in their facilities to ideally optimize maintenance of their manufacturing operations and improve their production planning. These guidelines are designed to aid in answering key questions such as where implementation of PHM can improve productivity and costs, maintain process quality targets, or help solve chronic maintenance problems. This documented process should help to determine challenges the manufacturer is facing and where PHM can help.

PHM technologies are not new and have been applied within large industries including aerospace, automotive, energy, and process industries (Barajas and Srinivasa, 2008; Roemer, Nwadiogbu, and Bloor, 2001; Walker, 2010). As an example, such industries leverage PHM to assess and predict the condition of critical equipment including jet engines, gas turbines, or oil processing units. With the successes and insights gained from implementing PHM in mission-critical domains, it is logical that manufacturers in the 21st century should seek the benefits this technology can deliver. Whether in continuous processing or discrete manufacturing operations, large organizations and original equipment manufacturers (OEMs) have the opportunity to dedicate personnel and invest in identifying the benefits and paths of adopting PHM technologies. This opportunity is more challenging for small and medium-size manufacturers, who typically have limited funds for research and acquisition of new technologies and who experience greater PHM design and implementation hurdles (Helu and Weiss, 2016; Jin et al., 2016). Smaller organizations commonly rely on user-driven manual techniques due to