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Introduction

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For international standards, comments will be reviewed by the relevant UK national committee before sending the consensus UK vote and comments to the international committee, which will then decide appropriate action. If the international standard is approved, it is usual for the text to be published as a British Standard.

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Template for comments and secretariat observations

Date: xx/xx/20xx	Document: ISO/DIS xxxx
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1	2	(3)	4	5	(6)	7
MB	Clause No./ Subclause No./Annex (e.g. 3.1)	Paragraph/ Figure/Table/Note	Type of comment	Comment (justification for change) by the MB	Proposed change by the MB	Secretariat observations on each comment submitted
	3.1	Definition 1	ed	Definition is ambiguous and needs clarifying.	Amend to read '...so that the mains connector to which no connection...'	
	6.4	Paragraph 2	te	The use of the UV photometer as an alternative cannot be supported as serious problems have been encountered in its use in the UK.	Delete reference to UV photometer.	



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SECRETARIAT:

United States of America

SECRETARY:

Mr Donald (Bob) Lattimer

OF INTEREST TO THE FOLLOWING COMMITTEES:

PROPOSED HORIZONTAL STANDARD:

☐

Other TC/SCs are requested to indicate their interest, if any, in this CD to the secretary.

FUNCTIONS CONCERNED:

☐ EMC

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☐ QUALITY ASSURANCE

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TITLE:

Industrial automation equipment and systems - Predictive maintenance

NOTE FROM TC/SC OFFICERS:

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

**INDUSTRIAL AUTOMATION EQUIPMENT AND SYSTEMS –
PREDICTIVE MAINTENANCE**

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The text of this International Standard is based on the following documents:

FDIS	Report on voting
XX/XX/FDIS	XX/XX/RVD

Full information on the voting for the approval of this International Standard can be found in the report on voting indicated in the above table.

This document has been drafted in accordance with the ISO/IEC Directives, Part 2.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under "<http://webstore.iec.ch>" in the data related to the specific document. At this date, the document will be

- 153 • reconfirmed,
- 154 • withdrawn,
- 155 • replaced by a revised edition, or
- 156 • amended.

157

158 The National Committees are requested to note that for this document the stability date
159 is 20XX..

160 THIS TEXT IS INCLUDED FOR THE INFORMATION OF THE NATIONAL COMMITTEES AND WILL BE DELETED
161 AT THE PUBLICATION STAGE.

162

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INTRODUCTION

Efficient production significantly relies on the availability of the production equipment. In order to guarantee the intended usage of equipment and to avoid unplanned downtimes, the status of the equipment and its components – further referred to as “asset” – need to be monitored and assessed. The results of the predictive maintenance assessment are e.g. the remaining lifetime prediction, necessary maintenance activities, etc. Changes of production workflow can also be initiated, targeting on re-organization of the equipment usage. The work process of PM is shown in figure 1.

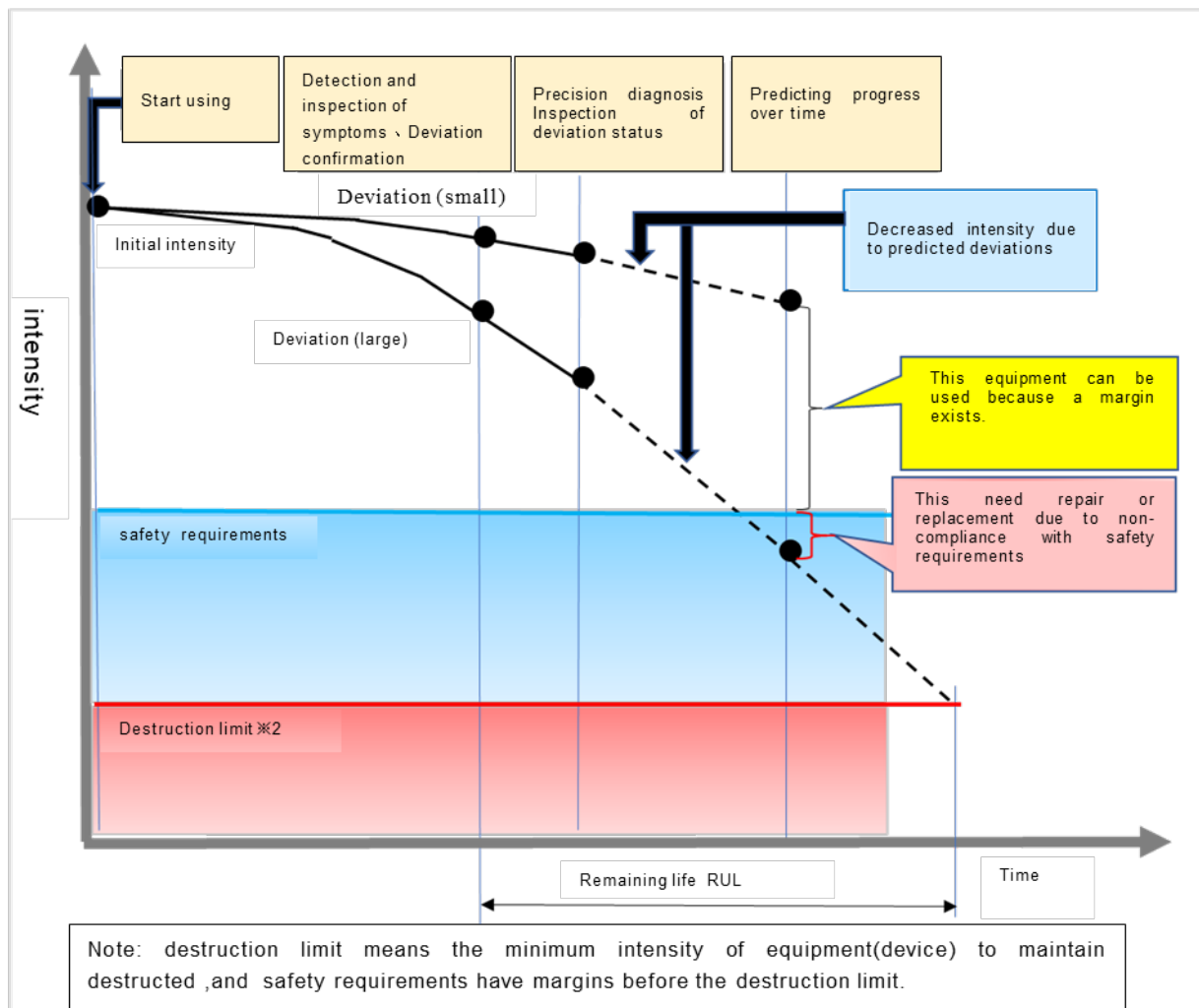


Figure 1 – Predictive maintenance work process

A main prerequisite for such prediction is the availability of status information. Modern automation equipment are often equipped with sensors and capabilities for self-monitoring. These functions may gather data that can be used to determine the equipment status. However, the equipment are delivered from different vendors and are based on different technologies. Thus, a uniform solution for accessing the data and calculating status information is currently not available. This significantly impedes the efforts for an introduction of predictive maintenance solutions.

In addition, the definition, scope, procedure and functional structure of PM need to be defined by standards, including the relationship between PM and CBM (Condition Based Maintenance), DBM (Diagnostic Based Maintenance), PHM (Predictive and Health Management), SHM (Structural Health Monitoring) and other concepts. Industrial automation equipment and systems have two different roles in predictive maintenance, "measuring tool" and "operating tool".

187 prediction ", and condition monitoring, fault diagnosis and remaining life prediction methods
188 may be based on data driven, mechanism model or both, without standardization, it is hard to
189 keep the accuracy and comparative of the PM results.

190 From the description above, a demand for standardization can be derived. Providing an
191 appropriate method and infrastructure, consisting of uniform predictive method and interfaces.
192 Such an approach will support an easy composition of complex condition monitoring and
193 predictive maintenance solutions, provide critical information for equipment and factory based
194 on original data and analytical methods.

INDUSTRIAL AUTOMATION EQUIPMENT AND SYSTEMS – PREDICTIVE MAINTENANCE

1 Scope

This standard provides guidance on the Functional structure model, procedure, method, function block interface, data requirements for predictive maintenance of equipment, devices and systems for industrial automation application.

Condition monitoring is not in the scope of this standard, but can be an important input for predictive maintenance.

2 Normative References

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 62904 Industrial-process measurement, control and automation - Uniform representation of condition monitoring functions

IEC 63082-1 Intelligent Device Management - Part 1: Concepts and Terminology

3 Terms, definitions, and abbreviated terms

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at <http://www.electropedia.org/>
- ISO Online browsing platform: available at <http://www.iso.org/obp>

3.1 Terms and definitions

3.1.1

predictive maintenance

form of preventive maintenance performed continuously or at intervals governed by observed conditions to monitor, diagnose or trend a structure, system or component's condition indicators. Results indicate present and future functional ability or the nature of, and schedule for, planned maintenance

[SOURCE: IEC 62342:2007, 3.14, modified – notes have been deleted]

3.1.2

preventive maintenance

Maintenance carried out at predetermined intervals or according to prescribed criteria and intended to reduce the probability of failure or the degradation of the functioning of an item.

[SOURCE: IEC 61918:2013, 3.1.55]

3.1.3

condition monitoring

recording and evaluation of technical entity status for maintenance purposes

3.1.4

maintenance

activity including supervisory actions, intended to retain an item in, or restore it to, a state in which it can perform a required function

3.1.5

condition-based (conditional) maintenance

preventive activity performed on the basis of the documentation of the performance degradation of an item (as results of, for example, auto diagnostic or wear measurement)

Note1 to entry It is based on a proper visibility of performance degradation or intermittent failures.

[SOURCE: IEC 61918:2013, 3.1.22]

3.1.6

infrastructure interface

shared boundary between two function block defined by functional characteristics, signal characteristics, or other characteristics as appropriate.

[SOURCE: IEC 62390:2005, 3.1.16, modified – “functional units” to “function block”]

3.2 Abbreviated terms

PM	Predictive maintenance
RUL	Remaining Use Life
CBM	Condition Based Maintenance
TBM	Time Based Maintenance
FMEA	Fault modes and effects analysis
FTA	Fault tree analysis
FDT	Field Device Tool
DTM	Device type manager
OPC UA	OLE for process control unified architecture

4 General

4.1 Overview

The implementation of predictive maintenance of automation equipment and systems can be divided into the following three categories according to the differences in requirements and purposes, as shown in Figure 2:

Category I: the realization of condition-based maintenance (CBM), that is, through the acquisition of critical data of the equipment operating state, complete functions of status identification and basic fault diagnosis, and provide basic repair and maintenance strategies, such as alarms, shutdowns etc. This type of predictive maintenance can be based on MES or other information systems.

Category II: the realization of predictive-based maintenance, that is, through the acquisition of data related to the operating status of the equipment, complete the functions of status recognition, fault diagnosis, life prediction, etc., and provide repair and maintenance programs in advance to support the repair and maintenance management of the equipment. This type of

predictive maintenance should be based on an independent system that can be interconnected with MES or other information systems.

Category III: the realization of maintenance based on the whole life cycle management, that is, through the comprehensive acquisition of equipment operating state data, complete the functions of state recognition, fault diagnosis, life prediction, etc., and can judge the confidence of the life prediction result, and can provide a complete and credible repair and maintenance program in advance and guide the management of repair and maintenance of equipment. The system that performs this task can continuously optimize the prediction results and improve the confidence and feasibility of the prediction with the help of technologies such as virtual simulation, artificial intelligence, and system integration. This type of maintenance not only reduces the cost of use and maintenance of equipment, but also creates new value by optimizing operating decisions.

Breakdown maintenance and preventative maintenance are also important maintenance, but are outside the scope of this standard. The object of this standard is the predictive maintenance of category II, and some of the contents can be apply to the predictive maintenance of category I and III.

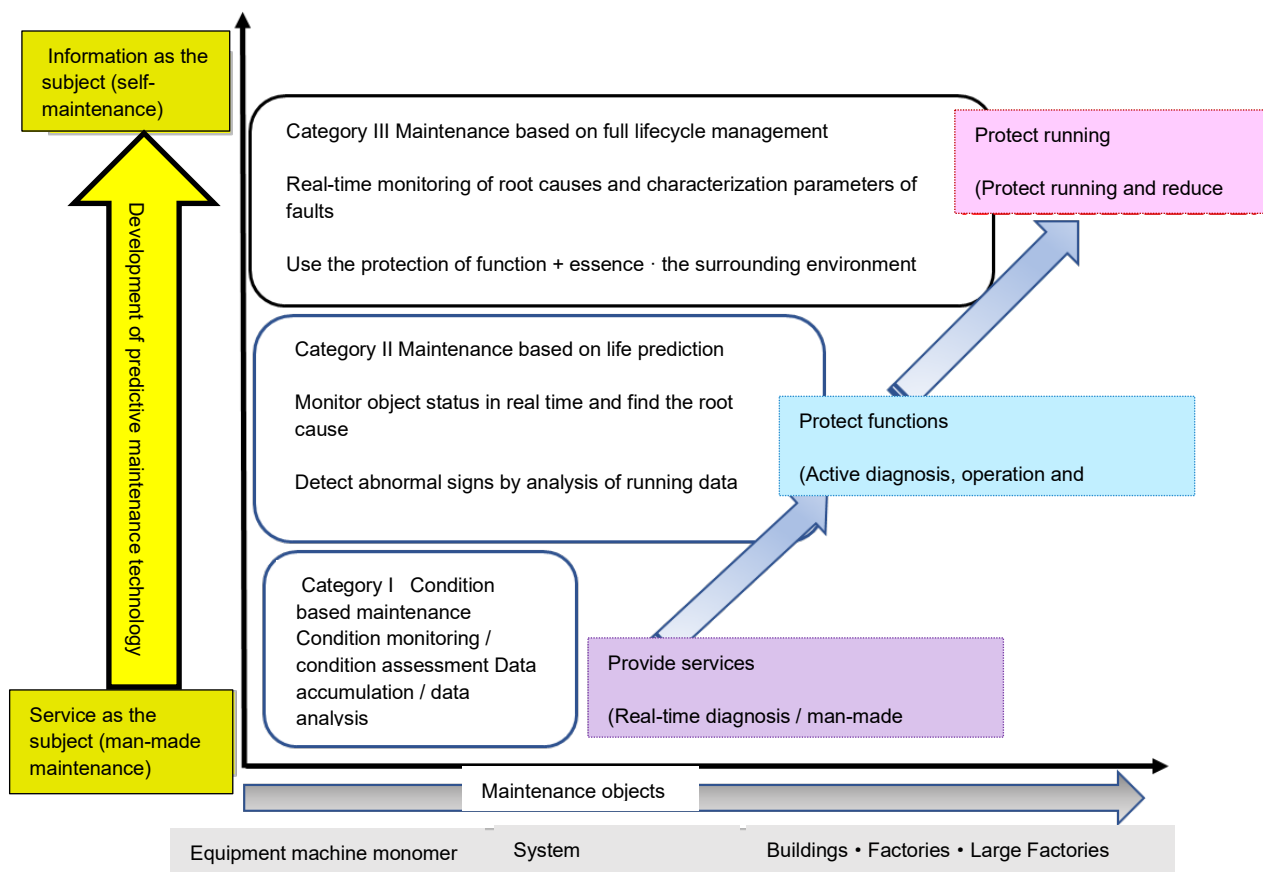


Figure 2 – Automatic equipment and system predictive maintenance level

4.2 Functional structure model

The overall functional structure for PM will, however, stay rather fixed (see Figure 3). The determination of the current state of an asset needs to be conducted using sensing functions. Based on this, a calculation of the state of health and a condition status assessment can be performed. This is a prerequisite for fault diagnosis and for defining repair measures on the one hand, and for remaining life prediction and for defining maintenance actions on the other.

The fault diagnosis process includes fault identification, fault location, etc. If it is judged that the fault has occurred, it is not necessary to enter the prediction process, but directly enters the maintenance management phase. If the fault does not occur or is about to occur, the data

of fault diagnosis and the data of condition monitoring is required to be transmitted together to the prediction phase to carry out the RUL prediction and transmit the information to the phase of maintenance management.

RUL prediction is the core stage of predictive maintenance. The predicted inputs include history information of equipment (working conditions, environment, fault information, etc.), equipment status information, fault diagnosis information, etc. The relevant prediction methods are described in Chapter 7 of this standard.

Finally, all the maintenance measures need to be seamlessly integrated into a maintenance management solution at the Manufacturing Operation Management level. Independent of the specific functionalities, a systematic approach should be introduced, in order to establish a predictive maintenance system.

The Maintenance actions and Repair measure is not in the scope of PM, but shall be within the scope of Maintenance activity.

This functional structure covers both approaches, on-site and remote maintenance. The technological developments, especially the communication and data processing solutions, will enhance the usage of remote monitoring and maintenance. The mapping of this functional structure model in an automation system is shown in Annex A.

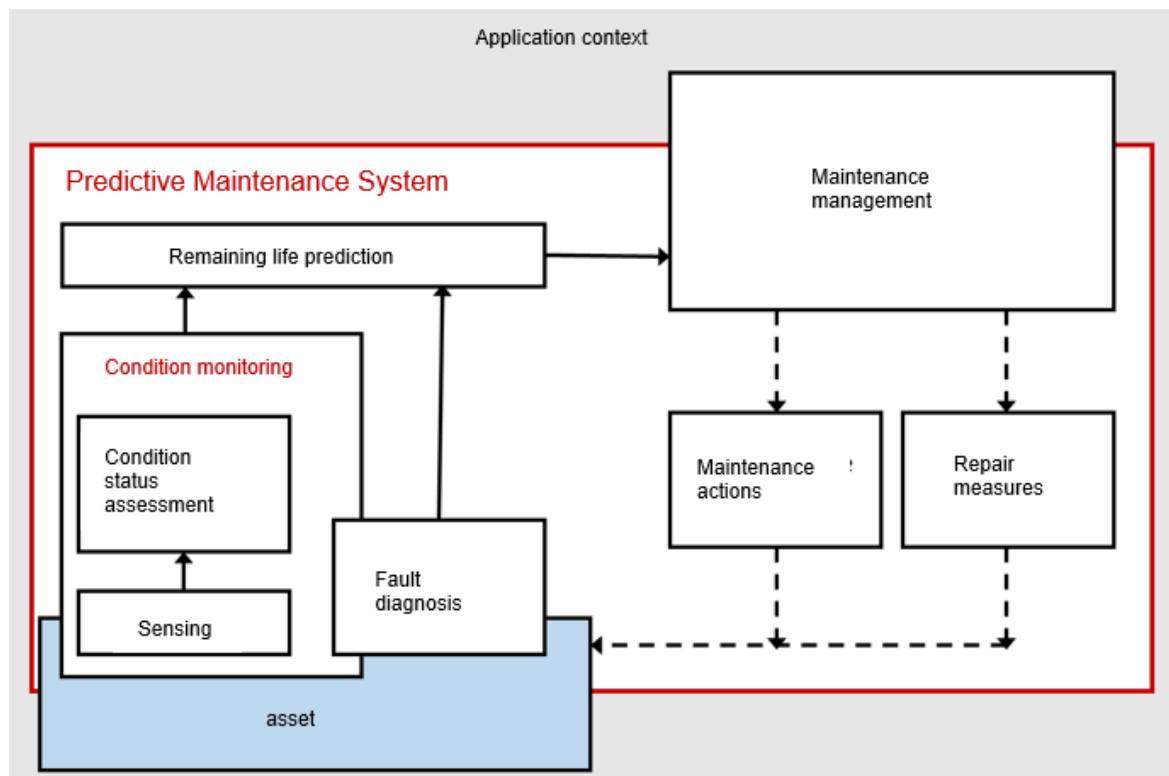


Figure 3 – Functional Structure Model of Predictive Maintenance

4.3 Procedure

The general process and the key steps that should be followed in the implementation of predictive maintenance of equipment are shown in Figure 4. The work of predictive maintenance of equipment shall focus on identifying and avoiding failure modes of root causes.