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Cyber Physical System based Proactive Collaborative Maintenance

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Abstract

This document collects the most important terms used in documents in order to provide a common understanding of the terminology used.

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1 Introduction

The ISO 13372:2012 [1] standard defines the most common terms used in condition monitoring, and provides a good background for a common terminology. This terminology is continuously updated and extended with the terms used in MANTIS.

The ISO 13372:2012 standard is mostly informative, therefore most of the content is available in the preview. The document can be previewed here: https://www.iso.org/obp/ui/#iso:std:iso:13372:ed-2:v1:en

1.1 Structure

The basis of this Vocabulary is the ISO 13372:2012 standard, which is extended with new terms introduced by MANTIS. The document keeps the ISO 13372:2012 structure, and it has been extended with definitions from ISO standards 13379, 13380, 13381.

The new terms should be added to the related section. The suggested workflow for extending the vocabulary is the following:

1. Check for definition within this document. If no similar definition is found, proceed to step 2.
2. Check the Vibration Institute "The Terminology Project" [5]. If the definition is found there, add to the relevant section in this document.
3. If not found in either lists, formulate and the definition as needed.

2 Vocabulary based on ISO standard 13372:2012

2.1 General terms

2.1.1 breakdown maintenance

maintenance performed after a machine (2.1.10) has failed

2.1.2 condition-based maintenance

DEPRECATED: predictive maintenance

maintenance performed as governed by condition monitoring programmes

2.1.3 condition monitoring

acquisition and processing of information and data that indicate the state of a machine (2.1.10) over time

Note 1 to entry: The machine state deteriorates if faults (2.1.8) or failures (2.1.7) occur.

2.1.4 criticality

index of the severity (2.1.16) of an effect combined with the probability of expected frequency of its occurrence

2.1.5 diagnostics

examination of symptoms (2.9.4) and syndromes (2.4.9) to determine the nature of faults (2.1.8) or failures (2.1.7) (kind, situation, extent)

2.1.6 equipment

machine or group of machines including all machine or process control components

2.1.7 failure

termination of the ability of an item to perform a required function (2.1.9)

Note 1 to entry: Failure is an event as distinguished from fault (2.1.8), which is a state.

Note 2 to entry: Failure is the manifestation of a fault.

Note 3 to entry: A complete failure of the main capability of a machine is a catastrophic failure (as defined by the end user).

2.1.8 fault

condition of a machine that occurs when one of its components or assemblies degrades or exhibits abnormal behaviour, which may lead to the failure (2.1.7) of the machine (2.1.10)

Note 1 to entry: A fault can be the result of a failure, but can exist without a failure.

Note 2 to entry: Planned actions or lack of external resources are not a fault.

2.1.9 function

normal or characteristic action of a machine (2.1.10) or the system (2.1.17) of which it is a part

2.1.10 machine

mechanical system designed expressly to perform a specific task, such as the forming of material or the transference and transformation of motion, force or energy

Note 1 to entry: This is also sometimes referred to as equipment (2.1.6).

2.1.11 machine characteristics

distinguishing attributes, qualities and properties of a machine (2.1.10) and its subsystems which, by their presence and the relative magnitudes of their effects, define the configuration, performance, behaviour and capabilities of the machine

2.1.12 machine system

DEPRECATED: machine train

mechanical system in which the principal subsystem is a specific machine (2.1.10) and whose other subsystems are components and auxiliaries whose individual functions (2.1.9) are integrated to support the actions and work of the machine

2.1.13 machinery health management

capability to make appropriate decisions about maintenance actions based on diagnostics (2.1.5) or prognostics (2.1.15) information, available resources and operational demand

2.1.14 machinery health monitoring

process which provides a means of determining the continued serviceability of machines (2.1.10) or components without the need for component removal or inspection

2.1.15 prognostics

analysis of the symptoms of faults (2.1.8) to predict future condition and residual life within design parameters

2.1.16 severity

extent of loss, damage or harm caused by a fault (2.1.8) or failure (2.1.7)

2.1.17 system

¡in condition monitoring and diagnostics¿ set of interrelated elements that achieve a given objective through the performance of a specified function (2.1.9)

2.1.18 preventive maintenance

maintenance performed according to a fixed schedule, or according to a prescribed criterion, that detects or prevents degradation of a functional structure, system (2.1.17) or component, in order to sustain or extend its useful life

2.2 Machine characteristics

2.2.1 critical machinery

machinery which is required to accomplish a major part of a process

Note 1 to entry: This also includes machinery required to maintain safety or comply with environmental requirements.

2.2.2 maintainability

ability of a machine (2.1.10) or part of a system (2.1.17) to be retained in, or restored to, a state in which it can perform the required function(s) (2.1.9)

2.2.3 performance

behaviour, characteristics and efficiency of a technological process, running in a machine (2.1.10) derived by measurement and calculation of one or more parameters (2.9.3), for example, power, flow, efficiency or speed, which singly or together provide the necessary information

2.2.4 reliability

probability that a machine (2.1.10) will perform its required functions (2.1.9) without failure (2.1.7) for a specified time period when used under specified conditions

2.3 Operation and maintenance

2.3.1 alignment

condition whereby the axes of machine system (2.1.12) components are either coincident, parallel or perpendicular, according to design criteria

2.3.2 health and usage monitoring system

HUMS

system that constantly checks the performance (2.2.3) of equipment (2.1.6) providing alerts (2.4.3) or alarms (2.4.2) in advance of potential equipment failures (2.1.7) and collects data for evaluation

2.3.3 reliability centred maintenance

RCM

disciplined logic used to identify those cost effective and technologically feasible maintenance tasks that realise the inherent reliability (2.2.4) of equipment at a minimum expenditure of resources over the life of the equipment (2.1.6)

2.3.4 thermal growth

change in the dimensions of a system (2.1.17) component caused by expansion due to changes in temperature

2.4 Faults

2.4.1 abnormality

deviation from a standard condition

2.4.2 alarm

operational signal or message designed to notify personnel when a selected anomaly (2.4.4), or a logical combination of anomalies, requiring corrective actions is encountered

Note 1 to entry: An alarm is a more severe anomaly zone than an alert (2.4.3) and should be identified with a red indicator.

2.4.3 alert

operational signal or warning message designed to notify personnel when a selected anomaly (2.4.4), or a logical combination of anomalies, requiring heightened awareness is encountered

Note 1 to entry: An alert is the first zone of an anomaly (2.4.4) and should be identified with a yellow indicator.

2.4.4 anomaly

irregularity or abnormality (2.4.1) in a system (2.1.17)

2.4.5 distortion

departure from normal shape or configuration

2.4.6 failure mode

observable manifestation of a system fault (2.1.8)

2.4.7 fault progression

characterization of the change in the observability of a fault (2.1.8) over time

2.4.8 sign

characteristic parameter (2.9.3) of a signal, which shows information about a state

Note 1 to entry: Compare symptom (2.9.4).

2.4.9 syndrome

group of signs (2.4.8) or symptoms (2.9.4) that collectively indicate or characterize an abnormal condition

2.5 Data collection and data acquisition

2.5.1 attenuation

decrease in strength of a signal, usually as a result of the distance a signal travels or the density of the medium through which it travels

2.5.2 background noise

unwanted noise present in a signal which cannot be attributed to a specific cause

2.5.3 dynamic range

¡in condition monitoring and diagnostics¿ ratio of the largest magnitude to the smallest magnitude that a transducer or analyser can detect

Note 1 to entry: Dynamic range is generally expressed in decibels as 20 times the logarithm to the base 10 of the ratio of the largest magnitude to the smallest magnitude.

2.5.4 thermography

¡in condition monitoring and diagnostics¿ use of infrared imagers, whereby the temperatures of a wide variety of targets can be measured, remotely and without contact, by measuring the infrared energy radiating from the surface of the target and converting this measurement to an equivalent surface temperature

2.5.5 time window

¡in condition monitoring and diagnostics¿ time required to digitally acquire the number of samples required to accurately reconstruct the input signal

2.5.6 triboelectric noise

noise generated into a shielded cable, caused by bending or motion of the cable

2.6 Data characteristics

2.6.1 asynchronous

DEPRECATED: non-synchronous

pertaining to two or more processes that do not depend upon the occurrence of specific events such as common timing signals

2.6.2 descriptor

feature

data item derived from raw or processed parameters (2.9.3) or external observation

2.6.3 noise floor

level of noise present in a system (2.1.17) with no exciting signal present

2.6.4 off line

¡in condition monitoring and diagnostics¿ periodic or intermittent collection of data

Note 1 to entry: A sensor or collection system is temporarily connected to the machine.

2.6.5 on line

¡in condition monitoring and diagnostics¿ permanent and continuous collection of data

Note 1 to entry: A subset of this is a surveillance where sensors and collection system are permanently connected, but data are not continuously collected.

2.6.6 subsynchronous component

¡on a spectrum of a vibration signal¿ frequency component that occurs at less than one times the shaft rotational speed

2.6.7 synchronous component

phased-locked components

¡on a spectrum of a vibration signal¿ frequency component that occurs at integer multiples of the shaft rotation speed

2.6.8

thermal vector

vibratory force brought about as a result of uneven thermal distribution in a system (2.1.17)

2.6.9 vibration signature

measure of all frequencies comprising the vibratory movement of a system (2.1.17)

2.7 Data processing and signal processing

2.7.1 electrical signature analysis

ESA

technique which uses the line current and voltage of an electrical machine (2.1.10) to extract information about the health of the electrical machine

2.7.2 frequency domain

display of frequencies present in a sample of a waveform

2.7.3 time domain

display of the behaviour of a system (2.1.17) during a specific period of time

2.7.4 waterfall

three-dimensional multiple spectra display versus time or revolutions per minute

2.7.5 preprocessing

Formatting the raw input data into a predefined common format that can be machine processed by different modules.

2.7.6 significant event selection

Filtering/correlating/suppression, etc. of events and selecting the ones that indicate an anomaly. The output of the significant event selection is usually an alert.

2.8 Analysis

2.8.1 critical speed map

rectangular plot of the natural frequency of a system (2.1.17) (y-axis) versus the bearing or support stiffness (x-axis)

2.8.2 failure modes and effects analysis

FMEA

¡in condition monitoring and diagnostics¿ structured procedure to determine equipment functions and functional failures, with each failure (2.1.7) being assessed as to the cause of the failure and the effects of the failure on the system (2.1.17)

Note 1 to entry: The technique may be applied to a new system based on analysis or an existing system based on historical data.

Note 2 to entry: A FMEA procedure is outlined in IEC 60812[11].

2.8.3 failure mode effects and criticality analysis

FMECA

FMEA with a classification process based on the severity of the faults (2.1.8)

Note 1 to entry: This is in comparison with the criticality (2.1.4) thresholds.

Note 2 to entry: A FMECA procedure is also outlined in IEC 60812[11].

2.8.4 failure modes symptoms analysis

FMSA

process based on FMECA that documents the symptoms produced by each mode and the most effective detection and monitoring techniques in order to develop and optimize a monitoring programme

Note 1 to entry: This process is outlined in ISO 13379-1.

2.8.5 failure rate

number of failures (2.1.7) within a population divided by the number of life units used by that population

Note 1 to entry: Failure rate is always measured during an interval under stated conditions.

2.8.6 fault frequency

frequency component that characterizes a component degradation or failure (2.1.7)

2.8.7 frequency analysis

machine analysis performed by examining a frequency domain (2.7.2) display

Note 1 to entry: The frequencies that are present are used to determine the forcing functions.

2.8.8 Pareto analysis

simple method for separating the major causes (□vital few□) of a problem from the minor ones (□trivial many□)

2.8.9 risk assessment

¡in condition monitoring and diagnostics¿ process of balancing risk with cost, schedule and other management considerations

Note 1 to entry: Risk assessment consists of identifying risks, assessing those risks, determining a course of action and tracking the effectiveness of the decision.

2.8.10 root cause

set of conditions or actions that occur at the beginning of a sequence of events that result in the initiation of a failure mode (2.4.6)

2.8.11 root cause failure analysis

RCFA

after a failure (2.1.7), the logical systematic examination of an item, its construction, application and documentation in order to identify the failure mode (2.4.6) and determine the failure mechanism and its basic cause

Note 1 to entry: Root cause failure analysis is often used to provide a solution to chronic problems.

2.8.12 confidence level

figure of merit (e.g. percentage) that indicates the degree of certainty that the diagnosis/prognosis is correct

Note 1 to entry: This figure essentially represents the cumulative effect of error sources on the final certainty or confidence in the accuracy of the outcome. Such a figure can be determined algorithmically or via a weighted assessment system.

2.9 Diagnostics

2.9.1 baseline

descriptor (2.6.2) or group of descriptors which provides a criterion of the normal behaviour of a machine (2.1.10) under various process states

Note 1 to entry: The baseline should be decided under steady-state condition parameters of the machine. The machine behaviour may change because some condition parameters, such as temperature, are changing even if the process states are steady.

Note 2 to entry: The baseline is used to define the □as new□ state of a machine so that deviation can be observed and quantified.

2.9.2 diagnosis

conclusion or group of conclusions drawn about a system (2.1.17) or unit under test

Note 1 to entry: This gives more detailed information about the kind, situation and extent of a monitored fault (2.1.8) or failure (2.1.7).

2.9.3 parameter

variable representing some significant measurable system characteristic

2.9.4 symptom

perception, made by means of human observations and measurements [descriptors (2.6.2)], which may indicate the presence of one or more faults (2.1.8)

2.10 Prognostics

2.10.1 availability

probability that a machine (2.1.10) will, when used under specified conditions, operate satisfactorily and effectively

2.10.2 prognosis

estimation of time to failure (2.1.7) and risk for one or more incipient failure modes (2.4.6)

2.10.3 estimated time to failure

ETTF

estimation of the period from the current point in time to the point in time where the monitored machine is deemed to be in the failed condition

2.10.4 remaining useful life

RUL

remaining time before system health falls below a defined failure threshold

2.10.5 predictive horizon

threshold for prediction of lead time to failure as desired by the user

3 Summary

This document summarizes the terminology used in MANTIS, which is based on the ISO 13372:2012 standard extended with new terms.

References

[1] ISO 13372:2012 - Condition monitoring and diagnostics of machines □ Vocabulary

[2] ISO 13379 (all parts), Condition monitoring and diagnostics of machines □ Data interpretation and diagnostics techniques

[3] ISO 13381-1, Condition monitoring and diagnostics of machines □ Prognostics □ Part 1: General guidelines

[4] ISO 13373, (all parts), Condition monitoring and diagnostics of machines □ Vibration condition monitoring

[5] Vibration Institute - The Terminology Project [online] http://www.vi-institute.org/terminology