Monitor Equipment Condition for fertilizer plants

Document Development Guidance
Department: Maintenance
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AmmoniaKnowHow
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UreaKnowHow.com
Where the Urea industry meets

Contents

1 SYNOPSIS

AmmoniaKnowHow.com and UreaKnowHow.com support fertilizer manufacturers by providing essential services to the industry, using our syngas technologies and scientific knowledge developed in multiple projects worldwide.

Together we initiate a program to enhance the guidelines and procedures for operation, engineering, maintenance and process safety in the fertilizer industry utilizing the best practices and standards available today.

Using knowledge gained from our industry, historic risk registers, lessons learned from projects and from FIORDA members we are committed to give proper advice to improve safety, reliability and projects performance of fertilizer plants.

2 WHY DEVELOP SPECIFIC GUIDELINES AND PROCEDURES

Guidelines and Procedures are developed to help staff and management teams run the organization. In the best use situations, procedures play a strategic role in an organization. They are developed in light of the mission and objectives of the company and they become the media by which management's plans, rules, intents, and business and operation processes become documented and communicated to all staff.

Carefully drafted and standardized guidelines and procedures save the company countless hours of management time. Guidelines, procedures and employee handbook should be an important part of the operation. They should be the first thing given to a new employee (either in hard copy or an electronic version). They should also be easily accessible in their most up-to-date version. Hence it is extremely important that an organization's procedures are a "living document" prepared and saved in Microsoft Word and easily exported into portable versions (like PDF) and made available over the company network.

3 PURPOSE OF THIS DOCUMENT

The purpose of this document is toto confirm that assets define and implement a robust condition monitoring program to achieve the benefits of adopting a predictive maintenance approach, which include:

- Minimization of intrusive maintenance.
- Transition from reactive to planned maintenance intervention.
- Achieving asset availability targets.
- Optimization of maintenance costs.
- Reduced risk via knowledge of equipment and system —health.
- Early detection of problems.
- Avoidance of catastrophic failures. Optimized spares holding.
- A better sense of equipment health ownership and teamwork between operations, maintenance and the reliability department.

4 METHODOLOGY

An effective Condition Based Maintenance (CBM) program shall provide condition monitoring and predictive maintenance (PdM) techniques to maintain the health of individual equipment and systems.

Condition monitoring is the process of collecting and trending various operating variables in order to infer equipment health. Information is collected by instrumentation, PdM tools and techniques, and the human senses, in order to detect and intervene when deteriorating or abnormal conditions occur.

Condition monitoring, when effectively applied, provides both an early indication of potential failures and the ability to avoid or defer unnecessary intrusive maintenance. The more advanced predictive monitoring systems utilize mathematical modelling of historic data to compare predicted and actual measurement variables to also optimize performance.

In order for condition monitoring to be effective, it shall be focused on critical equipment and utilize technologies which are sensitive to the onset of equipment faults. Such technologies include (but are not limited to):

- Vibration Analysis.
- Lube Oil, Grease and Fluid Analysis. Thermography (infrared/temperature).
- Acoustic Emission/Ultrasonic (airborne sound).
- Process and Operating Parameter / Performance Trending.
- Pressure - Volume Analysis (reciprocating compressors and engines).
- Electric Motor Analysis.

- Battery Load Testing.
- Partial Discharge Monitoring. Exhaust Gas Analysis.
- Watch Keeping (e.g. fuel and lube oil consumption trending).
- Impressed Current Cathodic Protection Analysis.
- Stroboscope (strobe light for detecting coupling issues and axial shuttling of rotors).

The selection and application of these technologies and analysis techniques shall be equipment specific and related to identified failure modes; which may incorporate the use of Failure Mode and Effects Analysis.

The objective of condition monitoring is to identify the onset of equipment faults in sufficient time to act. Therefore, the CMS should be capable of identifying normal equipment condition, deviation from normal condition and deterioration in condition. Online protection systems are designed to avoid catastrophic failure; however, they may not provide early warning of deviations from the norm. This is the requirement of the CMS either through the use of sophisticated alarm settings or periodic evaluation through human analysis.

Figure 1 illustrates the P-F Interval, where: 'P' indicates the point at which degradation in performance/condition is detected (i.e. the point of "Potential Failure") and 'F' indicates the point of Functional Failure (i.e. where the equipment is no longer capable of adequately performing its function).

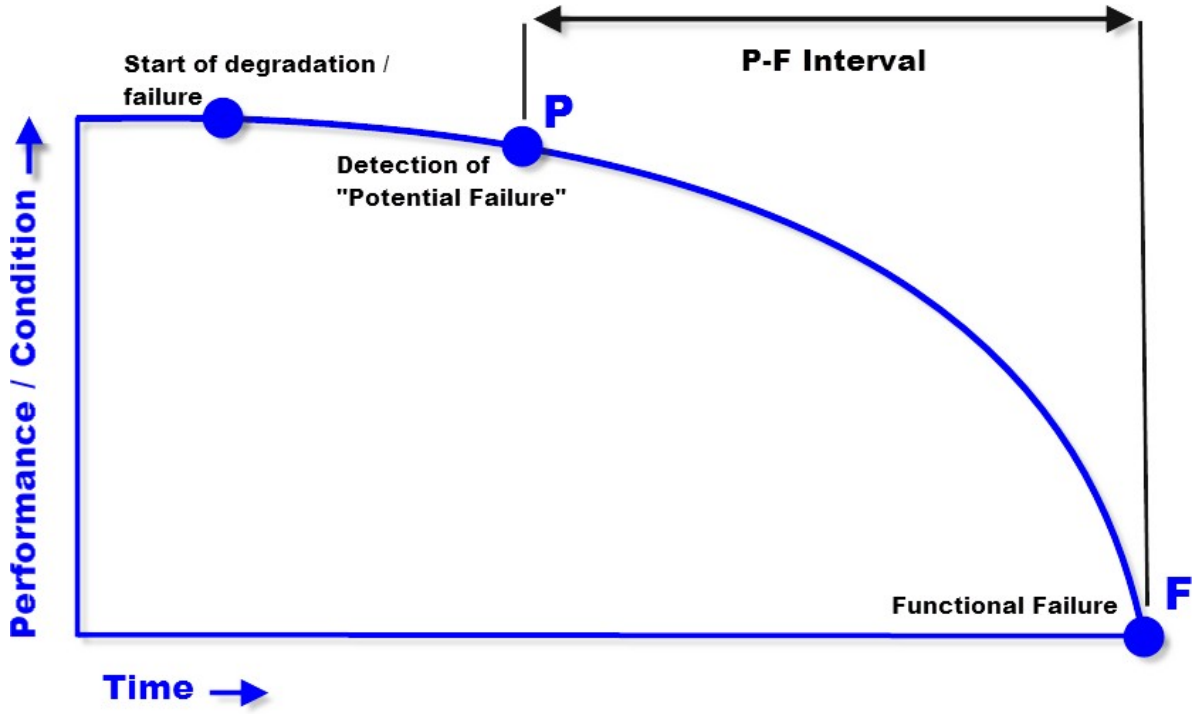

Figure 1. The P-F Interval

The purpose of the CMS is to identify the point of potential failure in sufficient time to intervene before functional failure occurs. Online monitoring automatically acquires data and triggers preset alarms. Portable data collection however, makes it necessary for offline data to be acquired periodically by personnel sufficiently trained in data acquisition to verify consistent data quality. The scheduling of this data shall be at least 1/2 the P-F interval for the technology employed. Typically, it should be scheduled to be approximately 1/3 of the time between the detection and failure.

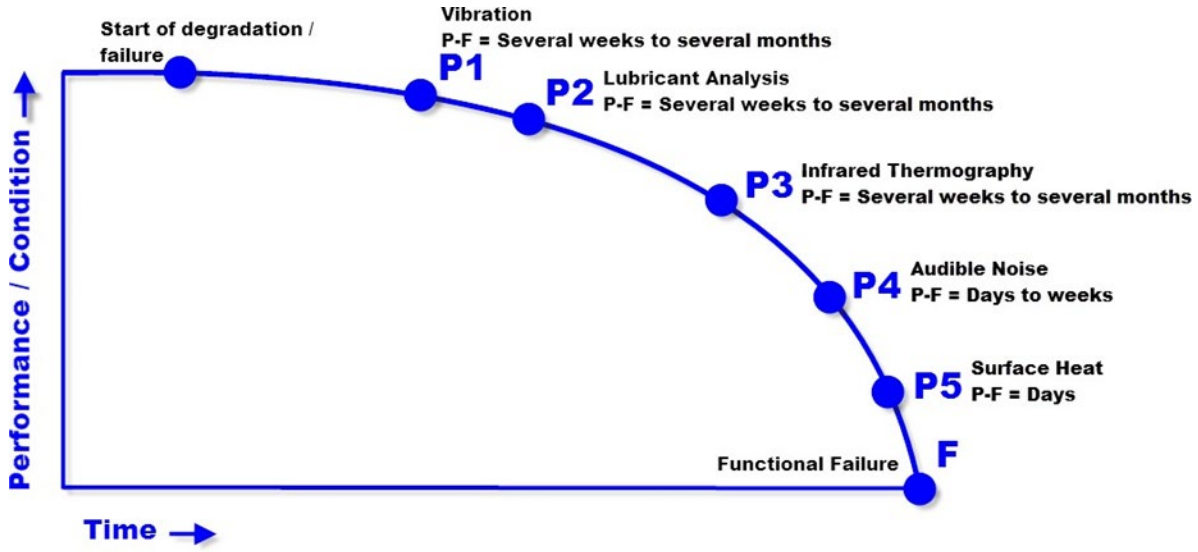

Figure 2. Example P-F Detection Intervals

Collected data shall be analysed and maintenance recommendations reported in a timely manner. When the potential failure is detected, the data collection schedule should be reduced to track the rate of deterioration. (Refer to Figure 2.) Once the fault is rectified, the P-F cycle is reset (refer to Figure 3) and the normal data collection schedules can resume.

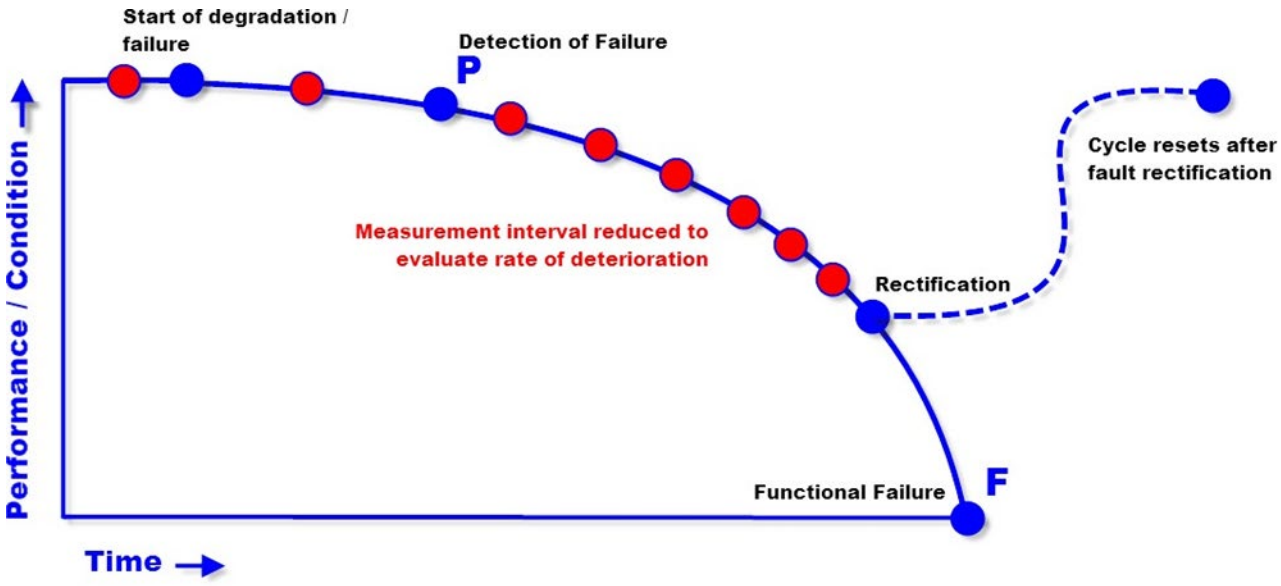

Figure 3. The P-F Cycle

5 CAPTURE OF BASELINE DATA

Baseline data should accurately define the initial stable condition of the equipment across its intended operating envelope. Baseline data shall be captured during Factory Acceptance Testing (FAT), commissioning and Site Acceptance Testing (SAT) and after any significant maintenance intervention or

overhauls. It is fundamental to establishing healthy machine condition and the reliability envelope. The aim of condition monitoring is to identify degradation in condition, making baseline data as its primary reference.

6 COMMISSIONING AND ACCEPTANCE TESTING

Commissioning, SAT and Proving Periods should cover the entire operating envelope and comparisons made with the FAT results to verify that site conditions and foundation stiffness have not rendered the baseline data captured at earlier tests irrelevant.

Generally, data acquisition during SAT should reflect the normal operating conditions of the equipment. Clear descriptions of operating conditions, such as speed, load or temperature and flow should accompany any condition monitoring data collected. Condition monitoring is based on trending from a known healthy baseline condition. As trending examines the rate at which health values change with operating time, it is especially important that the operating conditions during successive measurements remain the same, in order for such trending to be valid. When this is not possible, the effects of such changes need to be considered in the analysis process.

7 CONDITION MONITORIG PROCESS

Processes and procedures should be defined to control and document the condition monitoring activities. These should include:

- Data collection schedules.
- Data collection method statements
- Acceptance levels for data analysis – these may be derived for generic equipment types from API standards, generic equipment power ratings, e.g. ISO-10816, OEM guidelines or percentage deviation from historical trends / baseline data. The rationale for the acceptance limits should be clearly documented and accessible. Changes to alarm limits should be approved and documented through MoC.
- Exception reporting.
- Maintenance recommendations.
- Feedback on successful maintenance actions.
- Feedback on missed calls and incorrect diagnoses.

KPIs should be generated and stored for demonstrating the effectiveness of the CM implementation and strategy. Examples of these include:

- Number of equipment pieces monitored (critical and non-critical).
- Number of false positives.
- Estimated value of saves.
- Availability and reliability from MTBF and MTTR.

The ordering of a new piece of equipment provides the end user a prime opportunity to input maintenance concerns, familiarize personnel with specific fabrication details and procedures, and to personally observe actual fabrication. The objective is to establish a plan for maintenance and eventual repairs. Based upon industry experience, the following considerations should be made and exercised if practical and possible:

Review equipment design and specifications with the process licenser to become familiar with their requirements and to input any concerns the local plant may have.

Review fabricator detail drawings to become familiar with equipment and determine what the future maintenance requirement will be.

When equipment involves special gaskets and so on to make sure drawings are provided with appropriate dimensions to allow for these to be made locally if necessary.

Select spare parts with both operation and maintenance in mind. Keep in mind that some of the materials involved with lining, welds, tubes, and so on are relatively exotic and long lead.

Obtain the recommendation of a process licenser and fabricator for future inspection, maintenance and repair activities.

8 RESPONSIBILITY

Monitor Equipment Condition is a document owned by the Maintenance department within the organization. They are responsible to develop the guidelines and philosophy for Projects and Facilities to support the delivery of company maintenance strategy.

9 DEVELOP YOUR OWN ORGANIZATION PROCEDURES

Although templates can give you a head start on procedures development, other factors must be considered as you write your own internal documents.

One factor is your organization's culture. Organizational attitudes toward procedures determine the spectrum. On one end of the scale are companies that have a procedure for everything. At the other end of the spectrum are companies that only have only a few guidelines (only those required by the laws that are relevant to that company). Most companies fall somewhere in between these two extremes. The manager writing any guideline needs to understand where on the spectrum the company it falls and how the policy can be made to fit the organization's culture to enhance compliance.

Other two factors to be consider when developing guidelines and procedures are the fertilizer technology that company employs and local and international standards applicable to the industry. Internal standards and procedures must be developed in line with these factors, being applicable for your own plants and in line with regulatory requirements.

The last, but not least, factor when developing your own procedures is the best industry practice that you need to employ. Liaison with your fertilizer association, participation in industry meetings and conferences and using fertilizer industry consultants can bring a fresh eye, new ideas and enhance the quality of your own guidelines and procedures.

10 DEFINITIONS

API	American Petroleum Institute
CBM	Condition Based Maintenance
CM	Condition Monitoring
CMS	Condition Monitoring System
CMMS	Computerized Maintenance Management System
DCS	Distributed Control System
ISO	International Standards Organization
IT&S	Information Technology and Services

FMEA	Failure Mode and Effects Analysis
MoC	Management of Change
OEM	Original Equipment Manufacturer
PCN	Process Control Network
PD	Partial Discharge
PdM	Predictive Maintenance
RCFA	Root Cause Failure Analysis
RE	Rotating Equipment

Fertilizer Industrial Services Ltd

Venture House, Arlington Square
Downshire Way, Bracknell, RG12 1WA, UK
P: + 44 (0) 7494 783 534
Web: www.fertilizer.services
E-mail: dan.cojocaru@fertilizer.services