MAINTMASTER®

Maintenance Manual

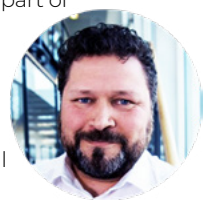

MAINTMASTER®

Contents

Maintenance according to European standards

Maintenance is often considered to be the same as repairing something that has broken, which is an old and outdated definition of maintenance work. The pyramid on the next page shows that corrective maintenance is only a small part of the tasks in a maintenance organisation. A large part of the work involves identifying future maintenance needs and planning and preparing for this to achieve the most cost-effective maintenance possible. The main objective of a maintenance organisation is always to maintain or increase operational reliability. This means that machines and equipment work as expected during planned operation. To achieve this, the maintenance organisation needs a clear vision and strategy with established procedures and goals. An example of a maintenance strategy can be to achieve more efficient production through preventive and condition-based maintenance. It is also important that in the daily work, you work long-term with, for example, root cause analyses in corrective maintenance in order to eventually increase the degree of planning and thereby create cost-effective maintenance.

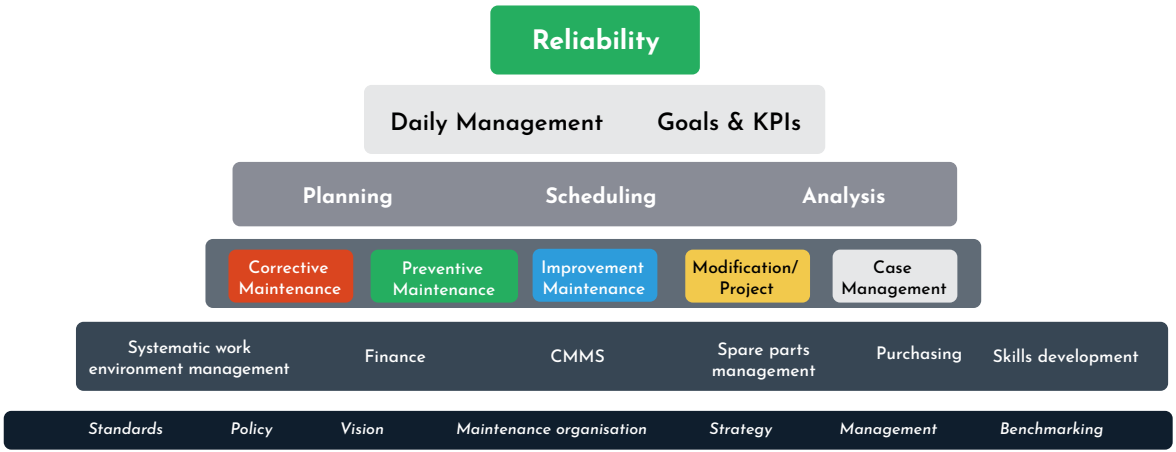
This manual can be used as a practical guide and support in the daily maintenance work and as part of the introduction material for newly hired staff. Feel free to contact us if you want help to develop your own maintenance manual for your organisation. It is very important that all maintenance personnel understand the importance of well performed preventive maintenance, as well as the consequences of unplanned production stoppages. They should also be able to assess how improved maintenance, or developed preventive maintenance, can increase the operational safety of a plant. The manual has been updated from the first edition in 2016.



Mikael Andersson
MaintMaster Systems

MaintMasters maintenance pyramid

The pyramid below describes some of the most important maintenance processes and functions that form the basis for achieving well-functioning maintenance. All processes must work in order to achieve cost-effective and well-functioning reliablity work.



Vision, Strategy & Policy

Maintenance vision, strategy and policy

Documents to increase the operational reliability of a facility, i.e. to function as expected during planned operation. The vision is a long-term goal that the organisation should actively work towards. The strategy is a plan for how the organisation will achieve the vision, while the policy is a declaration of intent and a guideline to steer decisions and achieve the desired goals.

EXAMPLE OF **MAINTENANCE VISION**

- Proper maintenance provides reliability and good availability throughout the plant, and traceability through reporting in the maintenance system provides facts about weaknesses and deficiencies.
- Through all employees' insight into the importance of maintenance for operational reliability, we will achieve cost-effective maintenance of the entire facility.
- This will be made possible through employee engagement, utilisation of the maintenance system and respect for procedures and instructions.

Maintenance vision, strategy and policy

EXAMPLE OF A **MAINTENANCE POLICY**

- Our maintenance is characterised by safety, efficiency, quality and flexibility.
- Leadership should be visible and supportive.
- We are all teachers, trainers and coaches. Fast feedback is important.
- A maintenance technician should know and understand the maintenance terminology of the European standard (EN 13306), and have the ability to use them in practice.

EXAMPLE OF A **MAINTENANCE STRATEGY**

- Achieve high availability through consistent reliability work with an economic trade-off to meet production targets.
- The European standard for maintenance (EN 13306) and its concepts form the basis of our daily work.
- Preventive maintenance is planned and based on condition-based maintenance. This minimises unplanned maintenance interventions.
- Establish close co-operation between maintenance and operations staff.
- We use the LEAN concept and work with continuous improvement and systematic problem solving to address root causes.

Maintenance Standard

Maintenance standard

There are a variety of definitions and explanations of the concept of maintenance. Often, the explanation varies with factors such as industry and the level of the organisation. For a maintenance technician carrying out a practical maintenance action, the term maintenance may mean changing a coupling between a motor and a pump. For someone in management, the concept of maintenance may rather be associated with a tool to increase competitiveness, productivity and profitability.

The following maintenance standards specify general terms and definitions for technical, administrative and management areas of maintenance.

EN 13306 MAINTENANCE TERMINOLOGY

- Everyone does the same and talks about the same things
- Securing evidence and data for analyses
- Concepts that work internationally

EN-15341 MAINTENANCE KEY PERFORMANCE INDICATORS

- Key figures based on terminology standards
- International understanding

EN-13460 DOCUMENTS FOR MAINTENANCE

- Support for new purchases
- Ensure a basis for preventive maintenance

What does maintenance mean?

The Maintenance standard states that:

Maintenance is the combination of all technical, administrative and managerial actions during the lifetime of a device in order to maintain it in, or restore it to, a condition to perform the required function.

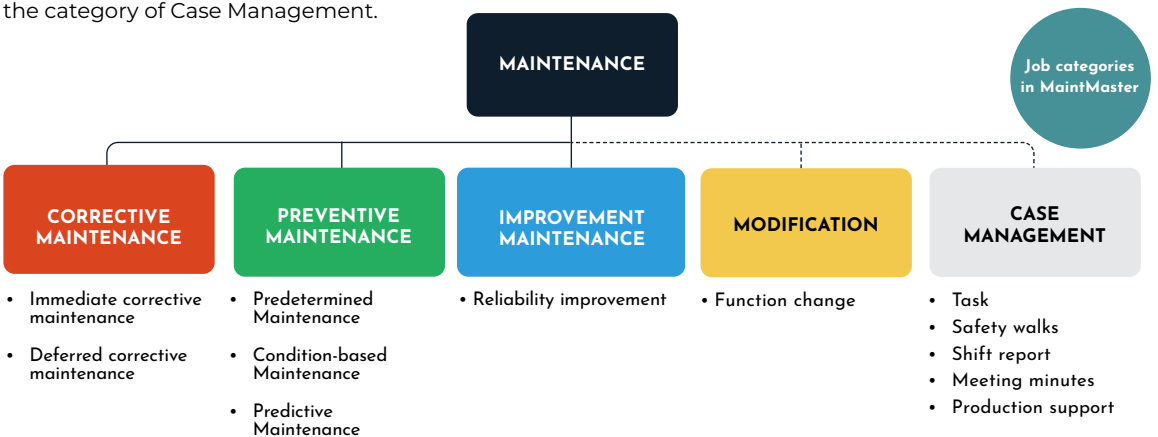
A maintenance engineer should know and understand maintenance terminology and standards, and have the ability to use them in practice.

In order to make proper analyses, it is necessary that everyone talks and reports in the same way, and that we understand what the different concepts mean in maintenance terminology. This allows us to measure and make correct and fact-based analyses, which in turn form the basis for the maintenance organisation's decision-making.

According to standard EN 13306:2017

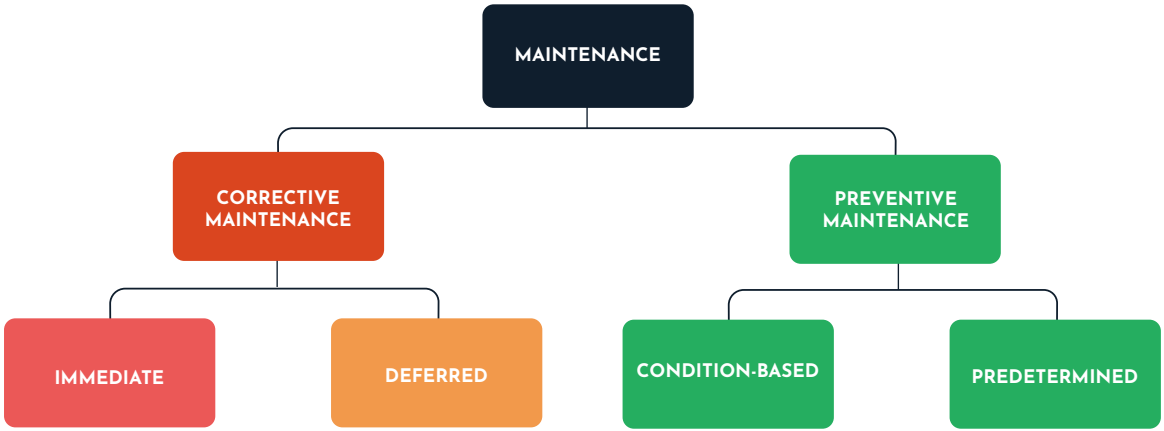
Maintenance categories

All maintenance work that aims to maintain or improve the dependability of a machine or equipment is divided according to standard EN 13306 into three types of work, corrective, preventive and improvement maintenance. In addition to maintenance activities, the maintenance organisation handles many other projects and other types of support activities for the production organisation. Projects that do not aim to improve reliability are by default a Modification and other support activities are registered in MaintMaster in the category of Case Management.



According to standard EN 13306:2017

Types of maintenance



- Expensive maintenance
- Ineffective
- Low availability
- Lost revenue
- Poor delivery reliability
- Quality losses

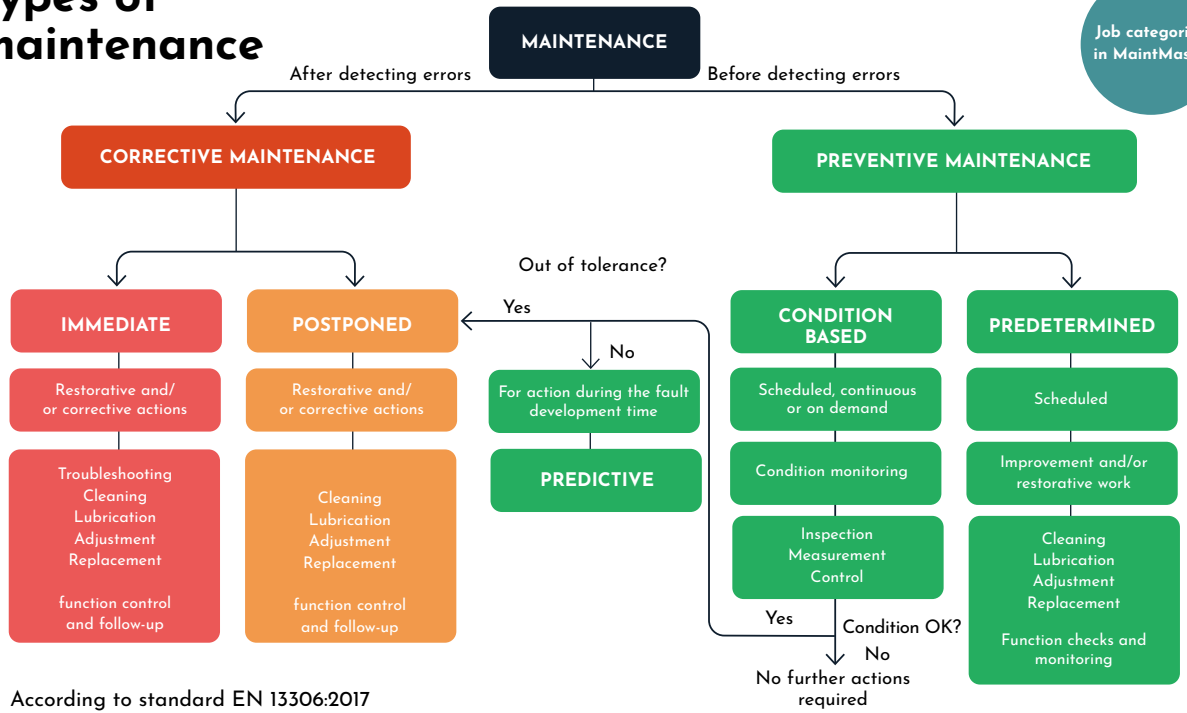
- Increases degree of planning
- More efficient maintenance
- Higher availability
- Higher profitability
- Cheaper maintenance
- Fewer quality losses
- Better delivery reliabilty
- Less consequential damage

- Minor defects fixed immediately
- Other defects are reported for scheduling and planning

- Fewer defects
- Higher availability
- Improving the working environment
- Fewer quality losses
- Higher profitability
- Cheaper maintenance
- More time for improvements

According to standard EN 13306:2017

Types of maintenance



Job categories in MaintMaster

According to standard EN 13306:2017

Preventive Maintenance

Effective preventive maintenance increases operational reliability, which leads to increased profitability. In the long run, it also reduces maintenance costs. We use the concept of condition-based maintenance, which is based on optimising the availability of the company's processes by anticipating the critical points in our equipment and thus preventing problems before they occur.

Maintenance activities that are "unnecessary" are eliminated by systematically ensuring that the work performed provides increased availability at a lower cost. We also ensure that maintenance is a coherent entity, which means secure access to spare parts and a functioning network of maintenance providers.

Preventive maintenance

Preventive maintenance is the maintenance performed at predetermined intervals or according to predetermined criteria in order to reduce the probability of failure or degradation of a device's function. Preventive maintenance can consist of Condition-Based, Predetermined and Predictive maintenance.

CONDITION-BASED MAINTENANCE

Preventive maintenance, consists of checking and monitoring the condition of a unit in terms of its functioning and characteristics and taking the necessary actions.

Control and monitoring of performance and characteristics can be scheduled, on-demand or continuous. Subjective or objective judgement.

PREDETERMINED MAINTENANCE

Preventive maintenance is carried out in accordance with specified intervals or after a specified use but without prior authorisation.

These can be, cleaning, lubrication and replacement of a component or spare part.

PREDICTIVE MAINTENANCE

Condition-based maintenance action is undertaken as a result of a prediction of a unit degradation function based on analysis and evaluation of key characteristics.

According to standard EN 13306:2017

Condition-based maintenance (CBM)

Is a methodology to acquire information on the health status of individual machines in order to identify the correct maintenance action at an optimal time. Condition-based maintenance therefore requires methods to obtain information about the health of the machine. This usually involves various measurement techniques, such as vibration measurement, thermography, ultrasonic measurement and oil analysis. The maintenance process for condition-based maintenance consists of five process steps: Collecting Data, Analysis, Work Order, Corrective actions and Functional Check.

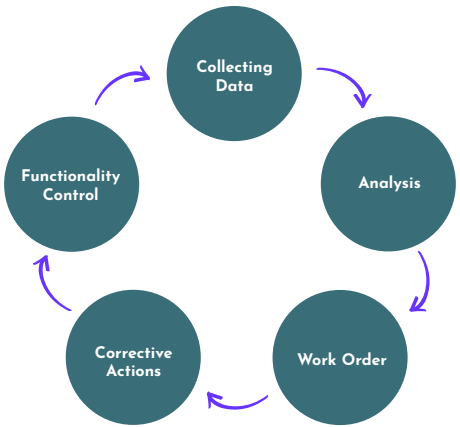
ADVANTAGES

The right maintenance action at the right time
Planned maintenance measures instead of emergency measures
Minor machine faults are detected in good time and corrected.
Emergency breakdowns due to wear and tear decrease
High competence development rate of maintenance staff
Knowledge of own machinery is built up in the organisation.

DISADVANTAGES

May involve high initial investment costs
Risk of premature refurbishment of machinery
Can be difficult to embed CBM throughout the organisation

Based on standard EN 13306:2017



Predetermined maintenance

Refers to preventive measures scheduled per calendar or operating time, such as replacing oil, belts, clutch elements and other worn parts. The term also includes scheduled inspections where machines and components are dismantled for inspection.

ADVANTAGES

Reducing the risk of emergency breakdowns
Improved operational reliability
Increases the level of planning of maintenance activities
Professional development of staff
Reduced maintenance costs

DISADVANTAGES

Cost of unnecessary spare parts and labour time
Risk of excessive 'maintenance' of machinery
Costs of unnecessary downtime
Often static maintenance planning with limited feedback of experience to the maintenance plan

Based on standard EN 13306:2017

Predictive maintenance

According to the standard, predictive maintenance means finding the failure during its failure evolution time by prediction from repeated analyses or by evaluating known properties and parameters of a unit's degradation. Using today's technology, it is common to have some intelligent monitoring system that analyses and processes various measurements. This allows you to quickly determine when to change bearings in a unit, for example.

In the maintenance system, we handle this by connecting MaintMaster's wireless sensors directly via "plug and play" to measure, for example, temperature, pressure or humidity. Through a simple configuration, you set a trigger for when you want to create a work order with an appropriate instruction for what to check or perform.

Condition checks can also be done by visual inspection or Collecting Data, which are then analysed and decisions are made on planned and Predictive maintenance. This can be scheduled inspections and Collecting Data by operators or maintenance personnel. The goal of predictive maintenance is to reduce downtime and to predict when it is time to replace a device, for example, at an optimised time to take advantage of its full lifespan.

Based on standard EN 13306:2017

ADVANTAGES

Minimise downtime and increase planning efficiency

Reduction of service and material costs

Extends the use of components and machines

Status-based maintenance replaces time-based maintenance

Reduced maintenance costs

DISADVANTAGES

May increase initial costs

Operator maintenance

Operator maintenance aims to increase the operational reliability of production equipment by establishing close cooperation between maintenance technicians and operators. Operators have a unique insight and knowledge of daily operations that is very valuable for maintenance. At the same time, maintenance has unique understanding of care and function. By exchanging and transferring knowledge closer to the equipment, unwanted variations can be detected and corrected before faults occur. Maintenance technicians have a very important role as supervisors, teachers and coaches in this work.

Involving operators in the execution of certain maintenance actions also provides more opportunities for daily supervision and weekly maintenance. Examples of maintenance actions that can be carried out by operators include checks, lubrication, some replacements and simple repairs.

Operator maintenance will eventually also free up time for maintenance staff to work more on corrective maintenance, such as specialised maintenance and improvements to increase operational reliability.

Production should be responsible for ensuring that the planned operator maintenance is carried out according to the applicable procedures and intervals and that the implementation is reported according to instructions in the maintenance system. If a deviation is detected during an inspection, this is handled via a follow-up job in the maintenance system.

Based on standard EN 13306:2017

Corrective Maintenance

Corrective maintenance

Corrective maintenance is maintenance carried out after a malfunction has been detected and to bring the unit into a condition to perform the required function.

Corrective maintenance can consist of both deferred and immediate corrective maintenance.

DEFERRED CORRECTIVE MAINTENANCE

Corrective maintenance is not carried out immediately after the detection of a malfunction but is deferred in accordance with given maintenance directives. The work can be planned.

IMMEDIATE CORRECTIVE MAINTENANCE

Maintenance performed immediately after a malfunction is detected to avoid unacceptable consequences.

According to standard EN 13306:2017

Corrective maintenance

ADVANTAGES

Suitable for machines that are easy to replace or have a low purchase cost.

Suitable for specific machines in redundant systems where no costly side effects can be expected in case of failure.

Requires no or limited investment in skills or technology.

DISADVANTAGES

Involves acute unforeseen breakdowns.

Difficult and sometimes impossible to plan maintenance activities.

Capital destruction - minor machine problems go undetected and develop into costly breakdowns.

Low or no professional development of staff

Risk of injury in case of breakdown.

Increased environmental impact.

Higher energy consumption.


Improvement
Maintenance

Improvement maintenance

According to the European standard, improvement is defined as: "The combination of all technical and administrative measures, aimed at improving the reliability of a unit, without changing its required function." For maintenance, this means all actions aimed at extending the service life and eliminating future failures.

Within the framework of Improvement Maintenance, one should exclude actions where the purpose of the activity is to improve the speed and quality output of machinery or equipment. The same applies to the adaptation of equipment for a new product or packaging. We register and report these actions as a Modification in MaintMaster.

EXAMPLES OF ACTIVITIES FOR IMPROVEMENT MAINTENANCE

- Building out errors
- Training activities
- Organisational change
- Developing work instructions
- Implementation of a maintenance system
- Improve the maintainability of a piece of equipment

Based on standard EN 13306:2017

Modification

Modification

According to the standard, modification is defined as: "The combination of all technical and administrative measures, to change one or more functions of an entity."

For maintenance, this means any action to improve product quality or speed. It also applies when we adapt equipment for a new product or packaging. These actions should be costed separately from the maintenance budget and are usually costed as an investment.

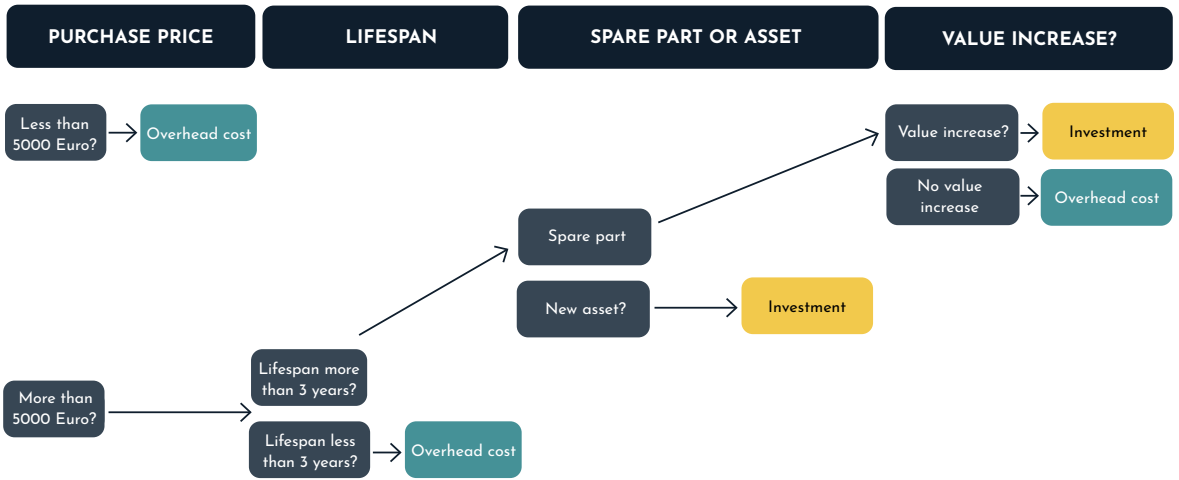
COMMENTS

- Modification is not a maintenance action but refers to changing the required function of an item to a new one. Any changes made during a modification may affect the reliability characteristics of an item, but since the purpose is to change, the activity is still classified as a modification.
- Modification does not imply replacement with an equivalent unit
- Modification of a unit may be a task for the maintenance organisation

Based on standard EN 13306:2017

Decision support data: Overhead costs or investment

It can sometimes be difficult to determine whether a planned activity should be recognised as an investment (modification) or as an expense (improvement). The diagram below is intended to serve as an aid in determining when a similar issue arises.



Case Management

The maintenance organisation works primarily with maintenance-related issues and activities to maintain and improve the dependability of the plant through corrective, preventive or improvement maintenance. In addition, it is common to participate in or project manage dependability modification projects or quality or speed improvement projects. Right or wrong? You can have many long discussions about this and about who should do what in an organisation, but the question is based on what decisions and strategy choices have been made previously in management. Unfortunately, in order to make the right decisions about different responsibilities and tasks, it is not always easy for a maintenance manager to justify to a management team how to organise themselves and which tasks they should be responsible for in a maintenance organisation in order to reach set goals. This is why it is important to report time spent on completed work in a maintenance system.

Good data always facilitates the decision-making process and makes it easier to decide on important changes that promote dependability. For example, it is common to give qualified maintenance technicians tasks that are not maintenance related at all, such as putting up shelves, whiteboards or moving furniture and fluorescent lights in an office. The tasks can be many and it may not be a wrong choice. However, you should know how much time you spend on these types of tasks. If a significant proportion of the time in a maintenance organisation is spent on emergency corrective maintenance, you don't really need to think long and hard about whether this type of simple task adds much value to the reliability of the facility. It may not be wrong that the maintenance staff performs non-maintenance related tasks but it is definitely important that this is reported and the time spent to make good and forward-looking decisions. The job category "Case management" in MaintMaster can be used to report this type of work, see model on page 12.

Organisation

Business plan for maintenance

It is common for the company management to work with a business plan to describe the company's goals and visions and how this is to be implemented during a set period of time. In the same way, maintenance should also specify its activities to develop the maintenance organisation and how we can simultaneously support the company's business plan to achieve the set goals. Below is an example of how to specify the maintenance organisation's selected activities for the next three years. At the top of the business plan, we also show selected KPIs to be able to follow the development.

Business plan for maintenance

Key performance indicator

KPI	Last year	This year	Next year	Year 2
Percentage of fault reports from operators	-	20%	50%	75%
Reported time on completed jobs	-	50%	75%	85%
Preventive maintenance backlog	-	TBD	TBD	TBD
Unplanned (emergency) compared to planned maintenance	-	70/30	60/40	40/60
Completed breakdowns with a specified down time	-	65%	75%	97%

Activities

This year

Implementation of MaintMaster
Develop a Vision, Strategy and Policy for maintenance
Create a maintenance manual and a training plan for maintenance staff.
Train maintenance staff in simple rotor shaft analysis
Develop process for root cause analysis in MaintMaster.
Start with meetings for daily management

Next year

Conduct maintenance inventory on lines 3 and 4
Set up plan for condition-based maintenance on lines 1 and 2
Start weekly meeting for planned maintenance stops
Include spare parts in recurring maintenance jobs

Year 2

Start Pit-Stop process on lines 3, 4 and 5
Start with IoT sensors on selected objects

Roles and responsibilities in a "reliable" maintenance organisation

One of the most important goals of the maintenance organisation is to achieve high operational reliability through cost effective maintenance. An important part of this is that you have the right resources and an organisation supporting the chosen strategy to achieve your goals. Depending on the size of the organisation, you may need to combine different roles to make it work. However, it is important that it is clear which roles are responsible for different tasks and responsibilities in maintenance.
Always strive for redundancy in the organisation to handle the daily work if someone is absent.

At MaintMaster, we are convinced that this is a very important part of building a reliable maintenance organisation. The picture below shows an example of allocating different responsibilities within maintenance. Another important part is that everyone in the organisation understands their role, not just management. Focus on what your role needs to deliver. For example, as a manager or leader, you need to spend more time planning in the long term than helping out daily with a tool in your hand. Attendance is important, but evaluate how much of your working time is spent on day-to-day activities. Meetings are very important. Make sure that every meeting is meaningful. Everyone knows how easy it is to get tied up in meetings that have no meaning for you or your organisation.

Roles and responsibilities in a "reliable" maintenance organisation

The maintenance organisation is responsible for carrying out, planning, managing and developing maintenance activities to ensure high reliability and availability of sites, machinery and equipment. The organisation can have different sizes, structures and competencies depending on the needs, resources and goals of the company and different forms of cooperation with external factors, such as suppliers, contractors or consultants.

This may involve outsourcing some parts of the maintenance to other parties, either fully or partially. It may also involve the use of external expertise for specific tasks or projects. Whichever form of co-operation is chosen, it is important to have clear agreements, communication and follow-up between the parties involved.
There is no template for what an optimal maintenance organisation should look like; it depends on many factors such as the size, type, complexity, level of maturity and objectives of the business. However, it is important that the maintenance organisation carefully considers its maintenance strategy and adapts it to the needs and conditions of the business, and constantly strives to improve and develop its work. A good maintenance organisation is an important factor in achieving high operational reliability and availability, as well as contributing to the profitability and competitiveness of the business.

The following roles are examples of commonly used roles in a maintenance organisation.

Maintenance Manager
The person who has overall responsibility for the maintenance management and its performance. The maintenance manager leads and manages the maintenance organisation in accordance with the company's vision, strategy and policy. The Maintenance Manager is also responsible for monitoring and reporting maintenance KPIs, budget and costs.

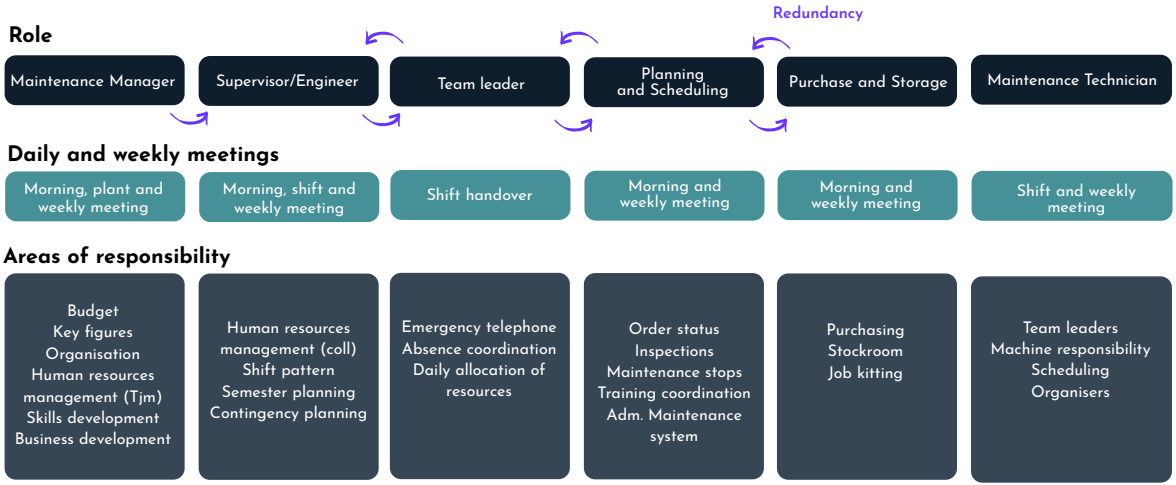
Maintenance Supervisor
Leads and allocates tasks to technicians. May also provide support and assistance to various roles within the maintenance organisation. Supervisors usually also have staff responsibilities for maintenance technicians.

Maintenance planner
Plans and coordinates maintenance work in co-operation with production, suppliers and maintenance staff. The maintenance planner is responsible for optimising the use of resources, minimising downtime and maximising maintenance efficiency. The maintenance planner is also responsible for documenting and archiving maintenance information in a maintenance system.

Maintenance Technician
The person who carries out the actual maintenance work on the plant, machinery or equipment. The maintenance technician may have different specialisations, such as mechanical, electrical, automation or instrumentation. The maintenance technician is responsible for following the planned maintenance activities, reporting deviations and faults, and suggesting improvements.

Maintenance Engineer
Has technical skills and knowledge in one or more areas of maintenance. The maintenance engineer supports and guides the maintenance staff in technical matters, analyses the causes of faults and malfunctions, and develops and implements solutions to prevent or correct faults. The maintenance engineer is also responsible for evaluating and updating maintenance plans, instructions and procedures.

Roles and responsibilities in a "reliable" maintenance organisation



Professional maintenance

Effective maintenance works with value-creating maintenance work from a preventive, planned and improvement perspective, where work that requires urgent corrective action is seen as a quality deficiency and measures are taken to reduce the risk of the event occurring again. An essential part of ensuring that professional maintenance works is that the work is coordinated with the work carried out by operational staff.

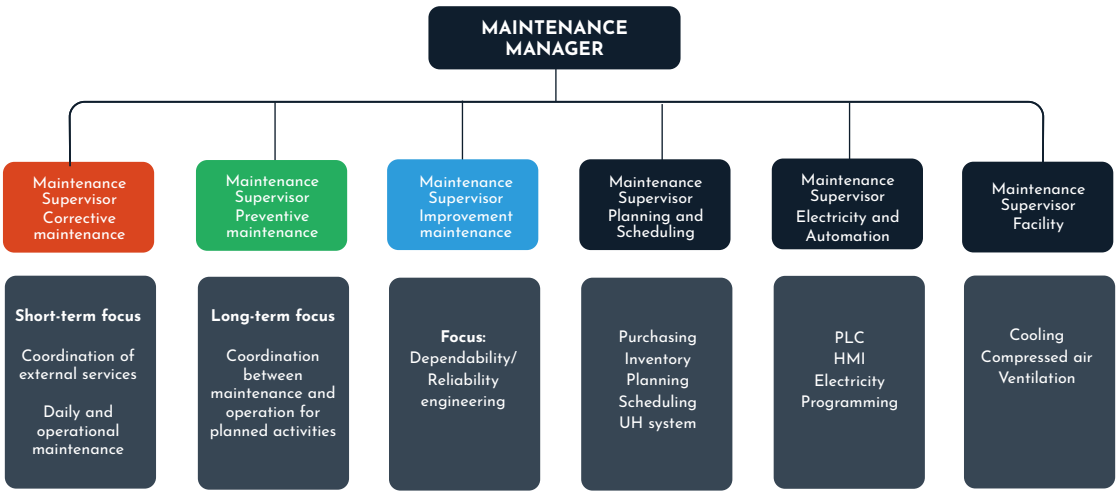
Professional maintenance is goal-oriented maintenance that constantly improves operational reliability based on the needs of production by measuring and directing operations toward results. This is created by standardising how improvement work, target management and result measurement are carried out and by building in continuous optimisation of existing maintenance arrangements.

Below are examples that can be included in professional maintenance:

- Targeted maintenance and monitoring using key performance indicators.
- Budget work
- Standardised approach
- Corrective and preventive maintenance
- Planning and scheduling of maintenance operations
- Maintenance strategy
- Analysis (6-sigma, FMEA, SPL, Root Cause Analysis)
- Skills development
- Vibration and oil analyses
- Thermography
- Spare parts management
- Documentation
- LCC (Life Cycle Purchase Price)

Maintenance organisation, based on EN 13306

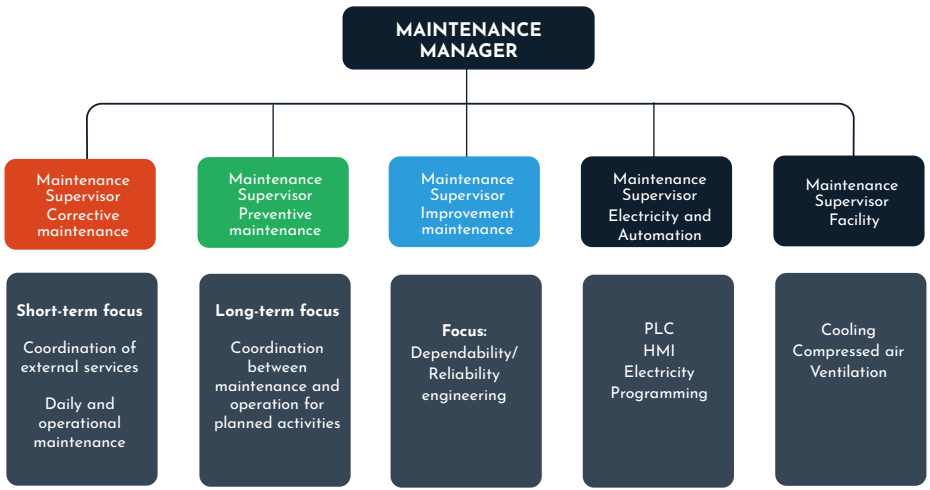
Approximate organisation (100+ people)



Based on Standard EN 13306:2017

Maintenance organisation, based on EN 13306

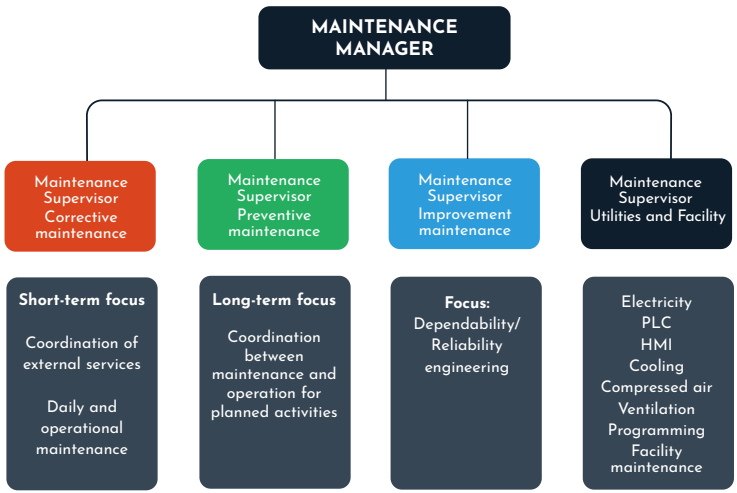
Approximate organisation (70-100 persons)



Based on Standard EN 13306:2017

Maintenance organisation, based on EN 13306

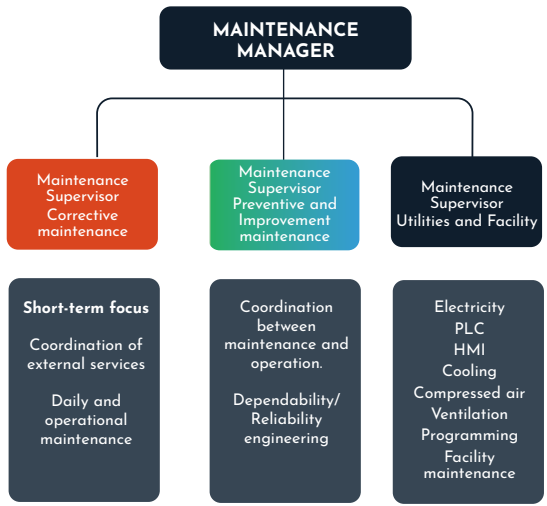
Approximate organisation (30-70 people)



Based on Standard EN 13306:2017

Maintenance organisation, based on EN 13306

Approximate organisation (15-30 people)



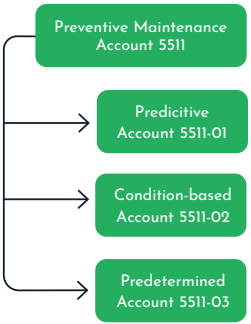
Based on Standard EN 13306:2017

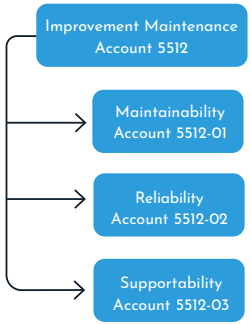
Finance

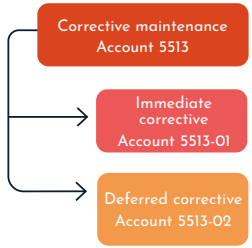
Account setup for maintenance costs

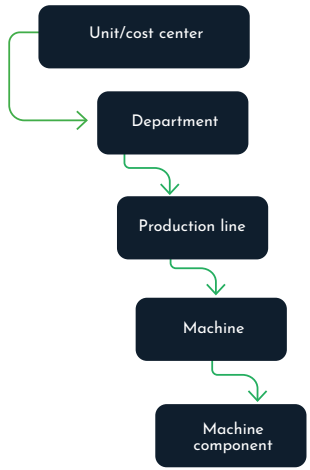
Financial follow-ups of maintenance costs are usually booked on specific accounts, which according to the BAS chart of accounts for "Maintenance of machinery and other technical installations". But it is also common in maintenance to have different accounts for other types of maintenance work, such as electrical work or mechanical repairs. In MaintMaster this is not necessary, as we can link users to different groups such as "Electrician" or "Mechanic". This allows you to easily follow up on different types of work via selection in MaintMaster. In the diagram on page 46 you can see how we link account numbers to job categories in order to make cost follow-ups for each category. By extension, this can significantly facilitate the budget work by, for example, following and/or calculating cost outcomes for the various categories per line or machine.

Account setup for maintenance costs









Based on EN 13 306 and BAS chart of accounts 2023

Goals & KPIs

Goals & Key Performance Indicators (KPIs)

The goal of maintenance should always be to increase operational and personal safety, which in turn has positive effects on availability. Operational safety depends on the combined characteristics of functional safety, maintainability and maintenance safety. These can be measured according to the following metrics:

EXAMPLES OF METRICS

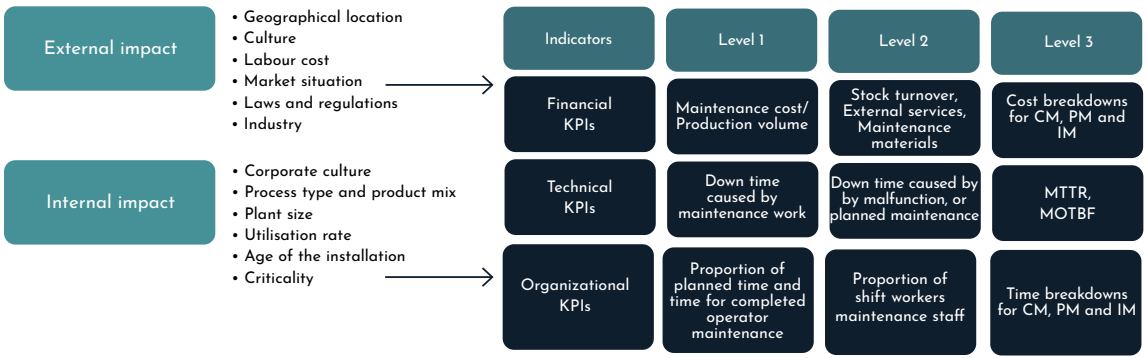
- Relationship between planned and unplanned maintenance work
- Maintenance cost divided by production volume or number of units produced.
- Number of stops per machine or line
- Downtime per object
- MOTBF: Mean Operating Time Between Failures.
- MTTR: Mean Time To Restore.
- MMDT: Mean Maintenance Down Time (MMDT).
- MWT: Mean Waiting Time.

High operational reliability provides:

- Lower maintenance costs
- Higher profitability
- More stable production
- Less loss of quality
- Lower energy costs
- Improving the working environment
- More time for improvements

KPIs: EN 15341:2007 Maintenance engineering

To effectively manage maintenance activities, it is important to measure what we do, how much and how well we do it. To do this, you need to identify a number of metrics, these are often referred to as key performance indicators (KPIs). The image below shows some examples from the standard, which contains 71 pre-defined KPIs divided into 3 categories; financial, technical and organisational indicators. Choose an overall KPI from each category that adds value to the maintenance operation over time and that all staff can relate to.



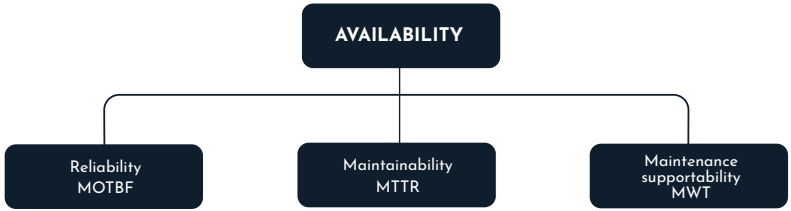
According to standard EN 13306:2017

Goals & KPIs: Dependability

According to European Standard, dependability is defined as: Dependability includes availability, safety, durability, economics, and their influencing factors (reliability, maintainability, supportability, conditions of use and operators influence).

Availibility

According to European Standard availability defines as: The ability of a unit to perform the required function under specified conditions at a given time or within a set time interval, provided that the required support functions are available. Note: Availability depends on the combined characteristics of reliability, maintainability, and maintenance supportability.

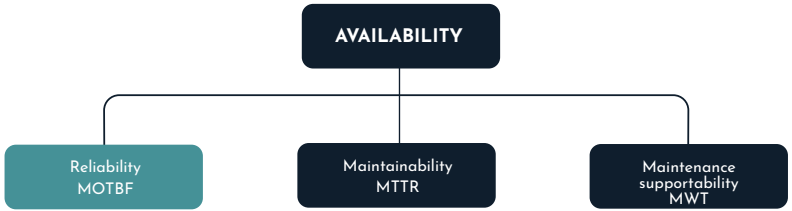


According to standard EN 13306:2017

Goals & KPIs: Reliability

Reliability
The ability of a unit to perform the required function under given conditions during a given time interval.

A measure of functional safety is the Mean Operating Time Between Failures (MOTBF). That is the time that elapses between the last corrective actions for a failure until the next failure occurs. Through regular condition checks of machines and planned actions to correct deviations, the time between failures can be increased, leading to higher functional safety.

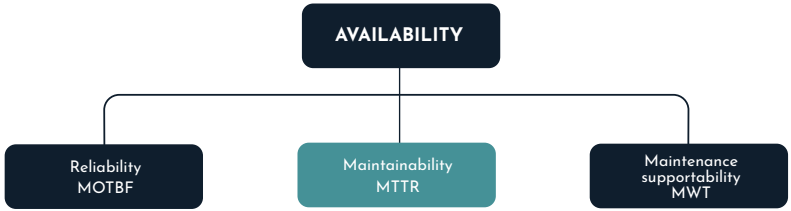


According to standard EN 13306:2017

Goals & KPIs: Maintainability

Maintainability
The ability of a unit, under given conditions of use, to be maintained in or restored to a condition that enables it to perform the required function, where maintenance is carried out under given conditions and using established procedures and resources.

An example of a key performance indicator to measure maintenance adequacy is Mean Time to Restore (MTTR). MTTR is the mean time to resolve a fault and one way to influence this can be for maintenance to be involved in the design of a new plant to ensure that wear parts are easy to replace and that the necessary resources such as lifting aids are available in the design of a machine.

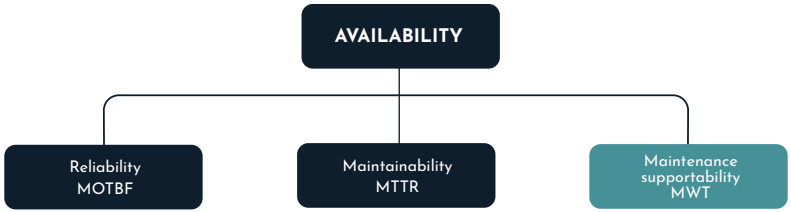


According to standard EN 13306:2017

Goals & KPIs: Maintenance supportability

Maintenance supportability
The ability of a maintenance organisation to provide the right maintenance support at the required location so that the required maintenance activity is performed when required.

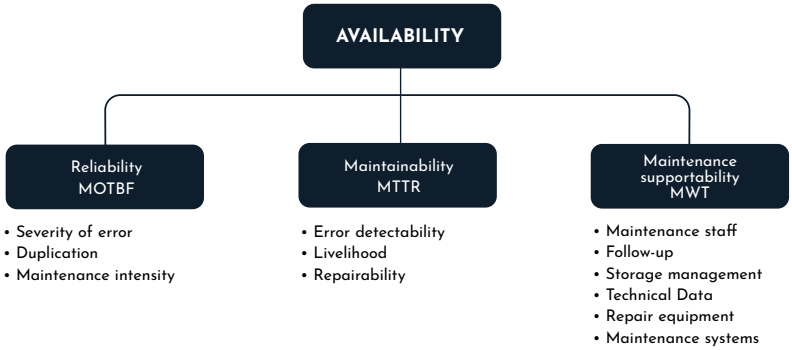
Maintenance supportability describes the ability of the maintenance organisation to provide the resources required to perform maintenance activities and can be described as the Mean Waiting Time (MWT) for a maintenance task. Some things that lead to increased maintenance safety are the planning of maintenance activities and ensuring the availability and high quality of technical documentation.



According to standard EN 13306:2017

Goals & KPIs: Dependability

Functional safety and maintainability take into account the ability of the technical system to meet dependability, while maintenance safety describes the ability of the maintenance organisation to effectively address failures. These three factors are in turn determined by a number of sub-factors and maintenance activities.



According to standard EN 13306:2017

Implementation in MaintMaster

Why do you need a maintenance system?

The management and planning of maintenance requires a systematic approach. The information that can be collected in a maintenance system provides invaluable support in planning and executing all types of maintenance activities and helps to ensure operational reliability. Regardless of the strategy, some form of preventive maintenance is always required, and for this to work, documentation, planning and follow-up are required to get the intended return on investment. A maintenance system is also the hub for all the information a maintenance technician or planner needs. What has been done previously, which spare parts are suitable, have we carried out inspections according to routine, what deviations have we found?

In MaintMaster, job categories and codes are customised according to standard EN 13306. This enables easy monitoring and value-adding decision-making.

MAINTENANCE ACCORDING TO EUROPEAN STANDARDS

In order to make correct analyses, it is necessary that the staff report in the same way and that they understand what the different definitions mean in the maintenance system. MaintMaster is adapted to the *EN 13306 Terminology for maintenance*, where it is clear what the different terms mean. The following pages show different terms and concepts in the standard with an explanatory text and how this is implemented in MaintMaster.

Job categories, completion code groups and completion codes in maintmaster

Adapted to standard EN 13306

Job category	CORRECTIVE MAINTENANCE	PREVENTIVE MAINTENANCE	IMPROVEMENT MAINTENANCE	MODIFICATION/ PROJECT	CASE MANAGEMENT
Completion code group	• Urgent Remediation • Deferred Remediation	• From routine	• Reliability improvement	• Function change	• Administration/tasks
Final code	• Lack of maintenance • Handling • Wear and tear defects • Aging error • Failure mechanism • Secondary error • Production support • No error was detected	• Status ok • Deviation identified • Deviation identified & resolved • Status ok (change routine)	• Functional safety • Maintenance safety • Maintainability	• Quality • Speed • Product customisation • Personal security • Environment • Reconstruction	• Services • Working environment • Purchasing & storage • Production support • Skills development • Planning & scheduling • Organisational
Xp field (Value list)		FU-TYPE • Authorisation control • Predetermined maintenance • Predictive maintenance • Operator maintenance	IMPROVEMENT TYPE • Rebuilding • Rotor axis analysis	PROJECT TYPE • Change • New Installation • Layout change	TYPE OF CASE • Meeting • Task • Order • Suggestions for improvement
Priority	• Operation stop • Failure to operate • Errors & breaks	Normal handling	Normal handling	Normal handling	Normal handling

Work order flow (example)

Fault Report
To report faults, you call maintenance directly, and who answers is governed by current procedures. The customer then creates a fault report in the maintenance system by clicking on the "Corrective Maintenance" button and selecting the priority of the job, as explained below. The order is then forwarded to the respective area manager for further processing. The recipient of a fault report must always ask the customer if a fault report is registered in the maintenance system. In cases where the orderer cannot or feels uncertain, the responsible technician or manager shall assist in handling a fault report. This can be done afterwards when the fault in question has been rectified, but the basic principle is that jobs should only be carried out in exceptional cases unless an order has been placed in the maintenance system.

Recipient of the fault report
The person in charge of the relevant line, area or equipment is responsible for the planning, execution and reporting of these jobs.

Cancellation of work orders
After completing the maintenance operation, the job must be reported immediately with the time taken and a simple analysis of the action taken to correct the problem. In the case of emergency measures using the job category "Corrective maintenance" and the completion code group "Emergency corrective maintenance", you must also state how much downtime the fault in question has caused before the job is completed in MaintMaster.

Work order flow (example)

Ordering other jobs and cases

The job category "Case management" is used in the same way as above but with the difference that it is only used for ordering other types of cases that do not relate to a fault report, such as improvement suggestions and work orders. For all other job categories we normally use the priority "Normal processing".

PRIORITY LEVELS FOR FAULT REPORTING (JOB CATEGORY "CORRECTIVE MAINTENANCE")

Breakdown – The machine is at a standstill, the fault needs to be rectified immediately.

Production failure – The machine is working but perhaps not very well.

Errors & Deficiencies – For handling deviations and things that do not directly affect operations but should be handled.

Completion code groups: Corrective Maintenance

Completion code group: Immediate corrective maintenance

Maintenance performed immediately after a defect has been detected in order to avoid unacceptable consequences.

The machine is down, fix now! Downtime must always be specified following completion with this completion code group.

Completion code group: Deferred corrective maintenance

Corrective maintenance that is not carried out immediately after the detection of a malfunction but is deferred in accordance with the given maintenance directives.

The machine works, but not very well. The job can be scheduled for a later date.

Tips

Always strive to move actions from unplanned to planned maintenance activities. Initially, this is the fastest way to achieve higher reliability and more efficient maintenance work.

According to standard EN 13306:2017

Completion codes for completion code group:
Emergency and deferred corrective maintenance

The following completion codes are used in this example to indicate the reason why an error has occurred.

Lack of maintenance
Defects arising from improper or unperformed maintenance.

Handling
Errors resulting from improper handling of equipment or machinery.

Wear and tear faults
Faults whose probability of occurrence increases with the operating time or the number of completed work cycles or the load to which a unit is subjected.

Ageing errors
Faults whose probability of occurrence increases with time. This time is independent of the operating time of the unit.

Error mechanism
Physical, chemical or other process that leads to or has led to failure. e.g. design failure, incorrect choice of materials or method failure.

Secondary error
Failure of a unit directly or indirectly caused by the failure of another unit, e.g. power failure, loss of compressed air, etc.

Production support
Used for reporting support services to production that are not directly maintenance related, such as assistance with changeover or machine start-up.

No fault was detected
Completion code for those occasions when no fault can be found. Can be used, for example, when a "loose contact" is suspected and when restarting or resetting equipment. The error cannot be recreated.

According to standard EN 13306:2017

Completion code group and completion codes: Preventive Maintenance

Completion code group: Prevention according to routine
All maintenance activities regarding preventive maintenance are completed with the completion code group "Preventive according to routine", followed by one of the following completion codes to facilitate the follow-up of completed R&M activities.

According to standard EN 13306:2017

Status OK
Action or inspection is carried out according to plan/ instruction and the equipment is in a satisfactory condition and authorised for continued use.

Deviation identified
Control is carried out according to instructions and deviation is identified. Deviation management is planned and managed via follow-up jobs.

Deviation identified and corrected
Control is carried out according to instructions and a minor deviation is identified. Minor non-conformities can be addressed directly without a follow-up job, as the follow-up of these actions does not add much value.

Status OK (change routine)
The equipment is in good condition and approved for continued use but the routine or intervals need to be adjusted in the original job.

Property to indicate the type of preventive maintenance

By using a property with a value list as shown below and which is linked to the job category "Preventive Maintenance", it is easy to specify when setting up a new recurring preventive maintenance whether the job in question is, for example, predetermined or authorisation-based.

Create a Property in MaintMaster of type Value list with the name Type of RD action. Fill in the following optional values.

Predetermined maintenance
Preventive maintenance carried out at specified intervals or after a specified use but without prior authorisation.

Authorisation-based maintenance
Preventive maintenance which consists of checking and monitoring the condition of a unit in terms of its operation and characteristics.

Predictive maintenance
Maintenance action following a condition-based maintenance, when a prediction of a unit's deteriorating performance based on analysis and evaluation of key characteristics is made.

Operator maintenance
Maintenance carried out by the user or operator of the machinery

According to standard EN 13306:2017

Completion code group and completion codes: Improvement Maintenance

Completion code group: **Reliability improvement**
The completion codes below are used to indicate the purpose of the improvement work.

Functional safety
Ability of a unit to perform the required function under given conditions during a specified time interval.

Maintainability
The ability of a unit, operating under specified conditions, to be maintained in, or restored to, a state capable of performing the required function when maintenance is performed under specified conditions and using established procedures and resources.

Maintenance safety
The ability of the maintenance organisation to provide the right maintenance resources at the required location, to perform required maintenance actions on a unit, at a specified time or during a specified time interval.

According to standard EN 13306:2017

Completion code group and completion codes: Modification

Completion code group: Function change
The completion codes below are used to indicate the purpose of a completed modification.

Quality
For reporting back an action where the purpose is or has been to improve the quality output of a machine or equipment.

Speed
For reporting back on an action where the purpose is or has been to improve the speed or cycle time of a machine or equipment.

Product customisation
Used to report back an adaptation or adjustment of a piece of equipment for example for a new product or packaging.

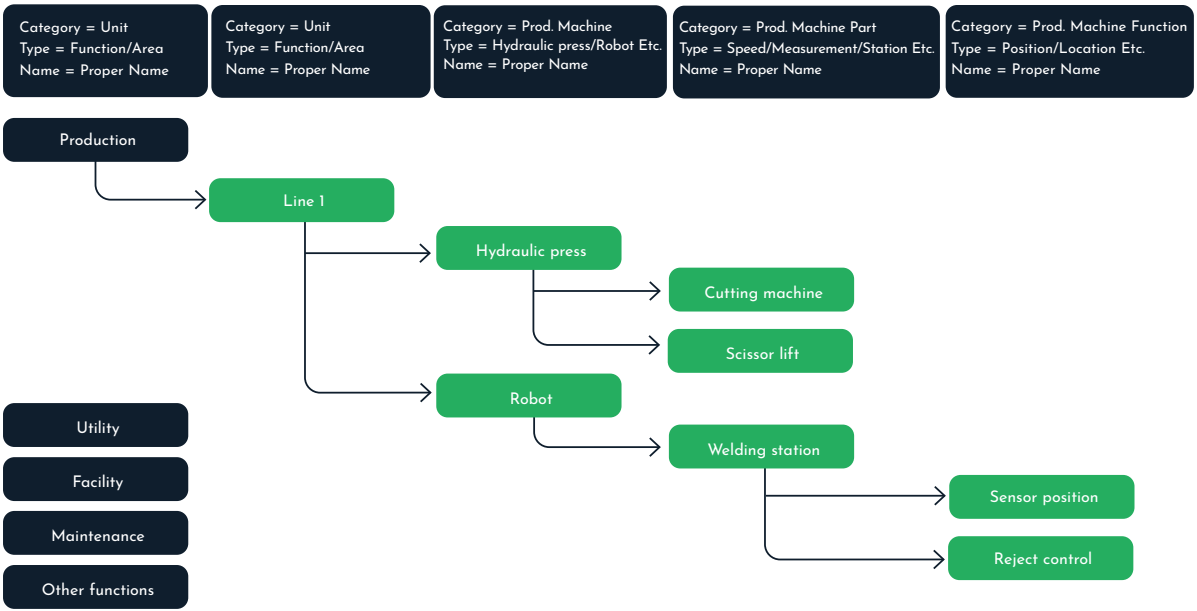
Personal security
Used to report back on cases where the aim is to improve personal safety. Including ergonomic improvement activities.

Environment
For reporting environmental improvement cases.

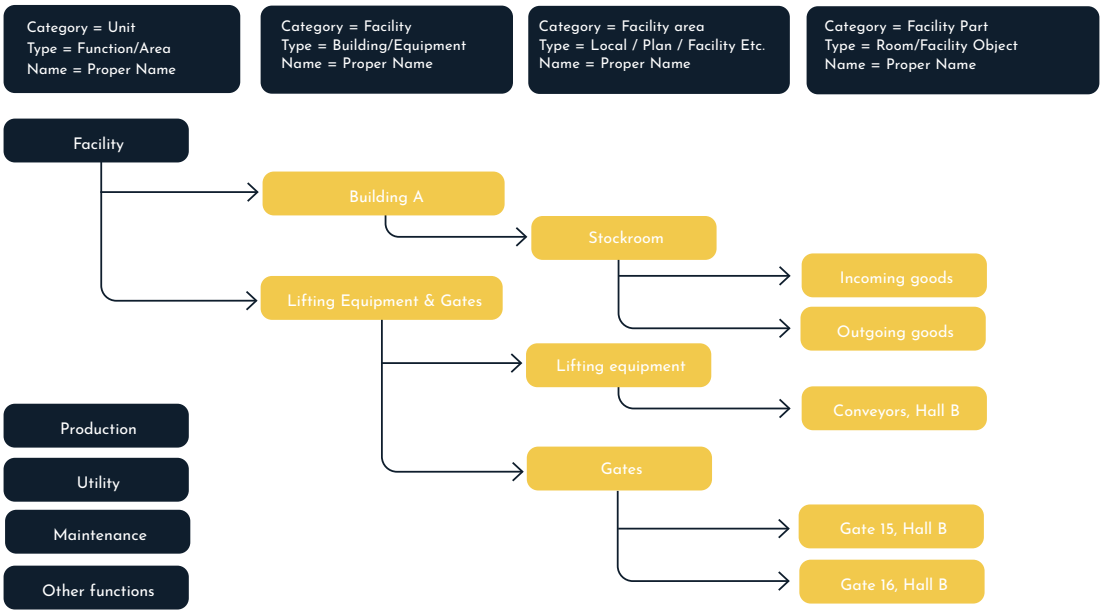
Manufacturing
Manufacture of new machinery, tools or spare parts.

According to standard EN 13306:2017

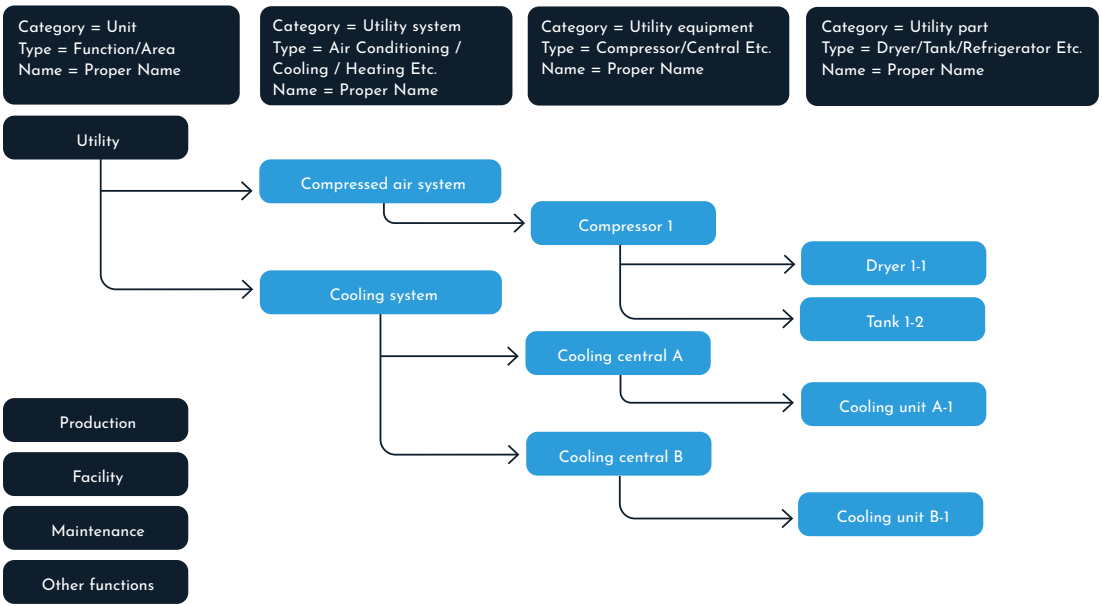
Build your tree: Production (green icons)



Build your tree: Facility (yellow icons)



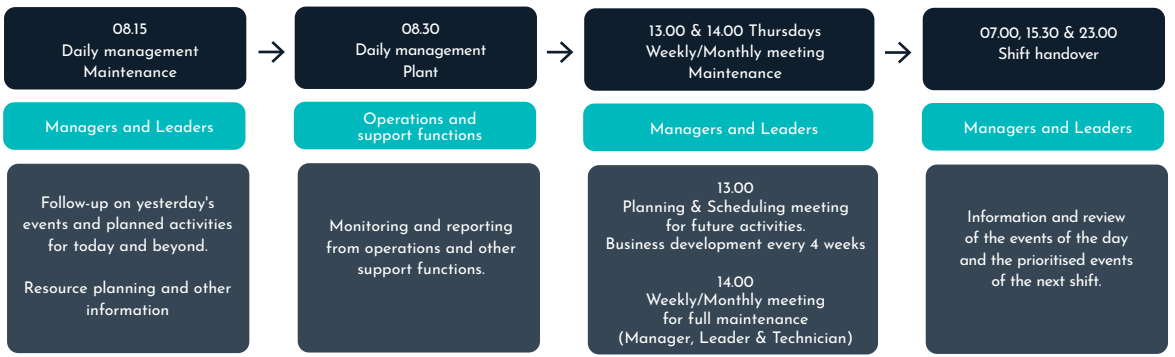
Build your tree: Utility (blue icons)



Planning & Scheduling

Daily management

Follow-up of past events and daily management of planned activities or newly emerged problems is an important part of the maintenance organisation's everyday life in order to maintain a functioning dialogue between different teams. Establish an agenda for each meeting and think about who should attend each meeting. Feel free to use a white board or a summary page with selections in MaintMaster to visualise which activities are ongoing or recently completed. Below is an example of a meeting structure that not only includes daily management but more a basic planning for several different recurring meetings in a maintenance organisation. If you do not have a meeting structure in place, a tip is to start on a small scale with a morning meeting every day and then build on the process.



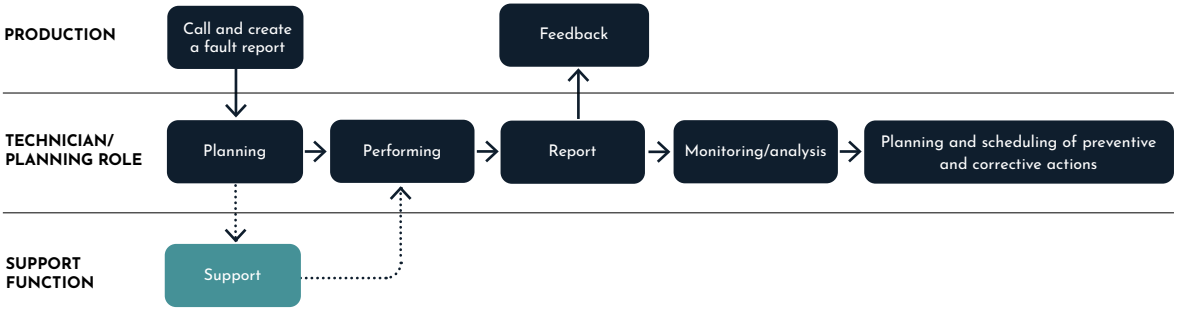
Preparation of maintenance activities

In order to ensure efficient and safe preventive maintenance at a good quality, it is very important that these activities are prepared in terms of spare part requirements, time and other necessary resources needed to carry out the action without unnecessary delays.

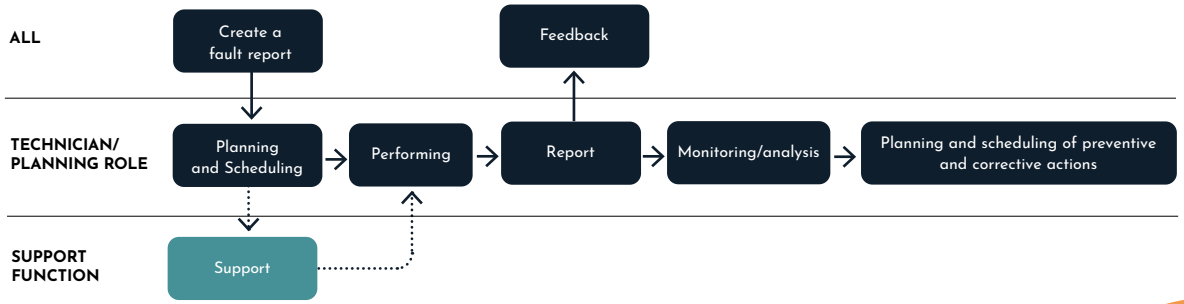
Some of the steps in the preparation process are:

- Registration and updating of asset records including image navigation in the maintenance system.
- Decision and recording of spare parts to be stocked and linking them to items in the maintenance system.
- Organisation of spare part needs and time for recurring maintenance activities, including operator maintenance.
- Development of instructions for preventive maintenance.
- Labelling of equipment in the form of inventory numbers and lubrication points, etc.
- Recording changes to machinery and equipment and updating related maintenance documentation.

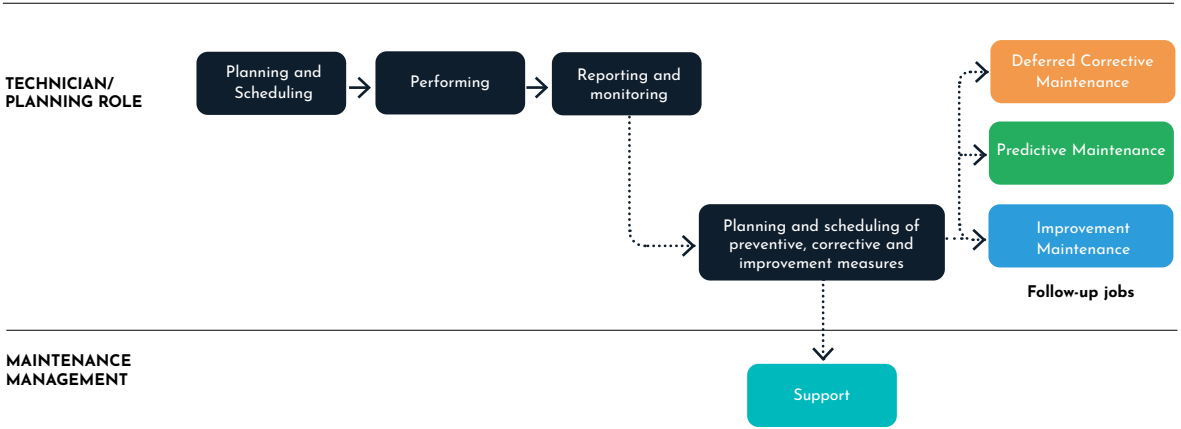
Immediate corrective maintenance



Deferred corrective maintenance



Preventive maintenance



Spare Parts Management

Spare parts management

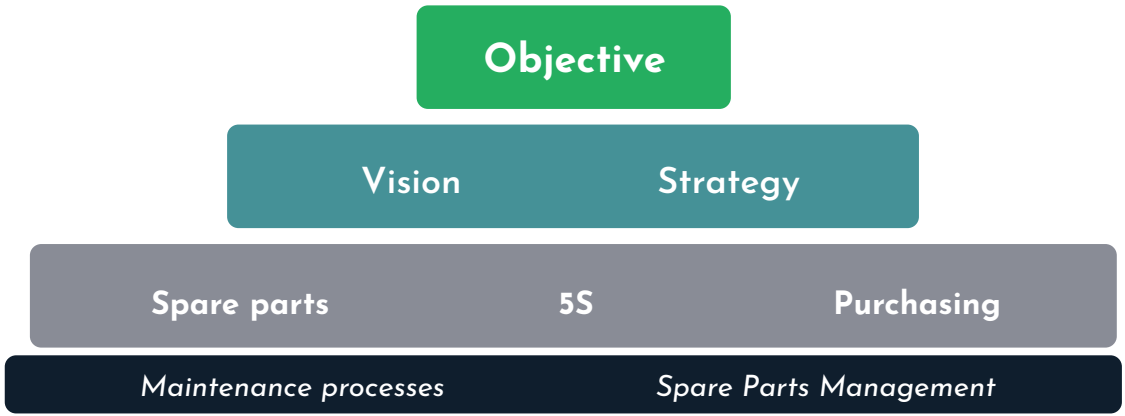
Spare parts management is about how spare parts should be systematised and structured to enable efficient inventory management that will lead to increased operational reliability and reduced tied-up capital.

When maintenance is performed, it often involves some form of material consumption. A breakdown often causes major problems and can be further exacerbated if spare parts are not available.

Without spare parts, there is a risk of downtime, which can lead to lower quality of the goods produced, hazardous emissions and danger to staff. This usually means building up an inventory of a large number of spare parts, which often leads to a large amount of capital being tied up. Another reason can be that it is often difficult to plan the consumption of spare parts as they have a varying demand. It is therefore important to have a good system for stocking spare parts. This reduces the risk of production stopping and simplifies the maintenance of the equipment. The aim of spare parts management is to minimise the total cost of ownership.

The total cost includes costs for storage, administration and various forms of shortage costs.

Spare parts management



The pyramid shows the different main processes of spare parts management

Spare parts management: Vision

Selected methods, systems and all employees will work together to achieve a cost-effective spare part stock.

We have clear and concrete key figures that reflect our success in implementing working methods and costs in the stockroom.

Spare parts management is a strong contributor to increased reliability in production.

We work in a structured manner and have good order and tidiness in all storage areas, where the labelling of articles is also clear and functional.

Spare parts management: Strategy

Our spare part strategy is based on secure access to the right spare parts at the right time. Not all spare parts always.

Items are registered and linked to objects in the maintenance system by technicians. Consumable and insurance spare parts withdrawals are recorded directly against jobs in the maintenance system.

To optimise inventory, we conduct needs assessments and classify items to determine whether spare parts should be kept in stock or procured when needed.

Objectives and key performance indicators for spare parts management

The aim of spare parts management is to keep the total cost of maintaining spare parts as low as possible, without compromising operational safety in any way.

High operational reliability requires that spare parts are available or that the delivery time is as short as possible. If faults do occur, it is important to find and rectify them as quickly as possible. The total cost includes costs for inventory, administration and various forms of shortage costs.

SOME EXAMPLES OF KPIs WE CAN USE TO MEASURE SPARE PARTS MANAGEMENT ARE:

- Stock value and quantity
- Number of emergency orders
- The value of discarded material
- Total cost (storage cost + shortage cost)
- Downtime (Depending on lack of spare part)
- Warehousing cost
- Turnover rate (Excluding insurance reserves)
- Inventory value / Insurance value of the installation

Spare parts management

Assessing the need for spare parts

Maintenance activities often imply a need for replacement parts to be available in the stockroom. Therefore, to avoid unnecessary production downtime caused by long lead times, selected spare parts should be kept in stock. Items are registered and linked to objects to reduce lead times when ordering. For recurring maintenance activities such as predetermined maintenance, spare parts should be ordered for the planned event instead of being kept in stock. Costs for stockpiling should be weighed against costs arising from shortages, but there are several other elements to take into account in order to make a proper needs assessment.

EXAMPLES OF DATA FOR NEEDS ASSESSMENTS:

- Consumption statistics
- Supplier co-operation
- Commitment from maintenance technicians and management
- Classification of spare parts

Assessing the need for spare parts

Classification of spare parts

To make it easier to optimise the stock, items could be divided into the following classes:

CONSUMABLES

- **Items that cannot be considered as a spare part and may have a high consumption or low value.**

CONSUMABLE SPARE PARTS

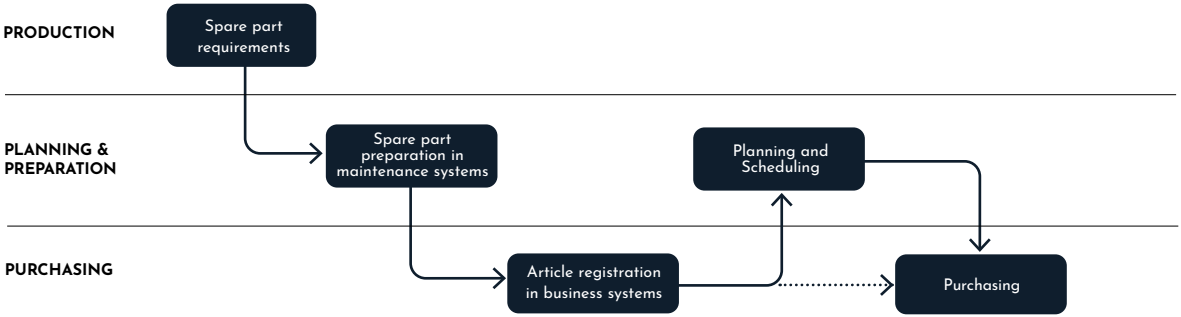
- Standard items such as sensors, cylinders and valves that can be used on several types of equipment, often with a lower value and a short lead time.

INSURANCE SPARE PARTS

- Spare parts that are kept in stock to avoid long and costly downtime. These can be expensive and often have a long lead time.

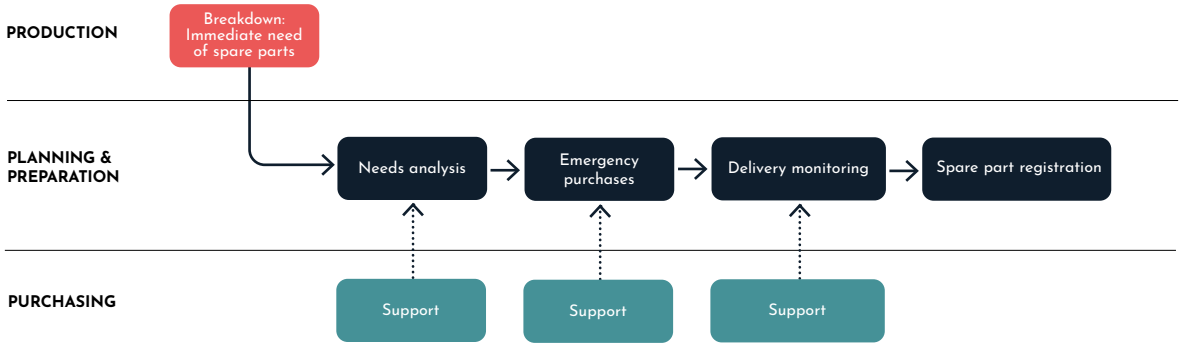
Spare part preparation and registration

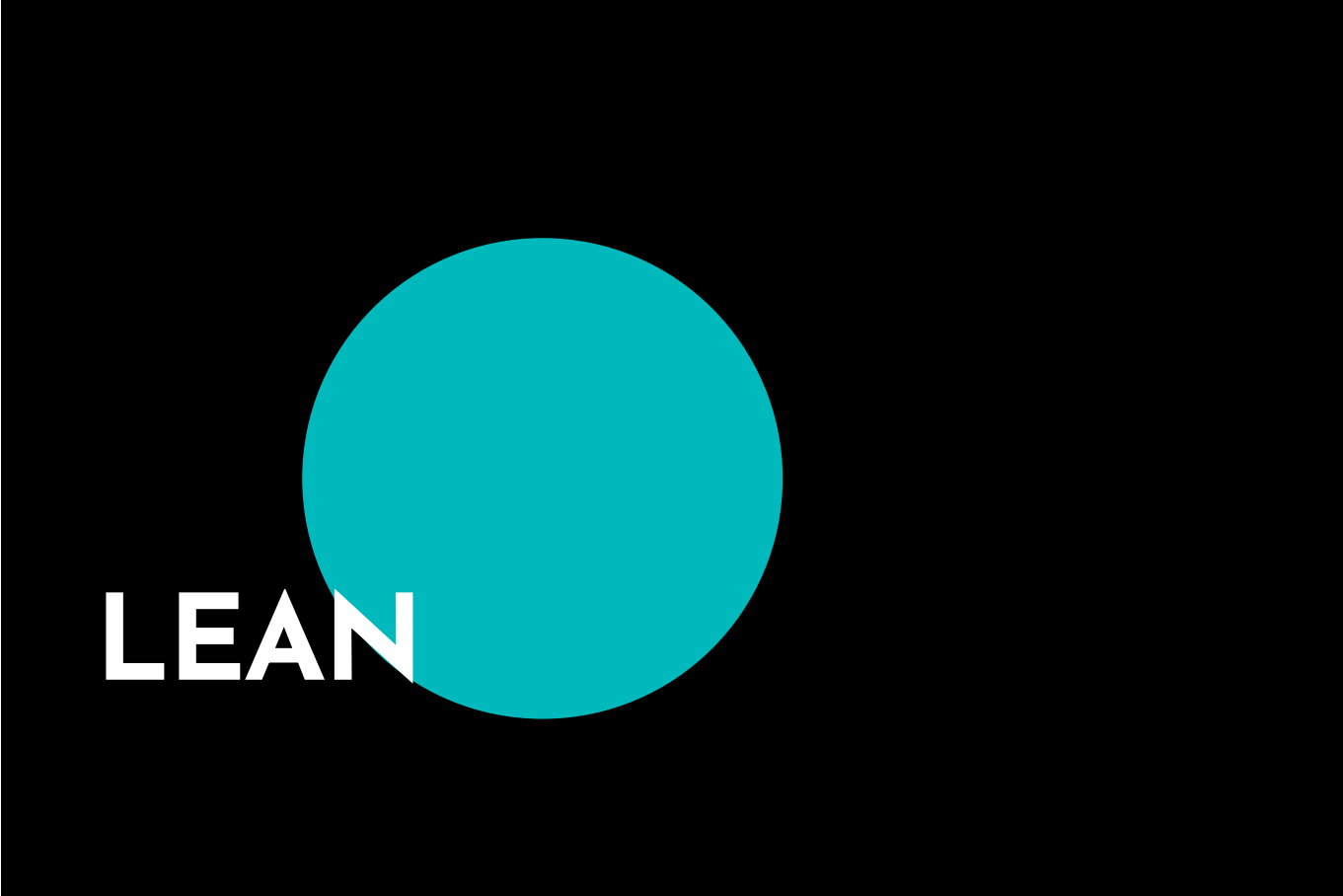
The process map below shows the responsibilities and procedures for registering and purchasing spare parts in a normal situation. The preparation manager or technician is responsible for ensuring that spare parts preparation is carried out for the line or equipment within their given area of responsibility. Support for this work may be called upon from maintenance management.



Immediate spare part need (non-stock item)

The process map below shows the responsibilities and procedures for registering and purchasing spare parts in case of an emergency. The responsibility for an emergency purchase lies with the maintenance or department manager, fact finding and ordering is delegated to the maintenance technician who can invoke the support of the maintenance management.

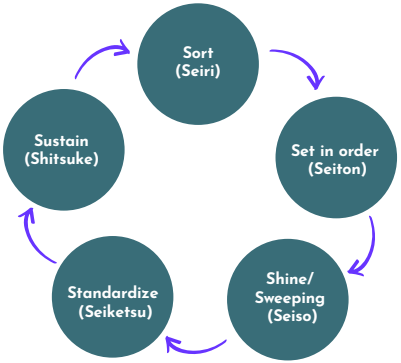



LEAN

LEAN - 5S

5S is a method for creating and maintaining an efficient, safe and orderly workplace. 5S can be introduced equally well in an office or in production and is based on everyone's participation. 5S comes from five Japanese words, which have been translated into English, see explanation below.

A well-organised workplace makes work easier and significantly reduces the risk of injury. It also increases opportunities for better maintenance and reduces waste such as long changeover times and rejects. Above all, it makes for a more pleasant workplace and a more stable process.



Systematic Work Environment Management

Systematic work environment management

Safe maintenance work

Maintenance aims to reduce disturbances and interruptions in production, and according to the Work Environment Act, the work must be planned and organised so that it can be carried out in a healthy and safe environment. Even extraordinary work, such as repairs due to a machine breakdown, must be planned and prepared so that it does not pose a risk to maintenance technicians or people in the vicinity. Machinery, equipment and other technical devices must be designed, positioned and used in such a way as to provide adequate protection against ill health and accidents.

Coordination responsibilities

A contractor's activities always have a client within the organisation, and it should be established who has the coordination responsibility for the work carried out by a subcontractor. The coordinator must schedule the work and ensure that the responsibility for protective devices, barriers and other protective measures, such as hot work is clearly divided between the client and the contractor. Communication and joint planning are needed to reduce the risks that may arise during ongoing maintenance work. The client of the service is also responsible for ensuring that the contractor has knowledge of and complies with all applicable regulations.

Notes

Notes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