MAINTENANCE MANAGEMENT

INTRODUCTION TO MAINTENANCE

CONCEPT

HISTORY AND EVOLUTION

TYPES

PHYSICAL ASSETS MANAGEMENT

EUROPEAN REGULATION

BUILDINGS FACILITIES AND REGULATIONS

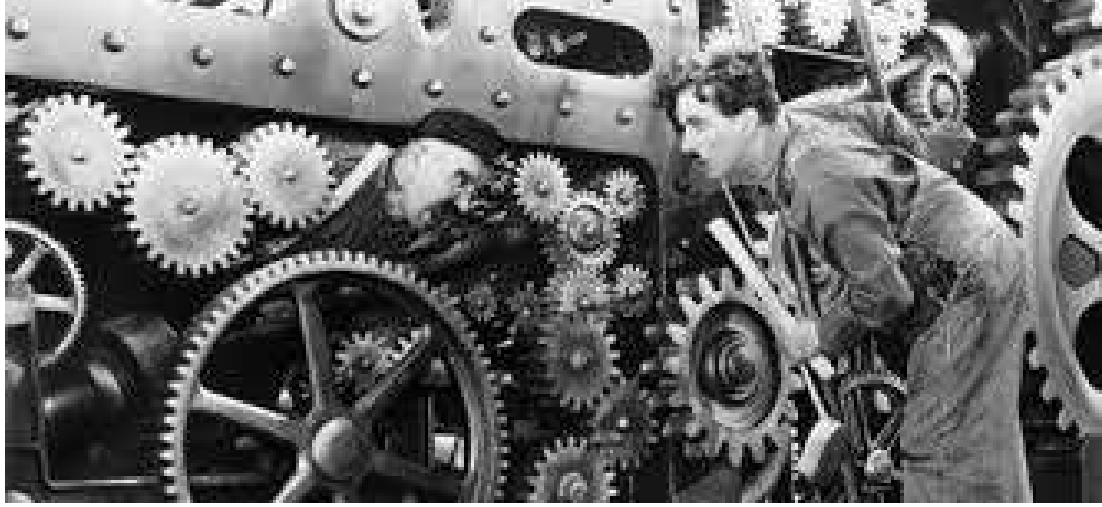
TIPS

MIGUEL LÓPEZ RÍOS
Industrial Engineer
mlopezrios@coiico.com
Project Designer / Planning / Management
Consultancy / Training

SHEng
SMART HEALTHCARE ENGINEERING
2023-1-RO01-KA220-HED-000159985
Co-funded by the European Union

INTRODUCTION TO MAINTENANCE

CONCEPT



MAINTENANCE IS SOMETHINGTHAT…

"WHEN EVERYTHING IS GOING WELL, NOBODY REMEMBER THAT EXISTS.

WHEN EVERYTHING IS GOING BAD, THEY SAY IT DOESN'T EXIST.

WHEN IT' MEANS SPENDING, THEY SAY IT'S NOT NECESSARY.

BUT WHEN IT REALLY DOESN'T EXIST, EVERYONE AGREES THAT IT SHOULD EXIST."

UNE

UNE-EN 13306

Maintenance

July 2018

Maintenance terminology

2 Fundamental terms

2.1
maintenance
combination of all technical, administrative and managerial actions during the life cycle of an item intended to retain it in, or restore it to, a state in which it can perform the required function

Maintenance is above all a human team, well trained and equipped with the necessary technical means to maintain, above certain limits, the availability of the equipment and facilities that must ensure the production of a company under well-defined conditions of Quality, Cost and term, complying with current Safety, Regulatory and Environmental standards.

INTRODUCTION TO MAINTENANCE

CONCEPT

PLAN GOALS AND OBJECTIVES MEASUREMENTS REPORTS

2 Fundamental terms

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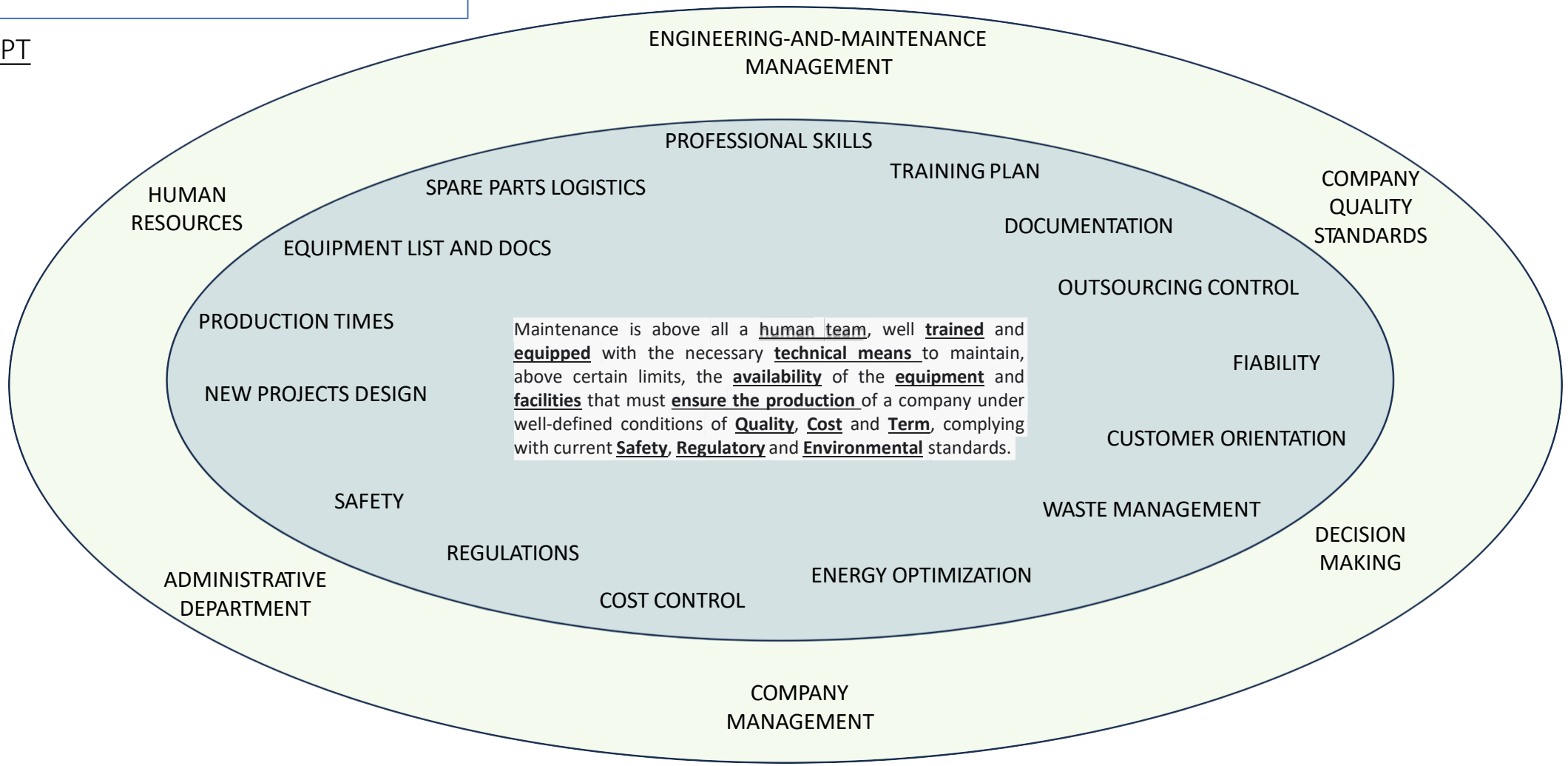

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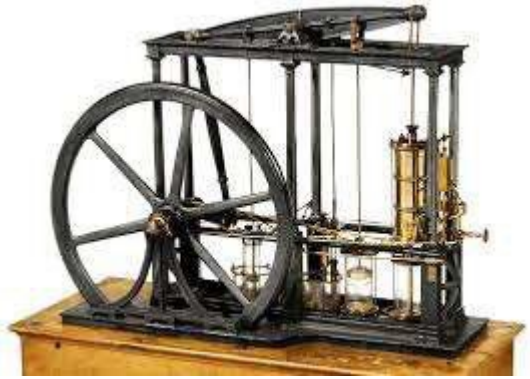


Henri Fayol
1841-1925

Frederick Winslow Taylor
1856-1915

Henry Ford
1863-1947

HISTORY AND EVOLUTION

INDUSTRIAL REVOLUTION (c. XVIII)
- Simple mechanical machines. Relaibilty and easy solutions.
- Production stops / Population density.
- **Reactive maintenance**. Non structured maintenance.
- Machine **users self repair**.

FIRST WORLD WAR (1914-1918)
- Fast and continuos production.
- Maintenance teams.
- **Corrective Maintenance**.

SECOND WORLD WAR (1939-1945)
- Realibilty.
- More complex machines and systems.
- **Preventive Maintenance** concept.
- Scheduled Maintenance to prevent unexpected failures.

COMPETENCE AND JAPAN (50s - 90s)
- Quality involved.
- Competitive market.
- Electronic components.
- **Predictive Maintenance**. Condition monitoring.
- Risk Evaluation. Decission making.
- Performed when necessary rather than scheduled.
- Maintenance Planning and Management.

NOW AND FUTURE
- Internet of Things.
- Big Data Analysis.
- **Prescriptive Maintenance**.
- Artificial Intelligence.

ADMINISTRATIVE MANAGEMENT

SCIENTIFIC MANAGEMENT

ASSEMBLY LINE

STADISTIC CONTROL

PDCA

QUIALITY MANAGEMENT

JIT

TPM

TPM

TQM

CMMS

BIM

Seiichi Nakajima
1919-2015

Walter Andrew Shewart
1891-1967

Taiichi Ohno
1912-1990

William Edwards Deming
1900-1993

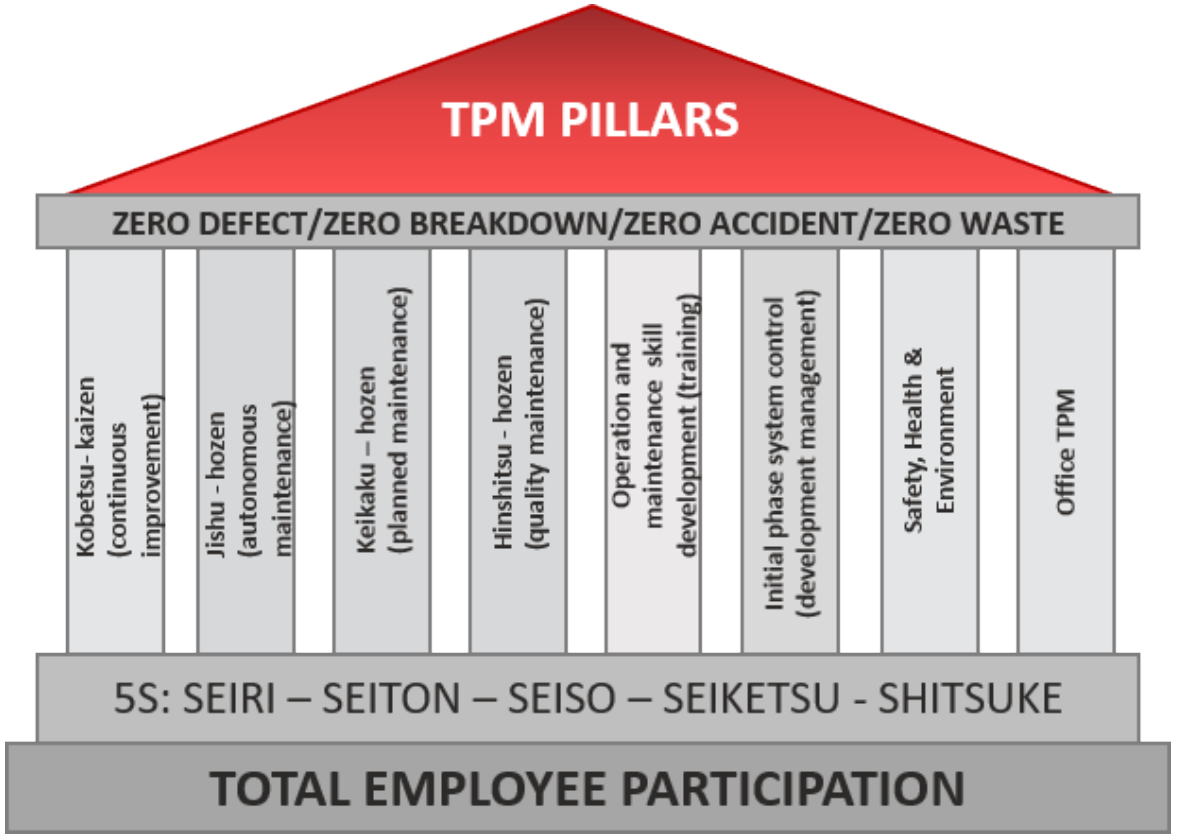
MAINTENANCE ENGINEERING

UNE-EN 17666

Maintenance
Maintenance engineering
Requirements

INTRODUCTION TO MAINTENANCE

HISTORY AND EVOLUTION



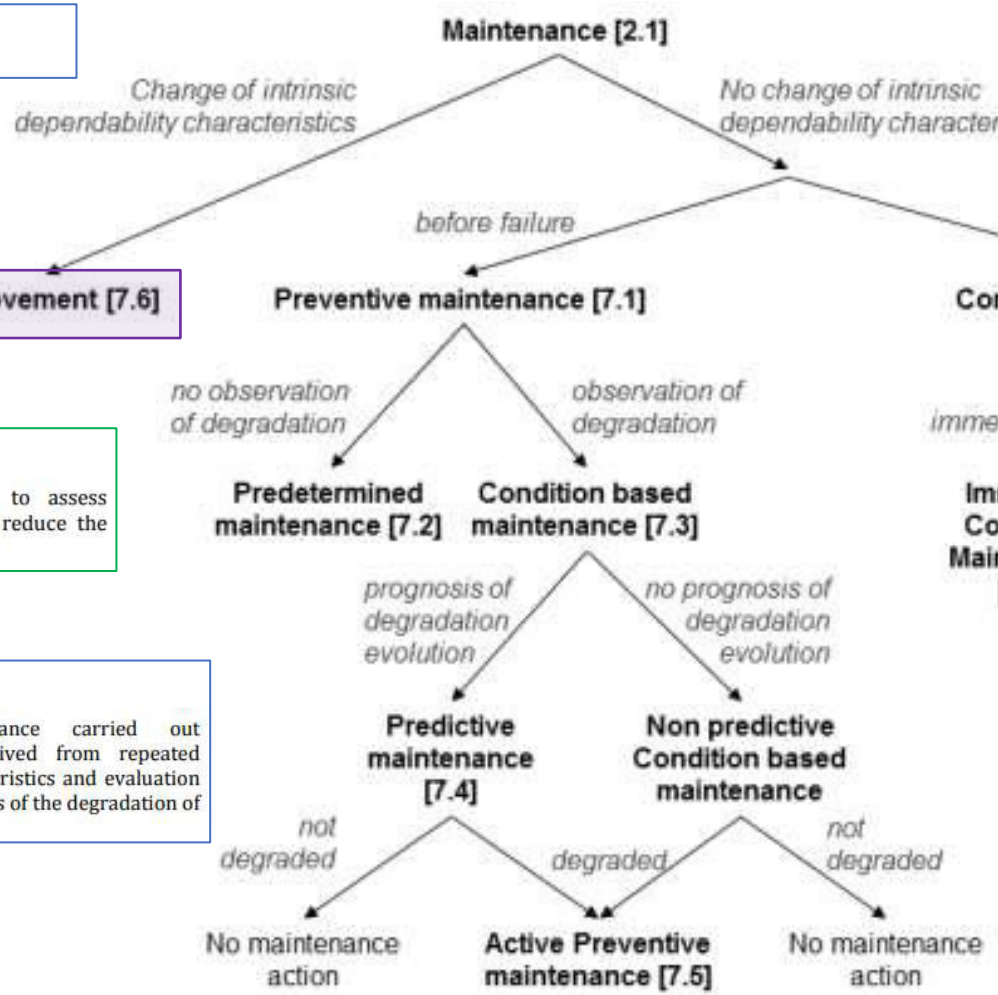
SEIRI / Sort: eliminate anything that is not truly needed in the work area
SEITON / Straighten: organize the remaining items
SEISO / Shine: clean and inspect the work area
SEIKETSU / Standardize: create standards for performing the above three activities
SHITSUKE / Sustain: ensure the standards are regularly applied

TPM

5 foundations
8 pillars
4 goals

INTRODUCTION TO MAINTENANCE

TYPES

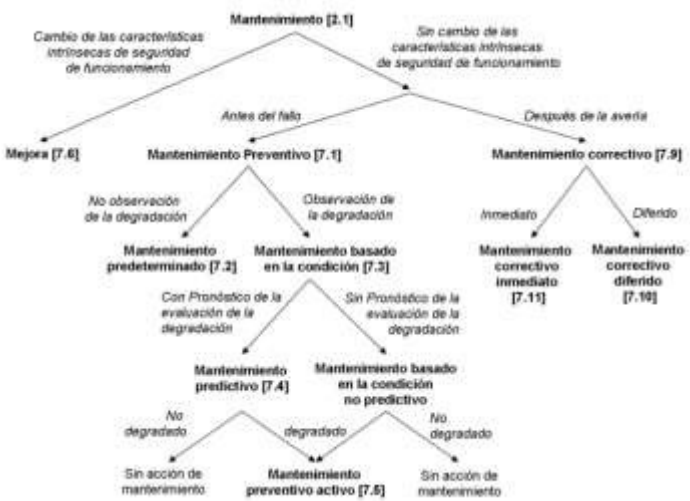


7.1
preventive maintenance
maintenance carried out intended to assess and/or to mitigate degradation and reduce the probability of failure of an item

7.4
predictive maintenance
condition-based maintenance carried out following a forecast derived from repeated analysis or known characteristics and evaluation of the significant parameters of the degradation of the item

7.9
corrective maintenance
maintenance carried out after fault recognition and intended to restore an item into a state in which it can perform a required function

Figure A.1 — Maintenance types



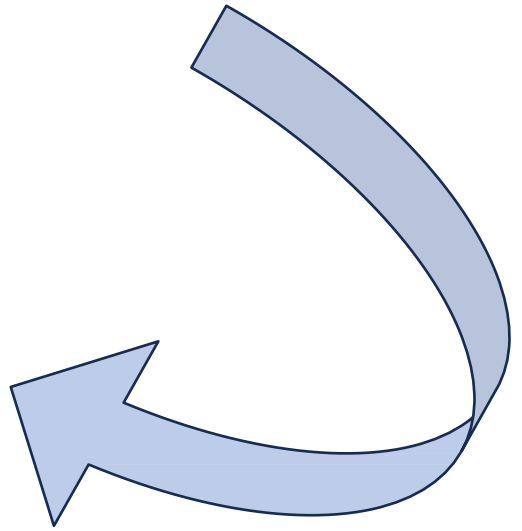
INTRODUCTION TO MAINTENANCE

TYPES

7.9
corrective maintenance
maintenance carried out after fault recognition and intended to restore an item into a state in which it can perform a required function

When we only perform corrective maintenance, the term "maintenance" is synonymous with "repair". This does not mean that this type of intervention cannot exist, in fact the ultimate goal of all types of maintenance is to repair or replace damaged components, with the aim of extending the useful life of the machine, and for this corrective interventions are inevitable. . But it is a mistake to focus all maintenance actions on this sole purpose

- Unexpected stops that normally occur when production must be higher.
- Catastrophic shutdowns, as significant damage may occur. Sometimes due to the loss of a bearing we can have serious breakages in the transmissions.
- Their repair costs become very high.
- The need to have spare parts in stock increases due to the uncertainty of what may fail.
- The risks of accidents increase.
- We are completely unaware of the state of our machines.
- We treat chronic failures as common without discovering the origin of the problema.



INTRODUCTION TO MAINTENANCE

TYPES

7.1
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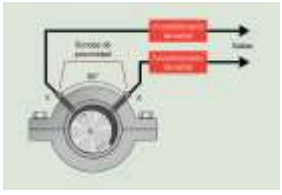
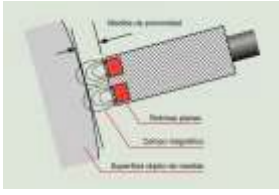
A step forward is represented by preventive or scheduled maintenance, which is based on the replacement of components when we assume that their life has been exhausted. The theoretical study of their lives is usually provided by the equipment manufacturer, who normally provides a preventive maintenance guide, indicating **component replacement** and **lubrication intervals**.

On the other hand, preventive maintenance also has a series of **drawbacks**:

- The main one lies in intervening on a machine that is working correctly, simply because it´s time to be serviced.
- When we act on the machine, we change components that are normally in good condition and we do not know their real state until we dismantle them.
- We can change components that have exhausted their theoretical life and not see others that are in poor condition. We have no control over hidden damage.
- Regarding its cost, it can skyrocket as a result of frequent interventions on the machines, many of them unnecessary.

INTRODUCTION TO MAINTENANCE





TYPES

- Vibration análisis
- Infrared thermography
- Visual inspection
- Oil análisis
- Ultrasounds
- Laser alignment
- Analysis of dissolved gases
- Analysis of motor currents
- Insulation test

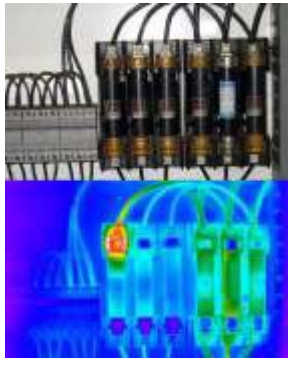
The basis of predictive maintenance lies in the monitoring of the equipment, since we must evaluate the parameters mentioned above with the installation in normal operation. It is not, therefore, necessary to make a stop to evaluate their condition, we know the status of our machines while they are working

7.4
predictive maintenance
condition-based maintenance carried out following a forecast derived from repeated analysis or known characteristics and evaluation of the significant parameters of the degradation of the item

It essentially consists of the study of certain variables or parameters related to the state or condition of the equipment we maintain. The study of these parameters provides us with information on the state of its components and, also very important, on the way in which said equipment is functioning, allowing us not only to detect component problems but also design and installation problems. The objective of predictive maintenance is to reduce operation and maintenance costs by increasing the reliability of the equipment.

Predictive maintenance actions go through initial drawbacks of high investment costs in technology and training, with profitability in the medium and long term. But the advantages are obvious:

- We know the status of the machine at all times.
- We eliminate the vast majority of breakdowns.
- We only stop or intervene in the machine when it is really necessary.
- We know the damage to the components from an initial phase of deterioration, allowing us to schedule their replacement at the most convenient time.
- By intervening on the machine we know the problem, shortening the repair time.
- We can identify hidden failures as well as the root cause of chronic failures.
- We reduce the number of spare parts in the warehouse, acquiring them only when we detect the problem in an initial phase.
- We get bonuses on insurance premiums.
- We increase the safety of the plant



INTRODUCTION TO MAINTENANCE

TYPES

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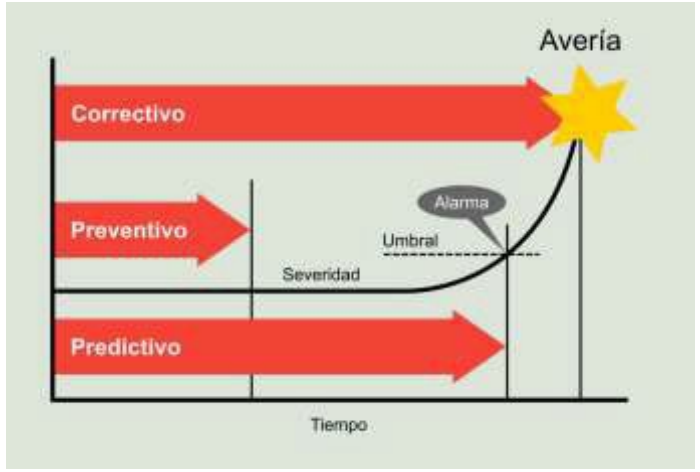
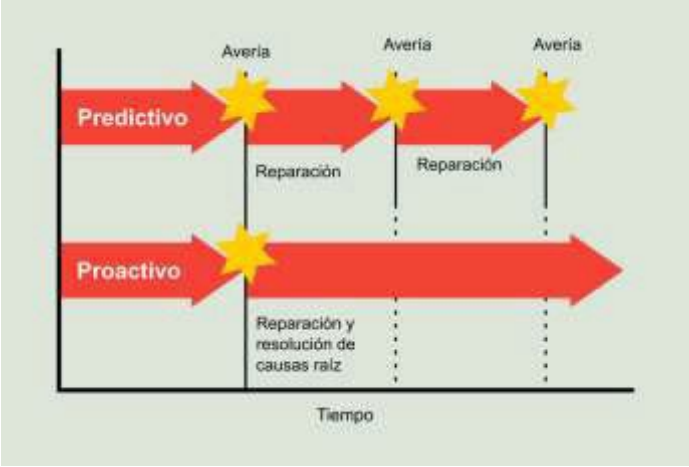


UNE-EN 17007
Maintenance process and associated indicators
Proceso de mantenimiento e indicadores asociados.

UNE-EN 15341:2020+A1
Maintenance
Maintenance Key Performance Indicators
Mantenimiento. Indicadores clave de rendimiento del mantenimiento



8.7
fault diagnosis
actions taken for fault recognition, fault localization and identification of causes

10.4
failure analysis
logical and systematic examination of item failure modes and causes before or after a failure to identify the consequences of failure as well as the probability of its occurrence

Note 1 to entry: Failure analysis is generally performed to improve dependability.

7.6
improvement
dependability improvement
combination of all technical, administrative and managerial actions, intended to ameliorate the intrinsic reliability and/or maintainability and/or safety of an item, without changing the original function

Note 1 to entry: An improvement may also be introduced to prevent misuse in operation and to avoid failures.

Total Quality Management (TQM) applied to Maintenance-and-Engineering Department.

UNE-EN 60300-1
Dependability management
Part 1: Dependability management systems
Gestión de la confiabilidad. Parte 1: Sistemas de gestión de la confiabilidad.

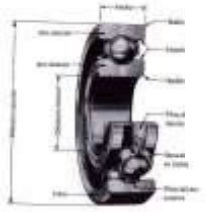
Reliability-centered maintenance (RCM)

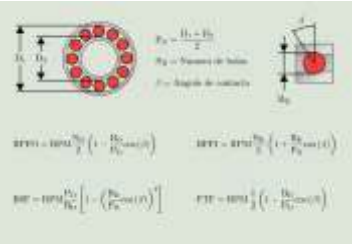
Total Productive Maintenance (TPM)

UNE-EN 16991
Risk-based inspection framework
Marco de la inspección basado en el riesgo.

Root Cause Analysis (RCA)

It is possible that the bearing whose working life is excessively short is insufficiently sized or simply is not the most appropriate type of bearing for the application being given.





INTRODUCTION TO MAINTENANCE

TYPES

7.18
maintenance level
level of maintenance
maintenance task categorization by complexity

EXAMPLES:

- Level 1 is characterized by simple actions carried out with minimal training.
- Level 2 is characterized by basic actions which have to be carried out by qualified personnel using detailed procedures.
- Level 3 is characterized by complex actions carried out by qualified technical personnel using detailed procedures.
- Level 4 is characterized by actions which imply the know-how of a technique or a technology and carried out by specialized technical personnel.
- Level 5 is characterized by actions which imply a knowledge held by the manufacturer or a specialized company with industrial logistic support equipment.

7.19
maintenance outsourcing
contracting out of all or part of the maintenance activities of an organization for a stated period of time

Note 1 to entry: In the case of complete outsourcing of all maintenance activities this is referred to as "complete maintenance outsourcing".

INTRODUCTION TO MAINTENANCE

PHYSICAL ASSETS MANAGEMENT

UNE-EN 16646

Maintenance
Maintenance within physical asset management

Mantenimiento. Mantenimiento en la gestión de los activos físicos.

1 Scope

This European Standard introduces physical asset management as a framework for maintenance activities. It also introduces the relationship between organizational strategic plan and maintenance management system and describes the interrelations between maintenance process and all the other physical asset management processes. It addresses the role and importance of maintenance within physical asset management system during the whole life cycle of an item.

3.1.12
physical asset
item that has potential or actual value to an organization

Note 1 to entry: Examples of physical assets are components, machines, plants, construction works, buildings.

3.1.13
physical asset management
coordinated activities of an organization to realize value from physical assets

Note 1 to entry: Realization of value will normally involve a balancing of costs, risks, opportunities and benefits.

Note 2 to entry: In the life cycle context, physical asset management is the optimal life cycle management of physical assets to sustainably achieve the stated business objectives.

UNE-EN 17485

Maintenance
Maintenance within physical asset management
Framework for improving the value of the physical assets through their whole life cycle

UNE-EN 15331

Criteria for design, management and control of maintenance services for buildings

Criterios para el diseño, la gestión y el control de servicios de mantenimiento de edificios.

UNE-EN 17840

Performance and condition assessment for buildings and civil engineering works
Framework for assessment within physical asset management

Evaluación del desempeño y la condición de edificios y estructuras de ingeniería civil. Marco para la evaluación en el contexto de la gestión de activos físicos.

INTRODUCTION TO MAINTENANCE

EUROPEAN REGULATION

The brief and recent history of maintenance standardization in Europe begins with the first attempt to unify maintenance activities, carried out by the OECD in 1963, which defines maintenance as "constant control of the facilities and overall maintenance, repair and review Works necessary to ensure the regular operation and good state of conservation of the production plants, their services and facilities." The standardization process itself begins primarily in the United Kingdom, due to its special awareness of maintenance regulations (Clifton, R.H., pp 82-92, 74). In November 1970, the EFNMS (European Federation of National Maintenance Societies) was founded in Duisburg (Germany), proposing in 1972 a project to unify the lexicon in common use in the field of maintenance. During the eighties, maintenance standardization developed significantly in France. In the 1990s, especially at the end of the decade, numerous regulatory documents appeared in France, the United Kingdom, Germany, Austria and Italy. In August 1993, the EFNMS initiated the "Euroguidelines Project", on European guidelines regarding maintenance terminology, concepts, objectives, strategies and implementation. On April 26, 1994, the first meeting was convened in Brussels to develop a European regional standard on maintenance, creating the Technical Committee CEN/TC 319 "Maintenance".

OECD: Organization for Economic Co-operation and Development

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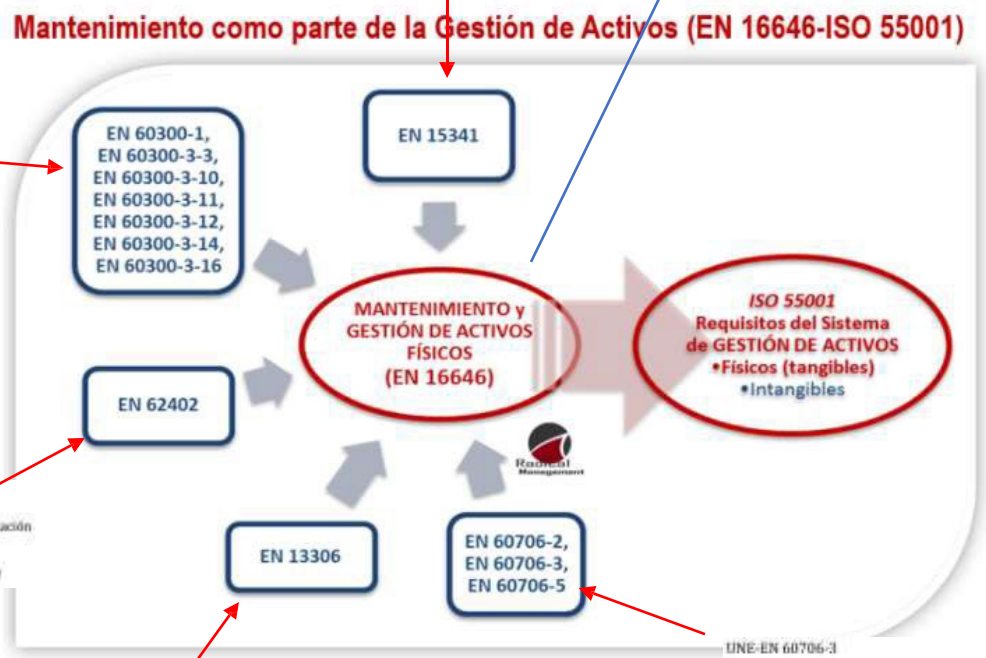
UNE-EN 15341:2020+A1

Maintenance
Maintenance Key Performance Indicators



UNE-EN 60300-1

Dependability management
Part 1: Dependability management systems

Gestión de la confiabilidad. Parte 1: Sistemas de gestión de la confiabilidad.

UNE-EN IEC 62402:2019

Gestión de la obsolescencia. (Ratificada por la Asociación Española de Normalización en agosto de 2019.)

Obsolescence management (Endorsed by Asociación Española de Normalización in August of 2019.)

UNE-EN 60300-1

Dependability management
Part 1: Dependability management systems

Gestión de la confiabilidad. Parte 1: Sistemas de gestión de la confiabilidad.

UNE-EN 60706-3

Maintainability of equipment
Part 3: Verification and collection, analysis and presentation of data

Mantenibilidad de equipos. Parte 3: Verificación y recogida, análisis y presentación de datos.

Imagen procedente de Radical Management

INTRODUCTION TO MAINTENANCE

EUROPEAN REGULATION

UNE-EN 13460

Maintenance
Documentation for maintenance

Mantenimiento. Documentos para el mantenimiento.

EN 13460:2009 (E)

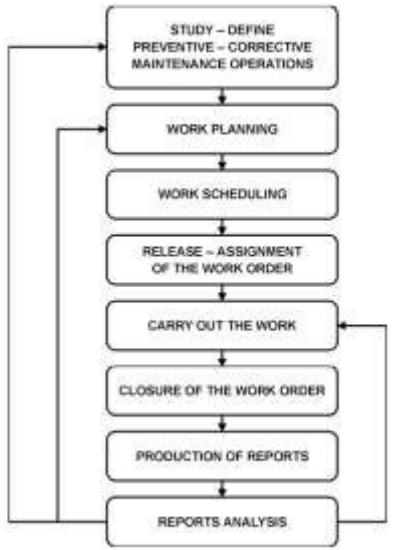


Figure C.1 — Maintenance workflow

REFERENCIAS	TÍTULO	TIPO	ESTADO
UNE-EN 15628:2015	Mantenimiento. Cualificación del personal de mantenimiento	Norma europea	En vigor
UNE-EN 16646:2015	Mantenimiento. Mantenimiento en la gestión de los activos físicos	Norma europea	En vigor
UNE-EN 13460:2009	Mantenimiento. Documentos para el mantenimiento.	Norma europea	En vigor
UNE-EN 13306:2018	Terminología del mantenimiento.	Norma europea	En vigor
UNE-EN 13269:2016	Mantenimiento. Guía para la preparación de contratos de mantenimiento.	Norma europea	En vigor
UNE-EN 15341:2020	Mantenimiento. Indicadores clave de rendimiento del mantenimiento.	Norma europea	En vigor
UNE 151001:2011	Definición y evaluación de índices de mantenibilidad de dispositivos industriales	Proyecto de norma	En vigor
UNE-EN 15331:2012	Criterios de diseño, gestión y control de los servicios de mantenimiento de edificios.	Norma europea	En vigor
UNE-EN ISO 41012:2019	Gestión de Inmuebles y Servicios Soporte. Directrices para el aprovisionamiento estratégico y el desarrollo de acuerdos.	Norma europea	En vigor
UNE-EN ISO 41011:2018	Gestión de Inmuebles y Servicios Soporte. Vocabulario	Norma europea	En vigor
UNE-EN 17007:2018	Procesos de Mantenimiento e Indicadores Asociados	Norma europea	En vigor
UNE-EN 16991:2018	Marco de la Inspección Basada en el Riesgo	Norma europea	En vigor
UNE EN 17485	Mantenimiento. Mantenimiento en el marco de la gestión de activos físicos. Marco para mejorar el valor de los activos fi	Norma europea	En vigor
UNE-EN 17666:2024	Mantenimiento. Ingeniería de mantenimiento. Requisitos	Norma europea	En vigor
PNE-EN 17840	Evaluación del desempeño y de la condición para edificios y obras de ingeniería civil. Marco para la evaluación dentro d	Proyecto de norma	En vigor

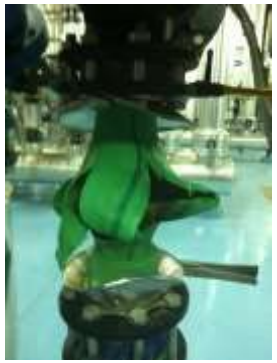
INTRODUCTION TO MAINTENANCE

- Operating Room
- Intensive Surveillance Units
  Technical rooms
- X-ray Areas
- …..

- BUILDINGS FACILITIES AND REGULATIONS
  - Heliport
  - Laboratories
    Guest rooms
    Industrial Laundry
    Industrial kitchen
    Restaurants
    Shops
  - Conference rooms
  - Parking
    Storage Rooms
    Administration Office
    …..

HVAC (Heating, Ventilating, Air Conditioning)	RITE 2007 / DB-HS3 (CTE)
Hot Water System	RITE 2007 / DB-HS4 (CTE)
Electrical System	REBT 2002
Water supply system	DB-HS4 (CTE)
Refrigeration	RD 552/2019
Fire Protection System	RSCIEI / DB-SI (CTE)
Electrical System	REBT 2002
Sanitation System	DB-HS5 (CTE)
Thermal Generation Boilers	RITE / REP
Sanitation System	DB-HS5 (CTE)
Fuel Storage System	RIP / RAPQ
Compressed Air installation	REP
Pneumatic installation	
Steam installation	
Medical gas installation	
Cryogenic facilities	
Telecommunication Systems	
Transport systems and elevators	
…..	

INTRODUCTION TO MAINTENANCE



ACCIDENTS

PROFESSIONAL TRAINING

OTHER DEPARTMENTS

OTHER DEPARTMENTS

“La SSMM, que se pueda comer en el suelo”.

TIPS

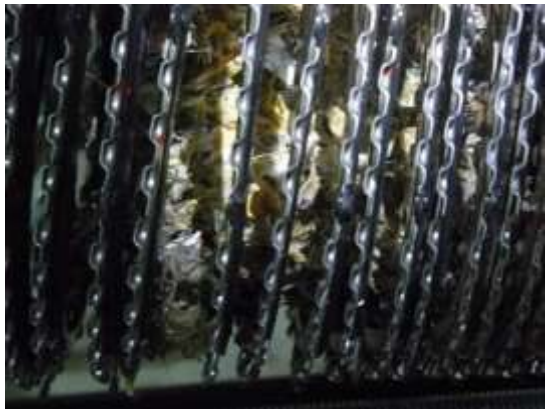
SPARE PARTS

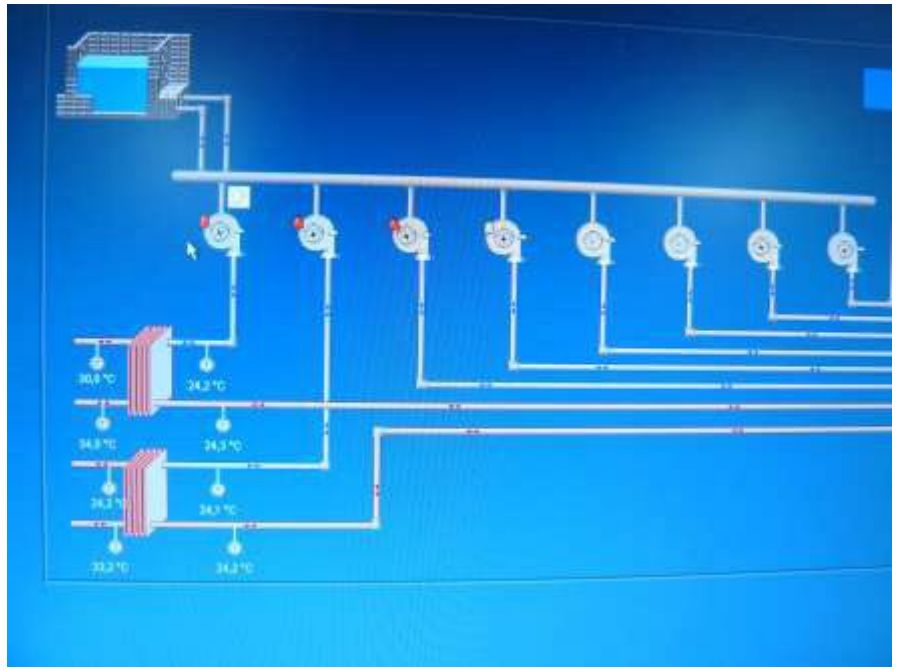
CAUSE TO ROOTS

(Poner vídeo del secador si hay tiempo)

What type of Maintenance would you say is this?

INTRODUCTION TO MAINTENANCE





TIPS