CONTENTS

1 – INTRODUCTION TO WCM

1.1. DEFINITION

WCM means:World Class Manufacturing,

WCM means constantly seeking to improve overall company performance by eliminating sources of loss in production systems. This is done by applying the five principles of WCM :

- Production performance management
- Product and equipment design management
- Product quality management
- Support service performance management
- Working conditions management

1.2. Sources of loss

How can we eliminate sources of loss in new installations?
By identifying and eliminating, in the study, manufacture and assembly phases, each anomaly that is liable to cause losses. The types of losses targeted include:

- Breakdowns
- Setups and adjustments
- Defective spare parts
- Starting and bringing machines up to speed
- Minor stops and running empty
- Reduced speed
- Defective and redone pieces
- Use of energy, tools and consumables
- Yield

Etc…

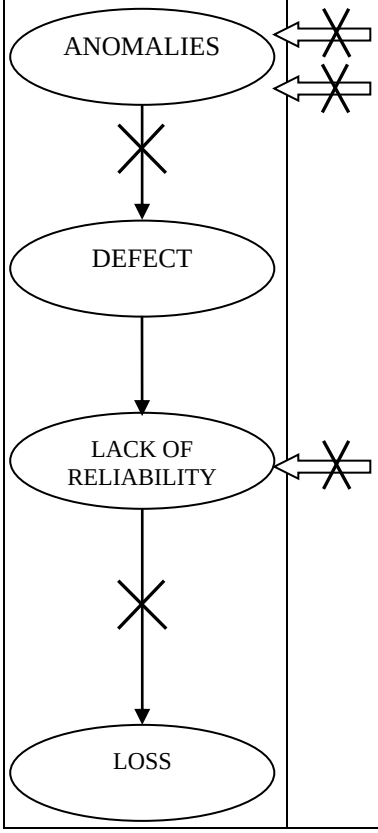
1.3. GENERAL CONCEPTS

There are 8 pillars to the WCM approach:

- Pillar no. 1: Loss elimination
- Pillar no. 2: Autonomous maintenance
- Pillar no. 3: Scheduled maintenance
- Pillar no. 4: Education and training
- **Pillar no. 5: WCM development (for new installations)**
- Pillar no. 6: Quality maintenance
- Pillar no. 7: WCM in the office
- Pillar no. 8: Safety, health and environment

The role of the first three pillars can be seen in the following chart, which shows the chronological chain at the origin of a loss (a defect in this case) and how the chain can be broken.

Chain	Entries into the chain	Pillar involved	Role of the pillar	Who is

				involved?
	External cause of wear Normal conditions not respected Natural wear (use, etc.)	Pillar no. 2: Autonomous maintenance Pillar no. 3: Planned maintenance Pillar no. 1: Eliminate losses	- Eliminate anomalies - Remove external causes of wear - Respect normal conditions (via standard-based inspection process) - Prevent tool wear in order to avoid production breakdown - Preventive and conditional inspections - Replace worn parts - Eliminate the loss as fast as possible, because it costs money, and find the causes	Machine operator and maintenance personnel Maintenance personnel All levels

1.4. GENERIC ITEMS

The organisation is set up to ensure, for all the phases (studies, manufacturing, ercetion, commissionning and test run) that the projet is manage to obtain an equipment which is:

- Reliable
- Maintainable
- Inspectable
- Operable
- Flexible
- Resource economy
- Safe
- Environmentally friendly

1.4.1. RELIABILITY

Equipment must be reliable in order to avoid poor performance and unforeseen stoppages.

- Low failure rate
- Low rate of defective products
- Stable operational cycles (Process)
- Low rate of minor stops
- Simple design (complexity can mean unreliability)
- The longest possible MTBF (Mean Time Between Failures)

1.4.2. MAINTAINABILITY

Easy to check and correct degradations.

- Easy to find failure zones
- Easy to change parts
- Short stop and restart time
- Easy to add and change lubricants
- Easy to put back in working order
- Minimum of adjustments
- Easy to perform routine checks
- The shortest possible MTTR (Mean Time To Repair)

1.4.3. INSPECTABILITY

Inspectable equipment allows manufacturing personnel to perform maintenance operations such as cleaning, inspection, or lubrication in a short amount of time.

- Easy to clean, lubricate, and inspect
- Easy to remove waste products

- Easy to find areas where lubricants are stored
- Areas to be inspected should be grouped together as much as possible
- Easy to identify the operation and control gauges, as well as the normal working ranges

1.4.4. OPERABILITY

Operational equipment means work can be done quickly and correctly when the equipment is running or being calibrated.

- Easy to carry out calibration
- Easy to change tools
- Ergonomic workstation (access to hand controls, visibility of control gauges)

1.4.5. FLEXIBILITY

With flexible equipment, future changes in a product line can be anticipated, by making equipment modifications easy.

- Present and future product lines
- Low cost of modifications needed for changeovers
- Low changeover downtime

1.4.6. RESOURCES ECONOMY

Efficient use of operating resources

- Raw material low yield
- Low consumption of energies
- Low consumption of tools
- Low consumption of lubricants, spare-parts…

1.4.7. SAFETY

Safe equipment complies with current European and national legislation with respect to workplace safety and European conformity (CE).

1.4.8. ENVIRONMENTALLY FRIENDLY

Equipment that is environmentally friendly is efficient in terms of energy use, tool wear and consumption of lubricants and all other resources necessary to equipment function.

- Low rate of pollution (dust, smoke, water, etc.)
- Low energy consumption
- A percentage of recyclable parts (recyclable materials, such as steel, should be used)
- Low noise level

- Complies with current legislation

2. SUPPLIERS PARTICIPATION

By submitting, the supplier get involved in the WCM process and commit himself to integrate the WCM principles throw his services or supplies. And in particular:

2.1 DURING PRE-DESIGN PHASE, the supplier must identify the impact of his services or supplies on the industrial working of the installation, throw the 8 previous generic items.
He have to explain with his bid the planned counter-measures to optimize each items.
Targets for each items must be clear and

2.2 DURING THE DESIGN PHASE, the supplier must include all of these WCM actions in the development of his installation. The supplier must participate in the process, i.e. he or she must clearly explain what constructive measures will be taken to comply with the actions listed above. These measures must be discussed with and validated by the client.

2.3 DURING THE ASSEMBLY AND TESTING PHASES, the supplier and the client will check that WCM principles are being applied. In case of an oversight or anomaly not in compliance with WCM principles, the supplier must come up with a solution to remedy the problem.

3 – MAIN PRACTICAL RECOMMENDATIONS

- To assist the supplier in taking WCM actions into account, paragraph 3 of the present set of specifications lists the main practical recommendations to consider. This list is not exhaustive, as specific situations will always arise.

3.1. ACCESS

- Particular attention should be paid to the means of access.
- Access points should be properly sized and should protect the user.
- Changes in level (e.g. stairs, ladders) should be avoided.
- Access areas should be designed to facilitate inspection routes by operator and maintenance personnel (avoid crossing high-risk areas, etc.).

- Access:

  - To inspection points
  - To lubrication areas
  - To control gauges
  - To adjustment areas
  - To areas that are regularly maintained
  - To parts that are frequently replaced
  - To operation, loading and safety units
  - To switch boxes and electrical cabinets

  must be easy and risk-free.

➔ Use various ways to facilitate inspection (**SIGHT**, sound, smell)

- Sensors must be accessible without ladders or scaffolding (design equipment to make them easy to reach).

- Make it possible to carry out the maximum number of checks and inspections without the use of tools.

- Personnel must be able to open and access switchboxes and cabinets without incident.

- Pipes, tubing and cables must be designed so they do not encroach upon passageways for personnel.

- Try to group together as much as possible:

  - Operating controls
  - Safety controls
  - Inspection equipment
  - Etc.

  - Lubrication points

  - Process information concerning points to be checked (temperature, speed, intensity, power, etc.) in the control booth or control room.

- In the same way, access to parts requiring maintenance (worn parts, for example) should be designed keeping both speed and intervention conditions in mind. Disassembly and reassembly of these parts should be able to be done in an easy and rapid manner. Specific tools for disassembly/reassembly of these parts should be stored in the vicinity.

- The handling of these parts should also be studied (sling points, sling type and weight).

- The positioning and adjustment of the various pieces of equipment shall be ensured by set screws and/or specially made shims that are fastened down on place. Avoid relying on positioning shims that might be mislaid if the equipment needs to be dismantled.

3.2. MARKINGS

- Markings are crucial for:
  - Facilitating the operation and maintenance of the installation
  - Safe intervention

- Mark equipment, on documents and on the parts themselves, in compliance with the functional and geographic layout, and using the same marks as those in the "Automated maintenance management".

- Suppliers can therefore ensure that the various parts will be called by the same name by the various professionals who work on the installation.

- When marking the various parts:
  - Place labels on vertical surfaces so that they will not become dusty.
  - In general, labels should be printed on white dilophane (but use yellow for gas, red for fire, etc.) or metallic dilophane for high-temperature environments. For high-temperature zones, label materials should be selected for their heat resistance.
  - Numbers should be engraved (in black or white letters for fire).
  - Labels should be screwed or riveted (never glued) in place, or attached with collars.
  - Labels should be placed in the immediate vicinity of the relevant check points, but never on removable parts (e.g. label pipes but not valves)

- Each device involved in operation, materials handling (specific marking) or safety must be labelled in a SPECIFIC and LITERAL manner.

- Pipes must be identified using the standard fluid-specific colors; flow direction must be indicated with arrows.

- The normal operational position of valves and taps (open, closed) must be indicated in accordance with the rules defined in each sector of the Plant.

- The normal operational values must be marked (normal levels in green, abnormal levels in red).

- Hazardous products must be marked using their specific logos.

- Mark computer equipment and cabling, and electrical cables.

- If necessary, mark access points in the floor (different color than floor)

- Mark how nuts should be tightened.

3.3. CLEANLINESS

- The installation should be designed for easy cleaning.

- Eliminate all possible sources of:

  - Leaks
  - Deposits
  - Pollution

- Installations should be designed to facilitate the detection and elimination of:

  - Fatal leakage of oil, grease, chemical products and other various fluid pollutants by means of permanent recuperation (holding tanks, drains, etc.).

  - Sources of deposits (dust, steam, etc.) through catchments, transport and treatment devices.

- The possibility of replacing lubrication tasks with self-lubricating systems should be investigated whenever possible.

- If it is not technically or economically feasible to deal with leaks and dirt at their source, the following areas should be protected:

  - Illuminated parts
  - Sensitive tool parts
  - Checking and operational areas (covers, cabinets, electrical areas, etc.)
  - Areas difficult to clean

- The supplier should also plan for:

  - Leak- and pollution-free methods of filling and changing reservoirs or any other installation requiring fluids (gear boxes, couplers, brakes, etc.).

  - Installations in which vacuums can be used in hard-to-reach places (standpipe).

- Means of removing waste (chutes, motors, drains, etc.).

3.4. STORAGE

- Every instrument and tool necessary for operation and maintenance activities must have a specific, identified storage area that is protected if necessary and that does not impede access or passage.

- Plan for as many compartments or cabinets for storing materials and spare parts as necessary.

- Oils and lubricants should have storage areas if these do not exist in the Plant sector. Fire safety arrangements shall be installed in agreement with the client and site safety regulations.

IMPORTANT

- Keep only necessary items on site:

  - No unnecessary objects
  - No used or obsolete parts

Hazardous products must be stored in areas that are closed and locked, to which only authorized personnel have access. The supplier shall ensure all safety arrangements (detection, fire protection, etc.) for these products.

3.5. LIGHTING

- There should be enough light to eliminate any shadowy areas.

- The supplier shall furnish evacuation lights that indicate the way to safety in case of power failure.

3.6. MAINTAINABILITY

- Standardize parts as much as possible.

- Group together the various gauges (temperature, pressure, flow rate, intensity, power, etc.) in a readable manner and as close to the operator as possible. Scales and units shall be chosen for readability.

- Design the way in which replaceable parts are attached so that removing them is easy (quick coupling, quick-connection plugs, clips, fast mechanical and hydraulic locking systems, etc.). Ensure that foolproof devices are well positioned.

- After replacing a part, any necessary adjustments should be written down on a document. For electronics, these adjustments can be grouped together on specific plates.

3.7. SAFETY

- Within the framework of risk analysis, all measures for guaranteeing the safety of personnel during WCM visits shall be taken (fixed or moveable protection, local materials handling devices, etc.).

4 – PLANNED MAINTENANCE

To improve equipment reliability and keep maintenance costs down, suppliers must:

- Manage natural degradations (tool wear) by applying the principles of conditional and/or predictive maintenance.
- Eliminate failures and precisely define the standard state of the installation (cleanliness, checkpoints, lubrication, bolts to be tightened, etc.)
- Plan maintenance sessions.
- Manage maintenance costs.

A maintenance log created by the supplier, using the model on the following page, is indispensable.

4.1. CONDITIONAL MAINTENANCE

Plan to equip certain machines (reducers, motors, fan bearings, etc.) with the means to measure vibrations, heat, etc.

Carry out measurements of vibration, T°, pressure, cycle time, thermography, etc. at the beginning of industrial operations in order to create a set of references.

4.2. ELIMINATE FAILURES – MAINTAINABILITY

See paragraph 3.6.

4.3. PLANNING MAINTENANCE SESSIONS

In order to establish a general Maintenance Plan for the installation, the supplier must provide maintenance logs.

These logs should be structured like the example given below.

All the operations to carry out are listed, as well as their frequency, how long they should last, and the necessary personnel (number and qualifications).

Operations can be described in intervention sheets that list the procedure to follow and the equipment needed.

These documents shall also be stored in electronic form in order to integrate them into the centralized maintenance management system.

Maintenance log

Installation:_____

Machine:_____ Machine supplier: _____

No.	Operations	Frequency	Intervention sheet no.	Length of time	Number of personnel and qualifications	Notes on safety and intervention conditions

Example of an operation:

- Visual check
- Adjustment
- Replacement
- Adding oil
- Oil change
- Cleaning
- Lubrication
- Sampling for lubricant analysis
- Draining

Etc.

4.4. MAINTENANCE COSTS

In order to keep maintenance costs down, the supplier must examine the possibility of:

- Reusing spare parts already stored on site.
- Limiting the number of spare parts (part standardization).
- Keeping strategic parts in supply.
- Facilitating maintenance operations by limiting the quantity of equipment needed and by reducing as much as possible the length of time spent on interventions.

5 – TECHNICAL DOCUMENTATION

- Technical documentation provided must be in English and in Romanian language
- Each machine must have its own technical file.
- The contents of the technical documentation should resemble the example given below.

MODEL TABLE OF CONTENTS FOR TECHNICAL DOCUMENTATION

Chapter 1: CE compliance
- 1.1. Declaration of CE compliance / Certificates of incorporation
- 1.2. Risk analysis
- 1.3. Instructions for use
- 1.4. List of norms, directives and technical regulations
- 1.5. List of drawings as built; Mechanics / Fluids
- 1.6. List of electrical drawings as built
- 1.7. Calculations

Chapter 2: Functional description
- 2.1. General Functional Analysis
- 2.2. Detailed Functional Analysis
- 2.3. Motor List
- 2.4. Drawings of various procedures / Kinematic diagram of principal

Chapter 3: Technical documents about the equipment furnished
- 3.1. 1st piece of equipment
- 3.2. 2nd piece of equipment
- …

Chapter 4: Material safety sheets (Toxicological analysis)
- 4.1. Product no. 1
- 4.2. Product no. 2
- …

Chapter 5: Upkeep and maintenance
- 5.1. Upkeep and lubrication (maintenance log)
- 5.2. List of spare parts and parts that need replacing
- 5.3. Instructions for changing tools

Chapter 6: Reception of works
- 6.1. Adjustment reception report (alignment certificates, surveyor reports, adjustment parameters, etc.)
- 6.2. Measurement reception reports (measurements of vibrations, heat, power, intensity, pressure, flow, etc.

Chapter 7: Manufacturing Quality Assurance
- 7.1. Materials certificates
- 7.2. Aptitude certificates
- 7.3. Testing reception report
- 7.4. Regulatory reception report (e.g. static testing of hoisting dynamics, electricity, etc.)
- 7.5. Inspection reception report and various checks