MAINTENANCE

Quality & Industrial Performance version 3

“Going From Reactive to Proactive”

Introduction

PURPOSE:

- Maintain the different equipment of a process in good working conditions
- Improve the overall effectiveness of the process
- Contribute to management of risk related to continued activity
- Management of the different type of maintenance
- Management of the spare parts

SCOPE:

- Assembly Area
- Manufacturing Operations
- Maintenance Area
- All Operations

RESPONSIBILITY:

- Ownership
  - ✓ Maintenance Manager
- Operations Manager

Benefits

- Maximizes equipment capability which can lead to reducing stock/buffer levels.
- Increases equipment availability/uptime helping organization to:
  - Prevent plant disruption
  - Reduced overtime production costs required to make up lost units educe overtime activities (extra hour)
- Provides a systematic approach for *Maintenance Management*
- Enhances operator's and maintenance's equipment expertise and skills.
- Improves productivity and manufacturing lead time.
- Reduced accidents
- Allows fast recovery after unplanned maintenance due to machine/equipment breaking down through:
  - Spare parts management: critical spare parts availability
  - Resources management: availability of right resource (skill, devices, people) at right time

Strategy and Organization, what are we searching for ?

Item	Requirement	#Criteria	Criteria requirement
MAI1	Maintenance organization is established and deployed and the activities of maintenance are planned, performed and tracked.	**MAI11**	**A maintenance process is implemented by dedicate ressources and covers all the machines, tools, equipments and facilities on site. It includes preventive and corrective maintenance.**
		MAI12	**The planning of the preventive maintenance takes into account risk classification of the equipment (safety, bottleneck, process without degraded mode,...) and corrective maintenance recurring issues. Its execution is managed.**
		MAI13	**A fast and reactive communication is assured between production and maintenance in order to take corrective actions with effectiveness.**
		MAI15	**Records of all maintenance activity and results are formalized and accurately filled in.**
		MAI14	Maintenance activities are considered as Standardized Work and LPA is implemented. Technical documentation is available and managed for all the equipment.

Criteria of Requirement

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Next Requirement

Strategy and Organization

Scope adressed

- Process Equipments
- Handling devices / conveyors
- Facilities
- ….

Handling devices

Buildings

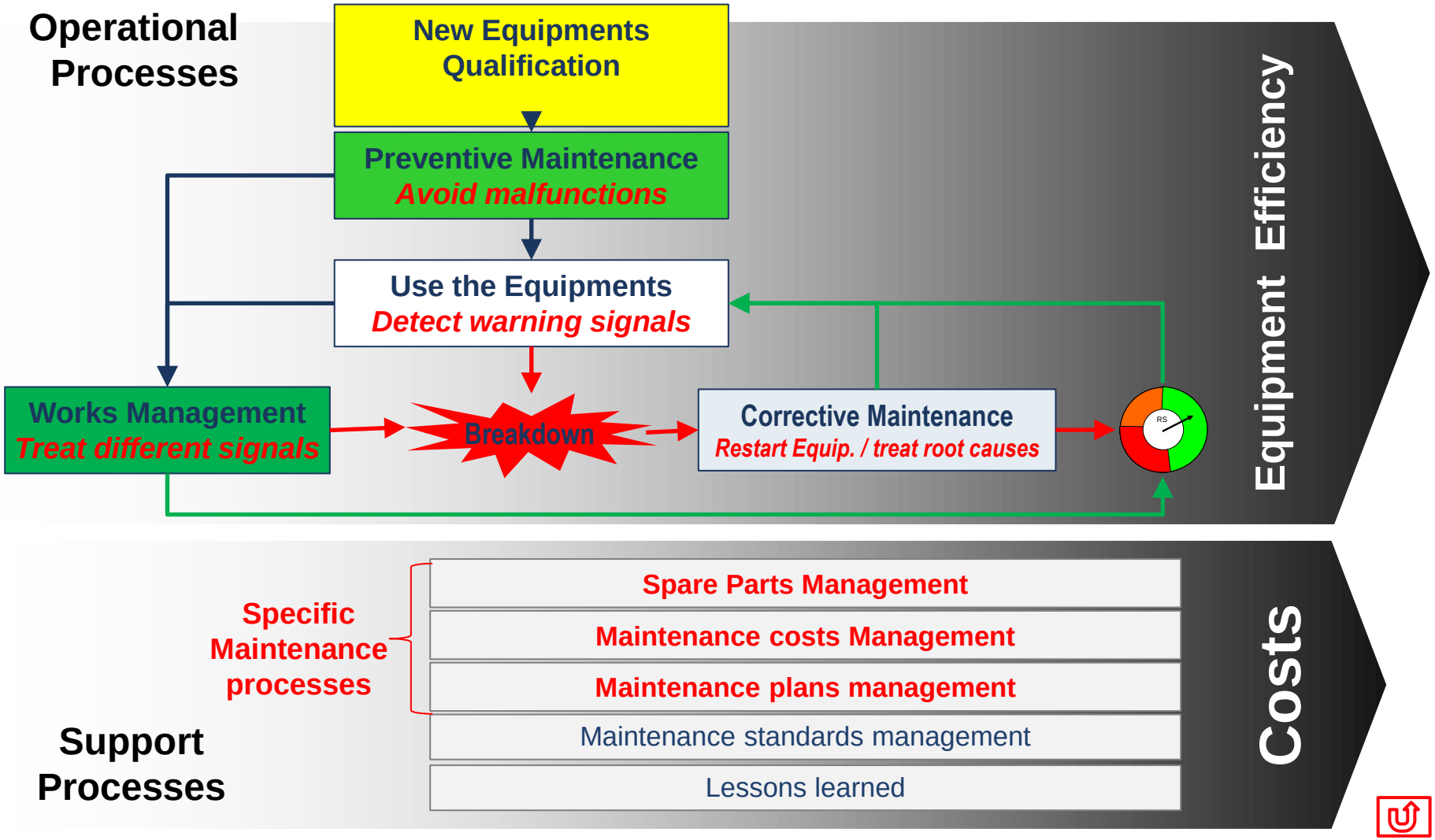
Tank

PROCESS

Fork-lift truck

Fluids

Process Roadmap

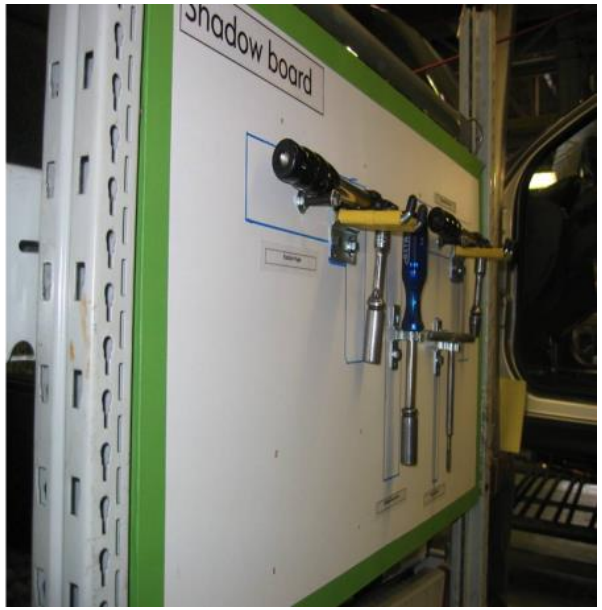


Resources available

- TPM plans should be incorporated into each facilities Master Business Plans, which could span a multi-year timeframe. Planning will help balance workload, ensure proper support is available for the teams, and to establish a TPM glide path to the targets set by leadership.
- Organization shall establish a proper support in all shifts (night, weekend, overtime etc.) for preventive & corrective maintenance.
- All necessary skill shall be available for the teams all time (e.g.: Electric, Automation, Mechanic, etc.). This information shall be posted on Flexibility Chart.
- Workload planning is established & followed. Organization is fully compatible with manufacturing activity (e.g.: site at full capacity with 3 shifts with no sufficient preventive maintenance).

Suitable maintenance facilities & equipment available

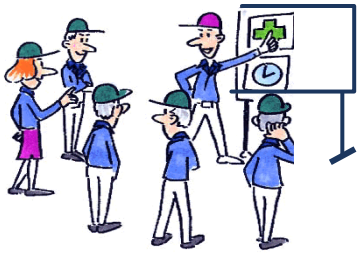
- Proper maintenance facility/equipment shall be available to maintenance team/operator (e.g.: standard toolbox, safety equipment – PPE, adequate place, etc.)
- Handling equipment dedicated to maintenance operations (winch, hoist equipment, manlift,…).



Maintenance Management System

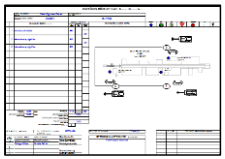
PLAN

Business Plan Deployment



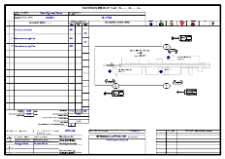
Production, Maintenance, Quality, Engineering, WFG, Supplier, etc.

Production



Scheduled, Standardize Tasks

Maintenance

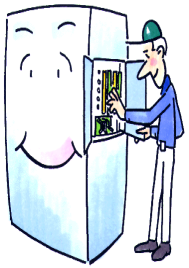


DO

Production

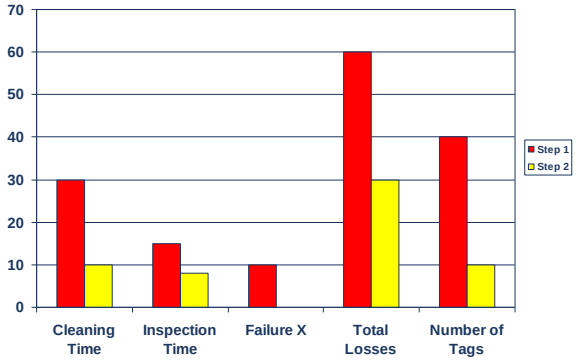
Execute Tasks

Partnership



Maintenance

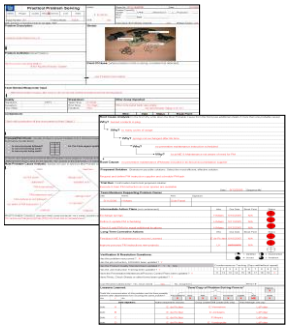
CHECK



Did Plan Deliver the Right Results?

Checks with established frequency

ACT



Problem Solve and Countermeasure Review & Update the Standard

Maintenance: types

- **Corrective Maintenance:**
  - Maintenance performed after a breakdown detection
  - Purpose: Ensure the re-start of the equipment as soon as possible (even with degraded solutions)
- **Preventive Maintenance:**
  - Maintenance performed according to predefined frequencies or on the basis of predefined criteria (nb of cycles…)
  - Purpose: Reduce the probability of breakdowns or the wear of the equipment. Example: Aircraft Maintenance
- **Condition Based Maintenance (specific type of preventive maintenance):**
  - Maintenance based on the measurement of key parameters on the equipment
  - Example: Vibration Analysis on rotating machines, Fluids analysis, thermography on electrical equipment.

Total Productive Maintenance (TPM): Key Principles

Total

- The *entire* organization (from management to maintenance, to engineering, to production operators)
- Team work!

Productive

- Improved capability of equipment
- Elimination of waste and reduction of cost
- Achieving equipment availability and quality targets

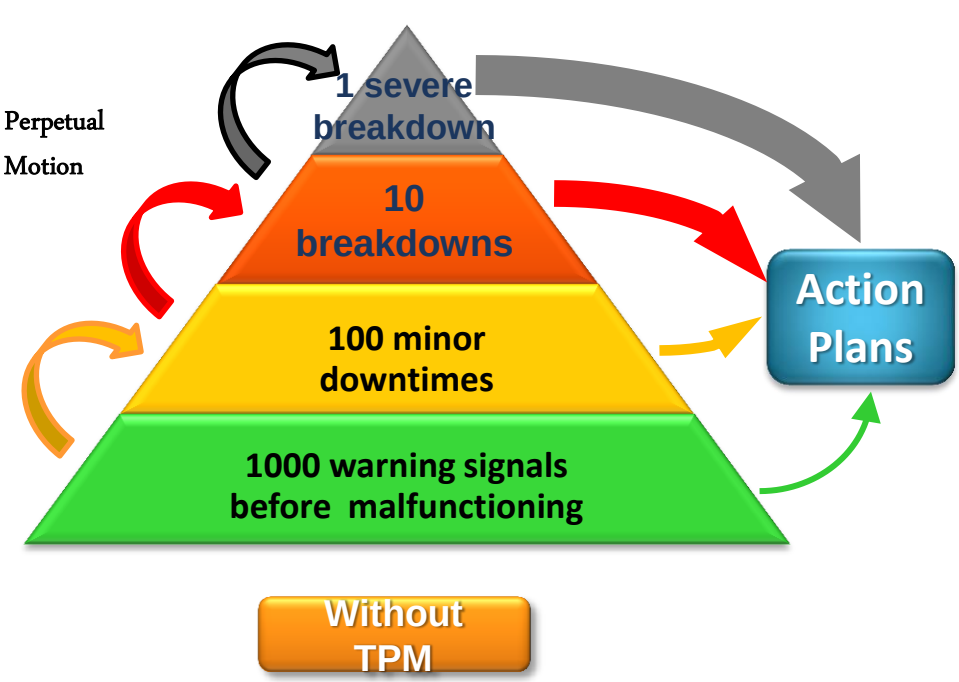
Maintenance

- Predictive, Preventive, Corrective, and Reactive maintenance
- Optimize the life of equipment

Total Productive Maintenance (TPM): Key Principles

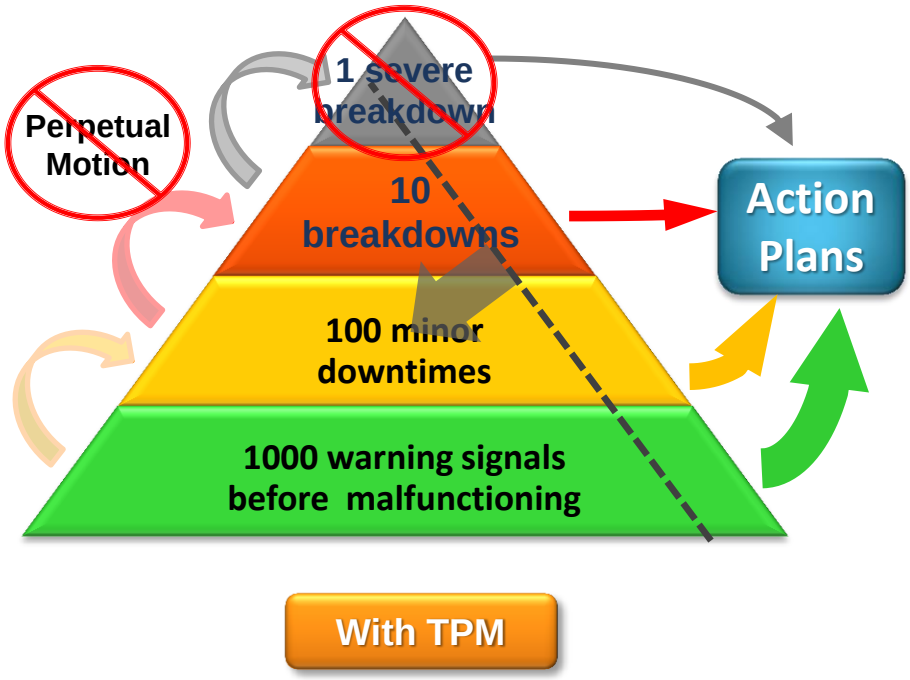
TPM : Continuous Improvement of the reliability of the equipment based on the daily involvement of all the operational on the shop floor

The action plans are driven by severe issues (breakdowns)



Without TPM

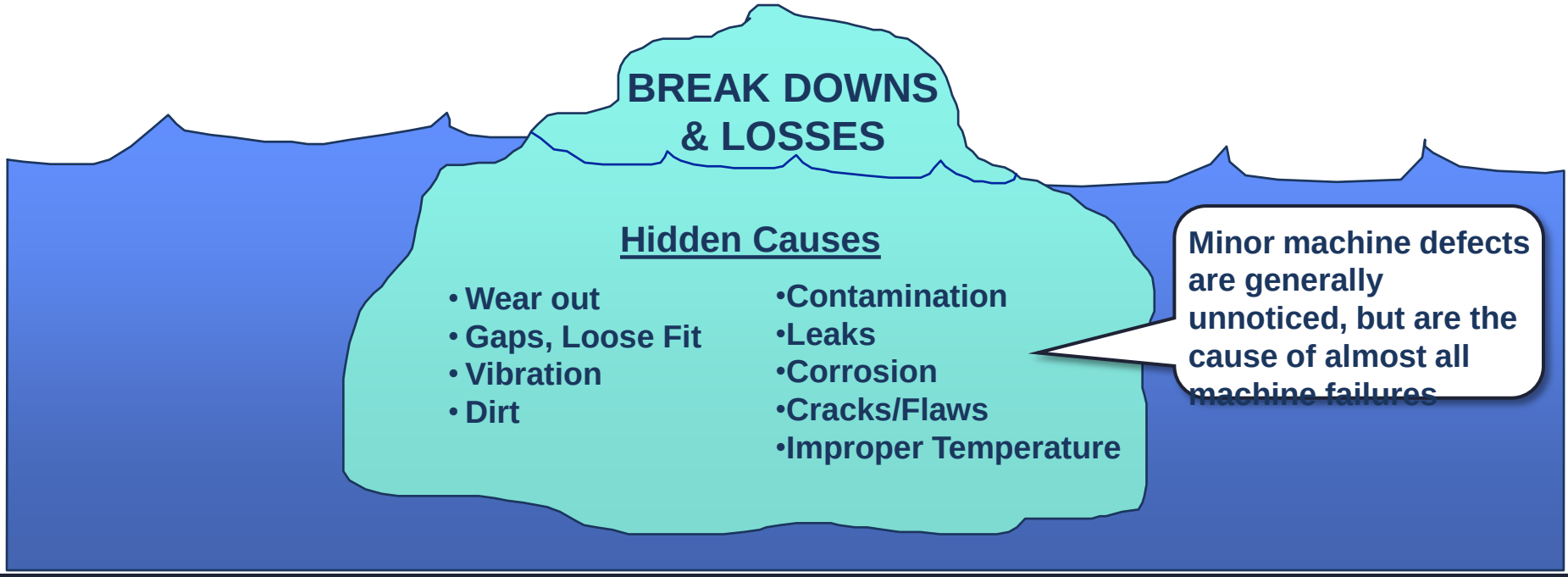
The actions plans are driven by warning signals (symptom)



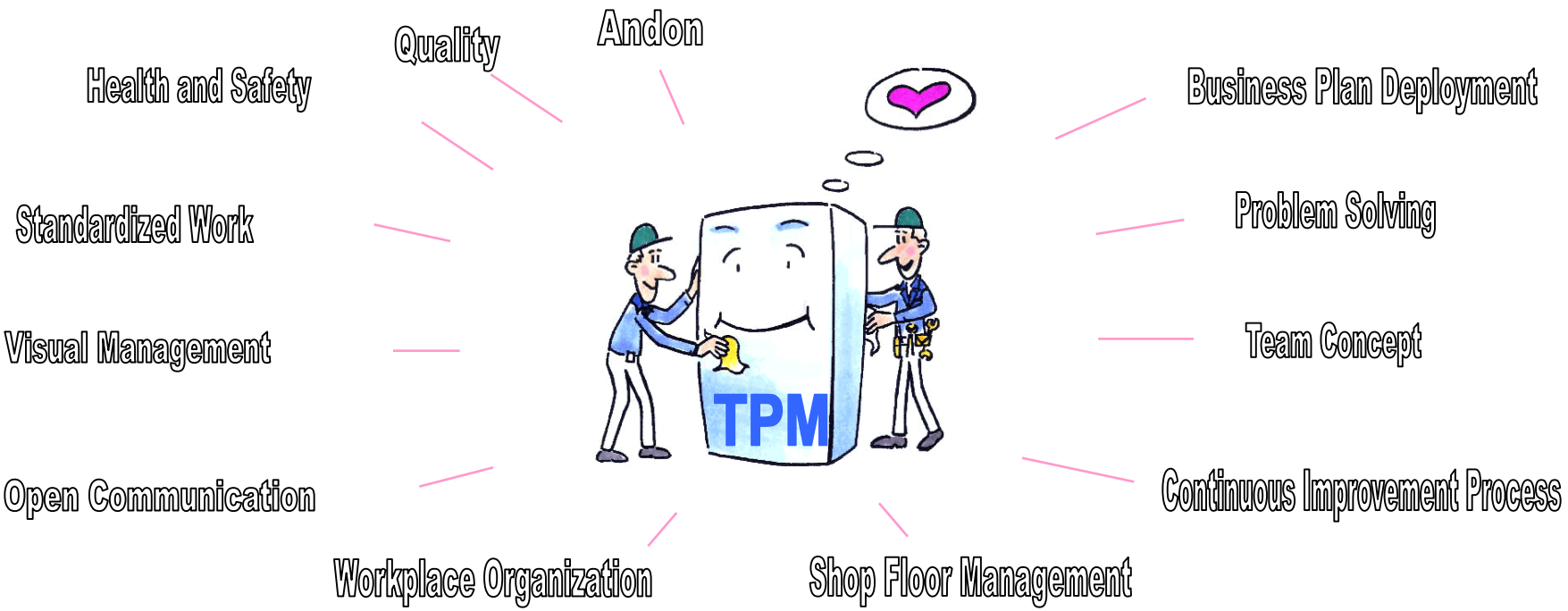
With TPM

Total Productive Maintenance (TPM): Key Principles

- We naturally see breakdowns very easily. But every breakdown is the result of a hidden cause; the stuff we generally ignore or don't see. We need to understand these hidden causes and be proactive. If we chip away at those hidden causes, we will see fewer breakdowns as a result.
- TPM activities must focus on the relentless pursuit of detecting and correcting all minor machine defects before they become major equipment failures.



Total Productive Maintenance (TPM): Key Principles



- TPM activities involve the entire organization and requires team work, and team member involvement.
- TPM can provide many benefits to an organization, but it is most effective when integrated with all other QSB+ Elements.

Plant Overall Organization

Customer Demands

Nominal Industrial Performance

E-SOP & MPS

Forecast

Manufacturing Program

Customer Needs Satisfaction

Industrial Performance Check

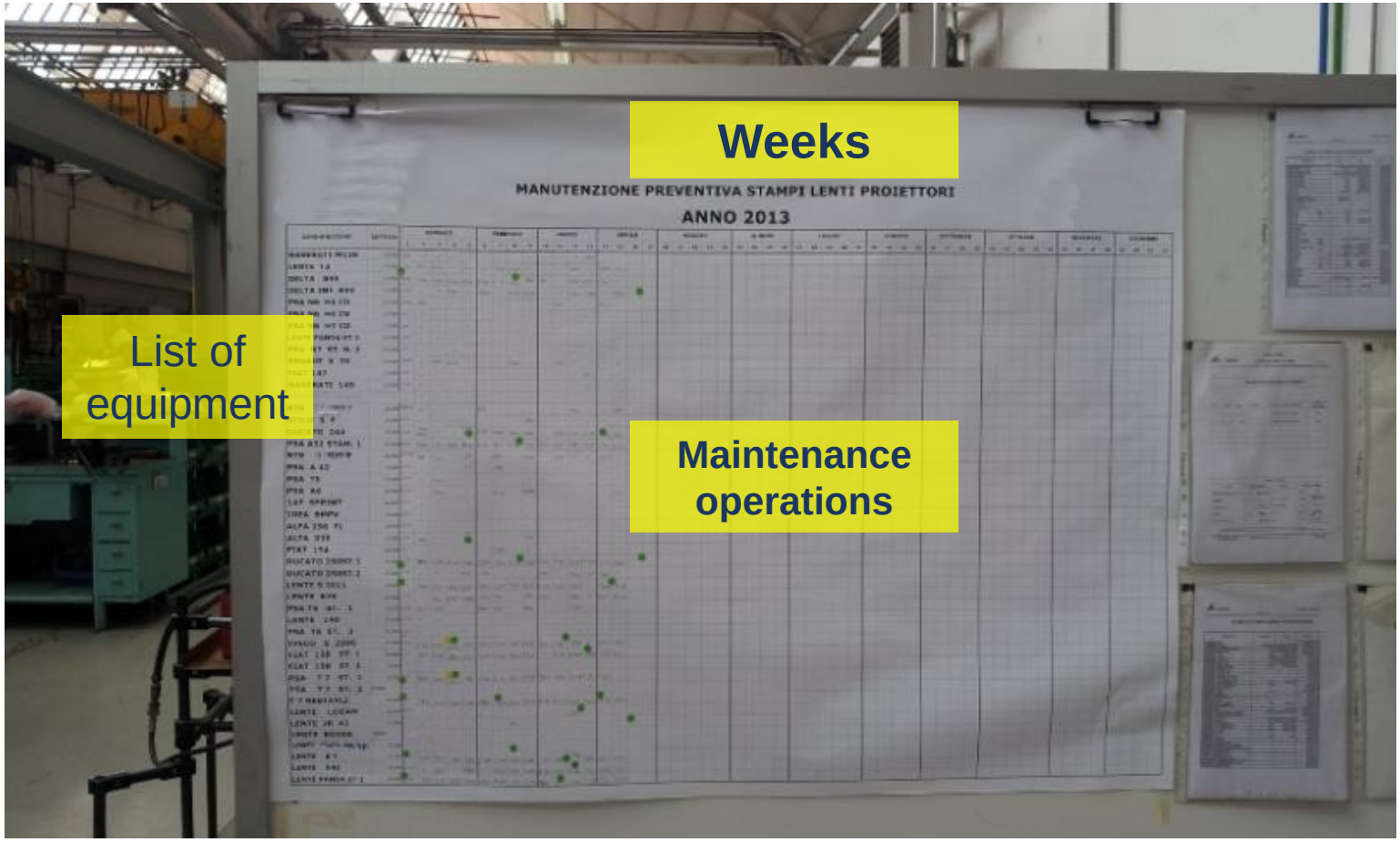
Maintenance as Contributor

Preventive Maintenance Planning

- The Preventive Maintenance Planning shall be established by Maintenance Area and supported by Manufacturing Area.
- The following inputs shall be take into consideration when establishing the Preventive Maintenance Planning:
    - Equipment Classification Risk: constraint or bottleneck, safety, unique equipment (without replace), etc.
    - Availability (according to Master Schedule Production Plan)
    - Performance
    - Time allocated to maintenance
    - Corrective Maintenance Results
- Start-up process validation shall be performed after maintenance activity. The results of start-up shall be recorded to ensure traceability

Preventive Maintenance Planning

(Example)



Preventive Maintenance Planning (Example)

Equipem.	Désignation objet technique	ABC	Op.	Désign. opération	Pos. trav	El	TOT.	2008 S43	S44	S45	S46	S47	S48	S49	S50	S51	S52
900000015	CH3-ASSEMBLAGE2003 TAB 3P+COLL ASSEMB 2	A	10	CONSIGNE G730	MC12GR	A	3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3
1001058	CH3-BORDENBC MALAXEUR BORDEN BC	B	10	CONSIGNE M760	MC12ME	A	2,5	0,5		0,5				0,5		0,5	
1001211	CH3-ARMCOLLECT ARMOIRE SABLERIE 0M	B	10	CONSIGNE DE DEMARRAGE DIMANCHE SOIR	MC12EL	A	1		0,5								
1001241	CH3-DEGRAPL10 DEGRAPPEUSE PL10	B	10	CONSIGNE ATF POSTE DE DEGRAPPAGE PL10	MC2	M	1,5	0,3		0,3		0,3		0,3		0,3	
900000020	CH3-ASSEMBLAGE2008 ROBOT 1 ABB64N17545	C	10	NETTOYAGE CLIM 1	MC12EL	A	0,9		0,3			0,3			0,3		
			20	NETTOYAGE CLIM 2	MC12EL	A	0,9		0,3			0,3			0,3		
			30	NETTOYAGE CLIM 3	MC12EL	A	0,9		0,3			0,3			0,3		
			40	NETTOYAGE CLIM 4	MC12EL	A	0,9		0,3			0,3			0,3		
			50	NETTOYAGE CLIM 5	MC12EL	A	0,9		0,3			0,3			0,3		
1000914	CH3-GAZEUR3DV GAZEUR DV 3	C	10	CONSIGNE M540	MC12ME	A	1,2	0,3		0,3			0,3			0,3	
1000917	CH3-GAZEUR6DV GAZEUR DV 6	C	10	CONSIGNE M540	MC12ME	A	0,6		0,3								0,3
1000920	CH3-HANSBERG3DV NOY HANSBERG 3 DV	C	10	CONSIGNE W508	MC12ME	M	0,3					0,3					
1000921	CH3-HANSBERG4DV NOY HANSBERG 4 DV	C	10	CONSIGNE W508	MC12ME	M	1,2	0,3			0,3			0,3			0,3
1000922	CH3-HANSBERG5DV NOY HANSBERG 5DV	C	10	CONSIGNE W508	MC12ME	M	0,9	0,3				0,3				0,3	
1000923	CH3-HANSBERG6DV NOY HANSBERG 6 DV	A	10	CONSIGNE M511 A	MC12ME	A	0,3				0,3						
			20	CONSIGNE M511 B	MC12ME	A	0,3				0,3						
900000090	CH3-MC04L04/003 DECHARG ABB64N17411	A	10	NETTOYAGE CLIM	MC12EL	A	3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3
1000980	CH3-PL1 POSTE EN LIGNE 1	B	10	CONSIGNE G501	MC12GR	M	2,5	0,5		0,5		0,5		0,5		0,5	
1000985	CH3-PL4 POSTE EN LIGNE 4	B	10	CONSIGNE M503	MC12ME	A	1		0,5			0,5					
1001052	CH3-ASPI12M ASPIRATION 12M CLS	B	10	AR/DEM ASPI 12M	MC12EL	A	1,5	0,3		0,3		0,3		0,3		0,3	
1001058	CH3-BORDENBC MALAXEUR BORDEN BC	C	10	CONSIGNE E760	MC12EL	M	0,6		0,3			0,3					
1001120	CH3-NOY228BC NOY 228 BC(24/5REP6)	A	10	CONSIGNE M707 (NOY 228BC)	MC12ME	A	1,2	0,3		0,3			0,3			0,3	
1001122	CH3-NOY250BF NOYAUTEUSE 250 BF	B	10	CONSIGNE M715	MC12ME	A	0,6		0,3								0,3
1001124	CH3-NOY251BF NOYAUTEUSE 251 BF	B	10	CONSIGNE 715	MC12ME	A	0,3					0,3					
1001126	CH3-NOY252BF NOYAUTEUSE 252 BF	B	10	CONSIGNE E708 252BF	MC12EL	A	1,2	0,3			0,3			0,3			0,3
1001126	CH3-NOY252BF NOYAUTEUSE 252 BF	C	10	CONSIGNE 715	MC12ME	A	3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3
1001128	CH3-NOY253BF NOYAUTEUSE 253 BF	A	10	CONSIGNE 715	MC12ME	A	0,3				0,3						
1001130	CH3-NOY254BF NOYAUTEUSE 254 BF	B	10	CONSIGNE 715	MC12ME	A	0,5					0,5					
1001132	CH3-NOY255BF NOYAUTEUSE 255 BF	B	10	CONSIGNE 715	MC12ME	A	2	0,5		0,5			0,5			0,5	
1001134	CH3-NOY256BF NOYAUTEUSE 256 BF	B	10	CONSIGNE 715	MC12ME	A	0,5				0,5						
1001136	CH3-NOY257BF NOYAUTEUSE 257 BF	C	10	CONSIGNE 715	MC12ME	A	3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3
1001138	CH3-NOY258BF NOYAUTEUSE 258 BF	B	10	CONSIGNE 715 A	MC12ME	A	2,5	0,5		0,5		0,5		0,5		0,5	
							2,5	0,5		0,5		0,5		0,5		0,5	
							2,5	0,5		0,5		0,5		0,5		0,5	
1001388	CH3-TAPIS220 TAPIS 220	A	10	CONSIGNE TAPIS 220 (GRAISSAGE G621)	MC12GR	A	1,2	0,3		0,3			0,3			0,3	
1001390	CH3-TAPIS221 TAPIS 221	B	10	CONSIGNE TAPIS 221 (GRAISSAGE G622)	MC12GR	M	0,6		0,3								0,3
1001834	CH3-MACHCOQUIL7 COQUILLEUSE REP7 1DW	B	10	CONSIGNE MB07	MC12ME	A	0,3					0,3					
1001241	CH3-DEGRAPL10 DEGRAPPEUSE PL10	B	10	CONSIGNE G609	MC12GR	M	1,2	0,3			0,3			0,3			0,3
1001243	CH3-DEGRAPL11 DEGRAPPEUSE PL11	C	10	CONSIGNE G609	MC12GR	M	1,2	0,3		0,3			0,3			0,3	
1001392	CH3-TAPIS222 TAPIS 222	A	10	CONSIGNE G623 (GRAISSAGE TAPIS)	MC12GR	M	0,3				0,3						

Weeks

List of equipment

List of maintenance operations to perform

Always red
=> Frequency must be increased

Always green
=> Frequency can be decreased

0,3 **Operation postponed**

~~0,3~~ **Operation not performed**

0,3 **Near miss breakdown. Emergency reparation needed**

0,3 **OK, no reparation needed**

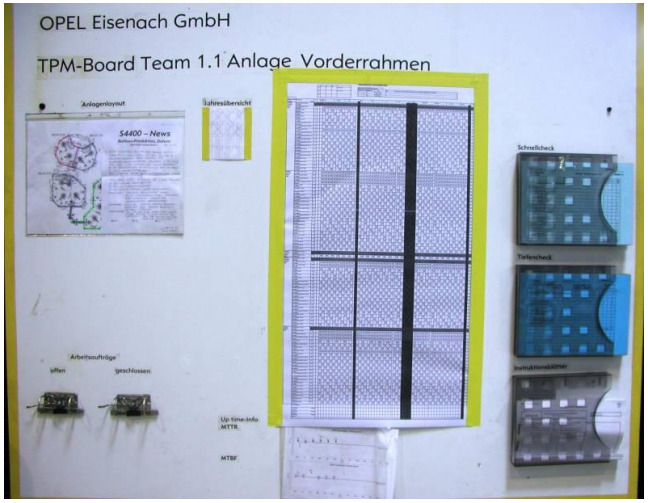
0,3 **Limit, reparation needed, no emergency**

Document allows:

- To follow up preventive operations
- To identify maintenance plan improvement

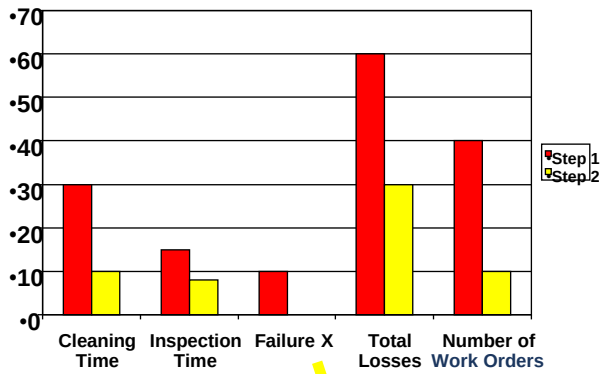
Visual Management and Communication

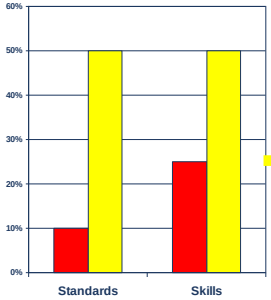
- An equipment or TPM board contains the information and results being developed throughout the maintenance process.
  - Standardized Work
    - Maintenance tasks
    - Detailed task instructions
  - Check sheets of TPM completion
  - Performance of the machine
    - Quantification of losses by category
    - Trend of losses by category
  - TPM activity indicators
    - Work Order tags completed
    - Problems found and fixed by the operator & team

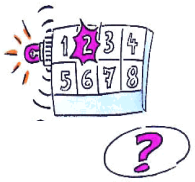


Visual Management and Communication

- Visual management of performance and problems are used to communication between the operators, maintenance, line engineers and management.





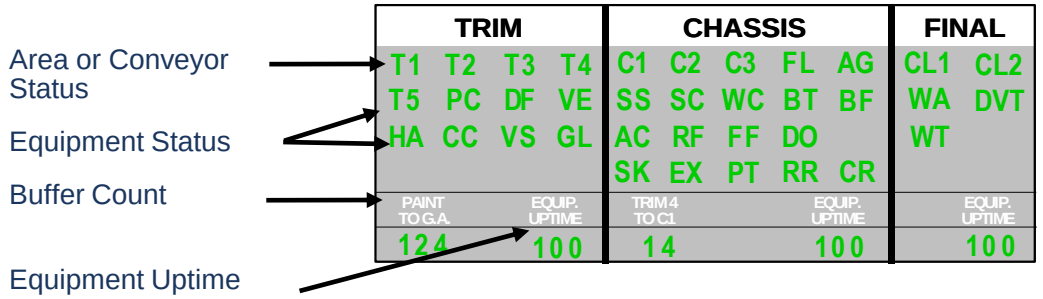


- An Maintenance Andon System (for example) could be used to assure the Fast Communication between manufacturing and maintenance areas in case of breakdown.

Visual Management and Communication – Andon Board

- The Maintenance Board supports the Maintenance organization by providing information related to abnormalities with equipment and tools and location where help is requested.
- The Maintenance Board displays will vary depending on the maintenance deployment strategy implemented. In some cases, extra marquees may be added as necessary to support the effectiveness of the maintenance function. Shown below are examples of departmental maintenance boards.

(Example)



Line	Condition
Area or Conveyor Status	Equipment and conveyors running.
	Line not running. Conveyor or equipment not running.
Equipment Status	OK
	Equipment Fault.
Equipment Uptime Actual	000 Displayed is the Actual uptime of the equipment in each respective area.
Buffer Count	000 Paint to General Assembly buffer count.
Buffer Count	000 Trim 4 to Chassis 1 buffer count.

Preventive Maintenance Planning

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    - Availability (according to Master Schedule Production Plan)
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- Start-up process validation shall be performed after maintenance activity. The results of start-up shall be recorded to ensure traceability

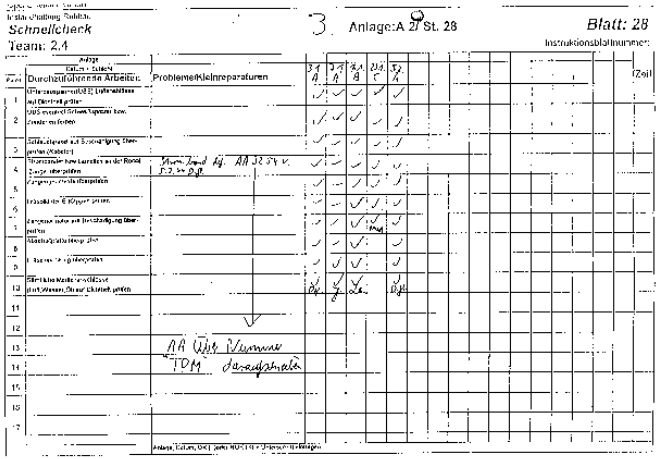
Preventive Maintenance Planning – Check List

Check Sheets list the tasks designed to maintain equipment performance and prevent unscheduled downtime.

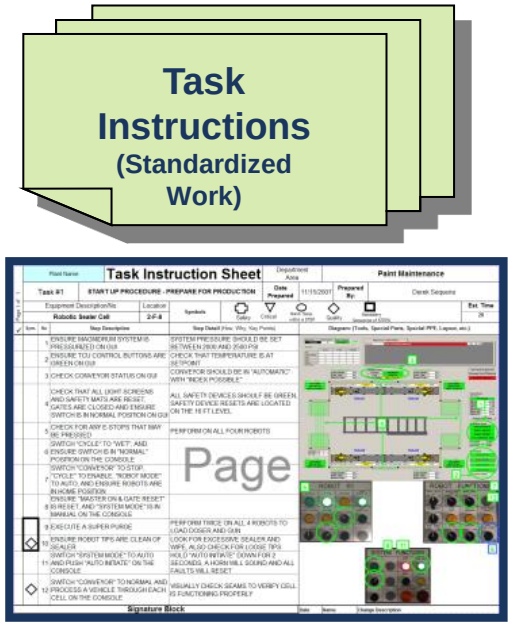
- Inspection location #'s and point's (where?)
- Inspection method (what are you checking?)
- Acceptable operating condition (how do you know what is ok?)
- Corrective action (what happens if you do detect an abnormality?)
- Time (how long does it take?)
- Frequency (when are the specific inspections to be performed?)
- Check sheets should be visualized (e.g. Equipment TPM Boards)

Preventive Maintenance Planning – Inspection Check Sheet

- Check Sheets should also be developed and used for daily routine maintenance tasks, where applicable, at the operators workstation. List the tasks designed to maintain equipment performance and prevent unscheduled downtime.
- Check sheets should be visualized (e.g. Workstation board).
- Supported by Task Instruction Sheet document's where further detailed instructions are required.



Daily Workstation Check Sheet



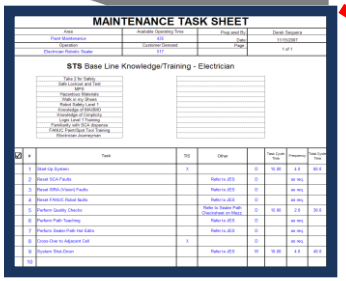
Preventive Maintenance Planning – Developing Standards

- Maintenance Team and Operators must work together to define the standardized maintenance work that will ensure continued equipment performance and improved level.
- Equipment components to be preventively inspected are identified. Equipment manufactures' and engineering suggestions are to be considered.
- Routine inspection, cleaning, lubrication, tightening and minor maintenance tasks are given to the operators. Maintenance assumes responsibility for the remainder.
- Standardized work is developed for maintenance tasks.

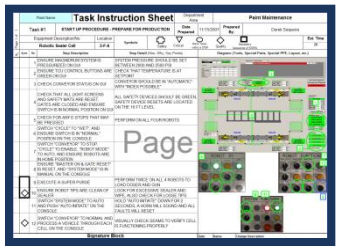
Preventive Maintenance Planning – Standard Work

- Standardized Work documentation lists maintenance tasks to be performed and provides further detailed information; inspection method, safety equipment required, safety precautions, required tools, required sequence, time, criteria for OK/NOK, and key points to consider.
- Standardized Work is an effective tool for job instruction training and problem solving, and a basis for continuous improvement activities.

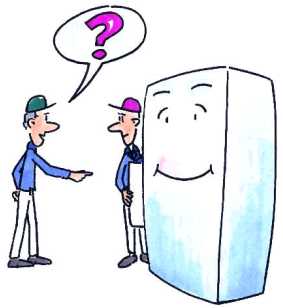
Maintenance Tasks



Task Instructions (Standardized Work)



Post at Equipment or on a TPM Board



Training
Problem Solving
CIP

Auditor hints

During the audit, look for:

- Preventive maintenance for safety equipment has to be performed on time without exception.
- Check that a maintenance system in place to manage all maintenance activity, supported by IT tools like CMMS (computer maintenance management system), Excel...
- Available resources by technology including outsourced experts (flexibility chart).
- Implementation of resources near the manufacturing activities.
- Are there free resources to manage the corrective maintenance?
- Facilities available (areas well defined, conditions, 5S level,...)
- Management improvement strategy and periodical reviews.
- Review major brand types of major equipment - ask about process to purchase new machines
- A generic plan to improvement of a type of equipment (e.g.: electrical screw drivers).
- Choose a bottleneck equipment in the workshop, and ask for modifications to improve reliability

Auditor hints

During the audit, look for:

- Choose machines (constraint/complex one) and a tool to verify:
  - Maintenance planning: identification of the equipment, task to do, when
  - Follow up of the maintenance schedule and its visual management. Verify the link with the MPS
  - maintenance work instructions (including changes due to lesson learned)
  - technical documentation for a precise equipment including document management
  - records of corrective maintenance activity (type of equipment, is there repetitive breakdown,...)
  - records of preventive maintenance on an equipment with a recent breakdown
- Verify that maintenance activities are fully deployed and covers all equipment (machines, facilities, tools)
- Different type of preventive maintenance depending on the type of equipment (pure preventive approach & conditional maintenance)
- Management of the postponed operations, evidence of preventive plan optimization
- Verify that it is possible to establish the “history” of an equipment: list of operations (preventive & corrective) performed over the 6 last months.

Level 1 Maintenance, what are we searching for ?

Item	Requirement	#Criteria	Criteria requirement
MAI2	Level 1 maintenance is systematically applied and integrated to workstation instructions.	**MAI21**	**Level 1 (L1) maintenance operations take into account equipment identification, cleaning, self-maintenance and safety devices verification.**
		MAI22	**L1 maintenance is performed under manufacturing responsibility at operator's workstation. L1 operations are integrated in the workstation's work instructions.**
		MAI23	**Any deviation, anomaly is recorded and, if necessary, escalated to a higher level maintenance activity.**
		MAI24	Operators suggestions to improve reliability or optimize maintenance operations are collected and addressed with short and medium term improvement actions established
		MAI25	Records are analysed and used as lessons learned to improve maintenance operations.

Criteria of Requirement

21 – page 30 - 32
22 – page 33 - 38
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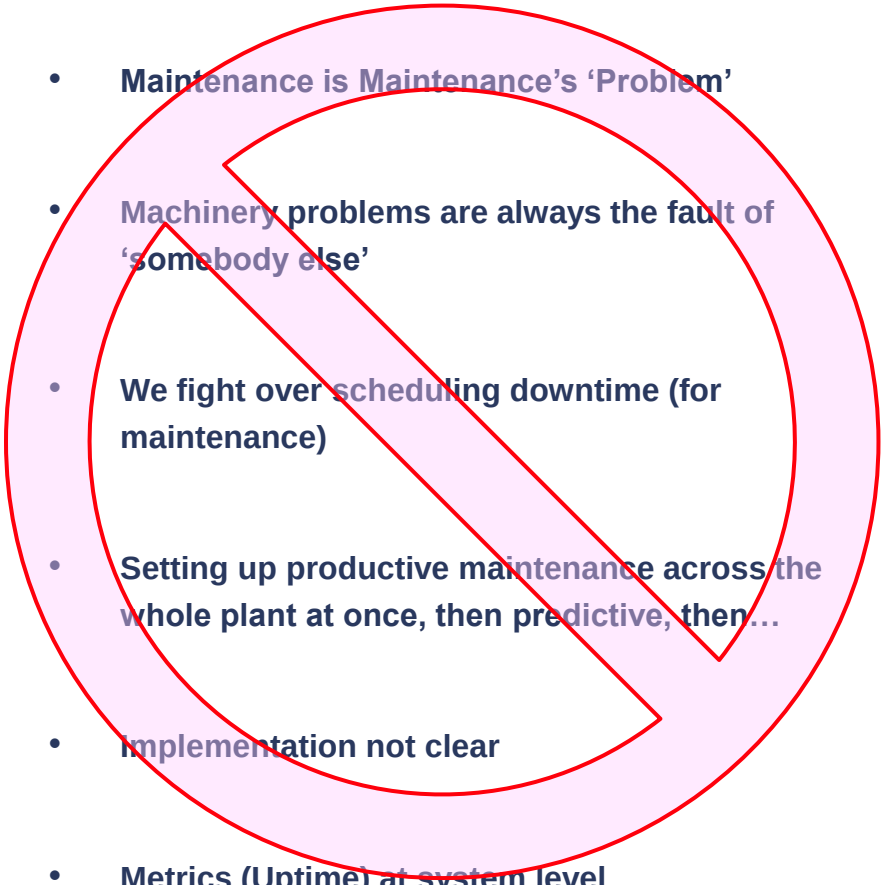
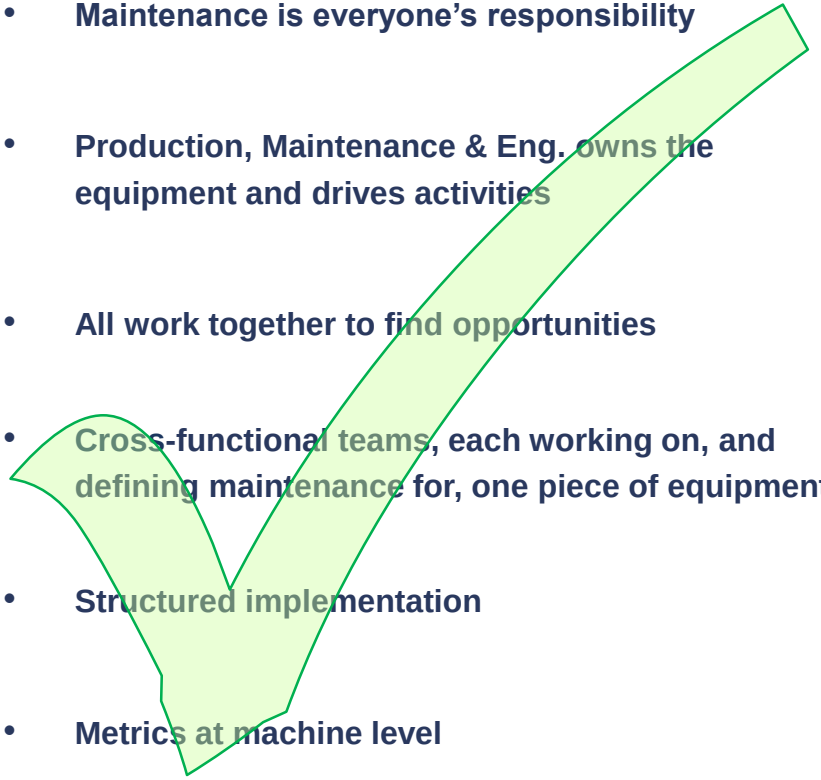
Auditor Hints – page 50

Prev. Requirement Next Requirement

Total Productive Maintenance Philosophy



- Maintenance is Maintenance's 'Problem'
- Machinery problems are always the fault of 'somebody else'
- We fight over scheduling downtime (for maintenance)
- Setting up productive maintenance across the whole plant at once, then predictive, then…
- Implementation not clear
- Metrics (Uptime) at system level



- Maintenance is everyone's responsibility
- Production, Maintenance & Eng. owns the equipment and drives activities
- All work together to find opportunities
- Cross-functional teams, each working on, and defining maintenance for, one piece of equipment
- Structured implementation
- Metrics at machine level

It is a change from *" I Run It, You Fix It"* attitude to *" We Take Care of Our Own Equipment"* attitude.

Level 1 Maintenance – Principles

- The operator, who is always near the equipment, is able to ensure all the checks and the maintenance basic operations. He prevents the degradation of the equipment
- Operations performed by the operator alone with his 5 senses or with very basic tools

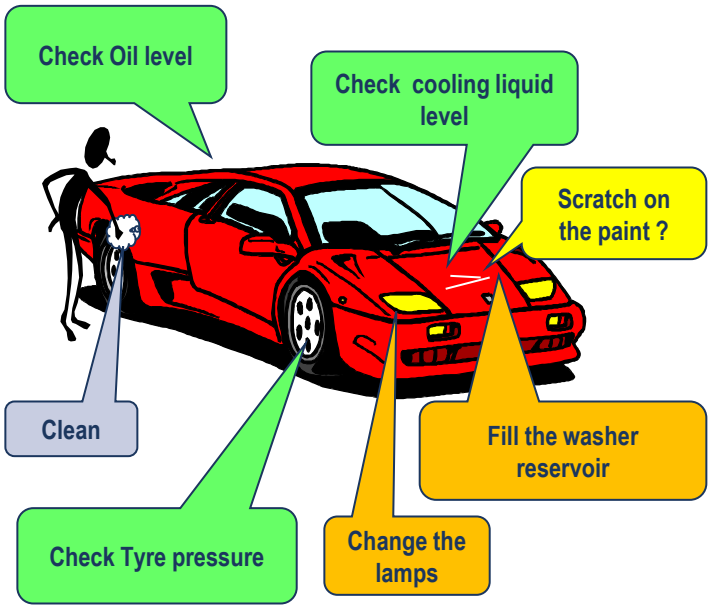
Visual checking

Cleaning

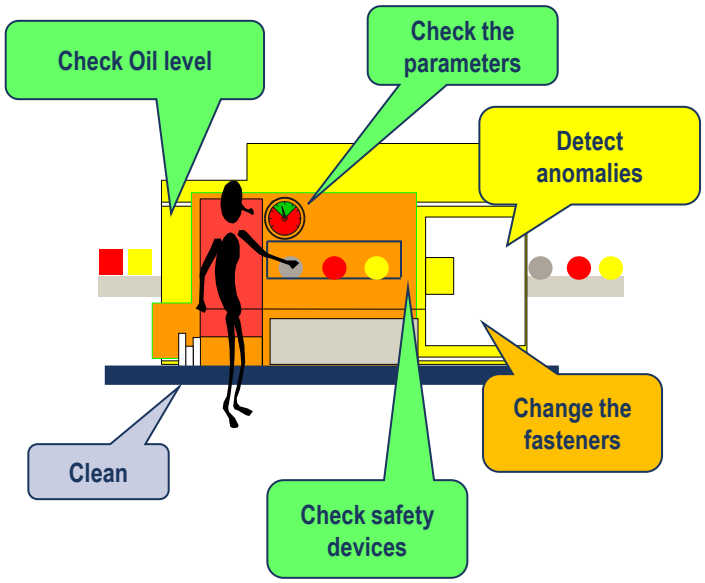
Small deviation detection

Basic tuning Self maintenance

I take care of my car



I take care of my machine



Level 1 Maintenance – Operator Maintenance

- Operator Maintenance enables operators to perform repetitive maintenance tasks such as equipment cleaning, lubrication, routine inspections, minor repairs, etc., thus freeing up the maintenance team members to spend more time on value added activity and technical repairs. Operators are responsible for the upkeep of their equipment to prevent it from deteriorating. The aim is to maintain the equipment in new condition.
- Operator maintenance involves equipment operators in keeping the machines running smoothly, through daily cleaning and inspection as well as training to recognize early signs of trouble and making simple repairs.
- Production team members and team leaders are trained to perform maintenance tasks and repairs as defined by standardized work documentation.

Level 1 Maintenance – Operator Maintenance

- Production team members are an important part of our maintenance system because they know the equipment the best. Working with the machine or equipment on a daily basis allows them to quickly know when something is wrong, what maintenance is required to keep it running smoothly, and the improvements that can be made to the equipment and workplace.
- Operator maintenance tasks are simple in nature. They include:

- Create/maintain visual management and 5S in their workplace
- Clean & Inspect equipment
- Perform daily maintenance (lube, etc…)
- Quality checks and adjustments
- Diagnose equipment-related defects

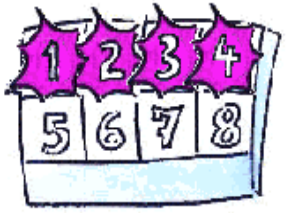
- Change tooling, etc.
- Equipment fault resets
- Make minor repairs & adjustments
- Maintain performance documentation

Level 1 Maintenance – Operator Maintenance

- Production is responsible for the completion of operator maintenance according to their local operating plan. If operator maintenance tasks are behind schedule, production is responsible for prioritizing operator task completion.

- **Planned**
  - During normal operations (planned gaps/scheduled times)
  - When buffers are full
  - When production levels are met

  (This will often differ between shops)



- **Unplanned (opportunistic)**
  - During large breakdowns
  - Unscheduled downtime
  - As unplanned TPM times are usually unevenly distributed among shifts, team members should assume the tasks of another shift (depending on the local operating plan) once they have completed the TPM tasks for which they are responsible.

Operator Maintenance – Cleaning, Clearing & Organizing

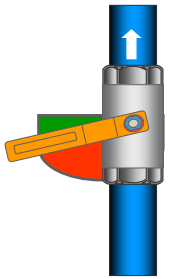
- Cleaning, clearing and organizing is crucial and a highly visible part of operator maintenance activities.
- Ensure safety training and understanding so team members work safely.
- Get rid of all dirt, debris, stains and prevent accelerated deterioration.
- Lubricate, tighten fasteners as appropriate.
- Identify hidden problems made apparent by cleaning, and correct them.
- Touch all parts of the equipment to find broken, loose, worn, damaged, or missing elements. Tighten fasteners as appropriate. (Utilize work order process when required).
- Organize the workplace.
- In short, maintain the machine to it’s original performance; attaining the desired Quality, Safety, and Productivity levels.

Operator Maintenance – Things to check (visual) (Example)

Pressure on manometers

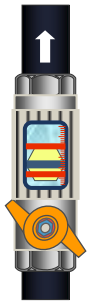
Needle in the green zone

Valves



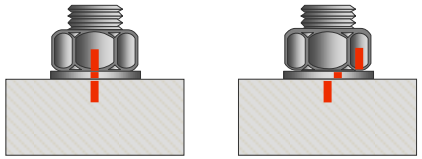
Closed position in the green zone

Flowmeter



Indicator between the red lines

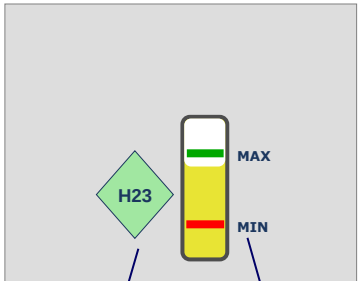
Detection of loosening



OK: marks aligned

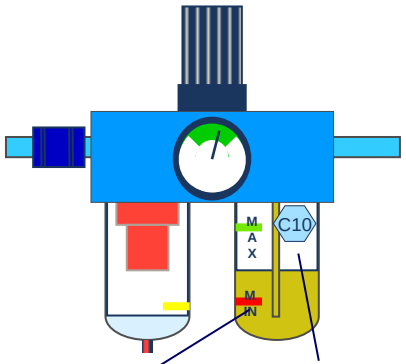
OK: marks are misaligned. The bolt is untighted

Visual standard to immediately detect deviations



Lubricant Reference

Level

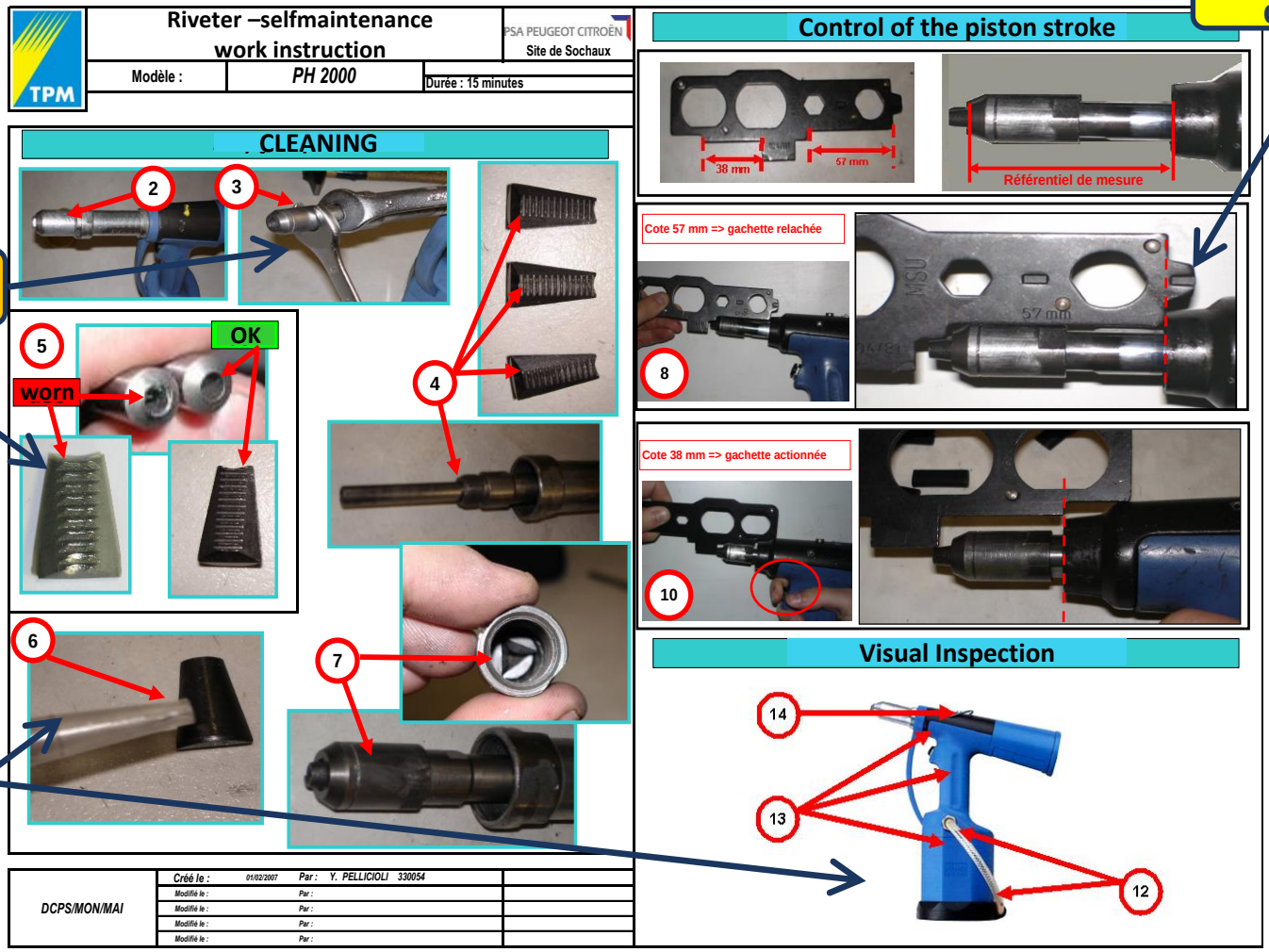


Level

Lubricant Reference

Level 1 Maintenance – Self Maintenance Example

(Example)



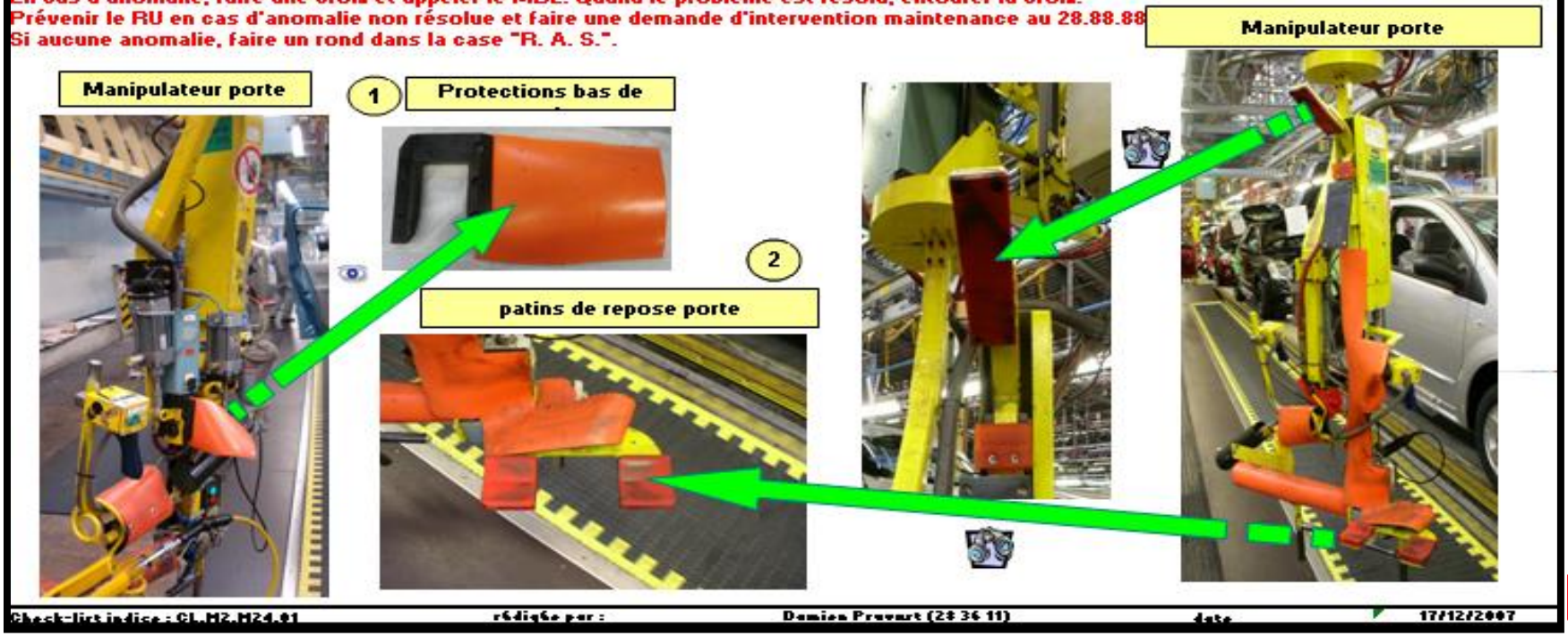
Level 1 Maintenance – Check List Example (Example)

DIFA/DCPA/MON 2	TPM FABRICATION CHECK-LIST DE PRISE DE POSTE	Poste : 15G Montage porte ARG	PSA PEUGEOT CITROËN

SEMAINE : UTILISATEUR : Opérateur

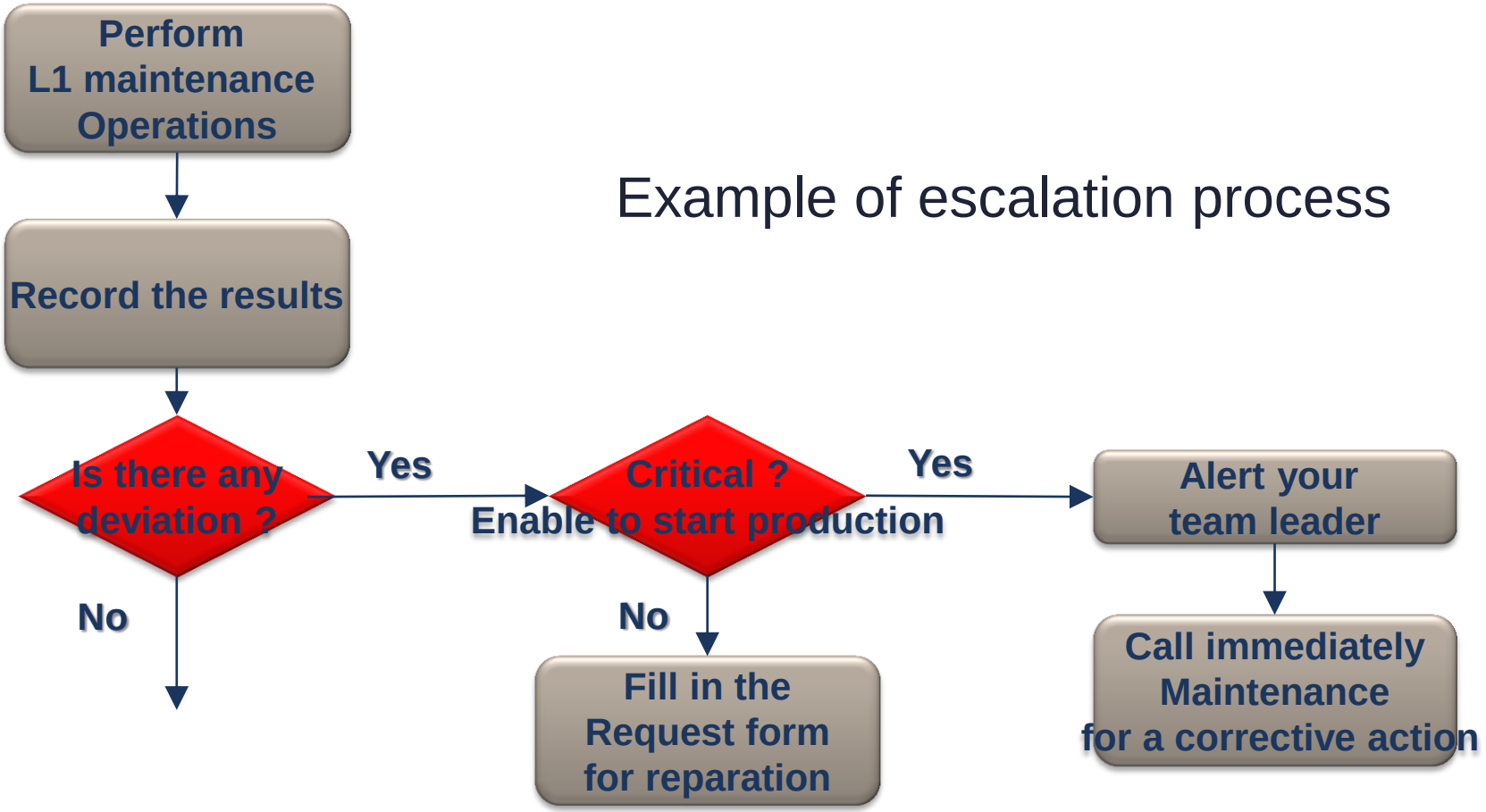
Référence : A changer prise de poste.		Lundi			Mardi			Mercredi			Jeudi			Vendredi			Samedi		
		A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
PRESENCE ET ETAT DES PROTECTIONS BAS DE PORTE	1																		
ETAT ET USURE PATIN DE REPOSE PORTE	2																		

En cas d'anomalie, faire une croix et appeler le MDL. Quand le problème est résolu, entourer la croix.
Prévenir le RU en cas d'anomalie non résolue et faire une demande d'intervention maintenance au 28.88.88
Si aucune anomalie, faire un rond dans la case "R. A. S.".



Check-list indice : CL-M2-M24.01 | rédigée par : Damien Prevost (28 36 11) | date : 17/12/2007

Level 1 Maintenance – Key Activities of Operator Maintenance



Example of escalation process

Continuous Improvement – Based on Maintenance Feedback

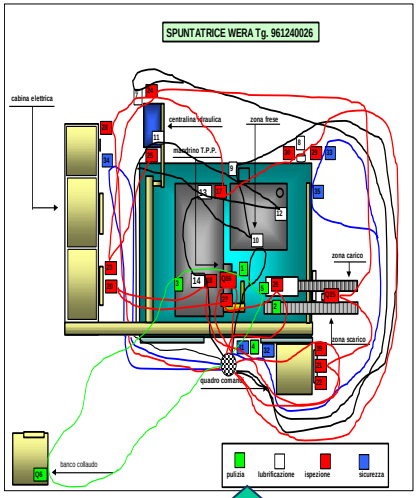
- The organization shall have a continuous improvement process which supports the manufacturing output improvement.
- The continuous improvement could be performed by:
  - **Operator:**
    - Once TPM is established, Operator Maintenance becomes self-sustaining and continuously improving.
    - Operators monitor their own work and implement improvements
    - Operators continuously improve the existing standards to identify new aspects of the workplace to be managed, and set appropriate standards for them; e.g. raw materials, tools, spare parts, gauges, location of bins and pallets, location of fixtures, etc.
    - Operators continuously improve their standardized work, check sheets, task frequencies and visual controls to remove unnecessary, wasteful, or uneven work.
    - Data is used to drive adjustments and improvements.

Continuous Improvement – Based on Maintenance Feedback
(Continued)

- **Maintenance Team:**
  - The maintenance team works to improve the efficiency and cost of the maintenance activities. Maintenance teams gather experience with the equipment and begins to identify the components where preventive maintenance should be applied or re-engineered.
  - Existing maintenance standards are reconsidered based on careful observation of the equipment and it's deterioration under the existing maintenance standard. Components that are substituted are inspected for signs of wear and the maintenance frequencies are adjusted accordingly.
  - Unnecessary inspections and substitutions should be eliminated
  - **The tools of continuous improvement are applied to maintenance Standardized Work for periodic repairs – how can they be made more efficient? How can waste be eliminated from maintenance activities? What additional skills and trainings would improve efficiency? (See next Slide)**
  - Emphasis is placed on identification and prioritization of process constraints (bottlenecks), by utilizing the Throughput Improvement Process (TIP) *(e.g. 'rolling' Top 5 'worst').*
  - Apply all improvements to similar equipment in the plant and/or company.
  - Data is used to drive adjustments and improvements.

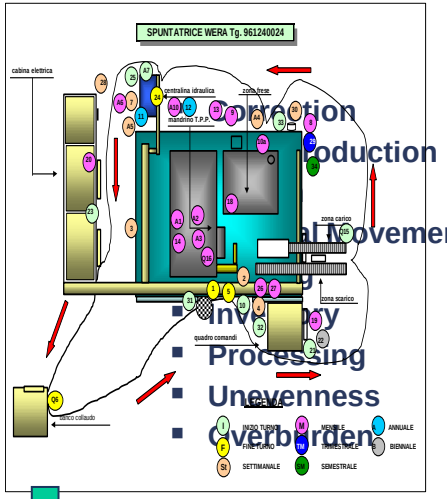
Continuous Improvement – Maintenance Activity

PLAN



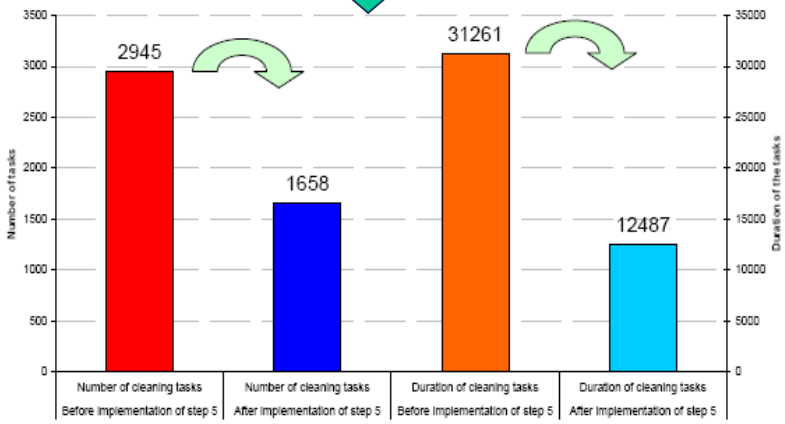
Identify and Eliminate Waste

DO

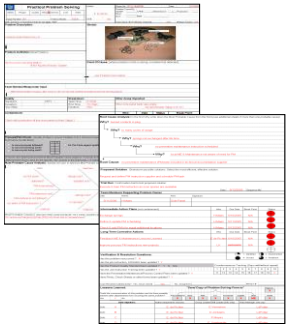


- Correction
- Production
- Material Movement
- Inventory
- Processing
- Unevenness
- Overburden

CHECK



ACT



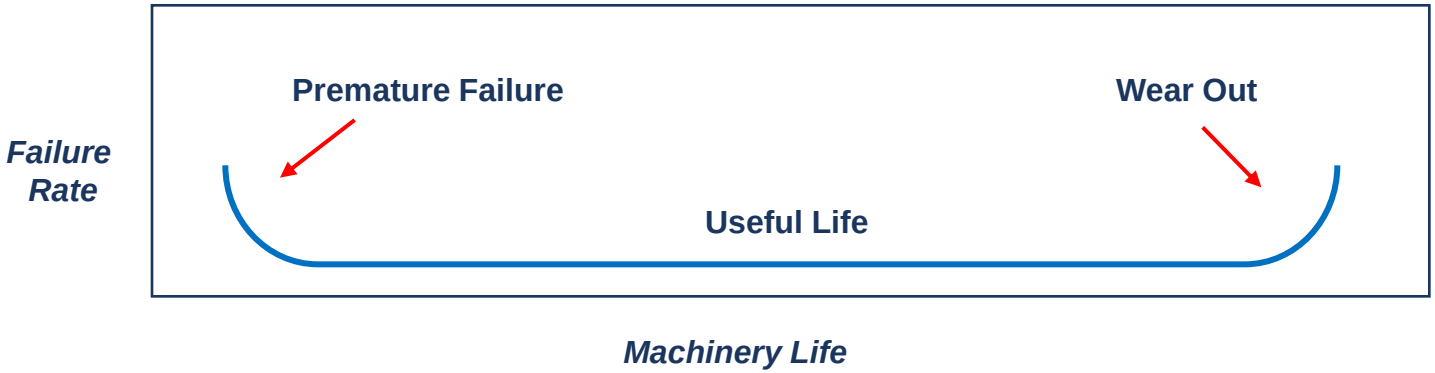
Problem Solve and Countermeasure The Unexpected (if necessary)

Reliability & Maintainability

- The main objectives of Reliability and Maintainability are to;
  - Design and improve equipment effectiveness
  - Optimize equipment availability
  - Improve/eliminate the operational and maintenance problems with any new generation of equipment/machinery
  - Ensure new equipment can be easily maintained
  - Ensure production requirements are met
  - Purchase equipment with low, predictable failure rates
  - Lower life cycle costs to maintain competitiveness.
  - Collect data/feedback from current equipment to support continuous improvement of equipment design

Reliability & Maintainability – Life Cycle

- Reliability and maintainability concepts are used in the life cycle phases of manufacturing machinery and equipment to support up-front engineering in the design process.
- There are many life cycle failure patterns depending on the component (ex. mechanical, electrical, electronic, etc.). One typical failure pattern we see for new machinery and equipment consists of three phases:
  - Premature Failure
  - Useful Life
  - Wear Out



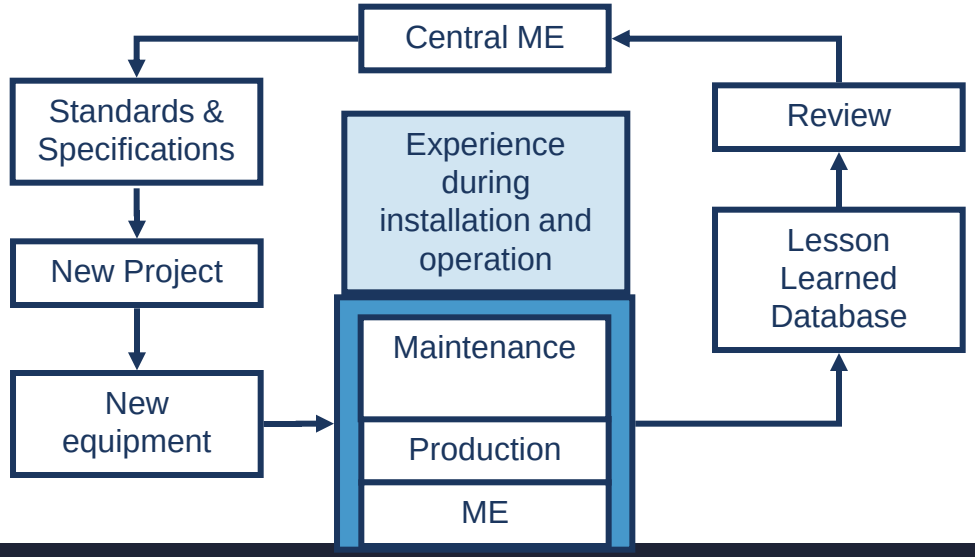
Reliability & Maintainability – Suppliers

- **Suppliers are a large part of reliability and maintainability and they must support this process with deliverables such as:**

  - Bill of Materials at design completion
  - Recommended spare parts lists
  - Technical training development & documentation
  - Hands on training with appropriate plant personnel
  - Run-off reports (failures and corrective actions)
  - Failure Mode Effects Analysis
  - Equipment preventative maintenance tasking lists
  - Baseline data for predictive technologies
  - Documentation such as lubrication charts and repair manuals
  - Effective use of predictive technologies on their equipment.
  - Effective labeling to allow quick decision making
  - Easy access to all controls and readout devices

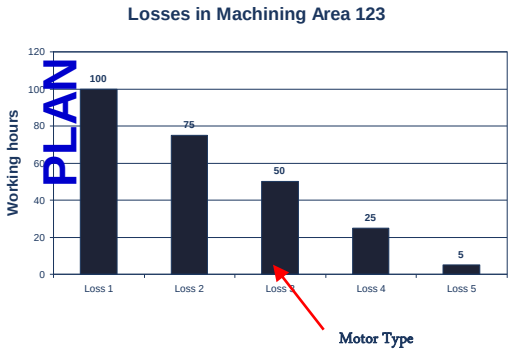
Reliability & Maintainability – Continuous Improvement

- **It is vital that all the lessons learned, modifications to equipment design, and equipment performance are well documented and fed back to engineering**
- **It is engineering's responsibility to understand the changes, offer additional suggestions for continuous improvement, and to change the standard for future equipment so that they arrive with the improvements already 'built in'.**
- **Throughout the operator and technical maintenance processes; a safe, effective, and optimized maintenance plan is developed – the plan must then be copied to other similar equipment in the plant or across the company.**



Reliability & Maintainability – Continuous Improvement

PLAN



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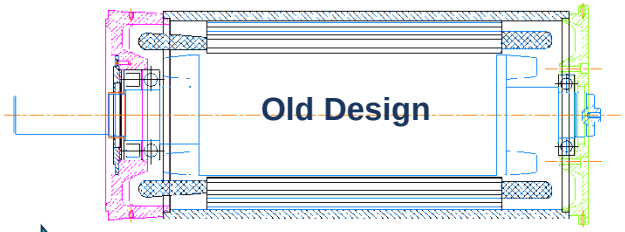
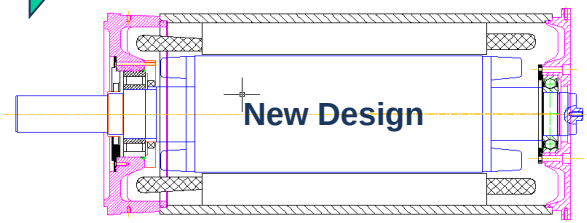


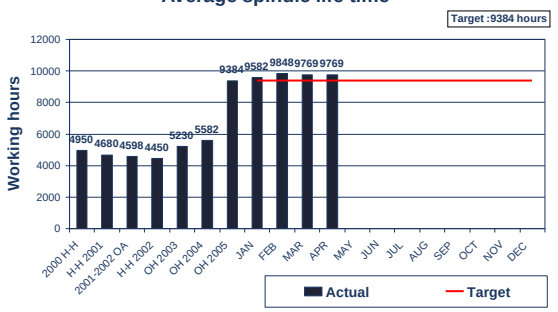
Cylindrical roller bearing
No greasing possibility
Average lifetime 0.5yr



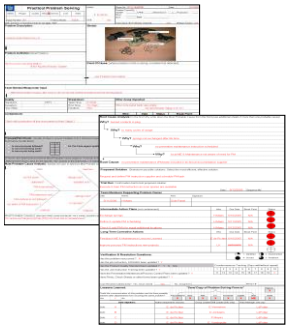
Reconstruction of shield
Installation of greasing possibility
Use of SKF Carb. bearing
Expected lifetime >1.0yr

CHECK

Example



ACT



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Continuous Improvement – Based on Maintenance Feedback

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    - Operators continuously improve their standardized work, check sheets, task frequencies and visual controls to remove unnecessary, wasteful, or uneven work.
    - Data is used to drive adjustments and improvements.

Preventive Maintenance Planning (Example)

Equipem.	Désignation objet technique	ABC	Op.	Désign. opération	Pos. trav	El	TOT.	2008 S43	S44	S45	S46	S47	S48	S49	S50	S51	S52
900000015	CH3-ASSEMBLAGE2003 TAB 3P+COLL ASSEMB 2	A	10	CONSIGNE G730	MC12GR	A	3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3
1001058	CH3-BORDENBC MALAXEUR BORDEN BC	B	10	CONSIGNE M760	MC12ME	A	2,5	0,5		0,5				0,5		0,5	
1001211	CH3-ARMCOLLECT ARMOIRE SABLERIE 0M	B	10	CONSIGNE DE DEMARRAGE DIMANCHE SOIR	MC12EL	A	1		0,5								
1001241	CH3-DEGRAPL10 DEGRAPPEUSE PL10	B	10	CONSIGNE ATF POSTE DE DEGRAPPAGE PL10	MC2	M	1,5	0,3		0,3		0,3		0,3		0,3	
900000020	CH3-ASSEMBLAGE2008 ROBOT 1 ABB64N17545	C	10	NETTOYAGE CLIM 1	MC12EL	A	0,9		0,3			0,3			0,3		
			20	NETTOYAGE CLIM 2	MC12EL	A	0,9		0,3			0,3			0,3		
			30	NETTOYAGE CLIM 3	MC12EL	A	0,9		0,3			0,3			0,3		
			40	NETTOYAGE CLIM 4	MC12EL	A	0,9		0,3			0,3			0,3		
			50	NETTOYAGE CLIM 5	MC12EL	A	0,9		0,3			0,3			0,3		
1000914	CH3-GAZEUR3DV GAZEUR DV 3	C	10	CONSIGNE M540	MC12ME	A	1,2	0,3		0,3			0,3			0,3	
1000917	CH3-GAZEUR6DV GAZEUR DV 6	C	10	CONSIGNE M540	MC12ME	A	0,6		0,3								0,3
1000920	CH3-HANSBERG3DV NOY HANSBERG 3 DV	C	10	CONSIGNE W508	MC12ME	M	0,3					0,3					
1000921	CH3-HANSBERG4DV NOY HANSBERG 4 DV	C	10	CONSIGNE W508	MC12ME	M	1,2	0,3			0,3			0,3			0,3
1000922	CH3-HANSBERG5DV NOY HANSBERG 5DV	C	10	CONSIGNE W508	MC12ME	M	0,9	0,3				0,3				0,3	
1000923	CH3-HANSBERG6DV NOY HANSBERG 6 DV	A	10	CONSIGNE M511 A	MC12ME	A	0,3				0,3						
			20	CONSIGNE M511 B	MC12ME	A	0,3				0,3						
900000090	CH3-MCCL04/003 DECHARG ABB64N17411	A	10	NETTOYAGE CLIM	MC12EL	A	3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3
1000980	CH3-PL1 POSTE EN LIGNE 1	B	10	CONSIGNE G501	MC12GR	M	2,5	0,5		0,5		0,5		0,5		0,5	
1000985	CH3-PL4 POSTE EN LIGNE 4	B	10	CONSIGNE M503	MC12ME	A	1		0,5			0,5					
1001052	CH3-ASPI12M ASPIRATION 12M CLS	B	10	AR/DEM ASPI 12M	MC12EL	A	1,5	0,3		0,3		0,3		0,3		0,3	
1001058	CH3-BORDENBC MALAXEUR BORDEN BC	C	10	CONSIGNE E760	MC12EL	M	0,6		0,3			0,3					
1001120	CH3-NOY228BC NOY 228 BC(24/5REP6)	A	10	CONSIGNE M707 (NOY 228BC)	MC12ME	A	1,2	0,3		0,3			0,3			0,3	
1001122	CH3-NOY250BF NOYAUTEUSE 250 BF	B	10	CONSIGNE M715	MC12ME	A	0,6		0,3								0,3
1001124	CH3-NOY251BF NOYAUTEUSE 251 BF	B	10	CONSIGNE 715	MC12ME	A	0,3					0,3					
1001126	CH3-NOY252BF NOYAUTEUSE 252 BF	B	10	CONSIGNE E708 252BF	MC12EL	A	1,2	0,3			0,3			0,3			0,3
1001126	CH3-NOY252BF NOYAUTEUSE 252 BF	C	10	CONSIGNE 715	MC12ME	A	3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3
1001128	CH3-NOY253BF NOYAUTEUSE 253 BF	A	10	CONSIGNE 715	MC12ME	A	0,3				0,3						
1001130	CH3-NOY254BF NOYAUTEUSE 254 BF	B	10	CONSIGNE 715	MC12ME	A	0,5					0,5					
1001132	CH3-NOY255BF NOYAUTEUSE 255 BF	B	10	CONSIGNE 715	MC12ME	A	2	0,5		0,5			0,5			0,5	
1001134	CH3-NOY256BF NOYAUTEUSE 256 BF	B	10	CONSIGNE 715	MC12ME	A	0,5				0,5						
1001136	CH3-NOY257BF NOYAUTEUSE 257 BF	C	10	CONSIGNE 715	MC12ME	A	3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3
1001138	CH3-NOY258BF NOYAUTEUSE 258 BF	B	10	CONSIGNE 715 A	MC12ME	A	2,5	0,5		0,5		0,5		0,5		0,5	
							2,5	0,5		0,5		0,5		0,5		0,5	
							2,5	0,5		0,5		0,5		0,5		0,5	
1001388	CH3-TAPIS220 TAPIS 220	A	10	CONSIGNE TAPIS 220 (GRAISSAGE G621)	MC12GR	A	1,2	0,3		0,3			0,3			0,3	
1001390	CH3-TAPIS221 TAPIS 221	B	10	CONSIGNE TAPIS 221 (GRAISSAGE G622)	MC12GR	M	0,6		0,3								0,3
1001834	CH3-MACHCOQUIL7 COQUILLEUSE REP7 1DW	B	10	CONSIGNE MB07	MC12ME	A	0,3					0,3					
1001241	CH3-DEGRAPL10 DEGRAPPEUSE PL10	B	10	CONSIGNE G609	MC12GR	M	1,2	0,3			0,3			0,3			0,3
1001243	CH3-DEGRAPL11 DEGRAPPEUSE PL11	C	10	CONSIGNE G609	MC12GR	M	1,2	0,3		0,3			0,3			0,3	
1001392	CH3-TAPIS222 TAPIS 222	A	10	CONSIGNE G623 (GRAISSAGE TAPIS)	MC12GR	M	0,3				0,3						

Weeks

List of equipment

List of maintenance operations to perform

Always red => Frequency must be increased

Always green => Frequency can be decreased

0,3 **Operation postponed**

~~0,3~~ **Operation not performed**

0,3 **Near miss breakdown. Emergency reparation needed**

0,3 **OK, no reparation needed**

0,3 **Limit, reparation needed, no emergency**

Document allows:

- To follow up preventive operations
- To identify maintenance plan improvement

Auditor hints

During the audit, look for:

- Ask operators about Level 1 maintenance responsibilities.
- Verify few L1 maintenance working instruction and record.
- Look at the equipment status on the shop floor (is there an identification (number), cleanliness, protection in good condition, leakage, …).
- LPA records.
- Evidences of activities transfer from preventive maintenance to L1.

Spare Parts, what are we searching for ?

Item	Requirement	#Criteria	Criteria requirement
MAI3	The spare parts and their storage are managed. The critical parts are identified.	MAI31	**A list of critical spare parts is determined, managed and regularly updated.**
		MAI32	**A spare parts stock is available with a minimum stock level for critical spare parts. Spare parts tracking system is combined with maintenance system in order to control physical inventory.**
		MAI33	**The spare parts are stored in suitable conditions**
		MAI34	An approach of standardisation / optimization of the equipment is deployed (for example: use of the same filters, same interfaces tools, etc).
		MAI35	Periodic physical inspections are performed for long term stored items.

Criteria of Requirement

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List of Critical Spare Parts

(Example)

Drawing #	Id #	MNEMO	Supplier	Supplier Reference	DESIGN	Stock (mini)	Critical
1045949300	4301		ARELEC	351128	AIMANT DIA16 vis FHcM3	5	O
1045949300	4302		VANEL	T050.050.0200A	RESSORT DE TRACTION	1	O
1045949300	4306		CAPRI CODEC SA	672107	CONDUIT STANDARD NOIR ADAPTALOCK PG21	4	O
1045949300	4341		RADIOSPARES SAS	187-7621	CLIPS SERRE CABLES	1	N
1045949300	4342		RADIOSPARES SAS	316-872	CLIPS SERRE CABLES	1	N
1045949300	4345		CAPRI CODEC SA	681607	EMBOUT DE GAINE ADAPTALOCK	2	O
1045949300	4347		CAPRI CODEC SA	671607	CONDUIT STANDARD NOIR ADAPTALOCK	2	O
1045949300	4348		CAPRI CODEC SA	211600	REDUCTEUR DE PRESSE ETOUPE PG21 / PG16	1	N
1045949300	4349		LUTZE SA	601005	REDUCTEUR DE PRESSE ETOUPE PG16 / M32x1,5	1	N
1045949003	4305	VBNG	BOSCH REXROTH SAS	0822390607	VERIN COMPACT A GUIDAGE	1	O
1045949003	4307	VCARNG	ASCO JOUCOMATIC SA	42900028	mini verin filete s.effet	1	O
1045949003	4309		LEGRIS SA	3101 04 19	RACCORDS INSTANTANES	1	O
1045949003	4340		STAUBLI FAVERGES	COMBITAC 34.0020	CONNECTEUR FICHE	1	O
1045949011	4338		LUMBERG	RKMF 3/05M	EMBASE FEMELLE M8 3 POLES	4	O
1045949011	7301	SDEPG	HBM FRANCE SARL	K-WA-T-010W-32K-K2-F1	CAPTEUR DEPLAC. INDUCTIF	1	O
1045949011	7304	SQ_ESSNG	IFM ELECTRONIC	KF5001	DETECTEUR DE PROXIMITE	1	O
1045949011	7305		IFM ELECTRONIC	EVC008	CONDUCTEUR A USAGE PARTICULIER EQUIPE	1	N
1045949011	7306		LUMBERG	RSMCK3	PRISE DE COURANT ET CONNECTEUR	1	N
1045949011	7307	SQ_TAMNG	SCHNEIDER ELECTRIC France	XS1N05PA311S	DETECTEUR DE PROXIMITE KE2-0000015	1	O
1045949011	7308		LUMBERG	RSMCK3	PRISE DE COURANT ET CONNECTEUR	1	N
1045949011	7312	SQREPBNG /	BOSCH REXROTH SAS	830100631	CAPTEUR SERIE ST6	2	N

Identification of the part on the equipment

Part reference, description & supplier

Stock Needed

Critical Part

Spare Parts Management

Identification of the critical spare parts

- Criteria to define critical spare parts shall be defined according to procedure by organization
- List update shall be conducted periodically based on maintenance results

Spare parts storage

- Storage conditions: suitable conditions shall be defined (procedure) in order to avoid damage
- Stock management: min condition shall be managed
- Inspections & verification: periodically the physical inspections of spare parts shall be defined and performed

Spare Parts Stock:

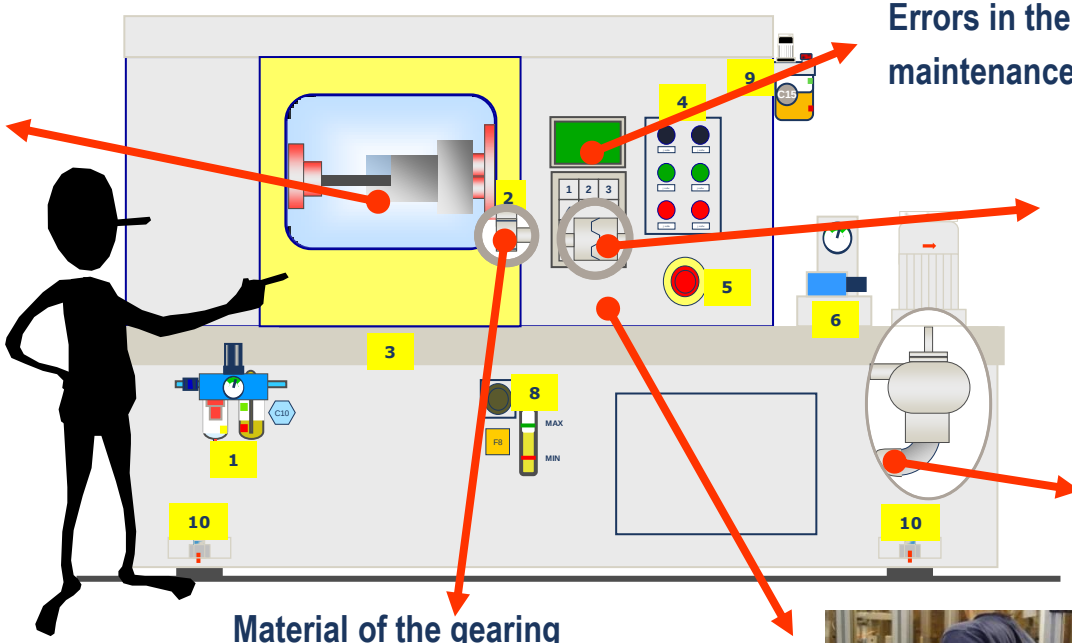
(Example)

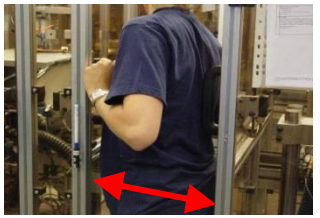
Standardization and Improvements

Improvement based Maintenance

- Identify the weak points of the equipment & root cause of breakdowns
- Implement action plans to improve reliability or maintainability

Difficult cleaning





Auditor hints

During the audit, look for:

- List of critical spare parts.
- Stock of spare parts: reception / organization / consumption
- Conditions of storage: rust, dust, contamination, etc.
- Computer aided system.
- Inventory (take an example of a critical part and verify the robustness of the inventory).
- Choose one spare part in the list and verify that a minimum stock level exist
- Ask if they have a policy to reduce spare part reference, quantity ? In order to reduce the value of stock spare part.
- Procedure to take a part from the stock
- Supply of spare parts: who is responsible ? / Relation between orders and stock management ?
- Choose one spare part, check that the location and quantity are correct in the storage

Customer Tools Management, what are we searching for ?

Item	Requirement	#Criteria	Criteria requirement
MAI4	The customer's product specific tools are managed to preserve tool condition till end of their lifetime.	MAI41	**Each Customer Specific Tool (CST), owned by customer, is identified in a single and inalterable way according to customer requirements (customer marking). Identification includes tool change level.**
		MAI42	**each CST is managed through a 'diary sheet' or equivalent document. It allows to track Lifetime of the tool (stroke number,…) and all maintenance activities.**
		MAI43	**The storage of the CST is organized and managed. Storage conditions guarantee the safeguarding of the CST until its end-of-life.**
		MAI44	Product/process re-qualification is carried out for each replacement tool according to customer requirement.

Criteria of Requirement

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Customer Tools Management

Scope

- Tools owned by the customer
- Tools dedicated to a specific part reference

Contractual requirements

- Identification
- Customer approval
- Logbook sheet, records & tool follow up

Storage conditions

- Rules related to store conditions after end of mass production phase and handling shall be established and followed.
- Records of tooling cleanness process shall be kept

Sub-Tier List

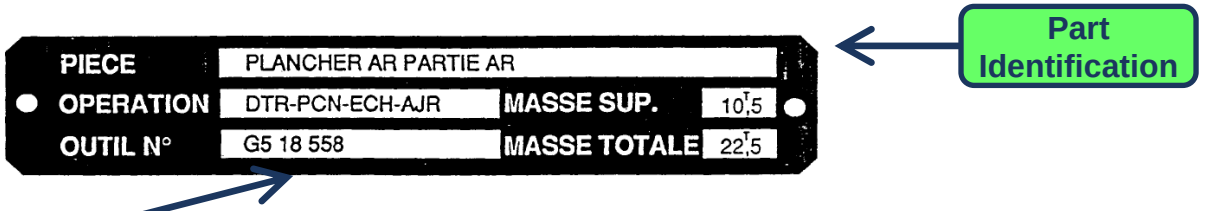
- A list of all tooling that are in the sub-tier shall be available

Tooling replacement

- When the tooling is replaced (for example due to worn out condition) an approval process (for example PPAP) shall be followed.

Customer Tools Management

- **CST Identification**



- **CST Logbook S**
- **A logbook is av** **CST**
- **In the logbook, the following information are tracked:**
  - Production history (nb of parts produced, functioning time, etc..)
  - Breakdowns history
  - Records of maintenance activities
  - History of modifications (with customer approval)
  - Quality records (if existing control plan)

Auditor hints

Check few tools to verify:

- General conditions of the tools (leakage, rust, ...)
- Identification and visual management of the tools
- A diary sheet and records, lifetime followed
- Communication & Customer approval for each change on a example
- Storage conditions
- Standardized maintenance operations

Maintenance Effectiveness, what are we searching for ?

Item	Requirement	#Criteria	Criteria requirement
MAIE	Indicators are defined and tracked to ensure effectiveness of all the maintenance activities.	**MAIE1**	**Performance & Reliability targets are defined on the basis of historical data and related indicators are tracked (e.g. OEE, Failure Rate, MTBF, MTTR, stop of lines).**
		MAIE2	**Paretos of breakdown.**
		MAIE3	**Planning of maintenance is managed and followed : Monitoring of the gaps to the planning of maintenance (included sub-contracted activities of maintenance).**
		MAIE4	Deviations found during spare parts inventory audit.
		MAIE5	Ratio of corrective maintenance against preventive maintenance.

Criteria of Requirement

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2 – page 71
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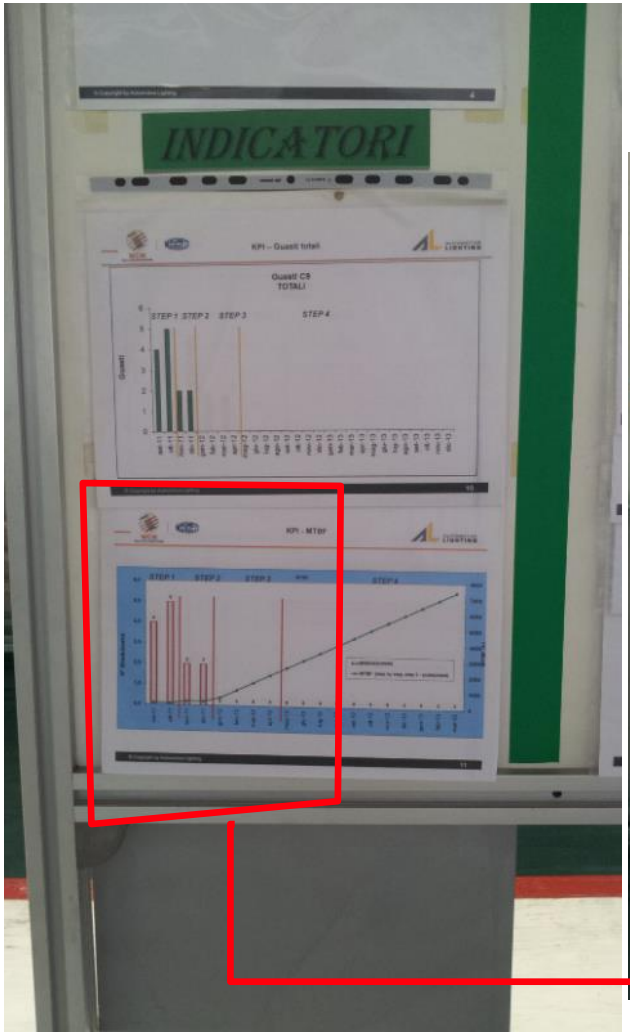
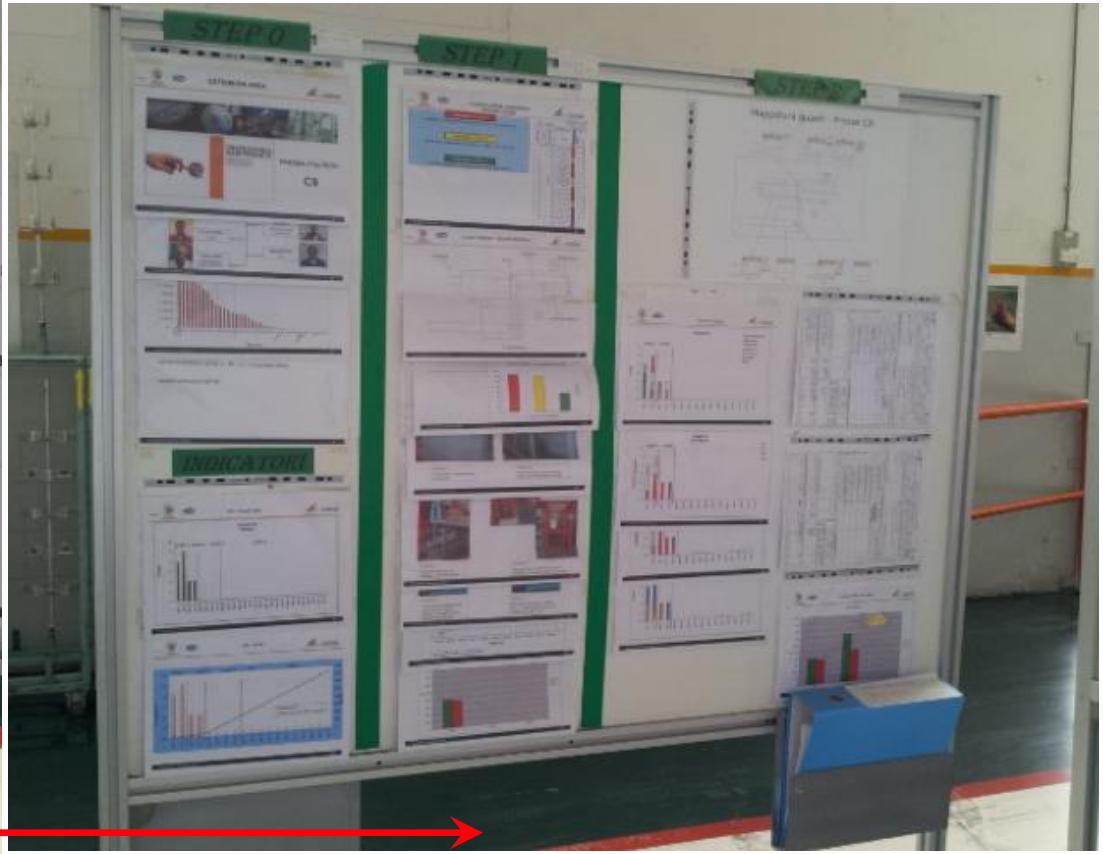
Prev. Requirement
What goes wrong

Maintenance Metrics Dashboard



(Example)



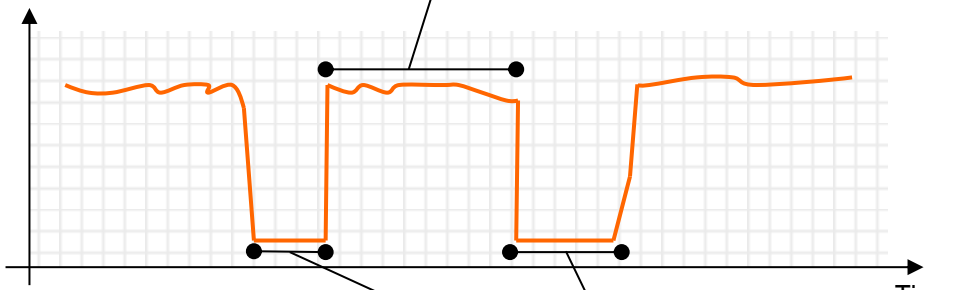
MTBF & MTTR

❑ MTBF

MTBF gives information on the **reliabiliy** of the equipment

Mean Time Before Failure

$$MTBF = \frac{\text{Operation Time}}{\text{Nb of breakdowns}}$$



❑ MTTR

MTTR gives information on the **maintenability** of the equipement (maintenance friendly)

Mean Time To Repair/Recovery

$$MTTR = \frac{\text{Reparation Time}}{\text{Nb of breakdowns}}$$

❑ High equipment effectiveness means

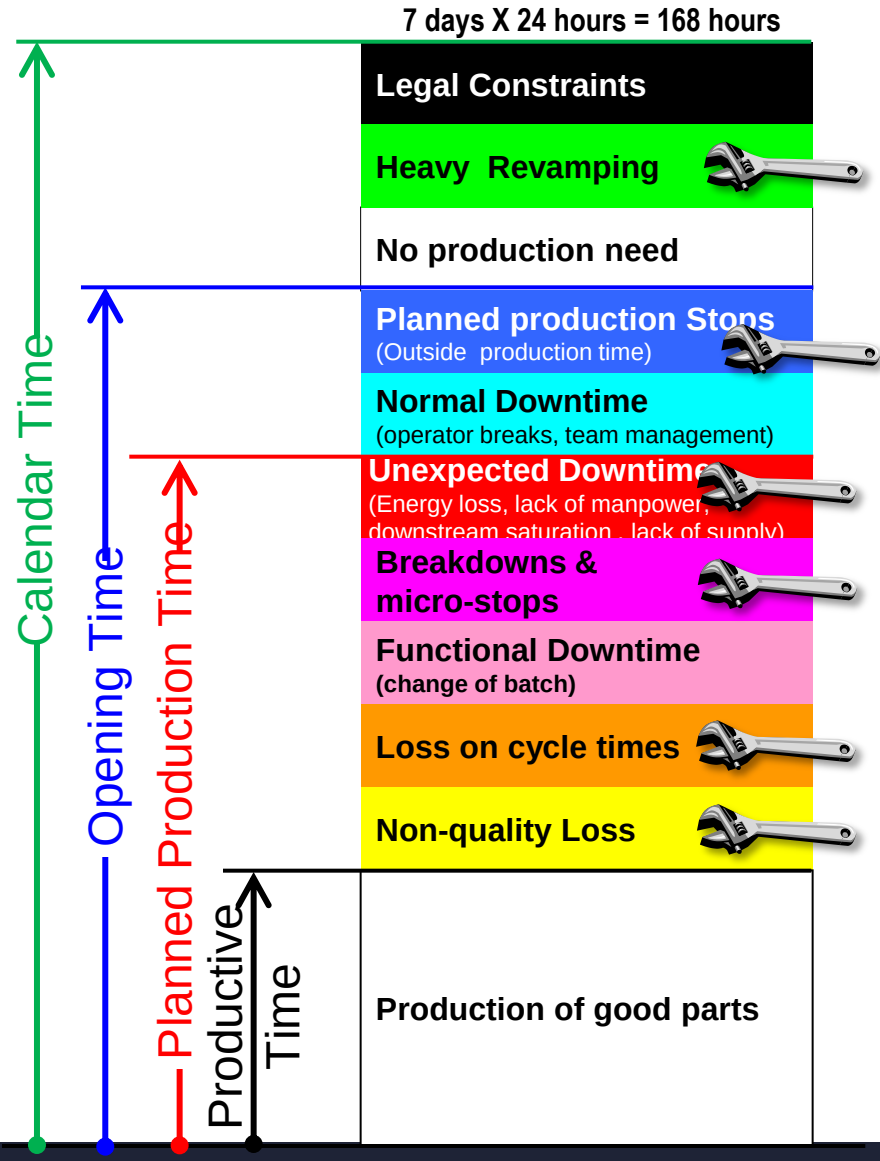
High MTBF ⊕ Low MTTR

Different measures of effectiveness

TEEP (Total Effective Equipment Performance)
Customer: Plant director & Shareholder

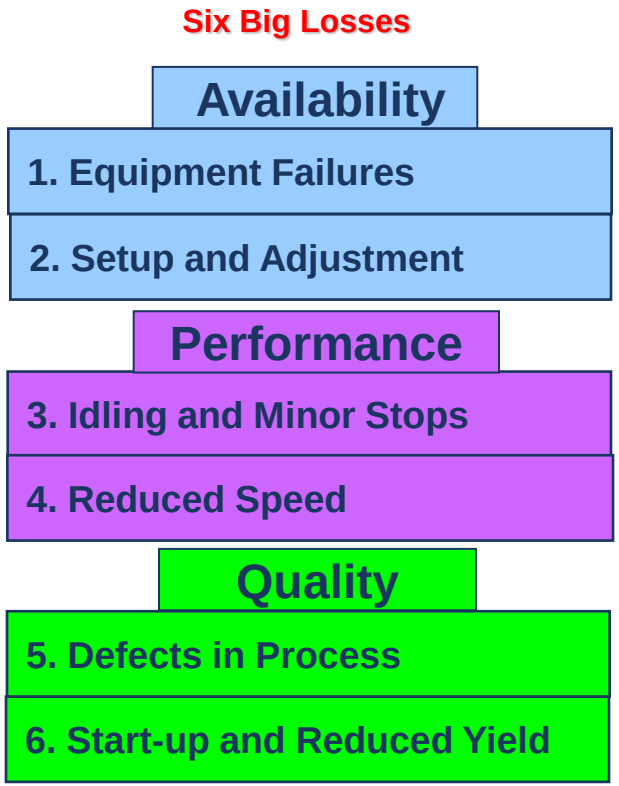
$$TEEP = \frac{Productive\ Time}{Calendar\ Time}$$

Maintenance involvement



TPM – Operating Equipment Effectiveness

- TPM supports maximizing Operating Equipment Effectiveness (OEE) through the elimination of the **Six Big Losses**. When breakdowns and defects are eliminated or reduced and equipment operational rates improve; costs are reduced, inventory can be minimized, and productivity increases.



1. **Breakdowns requiring repair**
2. **Changes in operating conditions requiring work**
3. **Temporary events such as halting, jamming, idling**
4. **Equipment not running at original or theoretical design speed**
5. **Products manufactured that are off-spec or defective requiring re-work or scrap**
6. **Changeover impacts causing reduced quality until stabilized**

TPM – Operating Equipment Effectiveness

- OEE is a common metric used for measuring TPM which tells us how effectively our equipment is running.
  - Improved as availability and productivity go up and in-process defects or rework goes down.
  - Reduced by equipment-related losses.
- OEE as a concept represents the integrated effects of the Six Big Losses
- Improvements in OEE result from reductions in the Six Big Losses

Availability % X **Performance %** X **Quality %** **= OEE**

Reliable Equipment

Right Capacity (speed) equipment building product as needed

With No Defects

Availability
1. Equipment Failures
2. Setup and Adjustment

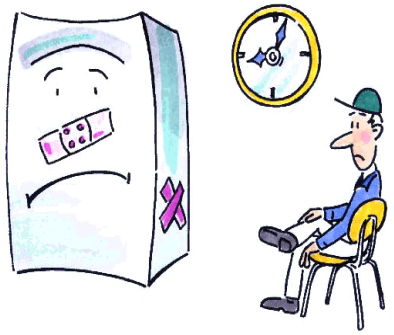
Performance
3. Idling and Minor Stops
4. Reduced Speed

Quality
5. Defects in Process
6. Start-up and Reduced Yield

Availability Losses

1. Equipment Failures

When the equipment breaks, and you can not run production, it takes time and resources to correct the problem. In turn the breakdown results in additional overtime to meet the production goals. Ultimately the plant loses money through breakdown losses.



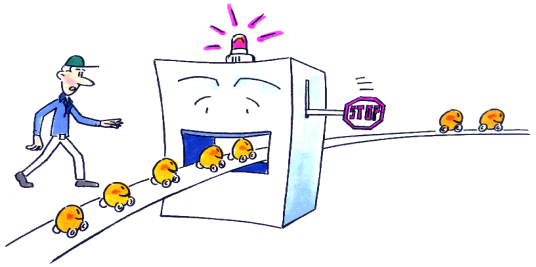
2. Set up and Adjustment

Set up losses occur when it takes time to change tools and dies. Tools and dies are changed with model changes, when a new tool is required, or adjustment is required on a machine to turn out the next good part. Improvements can be made by focusing on establishing standardized work and operational standards for External and Internal Set-Ups and equipment/tool changeovers.

Performance Losses

3. Idling and Minor Stoppages

Sometimes while running the machine, minor stoppages occur. For example, a part is not properly placed, a welding gun gets stuck to a part, or the material flow in a machine is not right. These minor stoppages can add up, and the job will require additional time to finish. These are referred to as idling and minor stoppages.



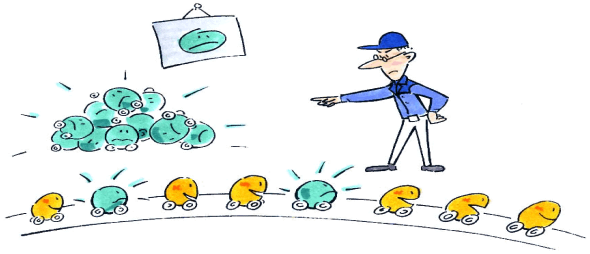
4. Reduced Speed

Speed loss occurs when there is a difference between the speed at which a machine is designed to operate (ideal operating cycle) and its actual speed. For example, we experience speed loss when a machine is intentionally slowed down because its designed speed results in quality defects or mechanical problems which cause downtime.

Quality Losses

5. Defects in Process

Defective products may be produced due to a malfunction of a machine, an imprecise tool, tool wear, tool breakage, or lack of precision. Once a defect occurs, time must be invested in the repair or rework, or the part may have to be scrapped altogether.



6. Start-up and Reduced Yield

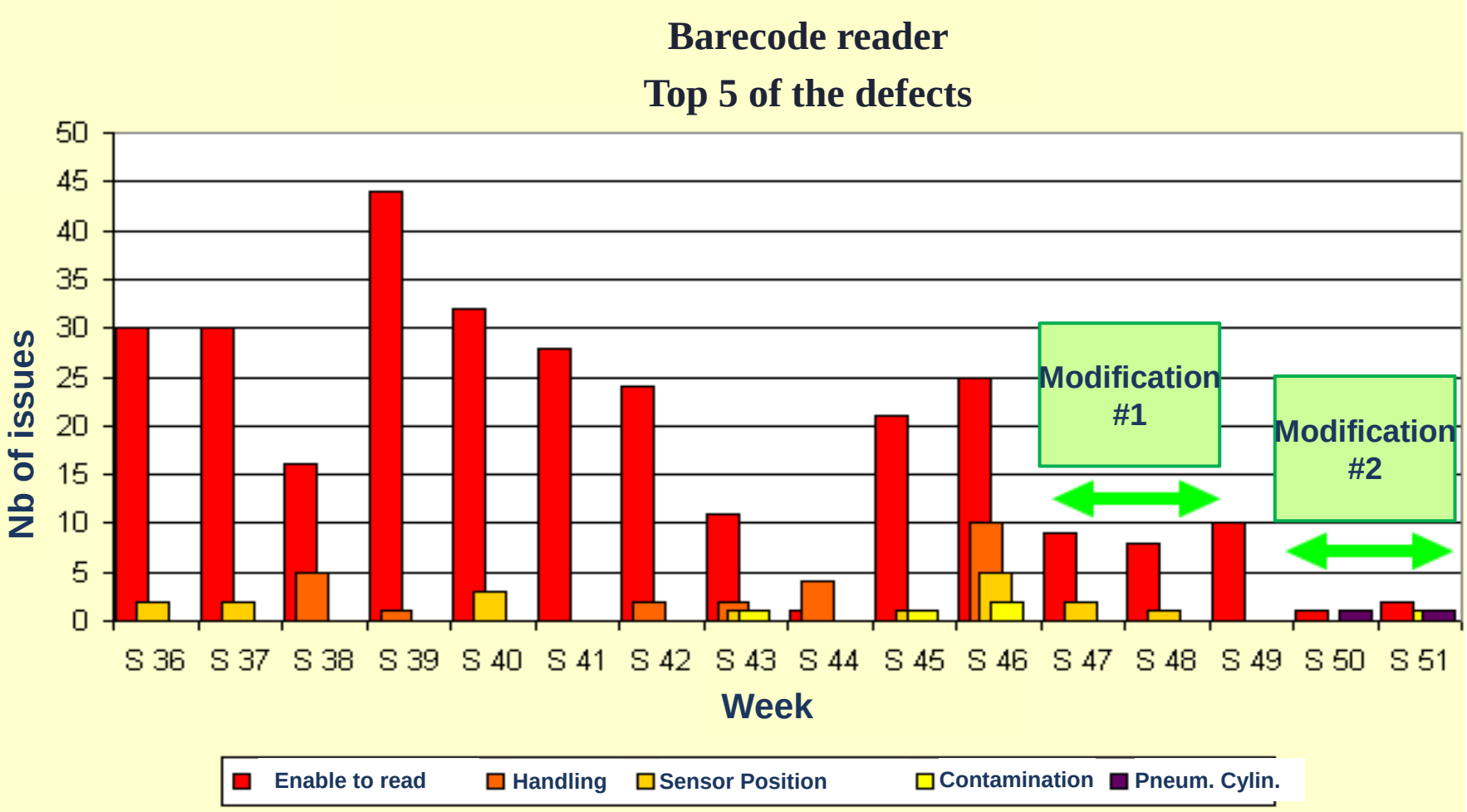
Start up losses are usually yield losses that occur during the early stages of production--from machine start up to stabilization. The volume of losses varies with the degree of stability of processing conditions; for example, the maintenance level and precision of equipment, fixtures, and tooling; operator skills, and so on. In machining plants, we also need to watch for *tool losses*--the losses and defects caused by tool wear or breakage--this is also considered yield loss.

TPM – Operating Equipment Effectiveness

- The six big losses are Waste!
- Waste elimination is about the right equipment building quality products as they are needed, without losses.

Total Productive Maintenance GMS: 7 Forms of Waste	Six Big Equipment Losses					
	Availability		Performance		Quality	
	Equipment Failures	Set-up & Adjustment	Idling & Minor Stops	Reduced Speed	Defects in Process	Start-up and Reduced Yield
Correction	X	X	X		X	X
Overproduction	X	X	X	X		
Material Movement	X	X			X	X
Motion	X	X	X	X	X	X
Waiting	X	X	X	X	X	X
Inventory	X	X			X	X
Processing	X	X			X	X

Pareto of breakdowns (example)



Metrics related to process

- **Ratio of preventive maintenance:**

$$\text{Ratio} = \frac{Preventive\ maintenance\ time}{Preventive\ Maint.+Corrective\ Maint.time}$$

  - Ability of the supplier to anticipate and manage the availibility of the equipment
  - Good situation : **above 50%**
  - Look at the trend: improvement or not ?

- **Ratio of L1 maintenance:**

$$\text{Ratio} = \frac{L1\ maintenance\ time}{Preventive\ Maint.\ time}$$

  - Ability of the supplier to anticipate severe issues. Deployment of L1 maintenance allows supplier to reduce maintenance cost and to center activity on equipment standardization & improvement
  - Look at the trend: improvement or not ?

Auditor hints

- Customer complaints caused by machine or tool problem (e.g.: burrs issue…).
- Verify quantity of few Spare Parts in stock.
- Check few maintenance working instructions whether they are standardized.

What goes wrong ?

- No preventive maintenance: they are waiting for breakdown … ➔ risk of major disruption
- Preventive operations are always postponed & frequency are not respected causing breakdowns
- No maintenance records ➔ unable to analyze situation & improve reliability
- Spare parts stock is not correctly manage: “dead references”, critical spare parts under mini level,… ➔ risk of major disruption + costs
- L1 not well performed ➔ maintenance overload, preventive planning is not correctly done ➔ breakdowns
- Manufacturing planning is established without taking into account maintenance ➔ preventive is not performed correctly ➔ breakdowns
- Skills are not available everytime ➔ breakdowns can last too much time

Prev. Requirement