



# Maintenance Indicator Guide

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## Abbreviations

KPI	Key Performance Indicator
SPI	System & Process performance indicators
WO	Work Order

## 1. INTRODUCTION

A solid, understandable and comparable base of performance measurements is needed if an organization wants to understand where the opportunities lie for improvement, wants to capitalize on those opportunities and wants to evade slipping back. Comparing performance indicators - along the time axis or between organizations - creates a learning challenge and gives management a tool to follow up on the progress of ongoing as well as on the sustainability of completed projects.

Having worked on improving the maintenance processes and the reliability of our assets, all LafargeHolcim companies must ensure the sustainability of the obtained results as well as embark on further continuous improvement. This guide on maintenance relevant indicators provides the clear definitions needed, proposes an efficient reporting and suggests a way of use.

There are also many different standards available, this document refers primarily to the Maintenance Key Performance Indicator - European Standard EN 15341, a reference is indicated where applicable.

## 2. MAINTENANCE INDICATORS GUIDE

Using the indicators as defined in this guide will also enhance the mindset of faster learning, enabling a culture of looking forward to improving performance instead of looking back to pinpoint failures. It is therefore of up most importance that these indicators are reported and used in all LafargeHolcim companies with full integrated cement plants and grinding stations.

### 2.1 Purpose

The main purpose of this guide is to provide a standard and consistent definition of maintenance relevant indicators for cement plants and grinding stations of LafargeHolcim. These indicators can also be used in ACM plants where applicable, especially the SPI's<sup>1</sup>. These standard definitions are done in the sense that all companies must measure the necessary data and calculate the indicators exactly in the same way, based on the MAC SAP standard. Maintenance relevant indicators shall be structured based on their intention and on the relevant requirements on the different management levels. Two different types of indicators are defined:

- KPI: **Key Performance Indicators (K)**
- SPI: **System & Process Performance Indicators (S)**

A second purpose of this guide is to provide support in using these indicators. Whenever indicators are calculated there will be the question how to interpret trends and comparisons. The guide therefore includes with each indicator a help section on interpretation for having a general overview of all the indicators and their relevance

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<sup>1</sup> Refer also to the MA-ACM guidelines on the Portal for Basic Maintenance Indicators for use in a non-SAP PM environment

for a proper working of the maintenance process. Using also means reporting: a proposal for an efficient reporting at all levels complements the guide.

## 2.2 Objectives

Maintenance performance is the result of actively using resources to retain an item, or restore it to a state in which it can perform its required function. It can be expressed as an achieved or expected result. Maintenance Performance depends on external and internal factors such as: geographical location, processes, size, utilization rate and age and is achieved by:

- Implementing preventive maintenance strategy
- Improve work planning
- Reinforce labor utilization by better scheduling
- Usage of data history, tools and operating techniques to define improvement.

Maintenance Performance is an outcome of complex activities which can be evaluated by appropriate indicators to measure both the actual and expected results.

- Measure the status (periodic)
- Evaluate Performance and identify Strengths & Weaknesses
- Benchmark Performance
- Control progress and set individual objectives and targets

Refer to the Maintenance Manual on Share@LH for more information

## 3. MAINTENANCE INDICATORS ARCHITECTURE & STRUCTURE

All maintenance Indicators in this current guide must be available at plant level but only KPI are requested to be reported at high management level.

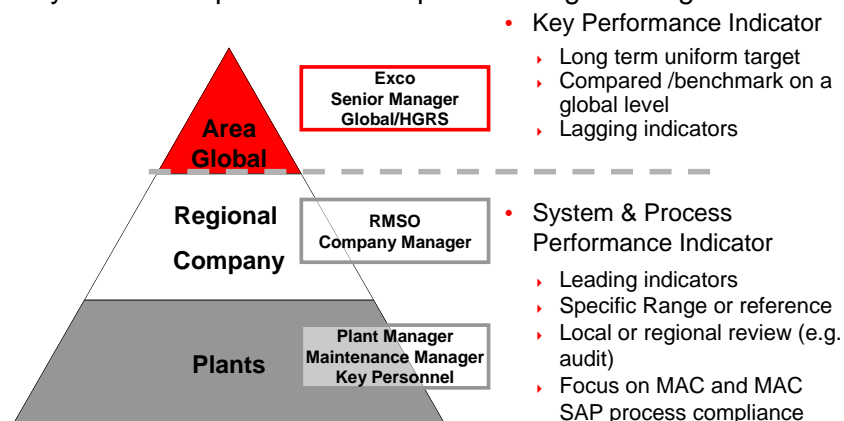


Figure 1: Indicator structure

### 3.1 **KPI – Key Performance Indicator**

Key Performance Indicators are quantifiable measurements, defined upfront, that reflect the critical success factors of an organization. Key Performance Indicators usually are long-term considerations and the definition of what they are and how they are measured do not change often. KPI's are typical **lagging** indicators that reflect on a high level (e.g. management level 1 and 2) the historical performance of an organization.

A KPI is the necessary information to manage a particular part of the business on different management levels. In regards to maintenance relevant indicators, the maintenance KPI's shall focus on:

- Specific, uniform targets
- Long-term targets
- Shall be compared / benchmarked on a **global** level
- Typical lagging indicator (consequence of many leading indicators → System and Process Performance indicator)

### 3.2 **SPI – System and Process Performance Indicator**

Complementary to the KPI's, the SPI's are an additional set of **leading** indicators in which the local management can select the appropriate one. The SPI's are therefore useful as short-term predictors of the performance. In addition they shall provide indications how well maintenance processes are in use in order to provide most effective support to the maintenance management system. The SPI's are mainly used by the direct responsible at plant level and shall focus on:

- Specific ranges or references
- Short-long term reference
- Local or regional review (e.g. audit)
- Reference to Quality of Maintenance
- MAC SAP standard compliance

### 3.3 **Target and reference value**

The target and reference value define in this document has been defined based on LafargeHolcim experience. However some new indicators will need adjustment of target after analysis of actual results, for these indicators estimation has been discussed among LafargeHolcim maintenance community.

To the opposite of KPI, SPI indicators are set to support the plant improvement. The plant should follow some of this indicator with intermediate reference in order to ensure that system and process are in place. The frequency of review will very much depend on the plant situation. The good performing plant will have to check that the system and process performance is still correctly applied on a yearly base.

4. **LIST OF INDICATOR (\* INDICATE INDICATOR WITH CHANGE)**

#	Description	Purpose
K1*	MTBF	Average duration between any failures for main equipment.
K2	Net Availability	Measure the total time for which the equipment could potentially be operated
K3*	Maintenance Cost	Monitor the maintenance cost in comparison with the plant specific reference value.
K4	PMR%	Monitor the level of preventive maintenance being planned and completed.
K5*	PMR efficiency	Identify if the preventive maintenance program is efficient by being a main generator of work requests
K6	Scheduling Compliance	Measures the percentage of performed scheduled work orders vs. the total scheduled work orders Update of Plant Attainment
K7	Planning Accuracy	Measure the accuracy of how own labor hours have been estimated, planned and scheduled
S1	Call Out	Monitor the number of work orders that have been performed due to a call out
S2	Outstanding work	Quantify the workload in weeks of the upcoming activity
S3	Overdue	Quantify the level of work that has not yet been completed but was planned or scheduled in the past
S4	Schedule Ratio	measures the level of scheduling of own available maintenance hours
S5	PMR not performed	Measure the quantity of PMR not executed
S6	BOM material PR ratio	Ensure that maintenance materials reserved via work order and purchased are indicated in the BOM
S7	Aging maintenance request	Measures the number of maintenance request (SAP PM notification) that are not processed within 10 days.
S8	PM01 without WR	Measures the ratio of corrective maintenance work orders (PM01) not assigned to a notification
S9	Material reservation usage	Measures the amount of maintenance material planned in advanced and issued.
S10*	Aging Work Order	Measure the quantity of not closed work orders in order to ensure that the feedback process and validation is done
S11	PM02 manual call ratio	Monitor the proper usage of the system and to make sure that none of the preventive maintenance tasks are missed due to non-automatic generation of work orders
S12*	Unplanned	Measure the quantity of unplanned and unscheduled work executed during the week
S13	Reliability Factor	Measures in percentage the time in which an equipment was affected due to production stoppages or failures

## KEY PERFORMANCE INDICATOR (KPI)

### **(K1) MTBF (different targets for Kiln/Mill) – Target updated for 2014**

#### Definition

This indicator measures the average duration between failures for main equipment.

Note: Currently not applied to ACM.

#### Purpose

The MTBF is a main indication to reflect the equipment reliability and is used by the plant management to evaluate the effectiveness of the maintenance strategy and the stability of the operation process. Maintenance activities should focus on a positive trend of this indicator. The purposes of this indicator are:

- To quantify the frequency of failures in relation to the operating time for a main equipment, in order to determine the overall effectiveness of its preventive maintenance strategy
- To indicate the need for Preventive Maintenance Routines (PMR) to be introduced or amended for a main equipment
- To indicate the need for changes in operational procedures or engineering design
- To monitor trends and review the maintenance strategy to avoid repetitive failures
- When trending, an increase in MTBF indicates improved asset reliability.

#### Calculation

##### **EN15341:2007 norm. # T16**

Mean Time Between Failure [h]	=	$\frac{\text{Actual operating time [h]}}{\text{Failures [#]}}$
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Actual Operating Time

**Actual Operating Time [hrs]** = *calendar time* - *idle time* - *other downtime*

Where:

- *calendar time* = 24 hours \* number of days in the period  
i.e. total time in hours
- *idle time* = equipment is not operating but in condition for immediate startup
- *other downtime* = equipment is not operating and not in condition for immediate startup

The category time is defined by the Cause Code

Failures

**Failures [#]** = Numbers of Failures (excl. planned) + Numbers of (planned maintenance stops -2\*)

For kiln 2 planned stop per year can be deducted

For mill 2 planned stop per month can be deducted



Failures, in the sense of this indicator, are unplanned events preventing main equipment from performing its function, as well a planned maintenance or any other event marked “Yes” in column “included in MTBF calculation” of file “Cause Code Groups”. For more details whether a stop is included in MTBF or not please refer to the list of 'Cause Codes'. The value of Number of Planned Maintenance minus Planned Maintenance that can be excluded is never negative.

The cause codes list is available on the Portal under the COP maintenance\MAC




This indicator is an HARP indicator and additional information can be found under the chapter 8.3.6.5 of the HARP manual

## **Frequency (Reporting / Reviewing)**

This indicator must be reviewed and discussed between production and maintenance on a weekly, monthly base and shall be trended over 12 months as rolling average value.

## **Target / Reference Value / Range**

The target of this indicator is related to the equipment it refers

	≥ 500 h for Kilns	≥ 225 h for Ball mills ≥ 125 h for Other mills
	≥ 250 h < 500 h for Kilns	≥ 75 h < 225 h for Ball mills ≥ 50 h < 125 h for Other mills
	< 250 h for Kilns	< 75 h for Ball mills < 50 h for Other mills

## **Comments / Example / Implication to other Indicators**

Examples are bearing failure, cyclone blockage, burnt motor, false contact in a level detector, planned maintenance, etc.

**Note for kilns:** A maximum of 2 Planned Maintenance (Preventive / Shutdown) (cause code 2070) per year for a kiln is permitted to be excluded from the MTBF calculation. All other Planned Maintenance (Prev/Shutdown) for kiln maintenance in excess of 2 stops per year must be included in the MTBF calculations.

**Note for mills:** A maximum of 2 Planned Maintenance (Preventive / Shutdown) (cause code 2070) per month for raw mill system and cement grinding mill system is permitted to be excluded from the MTBF calculation. Additional Planned Maintenance (Preventive / Shutdown) for cement mill and raw mill maintenance in excess of 2 stops per month (24 per year) must be included in the MTBF calculation.

It is of the utmost importance to always refer to the equipment which generated the stop. In TIS or SAP the main equipment is defined by “equipment affected” and the equipment which creates the failure is called “equipment”

## (K2) Net Availability (Kiln)

### Definition

Net Availability Index of a relevant asset corresponds to the ratio of operating time and idle time to calendar time.

Note: Currently not applied to ACM. See REE % in HARP (Chapter 15.4.2.10)

### Purpose

The Net Availability Index measures the total time for which the equipment could potentially be operated while the Gross Availability Index measures the utilization of the asset, as it refers to operating time only.

### Calculation

#### **EN15341:2007 norm. # T2**




$$\text{Net Availability [\%]} = \frac{(\text{Operating time [h]} + \text{Idle time [h]}) \times 100}{\text{Calendar time [h]}}$$

Operating Time	Requires that the asset is operating and that it is fed.
Calendar Time	= Operating Time + Idle Time + Other Downtime = 24 hours x # of days in the period i.e. total time in the period
Idle Time	= equipment is not operating but is in a condition for immediate start up

### Frequency (Reporting / Reviewing)

This indicator must be reviewed and discussed between production and maintenance on a weekly/monthly base and shall be trended over 12 months as rolling average value.

### Target / Reference Value / Range

	≥ 90%
	50% < Net Availability < 90 %
	< 50%

### Comments / Example / Implication to other Indicators

Reference to HARP on the portal, chapter 8.3.6.2

## (K3) Maintenance Cost (Δ% to Reference Value)

### Definition

Maintenance cost is a ratio of the delta of actual specific maintenance cost and the maintenance cost reference value expressed in percentage of the actual maintenance cost

Note: Currently not applied to ACM.

### Purpose

Monitor the maintenance cost in comparison with the plant specific reference value. This indicator is also used in the maintenance index.

### Calculation

$$\text{Maintenance Cost [\%]} = \frac{(\text{actual specific maintenance cost}^* - \text{Reference Value}^{**}) \times 100}{\text{Reference Value}^*}$$

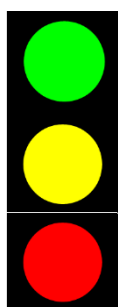
Actual specific Maintenance cost	Actual specific Maintenance cost per ton as defined by HARP * in Reporting Currency and excl. Raw material Extraction [RC/tcem]
Reference Value	Plant Specific maintenance guide value as defined by HGRS ** annually determined and communicated by HGRS [RC/t <sub>cem</sub> ]

### Frequency (Reporting / Reviewing)

This indicator must be reviewed on a monthly base and shall be trended on the YTD case. In addition, the forecasted value for the current operating year shall be reviewed.

### Target / Reference Value / Range

Best performing will reach 0% or less



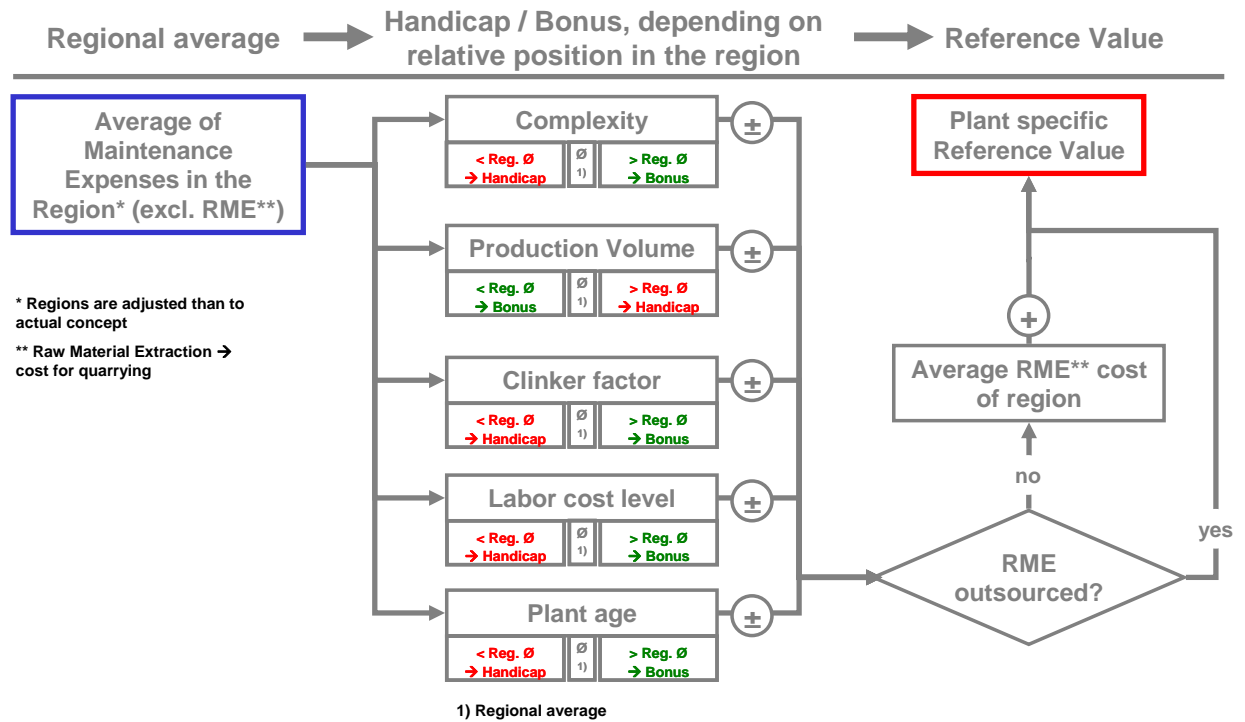
≤ 0 % gap between actual expense vs. reference value

> 0% – 20 % gap between actual expense vs. reference value

> 20 % gap between actual expense vs reference value

### Comments / Example / Implication to other Indicators

Calculation model for reference values:



## (K4) PMR %

### Definition

The PMR% is an indicator to measure the quantity of completed PMR's compared with all the maintenance work performed.

### Purpose

Monitor the level of preventive maintenance being planned and completed.

### Calculation

#### **EN15341:2007 norm. # O18**

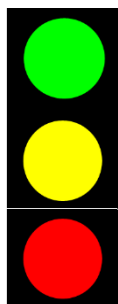
PMR (%)	=	$\frac{\text{actual labor hours on final confirmed operation from PM02 Work Orders} \times 100}{\text{Total maintenance work performed}}$
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Actual Labor on completed PMR	Completed PMR work orders are those work order operations that have been finally confirmed.
Total maintenance work performed	Total labor hours confirmed on all maintenance work order including overtime and sub contracted work. Vacation, sick, training or non direct maintenance hours are excluded

### Frequency (Reporting / Reviewing)

This KPI must be computed and reviewed on weekly base by the preventive maintenance engineer. The report should trend the weekly value over 13 and 52 weeks.

### Target / Reference Value / Range



Range between 15% to 30%.

Between 30% and 50 % or between 10% and 15%

> 50%. Or < 10%

This target is valid for the overall maintenance activity and not by work center.

Plant with intensive usage of 3<sup>rd</sup> party will have higher PMR% ratio.

The accurate target value must be related to MTBF and Maintenance Cost indicators.

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### **Comments / Example / Implication to other Indicators**

Preventive Maintenance Routines include all routine maintenance activities designed to minimize the risk of unplanned failures including:

- Routine overhauls and checks
- Predictive routines e.g. oil sampling, vibration analysis, etc.
- Fixed frequency inspections (smell, hear, feel and see).
- Fixed frequency replacements of parts or equipment when economically justified

This indicator must be correlated with the PMR efficiency see K5

### (K5) PMR efficiency (%) – Update target based on usage from Opco

#### Definition

Number of maintenance work request from preventive maintenance vs. work requests.

#### Purpose

Identify if the preventive maintenance program is efficient by being a main generator of work requests.

#### Calculation

$$\text{PMR Efficiency} = \frac{\# \text{ Maintenance request generated from PM02 Work Orders} \times 100}{\# \text{ of Maintenance request}}$$

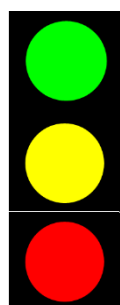
In order to be easily generated the workflow “Notification from PMR” must be implemented in SAP.

Maintenance request created from completed PM02 Work Orders	Maintenance request generate from PM02 work orders ( user Status CPM) <i>and maintenance plan indicated in the notification fields – Exclude DLFL</i>
# of Maintenance request	Overall maintenance request generate in the plant <i>Exclude DLFL</i>

#### Frequency (Reporting / Reviewing)

This KPI must be computed every week on a 52 weeks rolling average.

#### Target / Reference Value / Range



> 35% Good

Between 15% to 35%

< 15% Poor

#### Comments / Example / Implication to other Indicators

A low ratio of PMR efficiency with a high level of PMR% will indicate a potential of optimization in the preventive maintenance strategy (like review frequency, ensure that feedback is record properly and executed inspections are analyzed).

If the MTBF in the same time is low then the inspections program should be reviewed including training program.

## (K6) Scheduling compliance

### Definition

The scheduling compliance KPI measures the percentage of performed scheduled operations vs. the total scheduled operations.

### Purpose

The schedule compliance indicates how much scheduled operation has really been done in relation to the total operation in the weekly plan.

### Calculation

#### **EN15341:2007 norm. # O22**

$$\text{Scheduling Compliance (\%)} = \frac{\text{Number of operation performed as scheduled} \times 100}{\text{Total number of scheduled operation}}$$

Number of  
operation  
performed as  
scheduled

Number scheduled operations confirmed or operation technically closed with hours or good receipt committed. Those operations which have been committed in the weekly plan.

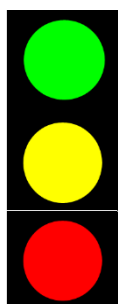
Total number of  
scheduled  
operation

All operations which have been committed in the weekly plan

### Frequency (Reporting / Reviewing)

This indicator must be reviewed on a weekly basis and shall be trended over 13 and 52 weeks. The reference is the committed and frozen weekly / daily plan for the corresponding week. The week period is from Monday at 00:00:00 to Sunday at 23:59:59.

### Target / Reference Value / Range



> 85% of operations performed as scheduled

> 50 – 85% of operations performed as scheduled

< 50% of operations performed as scheduled



**Comments / Example / Implication to other Indicators**

This indicator has to be correlated with the Planning Accuracy indicator (K7) and schedule ratio (S4). A high schedule compliance combined to a low planning accuracy (K7) will indicate an issue in maintenance processes of confirmation or execution.

Benchmark between plant must always been moderated with the schedule ratio (S4). If a plant (A) reached 100% in schedule compliance and another one (plant B) 75%, it doesn't mean that plant A is better the B. If plant A has scheduled ratio of 50% and plant B 98% meaning that B has scheduled all its resource in the weekly plan and A only half of it the outcome looks radically different as plant B achieved must better results in achievement of its weekly plan.

The reschedule of the work order within the same week will not impact this indicator.

## (K7) Planning accuracy (%)

### Definition

Measure the accuracy of how own labor hours have been estimated, planned and scheduled.

### Purpose

The planning accuracy KPI measures how close were the planned hours on the work order operation to the actual hours required to complete the work order operation in the weekly plan. The objective is to measure how close the planners estimate and schedule the hours needed to complete the job.

### Calculation

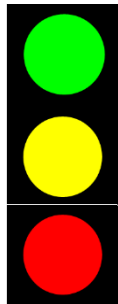
$$\text{Planning Accuracy (\%)} = 100 * \left( 1 - \frac{\text{SUM (ABS( Estimated - Actual) Labor Hours for all confirmed scheduled operations))}{\text{Estimated Labor Hours on all completed scheduled operation}} \right)$$

Sum of variance	Absolute sum of estimated hours minus actual hours for all scheduled
Actual-Estimated	operations final confirmed or partial confirmed
hours	Sum (ABS( Estimated minus Actual) Labor Hours) at operation level
Total estimated	
hours of	Estimated hour from scheduled work order operations. Those
scheduled	operations which have been committed in the weekly plan.
operation	

### Frequency (Reporting / Reviewing)

This indicator must be reviewed on a weekly base and shall be trended over 13 and 52 weeks. The reference is the committed and frozen weekly / daily plan for the corresponding week. The week period is from Monday at 00:00:00 to Sunday at 23:59:59.

### **Target / Reference Value / Range**



> 90% good

Between 60 and 90 % to be further improved

< 60% poor

### **Comments / Example / Implication to other Indicators**

This indicator allows the check the accuracy of time estimation for all performed work. The importance of time estimation allows better work order schedule and emphasis the quality of downtime duration communication to all stakeholders.

Major deviation must be investigated in order to understand its reason. Record the reason of deviation in order to take into account the actual data for future planning of the same work.

If actual hours are less than scheduled, it may be due to better organization of the team on the job site or that the scope of the work has been change.

If actual hours are more than scheduled, it may be due to an unforeseen activity or that the scope of the work has been change.

This indicator must always be correlated with the scheduled compliance (K6)

## **SYSTEM & PROCESS PERFORMANCE INDICATORS SPI**

### **(S1) Call out (#)**

#### **Definition**

Measure the number of times per week maintenance personnel had to come to the plant during off time (e.g. night, weekend) to performed an unexpected or emergency work.

#### **Purpose**

The purpose of this indicator is to monitor and trend the number of work orders that have been performed due to a call out. Typical call outs are during non-working hours (e.g. night, weekends), considering no shift maintenance.

#### **Calculation**

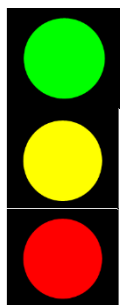
$$\text{Call Out (\#)} = \text{\# of Call Out Work Orders}$$

Number of call  
out work order      # of work order with an user status CALL

#### **Frequency (Reporting / Reviewing)**

This indicator must be reviewed on a weekly base and shall be trended over 52 weeks as rolling average value.

#### **Reference Value / Range**



< 5 per week in average for a year is good  
It is equivalent to < 260

Between 5 to 15 it should be further improved

> 15 per week in average for a year is poor  
It is equivalent to > 780

#### **Comments / Example / Implication to other Indicators**

Call out are the highest level of emergency work. It means you have to call person out of there shift. That creates overtime and as a serious safety implication due to the lack of preparation and off shift condition. This indicator must be related to the MTBF and Maintenance cost. Each one of the call out must be analyzed through RCFA.

## (S2) Outstanding work (week)

### **Definition**

The total man-hour weeks required to complete all outstanding work orders in the next 13 weeks.

### **Purpose**

Quantify the workload in weeks of the upcoming activity. This indicator should be related to the available internal resources in order to support the decision of third party services usage.

### **Calculation**

$$\text{Outstanding work (W)} = \frac{\text{Sum of estimated hours}}{\text{Weekly Average available capacity**}}$$

Sum of estimated hours      Total of estimated hours of all operations from release work order that have a schedule due date within the next 13 weeks,

Weekly Average available capacity      Weekly available hours average of internal work centers for the next 13 weeks

### **Frequency (Reporting / Reviewing)**

This indicator should be analyzed on a weekly base for the next 13 weeks. A proper and even weekly distribution over the next 13 weeks should be achieved in order to ensure a proper planning process.

### **Reference Value / Range**

Outstanding work should cover 4 weeks of work for planned and ready work (all material available and work order release). Ready means that all spare and resources are available.

### **Comments / Example / Implication to other Indicators**

This indicator must be followed at work center level.

In order to be able to follow ready work, the “material availability” workflow must be implemented.

Shutdowns (revision number): should be display

## (S3) Overdue (h)

### **Definition**

The total labor hours required to complete all overdue work orders.

### **Purpose**

Quantify the level of work in the past not performed or already planned and scheduled once in the past and not done.

### **Calculation**

$$\text{Overdue (h)} = \text{Sum of estimated labor hours on all overdue work order}$$

Total overdue hours	Total estimated hours of all operations that have not been completed by their first scheduled date Total estimated hours of all operations with a Basic Start Date of the work order and the Earliest scheduled date of the operation in the past
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### **Frequency (Reporting / Reviewing)**

This indicator must be reviewed on a weekly base and shall be trended over 13 weeks.

### **Reference Value / Range**

The reference value for this indicator for LafargeHolcim is 0 and should be followed by work center and planner group.

### **Comments / Example / Implication to other Indicators**

This indicator should be reviewed together with the Outstanding work (S2) and the Schedule Compliance (K6).

A high amount of overdue hours does not necessarily indicate delayed in work execution it can also indicate a poor utilization of the work order system.

## (S4) Schedule Ratio (%)

### Definition

Measures the percentage of estimated available working hours that have been scheduled on work orders for the coming week

### Purpose

This indicator measures the level of scheduling of own available maintenance hours.

### Calculation

#### **EN15341:2007 norm. # O5**

$$\text{Schedule Ratio (\%)} = \frac{\text{Total estimated hours on scheduled work orders} \times 100}{\text{Total estimated available own Labor Hours}}$$

Total estimated hours on  
scheduled work orders

Sum of the estimated hours from work order in the weekly  
plan

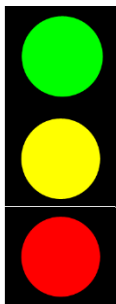
Total estimated available  
own Labor Hours

Weekly available hours estimation from work center

### Frequency (Reporting / Reviewing)

This indicator must be reviewed on a weekly base and shall be trended over 13 and 52 weeks. The reference is the committed and frozen weekly / daily plan for the corresponding week. The week period is from Monday at 00:00:00 to Sunday at 23:59:59.

### Reference Value / Range



> 95% Very good

Between 50% and 95% Improvement required

< 50% poor

### Comments / Example / Implication to other Indicators

In order to determine the available hours, the total hours (Sum of the normal working time (paid)) will be reduced by vacation, holidays, training, meetings etc.

## (S5) PMR not performed (%)

### Definition

It is the number of PMR *not* performed divided by the total number of PMR

### Purpose

Measure the quantity of PMR not executed. On an optimized preventive maintenance program all preventive maintenance tasks must be performed.

### Calculation




$$\text{PMR not performed (\%)} = \frac{\text{PMR not performed} \times 100}{\text{Total PMR}}$$

PMR not performed	All PM02 work order not Technically closed or closed with no Hours nor Good receipt
Total PMR	All PM02 work order

### Frequency (Reporting / Reviewing)

Indicator to be calculated on a monthly based and trends on 12 months rolling.

### Reference Value / Range

	< 5 % Good
	Between 5 to 10 % to improve
	> 10% Poor

### Comments / Example / Implication to other Indicators

A high ratio of PMR not performed can be an explanation of poor MTBF. Performing the PMR is the first step towards proactive maintenance.



## (S6) BOM Material PR ratio

### Definition

Number of maintenance material item purchased (limited number of PCS code) via a work order and not linked to a BOM divided by number of maintenance material item purchased.

### Purpose

Ensure that maintenance materials reserved via work order and purchased are indicated in the BOM and therefore support the development of the BOM.

### Calculation

$$\text{BOM Material PR ratio} = \frac{\# \text{ PO item on maintenance material not attached to BOM} \times 100}{\text{Total \# PO item on maintenance material}}$$

# PO item on maintenance material not attached to BOM	Purchase order of maintenance materials with material numbers which are not assigned to any BOM. For maintenance materials belong to the following PCS family: PCS 03* and some PCS04* and with material type Spare part if available (i.e. ZSWP)
Total # PO item on maintenance material	All Purchase order on maintenance materials belonging to the following PCS family PCS 03* and some PCS04* and with material type Spare part if available (i.e. ZSWP)

*Purchase Orders generate from the MRP on maintenance material reserved from MRP has to be take into account (for MRP type V1, PD)*

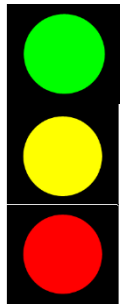
List of PCS04 material part of the selection:

- 0401\*: Refractories Materials
- 0402\*: Grinding Media
- 0403\*: Mill Linings
- 0406\*: Lubricants
- 040702: Filter elements
- 0411\*: Rubber tires

### **Frequency (Reporting / Reviewing)**

This indicator must be reviewed on a monthly base and shall be trended over 12 months.

### **Reference Value / Range**



< 15% Good

Between 15 to 50 % potential for improvement

>50% Poor

### **Comments / Example / Implication to other Indicators**

High level of purchase order on maintenance material not attached to a BOM indicates an underdevelopment of BOM.

Information to improve the BOM is available in the list of purchased material. It can also indicate that maintenance materials are purchased on work order not assigned to equipment. In this case the equipment history will not be properly built.

## (S7) Aging Maintenance Request (#)

### **Definition**

Number of maintenance requests (SAP Notification MR) that were created more than 10 days ago and are not assigned to a work order or revision number or are not closed.

### **Purpose**

Measures the number of maintenance request that are not processed within 10 days. Shall indicate the way maintenance request are managed within the plant. 10 days represent a week plus a week end.

### **Calculation**

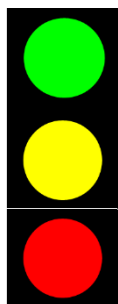
$$\text{Aging maintenance request (\#)} = \text{maintenance request older than 10 days not in process}$$

Maintenance request older than 10 days not in process      MR which have been created more than 10 days ago and were neither assigned to a work order nor to a revision number

### **Frequency (Reporting / Reviewing)**

Indicator to be measure on a weekly based and trends over 13 weeks

### **Reference Value / Range**



< 5 Good

5-10 need further improvement

>10 Poor

### **Comments / Example / Implication to other Indicators**

This indicator has to be measure at plant level. High level of aging work request can indicated that the work order process is not properly used. In case of low MTBF this will indicate that detected issues are not taken into account and resolve.

## (S8) PM01 without WR

### **Definition**

Number of corrective work orders without an assigned notification as percentage of the total number of corrective work orders.

### **Purpose**

This indicator measures the ratio of corrective maintenance work orders (PM01) not assigned to a notification.

### **Calculation**

PM01 without WR (%)	=	$\frac{\text{Number of Work order (PM01) without work request} \times 100}{\text{Total number of Work order (PM01)}}$
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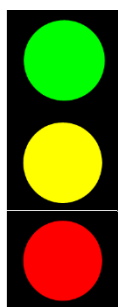
Number of Work order PM01 without work request      Work order with PM01 type with no notification assigned

Total Number of work Order (PM01)      All work order with PM01 type

### **Frequency (Reporting / Reviewing)**

Indicator to be measured on a weekly based and trends over 52 weeks rolling average.

### **Reference Value / Range**



< 1 % Good

Between 1% and 10%, further improvement is required

>10 % Poor

### **Comments / Example / Implication to other Indicators**

Notification records equipment failure and malfunction and the related cause codes. Missing this information will compromise reliability analysis and improvement in maintenance cost and MTBF.

## (S9) Material reservation usage

### Definition

Number of maintenance materials planned and reserved in advance and issued in reference to the total number of maintenance materials issued.

### Purpose

This indicator measures the amount of maintenance material planned in advanced and issued.

### Calculation

Material reservation usage (%)	=	$\frac{\text{Number of maintenance material reserved} \times 100}{\text{total number of maintenance material issued}}$
--------------------------------	---	--

Number of maintenance material reserved      All maintenance material\* reserved more than 72h before issued date

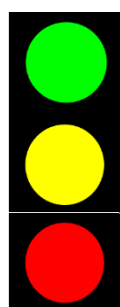
Number of maintenance material issued      All maintenance material\* issued

\* Maintenance materials list defined for SPI S6

### Frequency (Reporting / Reviewing)

Indicator to be measured on a weekly based and trends over 13 weeks

### Reference Value / Range



> 50% Good

Between 10% and 50% need improvement

< 10% poor

### Comments / Example / Implication to other Indicators

Low ratio will indicate that reservation process is not in place or that material are reserved just before being issued. Increase of reservation will support the procurement process and allows better cost of purchased and reduces Net Working Capital.

## (S10) Aging Work Order – New name and calculation simplified

### **Definition**

*Number of work order with a basic finish date overdue since more than 10 days and not technically completed.*

### **Purpose**

This indicator measure the quantity of work orders those are not closed in order to ensure that the feedback process, the cancellation of all open reservation and purchase request not required are done. *Within 10 days the work order must be closed or reschedule in the future.*

### **Calculation**

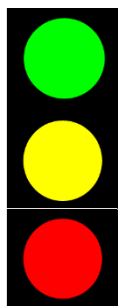
$$\text{Aging work order} = \text{Number of work order not technically completed}$$

Number of work order not technically completed      All work order not TECO and with an basic finish date more than 10 days

### **Frequency (Reporting / Reviewing)**

Indicator to be measure on a weekly based and trends over 13 weeks.

### **Reference Value / Range**



< 30 very Good

Between 30 to 100 to be improved

>100 Poor

### **Comments / Example / Implication to other Indicators**

High number of work order renders the scheduling process more complex and slows down the system. This will also compromise the equipment history construction and at the end planner, supervisor and procurement officer lose time in administration of the data for no added value.

## (S11) PM02 manual call ratio

### Definition

Number of preventive maintenance work orders that were called or created manually in SAP (not using the Deadline monitoring) in reference to the total number of work orders.

### Purpose

To monitor the proper usage of the system and to make sure that none of the preventive maintenance tasks are missed due to non-automatic generation of work orders.

### Calculation

$$\text{PM02 manual Call ratio} = \frac{\text{Number of preventive maintenance work orders manually generated} \times 100}{\text{Total preventive maintenance work order}}$$

Number of PM02 work order manually generated

All work order with type "PM02" with field "created by" <>IP10\*

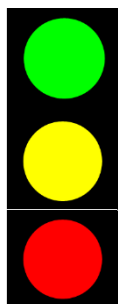
Total PM02 work order

All work order with type "PM02"

### Frequency (Reporting / Reviewing)

This indicator should be measured on a monthly base and trends with over 12 months with 3 months rolling average value.

### Reference Value / Range



< 5% Good

Between 5 and 20% to be improved

> 20%

### Comments / Example / Implication to other Indicators

The 5% target is taking into account the preventive maintenance work order call manually for shutdown inspection on Kiln.

High ratio indicates that preventive maintenance is launched manually and therefore can be forgotten.

## (S12) Unplanned - New

### Definition

The Unplanned % is an indicator to measure the quantity of unplanned and unscheduled work executed during the week.

### Purpose

Monitor the level of reactive work of the maintenance in a week.

### Calculation

$$\text{Unplanned\%} = \frac{\text{Actual work confirmed on Unplanned Operations} \times 100}{\text{Total maintenance work performed}}$$

Actual work confirmed  
on Unplanned  
Operations

All confirmation that is on any operation that is not part of the weekly schedule (Snapshot). Those operations which have not been committed in the weekly plan.

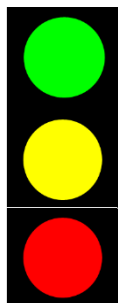
Total maintenance work  
performed

Total labor hours confirmed on all maintenance work order including overtime and sub contracted work.  
Vacation, sick, training or non direct maintenance hours are excluded

### Frequency (Reporting / Reviewing)

This KPI must be computed and reviewed on weekly base by the preventive maintenance engineer. The report should trend the weekly value on a 52 weeks rolling average.

### Reference Value / Range



< 10% Good

Between 10% and 20% to be improved

> 20%

### Comments / Example / Implication to other Indicators

Unplanned work must be compared with schedule compliance. High unplanned with high schedule compliance shows low resource schedule and high reactive environment



## (S13) Reliability Factor by Kiln

### Definition

Reliability Factor of a relevant asset corresponds to the ratio of operating time and production stoppages of failures.

**Note: this indicator is not part of the official Maintenance and Performance Indicators dictated by LHARP.**

### Purpose

The Reliability Factor measures in percentage the time in which an equipment was affected due to production stoppages or failures.

### Calculation

Reliability Factor%	=	$\frac{\text{Actual operating time [hrs]}}{\text{Actual Operating time + Incident stoppage [hrs]}}$
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Actual operating time

**Actual operating time [hrs] = calendar time - idle time - other downtime**

Where:

- *calendar time* = 24 hours \* number of days in the period i. e. total time in hours
- *idle time* = equipment is not operating but in condition for immediate startup
- *other downtime* = equipment is not operating and not in condition for immediate startup

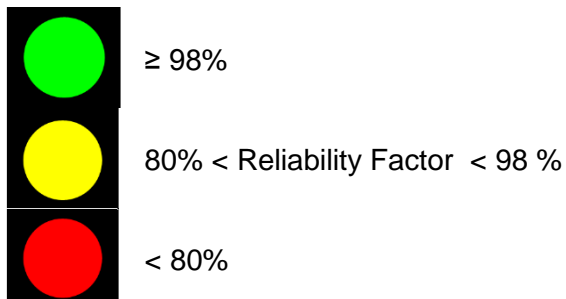
Incident stoppages

For a Kiln, a stoppage is scheduled during preparation of the budget. If the scheduled stoppage is moved up more than 15 days, the first 5 days are considered as incidents. If stoppage is lengthened for technical reasons, the excess duration is considered as an incident. No more than two scheduled shutdowns can be planned per year. An incident on the raw mill which result in a stoppage of the kiln line is included in the RF burning line calculation

### Frequency (Reporting / Reviewing)

This indicator must be reviewed and discussed between production and maintenance on a weekly/monthly base and shall be trended over 12 months as rolling average value.

## Reference Value / Range



## Comments / Example / Implication to other Indicators

For a Kiln, a planned maintenance stop is scheduled during preparation of the budget. If the scheduled stoppage is moved up more than 15 days, the first 5 days are considered as incidents. If stoppage is lengthened for technical reasons, the excess duration is considered as an incident. No more than two scheduled shutdowns can be planned per year. An incident on the raw mill which result in a stoppage of the kiln line is included in the RF burning line

## 5. REVISION LOG

Revision	Date	Object of revision	By
4.0	06.12.2001	Unknown	CTS/MTC
5.0	01.07.2011	Revision of KPI and integration of SPI	CMS/MER
5.1	1.06.2012	<p>S3: Overdue. Clarification of the definition of overdue operation:</p> <ul style="list-style-type: none"> <li>- All operation in the past</li> <li>- All work orders already scheduled in the past but not confirmed.</li> </ul> <p>K1: Update target of MTBF  K3: Typing error in the formula  K5: Adjust Target</p>	CMS/MER
6	01.01.2014	<p>S10: Review name and simplify the calculation for better understanding</p> <p>S12: Re-introduce the indicator that plants already use.</p> <p>S5: Typing mistake</p>	CM/PEM
6.1	01.04.2014	<p>S12: Correction of the targets</p> <p>Detected by NASC, HSEA and HSEE</p>	CM/PEM
6.2	01.06.2014	S6: Clarification on the PO from material reservation	CM/PEM
6.3	22.02.2017	Verification for application to LafargeHolcim and change of layout	CIP/MAE
6.4	08.05.2017	Inclusion of Reliability Factor for application to some LafargeHolcim facilities	CIP/MAE