

## Performance Indicators as monitoring tool for PSM

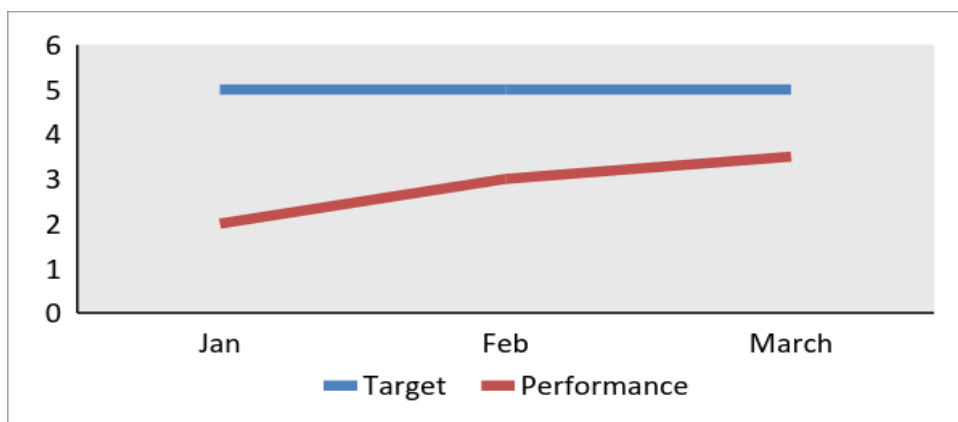
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### Introduction

Performance indicators are numerical online tools to evaluate the success of an organization or of a particular activity in its way to achieve its target, focusing on the fact that *“you don't improve what you don't measure”* performance indicators can be used to improve performance and increase profit or decrease losses by comparing organization performance measures with other peers in industry.

Process safety management system is a set of elements which intended to manage hazards associated with the, process industries and is intended to ensure prevention of, preparedness to, respond to and recovery from hazardous and flammable material releases which may lead to disasters.

In the following pages real life example for a set of performance indicators related to process safety elements which was implemented in one of Methanex sites.



Graph no.1

Methanex is the largest producer and distributor of methanol in the globe with production facilities in Canada, USA ,Chile ,Trinidad ,New Zealand and Egypt

the plant is for methanol production which utilizes natural gas and water in a catalytic reaction to produce methanol ,the plant contains pressurized vessels with high temperature reactions ,heat exchangers ,pumps , compressors and turbines ,it is a mixture between parts of refinery and petrochemicals industry .

### Performance indicators

#### Safety critical elements readiness

The performance of safety critical elements can be monitored through the maintenance history for these elements ,excluding this elements and focusing on them apart from the plant equipment is always an indication of how your critical safety equipment are healthy and ready to react .

The challenge is how to identify the safety critical elements and this can be done through sequence steps:

- Identify the SCE definition.
- Identify the major SCE groups.
- Perform a Risk based criticality study.

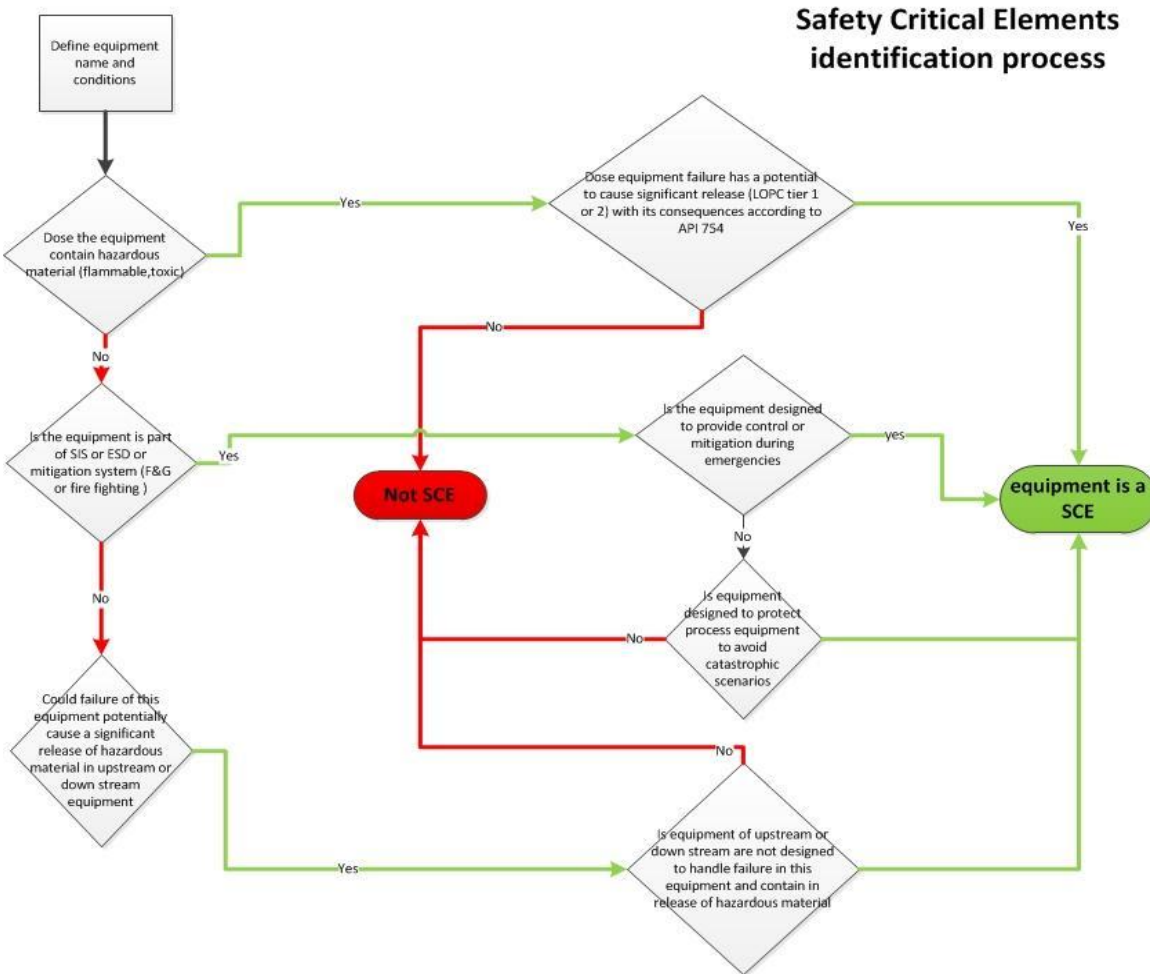
To identify safety critical elements the below workflow shall be followed

#### Phase 1: Identify Major Safety critical elements groups

- PSV's and breathers
- Emergency shutdown system

- Fire Fighting systems
- Fire & Gas systems
- Pressure vessels

**Phase 2:** Study and Filter for the SCE according to their failure consequences



Graph No.2 (SCE identification work flow)

**Performance indicators:**

- Pressure safety valves preventative maintenance completion
- Emergency shutdown systems preventative maintenance completion
- Fire Fighting system preventative maintenance completion
- Fire and gas system preventative maintenance completion
- Pressure vessels preventative maintenance completion
- Pressure piping preventative maintenance completion

The follow up of this indicator comes after ensuring that all equipment are covered by testing, inspection and preventative maintenance plan according to manufacturer recommendations , codes and practices recommendations , in some cases some indicators can be added for more detailed follow up for example :

- pressure safety valves testing
- Emergency shutdown system functional testing
- Firefighting systems functional testing

### Safe operating limits and safe design limits?

Safe operating limits excursion monitoring is an essential performance monitoring tool to ensure:

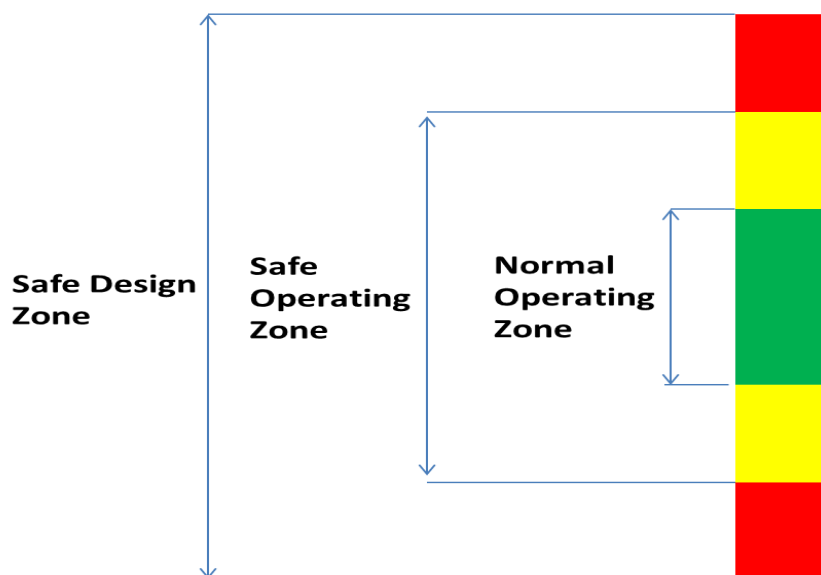
1. Equipment are operating within the design conditions
2. Avoid loss of containment due to equipment failures

The plant should have proper data and tools in order to be able to report the operating envelope excursion.

Required monitoring Data:

1. identifying equipment design limits (temperature and pressure )
2. Identifying safe operating limits

See graph no. 3 indicating the difference between design limits and operating limits



Graph no.3 (different operating zones )

Graph description:

**Green zone:** normal operating condition of pressure and temperature, normally controller set point is in the middle of this zone.

**Yellow zone:** Safe operating zone but you are approaching the design limits, Alarms normally are on first quarter after the green zone, it is called also the troubleshooting zone and operator shall take action to return to the normal operating zone.

**Red zone:** safe design limit zone where Emergency shutdown system start take action ,pressure safety valves setting are on this zone borders ,aging equipment may experience troubles in this zone

**Tools:**

1. Software that can access your DCS system information or ability to extract this data in excel format
2. Excel sheet contains all identified tags for condition monitoring for each equipment with required filtering tools to count number of excursions

An example for excel sheet for safe operating limits excursion monitoring as below in graph no.4

S/N	Equipment	Description	Type	Process Stream	Unit	Tag	Data Base			No. Of Exceedence
							Design	LL	HH	
1	IV-0101	NATURAL GAS K.O. DRUM	Vessel	Natural gas	IC	T05102	100			The time is invalid.
	IV-0101	NATURAL GAS K.O. DRUM	Vessel		Blarg	P05102	000			The time is invalid.
2	1R-0101	MERCURY REMOVAL VESSEL	Reactor	Natural gas	IC	T05102	100			The time is invalid.

Graph no.4 (Example for safe operating limits follow up sheet )

**Challenges**

In this performance monitoring activity the challenge is to identify the safe operating limits data which can be started by producing a process data narrative which shall include operation manual information, manufacturing data, process knowledge licensors data and integrity operating envelope data, at some point safe operating limits can be identified by experience and can be modified in the future according to monitoring and inspection findings.

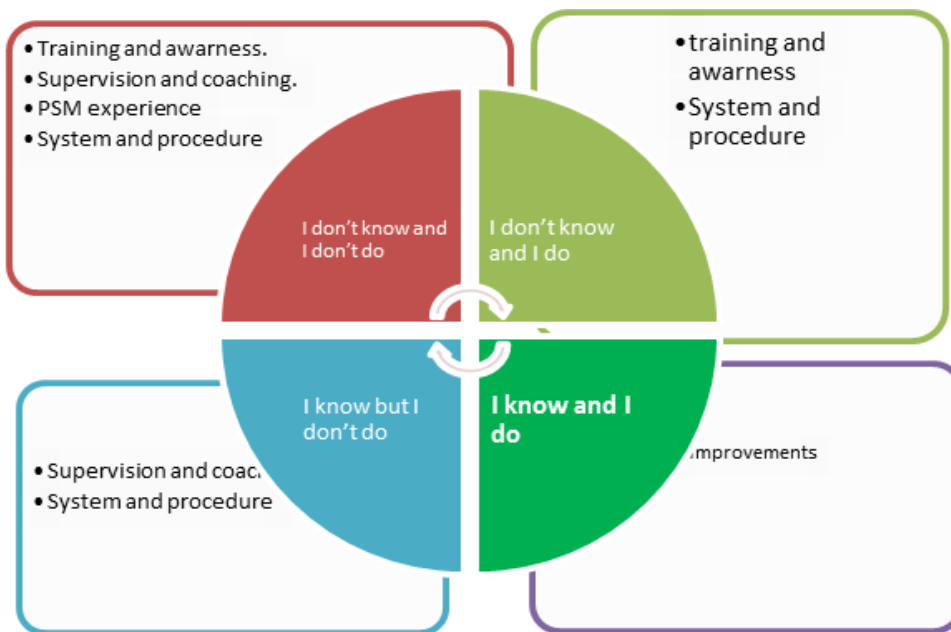
**Performance indicators:**

- Number of safe operating limit excursion for pressure
- Number of safe operating limit excursion for Temperature
- Number of safe operating limit excursion for Concentration

**Process safety culture**

A good indicator for Site process safety culture can be produced by internal surveying for the site personnel, this survey shall give result in the following zones of culture:

- a) I know and I do.
- b) I don't know and I do
- c) I Know and I don't do
- d) I don't know, and I don't do.



Graph no.5 (Process safety culture zones)

The results which will be “employee percentage “shall guide the site management in which direction they shall exert efforts.

**Performance indicators:**

- Process Safety culture survey action completion
- Yearly indicator for process safety culture level

**Leak stops**

A close follow shall be done for all workflow steps of a leak through the following:

- Leak detection criteria.
- “Leak stop” design and approval.
- “Leak stop” monitoring.
- Repair plan on nearest opportunity.

A performance indicator for the number of “leak stops” in the site and another indicator can be added for the leak stops which in service for more than 1 month.

An example of the follow up sheet for leak stops can be as per [graph no.6](#)

Sr. No.	Tag number	Clamp Sr.	Area	Clamp Type	Installation Date	Description	Reason	Required Spares	Apr-14
1	1E-1511	2	ASU TSA reactivation heater	Injected clamp + Leak containing can	Dec-11	Two clamp on the two HEX flanges	Steam leakage	Complete HEX (preparation for installation WO656204)	Plan for Seal weld again WO708065 / Plan to replace the Exchanger WO D656204
2	1TK-2602B	4	Mech Product tank# B	Injected Clamp	Aug-13	Two Stud & Nut from Both Manway Flange sides	Mech leakage	End Flang 24" 150# Or as the DWG Plate OD:820 mm ASTM A573 CL 1 + Gasket Compressed non asbestos 24" full face (Current gasket Graphite) + 28 M20 bolt B7	Plan to Replace gasket and Stud bolts WO D656203

Graph no.6 (Example of leak stops follow sheet)

Leak stop: “ all nonstandard repairs for piping, valves, exchangers..etc. which intended to stop leaks online with safe mitigations plans till the site is ready to the standard repair” .

Leak stop should be considered as temporary change and shall be engineered and documented till the original status is obtained.

Performance indicators:

- Total Number of leak stops
- Number of leak stops for more than 1 month (or due for status review )

**Work Permit control system**

Permit system performance shall be closely monitored

**Performance Indicators:**

- Number of WSCS audits
- WSCS audit compliance score (administrative )
- WSCS audit technical compliance

## Management of change

Changes in the site shall be followed in the performance indicators matrices to ensure full control of managing risks related to change work flow

### Performance indicators:

- Total number of MOC`s
- Number of MOC`s deviations.
- Number of temporary MOC`s in place.
- Number of Due temporary MOC`s.
- Number of emergency MOCs.
- Number of MOCs placed in service before PSSR was completed.

## Incident management system

The incident management system indicate the learning of the organization the site should be able to report all near misses and accidents and investigate for root cause and be able to follow up on action completion and its effectiveness .

### Performance indicators:

- Investigation completion on time
- Action completion on time
- Percentage of action completion

## Automation and inhibition

If control system is blind so it is not exist a close follow up for the readiness of automatic control system and its alarm shall be follow up by having a procedure for by passing a control action or inhibition of alarm.

### Performance indicator:

- Number of interlock bypasses.
- ESD system bypass
- Number of long term interlocks bypasses (more than 1 week).
- No. of Audits of override register
- Number of Overrides
- Number of Inhibits

## Alarm management

Alarm is an important tool and preliminary safe guard for site process safety , failure in designing and follow up on alarm management system will result in losing the benefits of alarming ,in order to have a workable alarm system the following shall be implemented :

- Alarm philosophy
- Alarm rationalization
- Implementation of the alarms

### Performance indicators:

- Number of alarms per operator per hour
- Number of fleeting alarms per hour
- Number of inhibits for alarms

### Substandard conditions and special operating conditions

Substandard conditions are the process design deviation from the original design for limited time with proper engineered mitigation.

#### Performance indicators:

- Total number of substandard conditions
- Number of substandard conditions that exceeded 2 months in service

Special operating conditions other than the standard for specific capacity of the plant mentioned in the operating manual.

#### Performance indicator:

- Total number of special operating conditions

### Preventative maintenance completion

#### Performance indicators;

- PM compliance ,all preventative maintenance completion versus plan
- Total (Planned Maintenance ) VS (Non routine Maintenance ) for the month : % of PM work orders (Count / Labor Hrs)” to “the % of CM work orders (Count / Labor Hrs.)” - completion within the Target period , this important indicator will give an idea on how effective is your preventative maintenance plan
- Number of outstanding W.O priority 0 and 1, these priorities are the emergency work orders and this indicator will tell you how ready your maintenance team to respond to emergency maintenance cases.

### Fire system impairments

Readiness of firefighting systems is important , firefighting systems are normally in standby mode ,it may be used once in a plant lifetime , the target of these indicators is to ensure that the firefighting systems are ready all the time .

#### Performance indicators:

- Total number of impairments for firefighting systems
- Fire system impaired for more than one month

### Audits

Audits are the proof of a working system is functioning as it is intended to be, action completion is the indication of the audit system success.

#### Performance indicators:

- Audit Corrective action overdue (
- Audit corrective action open

## Operation systems follow up

Day to day general operation systems performance shall be monitored and analyzed during different modes of operations:

- Normal operation
- Normal shut down
- Normal start up a
- Emergency shut down

### Performance indicators:

- Number of long term isolations in place (> 7 days)
- Number of automatic control loops are on manual mode
- Number of PSV/PRVs/Bursting Discs which have lifted/failed during service
- Demand on ESD system
- Number of Site Operating Procedures issued for comment (issued/total)
- Number of PSV's activated during upset

## Conclusion

Performance indicators are important tool, the previous set of indicators are prepared throughout the life time of the site and according to the day to day follow up needs, it is not static set but it is dynamic can be changed whenever the site condition need , it may fit for one site and may not for other , careful should be taken for the definition of each indicator to ensure consistency of data gathering specially form shift functions .

Challenges in preparing the background matrices get all site related disciplines working together in harmony and they are all in the same frame of work is the milestone of having the complete set of performance indicators , discussing the deviations of some elements during plant meetings instead of discussing slips and trips all the time is a changing to the site culture towards a more mature form .



<h2 style="margin: 0;">Site Monthly Process Safety Report</h2>				
<table style="width: 100%; border: none;"> <tr> <td style="width: 60%;"><b>Period</b></td> <td style="text-align: right;">January 2015</td> </tr> <tr> <td><b>Site status</b></td> <td style="text-align: right;">Shut down</td> </tr> </table>	<b>Period</b>	January 2015	<b>Site status</b>	Shut down
<b>Period</b>	January 2015			
<b>Site status</b>	Shut down			

1 Incident investigation	Target	Actual
Incident Investigation Action Completion %	85	[Red Box]
Incident Investigation Completion%	75	[Red Box]

2 Audit	Target	Actual
Monthly Site walk down	1/month	[Red Box]
Site walk down action completion	1	[Red Box]
Permit Audits (WSCS)	4	[Red Box]
Audit Corrective action over due	0	[Red Box]
Audit corrective action open	0	[Red Box]

3 Emergency Response	Target	Actual
Emergency drills Completion	4/M	[Red Box]

4 Asset integrity and reliability	Target	Actual
Fire impairment certificates (More than 6 months )	0	[Red Box]
Hydrocarbon Spills less than 1000 kg	0	[Red Box]
Hydrocarbon Spills greater than 1000 Kg	0	[Red Box]
Chemical spills	0	[Red Box]
Site Process Safety Incident /Near Miss as per tire 1	0	[Red Box]
Site Process Safety Incident /Near Miss tire 2	0	[Red Box]
Site Process Safety Incident /Near Miss tire 3	0	[Red Box]
Loss of Primary Containment TOTAL	0	[Red Box]
Leak stops installed (Clamps)	0	[Red Box]
Fires (Process and non process)	0	[Red Box]
Number of passing PSV's in service	0	[Red Box]
Number of cases where process operated beyond Safe Operating Limit (SOL) (Excursion beyond safe operating envelope) Pressure	0	[Red Box]
Number of cases where process operated beyond Safe Operating Limit (SOL) (Excursion beyond safe operating envelope) Temperature	0	[Red Box]
Number of cases where process operated beyond Safe Operating Limit (SOL) (Excursion beyond safe operating envelope) Concentration	0	[Red Box]
Number of PSV/PVs/Bursting Discs which have lifted/failed during service	0	[Red Box]
All Number of cases where process operated beyond Safe Operating Limit (SOL) (Excursion beyond safe operating envelope)	0	[Red Box]

<h2 style="margin: 0;">Site Monthly Process Safety Report</h2>	
<b>Period</b>	January 2015
<b>Site status</b>	Shut down

PM compliance (general)	75%
Total (Planned Maintenance ) VS (Nonroutine Maintenance ) for the month	70-30%
Number of outstanding W.O priority 0 and 1	0
Pressure vessels inspected against plan *SCE	< 95%
Piping inspected against plan	0
Demand on ESD system	0
Number of automatic control loops are on manual mode (305)	0
PSV's Testing against plan *SCE	< 95%
Total SCE Overdue PM	0
Total SCE Overdue CM	0
Fire fighting system testing and inspection according to the plan *SCE	100%
F&G System PM over due *SCE	< 95%
FF System PM over due *SCE	< 95%
ESD PM's over due *SCE	< 95%

### 5 Contractor Management

Conduct audit of contractors facilities	1	0
Number of site contractors	0	0
Number of site contractors employees	0	0
Conduct safety meetings with contractors	2Q/1Q	0

### 6 Management fo change

Number of Non Complianace with with MOC Procedures	0
Number of temporary MOCs are due for revalidation/approval by TCM	0
Number of temporary MOCs which have been in place for more than 90 days.	0

### 7 Safe Work Practices

<h2 style="margin: 0;">Site Monthly Process Safety Report</h2>	<b>January 2015</b>
<b>Period</b> <b>Site status</b>	Shut down

Average total Alarms per hour per person	8/hr
Number of Fleet alarms	0
Number of LO/LC Register compliance Audits	12
Number of long term isolations in place (> 7 days)	0
ESD system bypass	0
Overrides	0
Inhibits	0
Number of Long Term Overrides/Inhibits > 24 hrs	0
Number of Long Term Overrides/Inhibits > 7 days	0
Number of Long Term Overrides/Inhibits > 4weeks (as per WSCS)	0
No. of Audits of override register	12/Q
Number of PSV's activated during upset	0
Opened SSC	0
Total Number of SSC	0
Opened SOC	0
Total Number of SOC	0

### 8 Hazard identification and Risk assessment

Risk Register Action Reviews	1/W
PHA ,PHR,PSSR and other risk analysis actions overdue	0

### 9 Operating procedures

Number of Site Operating Procedures issued for comment (issued/total)	X/21
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### 10 Training

% of RC training completion	0.75
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Over all systems comments