

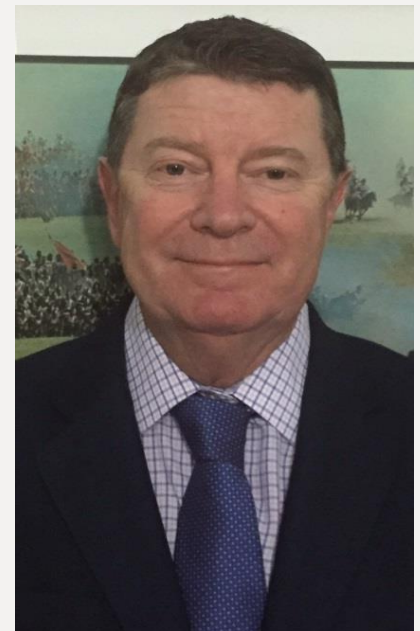
A REAL WORLD EXAMPLE OF MONITORING PROCESS SAFETY METRICS IN A REFINERY OVER FIVE YEARS

Bapco Operational Excellence Team

08 Month 2017

BIO

- Dr Mark Hodgkinson-PhD (chemistry), BSc (Hon) Chemistry
- Dr Mark Hodgkinson holds is currently the OEMS Project Manager for Bapco. He holds a PhD and BSc in Chemistry and Chemometrics. He has over 25 years' experience in the Oil and Gas Field and also 15 years in Applied Microbiology fields such as water treatment.
- His professional interests include: Operational Excellence, Operational Intelligence, System Design , Change management, Business planning and Multivariate processes monitoring
- His leisure interests include Historical Board Gaming and Golf.
- OE Team++++++

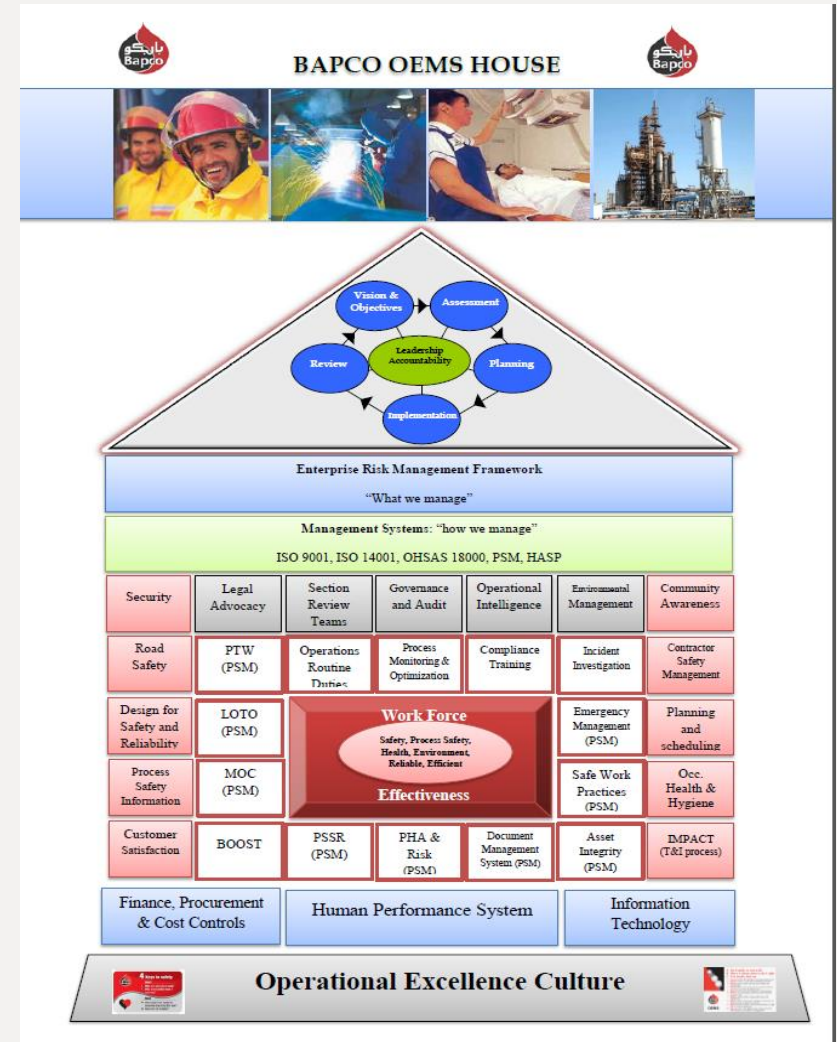


OUR BEGINNINGS 2010

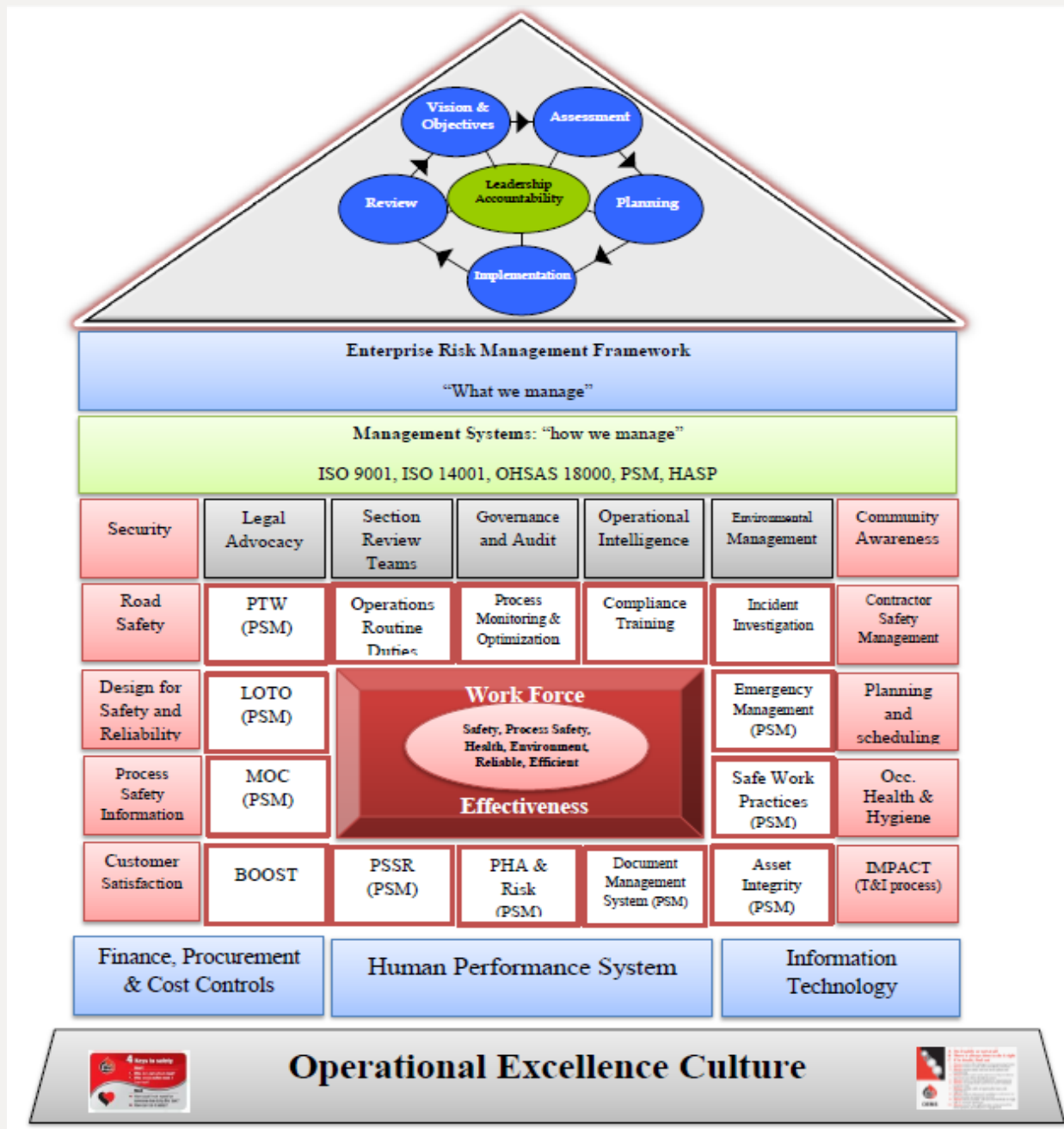


EARLY GENERATION OF METRICS

- Bapco implemented an Operational Excellence Management System over the top of all our Management systems including Process Safety Management .
- Each Process has Leading and Lagging indicators



Note PSM Processes



METRIC ATTRIBUTES

- All metrics are stated in the peak process documents (Process Descriptions) . We had leading and lagging indicators before API 754.
- An example of one (1) of the five (5) Leading indicators for this process

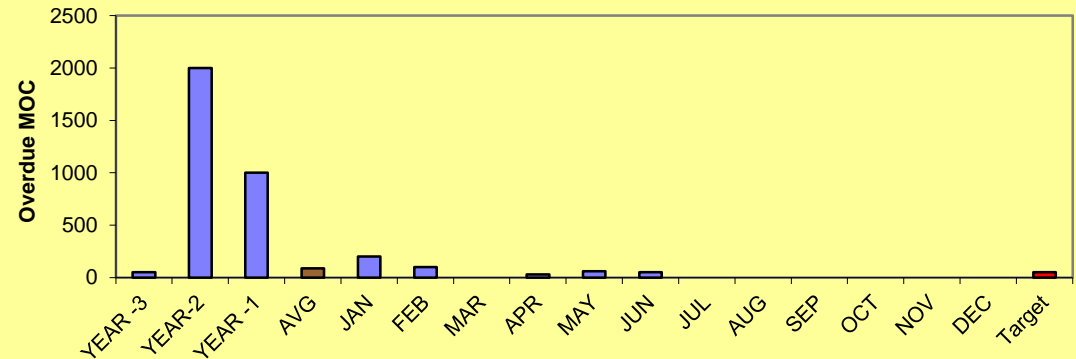
What is measured?	Leading: % Safety Critical Compliance checks for Relief Valves tests, Emergency Shutdown Device (ESD) tests and Over speed Trip Devices Tests (OTT). (PSV/RV, ESD Loops, Turbine trip tests)
Why is it measured?	Predicts this OEMS process performance by assessment of compliance.
Who measures it?	PMD – Maintenance Planning Section.
How is it measured?	Count of the actual checks and inspections performed against those that were scheduled for the month. Any re-schedule due to units unavailability counts as a miss.
Reporting format?	Tabular report to EHS Committee and Area Review and Monthly Tabular report via Operational Excellence Maintenance Measure (OEMM) by PMD Planning Section / XHQ.

METRIC ATTRIBUTES

- We used home built Spreadsheets to present summary results and detailed plots. All of this was very manual and ugly!
- Details of exactly what metrics to follow.

OE PROCESS		Active links: right click, then hit object fill to change	Commentary for this month	EHS: LEAD Extra	EHS: LEAD	EHS: LAG	EHS: LAG Extra
1	OE Leadership Accountability	Yellow circle	1 OEMS LBAT being prepared ok		Yellow circle		
4	2.1, 2.2 Design and Construction for Safety and reliability (CPDEP)	Green circle	4 Process in control ok		Yellow circle	Green circle	
5	2.4 Pre-start-up Safety Reviews (PSSR)	Green circle	5 Process in control ok		Yellow circle	Green circle	
6	3.1 (a) Risk & Process Hazard Analysis (PHA)	Yellow circle	1 12 Process Safety Event (likely). Target is in danger unless action taken ok	Yellow circle	Yellow circle	Green circle	
8	3.2 (a) Safe Work Practices	Red circle	2 LTI YTD. Target Failed ok	Yellow circle	Yellow circle	Green circle	Yellow circle
9	3.2 (b) Permit to Work (PTW)	Green circle	9 Process in control ok		Yellow circle	Green circle	
10	3.2 (c) Lock Out Tag Out.(LOTO)	Green circle	10 Process in control ok		Yellow circle	Green circle	
14	3.4 (a) Document Management System (DMS)	Yellow circle	14 Document Reviews are below target.ok		Yellow circle	Green circle	
15	3.4 (b) Process Safety Information (PSI)	Yellow circle	15 P&ID Backlog is >>> than target. Ok		Yellow circle	Green circle	
16	3.5 Compliance Training	Green circle	16 Process in control ok		Yellow circle	Green circle	Yellow circle
17	4 Management of Change	Yellow circle	17 Too many overdue MOC's: ok	Yellow circle	Yellow circle	Green circle	
18	5.3 Operations Route in Duties	Green circle	18 Process in control ok	Yellow circle	Yellow circle	Green circle	
	5.4 Asset integrity	Green circle		Yellow circle	Yellow circle	Green circle	Yellow circle

Leading Indicator: MOC closure overdue : Minimise

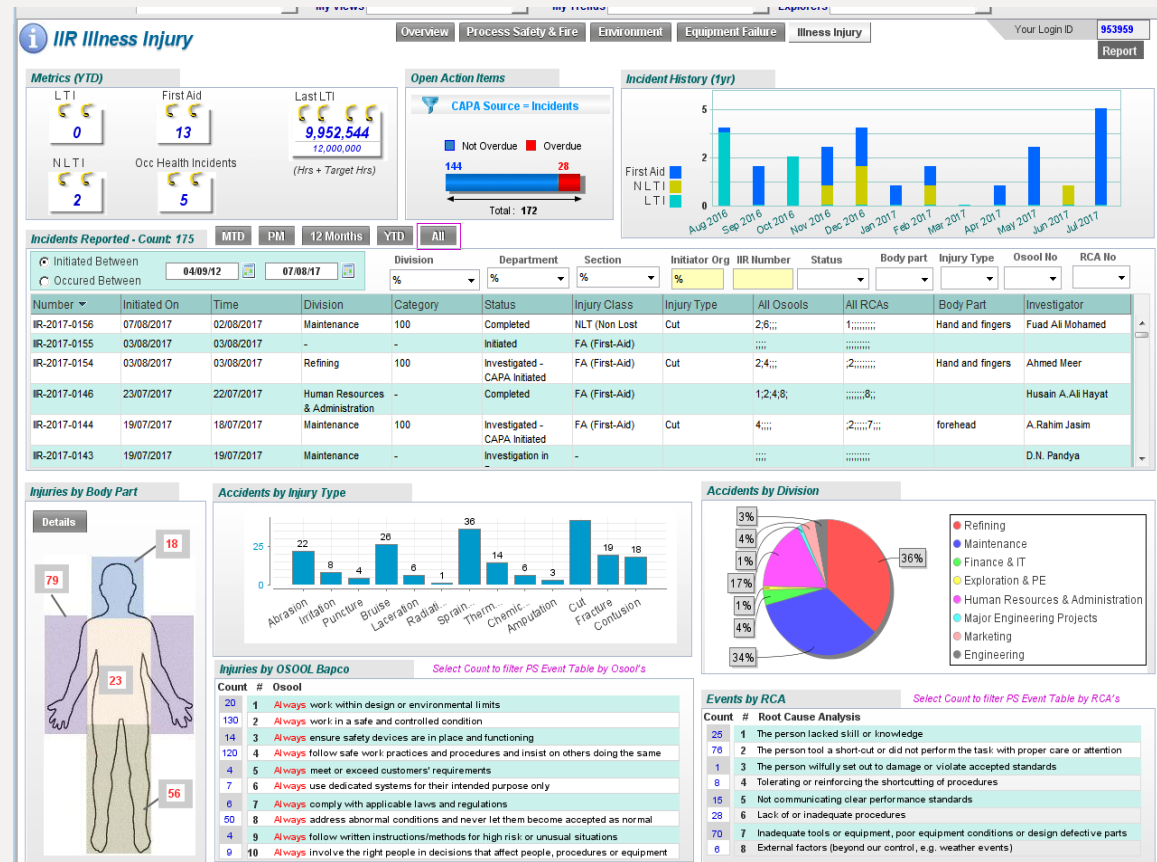


2013 ENHANCEMENTS



EARLY GENERATION OF METRICS

- Bapco implemented an Operational Intelligence Platform (Siemen XHQ) with the KPI Solution in built
- We realized that we needed “health or Risk” metrics as well as Leading and Lagging indicators (Hopkins 2007)



METRIC ATTRIBUTES

- The Lagging Indicator for the previous Leading Indicator.

What is measured?	Lagging; All Loss of Containment (API 754 T1, T2). <i>This KPI measures the number of days between LOC events</i>
Why is it measured?	Measures the performance of this process.
Who measures it?	QA Specialist
How is it measured?	All Loss of Containments in the incident Investigation Database..
Reporting format?	Tabular report to EHS Committee and Area Review. / <i>XHQ</i>

THE CONCEPT (HOPKINS 2007)

Lead

- Leading Indicator
- Prediction from compliance, conformance, activities

Health

- Health Indicator
- The results of the Leading indicator activities

Lag

- Lagging Indicator
- Process Failure

EXAMPLE “HEALTH” METRICS

What is measured?	Relief and Safety Valves found to be failed to danger (PSVs that failed their pop test) API 754 T3)
Why is it measured?	Gives an indication of the risk level this process must control.
Who measures it?	PMD/MSD but reported by Reliability Engineering Dept.
How is it measured?	Number of Safety Device checks that find that the device may not have worked as required.
Reporting format?	Tabular report to EHS Committee, Area Review and XHQ.

EARLY GENERATION OF METRICS

- KPI Functionality included
- A wrap up to an index
- RAG
- Bar Charts



2017 ENHANCEMENTS



VIZION OE/PSM

- State of the art, (best in class) KPI/KOP System.

Input
Screen

Vizion OE

Hello, BAPCODOM\vhqadmin!

Performance Indicators

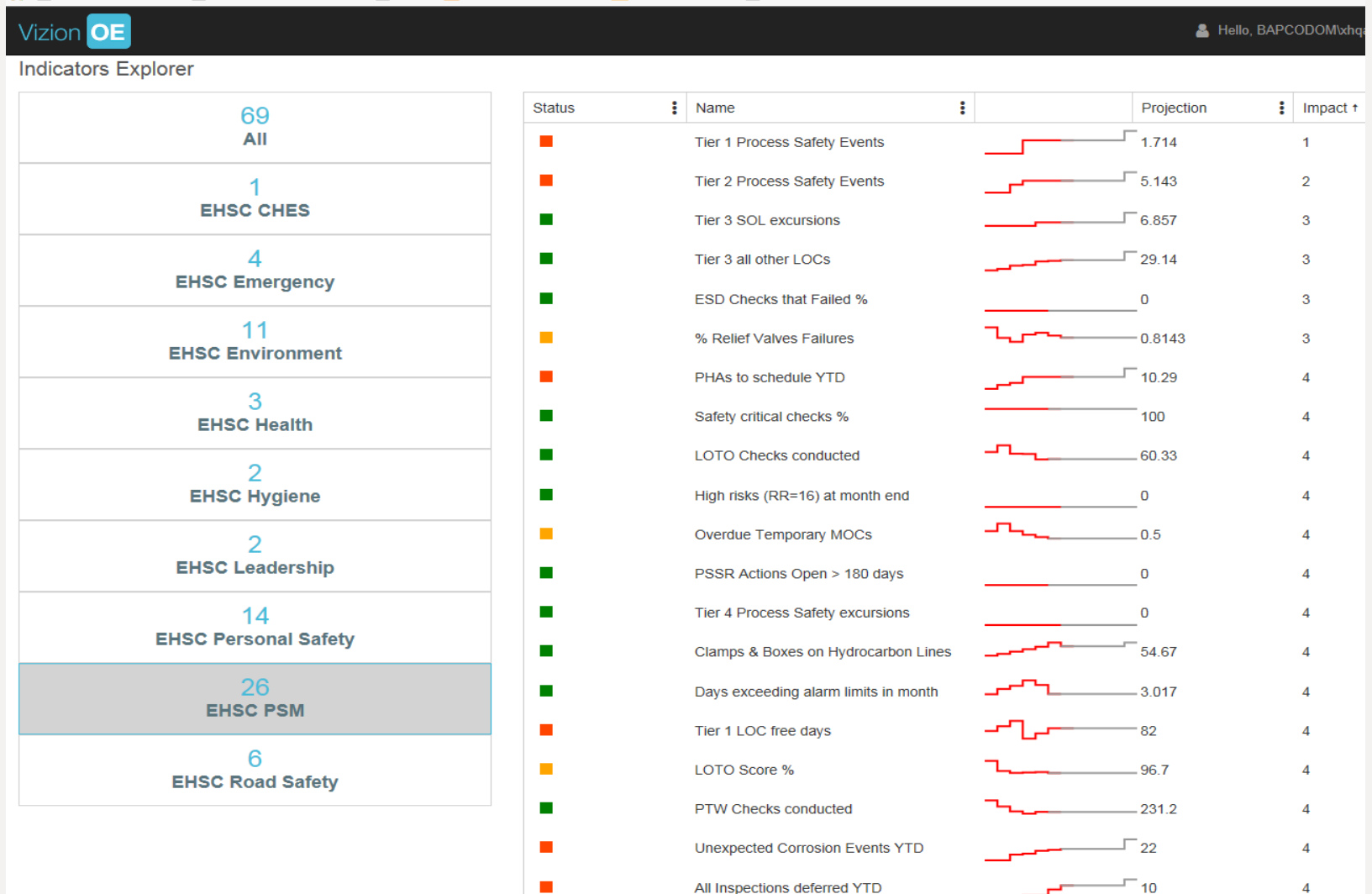
+ Add

Name	Type	Category	Impact		Order
Tier 1 Process Safety Events	EHSC PSM	General	1	V T	1
Tier 2 Process Safety Events	EHSC PSM	General	2	V T	3
% Relief Valves Failures	EHSC PSM	General	3	V T	18
ESD Checks that Failed %	EHSC PSM	General	3	V T	19
Add missing values her LOCs	EHSC PSM	General	3	V T	5
Tier 3 SOL excursions	EHSC PSM	General	3	V T	5
All Inspections deferred YTD	EHSC PSM	General	4	V T	23
Clamps & Boxes on Hydrocarbon Lines	EHSC PSM	General	4	V T	21
Days exceeding alarm limits in month	EHSC PSM	General	4	V T	26
High risks (RR=16) at month end	EHSC PSM	General	4	V T	12
LOTO Checks conducted	EHSC PSM	General	4	V T	15
LOTO Score %	EHSC PSM	General	4	V T	16
Open Actions in Proces Safety or Fire	EHSC PSM	General	4	V T	20
Overdue MOCs	EHSC PSM	General	4	V T	7
Overdue Temporary MOCs	EHSC PSM	General	4	V T	8
PHA Actions Open	EHSC PSM	General	4	V T	11
PHAs to schedule YTD	EHSC PSM	General	4	V T	10

VIZION OE/PSM

- State of the art, (best in class) KPI/KOP System.

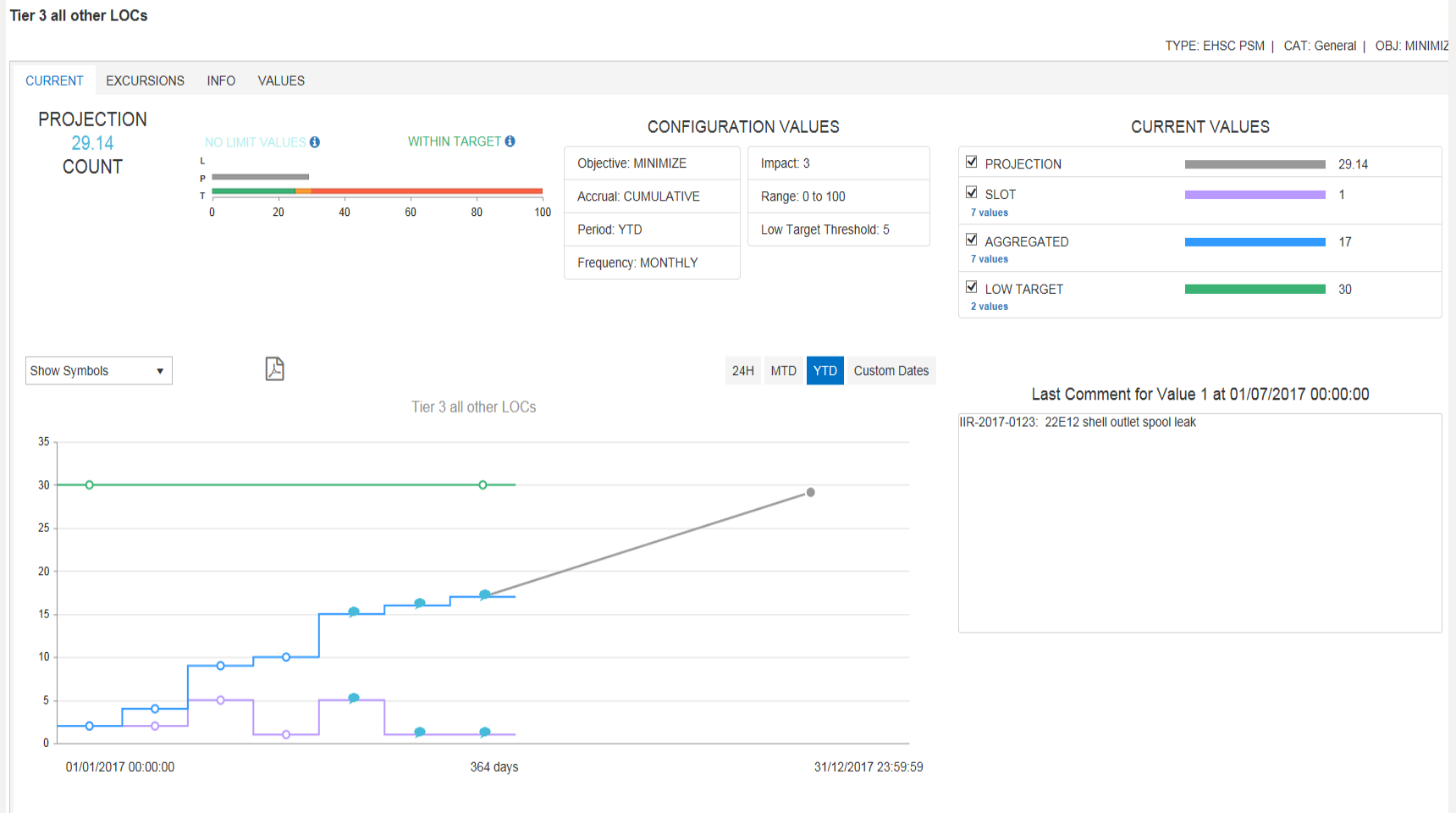
Explorer



VIZION OE/PSM

- State of the art, (best in class) KPI/KOP System.

Flexible
Plots



PSM METRICS MAP



PSM Process	Leading	Health/Risk	Lagging
Process Safety Information.	Drawings and data sheet up date conformance		Incidents where a root cause includes PSI found to be missing or wrong.
Process Hazard Analysis.	PHA to Schedule Open PHA Actions Overdue PHA actions	PHA Actions > Risk Rank X	Incident investigations that show the root cause includes PHA was not done or action item from PHA was not implemented in the specified time period.
Operating Procedures	Ops and Mtce Document Reviews Over due	Ops and Mtce Documents changed per year	Incident investigations that show the root cause includes poor or missing document

PSM METRICS

PSM Process	Leading	Health/Risk	Lagging
Training	Mandatory Training conformance.		Incidents where a root cause includes Training Issues
Contractors Safety Management	% Contractor Safety Meetings to schedule	Number of safety violations by contractor	Contractors Statistics (LTI, NLTI, FA).
Pre-Start Up Safety Review	PSSR Actions overdue (180 days)		Lagging: PSSR faults -Post Start up PSSR incidents captured under Tier 4 : PSM incidents
Mechanical/Asset Integrity	Compliance of Statutory Checks /Inspections on equipment and safety critical devices LOTO, PTW checks	The result of the checks. Safe Operating Limit Excursions. Boxes/Clamps on H/C lines. Unexpected Corrosion events. Alarms levels.	Loss of Containments T1,T2, T3

PSM Process	Leading	Health/Risk	Lagging
Safe Work Practice PTW, Isolation, Confined Space, Stop Work, Excavation. Others.....	Leading: Conformance to standard for working at heights, Excavation and Falling objects. BBS.	% Behavioural showing PPE Compliance PTW, LOTO, Safety Audit/checks/Inspecti on findings.	Lagging : Injury Frequency Rate
Management of Change.	MOC's overdue Temporary MOC's O/D	MOC Audit findings	Incidents where MOC failure was a Root Cause.
Incident Investigation	Overdue Incidents Investigations Near Miss to Incident ratio.	Incident Investigation CAPA close out rate	Repeat Incidents
Emergency Planning and Response	Emergency Exercises Fire Drills	Fire Equipment Readiness	Fires API 754 T1, T2
Compliance Audit Governance and Audit	Audits to schedule	Audit findings CAPA close out rate	Tier 1 and 2 HSE Incidents.



A WORKED EXAMPLE

© Bapco 7 October 2014

XHQ Solution Viewer - Internet Explorer

10/09/17 13:34:52

Bapco

RefiningMarketing GDN Shipping People VisionOE

Overview My Views My Trends Explorers

Special Focus OD Safety Work Orders 3 Safety Work Requests Held 3

IMS Audits Incidents Lab Samples Results

Your Login ID 953959

PEI Entry Form

Your Login ID 95395

Overview

Operational Audits

Special Focus OD Safety Work Orders 3 Safety Work Requests Held 3

Quiz # 2

Click any blue counts to filter the lists and charts by that type

Operational Audits Analytics

MTD PM YTD

Audit Date Between 01/01/17 and 10/09/17

Type %

Audited Department %

Audited Section %

Auditor %

Auditor Badge %

Nearest Location %

Checks Metrics

Checks are Audits performed within the Section of the Auditor

	MOC	Safety	LOTO 2015	LOTO	PTW 2014	PTW	Operational Managers' Tours
Audits Performed	14	123	444	12	1,692	65	93
Issues Noted	3	79	196	13	537	44	62
Average Score / 100	98	95	97	93	98	97	87

Inspections Metrics

Inspections are Audits performed outside the Section of the Auditor

	MOC	Safety	LOTO 2015	LOTO	PTW 2014	PTW	Operational Managers' Tours
Checks Performed	2	32	49	2	267	13	25
Issues Noted	2	14	36	1	190	4	17
Average Score / 100	91	97	95	97	96	98	86

Audits & Issues (1 year rolling)

Inspections and Checks

Issues

Issues and their Recurrences

Survey	Q.	Question	Times Failed?
LOTO	1	Have all energy sources been identified?	6
LOTO	2	Has the energy source been locked-out and or Tagged?	7
LOTO	3	Has the owner stipulated the Lock-Out / Tag-Out on the issued permit?	11
LOTO	4	Has the owner locked-out the source of energy?	7
LOTO	5	Has Maintenance locked-out the source energy?	17
LOTO	6	Has the correct colour coded locks been installed?	1
LOTO	7	Was the condition of the locks good?	2
LOTO	8	Has the chain been installed correctly?	5
LOTO	9	Has the source energy been Tagged-Out?	7
LOTO	10	Were the tags correct? e.g. Lock-Out / Do not Operate	3
LOTO	11	Have the tags been signed by the Owner and	9
LOTO	12	Was the key of Maintenance lock with the Maintenance Worker on the job?	3
LOTO	13	Is the clearance card available in the Work Station / Control Room?	16
LOTO	14	Have all the tags been entered in the Clearance Card?	19
LOTO	15	Has the Clearance Card been properly filled?	49
LOTO 2015	1	Are Isolation Confirmation Certificate (ICC) forms clearly displayed in the wall file holder at the relevant location?	20
LOTO 2015	2	Has a mandatory equipment isolation/ blinding sketch been	79

List of Audits & Checks - Count: 2878

ID	Date	Type	Auditor	Auditor Sect...	Audited Department	Audited Section	Location	Issues	Comments
107567	10/09/17 09:14:00	OPERATIONAL READING SS	Ruben Anthony Rivera (953450)	LSDP_Complex	Oil Processing - South	LSDP_Complex	#1HCU	0	Change is commissioned
107566	09/09/17 21:54:00	PTW 2014	Jasim Mohamed Jasim Moh'd Bu-Husain (700750)	South_Process	Oil Processing - South	South_Process	NO.4A CRUDE (VACUUM)	0	No comments.
107565	09/09/17 21:50:00	PTW 2014	Jasim Mohamed Jasim Moh'd Bu-Husain (700750)	South_Process	Oil Processing - South	South_Process	NO.4A CRUDE (PREFLASH/ATMOS/STAB)	0	No comments.
107564	09/09/17 21:47:00	PTW 2014	Jasim Mohamed Jasim Moh'd Bu-Husain (700750)	South_Process	Oil Processing - South	South_Process	NO.4A CRUDE (VACUUM)	0	No comments.

A WORKED EXAMPLE

Audit Information

Date / Time	Survey Department	Survey Location
8/22/2017 11:41:00 PM	Oil Processing - North	NO.1 VDU
Survey Type	Survey Section	Org Code
PTW 2014	North_Process	03RN11

Additional Information

Receiving Authority:	874215
Description of Work:	inspect burner of heater 2F1
Safe Work Permit Number	394340
Associated Certificates/ Forms	JSA:ICC.

Auditor

Auditor	Department	Org Code
Ahmed Hasan Ahmed Ashoor	Oil Processing - North	03RN11
Badge	Section	
708795	North_Process	

Question	Answer
1 Is the scope of work clearly identified?	YES
2 Are necessary risk assessments available for review?	YES
3 Are identified hazards listed on the permit to work, JSA or RAMS?	YES
4 Are appropriate precautions listed on the permit to work (including clearly specified isolations)?	YES
5 Is the operational time limit of the permit clear? (are extensions properly authorised?)	YES
6 Are certificates completed properly and appended to the permit?	YES
7 Are other area or system activities cross-referenced correctly via the permit?	N/A
8 Are copies of permits, certificates and attachments legible?	YES
9 Are signatures and initials traceable and legible?	YES
10 Are copies of permits and certificates posted at the correct locations?	YES
11 Are attachments, drawings etc. held at the correct locations?	N/A
12 Are Users briefed on the permit to work, and have they acknowledged understanding of requirements?	YES
13 Do people know what to do in the event of emergency?	YES
14 Are isolations appropriate for the task, clearly specified on the isolation certificate, and correctly implemented?	YES
15 Are common isolations cross-referenced?	N/A
16 Are the right people aware of isolated equipment?	YES
17 Is the Owner Dept. aware of the work?	YES
18 Is the work being carried out in conformance with the permit and associated certificates?	YES
19 Are control measures and personal protective equipment appropriate for the task?	YES

Issues and their Recurrences

Survey	Q.	Question	Times Failed?
		RAMS?	
FW 2014	14	Are isolations appropriate for the task, clearly specified on the isolation certificate, and correctly implemented?	
FW 2014	2	Are necessary risk assessments available for review?	
FW 2014	7	Are other area or system activities cross-referenced correctly via the permit?	
FW 2014	22	Are safety compliance spot checks being carried out and recorded on the original copy of the SWP?	1
FW 2014	9	Are signatures and initials traceable and legible?	2
FW 2014	16	Are the right people aware of isolated equipment?	2
FW 2014	20	Are tools and equipment suitable and in good condition?	16
FW 2014	13	Do people know what to do in the event of emergency?	
FW 2014	23	Have the SWP and associated Certificate forms been cancelled properly?	3
FW 2014	17	Is the Owner Dept. aware of the work?	17
FW 2014	5	Is the operational time limit of the permit clear? (are extensions properly authorised?)	8
FW 2014	1	Is the scope of work clearly identified?	4
FW 2014	18	Is the work being carried out in conformance with the permit and associated certificates?	4

THANK YOU