Bottom-line Benefits through innovation in Process Safety KPI Management

Martin Sedgwick, Head of Asset Management, ScottishPower, Cathcart Business Park, Spean Street, Glasgow, G44 4BE Email: <u>martin.sedgwick@scottishpower.com</u>

Alec Harley, Head of Process Safety, Lockheed Martin, India of Inchinnan, Greenock Road, Inchinnan, Scotland, PA4 9LH Email: <u>alec.harley@civil.lmco.com</u>

With the assistance of the Lockheed Martin, ScottishPower has been able to transform its organisation into a leading global exponent of process safety.

ScottishPower embarked on a project to implement a fully integrated process safety management system based on guidance published by the HSE on developing process safety indicators (HSG 254) and the American Petroleum Institute's Recommended Practice (RP) 754, in addition to drawing on lessons learned from the Texas City refinery and Buncefield oil depot explosions to address process safety at every level in the organisation.

A critical success factor in the project was the implementation of a near real-time Key Performance Indicator (KPI) monitoring system developed by Lockheed Martin, which was introduced to allow staff at all levels to see the current status of the risk control barriers across all sites. This innovative approach to KPI management enables concerns to be addressed well before they become problems and to date has delivered improved safety and reliability as well as tangible bottom-line benefits.

Through this proactive approach to process safety management ScottishPower has realised significant improvements across its business both in terms of asset management, production efficiency and bottom line contribution, including:

A 36% reduction in Operations and Maintenance costs;

A 22% increase in Plant Availability;

A 52% reduction in Equivalent Forced Outage Rates (EFOR);

A reduction in its Annual Insurance Premium.

In 2010 the Institution of Chemical Engineers recognised the company's achievements by awarding it first prize in the IChemE 2010 category of innovation in process safety; in 2011 it became the subject of one of the first case studies to be published jointly by the UK Health and Safety Executive (HSE, 2011); and in 2013 it won the Institute for Risk Management's award for Global Award for innovation.

Innovation has continued through the partnership. The most recent step in the journey has been the introduction of a live-bowtie view which provide daily visibility of how the barriers are performing around the hazards they are designed to control.

Lockheed Martin and ScottishPower will jointly present a case study on the project highlighting the benefits realised and key learnings.

Introduction

On December 11, 2005, an explosion occurred at the Buncefield oil depot in Hertfordshire, leading to Europe's biggest peacetime fire. In July 2010, following a comprehensive investigation and subsequent prosecution, Gordon MacDonald, a senior member of the UK Health and Safety Executive (HSE) posed three questions:

- 1. Do we understand what could go wrong?
- 2. Do we know what our systems are to prevent this happening?
- 3. Are we getting the right information to assure us that these systems are working effectively?

Answering these three questions has led to the development of a systematic approach to developing Process Safety Indicators (PSPIs) that can be applied to all process industries.

ScottishPower partnered with Lockheed Martin UK as a strategic partner to assist in the development and delivery of the underpinning information technology and information management strategy including the development of a Process Safety KPI Dashboard and associated core IT systems. Central to the program is the development of quantitative leading and lagging Key Performance Indicators from a Bow Tie Hazard identification and analysis process. Of particular importance was the systems integration work delivered in automating the KPI management process, as this automation enables the KPI dashboard to pull data directly from the underlying business system and update the status of the KPI's and "live" Bowties on a daily basis and risk rank them without adding any reporting burden to staff. It has also meant that all staff have a single source of truth in the KPIs that are produced and have the ability to understand current barrier performance in Bowtie format. This innovative approach to KPI development and management enables ScottishPower to be aware of the current, hidden safety, human and asset risk. It enables the organization to make more accurate decisions at shift management to boardroom level before critical barriers fail.

This paper explains how Bowtie theory can be used to develop KPIs covering an entire asset base and the benefits that can be obtained using this methodology.

Description and Application of Equipment and Processes

Establishing the Key Performance Indicators, KPIs

To deliver an integrated process safety and asset integrity management system, and specifically to establish a comprehensive set of leading and lagging process safety performance indicators, ScottishPower followed the UK HSE Guidance on establishing process safety performance indicators (HSG 254)

A multi-functional team from the business (including key contractors where processes were undertaken by external staff) followed the six stage approach in HSG 254 to identify 90 Hazards/Hazardous Events and the 42 Risk Control Systems (or "preventative barriers") that are required to manage these hazards. The team then reviewed each risk control system to identify one or more leading indicators, crib sheets were used to capture detailed specifications for each KPI. Whilst the process covers a range of power plant technologies it was found the majority of leading indicators could be applied but different targets and tolerances were set according to the power plant type and risk. In total 100+ Leading Indicators were identified across all Risk Control Systems. As below:

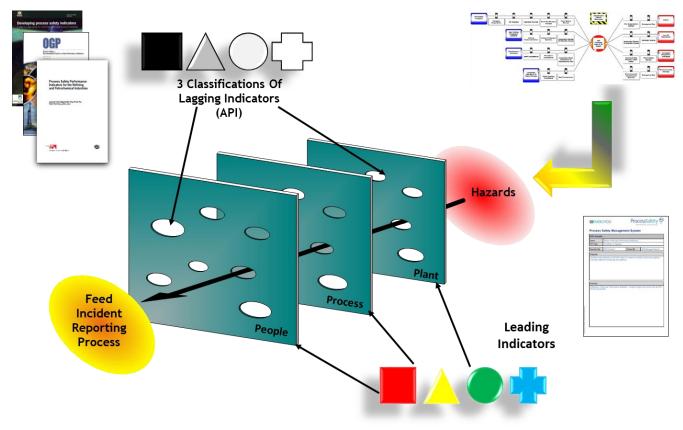


Figure 1 - Risk Control Systems Principles

It was clear that 42 Risk Control Systems and the associated 100+ leading Indicators was too large a data set to present meaningful information to the management team so the 42 risk control systems were nested into 8 headline Risk Control Areas to form the basis of the Process Safety and Asset Integrity Management System (PSAIM system) that covers:

- Operational and Compliance Audits;
- Technical Risk Management;
- Staff Competence;
- Operational Management;
- Maintenance Management;
- Critical Systems Management;
- Alarm and Instrument Management; and

• Emergency Preparedness.

Figure 2 shows how this was collated into a formal management system in terms of Risk Control Areas.

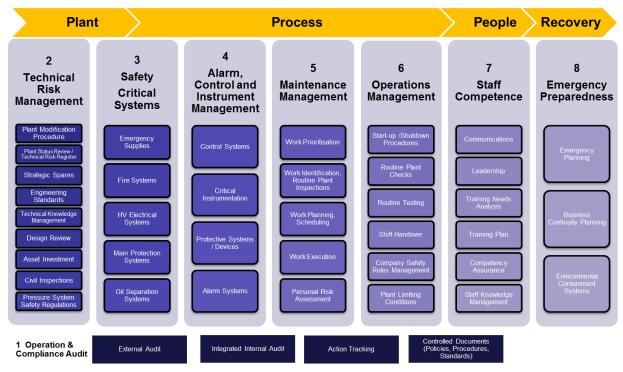


Figure 2 - Risk Control Area Model

In terms of Lagging Indicators, ScottishPower took a simple view that incidents and near misses were the single source of Lagging Indicators. To capture this lagging data, a new incident management process was implemented to capture and drive out consistent investigation of root causes. To ensure staff report process related incidents and near misses a major cultural awareness program was developed which trained staff on the importance of the role that "lagging" indictors play in learning from events and preventing such incidents occurring again across the power fleet. Further to this a companywide Technical Incident process has been developed.

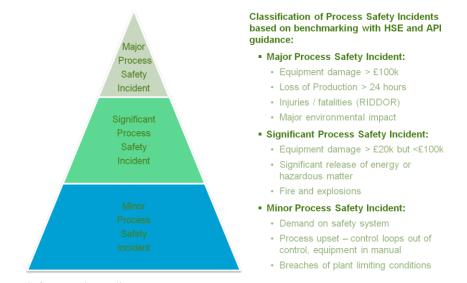


Figure 3 - Process Safety Lagging Indicators

To improve performance and track trends a system of simple colour coded targets were set for each KPI. Blue shows where performance meets a level that is considered industry best practice. Green indicates performance is on target, amber that it is within acceptable tolerance and red to shows where it is below acceptable. Both "leading and lagging" indictors are brought together to build a live "Bowtie" model approach. The key focus is always on leading indicators as these are more predictive in terms of preventing a major accident. This was then developed into a visible PSMS to allow the RCS barriers to be measured daily; this is shown in Figures 4 and 5

C Matrix - Windows Internet Explorer	
G + http://ocahost.KpDeshboard/	🖌 🛃 🗶 Uve Search
Ele Edit yew Favorites Iools Help	
🚖 🕸 🍘 Matrix	💁 • 🔂 - 🖶 • 🔂 Bage - 🎯 Tgols - 🎽
	Report Steves Steves (System Administrator)
Matrix Manual Data Reports User Profesorces	Links Holp Admin Print
Fill Till 10/11/2013 Date: 10/11/2013 Group/Dusiness Unit: Energy Co \ United Kingdom \ Coal \ Glenthridge Hazard/Realisation Event: Energy Co \ Catactrophic Failure (Searage) \ Loss of Or Supply Modity:	
	View in Tabular Format

antina disente da seconda de la companya	
	*
	Scoal intranet 👫 100% -

Figure 4 – Live Bowtie



Figure 5 – Management System Live view

A key concept of the approach is that not all indicators are of equal importance when considering predictability in terms of risk. Three types of indicators were identified, Operational Control, Generic and Program Indicators. In terms of preventing a major incident or accident it is the Operational Control Indicators that need to be focused on.

Many organizations have process safety key performance indictors based on program and generic categories as often these are easier to measure. Whilst these indicators are important in terms of setting leadership and culture they are very rarely involved with the initiation of a process safety incident or event and are often over measured and can give a false sense of security that risks are being managed. Operational Control Indicators are often under collected due to the complexity of requiring some real time data to be transformed into relevant KPIs but are the key to preventing future incidents. The types of indictors in each group are summarized below in Figure 6:

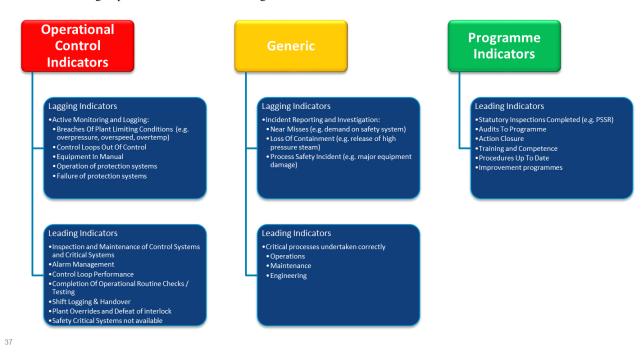


Figure 6: Types of Indicators

Having recognized the categories of KPIs, a risk model and set of mathematical algorithms were developed to allow the important KPIs to be easily visible to the organization. The KPI dashboard was then modified to take these concepts into the governance and management process of the individual indicators and power plants. Figures 7 and 8 shows the concepts:

Kpi Detail	l - Windows Internet E	xplorer								
- ()	🙋 http://localhost/KpiDa	shboard/KpiDeta	tail.aspx					~	Live Search	٩
	/jew F <u>a</u> vorites <u>T</u> ools	Help								
* 6	🖗 Kpi Detail									🔹 🔹 🔂 Page 🔹 🎯 Tools 🔹
M	atrix Manual	Data Su	ummary	Report	KF Monthly F		ails er Preference			A R T I N es (System Administrator) Print
. 1916	atrix Mariuar	Dala Su	ummary	Report	Monthly P	cepon Os	er Freierence	S LIIKS	rieip	Fillit
Group:	Coal	✓ Control	ol Area:	All		✓ Date: 2	9/11/2010	~	34.3% (24)	• 10.0% (7) • 11.4% (8)
Business	s Unit: Longannet	Contro	ol Syste	m: All		✓ Refresh			100.0% (1)	44.3% (31)
Lagging	Longuiner							Trend D.1		
Lagging Links	Longuiner	(PI Category				Refrest Status	Count	Trend D-1 N/A		44.3% (31) Trend M-3 N/A
Lagging Links	F	(PI Category Incident	y Name				Count		Trend M-1	Trend M-3
Lagging Links ≌	Major Process Safety	(PICategory Incident afety Incident	y Name			Status	Count 1	N/A	Trend M-1 N/A	Trend M-3 N/A
Lagging Links រ័ រ័	Major Process Safety Significant Process Safety Minor Process Safety	(PI Category Incident afety Incident Incident	y Name t			Status	Count 1 0	N/A N/A	Trend M-1 N/A N/A	Trend M-3 N/A N/A
Lagging Links ដ	Major Process Safety Significant Process Safety Minor Process Safety	(PICategory Incident afety Incident	y Name t		E	Status	Count 1 0 0	N/A N/A	Trend M-1 N/A N/A	Trend M-3 N/A N/A
Lagging Links ឆ្ម រ ដ Leading .inks	Major Process Safety Significant Process Safety	(PI Category Incident afety Incident Incident	y Name t <u>Metric</u> <u>Ta</u>	arget Tole	rance Pra	Status	Count 1 0 0	N/A N/A N/A	Trend M-1 N/A N/A N/A	Trend M-3 N/A N/A N/A
Lagging Links Leading Leading inks M Pire 78) Saft Back HV E Back	Major Process Safety Significant Process Safety Minor Process Safety KPI Name	(PI Category Incident afety Incident Incident Business M Unit	y Name t <u>Metric</u> Tr <u>Type</u>	arget Tole	rance Pra 5% 8	Status	Count 1 0 0 Actual I 82% No C	N/A N/A N/A	Trend M-1 N/A N/A N/A M-3	Trend M-3 N/A N/A N/A
Lagging Links Leading inks T8 T8 T8 HV E Back (192 Carlor Back Main Back	Major Process Safety Significant Process Si Minor Process Safety <u>KPI Name</u> Systems PMC (64 of Electrical Systems Klog Size in Months	(PI Category) Incident afety Incident Incident Business M Unit	y Name t <u>Metric</u> Tr Type <	arget Tole 50% 11 4m 2	rance Ε Pra 5% ε m ·	Status	Count 1 0 Actual 82% No C 1m	N/A N/A N/A D-1 <u>M-1</u> Change †	Trend M-1 N/A N/A N/A M-3	Trend M-3 N/A N/A N/A

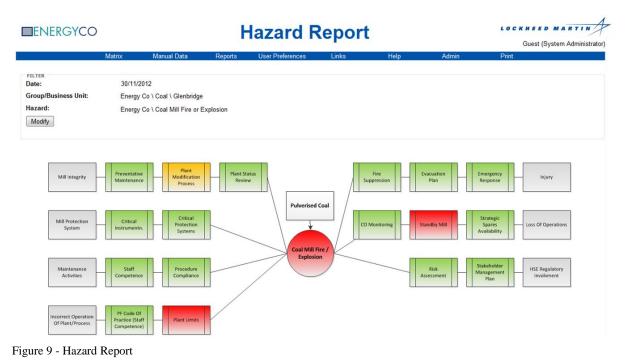
Figure 7 – Risk Ranking of KPIs

			Wei	ghted K	PI Repo	rt			ED MARTIN
	Matrix	Manual Data	Reports	User Preferences	Links	Help	Admin	Print	
FILTER Date:	30/11/2012	2							
Group/Business Unit: Modify	Energy Co	\ Coal \ Glenbridge							
Technical Risk Managem	ent	Critical System	3	Alarm / Ins	trumentation Managem	ent <u>Ma</u>	a 2.38 4	a	
Operations Management		Operational and	Compliance Audits	s Staff Com	2.55 4	En	ergency Prepared	ness 3	

Figure 8 – Portfolio View

Key Hazard Report

Once the KPIs have been developed linking key hazards to risks, it is a simple task to provide hazard reports and the condition of both preventative and mitigation barriers. Preventive barriers are those leading indicators which prevent and predict an incident such as corrosion inspections and mitigation barriers are those leading indicators which reduce the impact of an incident such as the availability of a main protection or shutdown system. This is shown in Figure 9.



Prevention of a Major Accident Hazards

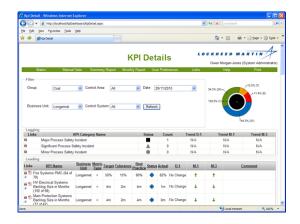
To prevent a Major Accident Hazard the key performance indicators need to be visible to all in the organization from the operator or maintenance technician up to the CEO level. These indictors then need to be acted upon throughout the organization and seen as the driving force behind the business in terms of reducing safety risk and improving performance and efficiency.

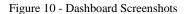
To make this happen the indicators are made visible to all employees of the company, including contractors through the use of the intranet, handheld tablets and daily discussions with staff. This is achieved by proving the dashboard with a number of features such as drill down to individual pieces of work, trending and reporting screens. To ensure no indicators are missed through data aggregation etc. red indictors at a plant level will feed through as red to the top of the organization but the risk ranking process allows the focus to be on those indicators which are of most significance. Figure 10 shows a number of screenshots used by the organization.

Summary Report - Windows Internet				
🔾 🕑 🔹 🙋 http://localhost/KpiDashboard	(SummaryReport.aspx	~	5 X Uve Search	P -
le Edit View Pavorites Ipols Help				
🕈 🕸 🖉 Summary Report			💁 • 🖾 · 🖶 • 🕑 Expe	• 🕜 Tgols •
Matrix Manual Data	Summar Summary Report Monthly Report	ry Report	CKHEED MARTIN Owen Morgan-Jones (System Ac Helo Pir	
Filter Date: 29/11/2010 ¥		inessUnit: Longannet 🖌 Refresh		
Technical Risk Management 8.3% (1) 41.2% (3) 	Citical System Management	Alarm / Instrumentation Management +2.95 (3) 100.055 (1) 57.155 (4)	Maintenance Management 26.455 (6) 54.555 (6) ²	-+9.15 (1)
Deparations Management	Operational and Compliance Audits	Staff Competence	Emergency Preparedness	
9			S Local intranet	1 100% ·

a 🖉 . 🐻 under	(bret.berdrois.es:106)	EpiDashboard/TransactionalD	rilDown_aspx?¥p	63=40%bu	inessUnitId	=16Date=27/0	10,72011 👻 🐤	Uve Seard		
le Edit Yew Fgvc	vites Iools Help									
🔹 🕅 🖌 🎮	en 🍊	ci Detai	ng Trend	Transact	× …lens	de Infollere		9.0.		Tgols
. 00										
		-								
		Trans	sactio	nal	Dril	I Dov	vn			
									m/623534	4 (Gues
N	tatrix Summ	ary Report Monthly 8	Report Use	r Preferen	es	Links	He	6	Print	
< Back to KPI Detai	le.									
									Export To E	Excel
5 drill down record(s)) returned.									
Date	Business Unit	Work Order Number	Weighting	21828	Status	Overer				
Date 7/01/2011 00 00:00	Business Unit Longannet	L708/22787	Weighting	CLOSED	CLOSE	LT_HVE			CIRCUIT BREAKER 11	
Date 7.01/2011 00:00:00 7.01/2011 00:00:00	Business Unit Longannet Longannet	L108/22787 L108/94795		CLOSED	CLOSE	LT_HVE LT_HVE	11KV UNIT TR	ANSFORMER 3 SP	CIRCUIT BREAKER 11 8 CIRCUIT BREAKER	11KV UN
Date 740 1/2011 00:00:00 740 1/2011 00:00:00 740 1/2011 00:00:00	Business Unit Longannet Longannet Longannet	L708/22787 L708/34795 L708/50511		CLOSED CLOSED CLOSED	CLOSE CLOSE CLOSE	LT_HVE LT_HVE LT_HVE	11KV UNIT TR UNIT 3 8 FD F	ANSFORMER 3 SP AN MOTOR 11KV 5	CIRCUIT BREAKER 11 6 CIRCUIT BREAKER 1/6 CIRCUIT BREAKER	11KV UN R 11KV U
Date: 7/01/2011 00:00:00 7/01/2011 00:00:00 7/01/2011 00:00:00 7/01/2011 00:00:00	Business Unit Longannet Longannet Longannet Longannet	L708/22787 L708/34795 L708/30511 L708/35504		CLOSED CLOSED CLOSED CLOSED	CLOSE CLOSE CLOSE CLOSE	LT_HVE LT_HVE LT_HVE LT_HVE	11KV UNIT TR UNIT 3 & FD F 17KNT1KV UR	ANSFORMER 3 SP AN MOTOR 11KV (NIT TRANSFORMER	CIRCUIT BREAKER 11 6 CIRCUIT BREAKER 1/6 CIRCUIT BREAKER R 2 AUXILIARY TRANS	11KV UN R 11KV U FORMER
Date 74012011000000 74012011000000 7401201100000 7401201100000 7401201100000	Business Unit Longannet Longannet Longannet Longannet	L708/22787 L708/24795 L708/96511 L708/25504 L710/100996		CLOSED CLOSED CLOSED CLOSED CLOSED	CLOSE CLOSE CLOSE CLOSE CLOSE	LT_HVE LT_HVE LT_HVE LT_HVE LT_HEAM	11HOV UNIT TH UNIT 3 & FD F 17HOUTSHOV UN US OEN TFR C	IANSFORMER 3 SF AN MOTOR 11KV 0 NIT TRANSFORMED COOLING SYSTEM	CIRCUIT BREAKER 11 6 CIRCUIT BREAKER 176 CIRCUIT BREAKER 8 2 AUXILIARY TRANS 5: CARRY OUT CLEAN	11KV UN R 11KV U FORMER ENG IN C
Date 7.0 1/2011 00 00 00 7.0 1/2011 00 00 00	Business Unit Longannet Longannet Longannet Longannet Longannet Longannet	L708/22787 L708/24795 L708/26511 L708/25504 L710/100996 L710/100998		CLOSED CLOSED CLOSED CLOSED CLOSED CLOSED	CLOSE CLOSE CLOSE CLOSE CLOSE CLOSE	LT_HVE LT_HVE LT_HVE LT_HVE LT_TERM LT_TERM	11KV UNIT TR UNIT 3 & FD F 17KV/11KV UN U1 GEN TFR 0 U4 GEN TFR 0	IANSFORMER 3 SF IAN MOTOR 11KV 1 NIT TRANSFORMED COOLING SYSTEM COOLING SYSTEM	CIRCUIT BREAKER 11 6 CIRCUIT BREAKER 176 CIRCUIT BREAKER 12 AURILIARY TRANS 5: CARRY OUT CLEAN 5: CARRY OUT CLEAN	11KV UNI R 11KV U IFORMER ENG IN CI ENG IN CI
Date 7.0 12011 (0 00 00 7.0 12011 (0 00 00	Business Unit Longannet Longannet Longannet Longannet Longannet Longannet	L708/22787 L708/94795 L708/9611 L708/9504 L719/700966 L719/7010966 L719/701000		CLOSED CLOSED CLOSED CLOSED CLOSED CLOSED	CLOSE CLOSE CLOSE CLOSE CLOSE CLOSE CLOSE	LT_HVE LT_HVE LT_HVE LT_HVE LT_TERM LT_TERM LT_TERM	11KV UNIT TR UNIT 3 8 FD F 17KV/11KV UP U1 GEN TFR 0 U4 GEN TFR 0 U2 GEN TFR 0	RANSFORMER 3 SF (AN MOTOR 11KV) NIT TRANSFORMER COOLING SYSTEM COOLING SYSTEM	CIRCUIT BREAKER 11 6 CIRCUIT BREAKER 16 CIRCUIT BREAKER 2 AUXILIARY TRANS 9: CARRY OUT CLEAN 9: CARRY OUT CLEAN 9: CARRY OUT CLEAN	11KV UN R 11KV U FORMER ENG IN C ENG IN C
Date 7.01/2011 00 00 00 7.01/2011 00 00 00	Butiness Unit Longannet Longannet Longannet Longannet Longannet Longannet Longannet	L108/22197 L108/54795 L108/54795 L108/55604 L110/700066 L110/700066 L110/7010000 L110/701000		CLOSED CLOSED CLOSED CLOSED CLOSED CLOSED CLOSED CLOSED	CLOSE CLOSE CLOSE CLOSE CLOSE CLOSE CLOSE CLOSE	LT_HVE LT_HVE LT_HVE LT_HVE LT_TERM LT_TERM LT_TERM LT_TERM	11KV UNIT TR UNIT 3 & FD F STROUTIRO UN UT GEN TFR 0 U4 GEN TFR 0 U2 GEN TFR 0 U0 GEN TFR 0	RANSFORMER 3 SF IAN MOTOR 11KV (NIT TRANSFORME) COOLING SYSTEM COOLING SYSTEM COOLING SYSTEM	CIRCUIT BREAKER 11 8 CIRCUIT BREAKER 146 CIRCUIT BREAKER 12 AUDULARY TRANS 0: CARRY OUT CLEAN 0: CARRY OUT CLEAN 0: CARRY OUT CLEAN 0: CARRY OUT CLEAN	11KV UN R 11KV U PORMER ENG IN C ENG IN C ENG IN C
Date 7.012011000000 7.01201100000 7.01201100000 7.01201100000 7.01201100000 7.01201100000 7.01201100000 7.01201100000	Butineen Unit Longannet Longannet Longannet Longannet Longannet Longannet Longannet Longannet	L108/22/87 L108/54/95 L108/56511 L108/25504 L110/00966 L110/00966 L110/00966 L110/00960 L110/009002 L110/00987		CLOSED CLOSED CLOSED CLOSED CLOSED CLOSED CLOSED CLOSED	CLOSE CLOSE CLOSE CLOSE CLOSE CLOSE CLOSE CLOSE	LT_HVE LT_HVE LT_HVE LT_HVE LT_HVE LT_TERM LT_TERM LT_TERM LT_HRM	11KV UNIT TR UNIT 3 & FD F STRAFTSKY UP U1 GEN TFR 0 U4 GEN TFR 0 U2 GEN TFR 0 U0 GEN TFR 0 275KV/15KV 1	RANSFORMER 3 SF IAN MOTOR 11KV (NIT TRANSFORME) CODUING SYSTEM CODUING SYSTEM CODUING SYSTEM CODUING SYSTEM Station Transformer	CIRCUIT BREAKER 11 50 CIRCUIT BREAKER 156 CIRCUIT BREAKER 51 CARRY OUT CLEAN 51 CARRY OUT PMI 4103	11KV UN R 11KV U PORMER ENG IN C ENG IN C ENG IN C ENG IN C
Date 7.012011000000 7.01201100000 7.01201100000 7.01201100000 7.01201100000 7.01201100000 7.01201100000 7.01201100000 7.01201100000 7.01201100000	Butineza Ubil Longannet Longannet Longannet Longannet Longannet Longannet Longannet Longannet Longannet	L108/22/87 L108/6/4765 L108/6/0511 L108/6/6511 L108/25504 L1109/00666 L1109/00666 L1109/00666 L1109/0002 L1109/01667 L1109/01641		CLOSED CLOSED CLOSED CLOSED CLOSED CLOSED CLOSED CLOSED CLOSED CLOSED	CLOSE CLOSE CLOSE CLOSE CLOSE CLOSE CLOSE CLOSE CLOSE CLOSE	LT_RVE LT_RVE LT_RVE LT_RVE LT_RVE LT_TERM LT_TERM LT_TERM LT_TERM LT_RVE AMEC	11kV UNIT TR UNIT 3 & FD F STRATISKY U U1 GEN TFR 0 U2 GEN TFR 0 U2 GEN TFR 0 U2 GEN TFR 0 275kV/11kV 1 Asset 3 3kV/H	IANSFORMER 3 SF IAN MOTOR 11KV (NIT TRANSFORMER COOLING SYSTEM COOLING SYSTEM COOLING SYSTEM COOLING SYSTEM SOLIDI TRANSPORT INFO	CIRCUIT DREAMER 11 5 CIRCUIT DREAMER 15 CIRCUIT BREAMER 15 CIRCUIT BREAME 10 CARRY OUT CLEAN 10 CARRY OUT CLEAN	11ICV UNI R 11ICV UNI PORMER INO IN CI INO IN CI INO IN CI INO IN CI INO IN CI INO IN CI
Date 7.0 1/2011 00 000 00 7.0 1/2011 00 000 00 7.0 1/2011 00 00 00	Butional Diff Longanset Longanset Longanset Longanset Longanset Longanset Longanset Longanset Longanset Longanset	L 19692787 L 19892787 L 19896919 L 198969514 L 19896966 L 199790966 L 199790966 L 199799002 L 199799002 L 199799002 L 199791002 L 199791002 L 199791002		CLOSED CLOSED CLOSED CLOSED CLOSED CLOSED CLOSED CLOSED CLOSED CLOSED	CLOSE CLOSE CLOSE CLOSE CLOSE CLOSE CLOSE CLOSE CLOSE	LT_INVE LT_INVE LT_INVE LT_INVE LT_INVE LT_ITERM LT_ITERM LT_ITERM LT_INVE AMEC LT_INVE	11KV UNIT TE UNIT 3 & FD F 17K0/11KV UN U1 0EN TER 0 U2 0EN TER 0 U3 0EN TER 0 U3 0EN TER 0 2756/011KV 1 Amet 3 3KVN 3 3KV BOILER	IANSFORMER 3 SF IAN MOTOR 1150 S NIT TRANSFORME COOLING SYSTEM COOLING SYSTEM COOLING SYSTEM COOLING SYSTEM Station Transform Station Transform ISS V Tullenel HOU R UNIT BOARD 4 : C	CIRCUIT BREAKER 11 5 CIRCUIT BREAKER 11 15 CIRCUIT BREAKE 12 AUXILIARY TRANS 5: CARRY OUT CLEAN 5: CARRY OUT CLEAN 5: CARRY OUT CLEAN 1: Cany out PUL CLEAN 1: Cany out PUL CLEAN 1: Cany out PUL CLEAN 1: Cany out PUL CLEAN 2: CARRY OUT CLEAN 1: Cany out PUL CLEAN 2: CARRY OUT CLEAN 1: Cany out PUL CLEAN 2: CARRY OUT CLEAN	11KV UN R 11KV U FORMER ENG IN C ENG IN C ENG IN C ENG IN C FORMER PARTIES OF
Date 7.01/2011 00 00 00 7.01/2011 00 00 00	Butiness Did Longannet Longannet Longannet Longannet Longannet Longannet Longannet Longannet Longannet Longannet Longannet	L108922987 L1086054795 L10860591 L1086059504 L110000600 L110000600 L110000600 L1100010000 L1100010807 L1100010807 L1100019807 L110003123 L110003276		CLOSED CLOSED CLOSED CLOSED CLOSED CLOSED CLOSED CLOSED CLOSED CLOSED	CLOSE CLOSE CLOSE CLOSE CLOSE CLOSE CLOSE CLOSE CLOSE CLOSE	LT_HVE LT_HVE LT_HVE LT_HVE LT_HVE LT_TERM LT_TERM LT_TERM LT_HVE AMEC LT_HVE LT_HVE	11kV UNIT TR UNIT 3 8 FD F 17k011kV U U1 0EN TFR (U4 0EN TFR (U2 0EN TFR (U2 0EN TFR (275k011kV (Asset 3 3k0 3 3kV BOLEF 3 3kV BOLEF	IANSFORMER 3 SF IAN MOTOR 1150 (NIT TRANSFORMER COOLING SYSTEM COOLING SYSTEM COOLING SYSTEM COOLING SYSTEM Station Transformer INST TURBINE MOARD 4: C R UNIT BOARD 4: C R UNIT BOARD 4: C	CIRCUIT DREAMER 11 5 CIRCUIT DREAMER 15 CIRCUIT DREAMER 15 CIRCUIT RREAMER 12 AUDOLLARY TRANS 12 CARRY OUT CLEAN 13 CARRY OUT CLEAN 14 CARY	THEOLONIA R THEOLONIA IF ORMER ING IN CI- ING INC INCO INCO INCO INCO INCO INCO INCO INCO
Date 7.0 1/2011 00 00 00 7.0	Buttonez DM Longannet Longannet Longannet Longannet Longannet Longannet Longannet Longannet Longannet Longannet Longannet Longannet	L108/22187 L108/04195 L108/04911 L108/05014 L119/100006 L119/100006 L119/100006 L119/100000 L119/101000 L119/101000 L119/101044 L119/101044 L119/101044		CLOSED CLOSED CLOSED CLOSED CLOSED CLOSED CLOSED CLOSED CLOSED CLOSED	CLOSE CLOSE CLOSE CLOSE CLOSE CLOSE CLOSE CLOSE CLOSE CLOSE CLOSE CLOSE	LT_INVE LT_INVE LT_INVE LT_INVE LT_INVE LT_ITERM LT_ITERM LT_INVE AMEC LT_INVE LT_INVE LT_INVE	11KV UNIT TE UNIT 3 & FO F 17X0/11KV U U1 0EN TER (U2 0EN TER (U2 0EN TER (U2 0EN TER (U2 0EN TER (2750/01KV (Amet 3 30/00 3 3KV BOILER 3 3KV BOILER 11KV UNIT BO	RANSFORMER 3 SF (AN MOTOR 116/0 NIT TRANSFORME) COOLING SYSTEM COOLING SYSTEM COO	CIRCUIT BREAXER 111 SCIRCUIT BREAXER SP5 CIRCUIT BREAXER IS CONTO CLEAN SCARPY OUT CLEAN SC	11IO UNI R 11IO U FORMER ENG IN CI ENG IN CI ENG IN CI ENG IN CI ENG IN CI E FORMER patters on patters on SFG circuit
Date 70 12011 00 00 00 70 12011 00 00 00	Buttiess Did Longannet Longannet Longannet Longannet Longannet Longannet Longannet Longannet Longannet Longannet Longannet Longannet	L108/22197 L108/4295 L108/4295 L108/429504 L114/100006 L114/100006 L114/100006 L114/100006 L114/100006 L114/100006 L114/100006 L114/100006 L114/100006 L114/100006		CLOSED CLOSED CLOSED CLOSED CLOSED CLOSED CLOSED CLOSED CLOSED CLOSED CLOSED	CLOSE CLOSE CLOSE CLOSE CLOSE CLOSE CLOSE CLOSE CLOSE CLOSE CLOSE CLOSE CLOSE CLOSE	LT_HVE LT_HVE LT_HVE LT_HVE LT_HVE LT_TERM LT_TERM LT_TERM LT_TERM LT_HVE LT_HVE LT_HVE LT_HVE LT_HVE	11507 UNIT TE UNIT 3 & FO F 1776071507 UNIT TE U1 0 (INIT FR (U1 0 (INIT FR (U2 0 (INIT FR (U2 0 (INIT FR (U2 0 (INIT FR (U2 0 (INIT FR (2 550/11507) Asset 3 350/0 3 367/ BOLLES 3 367/ BOLLES	NANSFORMER 3 SF IAN MOTOR 11XV I NIT TRANSFORME COOLING SVISTEM COOLING SVISTEM COOLING SVISTEM COOLING SVISTEM COOLING SVISTEM RUNT TURINE HOU RUNT TURINE HOU	CIRCUIT BREAKER 11 6 CIRCUIT BREAKER 18 CIRCUIT BREAKER 18 CIRCUIT BREAKER 18 CARRY OUT CLEAN 19 CARRY OUT CLEAN 19 CARRY OUT CLEAN 19 CARRY OUT CLEAN 10 CARRY OUT CLEAN 11 Carry out PMI-4103 11 Carry out PMI-4103 12 CARRY OUT CLEAN 11 Carry out PMI-4103 12 CARRY OUT CLEAN 12 CARRY OUT CLEAN 12 CARRY OUT CLEAN 13 CARRY OUT CLEAN 14 CA	1100 UNI R 1100 UN FORMER ING IN CI ING INC INCI ING INCI ING INCI ING INCI ING INCI ING INCI ING INCI ING INCI ING INCI ING INCI INCI INCI INCI INCI INCI INCI INCI
Date 70 102111000000 70 10201100000 70 10201100000 70 10201100000 70 10201100000 70 10201100000 70 10201100000 70 10201100000 70 10201100000 70 10201100000 70 10201100000	Barrierz DZ Lenganet Lenganet Lenganet Lenganet Lenganet Lenganet Lenganet Lenganet Lenganet Lenganet Lenganet Lenganet Lenganet	L108/22197 L108/A/95 L108/00011 L109/000011 L109/00000 L110/000000 L110/000000 L110/000000 L110/000000 L110/00000 L110/00000 L110/002/0 L110/002/0 L110/00001 L110/00001		CLOSED CLOSED CLOSED CLOSED CLOSED CLOSED CLOSED CLOSED CLOSED CLOSED CLOSED CLOSED	CLOSE CLOSE CLOSE CLOSE CLOSE CLOSE CLOSE CLOSE CLOSE CLOSE CLOSE CLOSE CLOSE CLOSE CLOSE CLOSE	LT_HVE LT_HVE LT_HVE LT_HVE LT_TERM LT_TERM LT_TERM LT_TERM LT_TERM LT_HVE LT_HVE LT_HVE LT_HVE LT_HVE	1150 UNIT TE UNIT 3 B FO F STAAT150 UNIT 5 B FO F STAAT150 UNI 6 B U1 0 EN TFR (U2 0 EN TFR (2 250 O EN 5 0 EN 5	RANSFORMER 3 SF AAN MOTOR 1150 (1150 (115)	CIRCUT BREAKER 11 6 CIRCUT BREAKER 14 CIRCUT BREAKER 12 ADDULARY TRAVE 15 CARRY OUT CLEAN 15 CARRY OUT CLEAN 16 CARRY OUT CLEAN	1100 UNI R 1100 UN FORMER ENG IN CI ENG ENG ENG ENG ENG ENG ENG ENG ENG ENG ENG ENG ENG ENG ENG
Date 70 10211 10 0000 70 10211 10 0000 70 10211 00000 70 10211 00000	Rummers Unit Longanet Longanet Longanet Longanet Longanet Longanet Longanet Longanet Longanet Longanet Longanet Longanet Longanet Longanet	L108/22197 L108/4295 L108/4295 L108/42954 L115/100066 L115/100066 L115/100066 L115/100066 L115/101944 L115/101944 L115/101946 L115/101946 L115/104601 L115/104605		CLOSED CLOSED CLOSED CLOSED CLOSED CLOSED CLOSED CLOSED CLOSED CLOSED CLOSED CLOSED CLOSED	CLOSE CLOSE CLOSE CLOSE CLOSE CLOSE CLOSE CLOSE CLOSE CLOSE CLOSE CLOSE CLOSE	LT_HVE LT_HVE LT_HVE LT_HVE LT_HVE LT_TERM LT_TERM LT_TERM LT_TERM LT_HVE AMEC LT_HVE LT_HVE LT_HVE LT_HVE	1150/UNIT 15 UNIT 3 8 76 / 1770/150/U U1 0EN TFR 0 U2 0EN TFR 0 2 350/00 US 0 3 350/00 US 0 3 350/00 US 0 150/UNIT 80 Ab Flad Raa 150/UNIT 80	NANSFORMER 3 SF TAAN MOTOR 115/01 TTRANSFORME COOLING SYSTEM COOLING SYSTEM COOLING SYSTEM COOLING SYSTEM COOLING SYSTEM SUST TURINGE HOU R UNIT BOARD 4: C R UNIT BOARD 4: C	CUICUT BREAKEN 11 COLOT BREAKEN EN CITOLIT BREAKEN EN CITOLIT BREAKEN EN CANNY OUT CLEAN E CANNY OUT CL	1160 UNI R 5160 UN FORMER ENG IN CI ENG IN CI ENG IN CI ENG IN CI FORMER Paction on STG cloud withly, Ed to Ably, Ed
Date 70 10211 (0 0000 70 10211 (0 0000) 70 1021 (0 0000) 70 1021	Rentrees Del Longanet Longanet Longanet Longanet Longanet Longanet Longanet Longanet Longanet Longanet Longanet Longanet Longanet Longanet	L108/22/97 L108/04/95 L108/04/95 L108/04/95 L109/05004 L109/05006 L109/05006 L109/05006 L109/05006 L109/05006 L109/05006 L109/05006 L109/05006 L109/05016 L109/05016		CLOIED CLOIED CLOIED CLOIED CLOIED CLOIED CLOIED CLOIED CLOIED CLOIED CLOIED CLOIED CLOIED	CLOSE CLOSE CLOSE CLOSE CLOSE CLOSE CLOSE CLOSE CLOSE CLOSE CLOSE CLOSE CLOSE CLOSE CLOSE CLOSE CLOSE	LT_RVE LT_RVE LT_RVE LT_TERM LT_TERM LT_TERM LT_TERM LT_TERM LT_RVE AMEC LT_RVE LT_RVE LT_RVE LT_RVE LT_RVE LT_RVE	1150 UNIT TS UNIT 3 8 PD F 175001150 UNI 0EN TFR (UNI 0EN TFR (UD 0EN TFR (UD 0EN TFR (UD 0EN TFR (D 0EN TFR (D 0EN TFR (2550011500 U 3 300 POLLER 3 300 POLLER	RANSFORMER 3 SF AAN MOTOR 115/0 ' INT TRANSFORME COOLING SYSTEM COOLING SYSTEM COOLING SYSTEM COOLING SYSTEM COOLING SYSTEM SASSE TRANSFORME SASSE TRANSFORME COOLING SYSTEM SASSE TRANSFORME COOLING SYSTEM COOLING SYSTEM SASSE TRANSFORME COOLING SYSTEM SASSE TRANSFORME COOLING SYSTEM SASSE TRANSFORME COOLING SYSTEM SASSE TRANSFORME COOLING SYSTEM SASSE TRANSFORME COOLING SYSTEM SASSE TRANSFORME COOLING SYSTEM SASSE TRANSFORME SASSE TRANSFORME SA	CRUIT BREAKER 11 6 CRUIT BREAKER 149 CRUIT REAKER 15 CRUIT REAKER 15 CRUIT VIEW VIEW 15 CRWY OUT CLEAN 15 CRWY OUT CLEAN	1160 UNI R 1160 UN FORMER ENO IN CI ENO INCLESSION CO ENO INCLESION CO ENO INCLESSION CO ENO INCLESI
201201000000 2012011000000 2012011000000 2012011000000 201201100000 201201100000 201201100000 201201100000 201201100000 201201100000 201201100000 201201100000 201201100000	Buttere UM Longanet Longanet Longanet Longanet Longanet Longanet Longanet Longanet Longanet Longanet Longanet Longanet Longanet Longanet	L108/22197 L108/64/98 L108/60911 L108/05004 L119/00000 L119/00000 L119/0000 L119/0000 L119/0000 L119/0000 L119/0000 L119/0000 L119/0000 L119/0000 L119/0000 L119/0000 L119/0000 L119/0000		CLOSED CLOSED CLOSED CLOSED CLOSED CLOSED CLOSED CLOSED CLOSED CLOSED CLOSED CLOSED CLOSED CLOSED	CLOSE CLOSE CLOSE CLOSE CLOSE CLOSE CLOSE CLOSE CLOSE CLOSE CLOSE CLOSE CLOSE CLOSE CLOSE CLOSE CLOSE	LT_MVE LT_MVE LT_MVE LT_MVE LT_MVE LT_TERM LT_TERM LT_TERM LT_MVE LT_MVE LT_MVE LT_MVE LT_MVE LT_MVE LT_MVE LT_MVE LT_MVE LT_MVE	1150/UNIT 15 UNIT 3 8 FoF 1730/1150/UNIT 15 UNI 08N TFR (UNI 08N TFR (UNI 08N TFR (UNI 08N TFR (27550/1150/1 Amet 3 350/0 3 380/ 800LER 3 380/ 800LER 3 380/ 800LER 3 380/ 800LER 1150/UNIT 60 3 380/ TURBIN 3 300/ TURBIN 3 300/ TURBIN	NANSFORMER 3 SF TAAM MOTOR 11X/0 2 TAAM MOTOR 11X/0 2 COOLUNG SVSTEM COOLUNG SVSTEM COOLUNG SVSTEM COOLUNG SVSTEM Station Transformer Station Transformer Station Transformer Mary Transformer DARD 3 Carry out op Johny T carriermer DARD 4 Carry out op Station 5 Carry out op St	CIRCUIT BREAKER 11 6 CROUT BREAKER 100 CROUT PREAKER 100 CROUT PREAKER 10 CROUT PREAKE 10 CROUT OUT CLEAN 10 CROUT CUEAN 10 CR	1160 UNI R 1160 UN FORMER ENG IN CI ENG IN ENG
5 dril down record(s) 76 total total 76 total total 76 total total 76 total total 76 total total 76 total total 76 tota	Rentrees Del Longanet Longanet Longanet Longanet Longanet Longanet Longanet Longanet Longanet Longanet Longanet Longanet Longanet Longanet	L108/22/97 L108/04/95 L108/04/95 L108/04/95 L109/05004 L109/05006 L109/05006 L109/05006 L109/05006 L109/05006 L109/05006 L109/05006 L109/05006 L109/05016 L109/05016	4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4	CLOIED CLOIED CLOIED CLOIED CLOIED CLOIED CLOIED CLOIED CLOIED CLOIED CLOIED CLOIED CLOIED	CLOSE CLOSE CLOSE CLOSE CLOSE CLOSE CLOSE CLOSE CLOSE CLOSE CLOSE CLOSE CLOSE CLOSE CLOSE CLOSE CLOSE	LT_RVE LT_RVE LT_RVE LT_TERM LT_TERM LT_TERM LT_TERM LT_TERM LT_RVE AMEC LT_RVE LT_RVE LT_RVE LT_RVE LT_RVE LT_RVE	1150 UNIT TE UNIT 3 BITO 1750/1150/U U1 0EN TER (U2 0EN TER (U3 0EN TER (3 30/ BOLLE) 3 30/ B	DANSFORMER 3 SF TAAN MOTOR TINO 3 NT TRANSFORMES CODUING SYSTEM CODUING SYSTEM CO	CRUIT BREAKER 11 6 CRUIT BREAKER 149 CRUIT REAKER 15 CRUIT REAKER 15 CRUIT VIEW VIEW 15 CRWY OUT CLEAN 15 CRWY OUT CLEAN	11KV UNI R 11KV U FORMER ENO IN CI ENO INCO ENO INO INCO ENO INCO EN

	Windown	s Internet Exp	plorer						
🕞 - 🙋	http://p	rocesssafetydev	.gen.scot	tishpower.co	om/KP1Graph	.aspx?KPIId=218SR 💙	😽 🗙 Uve Ser	rch	P -
Edit View	Favoril	tes Iools H	elp						
ERCENTAGE	OF PM TO	D CM							
0									
10								~	
				1	3.0	~~~~~~	a man		1
10	_			AND T					-
0	_		-	-					-
		-	مر						
	~	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~	سر	-					
	~	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~	~						
	~					~			
	Status	Best Practice				2			
	_	Best Practice		Tolerance	Actual	2			
Date	+		Target	Tolerance	Actual	2			





Review and Governance

The Process Safety KPI Dashboard as a monitoring and reporting tool was developed following rigorous, practical application of the HSE's guidance on process safety indicators (HSE, 2006) and delivers the following capabilities:

- Near-time visibility of leading indicators for key risk control systems across all power stations providing 'at a glance'' assessment of plant condition, the performance of barriers and key processes;
- Improved reporting of incidents and near misses, enabling information to be shared more widely and repeat incidents to be prevented;
- Provision of timely, accurate and comprehensive information to support the governance of process safety through early identification and proactive management of risks;
- A governance framework to ensure that performance and actions are reviewed on a monthly basis.

The dashboard provides directors with information that had not previously been visible. Some staff and contractors felt uncomfortable that detailed information on processes in which they were involved had become so visible. Leading and lagging indicators are a major source of performance information, supplemented by other information such as the Asset Risk Framework, management reviews and audits against business engineering standards, PAS 55, ISO-14001, OHSAS-18001-accident and incident investigations and benchmarking.

The organization had to work hard to respond constructively to some of the information that was being presented. The key outcomes were a better appreciation of the underlying causes of process safety issues and the action plans being put in place to resolve them; and a company-wide focus on tracking actions and seeing the performance improvements coming through onto the dashboard.

It is the visibility and governance framework that has allowed leaders to own and drive the program and to deliver business improvement. ScottishPower set up a Governance schedule that drives regular reviews of process safety performance information at all levels in the business to identify trends and initiate the proactive actions required to prevent plant related incidents. Governance takes two forms:

- Formal Governance regular review meetings are scheduled at all levels in the organization from facility level up to the ScottishPower Board to establish ownership and accountability for process safety management. The information that drives this process is fully transparent so all staff can play their part in improving performance.
- Culture alongside the formal governance process, all staff are required to understand the hazards and risks evident in everyday operations and report and challenge any concerns they may have about process safety. This

culture is described as maintaining a 'chronic sense of unease'; to ensure people are always thinking about what could go wrong and never complacent.

Ongoing Development of Process Safety Indictors

The ongoing development of process safety key performance indictors has been shaped by the review of major process incidents led by regulators in proving a framework. A number of industry bodies have also provided guidance for specific industries to help frame thinking on the subject.

The most difficult part in developing indictors is the actual transformation of a concept on paper to a real and relevant practical, ideally automated approach that reduces the burden of reporting on the organization. To ensure compliance with the requirement to report effective indictors a government oversight or regulatory guidance framework needs to be established.

The development of the identification and definition including the collection and use of indictors to prevent a major accident requires to be driven by Industry and Industry bodies to help define a more detailed approach with a focus on "Operational Control Indictors". The smart use of IT systems and integration are essential and critical success factors and should not be overlooked in finding an effective, sustainable solution for process safety performance indictors to prevent future major accidents.

Conclusions

Using a systematic and standardized approach, an organization can create a set of Process Safety and Asset Integrity performance indicators that encompass all of the Major Accident Hazards it needs to manage. Undertaking a program to visualize these indicators, an organization can deliver near real-time information on the risk being carried by an asset or business area to staff at all levels, thereby encouraging and supporting a strong safety culture.

References

ANSI/API, April 2010. API Recommended Practice (RP) 754, Process Safety Performance Indicators for the Refining and Petrochemical Industries. API Publications.

Harley. A, November 2014. The use of Bowtie theory to develop and deliver Process Safety Indicators. Mary Kay O'Connor Process Safety Center 2014 Symposium, Texas A&M University.

OGP – International Association of Oil & Gas Producers, November 2011. Process Safety – Recommended Practice on Key Performance Indicators. Report 456. OGP

UK HSE, 2011, Case Study - Scottish Power

UK HSE, 2006. Developing Process Safety Indicators. HSG25

UK HSE, 2013 Hazardous Installation Directorate (HID) Regulatory Framework