

PROCESS SAFETY PERFORMANCE INDICATORS – A TOOL TO HELP SENIOR MANAGERS SHOW PROCESS SAFETY LEADERSHIP

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As is the case with many major hazard companies, Basell Polyolefins has achieved a significant reduction in work place injuries over recent years. A key factor in achieving this has been the leadership and engagement of senior managers. They have been helped by having been able to measure their successes and failures by counting the number of injuries. Since 2003, Basell has been developing a process safety performance indicator (PSPI) system which is intended to help senior managers similarly engage in achieving improvements in process safety. While process safety incidents across the industry have not killed or injured as many people as falls from height and moving vehicle accidents, they often have far greater business consequences.

This paper will describe Basell's leading and lagging PSPI framework, and show how it is helping senior managers to get engaged in process safety. This is true not only for managers of a technical but also a non technical background. They now have a tool which will help them show leadership in process safety.

INTRODUCTION

Lack of adequate process safety performance indicators (PSPIs) has been cited as a factor in a number of recent major accidents (Hopkins 2000, HSE 2003, US Chemical Safety and Hazard Investigation Board 2007). Against this background and interest from the regulators (HSE 2006), many companies involved in major hazards are developing PSPI programmes.

Basell's PSPI corporate framework was piloted at the company's Carrington UK site over the period 2003 to 2006, and was adapted and implemented as a company wide initiative in 2007. Basell makes polypropylene and polyethylene in 19 countries and has 6,800 employees.

The framework comprises lagging and leading indicators. A suite of lagging indicators is analogous to the different categories of injuries. These are standard across the whole company, and are reported every month up through the line. There was already a mature incident reporting system in all sites in the company, and these incidents would anyway have been recorded. But what is new is the headlining of these narrowly defined incidents. This offers learning opportunities which have been derived from analysing the information, to identify "big picture" conclusions.

The other part is leading indicators, and the decision was taken that it was not appropriate to try to select a standards set for the whole company. It was decided that it was

better for sites to choose their own. While this precludes the possibility to benchmark, it allows the sites to focus on issues which are relevant to them, and also increases buy in. Some successes have also been achieved with leading indicators, although somewhat less tangible.

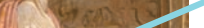
THE SWORD OF DAMOCLES

Legend has it that Damocles was a young courtier in the court of Dionysius II of Syracuse. And he was a bit of a wag. One day he observed to Dionysius that the job of being king must be a pretty good one, with all the power and privilege. Dionysius responded that he could give it a try if he liked. So Damocles was installed in the throne, and Dionysius arranged for a slap up banquet with wine women and song. At the end of the evening, Dionysius asked Damocles what he had thought of his spell in charge, and Damocles told him that he had had a great time. Dionysius then asked him what he had thought about the sword. He pointed to a large sharp sword which was hanging above the throne by a single thread of horse hair. Damocles swiftly vacated the position. Dionysius explained that the sword was there as a reminder that the position carried responsibilities. Without it, it would be too easy to get busy enjoying the trappings of power, and forget about the important stuff. Damocles had gained a better understanding of the role, and was no longer envious of Dionysius.

**Injury statistics,
PSPIs**



**Senior
Manager**



**Junior
Manager**



Figure 1. Managers engaged in a safety discussion (The Sword of Damocles, Richard Westall 1812, Ackland Art Museum)

THE HISTORY OF PROCESS SAFETY PERFORMANCE INDICATORS AT BASELL

In the 1990s and early 2000s the measuring and reporting of injury performance as a Total Recordable Rate (TRR) in our company had been an effective Sword of Damocles. It had helped to drive down injuries. Senior managers had played a key role in this. They were interested in safety, and TRR was a simple, easily understood tool which they could use to engage themselves. Senior managers had given site managers clear injury performance objectives, and site managers had found solutions appropriate to their own sites to achieve the desired objectives. TRR had a strong symbolic value.

WHAT INTERESTS MY BOSS FASCINATES ME!

Organisations need objectives. The greatest advantage of management by objectives is that it makes it possible for a manager to control his own performance (Drucker 1968). Defining what needs to be achieved rather than prescribing how it should be done, allows managers to apply a broader vision. This leads to stronger motivation and higher performance. In order for it to work, a manager needs to know not only what his goals are. He also needs to be able to measure his performance and results against the goals. Managers need to be provided with clear measurements or metrics. According to Drucker,

“They do not need to be rigidly quantitative; nor do they need to be exact. But they have to be clear simple and rational. They have to be relevant and direct attention and efforts where they should go. They have to be reliable – at least to the point where their margin of error is acknowledged and understood. And they have to be, so to speak, self announcing, understandable without complicated interpretation or philosophical discussion.

Each manager should have the information he needs to measure his own performance and should receive it soon enough to make any changes necessary for the desired results.”

In other words, what gets measured gets done. Or as it has been said “What interests my boss fascinates me”.

But the shortcomings of TRR started to become apparent. Despite a TRR trend which headed ever downwards, the company at sites around the world had nevertheless had fatalities. Because of the profile which TRR was given, significant management time was spent on sometimes minor injuries. At the same time, senior managers seemed to be less interested in losses of containment and fires.

From the outset we realised that it was essential to think not only about how and what to measure, but also how the tool could be used by senior managers to drive improvements. Hopkins (2007) examined how BP at Texas City had been measuring but not managing process safety performance. In contrast, by tracking and “headlining” the number of injuries, Texas City workplace safety had improved dramatically. Managers’ remuneration, even though it was only small amounts of money, was affected by injury

performance in their area of control. Injury statistics, like Damocles' Sword, had a powerful symbolic value which had strongly influenced manager behaviour.

So in 2003 at Carrington we set about designing a simple tool comprising leading and lagging indicators, which we hoped would achieve for process safety what TRR had done for workplace safety. We recognised that senior managers at the highest level in our company were interested in safety, and we wanted to channel their interest towards process safety. We had in mind that if it worked at a site level, it could form the basis of a corporate implementation.

There was nothing new about the concept of leading and lagging indicators. OHSAS18001 (BSI 1999) for example talks about proactive and reactive indicators. We were trying to apply the concepts to process safety.

SITE LAGGING INDICATORS

We started by establishing a suite of seven lagging process safety indicators, which we defined in terms of consequence, Appendix 1. In arriving at our definitions we took account of those in RIDDOR for dangerous occurrences (HSE 1995), and a PSPI pilot run in Scotland by the HSE and the SCIA (HSE/SCIA 2003). Additionally we adjusted and calibrated them to suit our own situation. We added a category for releases of substances which could have an impact on the environment. Note that we do not have a category for toxics, as this is not relevant for our business.

To facilitate incident reporting and analysis, the seven categories were set up in the site's computer based HSEQ management system QPulse.

SITE LEADING INDICATORS

In 2004 we moved on to develop a system for leading indicators. We decided that we needed to define the framework in Table 1 for each indicator.

WHICH RISK CONTROL SYSTEMS TO MEASURE

In planning our approach we struggled with items 1 and 2 in Table 1- how to decide which process safety issues to tackle. Of course we could think of lots of things to measure,

Table 1. Framework for leading PSPIs

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1. Which risk control system is weak and needs to be reinforced.
 2. What specifically is the issue; what does the weakness relate to.
 3. Definition of a metric.
 4. How will the data be collected, and who will do it.
 5. How will the results be monitored, and corrective actions identified.
 6. What target would we aim for.
-

but we wanted to work with only a handful of indicators, five or six. We could have locked the management team in a smoke filled room until they came up with the five. But we decided to use a team of people who represented horizontal and vertical cross sections of the work force. We asked the team to brain storm around the question “**As you go about your work, what are the things which make you feel uncomfortable about process safety**”. The team used a diagrammatic representation of our HSE management system as a guideword list of risk control systems, to prompt thought about which systems were weak. The only constraint we put on the brainstorming was that, for a weakness to be added to the list, the proposer had to give an example of how it had in his experience given rise to a risk. We got a list of 14 items, and used a risk ranking tool to prioritise them.

DEFINING THE METRICS AND MEASUREMENT SYSTEM

We then looked at trying to define a metric for each of the top five issues, and how we would collect the data. From our investigations, we had decided that the metrics should have the attributes listed in Table 2.

We were not able to find a metric which met these criteria for every one of the top five issues. For example, the team had identified shift handover as a potentially weak area, but we were not able to find a suitable metric. So we concluded that although shift handover deserved attention, it would have to be via a means other than as a leading PSPI. We picked another weakness to make up the list of five. As an aside, in the meantime we have given further thought to how we could measure shift handover. We have found some criteria which we could use as the basis for periodic audits, but have some concerns about whether this will be cost effective in terms of data collection; unless we can get the teams to audit themselves, somebody probably from the HSEQ Department will have to work unsociable hours to do the audits!

MONITORING

In planning how we would monitor the data we were mostly able to use existing arrangements, e.g. the site HSE Committee, or the periodic inspection review meeting. But we

Table 2. Desirable attributes of leading PSPI metrics

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- Support continual improvement
 - Drive appropriate behaviour
 - Emphasise achievements rather than failures
 - Be precise and accurate
 - Be difficult to manipulate
 - Be owned and accepted by the people involved in related work activities and those using the metrics
 - Be easily understood
 - Be cost-effective in terms of data collection
-

recognised it was important that people with the power to make decisions were part of the monitoring process.

The leading metrics we settled on and their associated framework are given in Appendix 2.

CONCERNS PEOPLE RAISED

“Oh no! Not another report for management!”

A valid concern, but we sought to impress on people that it is not just about reporting, it is about creating a simple tool which managers can use to focus on and improve process safety.

“But all incidents already get reported”

This is true, but the process safety incidents get buried, and we do not see the process safety big picture.

“We do see the big picture, because all process safety incidents get a full investigation”

We calibrated the lagging incident definitions so that we get about twenty incidents a year, on a site of about 150 people and three plants. We have to be somewhat selective on which incidents to carry out a full in depth root cause analysis, and do not consider it a good use of resources to do twenty of those a year.

“We should take account of risk in deciding which incidents to count”

As mentioned in Table 2, good indicators are precise and accurate, difficult to manipulate, and easily understood. Risk is none of these. We based our definitions on pure consequence, which means that a 49 kg release of a flammable material in the open air would not count as a PSPI, while a 50 kg would. This does not mean the 49 kg release is unimportant, but you have to draw the line somewhere. And if the 49 kg release was of particular interest, we would anyway investigate it to get root causes and learnings.

Perhaps a more fundamental objection to using risk criteria is that recent work appears to indicate that high risk near misses are a poor predictor of actual incidents. The things which we perceive as high risk are apparently not the things which cause the actual incidents. The Institute of Petroleum (2005) analysed the causes of some 600 potential and 800 actual major hazard incidents. The analysis considered 31 causes. There were substantial differences in the frequency of causes of actual and potential incidents. For example “Leak from flanged joint or coupling” was the second most frequently occurring potential incident cause, but only ranked seventh in the actual incidents. A PSPI programme which identified this cause for attention based on counting potential incidents, might divert resources away from work which could reduce the number of actual incidents.

“The iceberg theory tells us that our existing near miss reporting and behavioural programmes will prevent major accidents”

Groeneweg (2006) analysed the Oil & Gas Producers Association safety performance indicators over the years 1997 to 2004. This represented 12.3 billion hours of data. He looked for correlations between companies for the different severities of injuries. He wanted to find out if the companies which had the highest fatal accident rate (FAR) also had the highest lost time injury frequency (LTIF). He found no correlation. He also looked for correlations between other indicators: total recordable injury frequency, and near misses. He found no (or hardly any) correlation. His conclusion is that the iceberg theory does not hold. He suggests that injuries which affect one or a few people are related to behaviour, but the injuries which result in large numbers of fatalities are due to failures in the “primary processes”. Put another way, if you want to prevent fatalities, you need to target your safety programme on the things which cause fatalities. Likewise for major accidents. Kletz (1993) previously suggested that injury statistics have been over valued by industry, and that we should measure the things we want to control.

THINGS WE HAVE LEARNED FROM THE SITE IMPLEMENTATION THE NEED FOR A CHAMPION

Somebody needs to be given the job of overseeing the programme. This is not complicated stuff, and many of the elements of it use existing systems. But it does need to be tended.

SENIOR MANAGEMENT INVOLVEMENT

The Site Manager has found it easy to monitor the programme through the site’s QPulse HSE MS software, and he has used this to raised the profile of process safety. Although the HSEQ Department is the owner of the PSPI tool, the Site Manager has picked it up and is using it.

THE BOTTOM LINE. DOES IT WORK?

Since we defined the lagging indicators in 2003, we have recorded 80 process safety incidents. In the first year we noticed that we had had 10 fires. We had previously been aware that we did have fires, but had not realised just how many. These were all minor incidents, as were the other 70, but nevertheless it was mind focusing. Most of the fires were smouldering insulation, so we took some simple steps to reduce the leaks, and to remove the insulation from around the leak points. In the second year we had almost eliminated the insulation fires.

We have used the lagging indicator data to focus on other areas.

LEADING INDICATORS ARE MORE DIFFICULT

There is no question that this is the case. And some of the indicators we chose have not worked for us. The permit to work monitoring did not yield useful information, because the audit tool we were using was not sufficiently discerning. The process safety training

indicator failed because we had not got buy in from the people required to collect the data. But we are now much better at communicating process safety information to shift technicians, are better at closing out inspection findings, and have a better control of our controlled inspection programme. While the lagging indicator programme is running exactly as it was set up in 2003, we have had to make more running adjustments to the leading indicators.

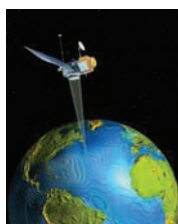
GOING GLOBAL

In 2006 it was decided to make the Carrington PSPI framework the basis for a corporate programme. We understood that for the programme to be a success, we needed to convince senior managers to pick up the tool and start using it. This would involve a change process. Prochaska's change model identifies 6 stages: Pre-contemplation, Contemplation, Preparation, Action, Maintenance and Relapse. We assessed that the company was at the Preparation stage, so the emphasis of our change process was initially on problem solving and establishing support systems. In case some people were still at the Contemplation stage, we promoted the expected positive outcomes. To help with the marketing we branded the programme with a satellite navigation logo, and the motto "PSPIs. Navigating to HSE success". Figure 2.

We made some adjustments to existing corporate guidelines, and wrote a new guideline on PSPIs. For the lagging indicators we used the Appendix 1 definitions. For the leading indicators, we had decided that there was no single set which would be appropriate across the company. Adopting a single set would have run the risk that sites be forced to collect data which was not useful, diverting efforts from indicators which might be more useful in their location. Also we felt it important that sites buy into their own set of indicators. The PSPI guideline therefore concentrated on giving the sites a simple methodology to follow to pick their own.

The corporate PSPI programme was officially implemented in April 2007. Each site was given two objectives:

- To collect and report to Corporate HSE the lagging indicators every month;
- By the end of the year to have selected their own set of five leading indicators.



PSPIs

Navigating to HSE Success

Figure 2. PSPI logo

SENIOR MANAGEMENT INTEREST AT THE CORPORATE LEVEL

The company Chief Financial Officer visited the site before a decision had been taken to roll it out globally. We took the opportunity to sell the concept to him. Although we suspect he is not an expert in process safety, he understands risk very well. He publishes a monthly letter on the company intranet, and we were very pleased to see the following words of support in his March 2007 letter, just before the launch in April:

“Our good start to 2007 continued in February, both in terms of safety and financial results. ... But as good as we are in personal safety – which is a shared value throughout Basell – we know that we must also maintain world-class process safety performance. ... Basell’s HSE team will soon introduce Process Safety Performance Indicators (PSPIs) as a way to further improve our ability to control the risks associated with the processes and hazards in our plants. PSPIs will help us measure how well we have been controlling process risks and, more importantly, they will provide critical information we can analyze to determine what we have to do to improve.”

He had moved easily from Prochaska’s Preparation stage to the Action stage.

AVOIDING MANAGEMENT BY “DRIVES”, OR INITIATIVE OVERLOAD

In the absence of the PSPI tool, managers had little else available to them but to react to the latest incident. Managers then get only an incomplete picture, and steer the organisation in a direction which might not be helpful – “We need more process safety training”, or “Our sites are not managing changes adequately”. This management by “crisis” or by “drives” can be counter productive (Drucker 1968). Things always collapse back into the *status quo ante* three weeks after the drive is over. It puts emphasis on one aspect of safety, to the detriment of everything else. In the words of Peter Drucker:

“People either neglect their job to get on with the current drive, or silently organise for collective sabotage of the drive to get their work done. In either event they become deaf to the cry of “wolf”. And when the real crisis comes, when all hands should drop everything and pitch in, they treat it as just another case of management-created hysteria.

Management by drive, like management by “bellows and meat axe”, is a sure sign of confusion.”

STATUS OF THE GLOBAL IMPLEMENTATION

LAGGING INDICATORS

It is early days, but from implementation in April until September 2007, there had been 357 process safety incidents recorded. Of these 55 were fires (all minor), of which 27 were associated with the same type of equipment. Each one of these has been investigated locally, but we are confident that we will be able to extract useful big picture learnings from this information, share it around the company, and reduce the number of fires.

LEADING INDICATORS

Many sites by now have chosen their leading indicators. Indicators related to integrity inspection seem to be a popular choice.

LACK OF AN INCIDENT DATABASE

We do not currently have a company wide corporate incident recording system or database. This means we have to work a little harder at the data collection and monthly reporting at the corporate level, to make sure that senior managers have the right information; they need to be able to understand what is going on on their patch, the sites which they are responsible for.

The company does have a knowledge exchange system where discussion topics can be posted and questions raised. This has been effective in sharing information about the PSPI system, and also sharing experiences and information about process safety incidents.

THE HSE GUIDANCE AND THE BAKER PANEL REPORT

In 2006, the HSE published guidance on PSPIs (HSE 2006). Unfortunately we did not have the benefit of it when we were developing our programme. It is an excellent document, and we would like to offer some comments.

As mentioned above, in some cases, having chosen the weak risk control system, we found it difficult to define a metric. We like the suggestion in the guidance to ask “What does success look like”.

On how to choose which risk control systems to measure, we think the guidance could give more help – management team in smoke filled room or workforce involvement?

A significant difference between our two approaches is the HSE’s recommendation to chose linked pairs of leading and lagging indicators. This is with the intention of giving “dual assurance”. This is a good idea, but we wonder if it will make the process of finding suitable leading indicators more difficult, possibly too difficult for some. A set of disconnected but nevertheless individually relevant lagging and leading indicators might be good enough. In our experience, a major benefit of the PSPI programme has been that it has moved process safety in general onto the radar of senior managers; maybe it does not matter too much if the indicators are not exactly correct.

Hopkins (2007) examined the meaning of “leading” and “lagging” indicators in the HSE guidance and Baker (2007), and found that the terms were not used consistently. He identified three types of process safety indicator:

- A. Measures of routine safety related activity, e.g. proportion of safety critical instruments tested on schedule.
- B. Measures of failures discovered during routine safety activity, e.g. proportion of safety critical instruments which fail during testing.
- C. Measures of failures revealed by an unexpected incident, e.g. numbers of safety critical instruments which fail in use.

Indicators of type A are consistently referred to as “leading”, and type C as “lagging”, but categorisation of type B is inconsistent within both documents. However, he concluded that this was of little consequence; it is more important to define indicators which are not only relevant but which also generate a statistically useful number of “hits”.

WHERE NEXT?

DO WE WANT MORE OR FEWER INCIDENTS?!

We think that for the lagging indicators, at least initially, we want to encourage the reporting. Of course we do not want to have more incidents, we only want to have a better view on what incidents we are already having! For that to happen, senior managers must handle the tool with care; rather than a gun to the head of the site managers, it must be a vehicle for an informed discussion about process safety.

BENCHMARKING AND SETTING TARGETS

An interesting question which is already on the minds of senior managers is whether we should set corporate targets for the lagging PSPIs analogous to injury rates. For the time being, this would seem unnecessary as we are getting the benefit just from the profile PSPIs have brought to process safety, and from the big picture learnings. But at some point we will inevitably need to define targets. An interesting question is what the denominator should be for the PSPI rate – per plant, per ton of throughput, per ton of hazardous material inventory, per man hour?

For leading indicators we do not see a possibility to benchmark, since every site has a different set. The only objective is to have the system in place and working. Nevertheless, this objective and the expectation that sites demonstrate how they are using leading indicators to drive improvements in process safety performance has a powerful symbolic value, like the Sword of Damocles.

Hopkins (2007) advocates relating senior manager remuneration to PSPIs, but comments that this works because it is symbolic, affecting reputation and pride, rather than exercising any real financial leverage. Hopkins also cautions against perverse outcomes, which are a consequence of the measure itself being managed rather than safety. This author believes this risk can be controlled by ensuring that the PSPIs have the attributes listed in Table 2.

LAGGING INDICATOR DEFINITIONS

We do not have a category for dust hazards, and these are relevant for our business. We are thinking about what would be a suitable definition.

THE CHANGE PROCESS

The organisation is moving through the process of changing the safety focus towards process performance. We are moving through the Action stage of Prochaska's change model;

strategies should therefore emphasise how this new tool has put managers in a better position to control process safety, what the benefits are for them, and that the normal short term fluctuations in personal safety performance will not be blamed on efforts being diverted away. As we move through the maintenance stage we will need to ensure that adequate support is given, and that internal rewards are reinforced. We should also be prepared for relapses, for example a drop off in lagging indicator reporting, and what we will do about it.

CONCLUSIONS

There is no “silver bullet” for HSE performance. PSPIs are just one of the required elements of a properly functioning management system. And we know that there are many areas where we have to improve.

Before our PSPI programme was implemented, senior managers were already interested in process safety. But it had not been as easy for them to engage themselves as it had been in personal safety, since they had no process safety Sword of Damocles. Now they have a tool. Although with hindsight we should not have been surprised, we have discovered that the PSPI programme is driving improvements not only because of the useful information it produces but also, perhaps more importantly, because it is helping senior managers to demonstrate leadership.

Consequently we have concluded that while choosing the right indicators is important, it is more important to design a programme which is easy for senior managers to use, produces reliable data and which helps senior managers exercise their leadership accountabilities with regard to process safety.

REFERENCES

- Baker J. (2007) *The Report of the BP US Refineries Independent Safety Review Panel*. Download from www.bp.com
- British Standards Institution (1999) *BSI-OHSAS 18001 Occupational health and safety management systems – Specification*. BSI, London.
- Drucker P.F. (1968) *The Practice of Management*, Pan Books, London.
- Groeneweg J. (2006), *The future of behaviour management*. Health and Safety Culture Management for the Oil and Gas Industry. Conference, Amsterdam, The Netherlands.
- Health and Safety Executive (1995) *The Reporting of Injuries, Diseases and Dangerous Occurrences Regulations*. HSE Books, Sudbury.
- Health and Safety Executive (2003) *BP Grangemouth – Major Incident Investigation Report*. Download from www.hse.gov.uk
- Health and Safety Executive/Scottish Chemical Industries Association (HSE/SCIA) (2003). *Pilot project on voluntary reporting of major hazard performance indicators: Process safety and compliance measures – Guidance notes*.
- Health & Safety Executive (2006) *Developing process safety performance indicators, A step by step guide for chemical and major hazard industries HSG254*, HSE Books, Sudbury.

- Hopkins A. (2000) *Lessons from Longford, The Esso Gas Plant Explosion*. CCH Australia Ltd., Sydney.
- Hopkins A. (2007) *Thinking about process safety indicators* Human & organisational factors in the oil, gas & chemical industries. Conference, Manchester.
- Institute of Petroleum, (2005) *A framework for the use of key performance indicators of major hazards in petroleum refining*. Energy Institute, London.
- Kletz T. (1993) *Accident data – the need for a new look at the sort of data that are collected and analysed*. *Safety Science* **16**, 407-415.
- US Chemical Safety and Hazard Investigation Board (2007) *Investigation Report Refinery Explosion and Fire, BP Texas City*. Download from <http://www.chemsafety.gov/>

Appendix 1. Company Wide Lagging Process Safety Performance Indicators

Electrical Short Circuit

Electrical short circuit or overload which was either attended by fire or explosion or which resulted in the stoppage of a piece of process equipment.

Explosion or fire

An explosion or fire occurring in any plant or place, where such explosion or fire was due to the ignition of process materials (including lubricating or heat transfer oils), their by-products (including waste) or finished products.

Release of flammable material inside a building

The sudden, uncontrolled release inside a building of 3 kg or more of a flammable liquid, 1 kg or more a flammable liquid at or above its normal boiling point, or 1 kg or more of a flammable gas.

Release of flammable material in the open air

The sudden, uncontrolled release in the open air of 50 kg or more of any of a flammable liquid, a flammable liquid at or above its normal boiling point, or a flammable gas.

Release of a substance which could have an impact on the environment

The sudden, uncontrolled release of 50 kg or more of a substance which could have an impact on the environment.

Safety Related Protective System called into operation

Emergency depressurisation/flaring, operation of pressure relief devices, breaking of bursting discs, operation of final element instrumented protective functions, quenching of exothermic reactions, crash cooling etc. which are instigated either automatically or by operator intervention. This category is restricted to systems beyond warning devices. Excluded are protective systems designed solely to ensure the integrity of the process or product quality where there is no safety or environmental protective duty. Excluded are activations of these systems simply due to instrument malfunction, unless the malfunction caused process conditions to deviate away from safe operation.

Safety Related Unplanned Shutdowns

Occasions where a process or activity has to be shut down or halted because it would be otherwise unsafe to continue.

This covers emergency stoppage of an individual plant, either automatically or by operator intervention, to prevent a loss of containment or other dangerous situation irrespective of the time involved, or stoppage or suspension of a planned plant or process start up due to a failure or malfunction of part of the plant or equipment, if unchecked, it had the potential to give rise to an emergency.

Appendix 2. Carrington Site Leading Process Safety Performance Indicators

HSEMS element	Issue	Definition of metric	System of measurement	System of monitoring	Target
Inspection	Inspection findings are not being closed out	% of inspection recommendations progressed.	Inspection findings are recorded in an Access database. Report generated quarterly by Maintenance.	Quarterly Inspection Meeting, chaired by Site Mgr.	
Inspection	Inspections are overdue	% of controlled inspections which are due and complete at the end of the month. Reported by department and site overall.	Site Inspector generates a report from SAP at the end of the month.	Quarterly Inspection Meeting.	
15 Communication, Safe operation	Technicians are not receiving all relevant process safety information	% of Key Communications which are signed off by all of the intended recipients in 2 months.	Dept mgrs choose Key Communications, and report in standard format.	Site HSE Council, chaired by Site Mgr.	
Permit to work	Lack of ongoing information on how well it is working	% of PTWs inspected during weekly plant safety walks which are found to be all satisfactory according to the check list in Appendix 1 of CHSES.2	Operations managers to fill in table of results.	Monthly departmental HSE meeting, and monthly Site HSE Council.	
Training	People are overdue with important refresher or process safety related training	% of people who have attended defined safety training by due date.	Training Dept extract data from Training Records system, and report quarterly.	Data monitored at quarterly Site Training Steering Committee Meeting.	