

Incitec Pivot Limited

INNOVATION ON THE GROUND

Operations Risk Management for Explosives Manufacturing Report

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Abstract

Theme: Risk Assessment and HAZOP

Operations Risk Management – The introduction of a refreshed approach to risk management in explosives manufacturing.

This paper describes Incitec Pivot Limited's journey in piloting a refreshed approach to risk management to its explosives manufacturing sites across North America and Australia. It documents the challenges, successes, learnings, and insights to date.

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Definitions

Bow Tie: A risk diagram showing how various threats can lead to a loss of control of a hazard and allow this unsafe condition to develop into a number of undesired consequences. The diagram can also show all the barriers and degradation controls deployed.

Critical Control: Controls that have been identified as having the largest impact on reducing the likelihood and/or consequence of an event, and which are effective, independent, and auditable.

Critical Control Verification (CCV): An activity that is used to periodically assure the effectiveness of Critical Controls.

Hazards and Operability (HAZOP): A systematic qualitative risk assessment methodology used to identify process hazards and potential operating problems using a series of guide words to study process deviations.

Layers of Protection Analysis (LOPA): A semi-quantitative risk assessment methodology used to evaluate the effectiveness of independent protection layers in reducing the likelihood or severity of an undesirable event using predefined values for the initiating event frequency, independent protection layer failure probabilities, and consequence severity.

Material Process Safety Risk: An inherent risk with the potential to impact the organisation's objectives in a significant manner that warrants a detailed risk analysis with a robust mechanism for monitoring control(s). For Operations Risk Management, these are risks that have the potential to cause one or more fatalities, originating from a loss of control of some form of Process Safety Hazard (fire, explosion, toxic, corrosive, etc.).

Operations Risk Management (ORM): Incitec Pivot Limited's refreshed approach to risk management, which provides specific direction on the risk management activities required to manage process safety risks from end-to-end.

Risk Register: A master register maintained at a Site or functional unit that formally records the identified Material Process Safety Risks at that Site or function.

1 Background

1.1 The Case for Change

The Incitec Pivot Limited Risk Management Procedure was published in 2016. It was applicable companywide, from the corporate functions (Finance, Information Technology, Human Resources, etc.) right through to the operational sites that manufacture the company's core products – explosives and fertilisers. The focus of this paper is on these manufacturing sites which produce explosives and fertilisers in 15 locations across North America and Asia Pacific. Broadly speaking, the procedure required:

- Identification of risks, and ranking based on severity of the potential consequence, regardless of whether the potential impact was to safety, finance, environment, etc.;
- Performing bow tie analysis for every high-consequence risk and entering them into a central Risk Register;
- Conducting a basic risk analysis for lower-consequence risks and entering them into either the Risk Register or as a Hazard into an Incident Register;
- Performing Critical Control Verifications (CCVs) on each control that was deemed a critical control to validate that the control was in place and effective;
- Performing an annual review of all risks in the Risk Register, and 3-yearly review of the entire Risk Register.

After the procedure had been in effect for a few years, it became apparent that there was variation and inconsistency in how it had been applied across the manufacturing sites. For example, some sites had:

- Created a variety of interpretations of terminology to distinguish between different types of risks in the Risk Register. Because these terms were not defined in the procedure itself, sites were using these terms differently.
- Produced bow ties of varying quality.
- CCVs varying in quality and format, and/or a large amount of CCVs scheduled to be completed each month

Often there was a missing link between the different risk management tools/processes used. For example, a site may have conducted comprehensive HAZOPs, consequence modelling, bow ties, LOPAs, or emergency response assessments, but having been developed in isolation of one another they tended to be standalone documents, and rarely were the results of these risk assessments updated into sites' Risk Registers. As a result, it was not always obvious how a specific risk was managed from end-to-end.

A separate review of the CCVs across the manufacturing sites showed that because each site had independently been left to identify their highest-consequence risks, their critical controls, and develop their CCVs, the CCVs varied in content and complexity even for the same risk scenario. Some sites had one CCV a month while others had upwards of 15, resulting in an administrative burden. Furthermore, this variation in CCV content and quality made it difficult to obtain a holistic view of all the company's critical controls based on CCV results alone.

1.2 Development of Operations Risk Management

Although the Risk Management Procedure set a solid foundation for risk management at IPL, the executive leadership team recognised that more guidance was required for the manufacturing sites given the nature of risks that must be managed at sites.

The risks of greatest concern on a manufacturing site tend to be health and safety related – whether process safety (i.e. fire, explosion, toxic gas release) or personal safety (falls,

confined spaces, engulfment, etc.). As the company's corporate Process Safety team was challenged to consider an updated approach to risk management, we reflected on the general differences between these types of risks. The controls for personal safety risks tend to be more administrative and procedural in nature, and heavily dependent on the behaviour and direct action (or inaction) of the individuals involved in a task e.g. working at heights. In contrast, the controls for process safety risks tend to be engineering-based (safety instrumented trips, relief devices, etc.) and depend on the collective actions of many across a whole operation be they engineers, designers, installers, maintenance, operations, or management.¹ Process safety risks also have the potential to result in large-scale loss of life both onsite and offsite compared to personal safety risks which tend to affect one person at a time (although at a higher frequency). Hence, the management of process safety risks needed a different approach than the management of personal safety risks. The previous Risk Management Procedure did not distinguish between process safety and personal safety risks, instead requiring all high-consequence risks to be managed in the same way.

To address this, the Process Safety team has spent the last few years developing and implementing a refreshed approach to risk management specifically for the manufacturing sites, called Operations Risk Management (ORM). ORM provides specific direction on the risk management activities required to manage process safety risks from end-to-end. It "operationalises" the management of these risks by integrating it into standard work for the site. The process includes development of a Critical Control Dashboard to monitor critical controls, which is expected to provide better visibility of critical controls, standardise the way critical controls are monitored across the business, and reduce the administrative burden of CCVs.

The objective is for each site, and the executive leadership team, is to have greater visibility of critical control effectiveness for the highest consequence process safety risks (fatality or multiple permanent impairments) at its manufacturing sites. The initial concept of ORM was developed in 2018-2019 and piloted at one manufacturing site in Australia in 2019-2020. Since then, the rollout of ORM has commenced across the remaining 14 sites, and implementation continues to this day.

An ORM Procedure has been developed to specify how manufacturing sites are to manage their high-consequence process safety risks, and now forms part of the company's overall Risk Management Framework (refer to Figure 1). For all other risks (including personal safety risks), the previous Risk Management Procedure has been refreshed and renamed the Functional Risk Management Procedure.

¹The authors note here that it is not universally the case that process safety risks rely primarily on engineered controls, and often process safety risks do rely on administrative controls, especially in the case of manual tasks such as explosives assembly. We expand upon these learnings in section 2.1.8 of this paper, however in this section our intent is to describe the mindset of the corporate Process Safety team at the time of the development of our refreshed risk management procedure

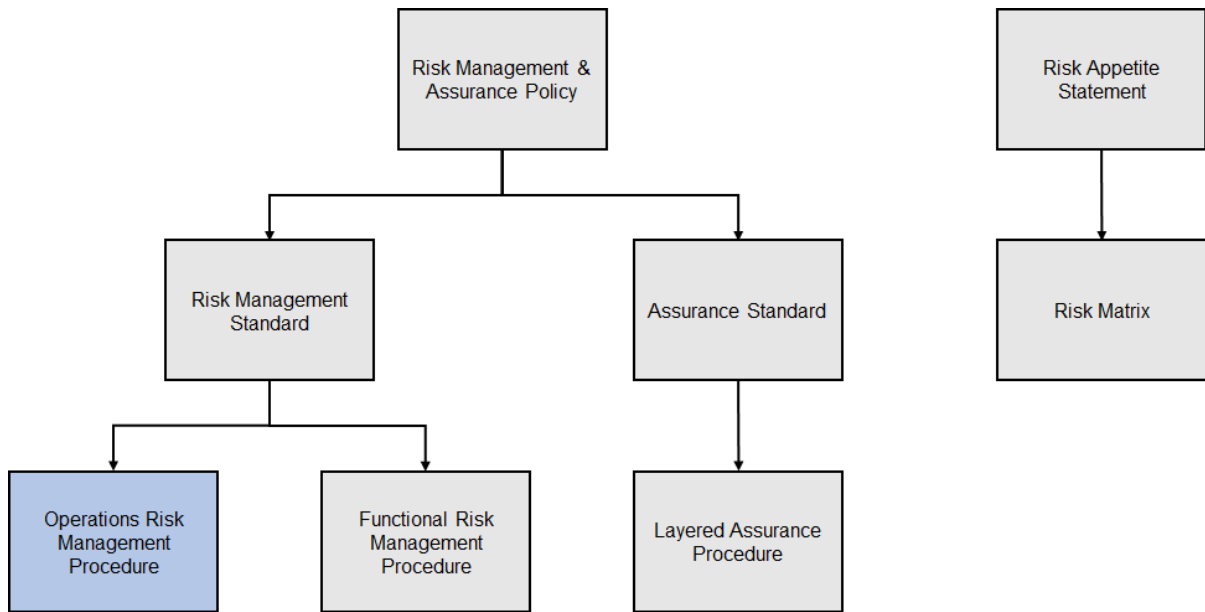


Figure 1: ORM within IPL's Risk Management Framework

The ORM procedure is based on the ISO 31000 risk management process beginning with risk identification, followed by risk analysis, evaluation, and treatment supported by recording and reporting, monitoring and review (refer to Figure 2).

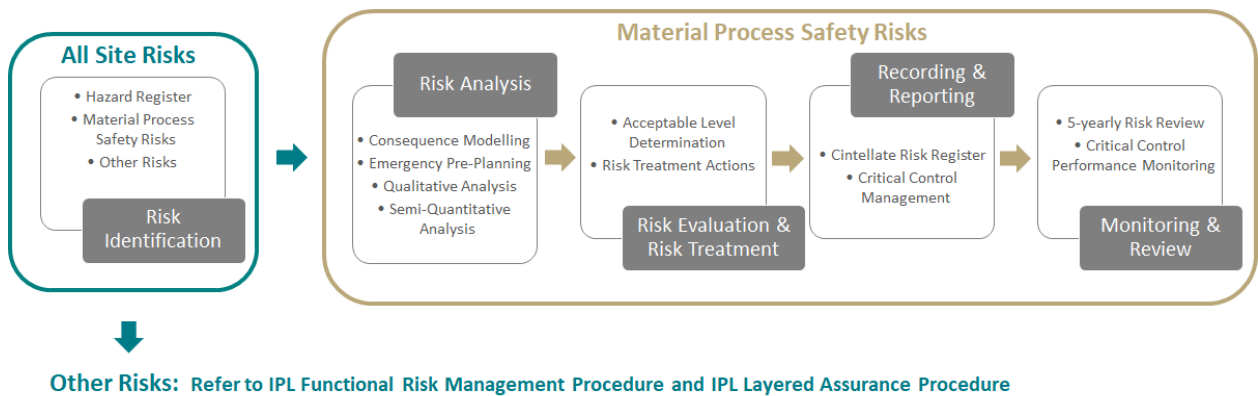


Figure 2: Overview of the ORM Process which is based on ISO 31000

ORM is designed to meet the needs of IPL's manufacturing sites by outlining the exact activities required to meet the objective of each of these steps, and the tools/processes that should be used, as outlined in Table 1-1.

Table 1-1: Key tools/processes used in the Operations Risk Management process at IPL

| ISO 31000 Risk Management Step | Tool/Process Used | Objective(s) |
|--------------------------------|-------------------|--|
| Risk Identification | Hazard Study 2 | <ul style="list-style-type: none"> - Identify hazards and risks on site, and categorise as Material Process Safety Risks or Other - Cross-disciplinary assessment of worst credible consequence of each Material Process Safety Risk |

| ISO 31000 Risk Management Step | Tool/Process Used | Objective(s) |
|--------------------------------|---|--|
| Risk Analysis | Consequence Modelling | <ul style="list-style-type: none"> - Confirm and document the worst credible consequence of each Material Process Safety Risk - Provide a data-based assessment of consequence that is consistent across the company |
| | Emergency Pre-Planning | <ul style="list-style-type: none"> - Emergency response assessment of each Material Process Safety Risk |
| | Qualitative Analysis (e.g. Bow Tie Analysis, HAZOP) | <ul style="list-style-type: none"> - Detailed analysis of each Material Process Safety Risk's causes, consequences, and preventative and mitigative controls - Identification of critical controls |
| | Semi-Quantitative Analysis (e.g. LOPA, Fault Tree Analysis) | <ul style="list-style-type: none"> - Confirmation that the Material Process Safety Risk has sufficient and effective controls |
| Risk Evaluation & Treatment | Acceptable Level Determination | <ul style="list-style-type: none"> - Demonstrate the Material Process Safety Risk is at an acceptable level per the company's risk appetite, or determine the actions required to meet this level |
| | Risk Treatment Actions | <ul style="list-style-type: none"> - Apply and manage risk treatment actions to bring the Material Process Safety risk to an acceptable level |
| Recording & Reporting | Risk Register | <ul style="list-style-type: none"> - Record all Material Process Safety Risks and associated analysis, evaluation and treatment actions in a central online database accessible by all personnel |
| | Critical Control Management Plan | <ul style="list-style-type: none"> - Develop a Critical Control Management Plan which identifies all critical controls, and flag each one in their relevant management system to enable performance monitoring |
| Monitoring & Review | Periodic Risk Review | <ul style="list-style-type: none"> - Ensure that each Material Process Safety Risk undergoes a regular review cycle to verify the above steps are up-to-date |
| | Critical Control Performance Monitoring | <ul style="list-style-type: none"> - Developing an automated dashboard that monitors KPIs which indicate effectiveness of critical controls |

1.3 ORM Implementation to Date

The ORM process was piloted throughout 2019-2020 at the Phosphate Hill site in Australia which manufactures ammonium phosphate fertilisers. Following pilot completion, the executive leadership team was supportive of planning further ORM implementation across the remaining manufacturing sites. With this support, the corporate Process Safety team conducted planning activities to determine the current state of risk management at each site,

the work required to bring the site to the ORM standard and expected timing and resources (both on-site and corporate-based) required to implement.

This approach to implementation has been relatively unique compared to the roll-out of previous company standards, in that implementation is customised for each site and is supported by a central team. It was recognised early in the development of ORM that the ‘one size fits all’ approach would not be successful as it would not account for the inherent differences between sites in:

- Availability and quality of existing information/processes e.g. existing risk registers, HAZOP, bow ties, LOPA, etc.;
- Competency of personnel to implement as required e.g. skill level and experience of site personnel to facilitate risk assessments;
- Capacity of the site to take on the work required to effectively implement ORM, given other site activities such as capital projects, plant shutdowns and regulatory and corporate assurance activities.

‘ORM Readiness Assessments’ were conducted by the Process Safety team with site representatives to assess how ready each site was to implement ORM based on the three criteria above. The results of these assessments were then used as an input to develop an ‘ORM Implementation Plan’ for each site, again developed by the central team and site representatives. These plans considered the estimated workload, resources available to implement, and any schedule constraints. A high-level view of the resulting plans for ORM Implementation across all manufacturing sites is shown in Figure 3.

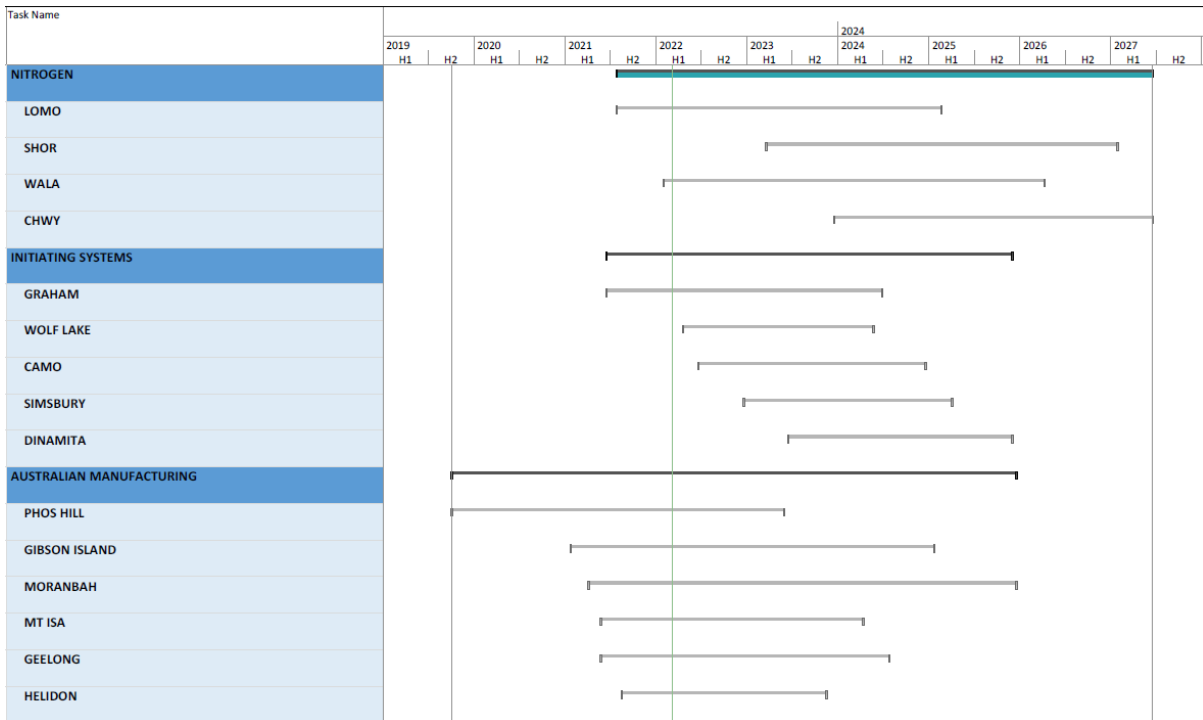


Figure 3: ORM Implementation Plans - Global Manufacturing (as of December 2021)

The rest of this paper will be primarily focused on the sites which manufacture explosives, being the five IS sites in North America, and one in Helidon, Australia. These sites manufacture a range of products such as dynamite, cast boosters, PETN, detonators, detonating cord, and shock tube.

2 Observations and Lessons Learnt

As indicated in Figure 3, most sites have commenced implementation (at time of writing) and are at various stages of their implementation plans. Implementation has been supported heavily by the corporate Process Safety team, working with each site to guide and coach site personnel through each step of ORM.

The following section describes the observations and lessons learnt to date.

2.1.1 Availability of site resources is vital

Each step of the ORM Process requires collaboration between key people on site across many disciplines – to participate in risk assessment workshops, plan an emergency response, or link maintenance/inspection data to the critical control dashboard. ORM cannot be implemented by one or two people in isolation from the rest of the site, particularly as risk management is the responsibility of everyone on site and should not be viewed as an “add-on” to normal operation. Because ORM relates to many different workgroups, implementation is a resource-intensive period for the site. However once implemented the effort to upkeep the process is expected to be less than the effort sites were expending with the previous risk management process (for example, reduced CCV activity).

Long-term, ORM activities must be integrated into daily standard work on site. As such, the implementation of ORM requires input and effort from a wide range of people across the site – engineering, maintenance, operations, leaders, and more. Availability and commitment of these resources throughout the implementation of ORM is vital to progress but also in advancing overall process safety and risk management competency across the site so that everyone understands how their daily work impacts on risk. Obtaining this commitment from site personnel to date has been an exercise in forward planning, communication and change management. Ultimately, however, the degree of commitment is heavily reliant on leadership support.

2.1.2 Leadership support is important

As discussed above, the implementation of ORM requires a large commitment from sites which in turn is dependent on the support of their leaders and upper management. The importance of leadership support and the impact it has had so far in ORM implementation at IPL has been clearly observed.

A leader of one business unit has consistently demonstrated their support of ORM implementation by attending progress meetings for different sites, seeking progress updates from sites, and verbally/visibly championing ORM in meetings and other forums. We observed that the sites under this business unit have all made steady progress in implementation, compared to sites in the other business units. We believe that the support from this leader stems from their having initially been involved in the ORM pilot and hearing firsthand the positive feedback from the site manager, engineers, and other site personnel. As a result, this leader has trust in the process and the benefits that this commitment will have in the long-term.

The intent was to run two more pilots in the other business units to recreate this level of support from their respective leaders. However, due to challenges including the availability of site resources, these pilots have not progressed as fast as originally expected. As a result, the corporate Process Safety team has had to find other opportunities of demonstrating the benefits of ORM to the leaders of these other business units.

2.1.3 The Risk Champion(s) greatly influences implementation

The level of experience and understanding of process safety management across the explosives sites varies. One of the sites has a dedicated process safety engineer on site, while the remaining sites rely on the experience of another competent person (for example an HSE professional, engineering manager, discipline engineer, or maintenance manager) to oversee the management of process safety risks on site.

ORM implementation is designed to be led by one or more 'Risk Champions' who are site-based personnel working closely with and supported by the corporate Process Safety team. We have observed that implementation is very dependent on the experience and capacity of the Risk Champions. No matter how supportive of the process a business leader or Site Manager may be, successful implementation requires at least one or two people based at the site who understand the case for change who have the knowledge (and therefore confidence) to drive it amongst their site peers. We have observed that the sites which have this kind of Risk Champion tend to progress generally as per their implementation plan.

Sites that have a Risk Champion(s) with less experience or understanding of process safety have required a much higher degree of support from the corporate Process Safety team, resulting in a slower rate of implementation. The corporate Process Safety team is often limited in its ability to directly manage or direct site personnel to provide data, attend workshops, complete tasks, etc. Hence the importance of the Risk Champion, being the person "on the ground" to drive the implementation.

2.1.4 Implementation must be well-supported centrally

Many sites run a lean operation thus resourcing can be a challenge at the best of times. Often, it is not practical to expect every site to have someone in-house who has the experience or competency to conduct activities such as bow tie workshop facilitation, or LOPA facilitation.

In addition to support from leaders, and commitment of site resources, the success of ORM implementation therefore also depends on a certain level of central support from the corporate Process Safety function and other subject matter experts (e.g., company discipline engineers). There must be a central pool of specialists that is available for the site to use as needed.

This centralized support also ensures a level of oversight and promotes consistency in the way ORM is implemented across different sites.

2.1.5 Existing work that already satisfies ORM intent should be credited

When asked what they wanted from ORM, stakeholders across the business (particularly in North America) said that alignment with regulatory requirements was important. The North American sites have prescriptive regulations set by OSHA Process Safety Management and/or EPA Risk Management standards - something not encountered during the ORM pilot in Australia – and so alignment with these requirements is important to avoid unnecessary duplication of effort. For example, sites under these jurisdictions are required to conduct 5-yearly Process Hazard Analyses (PHAs) for hazard and risk analysis of their covered processes. Rather than require sites to develop bow ties on top of this to demonstrate compliant risk analysis, the ORM Procedure was adjusted to allow sites to take credit for existing PHAs, provided the ORM objectives (refer to Table 1-1) can still be met.

2.1.6 Where applicable, ORM implementation schedules should be aligned with existing schedules for regulatory compliance activities

For sites where the U.S. OSHA Process Safety Management standard and/or EPA Risk Management Program rule apply, and for which it was determined that the existing PSM/RMP compliant Process Hazard Analysis (PHA) did not meet the ORM objectives (refer to Table 1-1), we learned that the most efficient way to update these hazard and risk analyses to meet ORM objectives is to schedule this work in concurrence with existing 5-yearly PHA updates. The sites are already committed to their regulatory compliance schedules, and plan in advance to dedicate the resources and time to accomplish their PHA revalidations. By setting expectations on identifying Critical Controls as part of the output of those studies, ORM implementation is integrated into the sites' existing PSM activities.

2.1.7 Critical control performance data must be readily accessible

The Critical Control Dashboard is effectively the visual representation of the ORM process – it is an automated dashboard that summarises the effectiveness of the critical controls for each Material Process Safety Risk at any point in time.

The dashboard currently draws data from a CMMS (Computerized Maintenance Management System) to display the current state of maintenance and inspection of typical critical controls such as relief devices, safety instrumented functions, etc. The intent is for the Critical Control Dashboard to include approximately 30 different KPIs that provide information about the effectiveness of critical controls.

| Process Safety Critical Control Tracking Dashboard | | | | | | | | | | | | | | | |
|--|-------|----------|----------|--------------|----------|----------|----------|----------|----------|---------------|----------|----------|----------|----------|---|
| Incitec Pivot Fertilisers | Year | 2022 | Site | EXAMPLE ONLY | | | | | | Monthly Score | | | Target | | |
| | KPI # | KPI Name | 01 - JAN | 02 - FEB | 03 - MAR | 04 - APR | 05 - MAY | 06 - JUN | 07 - JUL | 08 - AUG | 09 - SEP | 10 - OCT | 11 - NOV | 12 - DEC | |
| Instrumented Protective Systems | 1A | # | Overdue | 2 | 1 | 1 | 1 | 6 | 3 | 2 | 0 | 0 | 0 | 0 | 0 |
| Relief Devices | 2A | # | Overdue | 2 | 2 | 2 | 2 | 2 | 12 | 12 | 12 | 12 | 12 | 12 | 0 |
| Process Control System (PCS) | 3A | # | Overdue | 5 | 5 | 5 | 5 | 9 | 11 | 12 | 9 | 9 | 0 | 0 | 0 |
| Integrity Management | 4A | # | Overdue | 2 | 1 | 1 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Figure 4: Example of ORM Critical Control Dashboard (by Critical Control type) which is currently populated with figures for critical controls that have overdue work orders (Mock data for illustrative purposes only)

| Material Process Safety Risk Performance Dashboard | | | | | | | | | | |
|--|-------------|---------------------------------|-------|----------------|-------|-------------------------------|-------|----------------------|-------|--|
| Year | 2022 | Instrumented Protective Systems | | Relief Devices | | Process Control Systems (PCS) | | Integrity Management | | |
| Month | 3 | Fail | Total | Fail | Total | Fail | Total | Fail | Total | |
| Risk Event | Risk No. | | | | | | | | | |
| Loss of Containment of process Gas from synthesis loop | RSK-1001157 | 0 | 15 | 0 | 5 | 3 | 20 | 0 | 8 | |
| Loss of containment of ammonia from the ammonia storage area | RSK-1001158 | 0 | 3 | 0 | 6 | 0 | 11 | 0 | 2 | |
| Loss of containment of reformed gas from the Reformer section | RSK-1001159 | 3 | 10 | 0 | 0 | 2 | 10 | 0 | 19 | |
| Loss of containment of process gas from the condensation section | RSK-1001160 | 0 | 5 | 0 | 4 | 0 | 6 | 0 | 5 | |
| Loss of containment of ammonia from the refrigeration area | RSK-1001161 | 0 | 4 | 1 | 2 | 0 | 1 | 0 | 5 | |
| Loss of containment of natural gas from natural gas system | RSK-1001163 | 0 | 15 | 0 | 0 | 0 | 1 | 0 | 5 | |
| Loss of containment of process gas from the desulphurisation reactor | RSK-1001165 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |

Figure 5: Example of ORM Critical Control Dashboard (by Material Process Safety Risk) (Mock data for illustrative purposes only)

To date, three of these KPIs have been populated on the dashboard at the pilot site:

- No. of overdue work orders on instrumented protective systems (trips);
- No. of overdue work orders of relief devices;
- No. of overdue work orders on equipment inspections.

The data above is what is readily available at some (not all) sites currently. In the future, the Critical Control dashboard would also include additional KPIs such as:

- Failure during testing of instrumented protective systems;
- Overrides of instrumented protective systems;
- Automated process control systems put in manual;
- Demands on relief devices;
- Deficiency identified during inspection of equipment;
- And so on.

| Process Safety Critical Control Tracking Dashboard | | | | | | | | | | | | | | | |
|--|----------|----------|----------------------------|----------|--------------|----------|----------|----------|---------------|----------|----------|----------|----------|----|----|
| KPI # | KPI Name | 2022 | | | EXAMPLE ONLY | | | | Monthly Score | | | Target | | | |
| | | 01 - JAN | 02 - FEB | 03 - MAR | 04 - APR | 05 - MAY | 06 - JUN | 07 - JUL | 08 - AUG | 09 - SEP | 10 - OCT | 11 - NOV | 12 - DEC | | |
| Instrumented Protective Systems | 1A | # | Overdue | 2 | 1 | 1 | 1 | 6 | 3 | 2 | 0 | 0 | 0 | 0 | 0 |
| | 1B | # | Function Testing Failure | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 1C | # | Failure In Service | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Relief Devices | 2A | # | Overdue | 2 | 2 | 2 | 2 | 2 | 12 | 12 | 12 | 12 | 12 | 12 | 12 |
| | 2B | # | Function Testing Failure | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 2C | # | Failure In Service | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Process Control System (PCS) | 3A | # | Overdue | 5 | 5 | 5 | 5 | 9 | 11 | 12 | 9 | 9 | 0 | 0 | 0 |
| Integrity Management | 4A | # | Overdue | 2 | 1 | 1 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 4B | # | Function Testing Failure | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Emergency Response | 6A | # | Overdue - Emergency Drills | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 6B | # | Overdue - Detectors | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Figure 6: Example of ORM Critical Control Dashboard which would be populated in future with data for additional KPIs (Mock data for illustrative purposes only)

We have learnt that the data for these additional KPIs does not currently get recorded in a formal manner, and many sites still use paper-based records that make automatic tracking challenging. As a result, the development of the dashboard is limited until the business has a systematized method to record this data. Critical control performance data must be readily accessible via existing tools/management systems before the automated Critical Control dashboard can be fully functional.

2.1.8 CCVs are still appropriate for administrative controls

The development of a Critical Control Dashboard for monitoring critical controls is not so readily replicable at an explosive manufacturing site as it is for a fertiliser manufacturing site. Explosives sites involve more batch operations (rather than continuous) and more procedural/administrative controls (rather than engineered) than at the fertiliser manufacturing sites. Many of our explosive sites therefore do not have a CMMS system in place.

As such, it has become apparent that monitoring the effectiveness of critical controls at the explosive sites will need to be different. The solution is for these sites to retain the use of CCVs for verification, however there will be work required to review and potentially redesign the CCVs to ensure they are effective enough to test each critical control whether it is an operating procedure, or critical inspection activity, for example.

2.1.9 Suitable Qualitative and Semi-Quantitative risk assessment methodologies for explosives manufacturing sites may differ from fertiliser sites

At the time the Operations Risk Management process was originally developed, the corporate Process Safety team had the most experience conducting hazard and risk analysis activities for large-scale, continuous chemical processing facilities. Even within industry, the development of Process Safety risk management tools and techniques originated primarily from the Chemicals and Oil & Gas sectors. While the core concepts are equally applicable and critical for risk management at explosives manufacturing facilities, the

specific risk assessment tools and methodologies used should be tailored towards the nature of those processes (i.e., more batch operations, manual assembly, and frequently dependent on procedural/administrative controls).

The first iterations of the Operations Risk Management procedure specified that Bow Tie and LOPA would be the Qualitative and Semi-Quantitative risk assessment methodologies of choice, respectively. The procedure has since been updated to allow for alternative methodologies to be used, such as Fault Tree Analysis or FMEA.

3 Next Steps and Looking to the Future

3.1.1 Establish Regional Subject Matter Expert support teams

The success of the original pilot at Phosphate Hill was likely due to the deployment of a dedicated team of three engineers from the corporate Process Safety team for 18-24 months (on and off). These engineers would regularly visit site to facilitate workshops, coach the Risk Champions, and build relationships with personnel across the site to also improve general process safety awareness and competency amongst those whose roles are not specifically process safety focused.

When the Covid-19 pandemic hit in early 2020, all travel to site was suspended. By that time, the pilot was completed however the ORM Readiness Assessments, development of ORM Implementation Plans, and commencement of ORM implementation at many sites had to be performed virtually.

The corporate Process Safety team believes that returning to the 'task force' model of implementation at each site would encourage the same motivation for implementation as it did during the pilot. Hence, a regional support model has been proposed, in which a team of two to three Process Safety professionals would provide a high degree of in-person support in a condensed but more intense timeframe before moving to the next. This kind of model is expected to provide sites with more targeted support that would drive effective and timely implementation.

3.1.2 Expand performance data in the Critical Control Dashboard

As described in section 2.1.7 and 2.1.8, more work is required to improve the sites' management systems and CCV processes so that better data is available for the Critical Control Dashboard.

This will require collaboration between the corporate Process Safety, Asset Management, and HSE teams to determine how this data can best be sourced, systematized, tracked, and reported.

3.1.3 Develop ORM Training and Awareness packs

The intent of ORM is to ensure all sites can independently and confidently maintain the process long after it has been implemented. To achieve this, one or more Risk Champions are appointed at each site to drive the initial implementation. These Risk Champions are supported by the corporate Process Safety team. Care must be taken to develop the Risk Champions' ORM competency (and ideally that of as many people across the site as possible) during the implementation process so that they are familiar with what is required to maintain the process in the future.

Indeed, ORM implementation to date has shown that this process has already been educational for sites which were previously not as mature in risk management. For example, we have seen the development of the Hazard Register at one site and bow ties at another

site have been a good way of starting the conversation amongst cross-functional teams on their operations, and of increasing awareness of risks and how they are managed.

The intent is to also build systems and processes that ensure training and competency is independent of individuals, who can and will move on over time. This will involve working with the corporate HR team to ensure that the competencies required to uphold parts of ORM are incorporated into job descriptions (e.g., engineers on site should have risk assessment training and experience, process safety professionals on site should have risk assessment facilitation training and experience), and to work with the Learning and Development team to develop and assign formal ORM training modules to specific roles.

3.1.4 Develop ORM assurance process and tools

Assuring the business that ORM has been applied in a consistent manner across the range of manufacturing sites will provide confidence to leaders and to the sites in this refreshed risk management process. It will also highlight any gaps or areas of weakness that may need further work, indicate how consistently ORM has been implemented, and whether it meets the intended outcomes i.e. providing improved visibility of critical control effectiveness for high consequence process safety risks.

As such, the corporate Process Safety team will develop an assurance process and tools that can be incorporated into a regular audit schedule.