Process safety implementation using Bow-Tie Methodology

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Authors

Christian Riopel
Process Safety Manager: Rio Tinto Fer et Titane

Guy Brouillard
Process Safety Manager: GCM Consultants
PSM, a component of the global Rio Tinto Safety Strategy

Improving safety performance: A balanced approach

Fatality elimination
- Leverage SPIs
- Embed critical controls
- Human performance

Reducing injuries
- Contractor safety
- Hazard and risk awareness
- Severity focus
- Workplace conditions

Everyone goes home safe and healthy every day

Catastrophic event prevention
- Aviation
- Underground
- Process safety
- Geotech
- HSEC in design
Rio Tinto Process Safety Model

Defining the Requirements

**Standard**
- The structure of the Standard to align to the four component model, with corresponding elements.
- Each section (component) starts with the intent for each component and then defines the requirements for corresponding elements.

**Group Procedures**
- One for each component of the model.
- They describe the intent for each element of process safety and the additional requirements to that of the standard.

1. **Commitment to process safety** – Process safety hazard identification and risk analysis
2. **Understanding hazards and risks** – Process safety governance, roles and capability
3. **Systems to manage risk** – Process safety operational control and management
4. **Learning from experience** - Process safety monitoring and improvement
Implementation Strategy - Three Key Components

1. **Group Milestones** – Group-wide activities and systems to support controls

2. **Control-centred** – Understand the controls
   - Process Hazard Analysis

3. **Business Plans** – Local systems to support controls:
   - Process Safety Information
   - Asset Integrity
   - Operating Procedures
RTFT Metallurgical Complex

Metal Powder Plant

UGS Plant

Ore Preparation Plant

Steel Plant

Reduction Plant
Current situation:

• In 2014, RTFT was selected to conduct one of two pilot projects for Rio Tinto.

• The RTFT metallurgy complex is one of the Rio Tinto sites with the most risks generated by the process, both in terms of quantity and in terms of the diversity of hazards present.

• With a growing emphasis on Process Safety Management within Rio Tinto, it became apparent that a different, more rigorous approach was required to analyse and control the risks.

• RTFT had been working with GCM Consultants in process safety for several years, and GCM had the experience to lead this Bow-Tie pilot project.
Solution:

- The Bow-Tie analysis focusses on a hazard which, if uncontrolled, will lead to unwanted events (Top Event) such as explosion, release of hazardous material, etc.

Figure 1: Illustration of structure and terminology used in bow-tie analysis in Rio Tinto. Further description of each of the elements is provided below.
Solution:

• For each identified cause (threat), the team identifies specific barriers that are present to prevent the consequence.

Figure 1: Illustration of structure and terminology used in bow-tie analysis in Rio Tinto. Further description of each of the elements is provided below.
Solution:

• Barrier effectiveness is assessed and recommendations are issued by the team for improvement.

Barrier criteria must be met to be credited as a risk reduction factor:
- Effective
- Independent
- Auditable

Figure 1: Illustration of structure and terminology used in bow-tie analysis in Rio Tinto. Further description of each of the elements is provided below.
Benefits:

- The two pilot projects met Rio Tinto’s expectations and the Bow-Tie was adopted as the formal methodology to be applied on Process Safety risk analysis. Roll out to the entire corporation followed the pilot projects.
- The visual nature of the process is engaging for frontline participant and helps gain ownership of actions defined by the team.
- Same rigor for barriers as IPL definition in a LOPA - becomes a Semi-Quantitative method.
- Bow-tie results is used to validate if risk tolerance is met.
Bowties trigger improvements on other elements of the Rio Tinto PSM Standard

1. Organisational Resources, Accountabilities & Responsibilities
2. Training, competency and awareness
3. Process Safety Information
4. Hazard Identification
5. Inherent Safety & Plant Layout
6. Process Hazard Analysis
7. Pre start-up Safety Review
8. Operating Procedures
10. Process Safety Asset Integrity
11. Design, Installation & Fabrication
12. Management Of Change
13. Business Resilience & Recovery
14. Measuring & Monitoring
15. Incident & Action Management
16. Performance Assessment & Auditing
Bow-Tie Analysis

Since implementing Bow-Ties:

• RTFT has completed the analysis of 35 scenarios and implemented more than 280 recommendations identified by participants.

• On many processes, real improvements are seen such as:
  o No fire or explosion involving iron powder for the last 2 years
  o Significant reduction in SO$_2$ leaks and continuous monitoring alarming in the Ore Preparation Plant
  o No loss of integrity on CaC$_2$ railcar for the last 18 months
  o Etc.
For Rio Tinto Fer et Titane, the Bow-Tie methodology:

- is central to the PSM implementation strategy and creates a bridge between most PSM elements
- is a game-changer within RTFT; it helps engage the workforce due to its graphical representation
- helped build the barrier thinking approach at different levels of the organisation and drive management decisions

Next steps...

- Implement a critical control effectiveness verification process (auditing of barrier effectiveness)
- Reinforce the use of Bowtie for incident investigation
- Use Bow-Ties and include a review of them during the Management of Change process
Thank-you!
Questions

Christian Riopel: Christian.Riopel@riotinto.com office: (450) 746-3000 ext 4424

Guy Brouillard: gbrouillard@gcmconsultants.com office: (514) 351-7546 ext 5196