



Rio Tinto

Fer et Titane



**Process safety
implementation using
Bow-Tie Methodology**

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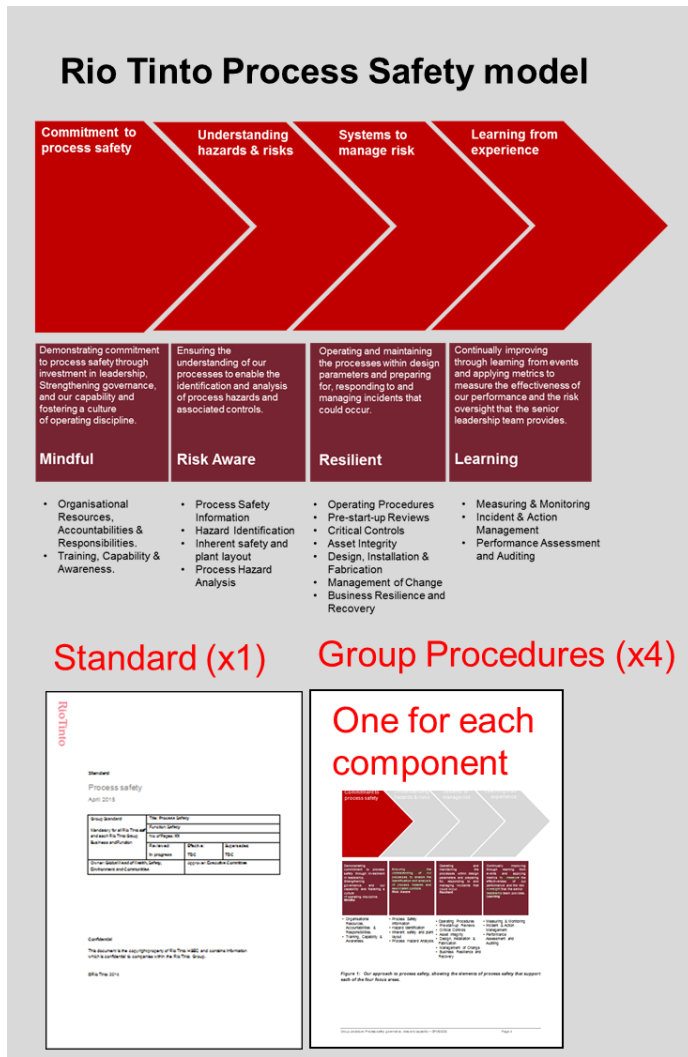
Process Safety Manager: GCM Consultants

PSM, a component of the global Rio Tinto Safety Strategy

Improving safety performance:
A balanced approach



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.
- Commitment to process safety** – Process safety hazard identification and risk analysis
 - Understanding hazards and risks** – Process safety governance, roles and capability
 - Systems to manage risk** – Process safety operational control and management
 - Learning from experience** - Process safety monitoring and improvement

Implementation Strategy - Three Key Components

Vision

Target

Governance

Strategy

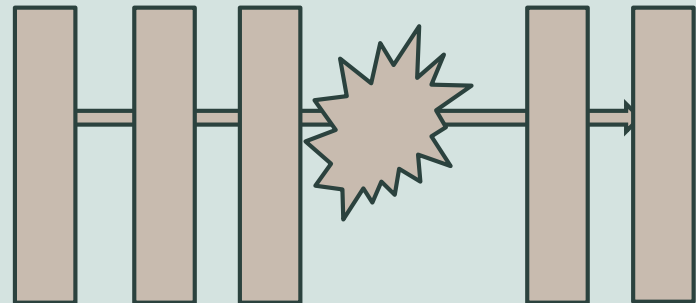
Standard

Road Map

Measures

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



Reduction Plant



Steel Plant



Process Hazard Analysis

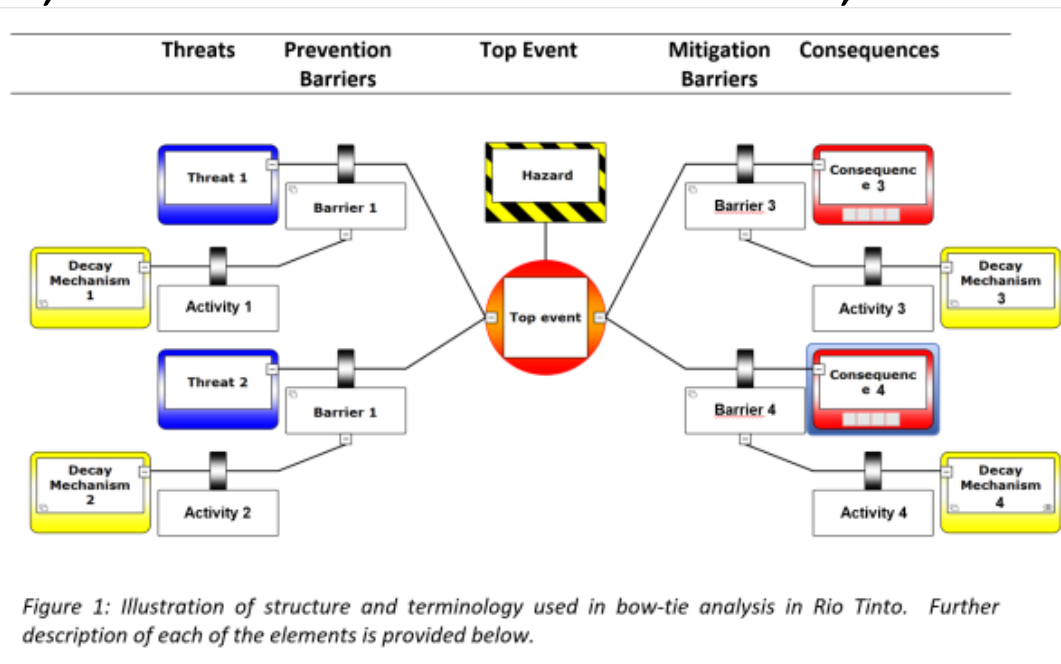
Current situation:

- 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.

Bow-Tie Analysis

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.



Bow-Tie Analysis

Solution:

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

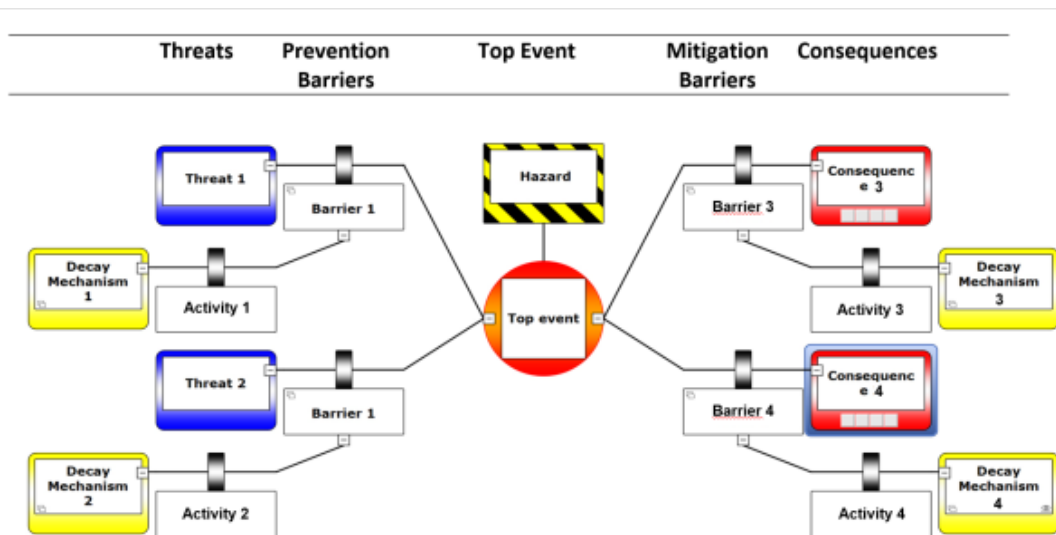


Figure 1: Illustration of structure and terminology used in bow-tie analysis in Rio Tinto. Further description of each of the elements is provided below.

Bow-Tie Analysis

Solution:

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

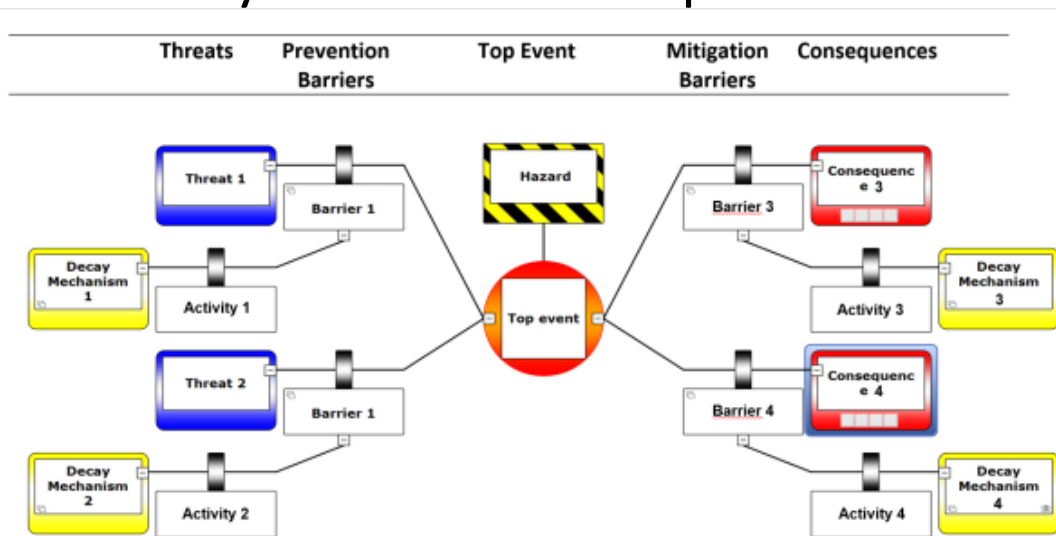


Figure 1: Illustration of structure and terminology used in bow-tie analysis in Rio Tinto. Further description of each of the elements is provided below.

Barrier criteria must be met to be credited as a risk reduction factor:

- Effective
- Independent
- Auditable

Bow-Tie Analysis

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

Bowtie Process

3. Process Safety Information

4. Hazard Identification

6. Process Hazard Analysis

2. Training, competency and awareness

7. Pre start-up Safety Review

8. Operating Procedures

9. Process Safety Critical Controls

10. Process Safety Asset Integrity

13. Business Resilience & Recovery

15. Incident & Action Management

12. Management Of Change

5. Inherent Safety & Plant Layout

14. Measuring & Monitoring

11. Design, Installation & Fabrication

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:
 - No fire or explosion involving iron powder for the last 2 years
 - Significant reduction in SO₂ leaks and continuous monitoring alarming in the Ore Preparation Plant
 - No loss of integrity on CaC₂ railcar for the last 18 months
 - Etc.

Conclusion

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



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