Bow-tie Risk Analysis

Paulo Rheinboldt
Process and Industrial Safety Consultant
Det Norske Veritas
Objectives

- Presentation the Bow-tie methodology basic concepts
Risk Management is growing in importance because ...

- Increasing complexity and uncertainty in the work space
- Increasing opportunities
- Increasing stakeholders expectations

Need to optimize management of Upside Risks & Downside Risks
Need to optimize management of Enterprise Risk & Operational Risks
Risk Management: A process to ensure that all significant risks are identified, prioritized, and managed effectively (DNV).
Risk and Loss Causation

- Basic Causes
  - Lack of Control
    - Inadequate System
    - Inadequate Standards
    - Inadequate Compliance
  - Basic Causes
    - Personal Factors
    - Job / System Factors
  - Substandard Acts or Practices
  - Substandard Conditions

- Immediate Causes
  - Event Contact (or near) with energy or substance

- Immediate Consequences
  - People
  - Equipment
  - Material
  - Environment

- Ultimate Consequences
  - Loss

Causes and Consequences

Threshold Limit
Managing Risk

Risk Recognition
- Establish the context
- Identify all hazards, threats, & opportunities

Risk Evaluation
- Analyze the risks
- Evaluate the risks

Risk Control
- Develop control plans
- Implement control plans

Risk Monitoring
- Monitor risks & controls
- Review & improve risk management system

WHAT MATTERS?
WHAT CAN GO WRONG (OR RIGHT)?
WHAT IS THE RISK?
SO WHAT?
WHAT DO WE DO NOW?
LET’S DO IT!
IS IT WORKING?
CAN WE MAKE IT BETTER?
Why Bow-tie?

- Visualization of the relationship between undesirable event, its causes, accidental scenarios, the preventive and mitigation measures to limit their consequences
- Demonstrates the effectiveness of existing controls
- Structured risk analysis where quantification is not possible or desired
- Extremely versatile / Success in various applications
- Required multidisciplinary team
The “Swiss Cheese” Barrier Model
Prevent Barriers

HAZARD

Hydrocarbon inventory in plant and storage facilities

HAZARD REALIZATION

Loss of containment
Ignition
Fire/Explosion

Facilities
Processes
People
Prevent Barriers

HAZARD
Hydrocarbon inventory in plant and storage facilities

Inherent Design Plant layout
Relief and Bow-down System
Maintenance & Inspections
Operational Procedures
Work Control
Audit & Self Regulation
Effective Supervision
Training & Competency

Communication

So what do we do now?

HAZARD REALIZATION
Loss of containment
Ignition
Fire/Explosion

Facilities
Processes
People
Detect, Control, Mitigate and Recovery Barriers

**HAZARD**
- Hydrocarbon inventory in plant and storage facilities

**HAZARD REALIZATION**
- Loss of containment
- Ignition
- Fire/ Explosion

**Detect**
- Gas, Fire, Pressure Temperature High - Low

**Mitigate**
- Limit Effect (e.g. deluge system)

**Control**
- Limit extent (e.g. blow-down)

**Crisis Management & Business Recovery**
- Emergency Response
- Evacuation, Escape and Rescue

**Learning**
- From Events
- Operational Procedures
- Effective Supervision
- Work Control, Relief and Blow-down System

**Reliability & Inspections**
- Audit & Self Regulation
- Management of Change

**Communication**
- Training & Competency
Bow-tie Diagram

A visual representation of:

What can **cause** an Important Event?  What events could result?  And barriers needed to control
Bow-tie Diagram

Hazard

Top Event

Threats

Barriers

Recovery Measures

Consequences

Escalation Factor

Escalation Factor Control

Escalation Factor Control

Escalation Factor Control

Escalation Factor Control

Critical Safety equipments

Critical Safety Tasks
- Operation
- Maintenance
- Engineering
Bow-tie Diagram Construction

1. Define the Hazard and the **Top Event** which is the initial consequence
   "What happens when the danger is" released "?"
2. Identify the **Threats** which are the Top Event causes
   "What causes the release of danger?"
   "How can lost control?"
3. Identify the existing Protection **Barriers** each Threat
   - Prevent the Top Event occurrence
   - Can be independents or dependents
   "How can controls fail?"
   "How can that their effectiveness can be compromised?"
Bow-tie Diagram Construction

4 Identify for each Barrier their **Escalation Factors**
   - Factors that make the Barrier fail
     “How can we avoid that the hazard being released?”
     “How can we keep the control?”

5 Identify for each Barrier their **Escalation Factors Control**
   - Factors that prevent or minimize the possibility of the Barrier or the Recovery Measures becomes ineffective
     "How to ensure that the controls will not fail?"

6 Identify the consequences
   - Top Event could have several consequences
Bow-tie Diagram Construction

7 Identify the **Recovery Measures**
   - Factors that make the barriers fail
     "How can we limit the severity of the event?"
     "How can we minimize the effects?"

8 Identify for each Recovery Measure their **Escalation Factors and Escalation Factors Controls**

9 For each Barrier, Recovery Measures and Escalation Factors Controls identify the **Critical Safety Tasks**
Critical Safety Tasks

Tasks prevent and/or minimize the possibility of the Barrier, the Escalation Factor Control or the Recovery Measures fails or becomes ineffective.

What tasks can be taken to ensure that the control is working?

- Project engineering, operation, maintenance, management.

"How can we ensure that these tasks are done?"

"Who do these tasks?"

"How do you know when to do the tasks?"

"How do you know what to do?"

"Is there a procedure, checklist, instruction?"
Bow-tie Example

Working at height

- Unsafe scaffolding
  - Scaffolding assembly standards
  - Contractor Inspection
  - Safety Dept Inspection

- Ladder inadequate use
  - Ladder uses standards
  - Contractor Inspection
  - Safety Dept Inspection

- Mobile platform defective
  - Pre-use Inspection
  - Maintenance Supervision
  - Safety Dept Inspection

Workers Falling

- PPE correct use
- Workers awareness induction
- First Aids Team
- Injuries

- PPE correct use
- Workers awareness induction
- Emergency Plan
- Fatality

Critical Safety Tasks
Safeguarding life, property and the environment

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