Bow-tie Risk Analysis

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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

Event

Causes

Basic Causes
- Lack of Control
  - Inadequate System
  - Inadequate Standards
  - Inadequate Compliance
- Basic Causes
  - Personal Factors
  - Job / System Factors
- Immediate Causes
  - Substandard Acts or Practices
  - Substandard Conditions
- Incident
  - Event Contact (or near) with energy or substance

Consequences

Immediate Consequences
- People
- Equipment
- Material
- Environment

Ultimate Consequences

Loss

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 IS THE RISK?
WHAT DO WE DO NOW?
IS IT WORKING?
WHAT CAN GO WRONG (OR RIGHT)?
SO WHAT?
LET'S DO IT!
CAN WE MAKE IT BETTER?
Risk Analysis and Assessment

- People
- Assets
- Environment
- HAZID

Qualitative Analysis
Semi-Quantitative Analysis
Quantitative Analysis

Benefits
Decisions
1
2
3
...

ALARP
Costs

Risk Analysis
Risks Evaluation
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
Prevent Barriers

HAZARD

Hydrocarbon inventory in plant and storage facilities

HAZARD REALIZATION

Loss of containment
Ignition
Fire/Explosion

Facilities
Processes
People

Inherent Design Plant layout
Relief and Bow-down System
Maintenance & Inspections
Operational Procedures
Work Control
Management of Change
Effective Supervision
Training & Competency
Communication

Control, Alarm & Shut-down System
Learning from Events
Audit & Self Regulation

Prevent Barriers

HAZARD
Hydrocarbon inventory in plant and storage facilities

HAZARD REALIZATION
Loss of containment
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Facilities
Processes
People

So what do we do now?
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)

Emergency Response
Evacuation, Escape and Rescue

Crisis Management & Business Recovery

Audit & Self Regulation
Management of Change
Communication
Training & Competency

Effective Supervision
Work Control, Alarm & Shut-down System

Learning from Events
Operational Procedures

Inherent Design
Plant layout
Maintenance & Inspections

Loss of containment
Ignition

Hydrocarbon inventory in plant and storage facilities
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

- **Threats**
- **Top Event**
- **Barriers**
- **Hazard**
- **Recovery Measures**
- **Consequences**

**Escalation Factors**
- 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
          - PPE correct use
            - Workers awareness induction
              - First Aids Team
                - Injuries
              - Emergency Plan
                - Fatality

- Ladder inadequate use
  - Ladder uses standards
    - Contractor Inspection
      - Safety Dept Inspection
        - PPE correct use
          - Workers awareness induction

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

Critical Safety Tasks
Safeguarding life, property and the environment

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