Safety in the Engineering Enterprise

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Global Business Development
Intergraph
Mary Kay O'Connor Process International Safety Symposium
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Topics

- Safety in Engineering
  - Issues
  - Safety categories

- Customer and sample use cases
  - Corrosion management
  - LDAR
  - Explosion impact studies
  - HAZOP
  - Tag-out
  - Escape routes
  - Area classifications
  - Instrument safety systems

- Summary
Safety = Business

- Cannot assign a price tag to Safety
  - Life
  - Environment
  - Plant/production
  - Corporate image
  - More

- Improving but still opportunities to be safer
  - The number of people killed in the workplace fell 17% last year
  - Rising cost of safety related incidents in several process sectors

- Lowering the Risk
  - Smart Designs
  - Access to current information
  - Intelligent Plant to monitor changes and the effect on safety

- SmartPlant assist to enforce safer designs
Safety in the Engineering Enterprise
Safety in the Engineering Enterprise
- To prevent this from happening -
Oh, yes! We discuss safety regularly—every time we have an accident, in fact....
Safety is at the Forefront
Safety in the Engineering Enterprise
- Understanding the Issues -

- No such thing as a 100% safe plant

- Accept risk will be there

- Key is to identify and mitigate risk to an acceptable level
  - Learn from the past
  - Start early with safety – build it into the design
  - Balance between cost and risk level
  - Make safety a part of everyone’s culture

- Increasing challenge as plants get larger and processes more complex
OSHA Process Safety Management Elements

1. Employee Participation
2. Process Safety Information
3. Process Hazard Analysis
4. Operating Procedures
5. Training
6. Contractors
7. Pre-Startup Safety Reviews
8. Mechanical Integrity
9. Hot Work Permits
10. Management of Change
11. Incident Investigation
12. Emergency Planning Response
13. Compliance Audits
14. Trade Secrets

SmartPlant Engineering Enterprise coverage
The $1-10-1000 Rule

- Making the right decision early
  - Cost of finding error during design $1
  - Cost of finding error during the checking process $10
  - Cost of finding the error in the construction/commissioning $1000
- Drive consistency in distributed projects
- Comply with company and regulatory standards
- Help capture knowledge and experience

P&ID  Piping  Instrumentation  Equipment  Electrical
Safety Solution Categories

**Process Safety**
- Ensure that if the process deviates from the design intent it will go into a safe state
- HAZOP, risk assessment and mitigation are the key components here
- **SmartPlant Engineering Enterprise can help here with:**
  - Design rules to enforce safe practices
  - Risk assessments with automated HAZOPs

**Personnel Safety**
- Create the design that allows safe operation such as operational spacing, personal protection, escape routes, training, etc.
- **SmartPlant Engineering Enterprise can help here with:**
  - Creating, maintaining and managing space for escape routes
  - Verification thru rules spacing to allow equipment operation
  - Verification of regulatory practices (OSHA/EPA) with the rules engine
Facility Safety

- Design the facility to be safe in abnormal situations such as explosions with fire proofing, structural integrity, equipment positioning and spacing

  SmartPlant Engineering Enterprise can help here with:
  - Impact analysis, interfacing with third parties
  - Thru rules and area classification to verify the fire proofing and other safety design criteria

Environmental Safety

- Offer capabilities to monitor, manage and contain the process to avoid impact on the environment

  SmartPlant Engineering Enterprise can help here with:
  - Using the logical and physical plant model to track and manage leakage
  - Design to contain the process such as containment structures, sloping, etc.
Risk Mitigation

Designing a safe plant is about identifying and understanding the risks

- Main risk mitigation methods
  - Control systems
    - SIS/SIL safety instrument systems to put the plant in a safe state and detect and manage abnormal conditions
  - Design
    - Design for safety using proven design practices such as type of materials, spacing, and configuration of equipment and connections.
  - Manufacturing and installation
    - Build equipment and other plant items to withstand the abnormal conditions such as explosions
  - Location
    - Build in safe location to absorb any abnormal conditions such as explosions, spills, etc.
Case Studies:
How SmartPlant Engineering Enterprise Can Help Lower the Cost of Safety
Facility Safety

Bechtel and Gexcon

- Gas explosion impact study for an off-shore facility
  - Impact studies to ensure stable and safe design
  - Identify possible design modification to increase safety and lower risks
  - Identify escape routes
  - Integration with FLACS
Explosion Impacts

- Verification of the design
  - Equipment placement
  - Structure
  - Escape routes
  - Training
  - Fire proofing
- The intelligent plant design in SmartPlant 3D
- The explosion analysis by FLACS from Gexcon
- Workflow
  - Design
  - Verify
  - Correct
- Rule based design in SmartPlant 3D make helps the right decisions early to avoid the rework cycle.
Validating Design for Gas Explosion Impact

- **Safe Design Rules**
- **Data Export**
- **FLACS Analysis**
- **CMR Gexcon**

- **Minimize Changes**
- **Design Feedback**

**Analysis Model**
FLACS : Import & Analyze Data

- Reads Data Files from 3D (Geometry & Materials)
- Analyzes the data
- Displays Graphics
- Perform Explosion Analysis
Impact Views
Design Safety into your Plant

**Personnel Safety**

- Emergency escape route management with Smart 3D
  - Define and assign spaces for escape in emergency situations in the 3D model
  - Clash detection in case items obstructing free passes
  - Training using the 3D model
  - Creating layout/deliverables identifying the routes for approval and records
S3D Escape Route AVI
Plant Operational Safety Management – Use Case

Process / Personnel Safety

BP Bulwer Island, Australia

- Corrosion Monitoring Package
  - Improve corrosion inspection testing procedures
  - Automation of manual processes
  - Reduce “on plant” time by inspection team
  - Provided improved analysis and reporting
  - Provide improved productivity & cost savings
  - Reduce risks
  - CMP overview
Engineering & Design Base at Work

Reference Information
- Inspection points
- Bar codes
- Equipment number
- Name
- Thickness
- Material used

Piping Inspection System
Corrosion management

True Business Benefits

BP Bulwer Island has:
- Saved over £100,000
- 100% confidence in data
- 30% increase in productivity
- Reduced risk to safety
Design Safety into your Plant

Environmental Safety

- Leak Detection and Repair (LDAR) by SECCO China
  - Leak discovery, time to repair records, and post repair re-exam
  - Repair strategies: how long to create work order? How long to complete the repair, what situation can wait till shutdown
  - Allowable leaking value
  - Detection procedure, frequency, spare parts types and quantities
  - Minimize the down time and increase the safety
  - Improve corrosion inspection testing procedures
  - Automation of manual processes
  - Reduce “on plant” time by inspection team
  - Provided improved analysis and reporting
  - Provide improved productivity & cost savings
  - Reduce risks
LDAR Inspection
TAG ON SmartPlant P&ID
LDAR Data Management

SPPID&SPF
工程数据管理系统
EDMS

RBI
Basic data

LDAR

检测任务
检测数据

维修历史记录
实施

工单
工单优先级计划

维修工作循环

策略
分析
建议

维修点...

泄露后复测

EDMS
Design Safety into Your Plant

Process Safety

- Automatic HAZOP analysis with SmartPlant P&ID and SmartPlant Process Safety
  - Identify the deviations from the design intent in abnormal situations
  - Pre-check the P&ID for safety devices and design methods
  - Create course and effect matrix
  - Create the course and consequence report
  - Provide the data for the engineer to make risk mitigation decisions
  - Manage the design action as a result of the mitigations
  - Provide the SIL factors to help determine the SIS
  - Provide auditable and consistent analysis that can be made part of the design activities to minimize the late finding/changes
SmartPlant Process Safety Information

HAZOP Study

Knowledge from experts, captured once only
Lessons learned

Full, auditable record
Comprehensive
Consistent
- Up to 50% time & cost reduction
SmartPlant Process Safety Analyzes SmartPlant P&IDs following the Hazop methodology.
SmartPlant Process Safety Automatically Detects Cause-Consequence Scenarios

<table>
<thead>
<tr>
<th>Node</th>
<th>Node2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Title</td>
<td>Separation</td>
</tr>
<tr>
<td>Description</td>
<td>Wet Cyclo-hexane enters tank where water separates into the boot. The tank has a Nitrogen blanket to suppress volatiles and maintain pressure at 3 Barg.</td>
</tr>
<tr>
<td>Deviation</td>
<td>MORE LEVEL - 24</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Consequence Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>T-0100</td>
<td>Heavy phase liquid out of light phase outlet</td>
</tr>
<tr>
<td>T-0100</td>
<td>Overfilling, liquid breakthrough on vapour outlet</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cause Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>BL026</td>
<td>Blind closed in error</td>
</tr>
<tr>
<td>FCV-1CV</td>
<td>CV stuck closed</td>
</tr>
<tr>
<td>H-101S</td>
<td>Heat exchanger blockage (tube side)</td>
</tr>
<tr>
<td>LCV-1CV</td>
<td>CV stuck open</td>
</tr>
<tr>
<td>NRV103</td>
<td>Check valve backwards</td>
</tr>
<tr>
<td>P-0102A</td>
<td>Pump fails (motor fault, loss of drive, impeller corroded away, etc)</td>
</tr>
<tr>
<td>P-0102A</td>
<td>Blocked pump suction</td>
</tr>
<tr>
<td>P-0102A</td>
<td>Impeller wear</td>
</tr>
<tr>
<td>P-0102A</td>
<td>Loss of performance</td>
</tr>
<tr>
<td>P-0102A</td>
<td>Pump outlet blocked</td>
</tr>
<tr>
<td>P-0102A</td>
<td>Reverse rotation</td>
</tr>
<tr>
<td>V017</td>
<td>Valve unintentionally opened</td>
</tr>
<tr>
<td>V019</td>
<td>Valve unintentionally opened</td>
</tr>
<tr>
<td>V022</td>
<td>Drain opened in error</td>
</tr>
<tr>
<td>V025</td>
<td>Valve unintentionally closed completely</td>
</tr>
<tr>
<td>V026</td>
<td>Valve unintentionally closed completely</td>
</tr>
<tr>
<td>V037</td>
<td>Valve unintentionally closed completely</td>
</tr>
<tr>
<td>V038</td>
<td>Valve unintentionally closed completely</td>
</tr>
<tr>
<td>V039</td>
<td>Valve unintentionally opened</td>
</tr>
</tbody>
</table>
Design Safety into Your Plant

Process Safety/Personnel Safety

- Rules-based area classification with SmartPlant 3D
  - Associate classification with plant items on the P&ID
  - Automatically create zones around the plant items based on standards/project practices
  - Rules verify if equipment placed within the zones are of the right classification
  - Zones are associated so will move when item is moved
  - Create the associated deliverables such as area classification layout
  - Add zones in the 3D model not associated to plant items such as ditches etc.
Area Classification Examples
Smart Safety in Action

- Engineering firms and plant owners can transfer their engineering, operational and safety relevant know-how into the rules-based design systems.
- Rules, embedded in the design systems, help to optimize the design and to reduce the number of design errors.
- Rules work as “watch dogs” who won’t allow non-compliant design or unauthorized design modifications.

Rules-based Area Classification in S3D
Ensure right and safe design from the start
SmartPlant Enterprise for Owner / Operators (SPO)

Examples covered in the SPO presentation:

Improving plant efficiency, reliability and reducing OPEX costs

- Lock Out / Tag Out (LOTO) ensures that equipment is isolated until maintenance or service work has been completed.
- Interoperability across operations systems to facilitate decision making responding to incidents.
- Management of plant changes.
Tag Out

- Automatically find all blinds and block valves to isolate equipment for maintenance or emergency shutdown
Intrinsically safe equipment and wiring shall not be capable of releasing sufficient electrical or thermal energy under normal and abnormal conditions to cause ignition of a specific atmospheric mixture in its most easily ignited concentration.
Work Process

1. Define the IS Circuit
2. Enter the circuit data for hazardous, non-hazardous devices and cables
3. Perform the calculation and validate the results based on your physical design
4. Report
Intrinsically Safe Calculation Results

### Non-hazardous area loop components

<table>
<thead>
<tr>
<th>Type</th>
<th>Value (Unit)</th>
</tr>
</thead>
<tbody>
<tr>
<td>R1 (Resistance)</td>
<td>300.00 ohm</td>
</tr>
<tr>
<td>L1 (Inductance)</td>
<td>4.20 mH</td>
</tr>
<tr>
<td>C1 (Capacitance)</td>
<td>0.34 μF</td>
</tr>
<tr>
<td>Vmax (Open circuit voltage)</td>
<td>28.0 V</td>
</tr>
<tr>
<td>Imax (Short circuit current)</td>
<td>93.0 mA</td>
</tr>
<tr>
<td>Pmax (Power)</td>
<td>0.6 W</td>
</tr>
<tr>
<td>L/R</td>
<td>0.05 mH/ohm</td>
</tr>
</tbody>
</table>

### Hazardous area loop components

<table>
<thead>
<tr>
<th>Type</th>
<th>Value (Unit)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Certificate of approval</td>
<td>Baseefa</td>
</tr>
<tr>
<td>Standard (IS)</td>
<td>IIC</td>
</tr>
</tbody>
</table>

#### Intrinsically Safe Calculation Results

- **Permissible**
  - Rmax: 100.00 ohm
  - Cmax: 0.24 μF
  - Lmax: 2.20 mH

- **Limit**
  - Resistance: 0.44 ohm
  - Capacitance: 0.00 μF
  - Inductance: 0.01 mH

- **Maximum permissible length 'A' limited by**
  - Resistance: 1260.32 meter
  - Capacitance: 1312.50 meter

- **The resistance limits the permissible length of cable A**
  - Maximum permissible length: 1260.32 meter
  - Actual length: 300.00 meter
Intrinsically Safe Calculation Report

### Area Classification
IS Certified FM/IEC

#### Hazardous Area
- Instrument
- MTL 700
- FCX Series

#### Non-Hazardous Area
- Safety Device
- MTL 700

### Calculation:
1. Resistance: 1260.32 meter
2. Inductance: 3000.75 meter
3. Capacitance: 1312.50 meter

### Final Result:
The resistance limits the permissible length of cable A <= 1260.32 meter
Example of SIF (1), Part of SIS 67SIS101

SIF: 1
GROUP: 67SIS101
DESCRIPTION: 67F-1 FLAME FAILURE.
TARGET SIL: 1

TYPICAL SIL VERIFICATION MODEL DIAGRAM FOR THIS SIF

SENSOR → LOGIC SOLVER → 2oo2 → 3oo3 → ISOLATOR → SOLENOID VALVE → 1oo2
SENSOR → ISOLATOR → SOLENOID VALVE → 1oo2
RELAY → MCB

SHUTOFF VALVE
SHUTOFF VALVE
SHUTOFF VALVE
SHUTOFF VALVE
Safety in the Engineering Enterprise
Additional Solution Scenarios

**Process Safety**
- Pipe line verification
- Design Review rules (straight pipe length before e.g. measuring items)
- Relieve vale management
- Spacing rules
- Pipe Stress Analysis
- Equipment failure analysis
- Lock-out Tag-Out

**Personnel Safety**
- Spacing rules
- Permit Management
- Location tracking
- Resource Management

**Facility Safety**
- None Conformities and Waivers
- Back-up Systems
- Fire Proofing
- Drilling compliance management

**Environmental Safety**
- Leak management
- HAZOP
- Containment design
- Impact studies

More……………………..
The cost of Safety can be high if not addressed early on.

We can lower the cost of Safety in the design with the rules based design solutions.

Capture lessons learned in rules.

Use SmartPlant Enterprise solutions, with the inbuilt rules to help make the right decisions throughout the facility lifecycle.

Be pro-active with safety
- Design it into the plant
- Make it part of the culture
- Share lesions learned in a corporate knowledgebase

Rules based design provides the possibility for safer / lower risk plants in operations.

Possible high cost and risks if not safe.

SmartPlant Enterprise can help lower the cost of safety.
DESIGN SAFETY INTO YOUR PLANT
WITH SMARTPLANT ENTERPRISE