Does My MOC Affect Relief or Flare System Design?

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Safety Preamble

“It should not be necessary for each generation to rediscover the principles of process safety which the generation before discovered. We must learn from the experience of others rather than learn the hard way. We must pass on to the next generation a record of what we have learned.”

- Jesse C. Ducommun
  Safety Pioneer
Objectives

- Background
- Observations
- MOC Examples
- Proposed Workflow/Checklist
- Conclusions
Purpose

- Improperly controlled change leads to poor process safety information (PSI), which can lead to safety, economic, and environmental consequences.
Purpose

- Improperly controlled change leads to poor process safety information (PSI), which can lead to safety, economic, and environmental consequences.

- How do changes in a facility impact flare and relief systems design & documentation?
Background

• What is Management of Change (MOC)?
Background

• What is Management of Change (MOC)?
  ➢ One of the 14 elements of Process Safety Management (PSM) per OSHA 29CFR1910.119
  ➢ OSHA 29CFR1910.119(l)(1)
  ➢ “The employer shall establish and implement written procedures to manage changes (except for “replacements in kind”) to process chemicals, technology, equipment, and procedures; and, changes to facilities that affect a covered process.”
Process Safety Management

PSM compliance

- Mechanical Integrity
- Employee Participation
- Mgmt. of Change (MOC)
- Training
- Emergency Planning & Response
- Pre-Startup Safety Review
- Process Safety Information
- Compliance Audit
- Operating Procedures
- Hot Work Permit
- Process Hazard Analysis
- Contractors
- Trade Secrets
- Incident Investigation

Does My MOC Affect Relief or Flare System Design?
Background

• MOC Items can impact many areas of PSM, including:
  ➢ Process Hazards Analysis
  ➢ Process Safety Information
    ➢ Relief System Design and Design Basis
Background – Relief System Design 101

• Relief System Design and Design Basis §(d)(3)(i)(D)
Does My MOC Affect Relief or Flare System Design?

Background – Relief System Design 101

- Relief System Design and Design Basis §(d)(3)(i)(D)
  - Requirements are in API STD 521, API STD 2000, etc.
  - The purpose is to prevent or reduce harm to personnel, equipment, and the environment
Background – Relief System Design 101

• Relief System Design and Design Basis §(d)(3)(i)(D)
  ➢ Requirements are in API STD 521, API STD 2000, etc.
  ➢ Analysis includes:
    ➢ 1. Identifying equipment to be protected.
    ➢ 2. Identifying applicable overpressure/underpressure scenarios.
    ➢ 3. Quantifying relief loads for applicable scenarios.
    ➢ 4. Designing or determining adequacy of relief devices.
Background – Relief System Design 101

• Relief System Design and Design Basis §(d)(3)(i)(D)
  ➢ Relief devices may include:
    ➢ Pressure Safety/Relief Valves
    ➢ Conservation Vents
    ➢ Rupture Disks
    ➢ Open Vents, etc.
Background – Relief System Design 101
## Background – Relief System Design 101

### API STD 521 Overpressure Scenarios

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Cause</th>
</tr>
</thead>
<tbody>
<tr>
<td>Closed outlets</td>
<td>Abnormal process heat or vapor input</td>
</tr>
<tr>
<td>Cooling failure to condenser</td>
<td>Heat transfer equipment failure</td>
</tr>
<tr>
<td>Top-tower reflux failure</td>
<td>Internal explosions or transient pressure surges</td>
</tr>
<tr>
<td>Side-stream reflux failure</td>
<td>Chemical reaction</td>
</tr>
<tr>
<td>Lean-oil failure to absorber</td>
<td>Hydraulic expansion</td>
</tr>
<tr>
<td>Accumulation of noncondensables</td>
<td>Exterior fire</td>
</tr>
<tr>
<td>Entrance of highly volatile material</td>
<td>Power failure</td>
</tr>
<tr>
<td>Overfilling</td>
<td>Maintenance</td>
</tr>
<tr>
<td>Failure of automatic controls</td>
<td></td>
</tr>
</tbody>
</table>
Background – Relief System Design 101

• Closed Outlets/Failure of Automatic Controls/Inadvertent Valve Operation:
  ➢ Generally may result in overpressure if upstream pressures can exceed the maximum allowable working pressure (MAWP) or if there is heat input
Background – Relief System Design 101

• Heat Transfer Equipment Failure (Tube Rupture):

  ➢ Generally may result in overpressure if high pressure side of an exchanger normal operating pressure exceeds the (MAWP) of the low pressure side.
Background – Relief System Design 101

• Power/Cooling/Steam failure:
  ➢ Generally may result in overpressure if the combination of upsets to feed, heat input, cooling, and outlets would result in an accumulation of matter/energy in the equipment.
Background – Relief System Design 101

• Exterior Fire:
  ➢ Heat input from a pool fire is generally considered an applicable overpressure scenario for ASME Sec VIII equipment with some exceptions.
Background

• Relief System Design and Design Basis §(d)(3)(i)(D)

• Safety Impact

  ➢ Lack of accurate Process Safety Information (PSI) may result in flawed Process Safety Management (PSM) and Process Hazards Analysis (PHA)

  ➢ Unidentified Hazards
Background

• Relief System Design and Design Basis §(d)(3)(i)(D)
• Environmental Impact
  ➢ Unnecessary Flaring
  ➢ Equipment or Piping Failure
  ➢ Release of Toxic or Flammable Materials
Background

- Relief System Design and Design Basis §(d)(3)(i)(D)
- Economic Impact
  - Property Damage
  - Loss of Revenue and Business Opportunities
  - Non-compliance Citations
Observations

• Facility changes affect process safety information (PSI)
• PSI changes affect relief and flare systems
Observations

• Facility changes affect process safety information (PSI)
• PSI changes affect relief and flare systems
• Often, PSI is not updated
• Why?
Observations

• Facility changes affect process safety information (PSI)
• PSI changes affect relief and flare systems
• Often, PSI is not updated
• Why?
  ➢ Lack of process safety resources or inefficient methods
  ➢ Nuances in relief and flare systems design not widely known
Observations

Where have you observed deficiencies in identifying the impact of MOC’s on relief systems design/documentation?
MOC Example #1

Pump Impeller

P-1

FV-1

NC

PSV-1

V-1
MOC Example #1

Pump Impeller

Maximum Discharge Pressure
• Blocked Outlet Applicability & Relief Rate

Maximum Discharge Pressure
• Blocked Outlet Applicability & Relief Rate
MOC Example #1

Pump Impeller

Maximum Discharge Pressure
  • Blocked Outlet Applicability & Relief Rate

Normal Discharge Pressure
  • Control Valve Failure/Inadvertent Bypass Valve Operation Applicability & Relief Rate
MOC Example #2
Operating Pressure

MAWP (S): 50 psig
MAWP (T): 100 psig

V-51
MAWP: 100 psig

PSV-51
100 psig

P_{\text{norm}} = 48 \text{ psig}
MOC Example #2

Operating Pressure

Change normal operating pressure from 48 psig to 60 psig

\[
p_{\text{norm}} = 48 \text{ psig}
\]

\[
V-51 \quad \text{MAWP: 100 psig}
\]

\[
E-51 \\
\text{MAWP (S): 50 psig} \\
\text{MAWP (T): 100 psig}
\]
MOC Example #2

Operating Pressure

Change normal operating pressure from 48 psig to 60 psig

- No issue for PSV-51 system, but results in potential applicable tube rupture scenario for E-51 (S)

![Diagram showing PSV-51, V-51 with MAWP 100 psig, and E-51 with MAWP (S): 50 psig, MAWP (T): 100 psig]
MOC Example #3

Liquid Level

- **V-41**
  - MAWP: 300 psig
- **V-42**
  - MAWP: 150 psig
- **PSV-41**
  - PSV: 300 psig
- **PSV-42**
  - PSV: 150 psig
- **FV-41**
- **P_{norm} = 260 psig**
MOC Example #3
Liquid Level

Increase LL in V-41

\[ P_{\text{norm}} = 260 \text{ psig} \]

V-41
MAWP: 300 psig
PSV-41
300 psig
FV-41

V-42
MAWP: 150 psig
PSV-42
150 psig
MOC Example #3

Liquid Level

Increase LL in V-41

- Increase external fire required relief rate

\[ P_{\text{norm}} = 260 \text{ psig} \]

V-41
MAWP: 300 psig

PSV-41
300 psig

V-42
MAWP: 150 psig

PSV-42
150 psig
MOC Example #3

Liquid Level

Increase LL in V-41

- Increase external fire required relief rate
- May affect relief load phase during gas-blowby

V-41
MAWP: 300 psig

FV-41
PSV-41
300 psig

PSV-42
150 psig

P_{\text{norm}} = 260 \text{ psig}
MOC Example #4

Electrical Line-up

![Diagram of a process flow with labels including:
- C-71 MAWP: 160 psig
- V-71 MAWP: 160 psig
- PSV-71 150 psig
- P-71 MAWP: 160 psig
- E-71 MAWP: 200 psig
- P-72
- P-73
- P-74
- 400# Steam
- E-72 MAWP (S): 200 psig
- MAWP (T): 200 psig
- To Flare]
MOC Example #4

Electrical Line-up

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<td>Bus A</td>
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<tr>
<td>P-72</td>
<td>Reboiler</td>
<td>Bus A</td>
</tr>
<tr>
<td>P-73</td>
<td>Reflux</td>
<td>Bus A</td>
</tr>
<tr>
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<td>Distillate</td>
<td>Bus A</td>
</tr>
<tr>
<td>E-71</td>
<td>Condenser</td>
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- **C-71**: MAWP: 160 psig
- **V-71**: MAWP: 200 psig
- **PSV-71**: 150 psig
- **E-71**: MAWP (S): 200 psig
- **E-72**: MAWP (T): 200 psig
- **400# Steam**

**To Flare**

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MOC Example #4

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Current applicability of Bus A Partial Power Failure (PPF)?
MOC Example #4

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Current applicability of Bus A Partial Power Failure (PPF)?

Change electrical line-up of P-72 to Bus B
MOC Example #4

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Current applicability of Bus A Partial Power Failure (PPF)?

Change electrical line-up of P-72 to Bus B

- Applicability of Bus A PPF?
- How might this impact your flare system design?
Observations

Is it possible your facility has not captured the impact of some of the MOC’s on relief and flare system design and documentation?
Observations

Is it possible your facility has not captured the impact of some of the MOC’s on relief and flare system design and documentation?

What are your plans to improve your Process Safety Management systems?
MOC Workflow & Checklist

• Identifies when relief systems documentation needs to be updated
MOC Workflow & Checklist

• Identifies when relief systems documentation needs to be updated
• Compiled based on input from relief and flare systems experts
MOC Workflow & Checklist

- Identifies when relief systems documentation needs to be updated
- Compiled based on input from relief and flare systems experts
- Contains lesser-known changes that may impact relief systems design
MOC Workflow & Checklist

• Includes auditing process steps
MOC Workflow & Checklist

- Includes auditing process steps
- Includes steps to check commonly missed impacts to relief systems documentation in other systems
MOC Workflow & Checklist

• Advantages to Workflow & Checklist
  ➢ Efficient
  ➢ Systematic
  ➢ Intuitive screening method
  ➢ Reduces reliance on relief and flare systems experts
MOC Workflow & Checklist

• Advantages to Workflow & Checklist
  ➢ Efficient
  ➢ Systematic
  ➢ Intuitive screening method
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• Sound engineering judgment
MOC Workflow & Checklist

Full workflow and paper available via e-mail: achilles.arnaez@smithburgess.com
Does My MOC Affect Relief or Flare System Design?

MOC Workflow & Checklist

- What does the MOC affect?
- Equipment / Facilities
  - Process Chemicals / Technology / Procedures
    - Is the Process Chemical / Technology / Procedures Change on the Relief and Disposal System MOC Checklist or is similar?
      - YES → Update Relief System Design and Documentation
      - NO → Perform Audit with Support from Subject Matter Expert to Verify no Update to Relief System Documentation is Needed
    - NO → Per the Audit, are any Updates to Relief System Documentation Needed?
      - YES → Perform Audit with Support from Subject Matter Expert to Verify no Update to Relief System Documentation is Needed
      - NO → END
    - YES → Update Relief System Documentation

- Time current Relief System Documentation Sourcing for any upstream or downstrme Relief System Documentation
  - Does the Current Relief System Contain any Exchanges?
    - YES → Update Upstream / Downstream Relief System Design and Documentation
    - NO → END

- For the Audit, are any Updates to Relief System Documentation Needed?
  - YES → Perform Audit with Support from Subject Matter Expert to Verify no Additional Updates to Relief (Disposal) System Documentation is Needed
  - NO → END

† Based on your professional experience, your Subject Matter Expert may be consulted during any of these steps if needed.

* Updates may involve re-evaluation of the Relief / Disposal System Documentation and may require additional information. Risk Management and Mitigation Plans may also need to be developed.
MOC Workflow & Checklist

**Column “A”: Process Chemicals / Technology / Procedures**

- Change in the unit charge rate
- Change in the feed stock composition
- New chemistry, or changes to chemistry of existing process
- Introduce new feedstocks, catalysts, chemicals, product streams, or new process sequence
- Changes to the process that could affect flows, pressures, compositions or changes involving the erosive, corrosive or toxic nature of the stream
- Set point change (level, pressure, temperature, flow)
- Change material in tank or increase tank throughput
- Change in flare system seal gas pressure

**OPERATION:**

- Change to the basic mode of unit operation (including new or modified feed to the unit)
- Changes to equipment operating or maintenance procedure
- Change to safe operating limits or require operating outside of the approved operating envelope
- Change in inventory of any vessel or exchanger
- Change to car-well/lock valves
- Change in electric or steam driven for a pump, compressor, etc.
- Change in minimum turnaround for the unit
- Change in sparing of equipment (i.e. pumps/compressors)
- Change in operation of control valves/bypass valves
- Change in flare line-ups or staging

**INSTRUMENTATION:**

- Addition, modification, or demolition of control valves, alarms, interlocks and other instrumentation
- Changes to instrumentation operating or maintenance procedure
- Change in actuator mechanism/motive fluid (i.e. instrument air to nitrogen)

**UTILITIES:**

- Utility operating condition changes
- Change in utility line-up (i.e. switching a LP steam user to a HP steam user or CW user to BFW user)
- Addition/Upgrading of firefighting equipment and/or drainage
- Electrical changes (pre-line information)

**Column “B”: Equipment / Facilities**

**RELIEF SYSTEM EQUIPMENT:**

- Addition, modification, or demolition of relief device (not including replacement in-kind)
- Change in relief device capacity (orifice size, etc.)
- Change in relief device discharge location
- Change in relief device manufacturer or model
- Change in relief device sub-type (i.e. conventional to bellows)
- Change in relief device set pressure or blowdown setting
- Change to relief device piping
- Change in sparing of relief devices
- Addition, modification, or demolition of flares, knockout drums, seal drums, and other disposal system equipment

**PROCESS EQUIPMENT:**

- Addition, modification, repurpose, relocation, or demolition of process equipment (not including replacement in-kind)
- Revision of vessel design code
- Revision of hydrotest pressure / MAWP or change in design pressure / temperature
- Change in piping connections to machinery that could affect alignment or pressure profile
- Increased/Decreased heat transfer surface area of heat exchanger
- Reduction/Addition of heat exchangers in series
- Change in tube metallurgy, tube size, or tube length
- Movement of internal weir in a vessel
- Removal/installation of fireproof insulation
- Change of restriction office plate size
- Change floating roof on a tank
- Changes to location of equipment

**ROTATING EQUIPMENT:**

- Addition, modification, or demolition of rotating equipment (not including replacement in-kind)
- Changes to machinery component design, materials or manufacturer (pumps, compressors, etc.)
- Changes of performance capability of equipment
- Changes of driver size (motor, turbine, engine)
- Change to the pump impeller size
- Change in electric or steam driven for a pump, compressor, etc.

**INSTRUMENTATION:**

- Addition, modification, or demolition of control valves, alarms, interlocks and other instrumentation
- Change of control valves or bypass valves (including valve size, trim, or failure position)
- Change in actuator mechanism/motive fluid (i.e. instrument air to nitrogen)
- Change to safety critical instrumentation

**UTILITIES:**

- Addition, modification, or demolition of electrical equipment
- Changes to electrical line-ups
- Change in utility line-up (i.e. switching a LP steam user to a HP steam user)
- Changes to utility equipment (cooling water systems, steam systems, etc.)
MOC Workflow

START

What does the MOC affect?

Column “A” Process Chemicals / Technology / Procedures

A

Column “B” Equipment / Facilities

B

Based on your professional experience, your Subject Matter Expert may be consulted during any of these steps if needed.

Updates may involve re-evaluation of the Relief / Disposal System Documentation and may require additional information. Risk Management and Integration Plans may also need to be developed.
Does My MOC Affect Relief or Flare System Design?
Checklist Examples

Relief System Equipment

- Addition, modification, or demolition of relief device (not including replacement in-kind)
- Change in relief device capacity (orifice size, etc.)
- Change in relief device discharge location
- Change in relief device manufacturer or model
- Change in relief device sub-type (i.e. conventional to bellows)
- Change in relief device set pressure or blowdown setting
- Change to relief device piping
- Change in sparing of relief devices
- Addition, modification, or demolition of flares, knockout drums, seal drums, and other disposal system equipment
Checklist Examples

Operation
- Change to the basic mode of unit operation (including new or modified feed to the unit)
- Changes to equipment operating or maintenance procedure
- Change to safe operating limits or require operating outside of the approved operating envelope
- Change in inventory of any vessel or exchanger
- Changes to car-seal/lock valves
- Change in electric or steam driver for a pump, compressor, etc.
- Change in minimum turndown for the unit
- Change in sparing of equipment (i.e. pumps/compressors)
- Change in operation of control valve bypass valves
- Change in flare line-ups or staging
MOC Workflow

* Update Relief System Design and Documentation

Is the current Relief System a limiting Pressure Source for any upstream or downstream Relief System Documentation?

YES

* Update Upstream / Downstream Relief System Design and Documentation

NO

E

* Based on your professional experience, your Subject Matter Expert may be consulted during any of these steps if needed.
* Updates may involve re-evaluation of the Relief / Disposal System Documentation and may require additional information. Risk Management and Mitigation Plans may also need to be developed.
MOC Workflow

Does the Current Relief System Contain any Exchangers?

- **YES**: Update Relief System Documentation of the other side of Exchangers that are in the Current System.
- **NO**

*Based on your professional experience, your Subject Matter Expert may be consulted during any of these steps if needed.*
*Updates may involve re-evaluation of the Relief / Disposal System Documentation and may require additional information. Risk Management and Mitigation Plans may also need to be developed.*
MOC Workflow

1. Is the current Relief System Discharging to a Common Disposal System (e.g., Flare, Vent Header)?
   - NO: G
   - YES: Update Disposal System Documentation

   * Based on your professional experience, your Subject Matter Expert may be consulted during any of these steps if needed.
   * Updates may involve re-evaluation of the Relief System Documentation and may require additional information. Risk Management and Mitigation Plans may also need to be developed.

2. END
MOC Workflow

1. Perform Audit with Support from Subject Matter Expert to Verify No Additional Update to Relief/Disposal System Documentation is Needed.

2. Per the Audit, are any Additional Updates to Relief Disposal System Documentation Needed?
   - NO → END
   - YES → Update Relief System Design and Documentation

* Based on your professional experience, your Subject Matter Expert may be consulted during any of these steps if needed.

* Updates may involve re-evaluation of the Relief / Disposal System Documentation and may require additional Information, Risk Management and Mitigation Plans may also need to be developed.
Conclusions

• Importance of evergreen process safety information (PSI)

• Difficulty of identifying impact of MOC’s on relief and flare system design

• Proposed workflow to improve process safety management (PSM)
"Does My MOC Affect Relief or Flare System Design"

For more information, please contact us:

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