How to measure status of PSM using the RBPS model

CCPS Workshop: Nice, September 29, 2015

Mick Pelupessy, Nico Mulder
Contents of this presentation

1. Introduction AkzoNobel Industrial Chemicals
2. Process Safety project overview
3. Initiative phase: defining the project
4. Base Lining phase: methods and results
5. Implementation phase: integrating with company program
6. Observations halfway down the Industrial Chemicals project
Industrial Chemicals in the value chain

- Salt
- Energy
- Chlorine
- Caustic lye
- Hydrogen
- Monochloroacetic acid
- Chloromethanes
- Hydrochloric acid
- Sodium hypochlorite
- Iron Chloride
- Ecosel® additives
- Pharmaceutical Salt
- Jozo
- Nezo
- Broxo
- KNZ licks
- Suprasel
- Sanal
Industrial Chemicals

- Businesses: Industrial Salt, Salt Specialties, Chlor-Alkali, MonoChloro Acetic acid
- 13 plants at 8 production sites (The Netherlands, Germany, Denmark, China)
- Research centre and staff offices in The Netherlands
- Approximately 1700 employees
## Process Safety project within Industrial Chemicals

**Phase 0: Initiative**

- *Pilots at plants* (2011-12)
  - In-house project team (4 FTEs): mix of expertise
  - Selected an overall reference grid (industry standard)
  - Defined set of achievement level criteria (proprietary)

**Phase 1: Base Lining**

- *Project activity* (2013-14)
  - Determined starting position for each plant
  - Improvement options and recommendable practices
  - Identification of issues that merit a joint approach

**Phase 2: Implementation**

- *Project activity* (2014-16)
  - Addressing gaps revealed during Base Lining
  - Guidance, standardization, sharing best practices
  - Embedding PSM in the plants governance structure

**Phase 3: Assurance**

- *Ongoing activity* (≥ 2016)
  - Verifying and ensuring that Process Safety remains sustainably embedded in the organization
  - Harmonization with other HSE and audit programs
A. Commit to Process Safety (5)
words, actions, demonstration, support

B. Understand Hazard and Risk (2)
what could go wrong, how badly, how often?

C. Manage Risk (9)
measures and resources to control the risks

D. Learn From Experience (4)
capture and apply lessons learned

Risk Based Process Safety model
(as per Centre for Chemical Process Safety)
A reference grid of 20 elements in 4 groups
Phase 0 – Initiative
Achievement level definition

Overall objective: sustainable process safety performance

Level 1: Basics
Minimum requirements are met
/tcp activity oriented

Level 2: Stability and Management
Instructions, procedures and RASCI are in place
/tcp work process oriented

Level 3: Sustainability
Improvement loops are effective
/tcp system oriented

Overall objective: sustainable process safety performance
Phase 1 - Base Lining *(completed)*: Assessing each plant’s starting position

**Inputs:**
- Risk Based Process Safety model (20 elements)
- Practices
- Procedures & instructions
- Policies

**Outputs:**
- Outcome of protocol (graphics)
- Level 1 gaps
- Level 2 and 3 improvement recommendations
- Recommendable practices

**Resources:**
- Interviewers *(Process safety team)*
- Interviewees *(Plant staff)*

**PSM Baselining** *(2-3 weeks per plant)*
- assessing documents
- interviewing
- fact checking
- case studies

**Base Lining criteria:**
- RBPS (CCPS) protocol questions
- Additional AkzoNobel protocol questions
- Interviewers expertise
- Achievement level definitions per element

**Reference criteria:**
- External standards
- AkzoNobel policies & standards
- Industry best practices
- Achievement level ladder

**Controls**
Example of result for a plant/site: Spider format: levels achieved

Note: fictive score
Example of result for a plant/site:
Temple format: score per level

Process Safety Management System

Level 3
- 54%
- 67%
- 46%
- 67%
- 86%
- 80%
- 40%
- 64%
- 29%
- 67%
- 71%
- 96%
- 40%
- 40%
- 40%
- 90%
- 70%
- 50%
- 20%
- 20%

Level 2
- 90%
- 80%
- 73%
- 80%
- 100%
- 79%
- 68%
- 90%
- 90%
- 95%
- 100%
- 90%
- 88%
- 82%
- 63%
- 88%
- 65%
- 53%
- 50%
- 38%

Level 1
- 100%
- 100%
- 100%
- 100%
- 100%
- 100%
- 100%
- 100%
- 100%
- 100%
- 100%
- 100%
- 92%
- 100%
- 100%
- 100%
- 100%
- 76%
- 100%
- 100%
- 100%

4 Process Safety Culture
5 Compliance With Standards
6 Process Safety Competence
7 Workforce Involvement
8 Stakeholder Outreach
9 Process Knowledge Management
10 Hazard Identification & Risk Analysis
11 Operating Procedures
12 Safe Work Practices
13 Asset Integrity & Reliability
14 Contractor Management
15 Training & Performance Assurance
16 Management of Change
17 Operational Readiness
18 Conduct of Operations
19 Emergency Management
20 Incident Investigation
21 Measurement & Metrics
22 Auditing
23 Mngt Review & Cont. Improvement

Note: fictive score
Example of result for a plant/site:

Spider format: levels achieved

Note: fictive score
Result overview for several plants:

*How to define the path forward* ……?

Note: fictive scores
Phase 2 - Implementation
Aggregated results - all plants: which elements require focus

<table>
<thead>
<tr>
<th>RBPS Elements</th>
<th>Number of recommendations per RBPS element,</th>
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<tbody>
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Commit to Process Safety
Understand Hazards and Risk
Manage Risk
Learn from Experience

Focus for PSM-team

Note: fictive data

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Commit to Process Safety
Understand Hazards and Risk
Manage Risk
Learn from Experience

Focus for PSM-team

Note: fictive data
Aggregated results - all plants: *elements covered in other (HSE) programs*

### Management program

<table>
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<th>Element</th>
<th>Total recommendations</th>
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<td>Understand Hazards and Risk</td>
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<td>Management Review &amp; Continuous Improvement</td>
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### RBPS Elements

<table>
<thead>
<tr>
<th>Element</th>
<th>Total recommendations</th>
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<td>General HSE Program</td>
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<td>Total number of recommendations per element</td>
<td>Note: fictive data</td>
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HSE common platform

transition from PSM project to PSM program

General context

• Industrial incidents have resulted in increased focus on process safety, by companies and industry associations as well as by regulators

• Although Process Safety Management does help manufacturing sites in meeting legal requirements, it has also gained the status of an essential operational excellence tool

AkzoNobel context

• AkzoNobel has defined 3 core HSE programs: People, Process and Product Safety

• The overall Process Safety program (approved by Executive Committee early 2014):
  - provides a common framework for all manufacturing operations (Chemicals as well as Coatings), compatible with major Process Safety legislation
  - foresees phased implementation at individual sites, based on process hazard rating

• Industrial Chemicals, with its potentially hazardous bulk operations, has taken the lead in in shaping a practical approach to Process Safety Management (initiative started in 2010)
Shaping a PSM model to match with existing policies, systems and practices

“A Process Safety Management system should address all twenty elements.

However, the PSM system need not be a stand-alone system with twenty sections exactly labeled as per RBPS definitions.

Where appropriate existing plant management systems can be used.”
Shaping a PSM model to match with existing policies, systems and practices

Objective: enhanced alignment of Process Safety program with the AkzoNobel Safety Common Platform
Switch to AN management systems
Integration in HSE building

Project Levels:

- **1**
  - Meeting all basic requirements

- **2**
  - Procedures RASCI's

- **3**
  - Improvement loops effective

Program levels:

- **Informal**
  - <60 %

- **Functional**
  - 60 – 80%

- **Integrated**
  - 80 – 90%

- **Leading**
  - >90 %

- **High Hazard Target**
  - 100 – 120%

Additional level to ensure High Integrity

- **BU Industrial Chemicals ‘Add On’**

- **Analysis shows project going beyond AkzoNobel program scope**

- **AkzoNobel program covers a broad range of plants - range: Low Hazard/High Hazard**

- **Base Lining effort not suitable for Low Hazard operations (1800 questions)**

- **High Hazard sites are subject to more stringent legal requirements**

CCPS Workshop Nice 2015 - 2812  18
**Switch to AN management systems**  
*Integration in HSE building*

<table>
<thead>
<tr>
<th>Project Levels:</th>
<th>Program levels:</th>
</tr>
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<tbody>
<tr>
<td>3</td>
<td>Improvement loops effective</td>
</tr>
<tr>
<td>2</td>
<td>Procedures RASCIs's</td>
</tr>
<tr>
<td>1</td>
<td>Meeting all basic requirements</td>
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<table>
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<td>High Hazard Target</td>
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<tr>
<td>Leading</td>
<td>&gt;90%</td>
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<tr>
<td>Integrated</td>
<td>80 - 90%</td>
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<tr>
<td>Functional</td>
<td>60 – 80%</td>
</tr>
<tr>
<td>Informal</td>
<td>&lt;60%</td>
</tr>
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</table>

- AkzoNobel PSM Program based on CCPS RBPS Elements
- Base Lining results have been translated to AkzoNobel Program Requirements
- PSM Program scan results serve to monitor project progress
- Improvement reported quarterly
Targets for High Hazard(*) and Medium Hazard plants

A proposed timing

<table>
<thead>
<tr>
<th>Project Levels:</th>
<th>Program levels:</th>
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<tr>
<td>3 Improvement loops effective</td>
<td>HHP: all BBs at “HHT” by end 2016</td>
</tr>
<tr>
<td>2 Procedures RASCI’s</td>
<td>MHP: all BBs at “HHT” by end 2017</td>
</tr>
<tr>
<td>1 Meeting all basic requirements</td>
<td>HHP: all BBs at “leading” by mid 2016</td>
</tr>
<tr>
<td></td>
<td>MHP: all BBs at “leading” by mid 2017</td>
</tr>
<tr>
<td></td>
<td>MHP: all BBs at “integrated” by mid 2016</td>
</tr>
<tr>
<td></td>
<td>HHP: all level 1 actions completed end 2015</td>
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<tr>
<td></td>
<td>MHP: all level 1 actions completed end 2015</td>
</tr>
</tbody>
</table>

(*) based on inventory of (highly) hazardous chemicals
Observations halfway down the PSM project at Industrial Chemicals

• **Process Safety is where Production, Asset Management and HSE meet:**
  – This process safety project has allowed project team as well as plants to get to grips with the complexity of Process Safety Management within an ongoing business
  – Risk of overloading plants with simultaneous programs by above stakeholder groups:
    ‡ *alignment of the various programs is essential to maintain focus*

• **Essential elements for the Base Lining phase have been:**
  – In-house expert team
  – The use of a management system model that can easily be understood
  – “Plant friendly” interviewing methods: discussing rather than auditing
  – Scoring per achievement level in order to enable prioritization

• **Essential elements for the implementation phase are:**
  – Assign local champions for the various process safety management elements
  – Providing central guidance documents and tools for issues that affect several plants
  – Promoting cross fertilization between plants: networking and sharing best practices
Much more could be said on managing Process Safety

Some guidance documents are listed below

Introduction/overview:
Article “Understanding Process Safety Management”
(Compiled by Adrian Sepeda for AIChE, 2010)

More detailed overview:
Brochure “Risked Based Process Safety Overview”
A summary of the risk based process safety (RBPS) management approach as detailed in “Guidelines for Risk Based Process Safety” : CCPS 2014

Comprehensive reference:
“Guidelines for Auditing Process Safety Management Systems” CCPS 2011

For managers’ awareness:
Book “Catastrophic Incident Warning Signs” : CCPS 2012
Back-up slides
### Maturity Levels

**General overview**

<table>
<thead>
<tr>
<th>ANIC Risk Based Process Safety maturity levels</th>
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<tbody>
<tr>
<td><strong>Maturity level 1</strong></td>
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<tr>
<td>&quot;Basics&quot;</td>
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**Descriptive summary**
- Maturity level 1: Effectively performing the required basic activities for process safety.
- Maturity level 2: Documenting how the required basic activities for process safety are to be carried out, and reporting and documenting the results.
- Maturity level 3: Evaluating the plants process safety performance and applying any verifying improvements to the local processes and systems.

**Criteria to achieve level**
- Maturity level 1: In compliance with previous level, on top of which:
  - The implementation of process safety is demonstrated by programs, tools, and documents.
  - The stability of process safety performance is demonstrated.
- Maturity level 2: In compliance with previous level, on top of which:
  - Sustainable embedding of activities for process safety that are within the plant's defined span of control is demonstrated.
  - Continuous improvement of the PSM system (including process safety indicators) in the plant is demonstrated.

**Orientation / Focus**
- Maturity level 1: Operating activities
- Maturity level 2: Documented work processes
- Maturity level 3: Systems and Controls

**Indicators / Criteria (for auditing use)**
- Maturity level 1: Outcome of interviews with staff and observations of plant staff operations
- Maturity level 2: Plant operational documents (procedure and instructions) and external audit documents
- Maturity level 3: Plant policies, internal memo documents, internal improvement plans, action tracking system

**Process Safety Management system characteristics**
- Maturity level 1: Consistent, coherent practices, knowledge, and competencies throughout the plant or site
- Maturity level 2: A basic system, largely describing PSM system at the plant or site, that covers most of the 36 elements in the system:
  - Risks are in place
  - KPIs are in place
  - Procedure is clearly defined and known
- Maturity level 3: Applicable to all 36 PSM elements:
  - Control loops have been defined
  - KPIs are managed actively
  - Improvement actions are allocated to personnel
  - Follow-up of actions is monitored
  - Management review and site auditing process are in place

**Process Safety leadership**
- Maturity level 1: Process safety expertise needs to be relocated outside the plant local organization on an ad hoc basis
- Maturity level 2: Process safety expertise is available within the plant organization
- Maturity level 3: All plant staff has been trained in process safety, and is aware of requirements

**Implementation degree**
- Maturity level 1: Practices in line with standards and regulations are present at plant level
- Maturity level 2: Written procedures and documentation are available at plant level appropriate for the standing organization
- Maturity level 3: Sustainable management systems at plant level
### Maturity Levels

#### Requirements per level

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<th>Maturity Level</th>
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<td>2</td>
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<td>5</td>
<td>Maturing</td>
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<td>6</td>
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<td>7</td>
<td>Maturity</td>
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#### Process Knowledge Management

- **Objective**: Maintain Process Safety Information current and complete.
- **Process Safety Information**
  - a) Written technical documents and specifications
  - b) Engineering documents and calculations
  - c) Specifications for design, fabrication and installation of process equipment
  - d) Other written documents such as materials safety data sheets

#### Hazard Identification & Risk Analysis

- **Identifying hazards and evaluating the risk of processes to make certain that risks to employees, the public, and the environment are consistently controlled within the organization's risk tolerance**
- **Risk Analysis** typically addresses three main aspects:
  - Hazard (What can go wrong?)
  - Consequences (How bad could it be?)
  - Likelyhood (How often might it happen?)
- This element also includes the requirement to manage and control the risks identified.

- **Initial Process Hazard Analysis (PHA)** has been performed.
- **PHA** is part of the Safety Report.
- **Authorities** have received/approved the Safety Report.
- **PHA recommendations** have been addressed properly.
- **PHA** is performed in cases of major changes.
- **Plant (site)** has access to knowledgeable PHA resources.

- **PHA** has been performed according to AN St 8 & Guidance Note 23.1 to 23.11.
- **Site** has local written PHA procedures.
- **PHA expertise** is available within the plant organization.
- **All disciplines** participate in PHA when required.
- **A PHA re-validation plan** exists; there may be a backlog in execution, but a closure plan has been agreed with authorities and realization is on track.

- **PHA validations** are revalidated at least every 5 years.
- **No backlog** in PHA planning.
- **PHA recommendations** are monitored periodically upon closure, and closure of recommendations is verified.
- **Several employees** from each discipline participate in PHA.
- **Procedures** contain criteria to trigger revalidation or redoing of PHA.
- **Management** reviews plant PHA status periodically.
A. Commit to Process Safety (5)
Cluster A: Commit to Process Safety:

words, actions, demonstration, support

1. **Process Safety Culture**  
   *Beliefs, behaviors, and customs that influence safety*

2. **Compliance with Standards**  
   *Maintaining and using an archive of applicable standards, codes, regulations and laws*

3. **Process Safety Competency**  
   *Ensuring that staff are able to consistently apply the appropriate information and knowledge for safe operations*

4. **Workforce Involvement**  
   *Active participation of company and contractor workers in Process Safety Management*

5. **Stakeholder Outreach**  
   *Engaging individuals or organizations that can be affected by the facility in a dialogue about process safety*
B. Understand Hazard and Risk (2)
Cluster B: Understand Hazard and Risk

what could go wrong, how badly, how often?

5. Process Knowledge Management

Making available technical information describing:
(1) the hazards of the chemicals in the process
(2) the technology of the process
(3) the equipment used in the process

6. Hazard Identification and Risk Analysis

Identifying hazards and evaluating the risk of processes to make certain that risks to employees, the public, or the environment are consistently controlled within the organization’s risk tolerance
C. Manage Risk (9)
Cluster C: Manage Risk (1)

measures and resources to control risks

8. **Operating Procedures**
   Written *instructions for routine activities*

9. **Safe Work Practices**
   *Work processes to manage risk of non-routine work*

10. **Asset Integrity and Reliability**
    *Assuring dependability of installed equipment, including critical safety or utility systems*

11. **Contractor Management**
    *Ensuring that contracted services support safe facility operations*

12. **Training and Performance Assurance**
    *Training = informative and practical education in tasks’ requirements and methods*
    
    *Performance assurance = ongoing verification that training can be applied in practical situations*
13. Management of Change
Review and authorization of proposed modifications to facility design, operations, organization or activities.

14. Operational Readiness
Verification that processes will be in safe condition before (re-)start.

15. Conduct of Operations
Pursue excellence in the performance of every task and minimize variations in performance.

16. Emergency Management
Planning for mitigation of possible emergencies.
D. Learn From Experience (4)
Cluster D: Learn From Experience

capture and apply lessons learned

17. Incident Investigation
   Process for reporting, tracking, and investigating incidents and near misses

18. Measurement and Metrics
   Performance and efficiency indicators
to monitor the effectiveness of the Process Safety program in near-real-time

19. Auditing
   Periodic systematic evaluation
whether management systems are performing as intended

20. Management Review and Continuous Improvement
   Ongoing “due diligence” review by management
that fills the gap between day-to-day work activities and formal periodic audits
## Assurance reviews:
*System based audit or topic based verification?*

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<th>ATEX</th>
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<th>Safety Instrumented Systems (IPF)</th>
<th>Integrity Operating Window</th>
<th>Life Saving Rules</th>
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