Offshore Facility Process Safety Systems Overview (SEMS – A New Paradigm)

Steven T. Maher, PE CSP
Ester M. Brawley-Roehl
Carlos D. Cheek

Risk Management Professionals
www.RMPCorp.com
877/532-0806
Key Topics

- 2010 Update – Offshore Facility Federal SMS Regulatory Framework
- Safety Management Systems & Regulatory Overlap
- Key SEMS/SEMP Elements
- Lessons Learned from Safety Management Systems Applications
- Offshore Protection Systems Evolution & Risk of High Consequence Events
- Regulatory Dynamics & Available SMS Resources Within Your Company
- Questions?
2010 Update – Offshore Facility
Federal SMS Regulatory Framework

• 2006/2009 – SEMS Concept / Proposed Rule
• 2010 – May 19 – MMS Restructuring Order 3299
• 2010 – May 27 – DOI Brief to the President
• 2010 – May 30 – Six-Month Moratorium on Deepwater (>500’) Drilling
• 2010 – June 8 – DOI Directive to Shallow Water (<500’) Drilling Operators
• 2010 – June 18 – DOI Directive on Blowout Prevention Requirements
• 2010 – June 22 – Preliminary Injunction of May 30 Moratorium
• 2010 – June – MMS Organization Transformation to BOEMRE (Bureau of Ocean Energy Management, Regulation, and Enforcement), with Appointment of Michael R. Bromwich
• 2010 – July 12 – Suspension of Deepwater Drilling Until As Late as November 30, 2010
• 2010 – Aug 04 – Macondo Well Static Kill Achieved – Following July 15 termination of oil flow directly into the GOM
2010 Update – Offshore Facility
Federal SMS Regulatory Framework

- 2010 – Aug 04 – Sep 13 – BOEMRE Public Forums in New Orleans, Mobile, Pensacola, Santa Barbara, Anchorage, Houston, Biloxi, and Lafayette
- 2010 – Sep 05-12 – Macondo Well BOP Recovered and Transported to NASA Michoud Facility for Analysis
- 2010 – Sep 08 – BP Released Investigation Report
- 2010 – Sep 08 – DOI Released Offshore Safety Board Report
- 2010 – Sep 19 – Final Kill of Macondo Well
- 2010 – Sep 30 – BOEMRE Press Release
  - Drilling Safety Rule ("drilling operations on the OCS")
  - Workplace Safety Rule ("operations in Federal waters")
- 2010 – Oct 12 – Decision to Resume Drilling
Today’s Focus = Workplace Safety Rule

- **Safety & Environmental Management System (SEMS) (30 CFR Part 250)**
  - **Applicability** – “…all OCS oil and gas and sulphur operations and the facilities under BOEMRE jurisdiction including drilling, production, construction, well workover, well completion, well servicing, and DOI pipeline activities.”
  - **Timeline** – Rule effective on November 15, 2010, with a SEMS Program to be in effect by November 15, 2011.
  - **Audits** – “An independent third-party or your designated and qualified personnel must conduct all SEMS audits;” “Audit documentation must be submitted to BOEMRE”
Safety Management Systems & Regulatory Overlap
Range of Offshore SMS Regulations/Guidelines

SEMS/SEMP
- 13 Primary SMS Elements

Safety Case
- SMS
- Risk Assessment & Quantification

Less Effort

Increased Effort, with Some Increased Benefits

RMP Risk Management Professionals
Key SEMS/SEMP Elements
SEMS/SEMP Elements

- General Provisions
- Safety & Environmental Information
- Hazards Analysis
- Management of Change
- Operating Procedures
- Safe Work Practices
- Training
- Mechanical Integrity
- Pre-Startup Review
- Emergency Response & Control
- Investigation of Incidents
- Audit of SEMS/SEMP Elements
- Records & Documentation
Lessons Learned from Safety Management Systems Applications
Key Program Upkeep Requirements
SEMS Key Periodic Requirements

• Every Five Years
  – Hazards Analysis (10-years for Low-Priority Facilities)

• Every Three Years (Triennial)
  – Refresher Training (Period Unspecified)
  – Audit of SEMS/SEMP Elements (3-year intervals, starting on the second year after initial SEMS program completion)

• Annual
  – Operating Procedures (Frequency Based on Degree of Hazard)
  – Emergency Action Plan (Period Unspecified)
SEMS Key Periodic Requirements

- **Non-Specific**
  - Safety & Environmental Information
  - MOC
  - Safe Work Practices
  - Mechanical Integrity
  - Pre-Startup Review
  - Incident Investigation

- **Non-Incidental Changes in Design or Operation!!**
Common Program Deficiencies
Common Deficiencies

- **Safety & Environmental Information (SEI)**
  - Process Flow Diagrams (PFDs) or Piping & Instrumentation Diagrams (P&IDs) are missing, not current, or not complete
  - SEI not properly filed, managed, or available
  - Relief system design or design basis not documented
  - Electrical area classifications not documented
Common Deficiencies

- **Hazards Analysis (HA)**
  - Five/Ten-year updates not done on-time
  - Recommendations not closed or closure not documented
  - Human factors not addressed in report
  - Accepted approach (e.g., API RP 14J) not used, or not used correctly
  - Inconsistent consideration of scenarios and risk-ranking

- **Management of Change (MOC)**
  - MOC Procedure not current or used
  - SEMS documentation not updated to reflect a change
Common Deficiencies

- **Operating Procedures (OP)**
  - Procedure outdated or periodic review not performed
  - Written procedures not synchronized with Operator actions
  - Key phases of operation not listed
  - Emergency shutdown procedure job assignments not clear
  - Temporary operations not included
  - Acceptable alarm setpoint range not documented
Common Deficiencies

- **Safe Work Practices (SWP)**
  - Employees not trained nor knowledgeable of the procedures
  - Safe work practices (e.g., LO/TO, HWP, Confined-Space Entry, Line Breaking) not followed (employees or contractors)
  - Activities are not documented and records kept on file
Common Deficiencies

• Training (TRN)
  – Documentation that demonstrates that training has been performed is not available
  – Personal protective equipment (PPE) procedures and training documentation not available or procedures not followed
  – Training records do not indicate the means used to verify that the employee understood the training
  – Training does not encompass maintenance procedures
Common Deficiencies

- **Mechanical Integrity (MI)**
  - Written procedures related to the ongoing integrity of the process not available, not complete, or not implemented
  - Inspections/maintenance are not occurring or inspection/maintenance frequency is not consistent with industry standards or best practices
  - Equipment deficiencies not corrected in a safe or timely manner
  - Facility relies on a Contractor and does not have a written preventive maintenance schedule that it is committed to
  - MI activity NOT DOCUMENTED!!
Common Deficiencies

- Pre-Startup Review (PSR)
  - Written procedures do not exist
  - Pre-Startup Review documentation is not completed or kept on file following implementation of the MOC procedure
  - Documentation is not completed, and signed-off, until after start-up
Common Deficiencies

- Emergency Response & Control (ER&C)
  - EAP – Not up-to-date
  - EAP – Phone numbers outdated
  - EAP – Usability
  - EAP – Periodic review not performed
  - Training
  - Physicals and fit testing
  - Emergency response equipment
Common Deficiencies

- Investigation of Incidents (II)
  - Incident investigations not done correctly
  - Lack of follow-through on recommendations
  - Findings not shared with affected employees
  - Incident investigation is not promptly initiated
  - No investigation or documentation of “near-misses”
Examples of “Near Misses”

• That liquid isn’t supposed to be in that tank. Oops, forgot that valve hidden beneath the deck plate.

• Relief valves relieving is not meant to be normal practice. A relief valve is not a pressure regulator, and this is a deviation from the design intent.

• ESD or BOP actuation is not a preferred normal shutdown mechanism.

• Fouling of equipment or repeated premature failure of controls and devices
Common Deficiencies

- Audit of SEMS/SEMP Elements (AUD)
  - Lack of follow-through on recommendations
  - Audit not completed by periodic deadline
  - Audit of program, but not supporting documentation

Most common program-wide deficiency: ADDRESSING RECOMMENDATIONS
Recommendation Follow-through Tips
Recommendation Follow-through

- Assign an individual responsible for following up on the recommendation.
- Assign a target completion date to each and every recommendation.
- Document the actions taken for addressing the recommendation, label it as “CLOSED,” and document the date of completion.
- Even if the facility performs all of the actions of their recommendations (i.e., installing sensors, labeling piping, etc.), if the documentation that originally stated the recommendation(s) is not updated; it is a deficiency.
Recommendation Follow-through

Generally-Accepted Bases for Declining Recommendations – Document, in writing and based upon adequate evidence, that one or more of the following conditions are true:

1) The analysis upon which the recommendation is based contains factual errors.

2) The recommendation is not necessary to protect the health and safety of employees and contractors.

3) An alternative measure would provide a sufficient level of protection.

4) The recommendation is infeasible.
Offshore Protection Systems
Evolution &
Risk of High Consequence Events
Focusing on the Objective
(The “Big Picture”)

- **RISK = PROBABILITY * CONSEQUENCES**
  - Probability = Likelihood of Occurrence
  - Consequences = Effects of Occurrence

- For Engineered Systems:
  - Risk = \( \sum P_i * C_i \)
Implications – Protection System Design

• Reminder:
  – If Risk is to be kept constant and Consequences increase, then
    • Scenario Likelihood must decrease
  – If Risk is to migrate lower over time & Consequences increase, then
    • Scenario Likelihood must decrease even further

• Protection system design and reliability is an integral part of
  maintaining risk below the acceptance threshold.

• What does this mean for safety system reliability for events
  involving ... ?
  – Large personnel consequences
  – Large environmental consequences
  – Large impacts on ports/harbors/shipping
Control/Protection System Spectrum – BPCS & SIS/HIPS

Increasing Reliability & Larger SIL (SIS-Only, ANSI/ISA-S84.01 & ANSI/ISA-S84.00.01)

- Smart Sensors
- Redundancy
- Diversity
- High Pedigree Devices
- Voting Logic

Decreased Cost  
Increased Redundancy, Diversity, Pedigree

BPCS = Basic Process Control System, SIS = Safety Instrumented System,  
HIPS – High Integrity Protection System
1990 Platform Safety Shut-Down System Effectiveness Study

- **Scope**
  - Type 3 Production Platforms – Stratfjord
  - Type 2 Production Platforms – GOM
  - Type 1 Production Platforms – Nigeria

- **Protection System Types** – Wide Range:
  - Pneumatic
  - Electronic

- **Findings – Dominant Risk Contributors**
  - End-Devices
  - Actuation Signals
  - Simple Logic Processing Units
Tandem Advances in Protection System Design Architectures & Analysis

Protection System Design Evolution

- Single-Element Analog Devices
- Electronic Sensing & Sig. Processing
- Voting Logic

Reliability Criteria & Design Architecture Specifications

<table>
<thead>
<tr>
<th>SIL-1</th>
<th>SIL-2</th>
<th>SIL-3</th>
</tr>
</thead>
<tbody>
<tr>
<td>$10^{-2} \leq PFD_{\text{avg}} &lt; 10^{-1}$</td>
<td>$10^{-3} \leq PFD_{\text{avg}} &lt; 10^{-2}$</td>
<td>$10^{-4} \leq PFD_{\text{avg}} &lt; 10^{-3}$</td>
</tr>
</tbody>
</table>

Safety Integrity Levels

Risk Management Professionals
Fault Tree Logic Representation

Significant Damage due to Fire / Explosion

HAZOP = Consequences
LOPA = Consequences

LV-1 or Bypass Open

HAZOP = Cause
LOPA = Init Event

Protection Layers (OP Action, Control Sys, Prot Sys)

operator
alarm
fails

HAZOP = Safeguards
LOPA = IPL

LV-1 Malfunctions Open
LT/LIC-1 Fails High
Bypass Valve Inadvertently Open by Operator

Operator Response to Alarm Fails
Pressure Relief Failure

Alarm Fails to Annunciate
LT/LIC-1 Fails High
Operator Fails to Respond to Alarm
PSV-1 Fails to Open on Demand
PSV-2 Fails to Open on Demand
LOPA Ratio Calculation

• LOPA is a subset of the QRA Framework; however, it has its own set of acronyms and terminology to focus the analysis:
  – IC – Initiating Cause (i.e., Initiating Event)
  – ICL – Initiating Cause Likelihood (Frequency)
  – IPL – Independent Protection Layer
  – PFD – Probability of Failure on Demand
  – TF – Target Frequency
  – VF – Vulnerability Factor – Conditional Modifiers

\[
\text{LOPA Ratio (Safety)} = \frac{\text{TF}_{\text{Safety}}}{\text{ICL} \times PFD_1 \times PFD_2 \times PFD_3 \ldots \times VF_i \times VF_{p}}
\]
Overlap Between Key Analysis Tools

QRA

PHA
(HAZOP, “What-If”, FTA, FMECA)

LOPA

SIL

Risk Management Professionals
Implications – Prescriptive Standards

• Reminder:
  – If Risk is to be kept constant and Consequences increase, then
    • Scenario Likelihood must decrease
  – If Risk is to migrate lower over time & Consequences increase, then
    • Scenario Likelihood must decrease even further

• What might this mean to …?
  – Recommended Practices & Design Guidelines
  – Redundancy
  – Diversity
  – Acceptable Design Configurations
  – Protection System Reliability
  – Mechanical Integrity

• Limitations of Prescriptive Standards
Regulatory Dynamics & Available SMS Resources Within Your Company
Business Issues in the Application of Safety Management Systems

• The bulk of SMS elements are common to other loss prevention programs (e.g., PSM, RMP) (see next page for comparison with SEMS elements).

• Offshore Facility Companies that also operate Onshore Facilities already have the infrastructure and expertise to implement Offshore SMS efficiently.
Overlap Between Key Programs

SEMS/SEMP

PSM

RMP

- HA
- SEI
- AUD
- TRN
- PSR
- SWP
- CON
- OP
- EP
- MOC
- ER&C
- Rec & Doc
- MI
- II
- GEN
<table>
<thead>
<tr>
<th>Section</th>
<th>API (RP 75)</th>
<th>OSHA (29 CFR)</th>
<th>EPA (40 CFR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safety &amp; Environmental Information</td>
<td>2</td>
<td>1910.119 (d)</td>
<td>68.65</td>
</tr>
<tr>
<td>Hazards Analysis</td>
<td>3</td>
<td>1910.119 (e)</td>
<td>68.67</td>
</tr>
<tr>
<td>Management of Change</td>
<td>4</td>
<td>1910.119 (l)</td>
<td>68.75</td>
</tr>
<tr>
<td>Operating Procedures</td>
<td>5</td>
<td>1910.119 (f)</td>
<td>68.69</td>
</tr>
<tr>
<td>Safe Work Practices</td>
<td>6</td>
<td>1910.119 (h,k)</td>
<td>68.85/87</td>
</tr>
<tr>
<td>Training</td>
<td>7</td>
<td>1910.119 (g)</td>
<td>68.71</td>
</tr>
<tr>
<td>Assurance of Quality &amp; Mechanical Integrity of Critical Equipment</td>
<td>8</td>
<td>1910.119 (j)</td>
<td>68.73</td>
</tr>
<tr>
<td>Pre-Startup Review</td>
<td>9</td>
<td>1910.119 (i)</td>
<td>68.77</td>
</tr>
<tr>
<td>Emergency Response &amp; Control</td>
<td>10</td>
<td>1910.119 (n)</td>
<td>68.95</td>
</tr>
<tr>
<td>Investigation of Incidents</td>
<td>11</td>
<td>1910.119 (m)</td>
<td>68.81</td>
</tr>
<tr>
<td>Audit of SEMS/SEMP Elements</td>
<td>12</td>
<td>1910.119 (o)</td>
<td>68.79</td>
</tr>
<tr>
<td>Records &amp; Documentation</td>
<td>13</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>
Recommended Strategies for SMS Implementation

- Recognize the Broad Spectrum of Activities Encompassed by SEMS
- Carefully Document If Exceeding Regulatory Requirements
- Integration & Minimize Duplication
  - Similar Objectives for all Performance-Based SMS Requirements
  - Use Program Overlaps to Minimize Duplication
  - Work Towards a Unified Program
- Start Simple
  - Weave Existing Elements into New Programs
  - “Gap Analysis” of Result
  - As Necessary, Update & Enhance Completeness of Existing Analyses
- Don’t Wait – Resources and the Cooperation of Multiple Departments/Organizations may be Required
Recent Webinars in Offshore Facility Process Safety Series

- **July 22, 2010** – Offshore Facility Process Safety Overview (Risk Management Professionals + Guest Speaker, Mark Steinhilber)

- **September 14, 2010** – Effective Creation & Appropriate Application of Safety Cases (Risk Management Professionals + Guest Speaker, Ian Sutton)

- **October 14, 2010** – Offshore Facility Process Safety Systems Overview (SEMS – A New Paradigm)

- **November 18, 2010** – SEMS Update and HAZOP Study, LOPA, & SIL Assessment Integration Made Easy
References

References


Questions?

Steven T. Maher, PE CSP
Ester M. Brawley-Roehl
Carlos D. Cheek

Steve.Maher@RMPCorp.com
Ester.Brawley-Roehl@RMPCorp.com
Carlos.Cheek@RMPCorp.com

Risk Management Professionals – 877/532-0806
www.RMPCorp.com