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

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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

- **1991, 1993, 2004** – SEMP Proposed & Evolved into API RP 75
- **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
- **2010 – Oct 15** – 30 CFR Part 250 – "Oil and Gas and Sulphur Operations in the Outer Continental Shelf – Safety and Environmental Management Systems; Final Rule" published in FR

Today's Focus = Workplace Safety Rule

- **Safety & Environmental Management System (SEMS)** (30 CFR Part 250)
  - **Focus** – API RP 75 (2004) – "Recommended Practice for Development of a Safety and Environmental Management Program for Offshore Operations and Facilities" (SEMP)
  - **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

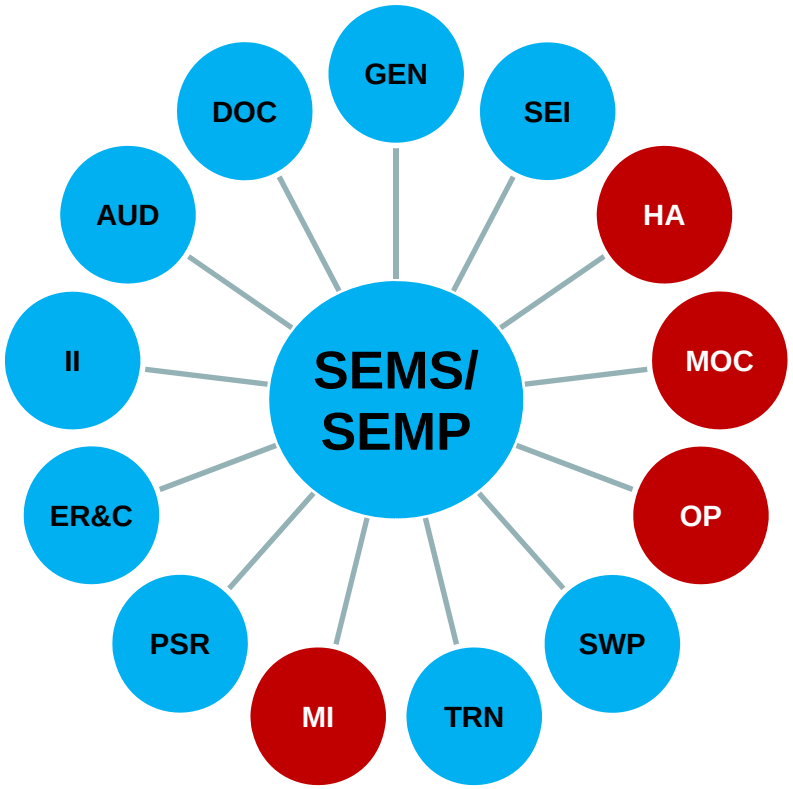
SEMS/SEMP
- 13 Primary SMS Elements

Safety Case
- SMS
- Risk Assessment & Quantification

Less Effort → **Increased Effort, with Some Increased Benefits**

Key SEMS/SEMP Elements

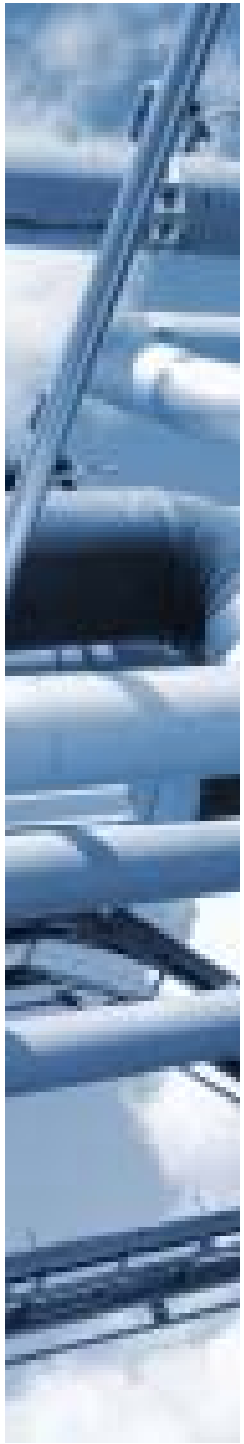
SEMS/SEMP Elements



- 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

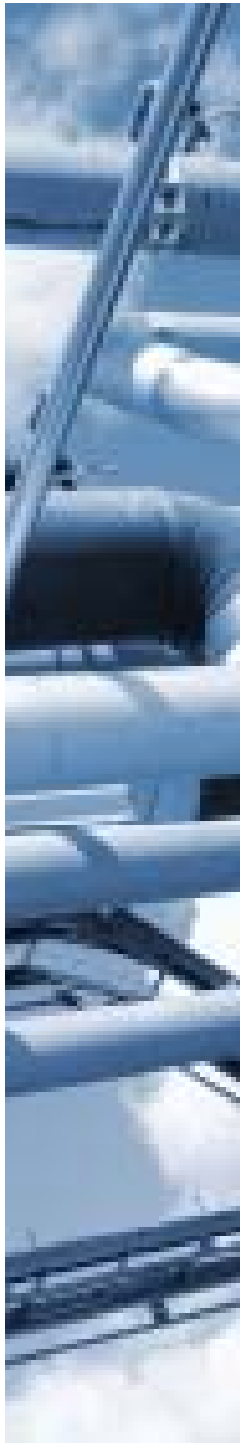


SEMS Key Periodic Requirements

- **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

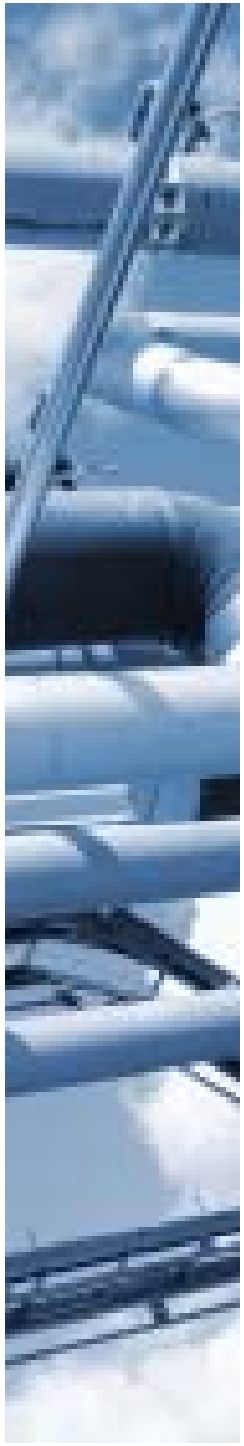
- **Non-Specific**
  - Safety & Environmental Information
  - MOC
  - Safe Work Practices
  - Mechanical Integrity
  - Pre-Startup Review
  - Incident Investigation
- **Non-Incidental Changes in Design or Operation !!**



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

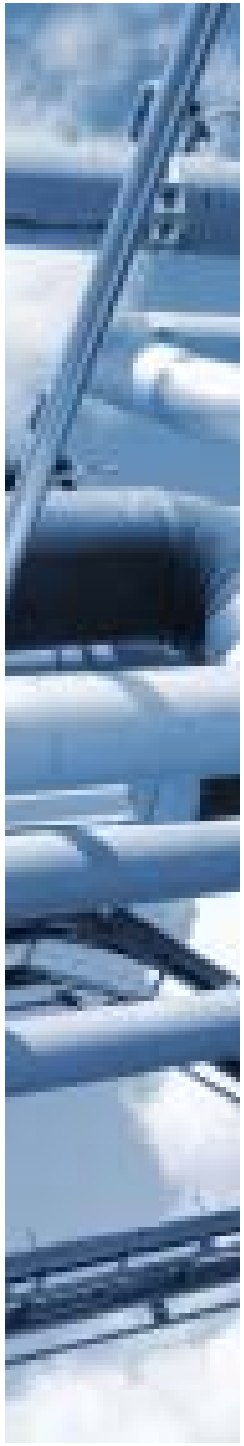


Common Deficiencies

- **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

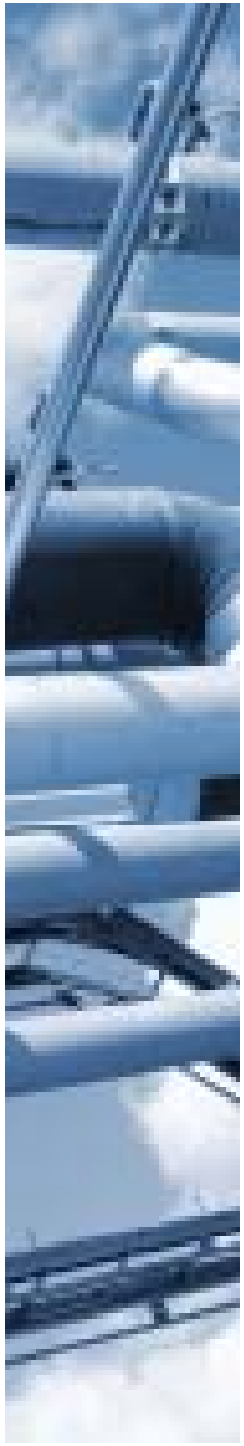
Common Deficiencies

- **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

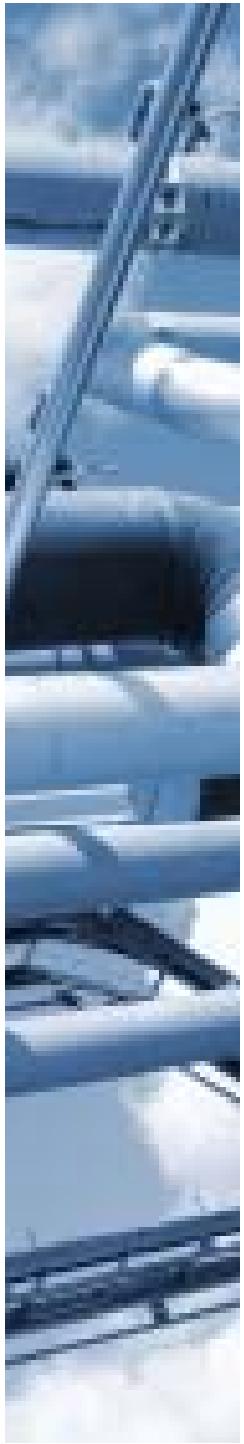
- **Mechanical Integrity (MI)**
  - Written procedures related to the ongoing integrity of the process not available, not complete, or not implemented
  - Inspections/maintenance are not occurring or inspection/maintenance frequency is not consistent with industry standards or best practices
  - Equipment 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

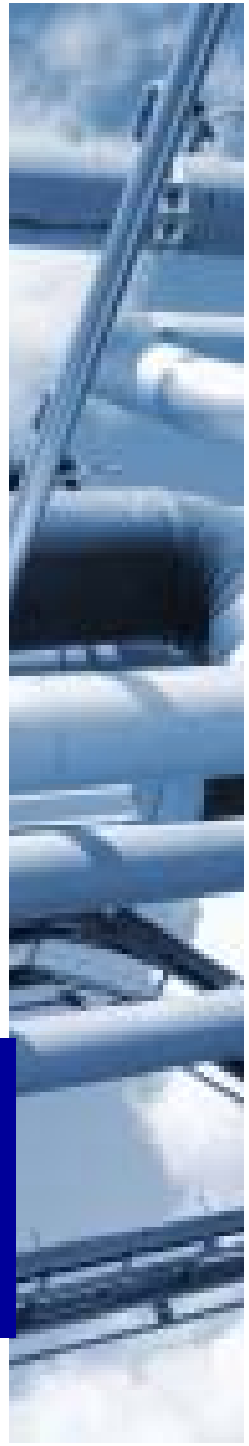
- **Investigation of Incidents (II)**
  - Incident investigations not done correctly
  - Lack of follow-through on recommendations
  - Findings not shared with affected employees
  - Incident investigation is not promptly initiated
  - No investigation or documentation of “near-misses”

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**.

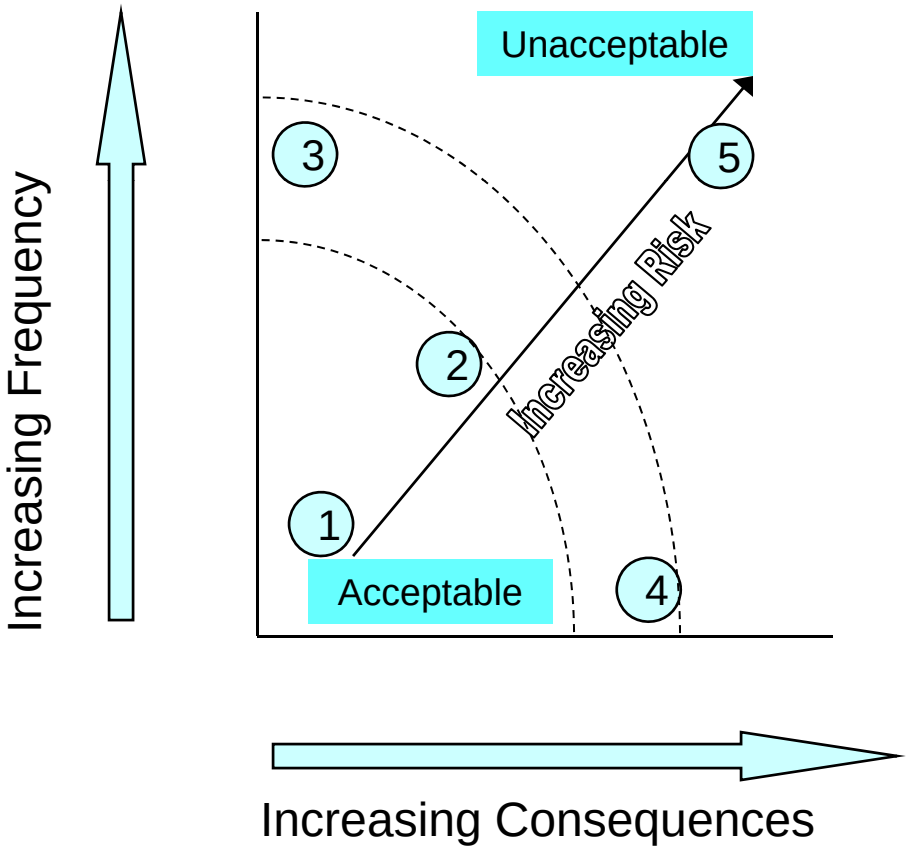
Recommendation Follow-through

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

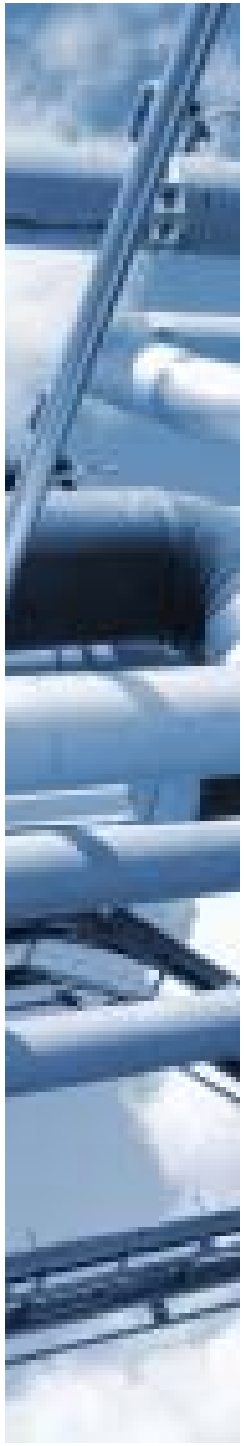
Focusing on the Objective
(The "Big Picture")



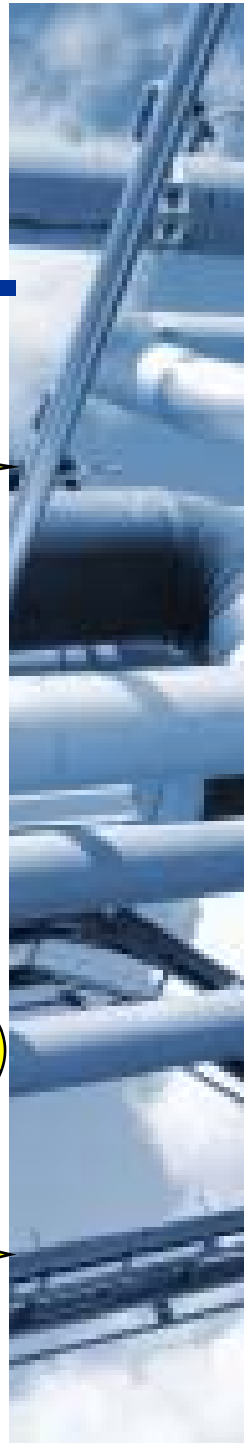
- **RISK = PROBABILITY * CONSEQUENCES**
  - **Probability = Likelihood of Occurrence**
  - **Consequences = Effects of Occurrence**
- For Engineered Systems:
  - **Risk = Σ $P_i * C_i$**

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

Electronic Sensing & Sig. Processing

Diversity

Single-Element Analog Devices

High Pedigree Devices

Separation of Control & Protection

Voting Logic

Decreased Cost

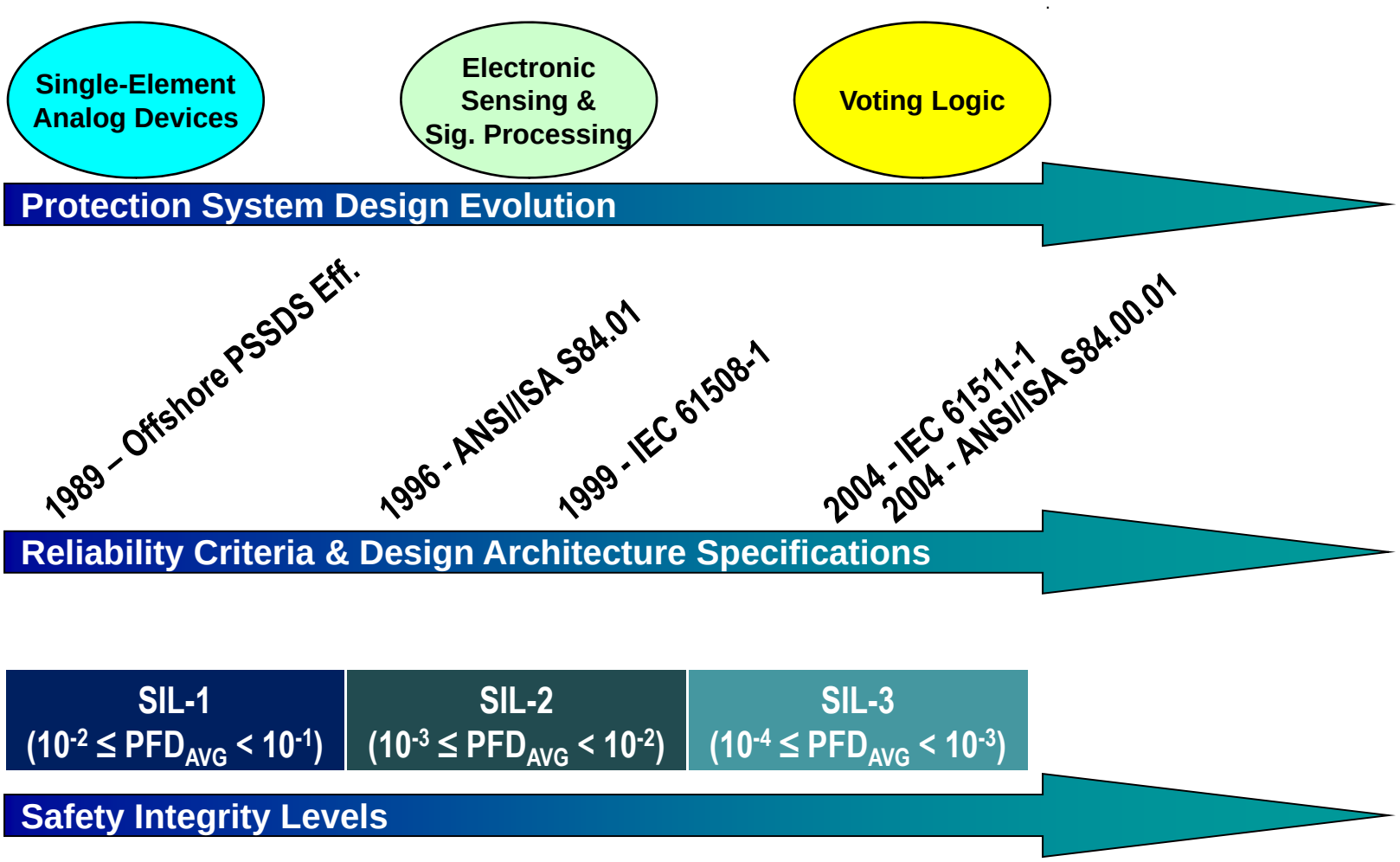
Increased Redundancy, Diversity, Pedigree

BPCS = Basic Process Control System, SIS = Safety Instrumented System,
HIPS – High Integrity Protection System

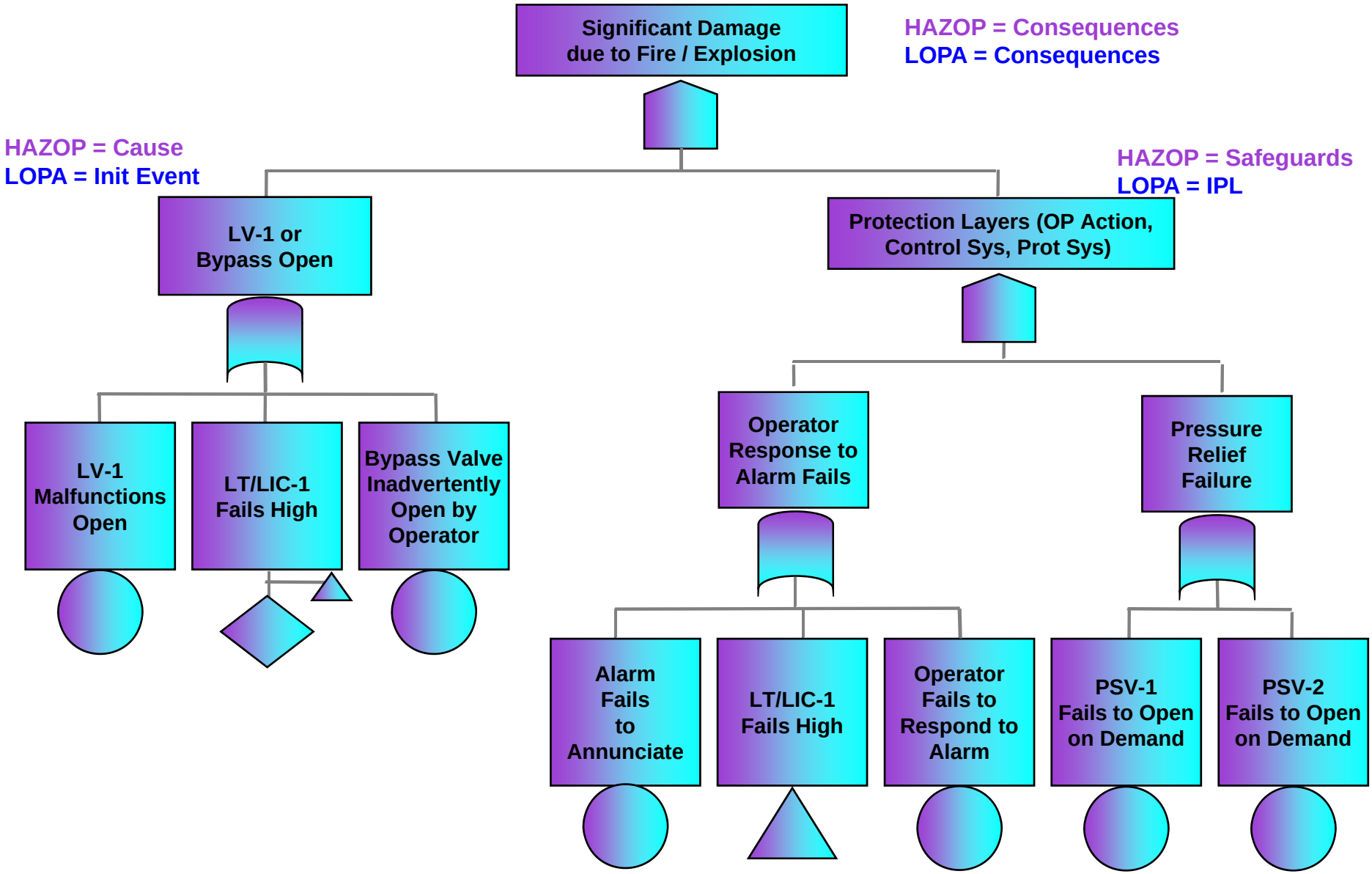
1990 Platform Safety Shut-Down System Effectiveness Study

- **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



Fault Tree Logic Representation

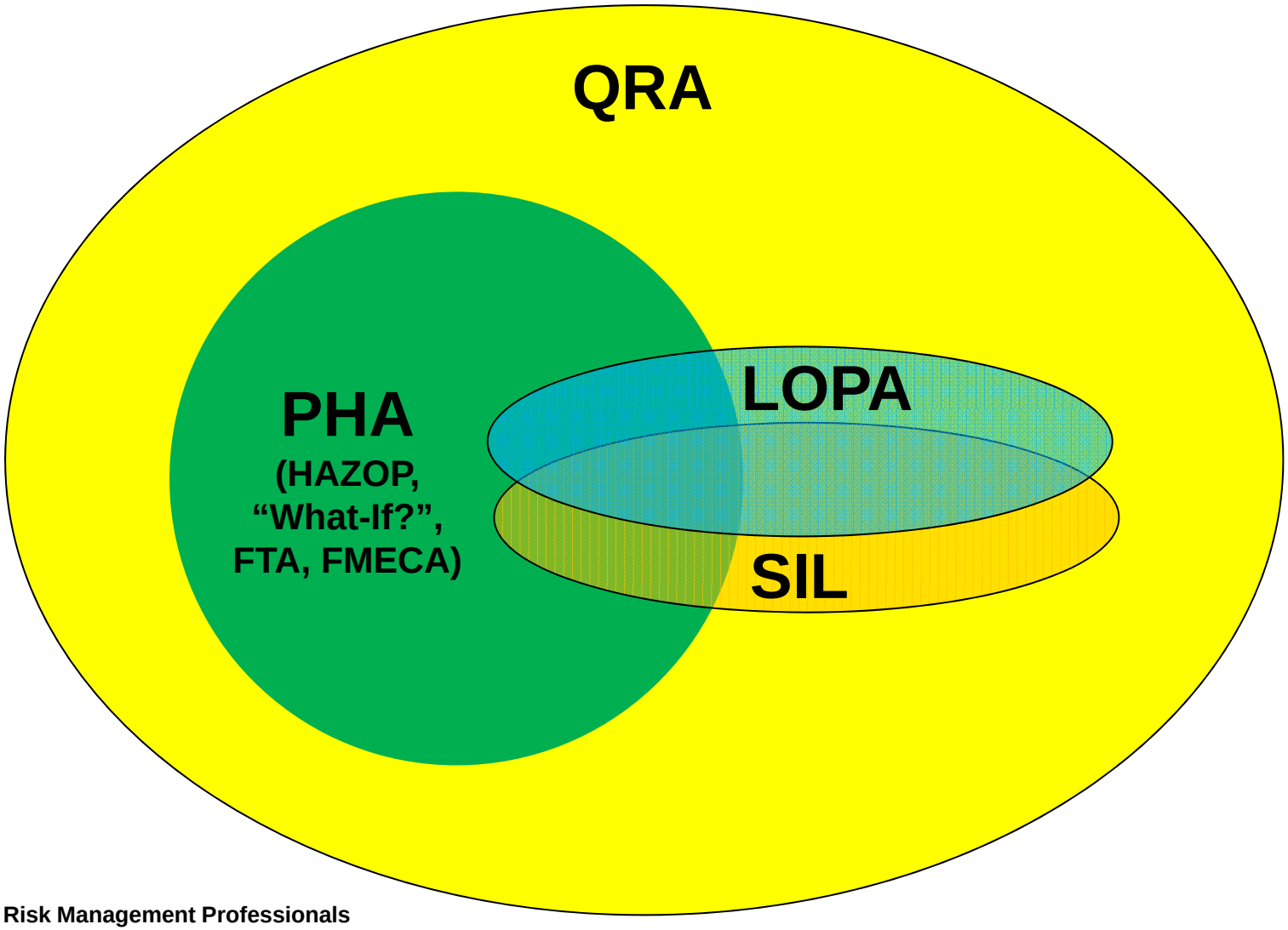


LOPA Ratio Calculation

- 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

$$LOPA\ Ratio\ (Safety) = \frac{TF_{Safety}}{ICL * PFD_1 * PFD_2 * PFD_3 ... * VFi * VFp}$$

Overlap Between Key Analysis Tools



Implications – Prescriptive Standards

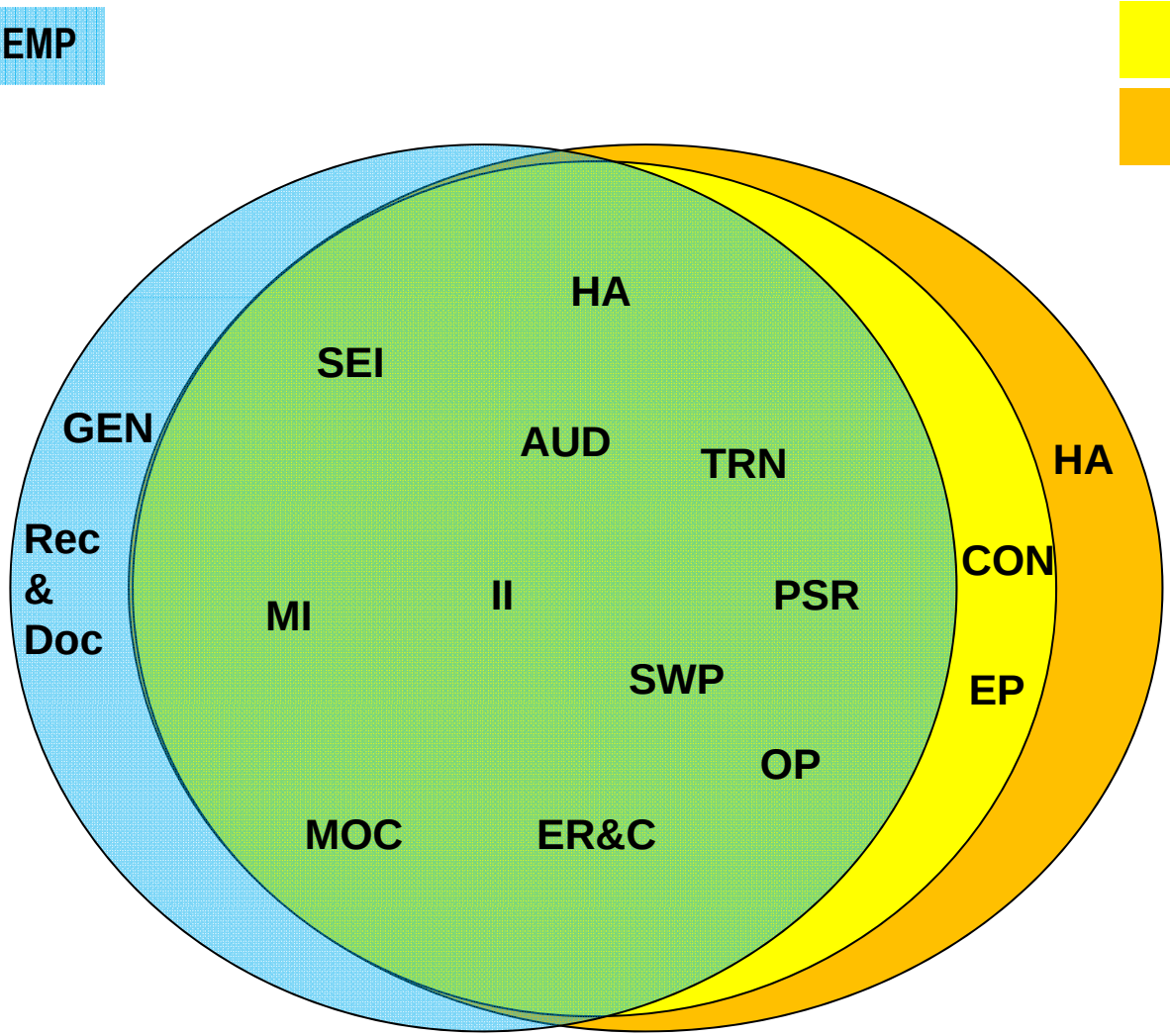
- Reminder:
  - If Risk is to be kept constant and Consequences increase, then
    - **Scenario Likelihood must decrease**
  - If Risk is to migrate lower over time & Consequences increase, then
    - **Scenario Likelihood must decrease even further**
- What might this mean to … ?
  - Recommended Practices & Design Guidelines
  - Redundancy
  - Diversity
  - Acceptable Design Configurations
  - Protection System Reliability
  - Mechanical Integrity
- **Limitations of Prescriptive Standards**

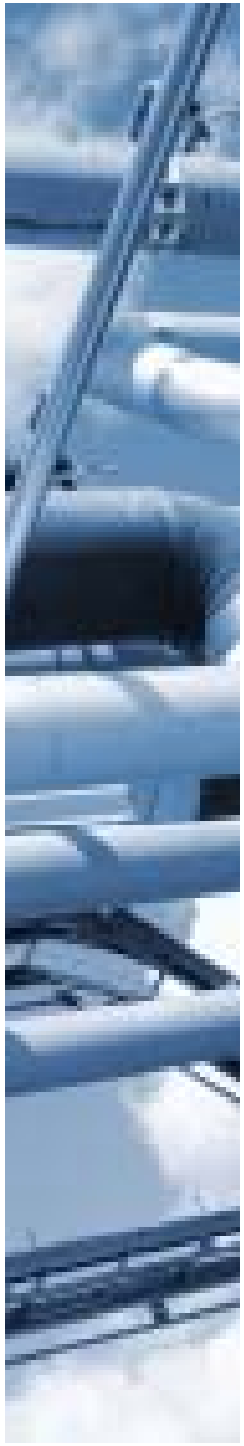
Regulatory Dynamics
&
Available SMS Resources Within Your Company

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





SMS Program Overlap Compliance Matrix

Section	API (RP 75)	OSHA (29 CFR)	EPA (40 CFR)
Safety & Environmental Information	2	1910.119 (d)	68.65
Hazards Analysis	3	1910.119 (e)	68.67
Management of Change	4	1910.119 (l)	68.75
Operating Procedures	5	1910.119 (f)	68.69
Safe Work Practices	6	1910.119 (h,k)	68.85/87
Training	7	1910.119 (g)	68.71
Assurance of Quality & Mechanical Integrity of Critical Equipment	8	1910.119 (j)	68.73
Pre-Startup Review	9	1910.119 (i)	68.77
Emergency Response & Control	10	1910.119 (n)	68.95
Investigation of Incidents	11	1910.119 (m)	68.81
Audit of SEMS/SEMP Elements	12	1910.119 (o)	68.79
Records & Documentation	13	---	---

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

1) 1987 – CCPS – “Guidelines for Technical Management of Chemical Process Safety”
2) 1990 – API RP 750, First Edition – “Management of Process Hazards”
3) 1992 – PSM – 29 CFR 1910.119, “Process Safety Management (PSM) of Highly Hazardous Chemicals, Explosives and Blasting Agents”
4) 1992 – UK Safety Case – Offshore Installations (Safety Case) Regulations 1992
5) 1996 – RMP – 40 CFR Part 68, "Risk Management Programs (RMP) for Chemical Accidental Release Prevention"
6) 2004 – API RP 75, Third Edition – “Development of a Safety and Environmental Management Program for Offshore Operations and Facilities”
7) 2005 – UK SC Update – “Statutory Instrument 2005 No. 3117, The Offshore Installations (Safety Case) Regulations 2005”
8) 2006 – SEMS Concept – 22May06 Federal Register – Title 30, Code of Federal Regulations (CFR) Part 250 – “Oil and Gas and Sulphur in the Outer Continental Shelf (OCS) – Safety and Environmental Management Systems”
9) 2009 – SEMS Proposed Rule – 17Jun09 Federal Register – “Safety and Environmental Management Systems for Outer Continental Shelf Oil and Gas Operations”
10) 2009 – MODU HSE Case – International Association of Drilling Contractors – “ Health, Safety and Environmental Case Guidelines for Mobile Offshore Drilling Units," May 2009
11) API RP 14B, Fourth Edition – “Design, Installation, Repair and Operation of Subsurface Safety Valve Systems”
12) API RP 14C, Seventh Edition – “Analysis, Design, Installation, and Testing of Basic Surface Safety Systems for Offshore Production Platforms”

References

13) API RP 14J, Second Edition – "Design and Hazards Analysis for Offshore Production Facilities"

14) California Code of Regulations (CCR) sections 1900-2954, (1998) published in handbook form as California State Lands Commission, Mineral Resources Management Division Regulations.

15) California Code of Regulations (CCR) Title 8, section 5189, "*Process Safety Management of Acutely Hazardous Materials."*

16) Pierson, John F. Jr. (2000, Aug.), *"Quantitative Risk Assessment as a Tool for Mitigating Risk – Venoco Case Study."* Paper presented at Prevention First 2000 Symposium sponsored by the California State Lands Commission, Long Beach, CA.

17) Shaefer, Scott D. (1988, Sept.), *"Safety Assessment of Management Systems."* Paper presented at Prevention First '98 Symposium sponsored by the California State Lands Commission, Long Beach, CA.

18) Shaw, Shannon J. (1998, Sept.), *"Focused Facility Inspection Program."* Paper presented at Prevention First '98 Symposium sponsored by the California State Lands Commission, Long Beach, CA.

19) Title 33, Code of Federal Regulations (CFR) Chapter I, Subchapter N, "*Artificial Islands and Fixed Structures on the Outer Continental Shelf."*

20) Bishop, Peter and Robin Bloomfield, "A Methodology for Safety Case Development (1998)," presented the Safety-Critical Systems Symposium, Birmingham, UK, February 1998.

Questions?

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