Three Critical EHS Management System Processes to Control Risks

by

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Abstract

Three management system processes are common to a number of EHS regulations and industry consensus standards/guidelines and are critical for an organization to implement in order to manage compliance and risks to people, the environment, and property/business continuity:

- **A Risk Management Business Process** involving four steps—
  #1) identifying hazards; #2) assessing risks, #3) selecting/implementing controls to manage risks, and #4) routinely monitoring the risk controls implemented.

- **A Learning from Events Business Process** involving five steps—
  #1) incident reporting, #2) risk assessment, #3) investigation and specification of corrective/preventive actions, #4 implementing and tracking actions to completion and #5) communication of lessons learned.

- **Business Processes for Managing Change** across key functional areas of the organization so as to identify and appropriately manage risks associated with change.
Some Definitions

A Business Process: a series of actions or tasks designed to produce specific deliverable(s) that may require involvement by multiple functional groups (e.g. R&D, engineering, procurement, quality, manufacturing, maintenance, EHS, etc).

A Management System: a grouping of related business processes that function interdependently and harmoniously to manage specific aspects of an enterprise.

Risk: a measure of potential human injury, environmental damage, property damage, or total economic loss resulting from exposure to hazards and expressed in terms of the magnitude of the potential consequences and the incident likelihood.

\[ \text{Risk} = (\text{Severity of Consequences from a Hazard}) \times (\text{Likelihood of the Outcome}) \]

A Risk-Based EHS Management System: an EHS management system with business processes that depend on risk-based decision making by employees at all levels of the organization.

Safety is the management of risk to an acceptable level.
Examples of Core “End-to-End” Business Processes for a Product Development / Manufacturing Company

Product design / development / commercial support processes

- Identify Market Need & Seek Ongoing Customer Input
- Develop Product Concept/Plan
- Transfer Technology
- Commercial Launch
- Improve Product

Manufacturing facilities design / construction / operation / maintenance processes

- Plan
- Design
- Procure
- Construct
- Operate
- Maintain
- Retire or Replace
We will answer 4 questions?

1. Why should your organization have an EHS Management System that is **risk-based**?

2. What are the **key risk-based EHS Management System processes** that should be aligned and integrated with **core business processes**?

3. What are the **procedural steps** in these key risk-based EHS Management System processes?

4. What can happen to organizations without an effective EHS Management System?

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**Safety** is the management of risk to an **acceptable** level
Is there evidence that EHS management systems work?
Yes-decades of industry experience by leading companies!

Example of one well known company’s experience

Conclusion: the better the EHS management system... the fewer the losses!

Based data for Procter & Gamble Manufacturing Facilities from Fulwiler (2002)
EHS Management System Processes
Link EHS Functions and Help Integrate Them with Company Business Processes
As our businesses continuously change to face new marketplace challenges and risks…our focus on compliance must begin to shift to quantifying and mitigating risk, much the same way as done in other elements of the business … safety professionals must be prepared to lead that effort…”

Why go beyond regulatory compliance?

1. Unacceptable residual risks may remain when in full compliance.

   In many situations regulations or agency adopted codes may not now address, or only partially address, key risk exposures (e.g. physical hazards, acute or chronic effects from certain chemicals, seismic hazards, etc).

2. We will be judged on standards of the future as well as today’s.

   “The real challenge is to get companies focused on tomorrow’s law rather than today’s. That is the standard to which we are ultimately accountable.”

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Stages in the Development of EHS Management System Processes

Phase 1: Reactive to EHS Losses and Violations (poor compliance record with realization that EHS compliance management system processes needed)

Phase 2: Regulatory Compliance-Based EHS Mgt. System Practices & Processes (typically segregated by EHS function)

Phase 3: Proactive/Risk-Based EHS Mgt. System Processes & Programs Integrated Across EHS Functions (EHS is a priority with resources allocated based on risks)

Phase 4: Proactive/Risk-Based EHS Mgt Processes Integrated with Business Processes/Technology (EHS risk management is a company value)

Phase 5: Continual Improvement Drives EHS Risk Reduction (with a focus on sustainable business practices and organizational culture)

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Examples of Management System Standards/Guidelines Relevant for EHS

- ISO 9001:2008--**Quality** Management System Standard
- ISO 14001:2004--**Environmental** Management System Standard
- GRI **Sustainability Reporting** Framework--G3 Guidelines

- OHSAS 18001:2007--**Occupational Health & Safety** Mgt System
- ANSI/AIHA Z10:2005--**Occupational Health and Safety** Mgt System


- US OSHA **Process Safety** Management
- US EPA **Risk Management** Plans
- Responsible Care Management System Processes (ACC)

- PAS 55-1:2008 **Asset** Management (from BSI)
- NFPA 1600:2007--**Disaster/Emergency** Mgt. and **Business Continuity**

- DNV International Safety Rating System--7th Edition (a guidance and rating tool)
- Oliver Wight ABCD Checklist for Operational Excellence (a guidance and rating tool)
These 7 elements of an EHS Management System will allow an organization to satisfy most EHS Mgt. System standards/guidelines:

<table>
<thead>
<tr>
<th>#1 Management Leadership/Periodic Reviews and Employee Participation</th>
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<tbody>
<tr>
<td>#2 Communications and Training</td>
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<tr>
<td>(communications internally at all levels, with on site contractors and external stakeholders; training for leaders at all levels and other employees)</td>
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<tr>
<td>#3 Compliance Assurance</td>
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<tr>
<td>(list of applicable regulatory and other requirements, self assessments/audits)</td>
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<td>#4 Risk Management</td>
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<tr>
<td>– Hazard identification</td>
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<tr>
<td>– Hazard analysis/risk assessment</td>
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<tr>
<td>– Risk-based decision making/implementation controls</td>
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<td>– Risk controls monitoring</td>
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<tr>
<td>Examples of risk controls/monitoring processes:</td>
</tr>
<tr>
<td>• Periodic work area inspections</td>
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<tr>
<td>• Mechanical integrity- EHS critical equip./systems</td>
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<td>• Procurement controls for hazardous materials</td>
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<tr>
<td>• On-site contractor pre-qualification/management</td>
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<tr>
<td>• Site work permits for hazard tasks</td>
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<td>• Emergency management</td>
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<td>#5 Management of Change</td>
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<tr>
<td>(e.g. product, process and facilities design reviews-DfS, DfE using risk-based decision making)</td>
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<td>#6 Learning from Events</td>
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<tr>
<td>(reporting of incidents, risk assessment, investigation, specifying corrective and preventive actions and tracking to closure, communication of lessons learned)</td>
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<tr>
<td>#7 Document Control &amp; Data Quality Management</td>
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### Examples of Linkages of EHS Mgt System Elements to Requirements of Several Standards/Guidelines

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<tr>
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<tbody>
<tr>
<td><strong>#1 Management Leadership/Review and Employee Participation</strong></td>
<td>Set objectives based on evaluation of environmental aspects and allocate resources for continual improvement of MS; conduct management reviews of audit findings/actions, performance against objectives</td>
<td>Management leadership &amp; employee participation, responsibility &amp; authority, initial &amp; ongoing review, objectives and implementation plans, management reviews</td>
<td>Organizational structure, policies, standards, procedures, responsibilities, incentive &amp; disciplinary process</td>
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<tr>
<td><strong>#2 Communications and Training</strong></td>
<td>Communication (internal and external) of policy and performance; Competence, training and awareness</td>
<td>Communications; Education, training, awareness</td>
<td>Communications &amp; awareness; Training and competency</td>
</tr>
<tr>
<td><strong>#3 Compliance Assurance</strong></td>
<td>Legal and other requirements, monitoring and measurements, evaluation of compliance, internal auditing</td>
<td>Monitoring and measurement, audits, feedback to planning process</td>
<td>Tracking legal requirements, compliance &amp; mgt system auditing, inspections</td>
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<tr>
<td><strong>#4 Risk Management</strong></td>
<td>Monitoring and measurements</td>
<td>Assessment and prioritization, procurement, contractors, emergency preparedness, monitoring and measurement</td>
<td>Inspections and monitoring</td>
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<tr>
<td><strong># 5 Management of Change</strong></td>
<td>Procedure to evaluate environmental aspects and impacts including proposed new activities</td>
<td>Design review and management of change</td>
<td>Change control system</td>
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<td><strong>#6 Learning from Events</strong></td>
<td>Non-conformity, investigation, corrective &amp; preventive actions, review of effectiveness</td>
<td>Incident investigation, corrective &amp; preventive actions, feedback</td>
<td>Incident reporting, response, investigation, corrective and preventive measures</td>
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<tr>
<td><strong>#7 Document Control &amp; Data Quality Mgt.</strong></td>
<td>Documentation and control of Documents</td>
<td>Documentation and control, records control</td>
<td>Documentation of organizational structure, policies, standards, etc.</td>
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</table>
Why align and integrate EHS business processes with core business processes?

- Simplicity
- Effectiveness
- Efficiency (cost)
- Sustainability of the processes

Safety is the management of risk to an acceptable level
Example of Alignment & Integration: Risk-Based EHS Mgt System & Quality Mgt System

“one of the seminal documents in which an ISO-9001:1994-harmonized OHSMS was described by Raychem...its basic structure and parallelism with ISO 9001:1994 clearly lead the way toward a logical OHSMS in an auditable form”

Source: Levine & Dyjack, AIHA Journal (Apr 1997)

Note: For more details see an overview provided by Majewski (1997), a detailed description of integrated processes by Culley (1998), and a discussion of several management systems by Redinger et al (2002)
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A Risk Management Business Process

4 Steps: Identify, Assess, Select Controls, Monitor

Safety is the management of risk to an acceptable level

Step 1: Identify Hazards
Step 2: Assess Risks (Severity x Likelihood)
Step 3: Make Risk-Based Decisions
Specify appropriate controls & implement
Step 4: Monitor Risk Control Measures

5 Decision Options (5Ts)

Terminate  Transfer  Treat  Tolerate  Tell those at risk

Note: Another example of a risk management process is Liberty Mutual’s Residual Risk Reduction™ or R3™ process (see Tolbert 2005)
For risk-based business processes to be most effective, employees at all levels across multiple functions (e.g. R&D, engineering, production, maintenance, and utilities supply) must be trained to identify hazards and assess the risks using at a minimum a simple risk scoring matrix and procedures such as the one shown here.

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The 5Ts Describe the Decision Options Concerning Risk Controls

Step 3: Make Risk-Based Decisions

- Protect Yourself-PPE
- Administrative Controls
- Engineering Controls: Contain It
- Transfer
- Find a Substitute
- Tolerate
- Terminate
- Tell Those at Risk

Assess risks and then…

Making Risk-Based Decisions
Justification for Multiple Layers of Protection for Risk Control & How an EHS Management System Decreases the Likelihood of Loss

What produces these holes?
- Inadequate procedures
- Inadequate design or automation
- Undetected defects in equipment or materials
- Gaps in training
- Gaps in supervision
- Unreasonable work schedules

Other holes are due to latent conditions

Loss

Source: Adapted from James Reason, Managing the Risks of Organizational Accidents (1997)
Step 4: Monitoring Risk Controls—A Sometimes Neglected Step in the Risk Management Process

Once recommended risks have been communicated and agreed upon, risk mitigation measures have been implemented, the organization must ensure that the risk controls are effective by means such as monitoring of:

• engineering controls--inspection, testing, calibration and maintenance of EHS critical equipment, systems and components (e.g. mechanical integrity programs)
• workplace exposures to hazards (chemical exposure monitoring, noise exposure monitoring, etc.)
• environmental performance (emissions to air; discharges to water; contamination of structures, soil or groundwater; waste generation and management)
• compliance with procedural controls (LOTO, line breaking, confined space entry, hot work, waste storage)
• compliance with PPE use
Monitoring Risk Controls--EHS critical equipment inspection, testing, calibration and maintenance:

Why?

To ensure that EHS critical equipment is functioning properly so as to maintain a constant state of “mechanical integrity” and readiness to minimize risks of:

- Loss of life or injuries
- Accidental environmental releases
- Property damage for the organization or for others
- Business interruption
Monitoring Risk Controls--EHS critical equipment inspection, testing, calibration and maintenance:

What are some examples?

- Boiler safety controls and boiler emissions controls

- Electrical Circuits for safety critical functions (e.g. cooling water or air scrubber circulation pump power circuits)
  - Thermographic (IR) Inspections of critical circuits, switchgear, transformers

- Emergency Equipment
  - Backup emergency electrical power generators
  - Emergency lighting
  - First aid kits
  - Eye wash and emergency showers
  - Spill response equipment
  - Rescue equipment
Monitoring Risk Controls--EHS critical equipment inspection, testing, calibration and maintenance: (examples continued)

- Machine guards (those with proximity detectors and interlocks)
  - Machine tool guards
  - Process equipment and robotic system guards

- Tanks & Vessels
  - Liquid level sensors
  - Leak detectors (e.g. for secondary containment)
  - Secondary containment (mechanical integrity)
  - Pressure and vacuum relief devices

- Wastewater collection and treatment systems
  - Lift station pumps and sump level sensors
  - Equalization tanks level sensors
  - Neutralization tanks pH sensors and neutralization feed pumps and controls
Monitoring Risk Controls--EHS critical equipment inspection, testing, calibration and maintenance: (examples continued)

- Manufacturing Area Environmental Monitoring
  - Toxic gas detectors \((\text{NH}_3, \text{Cl}_2, \text{H}_2\text{S}, \text{CO})\)
  - Organic vapor detectors (LFL detectors)
  - \(\text{O}_2\) monitors in areas storing asphyxiating gases
  - Local area ventilation system flow sensors/alarms
  - Room pressure indicators/controllers (magnehelic gauges)
  - Temperature sensors and controls
Monitoring Risk Controls--EHS critical equipment inspection, testing, calibration and maintenance: (examples completed)

Fire/Life Safety

- Fire Detection (smoke and heat detectors)

- Fire Door Closure Devices

- Fire Evacuation Alarms

- Fire Pumps and Water Supply Tanks

- Fire Hydrants and Water Distribution

- Fire Suppression Systems (Gaseous Agent Systems, Chemical Agent Systems, Water Sprinkler Systems--all types)
Monitoring Risk Controls--EHS critical equipment

PLAN: Identify Equipment and Specific Requirements and Document

• Identify all EHS critical equipment/components

• Identify Inspection, Testing, Maintenance Requirements (set priorities based on risk)
  • Codes/Regulations
  • Industry Standards or Guidelines
  • Manufacturer’s recommendations

• Prepare procedures and instructions including checklists
DO- Implement

- Complete inspections and work tasks (set priorities based on risk—loss exposures)
- Record results, document deficiencies
- Repair, replace, take other appropriate corrective actions
Monitoring Risk Controls--
EHS critical equipment

CHECK – Audit the Process

Audit the inspection, testing and maintenance reports/record:

• Are the inspections, testing and maintenance being performed correctly?

• Are the deficiencies being identified and documented?

• Are the deficiencies being corrected properly and in a timely manner?
Monitoring Risk Controls--EHS critical equipment
Act—Correct deficiencies found with priorities set based on risks

• Impaired smoke detectors and fire alarms (e.g. hot work related impairments not removed to return to service per procedures)

• Impaired fire suppression system (e.g. impaired fire pumps not returned to operational readiness state after maintenance)
A Learning from Events Business Process Is Another Key Requirement

It is vitally important to have an effective “Learning from Events” process to report close calls and unsafe conditions, to evaluate their risks, to investigate and identify root causes, and implement corrective and preventive actions to avoid future losses.

Note: For an overview of near-miss or close call incident management in the chemical process industries see review article by Phimister et al (2003) For a discussion of “incident-derived learning for safety see article by Gordon (Sept 2008)
Typical Steps in a Learning from Events Process

Step 1: Train Staff (on types of incidents to report and the reporting, investigation & assessment methods)

Step 2: Report EHS Incidents (including close calls & unsafe conditions)

Step 3a: Review & Implement Immediate Corrective Actions (as required)

Step 3b: Assess Risks Make Risk-Based Decisions

Step 4: Investigate (Identify Root Cause if Risks Warrant)

Step 5: Assign Preventive Actions if Risks Warrant

Step 6: Track Actions to Closure

Step 7: Communicate Lessons Learned

Step 8: Analyze Trends & Review with Management

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Management of Change Processes for Product Development and Manufacturing Organizations

• Design reviews for new/modified products and new/modified manufacturing processes can be combined into a single review process to be done cooperatively by various functional organizations dealing with equipment operability and reliability risks, product quality risks, and concepts such as “design for manufacture”, “design for quality”, “design for safety” (DfS) or “design for the environment” (DfE), etc.

• Engineering change management for existing equipment / systems can also incorporate EHS considerations into a standard change review protocol or procedure implemented by multiple functional organizations (engineering, quality, manufacturing, maintenance, EHS).
EHS Management of Change Processes—
“Design for Safety” (DfS) or “Design for Environment” (DfE)

Design for Safety (DfS) is a principle for design for new facilities, equipment and operations (public and private) to…protect people, property and the environment.

DFS advocates systematic processes to ensure state-of-art engineering and management principles are used and incorporated into the design of facilities and overall operations to ensure safety and health of workers, as well as protection of the environment and compliance with current codes and practices.


Notes: May also want to simultaneously consider Design for Quality, Environment, Manufacturability, Reliability, Maintainability, Energy Efficiency, Recyclability, etc. See Gradel and Allenby (1995)
For recent discussions of “Management of Change” & “Prevention Through Design” see articles by Hansen & Gammel (Oct 2008) and by Manuele (Oct 2008)
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A ROOT CAUSE OF THE BP REFINERY EXPLOSION IN MARCH 2005: LACK OF AN EFFECTIVE SAFETY MANAGEMENT SYSTEM

• The explosion in Mar-05 at a BP Texas City Refinery resulted in 15 fatalities and 180 injured workers. In terms of human suffering, regulatory violations, and financial loss, it was one of the worst industrial accidents in the US in decades.

• The **lessons learned** from this disaster have been widely publicized by the US Chemical Safety Board (CSB) and various engineering societies and are important for all manufacturers.
Risk-Based Decision Making

• Don’t focus just on driving down the IIR!

The year before the explosion, the BP refinery had the lowest IIR in its history, ~1/3 the oil refinery sector average. The CSB reported that for years the BP safety initiatives in Texas City focused primarily on reducing the IIR by preventing slips, trips and falls, rather than also including management system process improvements with equipment design, and preventive maintenance and mechanical integrity programs.

• Set Risk-Based Priorities to Repair/Maintain EHS Critical Equipment and Components!

Allocate capital, operating and maintenance resources based on risk considerations. At the BP Refinery "there were 3 key pieces of instrumentation (related to the unit restart that triggered the explosion) that were actually supposed to be repaired, that were not repaired, and the management knew this," said Carolyn Merritt, chairwoman of the CSB.
Learning from Events

No Effective Learning from Events Process Existed at BP’s Refinery - In the 10 years leading up to the Mar-05 disaster at BP in Texas City, there had been 8 major gasoline vapor releases on the same unit where the explosion occurred - any one of which could have been catastrophic. (Source: CSB Report 2007)

Luck ran out in March 2005

The BP Refinery Disaster

BP Preventive Action Implemented after the Explosion--
Document, Assess and Investigate EHS Incidents
Thoroughly: It's important to investigate all process incidents and loss of containment the same way serious injuries are investigated. Capture and incorporate into operating procedures and training programs lessons learned. (Source: Mogford 2006)
Risk-Based Decision Making

- **Risk Assessment & Communications**—Those who are at risk must be identified and be made aware of the risks and how to manage them.
  
  *What's the point of a joint contractor and employee pre-work safety meeting if you don’t communicate about major risks?*

- **Background**—One BP worker told CBS “60 Minutes” reporter Ed Bradley that the morning of the BP Texas City Refinery blast a safety meeting was held for 300 to 400 workers. "There was not a thing said about that unit starting up," said the worker, Pat Nickerson.

The BP Refinery Disaster
Example of Consequences from Lack of Engineering Change Management Control at A Polymeric Materials Processing Plant

• An electrically heated recirculating hot-oil heater was malfunctioning and causing odor complaints in a manufacturing plant work area
• Before the start of the day-shift an operator and maintenance mechanic decided to install a block-valve on the heating unit’s thermal expansion tank vent line to reduce the odor emissions into the work area
• Shortly after startup of the retrofitted unit, the unauthorized changed resulted in over-pressurization of the non-pressure rated vessel and failure of the vessel
• The steam explosion killed the operator and seriously injured the maintenance mechanic.
**SUMMARY**

**Phase 1**: Reactive to EHS Losses and Violations (poor compliance record with realization that EHS compliance management system processes needed)

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**You won’t get here without:**

- Acceptable Risk Exposures with World-Class EHS Performance
- Risk Management, Learning from Events, & Management of Change Processes

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**Go beyond compliance!**

- Unacceptable Residual Risks
- Phase 1: Reactive to EHS Losses and Violations (poor compliance record with realization that EHS compliance management system processes needed)
References

7. J. Reason, Managing the Risks of Organizational Accidents, Ashgate (1997)
19. OHSAS 18001:2007--Occupational Health & Safety Mgt
21. PAS 55-1:2008 Asset Management (from BSI)