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RESPONSIBLE CARE®
OUR COMMITMENT TO SUSTAINABILITY

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GULF PETROCHEMICALS & CHEMICALS ASSOCIATION
الاتحاد الخليجي للبتروكيماويات والكيماويات

6

# PROCESS SAFETY CODE

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# CHAPTER ONE

## Introduction

### History of Responsible Care®

In December 2009, the Gulf Petrochemicals and Chemicals Association (GPCA) Board of Directors formally adopted the Chemical Industry's initiative called 'Responsible Care®'.

Responsible Care® was created in 1984 by the Canadian Chemical Producers' Association, with the clear intent of establishing the following goals:

- Improved chemical processes.
- Enhanced practices and procedures.
- Reduction of every kind of waste, accident, incident, and emission.
- Reliable communication and dialogue.
- Heightened public scrutiny and input.

Responsible Care® has become an obligation of membership in GPCA Member Companies. A central idea behind Responsible Care® is the need to adopt philosophy of continuous improvement. It is not a program that provides a checklist of activities for member companies to implement. It will be improved continually in light of new information, new technology, new expectations, and a periodic reassessment of performance and objectives. Responsible Care® is a license to operate.

### Management Codes

Responsible Care® is underpinned by GPCA through the implementation of a number of Management Codes as indicated below:

| Management Code | Document Number |
|---|---|
| Community Awareness and Emergency Response (CAER) | GPCA-RC-C01 |
| Distribution | GPCA-RC-C02 |
| Product Stewardship | GPCA-RC-C03 |
| Security | GPCA-RC-C04 |
| Health & Safety | GPCA-RC-C05 |
| Process Safety | GPCA-RC-C06 |
| Environmental Protection | GPCA-RC-C07 |

Each of the above Codes includes expectations, termed Management Practices. The Management Practices provide specific requirements and guidance for Companies to fulfil their responsibilities in terms of Responsible Care® .It also provide set of questions which can be used by member companies for conducting self-assessment for each of the Management Practices.

## Objective of the Process Safety Code

The Process Safety Code is designed to support preventing un-intended hazardous releases (or hazardous substances releases).The Code comprises a series of Management Practices that reflect this goal, with the expectation of continuous performance improvement for each Management Practice. The practices are based on the principle that facilities will be safe if they are designed according to sound engineering practices, built, operated and maintained properly and periodically reviewed for conformance.

Individually, each management practice describes an activity or approach important to support preventing fires, explosions and accidental chemical releases. Collectively, the Practices encompass process safety from the design stage through operation, maintenance and training. The scope of this Code includes manufacturing, processing, handling and on-site storage of chemicals. This Code must be implemented with full recognition of the community's interest, expectations and participation in achieving safe operations.

The process safety management program in each member company facility is complemented by workplace health and safety programs, as well as waste and release reduction programs which address and minimize releases and waste generation. These three programs, and others, will help assure that GPCA member facilities are operated and maintained in a manner that protects the environment and the health and safety of workers and the public.

## Codes of Management Practices Links to RC 14001:2015 Standard

The implementation of the Process Safety Code will help in fulfilling the requirements of the Responsible Care® management system specification RC 14001. Notably, the implementation will help in closing gaps related to Process Safety requirements of the specification, particularly those requiring a system to prevent fires, explosions and accidental chemical releases.

| | | Process Safety Management Practices | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **RC 14001 Responsible Care® Elements** | | PS-1 | PS-2 | PS-3 | PS-4 | PS-5 | PS-6 | PS-7 | PS-8 | PS-9 | PS-10 | PS-11 | PS-12 |
| 4.1 | Understanding the organization and its context | | | | | | | | | | | | |
| 4.2 | Understanding the needs and expectations of interested parties | | | X | | | | | | | X | | |
| 4.3 | Determining the scope of the EHS&S management system | | | X | | | | | | | | | |
| 4.4 | EHS&S management system | | | | | | | | X | | | | |
| 5.1 | Leadership and commitment | X | | | | | | | | | | | |
| 5.2 | Policy | X | | | | | | | | | | | |
| 5.3 | Organizational roles, responsibilities and authorities | | X | | | | | | | X | | | |
| 6.1 | Actions to address risks and opportunities | | | | | | | | | | X | | |
| 6.1.2 | EHS&S aspects | | X | X | | X | X | | | X | | X | |
| 6.1.3 | Compliance obligations (Legal & Other Requirements) | | X | X | | X | X | | | | | | |
| 6.2 | EHS&S objectives and planning to achieve them | X | X | | X | | | | | | | | |
| 6.2.2 | Planning actions to achieve EHS&S objectives | | | | | | | | | | | | |
| 7.1 | Resources | X | X | | X | | | | | | | | |
| 7.2 | Competence | | | | | | | | X | X | | | |
| 7.3 | Awareness | | | | | | | | | X | | | |
| 7.4 | Communication | X | | | | X | X | | | X | | X | X |
| 7.5 | Documented Information | | X | | X | | | X | X | | X | | |
| 8.1 | Operational planning and control | X | X | X | X | X | X | X | X | | X | | X |
| 8.2 | Emergency preparedness and response | | | | X | X | | | | | | | |
| 9.1 | Monitoring, measurement, analysis and evaluation | | | X | X | | | | X | | X | X | |
| 9.1.2 | Evaluation of compliance | | | X | | | | X | | | X | X | |
| 9.2 | Internal audit | | | | X | | | | | | X | X | |
| 9.3 | Management Review | X | | | | X | | | | | X | | |
| 10.2 | Nonconformity and corrective action | | | X | X | | | | | | X | X | |
| 10.3 | Continual Improvement | X | | | | | | | | X | | | |

Table 1 – Process Safety Management Practices

Wherever possible these management practices should be included in the member company's existing programs which address the process safety related requirements. More so, these practices should be incorporated into the existing programs in such a way that these are part of the regular management review cycle.

# CHAPTER TWO

## Process Safety Code Management Practices

This section includes the process safety management practices and provides for each management practice some guidance and suggested activities / examples that can help member companies to implement the required process safety managing system and/or enhance the existing management systems and programs.

This section also includes for each of the management practices a set of self-assessment questions that can be used by member companies for conducting self-assessment to identify gaps and develop & implement an effective gap closure plans.

### PS-1: Leadership & Culture

Commitment by senior leaders through policy, goal setting, participation, effective communications and resource commitments in achieving goals and to ensure continual improvement.

#### 1.0 Guidance

Management commitment at all levels is required for effective process safety management (PSM). The objectives and accountability for safe process operation (Process Safety Policy) and specific process safety goals (metrics) for an organization should be established. Developing a PSM culture is the backbone to effective implementation of PSM and is critical in sustaining improvements.

These must be consistent with other aspects of the organizational vision, i.e., they must takes in account any other constraints and the availability of resources.

Successful PSM makes leaders at all levels of the organization accountable for visibly supporting their subordinates and provide them guidance of process safety issues, and for resolving conflicting views among safety, engineering, production and business managers.

Process safety culture is the combination of group values and behaviors that determine the manner in which process safety in managed.

To build sound process safety culture, the following essential features will help an organization manage its process safety challenges:

1. Maintain a sense of vulnerability.
2. Empower individuals to successfully fulfill their safety responsibilities.
3. Defer to expertise.
4. Ensure open and effective communications.
5. Establish a questioning/learning environment.
6. Foster mutual trust.
7. Provide timely response to process safety issues and concerns

Senior managers should communicate their understanding of process safety accountability for their unit and individuals within it. This accountability should also include communication and coordination of overlapping responsibilities between individuals / units to ensure that no gaps occur. Process safety metrics shall be developed and communicated to all personnel within the organization (for implementation, company may refer to API RP 754). These shall include both leading and lagging metrics.

- Leading metrics.
  A process-based and forward-looking set of metrics which indicate the performance of the PSM key work processes, operating discipline, or layers of protection that prevent incidents.

  Leading indicators are used to monitor the effectiveness of the process safety barriers by measuring the company's performance in maintaining robust risk controls.

- Lagging metrics.
  An outcome-based and retrospective set of metrics that are based on process safety incidents.

  Lagging indicators are used to assess the extent of weaknesses, defects or failures in the risk control system.

## 1.1 Suggested Activities / Examples

**Example No. 1**

Establish a formal corporate process safety policy.

- Collect information on process safety policies.
- Compose a written statement that describes your company's process safety philosophy.
- Publicize formal adoption of the policy by the corporate board of directors.
- Develop guidelines to help each business group or corporate functional area implement the policy.
- Establish a mechanism for senior management to support and promote open employee's feedback about the process safety policy during its development and implementation. This can be done during plant visits, safety reviews and inspections.

**Example No. 2**

- Define corporate and line management organizations for implementing process safety initiatives.
- Form committees or task forces and provide an organization chart and clear charter.
- Clearly define process safety responsibilities in job descriptions with clear accountability.
- Establish levels of authority for making process safety-related decisions.
- Commit adequate resources to sustain continual improvement of process safety.
- Provide incentives and recognition to employees who demonstrate extraordinary initiative in pursuing process safety.
- Acquire necessary equipment, tools, software and facilities, e.g., computer software for emergency relief system design and release prediction.
- Provide training and instruction to employees. Develop process safety training programs and materials.

Suggested deliverables include:

- Clear statements of commitment to PSM are included for facilities policies and procedures.
- Training and awareness for managers, coordinators and supervisors in leadership of process safety culture.
- Embedding PSM into regular meetings, day-to-day communications, and working practices.
- Organizational structure, resources and responsibilities / accountabilities for achievement of PSM plans.
- Establish Process Safety Goals with clear accountability. Process Safety leading and lagging goals / metrics are developed and communicated to all personnel within the organization.

### 1.2 Self-assessment

- Does the facility have a documented process safety policy?
- Does the facility have documented process safety goals?
- Does a system exist for reviewing goals on a regular basis?
- Are goals and Key Performance Indicators (target versus actual) communicated to management and employees on a regular basis?
- Are management directly involved in reviewing these goals?
- Does the organization develop actions plans for gaps existing in achieving the set goals?
- Are employees encouraged to participate in developing action plans?

## PS-2: Process Safety Information Management

Current, complete documentation of process design, operating parameters and procedures and information relating to the hazards of materials and process technology should be maintained and readily available.

### 1.0 Guidance

Process information necessary for the safe design, operation and maintenance of any facility should be documented, reliable, current and easily accessible by people who need to use it.

A process safety knowledge database is typically a catalogued collection of hard copy documents, manuals, electronic files and databases. Not all information needs to be in one place or one database. However, there must be an index to let users know what information is available, in which document, file or database, and where it is located. Process safety information is needed in the following areas:

**Chemical and occupational health hazards**

This normally takes the form of Safety Data Sheets (SDS) for every potentially hazardous material used, stored or produced at a site, plus information on reactivity, chemical and physical properties for use by those involved in process development and design.

**Process definition/design criteria**

This is information needed to operate a facility within its design range and to enable potential changes to be properly reviewed for their impact on the facility's safety and reliability. Minimum information required is:

- Process flow diagram;
- Safe upper and lower limits for levels, temperatures, pressures, flows, time, cycles and

compositions;
- Evaluation of the effects, including those on health, safety and the environment, of operating
- outside of these safe limits;
- Process chemistry, including process stability and chemistry of side reactions, by-products
- and contaminants, and potential reactivity hazards;
- Maximum intended inventory;
- Material and energy balances.

**Process and equipment design:**

This covers the data needed to ensure and maintain the mechanical and process integrity of the equipment at a facility. Minimum information requirements are:

- Piping and instrumentation diagrams (P and IDs);
- Materials of construction;
- Process control systems, including software integrity;
- Ventilation system design;
- Relief system design and design basis;
- Design codes and standards employed;
- Electrical classification drawings;
- Plot plan.
- Protective systems:
  These are data on systems which either prevent or mitigate incidents.
  Examples include:
  - Critical alarms;
  - Critical interlocks;
  - Pressure relief and venting systems;
  - Fire detection and protection equipment;
  - Emergency isolation valves;
  - Effluent treatment systems (scrubber, quench tank, etc.).

**Normal and upset conditions (operating procedures)**

Operating procedures should be readily accessible to those who work with or maintain the process. There should be a system for updating procedures to ensure they reflect current operating practice (including changes of process chemistry, technology, equipment, facilities or organization) and regular certification that procedures are current and accurate. Procedures should address:

- Steps for each operating phase, including:
  - Initial start up of a new facility;
  - Normal and temporary operations;
  - Emergency shutdown, including identification of conditions which require shutdown;
  - Normal shutdown;
  - Start-up following an emergency or normal shutdown.
- Plant operating limits:
  - Consequences of deviating from established operating limits;
  - Steps required to correct or avoid a deviation from operating limits.
- Safety systems and their functions.

**Process risk management decisions**
Risk management decisions should be documented, showing the decisions made and the basis on which they were made. This is a sensitive area because of implications for liability and due diligence, and should be carefully coordinated with the company's legal department.

**Information Management**
Knowledge and information gained from plant experience which is likely to be important for future safety of the facility should be documented in a system so that it is not overlooked or forgotten as personnel or the organization change.

### 1.1 Suggested Activities / Examples

**Example No. 1**

- Develop a system for retaining design information and a history of significant revisions.
- Develop and establish safe operating ranges for key process variables.
- List limiting conditions for continuous process operation, e.g., should operations be allowed to continue without the emergency shutdown system in service? Explain the consequences of exceeding stated safety limits.
- Establish a database for physical and chemical property data preferably maintained electronically.
- Develop a system to archive information of hazards.

Suggested Deliverables include:

- Documented roles and responsibilities for maintaining and approving process knowledge documentation.
- Complete, accurate and up-to-date process safety information, P&IDs, PFDs, and SDS, including operating ranges for key process variables.
- A system to store, maintain, catalogue and retrieve process safety information.
- Users are trained how to access the process safety information.

### 1.2 Self-assessment

- Does each facility have the following documented process safety information?
  - Process definition and design criteria (as a minimum, process flow diagrams, safe upper and lower limits for temperatures, pressures, flows, compositions, operating and emergency procedures).
  - Process equipment and design (as a minimum, materials of construction, piping and instrument diagrams (P&IDs), process control systems, electrical classification drawings, relief system design and design basis, design codes and standards employed, ventilation system design).
  - Chemical and occupational health hazards as a minimum, SDS for every chemical used, stored or produced at a site, plus information on reactivity, chemical and physical properties.
  - Process risk management decisions and its basis.

## PS-3: Capital Project Review and Design Procedures

Consideration and mitigation should be given to the potential safety effects on workers, the public and the environment during the design, construction and start-up phases of expansions, modifications and new facilities, utilizing established engineering practices consistent with recognized codes and standards.

## 1.0 Guidance

Change Management: The approval process for new capital projects or modifications to existing facilities should ensure the request has identified potential EHS&S risks, together with the provision of resources necessary to manage those risks. Process safety reviews must be satisfactorily completed at appropriate stages for the project to proceed.

The reviews shall include but are not limited to:

- Process hazard.
- Facility siting.
- Plot plans.
- Process design and review procedures.
- Project management procedures and controls.

Hazard reviews ensure that risks associated with hazardous chemicals have been identified and that adequate capital and other resources are made available to minimize exposures to employees, the public and the environment.

Siting of a proposed expansion or new plant should consider buffer zones between the plant and the community, worst credible scenarios for release of a toxic chemical, explosion or fire and effect(s) on exposed personnel. The exposure hazards, to and from, adjacent plants or facilities and possible exposures due to natural events such as earthquake, flood, tornado etc.

Plot plans of equipment and storage of hazardous materials shall be reviewed and evaluated to check congestion, e.g., overlapping hazard zones, difficult access, possible confinement of vapour release, etc., location of control rooms, offices and other permanent and temporary buildings, storage areas, loading and unloading areas, drainage and containment.

Process design and review procedures : The design process should include a system for review and approval, with appropriate sign-off, at each stage of the design process. Normal stages are:

- Conceptual design.
- Process design.
- Detailed engineering design.
- Construction.
- Commissioning.

The depth of each review will depend upon the complexity and degree of hazard of the process.

Project management procedures and controls: These controls ensure fabrication and installation of equipment corresponds to design intentions. A key control is the pre-startup safety review required before new or modified facilities are put into service. Minimum requirements for this review are:

- Confirm that construction meets design specifications including site visit;
- Ensure safety, operating, maintenance and emergency procedures are in place and adequate;
- Confirm that a process hazard analysis has been done and that recommendations have been resolved or implemented prior to start up;
- Confirm that modified facilities meet the management of change requirements;
- Ensure necessary training has been completed;
- Ensure critical equipment has been identified and incorporated into a preventative maintenance program.

Project management controls should be documented and form part of the project file.

### 1.1 Suggested Activities / Examples

**Example No. 1**

Develop a formal risk management program. Consider using the Centre for Chemical Process Safety (CCPS) program, defined in Guidelines for Risk Based Process Safety. Establish criteria for site selection and integrate process hazard evaluations to the overall project management process. Establish a formal requirement for design reviews and prestart-up reviews.

Provide training to develop in-house expertise in hazard evaluation, or ensure external resources are available. Establish a consistent corporate strategy for risk management, e.g., process hazard review protocol, use of generic risk control measures, levels of risk acceptance. Maintain a system and ensure that the following information is available to employees:

- Project management procedures and controls, inclusive of engineering code selections.
- Documented risk management system.
- Documented scopes of the hazard assessment studies.
- Process design, detailed engineering and construction documents.
- Complete, accurate and up-to-date identification and understanding of the process hazards and risks.
- Procedure/ process for managing risks properly through the plant life cycle.

### 1.2 Self-assessment

- Have hazard reviews been carried out for risks associated with hazardous chemicals that adequately address minimizing exposures to workers, the public and the environment?
- Is there a proven methodology used to conduct Hazard Reviews?
- Have the plot plans of equipment and storage of hazardous materials been evaluated to check congestion?
- Does the design process include a system for review and approval, with appropriate sign-off, at each stage of the design process?
- Are controls and/or procedures in place to ensure that fabrication and installation of equipment corresponds to design intentions?

## PS-4: Process Risk Management

Periodic assessment and documentation of process hazards and implementation of actions and credible emergency procedures to minimize risks associated with facility operations and maintenance, including the possibility of human error should be established. The assessments should ensure sufficient independent layers of protection through technology, facilities and personnel to prevent process safety incidents and the escalation from a single failure to a catastrophic event.

### 1.0 Guidance

A systematic risk management process shall exist to evaluate and control facilities risk associated with the hazards of a material (raw material and products), process, or activity which may have the potential to cause injury to people including public, or damage to property or the environment.

**Hazard identification**: The first and important step in process risk management is hazard

identification. If hazards are not identified, they cannot be considered in implementing a risk reduction program, nor addressed by emergency response plans.

There are several methods for hazard identification such as 'What If', Checklist, hazard and operability study (HAZOP), failure mode and effects analysis (FMEA), Fault Tree Analysis, layer of protection analysis (LOPA), quantitative risk analysis (QRA) etc., The Dow Fire and Explosion Index and Dow Chemical Exposure Index are recommended as useful reference for assessing the degree of hazard.

Control measures addressed by these studies must be completed or tracked until completion. All affected personnel must be informed about hazards and safeguards of all risks.

**Risk analysis of operations**: Once hazards have been identified, the risks are estimated from the potential consequences and the likelihood of occurrence, using qualitative and/or quantitative methods such as Fault Tree, Event Tree, Risk Indices, etc. The total risk is then evaluated by comparing against criteria for acceptability

**Reduction of risk:** Following risk evaluation, steps must be taken to reduce those risks which are deemed unacceptable. Such steps might include: inventory reduction, alternative processes, alternative materials, improved training and procedures, protective equipment, ensuring that items identified from hazard and risk analysis are closed off, etc.

The facility evaluates risks throughout the plant life cycle to ensure that the risks to people including public and the environment are consistently controlled within the risk tolerance criteria.

If any administrative controls are identified like operating, maintenance or emergency procedures, all concerned workers must be trained on these procedures.

**Residual risk management**: Since risk cannot be completely eliminated, plans are needed to control the residual risk of incident occurrence within acceptable limits and mitigate effects should an accident occur. It is vital to document the rationale and resolution of all recommendations.

A written emergency response plan must exist containing, as a minimum:
- Emergency escape routes and evacuation procedures.
- Procedures for employees required to operate critical systems.
- Procedures to account for people following an evacuation (headcount).
- Rescue and medical responsibilities.
- Emergency reporting procedures.
- Emergency response procedures (fire suppression, spill control, etc.).
- Organizational responsibilities during an emergency.

Each site should have a site wide alarm and/or communication system which:
- Has distinctive alarms to indicate alert, evacuate and "all clear";
- Has an easily remembered means of activation (e.g. recognized telephone number);
- Is regularly tested and maintained.

Employees should be trained in the use of the emergency plan and regular drills carried out to test its
effectiveness. Copies of the plan should be easily available to all employees.

## 1.1 Suggested Activities / Examples

**Example No. 1**

- Establish an interdisciplinary safety review team (or teams for large, long-duration projects), for hazard analysis and risk review.
- Establish authority / responsibility for safety approval of all new projects and modifications.
- Review projects during the design stage and/or participate in process hazard evaluations and provide appropriate safety related requirements to those responsible for design.

**Example No. 2**

- Analyse abnormal operation, emergency conditions and protection requirements in all process hazard evaluations.
- Apply adequate safety factors in equipment design to accommodate worst credible case, upset or emergency conditions.
- Consider installing secondary containment, flare system etc. in the design of emergency relief systems for flammable or hazardous materials.
- Use early leak detection systems, e.g., flammable vapour analysers, and online chromatographs, with alarms or automatic emergency controls.
- Design equipment and piping with adequate lock-out devices to allow safe maintenance.
- Provide release mitigation systems, e.g., water curtains, foam systems, and emergency scrubbers, for areas susceptible to major hazardous leaks.
- Consider installing detection / suppression systems for equipment that contains flammable vapours or dusts.

Suggested deliverables include:

- Hazard identification and risk analysis studies.
- Communication of key hazards, safeguards and risks to those controlling or affected.
- An effective emergency response plan for credible scenarios.
- Trained and equipped emergency response teams.

## 1.2 Self-assessment

- Are process hazards identified and the risks estimated?
- Has the facility evaluated the risks, throughout the plant life-cycle to ensure that the risks to people and the environment are consistently controlled within the risk tolerance criteria?
- Have control measures addressed by hazard studies been completed and tracked to completion?
- Do regular reviews take place to assess the actual operation & maintenance of the facility against established standards?
- Are affected personnel informed about hazards and safeguards of all risks?
- Are concerned workers trained on the risk administrative controls such as special operating and

maintenance procedures?
- Does the facility have written emergency plans that are regularly tested?
- Are risks subjected to independent validation?

## PS-5: Pre-Startup Safety Review (PSSR)

A process of safety reviews on all new and modified facilities prior to start-up and commissioning

### 1.0 Guidance

This Management Practice is intended to ensure that equipment is safe to start-up and operate. It covers start-up of new equipment, modified equipment, and existing equipment being restarted after a plant shutdown. A key control is the Pre Start-up Safety Review (PSSR) required before new or modified facilities are put into service. The PSSR should include independent team members and physical visit to the facility.

The facilities must be maintained and operated in a manner that demonstrates excellence in performance of every task and have zero tolerance to deviations.

Follow-up on actions arising from the PSSR are tracked and completed in a timely manner along with documented authorization for plant start-up.

The facilities shall be operated as per the written procedures and there shall not be any deviations to the same. The roles and responsibilities for operating must be documented in procedures and shall be approved by appropriate authorized personnel. A review of operating procedures shall be carried out periodically.

### 1.1 Suggested Activities / Examples

**Example No. 1**

- Establish an interdisciplinary safety review team (or teams for large, long duration projects), to follow and evaluate construction and commissioning of a project.
- Perform periodic on-site inspections during the construction stage of a project to verify that installation is in accordance with design.
- Compare construction work to appropriate drawings, e.g., P&IDs and isometrics drawings.
- Have a quality assurance program in place that includes inspection and verification of construction materials.
- Conduct PSSRs before charging any process chemicals/ utility systems.

**Example No. 2**

- Provide dated copies of procedures in control rooms.
- Periodically review procedures with operators on the job.
- Require all non-routine jobs to have written procedures that have been evaluated by the facility's management of change process.
- Train all operators on these emergency, and operating procedures.

Suggested deliverables include:

- Documented operations readiness management system.
- Guides, checklists and procedures to use for checking readiness to operate.

- Verification that actions identified as 'to be done before start-up', are completed.
- A documented authorization for the plant start-up.
- Written operating procedures for the various modes of plant operations.

### 1.2 Self-assessment

- Does the facility have documented Pre Start-up Safety Review checklists?
- Does the PSSR review include a facility visit?
- Does the facility have documented start-up, shutdown, normal operation and emergency procedures?
- Are the procedures easily accessible to applicable users?
- Does the facility have documented authorization for plant commissioning and start-up?
- Does the facility have a tracking system for actions identified on PSSR checklists?
- Does facility have process to periodically review the operation procedures and train the operators?

## PS-6: Management Of Change (MOC)

Management of change process shall be in place to ensure that modifications to existing plants do not introduce unaccepted/unforeseen hazards. The process shall be made in a manner that forces all changes are subjected to a process of technical and risk evaluation.

### 1.0 Guidance

A written Management of Change(MOC) procedure shall be available for all changes, except replacement in kind. The procedure shall address:

- Explanation of replacement in kind versus change.
- Clear definition of change (scope of application).
- Description and technical basis for the proposed change.
- Potential impact of the proposed change on EHS&S.
- Training requirements for employees or contractors following the change.
- Updating of documentation including process safety information, operating procedures, maintenance procedures, alarm and interlock settings, fire protection systems, etc.
- Contingency for 'emergency' changes.
- The required composition and qualification of the MOC review committee
- The required level of approvals commensurate with the impact of the change on the safety of the process.
- Clear workflow on how the MOC is to be carried out.
- Define the minimum content of the MOC package prior to review.

A change can be of process technology, facility (equipment/ material/ layout etc.), procedural or organizational changes that may have an impact on EHS&S. Any change must be properly reviewed and approved by qualified and authorized personnel prior to implementation. Changes can be temporary or permanent. Temporary changes shall be subject to conditions similar to those that apply to permanent changes and the time limit for the change should be clearly defined and properly logged and tracked.

Steps must be taken to ensure that all equipment is returned safely to normal conditions at the

end of the change. The facility must have a documented procedure and guidelines for performing management of changes. If a PSSR is required for a change, it must be documented along with the Management of Change and all actions of the PSSR must be documented and tracked until completion.

### 1.1 Suggested Activities / Examples

**Example No. 1**

- Define change and establish a system to identify changes before they are implemented.
- Establish a change review system that requires proposed changes to be documented.
- Train operating, engineering, purchasing and maintenance personnel to recognize changes.
- Develop a timely, practical mechanism for alerting management of these changes.
- Provide guidelines illustrating how changes can have serious process safety implications and which changes only represent 'replacements in kind.
- Establish an authorization procedure to manage temporary changes in facilities and procedures.
- Establish time limits for temporary changes, with specific renewal requirements.

Suggested deliverables include:

- Documented Management of Change procedure.
- MOC roles and responsibilities are documented.
- All changes undergo a suitable change reviews and approvals.
- Change documentation, test and inspection frequencies, operating procedures, training records.

### 1.2 Self-assessment

- Does the facility have a written MOC procedure?
- Are changes classified as temporary and permanent? Are time limits defined for temporary changes?
- Are changes properly reviewed and approved, by qualified and authorized personnel, prior to implementation?
- Are all actions from MOC documented and tracked to completion?
- Is membership criteria established for the MOC Committee?

## PS-7: Process and Equipment Integrity

Documented maintenance and inspection programs that ensure facility integrity should be effective.

### 1.0 Guidance

Procedures for fabricating, inspecting and maintaining equipment shall be available for maintaining mechanical integrity of critical equipment and systems including but not limited to:

- Pressure vessels and storage tanks.
- Piping, instrument and electrical systems.
- Process control software.
- Relief and vent systems and devices.
- Emergency and fire protection & response systems.
- Controls including monitoring devices and sensors, alarms and interlocks.
- Rotating equipment.

- Cathodic protection.
- Structure and Fire Proofing
- Emergency Isolation Valves
- Grounding and Bonding

A documented file should be maintained for each piece of critical equipment.

Equipment critical for process safety should be identified so that schedules can be established for monitoring and inspection to enable cost effective correction of problems before they develop to a critical stage.

Systems should be established where necessary to supplement industry standards such as piping and pressure vessel codes. Critical items may need special tracking to verify materials used are as specified.

Quality assurance should include a materials control system which ensures installed equipment meets the requirements of the design specification, traceability to its manufacturer, meets all required testing (with test results available) and is labelled clearly for identification by personnel doing the installation.

Critical steps in installation should be identified during planning, and field inspection used to verify that installation corresponds to design.

The Preventative Maintenance (PM) system should include methods of:
- Identifying critical equipment.
- Establish PM frequencies for critical equipment.
- Mechanism to ensure that PM is carried out at the required frequency.
- Recording of completed maintenance including equipment history.

Proper control of maintenance should include safe work practices which apply to both employees and contractors such as: permits to work and their application, opening of process equipment, control of access to the facility by maintenance, contractor, laboratory and other personnel shall be used. Permits to work shall also be used for activities such as but not limited to; hot work, confined space entry, lock out/tag out, excavation, etc.

Proper alarm and instrument management includes not only equipment hardware but also computer components and software instructions for process control. Systems should include but not limited to, identification of critical alarms and interlocks, a procedure to control changes to alarm set points and interlock systems and system of regular testing of interlock systems and pressure relief devices (PRDs).

Procedures should address safe removal from service, dismantling, decontamination and related disposal of waste.

## 1.1 Suggested Activities / Examples

**Example No. 1**

- Develop written programs.

- Establish approved inspection procedures and methods for performing various maintenance and testing tasks.
- Perform quality assurance inspection of vendor supplied components.
- Construct, install and perform functional checks of new equipment.
- Establish a preventive maintenance management system for routinely servicing equipment.
- Develop a critical equipment list and equipment checklist.

**Example No. 2**

- Perform regular inspection and non-destructive testing of major vessels, tanks and critical piping.
- Regularly proof-test standby equipment, critical alarms, interlocks and safety systems.
- Define criteria for decisions concerning whether equipment is suitable for continued service or should be replaced.
- Define appropriate maintenance and inspection frequencies for specific equipment.
- Establish proper procedures and tools for inspections and maintenance.
- Conduct training and qualification for applicable personnel.

Suggested deliverables include:

- Documented mechanical integrity management system.
- Documented and approved basis for the inspection and test frequencies and methodology.
- Reports, certificates and data verifying new and modified equipment.
- Performance data, enabling predictive intervention and identifying abnormal conditions for further investigation.

### 1.2 Self-assessment

- Does the facility has a critical equipment list that includes but is not limited to mechanical equipment, relief devices, instruments, alarms and fire protection?
- Does all identified critical equipment have a specified inspection plan?
- Are all inspection records traceable and history available, inclusive of failures and breakdowns?
- Are procedures available for changes to alarm limits/ trip setting of critical equipment?
- Is a system in place to manage bypassing safety interlocks and safeguards ?

## PS-8: Human Factors

System should be in place to consider the potential for human error in design of equipment, work stations and operating procedures and to identify, communicate and address potential human errors associated with routine and non-routine tasks.

### 1.0 Guidance

Human factors must be included when reviewing and assessing risks. Three key areas are:

1. Operator & technicians – process / equipment interface.
2. Administrative controls (operating and maintenance procedures, Permit to Work).
3. Human error assessment.

This includes contractor training and their integration to the facilities, to ensure that they do not introduce any process safety risks. A documented procedure for contractor management shall exist.

Individuals and organizations do not perform like machines but behave in ways which are strongly

influenced by intention or choice and thus by such factors as understanding, judgment and motivation. Actions may vary depending upon the individual or the situation.

Effective process safety management demands an understanding of human error so that systems are designed to prevent its occurrence or mitigate its effects. This applies to all aspects of process safety management including design, construction, maintenance and operation.
Human error should therefore be considered when designing equipment, procedures, etc.
By anticipating likely human failure modes, the system can be designed to facilitate both recognition of when an error has occurred and recovery to a safe state.
Common human failure modes include:

- Slips and lapses, where instructions are followed but a step is missed or performed at the wrong time;
- Mistakes, where the instruction being followed is not appropriate for the situation; and
- Violations, where an instruction is willfully disregarded.

Design of equipment may increase the potential for human error. Common examples are positioning of dials, colour coding, different directions for on/off switches etc. Computerized control systems can present operators with unmanageable amounts of information during an upset condition.

A task analysis (a step-by-step approach to examine how a job will be done) can be used to determine what can go wrong during the task and how these potential problem areas can be controlled.

Hazards may be controlled by the use of procedures or by the addition of protective equipment. Procedures that are well understood, kept current and strictly followed, are likely to be effective in managing human error. Similarly, protective systems need regular testing and maintenance to be effective.

Wherever possible, an engineering control is always a preferable option. However, required administrative controls should be considered by way of contingency such as;

- **Operating Procedures**

When identified during process risk reviews for administrative controls, an operating procedure must exist as part of risk management control. A documented operating and maintenance procedure for each such case must exist. All users of these procedures must be trained and tested on these procedures. For start-up and shutdown of a process unit, operating procedures must be available and personnel trained. Operating and maintenance procedures must address the hazards associated with the task and their precautions.

- **Permit to Work System**

A documented Permit to Work system shall be available. All operations and maintenance personnel must be trained on the Permit to Work system, inclusive of contractors. The Permit to Work system must include verification of isolation of energy sources and hazards of the work performed, e.g., hot work, confined space, confined space, excavation, lockout/tagout etc.

- **Contractor Management**

A documented procedure for managing contractors must exist. This shall include their selection, safety performance, training and integration into facilities, evaluation and performance. A periodic review of contractors must be done to evaluate their performance and continuation of their services based on safety performance. Training requirements for contractors to be listed and a matrix developed for training requirements similar to employees.

## 1.1 Suggested Activities / Examples

**Example No. 1**

- Use human factors assessment methods and tools to identify individual job tasks.
- Develop clear instructions and checklists for start-up, normal operation, standby, recirculation, normal shutdown and emergency shutdown actions. Include clear figures and illustrations for complicated tasks or refer to standard operating and maintenance procedures for more information.
- Develop procedures explicitly dealing with process upsets and emergencies, e.g., loss of containment events.
- Include essential safety equipment and personnel needed in routine and emergency maintenance activities. Conduct regular shift meetings to discuss problems.
- Conduct effective shift handover and ensure effective communication between the operating and maintenance shifts.
- Conduct periodic reviews of all work practices and procedures.

**Example No. 2**

- Develop safe work practices for discrete tasks performed by operating and maintenance personnel.
- Develop and implement proper methods for taking laboratory analysis samples.
- Define the use of specialized tools and equipment.
- Define the use of personal protective equipment.
- Develop recognition of hazards and appropriate emergency actions using techniques such as Job Safety Analysis.
- Describe the use of lock-out tag-out procedures, hot work permits, heavy lifting permits, confined space entry procedures and special activity permits, e.g., line breaks.

**Example No. 3**

- Develop a program for dealing with contractor safety issues.
- Establish a list of qualified bidders whose safety programs have been determined to be consistent with applicable sections of the Process Safety Code.
- Develop criteria for selecting contractors based on safety performance.
- Establish responsibility for ensuring contractor safety performance while on-site.
- Develop a contractor orientation program package to be supplied to contractors as a part of the process.
- Establish a procedure to review the contractor safety program, including inspecting written material, contractor facilities and lost-time injury records.
- Classify possible contractor job assignments according to the potential for workers creating and/or being exposed to process hazards in the workplace.
- Develop a brief videotape presentation on the general hazards associated with your facility.

Suggested deliverables include:

- Documented hazard identification and risks assessments of human errors and their control measures.
- Written operating procedures for operator responses to alarms.
- Written maintenance procedures.
- Documented Permit to Work procedures.
- A procedure / policy addressing contractor management, including pre-qualified list of approved contractors, safety training and evaluation as a minimum.
- Documentation of contractor selection processes and contractors' safety performance and their integration to facilities.

### 1.2 Self-assessment

- Does facility have a system in the design of equipment, work stations or operating procedures to consider the potential for human error?
- Does facility have a system that will identify, communicate and address potential human errors associated with routine and non-routine tasks?
- Are hazards controlled by human intervention? If yes, are written procedures available to users?
- Does the facility have start-up / shutdown procedures?
- Does the facility have a Permit to Work system?
- Are procedures addressing hazards and their precautions in place?
- Are concerned employees and contractors trained on the Permit to Work system?

## PS-9: Training and Competence

Identification of the skills, knowledge and competencies necessary for employees to maintain proficiency in safe work practices associated with safety critical activities.

### 1.0 Guidance

Personnel shall be competent and trained on process hazards and their control measures. The effectiveness of the training must be evaluated.
Key roles should be identified and their required skills, knowledge and abilities documented. The competency profiles, together with job descriptions and job safety analysis, provide the building blocks for development of competency programs. Testing and evaluation should be used to ensure that employees have the aptitude and required knowledge / skills to enable them to do their tasks in a safe manner.

Employees and contractors shall be trained on site safety systems. Training shall include available permit to work procedures, emergency procedures, specific hazards of areas and materials.

An assessment should be administered to employees and contractors to ensure the information given has been understood. It is especially important that people supervising contractors understand the training given.

A method of testing or verification should be used to ensure the training is understood to a level consistent with doing a job safely.

Specific criteria should be used for instructor selection and training to ensure instructors have sufficient teaching/communications skills as well as the necessary technical knowledge.

Records of training received by each person in each task are needed. These should include: the name of the trainer, the date of the training and the results of the competency verification. This document is then used to track training received and to schedule retraining.

Refresher training is needed to ensure skills/personnel remain at a level consistent with the safe operation of facilities. This is especially true where procedures are changed and/or new equipment is added.

### 1.1 Suggested Activities / Examples

**Example No. 1**

- Develop a formal program for initial training of new employees, employees placed in new positions or jobs, and contractors.
- Acquire or develop training materials, e.g., notebooks, videos.
- Select and develop qualified instructors.
- Include appropriate subject matter such as hazard recognition techniques, safe operating limits, SDSs, start-up / shutdown / maintenance procedures and compliance requirements for applicable laws and regulations.
- Develop consistent training plans that combine classroom training with field simulations and on-the-job training.

Suggested deliverables include:

- Documented training requirements for knowledge, skills and abilities for roles.
- Initial, refresher and development training required for each role and individual.
- Training records.
- Verified performance against the required standard.

### 1.2 Self-assessment

- Are all relevant process safety roles identified and their required skills, knowledge and abilities documented?
- Are all employees and contractors trained on site safety systems?
- Do all identified critical training have a requirement for assessment to ensure that the training provided is effective?

## PS-10: Incident Investigation, Reporting and Sharing

Investigation, reporting, appropriate corrective action and effective sharing of lessons to identified Stakeholders of each incident which resulted or could have resulted in a serious process safety incident.

### 1.0 Guidance

A documented procedure shall exist for serious or potentially serious investigations. Learnings from these investigations shall be communicated and documented to a pre-determined audience.

- Lessons learned are available for sharing within the organization.
- Minimum requirements for an investigation shall be implemented as follows;

- Investigation Team Leader (Senior Person), root cause analysis expert and someone who is familiar with the affected process.
- Process for identification of systematic causes

- Preparation of a factual investigation report endorsed by the Team Leader.

Report to management following the investigation stating:
- Incident date.
- Incident description.
- Factors which contributed to the incident.
- Recommendations to prevent recurrence.
- A follow-up system for timely implementation of corrective actions and recommendations.

In addition to these minimum requirements, a procedure should be developed for conducting an investigation and training of people involved in investigation on root cause analysis. All incidents shall be communicated to affected personnel along with the corrective and preventive actions.

## 1.1 Suggested Activities / Examples

**Example No. 1**
- Establish an incident investigation policy.
- Define internally reportable incidents and develop reporting criteria including incident classification.
- Develop an environment where employees feel encouraged, empowered and obligated to report incidents and near misses, and feel safe from retribution.
- Create an incident review committee or other structure, with senior management involvement, to ensure incident reports are acted upon by the company.
- Highlight recommendations from previous incidents that have yet to be implemented.

**Example No. 2**
- Develop an incident investigation program.
- Create incident investigation guidelines.
- Establish investigation team criteria and lists of company resources and sources of special expertise. Provide the necessary tools and guidance for team members.
- Establish a mechanism for tracking incident reports and recommendations.
- Ensure that all incidents are investigated and actions tracked through to completion.
- Provide resources for engaging third-party participation by outside experts and specialists needed because of unavailability of company personnel.
- Communicate lessons learned to all appropriate company groups.

Suggested deliverables include:
- Documented incident investigation management system including near miss.
- Incident root causes identified, together with recommendations for preventing recurrence.
- Data for trend analysis of incidents and causes.
- Documented learning from the incident investigation.

## 1.2 Self-assessment
- Does a procedure for incident investigations exist?
- Are all concerned personnel trained on this procedure?
- Does incident investigation team include at least one person who is trained on how to conduct investigation?
- For process related investigations, does the team have at least one person knowledgeable of the process?

- Are findings shared with the all concerned personnel?
- Are all identified actions tracked until completion and validated?

## PS-11: Audits and Corrective Actions

System for measurement of performance, audits for compliance and implementation of corrective actions to be established.

### 1.0 Guidance

Each site must have internal and external assessments / audits to determine the status and effectiveness of process safety management efforts versus goals and the progress toward those goals. Below are some type of audits:

Process Safety Management system audits verify that the systems are effective in assuring company / plant policies and procedures are being implemented. They also identify opportunities where systems may be strengthened.

Process safety audits provide increased assurance that facilities are being operated and maintained in a way which adequately protects the safety and health of employees, the environment, the surrounding community, plant assets. Audits shall be conducted on all process safety management elements. A more rigorous audit on administrative controls is always helpful and reduces incident rates when actions from these audits are effectively implemented.

Compliance reviews verify adherence to regulations and to company/plant standards and procedures.

Audits should be conducted by trained personnel and partially staffed with expertise from outside the plant being audited to provide objectivity and encourage cross learning.

The most important result of an audit is the identification of deficiencies & opportunities and corrective actions to reduce risk. An action plan to resolve recommendations with assigned responsibilities must be documented. An effective governance system to verify completion and track / report outstanding recommendations shall be developed. Audits shall not only address corrective actions but preventative actions as well.

### 1.1 Suggested Activities / Examples

**Example No. 1**

Establish a program to verify operating facilities' compliance with process safety requirements. The program should:

- Define the physical and organizational scope of the program.
- Commit adequate personnel for performing audits.
- Coordinate Process Safety Code audits with other regular audits, e.g., loss prevention, boiler, environmental, to avoid duplication.
- Establish a system to measure the effectiveness of the audit program.
- Develop lists of corrective measures.

**Example No. 2**
Verify that corrective actions have been implemented in a timely fashion.
- Assign specific responsibilities for correcting identified deficiencies.
- Establish target completion dates along with a resource plan.
- Require documentation of actions that resolve audit recommendations.
- Establish a system to track corrective action efforts. For example, how many were completed last quarter? How many are in progress? How many are behind schedule? How many are under study?
- Establish a priority authorization system for approving resources, i.e., capital items, staff, etc., for process safety related items.

Suggested deliverables include:
- Periodic assessment / audit of system elements against identified performance standards, addressing the manner, degree, quality and effectiveness of implementation.
- Reports of observations, findings and corrective action plans.
- Documented action plan with an action tracking system.

### 1.2 Self-assessment
- Does the organization have an audit / assessment program?
- Are all audit team members trained to conduct audits?
- Does the audit program cover all process safety management elements?
- Are audit findings reported to the management? Are corrective action plans from the findings of audits / assessments tracked through to completion?

## PS-12: Enhancement of Process Safety Knowledge

Establish and support a learning culture of process safety information and knowledge from both internal sources and through established networks.

### 1.0 Guidance
A management system for process safety should be designed for continuous improvement. Safety requirements are becoming more stringent, while knowledge of systems and technology is growing (e.g. consequence modeling techniques). Safe operation of a process plant calls for personnel to stay abreast of current developments, so that decisions on their application can be made on the basis of informed knowledge.

Process safety management (PSM) can benefit from the programs for quality control of production, services, environment, etc. applying an approach that applies the concepts of quality management programs, such as establishing goals, monitoring and reporting of progress (i.e. Plan, Do, Check, Act) to PSM. This can help defend against normalization of deviance.

Many of the programs and resources developed by professional and trade associations can be useful for enhancing process safety knowledge, as tools and support may have been adapted for the specific needs of an industry or sector. Moreover, participation in bodies with a focus on PSM enables access to tools and resources but also to networks of organizations and individuals with specialized knowledge on every aspect of PSM. These bodies include the CCPS and its parent AIChE, API, the CSChE PSM division, MKOPCS and IChemE ..etc

Companies should therefore encourage participation in such bodies, so that they can monitor developments, communicate relevant information to those within the company who could benefit from it, and also provide input to those external bodies.

Safety information should be readily accessible, and thus there is a minimum requirement for a process safety resource system. This may be quite simple for a small organization but should nevertheless contain:

- Material relevant to the design technology and operation of the process;
- A search facility available locally or through arrangement with another organization (e.g. a large reference library accessible locally or via the Internet).
- Examples of material contained in such a system might include:
- Incident reports;
- Plant equipment design data;
- Design practices and specifications;
- Appropriate laws and regulations;
- Trade association information;
- Physical and chemical properties, including reaction kinetics and safe handling information;
- Technical papers;
- Case histories concerning incidents which illustrate PSM principles; and
- Appropriate reference books.

## 1.1 Suggested Activities / Examples

**Example No. 1**

Create on-the-job proficiency tests. Identify specific skill or knowledge deficiencies and provide remedial training. Create special recurrent training programs.

**Example No. 2**

- Provide opportunities for employees to practice their skills in handling abnormal situations.
- Use process simulators as an option to challenge operators to deal with recovery from upset conditions.
- Periodically audit skill inventories and job assignments to ensure that no one is working in a position for which they are not qualified.
- Develop a pool of replacement employees that can substitute in several key positions.
- Review personnel assignments for maintenance turnarounds, vacation schedule relief, and contractors.

Suggested deliverables include:

- A system that managed the continues improvement of the process safety knowledge within the originations utilizing internal and external sources.
- Effective participation and membership in the bodies specialized in the the process safety management.
- Well maintained process safety resource center and reference library.

## 1.2 Self-assessment

- Does the facility have a process safety knowledge resource management system? Resource can be third party consultants / technical membership, etc.
- Does the facility have effective participation and membership in the bodies specialized in the process safety management?
- Does the facility maintain a document controlled source of latest process safety information?

# CHAPTER THREE

**References:**

- PSM Guide 4th Edition, Canadian Society for Chemical Engineering 2012
- Guidelines for Risk Based Process Safety, AIChE, CCPS
- Implementation Guide for Responsible Care® Process Safety Code of Management Practices; American Chemistry Council.
- GPCA-RC-C06, Issue 15-06-2011.
- American Chemistry Council ACC RC 14001®2015TITLE: RESPONSIBLE CARE MANAGEMENT SYSTEM® TECHNICAL SPECIFICATION
- American Chemistry Council RCMS®: 2013

**Definitions:**

- Process safety culture: is the combination of group values and behaviors that determine the manner in which process safety in managed.
- Lagging metrics: An outcome-based and retrospective set of metrics that are based on process safety incidents.
- Leading metrics: A process-based and forward-looking set of metrics which indicate the performance of the PSM key work processes, operating discipline, or layers of protection that prevent incidents.


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