Compliance Assurance Protocol Integrity Management Program for Facilities

VERSION 1.4: November 2023

About the Regulator

The BC Energy Regulator (Regulator or BCER) is the single-window regulatory agency with responsibilities for regulating oil and gas activities in British Columbia, including exploration, development, pipeline transportation and reclamation.

The Regulator's core roles include reviewing and assessing applications for industry activity, consulting with First Nations, ensuring industry complies with provincial legislation and cooperating with partner agencies. The public interest is protected by ensuring public safety, protecting the environment, conserving petroleum resources and ensuring equitable participation in production.

Vision, Mission and Values

Vision

A resilient energy future where B.C.'s energy resource activities are safe, environmentally leading and socially responsible.

Mission

We regulate the life cycle of energy resource activities in B.C., from site planning to restoration, ensuring activities are undertaken in a manner that:

Protects public safety and the environment

Supports reconciliation with Indigenous peoples and the transition to low-carbon energy

Conserves energy resources

Fosters a sound economy and social well-being

Values

Respect is our commitment to listen, accept and value diverse perspectives.

Integrity is our commitment to the principles of fairness, trust and accountability.

Transparency is our commitment to be open and provide clear information on decisions, operations and actions.

Innovation is our commitment to learn, adapt, act and grow.

Responsiveness is our commitment to listening and timely and meaningful action.

Additional Guidance

As with all Regulator documents, this document does not take the place of applicable legislation. Readers are encouraged to become familiar with the acts and regulations and seek direction from Regulator staff for clarification.

The Regulator publishes both application and operations manuals and guides. The application manual provides guidance to applicants in preparing and applying for permits and the regulatory requirements in the planning and application stages. The operation manual details the reporting, compliance and regulatory obligations of the permit holder. Regulator manuals focus on requirements and processes associated with the Regulator's legislative authorities. Some activities may require additional requirements and approvals from other regulators or create obligations under other statutes. It is the applicant and permit holder's responsibility to know and uphold all legal obligations and responsibilities. For example, Federal Fisheries Act, Transportation Act, Highway Act, Workers Compensation Act and Wildlife Act.

Throughout the document there are references to guides, forms, tables and definitions to assist in creating and submitting all required information. Additional resources include:

- Glossary and acronym listing on the Regulator website.
- Documentation and guidelines on the Regulator website.
- Frequently asked questions on the Regulator website.
- Advisories, bulletins, reports and directives on the Regulator website.
- Regulations and Acts listed on the Regulator website.

In addition, this document may reference some application types and forms to be submitted outside of the Application Management System but made available on the Regulator's website. Application types and forms include:

- Heritage Conservation Act, Section 12
- Road use permits
- Water licences
- Master licence to cut
- Certificate of restoration
- Waste discharge permit
- Experimental scheme application
- Permit extension application

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Document Revisions

The Regulator is committed to the continuous improvement of its documentation. Revisions to the documentation are highlighted in this section and are posted to the Documentation Section of the Regulator's website. Stakeholders are invited to provide input or feedback on Regulator documentation to ServiceDesk@bc-er.ca or submit feedback using the feedback form.

Version Number	Posted Date	Effective Date	Chapter Section	Summary of Revision(s)
1.3	May 19, 2022	May 19, 2022	Expectations and Requirements	Updates regarding the Professional Governance Act.
1.4	Nov.29, 2023	Nov.29, 2023	Various	Replace BCOGC with BCER; OGAA with ERAA; new logos, references and associations

Introduction

Permit holders of oil and gas facilities under the Regulator's jurisdiction are required to have a management system based asset-integrity protection program for anticipating, preventing and mitigating hazards and risks of and around their permitted facilities not to affect safety and environment adversely. An Integrity Management Program (IMP) – a preventive documented framework, consisting of a systematic, comprehensive, and proactive set of interrelated processes, enables effective management of asset integrity associated with activities throughout the life cycle of the asset, including design, procurement, construction, operation, maintenance and abandonment activities.

Permit holders' integrity management program for facilities (IMPF) must include policies, processes and procedures to:

- Set relevant company policies and performance objectives,
- Proactively identify hazards associated with process, various types of equipment and components of the facility, controls, and humans, and evaluate risks to people, environment, and the asset,
- Manage the asset risk, through identification and implementation of risk mitigation measures, including conducting inspection, maintenance, and monitoring activities, establish clear responsibilities and accountabilities,
- Ensure personnel are trained and competent,
- Manage documentation, reporting, evaluation and continual improvement.

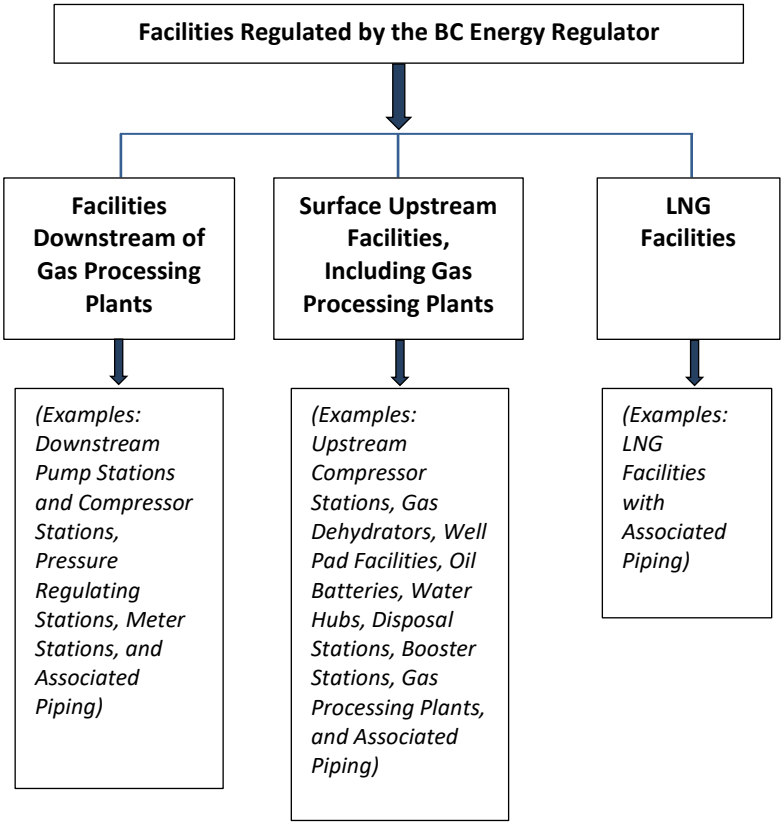
The purpose of this protocol is to provide guidance to facility owners and operators outlining the Regulator's requirements and expectations with regards to developing, implementing and maintaining an integrity management program for facilities (IMPF). This will:

- Ensure safe, environmentally responsible, and reliable operation, and,
- Manage the risks over the entire lifecycle, i.e., planning, design, construction, operation, maintenance, and decommissioning stages.

The requirements and expectations within this compliance assurance protocol apply to all types of facility assets owned and operated by the permit holder within the jurisdiction of Regulator, such as, well pads, gas plants, compressor stations, pumping stations, disposal stations, batteries, and LNG plants. Figure 1 is a non-exhaustive list of facilities regulated by the BCER and covered under this IMPF protocol.

The IMPF requirements also apply to all third-party operated facility assets licensed to a permit holder.

Figure 1: Types of Facilities Covered by the IMPF



Regulatory Standards and References

The BC Drilling & Production Regulation (DPR)[1]

- Section 78.1, requires that a facility permit holder must prepare and maintain an integrity management program and carry out operations in accordance with the integrity management program throughout the life cycle of the facility,
- Section 78 (1.1), requires that a facility permit holder must ensure that all tools and equipment used in facility operations are installed and operated in accordance with the manufacturer's specifications or sound engineering practices.

The BC Liquefied Natural Gas Facility Regulation (LNGFR)[2]

- Section 8 and Section 22 of LNGFR requires an LNG facility permit holder to develop and implement an Integrity Management Program, in accordance with CSA Z276[3],
- Subsection 3(1)(d) of the LNGFR requires the permit holder to establish facility hazards through a hazard identification study as well as carry out a process hazard analysis and a safety integrity level study prior to construction of the facility.

The BC Oil and Gas Processing Facility Regulation (OGPFR)[4]

- Section 33(1)(c)(i), requires that a gas processing plant permit holder must, until March 4 2022, continue to carry out operations in accordance with the integrity management program that applied to the gas processing facility under the Drilling and Production Regulation immediately before March 4, 2021.
- Section 6(2)(b)(iii), (iv) requires a processing facility permit holder must ensure that the management system for the processing facility includes:
    - An integrity management program that details the processes and procedures to maintain structures and equipment of the processing facility to avoid the failure of those structures and that equipment, and
    - A management of change program that details the processes and procedures to identify and manage any change that could adversely affect safety, security or environmental protection,
- Section 26(a) requires a processing facility permit holder must keep maintenance records under the integrity management program showing:
    - The date and type of each inspection, testing and maintenance activity performed on each component, and
    - The date that a component is placed into and, if applicable, taken out of service.

[1] BC Drilling & Production Regulation (DPR), 2018.
[2] BC LNG Facility Regulation (LNGFR), 2020.
[3] CSA Z276, Liquefied Natural Gas (LNG) – Production, storage, and handling, 2018.
[4] BC Oil and Gas Processing Facility Regulation (OGPFR), 2021

Flexibility and Scalability

All aspects of the IMPF are intended to be scalable for facility operators of varying size and scope. In cases where a permit holder is already operating under its own IMPF procedures, the permit holder shall ensure that the existing program/system meets all of the requirements outlined in this protocol. The IMPF is intended to be applied with flexibility to account for the existing internal programs and processes that already cover issues relating to the IMPF. This protocol serves as a basis of comparison and review between the Regulator's protocol and the permit holder's programs/systems.

Terminology

The terminology used within this protocol is consistent with CSA Z662[5], CSA Z276, as well as other referenced standards and recommended practices, including the Energy Resource Activities Act (ERAA) and subordinate regulations. Where there is a difference between terminologies, the definitions in ERAA and the subordinate regulations apply.

Within this protocol, the imperative terms "shall" and "must" have been used to refer to expectations /requirements that are mandatory. The permit holder must indicate how they meet mandatory regulatory requirements and standards that have been adopted by reference in regulation. The non-imperative term "should" implies that described requirements are non-mandatory. Permit holders may describe how they address such non-mandatory requirements within their IMPF, but there is no mandatory requirement to do so.

Safety Culture

Safety culture is the shared values, attitudes, beliefs, and behaviors that leaders and individual personnel of an organization holds in regards to safety and risk, which may positively and negatively influence safety and environmental protection outcomes (as per NARWGSC 2016[6]). As per CSA Z662 Annex A Clause A.1, awareness and understanding of safety culture enables better anticipation and management of system hazards and risks. Safety culture and implementation of management systems such as integrity or safety and loss management are positively correlated with each other.

The Regulator has been working closely with the North American Regulators Working Group on Safety Culture (NARWGSC) since 2014 to explore ways of improving safety performance. A more efficient method to conduct a safety culture assessment is in combination with a safety management or integrity management audit. Therefore, the attributes of a strong safety culture have been incorporated within the compliance assurance process for IMPs.

[5] CSA Z662, Oil & Gas Pipeline Systems, 2019

[6] NARWGSC, North American Regulators Working Group on Safety Culture: Safety Culture Indicators Research Project: A Regulatory Perspective, 2016.

A positive safety culture is indicated when an organization embraces the following twelve attributes (indicators):

1. Safety as a core value;
2. Leadership and management commitment to safety;
3. Goals and key performance indicators (KPIs) measurement;
4. Positive attitude towards legal and systems compliance (meeting and exceeding minimum standards);
5. Employees training and competency
6. Employees empowerment and accountability;
7. Open and honest communication at all levels;
8. Systemic consideration of risk;
9. Managing changes when necessary;
10. Non-punitive reporting;
11. Learning from events; and
12. Continual improvement.

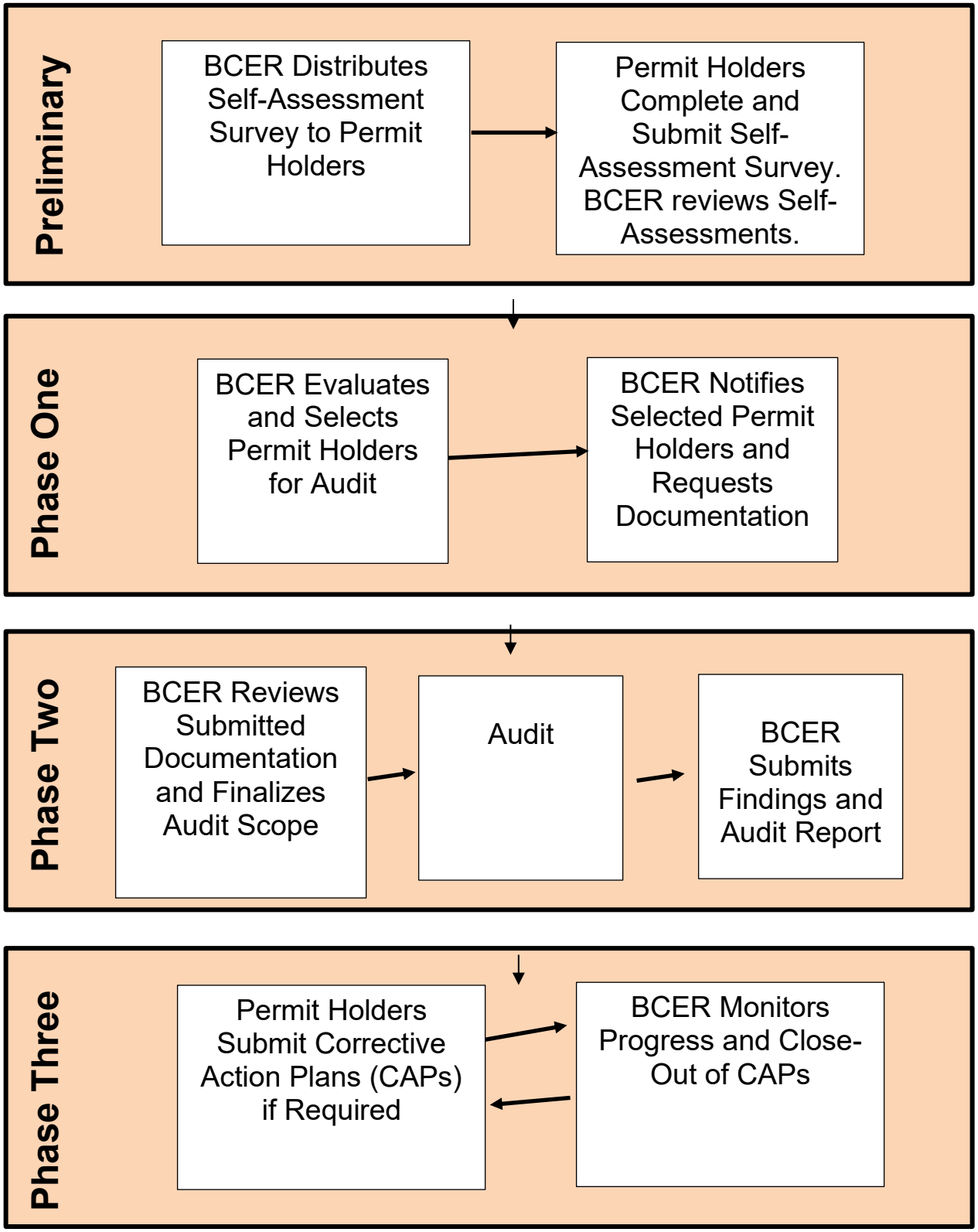
Compliance Assurance Process

The Regulator's compliance assurance protocol outlines the expectations and requirements for IMPF and standardizes the expectations for developing, documenting and implementing an IMPF. This protocol is based on the framework for an IMP outlined in the CSA Z662, Annex N.2, as well as the contents presented in CEPA's Recommended Practice[7] for an IMPF and other references [8] [9] [10] [11] [12] [13] [14].

The Regulator's compliance assurance process for facility IMPs is standardized and documented within this compliance assurance protocol. The process contains three phases as illustrated in Figure 2.

[7] CEPA – Facilities Integrity Management Program, Recommended Practice, 1st Edition, 2013.
[8] NEB - Pipeline Performance Measures Reporting Guidance, 2014.
[9] Guidelines for Mechanical Integrity Systems, Centre for Chemical Process safety of AIChE, 2006.
[10] AB – 512 – Owner-User Pressure Equipment Integrity Management Requirements, 2020.
[11] CAPP Safety Guide for Small, Portable Oil & Gas Production Facilities, 2014.
[12] National Energy Board (NEB) Management System and Protection Program Audit Protocol, 2013.
[13] CSA Z767 Process Safety Management, 2017.
[14] PRCI IM-2-1 Facility Integrity Management Program Guidelines, 2013

Figure 2: Compliance Assurance Process – Integrity Management Program



Permit Holder Self-Assessment

On a biannual basis, the Regulator requests that all permit holders complete and submit an IMP self-assessment. The self-assessment provides the Regulator with a snapshot of the permit holder's IMP that can be used to help inform audit scope, permit holder selection and industry trends. In addition, the self-assessment provides information to permit holders about the Regulator's expectations for IMP content and scope.

Phase One

Each year a number of permit holders are selected for audit based on the Regulator's criteria for permit holder selection. Permit holder selection is based on the following factors:

- Permit holders with active facilities are eligible for selection.
- Permit holders are typically audited every 5 years at a minimum.
- Additional audits may be scheduled based on changes in operations such as acquisitions of a significant number of new facilities, incidents and permit holder compliance performance.
- Where possible, corporate entities that are managed under the same overarching IMP program will be audited together for efficiency.
- Where possible, pipeline and facility IMPs for the same permit holder will be audited together for efficiency.

The Regulator notifies all permit holders in Q1 of the calendar year that they have been selected for IMP audit and requests any records that are required to prepare for the audit. Permit holders are usually given 30 days to provide the requested records.

Phase Two

The second phase of the assurance process involves an audit that the Regulator organizes with each of the selected permit holders. The scope and duration of the audit are selected based on previous audits, permit holder compliance history, the scale and risks associated with the permit holder's facilities and a review of submitted documentation. The audit scope will normally be as follows:

Baseline Audit: The baseline audit is the first IMP audit and will cover all required components of an IMP. The goal of this audit is to conduct a baseline assessment of the permit holder's IMP and to identify and address any significant gaps.

Primary Audit: The primary audit follows the baseline audit. The primary audit includes an in-depth review of the core components of an IMP:

- General IMP (scope)
- Risk Assessment
- Competency and Training
- Management of Change
- Operational Control

- Inspection, Maintenance and Monitoring (IMM)
- Evaluation of IMM Results
- Modification and Repair
- Incident Reporting

Secondary Audit: The secondary audit includes an in-depth review of the management system components of the IMP:

- Leadership Commitment
- Goals, Objectives and Targets
- Planning
- Organizational Roles and Responsibilities
- Communication
- Information Management
- Internal Audit
- Performance Measurement and Analysis of Data
- Management Review

The audit entails confirmation of audit scope, systematic review of processes, records, documents to verify compliance, and generation of audit findings. The findings include compliance and good practices along with their supporting evidence, areas where additional information may be required, opportunities for improvement, and observed non-compliances.

Findings of observed non-compliance are outlined and confirmed at the end of the audit. After the audit, the Regulator will issue the summary of findings identified as non-compliances to the permit holders.

Compliance and non-compliance are defined below:

Compliance (C) A particular component fulfills the requirements outlined under the compliance assurance protocol. The permit holder has demonstrated that its IMPF program, processes, or procedures meet the regulatory requirements.

Non-Compliance (NC) A particular component does not fulfill the requirements outlined under the compliance assurance protocol. The permit holder has not demonstrated that its IMPF program, processes, or procedures meet the regulatory requirements.

Depending on the criticality of any findings from Phase Two or independent of the annual IMPF process, the Regulator may evaluate certain elements of a permit holder's IMPF in further depth.

Phase Three

The third phase of the compliance assurance process requires permit holders to develop and implement corrective actions (any changes needed to programs, processes, procedures, or instructions) to address identified non-compliance findings and submit a Corrective Action Plan (CAP) to the Regulator. A CAP must also outline a schedule for implementation. The Regulator will continue to monitor and assess corrective actions until they are fully resolved. The Regulator may arrange compliance verification activities to ensure that corrective actions defined within the CAP have been implemented.

The permit holders that do not provide the required documentation/records for any of the phases will be subject to the Regulator's compliance and enforcement actions, which can include orders or administrative penalties, as applicable.

The Regulator's compliance assurance protocol is maintained by the Integrity Group. For further information please contact integrityengineering@bc-er.ca.

Framework

The Regulator's compliance assurance process for IMPF aligns with the management systems approach as per CSA Z662 Annex A and applies to the entire life cycle of facilities, as illustrated in Figure 3. The relation between the various life cycle phases and the impacts of various activities on integrity need to be identified. All hazards (including potential hazards) to the integrity of the facilities shall be identified. Risks shall be determined and controlled (through prevention and mitigation strategies) throughout the life-cycle phases of the facilities and risk shall be reviewed at handover from each phase through the integrity life cycle.

Program and other evaluations may be conducted at different corporate levels, at a system level to gauge one facility's performance against other facilities within the organization, or for selected facility assets with similar characteristics. Effective program evaluations shall include all aspects of a Permit holder's IMPF.

Expectations and Requirements

All submissions made to the Regulator in support of an application or a regulatory requirement that include work relating to the practice of professional engineering or professional geoscience are expected to accord with the Professional Governance Act, [SBC 2018], c. 47 and the Bylaws of Engineers and Geoscientists British Columbia (EGBC). This includes any requirements relating to authentication of documents.

The Regulator's requirements and expectations for IMPF have been developed based on CSA Z662, Annex N.2. They are aligned with management systems as per Annex A and covers the entire life cycle of pipeline systems. The five main components are further classified into 15 sub-components:

Planning

Leadership Commitment

- Scope
- Policy and Commitment
- Goals and Objectives
- Planning

Risk Assessment and Management

- Process Knowledge and Information
- Hazard Identification
- Risk Assessment
- Risk Tolerance
- Risk Reduction and Management
- Risk Assessment Review and Update

Implementing

- Organizational Structure, Roles and Responsibilities
- Communication Process
- Training and Competency
- Information Management - Documents and Records Control
- Managing Change
- Operational Controls

Risk Management

- Inspection, Monitoring and Maintenance
- Evaluation and Fitness-for-Service Assessment

- Modification and Repair

Checking

Program Assessment and Evaluation

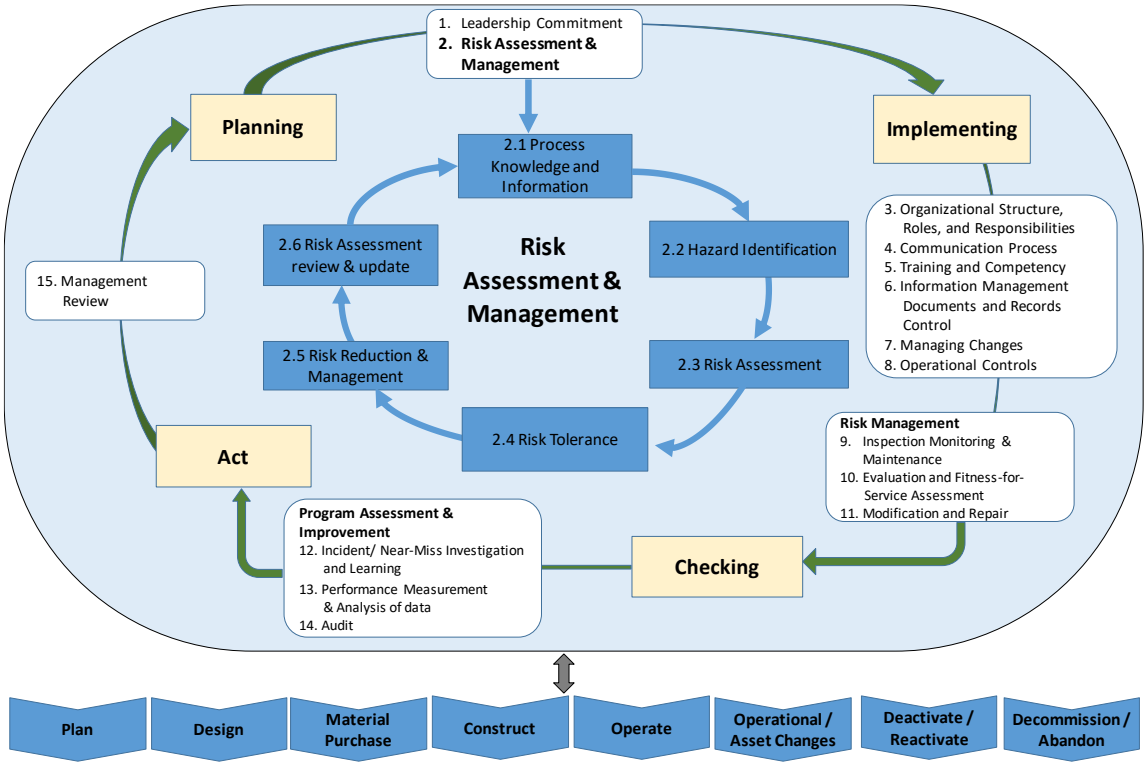
- Incident/Near-miss Investigation and Learning
- Performance Measurement and Analysis of Data
- Audit

Act

Continuous Improvement

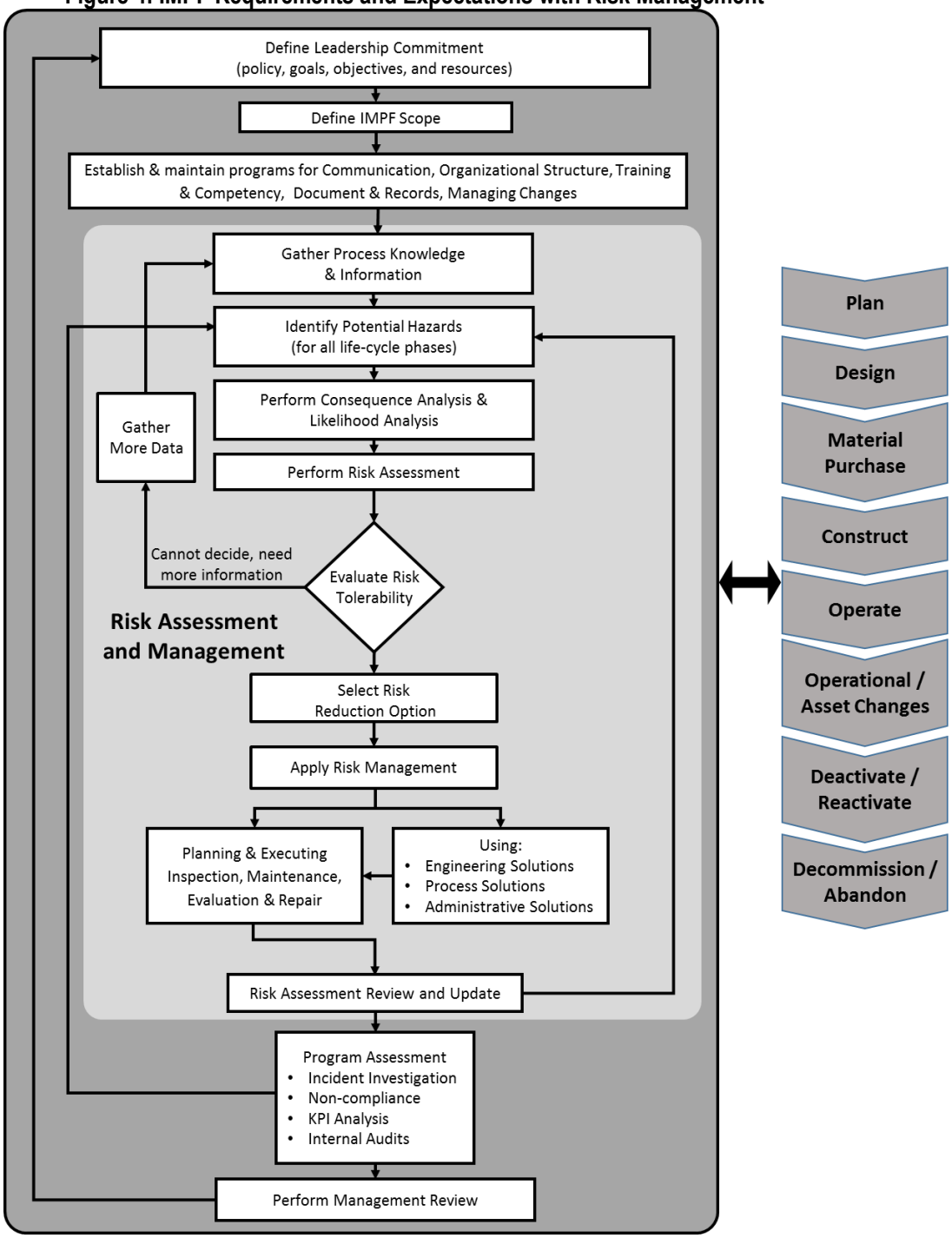
- Management Review

Figure 3: Integrity management program for Facilities with Management Systems Approach



IMPF requirements and expectations related to risk management are graphically presented in Figure 4.

Figure 4: IMPF Requirements and Expectations with Risk Management



PLANNING

1. Leadership Commitment

1.1 General IMPF

The permit holder shall document, establish and maintain the IMPF, as an overarching document, and ensure the effectiveness of the IMPF. The IMPF shall encompass all types of facility assets owned and operated by the permit holder within the jurisdiction of the Regulator. The permit holder shall clearly identify the facilities / equipment, and the processes managed under the IMPF, such as, facility piping; fixed, rotating and hydraulic equipment; aboveground and belowground storage tanks; instrumentation (measurement) and control; fire and safety; and structural and mechanical. Any facilities and equipment covered by other programs or documentation within the scope of the IMPF shall be appropriately referenced. Any existing reliability programs and prescribed equipment management programs can be referenced by the IMPF, and may continue to exist with the appropriate linkages to IMPF processes, such as, programs for pressure vessels, electrical controls and elevating devices.

The Permit holder can refer to CEPA's FIMP for additional guidance on developing a description of facilities within the IMPF.

The permit holder's IMPF document shall clearly specify if it applies to third-party operated facility assets. The permit holder must ensure that third parties are fulfilling contractual agreement requirements with respect to facility integrity.

1.2 Policy and Leadership Commitment

The permit holder's senior leadership shall articulate policy and leadership commitment to its IMPF. The permit holder shall establish and maintain leadership commitment to its integrity management systems for facilities, overall goals and objectives, providing resources, fostering risk management processes, and implementing and continually improving the integrity management program, through a positive safety culture.

Senior leadership (a person or a group of people who direct and control the highest level as defined by permit holder), shall sign and communicate policy and commitment within the organization to ensure safety and integrity.

1.3 Goals, Objectives and Targets

The permit holder's senior leadership shall establish goals and objectives for its IMPF. The objectives shall be consistent with the overall safety policies and objectives (corporate direction). The objectives and targets shall be measurable and must link to the high level performance measures (key performance indicators).

1.4 Planning

The permit holder's management (a person or group of people who directs or controls all or part of the facility and has assigned responsibility and accountability for compliance with legal and other applicable requirements) shall ensure that:

- Processes and procedures are defined to support the execution of all the key components of the IMPF,
- The methods for collection, integration and analysis of information related to the processes and mechanisms appropriate to the type of facility and operation shall be considered and be consistent with Figure 3,
- A process is defined to identify and ensure conformance with up-to-date regulatory and legal requirements, external standards and codes,
- Plans, processes and procedures are integrated to ensure that data and results are shared (internally and externally), across relevant elements, processes, and teams as required, and,
- Resources (personnel and technological requirements) are planned and provided to manage risk and to develop, implement, and continually improve the IMPF.

2. Risk Assessment and Management

The permit holder must ensure that the facility inventory data are gathered and integrated to support the Risk Assessment. The Permit holder shall develop a documented process to identify hazards associated with their processes and to evaluate risk of those processes – to make certain that risks to employees, the public, and the environment are consistently controlled within the permit holder's risk tolerance. The levels of risk broadly tolerable or as low as reasonably practicable (ALARP) shall be defined and documented. The risks shall be reassessed on a periodic basis, whenever there is a change to facility operation or operating environment that is different from previous risk assessment situations.

The permit holder must apply risk assessment at the early stages of facility development to foster an inherently safer design at lower cost and lower risk.

Detailed risk assessments shall be carried out by personnel (internal or external) who have relevant and specialized industry experience and training in carrying out risk assessments.

The permit holder can refer to PRCI's FIMP Guidelines for additional guidance on risk assessment.

2.1 Process Knowledge and Information

All facility data, from planning to commissioning phases, shall be gathered, maintained, and updated, and relevant information related to mitigation aspects shall be passed over to operational and integrity management personnel. The permit holder shall have information on the type of equipment, the purpose, dimension, material properties, function, and location of each piece of equipment, and equipment typical and operating conditions. The facility inventory data should also include processes, and facility design for all phases, from safe design, through construction, operation, maintenance, and decommissioning. Information related to processes and equipment could be:

- Design basis,
- Process chemistry,
- Plot plan,
- Electrical area classification,

- Process flow diagrams,
- Piping and instrumentation diagrams (P&IDs),
- Pressure relief systems (e.g., flare systems, depressurizing systems, relief devices),
- Description of control systems,
- Shutdown keys (emergency and regular operations),
- Hazardous effects of inadvertent mixing of different materials;
- Material and energy balances,
- Safe operating limits (e.g., levels, temperatures, pressures, flows, time, cycles, and compositions) and an evaluation of the safety consequences of deviations, and,
- Process risk assessments.

Information required for hazard identification of all materials used in the process could be related:

- General physical properties,
- Corrosivity,
- Reactivity,
- Flammability data,
- Polymerization characteristics,
- Decomposition data,
- Impurities data,
- Thermal and chemical stability data,
- Toxicity data including both acute and chronic effects, and,
- Special hazards, including
    - Shock sensitivity,
    - Pyrophoric properties,
    - Maximum deflagration or detonation pressure and flame speeds under all operating conditions, and,
    - Bio-hazards.

Facility permit holders shall identify the types of facilities and the standards and guidelines (such as API, ASME, CSA, other) to which they design, construct, and operate their facilities.

2.2 Hazard Identification

All hazards and hazardous scenarios at each life cycle phase shall be identified and documented using appropriate hazard identification techniques. The hazards considered in the hazard identification process shall be chosen based on a systematic hazards identification analysis that covers the entire facility and all materials, infrastructure, systems and activities.

A wide range of hazard identification techniques are available. The CSA Z662 as well as US DOE handbook[15] provide relevant guidance regarding the hazard identification process. Documentation could include a description of the scenario pathway (including event linkages and interdependencies), previous incidents at the facility, hazards that may be introduced as a result of changes made at the facility, or safeguards and controls that are in place to reduce the probability or magnitude of the consequence.

2.2.1 Facility Projects

Hazard reviews shall be completed for appropriate stages in the design, construction and start up of the project/facility before proceeding to the next level.

- At the planning stage, hazard and risk associated with the siting and installation phase should be assessed (using methods such as HAZID, consequence analyses of major credible accident scenarios, and risk criteria).
- Siting decisions and plot plans should consider the associated hazards and mitigation such as distance from waterbodies, buffer zones, natural hazards, and transportation related hazards (using methods such as qualitative risk analysis, HAZOPs and determination of safety integrity level requirements, preliminary quantitative risk analysis or detailed consequence assessment).
- The design process should have appropriate reviews and approvals at various design stages (using methods such as qualitative risk analysis, detailed Quantitative Risk Assessment (QRA), detailed HAZOPs, and vendor HAZOPs). The design process should consider inherent safety, regulatory requirements, codes and standards and good engineering practices.
- Controls shall be in place to ensure fabrication, installation, and construction conform to design specifications, standards and codes,
- Controls shall be in place for managing changes to the project scope, design, construction, and approvals.

[15] Chemical Process Hazards Analysis, an US DOE Handbook – 1100, 2004.

- As-built documentation shall reflect the exact details of the built facility to ensure that any future changes are being applied to known approved designs.

2.2.2 Process Operations

The permit holder shall maintain a process to identify and document hazards associated with their processes and the hazardous scenarios associated with the activities of the facility, resulting from operations, operating environment, and changes to the operating conditions (using methods such as revised QRA, management of change HAZOPs, or revised hazards analyses).

Facilities and equipment where potential interaction of hazards can increase risk must be identified.

2.3 Risk Assessment

Risk is the combination of the consequence and the likelihood of an undesired event. After having identified all possible hazards and scenarios, the permit holder shall assess the hazards and the degree of risk associated with these hazards as a function of likelihood and severity.

Risk can be determined either qualitatively or quantitatively using appropriate techniques/approaches, such as, FMEA (Failure modes and effect analysis), FMECA (failure modes, effects and criticality analysis), RCM (reliability centred maintenance), RBI (risk-based inspection), Fault tree, Markov analyses, and Structural Reliability Analysis.

In general, four of the most critical factors in selecting risk assessment methods are availability of data, organizational maturity, goals, and the magnitude of the decision associated with the risk analysis.

2.4 Risk Tolerance

The Permit holder shall set the criteria for risk tolerance that is relevant and consistent with the policies, goals and objective of an IMPF and the company. Prior to establishing risk criteria, the permit holder should consult appropriate internal and external stakeholders and relevant standards and regulations.

2.5 Risk Reduction and Management

Based on the risk assessment process, a facility permit holder shall prioritize facilities or equipment and shall implement risk reduction and control measures to prevent, mitigate, and manage risk where a chosen threshold or tolerance is exceeded. The permit holder shall:

- Develop a schedule for risk reduction measures, and,
- Track the implementation of such measures to completion.

Reduction of risk through mitigation could be approached by:

- Taking measures to reduce the probability of occurrence & severity of a given hazard, and,
- Reducing potential consequences, by influencing outcomes, should an event occur.

Companies should review mitigation measures appropriate to their facilities and consider the following three main types of measures:

- Engineering solutions that manage risk primarily through technology or the facility/equipment design specifications: e.g. valve seal design, facility equipment material specifications and upgrade, such as stainless steel or titanium,
- Process mitigation solutions that rely on managing facility/equipment operational conditions, such as modifying operating parameters, like pressure or temperature, to mitigate internal corrosion and reduce consequence, and,
- Administrative mitigation solutions that are primarily procedural, such as training competency development, facility patrol and frequency, improved public awareness programs, site security and monitoring practices, and improved emergency response procedures.

2.6 Risk Review and Update

2.6.1 Risk Assessment and Review

Risk assessment shall be reviewed at least annually and updated as required:

- When design and operation of the system changes,
- When facility environment changes,
- In response to incident investigation or mitigation failure,

- Information gained from operations and maintenance, inspection and testing, and integrity evaluations,
- When significant risk is determined or uncertainty of data exists, the permit holder must:
    - Perform a more refined level of risk analysis in an attempt to reduce the possibility of risk level overestimation. Risk analysis refinement should include but is not limited to the following:
        - Selection of a more rigorous approach for the analyses and estimates,
        - Additional observations and analysis of the operating conditions, and,
        - Inspections to provide more accurate and detailed information about the presence, location and severity of identified hazards.

2.6.2 Risk Management Review

After risk reduction measures are selected and implemented, risk management results shall be reviewed at least annually to ensure that risk reduction measures are effective and risk is reduced to a tolerable level.

IMPLEMENTATION

3. Organizational Structure, Roles and Responsibilities

The permit holder's IMPF shall include a suitable organizational structure, with well-defined responsibilities and authorities to establish and maintain an effective IMPF. The integrity management program shall involve personnel within a facility's maintenance, operations, and engineering departments. Key responsibilities of managers and supervisors in the integrity management program for facilities shall be to ensure:

- Knowledgeable personnel are performing appropriate activities using effective engineering and decision-making tools and methods,
- IMPF activities such as inspections are being executed and managed as planned, and,
- Appropriate controls are implemented and maintained within the integrity management system for all related activities.

4. Communication Process

The permit holder shall establish and implement an effective process for internal and external communication to coordinate information essential to the IMPF. The permit holder shall promote cross-functional and interdepartmental communication for decision, analysis and reviews. The communication process should consider what to communicate, when to communicate, how to communicate and with whom to communicate. Permit holder shall evaluate the effectiveness of its communication process.

5. Training and Competency

The permit holder shall establish, implement and maintain a process for developing competency requirements and enabling training of employees including contract employees) responsible for administrating and executing IMPF related activities, including operation and maintenance of the facilities. Training can include formal classes and education, on the job training, formal mentoring and self-directed learning. Training schedules and frequency must be maintained for all identified critical tasks by developing a training matrix for employees. Competency is the demonstrated ability to apply training, experience and knowledge in the execution of duties.

The permit holder shall have an established and implemented process for verifying that employees and other persons working with or on behalf of the Permit holder are trained and competent to perform their duties in a safe manner. Methods for collection and maintenance of training records must be clearly documented. Supervisors and employees shall review the training needs periodically to address latest developments and best practices. The training program review shall also ensure that it is relevant, practical and meets the IMPF needs.

The permit holder must have a process in place to evaluate and select contractors on the basis of ability and qualifications to perform specified duties. The evaluation process should include review of safety and environmental policies, procedures, past performance, ability and qualification check through audits, work-site inspections, and observations of performance as appropriate. The permit holder must also have a process in place to ensure that the performance requirements and expectations are defined and communicated to the contractor. The permit holder must have a process in place to monitor and assess contractors' performance, provide feedback and ensure that identified deficiencies are resolved.

6. Information Management Documents and Records Control

The permit holder shall establish and implement information and knowledge management process related to its IMPF. The permit holder shall establish, implement and maintain a process for managing documents and records needed for the effective implementation of IMPF activities during different stages of the facility life cycle, e.g., design, material selection, purchasing, construction, operation, maintenance, and decommissioning. The document and record management process shall encompass creation, security, updating, retention, retrieval and deletion of all information and records necessary for effective operation of the IMPF. It must apply to electronic and paper-based documents and records.

Responsibilities for document approval and re-approval shall be specified and shall identify appropriate controls to ensure that documents required by the IMPF include revisions and updates.

The process for records shall consider:

- Responsibilities and procedures for creating, gathering, updating, retaining, and deleting records,
- Evidence of past activities, events, changes, analyses and decisions,
- Index describing the types, forms and locations of records, and,
- Retention policy as otherwise required by legal and other applicable requirements.

Information related to location, construction records, operating conditions, inspection, testing and maintenance records, and facility incidents are considered as the minimum data necessary to support an IMPF.

Where records are incomplete due to asset transfers or other reasons, the permit holder shall acknowledge and provide information on how the IMPF is managed in the absence of these records and what reasonable actions are taken to recover, reproduce or revalidate the needed records.

7. Managing Change

The permit holder must develop and implement a systematic process for identifying, evaluating, controlling and documenting any change to facility design, specification, operations, standard, organization or activities and legal requirements to ensure that no unforeseen new hazards are introduced and that the risk of existing hazards to employees, public, or the environment is not unknowingly increased. This shall include the changes that are initiated and controlled by the operating company and also those that are not initiated and controlled by the permit holders.

Temporary or permanent changes initiated and controlled internally by the permit holder, including:

- The ownership of a facility,
- The organization and personnel of the Operating Company,
- The organization and personnel who operate and maintain the facility,
- Facilities, equipment, process chemical, process technology and control systems,
- Facility operating status, such as idling, facility shutdown, or decommissioning can introduce "temporary" hazards not expected during normal operations;
- Operating conditions,
- Product characteristics, and,
- Methods, practices, and procedures related to facility integrity management.

Changes initiated and controlled by external stakeholders:

- Standards and regulations related to facilities integrity management,
- Other installations (e.g., power lines) that cross piping and other equipment or facilities,
- Environmental factors, such as flood, fire, ground movement (if changes to the facility must be made to account for these factors), and
- Adjacent land use and development.

Not all changes are managed using the same procedure/process and therefore do not necessarily reside in the IMPF. Appropriate change control processes, such as Management of Change (MOC), shall be developed and implemented and the scope of MOC processes shall be clearly defined. The primary focus of MOC should be to manage risks related to design changes and modifications to equipment and process.

The MOC process shall address and document:

- Identification process for anticipated and actual changes,
- What constitutes a change (temporary or permanent) and what falls under replacement in kind, which is not subject to MOC,
- Reasons for change,
- Responsibilities and authorities for approving and implementing changes,
- Analysis of implications of the changes,
- Impact and risk of the changes,
- Communication method and associated records and documents,
- Timing of changes (approval and implementation), and,
- Close outs.

Changes that are managed through other corporate programs and processes shall be referenced to the IMPF as appropriate. For a change to be "replacement in kind" it should meet the original technical specifications of the system or equipment.

A process shall be developed and implemented for managing changes related to end of service requirements to dismantle, decommission, and dispose of equipment, and for operational waste.

8. Operational Controls

The permit holder shall establish and maintain procedures for the safe operation of each facility and address the initial start-up (new or modified facilities), normal operation, temporary operation, emergency operation (including shutdowns, start-up and restoration following maintenance or outage), identifying operating limits, alarm management, and control room operations. The permit holder shall ensure that the control room operators have the necessary tools, knowledge, training, and resources available to maintain safe operations of the facilities. The operational controls must also address hazards, risks, training, and communication.

To ensure integrity of facilities the permit holder must ensure that:

- Facilities have inherently safer designs,
- Facilities are manufactured, fabricated, installed consistent with applicable requirements, regulations, and standards,
- Quality control procedures are maintained for materials and construction, and,
- Inspection and construction inspection procedures and records are maintained.

9. Inspection, Monitoring and Maintenance

The permit holder shall document and maintain inspection, monitoring, and maintenance (IMM) programs that are appropriate for its facilities and are in accordance with applicable codes, standards, regulations, and the risk assessment process.

Some inspection standards, such as API 570[16] and API 653[17], now include provisions for determining inspection requirements based on risk. API RP 580[18] provides guidance on developing a risk based inspection program. Additional details on risk-based inspection methodology can be found in API RP 581[19]. Risk Based Inspection (RBI) is a supplemental risk assessment and management process focused on mechanical integrity which can be used to determine inspection strategies to manage risk for certain types of equipment. There are benefits to RBI, however due care and consideration is necessary, since incorrect risk assessments can lead to an inadequate inspection strategy and potentially hazardous scenarios.

Selection of IMM activities shall ensure that new hazards are not introduced. IMM activities vary from facility to facility depending on the type and complexity of the facility. Planning, scheduling, and frequency of IMM activities should consider parameters such as risk assessment results, effectiveness of inspection method and technology, previous integrity reviews, incident history, insufficient documentation, evaluation of anomalies, manufacturer's specifications, time dependent consideration, current state of facility/equipment, and industry data. The permit holder shall document schedules and ensure that the planned activities are carried out using relevant methods and procedures, and that incomplete work and issues are resolved. The Permit Holder's records must provide details of actual IMM activities that have been performed versus planned and future IMM activities schedules are planned accordingly. The permit holder shall ensure that the results of its IMM activities are integrated with data for its risk assessment and performance measures.

[16] API 570 – Piping Inspection Code, In-service Inspection, rating, repair and Alternation of Piping Systems, 2016.
[17] API 653 – Tank Inspection, Repair, Alteration, and Reconstruction, 2014
[18] API RP 580 - Risk-based Inspection, 2016.
[19] API RP 581 – Risk-based Inspection Methodology, 2016.

10. Evaluation and Fitness – for – Service Assessment

Through the execution of planned IMM activities, if any anomalies are identified, the permit holder shall carry out further inspections and investigations as appropriate, or undertake an Engineering Assessment (EA), such as Fitness-for-Service (FFS) Assessment, to evaluate severity of these anomalies and determine the required actions. A Fitness-for-Service assessment is a multi-disciplinary approach to determine whether a facility asset is fit for continued service. The asset in question may contain flaws or other damage, or may be subjected to more severe operating conditions than anticipated by the original design. The asset may be subject to time-dependent damage mechanisms. The outcome of a FFS assessment is a decision to run as is, set future inspection intervals, re-rate, alter or repair the facility asset. API 579-1[20] is a leading FFS standard that provides procedures for performing proper evaluations for existing facilities and equipment used in the oil and gas industry. The document contains sections for assessing procedures for preventing damage mechanisms such as brittle fracture, general metal loss, local metal loss, pitting corrosion, blisters, laminations, weld misalignment, crack-like flaws, creep damage, and fire damage. The CSA Z662 also provides relevant guidelines for evaluation of imperfections and anomalies found from the inspections. There are also other standards/technical documents that provide necessary guidelines to carry out an FFS.

[20] API 579-1/ASME FFS-1, Fitness-for Service, 2016.

11. Modification and Repair

When a permit holder identifies situations where modification or repair are required (as a result of an incident and / or the evaluation of inspection and monitoring activities), then the permit holder shall identify and document relevant corrective actions that are acceptable and appropriate for its facilities considering the service conditions. Repair methodology, processes, and records must be documented and maintained by the permit holder. Repair procedures shall be consistent with the requirements of the applicable codes, standards and regulations. Facility permit holders must take due care and consideration to ensure repairs are completed safely, designed appropriately, and executed correctly.

CHECKING

12. Incident / Near-miss Investigation and Learning

The permit holder shall document and implement its process to report, collect, investigate, and trend any hazards, potential hazards, incidents or near misses, and incidents affecting or having the potential to affect the integrity of their facilities.

The permit holder shall establish, implement and maintain a process for incorporating lessons learned from incidents and near-misses within the organization and from across industry where warranted into standards, procedures, and processes to mitigate systemic development of similar circumstances and to improve the effectiveness of the IMPF. In addition, any mitigation/repair corrections resulting from near misses and incidents applied to local facilities shall be reviewed for applicability to a broader scope (either geographically or by equipment type).

Records of investigations shall be maintained and communicated as necessary.

13. Performance Measurement and Analysis of Data

The permit holder shall establish and maintain a documented process to identify metrics or key performance indicators (KPIs) to measure the performance of its IMPF. Process for periodically reviewing, evaluating and trending facility performance through relevant Key Performance Indicators (KPI) shall be established and maintained. The permit holder shall take corrective actions when adverse trends are identified and shall update KPIs as required.

The permit holder shall develop and maintain both leading and lagging metrics (KPIs). The performance review through KPIs should also link to the management review process

Leading Indicators:

Process-oriented metrics that measure accomplishment and effectiveness of key work processes, programs, activities, operating discipline, or protective barriers to control risk and prevent incidents. These indicators provide insight into how well various components of the IMPF have been implemented and also give an indication of potential problems or deterioration in key safety systems early enough that corrective action can be taken.

Lagging indicators:

Outcome-oriented metrics that enable detection of events that have already occurred and can indicate potentially recurring problems. These indicators provide data about incidents and failures of IMPF activities as well as deficient performance of facility assets.

An appropriate mix of leading and lagging indicators performance metrics (KPIs) may include the following metric categories:

- IMPF program component implementation metrics identify potential organizational or program related inadequacies or failures that may contribute to incidents, thus leading indicator,
- Process / operational activity metrics (KPIs) monitor the surveillance and preventative actions undertaken; thus leading indicators,

- Operational deterioration metrics are operational and maintenance trends that indicate when integrity of the system is reduced, thus it could be leading or lagging,
- Failure measures indicate that the undesirable outcomes have occurred and the ultimate objective of the program has not been achieved, thus lagging. These indicators hopefully indicate progress towards goals.

The permit holder may follow the guiding principles outlined in API RP 754[21] for developing performance metrics (KPIs).

Examples of facilities specific leading KPIs:

- Percentage of training and competency needs assessments completed to individuals in key integrity related roles,
- Percentage of training sessions completed with skills verification,
- Number of key IMPF roles with competency criteria defined,
- Percentage of employees who participate in continuing education and symposia for enhancement of safety knowledge and technological innovation,
- Measurement of employee morale and level of expertise,
- Percentage of new projects emphasizing on inherently safer design,
- Percent of facility asset attribute errors found (through audit),
- Percent of complete records related to all life cycle phases,
- Percent of incomplete records related to all life cycle phases,
- Percent of operational changes completed by the MOC process,
- Number of procedural changes managed through formal process for managing changes,
- Number of organizational changes managed according to the process,
- Percent of MOCs are communicated to all employees who could be potentially affected by the change,
- Percentage of facility types where hazard identification method has been identified and applied,
- Number of detailed risk assessments undertaken,
- Number of near-miss incidents,

[21] API RP 754 – Process Safety Performance Indicators for the Refining and Petrochemical Industries, 2016.

- Number of incident investigations followed up with corrective actions demonstrating effective risk management solutions,
- Percentage of critical equipment/instrumentation that performs to specification when inspected or tested,
- Percentage of functional tests of critical instruments and alarms completed according to the defined schedule,
- Percentage of maintenance actions identified by inspection activities that are completed to the specified timescale,
- Total number of compressor stations where piping inspected in the year vs. total number of compressor stations where the piping was scheduled to be inspected, for routine staff inspection as well as for certified maintenance inspection,
- Number of facilities requiring repetitive maintenance,
- Number of facilities with deferred maintenance requirements,
- Number of severity faults detected by inspection, testing, and audits,
- Number (and locations) of repairs undertaken,
- Type (and locations) of repairs undertaken,
- Number and nature of unresolved safety issues.

Examples of facilities specific lagging KPIs:

- Total number of annual reportable incidents at facilities and the total number of facilities,
- Loss of containment by equipment or installation and geographic locations,
- Loss of containment associated with specific Facility Integrity programs,
- Number of business interruptions (above a predetermined threshold),
- Number of equipment failures (by equipment type).

14. Audit

The permit holder must develop and implement a process for auditing to examine conformity with the prescribed requirements under the IMPF. A permit holder's process must define the responsibilities, scope, objectives, frequency, and schedule for audits. An audit may be performed by external professionals or internal personnel not directly involved in the IMPF or the operations being audited. The process must also ensure auditor competency and independence. The process for completing corrective and preventive actions for non-conformances identified through audits and communication of lessons learnt shall be outlined, including timelines for when identified actions will be completed.

15. Act – Management Review

The Permit holder's IMPF shall be reviewed to determine the extent to which the performance goals and objectives have been met to assess program effectiveness.

Management shall formally review the adequacy, implementation and effectiveness of its integrity management program for facilities. The review shall be formal and documented and shall occur on a regular basis. The management review process must define the inputs, review methods, and responsibilities. Focus shall be on evaluating the adequacy and effectiveness of the IMPF to meet its stated goals and targets (through review of KPIs), implementation of the IMPF, compliance to company and regulatory requirements, and identification of corrective actions for continual improvement.

Consideration shall be given to:

- Goals and objectives,
- Changes and their effects of changes in the operating company, facilities and/or external factors,
- Results of the risk management process,
- Findings, status, and trends of corrective actions identified during internal and external audits,
- Status and trends of performance measures and KPIs,
- Frequency and trending of near misses,
- Results of incident investigation, evaluations and lessons learned,
- Regulatory, legal or standard changes that could affect the IMPF,
- Status and trends of integrity-related issues and recommendations identified during previous review and evaluations, operation, maintenance, or integrity-related work,
- Successes and problems experienced in detecting and preventing potential failure incidents, and,
- Opportunities for improvement and proposed changes to IMPF including policies and objectives.

Outputs from the management review shall include:

- Summary of assessment of the effectiveness of IMPF and risk management process,
- Decisions, and actions,
- Changes to required resources, and
- Improvements to processes and procedures to meet the requirements.

Senior management shall at least annually review and approve the output of management reviews, which shall be documented.