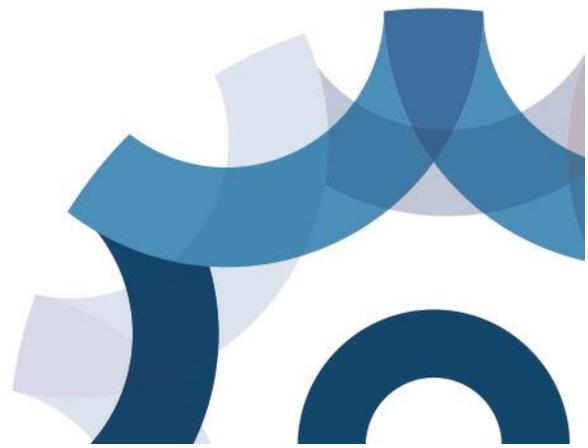


Maintenance
Program
Guideline for
Owners of
Ammonia Plants





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The goals of a maintenance program are to eliminate down time, maintain reliability of the service the equipment delivers, anticipate and accurately plan for maintenance and inspection needs and to extend the operating life of the equipment. An additional consideration is the safety and regulatory requirements for adequate preventative maintenance that both inspects and maintains the equipment.

Requirements for maintenance and inspection are described in codes and regulations, which include:

- *CSA B52 Mechanical Refrigeration Code states: In order to preserve the operating efficiencies, equipment integrity, personal protection, and protection to both the building environment and the natural environment, the owner or owner's representative responsible for the system, shall have maintenance of the system performed by a person certified as per the regulating authority. Section 8.4 describes minimum maintenance requirements that applies to all refrigeration systems.*
- *CSA B51 Boiler Pressure Vessel and Piping Code Section 13.1 states: In-service inspection of systems shall be performed as required for the specific installation in accordance with the code of construction or code of inspection adopted by the authority having jurisdiction.*

It is the owner's responsibility to operate the equipment in a manner that does not create a hazard. Periodic inspection of pressure equipment is intended to determine the condition of the equipment and its fitness to continue to operate safely. A maintenance program can establish consistent practices designed to improve the performance and safety of the equipment.

This guide provides a recommended format, based on industry best practice for developing a maintenance program. This guide is not a requirement, rather it is intended to provide a basic guideline of what an adequate maintenance program may contain.



The program should incorporate the following facets and document the program's policies, processes and procedures in a program manual. Each organization should address the required facets relative to the size and complicity of the ammonia refrigeration plant. Regulated work may be subcontracted provided controls are clearly defined for maintaining full responsibility for compliance with the Safety Standards Act, Safety Standards General Regulation, Power Engineers, Boiler, Pressure Vessel and Refrigeration Safety Regulation and CSA B52 by the plant owner/operator.

The program should be documented in a manual and should incorporate the following general requirements:

- *bound in a manner that allows for easy revisions and updating*
- *company logo or letterhead on each page*
- *typed name and date after a signature*
- *typed (handwriting not permitted)*
- *each page must be identified with a page number, total number of pages in the manual and manual revision number and date*

The program manual should provide clear and simple instructions on owner's/operator's policies and procedures for the maintenance program. The manual may be brief or detailed depending on the program requirements based on the size and complexity of the facility. The extent of a program needed to achieve an effective and practical maintenance program will vary considerably depending on the equipment that is at the facility. The documentation should be appropriate for the size, scope, and complexity of the plant and may range from a few paragraphs for small plants through to several pages for large, complex facilities or operations.



The following features should be included in the manual:

a) Title Page, owner/operator, the plant location.

b) Contents Page

The manual should contain a page listing the contents of the manual by subject, reference number (if applicable), page number, and revision number of each document.

c) Scope

The manual should clearly identify the plant, equipment and processes managed under the program. The scope should state the types of inspection, maintenance, repairs or alterations the manual includes.

d) Statement of Authority and Responsibility

A dated Statement of Authority, signed by the owner/operator or an authorized representative, should be included in the manual. Further, the Statement of Authority should include:

- i. The owner's commitment to provide resources for implementing the program
- ii. A statement that all the work carried out should meet the requirements of the Safety Standards Act, General Regulation, Power Engineers, Boiler, Pressure Vessel and Refrigeration Safety Regulation, CSA B52 and any other applicable codes or standards;
- iii. A statement that if there is a disagreement in the implementation of the program, the matter is to be referred for resolution to a designated position in the organization with the authority to resolve the matter;
- iv. The title of the individual who is responsible for the management of the program and that the position has the authority to carry out the responsibility. The individual assigned responsibility and accountability for the operation and maintenance program should ensure that:



- Processes and procedures are developed, documented and implemented to support the execution of all the key components of the maintenance program,
- A process is defined to identify and ensure conformance with changes to regulatory requirements and new editions of standards and codes
- Resources (personnel and technical requirements) are planned and provided to develop, implement, and continually improve the maintenance program

e) Manual Control

The manual should include the necessary provisions for revising and issuing documents to keep the manual current. The title of the individual authorized to approve revisions should be included in the manual. There should be provisions for signatures of the authorized individuals responsible for making changes and approving changes or revisions. Any manual changes should be approved prior to issuance of any revisions to the manual and implementation of the program changes.

f) Organization

An organizational chart should be included in the manual. It should include the title of the positions in all departments or divisions that perform functions that can affect the execution of the maintenance program such as a facility's maintenance, operations or engineering departments and it should show the relationship between each department or division.

The manual should identify the title of those individuals responsible for preparation, implementation, or verification of the maintenance program. The responsibilities should be clearly defined and the individuals should have the organizational freedom and authority to fulfill those responsibilities.

g) Training and Competency



The maintenance program should establish, implement and maintain a process for developing competency requirements and enabling training of employees or contractors responsible for administrating and executing, inspection, maintenance and repair. Training schedules and frequency must be maintained for all identified critical tasks. Procedures for training records should be documented in the manual.

The management program should have a process for verifying that employees and other persons working with or on behalf of the owner are trained and competent to perform their duties in a safe manner. Where contractors are utilized for the maintenance of a facility, there must be a process to evaluate and select contractors on the basis of ability and qualifications to perform contracted 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. There must also be a process in place to ensure that performance requirements and expectations are defined and communicated to the contractor. A process to monitor and assess a contractors' performance and ensure that identified deficiencies are resolved should be developed.

h) Document and Records Administration

The maintenance program should have a process for administering documents and records needed for the effective implementation of maintenance activities including but not limited to design, construction, inspection and maintenance. The document and record administration process should encompass creation, security, updating, retention, retrieval and deletion of all information and records. Records may be in electronic or paper-based format.

Responsibilities for document approval should be specified and should identify appropriate controls to ensure that revisions and updates to procedural, process or other record documents are reviewed and approved.

As a minimum information related to construction, operating conditions, inspection, testing maintenance and facility incidents should be documented and maintained. Where records are incomplete due to change of ownership, asset transfers or other



reasons, the management program should have a process for ensuring safe operation and maintenance in the absence of these records and how the missing information is to be recovered.

i) Inspection and Monitoring

The maintenance program should document and maintain inspection and monitoring procedures that are appropriate for the refrigeration system, and equipment. The procedures should be designed to ensure safe operation. Inspection and monitoring activities should follow relevant regulations, standards, codes and equipment manufacturer's instructions. Planning, scheduling, and frequency of inspection and monitoring should consider parameters such as effectiveness of inspection method and technology, previous inspection results, incident history, insufficient documentation, evaluation of anomalies, time dependent consideration, and current state of plant equipment. The program should document schedules and have controls to ensure that the planned activities are carried out.

If any irregularities, anomalies, damage or other unsafe conditions are identified, further inspections and investigations such as an engineering assessment, fitness for service evaluation, code guidelines for evaluation imperfections or anomalies or other means should be used to evaluate if the equipment or plant can continue to be operated safely. The outcome of the evaluation could be to monitor the irregularity by increasing the inspection frequency, altering operational procedures, rerating or repairing equipment.

As a minimum the inspection and monitoring program should include:

- i. Testing of pressure-limiting devices for set point accuracy and for their ability to properly stop the affected equipment at least once every 12 months
- ii. Testing of other safety devices at least for set point accuracy and for their ability to properly stop the affected equipment once every 12 months.
- iii. Inspection of power and control electrical terminations for evidence of excessive temperatures and corrosion at least once every 12 months or as per the manufacturer's recommendations



- iv. Inspection of all refrigerant lines, vent lines, and system components quarterly for vibration, corrosion, and/or physical damage.
- v. Inspection of all lines, including vent lines and outlets, or blockages and insulation condition.
- vi. Inspection of ancillary devices, components and fluids integral, external or remote to refrigeration equipment (e.g., indirect systems, hydronic systems, cooling towers, air distribution systems, etc.) for operational performance prior to initial startup and prior to annual start up and monthly thereafter during operation,
- vii. Sensors and instrumentation readings should be used to assist in identifying existing or pending problems.
- viii. Testing for refrigerant leaks shall be carried out
 - periodically as required by the manufacturer;
 - if there is physical evidence that may indicate a leak;
 - if the system operating conditions indicate a loss of refrigerant; and
 - if the vapour detector alarm is activated
- ix. Secondary coolant (brine) systems shall have
 - the water quality tested to prevent corrosion;
 - flow rates set to prevent erosion and maintain adequate heat transfer as per manufacturer's recommendations

j) Maintenance

Maintenance procedures should be developed based on codes, standards and manufacturer's instructions. Maintenance procedures should be documented and reviewed whenever a change, including operational changes, in equipment occurs. Written maintenance procedures provided by equipment manufacturers may be used as maintenance manuals. Maintenance work on regulated equipment should be carried out by refrigeration mechanics or individuals holding the appropriate certificate of qualification who have been trained in the maintenance and testing procedures applicable to the systems or equipment on which they are working. Maintenance procedures should be developed for all refrigeration equipment including:



- i. Pressure-relief valves replacement or recertification at intervals no longer than five years.
- ii. All safety-related maintenance recommendations by the equipment manufacturer(s)
- iii. All power and control electrical terminations shall be checked at least once every 12 months and tightened if necessary
- iv. Testing of ammonia leak detectors for function at the 300 ppm concentration, initiation of audible and visible alarm and starting ventilation. Testing to be done in accordance with the manufacturer's instructions at period not to exceed one year.
- v. Piping, pipe fittings, supports, hydrostatic relief valves, shut off valves, gauges and protective coverings
- vi. Pumps, pump supports, shut off valves, by pass valves, flexible connectors, drive components and lubrication
- vii. Compressor supports, shut off valves, by pass valves, back check valves, flexible connectors, strainers/filters, drive components and lubrication
- viii. Fire protection equipment, portable extinguishers, hydrants, valves and hoses
- ix. Calibration of gauges, instruments and other monitoring equipment

k) Installation, Repair and Alteration Methods

The manual should include processes for installations, repairs and alterations, including mechanical assembly procedures, materials and non-destructive examination methods, as applicable. Where modifications or repairs are required, there should be a process to identify and document relevant corrective actions that are acceptable and appropriate for the facility. Repair methodology must be documented to execute the repair. The processes should include procedures for giving notice to the Technical Safety BC before commencing any installation, repair or alteration and after completing any installation, repair or alteration.



m) Materials

The manual should describe the method used to ensure that only certified components and acceptable materials are used for installations, repairs and alterations. The manual should include a description of how new material, equipment or components are ordered, verified, and marked. The manual should identify the title of the individual(s) responsible for each function and a brief description of how the function is to be performed.

n) Incident and Near-miss Investigation

A process for reviewing incidents and near-misses within the facility and reports from across industry should be developed. Lessons learned should be incorporated into facility procedures and processes to improve the effectiveness of the maintenance program. Procedures should be reviewed and modified when necessary to prevent or mitigate future incidents.

Records of investigations should be maintained for the life of the facility until it is decommissioned.

o) Change Management

The program should have 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 are not unknowingly increased. This process should cover changes such as:

- i) Ownership of a facility,
- ii) The organization and personnel who operate and maintain the facility,
- iii) Equipment, process, process technology and control systems,
- iv) Operating status, such as idling, facility shutdown, or decommissioning which can introduce “temporary” hazards not expected during normal operations;
- v) Operating conditions,



- vi) Methods, practices, and procedures related to operation or maintenance of the facility
- vii) Standards and regulations related to facilities operation or maintenance,
- x) Adjacent land use and development that may be effected by ammonia discharge from pressure relief valves or emergency discharge systems

The management of change process should address:

- i) Identification of anticipated and actual changes,
- ii) What constitutes a change (temporary or permanent) and what falls under replacement in kind, which is not subject to the management of change process,
- iii) Responsibilities and authorities for approving and implementing changes,
- iv) Analysis of implications of the changes,
- v) Impact and risk of the changes,
- vi) Training required as a result of changes
- vii) Communication of the changes, their impact and required documentation,
- viii) Timing of changes (approval and implementation)

The maintenance program should be regularly monitored to measure conformance to the requirements of the program. and review the adequacy, implementation and effectiveness of the maintenance program on a regular basis. The review should evaluate if the program's goals have been met, compliance to facility and regulatory requirements and identification of actions for continual improvement of the operation and maintenance management program