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GUIDANCE FOR IMPLEMENTING PROGRAMS FOR OSHA 29 CFR 1910.119

PROCESS SAFETY MANAGEMENT OF HIGHLY HAZARDOUS CHEMICALS

PART FIVE

MECHANICAL INTEGRITY

by

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GUIDANCE FOR IMPLEMENTING PROGRAMS FOR OSHA PSM

MECHANICAL INTEGRITY

This document contains information that may assist a company in establishing, or reviewing and updating, the mechanical integrity element of their process safety management (PSM) program. The information in this document is based upon the U.S. Occupational Safety and Health Administration's regulation, 29 CFR 1910.119, *Process Safety Management of Highly Hazardous Chemicals*. However, this information may be of use to anyone developing or updating a PSM program for any purpose.

In 1993 the U.S. Department of Labor Occupational Safety and Health Administration (OSHA) commissioned Primatech Inc. to develop a "training material reference manual" related to 1910.119. The purpose of the manual is to provide OSHA's Office of Training and Education with a resource for training federal and state OSHA field officers on enforcing the PSM regulation.

The training material reference manual features an annotated form of the Program-Quality-Verification (PQV) inspection checklist originally presented in Appendix A of OSHA Instruction CPL 2-2.45A. Example programs are provided to illustrate the positive and negative indicators of the checklist questions. OSHA has agreed to allow Primatech to make this information available to interested parties. This should in no way be construed as acceptance by OSHA of the suitability of the information or examples provided herein.

The format of this document follows the PQV inspection checklist presented in Appendix A of OSHA Instruction CPL 2-2.45A, often referred to as the "compliance directive". For each question in the PQV inspection checklist, clarification is provided on the checklist item along with positive program indicators and negative program indicators for each question. The positive and negative program indicators are intended to provide ideas for the user to help them in assessing their existing or planned program.

The example programs provided in this document illustrate approaches taken by companies seeking to address the requirements of 1910.119. These examples have not been reviewed and/or endorsed by OSHA and should not be construed as model programs.

The example programs provided herein were developed for specific processes, and are not generic in nature. Since the OSHA PSM regulation is performance-based, readers are strongly encouraged to develop programs tailored to their own covered processes.

This document is offered for the user's general guidance only. This document does not attempt to provide any interpretation of the OSHA regulations.

Primatech makes no claims regarding the acceptability to OSHA of the information contained herein to OSHA. Consequently, Primatech can accept no liability for any use which the user may make of the information contained herein. Note that the information contained in this manual does not necessarily represent the opinion of Primatech.

OVERVIEW

This guidance document is arranged in a tabular format. The following is a description of each of the column headings used in the table:

PQV Question

The PQV question is derived from the checklist in Appendix A of the OSHA Compliance Directive (CPL 2-2.45A), which is based on the specific regulatory requirements for the element. Note that the verification portion of the checklist includes questions for records review, on-site conditions, and interviews. In order to avoid unnecessary duplication of information, this guidance document references the checklist questions from the records review section only. Specific questions or concerns from the on-site conditions and interviews sections that are not addressed in the records review section are accounted for in the positive and/or negative program indicators column.

Explanation

The explanation clarifies or provides additional insight into the PQV question. In some cases, the explanation provides an interpretation of the PSM requirement. In no cases should the information contained in this column be viewed as a substitute for the actual regulatory requirement.

Positive Program Indicators

The information included in the positive program indicators column is intended to provide guidance and examples on what to look for in a well developed program. This column also includes guidance on what to look for when evaluating PSM programs. This column is not intended to contain all conceivable attributes of a good program for all industry types. Rather, it is intended to provide suggestions and ideas on what a good program might include.

Negative Program Indicators

The information in the negative program indicators column is intended to provide guidance on possible signs of a poor or incomplete program. This information could be of assistance for identifying potential problem areas when conducting PSM program evaluations. A PSM program that contains one or more of these attributes does not necessarily constitute a poor program. Rather, this information is intended to serve as a guide on what to look for in a less developed program.

It is important for the user of this manual to understand that over 25,000 employers may be covered under the PSM standard. Covered facilities range from large complex chemical, petrochemical, or petroleum facilities, to relatively simple ammonia refrigeration or chlorination systems. This guidance document cannot cover all of the possible ranges regarding the content of PSM program elements in the various industry groups. Additionally, since the PSM standard is a performance based regulation, this guidance document can not address the specific approaches different companies or facilities may choose to implement in complying with the requirements.

In addition to the table, this guidance document contains several helpful appendices, including:

Appendix A - List of Acronyms	Contains description of key acronyms used in the guidance document.
Appendix B - Glossary of Terms	Contains definitions of key terms used in the guidance document.
Appendix C - Technical References	Contains a list of helpful technical references to support the information presented in the table.
Appendix D - Example Program(s)	Contains example(s) of how this PSM element has been adopted. Most of the examples are acutal programs provided by industrial companies.

MECHANICAL INTEGRITY [29 CFR 1910.119 (j)]

PQV Question	Explanation	Positive Program Indicators	Negative Program Indicators
1. Does the written mechanical integrity program include: • Pressure vessels and storage tanks • Piping systems and components such as valves • Relief and vent systems and devices • Emergency shutdown systems • Controls (including monitoring devices and sensors, alarms and interlocks) • Pumps	A written mechanical integrity program should exist and include specification, installation, preventive maintenance, and spare parts support of all process equipment for a covered process. Mechanical integrity ensures that all process equipment and maintenance of equipment is designed, constructed, and maintained as specified in applicable engineering codes and standards.	A written mechanical integrity program exists including files and records of date of inspection/test; identification of person performing inspection/test; *serial number or* identifier of equipment; description of inspection/test; and, results of inspection/test. Preventive maintenance program tasks are planned and performed in accordance with a written schedule. Interviews with a representative number of plant personnel confirm that preventive maintenance has been *performed* according to schedule. Mechanical Integrity program should identify all equipment covered under the program including: • Pressure vessels and storage tanks • Piping systems and components such as valves and heat exchangers • Relief and vent systems and devices • Emergency shutdown systems • Controls (including monitoring devices and sensors, alarms and interlocks) • Pumps	Documentation does not exist concerning the mechanical integrity program, or the *documentation is out-of-date.* Mechanical or electrical equipment, *including newly* installed equipment is not included in the mechanical integrity program and there is no written justification. The listing of equipment included in the program is incomplete or out-of-date. There is no written schedule for the performance of preventive maintenance

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MECHANICAL INTEGRITY [29 CFR 1910.119 (j)]

PQV Question	Explanation	Positive Program Indicators	Negative Program Indicators
2. Are there written procedures to maintain the on-going integrity of process equipment? Does the documentation indicate the procedures have been implemented?	Preventive maintenance is planned and performed in accordance with a written schedule, and the schedule identifies the maintenance procedures to be performed. Written preventive and corrective maintenance task procedures exist to ensure that specific process equipment is maintained correctly.	Preventive maintenance program tasks, including tests and inspections are planned and performed in accordance with a written schedule Written task procedures exist to maintain the on-going integrity of the process equipment, including schedules for tests and inspections. Written procedures are specific to different equipment types. Each procedure identifies the equipment to which it applies. Observations of onsite conditions and document review indicate that the maintenance schedules and procedures have been implemented. If appropriate, raw materials and spare parts are verified to meet process specifications, since any deviations in material quality could adversely affect the mechanical integrity of the equipment.	A maintenance program exists in which action is taken only when equipment fails in service. Written maintenance schedules and procedures do not exist or are not specific to the equipment installed.

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MECHANICAL INTEGRITY [29 CFR 1910.119 (j)]

PQV Question	Explanation	Positive Program Indicators	Negative Program Indicators
3. Has *training* been provided to each employee involved in maintaining the on-going integrity of process equipment in the following: • An overview of the process and its hazards? • Procedures applicable to the employee's job tasks to assure that the employee can perform the job tasks in a safe manner? (Review certification documents for employees doing non-destructive tests, welding on pressure vessels, etc., where these certificates are required.)	*Training should be provided to maintenance* personnel to ensure they are aware of the process and its associated hazards. Training should be provided, or certification verified (where required) in job specific tasks such as: • welding on code vessels • non-destructive testing • instrumentation calibration • pipe fitting • grinding and cutting operations Typically, all verification should be completed prior to commencement of any job specific task. Maintenance personnel are trained in the use of safe work practices such as: • hot work permits • lockout/tagout • confined space entry • line and vessel opening	*Where required, certification documents exist for* employees doing work such as: non-destructive testing; welding on pressure vessels; instrument calibration and pipe fitting. Training records clearly indicate that the maintenance personnel have received training on the maintenance task procedures which they are responsible for performing. In-house training programs, vendor training, or a combination of both are appropriate. Training records indicate that the training program includes an overview of the process and its hazards.	Training records do not indicate that the employees involved in maintaining the on-going integrity of the process have been trained in the maintenance tasks they are responsible for performing. Training of employees did not include an overview of the process or its hazards. Where required, employees are not certified in their respective job tasks.

PQV Question	Explanation	Positive Program Indicators	Negative Program Indicators
4. Are inspections and tests performed on each item of process equipment included in the program?	Process equipment included in the program should receive the appropriate inspections and tests. The decision to subject equipment to periodic tests and inspections should be based upon equipment vendor recommendations, operating history of the plant, and/or the same equipment in similar applications.	The maintenance records contain documentation which supports the decision to include or not include specific pieces of equipment in the test and inspection program. A mechanism exists to identify equipment defects or minor failures before they can develop into more serious failures. Examples of such mechanisms are: • logging/recording of process parameters which will reveal the defects, such as vibration monitoring of rotating equipment • periodic tests of infrequent system operation such as trips and interlocks • periodic checks of the calibration of instrumentation and other equipment which sense critical process parameters and then provide control functions • non-destructive testing (NDT) of mechanical equipment to detect degradation of original design wall thicknesses In general, a combination of the above methods is usually preferable. External inspections of mechanical equipment may cover such items as foundation and supports, anchor bolts, concrete or steel supports, guy wires, nozzles and sprinklers, pipe hangers, grounding connections, protective coatings and insulation, and external metal surfaces of piping and vessels. Internal inspections of mechanical equipment may cover items such as vessel shell, bottom and head; metallic linings, nonmetallic linings, thickness measurements for vessels and piping; inspection for erosion, corrosion, cracking and bulges; internal equipment like trays, baffles, sensors and screens for erosion, corrosion or cracking and other deficiencies.	No documentation exists to substantiate the exclusion of specific equipment from testing and inspections. No schedule exists for periodic tests and inspections. Observations of onsite conditions indicate that inspections and/or tests are not being performed according to the program schedule. Documentation of test results is incomplete or non-existent.

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MECHANICAL INTEGRITY [29 CFR 1910.119 (j)]

PQV Question	Explanation	Positive Program Indicators	Negative Program Indicators
4. Are inspections and tests performed on each item of process equipment included in the program? (contd.)	(See above)	Periodic inspections of electrical and control equipment may include calibration checks of meters, gages, or other devices which provide process parameter indications, and/or checks of trip functions and interlocks.	(See above)
5. Do inspection and testing procedures follow good engineering practices?	Testing procedures follow generally accepted good engineering practices or industry codes and standards. Applicable codes and standards, such as the National Board Inspection Code, American Society for Testing and Material (ASTM), API, NFPA, American National Standards Institute (ANSI) and American Society of Mechanical Engineers (ASME) were consulted to help establish an effective testing and inspection frequency, as well as appropriate methodologies.	Interviews with a representative number of engineers and maintenance employees confirm that inspection and testing procedures follow recognized and generally accepted good engineering practice. Document review confirms that inspection and testing procedures are in accordance with good engineering practices and industry standards such as: API, ASME and NFPA.	Inspection and testing procedures are inadequate or are not based on good engineering practices. Document review confirms that inspection and test procedures are not in accordance with good engineering practices and industry standards.
6. Are inspection and test frequencies consistent with the manufacturer's recommendation and good engineering practice? Are inspections and tests performed more frequently if determined necessary by operating experience?	Inspection and test frequencies follow generally accepted good engineering practices and manufacturer's recommendations, and are performed more frequently if necessary.	The frequency of inspections and tests are consistent with applicable manufacturer's recommendations, engineering codes and standards, and operating history. Applicable codes and standards, such as the National Board Inspection Code, ASTM, API, NFPA, ANSI and ASME were consulted to help establish an effective testing and inspection frequency, as well as appropriate testing and inspection methodologies. There is a system in place to analyze the maintenance history of equipment for trends, so that changes in the procedures, technique or frequency of testing, or the design of a piece of equipment can be made. For example, the need for more frequent inspection/ replacement of a temperature probe may indicate a need to switch probes or use one constructed with a more durable material.	Prior operating experience indicates a need for a more frequent test and inspection schedule which has not been implemented. A procedure or system does not exist to verify that a more frequent test and inspection schedule is needed. Test and inspection frequencies are not in accordance with manufacturer's recommendations.

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MECHANICAL INTEGRITY [29 CFR 1910.119 (j)]

PQV Question	Explanation	Positive Program Indicators	Negative Program Indicators
7. Is there documentation of each inspection and test that has been performed including all of the following: • Date of the inspection or test? • Name of person performing the procedure? • Serial number or other identifier of equipment on which procedure was performed? • *Description of inspection* or test performed? • Results of inspection or test?	Documentation exists to verify that the appropriate tests/inspections have been carried out at the specified frequency and that the results fall within acceptable limits.	Documentation exists for each inspection and test that has been performed. Documentation of each inspection or test performed includes: • the date • name and position of person performing the procedure • serial number or identification number of the equipment • description of the procedure • results of the procedure	Documentation does not exist or is incomplete for each inspection and test performed.

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MECHANICAL INTEGRITY [29 CFR 1910.119 (j)]

PQV Question	Explanation	Positive Program Indicators	Negative Program Indicators
8. Are deficiencies in equipment that are outside limits (as defined in process safety information) corrected before further use or in a safe and timely manner when necessary means are taken to assure safe operation?	When discovered, deficiencies outside acceptable limits should be corrected immediately. If deficiencies cannot be addressed immediately, alternate means are taken to assure safe operation until repairs can be made.	Written procedures exist to ensure safe operation if deficiencies cannot be immediately addressed. Such procedures may include: continuous or more frequent [illegible] of process parameter readings; increased unit staffing with continuous watches on critical equipment; operating at reduced temperatures or pressures, reduced flow rates or feed rates, and/or reduced unit throughput. Interviews with a representative number of engineers and maintenance employees confirm that equipment deficiencies are corrected before use when they are outside the acceptable limits. If not corrected immediately, they are corrected in a timely manner and necessary means are taken to assure safe operation. Maintenance records show when test or inspection results exceed allowable limits. Maintenance, operational, safety or other records show that deficiencies are identified and a rationale is recorded that explains what will be done to correct the deficiency, when the correction will be completed and what other plant operational actions are taken if necessary. Maintenance records show that deficiencies are corrected according to the schedule assigned.	Observations of a representative sample of process equipment indicate deficiencies outside acceptable limits. Deficiencies found are not corrected in a timely manner or are not corrected within design specifications. Temporary means to correct deficiencies are extended beyond the authorized time frame.

MECHANICAL INTEGRITY [29 CFR 1910.119 (j)]

PQV Question	Explanation	Positive Program Indicators	Negative Program Indicators
9. In the construction of new plants and equipment, does the employer assure that equipment as it is fabricated is suitable for the process for which it will be used?	Guidelines or records exist that demonstrate that fabrication of equipment is suitable for the specifications of the process for which it will be used.	For new plants or equipment being constructed, engineering and/or purchasing records show how the fabrication of equipment adhered to the appropriate design codes and standards. The purchasing documents (purchase orders, purchase specifications) for new, used, or modified equipment incorporate the engineering input necessary to ensure that the fabrication of new equipment and application of used equipment is appropriate for the intended use at the facility. The purchasing documents should contain (or be accompanied by) design specifications which include: • reference to the codes and standards which govern the equipment design and application • a description of its intended use • the expected flow, temperature, pressure, and other process parameters • the expected corrosion/erosion environment • the expected ambient conditions where the equipment will be installed • required functionality during emergency conditions such as fire, flood, loss of power, etc. In the case of used equipment, there is sufficient documentation to ensure proper maintenance has been performed. This is to ensure that the used equipment is still adequate for the planned service.	For new and used equipment, observations indicate that the equipment as it is fabricated is not suitable for the process for which it will be used. Purchasing records do not indicate that the engineering data necessary to ensure proper fabrication/application of new and used equipment has been incorporated. Used equipment has not been adequately maintained and is therefore unsuitable for use.

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MECHANICAL INTEGRITY [29 CFR 1910.119 (j)]

PQV Question	Explanation	Positive Program Indicators	Negative Program Indicators
10. Have appropriate checks and inspections been made to assure equipment is installed properly and consistent with design specifications and manufacturer's instructions? (Include contractor supplied equipment.)	Procedures should exist to ensure that equipment is installed properly (including tests, inspections, and functional checkouts) and is consistent with design specifications and manufacturer's instructions.	Where appropriate, written procedures for a new or modified facility include implementation of a pre-startup safety review. Documentation exists to show that typical installation checks were conducted such as: • non-destructive tests • hydrostatic tests • flushes • electrical continuity and resistance to ground te[illegible] • software checks • tests of trips end interlocks The requirements for these or other pre-startup tests and checkouts should be derived from either company engineering procedures and/or vendor recommendations.	There is no evidence to assure that equipment has been properly installed and is consistent with design specifications and manufacturer's instructions.

MECHANICAL INTEGRITY [29 CFR 1910.119 (j)]

PQV Question	Explanation	Positive Program Indicators	Negative Program Indicators
11. Does the employer assure that maintenance materials, spare parts, and equipment are suitable for the process application for which they are used? (Include contractor supplied equipment.)	Maintenance materials, spare parts and equipment should be suitable for the process application for which they are used.	The purchasing documents (purchase orders, purchase specifications) for spare parts incorporate the engineering input necessary to ensure that the parts or replacement material is appropriate for the intended use at the facility. The purchasing documents should contain (or be accompanied by) design specifications which include: • reference to the codes and standards which govern the design and application of the equipment where the parts or materials will be used • the expected flow, temperature, pressure, and other process parameters • the expected corrosion/erosion environment • the expected ambient conditions to which the parts or material will be exposed • required functionality during emergency conditions such as fire, flood, loss of power, etc. A system exists to ensure that material is logged and stored in a fashion that allows accurate tracking and application of parts and material when its is used; and preserves material integrity during storage. Observations of a representative sample of maintenance materials, spare parts, and equipment indicate that they are suitable for the process application for which they will be used, and that the storage system and environment will adequately segregate and preserve the integrity of the material.	Observations indicate that spare parts and equipment are being used for applications other than their intended use. Purchasing records do not indicate that engineering data necessary to ensure proper application of spare parts and material has been incorporated or referenced.

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LIST OF ACRONYMS

AIChE *	American Institute of Chemical Engineers
ANSI *	American National Standards Institute
API *	American Petroleum Institute
ASHRAE *	American Society of Heating, Refrigeration and Air-Conditioning Engineers
ASME *	American Society of Mechanical Engineers
ASTM	American Society for Testing and Material
AWS *	American Welding Society
BFD	Block Flow Diagram
CCPS *	Center for Chemical Process Safety
CGA *	Compressed Gas Association
CMA *	Chemical Manufacturers Association
DIERS	Design Institute for Emergency Relief Systems
EPA	Environmental Protection Agency
FEMA	Federal Emergency Management Agency
FMEA	Failure Mode and Effects Analysis
FTA	Fault Tree Analysis
HAZOP	Hazard and Operability Study
HHC	Highly Hazardous Chemical
IDLH	Immediately Dangerous to Life and Health
IIAR *	International Institute of Ammonia Refrigeration
ISA	Instrument Society of America
LC	Lethal Concentration
LD	Lethal Dose
MSDS	Material Safety Data Sheet
NFPA *	National Fire Protection Association
OSHA	Occupational Safety and Health Administration
P&ID	Piping and Instrument Diagram
PEL	Permissible Exposure Limit

PFD	Process Flow Diagram
PHA	Process Hazard Analysis
PSM	Process Safety Management
PQV	Program-Quality-Verification
SOCMA	Synthetic Organic Chemical Manufacturers Association
SOP	Standard Operating Procedure
STEL	Short Term Exposure Limit

* Mailing address and telephone numbers included

Referenced Agency Addresses and Phone Numbers

AIChE
American Institute of Chemical Engineers
345 East 47th Street
New York, New York 10017
Phone: 212-705-7338

ANSI
American National Standards Institute
11 West 42nd Street
New York, New York 10036
Phone: 212-642-4900

ASHRAE
American Society of Heating, Refrigerating and Air-Conditioning Engineers
1791 Tullie Circle, N.E.
Atlanta, Georgia 30329
Phone: 404-636-8400

ASME
American Society of Mechanical Engineers
22 Law Drive
P. O. Box 2300
Fairfield, New Jersey 07007-2300
Phone: 800-843-2763

AWS
American Welding Society
550 N.W. LeJeune Road
Miami, Florida 33126
Phone: 800-443-9353

CCPS
Center for Chemical Process Safety of the AIChE
345 East 47th Street
New York, New York 10017
Phone: 212-705-7319

CGA
Compressed Gas Association
1725 Jefferson Davis Highway, Suite 1004
Arlington, Virginia 22202
Phone: 703-412-0900

CMA
Chemical Manufacturers Association
2501 M Street, N.W.
Washington, D.C. 20037
Phone: 202-887-1100

IIAR
International Institute of Ammonia Refrigeration
1101 Connecticut Avenue, N.W., Suite 700
Washington, D.C. 20036
Phone: 202-857-1110

ISA
Instrument Society of America
67 Alexander Drive
P.O. Box 12277
Research Triangle Park, North Carolina 27709
Phone: 919-549-8411

NFPA
National Fire Protection Association
1 Batterymarch Park
Quincy, Massachusetts 02169
Phone: 800-344-3555

APPENDIX B

Glossary of Terms

GLOSSARY OF TERMS

BLOCK FLOW DIAGRAM or BFD[1]

A diagram used to show the major process equipment and interconnecting process flow lines as well as flow rates, stream composition, temperatures, and pressures. The BFD is intended as a simplified diagram.

CHECKLIST[2]

Detailed list of desired system attributes or steps for a system or operator to perform. Usually written from experience and used to assess the acceptability or status of the system or operation compared to established norms.

CONSEQUENCE[2]

The direct, undesirable result of an accident sequence usually involving a fire, explosion, or release of toxic material. Consequence descriptions may be qualitative or quantitative estimates of the effects of an accident in terms of factors such as health impacts, economic loss, and environmental damage.

DECISION TREES[4]

Decision trees are a special case of event tree models used to guide the user through multiple questions and provide a course of action based on the outcome of all of the questions. They provide no logical method of choosing the initiating event.

ELECTRICAL ONE-LINE DIAGRAM[1]

A diagram including legend of the electrical power distribution system that could contribute to a highly hazardous chemical release showing such items as power consumers, the chain of supply back through starters, distribution centers, substations to the main feeder, emergency power supply, and connections to various components. For complex systems, the one-line diagram may be a group of drawings.

FACILITY[3]

The buildings, containers and equipment that could reasonably participate in a catastrophic release as a result of being physically interconnected or of their proximity and in which dangerous substances are used, stored, manufactured, handled, or moved.

FAILURE MODE AND EFFECTS ANALYSIS or FMEA[1]

A specifically designed method to identify the conceivable ways that a highly hazardous chemical equipment or its components can fail and the effect of the failure on the system with respect to a release. The failure and effects are determined in a study of updated piping and instrument diagrams that describe the facility taking into consideration process chemistry, standard operating procedures, maintenance procedures, operator job descriptions, process flow diagrams, inventory tabulations, electrical one-line diagrams and other documents. The resulting qualitative analysis is translated into a quantitative FMEA when probabilities of the failure of components are assigned. The results of the FMEA are reported for a unit or system of a facility on an FMEA table. The results are entered on a FMEA table for each equipment item or component studied are as follows: the identification number of the item, the name of the item, the other equipment potentially affected with the equipment identification number and the effect of the failure on that equipment, a classification of the criticality ranking of the failure based on quantity or rate of the potential release, the probability of the failure and the suggested action in terms of equipment or procedure to prevent the failure or to mitigate the results of the failure.

FAULT TREE ANALYSIS or FTA[1]

The analysis of the logic diagram constructed from a study of the updated piping and instrument diagrams that describe the facility taking into consideration process chemistry, standard operating procedures, maintenance procedures, operator job descriptions, process flow diagrams, inventory tabulations, electrical one-line diagrams and other documents. The logic diagram is called a fault tree and represents a qualitative analysis of the hazards. Results of the FTA are reported for a unit or system on a table. Entered on the table are the descriptions of the various combinations of equipment or procedural failures that can lead to a release. The combinations are determined by solving the fault tree logic diagram for the minimal cut sets, that is, the smallest combination of equipment or procedural failures, which if all occur, will result in the "top event", that is the highly hazardous chemical release. The table is also entered with a criticality ranking based on the quantity or rate of the potential release, a probability for the respective failures and the suggested action in terms of equipment or procedure to prevent the failure or to mitigate the results of the failure. The analysis of the logic diagram includes the identification of "minimal cut sets." When probabilities are assigned to each element of the event sequence, a qualitative fault tree is obtained which gives the probability or frequency of occurrence of the release.

HAZARD[2]

An inherent physical or chemical characteristic that has the potential for causing harm to people, property, or the environment.

HAZARD ANALYSIS[1]

A systematic identification of the potential conditions that may result in an EHS accident.

HAZARD AND OPERABILITY STUDY or HAZOP[1]

A systematic study of updating piping and instrument diagrams that describe the highly hazardous chemical facility taking into consideration process chemistry, standard operating procedures, maintenance procedures, operator job descriptions, process flow diagrams, chemical inventory tabulations, electrical one-line diagrams and other documents. The study is performed by a multidisciplinary team to identify hazard or operability problems that would result in a highly hazardous chemical accident. Deviations from the design value of key parameters (flow, temperature, composition, time, quantity, etc.) of each segment of the highly hazardous chemical facility and its procedures are studied using guide words (such as, more of, less of, none of, part of, more than and other) to control the examination and evaluation. The study team shall consist of trained personnel knowledgeable in the technology and operations, such as process chemistry, the design of the system, the procedures of its operation and maintenance, and the related codes, standards and practices. In addition, the study team shall have technical expertise to answer most questions of the review without resorting to further expertise. The study team shall include a study leader specifically qualified for his or her leadership role by training or previous experience in HAZOP studies and a team secretary who shall record the results of the study. Persons who occupy these team study positions shall be technically trained and be available for the duration of the study. Results of the HAZOP study shall be reported by tabulation for a unit by key equipment, such as vessels or pipelines, and process parameter. The results are entered on the table as follows: guide word, causes of the deviation, consequences of the deviation in terms of a potential release, the criticality based on the quantity or rate of potential release and the suggested action in terms of equipment or procedure to mitigate the deviation.

HIGHLY HAZARDOUS CHEMICAL or HHC[3]

A substance possessing toxic, reactive, flammable, or explosive properties.

HUMAN ERROR[2]

Actions by or failures to act on the part of designers, operators, managers, or other individuals that may contribute to or result in accidents.

MATERIAL SAFETY DATA SHEET or MSDS[1]

A document which describes, at a minimum, the chemical and physical properties and the physical and health hazards of a substance.

MODIFICATION[1]

Any change in existing equipment or procedures that would require a change in process safety information and/or operating procedures. Modification does not include routine maintenance or replacement in kind.

OPERATOR[2]

An individual responsible for monitoring, controlling, and performing other tasks as necessary to accomplish the productive activities of a system. Often used in a generic sense to include people who perform various tasks (e.g.; reading, calibration, maintenance).

PIPING AND INSTRUMENT DIAGRAM or P&ID[1]

One or more detailed drawings including legends and citations of referenced documents showing: every item of highly hazardous chemical equipment and its identification number (including installed spare equipment); every pipe size, flow direction, identification number and identification of ANSI piping specification and break between piping specifications; symbols and identification of every instrument including instrument function to show trips and interlocks represented in accordance with Instrument Society of America standards or a standard adequate for the conduct of a safety review or hazard analysis with an appropriate symbol legend shown, every valve, the failsafe position of control valves or non-hand operated valves in the case of instrument air or power failure; steam traps; representation of insulation or heat tracing of piping, highly hazardous chemical equipment and instruments; sizes of all important equipment nozzles with location shown schematically to reflect function and elevation, such as, drains, vents, flushing connections and steam connections; references to inter-facing with other diagrams describing process, service, treatment, disposal, or utility systems; data on type, size, and set pressures of every relief valve and relieving device; instruments to monitor early detection of abnormal conditions or a highly hazardous chemical release; where critical, the relative elevations between equipment and of key piping; notes or symbols on such items as slope of critical piping to avoid pockets, or, where critical symmetrical piping; notes on each item of highly hazardous chemical equipment, such as, material of construction, design temperature, design pressure, design thermal duty of heat exchangers, design capacity and dynamic head of rotating equipment, etc.

PRELIMINARY HAZARD ANALYSIS[2]

A technique that is derived from the U.S. Military Standard System Safety Program Requirements. Focuses in a general way on the hazardous materials and major process areas of a plant, and is often used as a precursor to further hazard analyses.

PROCESS CHEMISTRY[1]

The chemical reactions which are relevant to possible scenarios of highly hazardous chemical releases, including information on raw materials, intermediates, products, and waste products.

PROCESS FLOW DIAGRAM or PFD[1]

A diagram including a legend of a facility which depicts the use, generation, storage or handling of a highly hazardous chemical showing items of equipment (groups of duplicate equipment may be represented by one symbol if desired), flow of material from item to item, simplified basic control loops or major control schemes, points of discharge to the environment, and showing or cross-referencing documents which give details of material balance, flows, raw materials, products, intermediates, treatment chemicals, operating conditions of temperature, pressure and steam characteristics, operating cycles and batch sizes where applicable. A process flow diagram includes, or references, a block flow diagram that depicts the receipt, handling and storage steps at the site of shipping containers of the highly hazardous chemical.

PROCESS SAFETY MANAGEMENT[2]

The application of management systems to the identification, understanding, and control of process hazards to prevent process-related incidents and injuries.

REPLACEMENT IN KIND[1]

The replacement of existing highly hazardous chemical equipment with identical or equivalent highly hazardous chemical equipment, and installation according to criteria for design and operation.

RISK[2]

Combination of the expected frequency (events/year) and the consequence (effects/event) of a single accident or a group of accidents.

STANDARD OPERATING PROCEDURE[1]

The document setting forth the operating procedures covering all details of the operation involving highly hazardous materials that are currently in effect at the facility.

TRUTH TABLES[4]

A listing of all combinations of the states of basic events, the resulting occurrence or non-occurrence of a top event, and the corresponding probabilities for the combinations.

WHAT-IF CHECKLIST[1]

A method of hazard analysis based on a systematic study of updated piping and instrument diagrams that describe the highly hazardous chemical facility taking into consideration process chemistry, standard operating procedures, maintenance procedures, operator job descriptions, process flow diagrams, inventory tabulations, electrical one-line diagrams and other documents. The study is performed by a multidisciplinary team to identify hazards or operability problems that could result in a highly hazardous chemical accident. The study is composed of a comprehensive list of questions prepared in advance from study of documents by team members either in conference or independently usually corresponding to their individual background. The study team shall consist of trained personnel knowledgeable in the technology and operations, such as process chemistry, the design of the equipment, the procedures of operation and maintenance and the related criteria for design and operation. In addition they shall have technical expertise to answer most of the questions of the review without recourse to further expertise. The team shall include a person assigned to lead the study and a person to record the results who are technically trained and will be available for the duration of the study. Results of the study shall be reported for a unit on a table. The results are entered on the table as follows: the "what if" question and its corresponding consequence/hazard, the criticality based on the quantity or rate of the potential release and the recommended action in terms of equipment or procedure to mitigate the consequence/hazard.

1. New Jersey Toxic Catastrophe Prevention Act, N.J.A.C. 7:31, New Jersey Department of Environmental Protection and Energy, June 18, 1993.

2. Guidelines for Hazard Evaluation Procedures, 2nd. ed., Center for Chemical Process Safety of the American Institute of Chemical Engineers, 1992.

3. Process Safety Management of Highly Hazardous Chemicals, 29 CFR Part 1910.119, Occupational Safety and Health Administration, February 24, 1992.

4. Reliability Engineering and Risk Assessment, Ernest J. Henley and Hiromitsu Kumamoto, Princeton-Hall, Inc., 1981.

APPENDIX C

Technical References

MECHANICAL INTEGRITY

"Power Piping," ANSI/ASME B31.1-1989.

"Chemical Plant and Petroleum Refinery Piping," ANSI/ASME B31.3-1990.

"Code Requirements for Relief Devices," ANSI/ASHRAE 15-1978.

"Avoiding Environmental Cracking in Amine Units," First Edition, API RP 945-90.

"Pressure Vessel Inspection Code: Inspection, Rating, Repair and Alteration," API Std. 510, June 1989.

"Inspection of Piping, Tubing, Valves, and Fittings," API RP 574.

"Prevention of Brittle Fracture of Pressure Vessels," API RP 920.

"API Guide for Inspection of Refinery Equipment."

"Sizing, Selection, and Installation of Pressure Relieving Devices," Part 1, API RP 520, July 1990.

"Guide for Pressure Relieving and Depressuring Systems," API RP 521, November 1990.

"Shell and Tube Heat Exchangers for General Refinery Services," Fourth Edition, API 660-82 (R 1987).

"Inspection of Pressure Vessels," API RP 572, 1992.

"Management Practices, Self-Assessment Process and Resource," API RP 9000.

"Safe Maintenance Practices in Refineries," API RP 2007, 1983.

"ASME Boiler and Pressure Vessel Code, Section VII, Division I - Pressure Vessel Requirements," American Society of Mechanical Engineers, New York, NY, 1968.

"ASME Boiler and Pressure Vessel Code, Section V - Nondestructive Examination," American Society of Mechanical Engineers, New York, NY.

"Welding Procedure and Performance Qualifications," AWS B3.0-77.

MECHANICAL INTEGRITY (cont'd.)

Guidelines for Hazard Evaluation Procedures, 2nd ed., Center for Chemical Process Safety of the American Institute of Chemical Engineers, 1992.

Plant Guidelines for Technical Management of Chemical Process Safety, Center for Chemical Process Safety of the American Institute of Chemical Engineers, 1992.

"Application and Maintenance of Safety Pressure Relief Valves for Refrigerant Systems," IIAR Bulletin No. 105, January 1976.

"Start-Up, Inspection, and Maintenance of Ammonia Mechanical Refrigerating Systems," IIAR Bulletin No. 110, January 1988.

"Avoiding Component Failure in Industrial Refrigeration Systems Caused by Abnormal Pressure or Shock," IIAR Bulletin No. 116, October 1992.

"Standard for the Manufacture of Organic Coatings," NFPA 35.

"Prevention of Furnace Explosions/Implosions in Multiple Burner Boiler Furnaces," NFPA 85C.

"National Board Inspection Code, A Manual for Boiler and Pressure Vessel Inspectors," The National Board of Boiler and Pressure Vessel Inspectors, 1992.

"Personnel Qualification and Certification in Nondestructive Testing," American Society of Nondestructive Testing, Recommended Practice No. SNT-TC-1A.

"Emergency Venting of Vessels," Factory Mutual Loss Prevention Data Sheet, 7-49.

"Methods and Controls to Prevent Inservice Cracking of Carbon Steel Welds in P-1 Material in Corrosive Petroleum Refining Environments," National Association of Corrosion Engineers, RP0472-87.

GENERAL REFERENCES

Ammonia Plant Safety (and related facilities), vol. 23, American Institute of Chemical Engineers, 1981.

Ammonia Plant Safety (and related facilities), vol. 24, American Institute of Chemical Engineers, 1984.

Ammonia Plant Safety (and related facilities), vol. 27, American Institute of Chemical Engineers, 1987.

Ammonia Plant Safety (and related facilities), vol. 28, American Institute of Chemical Engineers, 1988.

Ammonia Plant Safety (and related facilities), vol. 31, American Institute of Chemical Engineers, 1988.

"Guidelines for Safe Automation of Chemical Processes," American Institute of Chemical Engineers, 220p.

"Guidelines for Investigating Chemical Process Incidents," American Institute of Chemical Engineers, 347p.

"Guidelines for Auditing Process Safety Management Systems," American Institute of Chemical Engineers, 136p.

"Management of Process Hazards," American Petroleum Institute, Recommended Practice 750.

"Process Safety Management (Control of Acute Hazards)," CMA.

Chemical Manufacturers Association (CMA's Manager Guide), First Edition, September 1991.

"The Revised Field Operations Manual (FOM)," OSHA Instruction CPL 2.54B, June 15, 1989.

"State Plan Policies and Procedures Manual," OSHA Instructions STP 2.22A, Ch-2, January 29, 1990.

"Integrated Management Information Systems (IMIS) Forms Manual, Chapter V " OSHA Instruction ADM 1-1.12B, December 29, 1989.

"Systems Safety Evaluation of Operations with Catastrophic Potential," OSHA Instruction CPL 2-2.45, September 6, 1988.

"Process Safety Management Guidelines for Compliance," OSHA 3133; U.S. DOL, 1992.

"Process Safety Management," OSHA 3132; U.S. DOL, 1992.

"Safety and Health Program Management Guidelines," U.S. DOL, 1989.

"Review of Emergency Systems," June 1988; U.S. EPA, Office of Solid Waste and Emergency Response, Washington DC 20480.

"Chemical Exposure Index," Dow Chemical Co., May 1988.

"Accident Investigation * * * A New Approach," National Safety Council, 1983.

<u>Process Safety Management Resources from the American Institute of Chemical Engineers for Use by Industrial Hygienists</u>, James A. Gideon and Thomas W. Carmody, American Industrial Hygiene Association Journal (53), June 1992.

"Improving Construction Safety Performance," Report A-3, The Business Roundtable.

"Recommended Guidelines for Contractor Safety and Health," Texas Chemical Council.

"Loss Prevention in the Process Industries," Volumes I and II, Frank P. Lees, Butterworth, 1983.

"Guidelines for Engineering Design for Process Safety," 500p.

APPENDIX D

Example Programs

The following examples illustrate approaches taken by companies seeking to address the Mechanical Integrity requirements of 29 CFR 1910.119. These examples have not been reviewed and/or endorsed by OSHA and should not be construed as model programs. Primatech makes no claims regarding the acceptability to OSHA of the information contained herein.

The example programs provided herein were developed for specific processes, and are not generic in nature. Since the OSHA PSM regulation is performance-based, readers are strongly encouraged to develop programs tailored to their own covered processes.

CONTENTS

D-1 Mechanical Integrity Program - Petroleum Refinery

This example contains a description of a refinery mechanical integrity program. The program is written to ensure the mechanical reliability of the refinery's process equipment. It includes a list of equipment covered under this program as well as the department responsible for equipment maintenance.

PROCESS SAFETY MANAGEMENT

MECHANICAL INTEGRITY

- ALL EQUIPMENT IN THE REFINERY MUST BE DESIGNED, FABRICATED, INSTALLED AND MAINTAINED IN A MANNER CONSISTENT WITH THE SERVICE REQUIREMENTS.
- WRITTEN QUALITY CONTROL PROCEDURES THAT TRACK CRITICAL EQUIPMENT DURING THE FABRICATION STAGE SHOULD BE ESTABLISHED.
- TESTING AND INSPECTING PROGRAMS FOR CRITICAL EQUIPMENT WILL BE ESTABLISHED AND DOCUMENTED.
- ALL EMPLOYEES INVOLVED IN MAINTAINING THE ON-GOING INTEGRITY OF THE PROCESS EQUIPMENT MUST BE TRAINED.
- A LIST OF CRITICAL EQUIPMENT AND SYSTEMS WILL BE COMPILED TO ENSURE SAFE OPERATION OF THE PROCESS EQUIPMENT.

MECHANICAL INTEGRITY

All equipment in the refinery must be designed, fabricated, installed and maintained in a manner consistent with the service requirements. The following critical equipment apply:

1. Pressure vessels and storage tanks.
2. Piping systems (including piping components, such as valves).
3. Relief and vent systems and their controls.
4. Emergency shutdown systems.
5. Interlock, alarm and control systems.
6. Pumps and rotating equipment.

Written quality control procedures that track critical equipment during the fabrication stage should be established and implemented to ensure that materials and construction are in accordance with design specifications. This procedure is needed to help ensure that proper materials of construction are used, that fabrication and inspection procedures are in place and that installation procedures recognize field installation concerns. These procedures will come from the inspection department from established codes and standards, such as Engineering Guides, the American Society of Mechanical Engineers, the American Petroleum Institute, the American Institute of Chemical Engineers, the American National Standards Institute, the American Society of Testing and Materials, and the National Fire Protection Association. Maintenance and contractor supplied materials and spare parts must comply with the quality control procedure also. Examples would be replacement valves, piping, bolts and gaskets.

Documentation of the testing and inspection records of the critical equipment will be kept. This information must include the date of the inspection, who performed the inspection, the name and number of the equipment and any recommendations to correct or repair the equipment before it is put back in service. All deficiencies, which are outside the acceptable limits, must be corrected in the equipment before it is put back into service.

Critical equipment refers to vessels, machinery, piping, alarms, interlocks, and controls determined by management to be cital to prevent the occurrence of a catastrophic release. A catastrophic release is defined as a major uncontrolled emission, fire, or explosion, involving one or more highly hazardous chemicals that presents serious danger to employees or persons both inside and outside the workplace. The critical equipment list should include pressure vessels and storage tanks, piping systems, relief and vent systems and their controls, emergency shutdown and interlock systems, and alarm and control systems. The test procedure must include the method and frequency of testing and inspection, acceptable limits and criteria for passing the test or inspection. The method and frequency can be based on acceptable standards, as mentioned in the second paragraph of this section or prior operating records.

A list of all critical equipment and systems will be compiled from all departments to ensure the safe operation of the process equipment. Examples of critical equipment are vessels, exchangers, compressor and heater interlock systems, relief systems and critical alarms, i.e. shutdown, high and low level, temperature or pressure.

All employees involved in mainatining the on-going integrity of the process equipment must be trained in porcedures applicable to the job task. Appropriate training must be provided to maintenance personnel to ensure that they understand the preventive maintenance program procedures, safe work practices, and the proper use and application of special equipment or unique tools that may be required. This training should cover operation of the system or equipment, acceptable operating limits and frequency of testing.

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Purpose

The purpose of the Refinery Mechanical Integrity Program is to assure the continued mechanical reliability of the Refinery's process equipment. Equipment included in the program is listed below:

1) Pressure Vessels and Storage Tanks
2) Piping Components
3) Relief and Vent Systems and Devices
4) Emergency Shutdown Systems (Interlocks)
5) Controls (Honeywell TDC-3000 Control System)
6) Rotating Equipment

Overview

The Refinery Mechanical Integrity Program is an overview of the many integrity programs within the Refinery. Individual Mechanical Integrity Programs for the six groups of equipment listed above have been established. These individual programs provide the specific details for each group of equipment.

All the above equipment shall be designed, purchased, installed, and maintained according to recognized and generally accepted good engineering practices, as well as, applicable codes and standards, such as the National Board Inspection Code, American Society for Testing and Material, American Petroleum Institute, National Fire Protection Association, American Standards Institute, American Society of Mechanical Engineers.

All employees involved with the ongoing mechanical integrity of the Refinery shall be trained to ensure that they understand the preventative maintenance program procedures, safe practices and the proper use and application of special equipment that they may be requir to use. Records shall be kept to verify and track which employees have been trained.

All effected equipment shall have written procedures that outline the testing and inspection procedures in order to maintain the equipment in a safe working order. All results of the subject test shall be documented and retained in a file for future reference. Any deficiencies found that are outside acceptable limits shall be corrected and documented prior to putting back in service or in a safe and timely manner when necessary means are taken to assure safe operation. The procedures shall have guidelines that address frequency of inspections as well as definitions of responsibilities.

Program Descriptions

1) **Pressure Vessels and Storage Tanks**

Responsibility

The Technical Department Mechanical Engineering Group is responsible to establish and maintain the mechanical integrity program for pressure vessels and storage tanks. The detailed information on this program can be found with the Materials Engineering Supervisor.

Overview

This program ensures the on-going mechanical integrity for pressure vessels and storage tanks from initial design through fabrication, commissioning, and maintenance. Historical records are maintained for verification of applied minimum standards. The Refinery QA Manual, Inspection Programs Manual, and the Owner/User Manual are part of the elements that make up the mechanical integrity program for pressure vessels and storage tanks.

2) **Piping Components**

Responsibility

The Technical Department Mechanical Engineering Group is responsible to establish and maintain the mechanical integrity program for piping components. The detailed information on this program can be found with the Materials Engineering Supervisor.

Overview

This program ensure the on-going mechanical integrity for piping components from initial design through fabrication, commissioning, and maintenance. Included in the program is the On-Stream Piping Inspection Program which provides for the continuous monitoring of in-service piping. Also included is the Refinery Piping Specification which defines appropriate material design application for piping systems.

3) **Relief and Vent Systems and Devices**

Responsibility

The Technical Mechanical Engineering Group is responsible to establish and maintain the mechanical integrity program for relief and vent systems and devices. The detailed information on this program can be found with the Reliablity Engineering Supervisors.

Overview

The QA Program covers relief device quality assurance from specification through field inspection, PM testing, and valve repair. Available valve sizing computer programs are also discussed. The responsibilities of the various refinery departments concerning relief device quality assurance are identified in the program.

4) **Emergency Shutdown Systems (Interlocks)**

Responsibility

The Maintenance Department I/E Group is responsible for establishing maintaining the mechanical integrity of emergency shutdown systems. The detailed information on this program can be found with the I/E Superintendent.

Overview

The "Equipment Reliability & Mechanical Integrity for I/E Equipment" addresses the programs to ensure the on-going reliability of instrumentation and electrical equipment. The program contains information on required personnel training, inspection and testing as well as procedures for tracking the findings. Programs such as compressor interlock PM, heater interlock PM, and emergency generator PM are covered in the practice.

5) **Controls (Honeywell TDC-3000 System)**

Responsibility

The Maintenance Department I/E Group is responsible for establishing a-- maintaining the mechanical integrity of the control systems. The detailed information on this program can be found with the I/E Superintendent.

Overview

The "Equipment Reliability & Mechanical Integrity for I/E Equipment" addresses the programs to ensure the on-going reliability of the Refinery's controls systems. The program contains information on required personnel training, inspection and testing as well as procedures for tracking the findings. The TDC-3000 PM program is an example of the equipment covered in the practice.

6) **Rotating Equipment**

Responsibility

The Maintenance Department Machinist Reliability Group is responsible for establishing and maintaining the mechanical integrity of rotating equipment. The detailed information on this program can be found with the Machinist Reliability Superintendent.

Overview

The "Equipment Reliability & Mechanical Integrity for Rotating Equipment" addresses the programs to ensure the on-going reliability of rotating equipment. The program contains information on required personnel training, inspection and testing as well as procedures for tracking the findings. The written practice includes items such as Predictive and Preventative Maintenance Programs for pumps, turbines and compressors.

D-2 Mechanical Integrity Program - Hazardous Waste Handling System

The following are examples of inspection log sheets for tank storage areas. The inspections are separated into daily, weekly and annual inspections. It includes all equipment covered under the mechanical integrity program and the tests that should be performed on each individual piece of equipment.

TANK STORAGE AREAS
EXAMPLE OF ANNUALLY INSPECTION LOG

Check Location Of Inspection:

_______ Loose Solid Waste Tanks
_______ Container Pumpout Tank Farm
_______ Drum Extruder Tank Area
_______ Organic Tank Farm

_______ Laboratory Tank
_______ Slag Quench Tank
_______ External Truck Wash
_______ Fire Water Storage Tank

_______ Wastewater Treatment Tanks
_______ Process Water Storage Tank Farm
_______ Scrubber Water Holding Tank
_______ Neutralization System

Inspector's Name: _______________ **Date:** _______________ **Time:** _______________

Status: Acceptable	Status: Unacceptable		Equipment	Inspection/Maintenance	Deficiency	Corrective Action Taken (Date, Initials)
_______	_______	1.	Electrical Motors	Test motor winding as required; Comprehensive maintenance inspection		
_______	_______	2.	Pumps & Fans	Mechanical check for leaks; check bearings and seals; replace worn parts; comprehensive maintenance inspection		
_______	_______	3.	Instruments & Controls	Calibrate instruments; Comprehensive maintenance inspection		
_______	_______	4.	Programmable Controllers	*Verify program; Preventive* maintenance program		

TANK STORAGE AREAS
EXAMPLE OF ANNUALLY INSPECTION LOG
(Continued)

Status Acceptable	Status Unacceptable		Equipment	Inspection/Maintenance	Deficiency	Corrective Action Taken (Date, Initials)
______	______	5.	Steel Tank Conditions (ultrasonic wall thickness testing or its equivalent)	Deterioration, corrosion, erosion, cracks, leakage; Evaluation of minimum wall thickness	______	______
______	______	6.	Fiberglass Reinforced Plastic Tanks (dye-penetrant testing)	Cracking, curving, flexing; Evaluation of suspected cracks	______	______
______	______	7.	Concrete Tanks	Cracking, spalling, reinforcement bar exposure	______	______

NOTES: ______________________________

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TANK STORAGE AREAS
EXAMPLE OF WEEKLY INSPECTION LOG

Check Location Of Inspection:

_______ Loose Solid Waste Tanks	_______ Laboratory Tank	_______ Wastewater Treatment Tanks
_______ Container Pumpout Tank Farm	_______ Slag Quench Tank	_______ Process Water Storage Tank Farm
_______ Drum Extruder Tank Area	_______ External Truck Wash	_______ Scrubber Water Holding Tank
_______ Organic Tank Farm	_______ Fire Water Storage Tank	_______ Neutralization System

Inspector's Name: ____________________ **Date:** ________________________ **Time:** ____________________

Status: Acceptable	Status: Unacceptable		Equipment	Inspection/Maintenance	Deficiency	Corrective Action Taken (Date, Initials)
_______	_______	1.	Portable Fire Control Equipment (7)	Missing, low pressure	_______	_______
_______	_______	2.	Sprinkler System	Visual	_______	_______

NOTES: ____

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TANK STORAGE AREAS
EXAMPLE OF DAILY INSPECTION LOG

Check Location Of Inspection:

________ Loose Solid Waste Tanks	________ Laboratory Tank	________ Wastewater Treatment Tanks
________ Container Pumpout Tank Farm	________ Slag Quench Tank	________ Process Water Storage Tank Farm
________ Drum Extruder Tank Area	________ External Truck Wash	________ Scrubber Water Holding Tank
________ Organic Tank Farm	________ Fire Water Storage Tank	________ Neutralization System

Inspector's Name: ____________________ **Date:** ____________________ **Time:** ____________________

Status Acceptable	Status Unacceptable	Equipment	Inspection/Maintenance	Deficiency	Corrective Action Taken (Date, Initials)
______	______	1. Tank Structure • Steel Tanks • Reinforced Plastic Tanks • Concrete Tanks	Leakage, corrosion, deterioration, bulges; cracks; discoloration; peeling	______	______
______	______	2. Leak Detection Equipment	Operable	______	______
______	______	3. Secondary Containment System	Gaps; cracks; deterioration; erosion; valves are operable; presence of liquid; functional alarm	______	______
______	______	4. Overflow Control Equipment	Corrosion; deterioration; leakage	______	______
______	______	5. Foundation	Deterioration; cracks; erosion; uneven settlement	______	______

TANK STORAGE AREAS
EXAMPLE OF DAILY INSPECTION LOG
(Continued)

Status Acceptable	Status Unacceptable		Equipment	Inspection/Maintenance	Deficiency	Corrective Action Taken (Date, Initials)
______	______	6.	Piping and Valves	Leakage, corrosion, visual deterioration	______	______
______	______	7.	Overflow Control Equipment	Corrosion, deterioration, leakage	______	______

NOTES:

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