GUIDANCE FOR IMPLEMENTING PROGRAMS FOR OSHA 29 CFR 1910.119

PROCESS SAFETY MANAGEMENT OF HIGHLY HAZARDOUS CHEMICALS

PART ONE

PROCESS SAFETY INFORMATION

by

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GUIDANCE FOR IMPLEMENTING PROGRAMS FOR OSHA PSM

PROCESS SAFETY INFORMATION

This document contains information that may assist a company in establishing, or reviewing and updating, the process safety information (PSI) 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 actual programs provided by industrial companies.

PROCESS SAFETY INFORMATION [29 CFR 1910.119 (d)]

PQV Question	Explanation	Positive Program Indicators	Negative Program Indicators
1. Has written process safety information been compiled before conducting any process hazard analysis (PHA)?	The process hazard analysis (PHA) should be based on complete written process safety information (PSI). The PSI should be collected, updated, and available to the PHA team prior to, and during the course of conducting the PHA study. The completeness and accuracy of the PHA is questionable without accurate PSI. Note that if the original PSI, such as technical information, is not available, it may be developed in conjunction with conducting the PHA.	PSI such as Material Safety Data Sheets (MSDSs), block flow diagrams (BFD), process flow diagrams (PFDs), piping and instrument diagrams (P&IDs), operating and maintenance procedures, design calculations and reports, engineering studies, equipment data sheets and design specifications for equipment are up-to-date and were made available to the PHA team prior to, and during the PHA study. PSI is dated and precedes the date of the PHA study. PHA study report identifies the PSI referenced during the study. References include the title, date and revision number of the PSI document. Interviews with PHA team members show that PSI was updated, accurate and available to the study team. The PSI is organized in a fashion where it is accessible to perform the principal functions intended for it under the standard: employee access to all information related to PSM compliance and use as a resource bank to support the development of process hazard analyses, incident investigations, mechanical integrity programs, management of change functions, and employee training.	PSI was incomplete and out-of-date prior to and during the PHA study. There is an indication, by observing mark-ups, that extensive revisions were made to PSI documents during the course of the PHA study. This is a likely indication that the PSI document was not up-to-date and accurate prior to the PHA study. PSI was not compiled and available to the team during the PHA study. The PHA report does not reference the PSI documents that were used by the study team during the study.

PROCESS SAFETY INFORMATION [29 CFR 1910.119 (d)]

PQV Question	Explanation	Positive Program Indicators	Negative Program Indicators
2. Is information included pertaining to the hazards of the highly hazardous chemicals used or produced by the process, and does the information include at least: • toxicity information • PELs • physical data • reactivity data • corrosivity data • thermal and chemical stability data • hazardous effects of inadvertent mixing of different materials that could foreseeably occur? NOTE: MSDSs meeting the requirements of 29CFR1910.1200 (g) may be used to the extent they contain the information required	Documentation should exist which includes a description of the inherent physical and chemical hazards of each highly hazardous chemical used, handled, or stored onsite. This information should be up-to-date and readily available to employees so that they can better understand the physical and chemical hazards of the materials they handle.	Compilation of Material Safety Data Sheets (MSDSs) or other documents including this information for each highly hazardous chemical in the process. Interviews show that MSDSs and/or similar information are readily available to employees. Employee is informed on where information is maintained and how it can be accessed. Information is available to all employees, including during non-normal work hours. For example, MSDS type information should be available to shift workers during evening and weekend shifts. Observation of sample process chemicals and equipment indicates that the MSDS or equivalent documentation is complete and accurate. The physical data is complete including boiling point, melting point, vapor pressure, flash point, auto-ignition temperature, lower and upper exposure limits where appropriate. Where the potential exists for inadvertent mixing of materials with highly hazardous chemicals, information is available on the products and by-products of reaction. The potential for inadvertent mixing of materials may be identified during the course of a PHA study.	Information regarding the hazards of the highly hazardous chemicals does not exist or is incomplete. MSDS or other hazard information is not readily available to employees. Employees are not informed on where information is maintained. Information is not accessible during non-normal work hours, such as evenings and weekends when shift employees may require access. Information is incomplete or does not adequately reflect the hazards of the highly hazardous chemicals. Information is not available on the results of inadvertently mixing a highly hazardous chemical with another material, when the potential exists for such inadvertent mixing. The potential for inadvertent mixing is greater for batch operations and for continuous operation involving multiple raw materials.

PROCESS SAFETY INFORMATION [29 CFR 1910.119 (d)]

PQV Question	Explanation	Positive Program Indicators	Negative Program Indicators
3. Is information included concerning the technology of the process, and does it include at least: • a block flow diagram (BFD) or simplified process flow diagram (PFD)? • process chemistry? • maximum intended inventory? • safe upper and lower limits? • an evaluation of the consequences of deviations? (Where the original technical information no longer exists, it may be developed in conjunction with the PHA.)	The PSI should include data on the technology of the process to provide the technical basis for handling or processing of the highly hazardous chemical. This should include information such as: a block flow diagram (BFD) or simplified process flow diagram (PFD) as described in Appendix B; a description of considerations such as the process chemistry including the reactions taking place; descriptions of any side reactions, whether the highly hazardo chemical is consumed, generated or recycled in the process and the potential for exothermic reactions to occur (if applicable); maximum intended inventory; safe upper and lower operating limits of pressure, temperature and level for key pieces of process equipment; and an evaluation of the consequences of the deviations from safe upper and lower operating limits. If the original technical information is no longer available or is not accurate, it may be developed in conjunction with conducting the PHA. Some of the technical information may be necessary in order conduct the PHA, such as the BFD, PFD or safe upper and lower operating limits. Other information could be developed as a result of completing the PHA, such as consequences of deviating from safe upper and lower operating limits.	A BFD or PFD, as described in Appendix B to 29 CFR 1910.119, is available that visually summarizes the entire covered process. A detailed technical description of the chemical processes occurring in the covered equipment (appropriate to the complexity of the process) including: chemical reaction equations; stoichiometric calculations; quantities of highly hazardous chemicals generated or consumed; and; the heats of reaction for the substances involved. A description of process chemistry is included for processes where the highly hazardous chemical is reacted or otherwise transformed as part of the process. The description of process chemistry focusses on the potential for undesirable by-products to be generated or the inadvertent mixing of chemicals in the process, and a description of the physical or chemical means under which these scenarios could occur. This should also address runaway reactions, explosive polymerization, self-heating, and auto-catalysis. A procedure exists to track and record the inventory of highly hazardous chemicals (i.e. operator logs, shipping/receiving documents). Inventory tracking helps to ensure that the maximum intended inventory is not exceeded. Safe upper and lower limits for operation of equipment are clearly defined in either a stand alone document or within the standard operating procedures. Operating limits include the range for normal operation and minimum and maximum design limitations.	The BFD or PFD does not show all of the process components, their relationship, and the flow into and out of each component. The BFD or PFD does not include recent revisions or changes to the process. Description of process chemistry is inappropriately brief compared to the complexity of the process. Description of process chemistry does not address the highly hazardous chemicals present in the process. No documentation exists describing the maximum intended inventory for the highly hazardous chemicals. No documentation exists regarding inventory tracking. Safe upper and lower operating limits are either not clearly defined or exceed maximum and minimum design limits. Employees are not familiar with the process technology or the hazards that may exist due to the process technology.

PROCESS SAFETY INFORMATION [29 CFR 1910.119 (d)]

PQV Question	Explanation	Positive Program Indicators	Negative Program Indicators
3. Information concerning the technology of the process, (cont'd.)	(See above)	A written evaluation is made of the potential consequences which may result if safe operating limits are violated. Typically, an evaluation of the consequences of deviations from safe operating limits is included in a PHA.	No determination or description of the consequences of deviating from the safe operating limits is made. Description of consequences are inadequate, inaccurate or out-of-date.

PROCESS SAFETY INFORMATION [29 CFR 1910.119 (d)]

PQV Question	Explanation	Positive Program Indicators	Negative Program Indicators
4. Is information included pertaining to equipment in the process, and does it include at least: • materials of construction? • piping and instrument diagrams (P&IDs)? • electrical classification? • relief system design and design basis? • ventilation system design? • design codes and standards employed? • material and energy balances for processes built after May 26, 1992? • safety systems (e.g. interlocks, detection or suppressions systems)?	The PSI should describe the physical equipment design specifications and operation in order to provide employees with a clear understanding of the operating parameters and limitations. The PSI should include information on the equipment such as: materials of construction for vessels and piping; piping and instrument diagrams (P&IDs) for each covered process; electrical classification for equipment; the design basis for emergency relief and venting systems including the criteria used for release rate and sizing; the design basis for ventilation systems to assure that work areas are adequately ventilated; a listing of the design codes and standards to which a process was developed, material and energy balances for processes built after May 26, 1992 and safety system information.	Information exists including materials of construction for equipment, line lists, piping specifications, and equipment purchase specifications. For older processes where such data is unavailable or outdated, a compilation of field verified data should be available. A complete set of up-to-date P&IDs exist for the covered process including a legend and all associated equipment and piping. P&IDs include labelling of equipment and lines. Labeled lines include such information as line sizes and piping specifications. P&IDs include: a sign-off by preparer and approver(s); revisions clearly shown with dates and approvals; a complete title block; a reasonable and rational numbering scheme; and, clearly shown line continuations from sheet-to-sheet. Electrical classification of equipment is clearly identified. Electrical classifications are typically shown as an overlay on a plot plan, but other forms are acceptable. A written analysis of the criteria and calculations used to size and design emergency relief systems exists. A written analysis of the criteria and calculations used to size and design ventilation systems exists. A listing of the industry or corporate standards to which a process was designed is documented.	No data on materials of construction is available. Inaccurate or out-of-date information exists regarding materials of construction. Process drawings such as P&IDs are not up-to-date, incomplete, non-existent, lack the proper amount of detail or are inaccurate in their representation of the process. Lack of information on electrical classification. Lack of documented criteria used for the design of emergency relief systems. Lack of documented criteria used for the design of ventilation systems. Lack of documentation for installed devices. Lack of documented criteria used for the design of the process. No writte[illegible]erial or energy balance for processes [illegible]lt after May 26, 1992. No existing written information on equipment safety systems. Existing written information is incomplete or does not contain up-to-date information.

PROCESS SAFETY INFORMATION [29 CFR 1910.119 (d)]

PQV Question	Explanation	Positive Program Indicators	Negative Program Indicators
4. Information pertaining to equipment in the process (cont'd.)	(See above)	A written material and energy balance. This may exist as part of the process design specifications or it may be represented on *PFDs*. Documentation should include: original design calculations, equipment data sheets, equipment purchase specifications, design reports, and P&IDs. Written description of equipment specific safety shutdown interlocks, release detection systems, fire/release suppression systems, level, temperature, and pressure alarms, etc., exists. Examples of these descriptions include; safety analysis function evaluation (SAFE) charts or equivalent, data sheets, control logic diagrams and/or control system electrical schematics.	(See above)
5. Has the employer documented that equipment complies with recognized, generally accepted good engineering practices?	Documentation should exist to verify that existing equipment is installed and operated in conformance with accepted practices and standards. When no such documentation exists, employer should conduct and document an engineering review to ensure that installed equipment complies with good engineering practices. Good engineering practices could include association standards, consensus standards, or corporate practices.	Documentation exists showing that compliance with the appropriate consensus standards has been reviewed and is confirmed. Interviews with engineers should support any documentation that equipment complies with recognized and generally good accepted engineering practice. Observation of a sample of process components indicates that equipment complies with recognized and accepted engineering practices.	No review of equipment versus generally accepted good engineering practices and appropriata consensus standards is documented.

PROCESS SAFETY INFORMATION [29 CFR 1910.119 (d)]

PQV Question	Explanation	Positive Program Indicators	Negative Program Indicators
6. Has the employer determined and documented that existing equipment designed and constructed in accordance with codes, standards, or practices no longer in general use are designed, *maintained, inspected,* tested, and operating in a safe manner?	Documentation should exist to show that equipment designed to criteria no longer in general use is actually designed, operated, tested, inspected and maintained in a safe manner. Where this documentation does not exist, it can be developed in conjunction for conducting the PHA study. When no such documentation exists, employer should conduct and document an engineering review to ensure that installed equipment complies with good engineering practices. Good engineering practices could include association standards, consensus standards, or corporate practices.	Documentation exists verifying that equipment designed to criteria no longer in general use is operated in a safe manner. Verification should include a review of the design, testing, inspection, and maintenance protocol. Verification could include documentation of successful prior operation; documentation that the equipment is consistent with the appropriate editions of codes and *standards; or performing an engineering analysis* to determine that the equipment is appropriate for its intended use. Information supplied by a vendor and information from another company with the same equipment installed, should be maintained for existing equipment designed in accordance with criteria no longer in general use. Operating and maintenance records should indicate that regularly scheduled tests and inspections are performed and documented. Regularly scheduled tests/inspections could include daily, weekly, monthly, quarterly, or annual items. Well performed and documented operating and maintenance records, coupled with a good operating history of few incidents, will support the premise that the facility is operated in a safe manner.	Lack of documentation to show that equipment is maintained, inspected tested and operated in a safe manner. Operating and/or maintenance records are out-of-date, incomplete or inadequate to insure that the facility is operated in a safe manner.

APPENDIX A

List of Acronyms

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

Referenced Agency Addresses and Phone Numbers (Continued)

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

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

TECHNICAL REFERENCES

MANAGEMENT OF CHANGE

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Management of Change in Chemical Plants, Roy E. Sanders, Butterworth-Heinemann Ltd., Oxford, England, 1993.

WAC 296-67-045 Management of Change

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

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"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.

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"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

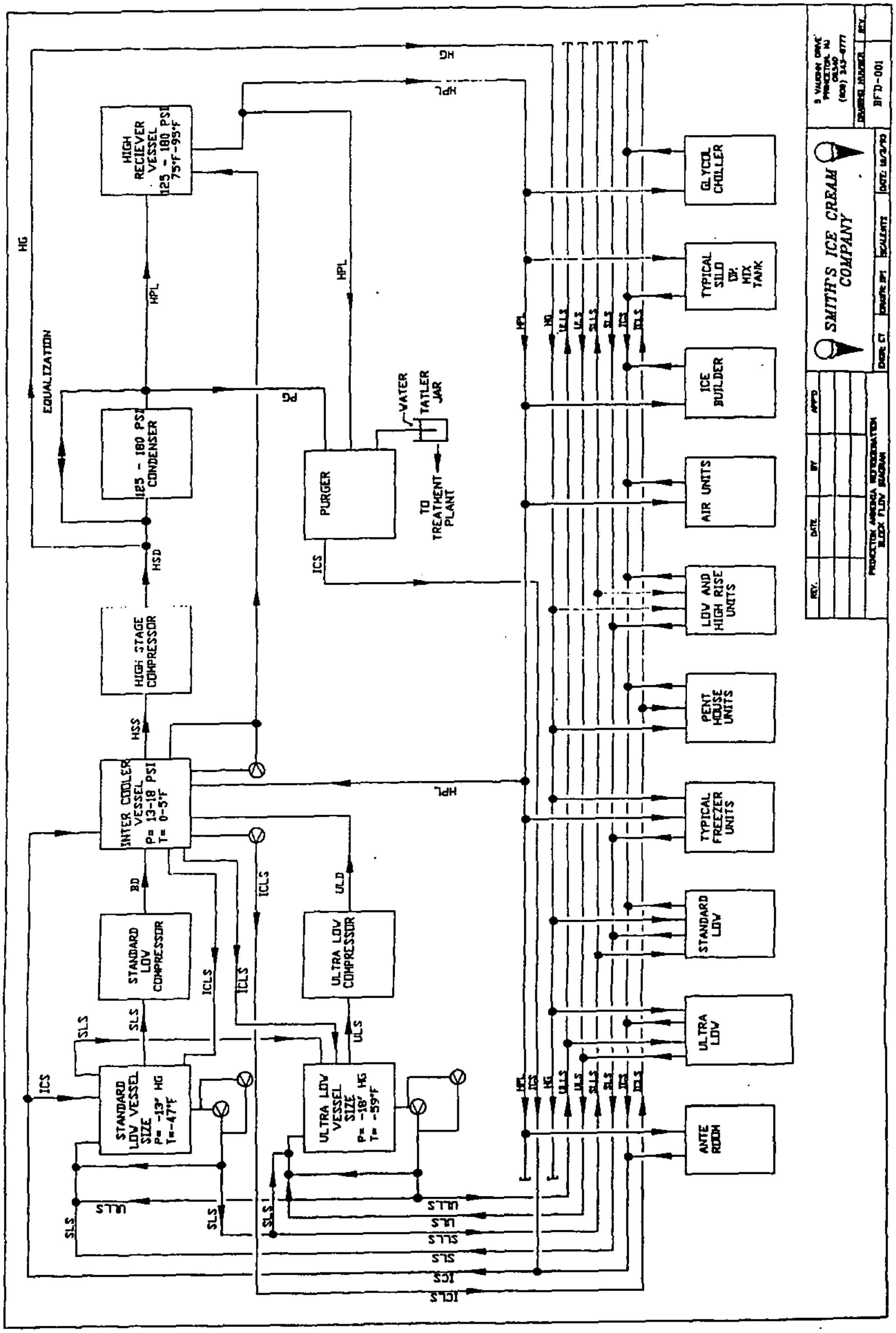
The following examples illustrate approaches taken by companies seeking to address the Process Safety Information requirements of 29 CFR 1910.119. These examples have not been reviewed and/or endorsed by OSHA and should not be construed as model programs. Primatech makes no claims regarding the acceptability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

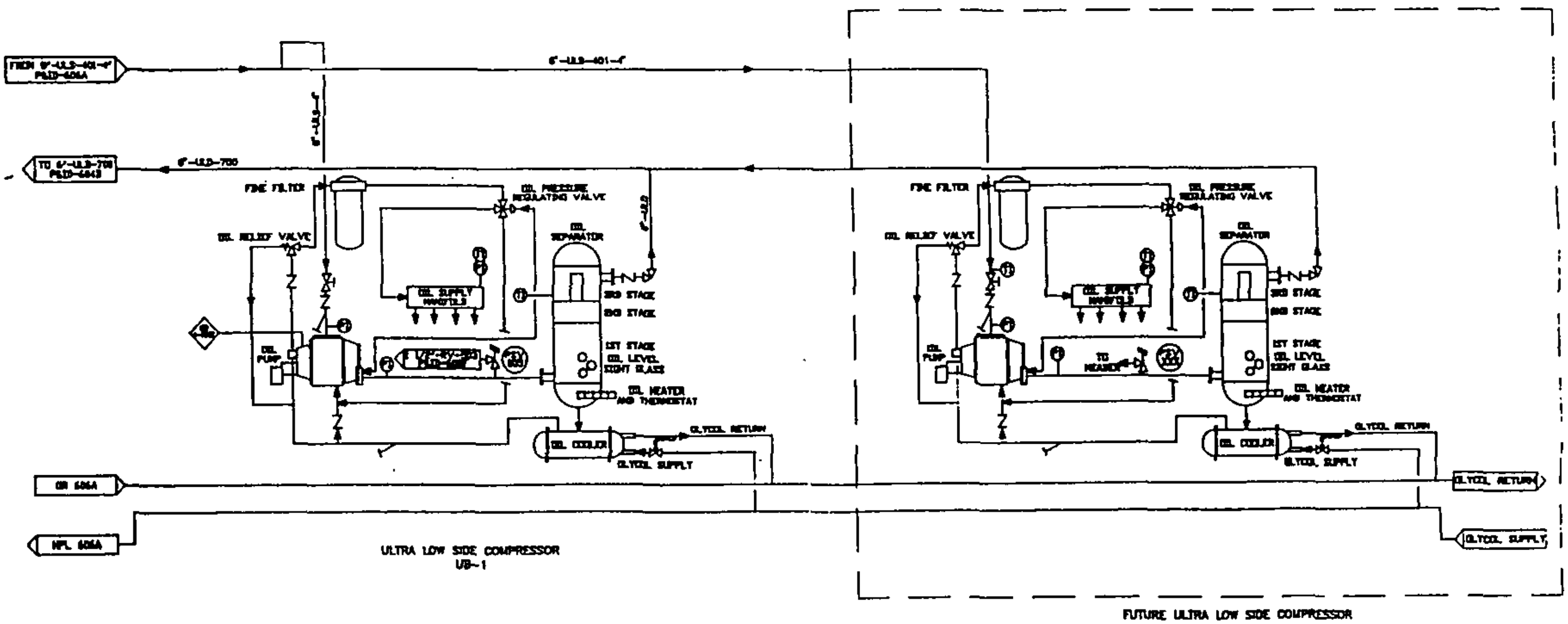
D-1.1 Block Flow Diagram (BFD) - Ammonia Refrigeration System

The following is a block flow diagram (BFD) of an ammonia refrigeration facility, including all major pieces of process equipment and process flow direction.


SMITH'S ICE CREAM COMPANY
5 VAUGHN DRIVE PRINCETON, NJ 08540 (609) 243-4777
PRINCETON AMMONIA REFRIGERATION BLOCK FLOW DIAGRAM
BFD-001
HIGH RECIEVER VESSEL 125 - 180 PSI 75°F-95°F
125 - 180 PSI CONDENSER
HIGH STAGE COMPRESSOR
INTER COOLER VESSEL P= 13-18 PSI T= 0-5°F
STANDARD LOW COMPRESSOR
ULTRA LOW COMPRESSOR
STANDARD LOW VESSEL SIZE P= -13" HG T=-47°F
ULTRA LOW VESSEL SIZE P= -18" HG T= -59°F
PURGER
WATER
TATLER JAR
TO TREATMENT PLANT
EQUALIZATION
GLYCOL CHILLER
TYPICAL SILO OR MIX TANK
ICE BUILDER
AIR UNITS
LOW AND HIGH RISE UNITS
PENT HOUSE UNITS
TYPICAL FREEZER UNITS
STANDARD LOW
ULTRA LOW
ANTE ROOM
HG
HPL
HSD
HSS
PG
ICS
ICLS
BD
ULD
SLS
ULS
ULLS
SLLS

D-1.2 Piping and Instrument Diagrams (P&IDs) - Ammonia Refrigeration System

The following are two piping and instrument diagrams (P&IDs) for an ammonia refrigeration facility. P&ID-606A illustrates two ultra low side compressors, one existing and one yet to be constructed. P&ID-606B illustrates an ultra low vessel, an oil separator, an ultra low side compressor and various other process equipment. Both drawings detail the ammonia refrigeration equipment in an "as-built" condition. They include every item of ammonia refrigeration equipment and its identification numbers, every pipe including size, flow direction and identification number, valves, references to inter-facing with other diagrams, relief valves and relieving devices.



REV.	DATE	BY	APP'D

PRINCETON PLANT - ULTRA LOW SIDE COMPRESSOR PIPING AND INSTRUMENTATION DIAGRAM

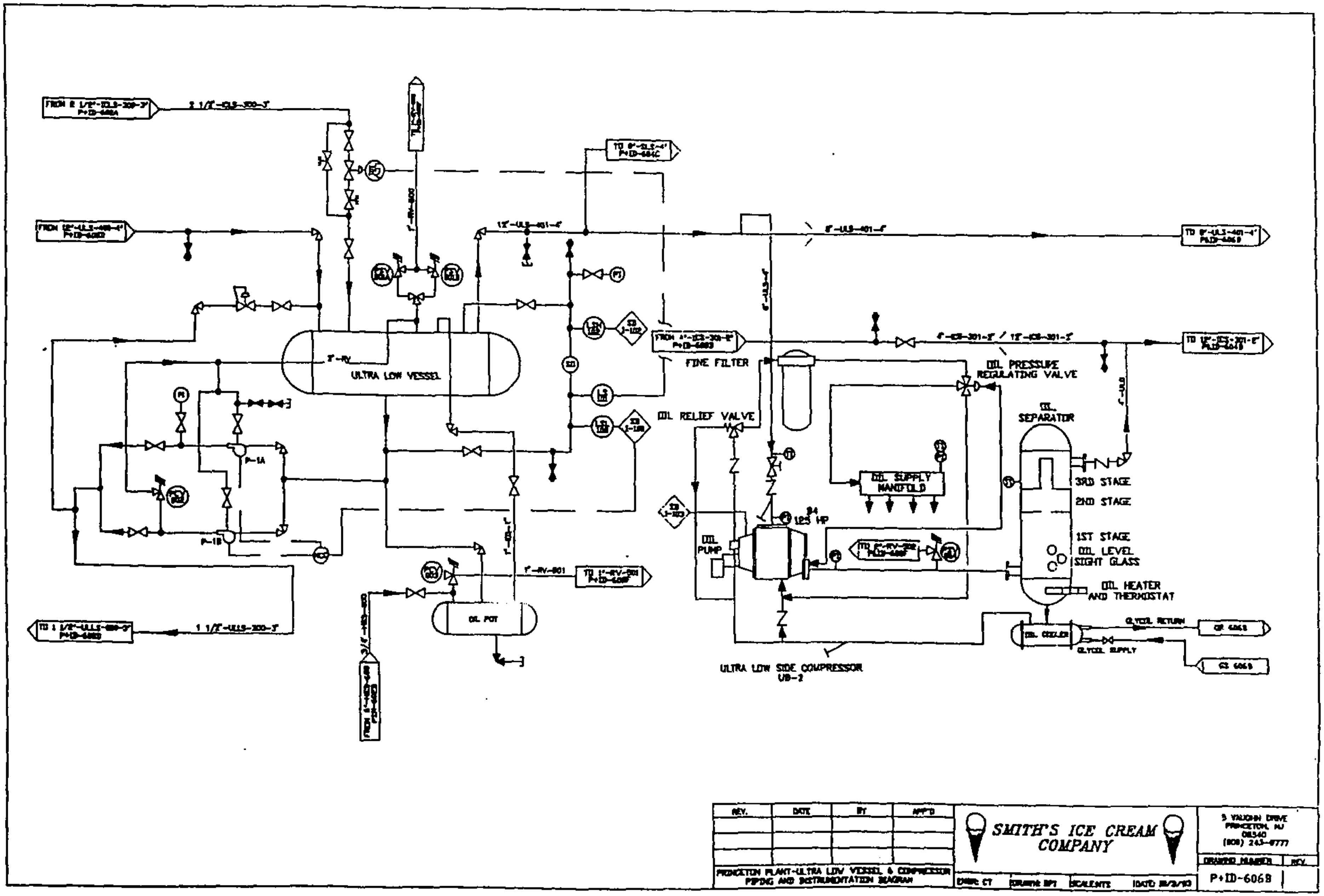
SMITH'S ICE CREAM COMPANY

5 VAUGHN DRIVE
PRINCETON, NJ
08540
(609) 243-8777

ENGR: CT | DRAWN: SPI | SCALE: NTS | DATE: [illegible]

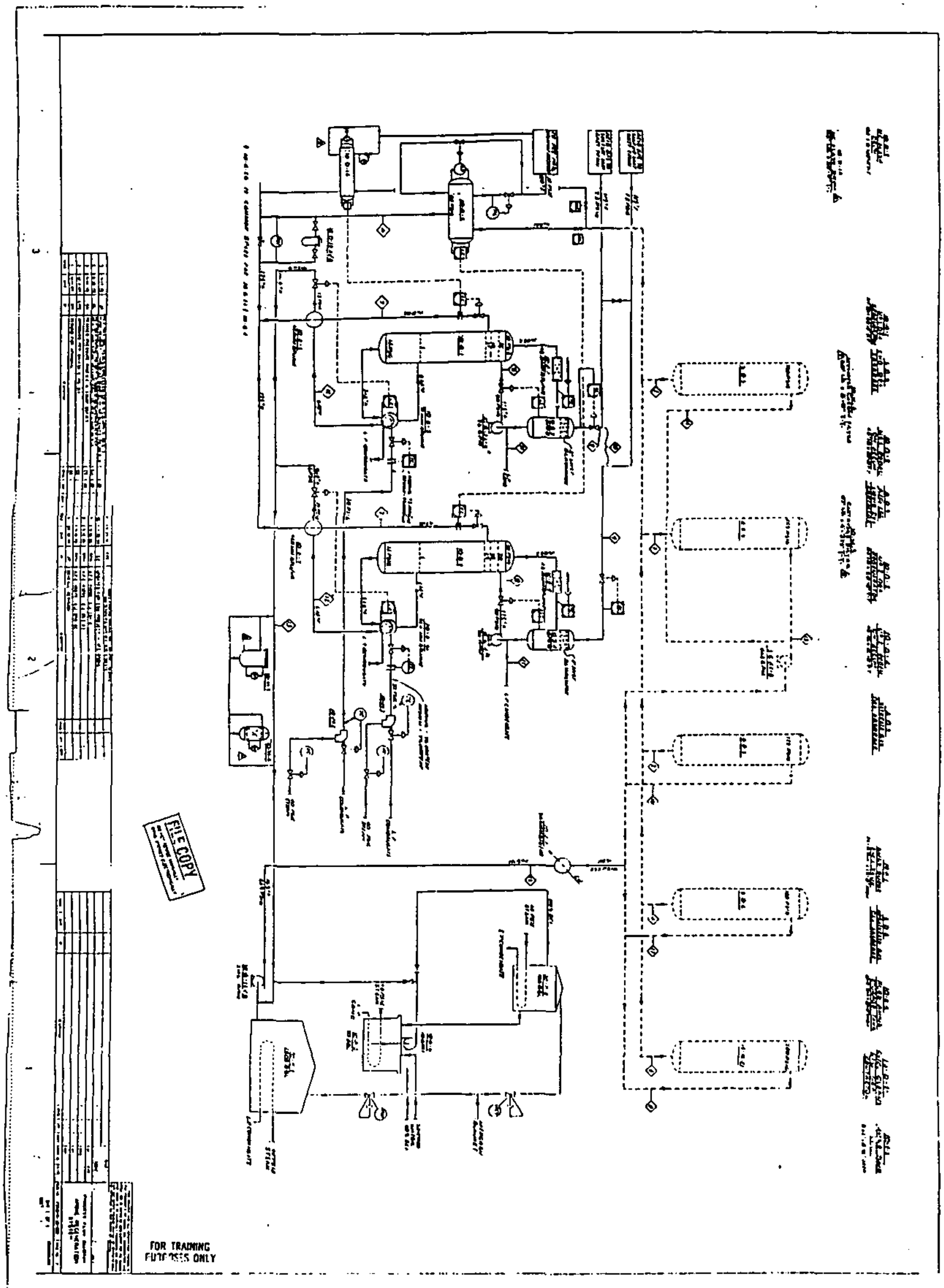
DRAWING NUMBER: P+ID-606A | REV.:

ABD00102664



D-1.3 Process Flow Diagram (PFD) - Amine Regeneration System

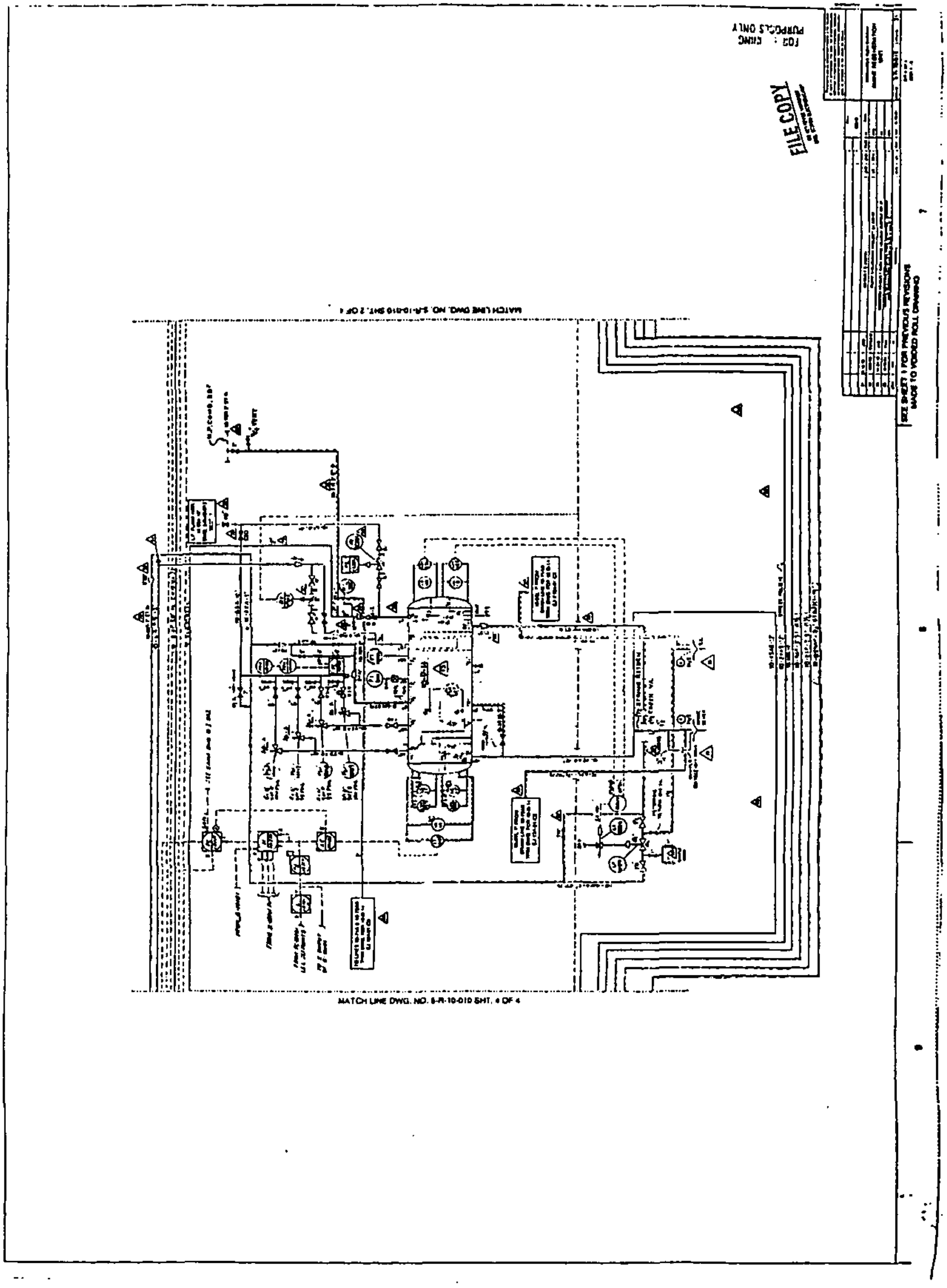
A typical process flow diagram (PFD) is included for an amine regeneration system. These systems are generally found within a petroleum refinery. It includes all of the major process equipment, control devices and the process conditions such as; flow direction, flow rate, temperature and pressure.


FILE COPY
FOR TRAINING
FUTPOSES ONLY

D-1.4 Piping and Instrument Diagrams (P&IDs) - Amine Regeneration System

Drawings 5-R-10-010, sheet 2 and 3 illustrate two typical P&IDs for an amine regeneration system. The drawings include amine regeneration equipment and its identification numbers, every pipe including size, flow direction and identification number, valves, references to inter-facing with other diagrams, relief valves and relieving devices.

ABD00102668



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