

NFPA[®]

36

Standard for
Solvent Extraction
Plants

2021



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NFPA® 36

Standard for

Solvent Extraction Plants

2021 Edition

This edition of NFPA 36, *Standard for Solvent Extraction Plants*, was prepared by the Technical Committee on Solvent Extraction Plants. It was issued by the Standards Council on October 5, 2020, with an effective date of October 25, 2020, and supersedes all previous editions.

This edition of NFPA 36 was approved as an American National Standard on October 25, 2020.

Origin and Development of NFPA 36

This standard was developed at the request of the solvent extraction industry in an effort to achieve greater uniformity in fire protection practices for extraction plants. The purpose of the standard is to provide reasonable standards for the design and operation of solvent extraction processes and extraction plants.

In the development of this standard, the Technical Committee on Solvent Extraction Plants recognized some fundamental differences between the operation of solvent extraction plants and the processing of solvents in other facilities. Many extraction plants are relatively small units in isolated locations; they operated without the benefit of overall fire protection measures, which are customary in large solvent processing facilities.

The operator of a solvent extraction plant must establish and maintain fire safety esprit de corps among a small number of employees, as opposed to relying on the established customs of large-scale operations.

There are certain hazards in the combining and separating of solids and solvents that are peculiar to the solvent extraction industry. Also serving as a complicating problem is the potential dust explosion hazard in some areas of the typical plant. Therefore, the technical committee determined that it would be desirable to give consideration to practices applicable to both dust-laden and flammable vapor-laden atmospheres.

NFPA 36 was tentatively adopted at the 1957 Annual Meeting of the association. A revision of this tentative edition was adopted at the 1958 Annual Meeting. NFPA 36 was officially adopted by the association at its 1959 Annual Meeting. Amendments were adopted in 1962, 1964, 1967, 1972, 1973, 1974, 1978, 1983, 1985, 1988, 1993, 1997, 2001, 2004, and 2008.

The 1997 edition of NFPA 36 incorporated the following amendments:

- (1) New appendix text to 1.1.1 to refer the user to NFPA 30, *Flammable and Combustible Liquids Code*, for solvent extraction processes not covered by NFPA 36
- (2) New 1.1.6, extending the scope of NFPA 36 to any preparation or meal finishing area that is connected to the solvent extraction process by a conveyor, thus establishing a boundary between those operations governed by NFPA 36 and those that might be governed by NFPA 61, *Standard for the Prevention of Fires and Dust Explosions in Agricultural and Food Products Facilities*
- (3) Revision of 5.2.5 to require compliance with all stated measures for preventing vapors from migrating beyond the controlled or restricted areas
- (4) New appendix text to 5.5.1 to provide guidance to the user in applying requirements for hazardous (classified) locations
- (5) New 5.8.1.7, which established specific requirements for actions to be taken to remove vapors from the extractor, especially during emergencies
- (6) New 5.8.9.6, which established a requirement for means to automatically sense excess pressure in the extractor or in the desolventizer-toaster and to automatically reduce the excess pressure to a safe level

- (7) Numerous editorial and minor technical improvements

The 2001 edition of NFPA 36 incorporated the following amendments:

- (1) A revised definition of *flame arrester*
- (2) A revision to 2.1.4 to require written authorization for repairs involving hot work
- (3) A revision of 4.1.2 to clarify which provisions do not apply when the liberation of dust is adequately controlled
- (4) A revision of Section 4.5 to better describe when repairs, including those involving hot work, can be performed without shutting down the entire process
- (5) A revision to 5.8.1.1 to clarify the requirements for venting of process equipment
- (6) A new 5.8.1.5 that stated that a flame arrester is not required in the discharge line from an emergency pressure relief valve
- (7) A new 5.8.1.7 that prohibited installing a shutoff valve in the overflow line from a tank or vessel
- (8) A revision to 5.8.1.9 to clarify the means of exhausting vapors from plant equipment

The 2004 edition of NFPA 36 was a complete editorial rewrite of the previous edition to comply with NFPA's *Manual of Style for Technical Committee Documents* and incorporated the following technical amendments:

- (1) Revised definitions of the terms *extraction process*, *flame arrester*, *flammable liquid* (to correlate with NFPA 30, *Flammable and Combustible Liquids Code*), *inert gas*, *lower flammable limit*, and *upper flammable limit*
- (2) Addition of a definition for *noncombustible material*, extracted from NFPA 220, *Standard on Types of Building Construction*
- (3) Revised procedures in 4.5.3 for transfer of solvent, to correlate with NFPA 30
- (4) Revision of 5.3.2 to require the design and construction of solvent storage tanks to comply with NFPA 30
- (5) Revision of Section 7.4, Drainage and Spill Control, to provide more specific design requirements for the separation sump
- (6) Addition of Figure 7.5.2 to illustrate typical locations for providing vent openings in the conveying system
- (7) Revision of Section 7.6, Cooling Towers, allowing flexibility in locating the various types of cooling towers relative to the extraction process
- (8) Addition of an exception to 8.2.6 that allowed a shutoff valve in a normal vent line or an emergency vent line if the shutoff valve meets specified criteria
- (9) Addition of physical property data for isohexane to Annex B to recognize its use as an extraction solvent

The 2009 edition of NFPA 36 incorporated the following technical amendments:

- (1) Revised definitions of the terms *flame arrester*, *inert gas*, and *lower flammable limit*
- (2) Addition of exceptions to 6.2.4 and to 7.9.2 to allow the use of electric space heaters that are approved for Class I, Division 1, Group D or Class II, Division 1, Group G locations
- (3) Revision to Figure 7.2.1 to show correct dimension reference lines for the extent of the hazardous location above a process vent
- (4) Revision to 7.4.2.3 to provide more detailed requirements for the separation sump
- (5) Addition of a new figure, Figure 7.4.2.3, to illustrate a typical separation sump design
- (6) Addition of a new annex item, A.7.4.2.4, to provide suggested means to provide emergency control of outflow from the separation sump, if the liquid seal fails
- (7) Deletion of existing 7.5.3, because it conflicted with 7.5.2
- (8) Removal of an erroneously placed line in Figure 7.7.1
- (9) Addition of requirements to 8.10.4 and 8.10.5 to monitor the discharge of oil for conditions that might present a significant hazard
- (10) Revision of 8.10.6 to correlate with changes made to 8.10.4 and 8.10.5
- (11) Correction to Table B.2(a)
- (12) Deletion of Table B.2(b), because it conflicted with Table B.2(a)

The 2013 edition of NFPA 36 incorporated the following technical amendments:

- (1) Referenced documents in Chapter 2 were updated to current editions.
- (2) Subsection 4.11.1 was expanded to address hand tools and power tools.
- (3) An annex discussion was added to provide guidance on determining whether special tools were needed.
- (4) Subsection 6.4.2 was revised to correlate with NFPA 61, *Standard for the Prevention of Fires and Dust Explosions in Agricultural and Food Processing Facilities*, by providing exceptions for dust collectors, centrifugal separators, and bin vent dust collectors located inside buildings.
- (5) Subsection 6.4.3 was broadened to apply to all types of filter media and to require explosion protection if there is a risk of a dust explosion in the enclosure.
- (6) Section 7.7 was revised to include guidance for use of the zone system for electrical area classification.

The 2017 edition of NFPA 36 incorporated the following technical amendments:

- (1) A new subsection was added to address trenches for solid-collecting conveyors.
- (2) A new Annex A subsection provided references to assessment methods for determining the need for lightning protection.
- (3) Section 8.2 was revised to maintain consistency with NFPA 30 and to clarify the normal and emergency venting requirements.
- (4) All exceptions were rewritten in enforceable, mandatory language.

The 2021 edition contains only minor changes to the standard. An alternate standard for spark-resistant construction has been added to aid users in applying mechanical ventilation requirements, portable fire extinguishers are required to be listed (a change from “approved”), and language regarding fixed combustible gas monitoring systems is clarified.

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Committee Scope: This Committee shall have primary responsibility for documents on safeguarding against the fire and explosion hazards associated with the design, construction, and operation of solvent extraction plants.

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NFPA 36

Standard for

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2021 Edition

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NOTICE: An asterisk (*) following the number or letter designating a paragraph indicates that explanatory material on the paragraph can be found in Annex A.

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Information on referenced and extracted publications can be found in Chapter 2 and Annex D.

Chapter 1 Administration

1.1 Scope.

1.1.1* This standard shall apply to the commercial scale extraction processing of animal and vegetable oils and fats by the use of Class I flammable hydrocarbon liquids, hereinafter referred to as "solvents."

1.1.2 This standard shall also apply to any equipment and buildings that are located within 30 m (100 ft) of the extraction process.

1.1.3 This standard shall also apply to the unloading, storage, and handling of solvents, regardless of distance from the extraction process.

1.1.4 This standard shall also apply to the means by which material to be extracted is conveyed from the preparation process to the extraction process.

1.1.5 This standard shall also apply to the means by which extracted desolventized solids and oils are conveyed from the extraction process.

1.1.6 This standard shall also apply to preparation and meal finishing processes that are connected by conveyor to the extraction process, regardless of intervening distance.

1.1.7* This standard shall not apply to the storage of raw materials or finished products.

1.1.8 This standard shall not apply to extraction processes that use liquids that are miscible with water.

1.1.9 This standard shall not apply to extraction processes that use flammable gases, liquefied petroleum gases, or nonflammable gases.

1.1.10 This standard shall prohibit the use of processes that employ oxygen-active compounds that are heat or shock sensitive, such as certain organic peroxides, within the area defined in 1.1.2.

1.2 Purpose. The purpose of this standard shall be to provide the following:

- (1) Requirements for the design, construction, and operation of extraction processes that utilize Class I flammable hydrocarbon liquids
- (2) Requirements for the prevention of fire and explosion in extraction processes and in associated preparation and meal finishing areas
- (3) A means by which plant fire protection and supervisory personnel can evaluate the processes and operations under their control
- (4) Guidance to regulatory and inspection officials in determining whether a given facility is being operated in accordance with good practice
- (5) A workable set of standards for the use of design engineers, architects, and others in the planning and design of new installations

1.3 Application. (Reserved)

1.4 Retroactivity. The provisions of this standard reflect a consensus of what is necessary to provide an acceptable degree of protection from the hazards addressed in this standard at the time the standard was issued. Unless otherwise specified, the provisions of this standard shall not apply to facilities, equipment, structures, or installations that existed or were approved for construction or installation prior to the effective date of the standard. Where specified, the provisions of this standard shall be retroactive. In those cases where the authority having jurisdiction determines that the existing situation presents an unacceptable degree of risk, the authority having jurisdiction shall be permitted to apply retroactively any portions of this standard deemed appropriate. The retroactive requirements of this standard shall be permitted to be modified if their application clearly would be impractical in the judgment of the authority having jurisdiction, and only where it is clearly evident that a reasonable degree of safety is provided.

1.5 Equivalency. Nothing in this standard is intended to prevent the use of systems, methods, or devices of equivalent or superior quality, strength, fire resistance, effectiveness, durability, and safety over those prescribed by this standard. Technical documentation shall be submitted to the authority having jurisdiction to demonstrate equivalency. The system, method, or device shall be approved for the intended purpose by the authority having jurisdiction.

1.6 Units and Formulas.

1.6.1 The units of measurement for this standard shall be in accordance with the International System of Units (SI). Measurements and values shall be expressed using the SI unit of measurement. An equivalent inch/pound measurement or value, in parentheses, shall be permitted to follow the SI value.

1.6.1.1 Table 8.2.3.1 shall not be required to meet this requirement.

1.6.2 Where a measurement is given in an SI unit with an equivalent unit following in parentheses, the first stated value shall be regarded as the requirement and the value in parentheses shall be considered to be approximate.

1.7 Code Adoption Requirements. (Reserved)

Chapter 2 Referenced Publications

2.1 General. The documents or portions thereof listed in this chapter are referenced within this standard and shall be considered part of the requirements of this document.

2.2 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 30, *Flammable and Combustible Liquids Code*, 2021 edition.

NFPA 69, *Standard on Explosion Prevention Systems*, 2019 edition.

NFPA 70®, *National Electrical Code*®, 2020 edition.

NFPA 214, *Standard on Water-Cooling Towers*, 2021 edition.

NFPA 220, *Standard on Types of Building Construction*, 2021 edition.

NFPA 780, *Standard for the Installation of Lightning Protection Systems*, 2020 edition.

2.3 Other Publications.

2.3.1 ASME Publications. American Society of Mechanical Engineers, Two Park Avenue, New York, NY 10016-5990.

ASME *Boiler and Pressure Vessel Code*, 2019.

2.3.2 ASTM Publications. ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959.

ASTM D323, *Standard Test Method for Vapor Pressure of Petroleum Products (Reid Method)*, 2015a.

ASTM E136, *Standard Test Method for Behavior of Materials in a Vertical Tube Furnace at 750 Degrees C*, 2016.

ASTM E2652, *Standard Test Method for Behavior of Materials in a Tube Furnace with a Cone-shaped Airflow Stabilizer, at 750 Degrees C*, 2016.

2.3.3 Other Publications.

Merriam-Webster's Collegiate Dictionary, 11th edition, Merriam-Webster, Inc., Springfield, MA, 2003.

2.4 References for Extracts in Mandatory Sections.

NFPA 30, *Flammable and Combustible Liquids Code*, 2018 edition.

NFPA 69, *Standard on Explosion Prevention Systems*, 2019 edition.

NFPA 5000®, *Building Construction and Safety Code*®, 2018 edition.

Chapter 3 Definitions

3.1 General. The definitions contained in this chapter shall apply to the terms used in this standard. Where terms are not defined in this chapter or within another chapter, they shall be defined using their ordinarily accepted meanings within the context in which they are used. *Merriam-Webster's Collegiate Dictionary*, 11th edition, shall be the source for the ordinarily accepted meaning.

3.2 NFPA Official Definitions.

3.2.1* Approved. Acceptable to the authority having jurisdiction.

3.2.2* Authority Having Jurisdiction (AHJ). An organization, office, or individual responsible for enforcing the requirements of a code or standard, or for approving equipment, materials, an installation, or a procedure.

3.2.3 Labeled. Equipment or materials to which has been attached a label, symbol, or other identifying mark of an organization that is acceptable to the authority having jurisdiction and concerned with product evaluation, that maintains periodic inspection of production of labeled equipment or materials, and by whose labeling the manufacturer indicates compliance with appropriate standards or performance in a specified manner.

3.2.4* Listed. Equipment, materials, or services included in a list published by an organization that is acceptable to the authority having jurisdiction and concerned with evaluation of products or services, that maintains periodic inspection of production of listed equipment or materials or periodic evaluation of services, and whose listing states that either the equipment, material, or service meets appropriate designated standards or has been tested and found suitable for a specified purpose.

3.2.5 Standard. An NFPA Standard, the main text of which contains only mandatory provisions using the word “shall” to indicate requirements and that is in a form generally suitable for mandatory reference by another standard or code or for adoption into law. Nonmandatory provisions are not to be considered a part of the requirements of a standard and shall be located in an appendix, annex, footnote, informational note, or other means as permitted in the NFPA Manuals of Style. When used in a generic sense, such as in the phrase “standards development process” or “standards development activities,” the term “standards” includes all NFPA Standards, including Codes, Standards, Recommended Practices, and Guides.

3.3 General Definitions.

3.3.1 Area.

3.3.1.1 Controlled Area. Any area that is more than 15 m (50 ft) but less than 30 m (100 ft) from the solvent extraction process, measured horizontally.

3.3.1.2* Meal Finishing Area. The area that contains the equipment needed to prepare the extracted and desolventized material for storage.

3.3.1.3 Restricted Area. The area within 15 m (50 ft) horizontally of the extraction process.

3.3.2 Condensate. Any material that has been condensed from the vapor state to the liquid state.

3.3.3 Condenser. A piece of equipment that lowers the temperature of a vapor to the point where it changes to a liquid.

3.3.4 Controlled Area. See 3.3.1.1.

3.3.5 Conveyor. Equipment that transports material from one point to another either pneumatically or mechanically, by means of a moving belt, a chain, buckets, or flights.

3.3.6 Desolventized Material. See 3.3.22.1.

3.3.7 Desolventizer. Equipment that removes the absorbed solvent from the material being processed.

3.3.8 Evaporator. Equipment that vaporizes the solvent from the oil-bearing miscella.

3.3.9 Extraction Process. See 3.3.27.1.

3.3.10 Extractor. Equipment that removes oil and fat from oil- or fat-bearing material by means of a suitable solvent.

3.3.11 Flakes. Oil- or fat-bearing material that has been rolled in preparation for the extraction process.

3.3.12 Flaking Mill. A piece of equipment that utilizes smooth rollers to prepare material for the extraction process.

3.3.13 Flame Arrester. A device that prevents the transmission of a flame through a flammable gas/air mixture by quenching the flame on the surfaces of an array of small passages through which the flame must pass. [69, 2019]

3.3.14 Flammable Limit.

3.3.14.1* Lower Flammable Limit (LFL). That concentration of a flammable vapor in air below which ignition will not occur. Also known as the lower explosive limit (LEL). [30, 2018]

3.3.14.2* Upper Flammable Limit (UFL). For the purpose of this standard, that concentration of a combustible material in air above which ignition will not occur.

3.3.15 Flammable Liquid. Any liquid that has a closed-cup flash point below 37.8°C (100°F), as determined by the test procedures and apparatus set forth in Chapter 4 of NFPA 30, and a Reid vapor pressure that does not exceed an absolute pressure of 276 kPa (40 psi) at 37.8°C (100°F), as determined by ASTM D323, *Standard Test Method for Vapor Pressure of Petroleum Products (Reid Method)*. Flammable liquids are classified according to Section 4.3 of NFPA 30. [30, 2018]

3.3.16 Heat Exchanger. For the purpose of this standard, equipment that transfers heat from one vapor or liquid to another vapor or liquid.

3.3.17 Hydrocarbon. A chemical substance consisting of only hydrogen and carbon atoms.

3.3.18* Important Building. A building that is considered not expendable in an exposure fire. [30, 2018]

3.3.19 Inert Gas. A gas that is noncombustible and nonreactive. [69, 2019]

3.3.20 Inerting. For the purpose of this standard, a technique by which a combustible mixture is rendered nonignitable by adding an inert gas.

3.3.21 Lower Flammable Limit (LFL). See 3.3.14.1.

3.3.22 Material.

3.3.22.1 Desolventized Material. Material from which all absorbed solvent has been removed.

3.3.22.2 Noncombustible Material. A material that, in the form in which it is used and under the conditions anticipated, will not ignite, burn, support combustion, or release flammable vapors when subjected to fire or heat. (See Section 4.3.)

3.3.22.3* Spent Material. Material from which the oil or fat has been extracted but which has not been desolventized.

3.3.23 Meal Finishing Area. See 3.3.1.2.

3.3.24 Miscella. A mixture, in any proportion, of extracted oil or fat and the extracting solvent.

3.3.25 Noncombustible Material. See 3.3.22.2.

3.3.26 Preparation Process. The operations involving the equipment used for the preparation of the material for the extraction process.

3.3.27 Process.

3.3.27.1 Extraction Process. The curbed area that contains the operations involving the extractor and the desolventizer, together with pertinent equipment such as heat exchangers, evaporators, and strippers, and which are contained in an enclosed building or in an open structure.

3.3.27.2 Preparation Process. The operations involving the equipment used for the preparation of the material for the extraction process.

3.3.28 Purging. For the purpose of this standard, the process of displacing flammable vapors from buildings, equipment, or piping.

3.3.29 Restricted Area. See 3.3.1.3.

3.3.30 Separation Sump. A containment basin that is used to separate oils, miscella, or solvent from water by means of the immiscibility of the liquids and their differing densities.

3.3.31 Solvent. For the purpose of this standard, any Class I flammable hydrocarbon liquid that has the ability to extract oils or fats from animal or vegetable material.

3.3.32 Spent Material. See 3.3.22.3.

3.3.33 Stripper. A distillation column or tower, usually operated under vacuum, that is used to remove residual solvent from the extracted oil or fat.

3.3.34 Toaster. Equipment that is capable of producing the desired cooking, toasting, and modification of protein by means of heat and moisture.

3.3.35 Upper Flammable Limit (UFL). See 3.3.14.2.

3.3.36 Vapor Recovery. The process of reclaiming solvent by means of condensation or absorption.

3.3.37 Vapor Scrubber. A device used to wash entrained dust from a vapor stream by means of a liquid spray.

3.3.38 Vapor Seal. Equipment or material that prevents the escape of solvent vapors from process equipment or conveyors.

Chapter 4 General Requirements

4.1 Scope. This chapter shall apply to the general operation of solvent extraction plants. The provisions of this chapter shall apply to all buildings, equipment, and operations in solvent extraction plants.

4.1.1 Limited and specific requirements in this standard shall apply to bulk solvent unloading and storage (*see Chapter 5*), preparation and meal finishing processes (*see Chapter 6*), and the extraction process (*see Chapter 7*), in addition to the general operation requirements of solvent extraction plants.

4.2 Noncombustible Material.

Δ 4.2.1* A material that complies with any of the following shall be considered a noncombustible material:

- (1)* The material in the form in which it is used, and under the conditions anticipated, will not ignite, burn, support combustion, or release flammable vapors when subjected to fire or heat.
- (2) The material is reported as passing ASTM E136, *Standard Test Method for Behavior of Materials in a Vertical Tube Furnace at 750 Degrees C*.
- (3) The material is reported as complying with the pass/fail criteria of ASTM E136 when tested in accordance with the test method and procedure in ASTM E2652, *Standard Test Method for Behavior of Materials in a Tube Furnace with a Cone-shaped Airflow Stabilizer, at 750 Degrees C*.

[5000:7.1.4.1.1]

4.3 Basic Operating Requirements.

4.3.1 Safe operating practices, including but not limited to start-up and shutdown procedures, shall be the responsibility of the management operating the extraction plant.

4.3.2 Operating and maintenance employees shall be instructed in plant operations in general.

4.3.3* Applicable plant regulations shall apply to all visitors and others who enter the plant, both during operating periods and during shutdown periods.

4.3.4* Repair Authorization. When it is necessary to make repairs to the areas covered by this standard, the work shall be authorized by the individual in responsible charge of the plant before the work is started. Where hot work is required, this authorization shall be in writing.

4.4 Sources of Ignition.

4.4.1 Electrical installations shall meet all applicable requirements of *NFPA 70*.

4.4.2 Provisions shall be made for protection against static electricity and lightning as required in other chapters of this standard.

4.4.3 Smoking. Smoking or other sources of ignition shall not be permitted within the restricted and controlled areas. Lighters and matches shall not be carried into the restricted or controlled areas of the extraction plant.

4.4.4 Powered vehicles, unless approved for such locations, shall be prohibited within the controlled or restricted area except by special permission of the individual in responsible charge of the plant.

4.5 Housekeeping.

4.5.1 Flammable liquids not contained in process equipment shall not be stored in the extraction process area except in small quantities, which shall be stored in approved safety cans.

4.5.2 Waste materials, such as oily rags, other wastes, and absorbents used to wipe up solvent, paints, and oils, shall be deposited in approved waste cans and removed from the premises not less than once each day.

4.5.3 Dust originating from material in process shall be kept to a minimum.

4.5.4 The space within the restricted and controlled areas shall be kept free of dry grass, weeds, trash, and all combustible materials, except as allowed for cooling towers in Section 7.6.

4.5.5 Any spills of oil, solvent, or deposits of solvent-bearing material shall be cleaned up immediately and removed to a safe place.

4.5.6 The discharge or removal of solvent-bearing material shall be recognized as a severe hazard, and operating procedures shall be established to minimize such occurrences.

4.6 Solvent Transfer Equipment.

4.6.1 Pumps shall be designed for the solvent, the working pressures, and the structural stresses to which they will be subjected.

4.6.2 Positive displacement pumps shall be provided with bypasses with pressure relief valves discharging back to the tank or to the pump suction.

4.6.3 Transfer of liquids among vessels, containers, tanks, and piping systems by means of air or inert gas pressure shall be permitted only under all of the following conditions:

- (1) The vessels, containers, tanks, and piping systems shall be designed for such pressurized transfer and shall be capable of withstanding the anticipated operating pressure.
- (2) Safety and operating controls, including pressure relief devices, shall be provided to prevent overpressure of any part of the system.
- (3) Only inert gas shall be used to transfer Class I solvents.

4.6.4 Where practicable, all pumps handling solvent in the processing equipment shall be located on the first floor level.

4.6.5 Pump houses, if used, shall be of noncombustible construction and ventilated.

4.7 Piping, Valves, and Fittings.

4.7.1 General. All piping, valves, and fittings shall be designed for the working pressures and structural stresses to which they will be subjected and shall be of steel or other material approved for the service intended.

4.7.2 Pipe Systems. Pipe systems shall be substantially supported and protected against physical damage caused by expansion, contraction, and vibration.