NFPA 36

Standard for Solvent Extraction Plants

2001 Edition

NFPA, 1 Batterymarch Park, PO Box 9101, Quincy, MA 02269-9101
An International Codes and Standards Organization

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NFPA 36

Standard for

Solvent Extraction Plants

2001 Edition

This edition of NFPA 36, *Standard for Solvent Extraction Plants*, was prepared by the Technical Committee on Solvent Extraction Plants and acted on by the National Fire Protection Association, Inc., at its November Meeting held November 12–15, 2000, in Orlando, FL. It was issued by the Standards Council on January 13, 2001, with an effective date of February 9, 2001, and supersedes all previous editions.

This edition of NFPA 36 was approved as an American National Standard on February 9, 2001.

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 this 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, operated without the benefit of overall fire protection measures, such as 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 either dust-laden or 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, and 2001.

The 1997 edition of NFPA 36 incorporated the following amendments to the previous edition:

- 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
- 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*
- Revision of 5.2.5 to require compliance with all stated measures for preventing vapors from migrating beyond the "controlled" or "restricted" areas
- New appendix text to 5.5.1 to provide guidance to the user in applying requirements for hazardous (classified) locations
- New 5.8.1.7, which establishes specific requirements for actions to be taken to remove vapors from the extractor, especially during emergencies
- New 5.8.9.6, which establishes 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
- Numerous editorial and minor technical improvements

This 2001 edition of NFPA 36 includes the following changes:

- A revised definition of *flame arrester*
- A revision to 2.1.4 to require written authorization for repairs involving hot work
- A revision of 4.1.2 to clarify which provisions do not apply when the liberation of dust is adequately controlled
- 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
- A revision to 5.8.1.1 to clarify the requirements for venting of process equipment
- A new 5.8.1.5 that states that a flame arrester is not required in the discharge line from an emergency pressure relief valve
- A new 5.8.1.7 that prohibits installing a shutoff valve in the overflow line from a tank or vessel
- A revision to 5.8.1.9 to clarify the means of exhausting vapors from plant equipment

Technical Committee on Solvent Extraction Plants

Leroy Venne, *Chair*
Cargill, Inc., MN [U]
(Rep. Corn Refiners Assn. Inc.)

George Eli Anderson, Crown Iron Works Co., MN [M]
Richard H. Barton, N. Hunt Moore & Associates, Inc., TN [SE]
Richard D. Farmer, Bunge Corp., MO [U]
Rep. International Oil Mill Superintendents Assoc.
Jerry Fawbush, Central Soya Co., Inc., IN [U]
Rep. National Oilseed Processors Assoc.
John E. Heilman, Heilman Consulting Group, CO [SE]
C. L. Kingsbaker, Jr., Atlanta, GA [SE]
Thomas D. Phillips, Southern Cotton Oil Co., TX [U]
Rep. National Cottonseed Products Assoc.
William A. Thornberg, Industrial Risk Insurers, CT [I]
Leslie R. Watkins, Les Watkins & Assoc. Inc., TX [SE]

Alternates

James M. Lay, Bunge Corp., MO [U]
(Alt. to R. D. Farmer)
George W. Moore, Industrial Risk Insurers, CT [I]
(Alt. to W. A. Thornberg)
Eugene F. Smith, Archer Daniels Midland Co., IL [U]
(Alt. to T. D. Phillips)

Robert P. Benedetti, NFPA Staff Liaison

This list represents the membership at the time the Committee was balloted on the final text of this edition. Since that time, changes in the membership may have occurred. A key to classifications is found at the back of the document.

NOTE: Membership on a committee shall not in and of itself constitute an endorsement of the Association or any document developed by the committee on which the member serves.

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

Changes other than editorial are indicated by a vertical rule in the margin of the pages on which they appear. These lines are included as an aid to the user in identifying changes from the previous edition.

A reference in parentheses ( ) following a section or paragraph indicates material that has been extracted from another NFPA document. The complete title and edition of the document the material is extracted from is found in Chapter 6. Editorial changes to extracted material consist of revising references to an appropriate division in this document or the inclusion of the document number with the division number when the reference is to the original document. Requests for interpretations or revisions of extracted text shall be sent to the appropriate technical committee.

Information on referenced publications can be found in Chapter 6 and Appendix D.

Chapter 1 General

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." (*See Section 1.5 for definitions of terms, including those of "extraction process" and "solvent."*)

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

Exception: As provided for in 1.1.3 through 1.1.6.

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 of conveying material to be extracted from the preparation process to the extraction process.

1.1.5 This standard shall also apply to the means of conveying extracted desolventized solids and oil 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 designing of new installations

1.3 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.

1.4 Retroactivity and Applicability to Existing Plants. 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 Definitions.

1.5.1* Approved. Acceptable to the authority having jurisdiction.

1.5.2* Authority Having Jurisdiction. The organization, office, or individual responsible for approving equipment, materials, an installation, or a procedure.

1.5.3 Class I Flammable Liquid. Any liquid having a flash point below 100°F (37.8°C) and having a vapor pressure not exceeding 40 psia (2068 mm Hg) at 100°F (37.8°C).

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

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

1.5.6 Controlled Area. Any area that is more than 50 ft (15.3 m) but less than 100 ft (30.5 m) from the solvent extraction process, as measured horizontally.

1.5.7 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.

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

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

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

1.5.11 Extraction Process. 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.

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

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

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

1.5.15 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 so that the emerging gases are sufficiently cooled to prevent ignition on the protected side. (**69:**1.9)

1.5.16 Heat Exchanger. Equipment that transfers heat from one vapor or liquid to another vapor or liquid.

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

1.5.18 Inert Gas. A noncombustible, nonreactive gas that renders the combustible material in a system incapable of supporting combustion.

1.5.19 Inerting. A technique by which a combustible mixture is rendered nonignitible by the addition of an inert gas.

1.5.20 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.

1.5.21* 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.

1.5.22* Lower Flammable Limit (LFL). That concentration of a combustible material in air below which ignition will not occur; mixtures below this limit are said to be "too lean."

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

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

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

1.5.26 Purging. The process of displacing flammable vapors from buildings, equipment, or piping.

1.5.27 Restricted Area. The area within 50 ft (15.3 m) horizontally of the extraction process.

1.5.28 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.

1.5.29 Solvent. Any Class I flammable hydrocarbon liquid that has the ability to extract oils or fats from animal or vegetable material.

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

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

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

1.5.33* Upper Flammable Limit (UFL). That concentration of a combustible material in air above which ignition will not occur; mixtures above this limit are said to be "too rich."

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

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

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

Chapter 2 Basic Rules

2.1 General Requirements.

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

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

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

2.1.4* 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.

2.1.5 Sources of Ignition.

2.1.5.1 Electrical installations shall conform to the requirements of NFPA 70, *National Electrical Code*®, as hereinafter specified.

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

2.1.5.3 There shall be no smoking or other sources of ignition within the restricted and controlled areas. Lighters and matches shall not be carried into the restricted or controlled areas of the extraction plant.

2.1.5.4 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.

2.1.6 Housekeeping.

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

2.1.6.2 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.

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

2.1.6.4 The space within the restricted and controlled areas shall be kept free of dry grass, weeds, trash, and all combustible materials. Any spills of oil, solvent, or deposits of solvent-bearing material shall be cleaned up immediately and removed to a safe place. 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.

Exception: As allowed by 5.2.7.

2.2 Emergency Procedures.

2.2.1 All employees shall be trained in the necessary action to be taken in time of emergency, including emergency shutdown procedures.

2.2.2 Personnel shall be thoroughly indoctrinated as to the location of exits.

2.2.3 All personnel shall be thoroughly trained in the use and limitations of each type of fire-fighting equipment on the premises, including control valves for the water spray systems.

2.2.4 A fire brigade, if established, shall be composed of selected personnel on each shift and shall be trained as a unit with each person assigned definite responsibilities in case of an emergency.

2.2.5 Periodic drills shall be held to ensure that employees can carry out the above procedures.

2.2.6 Emergency safety devices or systems provided in the plant shall be periodically tested in accordance with established procedures, and a record made thereof.

2.3 Repairs in Restricted and Controlled Areas When Plant Is in Operation or Unpurged.

2.3.1 Power Tools. Maintenance operations involving the use of power tools that can produce sources of ignition shall be prohibited.

Exception: As provided for in Sections 4.5 and 4.8.

2.3.2 Electrical Equipment. Repairs on live electrical wiring or equipment shall be prohibited. If it is necessary to replace or repair electrical wiring or equipment, the power shall be disconnected completely, and the switch shall be locked in an open position.

2.3.3 Welding and Cutting Operations. Welding and cutting, including brazing and soldering operations, shall be prohibited.

Exception: As provided for in Sections 4.5 and 4.8.

2.4 Repairs in Restricted and Controlled Areas When Plant Is Shut Down and Purged.

2.4.1* Repairs or alterations to equipment or buildings that can produce ignition sources shall be performed only when the plant has been shut down and completely purged and has been declared safe by the individual in responsible charge.

2.4.2 Before purging is initiated, the following steps shall be taken.

(a) Tanks, vessels, piping, and traps shall be emptied of all materials. All such material shall be removed to a safe location.

(b) All piping and other connections to storage facilities shall be disconnected, plugged, or blanked off.

2.4.3 Purging shall be accomplished by one or a combination of the following methods.

(a) Vapor freeing shall be permitted to be accomplished by the introduction of steam into the equipment. The equipment shall be adequately vented to prevent damage from excessive pressure or vacuum. Steam supply lines shall be bonded to the equipment. The rate of supply of steam shall exceed the rate of condensation so that the equipment is heated close to the boiling point of water. The equipment shall be steamed long enough to vaporize the residues from all portions. After the steaming, the procedures outlined in 2.4.3(b) shall be followed when hot work is to be performed.

(b) Vapor freeing shall be permitted to be accomplished by purging with air, and a safe atmosphere can be maintained by continued ventilating. When fixed ventilating equipment is not provided, air movers shall be permitted to be attached so that air is drawn in and discharged through the air mover, or air can be introduced through the air mover and discharged through another opening. Discharge shall be to a safe location. Air movers shall be approved for such locations. In air purging, the concentration of vapor in air usually will go through the flammable range before a safe atmosphere is obtained; therefore, precautions shall be taken to ensure that the air mover is bonded to the equipment in order to minimize the hazard of ignition by static electricity. (*See also 5.4.5.*)

(c) Vapor freeing shall be permitted to be accomplished by purging with inert gas and then ventilating with air, which minimizes the hazards inherent to passing through the flammable range.

2.4.4 To ensure a safe condition, even on units out of service, tests for flammable vapors shall be made with a combustible gas indicator under the following conditions:

(1) Before commencing alterations or repairs, including welding, cutting, or heating operations
(2) Immediately after starting any welding, cutting, or heating operations
(3) Frequently during the course of such work

All such work shall be stopped immediately when the presence of flammable vapor is indicated. The source of the vapor release shall be located and removed, and the tests required by this paragraph shall be repeated before such work is recommenced.

2.4.5 Upon completion of repairs or alterations, the plant shall be checked by the individual in responsible charge to ensure that operations can be resumed safely. (*See Section 2.5.*)

2.5 Extractor Start-up. Procedures for extractor start-up shall be established to minimize the hazard incident to passing through the flammable range. This shall be permitted to be accomplished by inerting to reduce the oxygen content.

2.6 Solvent Transfer Equipment.

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

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

2.6.3 The use of air pressure as the solvent transferring medium shall be prohibited.

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

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

2.7 Piping, Valves, and Fittings.

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

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

2.7.3 Process Piping.

2.7.3.1 Piping shall be pitched to drain to avoid trapped liquids, or suitable drains shall be provided. Armored hose shall be permitted to be used where vibration exists or where frequent movement is necessary.

2.7.3.2 Aboveground solvent pipe sections 2 in. (50 mm) in size or over shall be welded and flanged. Welding shall conform to good welding practice.

2.7.4 Drain Valves. Drain valves shall be provided with plugs to prevent leakage.

2.7.5 Pipe Connections. Pipe connections, 2 in. (50 mm) and over, to all tanks and vessels shall be bolted flanges that can be opened and blanked off.

2.7.6 Testing. After installation and before covering or painting, all piping systems, including suction lines, shall be pressure tested to not less than $1^1/_2$ times the working pressure but not less than 5 psi (0.4 kg/cm^2) at the highest point in the system. Tests shall continue for not less than 30 minutes without any noticeable drop in pressure.

Exception: Vapor lines operating at less than 20 in. (50 cm) of water column.

2.7.7 Identification of Piping and Equipment. All piping and equipment shall be coded for identification.

2.8 Exits. An extraction building or open process structure over two stories in height shall be provided with at least two remotely located means of egress from each floor, one of which shall be enclosed or separated from the process by a wall that is blank except for doors. The enclosure or separating wall shall be of masonry or other noncombustible construction. Self-closing, noncombustible doors, normally kept closed, shall be provided for access to the protected stairway.

2.9* Fire Protection.

2.9.1* An approved water spray, deluge or foam-water system, or a combination of these types of fixed protection systems shall be provided to protect the extraction process equipment and structure.

2.9.2* An approved system of automatic sprinklers shall be provided in the preparation area.

2.9.3* A system of yard hydrants shall be provided in accordance with accepted good practice.

2.9.4* Approved portable fire extinguishers of appropriate size and type shall be provided.

2.9.5* Where standpipe and hose protection is installed, combination water fog and straight steam nozzles shall be provided.

2.9.6 Where explosion prevention systems are installed, they shall be installed in accordance with the provisions of NFPA 69, *Standard on Explosion Prevention Systems.*

2.9.7 Fire alarm signals shall be relayed or sent to a constantly supervised point on or off the premises.

2.9.8 Where service is available, a public fire alarm box shall be located nearby.

Chapter 3 Bulk Solvent Unloading and Storage

3.1 Location.

3.1.1 Unloading Site. These sites shall be located so that ignition sources presented by locomotives or tank vehicles are at least 100 ft (30.5 m) from the extraction process and shall be at least 25 ft (7.6 m) from a building or any property line that is or can be built on. The fill connection to the storage tank shall be at least 25 ft (7.6 m) from the extraction process.

3.1.2 Bulk Solvent Storage Tanks.

3.1.2.1 Bulk solvent storage tanks shall be located outside of any building.

3.1.2.2 Underground solvent storage tanks shall be located at least 1 ft (0.3 m) from any building foundation or support and at least 3 ft (0.9 m) from the nearest property line that is or can be built on. The loads carried by the building foundations or supports shall not be transmitted to the tanks.

3.1.2.3 Aboveground solvent storage tanks shall be located in accordance with the following:

(1) Within the restricted area, at least 25 ft (7.6 m) from the extraction process and at least 25 ft (7.6 m) from any important building
(2) Within the controlled area, at least 25 ft (7.6 m) from any important building and at least 25 ft (7.6 m) from any property line that is or can be built on

(3) Outside the controlled area, at least 25 ft (7.6 m) from any important building and at least 25 ft (7.6 m) from any property line that is or can be built on

3.1.2.4 Aboveground storage tanks shall be enclosed by a fence, that is, within the fence already provided for in the restricted area or in a separate fenced area.

3.2 Design and Construction.

3.2.1 Unloading Stations. Unloading structures and platforms shall be constructed of noncombustible material and shall be designed and installed in accordance with accepted practice.

3.2.2* Storage Tanks. Storage tanks shall be designed, constructed, installed, and tested in accordance with accepted good practice.

3.3 Sources of Ignition.

3.3.1 Electrical Equipment. All electrical utilization equipment and its installation shall be suitable for Class I, Division 1 or 2, Group D hazardous (classified) locations.

3.3.1.1 Where enclosures that house solvent-handling equipment such as solvent pumps or valves are provided or where solvents are transferred to individual containers, these enclosures shall be considered to be Division I locations.

3.3.1.2* In outdoor locations, areas adjacent to loading racks or platforms or to aboveground tanks shall be considered to be Division II locations. Such areas shall be considered to extend 25 ft (7.6 m) horizontally from such racks or tanks, and upward from adjacent ground level to a height of 15 ft (4.6 m).

3.3.2 Static and Stray Currents.

3.3.2.1 All storage tanks, solvent transfer equipment, tank cars or tank trucks, and unloading structures shall be bonded effectively.

3.3.2.2 Transfer or storage tanks, unloading structures, tank cars, and tank trucks shall be electrically interconnected with supply piping or containers during the transfer of liquids.

3.3.2.3* Static protection shall be installed in accordance with accepted good practice.

3.3.3 Smoking and open flames shall be prohibited, and appropriate "No Smoking" and "Keep Fire Away" signs shall be posted in conspicuous locations.

3.4 Fire Protection Equipment.

3.4.1* Approved portable fire extinguishers of appropriate size and type shall be provided.

3.4.2 Additional fire protection for the unloading structure and bulk storage tanks shall be provided where an exposure hazard exists.

3.5 Unloading Procedures.

3.5.1 Adequate precautions shall be taken to relieve excessive pressure in cargo tanks before unloading.

3.5.2 Tank cars shall be unloaded in accordance with accepted good practice.

3.5.3* Tank vehicles for solvents shall be unloaded in accordance with accepted good practice.

Chapter 4 Preparation and Meal Finishing Processes

4.1 Application.

4.1.1 The provisions of this chapter shall apply to preparation processes that are connected by conveyor to the extraction process, regardless of intervening distance.

4.1.2 Where the processing operations do not involve the liberation of combustible dusts, 4.2.2, 4.2.3, and 4.3.1 shall not apply.

4.2 Construction of Building.

4.2.1 The building shall be of fire-resistive or noncombustible construction and shall be without basement or pits below grade.

4.2.2 The building shall be designed to provide explosion relief of at least 1 ft^2 for each 50 ft^3 (1 m^2 per 15 m^3) of volume.

4.2.3* The roof and exterior wall construction shall provide explosion relief by one or more of the following methods:

(1) Open air construction with a minimum area enclosed
(2) Light noncombustible walls and roof lightly attached to steel frame
(3) Light noncombustible wall panels and roof hatches
(4) Top-hinged windows with explosion relief hatches

4.2.4 Space heating, if required, shall be provided by indirect means. Temperatures on heated surfaces shall be limited to 250°F (121°C).

4.3 Electricity.

4.3.1* In areas where combustible dust presents a hazard, all electrical wiring and equipment shall conform to the requirements for Class II, Division 1, Group G, locations.

4.3.2* Static protection shall be provided in equipment located in areas where combustible dust presents a hazard.

4.4 Dust Removal.

4.4.1* A dust collecting system shall be provided where necessary.

4.4.2 When fabric filters are used for the collection of dust, they shall be located either outside of the building or in a fire-resistive room along an outside wall inside the building. The inside room shall be explosion resistant, and the outside walls or roof shall have explosion relief in the ratio of 1 ft^2 of relief area for each 30 ft^3 to 50 ft^3 (1 m^2 of relief area for each 9 m^3 to 15 m^3) of room volume.

4.4.3 Automatic sprinklers shall be installed within fabric-type dust collector housings.

4.4.4 Dust accumulations on floors, ledges, structural steel members, machinery, spouting, and other surfaces shall be removed concurrently with operations. This shall be done by vacuum cleaning or by other means that will not suspend dust in the air.

4.4.5 The use of compressed air or other means to blow dust from ledges, walls, and other areas shall not be permitted unless all machinery in the area has been shut down, and all sources of ignition have been removed.

4.5* Hot Work. Any repairs or alterations to preparation and meal finishing equipment that require welding, cutting, or other hot work shall be permitted, provided that either (1) or (2) applies.

(1) The extraction equipment has been shut down and cooled to prevent the release of vapor.
(2) The equipment being repaired has been isolated from any conveyor or duct through which a fire might be conveyed to or otherwise brought into contact with solvent vapors.

4.6 Tramp Metal. Means shall be provided to remove tramp metal from the process stream to protect rolling and grinding machinery.

4.7* Dryer Shut Down. Provisions shall be made to shut down any process dryer, and the air flow to it, that is a part of the preparation or meal finishing process in the event of a fire inside the dryer. Provisions shall also be made to inject smothering steam into the dryer.

4.8* Use of Power Tools. Electric power tools and grinders shall be permitted to be used while process equipment is operating, provided no combustible dusts, ignitible vapors, or accumulations of combustible materials are present in the work area and provided the process equipment is completely closed off to prevent any sparks from entering the process.

Chapter 5 Extraction Process

5.1 Location of Extraction Process.

5.1.1 The extraction process equipment shall be located in the open or in a building suitable for the purpose as shown in Figure 5.1.1.

5.1.2 An industrial-type fence shall be placed at a minimum of 50 ft (15.3 m) from the extraction process. A controlled area shall extend from 50 ft (15.3 m) to at least 100 ft (30.5 m) from the extraction process. The restricted and controlled areas shall be posted with signs around the perimeter warning of the possible flammable vapor hazard. All entrances and exits into the fenced area shall be secured to prohibit unauthorized entrance, and provision shall be made for emergency ingress and egress.

5.1.3 Basements, tunnels, pipe trenches, and pits shall be prohibited within 100 ft (30.5 m) of the extraction process.

Exception: This requirement shall not apply to separation sumps and the drainage troughs connected to them.

5.1.4 Except as permitted in 5.1.5, the extraction process shall be at least 100 ft (30.5 m) from any public thoroughfare, any building, or any property line that is or can be built on. The slope of the terrain and the prevailing winds shall be considered in locating the extraction process.

5.1.5 Structures and equipment essential to the operation of the extraction process, other than boilers and other open flame operations, shall be permitted to be located less than 100 ft (30.5 m) but more than 50 ft (15.3 m) from the extraction process, provided a vapor barrier erected in accordance with the requirements of 5.1.5.1 and 5.1.5.2 is provided.

5.1.5.1 The barrier shall be located between the extraction process and the possible source of vapor ignition and at least 50 ft (15.3 m) from the extraction process.

5.1.5.2 The barrier shall be of noncombustible vaportight construction without gates or other openings. The barrier shall be at least 4 ft (1.3 m) in height and designed so that there is at least 100 ft (30.5 m) of vapor travel around its ends to possible sources of ignition.

5.1.6* Where the circumstances or conditions of any particular installation are unusual and in such a manner as to render the strict application of distances specified in this standard impractical, the authority having jurisdiction shall be permitted to allow such deviation as will provide an equivalent degree of safety and be consistent with good engineering practice.

5.2 Construction of Extraction Process.

5.2.1 The building or structure shall be of fire-resistive or noncombustible construction with the first floor at or above grade. All solid sections of upper floors of the extraction process and concrete pads under the entire extraction process shall be curbed and sloped to drain and shall be directly connected to an outside separation sump. Drainage lines under the ground floor slab of the extraction process shall be prohibited.

5.2.2* Explosion relief of at least 1 ft^2 for each 50 ft^3 (1 m^2 per 15 m^3) of volume shall be provided by one or more of the following methods:

(1) Open air construction with a minimum area enclosed
(2) Light noncombustible wall panels and roof hatches
(3) Light noncombustible walls and roof lightly attached to steel frame
(4) Top-hinged windows with explosion relief latches

5.2.3 Provisions shall be made to guard against the introduction of solvent into the sewer systems.

5.2.4 A sump shall be provided to effect separation of water from oil, solvent, or miscella.

5.2.4.1 The separation sump shall be located within the restricted area but not closer than 25 ft (7.6 m) to the fence surrounding the restricted area.

5.2.4.2 The sump shall be concrete or of equivalent noncombustible construction, and effluent lines shall be trapped.

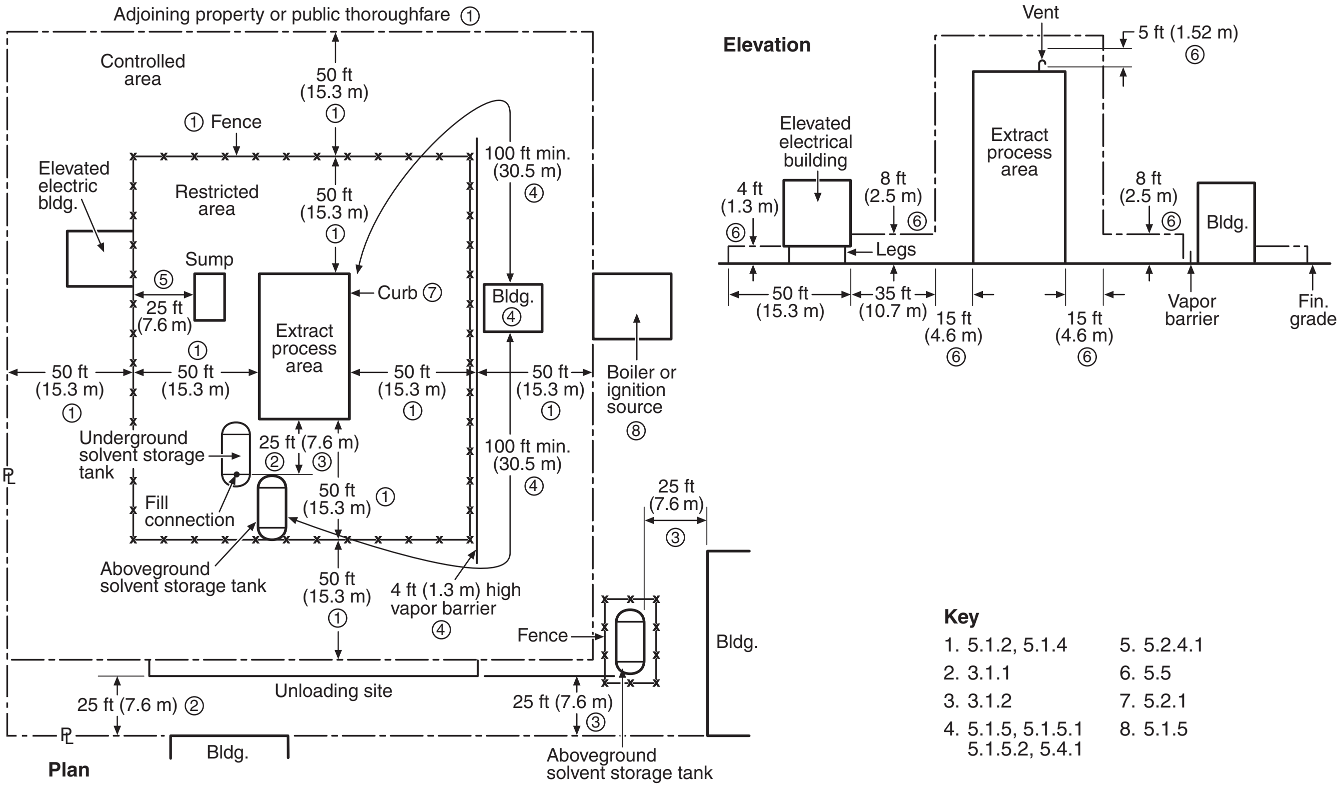
5.2.4.3 The sump shall consist of two or more sections, that is, one or more retention sections and a final water discharge section. The retention section(s) shall be sized to retain all solvent, miscella, and oil that can be released by a single break in a vessel or piping system, plus an additional 50 percent of this amount.

5.2.4.4 An emergency means shall be provided to prevent the outflow of solvent, miscella, or oil from the sump to the sewer system. In the event of any flow of fire protection water, provisions shall be made to contain the flow of oil, solvent, and miscella in a safe location.

5.2.4.5 A pump shall be provided to recover oil, solvent, or miscella collected in the sump.

5.2.4.6 Approved fixed automatic fire protection shall be provided above the separation sump.

FIGURE 5.1.1 A typical distance diagram.



5.2.5 Conveyors and spouts from or to other buildings shall be located and protected so that passage of solvent vapors or liquid to other areas is prevented. In addition to the provisions of 5.8.2.2 and 5.8.2.3, the following requirements shall be met.

(a) Conveying systems to the extraction area shall have an opening in one or more spouts in the controlled or restricted area to allow liquids or dense vapors to escape rather than flow back to the preparation area. Conveyors shall have, near the extraction process end, provisions for continuous air aspiration with visual indication of blower operation and both visual and audible indication of blower failure. Alternate means shall be permitted if an equivalent degree of safety is provided.

(b) The air intakes of pneumatic conveyors shall be located outside of any area that is classified as a Class I, Division 1, Group D or Class I, Division 2, Group D location, as described in Figure 5.5.1.

5.2.6 Conveyors and spouts shall be permitted to be enclosed in adequately supported, noncombustible bridge structures equipped with open grate floor sections for ventilation.

5.2.7* A cooling tower, if provided, shall be located based on its construction and fire protection.

5.2.7.1 If the tower is of noncombustible construction and the fill of the tower is of limited-combustible construction, as these terms are defined in NFPA 220, *Standard on Types of Building Construction*, then the tower shall be permitted to be located in the restricted area.

5.2.7.2 If the tower is of noncombustible exterior construction and protected by automatic sprinklers in accordance with NFPA 214, *Standard on Water-Cooling Towers*, it shall not be located in the restricted area but shall be permitted to be located in the controlled area.

5.2.7.3 If the tower is combustible and protected by interior and exterior automatic deluge fire protection systems in accordance with NFPA 214, *Standard on Water-Cooling Towers*, it shall not be located in the restricted area but shall be permitted to be located in the controlled area.

5.2.7.4 If the tower is combustible and unprotected, it shall not be located in the restricted or controlled area.

5.3 Ventilation of Extraction Buildings.

5.3.1 Enclosed plants shall have sufficient ventilation to change the volume of air at least six times per hour. This shall be accomplished by exhaust fans, preferably taking suction at floor levels and discharging to a safe location outside the building. The arrangement shall be such that all portions of solid floor areas will be subjected to continuous positive movement of air.

5.3.2 Ventilation fans intended to handle solvent vapors shall be designed with the increased horsepower necessary to handle higher density vapors.

5.4 Ignition Sources and Heating.

5.4.1 Except as provided in 2.1.5.4 and 5.1.5, no ignition sources shall be used within the building or within 100 ft (30.5 m) of the process unless the unit and building are purged.

5.4.2 Space heating, if required, shall be provided by indirect means. Temperatures on heated surfaces shall not exceed 250°F (121°C).

5.4.3 If steam tracing or jacketing is provided, temperatures on both internal and external heated surfaces shall not exceed 250°F (121°C).

Exception: Process temperatures shall be permitted to exceed this level, provided the temperature is reduced to 250°F (121°C) during shutdown periods.

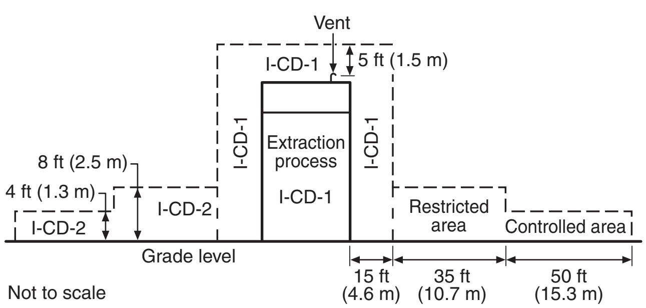
5.4.4 Power transmission belts shall not be used in any area that is classified as a Class I, Division 1 or Class I, Division 2 location as described in Figure 5.5.1.

5.4.5 Process vent fans, purge fans, and building ventilation fans that might handle solvent vapors, including any fans that have air intakes located in Class I, Division 1, or Class I, Division 2, hazardous (classified) locations, as depicted in Figure 5.5.1, shall be of AMCA Type B spark-resistant construction or better.

5.5 Electricity.

5.5.1* Electrical wiring and electrical equipment of the extraction process, outward 15 ft (4.6 m) into the restricted area and vertically at least 5 ft (1.5 m) above the highest vent, vessel, or equipment containing solvent, shall be installed in accordance with the requirements for Class I, Group D, Division 1 locations as shown in Figure 5.5.1.

FIGURE 5.5.1 Type and extent of hazardous areas.



I-CD-1: Class I, Division 1, Group C or D
I-CD-2: Class I, Division 2, Group C or D

5.5.2 Electrical wiring and electrical equipment within the restricted area beyond the 15 ft (4.6 m) distance and to a height of 8 ft (2.5 m) above the extraction process grade level shall be installed in accordance with the requirements of Class I, Division 2, Group D locations. (*See Figure 5.5.1.*)

5.5.3 Electrical wiring and electrical equipment within the controlled area and within 4 ft (1.3 m) of the extraction process grade level, except the preparation process (*see 5.1.5*), shall be installed in accordance with the requirements of Class I, Division 2, Group D locations. (*See Figure 5.5.1.*)

5.5.4 Permanent lights shall be installed where needed. Flashlights approved for Class I, Group D locations shall be provided.

5.6 Static Electricity.

5.6.1 All tanks, vessels, motors, pipes, conduit, grating, and building frames within the process shall be electrically bonded together.

5.6.2* Building frames and metal structures shall be grounded and tested periodically to determine electrical continuity.

5.6.3 All hose shall be electrically bonded to the supply line and to the tank or vessel where discharge takes place.

Exception: Hose used in water service.

5.6.4 Grounding wires or bonding connections shall be provided between any dispensing and any receiving vessel used for the transfer of solvent or mixtures of solvent and oil where bonding is not achieved through fixed connections. This shall include all sampling cocks.

5.6.5* If steam purging, cleaning, or sparging is used, all pipes or nozzles through which steam is discharged shall be bonded to the equipment being purged, cleaned, or sparged, or the objects shall be connected to ground.

5.7* Lightning Protection. Where needed, approved lightning protection shall be provided for the extraction process.

5.8 Process Equipment.

5.8.1 Venting.

5.8.1.1 Process equipment shall be a closed system and shall be vented to the outside atmosphere through an approved flame arrestor installed in accordance with the conditions of its approval. The manifolding of vents upstream of the flame arrestor shall be permitted. Vents shall terminate at least 20 ft (6.1 m) above the ground and shall be so located that vapors will not re-enter the building. Flame arrestors shall be protected against freezing and shall be accessible for inspection and repair.

5.8.1.2 Vessels or tanks containing solvent shall be protected with emergency venting to relieve excessive internal pressure in the event of fire. This shall apply to such vessels as extractors, solvent work tanks, miscella tanks, and solvent-water separating tanks. If the calculated required emergency vent capacity is less than the normal vent requirement, no additional emergency venting shall be required.

5.8.1.3* The total capacity of both normal and emergency venting for vessels and tanks in the extraction process, which are protected in accordance with 2.9.1, shall not be less than that derived from Table 5.8.1.3.

5.8.1.4 All emergency relief vents shall terminate at least 20 ft (6.1 m) above the ground and shall be so located that vapors will not re-enter the building or create a hazard from localized overheating of any part of a tank or structure.

5.8.1.5 Flame arrestors shall not be required in discharge lines from emergency pressure relief valves that are provided for vessels and tanks covered by 5.8.1.2.

5.8.1.6 Shutoff valves shall not be installed in normal or emergency vent lines.

5.8.1.7 Shutoff valves shall not be installed in overflow lines from vessels and tanks.

5.8.1.8 Flares or burners from process vents shall be prohibited within the restricted and controlled areas. Flares or burners, if installed outside these areas, shall be equipped with approved devices to prevent flashbacks in the vent piping.

Table 5.8.1.3 Total Minimum Emergency Vent Capacity in ft³ Free Air/Hr (14.7 Psia and 60°F) with Approved Automatic Water Spray, Deluge System, or Equivalent

Exposed Surface Area* (ft^2)	Vent Capacity (ft^3/hr)	Exposed Surface Area* (ft^2)	Vent Capacity (ft^3/hr)	Exposed Surface Area* (ft^2)	Vent Capacity (ft^3/hr)
20	6,300	160	50,400	900	147,900
30	9,480	180	57,000	1,000	157,200
40	12,630	200	63,300	1,200	167,100
50	15,810	250	71,700	1,400	176,100
60	18,960	300	79,500	1,600	184,200
70	22,110	350	86,400	1,800	191,700
80	25,260	400	93,600	2,000	198,600
90	28,440	500	106,200	2,400	211,200
100	31,500	600	117,600	2,800	222,600
120	37,800	700	128,400	and over	
140	44,100	800	138,600		

Notes:
1. For SI units, 10 ft^2 = 0.93 m^2; 36 ft^3 = 1.0 m^3.
2. Interpolate for intermediate values. If tank or vessel is protected by approved insulation in addition to water spray, deluge system, or equivalent protection as provided in 2.9.1, the flow capacities can be reduced by 50 percent.
*Exposed surface area means the exterior surface of a vessel or tank less that portion resting on a solid earth or concrete pad.

5.8.1.9 The extractor shall be provided with means to remove solvent vapors so that the concentration of vapors inside the unit in the area where work is required can be maintained at or below 25 percent of the lower flammable limit. A purge fan system or some other means providing an equivalent degree of safety shall be used to accomplish this. If a purge fan system is used to accomplish this, it shall meet all of the following requirements.

(1) The system shall take suction from the lower sections of the extractor to facilitate removal of vapors and shall discharge to a safe location outside the extractor building.
(2) The system shall be capable of changing the air in the empty extractor at least 20 times per hour.
(3) The system shall be designed and operating procedures developed to allow the normal process vent system to cool the equipment to a temperature below 100°F (37.8°C) prior to high volume air purging, where this is practical depending on the ambient temperature.
(4) The fan shall meet or exceed the requirements for an AMCA Type B spark-resistant unit.
(5) The fan and its ducting shall be electrically bonded to the extractor and shall itself be electrically grounded to prevent the accumulation of electrostatic charge.

5.8.2 Conveying Systems for Solids.

5.8.2.1 Pneumatic systems for handling solids shall be permitted to be used when material and air being handled are solvent free.

5.8.2.2 An adequate vapor seal designed to prevent the escape of solvent or solvent vapors shall be provided at the point where the solids enter the system.

5.8.2.3 An adequate vapor seal shall be used on the final discharge of material from the extraction system.

5.8.2.4 Gaskets, if used in these systems, shall be of a material that will not decompose or soften in the presence of oil, solvent, or steam.

5.8.3 Extractors, Desolventizers, Toasters, Dryers, and Spent Flake Conveyors. Extractors, desolventizers, toasters, dryers, and spent flake conveyors shall be of a design that minimizes the possibility of ignition of product deposits. Such equipment shall be protected by extinguishing systems using inert gas, steam, or a combination of the two, controlled from a safe remote location. (*See 5.8.9.1.*)

5.8.4 Grinders.

5.8.4.1 Finished meal grinding after the drying-cooling operation shall not be located in the restricted area. Such operations shall be permitted in the controlled area only when conforming to the provisions of 5.1.5.

5.8.4.2 Finished meal grinding of materials as discharged from the desolventizer shall not be permitted.

5.8.5 Miscella Filters. Only totally enclosed filters shall be used. Ventilation shall be provided to remove residual solvent vapors when filters are open.

5.8.6 Waste Water Evaporation. Process waste water shall pass through an evaporator before entering separation sump. (*See 5.8.9.4.*)

5.8.7 Pressure Vessels and Tanks.

5.8.7.1 Unfired pressure vessels such as desolventizers and evaporators shall be constructed in accordance with the *Boiler and Pressure Vessel Code* of the American Society of Mechanical Engineers.

5.8.7.2 All large vessels shall be equipped with bolted and gasketed plates for inspection or repairs.

5.8.7.3 Where sight glasses are installed, they shall be of the high pressure type protected against breakage and loss of product. Hydraulic transmission or hydrostatic gauges shall be used for remote observation of liquid levels.

5.8.7.4 Tanks shall be equipped with manual shutoff valves at the bottom.

5.8.7.5 Armored-type liquid level gauges shall be used.

5.8.8 Heat Exchangers, Condensers, and Flash Drums.

5.8.8.1 The water side of condensers and heat exchangers shall be kept at a greater pressure than the solvent or vapor side.

5.8.8.2 Provisions shall be made to ensure safe shutdown in the event of loss of primary cooling water. This shall be accomplished by one or more of the following methods:

(1) An automatic emergency gravity water supply tank of sufficient capacity
(2) A connection to an equally reliable water supply
(3) A provision to automatically shut off steam other than smothering steam, to immediately reduce steam-heated jacket pressure to atmospheric pressure, and to stop the flow of miscella to the distillation system

5.8.8.3 All steam condensate from the extraction process that is to be returned to the boiler shall be reduced to practically atmospheric pressure in a vessel where any entrained solvent will be flashed off.

5.8.9 Process Controls.

5.8.9.1 Provision shall be made for emergency shutoff of steam and shutdown of process equipment. This shall be accomplished through manual operation both near the process equipment and at a safe remote location.

Exception: Smothering steam, cooling water to condensers, exhaust fans, and lights.

5.8.9.2 All motor controls on such equipment shall be interlocked so that the stoppage of any piece of solids-handling equipment will stop supplying material to the stopped equipment and so that all equipment conveying material away from the stopped unit will continue to operate. This interlock system shall be designed to require the proper start-up sequence and shutdown procedures.

Exception: Where hazardous conditions would be created by stopping process equipment.

5.8.9.3 Centrally located audible alarms, visual alarms, or both shall be provided to indicate abnormal and hazardous conditions such as loss of steam, loss of cooling water pressure, failure of process pumps and aspirating and ventilating fans, fire, and stopped motors.

5.8.9.4 Temperature-sensing devices arranged to actuate audible and visual alarms shall be installed in the desolventizer and the water outlet from waste water evaporator to indicate when the temperature drops to a point where solvent carryover could create a hazard.

5.8.9.5 Automatic systems shall be provided to stop the discharge of meal or water at temperatures below which there would be a significant hazard.

5.8.9.6 Automatic systems shall be provided to prevent excess pressure in the extractor or the desolventizer-toaster from leading to a hazardous condition. This shall be accomplished by both of the following methods.

(a) Pressure-sensing devices shall be installed on both the extractor and the desolventizer-toaster. These devices shall be arranged to activate audible and visual alarms if the pressure in the extractor or desolventizer-toaster rises towards a point where the release of solvent vapors from the process can create a hazard.

(b) Automatic systems shall be provided on both the extractor and the desolventizer-toaster that will reduce the excess pressure and lead to a safe condition if the pressure in the extractor or desolventizer-toaster reaches a point where a significant hazard is created.

5.8.9.7 Unless solvent tanks are equipped with adequate overflow return lines, solvent flow from bulk storage to the work tank or from the work tank to bulk storage shall be remotely controlled by momentary switches or by other devices that provide for “dead man” controls to prevent overfilling of tanks.

5.9 Flammable Vapor Detection.

5.9.1 Approved portable combustible gas indicators shall be provided and maintained in good working order.

5.9.2* Provisions shall be made for monitoring the atmosphere in areas where flammable vapors can present a hazard. This shall be permitted to be accomplished by installing an approved combustible gas detection system with audible and visual alarms. Where such a system is used, it shall be tested and maintained in good working order in accordance with the manufacturers’ instructions.

Chapter 6 Referenced Publications

6.1 The following documents or portions thereof are referenced within this standard as mandatory requirements and shall be considered part of the requirements of this standard. The edition indicated for each referenced mandatory document is the current edition as of the date of the NFPA issuance of this standard. Some of these mandatory documents might also be referenced in this standard for specific informational purposes and, therefore, are also listed in Appendix D.

6.1.1 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, P.O. Box 9101, Quincy, MA 02269-9101.

NFPA 69, *Standard on Explosion Prevention Systems*, 1997 edition.

NFPA 70, *National Electrical Code®*, 1999 edition.

NFPA 214, *Standard on Water-Cooling Towers*, 2000 edition.

NFPA 220, *Standard on Types of Building Construction*, 1999 edition.

6.1.2 Other Publication. American Society of Mechanical Engineers, Three Park Avenue, New York, NY 10016-5990.

ASME *Boiler and Pressure Vessel Code*.

Appendix A Explanatory Material

Appendix A is not a part of the requirements of this NFPA document but is included for informational purposes only. This appendix contains explanatory material, numbered to correspond with the applicable text paragraphs.

A.1.1.1 Extraction processes that use flammable liquids, but are not within the scope of NFPA 36, might be within the scope of NFPA 30, *Flammable and Combustible Liquids Code*, and the user is referred to that document for guidance.

A.1.1.7 See NFPA 61, *Standard for the Prevention of Fires and Dust Explosions in Agricultural and Food Products Facilities*.

A.1.5.1 Approved. The National Fire Protection Association does not approve, inspect, or certify any installations, procedures, equipment, or materials; nor does it approve or evaluate testing laboratories. In determining the acceptability of installations, procedures, equipment, or materials, the authority having jurisdiction may base acceptance on compliance with NFPA or other appropriate standards. In the absence of such standards, said authority may require evidence of proper installation, procedure, or use. The authority having jurisdiction may also refer to the listings or labeling practices of an organization that is concerned with product evaluations and is thus in a position to determine compliance with appropriate standards for the current production of listed items.

A.1.5.2 Authority Having Jurisdiction. The phrase “authority having jurisdiction” is used in NFPA documents in a broad manner, since jurisdictions and approval agencies vary, as do their responsibilities. Where public safety is primary, the authority having jurisdiction may be a federal, state, local, or other regional department or individual such as a fire chief; fire marshal; chief of a fire prevention bureau, labor department, or health department; building official; electrical inspector; or others having statutory authority. For insurance purposes, an insurance inspection department, rating bureau, or other insurance company representative may be the authority having jurisdiction. In many circumstances, the property owner or his or her designated agent assumes the role of the authority having jurisdiction; at government installations, the commanding officer or departmental official may be the authority having jurisdiction.

A.1.5.21 Listed. The means for identifying listed equipment may vary for each organization concerned with product evaluation; some organizations do not recognize equipment as listed unless it is also labeled. The authority having jurisdiction should utilize the system employed by the listing organization to identify a listed product.

A.1.5.22 Lower Flammable Limit. Also known as the Lower Explosive Limit (LEL).

A.1.5.23 Meal Finishing Area. Facilities for storage and shipment of finished meal are within the scope of NFPA 61, *Standard for the Prevention of Fires and Dust Explosions in Agricultural and Food Products Facilities*, not NFPA 36.

A.1.5.30 Spent Material. Also referred to as *extracted material.*

A.1.5.33 Upper Flammable Limit. Also known as the Upper Explosive Limit (UEL).

A.2.1.3 See Appendix C for further information.

A.2.1.4 See Appendix C for a suggested safety work permit.

A.2.4.1 See Appendix C for a suggested work permit form.

A.2.9 Water spray or deluge systems that are used to protect solvent extraction process equipment or structures should be designed to provide a density of not less than 0.25 gpm/ft^2 (10.2 L/min·m^2) of protected surface area. *(See NFPA 13, Standard for the Installation of Sprinkler Systems, and NFPA 15, Standard for Water Spray Fixed Systems for Fire Protection, for additional information.)* Foam-water sprinkler or deluge systems that are used for the same purposes should be designed to provide a density of not less than 0.16 gpm/ft^2 (6.5 L/min·m^2) of protected surface area. *(See NFPA 13 and NFPA 16, Standard for the Installation of Foam-Water Sprinkler and Foam-Water Spray Systems, for additional information.)*

Preparation buildings should be protected with automatic sprinkler systems designed for Ordinary Hazard (Group 2), in accordance with NFPA 13.

A.2.9.1 See NFPA 13, *Standard for the Installation of Sprinkler Systems*; NFPA 15, *Standard for Water Spray Fixed Systems for Fire Protection;* and NFPA 16, *Standard on the Installation of Foam-Water Sprinkler and Foam-Water Spray Systems.*

A.2.9.2 See NFPA 13, *Standard for the Installation of Sprinkler Systems.*

A.2.9.3 See NFPA 24, *Standard for the Installation of Private Fire Service Mains and Their Appurtenances.*

A.2.9.4 See NFPA 10, *Standard for Portable Fire Extinguishers.*

A.2.9.5 See NFPA 14, *Standard for the Installation of Standpipe, Private Hydrant, and Hose Systems.*

A.3.2.2 For information on tank design and construction, venting, foundations and supports, installation of underground tanks, anchorage, spacing, dikes and walls for aboveground tanks, and testing of tanks, see NFPA 30, *Flammable and Combustible Liquids Code.*

A.3.3.1.2 See NFPA 70, *National Electrical Code.®*

A.3.3.2.3 See NFPA 77, *Recommended Practice on Static Electricity.*

A.3.4.1 See NFPA 10, *Standard for Portable Fire Extinguishers.*

A.3.5.3 See NFPA 385, *Standard for Tank Vehicles for Flammable and Combustible Liquids.*

A.4.2.3 See NFPA 68, *Guide for Venting of Deflagrations*, for further information.

A.4.3.1 See NFPA 70, *National Electrical Code.*

A.4.3.2 See NFPA 77, *Recommended Practice on Static Electricity.*

A.4.4.1 See NFPA 91, *Standard for Exhaust Systems for Air Conveying of Vapors, Gases, Mists, and Noncombustible Particulate Solids.*

A.4.5 See Appendix C for additional information.

A.4.7 NFPA 86, *Standard for Ovens and Furnaces*, contains information on steam smothering.

A.4.8 See Appendix C for additional information.

A.5.1.6 Factors having a bearing on this deviation could be topographical conditions, the nature of the occupancy and proximity to buildings on adjoining property, the character of the construction of such buildings, and adequacy of public fire protection facilities.

A.5.2.2 See NFPA 68, *Guide for Venting of Deflagrations*, for further information.

A.5.2.7 See NFPA 214, *Standard on Water-Cooling Towers.*

A.5.5.1 Electrical equipment and wiring systems that are installed in areas that are classified as hazardous (classified) locations in accordance with this standard and NFPA 70, *National Electrical Code*, should meet certain specific requirements to ensure that they will not provide a means of ignition for any ignitible atmosphere that might be present. Usually, this is accomplished by using explosionproof electrical equipment and wiring methods that are listed for use in such locations. Installation of such equipment and wiring should meet the requirements of Chapter 5 of NFPA 70. Due to their nature, explosionproof electrical devices and wiring methods are costly. Other means of providing equivalent safety are available.

One alternate method is to use purged or pressurized enclosures. Purged and pressurized enclosures are built to be relatively tight and are supplied with clean air from a compressed air system or from a fan taking suction from an uncontaminated source. The air supply is arranged to maintain a slight positive pressure inside the enclosure. Clean air leaks out, but contaminated air cannot leak in. General purpose electrical equipment that otherwise would not be allowed in the hazardous location can be installed in these enclosures, and the slight positive pressure that is maintained in the enclosure prevents ignitible atmospheres from entering the enclosure and reaching a source of ignition. NFPA 496, *Standard for Purged and Pressurized Enclosures for Electrical Equipment*, provides design and performance requirements for such systems. Note that purging and pressurization can be used for small enclosures, large enclosures, and even control rooms.

For low energy process control systems, intrinsically safe and nonincendive devices can be used. These electrical devices are typically of such low voltage, amperage, and capacitance that they cannot release ignition capable energy. Nonincendive devices can only be used in Division 2 locations, while intrinsically safe devices can be used in either Division 1 or Division 2 locations.

Finally, there is always the option of moving some electrical devices and equipment to other areas of the plant that are not classified.

A.5.6.2 See NFPA 70, *National Electrical Code,* and NFPA 77, *Recommended Practice on Static Electricity.*

A.5.6.5 See NFPA 77, *Recommended Practice on Static Electricity.*

A.5.7 See NFPA 780, *Standard for the Installation of Lightning Protection Systems.*

A.5.8.1.3 See Appendix B of NFPA 30, *Flammable and Combustible Liquids Code,* for background information.

A.5.9.2 Areas where routine sampling has been found desirable include the following:

(1) Raw material conveyor
(2) Desolventized material conveyor
(3) Finished oil or fat containers
(4) Waste water discharge
(5) Solvent and miscella pumps

Appendix B General Description of Solvent Extraction Process

This appendix is not a part of the requirements of this NFPA document but is included for informational purposes only.

B.1 General. The removal of vegetable oils from oil-bearing materials by solvent extraction involves almost exclusively the use of solvents. The preparation processes that are employed depend on the oil content of the seed, the physical characteristics of the seed, the type of extraction system used, and the desired end products.

B.2 Extraction Solvents and Their Properties. The primary solvent used for the extraction of vegetable oils is the petroleum hydrocarbon fraction sold commercially as "hexane." Hexane is used because of its low cost, stability, excellent thermal characteristics, and selectivity for oils and fats. Other solvents, such as pentane, heptane, and trichloroethylene, have been tried but have not been widely used. Table B.2(a) shows hexane's physical properties. Table B.2(b) shows a typical distillation analysis for hexane.

Two of hexane's more important properties also present safety concerns: its flash point and its vapor density. As shown in Table B.2(a), the flash point is –15°F (–26°C) and the boiling point is 156°F (69°C), making hexane a Class IB Flammable Liquid. The vapors of hexane are about three times more dense than air, which accounts for their tendency to flow across a surface and to collect in low spots and confined areas.

B.3 Preparation and Pretreatment. Oilseeds that have a high oil content, such as sunflower seed, rapeseed (canola), peanut, and corngerm, are difficult to prepare and do not allow economical direct extraction. Experience has shown that it is less costly to remove some of the oil by first pressing the seeds prior to solvent extraction. This is called "prepressing" and is done in screw presses. The oil from this prepressing is screened to remove fine material called "foots" and is then filtered or centrifuged to produce a clear oil. The foots are returned to the inlet of the screw press. Before pressing, the oilseeds are sometimes cracked, then flaked. Generally, the seeds must be cooked before pressing. This cooking step varies widely, depending on the variety of seed and the type of press. Some screw presses are able to handle whole, uncooked seeds. In any case, the cake produced by the prepressing is the raw material for the solvent extraction process. This cake may be granulated prior to the extraction step.

There are many ways to prepare soybeans for solvent extraction, although certain operations are common to all preparation processes. Soybeans generally bypass the prepressing step. The four major steps in preparing soybeans for solvent extraction invariably follow a sequence of cleaning, cracking, heating, and flaking. The demand for high protein soybean meal for poultry feed has led some extraction plants to add a process to remove the hulls from the cracked beans by using air separation. Sometimes the soybeans are dried to a relatively low moisture level and then dehulled before any heating takes place. Another method processes the beans at their normal moisture content, preheats them quickly in a fluidized bed drier, then cracks and dehulls the beans while they are still hot. The resulting meats are then conditioned in a second fluidized bed drier, prior to flaking.

Some processors, whether they dehull the beans or not, add an additional step that uses an extrusion device called an expander to produce pellets from the flakes. This process is said to improve the extractability of the flakes and to reduce the amount of hexane holdup in the flakes that leave the extractor.

Cottonseed and other soft seeds are prepared both with and without prepressing. Some processors consider the prepressing step to be essential, while others consider it costly and unnecessary. The preparation of cottonseed by the direct extraction method, that is, without prepressing, consists of cleaning, delinting, cooking, and flaking. The last two steps can be adjusted to optimize the efficiency of the extraction step and to overcome the toxic effects of a pigment gland, called *gossypol,* that is usually present in the seed. Prepressing of cottonseed produces higher-than-normal temperatures because of the cooking step prior to the prepressing and the frictional heat developed in the press. As with other soft seeds, moisture adjustment and granulation, flaking, or both, of the press cake usually follows.

Table B.2(a) Physical Properties of Hexane

Flammable limits (percent by vol.)	1.2–6.9
Ignition temperature °F	437
Flash point °F closed cup	–15
Molecular weight	86.2
Melting point	–137°F
Coefficient of expansion	0.00135
Boiling point at 14.7 psia	156.1°F
Specific gravity at 60°F	0.664
A.P.I. gravity at 60°F	81.6
Pounds per gal at 60°F	5.536
Vapor density (air equals 1)	2.975
Cubic feet vapor per gal liquid, 60°F, 14.7 psia	25.5
Vapor weight per ft^3 (lb at 60°F)	0.217
Vapor weight, ft^3 per lb at 60°F	4.61
Latent heat of vaporization at 760 mm Btu/lb	143.3
Heat of combustion, Btu/lb (gross)	20,970
Btu per ft^3 vapor (gross)	4,762
Btu per lb (net)	19,420
Vapor pressure at 100°F, psia	5.0
Specific heat liquid at 60°F	0.531
Specific heat vapor at 60°F	0.339
Solubility in water, moles per L at 60°F	0.0016

Table B.2(b) Distillation Analysis of Hexane

Percent Distilled	°F
Initial boiling point	146
5	148
10	148
20	149
30	149
40	149
50	149
60	150
70	150
80	151
90	152
95	153
Dry end point	156

B.4 Extraction. Modern systems for the extraction of vegetable oils and fats by solvents appear rather complex. This complexity, however, is largely due to the systems for control, safety, automation, and energy recovery. The basic extraction process is rather simple, as shown in Figure B.4.

Despite the seemingly complicated array of equipment, the process consists of just four major functions:

(1) Extraction
(2) Desolventizing
(3) Distillation
(4) Solvent recovery

In the extraction step, the oil is removed from the oil-bearing material. The extraction of the oil or fat leaves the oil-bearing material saturated with solvent. This solvent is removed in the desolventizer, which drives off the solvent by direct and indirect steam heating. The miscella, or oil-bearing solvent, goes to the evaporation or distillation system, where the solvent is removed from the oil by means of heat, direct steam, and vacuum. The evaporation of the solvent from the miscella is not difficult because the solvent has the relatively low boiling point of about 156°F (69°C), compared to the boiling point of the oils, which can usually withstand temperatures as high as 250°F (121°C) without discoloration or polymerization. Thus, a wide temperature differential between the solvent and the oil, plus the use of stripping steam and vacuum in the final stage, facilitates desolventizing of the oil. The solvent recovered in this process is reused.

The functions of various components of the extraction process are described in the paragraphs that follow.

B.5 Basket-Type Extractors. Basket extractors are of the following types:

(1) Vertical
(2) Rectangular
(3) Horizontal

The material to be extracted is carried through the extractor in individually suspended, perforated, or screen-bottomed baskets. The baskets are hung on longitudinal shafts located just above the center of gravity of the basket. The shaft ends are affixed to bearing brackets that are part of endless chains. The chains are supported and guided by large sprockets at the top and bottom of vertical extractors and at each end of horizontal extractors. This configuration is shown for a vertical extractor in Figure B.5.

FIGURE B.4 Flow diagram of extraction process.

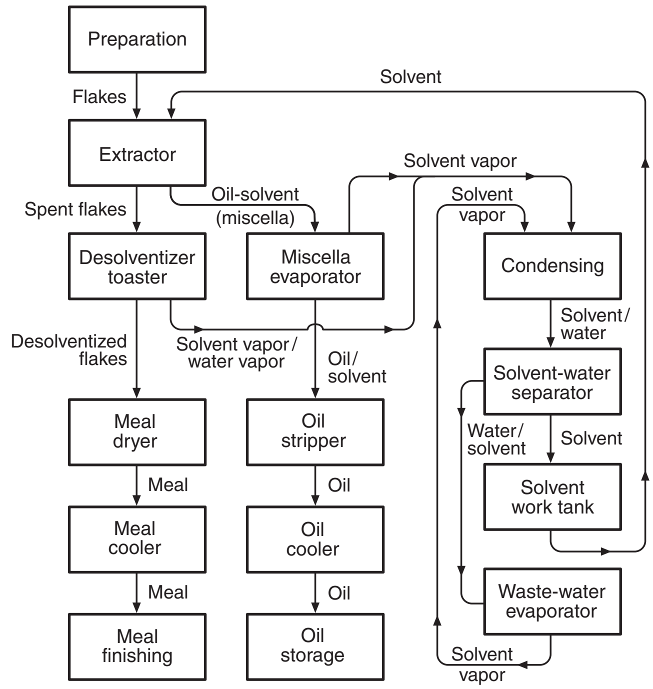
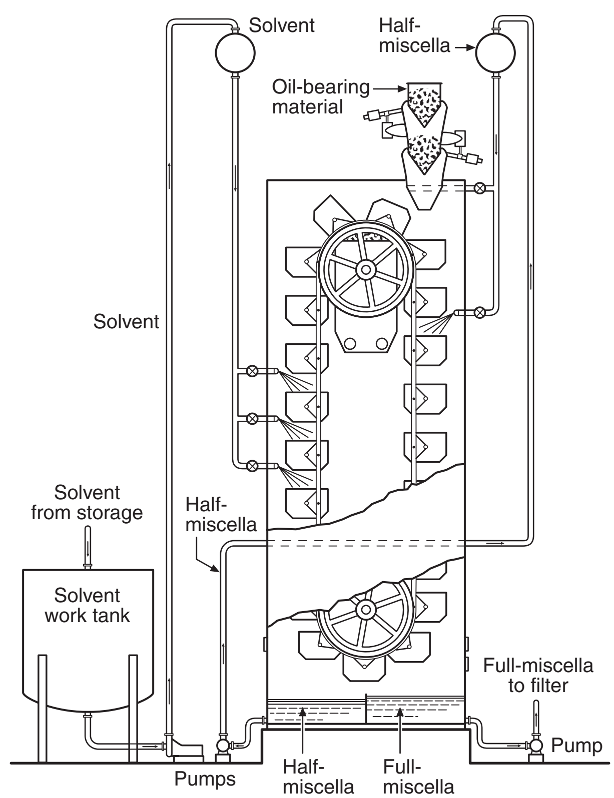


FIGURE B.5 Vertical basket extractor.



The baskets are guided by pins at the end of each basket that slide in a track fastened to the inside of the extractor. The track and pin arrangement prevents the basket from tipping until it reaches a point over a discharge hopper, where a mechanism inverts the basket and discharges the extracted material. As the basket passes the discharge position, it is righted and immediately recharged with oil-bearing material.

The number of baskets in the extractor depends on the through-put, the extraction time, and the design balance: 24 baskets to 36 baskets would be normal. The most common type of charging system is a continuous screw conveyor that feeds a mixture of oil-bearing material and half-miscella to the baskets. The extracted material is removed from the discharge hopper by a paddle conveyor or a mass-flow type of conveyor that is set in the bottom of the hopper.

Vertical and rectangular basket extractors have both ascending and descending baskets traveling through a shower of solvent and miscella. A concurrent phase takes place from the time the baskets are filled until they reach the bottom of the extractor on the downward leg. Half-miscella from the bottom of the ascending side of the extractor is pumped to a basket near the top of the descending side and percolates down through the baskets to the full-miscella chamber at the bottom. Raw solvent is sprayed onto one or more of the baskets near the top of the ascending side and flows concurrently through the baskets to the half-miscella chamber at the bottom of the ascending side.

Rectangular and horizontal basket-type extractors are quite similar to the vertical type, with the exception that a series of pumps continuously pump miscella to spray pipes above the baskets.

B.6 Rotary Extractors. *[See Figure B.6(a).]* A rotary extractor consists of a series of concentrically arranged cells supported from a vertical shaft. Extraction is effected in a manner similar to horizontal basket extractors, where the baskets pass beneath fixed nozzles fed from stage pumps recirculating various concentrations of miscella, as shown in Figure B.6(b). A primary difference is that the bed of material is much deeper in the rotary extractor; hence, the term *deep bed extractor* is sometimes applied to this type. Each cell has an open top and a hinged, perforated bottom door. As the cells travel around the track and pass beneath the feeding device, a slurry of oil-bearing material and half-miscella fills each cell. The rotation speed of the cells is variable to ensure that a continuous flow of slurry fills each cell to the desired level. While the cells are completing a revolution of the extractor, increasingly stronger concentrations of miscella, which is collected from the drain compartments that form the bottom of the extractor, are sprayed back onto the top of the cells. At approximately two-thirds of the distance around from the slurry inlet, raw solvent is sprayed onto the top of the cells, and the cells are allowed to drain free of excess solvent. After the drainage section, the cells pass over a discharge hopper. When each cell is directly over the hopper, a cut-out section of the track permits the cell bottom to be released, and the spent material drops into the hopper. Immediately after passing this position, the cell bottom is mechanically raised back to the closed position and is ready to be recharged. The spent material is continuously conveyed from the discharge hopper to the desolventizer at a uniform rate. This rate is regulated so that the discharge hopper is nearly empty when the next cell discharges.

FIGURE B.6(a) Rotary or deep bed extractor. *(Courtesy Chemical Engineering, vol. 57, no. 8, August, 1950, p. 109.)*

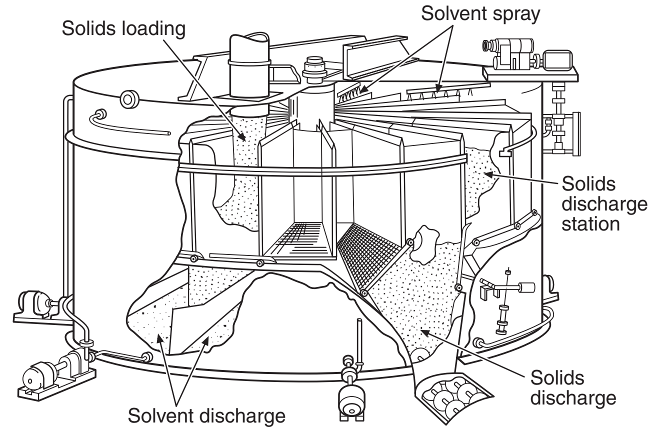
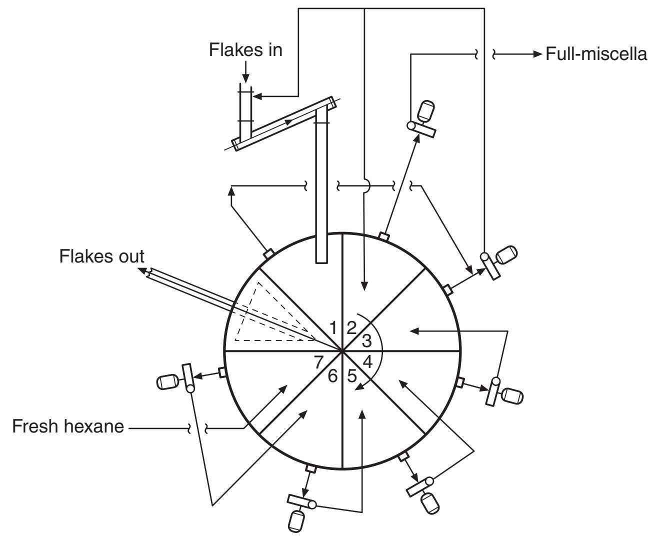


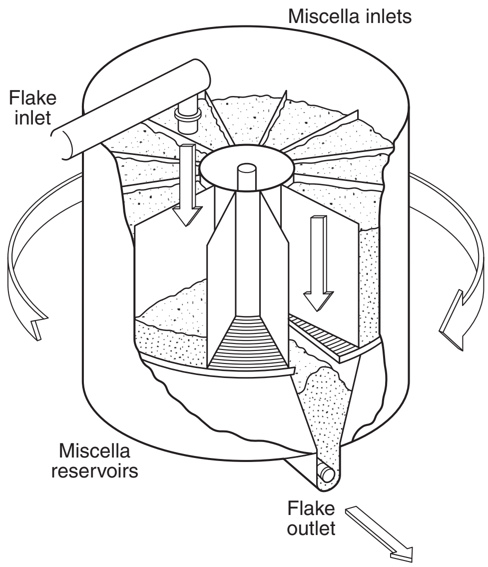
FIGURE B.6(b) Schematic of operation of rotary extractor.



Stationary-bottom and sliding-plate extractors [Figure B.6(c)] are variations of the deep bed rotary extractor. These extractors have concentric cells affixed to a central axis that is powered by a variable speed drive. The cells slide over a self-cleaning slotted bottom plate. Because of this feature, no doors are required to support the flakes. The cells are uniformly filled to a desired level. Several stage pumps are provided to recycle the solvent and gradient miscellas countercurrent to the mass as it is extracted. A drainage section is provided after the fresh solvent is added, and the extracted material drops into a discharge hopper, where it is conveyed to the desolventizer.

The stationary cell extractor is another type of rotary extractor. This type provides countercurrent extraction without moving the cells. Instead, the fill spout, spray nozzles, bottom screens, and miscella collection compartments rotate on a central shaft. The thrust load is carried on a circular track mounted on the bottom of the extractor shell. The oil-bearing material remains in the stationary basket until drained. As the bottom screen rotates under the basket, the material discharges into the internal discharge hopper from which it is conveyed from the extractor.

FIGURE B.6(c) Stationary-bottom or sliding-plate extractor.



B.7 Perforated Belt Extractor. *[See Figure B.7(a).]* Another type of extractor is the horizontal perforated belt extractor. In this type of extractor, the flakes are fed in a uniform depth onto one end of a slowly moving perforated belt. As the oil-bearing material, which is not as deep as in the rotary-type extractor, travels the length of the extractor, gradient miscellas are sprayed over the moving bed from stage pumps, in much the same fashion as the horizontal basket and rotary extractors. The belt is comprised of a pair of endless chains running on a set of large sprockets at each side of the extractor. Attached across the chains and forming a flat surface are a series of perforated plates or screens. Chambers or pans are arranged beneath the belt for the entire length of the extractor for collection of various concentrations of miscellas. The spent material is continuously discharged from the end of the belt into a hopper, from which it is conveyed to the desolventizer.

Another type of perforated belt extractor, the sliding cell extractor *[see Figure B.7(b)]*, provides two extraction surfaces where the flakes are separated by rectangular compartments, while traveling along the moving slotted screens or stationary vee-bar screen plates. This unit achieves countercurrent extraction by employing stage pumps and a series of collecting pans to direct the flow of the various miscella concentrations. Because there is an upper and a lower screen belt or plate, the filling device can be located over, but separated from, the discharge hopper.

When the partially extracted material reaches the end of the top belt, it falls from the upper cell into a similar compartment on the lower belt. The mass continues to be sprayed with miscella from the stage pumps until it reaches the fresh solvent wash prior to draining and feeding into the discharge hopper.

FIGURE B.7(a) Perforated belt extractor.

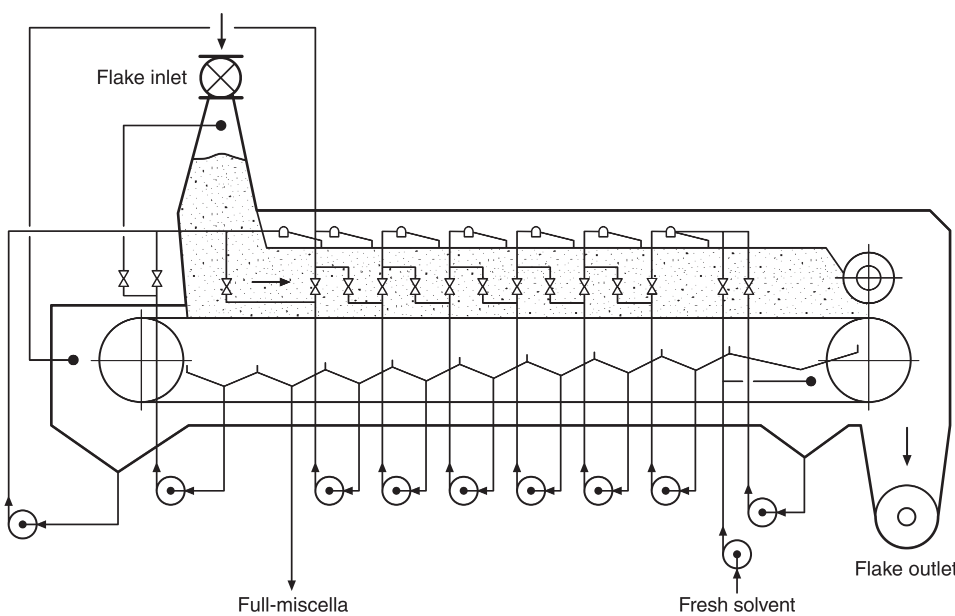
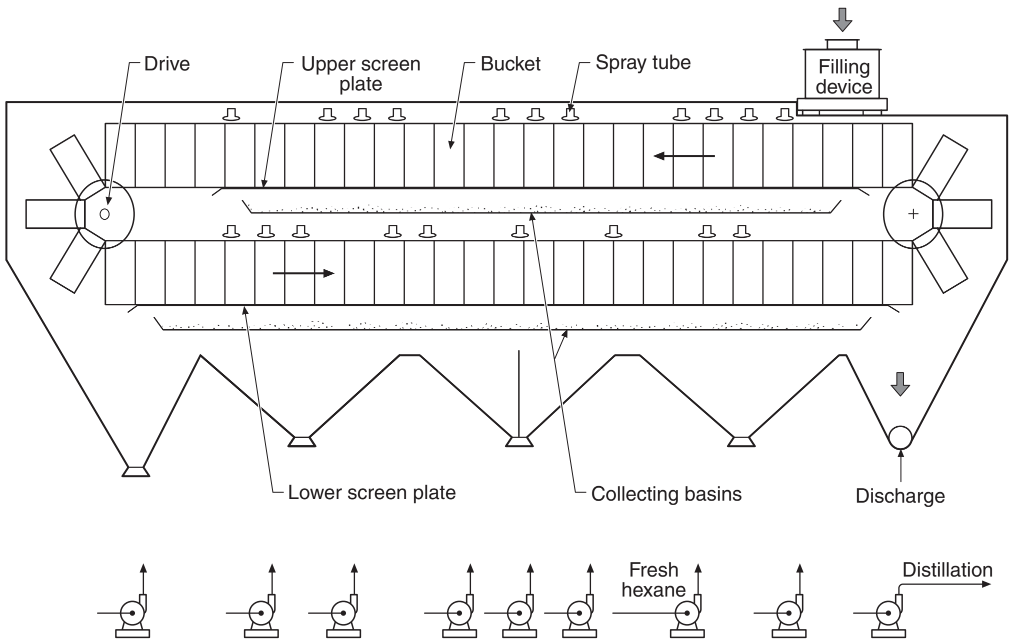


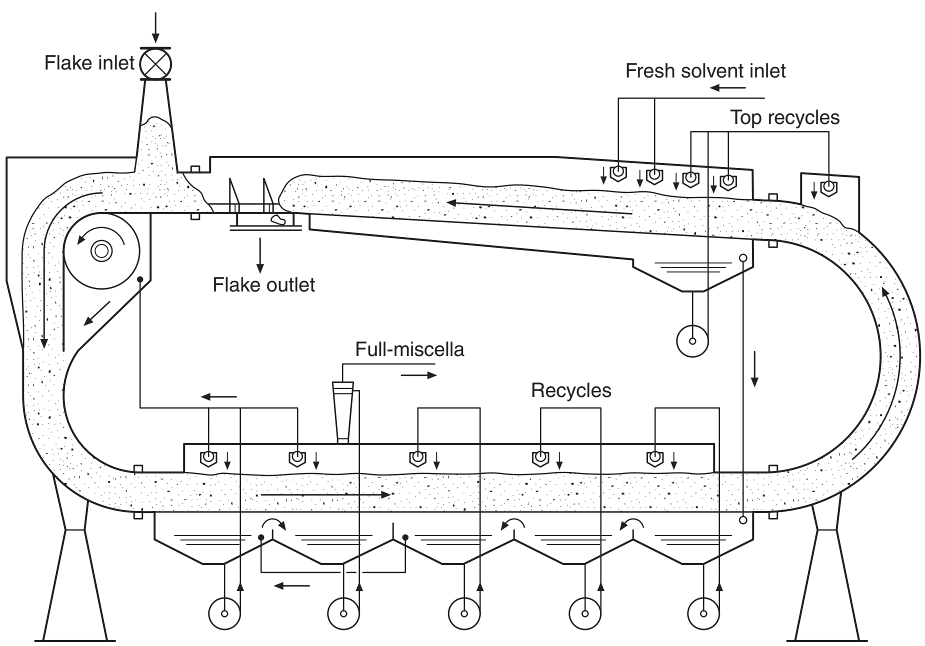
FIGURE B.7(b) Sliding cell extractor.



B.8 Rectangular Loop Extractor. *(See Figure B.8.)* The same basic principles are used in the rectangular loop extractor as in the sliding cell extractor. However, the overall shape of this extractor utilizes an "en masse"-type conveyor instead of individual baskets. The bottom part of the conveyor uses stationary, linear vee-bar screens. Flakes enter near the top of the extractor at the inlet hopper. A conveyor chain carries the flakes away from this hopper and down the first leg of the loop, where the flakes receive their first wash. In the bottom horizontal run of the loop, the flakes are washed with progressively weaker concentrations of miscellas. As the flakes travel up the vertical part of the loop, they are further extracted by a countercurrent wash of miscella flowing down the loop. On the sloping top run of the extractor, they receive a fresh solvent wash, are allowed to drain, and are discharged continuously from the unit.

The extractor conveying chain is open at the top, bottom, and sides. This allows easy loading and emptying of the material and for passage of the solvent through the flake bed as it is turned during its extraction wash cycle. The speed of the chain is automatically controlled by the level of flakes in the inlet hopper. A sensor in the feed hopper measures the level of flakes in the hopper and sends a signal to the extractor's variable speed drive.

FIGURE B.8 Rectangular loop extractor.



B.9 Other Types of Extractors. There are other types of extractors for extracting oil from oil-bearing materials, but they are not in general use. These other types include vertical immersion, filtration, and batch extractors. Some are used only for special applications.

B.10 Distillation. The distillation system of an extraction plant provides the means for evaporating and stripping the solvent from the oil. There are numerous methods for accomplishing this, from the early pot-type batch stills and pan-type evaporators to the currently popular long-tube rising film evaporators, followed by high vacuum stripping. Few of the pot stills or pan-type evaporators are still in use.

At this time, nearly all extraction plants use two long-tube rising film evaporators, with or without recirculation. The first evaporator usually operates under vacuum, while the second operates either under vacuum or at atmospheric pressure. Heat from the desolventizer vapor is recovered and used to supply heat to the first evaporator, while indirect steam supplies heat for the second evaporator. The choice of the type of oil stripper used depends on a number of factors, including the design and size of the other components in the system and the material being processed.

Stripping columns commonly used are either the packed column type or the disk-and-doughnut type. The stripping column distributes the oil into a very thin film on a large surface area with a relatively high velocity of dry steam passing over and through the film. A countercurrent flow is established by introducing the oil at the top of the column and allowing it to pass downward through the tower against the flow of the steam, which is introduced at the bottom of the tower. The tower must be operated under a vacuum of 22 in. Hg to 28 in. Hg (559 mm Hg to 711 mm Hg) to achieve highest efficiency. The mixture of steam and solvent vapor passes from the top of the tower to a condenser from which the condensate is pumped to a solvent/water separator. The solvent flows from the separator to a work tank. Water flows from the separator to the waste water evaporator. Finished oil is usually pumped from the stripping column by a rotary positive displacement pump.

B.11 Desolventizing and Toasting. Desolventizing of the spent material is accomplished in several ways. In one of these, spent material is desolventized by passing through a series of steam-jacketed rotary conveyors commonly called *schneckens.* These conveyors are usually stacked one above the other, and the material to be desolventized drops by gravity from one to the next. The last conveyor often has a direct flow of steam to remove the final traces of solvent. Vapors are piped to a scrubbing and condensing system. The desolventized material is discharged from the bottom conveyor through a vapor seal.

Another type of desolventizer is the recycled vapor type, which consists of a single cylindrical vessel with a rotating element that tumbles the spent material from the inlet to the discharge end. The vessel is steam-jacketed, and part of the solvent vapor that is driven off is superheated and passed directly back to the vessel. The superheated solvent vapor provides the energy to desolventize the material. This type of desolventizer is usually followed by some type of stripper, often using heat, vacuum, and direct steam to remove the final traces of solvent. The desolventized material is then discharged through a vapor seal.

Many extracted oilseed products require toasting or cooking in order to deactivate enzymes and other constituents and yield a nutritional product. The moisture and heat of the toasting process also agglomerates the fine particles of meal into a more granular form. This helps to reduce the dust problem in subsequent cooling and milling steps. Toasting can be carried out as a separate stage of the process. The meal is conveyed from the desolventizer to the toaster, which may be a vertical stacked cooker or a jacketed stationary drum-type unit with an internal agitator. The toasting section of the combination desolventizer-toaster, often called a *D-T,* is essentially a stacked cooker. The function of all toasters is to retain the spent material for a sufficient time at a temperature above 212°F (100°C) and at a specific moisture content. The length of time that the meal is held at these conditions determines the degree of cooking or toasting.

From a fire protection standpoint, the development of the desolventizer-toaster, with the elimination of the intermediate vapor seals, conveyors, and so forth, represents a significant advance. The D-T is now used in most large capacity solvent extraction systems and accomplishes two important processing steps with a minimum of moving machinery and maximum safety against escape of solvent vapors. The D-T consists of individual kettles or trays placed one above the other, each kettle containing a layer of spent material to a depth of 1 ft to 4 ft (0.3 m to 1.2 m). The feeding of material from one kettle to the next lower one is accomplished by an automatic gate mechanism or spout. The trays that form the floor of each kettle are steam-jacketed and direct steam is sparged into the material in the top kettle or kettles. Some of this steam condenses as it evaporates the solvent, raising the temperature and the moisture of the material to the levels required for toasting in the lower kettles. The top kettle is provided with a large pipe to conduct hot vapors through a scrubber to the condensing system. In normal operation, at least half of the kettles (trays) of the D-T are filled with desolventized material, providing an effective seal against fluctuating pressures and other changes in plant performance.

More recently, the fully counterflow D-T has been introduced. In this unit, the trays have a relatively uniform pattern of perforations that allow the passage of steam through each upper level tray and bed of material. Most or all of the direct steam is introduced at the bottom of the D-T and flows up through the beds in counterflow to the downward flow of material. This method desolventizes and toasts effectively, reduces the danger of solvent escaping from the bottom of the D-T, and is more energy efficient.

B.12 Condensing System. Condensing of solvent vapors and steam is usually accomplished by the use of shell-and-tube condensers. The tubes are normally made of stainless steel. Water flows through the tubes, and the solvent vapor and steam condense on the outer surfaces of the tubes. The cold water used in the condensers can be supplied from deep wells, cooling towers, spray ponds, or some other source that can supply water cool enough to operate the condensers efficiently and clean enough to prevent fouling of the tubes. Solvent vapor from the desolventizer is usually passed through a scrubber to remove any solids entrained in the vapor stream. The vapors are normally washed with liquid solvent, and this scrubbing liquid, along with the removed fines, is returned to the desolventizer. Water has also been used as a scrubbing liquid.

B.13 Vent Vapor Recovery System. It is standard practice in extraction plants to vent each piece of processing equipment to a common vent header. This header contains hexane vapor, water vapor, and air, which flow to the final solvent recovery