ANSI/NFPA 36 An American National Standard June 8, 1988

NFPA 36
Solvent Extraction Plants
1988 Edition

NFPA

National Fire Protection Association 1 Batterymarch Park, PO Box 9101, Quincy, MA 02269-9101

NOTICE

All questions or other communications relating to this document should be sent only to NFPA Headquarters, addressed to the attention of the Committee responsible for the document.

For information on the procedures for requesting Technical Committees to issue Formal Interpretations, proposing Tentative Interim Amendments, proposing amendments for Committee consideration, and appeals on matters relating to the content of the document, write to the Secretary, Standards Council, National Fire Protection Association, 1 Batterymarch Park, P.O. Box 9101, Quincy, MA 02269-9101.

A statement, written or oral, that is not processed in accordance with Section 16 of the Regulations Governing Committee Projects shall not be considered the official position of NFPA or any of its Committees and shall not be considered to be, nor be relied upon as, a Formal Interpretation.

Users of this document should consult applicable Federal, State and local laws and regulations. NFPA does not, by the publication of this document, intend to urge action which is not in compliance with applicable laws and this document may not be construed as doing so.

Policy Adopted by NFPA Board of Directors on December 3, 1982

The Board of Directors reaffirms that the National Fire Protection Association recognizes that the toxicity of the products of combustion is an important factor in the loss of life from fire. NFPA has dealt with that subject in its technical committee documents for many years.

There is a concern that the growing use of synthetic materials may produce more or additional toxic products of combustion in a fire environment. The Board has, therefore, asked all NFPA technical committees to review the documents for which they are responsible to be sure that the documents respond to this current concern. To assist the committees in meeting this request, the Board has appointed an advisory committee to provide specific guidance to the technical committees on questions relating to assessing the hazards of the products of combustion.

---

1. Adoption by Reference — Public authorities and others are urged to reference this document in laws, ordinances, regulations, administrative orders or similar instruments. Any deletions, additions and changes desired by the adopting authority must be noted separately. Those using this method are requested to notify the NFPA (Attention: Secretary, Standards Council) in writing of such use. The term "adoption by reference" means the citing of title and publishing information only.

2. Adoption by Transcription — **A.** Public authorities with lawmaking or rule-making powers only, upon written notice to the NFPA (Attention: Secretary, Standards Council), will be granted a royalty-free license to print and republish this document in whole or in part, with changes and additions, if any, noted separately, in laws, ordinances, regulations, administrative orders or similar instruments having the force of law, provided that: (1) due notice of NFPA's copyright is contained in each law and in each copy thereof; and, (2) that such printing and republication is limited to numbers sufficient to satisfy the jurisdiction's lawmaking or rulemaking process. **B.** Once this NFPA Code or Standard has been adopted into law, all printings of this document by public authorities with lawmaking or rulemaking powers or any other persons desiring to reproduce this document or its contents as adopted by the jurisdiction in whole or in part, in any form, upon written request to NFPA (Attention: Secretary, Standards Council), will be granted a nonexclusive license to print, republish, and vend this document in whole or in part, with changes and additions, if any, noted separately provided that due notice of NFPA's copyright is contained in each copy. Such license shall be granted only upon agreement to pay NFPA a royalty. This royalty is required to provide funds for the research and development necessary to continue the work of NFPA and its volunteers in continually updating and revising NFPA standards. Under certain circumstances, public authorities with lawmaking or rulemaking powers may apply for and may receive a special royalty when the public interest will be served thereby.

3. Scope of License Grant — The terms and conditions set forth above do not extend to the index to this document.

(For further explanation, see the Policy Concerning the Adoption, Printing and Publication of NFPA Documents which is available upon request from the NFPA.)

Statement on NFPA Procedures

This material has been developed under the published procedures of the National Fire Protection Association, which are designed to assure the appointment of technically competent Committees having balanced representation. While these procedures assure the highest degree of care, neither the National Fire Protection Association, its members, nor those participating in its activities accepts any liability resulting from compliance or noncompliance with the provisions given herein, for any restrictions imposed on materials or processes, or for the completeness of the text.

NFPA has no power or authority to police or enforce compliance with the contents of this document and any certification of products stating compliance with requirements of this document is made at the peril of the certifier.

NFPA 36

Standard for

Solvent Extraction Plants

1988 Edition

This edition of NFPA 36, *Standard for Solvent Extraction Plants*, was prepared by the Technical Committee on Solvent Extraction Plants, released by the Correlating Committee on Flammable Liquids, and acted on by the National Fire Protection Association, Inc. at its Annual Meeting held May 16-18, 1988, in Los Angeles, California. It was issued by the Standards Council on June 8, 1988 with an effective date of June 28, 1988, and supersedes all previous editions.

The 1988 edition of this standard has been approved by the American National Standards Institute.

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.

Origin and Development of NFPA 36

This standard was developed at the request of individuals in the solvent extraction industry who felt that there was a need for greater uniformity on fire protection for solvent extraction plants. The purpose of this standard is to provide reasonable standards for the design and operation of solvent extraction plants.

This standard was adopted tentatively at the 1957 Annual Meeting of the Association and a revised edition was adopted as a continued tentative standard at the 1958 Annual Meeting. At the 1959 Annual Meeting this standard was officially adopted and then revised in 1962, 1964, 1967, 1972, 1973, 1974, 1978, 1983, and 1985.

This 1988 revision incorporates a complete rewrite of Section 1-3, covering applicability of NFPA 36 to existing plants. It also incorporates minor revisions to subsections 5-1.6, 5-4.2, 5-8.8.2, 5-9.2, and Tables A-1 and A-2.

Committee on Flammable Liquids

Correlating Committee

Leon C. Schaller, *Chairman*
E I duPont de Nemours & Co.

G. E. Cain, G E Cain & Co.
J. A. Cedervall, Underwriters Laboratories Inc
Donald M. Johnson, San Bruno, CA
(Rep Western Oil & Gas Assn)
C. L. Kingsbaker Jr., Atlanta, GA
F. Owen Kubias, The Glidden Co.
Steven Landon, Trophy Club
(Rep. Textile Care Allied Trades Assn.)
Paul C. Lamb, Englewood, NJ
(Member Emeritus)

Technical Committee on

Solvent Extraction Plants

C. L. Kingsbaker Jr., *Chairman*
Atlanta, GA

George Eli Anderson, Crown Iron Works Co.
Kenneth D. Harp, Kings County Fire Dept.
John E. Heilman, Continental Grain Co
(Rep. NSPA)
La Rue Medders, Lloyds New York
N. Hunt Moore, N Hunt Moore & Associates Inc
Harold J. Sandvig, Cargill Inc. Corporate Safety
(Rep CRA)
C. E. Scott, Kemper Group HPR Dept
(Rep AAI)
R. I. Spencer, Industrial Risk Insurers
Thomas C. Wedegaertner, Nat'l Cottonseed Products Assn

Alternates

Frederick Deacon, Kemper Group HPR Dept.
(Alternate to C E Scott)
George W. Moore, Industrial Risk Insurers
(Alternate to R. I. Spencer)

Robert Benedetti, NFPA Staff Liaison

This list represents the membership at the time the Committee was balloted on the text of this edition Since that time, changes in the membership may have occurred

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

Contents

Foreword

In the preparation of this standard the members of the Committee recognized some fundamental differences between the operation of solvent extraction plants and the processing of flammable liquids in large-scale establishments.

Many solvent extraction plants are relatively small units in isolated locations operated without the benefit of overall fire protection measures such as usually are customary in large flammable liquids processing installations.

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

There are certain inherent hazards in the combining and separating of solids and flammable liquids which are peculiar to this industry. Also serving as a complicating problem is the potential dust explosion hazard in some areas of a typical plant. Therefore, it was felt desirable to give consideration to practices which would be applicable to either potential dust-laden or flammable vapor atmospheres.

NFPA 36

Standard for

Solvent Extraction Plants

1988 Edition

Chapter 1 Introduction

NOTICE: Information on referenced publications can be found in Chapter 6 and Appendix C.

1-1 Purpose.

1-1.1 This standard is intended to:

1-1.1.1 Prescribe reasonable requirements for safety to life and property from explosion and fire in the design, construction and operation of solvent extraction processes involving the use of flammable solvents.

1-1.1.2 Provide a means by which fire protection directors and supervisory process personnel may evaluate the operations under their authority.

1-1.1.3 Provide a guide by which inspectors may readily and impartially determine whether or not an existing installation is being operated in accordance with good practice.

1-1.1.4 Provide a workable set of standards for the use of design engineers, architects and others in planning and designing new installations.

1-1.2 This standard shall not be construed as limiting new ideas of equipment design to the present state of the art but rather shall be considered as a base from which higher standards of loss prevention and fire protection may be achieved.

1-1.3 Units. Metric units of measurement in this standard are in accordance with the modernized metric system known as the International System of Units (SI). Two units (kilogram and square centimeters), outside of but recognized by SI, are commonly used in international fire protection. If a value for measurement as given in this standard is followed by an equivalent value in other units, the first stated is to be regarded as the requirement. A given equivalent value may be approximate. The conversion procedure for the SI units has been to multiply the quantity by the conversion factor and then round the result to the appropriate number of significant digits.

1-2 Scope.

1-2.1 This standard applies to the commercial scale solvent extraction processing of animal and vegetable oils and fats by the use of flammable solvents except extraction processes employing liquefied petroleum gases.

1-2.2 This standard shall apply to all equipment and buildings within 100 ft (30.5 m) of the extraction process except as provided in 1-2.3, 1-2.4 and 1-2.5.

1-2.3 This standard also shall apply to the unloading and storage of solvent regardless of distance from the solvent extraction process.

1-2.4 Where the preparation process is housed separately and located a clear distance of 100 ft (30.5 m) or more from the extraction process, this standard shall begin with and include the means of conveying material from the preparation department to the extraction process.

1-2.5 This standard shall include the means of conveying extracted desolventized solids or oil from the extraction plant to the vessels and bins storing such material.

1-2.6 This standard does not include raw stock storage. Where grains or seeds are used, reference may be made to NFPA 61B, *Standard for the Prevention of Fires and Explosions in Grain Elevators and Facilities Handling Bulk Raw Agricultural Commodities.*

1-2.7 Processes employing oxygen active compounds, such as organic peroxides, which are heat or shock sensitive are prohibited within the area described in 1-2.2.

1-3 Application to Existing Plants.

1-3.1 The provisions of this standard shall apply to all solvent extraction plants. Existing plants that conform to the NFPA standards in effect at the time of construction[1] may be considered to be in compliance with this standard provided that they do not constitute a recognized hazard to life or adjacent property as determined by the authority having jurisdiction.

[1]Refer to 6-1.1 for a list of NFPA standards, in addition to NFPA 36, which may apply.

1-3.2 Modifications shall comply with the standard in effect at the time of the changes. When modifications adversely affect the intended function or the adequacy of other systems of the existing plant, those affected systems shall be upgraded consistent with good engineering practices and the provisions of this standard.

1-3.3 Modifications shall not be prohibited because of space limitations, provided the modifications comply with the provisions of 5-1.6.

1-4 Enforcement.

1-4.1 The authority having jurisdiction shall follow nationally recognized standards for fire prevention and fire protection which have been prepared in such a way that they may be taken to represent the best informed judgment available on the subject and which are in such published form as to be available for reference.

1-4.2 Where these standards require the authority having jurisdiction to approve process or protective equipment, he may require the applicant for such approval to submit information necessary to properly judge the suitability of the equipment for its intended purpose. In performing this function the authority having jurisdiction may require examination and tests to furnish such information or he may accept listings or approvals of equipment by laboratories or testing agencies which have an established procedure, the necessary facilities, and qualified personnel for examinations and tests appropriate for the particular equipment. In the absence of such established examination and test procedure for any item on which approval is necessary, the authority having jurisdiction may specify what examinations and tests shall be made.

Process and protective equipment for meeting the requirements of these standards are examined and tested by Underwriters Laboratories Inc., 333 Pfingsten Street, Northbrook, IL 60062; Factory Mutual Research Corporation, 1151 Boston-Providence Turnpike, Norwood, Massachusetts 02062; and Underwriters Laboratories of Canada, 7 Crouse Road, Scarborough, Ontario. These testing agencies have standards and procedures which apply to the examinations and tests they make, and the results are published in listings or approvals. Various provisions of these standards on solvent extraction are drawn so that, when applied to process and protective equipment meeting the terms of such listings and approvals, the desired results in safety from explosion and fire are obtained. Other approval criteria may be employed, but in such cases the authority having jurisdiction shall determine that equivalent results are assured.

1-5 Definitions.

Approved. Acceptable to the "authority having jurisdiction."

NOTE: 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 or 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 concerned with product evaluations which is in a position to determine compliance with appropriate standards for the current production of listed items.

Authority Having Jurisdiction. The "authority having jurisdiction" is the organization, office or individual responsible for "approving" equipment, an installation or a procedure.

NOTE: 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, 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 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."

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

Condenser. A heat exchanger that lowers the temperature of a condensable vapor to the point where the vapor changes to the liquid state.

Controlled Area. The area between 50 ft (15.3 m) and 100 ft (30.5 m) of the extraction process measured horizontally.

Conveyor. Equipment that transports material other than liquid from one point to another by means such as a moving belt, chain, air, buckets, flights or combinations of the above.

Desolventized Material. Extracted material rendered solvent-free by the process.

Desolventizer. Equipment capable of removing the solvent from the material in process.

Evaporator. Equipment that will vaporize the solvent from the oil-bearing miscella.

Extracted Material. (*See definition of Spent Material.*)

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

Extractor. Equipment which has as its function the removal of oil from the oil-bearing material by the use of a suitable solvent.

Fail Safe. Any equipment or operation which upon failure to function becomes less hazardous or remains no more hazardous than when in operation.

Flakes. Material prepared for extraction, such as soybean flakes.

Flaking Mill. A crushing roll-type device used for the preparation of material for the solvent extraction process.

Flame Arrester. Any approved device which effectively prevents ignition of flammable vapors on one side of the arrester when the other side of the arrester is exposed to a source of ignition.

Heat Exchanger. A shell and tube bundle designed to transfer heat from one vapor or liquid to another vapor or liquid.

Inert Gas. Any gas which is nonflammable, chemically inactive, and noncontaminating for the use intended and oxygen deficient to the extent required.

Inerting. The use of an inert gas to render the atmosphere of an enclosure substantially oxygen-free or to reduce the oxygen content to a point at which combustion cannot take place.

Labeled. Equipment or materials to which has been attached a label, symbol or other identifying mark of an organization 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.

Listed. Equipment or materials included in a list published by an organization acceptable to the "authority having jurisdiction" and concerned with product evaluation, that maintains periodic inspection of production of listed equipment or materials and whose listing states either that the equipment or material meets appropriate standards or has been tested and found suitable for use in a specified manner.

NOTE: The means for identifying listed equipment may vary for each organization concerned with product evaluation, some of which 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.

Miscella. A mixture in any proportion of extracted oil and the extracting solvent.

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

Purging. The process of displacing the flammable vapors from an enclosure.

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

Seal, Product or Mechanical. A device designed to prevent the transmission of liquid or vapor from one portion of the extraction process to another.

Separation Sump. An open pit used for the separation of mixtures of solvent and water based on the principle of the immiscibility and the differences in the specific gravity between the solvent and water.

Solvent. Any flammable liquid, such as pentane, hexane, and heptane, with suitable characteristics for the extraction of animal and vegetable oils and fats.

Spent Material. The material after the oil or fat has been extracted and before it is further treated or processed.

Stripper. The bubble cap, sieve plate, disc, and donut or porcelain ring packed column or tower, usually operated under vacuum, designed to remove residual solvent from the oil.

Toasters. Equipment capable of producing the desired cooking, toasting and modification of protein by means of heat and moisture.

Vapor Recovery. The process of condensing, absorbing or adsorbing solvent vapors.

Vapor Scrubber. A tower or column capable of washing the dust from vapor by the use of hot liquid sprays.

Vapor Seal. Any equipment or material which prevents the escape of flammable vapors from a tank or container.

Chapter 2 Basic Rules

2-1 General Requirements.

2-1.1 Safe operating practices, including but not limited to start-up and shut-down procedures, shall be the responsibility of management operating the solvent 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 may enter the plant, both during operating periods and during shut-down periods. Further information on the control of visitors may be found in Appendix B.

2-1.4 When necessary to make repairs to the plant, the work shall be authorized by the individual in responsible charge of the plant before the work is started. (*See Appendix B for a suggested safety work permit.*)

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 extraction process restricted or controlled areas.

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 small quantities which 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 orginating from material in process shall be kept to a minimum.

2-1.6.4 Except as provided in 5-2.7.2, the space within the restricted and controlled areas shall be kept completely 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 established to minimize such occurrences.

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 shut-down procedures.

2-2.2 Personnel shall be thoroughly indoctrinated as to the location of exits.

2-2.3 All personnel shall be throughly trained in the use of 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 in order that employees will 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 which may produce sources of ignition shall be prohibited.

2-3.2 Electrical Equipment. Repairs on live electrical wiring or equipment shall be prohibited. If necessary to replace or repair electrical wiring or equipment, the power shall be completely disconnected and the switch locked in an open position.

2-3.3 Welding and Cutting Operations. Welding and cutting, including brazing and soldering operations, shall be prohibited.

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 which may produce ignition sources shall be performed only when the plant has been shut down and completely purged, and declared safe by the individual in responsible charge. (*See Appendix B for a suggested work permit form.*)

2-4.2 Prior to initiating purging the following steps shall be taken.

2-4.2.1 Empty the tanks, vessels, piping, and traps of all materials. All such material shall be removed to a safe location.

2-4.2.2 Disconnect, plug or blank off all piping and other connections to storage facilities.

2-4.3 Purging shall be accomplished by one or a combination of the following methods.

2-4.3.1 The vapor freeing may 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 has to be sufficient to 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 2-4.3.2 shall be followed when hot work is to be performed.

2-4.3.2 Vapor freeing may be accomplished by purging with air and a safe atmosphere may be sustained by continued ventilating. When fixed ventilating equipment is not provided, air movers may be attached so that air is drawn in and discharged through the air mover or air may 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.

2-4.3.3 Vapor freeing may 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, tests for flammable vapors with a combustible gas indicator shall be made: (1) before commencing alterations or repairs, including welding, cutting or heating operations; (2) immediately after starting any welding, cutting, or heating operations; and (3) frequently during the course of such work. All such work shall be stopped immediately when the presence of solvent vapor is indicated. The source of the vapor release shall be located and removed and the procedure outlined above shall be followed 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 see that operations may be resumed safely. (*See 2-5.1.*)

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 may be accomplished by inerting to reduce the oxygen content.

2-6 Solvent Transfer Equipment.

2-6.1 Pumps.

2-6.1.1 Pumps shall be designed for the solvent, the working pressures and the structural stresses to which they will be subjected.

2-6.1.2 The use of air pressure as the solvent transferring medium shall be prohibited.

2-6.1.3 Where practicable all pumps handling flammable liquids in the processing equipment shall be located on the first floor level.

2-6.1.4 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 may 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 may be used where vibration exists or where frequent movement is necessary.

2-7.3.2 Aboveground flammable liquid 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 1½ 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 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 Controls.

2-8.1 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 the bulk storage shall be remotely controlled by momentary switches or other devices which provide for "dead man" controls to prevent overfilling of tanks.

2-8.2 Positive displacement pumps shall be provided with bypasses with pressure relief valves discharging back to the tank or to the pump suction.

2-9 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 which 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.

2-10 Fire Protection.

2-10.1 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. (*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 Deluge Foam-Water Sprinkler and Foam-Water Spray Systems.*)

2-10.2 An approved system of automatic sprinklers shall be provided in the preparation building when within 100 ft (30.5 m) of extraction process. (*See NFPA 13, Standard for the Installation of Sprinkler Systems.*)

2-10.3 A system of yard hydrants shall be provided in accordance with accepted good practice. (*See NFPA 24, Standard for the Installation of Private Fire Service Mains and Their Appurtenances.*)

2-10.4 Approved portable fire extinguishers of appropriate size and type shall be provided. (*See NFPA 10, Standard for Portable Fire Extinguishers.*)

2-10.5 Where standpipe and hose protection is installed, combination water fog and straight steam nozzles shall be provided. (*See NFPA 14, Standard for the Installation of Standpipe and Hose Systems.*)

2-10.6 Where explosion prevention systems are installed they shall be installed in accordance with the provisions of NFPA 69, *Standard on Explosion Prevention Systems.*

2-10.7 Fire alarm signals shall be relayed or sent to a constantly supervised point on or off the premises.

2-10.8 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 the line of adjoining property which may be built upon. The fill connection to the storage tank shall be at least 25 ft (7.6 m) from the extraction process.

3-1.2 Storage Tanks.

3-1.2.1 Bulk storage tanks shall be outside of any building. Underground tanks shall be located a minimum of 1 ft (30.5 cm) from existing building foundations and supports and at least 3 ft (9.2 cm) from the nearest line of adjoining property that may be built upon. The loads carried by the building foundations and supports shall not be transmitted to the tank. When aboveground installations are made, the tanks shall be located within the restricted area of the extraction process or in a remote fenced area and in both cases at least 25 ft (7.6 m) from any important building or line of adjoining property which may be built upon.

3-2 Design and Construction.

3-2.1 Unloading Stations.

3-2.1.1 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.

3-2.2.1 General. Storage tanks shall be designed, constructed, installed and tested in accordance with accepted good practice.

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.*

3-3 Sources of Ignition.

3-3.1 Electrical Equipment. All electrical equipment and its installation shall conform to Class I Group C or D (depending on solvent used).

3-3.1.1 Where enclosures are provided which house solvent handling equipment such as solvent pumps or valves or in which 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). (*See NFPA 70, National Electrical Code.*)

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 effectively bonded.

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. (*See NFPA 77, Recommended Practice on Static Electricity.*)

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. (*See NFPA 10, Standard for Portable Fire Extinguishers.*)

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 flammable liquids shall be unloaded in accordance with accepted good practice. (*See NFPA 385, Standard for Tank Vehicles for Flammable and Combustible Liquids.*)

Chapter 4 Preparation Process

4-1 Application.

4-1.1 The provisions of this chapter shall apply to preparation processes located within 100 ft (30.5 m) of the extraction process.

4-1.2 Where the processing operations do not involve the generation of combustible dusts, 4-2.2 through 4-4.5 do 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 sq ft (.1 m^2) for each 50 cu ft (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:

(a) Open air construction with a minimum area enclosed.

(b) Light noncombustible walls and roof lightly attached to steel frame.

(c) Light noncombustible wall panels and roof hatches.

(d) Top hinged windows with explosion relief hatches.

NOTE. Reference may be made to NFPA 68, *Guide for Venting of Deflagrations*.

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, Group G, Division 1 locations. (*See NFPA 70, National Electrical Code.*)

4-3.2 Static protection shall be provided in equipment located in areas where combustible dust presents a hazard. (*See NFPA 77, Recommended Practice on Static Electricity.*)

4-4 Dust Removal.

4-4.1 A dust collecting system shall be provided where necessary. (*See NFPA 91, Standard for the Installation of Blower and Exhaust Systems for Dust, Stock, and Vapor Removal or Conveying.*)

4-4.2 Dust collectors of the all-metal type shall be located outside of buildings or shall be equipped with exhaust stacks or ducts leading to the outside.

4-4.3 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 sq ft of relief area for each 30 to 50 cu ft (.1 m^2 of relief area for each 9 to 15 m^3) of room volume. (*See NFPA 61C, Standard for the Prevention of Fire and Dust Explosions in Feed Mills.*)

4-4.3.1 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 which 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.

Chapter 5 Extraction Process

5-1 Location of Extraction Process.

5-1.1 The solvent extraction process equipment shall be located in the open or in a building suitable for the purpose.

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, except separation sumps, shall be prohibited within 100 ft (30.5 m) of the extraction process.

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 line of adjoining property that may be built upon. The slope of the terrain and the prevailing winds shall be given consideration 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, may 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 following requirements is provided.

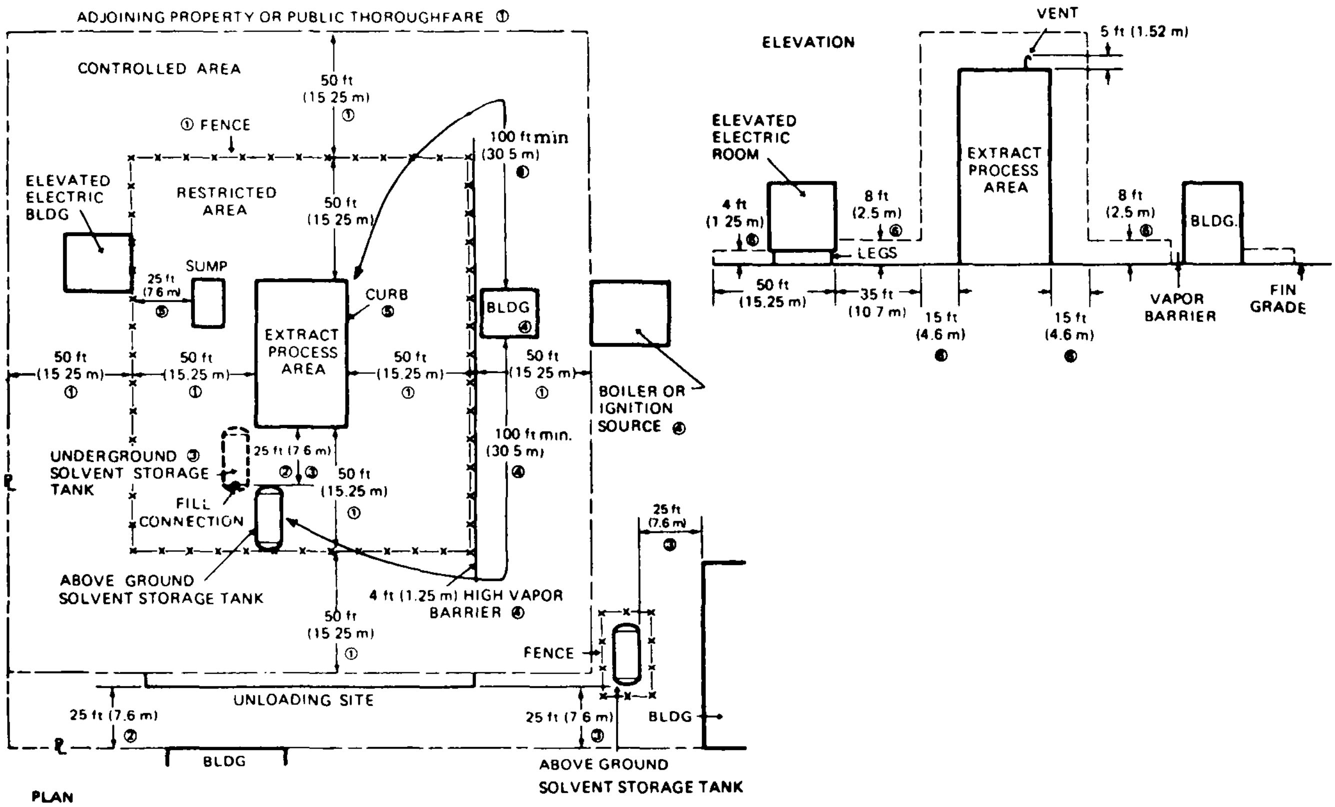
5-1.5.1 The barrier shall be located between the extraction process and the possible source of vapor ignition and at least 50 ft (15.3 m) from the extraction process.

5-1.5.2 The barrier shall be of noncombustible vapor-tight 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 such as to render the strict application of distances specified in this standard impractical, the authority having jurisdiction may permit such deviation as will provide an equivalent degree of safety and be consistent with good engineering practice. Factors having a bearing on this deviation could be topographical conditions, nature of occupancy and proximity to buildings on adjoining property, character of construction of such buildings, and adequacy of public fire protection facilities.

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 direct connected to an outside separation sump. Drainage lines under the ground floor slab of the extraction process are prohibited.



Index

1. 5-1.2, 5-1.4	3. 3-1.2	5. 5-2.4.1
2. 3-1.1	4. 5-1.5, 5-1.5.1, 5-1.5.2, 5-4.1	6. 5-5

Figure 1 A Typical Distance Diagram.

5-2.2 Explosion relief of at least 1 sq ft for each 50 cu ft (.1 m^2 for each 15 m^3) of volume shall be provided by one or more of the following methods:

(a) Open air construction with a minimum area enclosed.

(b) Light noncombustible walls and roof lightly attached to steel frame.

(c) Light noncombustible wall panels and roof hatches.

(d) Top hinged windows with explosion relief latches.

NOTE: Reference may be made to NFPA 68, *Guide for Venting of Deflagrations*.

5-2.3 Provisions shall be made for the safe discharge of liquids from the process area to guard against the introduction of flammable liquids into sewer systems.

5-2.4 A sump shall be provided to effect separation of water from oils, solvents or miscella.[1]

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.

[1]In the event of flow of fire protection water, complete separation of water from oils, solvent, or miscella may not occur.

5-2.4.2 The sump shall be concrete or equivalent noncombustible construction and influent and effluent lines shall be trapped.

5-2.4.3 The sump shall consist of two or more sections, the largest of which shall be sized to retain all solvent, miscella and oil which could be released by a single break in a vessel or piping, plus an additional 50 percent of this amount.

5-2.4.4 An emergency means shall be provided to prevent the outflow of solvents, miscella or oil from the sump to the sewer system.

5-2.4.5 A pump shall be provided to recover oils, solvents, or miscella collected in the sumps.

5-2.4.6 Approved fixed automatic fire protection shall be provided above the separation sump.

5-2.5 Conveyors and spouts from or to other buildings shall be located and protected to prevent passage of solvent vapors to other areas. This may be accomplished by one or a combination of the following methods:

(a) For other than pneumatic conveyors: by providing on the extraction end, continuous air aspiration to the outside and with a visual and audible indication of blower operation and failure.

(b) For the raw flake conveying system: by providing a break in the raw flake conveyor system at a point in open air in addition to continuous air aspiration as outlined in (a).

(c) For pneumatic conveyors: by locating the air intake in a vapor-free area outside the extraction process and a minimum of 8 ft (2.5 m) above the grade level.

5-2.6 Conveyors and spouts may 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. (*See NFPA 214, Standard on Water-Cooling Towers.*)

5-2.7.1 If the tower is noncombustible throughout, it may be located in the restricted area.

5-2.7.2 If the tower is of noncombustible exterior construction and protected by automatic sprinklers per NFPA 214, *Standard on Water-Cooling Towers*, it shall not be located in the restricted area but may 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, per NFPA 214, *Standard on Water-Cooling Towers*, it shall not be located in the restricted area but may 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 may exceed this level, provided the temperature is reduced to 250°F (121°C) during shut-down periods.

5-4.4 Power transmission belts shall not be used within Class I, Group C or D locations, as defined in Section 5-5.

5-4.5 Process vent fans, purge fans, and building ventilation fans shall be of sparkproof design.

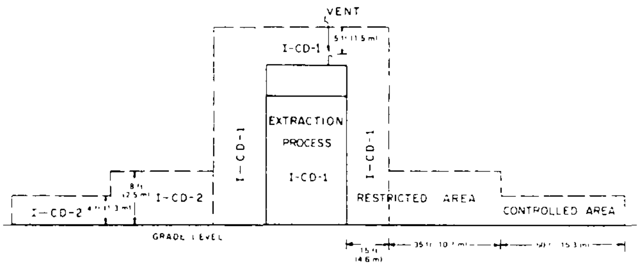
5-5 Electricity.

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 C or D, Division 1 locations. (*See Figure 2.*)

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, Group C or D, Division 2 locations. (*See Figure 2.*)

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, Group C or D, Division 2 locations. (*See Figure 2.*)

5-5.4 Permanent lights shall be installed where needed. Flashlights approved for Class I, Group C or D locations shall be provided.



I-CD-1 CLASS I, GROUP C OR D, DIVISION 1

I-CD-2 CLASS I, GROUP C OR D, DIVISION 2

Figure 2 Type and Extent of Hazardous Areas.

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

5-6.3 All hose except that used in water service shall be electrically bonded to the supply line and to the tank or vessel where discharge takes place.

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. (*See NFPA 77, Recommended Practice on Static Electricity.*)

5-7 Lightning Protection. Where needed, approved lightning protection shall be provided for the extraction process. (*See NFPA 78, Lightning Protection Code.*)

5-8 Process Equipment.

5-8.1 Venting.

5-8.1.1 Process equipment shall be a closed system and vented to the outside atmosphere through approved flame arresters installed in accordance with the conditions of approval. The manifolding of vents upstream of the flame arrester is permitted. Vents shall terminate at least 20 ft (6.1 m) above the ground and be so located that vapors will not re-enter the building. Flame arresters shall be protected against freezing and shall be easily accessible for inspection and repair. Flame arresters shall not be located within a building unless permitted by the conditions of approval.

5-8.1.2 Vessels or tanks containing flammable solvents shall be protected with emergency venting to relieve excessive internal pressure in the event of fire. This applies 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 is necessary.

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 2-10.1 shall not be less than that derived from Table 5-1 or Table 5-1(a). (*See Appendix A of NFPA 30, Flammable and Combustible Liquids Code, for background information*)

5-8.1.4 All emergency relief vents shall terminate at least 20 ft (6.1 m) above the ground and 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 Shutoff valves shall not be installed in normal or emergency vent lines.

5-8.1.6 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.

5-8.2 Conveying Systems for Solids.

5-8.2.1 Before entering the process, all solid material shall pass over or through a separator for the removal of tramp metal.

Table 5-1

Total Minimum Emergency Vent Capacity in Cubic Feet Free Air/Hour (14.7 Psia and 60°F) with Approved Automatic Water Spray, Deluge System, or Equivalent

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

Table 5-1(a)

Total Minimum Emergency Vent Capacity in Cubic Meters Free Air/Hour (1 Kg/cm^2 and 15.5°C) with Approved Automatic Water Spray, Deluge System, or Equivalent

Exposed Surface Area* Square Meters	Cubic Meters Hour	Exposed Surface Area* Square Meters	Cubic Meters Hour	Exposed Surface Area* Square Meters	Cubic Meters Hour
2	200	20	1870	90	4380
3	300	24	2070	100	4570
4	400	28	2260	120	4850
5	500	32	2440	140	5120
6	590	36	2610	160	5350
7	690	40	2780	180	5560
8	780	50	3140	200	5760
9	870	60	3480	230	6070
10	970	70	3820	260	6300
12	1160	80	4100	and over	
14	1350				
16	1540				
18	1730				

NOTE. 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 2-10.1, the flow capacities may 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.

5-8.2.2 Pneumatic systems for handling solids may be used when material and air being handled are solvent-free.

5-8.2.3 Seals designed to prevent the escape of solvent or solvent vapors shall be provided at the point where the solids enter the system.

5-8.2.4 Adequate seals shall be used on the final discharge of material from the extraction system.

5-8.2.5 Gaskets, if used in these systems, shall be of a material that will not decompose or soften in the presence of oils, solvent or steam.

5-8.3 Extractors, Desolventizers, Toasters, Driers and Spent Flake Conveyors. Extractors, desolventizers, toasters, driers, and spent flake conveyors shall be of a design which 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 5-8.9.4.*)

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 may 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 gages 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 gages 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 flammable liquid or vapor side.

5-8.8.2 Provision 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:

(a) An automatic emergency gravity water supply tank of sufficient capacity.

(b) A connection to an equally reliable water supply.

(c) 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, other than smothering steam, and shutdown of process equipment other than cooling water to condensers, exhaust fans, and lights. This shall be accomplished through manual operation both near the process equipment and at a safe remote location.

5-8.9.2 Except where hazardous conditions would be created by stopping process equipment, 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 shut-down procedures.

5-8.9.3 Audible or visual alarms or both centrally located 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 alarms, 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 Pneumatic or hydraulic controls and instruments may be used in place of electrical controls.

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 may present a hazard. This may 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 manufacturer's instructions.

Areas where routine sampling has been found desirable include: raw material conveyor, desolventized material conveyor, finished oil or fat containers, waste water discharge, and solvent and miscella pumps.

Chapter 6 Referenced Publications

6-1 The following documents or portions thereof are referenced within this standard and shall be considered part of the requirements of this document. The edition indicated for each reference is the current edition as of the date of the NFPA issuance of this document.

6-1.1 NFPA Publications. National Fire Protection Association, Batterymarch Park, Quincy, MA 02269.

NFPA 10-1988, *Standard for Portable Fire Extinguishers*

NFPA 13-1987, *Standard for the Installation of Sprinkler Systems*

NFPA 15-1985, *Standard for Water Spray Fixed Systems for Fire Protection*

NFPA 16-1986, *Standard on Deluge Foam-Water Sprinkler Systems and Foam-Water Spray Systems*

NFPA 24-1987, *Standard for the Installation of Private Fire Service Mains and Their Appurtenances*

NFPA 30-1987, *Flammable and Combustible Liquids Code*

NFPA 69-1986, *Standard on Explosion Prevention Systems*

NFPA 70-1987, *National Electrical Code*

NFPA 78-1986, *Lightning Protection Code*

NFPA 91-1983, *Standard for the Installation of Blower and Exhaust Systems for Dust, Stock, and Vapor Removal or Conveying*

NFPA 214-1988, *Standard on Water-Cooling Towers*

NFPA 385-1985, *Standard for Tank Vehicles for Flammable and Combustible Liquids*

6-1.2 Other Publication. American Society of Mechanical Engineers, 345 East 47th Street, New York, NY 10017.

ASME Boiler and Pressure Vessel Code, *1980*

Appendix A General Description of Solvent Process

This Appendix is not a part of the requirements of this NFPA document, but is included for information purposes only.

Physical Constants of Extraction Solvents.

The hydrocarbon fractions or petroleum naphthas known as normal hexane and heptane have become the predominent solvents for extraction of vegetable and animal oils and fats, because of their low cost, stability, excellent thermal qualities, and selectivity for oils and fats. Tables A-1 and A-1(a) show the physical properties of n-pentane, n-hexane, and n-heptane. Tables A-2 and A-2(a) show distillation analyses of petroleum naphthas of the n-pentane, n-hexane, and n-heptane types.

One of the most important physical properties of pentane, hexane and heptane fractions, insofar as safety work is concerned, is the high density of the vapors. As shown in Table A-1, the vapor of hexane is 2.975 times as heavy as air and this accounts for the tendency of the vapors to flow across a surface and into low spots and confined areas.

Preparation and Pre-Cooking.

The preparation of oil-bearing materials or solvent extraction varies as to original oil or fat content, physical characteristics of the material, type of extraction system and end products desired. The preparation of dead animal carcasses calls for different preparation techniques than cotton seed, flax seed or soybeans.

Probably the simplest of the preparation techniques would be that of preparing dead animals for fat extraction.

Table A-1

Physical Properties of Units n-Pentane, n-Hexane and n-Heptane US Customary Units

	n-Pentane	n-Hexane	N-Heptane
Flammable limits (percent by vol.)	1.4-7.8	1.2-6.9	1.0-6.0
Ignition temperature °F	500	437	399
Flash Point °F Closed Cup	−40	−15	25
Molecular weight	72.1	86.2	100.2
Melting point	−206°F	−137°F	−130°F
Coefficient of expansion	0.00154	0.00135	0.00122
Boiling point at 14.7 psia	96.9°F	156.1°F	208.0°F
Specific gravity at 60°F	0.631	0.664	0.688
A.P.I. gravity at 60°F	92.7	81.6	74.2
Pounds per gallon at 60°F	5.261	5.536	5.736
Vapor density (air equals 1)	2.49	2.975	3.459
Cubic feet vapor per gallon liquid, 60°F, 14.7 psia	27.5	25.5	20.8
Vapor weight per cu ft (lb at 60°F)	0.191	0.217	0.276
Vapor weight, cu ft per lb at 60°F	5.23	4.61	3.63
Latent heat of vaporization at 760 mm Btu/lb	153.0	143.3	136.8
Heat of combustion, Btu/lb (gross)	21,120	20,970	20,860
Btu per cu ft vapor (gross)	4,016	4,762	5,508
Btu per pound (net)	19,540	19,420	19,340
Vapor pressure at 100°F, psia	15.5	5.0	1.6
Specific heat liquid at 60°F	0.540	0.531	0.530
Specific heat vapor at 60°F	0.409	0.339	0.335
Solubility in water, moles per liter at 60°F	0.005	0.0016	0.0005

Table A-1(a)

Physical Properties of n-Pentane, n-Hexane and n-Heptane International System of Units (*See 1-1.3*)

	n-Pentane	n-Hexane	N-Heptane
Flammable limits (percent by vol.)	1.4-7.8	1.2-6.9	1.0-6.0
Ignition temperature °C	260	223	204
Flash Point °C Closed Cup	−40	−26	−4
Molecular weight	72.1	86.2	100.2
Melting point	−132°C	−93.8	−90
Coefficient of expansion	0.002772	0.00243	0.002196
Boiling point at 1 Kg/cm² ABS	36°C	68.9°C	97.8°C
Specific gravity at 15.5°C	0.631	0.664	0.688
A.P.I. gravity at 15.5°C	92.7	81.6	74.2
Kg per liter at 15.5°C	0.63	0.663	0.687
Vapor density (air equals 1)	2.49	2.975	3.459
Liters vapor per liter liquid at 15.5°C and 1 Kg/cm² ABS	205	190	156
Vapor weight per liter, gm at 15.5°C	3.06	3.48	4.42
Vapor weight, liter per gm at 15.5°C	0.327	0.287	0.226
Latent heat of vaporization at 760 mm Kg cal/Kg	85	79.6	76
Heat of combustion, Kg cal/Kg (gross)	11,734	11,651	11,590
Kg cal per cubic meter vapor (gross)	35,738	42,377	49,016
Kg cal per Kg (net)	10,856	10,790	10,745
Vapor pressure at 37.8°C, mm Hg ABS	801	258	82.7
Specific heat liquid at 15.5°C	0.540	0.531	0.530
Specific heat vapor at 15.5°C	0.409	0.339	0.335
Solubility in water, moles per liter at 15.5°C	0.005	0.0016	0.0005

This can be accomplished by grinding the entire carcass in large grinders which shred the meat and reduce the bones to a consistency that may be handled in the cooker-extractor. After the cooker-extractor is charged with a load of meat, the cooking process is begun and the charge is cooked several hours or until the protein and other coagulable material is set and the moisture content is reduced to a point low enough to allow solvent penetration. After cooking is complete the free grease is usually drained off, the charge is cooled to the proper temperature after which the vessel is charged with the extracting solvent and batch-wise extraction is begun. In some plants the extraction process is accomplished in a separate building.

Table A-2

ASTM Distillation Analysis of Commercial Petroleum Naphthas of the Pentane, Hexane and Heptane Types

Percent Distilled	Pentane	Hexane	Heptane
Initial Boiling Point	88°F	146°F	190°F
5	89	148	194
10	89	148	195
20	89	149	196
30	90	149	197
40	90	149	197
50	90	149	198
60	91	150	199
70	91	150	199
80	92	151	200
90	93	152	202
95	94	153	203
Dry end point	97	156	208

Table A-2(a)

ASTM Distillation Analysis of Commercial Petroleum Naphthas of the Pentane, Hexane and Heptane Types

Percent Distilled	Pentane	Hexane	Heptane
Initial Boiling Point	31.1°C	63.3°C	87.7°C
5	31.7	64.4	90
10	31.7	64.4	90.6
20	31.7	65	91.1
30	32.2	65	91.7
40	32.2	65	91.7
50	32.2	65	92.2
60	32.8	65.5	92.8
70	32.8	65.5	92.8
80	33.3	66.1	93.3
90	33.9	66.7	94.4
95	34.4	67.2	95
Dry end point	36.1	68.9	97.8

The end products of this type of process would be inedible fats for soap stock, fatty acids, etc., and tankage for animal feed mixtures. Where butcher shop meat scrap and other similar material is processed, there may be some variations in technique of grinding, prepressing or cooking but generally the process is the same.

In the above preparation process the meat after cooking may be prepressed in screw presses prior to solvent extraction in which case there would be a secondary phase of preparation to reduce the press cake to a consistency suitable for solvent extraction.

The preparation of soybeans for solvent extraction has, through a process of trial and error, become the most standardized preparation system of all of the oil-bearing seeds. With variation only in the arrangement of components and method of material transport, all soybean preparation techniques are identical. The beans from storage or day run bin are cleaned, cracked, tempered and flaked. Some slight variation from plant to plant may exist as to whether the beans are metered to the process by means of a variable feeder or whether they are fed to the process through a dump scale or through both. Some plants may dehull during preparation; the beans may be cracked in any type cracking mill that will accomplish the proper reduction in particle size. The cracked beans may be tempered in any of the various tempering driers and there are several types and makes of flaking mills. Nevertheless, the four prinicipal steps in the preparation of the soybeans for extraction invariably follow the sequence of cleaning, cracking, tempering and flaking.

There is still some difference of opinion as to the most efficient method of preparing cotton seed and flax seed for extraction. Some processors claim that efficient extraction of cotton seed or flax seed cannot be accomplished without prepressing as a step in preparation, while others hold that prepressing is unnecessary and costly. No doubt this difference of opinion will be resolved as time goes on but for the moment both methods will be considered.

The preparation of cotton seed for extraction under the direct method, that is without prepressing, consists of cleaning, delinting, dehulling, rolling and cooking. Variations in the above sequence of rolling and cooking have been and are still under experiment to determine the correct combination of particle size, cooking time, temperature, moisture content, etc. The toxicity of cotton seed meats due to their gossypol content is a determining factor insofar as the extent and place in sequence of the cooking stage of the process The prepressing by the use of screw presses as a stage of the preparation sequence is in itself a high temperature operation due to the cooking prior to prepressing and the frictional heat generated internally. Moisturizing, granulation and/or flaking usually follow prepressing.

The preparation of flax seed for solvent extraction generally follows that for cotton seed. Oil-bearing seeds such as castor beans, sunflower, safflower, milo, peanuts, copra, tung nuts, etc., will fall within one or the other above methods.

Extraction.

The extraction of animal and vegetable fats by the use of hydrocarbon solvents as practiced today appears rather complex. This, however, is a manifestation of control, safety and automation rather than the basic principle of the extraction itself which is relatively simple. Figure A-1 is a generalized flow diagram of the solvent extraction process.

Despite the seemingly complicated array of equipment there are just three basic functions of an extraction plant, i.e., extraction, desolventizing and distillation.

In the extraction stage the oil is removed from the oil-bearing material but after removal of the oil or fat the material remains saturated with solvent. This is removed by the desolventizer which drives off the solvent by the action of heat from both direct and indirect steam.

The miscella, as oil-bearing solvent is termed, goes to the evaporator or distillation system, as it is sometimes called, where the solvent is driven off the oil by the action of heat, direct steam and vacuum.

The evaporation of solvent from vegetable or animal oil poses little difficulty in as much as the solvent has a relatively low boiling range, approximately 146°F to 156°F (63°C to 69°C) and most oils can withstand temperatures up to 250°F (121°C) for short periods without undergoing discoloration or polymerization. Thus, a wide temperature differential plus the use of stripping steam and

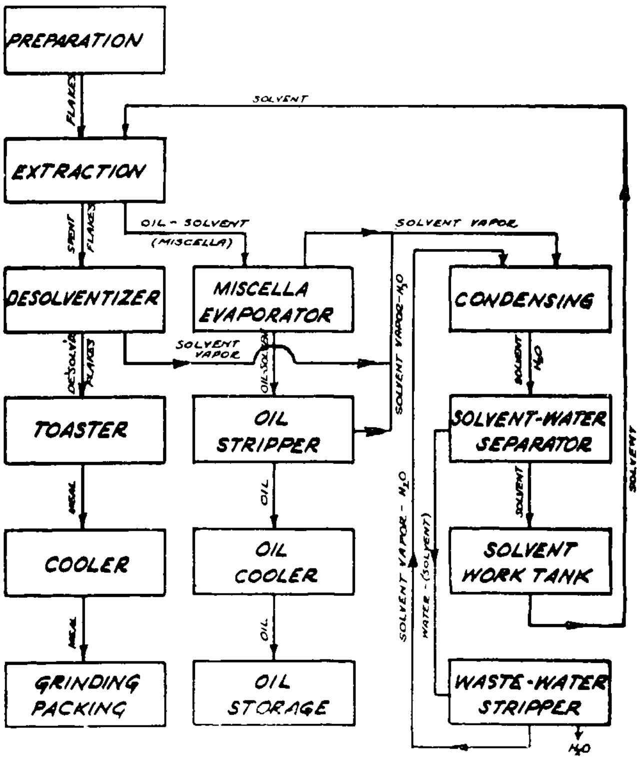


Figure A-1 Generalized Flow Diagram.

high vacuum in the final stage facilitates desolventizing of the oil.

The function of various components of the extraction process is explained in detail under the specific headings that follow.

Basket-type Extractors.

There are several variations of the basket extractor such as vertical, rectangular and horizontal. In this type of extractor the material is carried through the extractor in individually hung perforated or screen bottom baskets. The baskets are pivoted on a longitudinal shaft located near the center of gravity of the basket. The ends of these are affixed in bearings which are part of endless chains. These endless chains run on sprockets at the top and bottom of vertical extractors and at each end of a horizontal extractor (Figure A-2). Tipping of the baskets is prevented by a system of rollers levered to the ends of the basket shafts and running or sliding in guide tracks fastened to the inside of the extractor. At one location during the circuit the baskets are inverted over a discharge hopper where the extracted material falls from the basket. As the basket passes the discharge position it is righted and immediately charged with oil-bearing material. The number of baskets in the extractor is determined by desired throughput and design balance; 25 to 30 baskets would be usual. There are two standard methods of feeding material to these extractors. One type is a double gate volumetric feeder which is timed to the extractor and dumps an even basket load of material as succeeding baskets are positioned under it (Figure A-2). The gates of this type feeder may be either mechanically or hydraulically operated. The other type of charging device is a continuous screw type which feeds a mixture of the oil-bearing material and half miscella (Figure A-3). The extracted material from the discharge hopper is removed by rotary paddle conveyors or a mass flow-type conveyor set in the bottom of the hopper.

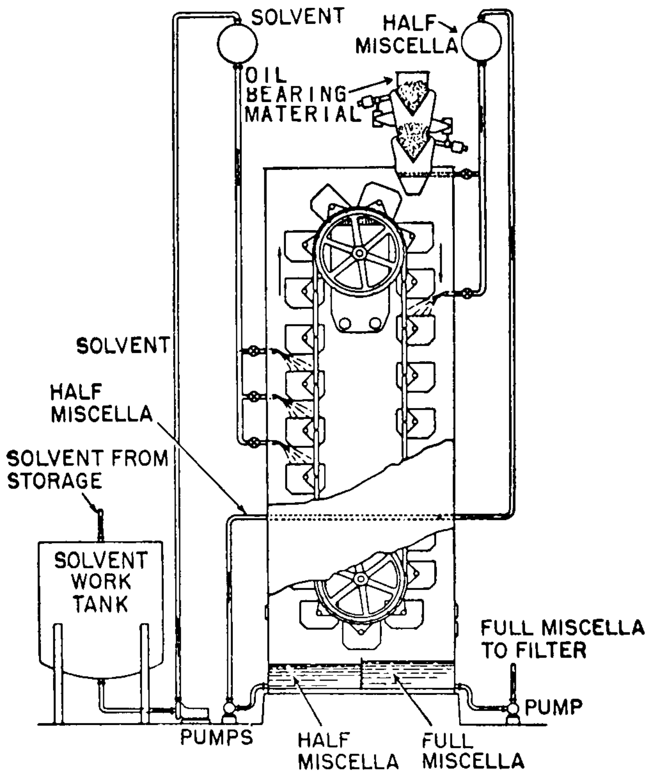


Figure A-2 Vertical Basket Extractor.

Since vertical and rectangular basket extractors have both descending and ascending baskets and the extracting solvent and miscella is all descending, these extractors are known as concurrent countercurrent. The concurrent phase takes place from the time the baskets are charged until they reach the bottom of the extractor. During this phase half miscella from the bottom of the ascending side of the extractor is pumped to a surge tank above the extractor from whence it flows to a basket near the top of the descending side and percolates down through the baskets to the full miscella chamber at the bottom of the descending side (Figure A-2). Raw solvent is sprayed to one or more of the baskets near the top of the ascending side and in true counter flow percolates down through the baskets to the half miscella chamber at the bottom of the ascending side; thus, the cycle of solvent and material is completed.

Rectangular and horizontal basket-type extractors are in principle quite similar to the vertical type with the exception that, where baskets are running horizontally, a series of stage pumps are used to continuously pump the gradient concentrated miscella to spray pipes above the baskets.

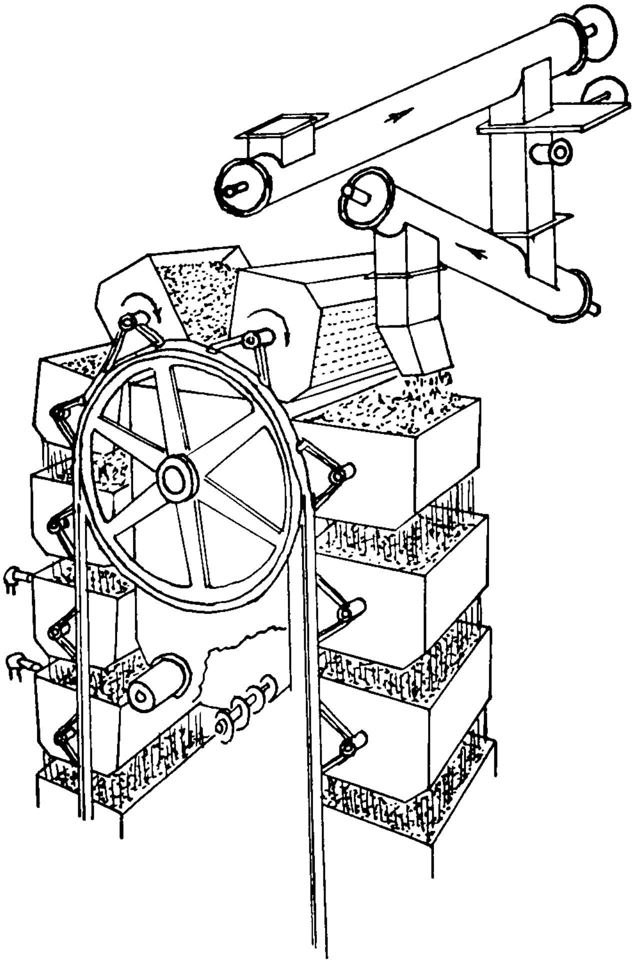


Figure A-3 Feeder and Discharge of Basket Extractor.

Rotary Extractor.

In principle of operation a rotary type of extractor is quite similar to a horizontal basket-type extractor. In construction, however, it is quite different. As Figures A-4 and A-5 show, the rotating element consists of a series of concentrically arranged cells with a hinged perforated bottom in each cell. As each cell successively passes under the intake feeding device, a slurry of oil-bearing material and half miscella fills each cell. The speed of rotation of the cell element and the continuous feed of material are so regulated that each cell is filled to the desired depth during its passage under the feeding device. While the rotating element is completing a revolution, several stage pumps pick up the gradient concentrated miscella from several chambers of drain pans under the cells and spray it back onto the top of the cells. At approximately two-thirds of the distance around from the intake, raw solvent is sprayed to the top of the cells after which the cells are allowed to drain free of excess solvent. After the draining stage the cells pass over a discharge hopper and as each cell is directly over the hopper, the cell bottom is tripped mechanically and the charge of spent material drops into the hopper. Immediately after passing this position the cell bottom is raised back into closed position mechanically and is ready for another charge of material. The spent material is continuously conveyed from the discharge hopper at a rate so regulated that at the time the hopper is empty another charge of spent material drops in.

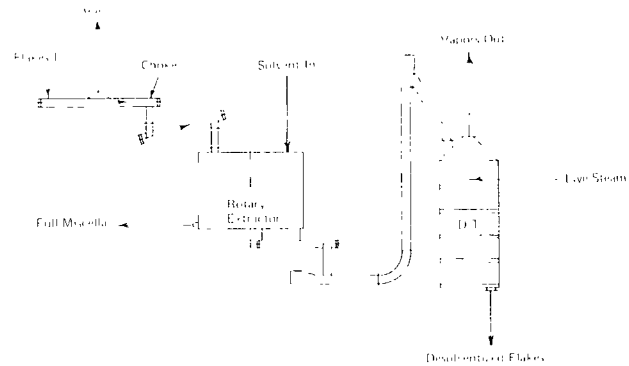


Figure A-4 Rotary System.

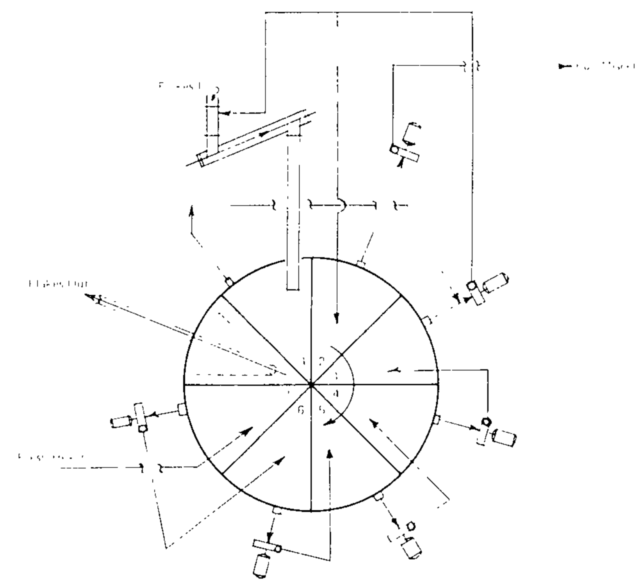


Figure A-5 Rotary Extractor.

Perforated Belt Extractor.

A variation of the horizontal and rotary extractor is a horizontal perforated belt extractor in which the raw material is fed in a uniform depth onto one end of the slowly moving perforated belt and during its travel the length of the extractor, gradient miscella is pumped stagewise in very much the same fashion as the horizontal basket and rotary. Mechanically this extractor is perhaps the simplest of the horizontal types. What has been referred to as a perforated belt is in reality two endless chains running on sprockets at each end of the extractor, and attached to the chains and forming a flat surface are a series of perforated plates. Suitable chambers or pans are arranged the length of the extractor for collection of miscella stagewise. The spent material is continuously discharged off the end of the belt to a hopper, thence, continuously conveyed from the extractor.

Vertical Total Immersion-type Extractor.

This type of extractor has as its basic principle the total immersion of the material in the extracting solvent during the entire extraction phase of the process. In the original U-tube type, total immersion was accomplished by introducing the oil-bearing material into the top of one leg of the U-tube wherein it descended against a counter flow of miscella, passed through the horizontal section at the bottom of the U-tube, thence up the other leg and out the top. The oil-bearing material was conveyed down, across and up by the use of large perforated flight screw conveyors. The raw solvent was introduced at the spent material end of the U-tube and the concentrated miscella was removed through an annular screen near the point where the oil-bearing material was introduced.

In the single tube-type total immersion extractor (Figure A-6), the oil-bearing material is introducted at the top of the extractor a short distance below the level of miscella after which it descends by gravity through a series of equally spaced plates with pie cut openings staggered in such fashion that the material cannot fall directly through the extractor but is retained for a short time on each plate. A slowly rotating sweep on each plate and attached to a central shaft maintains a constant rate of material feed down through the extractor. There are two types of spent material discharge devices in use. In one type the spent material enters heavy screw conveyors which push the material through a short tube and compact it against pressure loaded cones. As material is continuously forced against the plug it continuously feeds past the pressure loaded cone in like amount. In this way a solvent impervious plug is maintained at the base of the extractor. Raw solvent is pumped to the bottom of the extractor and flows upward in counter flow relation to the descending oil-bearing material. The concentrated miscella continuously overflows from a settling chamber at the top of the extractor.

The other type of material discharge consists of a liquid-tight inclined conveyor that picks up the spent material at the base of the extractor and elevates it to a point above the equalized level of liquid in the extractor. A drain screen as part of the inclined elevator drains the excess solvent from the spent material prior to discharge. As in the former type, raw solvent is introduced at the bottom of the extractor and concentrated miscella is removed at the top.

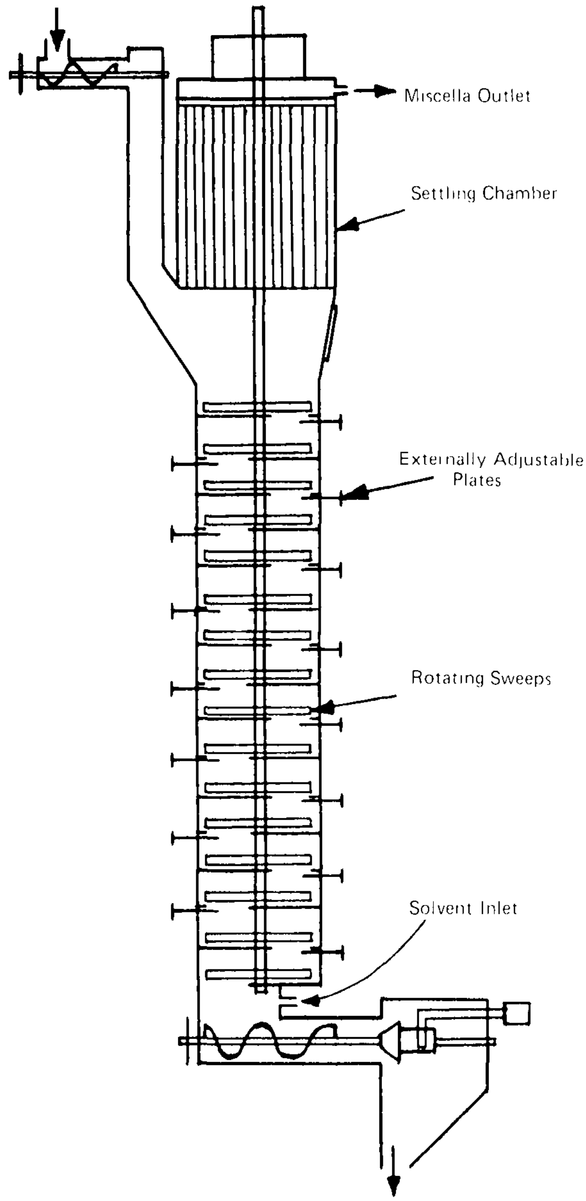


Figure A-6 Vertical Total Immersion Extractor.

Filtration-type Extractor.

Another method is the extraction of specially prepared high or low oil content materials by complete immersion in solvent followed by vacuum filtration (Figure A-7). The extractor is a horizontal, cylindrical vessel, in which a ribbon conveyor slowly rotates. Half miscella and prepared material are continuously fed into the extractor and the ribbon conveyor provides the necessary agitation and conveying to move the slurry through the extractor for continuous discharge to the vacuum filter. Hold-up time in the extractor is sufficient for oil to go into solution with the half miscella. The vacuum filter consists of a slowly rotating, horizontal, perforated and screened disc upon which the slurry is charged. An internal valving arrangement allows complete separation of the several countercurrent wash miscellas employed to remove entrained miscella from the filter cake. The slight vacuum maintained at the underside of the disc increases wash liquid throughput, and after the final oil-free solvent wash, the solvent content of the extracted material is reduced to about one-half that possible with gravity drainage alone. The layer of extracted material is removed continuously from the top surface of the disc by a screw-type conveyor.

Batch-type Extractors.

Generally, batch extractors are confined to the processing of animal fats. Due to the characteristics of the raw material and the necessity for rather prolonged cooking,

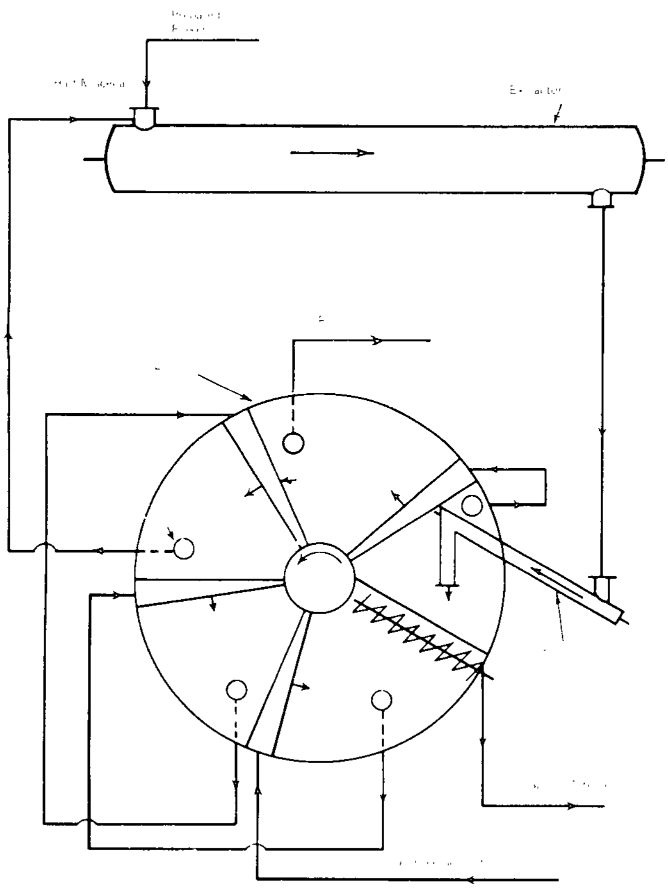


Figure A-7 Filtration-type Extractor.

this type of vessel lends itself efficiently as a combination cooker and extractor. Where expeller cake is extracted batchwise, the material is held up in bins ahead of the extraction in sufficient amounts to compensate for the intermittent charging of the extractor. This type of extractor may be more hazardous than continuous extractors due to the cycling and the greater chance of solvent vapor loss under careless handling.

Probably one of the contributing factors regarding the comparative hazard of some batch extractors against other types has been the practice of installing this equipment in too close proximity to other operations. While this type of extractor is quite simple in construction, at times considerable difficulty is experienced with drain screens, rotary pipe joints, door gaskets, etc. As in the case of all types of extractors, it is during times of operating difficulties that the greatest hazard exists.

Rectangular Loop Extractor.

The same basic extraction principle is used in most modern solvent extractors. The rectangular loop extractor is, however, different from the other designs in overall shape, in the use of an "en-masse" type-conveyor instead of individual baskets, in the use of a stationary, linear, vee-bar screen, and in the use of a liquid cyclone full miscella clarifer rather than a bank of filters or classifier screens.

In a typical oil seed example, flakes enter near the top of the rectangular loop 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 are first washed with half miscella. In the horizontal bottom run of the extractor loop, the flakes are washed with progressively less concentrated miscellas. As they travel up the vertical part of the loop, they are subjected to a fully countercurrent wash of miscella coming down the loop. On the sloping top run of the extractor, they are washed with fresh solvent, allowed to drain, and are discharged continuously from the chain near the top of the machine. The chain proceeds to the inlet hopper where it is refilled.

The chain is open at the top, bottom, and sides and is partly open along the line of travel. This allows free loading and emptying of material, and the free passage of solvent through the material as it is turned over several times during its wash cycle. The flaked material is in sliding contact with the stationary bar screens, providing a continuous cleaning action.

The chain speed is automatically controlled by the level of flakes in the inlet hopper; this allows the machine to absorb any reasonable surges from the preparation area, to maintain a uniformly filled chain, and to maintain an effective barrier against hexane vapor escape at the inlet. The level of flakes in the hopper is measured by a nuclear sensor which controls the infinitely variable-speed drive.

The full miscella is partly clarified of fines during its last recycle through the flake-bed. The last traces of flakes or fines are removed centrifugally in the liquid cyclone; the fines are redistributed evenly on the surface of the flake bed below the cyclone, and the clarified miscella is ready for evaporation.

Distillation.

The distillation system of a solvent extraction plant refers to the means of evaporating and stripping the solvent from the oil. There are numerous devices and methods for accomplishing this from the early pot-type stills to the currently popular constant level recirculation type, primary evaporation with high vacuum final stripping stage. A few of the pot- and pan-type evaporators are still in use but by far the bulk of the current processing is being done in the newer-type installations. Some of the pan-type evaporators were arranged as a series of stages, the miscella flowing by gravity from one stage to the next. Each stage accomplished a further evaporation of solvent and higher concentration of oil. From the last stage of this type system the oil with a slight amount of solvent left in was pumped or drawn to the stripping column which may have been of the bubble cap, sieve plate or packed tower type, operated with or without vacuum.

Some plants use the long-tube rising film evaporator with or without recirculation. The recirculating-type evaporator with constant level control and automatic temperature control provides some increased safety. The choice of oil stripper is determined by design balance with the other components of the distillation system, desired throughput rate, material being processed, etc.

Some of the types in use are packed towers, bubble cap, sieve plate and disc and donut towers. The packed and bubble cap towers have a disadvantage in that they may foul up with certain components and contaminants in the oil due to the high temperature at this phase of the pro-

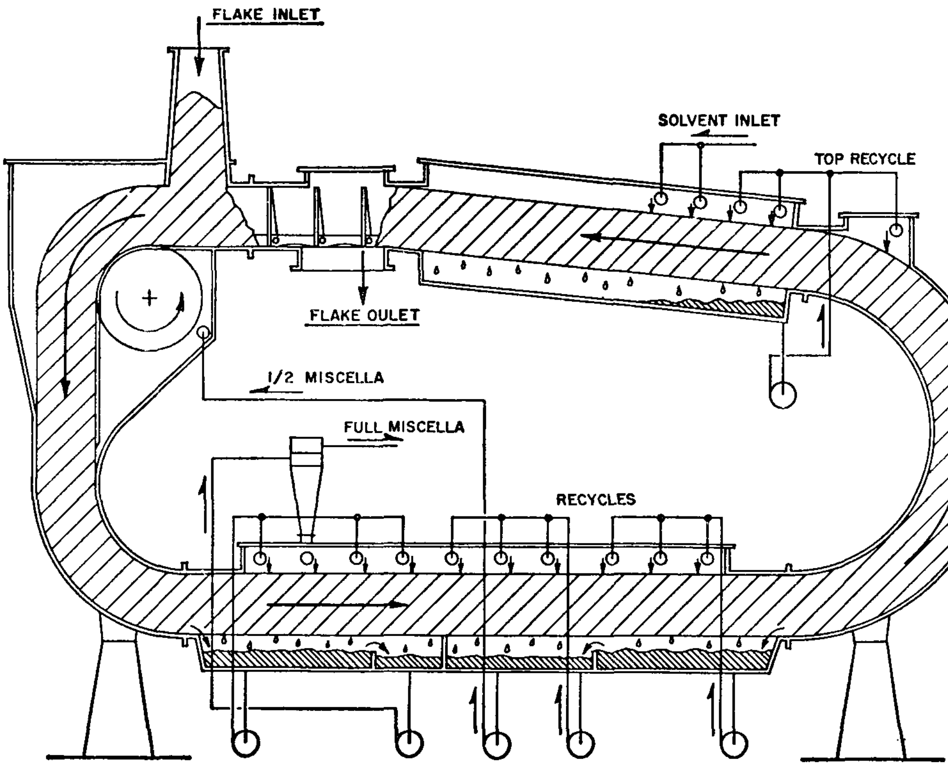


Figure A-8 Rectangular Loop Extractor.

cess. It is generally thought that this carbonized material which builds up on the film surfaces of the stripper is caused partially by phosphatides and a trace of meal fines in the oil. The sieve plate and disc and donut towers are the least subject to the above fouling. Any of the above types must for highest efficiency be operated under a vacuum of 22 to 28 in. (570 to 710 mm) of mercury.

The function of all stripping columns is contingent on spreading the oil to be stripped in a very thin film over a large surface area with a relatively high velocity of dry steam passing over the film. A counterflow relation of the above 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 stripping steam which is introduced at the bottom. The mixture of steam and solvent vapor passes from the top of the tower to the stripper condenser from whence the condensate is pumped to the solvent water separator. Solvent flows from the separator to the work tank and water flows from the separator to the waste water evaporator. The finished oil is usually pumped away from the vacuum stripping column by a rotary-type positive displacement pump.

Desolventizing.

The desolventizing of extracted material, or spent material as it is usually referred to, is accomplished in several ways. In the batch-type extractors the single vessel may serve as pre-cooking, extraction and desolventizing. After the last wash of solvent is drained from the batch extractor the jacket steam is turned on and by the action of indirect and direct steam plus the tumbling action of the material in the vessel, the solvent is driven from the material to a suitable condenser.

Where desolventizing takes place in other than the extracting vessel, the spent material may be desolventized by passing it through a series of jacketed tubes with a longitudinal rotating member inside consisting of a shaft with attached paddles or ribbon flights for both lifting and progression of the spent material. These tubes are usually stacked one above the other and the material after passing through a tube drops by gravity to the next lower tube. Vapor ducts attached to the ends of the tubes conduct the solvent vapor to a suitable vapor scrubbing and condenser system. The desolventized material is discharged from the bottom tube through a vapor seal such as a rotary- or plug-type seal.

Another type of desolventizer is the recycled vapor-type which consists of a single vessel of cylindrical shape with a rotating element which tumbles and progesses the spent material from the intake end to the discharge end. The vessel is steam jacketed and part of the solvent vapor that is driven off the material is superheated and passed directly back to the vessel. Since the evaporation of solvent tends to depress the temperature of the material being desolventized, or in other words has a refrigerating effect, the superheated vapors returned to the desolventizer aid in overcoming the above effect and allow a considerably higher desolventizing efficiency.

The advance in desolventizers, and certainly significant from a fire protection standpoint, is the use of a single vessel for desolventizing and toasting with the complete elimination of intermediate vapor seals, conveyors, etc. This desolventizer-toaster, or simply D-T as it is usually referred to, permits these two important steps in processing to be accomplished by a minimum of moving machinery and maximum safety against loss of vapors since at least half of the kettles of the D-T are loaded with desolventized material, at all times offering a very effective seal against fluctuating vapor pressures or any other sudden change in plant performance. The D-T consists of individual kettles stacked one above the other, the intermediate joints being gasketed vaportight. There is a series of kettles making up the combination desolventizer and toaster. Each kettle contains a layer of spent material from 1 to 2 ft (30 to 60 cm) in depth and the feeding of material from one kettle to the next lower is accomplished by an automatic gate mechanism or by spout. The kettles are steam jacketed and in operation steam is also sparged directly to the material. The top kettle is ducked to a suitable vapor scrubber and condenser.

Condensing Systems.

The condensing of solvent vapors and steam in extraction plants is accomplished by the use of more or less standardized-type condensers. These are usually of shell- and tube-type construction consisting of an outer shell with an internal tube bundle. The tubes are usually of brass, bronze or stainless steel and in most plants the water is passed through the tubes and the solvent vapor and steam to be condensed around the tubes and within the shell. There has been a tendency in recent years to do the condensing for the entire plant in one or two large condensers rather than placing a condenser at each stage requiring one. This is accomplished by regrouping the principal components of the plant into an arrangement that permits very short vapor ducts and a minimum of piping. The cold water for condensing may be from deep wells, cooling towers, spray ponds or any source where the water is cool enough to operate the condensers efficiently and clean enough to prevent fouling of the condenser tubes. Solvent vapor from the spent material desolventizer is usually passed though a vapor scrubber to prevent fouling of the condenser. The vapors may be scrubbed with either hot water or solvent. The recent trend has been to solvent scrubbing since by this method the fines scrubbed from the vapor are passed back to the desolventizer, whereas with a hot water scrubbing system the waste water containing the fines must be disposed of, which presents a problem in certain localities.

Vent Vapor Recovery Systems.

It is standard practice in solvent extraction plants to vent each piece of processing equipment to a common vent line. Then from this common vent pipe the vent gases are passed through any one of several types of recovery systems. Some of the smaller plants simply run the vent gases through a condenser, thence to atmosphere. Where the extraction plant is running well within its rated capacity and with adequate cold water for condensing, the vapor pressure of the vent will be practically zero and the vent losses would be negligible. Where there is a slight vent pressure and the vent gas temperature is somewhat higher than the atmospheric temperature, considerable loss of solvent will occur and even in the case of using a simple condenser in the vent system, some loss will still be sustained. All of the modern extraction plants use, in conjunction with the vent condenser, a refrigerated final vent condenser, a mineral oil absorption system or an activated carbon recovery system. By today's standards of efficiency the solvent losses in a well-designed extraction plant will not exceed one-half of one percent and may average considerably less than that. This is the total solvent loss in weight against the total weight of raw material processed. Twenty pounds (10 kg) of solvent used per ton (metric ton) of material processed would be referred to as one percent solvent loss.

Waste Water Evaporator.

Waste water that is continuously removed from the solvent-water separator passes to a vessel where steam is introduced to raise the water temperature to at least 185 °F (85 °C). Often the steam from the vacuum ejector of the final still is used for this purpose.

In plants where hot water is used for vapor scrubbing, the heated waste water is usually used. The solvent stripped waste water is continuously decanted from the stripper vessel and flows to the outdoor separation sump.

Toasting.

Many extracted oil seed products require toasting or cooking in order to modify the protein and other constituents for nutrition purposes. The action of moisture and heat in the toaster also agglomerates the very fine particles of material into a more or less granular form, thus reducing the dust problem in subsequent stages of cooling and milling.

Previous to the inception of the combination desolventizer-toaster, the toasting was carried out as a separate stage of the process. Often the material was conveyed from the desolventizer in the extraction building to the toaster outside of the extracton plant or in another building. Several of this type are in operation today. Toasters currently in use are the rotating drum-type, vertical stacked cookers, jacketed stationary drum-type with internal agitator with or without internal pressure and the toasting section of the combination desolventizer-toaster which is essentially a stacked cooker. The function of all toasters is contingent on holding the material for a length of time at a temperature of 225 °F (107 °C) and moisture at approximately 20 percent and under continual agitation. The length of time the material is held under the above conditions determines the degree of cooking or toasting. An approximate figure would be 45 minutes to one hour.

Appendix B Operational Practices

This Appendix is not a part of the requirements of this NFPA document, but is included for information purposes only.

Reports.

The foreman on each shift should keep a log of operations and abnormal conditions.

Visitors.

Since visitors are not always familiar with the hazards inherent to the operation of a solvent extraction plant, it is most important that they be properly informed of the safety regulations in force. Only those visitors approved by an individual in responsible charge should be permitted to enter the plant operating area.

All visitors should apply at the designated place for permission to enter, at which time they must leave all lighters, matches and smoking materials outside the fenced area. Visitors should be conducted by a plant employee. Visitors should not be permitted in the plant at any time when dangerous concentrations of vapors are present, and should a dangerous concentration occur during the time of the visit, guides should escort visitors as soon as possible to a safe location. A written record should be kept of all visitors entering the plant.

Safety Work Permit.

Where repair work is required in a restricted area by plant or outside personnel, a work permit authorized by the individual in responsible charge should be issued after inspection is made to assure safe procedures for the work specified. This permit should be restricted as to date and time for each specified job with additional copies as needed.

Preventive Maintenance.

In most plants a plan of regular scheduled shutdowns is followed. During these periods the repair work which cannot be done safely or effectively while the plant is operating and unpurged is undertaken. This affords an excellent opportunity for detailed inspection of the equipment in order to detect and correct conditions which may be the cause of unnecessary hazards developing and untimely and costly interruptions in plant operation.

WORK PERMIT

To: .... **Department** ....

For: (a) All repair work done by outside departments.
(b) Hot Work-Welding (gas or electric), burning or any work requiring heat, flame, or electric current.
(c) Entering a vessel.

Good For: Date .... **Time** .... **A.M. / P.M.**

To Date .... **Time** .... **A.M. / P.M.**

Area ....

Describe work to be done ....

....

....

....

NOTE Write in yes or no If question does not apply, check it off indicating that it has been given consideration

1. Have connections been blinded off? ....
2. Have valves been tagged and/or locked closed? ....
3. Have switches been tagged open? ....
   (Safety locks on push buttons not sufficient)
4. Has equipment and all attached piping been cleaned? ....
   With: Water .... Steam .... Inert Gas ....
5. Has equipment been ventilated? ....
6. Have trenches and sewer openings been covered and steam turned on? ....
7. Has gas test been made? ....
8. Is adjacent equipment safe? ....
9. Can sparks ignite material in vicinity or on lower floors or levels? ......
10. Have all process materials (solids, liquids, gases) been removed from the equipment? ....
11. Can this work be done other than by the use of flame? ....
12. Can the equipment be removed from the building? ....

NOTE Equipment or material to be removed for repair or disposal must be passed by Department Supervisor as free from dangerous material.

Are there any special precautions to be observed?

....

....

....

....

....

....

....

....

....

OPERATING SUPERINTENDENT **SAFETY FIRE INSPECTOR**

....

MAINTENANCE FOREMAN

To Worker

Appendix C Referenced Publications

C-1 The following documents or portions thereof are referenced within this standard for informational purposes only and thus are not considered part of the requirements of this document. The edition indicated for each reference is the current edition as of the date of the NFPA issuance of this document.

C-1.1 NFPA Publications. National Fire Protection Association, Batterymarch Park, Quincy, MA 02269.

NFPA 11-1988, *Standard for Low Expansion Foam and Combined Agent Systems*

NFPA 14-1986, *Standard for the Installation of Standpipe and Hose Systems*

NFPA 61B-1980, *Standard for the Prevention of Fires and Explosions in Grain Elevators and Facilities Handling Bulk Raw Agricultural Commodities*

NFPA 61C-1984, *Standard for the Prevention of Fire and Dust Explosions in Feed Mills*

NFPA 68-1988, *Guide for Venting of Deflagrations*

NFPA 77-1988, *Recommended Practice on Static Electricity*

NFPA 101® -1988, *Life Safety Code®*

NFPA 327-1987, *Standard Procedures for Cleaning or Safeguarding Small Tanks and Containers*

NFPA 704-1985, *Standard System for the Identification of the Fire Hazards of Materials*

C-1.2 Other Publications. American National Standards Institute, 1430 Broadway, New York, NY 10018.

ANSI A13.1-1975, *Scheme for the Identification of Piping Systems*

ANSI B36.10-1979, *Welded and Seamless Wrought Steel Pipe*