# Suggestions for the Fire Protection of

# LACQUER MANUFACTURING PLANTS

*Prepared by N.F.P.A. Committee on Manufacturing Hazards*

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**National Fire Protection Association**
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# National Fire Protection Association

INTERNATIONAL

Executive Office: 60 Batterymarch St., Boston, Mass.

The National Fire Protection Association was organized in 1896 to promote the science and improve the methods of fire protection and prevention, to obtain and circulate information on these subjects and to secure the cooperation of its members in establishing proper safeguards against loss of life and property by fire. Its membership includes over a hundred national and regional societies and associations and some four thousand individuals, corporations, and organizations.

Membership in the National Fire Protection Association is open to any Society, Corporation, Firm or Individual interested in the protection of life or property against loss by fire. All the valuable engineering and popular literature issued by the Association is sent, as issued, to every member. The Association is the clearing house for all the authoritative information on fire protection and prevention and members are privileged to submit to it their individual problems for solution. The Association is always glad to send samples of its publications to prospective members.

This pamphlet is one of a large number of publications on fire safety issued by the Association. The standard regulations, prepared by the technical committees of the National Fire Protection Association and adopted in the conventions of the Association, are intended to prescribe reasonable measures for minimizing fire losses. All interests concerned have opportunity through the National Fire Protection Association to participate in the development of the standards and to secure impartial consideration of matters affecting them.

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This pamphlet presents Suggestions for the Fire Protection of Lacquer Manufacturing Plants which were first submitted at the 1937 annual meeting (Proceedings 1937, page 351) and finally adopted at the 1938 annual meeting (Proceedings 1938, page 387).

### Committee on Manufacturing Hazards.

BENJAMIN RICHARDS, *Chairman,*
Underwriters Service Association.

R. E. ABBOTT,
Member at Large, General Motors Co.
H. M. CARMICHAEL,
Oil Insurance Association.
C. G. DURFEE,
Chemical Fire Extinguisher Association.
HENRY A. FISKE,
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R. W. WETHERBEE,
Factory Insurance Association.

## Suggestions for the Fire Protection of

# LACQUER MANUFACTURING PLANTS.

And applicable in part to paint and other like manufacturing.

### 1. Construction.

(a) The manufacture of lacquer involves unavoidable and severe fire hazards. For this reason the concentration of large values subject to one fire loss and a total interruption of the business by fire should be avoided.

(b) Preferably, the hazardous manufacturing should be conducted in one story, detached buildings or in one story buildings divided into relatively small areas by fire walls.

Bearing walls of buildings should be of masonry but the frame of the building should be of reinforced concrete members or insulated steel with a light incombustible roof which could be blown off readily by an explosion or if lost by fire would not involve much expense or time to replace. Shafting, sprinkler and other pipe systems and all such things should be hung from the steel or concrete frame of the building independently of the roof so that all equipment may remain intact in case of explosion. If roofs and upper floors are or must be of heavy construction specially designed explosion windows and vents should be provided and all structural steel insulated. In all cases special windows to care for explosions are recommended.

(c) The walls, except fire walls, may be of light material built in between the supporting members of the main frame but such light walls should only be used where the buildings do not expose other buildings and values nearby. If walls are of masonry they should be equipped with explosion type windows hung on pivots without latches so that in case of explosion internal pressures may be relieved.

(d) Internal partitions should be incombustible and preferably of such construction as to have a fire classification of two hours, based on the Standard Fire Test Specifications.

(e) There should be no basements or other space under the first floor as it is almost impossible to keep heavy flammable vapors out of such low places. The first floor should be about 18 in. above the grade to permit water and vapor drainage even though there may be snow on the ground.

(f) All stairways and elevators should be enclosed by fire-resistive partitions, as per paragraph (d), and have approved fire doors.

(g) Reasonable regard to safety requires more liberal exits than for ordinary occupancies. Each manufacturing room should have two or more safe exits, well separated, one of which must be directly to the outside. Access to all exits must be kept clear. Door fastenings should have safety releases.

### 2. Drains and Vents.

(a) In constructing the building permanent means for natural ventilation should be provided even though artificial ventilation is necessary and floors should be equipped to drain off heavy vapors and water applied in case of fire. Floor drains and vents may consist of scuppers placed at frequent intervals through the walls. The ordinary scupper with an iron cover is not satisfactory as scuppers should be left open for vapor drainage. Long, narrow scuppers at the floor level, tapering to a moderate sized outlet will take care

of a considerable amount of water and provide vapor drainage and if left open will not materially interfere with heating the rooms.

Vapor drainage pipes consisting of ¾ or 1 in. pipes placed at the floor level 8 or 10 ft. apart and passing through the walls, slanting downward so that the outer end is lower than the inside end, are valuable to drain heavy vapors off the floor. Inside drains properly screened and leading to other drain outlets, are also valuable but these should terminate where the solvents and vapors will not present a hazard to life or property.

(b) There should also be vents at the eaves and in the roof and at the ceilings of all rooms that hot air containing flammable vapors and light vapors may pass out at the top. With vents at both the top and bottom of the room, as outlined, good circulation is practically assured and the collection of stratified vapors, which always presents a danger, can be thereby largely avoided. To avoid direct drafts from outside louvers may be used.

(c) It may be assumed that in case of fire quantities of flammable liquids may be washed out of the building by water from sprinklers and hose streams and there should be gutters or dikes around the building to prevent the spread of such burning material and to confine such fire so that it may be extinguished with foam hose streams. Where possible such drains and diked areas should drain away to some safe place.

### 3. Heating and Ventilation.

(a) For general safety a fan ventilating system is probably essential although not necessarily so in a properly constructed and well ventilated building of small area. So far as possible flammable vapors should be drawn into the ventilating system at the source where they are produced, which can be done by having inlets to the ventilating system carried down to the level of all churn and mixer openings, open containers of flammables, etc., but in addition means should always be provided to take air from both the floor level and the ceiling level as outlined for natural ventilation. Possibly one of the safest ways to ventilate is to force air from outside under slight pressure into the room in a uniform way to get even distribution effecting a change of air and driving vapors out through floor and ceiling openings provided for the natural ventilation. Such a system can be easily combined with the heating system. When drawing out flammable vapors they usually follow a fixed path to the inlets of the ventilating system while with the pressure system outlined there will be no such fixed paths and all the air can be more readily changed and vapors thoroughly exhausted. In such a system and in any system means must be provided for heating the air for the comfort of the employees in winter. Powerful fans and excessive drafts should be avoided. A gentle and uniform flow of air provides better and safer ventilation.

(b) As humidification seems essential for safety under such a manufacturing hazard the heating and ventilating system should be provided with means for humidifying the air to maintain a relative humidity of over 50%. (60% at least is recommended.) Static electricity is thereby largely avoided and the fire hazard materially decreased. As is well known, the application of humidity also saves in heating costs as comfort can be maintained at lower temperatures. Modern, combined heating and air humidifying systems should be used but vapor laden air should not be recirculated in such systems. Ordinary steam jets or water atomizers may be used if better means are not available.

(c) Heating should be by a hot air system from a detached or entirely cut off heating plant but steam or hot water heating is acceptable. Heating pipes and unit heaters should be overhead.

(d) All heating, ventilating and exhaust systems should be installed in accordance with the N.F.P.A. Rules. (See pamphlets "Blower and Exhaust Systems for Dust Stock and Vapor Removal", and "Air Conditioning, Warm Air Heating, Air Cooling and Ventilating Systems".)

(e) It is recommended that the use of gas indicators be considered especially where hazards are severe or extensive. These devices may be of the fixed or portable type and are used to detect the presence of explosive and dangerous vapor mixtures. The fixed type may be arranged to give an automatic alarm.

**4. Occupancy.**

(a) Research laboratories, offices, storage areas, etc. should not be in the same building with lacquer manufacturing or if in the same building should be in a cut-off section. The practice of locating such laboratories in the upper story of a lacquer manufacturing building is bad as experience shows that even fireproof buildings are destroyed. It is unwise to "put all the eggs in one basket" so to speak, where in case of fire laboratory apparatus, formulas and records will be lost, embarrassing the continuance of production. Safety to life also calls for such separation.

(b) Congestion should be avoided in laying out a lacquer manufacturing room for ordinary or large scale production. The room should be confined strictly to that class of work. All flammable liquids should be handled by pumps in closed piping with the discharge piping from finishing mixers led to a separate cut-off filling room where the shipping containers are filled. Such a manufacturing room should not be endangered by mixing small batches in open containers. Where the sales call for such products a small separate building or cut-off room should be provided for such small scale mixing that the entire production may not be subject to loss from such dangerous processes. However, there is no reason why such a small batch mixing room could not be arranged with closed containers, everything being the same as the large mixing room except on a smaller scale.

(c) So far as possible all processes involving the use of flammable materials should be conducted in closed apparatus, containers, and strong, well supported piping.

**5. Grounding.** (See also Art. 7 j.)

All metal parts of the building, all machinery and metal equipment such as electric conduit, sprinkler system, etc. should be thoroughly grounded by good sized copper wires securely fastened in, care being taken that thorough grounds are secured. Ordinary piping cannot be depended upon for perfect grounding as oily threaded joints do not insure a proper ground. Grounding should also include protection of all outside above ground tanks containing flammable liquids. Grounds should be carefully maintained.

**6. Electric Equipment.**

(a) The entire electric equipment should be installed in accordance with the National Electrical Code and for Class 1 Hazardous Locations, which calls for equipment of types approved for use in explosive atmospheres, in such part of the plant as such hazardous areas may be defined.

(b) Portable lamps should be avoided but if used should have approved extension cords permanently connected or provided with approved explosion-

proof plug connections, and the lamps should have wire guards and be of the explosion-proof type. A special lamp mounted entirely in soft rubber is particularly well adapted for use in lacquer factories.

(c) Stacks, chimneys and all buildings should be protected by approved lightning rods.

### 7. Safeguards for Machinery and Processes.

(a) As the principal hazard involves the use of flammable liquids their storage and handling should be strictly in accordance with local ordinances and established standards. (See N.F.P.A. Suggested Ordinance Regulating the Use, Handling, Storage and Sale of Flammable Liquids.)

Such liquids should be stored in underground tanks where possible or, if necessary, in above ground tanks especially guarded and diked. Methods of handling by pumps or otherwise should be strictly standard.

(b) There appears to be no particular economic reason for using, as raw stock, film scrap or other scrap nitro-cellulose. Nitro-cellulose should be purchased in solution or if absolutely necessary in sealed drums with 30% moisture content (alcohol). A separate well detached building with masonry walls should be used for its storage. Such building should have a light roof which could be replaced at small cost in case of fire. There appears to be no occasion for lighting or other electric equipment in such a building. If lights are necessary flood lighting from the outside through the windows could be arranged.

If a manufacturer finds that he must "cut" old film or other waste stock, such work should be conducted in a well detached building of little value and with adequate special protection.

(c) Pebble Mills. If air pressure is used to exhaust the contents of pebble mills, excessive air pressure should be avoided by providing a relief valve at the air pump or air pressure storage tank. This relief valve should be set at not exceeding 10 lbs. and locked by padlock in this position. As low a pressure as possible should be used. When the air pipe lines are long and complicated with valves other supplementary air relief valves should be placed on the piping. One plant observed had a separate locked air relief valve where each air hose left the piping for connection to the pebble mills and these small relief valves were adjusted and locked for three pounds pressure. In making hose connections from the fixed piping to the pebble mills special hose, reinforced by wire, should be used not only for reliability but to help provide an electrical ground from the pebble mills to the air piping. Shut-off valves should be placed back of each air hose connection. Where possible inert gas should be used instead of air pressure to exhaust pebble mills. The use of air pressure for this purpose is not recommended.

(d) Churns and Mixers. There should be no open churns or mixers. All should be provided with permanent, well fitting covers. If the covers are large there should be supplementary small non-ferrous covers for hand holes where samples of the contents and examination of the mixing can be procured, or preferably some permanent, tight fitting sampling rod should be provided to avoid opening the mixers. All solvents should be placed in mixers through permanent piping and pumps. All pipes entering churns and mixers should extend to their bottoms and be permanently grounded to the churn or mixer. There are ample means available for accurately measuring the contents that the correct proportions may be obtained. Devices for measuring by gallons or by weight are on the market so there is no occasion for using open containers for solvents. The use of such open containers has been the most prolific source of fire and the loss of life. There should be no

gravity feed of solvents or pigment mixtures from galleries or upper floors. Experience has shown that when there have been explosions in churns or mixers the explosion has passed upward through such gravity feed pipes resulting in the explosion of the tanks above and fire in the rooms above. In no case should nitro-cellulose mixers be fed by gravity to churns or mixers.

(e) Only one barrel of nitro-cotton should be brought in at one time. The contents should be removed by using a bronze tool and passed directly into a pipe leading to the cutting tank which pipe should be immediately plugged after using. The plug should be of non-ferrous metal to avoid sparks and should be held in place securely. If the contents of one drum of nitro-cotton is not sufficient the first empty drum should be immediately removed from the premises before the next drum is brought in, the pipe opening to the mixer being plugged meanwhile. Even though this might add a little to the cost of operation it seems to be essential for safety. All nitro-cotton that may have been spilled on the floor or elsewhere should be immediately swept up and all nitro-cotton dust avoided.

(f) When cleaning churns and mixers with the covers open they should be filled with $CO_2$ gas or the vapors thoroughly pumped out before operations start. It is a serious risk to the life of a man to allow him to go inside a large mixer that contains hazardous vapors. Sometimes steam may be used. $CO_2$ is obtainable from "dry ice" for this purpose as well as from the usual containers. Tests of vapor contents and $CO_2$ should be made and gas masks used where necessary. After the $CO_2$ gas is used care should be taken to replace enough of it by fresh air if men are to work inside the tank.

(g) CLARIFIERS. Clarifiers frequently start fires on account of accumulations around the center of their rapidly revolving parts. A liberal outlet to prevent such clogging is necessary. Sometimes, as built by the manufacturers, such outlet is not adequate for certain classes of work. Frequent cleaning is also essential.

(h) CLEANING TANKS. All cleaning should be conducted by the soda or other non-hazardous process where possible. If solvents must be used for cleaning the cleaning vats should be protected by standard automatic covers or automatic foam or $CO_2$ gas extinguishing systems. Obviously the cleaning process should be conducted in a separate building or a separate cut-off fire section. (See N.F.P.A. Regulations for Dip Tanks.)

(i) MILLS (Banbury type, etc.). The amount of nitro-cellulose used in these should be kept to a small quantity not exceeding 20 lbs. to a batch. The mill should be located in a detached building or in a well cut-off small section with no other occupancy. An automatic sprinkler placed immediately over the mill will usually provide sufficient protection to keep it cool and prevent its damage if the nitro-cellulose being used is ignited. No nitro-cellulose stock should be permitted in the room except that actually being worked upon.

(j) GROUNDING. (See also Art. 5.) A liberal supply of well made lengths of grounding wires two to four feet long should be kept on hand and all employees should be required to use them. Whenever any connection is made where flammable liquids are drawn from churns, mixers, clarifiers or other containers into another container the two should be connected by these ground wires. The wires may be bare or insulated, of the heavy flexible type and should terminate in toothed battery type clips to make such grounding effective. Discharge valves on containers should be equipped with metallic flexible hose of such length as to rest on the bottom of the receiving container. A concrete floor is not a ground so a grounded brass or

bronze plate connected to the churns, separators, etc. should be installed upon which all trucks, tanks, etc. may be placed to receive flammable liquids. All trucks should have non-ferrous castors or wheels to avoid production of sparks. All tools used should be made of non-ferrous metals, these to include all scrapers, rakes, wrenches, etc. Preferably brass or white metal plugs should be provided for all metal shipping barrels and other such containers.

The shoes worn by employees should have brass nails in the heels and soles or be of the safety type shoe built especially for the purpose. Rubber heels and soles, and steel nails in shoes should be prohibited.

It should be recognized that some types of employee are particularly likely to retain static charges until they accumulate enough to produce sparks when they touch metals. There are known cases where a series of fires was entirely stopped by changing employees.

Belt Grounding. Belts should be avoided but if they must be used their speed should be limited to not over 150 ft. per minute. Direct drives or chain drives or gears running in graphite lubricants should be substituted for belts. Where belts must be used they should be grounded by using toothed "combs," properly grounded, to collect the static. These should be located as near the pulleys as possible and on the side of the part of the belt leaving the pulley.

A specially prepared belt dressing may be used to reduce static. Rubber belts should be avoided but where used they may be guarded by applying a dressing made of 82% spar varnish and 18% lamp black, but the solvent used should contain not less than 45% carbon tetrachloride to avoid flammable vapors when applying. This mixture is not satisfactory for leather belts but these can be fairly well guarded by using the following dressing:

100 c.c. liquid fish glue
80 c.c. glycerine
100 c.c. sulphonated castor oil
170 c.c. water
82 grams lamp black
20 c.c. of 2% ammonium hydroxide

The amount of fish glue and glycerine may be varied as may be necessary to meet conditions. This mixture can be applied by a brush when the belt is in motion.

Conductivity of Liquids. Some flammable liquids are not so "dry" as others so their liability to the production of "static" varies. Gasoline, naphtha, benzol, ether, carbon disulphide, ethyl acetate, and amyl acetate are poor electric conductors and so, when handled, will accumulate dangerous charges. Acetone, the alcohols and glycerine have sufficient conductivity in themselves to carry off charges if a ground is provided.

(k) Open Containers. If open containers must be used in mixing rooms they should be kept covered so far as possible. Covers should be provided to fit around the shafts of mixers, and containers being transported from one place to another should be immediately covered. The elevating of open containers on elevators, by block and tackle or any other such lifts or the supporting of such containers on barrels and other such careless practices should be absolutely prohibited. In small mixing rooms where the elevation of a container for filling shipping containers is thought to be essential portable elevators may be used. By proper lay-out of the processes this bad practice can be entirely eliminated. By using portable pumps and properly locating the can filling tanks, this defect may be corrected.

(1) Cookers. Cookers for synthetic resins and other such materials should not be heated by open flame. The Merrill or other such hot oil process should be used, all installed and located in an approved manner. Where gas or oil burners must be accepted oil and gas supplies should be arranged to be automatically shut off in case of fire by the use of sensitive heat operated devices placed on the ceiling of the room. This process should be in a separate building or cut off with a blank fire wall from other areas. Cookers and their stacks should be built for maximum safety with overflow vents terminating in a safe place.

**8. Storage.**

(a) Dry Colors. Dry colors may represent considerable value and are subject to heavy water damage and some may ignite spontaneously, especially if they get wet. The main supply of dry colors should be stored in a separate stock room, bringing into the work room such colors as are desired in small containers. A conveyor system might facilitate such dispensation. Certain inorganic colors may need special attention and separation from organic colors.

The shipping containers used by dry color manufacturers are notoriously poor. Most of them are second hand and practically none are water tight. Purchasers of dry colors should insist that they be shipped in metal barrels or cans with tight replaceable covers. Otherwise users of these colors should transfer them, when received, into such containers. Waterproof blankets should be spread over all poor dry color containers.

(b) Storage of Finished Product. Obviously finished products ready for shipment should be transferred immediately to a separate building or a separate cut-off fire section that this stock may not be lost in case of fire in the manufacturing departments. Such protection seems obvious to avoid unnecessary interruption of the business and unnecessary loss. Such storage should be confined to sealed containers. Shelving should be non-combustible and of an open or slatted type.

(c) Nitro-Cellulose, Pyroxylin or Soluble Cotton Storage. Store houses for such raw stocks should be well detached and specially designed and protected. (See N.F.P.A. Regulations for Storage, Handling and Use of Pyroxlin Plastics.) These storage buildings may be made fairly safe if protected with a standard deluge type sprinkler system, but sprinklers for such a severe hazard should be spaced not to exceed 20 sq. ft. per sprinkler, or possibly more closely under some conditions. (See special rules for such protection.)

Pyroxylin, in plastic form, pyroxlin cotton and pyroxylin scrap shall be stored only in tight substantial steel containers conforming to the I. C. C. standard. Opened containers should be avoided but if present should be kept covered, care being taken not to let exposed pyroxylin stock become dry.

Such storage should preferably be in the open at least 50 ft. from exposed property. If storage is inside, containers shall be stored on end preferably in a single tier but in no case over two tiers high. Windows should be painted or otherwise darkened to prevent the direct rays of the sun on the stock.

Pyroxylin scrap should preferably be in isolated storage vaults of standard construction. (See N.F.P.A. Regulations for Pyroxylin Plastics.)

(d) Storage of Solvents. Solvents should be stored, preferably in underground tanks, but in all cases in accordance with the standard requirements. (See N.F.P.A. suggested ordinance for Flammable Liquids.)

## 9. Fire Protection.

(a) All areas should be protected by a standard wet pipe automatic sprinkler system or a standard pre-action sprinkler system, but sprinklers should be spaced more closely than usual and pipe sizes enlarged according to the severity of the hazard. There should not be much over 100 sprinklers on any one valve. Such a sprinkler system should be supplemented by a deluge sprinkler system over the more severe hazards such as where nitrocellulose stock used, mixers and churns, etc. It is thought that although solvents and other such light flammable materials may not be saved in case of fire a liberal supply of water from sprinklers will save the building and all the machinery and equipment. Some sprinklers on a pre-action system may be left open over the severest hazards instead of providing a separate deluge system.

Where possible the sprinkler piping should be hung from structural members other than the roof so that it may remain intact in case of an explosion. Pipe hangers should be of the type to prevent the pipes from rising.

Where sprinklers are provided it may be assumed in case of fire, that flammable liquids will float and spread fire to wherever the water flows. Provision should be made for this hazard.

A special automatic sprinkler system, using fine spray, high pressure nozzles seems especially applicable to lacquer manufacturing fires as such a system gives the necessary extinguishing effect without using an excess of water.

(b) A foam generator should be provided on the premises with water hydrants by which it may be operated and necessary hose, nozzles, etc. with a liberal supply of foam powder kept on hand. (See Regulations for Foam Extinguisher Systems.) Such an equipment is valuable in fighting tank fires and indoor fires in flammable liquids. Also when burning solvents and such things are washed out of the building the fire outside may be promptly extinguished by foam. This necessarily calls for a trained, private fire brigade at each plant.

(c) Churns, mixers, solvent tanks, fixed open containers, etc. can be protected by automatic $CO_2$ gas or foam extinguisher systems which are highly recommended. Where a good supply of inert gas, such as from a large boiler plant, is available many processes can be permanently protected by the use of such gas. The equipment should be installed in accordance with the standard rules. (See Regulations for Carbon Dioxide and Foam Fire Extinguishing Systems.)

(d) For first aid fire equipment a good supply of large $CO_2$ gas or foam extinguishers should be provided, as well as the ordinary soda acid and carbon tetrachloride type. $CO_2$ and the carbon tetrachloride are particularly desirable for electric equipment although they are good for other hazards also. Foam and $CO_2$ hand hose and standpipe systems are economical as one battery of $CO_2$ gas tanks or foam engines can be installed in a safe place and piped to the different hose stations desired in the building. Standard remote control may be provided for releasing the extinguishing agents that the hose may be promptly used.

(e) Outside solvent tanks should be protected with hand operated or automatic water spray nozzles, especially where exposed to fire from nearby buildings or other tanks. These spray nozzles are of the atomizer type such as used in condensing systems and adequately protect such tanks by keeping them cool throughout a fire. Obviously an adequate water supply is necessary.