

# Steel Structures Painting Council

## PAINT APPLICATION GUIDE NO. 3

### A Guide to Safety in Paint Application

## 1. Scope

1.1 All necessary precautions should be taken to protect personnel and property from accidents due to falls, fumes, fire, explosion, or other dangers. Recommendations made herein are not all-inclusive and do not supplant or replace other measures covering unusual conditions. They are not intended to conflict with or supersede any federal, state, or local statute or regulation or the controls listed in Section 2.

1.2 This guide defines methods and practices which are most practical in maintaining safety during application of protective coatings on steel structures. Complete coverage of all aspects is not presented. The objective of this guide is to itemize basic actions and care that should be considered while working in or on access facilities, using professional tools to apply materials having potential hazards.

1.3 All personnel involved in the application of protective coatings should be aware constantly of the several hazards with regard to access facilities, specialized tools, and toxic or flammable materials. Many workers have some knowledge of one or two of these categories, but each should be advised of all precautions necessary and trained to prevent or eliminate dangerous conditions in all three areas.

1.4 Areas not included herein which appear in other SSPC documents:

- safety in surface preparation;
- pretreatment methods;
- removal of existent coatings;
- specialized areas of coil and appliance ceramics, container high bake coatings, and powder coatings; and
- paint manufacturing plants.

## 2. Regulating Controls

2.1 Federal laws should govern all works. Most of these are defined in the rulings of OSHA.

2.2 State safety requirements should exert control in relevant areas whenever federal law does not cover projects.

2.3 Municipal or township ordinances should be followed whenever specific rulings impose restrictions beyond the federal and state controls.

2.4 Safety practice and rulings may come from area labor groups. Such should control actions for improved personnel relations.

2.5 Some contract specifications may contain requirements for safe methods of practice for specific areas.

2.6 Rules of safety by individual contractors should be adhered to since such are based on previous experiences.

2.7 All safety instructions received from the paint manufacturer should be followed.

2.8 Safe storage regulations should control all work regardless of source: civil law, contractor rule, labor rule, designer specifications.

## 3. References

3.1 National Safety Council, 425 North Michigan Avenue, Chicago, IL 60611.

- Industrial Data Sheet No. 296, Bridge Painting
- Accident Prevention Manual for Industrial Operations, International Book Number 0-87912-024-X.
- Pamphlets, data sheets, instruction cards relevant to paint.

3.2 Occupational Safety and Health Administration (OSHA) Standards, Superintendent of Documents; U.S. Government Printing- Office, Washington DC 20402.

- 29 CFR 1910 Occupational Safety and Health Standards (General)
- 29 CFR 1910-94 Ventilation

3.3 American National Standards Institute (ANSI), 1430 Broadway, New York, NY 10018.

- ANSI A14.1 Safety Code for Wood Ladders
- ANSI A14.2 Safety Code for Metal Ladders
- ANSI Z87.1 Industrial Eye Protection
- ANSI Z88.2 Respiratory Protection
- ANSI Z9.3 Design, Construction, and Ventilation of Spray Finishing Operations

3.4 Hazardous Substance Guide for Construction, Associated General Contractors of America, 1957 E. St., NW, Washington, DC, 20006-5199.

**3.5 National Fire Protection Association Guide on Hazardous Materials**, P.O. Box 9101, Batterymarch Park, Quincy, MA 02269-9101.

**3.6 Chemical Manufacturers Association, Safety Guide SG10**, 2501 M St. NW, Washington, DC 20037.

**3.7 Industrial Ventilation—A Manual of Recommended Practice**, American Conference of Governmental Industrial Hygienists (ACGIH) 1980, 6500 Glenway Avenue, Bldg. D-7, Cincinnati, OH 45211.

**3.8 International Brotherhood of Painters and Allied Trades, AFL-CIO "Play It Safe," United Unions Building**, 1750 New York Avenue, NW, Washington, DC 20006.

**3.9 Threshold Limit Values for Chemical Substances in Workroom Air**, Adopted by ACGIH, 6500 Glenway Avenue, Bldg. D-7, Cincinnati, OH 45211.

**3.10 Federal Specification BB-A-1034.**

## 4. Definitions

**4.1 Personnel** includes all people who may have reason to spend time on the jobsite. All classes of painters, helpers, foremen, inspectors, managers, and owners of items involved should be considered.

**4.2 Coating** includes all liquid materials which may be applied to any surface for purposes of protection or decoration of that surface. Application may be with brush, roller, air gun, airless gun, trowel, and hand mitten.

**4.3 Solvents** are those liquids which dissolve coatings and reduce their viscosity to that suitable for application. They have a wide range of both volatility and flammability and evaporate from the applied film to leave the solids base for protection and decoration of the substrate.

**4.4 Access means** include all staging scaffolds, ladders, ropes, and other equipment to be used to place paint and painter in position for applications.

**4.5 Preventives** include both equipment and actions which may in any way increase a margin of safety for all persons at the jobsite during any phase of the operation.

## 5. Coatings

**5.1 HANDLING COATING MATERIALS:** Coatings materials should be stored in safe, well ventilated areas where sparks, flames, and the direct rays of the sun can be avoided. Containers should be kept tightly sealed until ready for use. Warning tags should be placed on toxic materials.

Recommended safety rules for *mixing operations* include the following:

- Use eye protection (goggles, etc.).
- Use protective gloves.
- Keep the face and head away from the mixing container.

- Use protective face cream.
- Avoid splash and spillage, and inhalation of vapors.
- Mix all materials in well ventilated areas away from sparks and flames.
- Use low-speed mechanical mixers.
- Clean up spillage immediately.
- Avoid excessive temperatures.

Protective devices and equipment required for application of coatings materials are determined by the type of coating as well as by the environment. The coatings manufacturers should provide Material Safety Data Sheets on each product. Unless definite information regarding explosion and toxicity hazards inherent in the material are provided by the manufacturer, a written request for such data should be made before starting the coatings application. Records of previous applications using similar materials also should be examined.

**5.2 HEALTH HAZARDS OF COATING MATERIALS:** A coating material may be considered a health hazard when its properties are such that it can either directly or indirectly cause injury or incapacitation, either temporary or permanent, from exposure by contact, inhalation, or ingestion. (Refer to Threshold Limit Values for Chemical Substances in Workroom Air.)

Degrees of health hazard are ranked according to the probable severity of injury or incapacitation, as follows:

**5.2.1** Materials which, on very short exposure, could cause death or major residual injury even though prompt medical treatment was given. Types of these materials are:

- Materials which can penetrate ordinary rubber protective clothing
- Materials which, under normal conditions, give off gases which are extremely toxic or corrosive through inhalation or through contact with or absorption through the skin

**5.2.2** Materials, which on short exposure, could cause serious temporary or residual injury even though prompt medical treatment was given. Types of these materials are:

- Materials giving off highly toxic combustion products
- Materials corrosive to living tissue or toxic by skin absorption

**5.2.3** Materials which, on intense or continued exposure, could cause temporary incapacitation or possible residual injury unless prompt medical attention is given. Types of these materials are:

- Materials giving off toxic combustion products
- Materials giving off highly irritating combustion products
- Materials which, under either normal conditions or fire conditions, give off toxic vapors lacking warning properties

**5.2.4** Materials which, on exposure, can cause irritation but only minor residual injury even if no treatment is given. Types of these materials are:

- Materials which, under fire conditions, give off irritating combustion products
- Materials which cause irritation to the skin without destruction of tissue

**5.2.5** Materials which, on exposure to fire conditions, offer no hazard beyond that of ordinary combustible material.

**5.3 FLAMMABILITY HAZARDS OF COATINGS MATERIALS:** A coating material may be considered a flammability hazard when it will burn under normal conditions.

Virtually all solvent solution coatings are highly flammable in liquid form, and vapors released in the process of application are explosive in nature if concentrated in sufficient volume in closed or restricted areas. Even vapors from ordinary enamels and oil paints may be accumulated in such density as to result in explosive reaction if a source of ignition is present. Generally speaking, however, solvents used in solvent solution coatings are more volatile and dangerous than those used in conventional paints or coatings.

Degrees of hazard are ranked according to the susceptibility of materials to burning, as follows:

**5.3.1** Materials which will rapidly or completely vaporize at atmospheric pressure and normal ambient temperature, which are readily dispersed in air, and which will burn. Types of these materials are:

- Any liquid which is liquid under pressure and having a vapor pressure greater than 14.7 psig (101 kPa) at 38 °C (100 °F)
- Materials which may form explosive mixtures in air, such as mists of flammable or combustible liquid droplets

**5.3.2** Materials that can be ignited under almost all ambient temperature conditions. These materials produce hazardous atmospheres with air under all ambient temperatures and are readily ignited. Types of these materials are:

- Materials having a flash point of 38 °C (100 °F) or below and having a vapor pressure not greater than 14.7 psig (101 kPa) at 38 °C (100 °F)
- Materials which ignite spontaneously when exposed to air

**5.3.3** Materials that should be moderately heated or exposed to relatively high ambient temperature before ignition can occur. Materials of this type are those having a flash point above 38 °C (100 °F) but not greater than 93 °C (200 °F).

**5.3.4** Materials that should be preheated before ignition can occur. These materials are those that will support combustion for five minutes or less at 815 °C (1,500 °F).

**5.3.5** Non-combustible materials.

**5.4 TOXICITY OF COATING MATERIALS:** Some of the pigments used in organic coating materials are toxic. Lead compounds and chromates are particularly dangerous, whether ingested or inhaled. Some paint additives, such as the mercurial compounds used to impart fungicidal properties, may be toxic if ingested.

The epoxies used in epoxy coatings and compounds are particularly irritating to the skin, and some persons are seriously affected by allergic reactions if proper hygiene is not practiced. Common reactions include swelling around the eyes or lips, rashes of the skin, etc. Some epoxy coatings have polyamides as curing agents that react much like a mild acid on tender mucous membranes.

The following basic safety precautions should govern the use of ALL coatings:

- Know the material with which you are working.
- Read and follow the precautions on the label.
- Always provide adequate ventilation (OSHA Standard 29 CFP 1910.94).
- Guard against fire, flames, and sparks, and do not smoke while working.
- Avoid breathing of vapors or spray mist.
- Use protective skin cream and other protective equipment.
- Avoid ingestion of toxic materials.
- Wash hands carefully before eating or smoking.
- Change clothing that has soaked up toxic materials.
- Practice good personal hygiene.

## 6. Solvents

**6.1** A wide variety of solvents are used in the formulation of modern coatings. Many of these solvents are highly flammable and must be handled with extreme care. In addition, these solvents are toxic to varying degrees and may cause serious effects to those working with them. Excessive breathing of concentrated solvent vapors may cause dizziness or nausea, excessive drying or irritation of the mucous membranes, and in rare cases, allergic reactions to the skin.

**6.2** Even common solvents that are ordinarily considered innocuous may be harmful if inhaled in high concentrations or for prolonged periods. For example, turpentine can cause narcotic poisoning and kidney damage when excessive amounts are inhaled. Systemic damage may also result from an acute dose (sufficient to produce unconsciousness), or from repeated excessive inhalation of such common solvents as acetate esters, alcohols, or ketones. Solvents such as toluene, xylene, ethyl ether, cyclohexanone, butyl alcohol, and the nitroparaffins have a relatively low chronic toxicity, but their narcotic effect in high concentrations can lead to unconsciousness followed by respiratory failure and death unless the victim is promptly restored to fresh air. Even the least toxic of the common paint and lacquer solvents can be dangerous in very high concentrations because of their narcotic effect, excepting the alcohols which are irritants (to the eyes and upper respiratory tract) rather than toxicants.

**6.3** Some common solvents usually not used directly in paints but often encountered in paint removers and cleaning liquids are dangerously toxic even at relatively low concentration; for example, methyl alcohol when inhaled or ingested repeatedly or to the point of unconsciousness may cause death

or permanent blindness. Benzene is a dangerous, cumulative poison that causes severe damage to the liver and blood-forming tissues of the body. Many chlorinated solvents, particularly chlorinated aliphatic hydrocarbons, are toxic; chloroform, for example, has poisonous after-effects, while carbon tetrachloride and seldom used tetrachloroethane are dangerously toxic with severe chronic, cumulative effects on the kidneys, liver, and lungs. Since solvent-type paint removers frequently contain highly toxic solvents, they should be used only with adequate ventilation controls and/or respiratory protection.

**6.4** The toxic systemic effects of organic solvents can be produced by absorption through the skin as well as by inhalation. Acute or chronic dermatitis or systemic poisoning may result from repeated or prolonged contact of toxic solvents with the skin. Sometimes, the vehicle resin itself may be irritating or toxic to the skin while the resin is in the uncured state. The catalysts or hardening agents (e.g., organic amines) used in two-component coating systems are frequently volatile and toxic materials until they have been incorporated into the resin.

**6.5** Avoid unnecessary or prolonged contact with the skin; the use of protective clothing and skin creams can eliminate the need for scrubbing the skin with toxic solvents. If the maximum allowable concentration of solvent in the air is exceeded, then fresh air masks should be supplied for the workmen.

## 7. Airless Sprayers

**7.1** As far as practicable, the recommended safety precautions of the National Safety Council as published in their Industrial Data Sheet No. D-296, "Bridge Painting" should be followed, particularly when working outdoors or on elevated structures.

**7.2** Particular care should be exercised when working in closed spaces, especially when spraying.

- Equipment and work should be grounded.
- Use only nonsparking tools.
- Keep matches, smokes, and open flame away from the area.

**7.3** Airless guns of the type which atomize paints and fluids at high pressure — 1,000 pounds or more to the square inch (6900 kPa)—should be equipped with automatic or visible manual safety devices which cannot permit the operator to pull the trigger and release the fluid until the safety is manually released.

If the gun has no safety control, it should have a diffuser nut which will prevent high velocity release while the nozzle tip is removed, plus a nozzle tip guard which will prevent the tip from coming into contact with the operator.

**7.4** In airless spraying, an unpressurized reservoir is used, as pressure is applied only to the paint in the pump, line, and spray gun. This type of spray represents a hazard of hypodermic injection of paint into persons who accidentally contact the stream.

The extremely high fluid pressure developed in airless spray painting equipment causes a powerful stream of paint to be discharged for some distance. THIS PRESSURE REMAINS IN THE SYSTEM EVEN THOUGH THE PUMP HAS BEEN SHUT OFF AND CAN BE RELIEVED ONLY BY BEING DISCHARGED THROUGH THE GUN.

The pressure is also dangerous when the nozzle has been removed. Some equipment is provided with a device that will prevent a hypodermic stream whenever the tip has been removed and the trigger squeezed.

Extreme care should be taken when pressure is being relieved from the system, and manufacturer's recommendations should be followed.

**7.5 SAFE OPERATING PRACTICES:** If safe operating practices are followed, reasonable care exercised by the operator, and equipment maintained in good order, the airless spray painting method is as safe as conventional methods. The following precautions should be part of every operator's training and should be strictly observed and rigidly enforced:

**7.5.1** Check all hose connections and fittings to ensure that they are tight and not leaking. The fluid hose should be designed to withstand the high pressure to which it is subjected. The hose, gun, and pressure vessel should be equipped with special fittings not interchangeable with low pressure fittings.

**7.5.2** Check the fluid hose to be sure that there are no weak or worn spots. Make certain the hose does not contact moving parts of machinery, or lie over and around sharp edges and corners, or come near objects that would damage it. Check for deterioration due to the exposure to chemicals or ordinary wear and tear. High pressure leaks from the hose or from the connections can cause hypodermic injections just as the gun tip can.

**7.5.3** Do not disconnect the gun from the fluid hose or the hose from the pump until the pressure has been released from the hose. This is accomplished by first closing off the main line air pressure to the pump and then bleeding off the pressure in the fluid hose by triggering the gun.

**7.5.4** When handling the gun but not actually spraying — for example, while changing piece parts or work position — hold the gun by the grip and remove the fingers from the trigger.

**7.5.5 NEVER POINT AN AIRLESS GUN AT ANY PART OF THE HUMAN BODY — YOUR OWN OR ANYONE ELSE'S!**

**7.5.6** Airless spray guns cannot be cleaned with the same methods used for conventional air-operated guns. It is hard to force waste material out of the gun except through its head, and material released at such high pressures can be driven into the fingers or hand if they are held over the spray cap or head of the gun.

**7.5.7** The gun should have a guard which completely protects the trigger. When the gun is under pressure but not being used, the safety latch should be kept in the non-operating position.

7.5.8 If production rates or paint usage rates are to be increased, or solvent changes made, existing controls should be reviewed to maintain safe conditions.

**7.6 RULES FOR SAFETY WITH PRESSURIZED EQUIPMENT:** The following safety rules apply to conventional and airless spray equipment, sandblasting equipment, and water blasting equipment that operate under pressure.

7.6.1 Use only pressure equipment that has been constructed as specified by the National Board Code and the ASME Code for Unfired Pressure Vessels.

7.6.2 Test safety relief valves used on pressure equipment daily.

7.6.3 Use remote control deadman valves with pressure equipment. Be sure that the deadman valves are a pneumatic type that use the same air for activation that is used for blasting or spraying.

## 8. Ladders

### 8.1 GENERAL SAFETY RULES:

8.1.1 See that all ladders conform to ANSI A14.1, "Ladders - Portable Wood - Safety Requirements" and ANSI A14.2, "Portable Metal Ladders."

8.1.2 Inspect ladders frequently. Look for loose steps or rungs; loose screws, bolts, metal braces, and rods; split or broken side rails or rungs; and loose or bent hinge spreaders.

8.1.3 When ladders are found to be lacking in any safety device or to be defective in any manner, they should not be used. Ladders found to be too defective for repairs should be destroyed.

8.1.4 Protect ladders with clear protective coatings so that cracks, splinters, or breaks will be readily visible.

8.1.5 Store ladders in a warm, dry place protected from contact with the ground.

8.1.6 Equip all straight and extension ladders with safety shoes, unless special conditions prohibit their use.

8.1.7 Do not use portable ladders greater than 60 feet in height. If greater heights are to be reached, provide intermediate landing platforms and use separate ladders.

8.1.8 Single ladders not constructed for use as sectional ladders should not be spliced together to form a longer ladder.

8.1.9 Extension ladders should not be taken apart in order to use either section separately.

8.1.10 Extension ladders should have a minimum of 15% overlapping of each section.

8.1.11 Ladders made by fastening cleats across a single rail should not be used.

8.1.12 Do not use stepladders over 20 feet in height.

8.1.13 Never use a stepladder as a straight ladder.

8.1.14 Never use the platform of a stepladder as a top step on which to stand.

8.1.15 In placing portable ladders, be sure that the horizontal distance from the top support to the foot of the ladder is one quarter of the working length of the ladder.

8.1.16 Straight and extension ladders should be "tied-off" when in use. A helper should hold the ladder while it is being tied or untied at the top.

8.1.17 When it is necessary to place a ladder over a doorway, the doorway should be roped off and signs should be erected to warn users of the door of the ladder's presence.

8.1.18 Ladders should never be used as skids, braces, scaffold members, or for any other purpose than that for which they are intended.

8.1.19 DO NOT USE METAL LADDERS OR STAGES IN AREAS WHERE CONTACT WITH ELECTRIC POWER LINES IS POSSIBLE.

8.1.20 Use hand lines, not ladders, to raise or lower materials and tools.

8.1.21 Do not reach too far in any direction while working from a ladder. Frequent changes in a ladder's position can forestall accidents from this source.

8.1.22 Always face the ladder when ascending or descending.

8.2 All ladders should be supported so that they are level at the base and given sufficient bearing so that they cannot sink into the supporting surface. Both hands should be free when climbing ladders. It is preferable that the hands hold the sides of the ladder, rather than the rungs, when going up or down.

8.3 The following table is the minimum for the construction of wood ladders.

TABLE 1  
DIMENSIONS FOR WOOD LADDERS

Cross- Section Length in feet	Inside Width in Inches		Uprights	Cleats
	Bottom	Top		
10 to 12	20	17	2" x 4"	7/8" x 3"
12 to 16	21	18	2" x 4"	7/8" x 3"
16 to 20	23	20	2" x 6"	7/8" x 3"

8.4 The following table is the minimum for the construction of a double wood ladder. Double ladders over 24 feet in length should not be used.

**TABLE 2**  
**DIMENSIONS FOR DOUBLE WOOD LADDERS**

Inside Wide Left Side	Right Side	Cross-Section Uprights	Cleats
18"	18"	2" x 4" (to 12 ft) 2" x 6" (12-24 ft)	1" x 3"

## 9. Scaffolding

**9.1** Scaffolds should be provided for all work that cannot be done from the ground or from solid construction, except such work as can be done safely from ladders.

**9.1.1** Scaffolds, platforms, runways, etc., should be kept free from loose sand, mud, grease, or other materials, any one of which could cause slipping, tripping, or overloading.

**9.1.2** Stairs, ladders, or other safe means of access should be provided to all work areas. The use of cross members or framework as a means of access to working areas should not be permitted.

**9.1.3** All rolling scaffolds should be equipped with a positive locking device to prevent accidental movement of the scaffold.

**9.1.4** The sections of metal scaffolds should be securely connected together using the regular patented and manufactured connections. Improvised connections, such as a turn or two of rope, should not be permitted.

**9.1.5** Runways, ramps, platforms, and scaffolds over six feet in height should be effectively guarded by the careful and workmanlike installation of guard or hand rails of 36 inches to 42 inches from the deck, with an intermediate rail and toe boards, not less than six inches in height, or side screens, as necessary, to protect workmen or property below from falling objects.

**9.1.6** All metal ladders, scaffolds, towers, and similar equipment should be erected in accordance with manufacturer's specifications and load limits should not be exceeded.

**9.1.7** Discarded packing boxes, barrels, piles of loose lumber, or other makeshift or "jury" rigging, should not be used for scaffolds or as supports.

### 9.2 GENERAL SAFETY RULES FOR SCAFFOLDING:

**9.2.1** Inspect all equipment before using. Never use equipment that is damaged or deteriorated in any way, especially rusted.

**9.2.2** Inspect erected scaffolding regularly to make sure it is maintained in safe conditions. Consult the scaffolding supplier when in doubt.

**9.2.3** Provide adequate sills for scaffold posts and use baseplates.

**9.2.4** Plumb and level all scaffolds as the erection proceeds. Use adjusting screws instead of wood blocks to adjust for uneven grade conditions. Do not force braces to fit—level the scaffold until proper fit can be made easily.

**9.2.5** Fasten all braces securely. Do not climb across braces.

**9.2.6** On wall scaffolds, place and maintain anchors securely between structure and scaffold at least every 30 feet of length and 25 feet of height.

**9.2.7** When scaffolds are to be partially or fully enclosed, specific precautions should be taken to assure the frequency and adequacy of ties attaching the scaffolding to the building. This is because of increased load conditions resulting from wind and weather. The scaffolding components to which the ties are attached also should be checked for additional loads.

**9.2.8** Freestanding scaffold towers should be protected against tipping by guying or other means.

**9.2.9** Equip all planked or staged areas with proper guard rails and add toeboards as required.

**9.2.10** Use of metal scaffolds near electric power lines is dangerous.

**9.2.11** Never use ladders or other makeshift rigs on top of scaffolds to increase the height.

**9.2.12** Do not overload scaffolds.

**9.2.13** All brackets should be seated correctly with side brackets parallel to the frames and end brackets at 90 degrees to the frames. Brackets should not be bent or twisted from normal position.

### 9.3 FOR ROLLING SCAFFOLDS, THE FOLLOWING ADDITIONAL RULES APPLY:

**9.3.1** Do not ride on rolling scaffolds.

**9.3.2** Remove all material and equipment from the platform before moving the scaffold.

**9.3.3** Caster brakes should be set at all times when scaffolds are in a fixed position. Casters with plain stems should be attached to the panel or adjustment screw by pins or other suitable means.

**9.3.4** Do not attempt to move a rolling scaffold without sufficient help. Watch out for holes in the floor or overhead obstructions.

**9.3.5** Do not extend adjusting screws on rolling scaffolds more than 12 inches.

**9.3.6** Use horizontal diagonal bracing near the bottom and at 20-foot intervals upward from the rolling surface.

### 9.4 WHEN PUTLOGS AND TRUSSES ARE USED, THE FOLLOWING ADDITIONAL RULES APPLY:

**9.4.1** Do not cantilever or extend putlog-trusses as side brackets without thorough consideration for the load to be supplied.

**9.4.2** Putlog-trusses should extend at least six inches beyond the point of support.

**9.4.3** Place proper bracing between putlog-trusses when the span of the truss is more than 12 inches.

## 9.5 FOR METAL SCAFFOLDING, THE FOLLOWING RULES APPLY:

**9.5.1** Provide adequate sills or underpinnings on all scaffolds to be erected on filled or otherwise soft ground.

**9.5.2** Compensate for unevenness of ground by using adjusting screws where blocking is not practical.

**9.5.3** Be sure that scaffolds are plumb and level at all times.

**9.5.4** Anchor running scaffolds to wall approximately every 28 feet of length and 18 feet of height. Use additional care when using pulley arms.

**9.5.5** Do not force braces to fit. Adjust levels of scaffolding until the proper fit can be made with ease.

**9.5.6** Horizontal diagonal bracing should be used to prevent racking of all scaffolds at bottom and intermediate levels of 30 feet.

**9.5.7** Handrailing should be provided on all scaffolds regardless of height.

**9.5.8** Erect the scaffold in such a manner that a ladder is accessible and is lined up from top to bottom.

## 9.6 FOR WOOD SCAFFOLDING, THE FOLLOWING ADDITIONAL RULES APPLY:

**9.6.1** A good rule of thumb for the use of wood scaffolding is that first of all it should be erected by professionals qualified to do so and who know the safety factors involved.

**9.6.2** All scaffolding lumber and planks should be thoroughly inspected before using. The pieces should be sound, straight, and free of large knots. Never use even slightly damaged materials.

**9.6.3** Decking should be at least two planks wide. A back rail, intermediate rail and toeboard should be provided.

**9.6.4** Never overload a scaffold and be sure that all planking meets load demands.

**9.6.5** Use a ladder to gain access to scaffolds. Never climb up and down on the horizontal pieces and be sure the scaffold is anchored or tied securely at the top.

**9.6.6** On any kind of a scaffold, be sure overhead protection is provided when there are others working directly above you.

**9.6.7** Keep scaffolds free of rubbish, waste, snow, ice, and all other potential tripping and slipping hazards.

**9.6.8** A good way to be safe in determining the minimum size of planks and their maximum distance between supports is to use the following table:

**TABLE 3  
SIZE AND SPAN OF PLANKS**

Size of Plank Inches	Span Allowed Feet
2 x 10 . . . . .	10
2 x 12 . . . . .	12
2 x 14 . . . . .	14
2 x 16 . . . . .	16
2 x 20 . . . . .	20
3 x 20 . . . . .	20

**9.6.9** Scaffold planks should extend over their end supports not less than six inches nor more than 12 inches.

**9.6.10** All nails used in scaffold construction should be driven full length. No nail smaller than 8d should be used in scaffold construction, and a sufficient number of nails should be driven to support the design loading. Design of the scaffold should be such that no nail is subject to a direct pull.

## 9.7 RULES FOR SAFETY WITH PLANKING:

**9.7.1** All planking used on a scaffold should be of sound quality lumber that is straight grained and free of knots. All planking should have at least 24 inches overlap. Secure all planks to wood scaffolding.

**9.7.2** Planking overhang should be 3 5/8 inches on stackup scaffolds. Wood cleats (1 inch x 4 inches) should be nailed across the top of planking at each frame and outside end frames.

**9.7.3** Planks used for platforms should be of uniform thickness. These planks should be laid close together and overlapped at the bearers. An overlap of at least two feet should be allowed with the bearer in the center of the overlap. Planks should be fastened securely to the bearer at the opposite end to prevent tipping.

**9.7.4** Platforms should be kept clear of slippery substances. They should be equipped also with handrails and ladders.

**9.7.5** Planking should never be painted over; paint can conceal defects. Scaffold boards should be identified by painting at each end. All scaffold board should be used exclusively for that purpose.

**9.7.6** The nominal size of planking should be determined from Table 4. Values given are for planks with the wide face up, with loads concentrated in the center. Loads given in the table are net. Allowance was made for the weight of the planking. Loads in the table may be increased 45% if select structural coast region Douglas Fir or merchantable structural square and solid Southern Pine planks are used.

**TABLE 4**  
**SAFE CENTER LOADS FOR SCAFFOLD PLANK,**  
**IN POUNDS**

Span in Feet	Size of Plank			
	2 x 10	2 x 12	3 x 10	3 x 12
	Dressed to 1-5/8 x 9-1/2	Dressed to 1-5/8 x 11-1/2	Dressed to 2-5/8 x 9-1/2	Dressed to 2-5/8 x 11-1/2
6	256	309	667	807
8	192	232	500	605
10	153	186	400	484
12	128	155	333	404
14	110	133	286	346
16		116	250	303

**9.8** Some additional precautions are necessary, in addition to the above where applicable, in the erection of rolling towers:

**9.8.1** Casters should be of adequate size in relation to the height of the tower, the surface over which the tower is to be used, and in accordance with all federal, state, and local codes, ordinances, and regulations. Casters with plain stems should be attached to the panel or adjustment screw by pins or other suitable means required to prevent sliding off the support. In no case should casters smaller than six inches in diameter be used.

**9.8.2** Do not extend adjusting screws on rolling towers more than 12 inches.

**9.8.3** The platform height should not exceed four times the smallest base dimension unless guyed or otherwise stabilized.

**9.8.4** Horizontal diagonal braces should be used near the bottom and at 20-foot intervals measured from the rolling surface.

**9.8.5** Cross brace both sides of every tower.

**9.8.6** The addition of ladders to the tower can provide a convenient means of ascending and descending.

**9.8.7** Install guardrails and toeboards.

**9.8.8** Towers of a height greater than three times the minimum base dimensions should be guyed or tied-off when in use.

**9.8.9** Apply all caster brakes when the tower is not in motion.

**9.8.10 DO NOT RIDE TOWERS!**

**9.8.11** Do not attempt to move a rolling tower without sufficient help.

**9.8.12** Provide unit lock arms on all towers.

**9.8.13** The 5' x 7' rolling tower now in general use is unstable at heights over 25 feet while in motion; stability should be maintained either with outriggers or with handling lines.

**9.8.14** Guy or tie-off all fixed towers every 18 feet of elevation.

**9.8.15** Do not use brackets on rolling towers.

**9.8.16** Do not attempt to use scaffold as material hoist towers or for mounting derricks without first determining the loads and stresses involved.

**9.8.17** Inspect all tower parts before using. Do not use parts that are damaged or deteriorated. Remember that the strength of rusted materials is not known.

## 10. Rigging

### 10.1 GENERAL SAFETY RULES FOR SWING STAGES:

**10.1.1** Every swing stage or scaffold should be rigged and operated under the direct supervision of an experienced rigger.

**10.1.2** Swing scaffolds and all supports should be so designed and constructed that they can sustain at least six times the maximum load for which they are intended.

**10.1.3** Swing scaffold platforms should not be less than 20 inches wide or more than 36 inches in overall width. The platform should be so shaped that it rests evenly on steel hangers or stirrups placed within eight to 18 inches from the ends of the platform planks. If wire rope slings are used, they should be of wire rope of at least 9,000 pounds breaking strength.

**10.1.4** If wood putlogs are used in place of steel hangers, the platform planks should overlap by at least one foot on each side of the putlogs.

**10.1.5** A swing scaffold should be tied adequately or anchored to the building to prevent swaying or tipping forward from the inside. No more than two men should use a swing stage at any one time (except on staging designed to carry the extra load factor to meet requirements of OSHA), and each should be equipped with a safety belt to which a safety lifeline has been attached to a substantial member of the structure and running to the ground. Safety lifelines should never be attached to the scaffold.

**10.1.6** Proper rope size for stages is not less than 3/4-inch Manila — 1/2 inch nylon — and 3/4 inch Manila for safety lines.

**10.1.7** Scaffold platforms should be constructed of wood members graded as "structural" plank free from damage affecting its strength. Where platforms are constructed of two 2 x 10's or two 2 x 12's, side by side, they should be firmly cleated together to act as a unit. If 2 x 10's are used, the span of the platform between hangers or falls should not be more than ten feet. If 2 x 12's are used, the span should not be more than 12 feet.

**10.1.8** All hooks used as part of the rigging for scaffold supports should be closed or "moused," except for those used on lower blocks which support painters' rope hitches and the large supporting hooks that are in contact with the roof or parapet.

**10.1.9** Hooks supporting scaffolds or staging should be made of mild steel (reinforcing steel is forbidden) and they should be free from flaws or other imperfections. Each hook



should be capable of supporting a load four times that to which it will be subjected in service.

**10.1.10** The expected load per hook in service should include its share (normally half) of the total scaffold and rigging weight, plus the total weight of men and movable equipment and tools which should never be considered less than 500 pounds.

**10.1.11** All hooks should be provided with rings for tie-back service. The ring should be fitted through a hole in the hook not less than five inches from the hook point.

**10.1.12** Each hook should be tied back to a substantial member of the structure with at least a 3/4 inch diameter Manila rope or equivalent. Where the rope blocks supporting scaffolds or bosun's chairs are not attached directly to hooks, the extension from the top block to the support should be wire rope at least 1/2 inch in diameter or equivalent, and sufficient protection should be required to prevent the wire rope from chafing.

**10.1.13** Lubricate the bearing points of swing stages frequently. Inspect the ratchet and lock pawl spring before each use and keep pawls constantly engaged except when unreeling cable or lowering scaffold. Close inspection of masonry for possible deterioration is essential.

**10.1.14** Guard rails should be 2 x 4 inches or the equivalent, approximately 42 inches high, with a mid-rail not to exceed eight feet. Toeboards should be a minimum of four inches in height. Guard posts, if constructed of pipe, should not be less than 1-1/4 inches in diameter, securely screwed into floor flanges which in turn are bolted to the outside board of the platform.

## **10.2 ACID OR OTHER CORROSIVE SUBSTANCES USED FOR CLEANING MAY BE APPLIED FROM A SWING STAGE ONLY UNDER THE FOLLOWING CONDITIONS:**

**10.2.1** The stage should be suspended only by means of cable. Use of fiber rope of any kind is prohibited.

**10.2.2** A highly diluted solution of hydrochloric or muriatic acid, or other chemicals designed for cleaning work, should be used. Do not add water to acids. In diluting acids, the acid should be added to the water — slowly.

**10.2.3** The workmen should wear approved protective equipment. The solution should be applied with a brush.

**10.2.4** All parts of the scaffold or other equipment should be liberally washed with water, or detergent and water, after each use to prevent corrosive action.

**10.2.5** Be sure wire rope does not dangle below the platform and is well protected from acids or cleaning solutions. Manila rope which has been used for any purpose where it may have come into contact with acids, harmful detergents, etc., should be discarded.

## **10.3 ADDITIONAL SAFETY RULES FOR SWING STAGES**

**10.3.1** Be sure to read the manufacturers' instructions on the proper use and maintenance of the equipment.

**10.3.2** Never overload equipment.

**10.3.3** Always use a guard rail of sound lumber. Never substitute with rope.

**10.3.4** Replace cables immediately that show five percent of the wires per layer broken or that show evidence of excessive wear or corrosion.

**10.3.5** Cables should be replaced only by experienced personnel, and then with the utmost care.

**10.3.6** Allow none but careful, experienced men to erect or operate the suspended stage.

**10.3.7** When locating cables on the jobsite, CHECK NEARBY POWER LINES OR ELECTRIC SERVICE WIRING TO PREVENT ELECTROCUTION. When in doubt, consult the power service company for advice.

**10.3.8** Wood stages should be 20 inches minimum width, rated by Underwriters' Laboratories for center load of 500 pounds with safety factor of 4. Wood stages over 24 feet in length should be cabled.

**10.3.9** Metal stages should be not less than 20 inches wide, rated by Underwriters' Laboratories for center loads of 500 pounds with safety factor of 4. Stages over 24 feet in length should be cabled, with no cracks in sidewalls.

**10.3.10** Ropes and blocks of the stage should be tested by suspending one foot off the ground and loading at least four times the estimated work load.

**10.3.11** Power devices should have free fall safety devices with hand controls in case of power failure. Cables should be inspected regularly. Safety factor of cables should be four to one.

## **10.4 SAFETY RULES FOR "BOSUN'S CHAIR":**

**10.4.1** No workman should be allowed to use a bosun's chair who is not competent to operate it or who is unsuited to the conditions imposed.

**10.4.2** A man in a bosun's chair should be attended by another workman at all times.

**10.4.3** The seat of the chair should be constructed of a minimum of one-inch hardwood, 24 inches in length by 12 inches in width. Tie-ins should always be provided to prevent the chair and its occupant from swaying during working operations.

**10.4.4** The lifeline should be equipped with an approved automatic locking device or "grab." The line should be extended from a separate anchorage on the roof to the ground and should be separate from the rest of the rigging.

**10.4.5** The two fiber rope seat slings should be of 5/8 inch diameter, threaded through the four seat holes so as to cross each other on the underside of the seat. A safety belt attached to the lower tackle hook or other fixed supports should be used by the occupant.

**10.4.6** A rope or strap guard should be installed to the front and rear of the chair 18 inches above the seat.

**10.4.7** To raise and lower the chair, use a rope tackle with not less than one single and one double block equipped with an approved safety hook with mounting device, using not less than a 5/8 inch rope or cable of equivalent strength.

**10.4.8** When the rope passes over sharp edges, necessary precautions should be taken to protect the rope.

#### **10.5 GENERAL SAFETY RULES FOR RIGGING:**

**10.5.1** Superintendents and foremen should supervise all rigging and make sure it is safe. When left overnight or over a weekend, rigging should be checked before being used. At no time should rigging be tied to handrails, etc.

**10.5.2** Block hooks should be moused off with wire to make sure they cannot jump out. The main spider cable should not be used to tie off.

**10.5.3** Make sure all scaffold boards have from 12 to 18 inches overhang; if not, make sure they are tied on both ends in order not to slip.

**10.5.4** Approved safety belts and lifelines should be worn by employees whose work exposes them to falling in excess of 15 feet. Lifelines should be secured to a substantial member of the structure or to securely rigged lines, using a positive-descent control device.

**10.5.5** If a worker's duties require horizontal movement, the rigging should be so constructed that the attached lifeline can slide along with him. Such rigging should be provided for all suspended staging, outdoor advertising sign platforms, floats, and all other catwalks or walkways 15 feet or more above ground level.

**10.5.6** When working on steeply pitched roofs, workmen should wear safety belts with lifelines securely fastened to substantial anchorages. Electrical or air supply lines should be secured at roof level so as to provide ample, but not excessive, amounts of line.

#### **10.6 GENERAL SAFETY RULES FOR ROPES:**

**10.6.1** When it is properly taken care of, old-fashioned Manila hemp is still a mainstay, although many of the newer plastic fiber synthetics have gained many converts because of their rotproof, long life, and lighter weight characteristics.

**10.6.2** Ropes made of such synthetics as nylon and dacron have several times the minimum breaking strength of Manila hemp and can last several times longer because of low-moisture absorption, rot and mildew resistance, and abrasion resistance, according to some manufacturers. In hot areas, these synthetics are subject to failure by melting.

**10.6.3** A safe working load for Manila should be not more than one-quarter of the breaking strength. In the larger sizes, inside yarns are treated to withstand more rugged service and are reverse twisted to prevent kinking of the rope.

**10.6.4** When not in use, rope should be stored in dry, unheated quarters — preferably coiled and hung on wood planks or platforms slotted to allow for air circulation. It is important to store rope away from concrete floors and protect it from freez-

ing, hot sunshine, heater pipes, stoves, radiators, or other heat sources. When rope fibers dry out and become brittle, much of the strength and durability is lost.

**10.6.5** Keep rope clean. If it gets dirty, wash it with clean water. A wet rope should be dried thoroughly before storing. Ropes seldom need lubrication. A well-made rope is sufficiently lubricated by the manufacturer to last for its entire service life.

**10.6.6** Overloading rope is costly and dangerous. The safety factor of a rope is the ratio between the minimum breaking strength and the load applied. A safety factor of five is recommended under ordinary circumstances, with due allowance for the condition of the rope.

**10.6.7** When ropes used as guy lines and other supports are exposed to weather, they should be slacked off to prevent overstrain due to shortening from wetting.

**10.6.8** It is good practice to reverse a rope periodically, end for end, as in tackle use, so that all sections of the rope receive equal wear. When rope wear is localized in a short section, periodic shortenings prevent the creation of a new wearing surface.

**10.6.9** Should a rope become damaged, cut and splice it. A good splice restores about 90% of the strength of the rope and is safer than a damaged section. Surface wear may come from allowing one rope to chafe another, or by dragging it over sharp or rough objects which cut or break the outer fibers.

**10.6.10** Under conditions where rope should necessarily run over blocks, winches, or cleats, be sure the surface is smooth and free from worn grooves, sharp corners, and the like.

**10.6.11** Pull the strands of rope apart and check the inside strands. If you can break one by pulling it, chances are that the rope is rotted and unsafe. A worn rope usually can be detected by the black, powdery appearance that can be seen between the strands when they are untwisted.

**10.6.12** When wire rope is used, it should be maintained in strict accordance with the recommendation of the manufacturer for the appropriate safe working load. A safety factor of not less than five is recommended at all times.

**10.6.13** Kinking and twisting of the wire rope should be avoided and at no time should a load be applied to a kinked rope. The use of anti-twist rope is recommended. Wire rope should be lubricated according to the manufacturer's specifications.

**10.6.14** Sources of friction between wire rope and other objects should be avoided as it can cause chafing or breaking of the wire of the overlay cables.

**10.6.15** Wire rope should be protected from acids.

## **11. Personnel Protection**

**11.1 GENERAL RULES FOR SAFE WORKING CONDITIONS:** The project superintendent and the painter foreman, with advice from the safety engineer or industrial hygienist, should be alerted to see that the following rules are obeyed.

**11.1.1** Check tank or other enclosed space interiors for explosion hazard, toxic materials, and adequate oxygen content for breathing. Before tank entry, provide life lines and harness with an extra man stationed outside the tank. Ascertain if the tank opening is large enough to remove an injured man. Before entering a tank, check with operating personnel to ensure that all process lines entering the tank are blanked off.

**11.1.2** Provide proper lighting in interior of tanks and other dark areas. Be sure that lighting does not create shadows or glare. All wiring should be so constructed that there is no danger of electric shock. In many instances, electric head lamps such as are used in mines may be used.

**11.1.3** When airline masks or hose masks are used, locate the intake air source or the blower in an area free from air contaminants. Check the output air for proper pressure and carbon monoxide content (cf. Federal Specification BB-A-1034). Protect hoses from damage and do not allow them to become tripping hazards.

**11.1.4** Rope off or barricade work areas as required to protect passersby.

**11.1.5** Provide an adequate number of portable fire extinguishers.

**11.1.6** Post warning signs which may include: "WET PAINT," "NO SMOKING," AND "MEN WORKING ABOVE."

**11.2** The employer should provide the employee special protective clothing and equipment as safety conditions require and where the same is not similar to what is normally worn or provided as tools of the trade. Examples of safety equipment to be provided by the employer are goggles, hard hats, and rubber gloves.

**11.2.1 Eye Protection:** Goggles or other suitable eye protection equipment should always be worn whenever there is the danger of exposing the eyes to flying particles, acid, caustic substances, harmful rays, or any condition considered hazardous by the supervisor of the operation. Goggles used for protection from harmful rays should also meet requirements for protection against impact hazards.

**11.2.2 Head Protection:** Approved hard hats should be worn at all times and on all work and by everyone on the jobsite without exception.

**11.2.3 Foot Protection:** When it is deemed necessary that rubber boots should be worn, they should be worn with steel innerliners to help prevent punctures and stone bruises. All employees should be encouraged to buy and wear approved "Safety Shoes."

### 11.3 PROTECTIVE CLOTHING:

**11.3.1 Ordinary work clothing:** Tears and rips in work clothing are potential causes of accidents. Torn clothing can get caught in moving machinery or on a ladder or scaffold, and may lead to a nasty fall. Mend tears and rips. Cuffs on trousers are dangerous, since they might also catch on projections and cause crippling falls. Floppy jackets, dangling ties, and other

similar items of clothing can catch in moving machinery, or may catch on projections and cause a fall.

**11.3.2** Oil or chemical-saturated clothing (or clothing saturated with paint or other flammable material) easily can lead to dangerous and fatal burns. Clothing saturated with these materials can also cause painful skin irritations and burns. Oil-saturated clothing should be laundered or discarded.

**11.3.3** Defective, poorly designed, ill-fitting, or dirty clothing should not be worn to work. It is false economy to tolerate worn out or dirty clothing or to permit employees to wear to work old clothing not designed for safety under on-the-job conditions.

**11.3.4 Protective Clothing for High Temperature and Highly Toxic Atmospheres:** Protective clothing capable of withstanding long operating temperatures of 260 °C (500 °F), and capable of providing protection from many highly toxic atmospheres has been produced. This type of clothing is a complete suit constructed of woven Teflon laminated to a film of FEP fluorocarbon with a layer of reflective metal vacuum deposited onto the FEP. The suit is complete with gloves, steel-toed boots, and helmet-type headpiece, all locked to the suit by sealing ring arrangements. (Details of this suit construction and use can be obtained from the Snyder Manufacturing Company, New Philadelphia, OH, or the E.I. du Pont Chemical Company.)

**11.3.5 Hard Hats, Safety Shoes:** Most industrial plants require that workmen wear rigid safety helmets and steel-toed safety shoes as a matter of basic safety protection. The files of industrial safety engineers and insurance companies contain a sufficient number of case histories to prove that safety depends on these devices of protection. Project superintendents and painter foremen should not permit a man to begin work on a job until he agrees to wear these items. Steel toe safety shoes should have rubber soles with no nails or brads exposed when the painter is to work in enclosed spaces where flammable vapors may be present.

## 12. Respirators

**12.1** When industrial work methods or processes create hazards of exposure to harmful vapors, gases, dusts, mists, or fumes, the work areas should be isolated and ventilated to eliminate or minimize the hazards.

**12.1.1** The American Standard Safety Code for Respiratory Protection, ANSI Z88.2, suggests in broad terms where protection is needed. The code does not spell out in detail the specific hazardous conditions requiring respiratory protection; instead, it provides that respiratory protection "shall be provided where a process presents the hazard of exposure to harmful vapors, gases, dusts, mists, or fumes."

**12.1.2 Approved Devices:** At the present time, respiratory protective devices are approved by National Institute for Occupational Safety and Health/Mine Safety and Health Administration (NIOSH/MSHA) in the following categories:

- Self-Contained Breathing Apparatus. The apparatus

includes the compressed oxygen cylinder and the compressed air cylinder, demand type.

- Supplied Air Respirators. The apparatus includes hose masks with blower, Type A; special hose mask without blower, Type B; air-line respirator, Type C; abrasive blasting helmet, Type CE; dispersoid (dust, fume and mist) respirators; and nonemergency gas respirators (chemical cartridge respirators).

**12.1.3 Classification of Hazards:** Because the selection of respiratory protective devices is based on the type of hazards encountered, The American Standard Safety Code for Respiratory Protection, ANSI Z88.2, classifies hazards as follows:

- Oxygen deficiency.
- Gaseous contaminants: Immediately dangerous to life, and Not immediately dangerous to life.
- Particulate contaminants (dust, fumes, smoke, mists, fogs).
- Combination of gaseous and particulate contaminants: Immediately dangerous to life, and Not immediately dangerous to life.

**12.1.4** It is suggested that self-contained breathing apparatus be used where oxygen deficiency and certain types of gaseous contaminant hazards exist and that supplied air respirators be used for the remaining types. However, it is always important to consult the plant or area safety engineer as to which type of protective device is best for a given condition.

## 12.2 AIR-LINE RESPIRATORS:

**12.2.1** Make certain that the air supply is respirable. Pay close attention to the location of the intake to the air supply device to make certain that the entering air is not contaminated from the exhaust of the compressor engine or from other sources. Provide a suitable filter to remove objectionable odors, oil, water mist, and rust particles from the air delivered to the air supply line.

**12.2.2** Make certain that the air-line respirator is in good operating condition. Attach the proper length of air supply hose to the source of compressed air and to the breathing tube. Adjust the pressure of the air at the inlet to the air supply hose so that it is within the proper pressure range. Adjust the facepiece, helmet, or hood to the wearer according to the manufacturer's instructions.

**12.2.3** When the rate of flow of air into the facepiece, helmet, or hood seems to be excessive, the wearer may decrease the flow of air by means of the air regulating valve with which most air-line respirators are equipped. However, to prevent the contaminant in the surrounding air from reaching the wearer's breathing zone, the flow of air should not be decreased below four cubic feet per minute for facepieces, or below six cubic feet per minute for helmets or hoods. Enter the contaminated area cautiously and leave by the same route.

**12.2.4** For the safe use of any device, it is essential that the user be properly instructed in its selection, use, and maintenance.

This is particularly important with respect to respirators. Competent personnel should give such instructions to the supervisors of all groups who may be required to wear respirators at their work. The supervisors, in turn, should instruct their men. No person should be allowed to wear a respirator of any type until he has received such instruction.

**12.2.5** The life of the wearer may be dependent on the proper functioning and ready availability of respirators, so it is highly important that respirators be properly maintained and stored.

**12.2.6** All respirators should be inspected at regular intervals to make sure that they are ready for use.

**12.2.7** All rubber parts such as facepieces, mouthpieces, exhalation valves, breathing tubes, and headbands should be inspected carefully for signs of deterioration such as hardening, checking, or tackiness. A check should be made during this inspection to see that all gaskets are present and that they are held tightly in place. Metal parts should be checked for signs of corrosion, and plastic and glass parts should be checked for breakage.

## 12.3 GENERAL SAFETY RULES FOR RESPIRATORS:

**12.3.1** If the wearer is to enter a confined space containing a hazardous atmosphere, first connect a strong lifeline to his body. The lifeline serves as a means of guiding him to the exit, as a means of exchanging prearranged signals between him and the man at the fresh air base, and as a means of aiding in rescue operations in case of an emergency or accident. The lifeline should be held by two attendants, one of whom is wearing a similar apparatus.

**12.3.2** Where a lifeline is used, a signal code to enable the wearer to communicate with the lifeline tender, and vice versa, is necessary. The following code is suggested:

### Tender to Wearer

1 pull — Are you okay?  
2 pulls — Advance.  
3 pulls — Back out.  
4 pulls — Come out immediately.

### Wearer to Tender

1 pull — I am okay.  
2 pulls — I am going ahead.  
3 pulls — Keep slack out of line  
4 pulls — Send help.

**12.3.3** If upon entering a contaminated area, the wearer is able to detect the contaminant by odor or taste, or by eye, nose, or throat irritation, he should return to the fresh air immediately and ascertain what is wrong with the equipment or the manner in which it is being worn. Bear in mind the time limitations of the apparatus and allow an adequate margin of time for return to fresh air. The mouthpiece and nose clip or the facepiece, should not be removed until the wearer is certain that he is in respirable air.

## 12.4 SAFETY RULES FOR RESPIRATORS:

**12.4.1** Make certain that the hose mask is in good operating condition. Set the blower in an assured source of respirable air.

**12.4.2** Connect the proper length of hose (not over 150 feet) to the blower and to the facepiece, making sure that all gaskets are in place and that the connections are tight. Where more than one hose line is to be used, each should originate at the blower. Operate the blower for a minute or two at a rapid rate to blow any dust out of the hose and to make sure that air is being delivered to the facepiece.

**12.4.3** Adjust the body harness securely to the wearer. Connect a strong lifeline to the D-ring of the body harness. Adjust the facepiece to the wearer so that it makes a gastight fit with his face. Operate the blower, and adjust the flow of air to the wearer's satisfaction. The blower should be operated continuously during the use of the mask.

**12.4.4** Check on the prearranged signals between the wearer and the blower operator. Enter the contaminated area cautiously. Be careful that the hose and the lifeline are not endangered by sharp edges or falling objects and remember that the wearer should retrace his steps and leave by the same route by which he entered.

## 13. Ventilation

**13.1** A clean air supply is required for all operations involved during the application of the coating materials, and during the curing and drying of the coating after application. This clean air supply is also required to provide make-up to the working atmosphere during these operations. A high quality air source is required for life support purposes.

**13.2** Air used to fulfill the requirements of coating will require monitoring prior to, during, and following use to assure proper quality. Effluent treatment is required for the removal of fumes, vapors, and particulates where monitoring analyses indicate that levels exceed the acceptable discharge limits.

**13.3 LIFE SUPPORT REQUIREMENTS:** The preparation of air used for life support involves the following factors:

- Threshold Limit Value (TLV) of nuisance and toxic dusts
- Fume, gas, and vapor content
- Air temperature

**13.4** The TLV for "inert" or nuisance particulates present in atmospheric air is given as 10 mg/cu.m of total dust containing less than 1% silica.

**13.5** Particles having an aerodynamic diameter of ten microns are capable of passing into the smallest passage-ways of the human lung. To produce an air supply acceptable for life support purposes, all particles greater than 2.0 microns should be removed from air, or the particulate concentration should be maintained at less than 5 mg/cu.m (whichever is lower).

**13.6** The fume, gas, and vapor content of respirable air is taken as the minimum quality required for life support. "Respirable Air" is considered to be that suitable for use in self-contained or air-supplied breathing (SCUBA) equipment used in underwater operations. The air quality recommended for life

support is defined as Type 1, Grade D, having the maximum limiting characteristics given in Table 5 below, except where exceeded by federal, state, or local regulations. [See Amendment 1 (12-15-78) to Federal Specification BB-A-1034 (6-21-68)].

**TABLE 5**  
**RESPIRABLE AIR TYPE I, GRADE D**

Oxygen (v/v)*	19.5-23.5%**
Hydrocarbons (condensed)	5 mg/m <sup>3</sup>
Carbon monoxide	10 mg/m <sup>3</sup>
Carbon dioxide	1,000 mg/m <sup>3</sup>

\*v/v —volume per unit volume or percent by volume

\*\*Balance (76.5-80.5) predominantly nitrogen

**13.7** Temperature of the air required for life support is related to the existing relative humidity (dew point temperature), the extent of physical activity, and the air velocity. Although partly concerned with maintaining a proper work atmosphere, the optimum temperature should range between 70 °F (21 °C) and 80 °F (27 °C).

**13.8** Equipment used to supply air for life support should be located so as to prevent entrainment of exhaust from any nearby internal combustion engines.

**13.9** Air required for general ventilation, where separate life support supplies are not provided, should meet the quality criteria outlined in Section 13.6. Air volumes should be adequate to maintain the quality stated under any and all operating conditions.

**13.10** The ventilation system should be designed to facilitate removal of particulates and solvent vapors from the most remote and lowest areas of the work area.

## 14. Barricades

**14.1** Floor openings should be planked over or barricaded with substantial railings as follows:

- Minimum 2 × 4 top rail, 3'6" above floor level.
- Minimum 2 × 4 intermediate rail, equidistant between top rail and floor.
- Minimum 1" × 4" toeboard.

**14.2** Doorways and passageways used by workmen should be protected from overhead dangers by suitable coverings.

**14.3** Barricades are to be placed at drives, entrances, and other openings to keep the public out of the jobsite.

**14.4** Openings to material hoists, elevator shafts, stairways, and walkways should be closed by gates or other moveable barricades with toe guards as described above.

**14.5** The unnecessary removal of any protective barricade is prohibited. Temporary removal requires other safety control, such as the posting of a guard to direct traffic. Whoever removes a barricade should be responsible for its replacement.

All barricades and gates should be adequately lighted at all times.

**14.6** In cases where the type of construction requires routing of passersby over sidewalks and streets, the temporary work should comply with all relevant local, state, and federal regulations.

**14.6.1** Passageways should have handrails and toe-boards to the street side and a solid eight-foot-high wall to the building side, with substantial overhead protection, solidly decked.

**14.6.2** Walkways should be smooth and even, with no projections or knot holes which might cause tripping. A ramp is advisable at each end, with cleats, or nonslip surface.

**14.6.3** Passageways should be well lighted, with red lights at each end.

**14.6.4** If equipment crosses walkway, traffic should be directed and frequent inspection of walkways made by the job superintendent.

**14.7** Good housekeeping is the first law of accident prevention in construction and should be a primary concern to all employees. The following rules should be known and heeded by each individual on the jobsite.

**14.7.1** Housekeeping should be part of the daily routine, with cleanup being a continuous work procedure.

**14.7.2** The work areas should be kept free of loose materials no longer needed at the jobsite. This is especially true in the vicinity of ladders, ramps, stairs, and passageways.

**14.7.3** An effective means of preventing careless litter should be provided: material trash bins and garbage cans should be placed in convenient locations so that the men can find it easy to keep the individual locations free from trash and other debris.

**14.7.4** Clean up all spilled grease, oil, paint, or other materials at once and remove waste material as it accumulates.

**14.7.5** All scaffolds, stairways, passageways and catwalks should be kept free from debris, supplies, and obstructions. Keep materials and supplies away from the edges of shafts, stairways, and floor openings.

**14.7.6** Follow good storage practices for tools, material, and equipment. Don't stack or store things in such a way that they can fall over and cause tripping hazards.

**14.7.7** Store waste, oily rags, and other flammable materials in metal cans or receptacles provided for that purpose.

**14.7.8** Flammable materials should be stored in closed, ventilated metal cabinets. Storage cabinets should be away from exits, stairways or doors used for exits.

**14.7.9** Cabinets should be identified with the sign: "FLAMMABLE — KEEP FIRE AWAY" (painted in red).

**14.7.10** Do not return tools or equipment to stock until all items have been properly cleaned.

## 15. Additional Recommendations

**15.1** The hazards in using chemical compounds such as acids and alkalies are generally known and precautions should be taken to protect personnel from all contact, including spray, mist, or spillage. The Chemical Manufacturers Association has published adequate methods for handling these safely.

**15.2** The protective clothing and equipment necessary for the various operations is listed in publications of the National Safety Council, the American Standards Association, the National Fire Protection Association, and others. Insurance companies should be contacted for technical advice on safety measures if there is any question.

**15.3** Spray booth operations should be carried out in detached buildings or cut off from other functions where possible. Where it is done in open areas, curtains of noncombustible material hung from ceiling to floor are recommended.

**15.3.1** Heating units or piping within such an area should be eliminated or protected against an accumulation of paint spray. Positive ventilation equipment should be used at all times.

**15.3.2** Accumulations of paint should be removed from the walls, floor, and ceiling of a spray booth at frequent intervals.

**15.3.3** Exhaust systems should be designed so that there is a minimum amount of spray deposit left in ducts, which can be easily removed.

**15.3.4** Only approved explosion-proof electrical equipment should be used in the spray area.

**15.3.5** No more than a day's supply of paint and solvents should be kept in the area.

**15.3.6** Finished materials should not be stocked in front of or close to the spray booth where evaporating thinners from the freshly finished materials can be inhaled.

### 15.4 PERSONNEL ACTIONS:

**15.4.1 Goggles:** Rubber, splash-proof goggles should be on the person at all times and should be worn while chipping, wire brushing, scraping, dusting, spraying, removing glass, or when working in any area where the use of goggles is designated, as in sandblasting areas or where there is danger from weld spatter. Goggles should be kept clean and a nonfogging compound should be applied as often as necessary.

**15.4.2 Safety Belt:** Safety belts with lines attached should be worn when working inside any tank or small enclosure or on top of high equipment, such as tanks, bridges, structural steel work, and water towers. When working from a bosun's chair, a lineman's safety belt should be worn. Safety belts should be tested once a month. Safety lines should be attended by a second person at all times.

**15.4.3 Air-Line Mask:** An approved air-line mask should be worn where specified. The air source for the mask should be taken from either a suitable pump supplied for the purpose; or it

may be taken from a suitable compressor, if a stoneware or other suitable filter is used. Do not use any source from which an oil or greasy odor is obtained.

**15.5 Paint Spray Booths:** Design construction and operation of paint spray booths should comply with the many requirements listed in federal, state, and local regulating controls, as suggested in Section 2.

**15.6** Application of hot-applied bituminous coatings involves special hazards. Heating kettles are designed to minimize possibilities of the contents catching fire, but carelessness cannot be permitted. Splashing or the upsetting of buckets of hot melts, with temperatures ranging up to 500 °F (260 °C) can result in serious burns. Smoke and fumes are irritating to the skin, as well as harmful to the respiratory tract.

#### 15.7 ELEVATED OPERATIONS:

**15.7.1** Since a painter on a bridge job is working at a considerable distance from ground or water, one of the main considerations is that he not suffer from vertigo, or fear of height.

**15.7.2** For their own protection, it is wise for men working regularly on high work, such as structural steel and bridges, to take regular physical examinations, so that any tendency toward vertigo or dizzy spells can be detected, as well as heart ailments or the effects of previous cases of lead poisoning.

**15.7.3** Catwalks or platforms should be at least 20 inches in width with guardrails provided at all locations where men are regularly at work. The planks should be rough sawn and pressure treated.

**15.7.4** All scaffolds, fixtures, hangers, cables, and ropes should be inspected by the foreman each day, or before each use. All standing or hanging scaffolds should be inspected daily for strains or weaknesses caused by wind sway.

**15.7.5** Ladders used for access to scaffolds or parts of the bridge should be securely lashed in place or provided with hooks on the top end.

**15.7.6** Special care is necessary in extremely hot or cold weather to make certain that life belts are used and are in condition. In very cold weather, a man's hands become numb and he may lose his grip and fall, while in very hot weather he may become dizzy.

**15.7.7** Another effective form of protection is the life net. It may be erected under either individual scaffolds or complete bays of the bridge. When used, the net should be inspected and kept in good condition.

**15.7.8** When scaffolds are used above railroad tracks, the planks should be securely fastened so the blast from locomotives passing underneath cannot dislodge them. Scaffold hooks should also be securely fastened in place.

#### 15.8 ELECTRIC FACILITIES:

**15.8.1** Utmost care should be practiced by all personnel in the application of paints in or near electric lines and equip-

ment. Inquiry should be made of the jobsite manager or operators to learn specific functions of local equipment and dry hazards relevant to such.

**15.8.2** Action should be taken to break the connection of the line or equipment from the power source whenever possible. The break area should be plainly marked and locked, with release controlled by the painting supervisor.

**15.8.3** All painters should be briefed by experienced supervisors on safe practices and precautions necessary around electric units prior to their doing any paint applications.

**15.8.4** Warning signs should be posted at all times with ample safe distances between them and electric units.

## 16. Limitations

### 16.1 FIRE HAZARD:

**16.1.1** Flammable, volatile solvents in paints constitute a major hazard with regard to fire and explosions wherever flame or spark exposure is possible. No painting should be done within 50 yards of steel welding or torchcutting activity.

**16.1.2** When painting is required in a confined area, all flame sources (pilots, lights, etc.) should be extinguished and no smoking permitted. Painting should cease whenever this condition may be breached, or when solvent vapor concentration reaches hazard level.

**16.1.3** Vapor exhaust equipment should be used to maintain minimum level of solvent concentration.

**16.1.4** The superintendents should acquaint themselves and their foremen with the fire hazards inherent in the job and jobsite.

**16.1.5** The use and storage of flammable materials are to be kept to restricted areas, and these areas are to be well marked with appropriate signs.

**16.1.6** Fire extinguishers and fire hoses should be placed at locations which are agreed upon or designated by the safety manager.

### 16.2 TEMPERATURE RANGE:

**16.2.1** Most paints should be applied when both ambient and substrate temperatures range from 40 °F (4 °C) to 120 °F (49 °C) with strong influence from the relative humidity condition in that bracket. The safety factor involved is the fire hazard with the rapid flash-off of solvent at the higher temperatures, or the formation of combustible vapor mixtures in low areas at the bottom of the range.

**16.2.2** Moisture and frost on surfaces create a footing hazard at lower temperatures. Personnel working at high temperatures may suffer heat exhaustion and risk falls from the access means. Daily warnings should be made if these conditions exist.

### 16.3 WIND VELOCITY:

**16.3.1** Exterior application of paint should cease when wind velocity reaches 25 miles per hour either in gusts or at a

steady rate. Where surfaces can be shielded from wind by artificial deflection means, work may continue.

**16.3.2** At velocities of 25 miles per hour, all elevated access means should be lowered to ground level, unless complete immobilization can be made.

## 17. Action on Accidents

**17.1** First aid kits of the required size should be provided at the various jobsite offices. These kits should contain the essential articles for the immediate treatment of superficial injuries.

**17.2** Supervisors and foremen should satisfactorily complete the first aid course given by the American Red Cross. It is urged that as many as possible of the employees participate in a regular first aid course as presented by the American Red Cross. Each crew should have at least one person trained in first aid.

### 17.3 REPORTING OF ACCIDENTS:

**17.3.1** Details of all accidents should be reported to OSHA and other government offices as soon as possible.

**17.3.2** Field offices should serve as first aid headquarters. Regardless how minor the injury is, all injuries should be reported in order that proper treatment may be obtained. Ar-

rangements for doctors and transportation should have been made, with the telephone numbers and addresses posted at the field offices.

**17.3.3** A list containing the date and time that the injured person was sent for treatment should be kept at the jobsite office.

**17.3.4** All subcontractors should be required to furnish the superintendent a copy for the accident report within two hours of the time that an injury is reported.

## 18. Notes

**18.1** While every precaution is taken to insure that all information furnished in SSPC guides is as accurate, complete, and useful as possible, SSPC cannot assume responsibility or incur any obligation resulting from the use of any materials, paints, or methods specified therein, or of the guide itself.

### 18.2 OTHER GENERAL REFERENCES ARE:

- British Standards Institution, BS - 5493: Code of Practice for Protective Coatings of Iron and Steel Structures Against Corrosion.
- OSHA Reference Manual, Painting and Decorating Contractors of America, 3913 Old Lee Highway, Suite 33 B, Fairfax, VA 22030.