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CODE OF PRACTICE FOR SAFETY AND HEALTH REQUIREMENTS IN ELECTRIC AND GAS WELDING AND CUTTING OPERATIONS

(*First Revision*)

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BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

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May 1968

Indian Standard

CODE OF PRACTICE FOR SAFETY AND HEALTH REQUIREMENTS IN ELECTRIC AND GAS WELDING AND CUTTING OPERATIONS

(First *Revision)*

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Indian Standard

CODE OF PRACTICE FOR SAFETY AND HEALTH REQUIREMENTS IN ELECTRIC AND GAS WELDING AND CUTTING OPERATIONS

(First Re vision)

0. FOREWORD

0.1 This Indian Standard (First Revision) was adopted by the Indian Standards Institution on 23 February 1968, after the draft finalized by the Welding General Sectional Committee had been approved by the Structural and Metals Division Council.

0.2 This standard was first published in 1957. In this revision certain modifications have been incorporated with regard to manual electrode holders, ventilation and health protection and the values have been specified only in metric units.

0.3 The aim of the Steel Economy Project of IS1 is to achieve efficiency and economy in the use of steel. One of the main channels through which economy of steel could be achieved is by the propagation of the use of welding in all steel fabrications. The use of welding calls for certain safety and health requirements to be met. Accordingly, the Sectional Committee decided to formulate this code of practice with a view to propagating the more rapid development of the welding industry in India.

0.4 This code requires reference to the following Acts, and Rules and Regulations laid down by the Government of India with their subsequent amendments, if any:

The Indian Electricity Act, 1910 (Act IX of 1910)
The Carbide of Calcium Rules, 1937
The Indian Electricity Rules, 1956
The Petroleum and Carbide of Calcium Manual, 1950
The Gas Cylinder Rules, 1940
The Factories Act, 1948

0.5 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS : 2-1960*. The number of significant places retained in the rounded off value should be the same as that of the specified value in the standard.

*Rules for rounding off numerical values (*revised*).

1. SCOPE

1.1 This code lays down requirements for the protection of (a) persons from injury and illness, and (b) properties (including equipment) from damage by fire and other causes, arising from electric and gas welding and cutting equipment, its installation, operation and maintenance.

1.1.1 The general provisions of this code of practice are applicable to welding and cutting of metals and other allied processes.

1.1.2 This code does not cover particular hazards which may be inherent when welding and cutting equipment is used in special types of industries.

2. TERMINOLOGY

2.1 For the purpose of this standard, the definitions given in IS :812-1957* shall apply, besides the definition given under 2.1.1.

2.1.1 *Confined Space* — A small or restricted space, such as a tank, boiler, pressure vessel or small compartment of a ship.

3. INSTALLATION AND OPERATION OF GAS WELDING AND CUTTING EQUIPMENT

3.1 General

3.1.1 A mixture of inflammable gases and air may be explosive over a wide range and shall be carefully guarded against. No device or attachment facilitating or permitting mixtures of air or oxygen with combustible gases prior to combustion, except the burner or in a standard torch, shall be allowed unless approved for the purpose.

3.1.2 In no case shall acetylene be generated or utilized at a pressure in excess of 0·14 kgf/cm² (gauge pressure).

3.1.2.1 *In case* acetylene is to be generated or utilized at a pressure in excess of 0·14 kgf/cm², prior permission of the Chief Inspector of Explosives, Government of India, shall be obtained.

3.1.2.2 The requirement under 3.1.2 shall not apply to the storage and use of acetylene when stored in cylinders containing a homogeneous porous substance with or without a solvent, if the conditions set forth in the Government of India (late Department of Labour) Notification No. M. 1268(1) dated 9 January 1939 are fulfilled.

3.1.2.3 Use of liquid acetylene shall be prohibited.

3.13 *Apparatus-All* apparatus, such as torches, regulators or pressure reducing valves, acetylene generators and manifolds shall be of satisfactory type and quality and manufactured according to sound engineering practice.

*Glossary of terms relating to welding and cutting of metals.

3.1.4 ***Cylinders*** — All portable cylinders used for storage and shipment of compressed gas shall be constructed and maintained in accordance with the requirements specified in the Gas Cylinder Rules, 1940, issued by the Government of India.

3.1.5 ***Instructions - Workmen*** in charge of the oxygen or fuel gas supply equipment, including generator and oxygen or fuel-gas distribution pipe system, shall be thoroughly conversant with the type of equipment, the process and safety requirements and shall have been judged competent by their employers before taking charge. They shall, at all times, possess the rules and instructions covering the operation and maintenance of oxygen or fuel-gas supply equipment including generators and oxygen or fuel-gas distribution piping system.

3.2 **Stationary Automatic Acetylene Generator**

3.2.1 ***Approval and Marking*** — Generators shall be of approved construction and shall be clearly marked giving the information mentioned below:

a) The maximum rate of acetylene (in cubic centimetres or cubic metres per hour) for which they are designed,

b) The weight and size of carbide necessary for a single charge,

c) The manufacturer's name and address, and

d) The name or number of the type of generator.

3.2.2 ***Rating - The*** total hourly output of a generator shall not exceed the rate for which it is approved and marked. When generators are coupled to deliver gas simultaneously, arrangements shall be made such that the rate of output of each does not exceed the rate fixed by the maker and the safety devices shall be adjusted to the increased output of gas.

3.2.3 ***Location of Generators - Generators*** shall preferably be placed outside the building in generator houses constructed and located in accordance with the requirements laid down under 3.2.4. However, the installation of approved generators within buildings shall be permitted provided they comply with the requirements given under 3.2.5.

3.2.4 ***Outside Generator Houses - No*** opening in any outside generator house shall be located within 1·50 m of any opening in another building.

3.2.4.1 Sides and roofs of generator house shall be of non-combustible material.

3.2.4.2 When a part of the generator house is to be used for the storage or manifolding of oxygen cylinders, the space to be so occupied shall be separated from the generator by partition walls running continuously from floor to roof or ceiling. The construction shall be of one of the types listed under 3.2.5.2. Such separation walls shall be without openings and shall be joined to the floor, other walls and ceiling or roof in a manner so as to effect a permanent, air-tight joint.

3.2.4.3 A portion of the exterior walls equal to not less than 1·0 cm² of vent area per 60 cm³ of room volume shall be of light, non-combustible material, preferably of single-thickness and single-strength glass. Single-thickness and single-strength glass skylights may be accepted in part or entirely in lieu of the glass area or its equivalent, provided the required ratio of vent area is thus obtained.

3.2.5 Inside *Generator Rooms or Compartments*

3.2.5.1 The installation of acetylene generators within buildings shall be restricted to buildings not exceeding one storey in height. However, this need not be construed as prohibiting such installations on the roof or top floor of a building exceeding such height.

NOTE — The word 'buildings' shall mean buildings having occupancy other than that directly associated with the production of acetylene or the storage and manifolding of gases used in welding and cutting.

3.2.5.2 Where generators are installed inside buildings, they shall be enclosed in a separate room or compartment of ample size. The walls, partitions, floor and ceiling of such rooms or compartments shall be of one of the types of construction listed below, or of other construction equivalent in strength and fire resistance. Walls or partitions shall be continuous from floor to ceiling and shall be securely anchored. At least one wall of an inside generator room shall be an exterior wall.

Types of Construction

a) Gypsum or cement plaster at least 20 mm thick on metal laths on each side of a stud partition;

b) Expanded metal laths enclosed in solid cement plaster not less than 65 mm;

c) Reinforced concrete;

d) Brick; and

e) Tile, gypsum or concrete block (cement plaster on each side to a thickness of 6 mm).

3.2.5.3 A portion of the exterior walls equal to not less than 1·0 cm* of vent area per 60 cm³ of room volume shall be of light, non-combustible material, preferably single-thickness, single-strength glass. Single-thickness, single-strength glass skylights may be accepted in part or entirely in lieu of the glass area or its equivalent, provided the required ratio of vent area is thus obtained.

3.2.6 *Installation* -The foundation for the generator shall be so arranged that the generator would be level and such that no excessive strain would be placed on the generator or its connection. Acetylene generators shall be grounded to water pipes.

3.2.7 *Space Around Generator* -There shall be ample space around the generator for free, unobstructed operation, maintenance, ready adjustment and charging.

3.2.8 *Ventilation, Heating and Lighting of Generator Houses or Rooms*

3.2.8.1 The space around the generator shall be well-ventilated. This may be done by employing openings near the floor level and near the highest practical point in the room.

3.2.8.2 The heating of generator houses or rooms shall be by steam, hot water or other indirect heating system; the furnace shall be so located that no flame or fire is in or near the generator enclosure. Electric heaters shall not be employed.

3.2.8.3 Generator house or room shall have natural light during daylight hours. Where artificial lighting is necessary, it shall be restricted to electric lamps *set* in air-tight frames in the exterior walls or roof of the generator house or room without being enclosed by wired glass panels. Electrical installations, not of the flame-proof type, may be permitted in the generator room provided air under pressure is blown through the electrical conduits and fittings.

Electric switches, telephones and all other electrical apparatus which may cause a spark shall be located outside the generator house or in a room or space separated from the generator room by an air-tight partition.

3.2.8.4 No person shall smoke within 5 m of a generator house or room.

3.2.9 *Protection Against Freezing-Generators* shall be placed where water would not freeze. The use of common salt (sodium chloride) or other corrosive chemicals for protection against freezing shall not be permitted. (For ' heating ' systems, see 3.2.8.2).

3.2.10 *Water Supply Connections-Water* shall not be supplied through a continuous connection to the generator, except when the generator is provided with an adequate open overflow or automatic water shut-off which would effectively prevent overfilling of the generator. The supply pipe shall terminate at a point not less than 5·0 cm above the regularly provided opening for filling so that it is possible to see the water as it enters the generator.

3.2.11 *Drain Connections* — Unless otherwise specifically approved, the generator shall not be fitted with continuous drain connections leading to sewers. All the residue from the carbide shall be discharged through an open connection into an open tank provided in the open air. The residue shall remain for at least ten hours in not less than four times its bulk of water in such tank.

NOTE -An open connection for the sludge draw-off at the generator is desirable to enable the generator operator to observe leakage of generating water from the drain valve or sludge cock.

3.2.11.1 Precautions shall be taken for preventing any lime sludge from being discharged into the drains.

3.2.12 *Generator Escape or Relief Pipe*

3.2.12.1 Each generator shall be provided with an escape or relief pipe of standard full-weight galvanized iron or steel, except that outside of buildings vent pipes larger than 10·0 cm in diameter may be of galvanized tubing of sheet steel not less than 2·0 mm in thickness.

3.2.12.2 The escape or relief pipe shall be installed without traps and in such a manner that condensation, if any, may drain back to the generator.

3.2.12.3 The escape or relief pipe shall be carried full size to a suitable point outside the building and shall terminate in a hood or bend located at least 6·0 m above the ground, preferably above the roof and away from sources of ignition, such as flues or chimneys and tracks used by steam locomotives. Generating chamber relief pipes shall not be inter-connected but shall be led separately to the outside air. The hood or bend shall be so constructed that it would not be obstructed by rain, snow, ice, insects or birds; the outlet shall be at least 90 cm from combustible construction.

NOTE — Provisions under **3.2.12** apply only to generators in which the gas holder bell is incorporated. These are not applicable to generators which are provided with separate gas holders. Also, the relief pipe shall be provided when the gas holder is installed in a room.

3.2.13 *Maintenance and Operation*

3.2.13.1 Generator room shall be open to authorized persons only. A label or printed card giving fully detailed instructions as to the use of the apparatus and a certificate by the licensee to the effect that the attendant who shall be mentioned by name has been properly instructed in the management of the apparatus shall be exhibited on or in close proximity to the apparatus.

3.2.13.2 When recharging the generator, the instructions of the manufacturer shall be strictly followed with regard to the sequence of operations.

3.2.13.3 The supply of calcium carbide and water to the generator shall be so regulated that the temperatures of the generating and cooling water do not rise above those indicated by the manufacturer, but in no case above 82°C.

3.2.13.4 The calcium carbide shall be completely decomposed in the apparatus, so that the lime sludge discharged therefrom shall not be capable of generating more gas.

The apparatus shall give no tarry or other heavy condensation products from the decomposition of the carbide.

3.2.13.5 In the case of generators, when the charge of calcium carbide is exhausted and before additional calcium carbide is added, the generating

chamber shall always be flushed out with water, renewing the water supply in accordance with the instruction card furnished by the manufacturer. Periodic cleaning and maintenance shall be performed in the manner specified by the manufacturer.

3.2.13.6 Charging of calcium carbide at other than daylight hours is allowed, if the generator room is lighted in accordance with 3.2.8.3.

3.2.13.7 The carbide used each time for recharging the generator shall be just sufficient to refill the space provided for calcium carbide without ramming the charge. Only a wooden tool shall be used in distributing the charge.

3.2.13.8 Partially decomposed charges of calcium carbide shall not be recharged into the generator.

3.2.13.9 Generator water chambers shall at all times be kept filled to proper level, except while draining, during the recharging operation.

3.2.13.10 Whenever repairs are to be made or the generator is to be charged or carbide is to be removed, the water chamber shall be completely filled to avoid the danger of explosion due to mixture of air and acetylene within the water space and also to prevent dropping of fresh calcium carbide into insufficient water. Before making any repairs involving welding, soldering, brazing or any hot work or operation liable to produce a flame or spark, the calcium carbide charge and feed mechanism, shall be completely removed to avoid wetting the same, and all acetylene shall be expelled by completely flooding the generator shell with water. The generator shall then be disconnected from the piping system and kept filled with water, as far as possible. It shall be maintained in a position so as to hold as much water as practicable.

Hot repairs shall not be made in a room where there are other generators unless all the generators and piping have been purged of acetylene. Hot repairs should preferably be made outdoors.

3.2.13.11 Relief valves shall be regularly operated to ensure proper functioning. Relief valves for generating chambers shall be set to open at a pressure not in excess of 0·14 kgf/cm².

3.2.13.12 All parts of the acetylene generator installation shall be maintained in good condition at all times.

3.2.13.13 In dismantling any part of an acetylene installation, special care shall be taken to prevent the generation of sparks by friction or impact unless that part of the installation has been:

a) thoroughly cleaned;
b) carefully cleaned of calcium carbide, residue and sludge;
c) thoroughly flushed; and
d) completely filled with water, steam or an inert gas,

3.3 Stationary Non-Automatic Acetylene Generator — In addition to the requirements laid down under 3.2, non-automatic acetylene generators shall comply with the requirements laid down under 3.3.1 and 3.3.2.

3.3.1 ***Limitations -Non-automatic*** generators shall not be used for generating acetylene directly at pressures exceeding 0·07 kgf/cm² and all water overflows shall be visible.

3.3.2 ***Gas Holders***

3.3.2.1 All gas holders shall be constructed on the gasometer principle, the bell being suitably guided. The gas bell shall move freely without tendency to bind and shall have a clearance of at least 5·0 *cm* from the shell.

3.3.2.2 The gas holder may be located in the generator room, in a separate room or outdoors. When the gas holder is located indoors, the room shall be ventilated in accordance with 3.2.8.1.

3.3.2.3 When the gas holder is not located within a heated building, gas holder seals shall be protected against freezing.

3.3.2.4 Means shall be provided to stop the generator feeding mechanism before the gas holder reaches the upper limit of its travel.

3.3.2.5 When the gas holder is connected to only one generator, the gas capacity of the holder shall be not less than one-third of the hourly rating of the generator.

3.3.2.6 Where acetylene is used directly from the gas holder, a hydraulic back-pressure valve shall be used between the gas holder and shop line.

3.4 **Portable Automatic Acetylene Generator**

3.4.1 *General*

3.4.1.1 All portable generators shall be of a type specifically approved for portable use and shall conform to the requirement specified in the Carbide of Calcium Rules, 1937, issued by the Government of India.

3.4.1.2 Portable generators shall not be used within 3 metres of combustible material other than floor.

3.4.1.3 Portable generators shall not be used in a room, the volume of which is less than 35 times the total gas generating capacity per charge of all the generators in the room. Generators shall not be used in rooms having a ceiling height of less than 3·00 m.

3.4.1.4 Portable generators shall be protected against the freezing of water in the generator and in its appurtenances. The use of common salt (sodium chloride) or other corrosive chemicals for protection against freezing shall not be permitted. (For hearing system, *see* 3.2.8.2).

3.4.1.5 The pressure in the generating apparatus shall not be increased above the designed pressure by placing weight on the generator or in any other manner.

3.4.2 ***Operation and Maintenance***

3.4.2.1 Portable generators shall be cleaned and recharged and the air mixture blown off outside buildings. In large, well-ventilated, one-storey buildings, special exceptions to this rule may be granted by the proper authorities.

3.4.2.2 When charged with calcium carbide, portable generators shall not be moved by crane or derrick unless necessary precautions are taken to prevent tilting or dropping.

3.4.2.3 When not in use, portable generators shall not be stored in any room in which open lights or fires are used unless such generators are free of carbide and thoroughly purged of gas. Storage rooms shall be ventilated to avoid the accumulation of acetylene.

3.4.2.4 When portable acetylene generators are to be transported and operated on vehicles, they shall be securely anchored to the vehicles. If transported by truck, the motor shall be turned off during charging, cleaning and generating periods.

3.4.2.5 Cleaning and repair of acetylene generators shall, as far as possible, be undertaken in daylight.

3.5 Calcium Carbide

3.5.1 ***Storage*** -The storage of calcium carbide shall conform to the requirements laid down in the Carbide of Calcium Rules, 1937 issued by the Government of India.

3.5.2 ***Containers and*** Packages-Calcium carbide shall be packed in metal containers of sufficient strength so as to permit handling without rupture and shall be provided with a screw top or its equivalent. The containers shall be constructed water and air-tight without the use of solder. However, solder may be used at such points as may be necessary in order to close small crevices which it is not possible to seal otherwise. Solder shall not be in used joints in such a manner that fire would disrupt the package.

NOTE- The metal from which the containers are made may contain not more than 0·1 percent of copper.

3.5.3 Marking- Packages containing calcium carbide shall be conspicuously marked ***' Calcium Carbide-Dangerous if not kept dry. The contents of this package are liable to give off a highly inflammable gas if brought into contact with moisture '.***

3.5.4 Opening Containers — Metal tools even so-called sparkless tools for opening calcium carbide containers, shall be used with caution to avoid

striking a spark; such a spark may cause ignition of an acetylene and au mixture.

3.5.5 *Handling* — Drums shall be handled in such a manner that they are not punctured or ruptured. Full drums of calcium carbide shall be used in rotation as received from the supplier.

3.5.5.1 All calcium carbide dust which is not usable shall be carefully removed from emptied containers and completely destroyed by immersion in not less than ten times its weight of water in a place in the open air at a safe distance from any flame.

3.5.5.2 The waste calcium carbide dust shall not be allowed to enter public drains or water courses.

3.5.6 ***Storage of Calcium Carbide Indoors***

3.5.6.1 *General* — Calcium carbide shall not be kept at any place containing impurities which will cause the evolution of any ignitable gas.

3.5.6.2 ***Storage building-Every*** building for the storage of calcium carbide shall be constructed of non-inflammable material with non-inflammable roofs and with tiled, paved? cemented, iron or steel floors raised at least 30 cm above the ground level. The buildings shall be well-ventilated and water-proofed.

3.5.6.3 ***Arrangements in storage buildings-*** Calcium carbide shall be stored only on racks or trestles standing at least 30 cm above the level of the floor of the building. No article of an inflammable or combustible nature shall be kept in the same building.

3.5.6.4 ***Storage -Calcium*** carbide shall be stored:

a) if in quantities aggregating not more than 225 kg -in a suitable un-inhabited building at least 6·0 m away from any other premises. However, quantities not exceeding 1 IO kg may be stored in a building connected with a shop at a distance not less than 3·0 mm from any other premises;

b) if in quantities aggregating more than 225 kg but not more than 1 350 kg-in a suitable uninhabited building at least 12·0 m away from any other premises; and

c) if in quantities aggregating more than 1 350 kg — in an un-inhabited building at least 18·0 m away from any other premises and at least 9·0 m away from any road.

Notices reading as follows, shall be displayed on the outside of the doors of the stores:

'Calcium Carbide — No naked light shall be brought near this store.'

NOTE 1 — The distances specified under 3.5.6.4 may be reduced suitably if warranted, provided screen walls are erected or other special precautions arc taken.

NOTE 2 -Not more than 1000×10^3 kg of carbide of calcium shall be stored in any one building, provided that not more than 250 x 10' kg of carbide of calcium is stored in any one room or other part of the building.

3.5.6.5 *Disposal of wet carbide* — If any carbide becomes wet, it shall be destroyed by being submerged in deep water. If deep water is not available, the wet carbide shall be spread out in the open in an isolated place and all precautions shall be taken to prevent any fire or artificial light or sources of ignition being brought near until the material has given off all its gas.

3.6 Service Piping Systems

3.6.1 *Material*

3.6.1.1 *General-Except* as provided under 3.6.1.2 and 3.6.1.3, all piping shall be of wrought iron, steel, brass, copper or other suitable material.

3.6.1.2 Oxygen *piping* -Black steel, wrought iron, brass or copper shall be used for oxygen piping up to a maximum working pressure of 3·5 kgf/cm". Black steel, brass or copper shall be up to a maximum working pressure of 2 1 ·0 kgf/cm². Piping meant to work at a pressure between 2 1 ·0 kgf/cm² and 140.0 kgf/cm² should be heavy gauge copper or approved steel tubing. Systems intended for a working pressure in excess of 140·0 kgf/cm² should be of extra heavy gauge copper or heavy gauge approved steel tubing.

All fittings and lengths of pipe for service lines shall be examined before assembly and, if necessary, hammered to free them from scale or dirt. They shall be washed out with a suitable non-flammable solution which would effectively remove grease and dirt. Hot solutions of tri-chlorethylene, caustic soda and tri-sodium phosphate solutions have been found effective cleaning agents for this purpose.

3.6.1.3 *Acetylene* Piping-Steels or wrought iron pipe shall be used for acetylene piping. Under no circumstances shall acetylene gas be brought in contact with metal containing more than 70 percent copper except in torches.

3.6.2 *Jointing*

3.6.2.1 Joints in steel or wrought iron pipe shall be welded, brazed or soldered or made up with threaded or flanged fittings. Rolled, forged or cast steel or malleable iron fittings may be employed.

3.6.2.2 Joints in brass or copper pipe may be welded, brazed or soldered or made up with threaded or flanged fittings; or if of the socket type, they may be brazed.

3.6.23 Joints in seamless copper, brass or other non-ferrous gas tubing shall be made. by means of suitable fittings; or, if of the socket pipe they may be brazed.

3.6.2.4 Threaded connections in oxygen piping shall be tinned or made up with litharge and glycerine (litharge and water are sometimes

used for service pressures over 21 ·0 kgf/cm²), applied to the male threads only.

3.6.3 *Installation*

3.6.3.1 All acetylene distribution installations shall be provided with suitably located shut-off valves for the isolation of the service-piping system or systems.

3.6.3.2 *Purifiers* — Purifiers shall be so designed that their walls resist attack by the purifying substance and they do not unduly impede the passage of the acetylene.

3.6.3.3 If acetylene is purified, the purifying substances shall not contain ingredients that form explosive substances with acetylene (*see* IS : 308-1962 *).

3.6.3.4 Sludge pits and drains for sludge from acetylene installation shall be open to the atmosphere and shall be adequately fenced.

3.6.3.5 The working of the acetylene installation shall be properly controlled. Generators and the conditions in which they operate shall not be modified without the approval of the competent authority.

3.6.3.6 Piping located inside or outside of buildings may be placed above or below ground. All piping shall be run as directly as practicable, carefully protected against injury, proper allowance being made for expansion and contraction, jarring and vibration. Pipe laid underground in earth shall be located below the frost line and protected against corrosion. After assembly, piping shall be thoroughly blown out with air or nitrogen to remove foreign materials. For oxygen piping oil-free oxygen, oil-free air or oil-free nitrogen shall be used.

3.6.3.7 Oxygen piping may be placed in the same tunnel, trench or duct with fuel-gas pipe lines, provided there is good natural or forced ventilation, but under no circumstances shall an oxygen pipe line be placed in a tunnel, trench or duct where it may be exposed to contact with oil.

3.6.3.8 Where, of necessity, low points occur in any piping carrying a moist gas, they shall be drained into drip pots constructed so as to permit pumping or draining out the condensate at necessary intervals, and provided with drain valves having outlets normally closed with screw caps or plugs. No open-end valve or pet-cocks shall be used, except that in drips located outdoors, underground, and not readily accessible, valves may be used at such points if they are equipped with means to secure them in the closed position. Pipes leading to the surface of the ground shall be encased or jacketed where necessary to prevent loosening or breaking.

3.6.3.9 When necessary, gas cocks or valves shall be provided for buildings at points where they would be readily accessible for shutting off

*Specification for dissolved acetylene (gas) (*revised*).

the gas supply to them in any emergency. Underground valve boxes or manholes shall be avoided wherever possible. When used, they shall be constructed so as to provide good natural ventilation. There shall also be provided a shut-off valve in the discharge line from the generator, gas holder, manifold or other source of supply.

3.6.3.10 When combustible gas lines or other parts of equipment are being purged of air or gas, open lights or other sources of ignition shall not be permitted within 6·0 *m* of uncapped openings.

3.6.3.11 No welding of additional hangers or supports to any oxygen or acetylene line shall be done until after the line has been thoroughly purged with air or nitrogen. Only oil-free oxygen, oil-free air, oil-free nitrogen or oil-free carbon dioxide shall be used to purge oxygen lines.

3.6.4 ***Testing*** -All high pressure piping and valve in the case of a dissolved acetylene factory shall be hydraulically tested to 49·0 kgf/cm² and before gas is compressed in dissolved acetylene cylinders, the high pressure system shall be purged with air.

3.6.4.1 Oxygen pipe lines shall be tested to 1·75 times the working pressure. But in case the working pressure is over 140·0 kgf/cm² they shall be tested to 1·6 times the working pressure. Oxygen piping to be used at a working pressure in excess of 21·0 kgf/cm² should be tested hydraulically with water before being tested by gas. Any medium used for testing oxygen pipe lines shall be free from oil. Naked lights shall not be used to detect leaks.

3.6.5 ***Painting and*** **Signs**

3.6.5.1 All buried pipe and tubing and all outdoor ferrous pipe and tubing shall be covered or painted to protect against corrosion.

3.6.5.2 All exposed oxygen pipe lines except copper pipes shall be identified by one colour of paint, and all exposed fuel-gas pipes by a different colour. Where more than one fuel-gas is employed, the pipe lines suppiying the different fuel-gases shall be identified by distinctive means.

3.6.5.3 Where colours are used as means for identification, a colour chart indicating the colours employed for this **purpose** shall be prominently displayed or the piping shall otherwise be identified.

3.6.5.4 All **outlet stations shall be identified suitably.**

3.6.5.5 Signs clearly establishing the location and identity of section shut-off valves shall be provided.

3.6.6 ***Hydraulic Back-Pressure Valves*** **- The terms ' hydraulic back-pressure valves ', ' hydraulic valves ' and ' hydraulic seals ' are used interchangeably.**

3.6.6.1 In low-pressure fuel-gas systems including acetylene, liquefied petroleum gas, city gas, natural gas, etc,where the gas, is piped at a pressure.

not in excess of 0·07 kgf/cm² an approved hydraulic back-pressure valve shall be employed at every point where gas is withdrawn from the piping system to supply a torch or machine. A shut-off valve shall be installed at the inlet of each hydraulic valve.

3.6.6.2 In fuel-gas systems where the gas is piped at a pressure in excess of 0·07 kgf/cm², ah approved service regulator, check valve or hydraulic back-pressure valve shall be employed at every point where gas in withdrawn from the piping system to supply a torch or machine. A shut-off valve shall be installed at the inlet of each hydraulic back-pressure valve, regulator or check valve.

3.6.6.3 The escape or relief pipe from hydraulic back-pressure valves shall be at least as large as the vent connection on the hydraulic back-pressure valve. The escape or relief pipe should be installed without lo v points where moisture may collect. If shop conditions make low points unavoidable, these points shall be provided with drip pots normally closed with screw caps or plugs. No petcocks shall be used.

3.6.6.4 The escape or relief pipe shall be carried full size to a suitable point outside the building and shall terminate in a hood or bend located at least 6·0 m above the ground, preferably above the roof, and as far as practicable from windows or other openings into buildings and also from sources of ignition, such as flues or chimneys and tracks used by steam locomotives. The hood or bend shall be so constructed that it is not obstructed by rain, snow, ice, insects or birds; the outlet shall be at least 90 cm from combustible construction. No valves shall be installed between the vessel and the safety valve nor in the safety valve discharge line.

3.6.6.5 Correct liquid levels in hydraulic back-pressure valves shall be maintained. Such liquid levels shall be checked at intervals frequexit enough *to ensure* correctness of the same. Permanent type anti-freeze may be used in hydraulic back-presssure valves for manifold branch line? and station outlet service, but not hydraulic back-pressure valves on acetylene generators.

3.6.7 ***Portable Outlet Headers-The*** term 'Portable outlet header' is used to mean any assembly of valves and connections used for service outlet purposes, which is connected to the service piping system by means of hose or other non-rigid conductors. Devices of this nature are commonly used at piers and drydocks in shipyards where it is not possible to locate the service piping close enough to the work to provide a direct supply.

3.6.7.1 Use of portable outle. headers shall be restricted to locations outdoors, and to temporary service where the conditions preclude a direct supply from outlets located on the service piping system.

3.6.7.2 Each outlet on the service piping from which oxygen or fuel-gas is withdrawn to supply a portable outlet header shall be equipped with a

shut-off valve located in a readily accessible position. The installation of a hydraulic back-pressure valve or non-return valve on the supply outlet of the fuel-gas service piping is some times desirable.

3.6.7.3 Hose used for connecting the portable outlet header to the service piping outlet shall comply with the requirements specified under 3.10.1 to 3.10.3 for torch hose.

3.6.7.4 Connection fittings for the supply hose shall comply with the requirements specified under 3.10.1.2 and 3.10.4. Connections for oxygen hose shall be of sufficiently different dimensions or patterns from that for fuel-gas to prevent intermixing in making a connection.

3.6.7.5 Outlet headers for fuel-gas service shall be provided with hydraulic back-pressure valves installed at the inlet ends preceding the service outlets unless an approved service regulator check valve or hydraulic back-pressure valve is employed at each outlet. Outlets provided on headers for oxygen service may be fitted for the use of pressure-reducing regulators or for direct hose connections.

3.6.7.6 If conditions necessitate, each service outlet on the portable header unit shall be provided with a valve assembly that includes a detachable outlet seal cap, chained or otherwise attached to the body of the valve.

3.6.7.7 Materials and methods of fabrication employed in the construction of portable outlet headers shall comply with the requirements specified under 3.6.1, 3.6.2, 3.6.4, 3.6.5.2 and 3.6.5.4.

3.6.7.8 Portable outlet headers shall be provided with frames which would support the equipment securely in its correct operating position, and protect it from injury during handling and operation.

3.7 **Storage, Handling and Use of Oxygen and Fuel-Gas Cylinders**

3.7.1 *Storage*

3.7.1.1 Cylinders shall be kept away from radiators and other sources of heat.

3.7.1.2 Inside buildings, cylinders shall, be stored in a well-protected, well-ventilated, dry location, well away from highly combustible materials, such as oil or excelsior. Cylinders shall be stored in definitely assigned places away from elevators, stairs or gangways. Assigned storage spaces shall be located where cylinders would not be knocked over or damaged by passing or falling objects. Cylinders shall not be kept in unventilated enclosures, such as lockers and cup-boards.

3.7.1.3 Cylinders containing oxygen and combustible gases, such as acetylene and hydrogen should not be stored in the same room. However, if stored in the same room under unavoidable circumstances, they should be kept far apart. Acetylene cylinders shall always be stored upright.

3.7.1.4 All cylinders shall be protected against excessive rise in temperature. Cylinders may be stored in the open, provided they are protected against inclemency of weather. During winter, cylinders stored in the open shall be protected against accumulation of ice or snow. Warm (not boiling) water shall be used to thaw ice in cylinder valve outlets. Cylinders stored in the *open* shall be screened against the continuous direct rays of the sun in localities where extreme temperatures prevail. Cylinders containing oxygen shall be stored separate from cylinders fuel-gases.

3.7.1.5 Full cylinders of oxygen and fuel-gas shall be used in rotation as received from the supplier.

3.7.1.6 Empty cylinders shall have their valves closed.

3.7.1.7 Valve protection caps, when provided for, shall always be in place, hand-tight, except when cylinders are in use or connected for use.

3.7.2 ***Handling***

3.7.2.1 When transporting cylinders by a crane or derrick, a cradle, boat or suitable platform shall be used. Slings or electric magnets shall not be used for this purpose. Valve-protection caps, when provided for, shall always be in place.

3.7.2.2 Cylinders may be moved by tilting and rolling them on their bottom edges; dragging and sliding shall be avoided. When cylinders are transported on a hand truck, they shall be secured in position. Cylinders shall not be dropped or struck, nor shall they be permitted to strike each other violently.

3.7.2.3 Valve-protection caps shall not be used for lifting cylinders from one vertical position to another. ***Bars*** shall not be used under valves or valve-protection caps to pry cylinders loose when frozen to the ground or otherwise fixed; the use of warm (not boiling) water is recommended. Valve-protection caps are designed to protect cylinder valves from damage. &fore raising cylinders provided with valve-protection caps from a horizontal to a vertical position, the cap shall be turned clockwise to see that it is hand-tight, then the cylinder shall be raised by grasping the cap.

3.7.2.4 A suitable cylinder truck,. chain or steadying device should be used to keep cylinders from being knocked over while in use.

3.7.2.5 Unless cylinders are secured on a special truck, regulators shall be removed and valve-protection caps, when provided for, shall be put in place before cylinders are moved.

3.7.2.6 Cylinder valves shall be closed before moving cylinders.

3.7.2.7 Cylinder valves shall be closed when work is finished.

3.7.2.8 Valves of empty cylinders shall be closed.

3.7.2.9 Cylinders shall be kept sufficiently far away from the actual welding or cutting operations so that sparks, hot slag, or flames might not reach them. Also acetylene cylinders shall always be kept with the outlet facing upwards.

3.7.2.10 Cylinders shall not be placed where they might become part of an electric circuit. Contacts with third rails, trolley wires, etc, shall be avoided. Cylinders shall be kept away from radiators, piping systems, layout tables, etc, that may be used for grounding electric circuits, such as for arc-welding machines. Tapping of an electrode against a cylinder to strike an arc shall be prohibited.

3.7.2.11 Cylinders shall never be used as rollers or supports, whether full or empty.

3.7.2.12 The numbers and markings stamped on cylinders shall not be tempered with.

3.7.2.13 Empty cylinders shall be marked 'empty' or 'MT' segregated from full cylinders and promptly returned to the supplier with valve-protection caps in place. All valves shall be closed.

3.7.2.14 No person other than the gas supplier shall attempt to mix gases in a cylinder. No one except the owner of the cylinder or person authorized for him shall refill a cylinder. No one shall use a cylinder's contents for purposes other than those intended by the supplier.

3.7.2.15 No one shall temper with the safety devices provided in cylinders or valves.

3.7.2.16 If an acetylene cylinder is heated accidentally or becomes hot due to excessive or severe back fire from use of faulty equipment, it shall be dealt with promptly as follows:

a) The valve shall be shut.

b) Regulator or other fittings shall be detached.

c) The cylinder shall be taken outdoors.

d) It shall be immersed in water or water shall be applied copiously.

e) The valve shall be opened and the cylinder kept cool in water until empty.

NOTE — As these operations may take **several hours, the suppliers should be contacted for further advice.**

3.73 *Fuel-Gas Cylinders*

3.7.3.1 Fuel-gases shall be called by their full names and not by the word **'gas'**

3.7.3.2 ***Storage***

a) Inside a building, cylinders except those in actual use or attached ready for use shall be limited to a gas capacity of 56 m^3 or 112 kg of liquefied petroleum gas. In large under-ventilated one-storey buildings, special exceptions to this rule may be granted by proper authorities.

b) For storage in excess of 56·00 m^3, total gas capacity of cylinders or 112 kg, of liquefied petroleum gas, a separate room or compartment conforming to the requirements specified under 3.2.5.2 and 3.2.5.3 shall be provided, or cylinders shall be kept outside or in a special building. The rooms or compartments of the special building for storage of gas cylinders shall have no open flame for heatmg or lighting and shall be well-ventilated. Signs reading, *'Danger — No* ***Smoking, Matches or Open*** *Lights'* (or other equivalent wording) shall be conspicuously pasted.

c) Fuel-gas cylinders shall be placed with valve-end up whenever they are in use. Acetylene cylinders shall be stored valve-end up.

3.7.3.3 The following special precautions shall be taken while storing liquefied petroleum gas:

a) No cylinders shall be stored below ground level or ***on*** the upper floors.

b) Between the storage shed and any building, public place, public road or any adjoining property which may be built upon, the following minimum distances shall always be maintained as a sefety zone, namely:

Quantity of Liquefied Petroleum Gas in Cylinders, kg	***Minimum Distances to be Kept Clear in Metres***
0 to 100	—
131 ,, 1000	3
1001 ,, 4000	5
4001 ,, 8000	7
8001 ,, 12000	9
12 001 ,, 30000	12
Over 30000	15

provided that the distances specified above may be reduced by the proper authorities (1) where screen walls are provided or other special precautions taken; or (2) where there are special circumstances which in their opinion would justify such reduction.

c) Liquefied petroleum gas exceeding 100 kg but not exceeding 300 kg may be kept in a storage shed forming part of, or attached to a building provided that it is separated therefrom by a substantial partition and the only means of access to it is from the

outside air. Such storage shed shall not be situated under any staircase, or near other entrances to, or exits from the rest of the building or other buildings.

d) No addition or alteration shall be carried out in the storage shed without the previous sanction in writing by the proper authority.

e) Sufficient number of fire extinguishers and adequate supply of sand shall be kept at the storage shed.

f) Empty cylinders which were being used for storing liquefied petroleum gas shall be kept in the approved storage shed, unless they have been thoroughly cleaned and freed from the inflammable gas.

g) The cylinders, if stored vertically, shall not be stored more than three high. If stored horizontally they shall not be stocked more than five high in the case of full cylinders and seven high in the case of empty cylinders.

3.7.3.4 *Use*

a) Fuel-gas cylinders shall be handled carefully. (Rough handling, knocks, or falls are liable to damage the cylinder, valve or safety devices and cause leakage.) Cylinders in use shall be held in position by straps, collars or chains to prevent them from falling over. The devices for holding the cylinders shall be such that it is possible to remove the cylinders rapidly in case of fire. Suitable designed equipment shall be used for transporting gas cylinders.

Before connecting a regulator to a cylinder valve, the valve shall be opened slightly and closed immediately. (This action is generally termed cracking.) This action is intended to clear the valve of dust or dirt that otherwise might enter the regulator. The valve shall be opened while standing to one side of the outlet, never in front of it.

A fuel-gas cylinder valve shall never be cracked near other welding work or near sparks, flame or other possible sources of ignition.

b) Before a regulator is removed from a cylinder valve, the cylinder valve shall always be closed and the gas released from the regulator.

c) Nothing shall be placed on top of an acetylene cylinder when in use which may damage the safety device or interfere with the quick closing of the valve.

d) If on opening the valve on a fuel-gas cylinder there is found to be a leak around the valve stem, the valve shall be closed and the gland nut tightened. If this does not stop the leak, the use of the cylinder shall be discontinued, and the same removed outdoors, properly tagged and the supplier advised. In case the fuel-gas leaks from the cylinder valve, and it is not possible to shut it off with the valve stem, the cylinder shall be removed outdoors, properly tagged and the supplier advised. A regulator may be attach-

ed to a cylinder valve to stop temporarily a leak through the valve seat.

e) If a leak should develop at a fuse plug or other safety device, the cylinder shall be removed outdoors, well away from any source of ignition; the cylinder valve shall be opened slightly and the fuel-gas allowed to escape slowly.

f) A warning shall be placed near the cylinders having leaking fuse plugs or other leaking safety devices not to approach them with a lighted cigarette or other source of ignition. Such cylinders shall plainly tagged, the supplier promptly notified and his instructions followed as to their return.

g) Safety devices shall not be tempered with.

h) Fuel-gas shall never be used from cylinders through torches or other devices equipped with shut-off valves without reducing the pressure through a'suitable regulator attached to the cylinder valve or manifold.

j) The cylinder valve shall always be opened slowly.

k) An acetylene cylinder valve shall not be opened more than 1½ turns of the spindle.

m) Where a special wrench is required, it shall be left in position on the stem of the valve while the cylinder is in use so that the fuel-gas flow may be quickly turned off in case of emergency. In the case of manifolded or coupled cylinders at least one such wrench shall always be available for immediate use.

3.7.4 Oxygen *Cylinders*

3.7.4.1 The following important precautions shall be observed:

a) Oxygen shall always be referred to by its name 'Oxygen' and not by the word air. Oxygen does not bum, but supports and accelerates combustion and, therefore, causes oil and other similar materials to bum with great intensity. Oil or grease in the presence of oxygen under pressure may ignite violently.

Warning -A serious accident may easily result if oxygen is used as a substitute for compressed air. Oxygen shall not be used in pneumatic tools, in oil pre-heating burners, to start internal-combustion engines, to blow out pipe lines, to dust clothing or work, to create pressure or for ventilation.

b) Cylinders, cylinder valves, couplings, regulators, hose and apparatus shall be kept free from oily or greasy substances. Oxygen cylinders or apparatus shall not be handled with oily hands or gloves. Oxygen cylinders shall not be handled on the same platform with oil or placed in position where oil or grease from overhead cranes or belts is likely to fall upon them. A jet of oxygen

shall not strike an oily suffice, greasy clothes, or enter a fuel oil or other storage tank.

3.7.4.2 Storage -Oxygen cylinders shall not be stored near (a) highly combustible material, especially oil and grease; (b) reserve stocks of calcium carbide, and acetylene or other fuel-gas cylinders; (c) any other substance likely to cause or accelerate fire; and (d) in an acetylene generator compartment.

3.7.4.3 *Use*

a) Oxygen cylinders shall not be dropped or otherwise roughly handled.

b) Unless connected to a manifold, oxygen from a cylinder shall not be used without first attaching an oxygen regulator to the cylinder valve. Before connecting the regulator to the cylinder valve, the valve shall be opened slightly for an instant and then closed. This action is intended to clear the valve of dust or dirt that otherwise might enter the regulator. The cylinder valve shall be opened while standing to one side of the outlet.

c) A hammer or wrench shall not be used to open oxygen cylinder valves. If it is not possible to open the valves by hand, the supplier shall be notified.

d) Oxygen cylinder valves shall not be tempered with nor shall any attempt to repair them be made. If trouble is experienced, the supplier shall be sent a report promptly indicating the character of the trouble and the cylinder's serial number. The supplier's instructions as to its return shall be followed.

e) After a regulator is attached, an oxygen cylinder valve shall be opened slightly at first so that the regulator cylinder-pressure-gauge hand moves up slowly; then the valve shall be opened all the way. If the high pressure is suddenly released, it is liable to damage the regulator and pressure gauges. The cylinder valve shall be opened while standing to one side of the regulator and not in front of the glass covered gauge faces.

f) When the oxygen cylinder is in use, the valve shall be opened fully (in the case of diaphragm-type valve) in order to prevent leakage around the valve stem Complete removal of stem from a diaphragm-type cylinder valve shall be avoided.

3.8 Manifolding of Cylinders

3.8.1 *General*

3.8.1.1 Cylinders are manifolded for the purpose of centralizing the gas supply, to provide a continuous supply of gas and to provide gas at a rate in excess of that which may be obtained from a single cylinder. Such manifolds shall be of substantial construction and of a design and materials.

suitable for the particular gas and service for which they are to be used. The wide range of pressures involved in the gases used, which range from the relatively, low pressures of some of the fuel-gases to the high pressures needed for oxygen, makes it necessary that care be employed in the construction, installation and maintenance of manifolds. It is advisable to obtain manifolds from, and have them installed under the supervision of those familiar with the proper practices with reference to their construction and use.

3.8.1.2 All component parts used in the methods of manifolding described under 3.8.2 shall be approved with regard to materials, design and construction either separately or as an assembled unit.

3.8.1.3 All manifolds and parts used in methods of manifolding shall be used only for the gas or gases for which they are approved.

3.8.1.4 When acetylene cylinders are coupled, approved flash arresters shall be installed immediately after the pressure-reducing device which shall be fitted to the outlet valve of the couplers.

3.8.1.5 Each fuel-gas cylinder lead should be provided with a backflow check valve if more than three fuel cylinders are coupled together.

3.8.1.6 The aggregate capacity of fuel-gas cylinders connected to a portable manifold inside a building shall not exceed 56·00 m^3 of gas.

3.8.1.7 Acetylene and liquefied fuel-gas cylinders shall be manifolded in a vertical position.

3.8.2 *Manifolding of Cylinders for Direct Supply to Consuming Devices*

3.83.1 In one type of manifolding, the gas passes from the cylinders through individual cylinders leads to a single common coupler block and from there through a single common pressure-reducing regulator to the consuming device.

3.8.2.2 In a second type of manifolding, the cylinders are con&ted together in sequence. The individual cylinders are provided with coupler tees attached to the cylinder valve. The gas content of each cylinder passes through the coupler tee and joins the main gas stream flowing through a common line composed of leads joining coupler tee to successive coupler tee. A properly supported regulator serves the entire group of connected cylinders.

NOTE — The units described under **3.8.2.2** and 3.6.2.3 arc generally called portable manifolds.

3.8.2.3 The aggregate capacity of fuel-gas cylinders connected as a unit inside a building as described in 3.8.2.1 or 3.8.2.2 shall not exceed 56·00 m^3 of gas or 112 kg in the case of liquefied petroleum gas (*See* Note under 3.8.2.2).

3.8.3 *Manifolding of Cylinders for Shop Pipe Line Supply Systems*

3.8.3.1 Cylinders are manifolded for shop pipe line supply systems by means of substantially supported stationary pipe-type headers to which a number of cylinders are connected by means of leads. One or more permanently mounted regulator serve to reduce and regulate the pressure of the gas flowing from the cylinders to the point or points of consumption. Such stationary manifolds shall comply with **3.8.3.2** and 3.8.4.

3.8.3.2 Fuel-gas manifolds (acetylene, liquefied fuel-gases and non-liquefied fuel-gases other than acetylene) shall comply with the following requirements:

a) Only cylinders containing fuel-gas at approximately equal pressure shall be manifolded.

b) Fuel-gas cylinders may be manifolded inside a building provided the following conditions are satisfied:

1) Adequate ventilation is provided in the part where they are manifolded;

2) No flame is brought near its vicinity; and

3) The portion of the building, where such manifolding is done, is separated from the rest of the building by means of a suitable flame-proof partition wall.

3.8.3.3 Special buildings or rooms, if provided, shall have no other occupancy except that they may be used for the storage of cylinders containing fuel-gaps and drums of calcium carbide. Such buildings or rooms shall have no open flames for heatmg or lighting and shall be well-ventilated.

3.8.4 Oxygen *Manifolds*

3.8.4.1 Oxygen manifolds shall not be located in an acetylene generator room, nor in close proximity to cylinders of combustible gases. Unless well separated, there shall be a fire-resistive partition of *one* of the types of construction listed under 3.2.5.2 between the oxygen manifold and the combustible gas cylinders. Oxygen manifolds shall be located away from highly inflammable material oil, grease or any substance likely to cause or accelerate fire.

3.8.4.2 Oxygen manifolds to which cylinders having an aggregate capacity of more than 170·00 m^3 of oxygen are connected shall preferably be located outside or in a special building. If located inside a building having other occupancy, such manifolds shall be located in a separate room of fire-resistive construction or in an area of fire-resistive construction with no combustible material within 6·0 m of the manifold.

3.8.5 *Liquid Oxygen* — Where liquid oxygen m a quantity exceeding 4501 kg is to be used for welding and cutting, the container or containers should preferably be located outside or in a special building having no other occupancy except that related to the handling and gasification of the oxygen.

3.9 Pressure-Reducing Regulators

3.9.1 Regulators or automatic reducing valves shall be used only for the gas and at pressures for which they are intended.

3.9.2 Pressure-adjusting screws on regulators shall always be fully released before the regulator is attached to a cylinder and the cylinder valve opened.

3.9.3 When repairs to regulators or parts of regulators, such as gauges, are necessary, such repairs shall be performed only by skilled mechanics. Working of low-pressure gauges attached to regulators shall be periodically tested to ensure their accuracy. Oxygen gauges shall not be tested with oil. In general it is best to return regulators to the supplier for repairs, calibrations or adjustments.

3.9.4 Union nuts and connections on regulators shall be inspected before use to detect faulty seats which may cause leakage of gas when the regulators are attached to the cylinder valves. When damaged nuts or connections are found, they shall be removed from service.

3.10 Hose

3.10.1 Hose for welding and cutting operations shall conform to IS : 447-1964* or IS : 3572-1966†.

3.10.1.1 Red is the generally recognized colour for acetylene and other fuel-gas hose and green or black for oxygen hose.

3.10.1.2 Screwed coupling on these hoses shall have different threads and shall be plainly marked to avoid interchanging the hose.

3.10.2 A single hose having more than one gas passage, a wall failure of which would permit the flow of one gas into the other gas passage, shall not be permitted. However, hoses joined by a web so as to form integral lengths of double hose may be accepted provided that the hoses are easily distinguished from each other by labelling (*not* readily removable, and at intervals not greater than 2·0 m on at least one of the divisions or sides of the dual hose with the name of the gas for which the division or side is intended, such as oxygen or acetylene, and provided further that there is supplementary identification by (a) different colours for the

* Specification for welding and cutting hose of rubber with woven reinforcement (*revised*) . (Second revision in 1968) .

†Specification for braided welding and cutting hose of rubber. (Since revised).

exterior or interior of the divisions or sides, or (b) feel or touch (that is, smoother versus ribbed or rough exterior wall surface).

When parallel lengths of oxygen and acetylene hose are taped together for convenience and to prevent tangling, not more than 10·0 cm out of every 20·0 cm shall be covered with tape.

3.10.3 Hose connections shall be made through substantial fittings, and clamped or otherwise securely fastened to these connections in such a manner as to withstand without leakage a pressure twice as great as the maximum delivery pressure of the pressure regulators provided on the system.

3.10.4 Hose shall not be crimped or kinked. Hose shall not be bent or otherwise deformed to control the pressure. Only torch, regulator or cylinder valves shall be used to control the flow of gas.

3.10.5 After connecting welding or cutting apparatus to oxygen and fuel-gas cylinders, or when starting to re-use the apparatus after an interval of one-half hour or more, each gas shall be allowed to flow through its respective hose separately for a few seconds so as to purge the hose of any mixture of gases. This operation shall not be performed in a confined space.

3.11 Blow Pipes

3.11.1 A blow pipe of the injector type intended for use with low pressure shall not be used in connection with high pressure acetylene unless a suitable control valve is fitted. A blow pipe of the non-injector type intended for use with high pressure shall not be used with low pressure acetylene.

3.11.2 All blow pipes and other apparatus shall be dismantled and cleaned internally at regular periods, preferably by the makers. The apparatus shall be maintained in proper working order.

3.11.3 Accumulation of slag on the blow-pipe-tip shall be frequently removed. No attempt should be made to alter or clean the blow-pipe-tip by a hard metal reamer; only hard wood sticks or soft brass wire shall be used for this purpose.

3.11.4 Cylinders shall not be used to support the work, nor shall the blow-pipe game be allowed to come in contact with the cylinders. The blow-pipe when alight shall not be hung on the cylinder or on the regulator.

4. INSTALLATION AND OPERATION OF ARC-WELDING AND CUTTING EQUIPMENT

4.1 General

4.1.1 Workmen designated to operate arc-welding equipment shall have

a thorough knowledge of requirements with regard to safety and shall have been judged competent by their employers before taking charge.

C1.2 Before starting operations, all connections to the machine shall be checked to make certain that they are properly made. The work lead shall be attached firmly to the work. Laying work connections loosely on the work should be avoided. Work leads should be as short as possible. The welding machine frame shall be grounded.

4.1.3 *Electric Shock* -The following precautions shall be taken to prevent electric shock:

a) Welders shall be instructed the method of avoiding electric shock. Voltages required for arc-welding are low and normally would not cause injury or severe shock. Hence, parts having these voltages are liable to be handled carelessly. These voltages are, nevertheless, sufficiently high that under certain circumstances they may be dangerous to life. This danger is particularly marked in very hot weather, when the welder is sweaty or when he is wet. The welder shall develop the habit of always keeping his body insulated from both the work and the metal electrode and holder. He shall always wear shoes and gloves. Particularly, he shall never permit the metal part of an electrode, the electrode coverings, or any metal part of the electrode holder to touch either his bare skin or any wet coverings on his body. Consistent use of electrode holders with well-insulated jaws, well-insulated cables, dry protective coverings on the hands and body and insulations from ground would be helpful in avoiding contact. It shall never be assumed that because contact with the electrode at one time is not harmful, similar contacts at other times would also be harmless.

b) Electrodes shall be removed from holders when not in use to eliminate danger of electrical contact with persons or conducting objects. Electrode holders when not in use shall be so placed that possibilities of electrical contact between them and persons or conducting objects are eliminated.

c) Welders and welding supervisors shall check their equipment regularly to see that electrical connections and insulation on the holders and cable are in good order. Anything that appears unsafe shall be promptly reported to the proper authority, and use of such equipment shall be discontinued until its safety has been assured. Repairs shall be made only by qualified personnel

4.2 Equipment

4.2.1 *General*

4.2.1.1 The arc-welding machines covered in this code are the principal types used for manual, semi-automatic and automatic arc-welding. They

include dc, single-operator, variable-voltage welding generators; dc, multiple-operator, constant-voltage machine; and ac, single- or multiple-operator, welding transformers.

4.2.1.2 Arc-welding apparatus shall be of suitable quality.

4.2.1.3 Standard machines shall be designed and constructed to carry their rated load under rated temperature rises, when and where the temperature of the cooling medium does not exceed 40°C and where the altitude does not exceed 1 000-0 m.

Conditions surrounding arc-welding usually involve damaging features that shall be specially considered in the construction of welding apparatus. A machine conforming to these standards shall, therefore, be suitable for operation when the following conditions prevail:

a) Exposure to gases and dust produced by arc, and

b) Exposure to salt or moist air as on board a ship or on sea coast.

4.2.1.4 Unusual service conditions may exist, and under such circumstances machine shall be specially designed to safely meet the requirements of the safety service. Chief among these conditions are:

a) exposure to unusually corrosive fumes,

b) exposure to steam or excessive humidity,

c) exposure to excessive oil vapour,

d) exposure to inflammable gases,

e) exposure to abnormal vibration or shock,

f) exposure to excessive dust, and

g) exposure to weather.

4.2.1.5 Open-circuit voltage (no-load voltage) of arc-welding machines should be as low as possible consistent with good welding and the types of electrode used, and should not exceed the following limits:

Type of Machine	*Voltage Max*
a) Single-operator, dc welding machines	loo
b) Constant-voltage, multiple-operator, dc welding machines	75
c) ac welding machines	100

It is possible to provide reliable control equipment to automatically reduce the no-load voltage on transformer-type welding machines. This equipment is available for use where welders are working on wet steel or in confined quarters or under other severe conditions where there may be greater

probability of the welder getting across the open-circuit voltage. Such controls shall be used when the voltages specified above are exceeded.

4.2.1.6 Special-service, voltage-reducing resistors, such as may be used for working from trolley voltage of 250 to 560 volts direct current, shall have protective means provided for automatically disconnecting them from the source of power during off-arc periods.

4.2.1.7 Single wound transformers (auto transformers) shall not be used to draw welding current directly from any ac power circuit having a voltage exceeding 100 volts.

4.2.2 *dc Arc-Welding Generators and Motor Generator Sets*

4.2.2.1 dc arc-welding generator sets shall conform to IS : 2641-1964*.

4.2.2.2 A suitable motor starter of the hand or magnetic type, having an ampere rating equal to the ampere rating of the motor, shall be used. It shall be mounted integrally with the motor generator and connected to operate the motor and shall be capable of interrupting stalled rotor current of the motor. The starter shall have over load and low voltage protection incorporated.

4.2.2.3 A suitable means of control for varying the welding current over the specified welding range shall be provided. A suitable current indicating device which shows the welding current corresponding to the setting of the generator control shall be provided.

4.2.2.4 All parts of the motor and generator equipment shall be suitably enclosed and protected to meet the usual service conditions defined under 4.2.1.3.

4.2.2.5 Neither terminal of the welding generator shall be bonded to the frame of the welding machine.

4.2.2.6 The following minimum information, as applicable, shall be given on the name plates of dc, variable-voltage generator and motor-generator arc-welding machines:

a) Manufacturer's name;

b) Type, designation and serial number of the machine;

c) Output volts at rated amperes output;

d) Rated amperes output;

e) Rated duty cycle;

f) Temperature rise in °C;

g) Speed in rev/min at rated load;

h) Frequency of power supply;

*Specification for electrical welding accessories.

j) Number of phases of power supply;

k) Voltages of power supply; and

m) Input amperes (rating of motor and starter) at generator rated load.

4.2.3 *ac Arc-Welding Machines*

4.2.3.1 An ac arc-welding machine shall be a completely assembled, compactly mounted unit of the oil-cooled or air-cooled type comprising the equipment necessary for furnishing alternating current electrical energy to the welding circuit.

4.2.3.2 Transformers shall conform to IS : 1851-1966*. The secondary circuit shall be thoroughly insulated from the primary. Cooling may be accompanied by natural or forced draught.

4.2.3.3 Control apparatus shall meet the following requirements:

a) All control apparatus shall be enclosed except for the operating wheels, levers or handles;

b) Any arrangements for changing primary taps shall be enclosed with a cover which could be opened only with tools; and

c) Control handles and wheels shall be large enough to be easily grasped by a gloved hand.

4.2.3.4 Any panels or mountings for current-carrying parts shall be of suitable insulating material.

4.2.3.5 Input terminals shall be completely enclosed and accessible only by means of tools. The primary side of the welding machine shall be provided with suitable wire terminals inside the machine case for the connection of conductors of at least the minimum size required, corresponding to the rating of the welding machine.

4.2.3.6 Welding (secondary) terminals shall be so arranged that no current-carrying parts are exposed to accidental contact.

4.2.3.7 All parts involved in the construction of the unit shall be enclosed in a substantial metal housing, mounted on a base, feet or wheels.

4.2.3.8 The rating of transformer-type, arc-welding machines shall be based on tap connections giving the rated open-circuit voltage and rated current. Where taps are provided giving higher primary input at rated secondary current, reduced capacity ratings shall be specified for these taps.

4.2.3.9 A disconnecting switch shall be provided at or near each welding machine which is not equipped with a disconnecting switch mounted as an integral part of the welding machine. The disconnecting switch shall

*Specification for single operator type arc welding transformers (*first revision*).

be a motor-circuit switch or a circuit breaker. The ampere rating shall be not less than the rated primary current of the welding machine. The horsepower rating of a switch used as a controller shall be not less than the numerical value obtained by multiplying the rated primary current of the welding machine by 0·1, 0·2 or 0·25, respectively, for 220-, 440- and 550-volt machines. These factors apply to P-pole switches.

4.2.3.10 All terminal connections, tap connections and control shall be plainly and permanently marked to designate their purpose and correct usage. The following minimum information shall be given on the name plates of transformer-type arc-welding machines:

a) Manufacturer's name;
b) Type, designation and serial number of the machine;
c) Frequency;
d) Primary volts;
e) Maximum input (primary) amperes (at rated output amperes);
f) Output volts at rated amperes output;
g) Rated amperes output;
h) Rated duty cycle or time rating;
j) Temperature rise in °C; and
k) Open-circuit voltage.

4.2.4 Manual Electrode Holders

4.2.4.1 Manual electrode holders shall conform to IS :2641-1964*.

4.2.4.2 Any current-carrying parts passing through the portion of the holder which the welder grips in his hand shall be fully insulated against the maximum voltage encountered to ground. Insulation of all metallic or current-carrying parts, including the jaws which grip the electrodes, is recommended wherever service conditions permit.

4.2.4.3 The dipping in water of hot electrode holders whether connected or not shall not be permitted as the retained moisture may cause an electric shock.

4.2.5 *Welding Service Cable and Connectors*

4.2.5.1 All welding cables shall conform to the requirements of IS: 434 (Part I)-1964† and shall be of the completely insulated, flexible type, capable of handling the maximum current requirements of the work in progress, taking into account the duty cycle under which the welder is working. Minimum cable sizes which may be used to carry the current specified shall conform to the requirements specified in IS : 434 (Part I)-1964†.

*Specification for electrical welding accessories.
†Specification for rubber-insulated cables: Part I With copper conductors (*revised*).

4.2.5.2 The cable shall be free from repair or splices up to a minimum distance of 3·0 m from the electrode holder.

4.2.5.3 When it becomes necessary to connect or splice lengths of the cable to another, substantial insulated connectors of a capacity at least equivalent to that of the cable, shall be used. If connections are effected by means of cable lugs, then these shall be securely fastened together by more than one bolt to give good electrical contact. The exposed metal parts of the lugs shall be completely insulated.

4.3 Installation

4.3.1 *General* — Installation, including power supply, shall conform to the requirements laid down in the Indian Electricity Act, 1910.

43.2 ***Earthing of Welding Machine Case*** --The frame or case of the welding machine shall be efficiently earthed in accordance with the Indian Electricity Rules, 1956.

4.33 ***Rating of Suppiy Conductors*** — For individual welding machines, the rated current-carrying capacity of the supply conductors shall be not less than the maximum primary current of the welding machines.

4.3.4 ***Earth Returns***

4.3.4.1 Welding current should preferably be returned to the welding machine by a single cable from the work to the welding machine. Connection of a cable from the welding machine to a common conductor or structure on which the work rests, or to which the work is connected may be permitted.

4.3.4.2 Pipe lines containing gases or inflammable liquids or conduits carrying electrical conductors shall not be used for a ground return circuit. Chain or wire rope shall not be used to carry welding current.

4.3.4.3 When a building structure or pipe line is used as a ground return circuit, it shall be checked to ascertain whether proper electrical contact exists at all joints. Sparking or heating at any point shall cause the rejection of the structure or the pipe line as a ground circuit, particularly if inflammable vapours or gases are present.

4.3.4.4 Where a structure or pipe line is continuously employed as a ground return circuit, all joints shall be bonded and appropriate periodic inspection shall be conducted to ascertain that no condition of electrolysis or fire hazard exists by virtue of such usc.

4.3.4.5 All earth connections shall be checked to determine that they are mechanically strong and electrically adequate for the required current. The earthing clamps shall conform to IS : 2641 - 1964*.

*Specification for electrical welding accessories.

4.4 Operation and Maintenance

4.4.1 *General*

4.4.1.1 All arc-welding equipment shall be maintained in safe working order at all times. Periodic inspection shall be conducted.

4.4.1.2 Printed rules and instructions covering operation and maintenance of equipment supplied by the manufacturers shall be strictly followed.

4.4.1.3 When the welder has occasion to leave his work or stop work for any appreciable time, or when the machine is to be moved, the power supply switch in the equipment shall be open. The equipment shall be disconnected from the source of power when not in use.

4.4.1.4 Welding equipment shall be maintained in good mechanical and electrical condition to avoid unnecessary hazards. Commutators shall be kept clean to prevent excessive flashing. Gasoline and other inflammable liquids shall not be used for cleaning commutators. Fine sand paper, such as No. 00 or commutator polish shall be used.

4.4.1.5 Welding equipment used in the open shall be protected from inclement weather conditions. Protective coverings shall not obstruct the ventilation necessary to prevent overheating of the machine. When not in use, the equipment shall be stored in a clean dry place. Machines which have become wet shall be thoroughly dried before being used.

4.4.1.6 It is good practice to blow out the entire generator type welding machine occasionally with clean, dry compressed air.

4.4.1.7 Electrical holders shall be provided with discs or shields to protect the hands of the operator from the heat of the arcs.

4.4.2 *Cable*

4.4.2.1 When, in the course of work, a cable (either work lead ore electrode lead) becomes worn, exposing bare conductors, the portion thus exposed shall be adequately insulated.

4.4.2.2 Welding cables shall be kept dry where practicable, and free from grease and oil to prevent premature breakdown of the insulation.

4.4.2.3 When it becomes necessary to carry cables some distance from the machines, they shall be substantially supported overhead, if practicable. If this is not possible, and cables are laid on the floor or ground, they should be protected in such a manner that they would not be damaged, entangled or interfere with safe movement of people. Special care shall be taken to see that welding supply cables are not in proximity to power sup ply cables or other high-tension wires.

5. INSTALLATION AND OPERATION OF RESISTANCE WELDING EQUIPMENT

5.1 General

5.1.1 All equipment shall 'be installed by a qualified electrician, in accordance with the Indian Electricity Act, 1910. There shall be safety-type disconnecting switch or such other equivalent device (such as a circuit interrupter), opening all the power circuit breaker or circuit to the machine. The device shall be conveniently located at or near the machine so that the power may be shut-off when the machine or its controls are to be serviced.

5.1.2 Workmen designated to operate such resistance welding equipment shall be properly instructed and judged competent, before they are allowed to operate such equipment,

5.2 Resistance Welding Machines

5.2.1 All external weld initiating control circuits shall operate on voltage not over 120 volts.

5.2.2 In the case of stored energy or condenser discharge type of resistance welding equipment, control panels involving voltages over 550 volts shall be suitably insulated and protected by complete enclosures. The doors of these shall be provided with suitable locks or interlocks so as to make the equipment safe from any residual charge in the condensers. A manually operated switch shall also be installed so as to provide an additional safety measure, thus assuring discharge of all the condensers.

5.2.3 The back doors of machines and panels shall be kept locked or interlocked to prevent tempering by unauthorized persons.

5.3 Portable Welding **Machines** -Wherever possible welding guns shall have suitable, counter-balanced devices for supporting the gun, including secondary leads.

5.4 Flash-Welding Equipment

5.4.1 Flash-welding machines shall be equipped with a hood to control the flying gash. In cases of high production, including handling of oily parts, adequate ventilating system shall be installed to carry of the metallic dust and oil fumes.

5.42 Controls of all automatic or air and hydraulic clamps should be so arranged as to prevent the operator from closing the clamps with his hands on the work or on the clamps during closing operations.

55 **Hazards** and **Precautions** — A careful job-analysis of the operations to be performed on each welding machine, shall be made and the safeguards and personal protective equipments which have to be used for each job, shall be determined.

6. FIRE PREVENTION AND PROTECTION*

6.1 Basic Precautions

6.1.1 Where practicable, the object to be welded shall be moved to a safe location designated for welding.

6.1.2 If the object is such that it is not possible to move it readily, all movable fire hazards in the vicinity shall be taken to a safe place.

6.1.3 If it is neither possible to move the object nor is it possible to move all the fire hazards to a safe place, then guards shall be used to confine the heat, sparks and slag, and to protect the immovable fire hazards.

6.1.4 If it is not possible to follow the requirements stated under 6.1.1, **6.1.2** and 6.1.3, no welding or cutting shall be performed.

6.3 Special Precautions

6.2.1 When the nature of work to be performed falls under the conditions given under 6.13, certain additional precautions shall be taken.

6.2.2 After combustible floors have been swept clean, they shall be protected by thoroughly wetting with water, covering with damp sand, sheet metal, asbestos, etc, or such other equivalent material. Provisions shall be made to protect welders from the hazard of shock when floors are wet.

6.2.3 Suitable, incombustible tables, jigs or work-places shall be provided for support of small or moderate size work during welding and cutting operations. Such operations should not be undertaken on work resting directly on concrete floors.

6.2.4 Wherever there are floor openings or cracks which are not possible to close, it is advisable to make certain that there are no highly combustible materials on the floor below to ensure that there is no fire hazard due to spark which might drip through to the floor. This precaution shall also be observed with regard to cracks or holes in walls, open door-ways and.open or broken windows.

6.2.5 Suitable fire-extinguishing equipment, such as pails of water, buckets of sand, hose lines or portable extinguishers shall be kept in readiness for instantaneous use. Care shall be taken to maintain them in good working condition at all times.

6.2.6 Additional personnel may be stationed as fire watchers, if required, not only while the actual welding or cutting operations are being performed but also for a sufficient period of time after completion of the work to ensure that no fire exists. This period may vary from 30 minutes to several hours, depending on the site conditions.

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*For more details regarding fire precautions reference may be made to IS : 3016-1965 ' Code of practice for fire precautions in welding and cutting operations '.

6.2.7 Where unusual fire hazard conditions prevail_, the site shall be inspected by a qualified person and welding and cutting coming within the scope of6.1.2 and 6.1.3 authorized before any work is started.

6.3 Welding or Cutting Containers

6.3.1 Welding or cutting operations on containers filled with explosive or inflammable substances shall be prohibited except in certain particular cases where all appropriate safety precautions have been taken and subject to any conditions imposed by the competent authority in particular for:

a) the repair by the electric welding process of water-sealed gas-holders where such gas-holders contain town gas, coal gas, furnance gas or similar inflammable gases other than acetylene at more than the atmospheric pressure;

b) urgent repairs *in the* open air of gas mains, where such gas mains contain town gas, coal gas, furnace gas or similar inflammable gases, other than acetylene at more than atmospheric pressure; and

c) such repair of pipes in oil refinery as is essential for safety.

6.3.2 If parts of installations subjected to great stresses, such as steam boilers and other pressure vessels, are to be repaired by welding, then such repairs shall be carried out by welders authorized for such work by a competent authority; and only such methods, equipment and filler metal as have been declared permissible for such purposes by the competent authority shall be used.

6.3.3 If an inert gas is used for purging, after the vessal has been filled, the gas should be allowed to flow slowly into it throughout the welding or cutting operation.

6.3.4 All hollow spaces, cavities or containers shall be vented to permit the escape of air or gases before preheating, cutting or welding. Purging with inert gas is recommended.

6.3.5 Welding of oil drums, motor car petrol tanks or any other contain. ers which might at any time have contained a liquid giving off and inflammable gas shall not normally be permitted. However, in case welding of such containers is absolutely necessary, the following precautions shall be taken before welding them:

a) They shall be thoroughly degreased using an alkaline or any other type of degreasing solution;

b) They shall then be thoroughly rinsed with hot water and allowed to dry for a few days;

cj After drying and before welding, they shall be purged thoroughly for a period of at least five minutes with an inert gas; and

d) The inert gas shall be allowed to flow through the container under a positive pressure while welding is taking place.

6.4 Sprinkler Protection - Where sprinkler protection exists, it shall be maintained without interruption while welding or cutting work is being performed. If welding or cutting is to be done quite close to automatic sprinkler heads, sheet asbestos or damp cloth guards shall be used to shield the individual heads temporarily.

7. PROTECTION OF PERSONNEL

7.1 General

7.1.1 In every factory all floors, steps, stairs, passages and gangways shall be of sound construction and properly maintained. These shall be provided with suitable hand-rails wherever necessary.

7.1.2 Safe means of access shall be provided to every place at which any person is at any time required to work as far as practicable.

7.1.3 A welder or helper working on platforms, scaffolds or runways shall be protected against falling. This may be accomplished by the use ofrailings, safety belts, life lines, or such other equally effective safeguards. Life belts and similar devices shall be of a type that will permit quick escape of the workman.

7.1.4 Automatic and semi-automatic resistance welding machines shall, where practicable, be equipped with gate guards or two-handed tipping devices so designed as to prevent the hands of the operator from reaching the danger zone after the pressure control has been actuated.

7.1.5 All portable welding equipment, such as gas cylinders, hoses, electric cables, etc, shall be so installed at the working place as to prevent all risks of the equipment, falling or tipping and of persons stumbling or tipping.

7.1.6 It shall be strictly prohibited to use any compressed gas or compressed air to clean dust, dirt, etc, of worker's clothes when these are being worn.

7.2 Protective Equipment*

7.2.1 The object of protective equipment is to protect the eyes and face from heat and the injurious effects of the rays (infra red, visible light and ultra voilet) given off from the electric arc. They should, therefore, be constructed of heat-resisting, non-ignitable material which is also impervious to the harmful rays. They shall be light for convenience in use, and strong to withstand rough service. The minimum amount of metal shall be used in their construction, particularly on the outside of the shield, for example, there should be no metal frame for the glass either on the outside or on the inside; metal rivets should not be used unless one end is covered by an insulating material, as these may be the means of causing electric shock.

*For more details regarding protective equipment, reference may be made to IS : 1179-1967 'Equipment for eye and face protection during welding (First revision) .

7.25 Head shields shall be fitted with an adjustable band to fit the wearer's head. This device shall be made as far as practicable from an insulating material. Any metal work forming part of it shall be thoroughly insulated from the wearer's head and the insulation shall be non-absorbent. The sides of the shield shall be sufficiently large so as to give protection to the neck and side of the head. This is especially important where welders work near each other.

7.2.2.1 The handles of head shields shall be of a material which is a bad conductor of both electricity and heat. It shall be fixed either inside the shield to protect the head from the heat and rays of the arc, or fixed outside and provided with a good guard.

7.2.2.2 The window through which the operator views the arc shall be of the required grade. The frame shall be such as to take protective glass with a piece of plain glass fixed in front facing the arc so that spatter from the arc is intercepted by the plain glass which may be renewed from time to time. The protecting glass shall be fixed such that the arc is not visible through cracks and chinks round the edges. Helmets shall be preferred to head shields.

7.2.3 Goggles

7.2.3.1 Goggles shall be used:

a) to protect the eyes of persons, other than the welder, from the rays of and electric arc; and,

b) to protect the eyes of persons from small flying pieces of slag while chipping it from the weld.

7.2.3.2 Goggles to protect the eyes from the injurious rays shall always be fitted with opaque side shields. The glasses of the goggles shall be of a suitable grade. Alternately, the goggles shall be fitted with Crookes spectacle glass. However, goggles fitted with this glass are suitable only for protection when the arc is not in the immediate neighbourhood. Glasses of greenish neutral colour are considered to afford the maximum protection for the eyes.

7.2.3.3 Goggles to protect the eyes from small flying pieces or slag shall be fitted with clean non-splinterable glass if there is no need to protect the wearer from rays from the arc. Side screens should, however, be fitted but they may be transparent if preferred. If goggles to protect the eyes from slag are also required to give protection from arc rays, they shall comply with the requirements specified under 7.2.2.1 and the optical glass should be protected from mechanical damage by a superimposed and easily replaceably piece of clear glass.

NOTE - It should be noted that goggles do not provide adequate protection for a welder, as it is necessary for his face to be protected in addition to his eyes and he should, therefore, use a helmet or head shield.

7.2.4 *Screens* — All electric welding operations shall be screened to prevent the rays of the arc from affecting other persons working in the neighbourhood. Where the work is done at fixed benches or in welding shops, permanent screens shall be erected, as far as practicable. Where this is not possible, temporary screens shall be used to limit the radiation. All screens shall be opaque, of sturdy construction to withstand rough usage, and of material which shall not readily catch fire by sparks or hot metal. They shall not, however, be so heavy or cumbersome as to discourage their use.

7.3 **Protection of Fellow Workers from Arc-Welding Rays**

7.3.1 Where arc welding is regularly carried on in a building, the walls of the welding bay shall be painted with a non-reflecting colour to prevent flickering reflections.

7.3.2 Where the work permits, the welder shall be enclosed in an individual booth painted with a non-reflecting paint, such as zinc oxide or lamp black. Alternately, an enclosure of non-combustible screens similarly painted shall be provided. Booths and screens shall permit circulation of air at floor level. Workers or other persons adjacent to the welding areas shall be protected from the rays by non-combustible or flame-proof screens or shields or shall be required to wear appropriate goggles.

7.4 **Protective** Clothing-Protective clothing required for any welding operations varies with the size, nature and location of the work to be performed. However, they should not be of such type or weight as to restrict the comfort of the operator unduly, thus discouraging its use.

7.4.1 The following protective means may be employed:

a) Leather or asbestos gloves, except when engaged in light work;

b) Flame-proof aprons made of leather, asbestos, or other suitable material for protection against radiated heat and sparks; and

c) Woollen clothing in preference to cotton clothing, the clothing being reasonably free from oil or grease.

7.4.2 Sleeves and collars shall be kept buttoned and pockets eliminated from the front of overalls and aprons. Trousers or overalls shall not be turned up on the outside.

7.4.3 For very heavy work, fire-resistant leggings, high boots or other equivalent means shall be used.

7.4.4 Lower-cut shoes with unprotected tops shall not be used.

7.4.5 In production work a sheet metal screen in front of the worker's legs may be employed to provide further protection against sparks and molten metal in cutting operations.

7.4.6 Caps or shoulder covers made of leather or other suitable material shall be worn during overhead welding or cutting operations. Leather skull caps may be worn under helmets to prevent head burns.

7.4.7 For overhead welding, or welding in extremely confined spaces, ear protection is also desirable. This may be accomplished by placing wool or rubber plugs in the ears or by covering them with wire screen protectors.

7.4.8 Where there is exposure to sharp or heavy falling objects, hard hats or head protectors should be used.

7.5 Work in Confined Spaces

7.5.1 Adequate ventilation shall be provided in confined spaces in accordance with the requirements laid down under 8.

7.5.2 When welding or cutting is being performed in any confined space, the gas cylinders and welding machines shall be left on the outside. Before operations are started, heavy portable equipment mounted on wheels shall be securely blocked to prevent accidental movement.

7.5.3 Where a welder has to enter a confined space through a manhole or other small opening, means shall be provided for quickly removing him in case of emergency. When safety belts and life lines are used for this purpose they shall be so attached to the welder's body that he is not jammed in a small exit opening.

7.5.4 When arc-welding is to be suspended for any substantial period of time, such as during lunch hours or overnight, all electrodes shall be removed from the holders and the holders carefully located so that there is no possibility of accidental contact. The machine shall also be disconnected from the power source. The welders should usefully insulated electrode holders.

7.5.5 When gas welding or cutting, the torch valves shall be closed and the gas supply to the torch positively shut-off at some point outside the confined area whenever the torch is not to be used for a substantial period of time, such as during lunch time or overnight. Where practicable, the torch and hose shall also be removed from the confined space.

7.5.6 After welding operations are completed, the welder shall mark the hot metal or provide some other means of warning other workers.

7.6 First-Aid Provisions — All injuries shall be reported as soon as possible for medical attention. Provision shall be made for rendering first-aid in accordance with the requirements specified under the Factories Act, 1948.

8. VENTILATION AND HEALTH PROTECTION

8.1 General

8.1.1 The requirements for ventilation and health protection have been established on the basis of the following three factors in gas- and arc-welding

which govern the amount of contamination to which welders may be exposed:

a) Dimensions of space in which welding is to be done (with special regard to height of ceiling):

b) Number of welders employed on the. work; and

c) Possible evolution of hazardous fumes, gases or dusts depending upon the metal being welded.

8.1.2 In individual instances, additional factors than those specified under 8.1.1 may also be involved, in which case ventilation or respiratory protective devices shall be provided to meet individual requirements. Such factors would include:

a) atmospheric conditions,

b) heat generated, and

c) presence of volatile solvents.

8.1.3 In addition to the hazards from burns, electricity and radiation, means for the control of which have already been standardized, under certain conditions there may be health hazards due to gases, fumes or dusts containing lead, zinc, cadmium, fluorine, mercury or compounds thereofor to the possible formation of oxides of nitrogen or due to extreme heat. These potential hazards are not serious except in spaces not properly ventilated. Health hazards from welding operations may be controlled by local exhaust or general ventilation, depending upon the nature of the hazard. When such a hazard is present, sufficient ventilation or individual respiratory protection shall be provided in accordance with the requirements of this section.

8.1.4 When it becomes necessary to perform welding in a space entirely screened on all sides, the screens shall be so arranged that no serious restriction of ventilation exists. It is desirable to have the screens so mounted that they are about 60 cm above the floor unless the work is performed at so low a level that the screen should be extended nearer to the floor to protect nearby workers from the glare of welding.

8.1.5 Local or general ventilating systems shall be provided and arranged sufficient to keep the amount of toxic fumes or dust below the maximum allowable concentration as specified in Table 1. Where, because of the intermittent nature of the work or for other good reasons, it is impracticable to control gases, fumes or dusts by such means, welders shall be required to use respiratory protective equipment.

TABLE 1 MAXIMUM ALLOWABLE CONCENTRATION OF TOXIC DUSTS AND GASES FOR EXPOSURE NOT EXCEEDING EIGHT HOURS DAILY

(*Clause* 8.1.5)

DUST OR GAS	VOLUME PER 1 000 000 PARTS OF AIR AT 25°C AND 760 mm PRESSURE	WEIGHT PER LITRE AT 25°C AND 760 mm PRESSURE
(1)	(2)	(3)
	Parts	mg
Xylene	200	0·868
Lead and certain of its inorganic compounds, the carbonate, sulphate, oxides, nitrate and chloride	—	0·000 015
Toluene (toluole)	200	0·752
Oxides of nitrogen (calculated as NO_2)	5	—
Styrene monomer	200	1·7
Methanol (methyl alcohol)	200	0·26
Formaldehyde	5	0·012
Methyl chloride	100	0·2
Trichloroethylene	200	—
Metallic arsenic and arsenic trioxide	—	0·000 5
Mercury	—	0·000 1
Chromium (as chromate, dichromate dust or as chromic acid mist)	—	0·000 1
Manganese dust and fumes	—	0·006
Carbon monoxide	loo (with atmospheric oxygen not below 19 percent by vol), and	0·11
	409 (for exposures not exceeding a total of one hour daily)	0·46
Hydrogen sulphidc	20	0·028
Benzene (benzol)	35	0·32
Cadmium or its compounds	—	0·000 1
Carbon disulphide	20	0·062

8.1.6 In confined spaces or other locations where the amount of toxic substances is likely to exceed the maximum allowable concentrations, supplied-air respirators, such as air-line respirators or hose masks with or

without blowers shall be provided. This applies not only to the welder but also to helpers and other personnel working in the immediate vicinity. Air supply for such equipment shall be clean and of equable temperature. Since welding operations are liable to alter the compositions of the atmosphere, blowing in fresh air may help to remove the polluted atmosphere in tanks and enclosed spaces.

8.1.7 Where welding operations are incidental to general operation, local exhaust ventilation shall be provided to prevent contamination of the general work.

8.1.8 Individual respiratory equipment shall be well maintained. It shall not be transferred from one employee to another without being sterilized.

8.1.9 Manufacturers' instructions pertaining to fluxes and electrode coverings shall be carefully observed.

8.1.10 No welding or cutting shall take place in the room where a vapour degreasing plant is also situated.

8.2 **Lead Cadmium and Mercury** — All welders eriagaged in welding or cutting metal containing (or coated with) lead, cadmium, or mercury-bearing substances, shall be provided with an approved type air-line respirator or hose mask except where local exhaust ventilation, sufficient to control the fumes generated as specified under 8.5 is provided and used. Exhaust ventilation shall not be substituted for respiratory protection required in welding or cutting operations inside confined spaces.

8.3 Fluoride-Bearing Fluxes **and Zinc** — Welding or cutting metals coated with zinc or zinc-containing substances and welding involving the use of fluoride-bearing flux shall be done indoors only when local exhaust ventilation as prescribed under 8.5, is provided. Where the work is to be done in a confined space, air-supplied respirators shall be provided.

8.4 **All** Other Welding **and Cutting**- When welding or cutting is done on metals under conditions not covered under 8.2 and 8.3, mechanical ventilation shall be resorted to only under one or more of the following conditions:

a) The working space is less than 280 m^3 per welder;

b) The room in which welding has to be done has a ceiling height of less than 5·00 m; and

c) The available space is confined or contains partitions, balconies or other structural barriers to the extent that they significantly obstruct cross ventilation.

8.4.1.1 The mechanical ventilation shall be at the minimum rate of 56 ms'per minute per welder or four air changes per hour, whichever is greater, except where local exhaust hoods and booths have been provided

as specified in 8.5 or air-line respirators are provided. Natural ventilation is considered sufficient for welding or cutting operations where the restrictions listed under 8.4 are not present.

8.9 Local **Exhaust Hoods and Booths -Mechanical** local exhaust ventilation shall be provided by the following methods:

a) By means of freely movable hoods intended to be placed by the welder as near as practicable to the work being welded and provided with a rate of air flow sufficient to maintain a velocity in the direction of the hood of 30·0 linear metres per minute at the point of welding when the hood is at its most remote distance from the point of welding. The rates of ventilation required to accomplish this control velocity using a 7-cm wide flanged suction opening are given in Table 2; and

b) By means of a fixed enclosure with a top and not less than two sides which surround the welding or cutting operations and with a rate of air flow sufficient to maintain a velocity away from the welder of not less than 15 linear metres per minute.

TABLE 2 RATE OF VENTILATION REQUIRED

WELDING ZONE FROM ARC OR TORCH	MINIMUM AIR FLOW PER MINUTE	DUCT DIA*
(1)	(2)	(3)
cm	m^3	cm
10 to 15	4·5	7
15 to20	8·0	9
20 to 25	12·0	11
25 to 30	17·0	13

NOTE 1 — Wherever possible, all exhaust from operation shall be discharged to the outdoors.

NOTE 2 -For hoods not provided with flanges, minimum air flow shall be increased by 60 m^3 per minute.

*Nearest 1 cm duct dia based on 1200 m per minute velocity in pipe.

8.6 **Work in Confined Spaces** -The following additional requirements shall be met where welding is done in confined spaces:

a) All welding and cutting operations carried on in confined spaces shall be adequately ventilated to prevent the accumulation of toxic gases or possible oxygen deficiency.

b) All air, replacing that withdrawn shall be clean and respirable. In such circumstances where it is impossible to provide such ventilation, air-supplied respirators or hose masks shall be used.

c) Where welding operations are carried on in confined spaces and welders and helpers are provided with approved air-supplied respirators or hose masks, a workman shall be stationed on the outside of such confined space to service the power and ventilation lines to ensure the safety of those working within.

d) Oxygen from a cylinder or torch shall never be used for ventilation.

8.7 Medical Control

8.7.1 All welders and workmen engaged in welding operations shall be thoroughly examined periodically.

8.7.2 Employment of persons under 18 years of age shall be prohibited in gas-or arc-welding and oxygen cutting tanks or in confined spaces, on scaffoldings or in pre-heated assemblies.

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