SRI LANKA STANDARD 727 : PART 4 : 1985

UDC 621 . 791 : 614 . 8

CODE OF SAFETY FOR WELDING AND CUTTING

PART 4 - SAFETY OF PERSONNEL

SRI LANKA STANDARDS INSTITUTION

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SLS 727:Part 4:1985

Gr. 9

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SRI LANKA STANDARD
CODE OF SAFETY FOR WELDING AND CUTTING
PART 4: SAFETY OF PERSONNEL

FOREWORD

This Sri Lanka Standard was authorized for adoption and publication by the Council of the Sri Lanka Standards Institution on 1985-11-20, after the draft, finalized by the Drafting Committee on Code of safety for welding and cutting, has been approved by the Mechanical Engineering Divisional Committee.

The existence of proper safety regulations and their use are the most important steps in any programme of safety and accident prevention.

This standard is presented in the hope that adherence to the safety requirements contained herein will result in the elimination of possible hazards due to welding and cutting; hence elimination of avoidable accidents and property damage.

This standard includes provisions for protection of personnel from hazardous conditions that can be caused by welding and cutting. The standard deals with such conditions arising mainly from ultra-violet rays, infra-red rays, and flying particles.

Part 3 of this standard covering provisions for fire prevention and protection has been published as a Sri Lanka Standard.

It is intended to publish further parts of this standard as follows:

Part 1 - Oxygen - fuel gas systems for welding and cutting

Part 2 - Arc welding cutting and resistance welding equipment

The assistance derived from the publications of the International Standards Organization, the American National Standards Institution and the British Standards Institution in the preparation of this standard is gratefully acknowledged.

1 SCOPE

This standard covers provisions for the safe use of oxy-fuel and arc cutting and welding equipment when used only for cutting and welding, to ensure that the personnel are provided with adequate protection against accidents and health hazards.

2 REFERENCES

ISO 4849 Personal eye-protectors - specifications

BS 679 Filters for use during welding and similar industrial operations

DIN 464 Glasses for eye protection equipment

3 PROTECTION OF PERSONNEL

3.1 General

3.1.1 Welders shall place welding cable and other equipment clear of passageways, ladders and stairways.

3.1.2 Welding and cutting operations pose potential hazards from fumes, gases electrical shock, heat radiation and sometimes noise. Personnel shall be warned against these hazards, where applicable by use of adequate precautionary labelling, posters signboards etc.

3.2 Eye protection

3.2.1 Criteria for selection

3.2.1.1 Helmets or handshields shall be used by welders or personnel viewing the arc during arc welding and cutting operations, excluding submerged arc welding.

3.2.1.2 Safety spectacles or goggles shall be worn by helpers of welding or cutting operations to provide protection from injurious rays from adjacent work, and from flying objects.

NOTE - The spectacles or goggles may have either clear or coloured glass, depending upon the amount of exposure to adjacent welding or cutting operations. Shade number 2 in Table 1 (see Appendix A) is recommended for safety spectacles or goggles used by the helpers for general protection.

3.2.1.3 Workers or other persons adjacent to the welding areas shall also be protected from radiant energy by noncombustible or flame-resistant screens or shields or shall be required to wear suitable eye protection. Booths and screens shall permit circulation of air at floor level, as well as above them.

NOTES

1 Where welding is regularly carried on in a building, the walls of the welding bay should be painted with a finish of low reflectivity to ultra-violet radiation.

2 Where the work permits, the welder should be enclosed in an individual booth painted with a finish formulated with a pigment such as zinc oxide which has low reflectivity to ultra-violet radiation, or he should be enclosed with noncombustible screens similarly painted.

3 When welding is carried out outside a building temporary means of screening the rays should be provided to protect the outsiders from the rays.

3.2.1.4 Goggles or other suitable eye protection shall be used during all gas welding or oxygen-cutting operations. Spectacles with suitable filter lenses and without side shields are permitted for use during gas welding operations on light work, for torch brazing, or for inspection.

3.2.1.5 All operators of resistance welding or resistance brazing equipment and their helpers shall use face shields, spectacles or goggles, depending on the particular job, to protect their faces or eyes, as required.

3.2.2 Specification for protectors

3.2.2.1 Helmet and hand shield bodies shall be made of material which is thermally and electrically insulating, noncombustible or sefl-extinguishing, and opaque to visible, ultra-violet, and infra-red radiation. Helmets, shields and goggles shall be capable of withstanding disinfection.

NOTE - Helmets or goggles should not be transfered from one employee to another without being disinfected. See Appendix **B** *for maintenance and disinfection of eye protectors.*

3.2.2.2 Helmets and hand shields shall be designed to protect the face, forehead, neck and ears from direct radiant energy from the arc and from weld-spatter.

3.2.2.3 Helmets and hand shields shall be provided with a window for filter plates and cover plates and shall be designed for easy removal and replacement of plates.

3.2.2.4 All protective parts shall be constructed of a material which will not readily irritate or discolour the skin.

3.2.2.5 Goggles shall be ventilated to deter fogging of the lenses. Ventilation of cup type goggles shall be baffled to prevent passage of light rays into the interior of the eyecup.

3.2.2.6 Cover lenses or plates shall be provided to protect the filter lens or filters in goggles, helmets or hand shields from welding spatter, pitting and scratching. Cover lenses and plates shall be clear glass, or self-extinguishing plastic.

3.2.2.7 All filter lenses and plates shall be impact resistant. All filter lenses shall be substantially free from straie, bubbles, waves and other flaws. Except when a lens is ground to provide proper optical correction for defective vision, the front and rear surfaces of lenses and plates shall be smooth and parallel.

3.2.2.8 Filter lenses and plates shall bear some permanent distinctive marking by which the manufacturer and shade number may be readily identified. In addition, all glass filter lenses and plates, when treated for impact resistance, shall be marked with the letter 'H' to designate impact resistance.

NOTE - A guide for the selection of appropriate shade number is given in Table 1 (see Appendix A). Further requirements for eye protectors are covered in ISO 4849.

3.3 Protective clothing

3.3.1 *Criteria for selection*

3.3.1.1 Appropriate protective clothing shall be worn by workers engaged in welding and cutting operations. Selection of protective clothing will vary with the size, nature and location of the work to be performed. Clothing should provide sufficient coverage and be made of suitable materials, to prevent skin burns caused by sparks, spatter or radiation. Synthetic or plastic materials which can melt and cause severe burns are not recommended for use as clothing near arcs.

3.3.1.2 All outer clothing such as jumpers or overalls should be reasonably free from oil or grease.

3.3.1.3 Sparks may lodge in rolled-up sleeves, pockets or clothing or cuffs of overalls or trousers. It is therefore recommended that sleeves and collars be kept buttoned and pockets be eliminated from the front of clothing.

3.3.1.4 When pockets are present, they should be emptied of flammable or readily combustible materials. Trousers or overalls should not have cuffs and should not be turned up on the outside. Trousers should overlap shoe tops to prevent spatter from getting into shoes.

3.3.2 *Gloves*

All welders and cutters shall wear protective flame-resistant gloves. Gloves made of leather or other suitable materials are recommended.

3.3.3 *Aprons*

Durable flame-resistant aprons made of leather or other suitable materials should be used to protect the front of the body when additional protection against sparks and radiant energy is needed.

3.3.4 *Leggings*

For heavy work, flame-resistant leggings or other equivalent means should be used to give added protection to the legs.

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

3.3.5 *Capes and sleeves*

Cape sleeves or shoulder covers with bibs made of leather or other flame-resistant material should be worn during overhead welding or cutting operations.

3.3.6 *Other protective clothing*

Properly fitted flame-resistant plugs in the ears or other suitable means, shall be used where hazards to the ears exist from sparks or spatter or noise. Caps made from flame-resistant material should be worn under helmets to pervent head burns.

3.4 Work in confined spaces

3.4.1 *Ventilation*

Ventilation is a prerequisite to work in confined spaces. For ventilation requirements, see 4.

3.4.2 *Location of equipment*

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

3.4.3 *Spaces through manholes and similar openings*

Where a welder must 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 lifelines are used for this purpose they shall be so attached to the welder's body that his body cannot be jammed in a small exit opening. A helper with a preplanned rescue procedure shall be stationed outside to observe the welder at all times and be capable of putting rescue operations into effect.

NOTE - Where conditions warrant, consideration should be given to the need for a respirator for rescue operations.

3.4.4 *Leakage in confined spaces*

In order to eliminate the possibility of gas escaping through leaks or improperly closed valves when gas welding or cutting, the torch valves shall be closed and the fuel-gas and oxygen 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 hour or overnight. Where practicable, the torch and hose shall also be removed from the confined space.

4 HEALTH PROTECTION AND VENTILATION

4.1 General

The requirements in this section have been established on the basis of the following factors in arc and gas welding and cutting which govern the amount of contamination to which welders may be exposed:

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

b) Number of welders or cutters;

c) Possible evolution of hazardous fumes, gases, or dust according to the metals involved; and

d) Location of welder's breathing zone with respect to the rising plume of fumes.

It is recognized that, in individual instances, other factors may be involved in which cases, ventilation or respiratory protective devices should be provided as needed to meet the equivalent requirements of this section. Such factors would include;

e) Atmospheric conditions;

f) Heat generated; and

g) Presence of volatile solvents.

4.1.1 *Screened areas*

When welding must be performed in a space entirely screened on all sides, the screens shall be so arranged that no serious restriction of ventilation exists.

NOTE - It is desirable to have the screens so mounted that they are about 0.5 m above the floor unless the work is performed at low a level that the screen must be extended nearer to the floor to protect nearby workers from the glare of welding. (see also **3.2.1.3***).*

4.1.2 *Concentration of toxic substances*

Local exhaust or general ventilating systems shall be provided and arranged to keep the amount of toxic fumes, gases or dusts below the acceptable concentrations of toxic dust and gases. (see Appendix C).

NOTES

1 Compliance shall be determined by sampling of the atmosphere. Samples collected shall reflect the exposure of the persons involved. When a helmet is worn, the samples shall be collected under the helmet, using any standard method.

2 Where welding operations are incidental to general operations it is considered good practice to apply local exhaust ventilation where practicable to prevent contamination of the general work area. When using recirculated air, the build up of toxic contaminants should be prevented.

3 Manufacturer's cautions pertaining to fluxes and electrodes should be observed.

4.1.3 *Avoidance of the fume plume*

Welders and cutters must take precautions to avoid breathing the fume plume directly. This can be done by positioning of the work, the head, or by ventilation which directs the plume away from the face. Tests have shown that fume removal is more effective when the air flow is directed across the face of the welder, rather than from behind.

4.2 Types of ventilation

4.2.1 *Natural ventilation*

4.2.1.1 Natural ventilation is acceptable for welding, cutting and related processes where the necessary precautions are taken to keep the welder's breathing zone away from the plume and where sampling of the atmosphere shows that concentrations of contaminants are below the levels referenced in Appendix C.

4.2.1.2 Natural ventilation often meets the conditions of Appendix C where the necessary precautions are taken to keep the welder's breathing zone away from the plume and all of the following conditions are met:

a) Space of more than 284 m^3 per welder is provided.

b) Ceiling height is more than 5.5 m.

c) Welding is not done in a confined space.

d) Welding space does not contain partitions, balconies, or other structural barriers that significantly obstruct cross ventilation. Welding space refers to a building or an enclosed room in a building, not a welding booth or screened area which is used to provide protection from welding radiation.

e) Materials covered in 4.3 are not present as deliberate constituents.

The only way to assure that airborne contaminant levels are within the allowable limits, however, is to take air samples at the breathing zones of the personnel involved. If natural ventilation is not sufficient to maintain contaminants below the levels referenced in Appendix A, mechanical ventilation shall be provided.

4.2.2 *Mechanical ventilation*

Mechanical ventilation includes local exhaust, local forced and general area mechanical air movement. Local exhaust ventilation is preferred.

4.2.2.1 Local exhaust ventilation

Local exhaust ventilation means fixed or moveable exhaust hoods placed as near as practicable to the work and able to maintain a capture velocity sufficient to keep airborne contaminants below the limits referenced in Appendix C.

4.2.2.2 Local forced ventilation

Local forced ventilation means a local air moving system such as a fan placed so that it moves the air at right angles (90°) to the welder across

the welder's face. It should produce an approximate velocity of 30 meters per min, and be maintained for a distance of approximately 600 *mm* directly above the work area. Precautions must be taken to insure that contaminants are not dispersed to other work areas.

4.2.2.3 General mechanical ventilation

Examples of general mechanical ventilation are roof exhaust fans, wall exhaust fans and similar large area air movers. General mechanical ventilation is not usually as satisfactory for health hazard control as local mechanical ventilation. It is often helpful, however, when used in addition to local ventilation.

General mechanical ventilation may be necessary to maintain the general background level of airborne contaminants below the levels referred to in Appendix **C** or to prevent the accumulation of explosive gas mixtures.

Where permissible, air cleaners that have high efficiencies in the collection of submicron particles may be used to recirculate a portion of air that would otherwise be exhausted. Some such filters do not remove gases. Therefore adeuqate monitoring must be done to assure concentrations of harmful gases remain below allowable limits.

4.3 Special ventilation concerns

4.3.1 *Low permissible exposure limit materials*

Certain materials, sometimes contained in the consumables, base metals, coatings, or atmospheres of welding or cutting operations, have low or very low permissible exposure limits. Among these materials are :

Antimony	Chromium	Mercury
Arsenic	Cobalt	Nickel
Barium	Copper	Selenium
Beryllium	Lead	Silver
Cadmium	Manganese	Vanadium

Refer to Material Safety Data Sheets provided by the manufacturer to identify any of the materials listed above that may be contained in the consumable.

Whenever these materials are encountered as designated constituents in welding, brazing, or cutting operations, special ventilation precautions shall be taken to assure the level of contaminants in the atmosphere is below the limits allowed for human exposure. Unless atmospheric test under the most adverse conditions have established that exposure is within acceptable concentrations, the following precautions shall be observed:

4.3.1.1 Confined spaces

Whenever these materials are encountered in confined space operations, local exhaust mechanical ventilation and respiratory protection shall be used.

4.3.1.2 Indoors

Whenever these materials, except beryllium, are encountered in indoor operations, local exhaust mechanical ventilation shall be used. Whenever beryllium is encountered in indoor operations, ventilation shall be used in **4.3.1.1.**

4.3.1.3 Outdoors

Whenever these materials are encountered in outdoor operations, respiratory protection may be required.

4.3.1.4 Adjacent persons

All persons in the immediate vicinity of welding or cutting operations involving the materials listed in **4.3.1** shall be similarly protected as necessary by ventilation or approved respirators.

4.3.2 *Fluorine compounds*

Fumes and gases from flourine compounds can be dangerous to health and can burn eyes and skin on contact.

In confined spaces, when welding or cutting operations involve fluxes, coatings, or other materials that contain fluorine compounds, local mechanical ventilation or respiratory protection shall be provided.

In open spaces, when welding or cutting involves materials containing flouorine compounds, the need for local exhaust ventilation or respiratory protection will depend upon the individual circumstances. However, experience has shown that such protection is desirable for fixed location production welding and for all production welding on stainless steels. Such protection is not necessary when air samples taken in breathing zones indicate that the flourides liberated are below allowable limits.

4.3.3 *Zinc compounds*

Fumes containing zinc compounds may produce symptoms of hausea, dizziness, or fever, sometimes called metal fume fever.

Welding or cutting operations involving consumbles, base metals, or coatings containing zinc should be done as described in **4.3.2** for fluorine compounds.

4.3.4 *Cleaning compounds*

Cleaning materials, because of their possible toxic or flammable properties, often require special ventilation precautions. Manufacturers' instructions shall be followed.

4.3.4.1 Chlorinated hydrocarbons

Degreasing or cleaning operations involving chlorinated hydrocarbons shall be so located that vapours from these operations will not reach or be drawn into the atmosphere surrounding molten weld metal or the arc.

In addition, these materials must be kept out of atmospheres penetrated by the ultra-violet radiation of arc welding operations. A reaction product having a characteristic, objectionable, irritating odor, and including highly toxic phosgene gas is produced when such vapours enter the atmosphere of arc welding operations. Low levels of exposure can produce feelings of nausea, dizziness and malaise. Heavy exposures may produce serious health impairments.

4.3.5 *Stainless steel cutting*

Oxygen cutting, using either a chemical flux or iron powder, gas-shielded arc cutting, or plasma cutting of stainless steel shall be done using local mechanical ventilation adequate to remove the fumes generated.

4.3.6 *Brazing furnaces*

In all cases, adquate mechanical ventilation shall be provided to remove all explosive or toxic gases which may emanate from furnace purging and brazing operations. Where complete combustion takes place in or at the furnace during the heating cycle, the requirement may diminish.

4.3.7 *Asbestos*

If welding or cutting is to be done on surfaces that are covered by asbestos insulation, or if asbestos is to be used for insulating sensitive equipment prior to welding, the regulations of the health authority having jurisdiction should be consulted before beginning the work. Protection of the employees in the area may require training, respiratory protection, wetting down the asbestos, and use of special protective clothing in addition to special ventilation.

APPENDIX A

TABLE 1 - Guide for shade numbers

Operation	Electrode size mm	Arc current A	Minimum Protective shade	Suggested shade no. (comfort)
Shielded metal arc Welding	Less than 2.5	Less than 60	7	-
	2.5-4	60-160	8	10
	4-6.4	160-250	10	12
	More than 6.4	250-550	11	14
Gas metal arc welding and flux cored arc welding		Less than 60	7	-
		60-160	10	11
		160-250	10	12
		250-500	10	14
Gas tungsten arc welding		Less than 50	8	10
		50-150	8	12
		150-500	10	14
Air carbon Arc cutting	(Light)	Less than 500	10	12
	(Heavy)	500-1000	11	14
Plasma arc welding		Less than 20	6	6 to 8
		20-100	8	10
		100-400	10	12
		400-800	11	14
Plasma arc cutting	(Light)[2]	Less than 300	8	9
	(Medium)[2]	300-400	9	12
	(Heavy)[2]	400-800	10	14
Torch brazing		-	-	3 or 4
Torch soldering		-	-	2
Carbon arc welding		-	-	14

	Plate thickness mm		
Gas welding			
Light	Under 3.2		4 or 5
Medium	3.2 to 12.7		5 or 6
Heavy	Over 12.7		6 or 8
Oxygen cutting			
Light	Under 25		3 or 4
Medium	25 to 150		4 or 5
Heavy	Over 150		5 or 6

NOTES

1 As a rule of thumb, start with a shade that is too dark to see the weld zone. Then go to a lighter shade which gives sufficient view of the weld zone without going below the minimum. In oxyfuel gas welding or cutting where the torch produces a high yellow light, it is desirable to use a filter lens that absorbs the yellow or sodium line in the visible light of the (spectrum) operation.

2 These values apply where the actual arc is clearly seen. Experience has shown that lighter filters may be used when the arc is hidden by the workpiece.

3 This table follows shade number adopted by American National Standards Institution. The comparable British and DIN shade numbers are specified in **BS 679** *and* **DIN 4647.**

APPENDIX B

MAINTENANCE AND DISINFECTION OF EYE PROTECTORS

B.1 MAINTENANCE

B.1.1 It is essential that the lenses of eye protectors be kept clean. Continuous vision through dirty lenses can cause eye fatigue and become a contributory factor to accidents. Daily cleaning of eye protectors is recommended.

B.1.2 Pitted or scratched lenses reduce vision and seriously reduce protection. They shall be replaced immediately.

B.1.3 Slack, wornout, sweat-soaked, knotted, or twisted headbands do not hold the eye protector in proper position. Visual inspection can determine when the elasticity is reduced to a point beyond proper function.

B.1.4 To prolong the life of eye protectors, they shall be placed in suitable cases or containers between periods of use.

B.2 ISSUE AND USE

Protectors are a personal item and should be for the individual and exclusive use of the person to whom they are issued. If circumstances require reissue, the protectors shall be thoroughly cleaned and disinfected as hereinafter described.

B.3 DISINFECTION

B.3.1 When a person is assigned protective equipment, it is recommended that this equipment be cleaned and disinfected regularly, without sharing by another person unless disinfected.

B.3.2 Thoroughly clean all surfaces with soap or suitable detergent and warm water. Carefully rinse all traces of soap or detergent. Completely immerse the protector for 10 minutes in a solution of modified phenol, hypochlorite, or quaternary ammonium compounds, in a strength specified by the manufacturer, at room temperature. Remove protector from solution and suspend in a clean place for air drying at room temperature, or with heated air. Do not rinse because this will remove the residual effect.

Ultra-violet disinfecting equipment may be utilized in conjunction with the washing procedure above, when such equipment can be demonstrated to provide comparable disinfection.

Protectors showing need for extensive cleansing should be disassembled to the extent possible without tools, prior to the washing and disinfection procedure. Replace defective parts with new ones.

B.3.3 The dry parts or items should be placed in clean, dustproof containers to protect them.

APPENDIX C

THRESHOLD LIMIT VALUES FOR CHEMICAL SUBSTANCES

Substances	mg/m^3
Antimony and compunds (as Sb)	0.5
Arsenic and compounds (as As)	0.2
Barium (soluble compounds)	0.5
Beryllium	0.002
Cadmium (metal dust and soluble salts)	0.2
Cadmium oxide fume (as Cd)	0.1
Chromium, soluble chromic, chromous salts (as Cr)	0.5
Cobalt (metal fumes and dusts)	0.1
Copper fume	1
Copper dusts and mists	1
Flouride (as F)	2.5
Flourine	2
Lead, inorganate, fumes and dusts	0.15
Lead arsenate	0.15
Manganese and compounds (as Mn)	5
Mercury (Alkyl compounds)- Skin	0.01
Mercury (all forms except Alkyl)	0.05
Nickel, carbonyl	0.007
Nickel, metal and soluble compounds (as Ni)	1

Substances	mg/m^3
Selenium compounds (as Se)	0.2
Selenium hexafluoride	0.4
Silver, metal and soluble compounds	0.01
Vanadium ($V_2 O_5$), as V dust	0.5
Zinc chloride fume	1
Zinc oxide fume	5

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Printed at SLSI (Printing Unit)

SRI LANKA STANDARDS INSTITUTION

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The principal objects of the Institution as set out in the Act are to prepare standards and promote their adoption, to provide facilities for examination and testing of products, to operate a Certification Marks Scheme, to certify the quality of products meant for local consumption or exports and to promote standardization and quality control by educational, consultancy and research activity.

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Printed at the Sri Lanka Standards Institution, 17, Victoria Place, Elvitigala Mawatha, Colombo 08.