SRI LANKA STANDARD 727 : PART 2 : 1988

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CODE OF SAFETY FOR

# WELDING AND CUTTING

PART 2 - ARC WELDING AND CUTTING EQUIPMENT, AND RESISTANCE WELDING

SRI LANKA STANDARDS INSTITUTION

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## PART 2:ARC WELDING AND CUTTING EQUIPMENT, AND RESISTANCE WELDING

SLS 727:Part 2:1988

Gr. 10



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# SRI LANKA STANDARD
# CODE OF SAFETY FOR WELDING AND CUTTING
## PART 2: ARC WELDING AND CUTTING EQUIPMENT, AND RESISTANCE WELDING

FOREWORD

This Sri Lanka Standard was authorized for adoption and publication by the Council of the Sri Lanka Standards Institution on 1988-05-20, after the draft, finalized by the Drafting Committee on Code of Safety for Welding and Cutting, had 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. The following parts of this standard have been already published as Sri Lanka Standards:

Part 1 Oxy-fuel gas systems

Part 3 Fire prevention and protection

Part 4 Safety of personnel

Provisions for guarding of industrial machinery are laid down in the legislative enactment of Sri Lanka ; volume V; Chapter 128, which is commonly known as 'Factories Ordinance'. The "Factories Ordinance' is referred to in **6.3.2.1** of this standard where guarding of moving parts of stationary resistance welding equipment is specified.

The assistance derived from the publications of the American National Standards Institution and the Institution of Electrical Engineers, London, in the preparation of this standard is gratefully acknowledged.

**1 SCOPE**

Part 2 of the Code of Safety for Welding and Cutting covers safety precautions specific to the installation and operation of arc welding and cutting equipment and welding equipment using resistance welding principles.

## 2 REFERENCES

SLS 692 Safety colours and signs
SLS 727 Code of safety for welding and cutting
Part 1 Oxy-fuel gas system
Part 3 Fire prevention and protection
Part 4 Safety of personnel

IEE Wiring Regulations, published by the Institution of Electrical Engineers, London.

## 3 TERMINOLOGY AND DEFINITIONS

For the purpose of this standard the following terminology and definitions shall apply ;

### 3.1 Terminology

**3.1.1** Approved equipment/apparatus : Whenever the word 'approved' is appearing in this standard, reference is made to equipment/apparatus approved by the Sri Lanka Standards Institution or any other agency authorized by the Sri Lanka Standards Institution.

### 3.2 Definitions

**3.2.1** *resistance welding* : A group of welding processes which produces coalscence of metals with the heat obtained from resistance of the workpiece to electric current in a circuit of which the workpiece is a part, and by the application of pressure.

**3.2.2** *ripple voltage* : Ripple voltage is the difference between the average and instantaneous values of a pulsating unidirectional voltage.

*NOTE - The root-mean-square value of the ripple voltage may be measured with a root-mean-square indicating meter in series with a capacitor having sufficiently low impedance so as not to affect appreciably the indication of the voltmeter. Rectifier-type instruments should not be used.*

**3.2.3** *per cent ripple voltage* : Per cent ripple voltage is the ratio, in per cent of the effective (root-mean-square) value of the ripple voltage to the average value of a pulsating unidirectional voltage.

## 4 GENERAL REQUIREMENTS

### 4.1 Set up and installation

**4.1.1** *Condition of equipment*

All welding and cutting equipment shall be kept in good working condition, inspected periodically to be sure it is in good working condition and when found to be defective (incapable of reliable, safe operation) shall be promptly repaired by qualified personnel or withdrawn from service.

**4.1.2** *Operation*

All equipment shall be operated in accordance with manufacturers recommendations and instructions, provided these are consistent with this standard.

**4.2 Responsibilities**
Operators and management shall recognize their joint responsibilities for safety in welding and cutting.

**4.2.1** *Management*

**4.2.1.1** Training
Management shall assure that welders and their supervisors are trained in the safe operation of their equipment, the safe use of the process and emergency procedures.

**4.2.1.2** Designated areas and procedures
Management shall designate approved areas, and establish procedures for safe welding and cutting.

Management shall designate an individual responsible for authorizing welding and cutting operations in areas not specifically designed or approved for such processes. The individual shall be aware of the hazards involved and shall be familiar with the provisions of this standard.

4.2.1.3 Approved equipment
Management shall ensure that only approved apparatus, such as welding machines, electrode holders, personal protective devices etc., are used.

**4.2.1.4** Contractors
Management shall select contractors to perform welding who have suitably trained personnel and who have an awareness of the risks involved.

Management shall advise contractors about flammable materials or hazardous conditions of which they may not be aware.

**4.2.2** *Supervisors*

**4.2.2.1** Safe use of equipment
Supervisors shall be responsible for the safe handling of welding equipment and for the safe use of the welding process.

**4.2.2.2** Combustibles
Supervisors shall determine what combustible materials and hazardous area are present or likely to be present at the work location. They shall ensure that combustibles are not exposed to ignition by taking one of the following actions (also see **2.2 of SLS 727 : Part 3 : 1986**) :

a) Have the work moved to a location free from combustibles ;

b) Have the combustibles moved to a safe distance from the work or properly shielded against ignition if the work cannot readily be moved ; or

c) Schedule welding and cutting so that combustibles are not exposed during these operations.

**4.2.2.3** Authorization
Supervisor shall secure authorization for the welding or cutting operations from the designated management representative.

Supervisors shall oversee that the welder has approval that conditions are safe, prior to commencing work (also see **3.2 of SLS 727 : Part 3 : 1986**).

4.2.2.4 Protective equipment and fire protection
Supervisors shall ensure that proper personal protective equipment is used. They shall ensure that fire protection and fire extinguishing equipment are properly located at the site, and that fire watchers are assigned and hot-work authorization procedure are followed where required (see **4.5**) .

Where a fire watcher is not required, a final inspection shall be made by the supervisor 30 minutes after the completion of welding operation to detect and extinguish possible smouldering fires.

4.2.3 *Welders*

4.2.3.1 Safe handling of equipment
Welders shall take all precautions to avoid injury by proper control and safe handling of equipment.

4.2.3.2 Safe conditions
Welders shall cut or weld only where all safety precautions have been met.

4.2.3.3 Permission
Welders shall have obtained permission of the supervisor before starting to weld or cut. Welders shall continue to weld or cut only so long as conditions are unchanged from those under which permission was granted.

**4.3 Protection of personnel and the general area**
Relevant provisions under **3 of SLS 727 : Part 4 : 1985** shall apply.

**4.4 Ventilation**
Relevant provisions under **4 of SLS 727 : Part 4 : 1985** shall apply.

**4.5 Fire protection and prevention**
Provision of **SLS 727 : Part 3** shall apply.

**4.6 Confined spaces**
Work in confined spaces requires special precautions.

4.6.1 *Ventilation in confined spaces*
In addition to the requirements for adequate ventilation to keep air borne contaminants in breathing atmospheres below allowable levels, as described in **4.4**,ventilation in confined spaces must also be sufficient,

a) to assure adequate oxygen for life support ;

b) to prevent accumulation of flammable mixtures ; and

c) to prevent oxygen enriched atmospheres.

*NOTE - Asphyxiation causes unconsciousness and death without warning. Confined spaces shall not be entered unless they are well ventilated, or unless the welder is wearing an approved air-supplied breathing apparatus with a similarly equipped second person present (see **4.6.5**). Confined spaces should be tested for toxic or flammable gases and vapours, and for adequate or excess oxygen before entering. Approved instruments must be used. Gases heavier than air such as argon and carbon dioxide may accumulate in pits, tank bottoms, low areas and near floors; gases lighter than air such as helium may accumulate in tank tops, high areas and near ceilings.*

*The same precautions shall apply to these areas as to confined spaces. If possible, a continuous monitoring system with audible alarms should be used for confined space work.*

*Adequate ventilation in confined spaces must be assured not only to protect welders or cutters themselves, but also to protect all personnel who may be present in the area.*

4.6.1.1 Air quality
Only clean, respirable air shall be used for ventilation. The quality of air for ventilation shall be such that personnel exposures to hazardous contaminants are maintained below the limits specified in **4.4**.

4.6.1.2 Prohibited ventilation gases
Only air shall be used for ventilation. In order to prevent the danger of explosion, Oxygen or any other gas or mixture of gases shall not be used for ventilation.

4.6.1.3 Ventilation in areas immediately dangerous to life and health
When welding, cutting or related processes are performed in areas immediately dangerous to life and health, positive pressure, self-contained breathing apparatus or airline respirators of approved type shall be used.

**4.6.2** *Service equipment*

4.6.2.1 Welding power sources
When welding or cutting is performed in confined spaces, welding power sources shall be located outside the confined space.

4.6.2.2 Heavy portable equipment on wheels
Heavy portable equipment mounted on wheels shall be securely locked to prevent accidental movement before operations are started in a confined space.

**4.6.3** *Adjacent areas*
When welding or cutting is to be done over or adjacent to any confined space, personnel must be made aware of the respiratory hazards in the confined space. They shall not enter such spaces without necessary precautions.

**4.6.4** *Emergency signal*

When a person enters a confined space through a manhole or other small openings, means shall be provided for signalling outside personnel for help.

**4.6.5** *Attendant in areas immediately hazardous to life*

When operations are carried on in confined spaces where atmospheres immediately hazardous to life may be present or may develop, an attendant shall be stationed outside the confined space to ensure the safety of those working within.

**4.6.5.1** Attendant's responsibilities
The attendants shall have a preplanned rescue procedure for quickly removing or protecting those working inside. They shall observe the workers inside and/or be in constant communication with them. In case of emergency they shall be capable of putting rescue operations into effect. An attendant shall see that a positive pressure, self-contained breathing apparatus or airline respirators with emergency escape provision are available.

**4.6.5.2** Safety belts and life lines
When safety belts and life lines are used for emergency rescue purposes, they shall be attached to the person's body so that they do not become obstructed in passing through a small or tortuous exit path in following the preplanned rescue procedure.

**4.7 Public exhibitions and demonstrations**
This section contains additional safety precautions specific to welding and cutting performed at public demonstrations and exhibitions to ensure the protection viewers, demonstrators and the public.

**4.7.1** *Supervision*
Installation and operation of welding, cutting and related equipment shall be done by or under the supervision of, a competent operator.

**4.7.2** *Site*
**4.7.2.1** Site design
The site shall be constructed, equipped and operated so as to prevent the possibility of injury to viewers at the site.

**4.7.7.2** Site location
Materials and equipment on the site shall be located so as not to interfere with evacuation of people during an emergency.

**4.7.3** *Fire prevention*
**4.7.3.1** Extinguishers
Site shall be provided with sufficient portable fire extinguishers of appropriate size and type.

**4.7.3.2** Combustibles
Combustible materials at the site shall be shielded from flames, sparks and molten metal.

**4.7.3.3** Fire department of the local authority
The fire department of the local authority shall be notified in advance of such use of the site.

**4.7.4** *Protection of the public from radiation and fumes*
**4.7.4.1** Radiation
The public shall be shielded from harmful ultraviolet, infrared and other electromagnetic radiation. Shielding shall protect direct viewers and adjacent passers-by.

**4.7.4.2** Fumes and gases
The public shall be protected from hazardous concentrations of the fumes and gases.

**4.8 Warning signs and posters**
Welding and cutting operations pose potential hazards from fumes, gases, heat, radiation, sparks, flying particles and sometimes noise. Personnel shall be warned against these hazards, where applicable,by use of adequate precautionary labelling, signboards, posters, etc. (see **SLS 727 : Part 3** and **SLS 727 : Part 4** for details).

## 5 SAFETY OF ARC WELDING AND CUTTING EQUIPMENT

### 5.1 General

5.1.1 *Scope*
This section contains safety precautions specific to the installation and operations of arc welding and cutting equipment.

5.1.2 *Equipment*
Arc welding and cutting equipment shall be chosen as specified in **5.2** and shall be installed as specified in **5.3**. Rules and procedures covering the operation and maintenance of the arc welding and cutting equipment shall be readily available.

5.1.3 *Personnel*
Persons in charge of the equipment or designated to operate the arc welding and cutting equipment shall have been properly instructed and qualified to maintain or operate such equipment and judged competent by their employers for their work responsibilities.

### 5.2 Selection of arc welding equipment

**5.2.1** *Safety standards*
The safety aspects of welding shall be given consideration in the choice of arc welding equipment for the job to be done.

*NOTE - Consideration for safety in design is obtainable by choosing apparatus complying with any national standard approved by the Sri Lanka Standards Institution, covering safety of arc welding and cutting equipment. However, requirements of any such standard should be subject to the provisions of this code.*

**5.2.2** *Voltage under hazardous conditions*
If a significant amount of work time is spent in electrically hazardous conditions, (see note under **5.4.10**) the use of automatic controls is recommended to reduce the no-load voltage to a value not more than 38 volts rms a.c. or 50 volts d.c. at rated input voltage. This also applies to **5.2.3.1**.

**5.2.3** *Other conditions*
**5.2.3.1** Open circuit voltage (normal processes)
The open circuit voltage of arc welding power sources shall comply with those specified in **5.2.3.1 (a)** and **5.2.3.1 (b)**.

**5.2.3.1** (a) Manual and semiautomatic arc welding power sources

| | | |
|---|---|---|
| i) | Alternating current arc-welding power sources | 80 volts rms |
| ii) | Direct-current arc welding power sources with more than 10 per cent ripple voltage (see **3.2.3**) | 80 volts rms (see Note) |

| | | |
|---|---|---|
| iii) | Direct - current arc welding power sources with 10 per cent or loss ripple voltage (see **3.2.3**) | 100 volts average |

*NOTE - Because of the high ripple content, the average value reading may be in error; therefore, the rms value is used.*

**5.2.3.1** (b) Automatic arc-welding power sources

| | | |
|---|---|---|
| i) | Alternating current arc welding power sources | 100 volts rms |
| ii) | Direct-current arc welding power sources with more than 10 per cent ripple voltage (see **3.2.3**) | 100 volts rms (see Note) |
| iii) | Direct-current arc welding power sources with 10 per cent or less ripple voltage (see 3.2.3) | 100 volts average. |

*NOTE - Because of the high ripple content, the average value reading may be in error; therefore, the rms value is used.*

**5.2.3.2** Open circuit voltage (special processes)
When special welding and cutting processes require open circuit voltage higher than those specified in **5.2.3.1**, adequate insulation or other means shall be provided to protect the operator from making accidental contact with the high voltage (see **5.2.2**).

**5.2.3.3** Work terminal to earthed enclosure
If welding lead terminal intended to be used exclusively for connection to work is connected to the earthed power source enclosure, it shall be done by a conductor at least 10 per cent smaller in diameter than the earthing conductor and the terminal shall be marked to indicate that it is earthed. Terminal for welding leads should be protected from accidental electrical contact by personnel or by metal objects, i.e., vehicles, crane hooks, etc. Protection may be obtained by the use of dead front construction utilizing receptacles for plug connections by locating terminals in a recessed opening or under a non-removable hinged cover, by heavy insulating sleeves, or by other equivalent mechanical means to satisfy the requirements.

**5.2.3.4** Portable control devices
No connection for portable control devices such as push buttons to be carried by the operator shall be connected to a circuit of higher than 120 volts rms. Exposed metal parts of portable control devices operating or circuits above 50 volts shall be earthed by an earthing conductor in the control cable.

**5.2.3.5** Autotransformers
Autotransformers or reactors shall not be used to draw welding current directly from any primary ac power source having a voltage exceeding 80 volts.

**5.2.3.6** Equipment leading
Care should be taken in applying arc welding equipment to ensure that the current rating chosen is adequate to handle the job. Welding machines should not be operated above the current ratings and corresponding rated duty cycles as specified by the manufacturer. Consideration should be given to the fact that actual welding currents may be higher than shown by indicators on the machines if welding is done with short leads or low arc voltages.

Particularly high over-currents are likely on general purpose welding mechines when used with low arc voltage processes such as Tungsten Inert Gas (TIG) welding.

5.2.3.7 Welding cables
Welding cables shall be of the flexible and approved type designed specially for the rigors of welding service and of a size adequate for reasonably expected current and duty cycles. Special attention should be paid to the insulation of cables used with equipment which includes high voltage high frequency oscillators.

**5.3 Installation of arc welding equipment**

5.3.1 *Wiring regulations*
Installation including earthing, necessary disconnects, fuses and type of incoming power lines shall be in accordance with the requirements of the current IEE wiring regulations (see 2).

5.3.2 *The work*
The workpiece or metal upon which the welder welds shall be earthed to a good electrical earth.

5.3.2.1 Earthing
Earthing can be done by locating the work on an earthed metal floor or platen, or by connection to an earthed building frame or other satisfactory earth. The work lead shall not be the earthing lead. It is preferable to connect the work lead direct to the work. Care should be taken, however, to avoid double earthing; otherwise, the welding current may flow through a connection intended only for safety earthings, and may be of a higher magnitude than the earthing conductor can safely carry. Special radio frequency earthing may be advisable for equipment using high frequency arc stabilizers.

5.3.2.2 Current return
Preferably, welding current should be returned to the welding machine by a single cable from the work to the welding machine. However, connection of a cable from the welding machine to a common conductor or properly bonded structure on which the work rests, or to which the work is connected is a permissible alternate procedure. Single-phase alternating current machines in groups of three with their inputs connected in delta to a three-phase supply circuit connected in star on the secondary circuits may use a single work lead from the neutral of the three units to the structure being welded. The single cable shall be of a size suitable for the current rating of at least one machine. Refer to 5.3.6 for voltage and shock consideration.

5.3.3 *Electrical continuity in structure*
When during construction or modification, a building or any other fabricated metal structure is used for a welding current return circuit, it shall be checked to ascertain whether proper electrical contact exists at all joints. Sparking or heating at any joint shall be the cause for rejection of the structure as a return circuit.

5.3.4 *Conduit and pipe earth limitations*
Conduits containing electrical conductors shall not be used for completing a work lead circuit. Pipelines shall not be used as a permanent part of

welding circuit, but may be used during construction, extension or repair providing the current is not carried through threaded joints, flanged bolted joints, or caulked joints. In addition, special precautions must be used to avoid sparking at the connection of the work lead cable.

**5.3.5** *Prohibited work lead connection*
Chains, wire ropes, cranes, hoists and elevators shall not be used to carry welding current.

5.3.6 *Connections to minimize shock hazard*
Where welders are working on one structure, sufficiently close to each other, and someone is likely to touch the exposed parts of more than one electrode holder simultaneously, machines shall be connected to minimize shock hazards as follows:

**5.3.6.1** Direct-current (dc) machines
Unless required by 5.3.6.3 all dc machines shall be connected with the same polarity.

*NOTE - A test lamp or voltmeter may be used to determine whether the connections are correct.*

**5.3.6.2** Alternative-current (ac) machines
Unless required by **5.3.6.3**, all single phase ac machines shall be connected to the same phase of the supply circuit and with the same instantaneous polarity.

*NOTE - A voltmeter can be used to determine whether the connections are correct.*

**5.3.6.3** Special cases
In operations on one structure, involving several welding machines, the dc welding process requirements may require the use of both polarities, or supply circuit limitations for ac welding may require distribution of machines among the phases of the supply circuit. In such cases, no-load voltages between electrode holders will be two times normal in dc or 1, 1.41, 1.73 or 2 times normal ac machines. Similar voltage differences will exist if both ac and dc welding are done on the same structure. In these cases, operator and other area personnel shall be instructed to take necessary precaution to avoid contact of the exposed parts of more than one electrode holder.

**5.4 Operation**
**5.4.1** *Worker instruction*
Workers assigned to operate or maintain arc welding equipment shall be acquainted with the requirements of SLS 727 applicable to their work assignments.

**5.4.2** *Checking connections*
After assembling any connection to the machine, each assembled connection shall be checked once before starting operations to ascertain that it is properly made. In addition, the work lead shall be firmly attached to the work; magnetic work clamps shall be freed from adherent metal particles and spatter on contact surfaces. Coiled welding cable should be spread out before use to avoid overheating and damage to insulation. Jobs alternately requiring long cables and short cables should be equipped with insulated

connectors so that idle lengths can be disconnected when not needed.

**5.4.3** *Machine frame earthing*
Earthing of the welding machine frame shall be checked. Special attention shall be given to safety earthing connections of portable machines (see relevant section of current IEE Wiring Regulations, published by the Institution of Electrical Engineers, London).

**5.4.4** *Leaks*
There shall be no leaks of cooling water, shielding gas or engine fuel that can adversely affect the welders' safety.

**5.4.5** *Instructions for safe operation*
Written rules and instructions covering the safe operation of equipment shall be made available to the welder and shall be strictly followed.

**5.4.6** *Work interruptions*
When the welder has occasions to leave his work or stop for any appreciable time, the electrode holder shall be de-energized by turning off the machine.

**5.4.7** *Moving the machine*
When the machine is to be moved, the input power supply to the equipment shall be electrically disconnected.

**5.4.8** *Usage under inclement weather conditions*
Welding equipment used in the open should be protected from inclement weather conditions. Protective covers should not obstruct the ventilation necessary to prevent overheating of the machine. Air filters in the ventilating systems of the electrical components are not recommended, unless provided by the manufacturer of the welding machine. The reduction of air flow resulting from the use of an air filter on equipment not so designed can subject internal components to an overheating condition and subsequent failure.

**5.4.9** *Equipment not in use*
When not in use, metal and carbon electrodes shall be removed from holders to eliminate danger of electrical contact with persons or conducting objects. When electrode holders are not in use they shall be so placed that they cannot make electrical contact with persons, conducting objects, flammable liquids or compressed gas cylinders. Guns of semiautomatic welding machines, when not in use, shall be placed so that the gun switch cannot be operated accidentally.

**5.4.10** *Electric shock*
Avoidance of electric shock is largely within the control of the welder; therefore it is especially important that the welder be thoroughly instructed in detail how to avoid shock. Safe procedures shall be observed at all times when working with equipment having voltages necessary for arc welding.

*NOTES*

*1. These voltages can be dangerous to life. Even mild shocks can cause involuntary muscular contraction, leading to injurious falls from high places. Severity of shock is determined largely by the path, duration and amount of current flowing through the body which is dependent upon voltage and contact resistance of the area of skin involved. Clothing damp from perspiration or wet working conditions may reduce contact resistance*

*and increase current to a value high enough to cause such violent muscular contraction that the welder cannot release contact with live part.*

*2. When welding or cutting is to be done with covered electrodes, using alternating current (ac) or single-phase transformer rectifier arc welding machines under electrically hazardous conditions due to water or perspiration, the welding operator shall take special care to avoid electrical shock by selecting clothing in good condition such as dry gloves and electrical hazard footwear, and avoiding accidental contact with live electrical parts.*

*Other examples of electrically hazardous condition are locations in which the freedom of movement is restricted, so that the operator is forced to perform the work in a cramped (kneeling, sitting, lying) position with physical contact with conductive parts, and locations that are fully or partially limited by conductive elements and in which there is a high risk of unavoidable or accidental contact by the operator.*

*These hazards can be minimized by insulating conductive parts near the vicinity of the operator.*

**5.4.10.1** Live metal parts
The welder shall never permit the live metal parts of an electrode or holder to touch bare skin or any wet covering of the body.

**5.4.10.2** Insulation
Welders shall protect themselves from electrical contact with the work or earth by dry insulating material, particularly, they shall be protected against large area contacts by insulation when working in a sitting or prone position.

**5.4.10.3** Gloves
Adequately dry gloves in good condition shall be used.

**5.4.10.4** Holders
Electrode holders shall be well insulated and kept in good repair.

**5.4.10.5** Water immersion
Electrode holders shall not be cooled by immersing in water.

**5.4.10.6** Water-cooled holders
Water cooled holders and guns shall not be used if any water leak or condensation exists which would adversely affect the welder's safety.

**5.4.10.7** Changing electrodes
The welding machines that supply power to the arc shall always have the output electrically de-energized when tungsten electrodes are changed in gas tungsten arc electrode holders.

**5.4.10.8** Other practices to avoid
The welder shall not coil or loop welding electrode cable around parts of the body. Precautions should be taken to prevent shock-induced falls when the welder is working above ground level.

## 5.5 Maintenance

**5.5.1** *General*
All arc welding equipment shall be maintained in safe working order at all times. The welder or maintenance personnel shall report any equipment defect or safety hazard to the supervisor and such equipment shall not be used until its safety has been assured. Repairs shall be made by qualified personnel only.

*NOTE - Periodic inspections are strongly recommended.*

[illegible] welding equipment
Welding equipment shall be maintained in good mechanical and electrical condition to avoid unnecessary hazards. Commutators shall be kept clean to prevent excessive flashing.

**5.5.2.1** Inspection
Rectifier welders should be inspected frequently to detect accumulations of dust or lint that would interfere with ventilation. Electrical coil ventilation dusts should be similarly inspected and cleaned. It is good practice to blow out the entire welding machine with clean, dry compressed air using adequate safety precautions. Fuel systems on engine driven machines should be inspected and checked for possible leaks and accumulations of water that might cause rusting. Rotating and moving components should be kept properly shielded and lubricated.

**5.5.2.2** Modifications
When it is necessary to modify equipment in order to meet noise level requirements it should be determined that the modifications or additions to the equipment do not cause the electrical or mechanical ratings of the equipment to be exceeded or overloaded.

**5.5.3** *Wet machines*
Machines which have become wet shall be thoroughly dried and properly tested before being used. When not in use, the equipment should be stored in a clean, dry place.

**5.5.4** *Welding cable*
Welding cable shall be inspected for wear or damage. Cables with damaged insulation or connectors shall be replaced or repaired to achieve the mechanical strength, insulating quality, electrical conductivity and watertightness of the original cable. Jointing lengths of cables shall be done by means specifically intended for the purpose. The connection means shall have insulation adequate for service conditions.

**5.5.5** *Compressed gases*
Use of compressed gases for shielding in arc welding operations shall follow the applicable provisions of **SLS 727 : Part 1.**

# 6 RESISTANCE WELDING SAFETY

## 6.1 General

**6.1.1** *Scope*
The scope of this section is limited to welding equipment using resistance welding principles as defined in **3.2.**

**6.1.2** *Selection*
All resistance welding equipment shall be selected for safe application to the work intended. The personnel safety aspects of resistance welding shall

be given consideration when choosing equipment for the work to be performed (also see **6.3** and **6.4**).

**6.1.3** *Operator training*
Workers designated to operate resistance welding equipment shall have been properly instructed and judged competent to operate such equipment.

**6.2 Installation**
All equipment shall be installed in conformance with the current IEE Wiring Regulations (see **2**) or its equivalent in protection, based on advances in technology. The equipment shall be installed by qualified personnel under the direction of a technical supervisor.

6.3 Guarding
6.3.1 *Control initiating devices*
Control initiating devices such as push buttons, foot switches, retraction and dual schedule switches or portable guns, etc, on any welding equipment shall be arranged or guarded to prevent the operator from inadvertently activating them.

**6.3.2** *Stationary equipment*
6.3.2.1 General
All chains, gears, operating linkages and belts associated with welding equipment shall be protected in accordance with the Factories Ordinance.

**6.3.2.2** Single ram and single point equipment
On stationary single ram welding machines, unless the workpiece size, configuration or fixture occupies both of the operators hands remotely from the point of operation during the machine cycle, operations should be in a manner that will prevent injury to the operator by one or a combination of the following; machine guards or fixtures that prevent the operator's hands from passing under the point of operation ; two handed controls; latches, presence sensing devices; or any similar device or mechanism that prevents operation of the ram while the operator's hands are under the point of operation.

**6.3.2.3** Multi-gun equipment
All multi-gun welding machine operations, when the operator's fingers can be expected to pass under the point of operation, shall be effectively guarded by the use of a device such as but not limited to, presence sensing devices, latches, blocks, barriers or two handed controls.

**6.3.3** *Portable equipment*
**6.3.3.1** Support system safety
All suspended portable welding gun equipment, with the exception of the gun assembly, shall be equipped with a support system capable of supporting the total impact load in the event of failure of any component of the supporting system. The system shall be designed to be fail safe.

*NOTE - The use of devices such as cables, chains, clamps, etc. is considered satisfactory.*

**6.3.3.2** Moving holder
Where it enters the gun frame, the moving holder mechanism shall be designed so as to prevent no shear points to the fingers placed on the operating movable holder, otherwise guarding shall be provided. If suitable guarding cannot be achieved, the use of two handles, one for each hand with one or two operating switches located at appropriate holding points may be

utilized. These handles and operating switches are to be sufficiently remote from the shear or pinch points, or both, to eliminate the possibility of any finger entering the shear or pinch point when the hands are on the controls.

**6.4 Electrical**

**6.4.1** *Voltage*

All external weld-initiating control circuits shall operate not over 120 volts rms for stationary equipment, and not over 36 volts for portable equipment.

**6.4.2** *Capacitors*

Resistance welding equipment and control panels containing capacitors used for stored energy resistance welding involving high voltages (over 550 volts rms) shall have suitable insulation and protection by complete enclosures, all doors of which shall be provided with suitable interlocks and contacts wired into the control circuit (similar to elevator interlocks). Each interlock or contact shall be so designed as to effectively interrupt power and short circuit all capacitors when the door panel is open.

A manually operated switch or suitable positive device shall be installed in addition to the mechanical interlocks or contacts, as an added safety measure assuring absolute discharge of all capacitors.

The panel box itself is considered an enclosure and capacitors located inside such a panel box do not need further enclosure when the other requirements of this paragraph are met.

**6.4.3** *Locks and interlocks*

**6.4.3.1** Doors

All doors and access panels of all resistance welding machines and the control panels, accessible at production floor level, shall be kept locked or interlocked to prevent access by unauthorized persons to live parts of the equipment. A door or access panel shall be considered locked if a key, wrench, or other instrument is required to open it.

**6.4.3.2** Remotely located control panels

Control panels located on overhead platforms or in separate rooms shall be either locked, interlocked, or guarded by a physical barrier and signs and the panels closed when the equipment is not being serviced. The signs must be in accordance with **SLS 692.**

**6.4.4** *Spark shields*

Protection shall be provided from the hazard resulting from flying sparks by methods such as the installation of a guard of suitable fire resistance material or the use of approved personal protective eye wear (see **SLS 727: Part 4**). The variations in resistance welding operations are such that each installation must be evaluated individually. The primary intent is the protection of personnel other than the operator whose protection is discussed in **SLS 727 : Part 4.**

For flash welding equipment flash guards of suitable fire-resistant material shall be provided to control flying sparks and molten metal. Suitable precautions should be taken to avoid fires as set forth in **SLS 727 : Part 3.**

6.4.5 *Stop buttons*
One or more safety emergency stop buttons shall be provided on all welding machines that have the following characteristics:

a) Require three or more seconds to complete a sequence ;

b) Have mechanical movements that can be hazardous to persons if guards were removed; and

c) The installation and use of these emergency stop buttons will not in themselves create additional hazards to persons.

In the above context, sequence means the action and time required by the machine from the time the run buttons are locked in (interlocked) and can be released, until the machine stops of its own accord.

6.4.6 *Earthing*
The welding transformer secondary shall be earthed by one of the methods specified in a or b below or equivalent protection shall be provided as specified in c below :

a) Permanent earthing of the welding secondary circuit ; or

b) Connecting earthing reactor across the secondary winding with reactor tap (s) to earth,

c) As an alternative, on non-portable machines, arranging for an isolation contactor to open both sides of the line to the primary of the welding transformer.

*NOTE - The earthing of one side of the secondary windings on multi-spot machines can cause undesirable circulating currents to flow between transformers when multi-phase primary supplies or different secondary voltages or both are used for the several guns. A similar condition can also exist with portable spot welding machines, when several units are used on the same fixture or assembly, or on one that is nearby. Such situations may require use of a earthing reactor or isolation contactor.*

**6.5 Static safety devices**
On large welding machines incorporating a platen, electrically interlocked safety devices, such as pins, blocks or latches shall be provided where the platen or the head can move. The intent is to require these devices when the machine area is so large that the maintenance or set up would require the insertion of more than hands into the closure area. The device, when used, shall cause the energizing circuit to be broken, and the device itself will prevent movement of the platen or head under static load. More than one device may be required, varying with machine size or accessibility, but each device alone shall be capable of sustaining the full static load involved.

**6.6 Ventilation**
Ventilation shall be provided in accordance with **SLS 727 : Part 4.**

**6.7 Maintenance**
Periodic inspection and necessary repairs shall be made by authorized personnel. The operators or maintenance personnel shall report any equipment defects to supervisory personnel.

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