CHAPTER - 6 RISK ASSESSMENT AND DISASTER MANAGEMENT

6.0 Introduction

The ferroalloy and steel sector, unlike the chemical processing sector has mainly occupational safety hazards. The choice and the implementation of specific measures for preventing workplace injury and ill health in the work-force of the ferroalloy industry depend on the recognition of the principal hazards, and the anticipated injuries and diseases, ill health and incidents. The risk assessment for the proposed primary metallurgical industry is based on hazard identification followed by precautionary measures. A detailed risk assessment shall be developed after preparation of final P & I drawings. The most common incidents or hazards that cause injuries, ill health and loss of property are mentioned as follows:

(i) Slips, trips and falls on the same level;
(ii) Falls from height;
(iii) Unguarded machinery;
(iv) Falling objects;
(v) Engulfment;
(vi) Working in confined spaces;
(vii) Moving machinery, on-site transport, forklifts and cranes;
(viii) Exposure to controlled and uncontrolled energy sources;
(ix) Exposure to asbestos;
(x) Exposure to mineral wools and fibers;
(xi) Inhalable agents (gases, vapors, dusts and fumes);
(xii) Skin contact with chemicals (irritants (acids, alkalis), solvents and sensitizers);
(xiii) Contact with hot metal;
(xiv) Fire and explosion;
(xv) Extreme temperatures;
(xvi) Radiation (non-ionizing, ionizing);
(xvii) Noise and vibration;
(xviii) Electrical burns and electric shock;
(xix) Manual handling and repetitive work;
(xx) Exposure to pathogens (e.g. legionella);
(xxi) Failures due to automation;
(xxii) Ergonomics;
(xxiii) Lack of OSH training;
(xxiv) Poor work organization;
(xxv) Inadequate accident prevention and inspection;
(xxvi) Inadequate emergency first-aid and rescue facilities;
(xxvii) Lack of medical facilities and social protection.

The hazards identified are discussed with respect to the nature and control strategies as follows;

6.1 Physical hazards (TOR No. 69)

6.1.1 Noise

Hazard description: Exposure to noise levels exceeding those set by the EP act and factories act may result in noise-induced hearing loss. Exposure to high noise levels may also interfere with communication and may result in nervous fatigue with an increased risk of occupational injury.

Assessment of risk (TOR No. 69): The assessment shall, as appropriate, consider:
(a) The risk of hearing impairment;
(b) The degree of interference to communications essential for safety purposes; and
(c) The risk of nervous fatigue, with due consideration to the mental and physical workload and other non-auditory hazards or effects.

In order to prevent adverse effects of noise on workers, employers shall:
(a) Identify the sources of noise and the tasks that give rise to exposure;
(b) Seek the advice of the authority and/or the occupational health service about exposure limits and other standards to be applied;
(c) Seek the advice of the supplier of processes and equipment about expected noise emission.

**Control Strategies:** Based on the assessment of the exposure to noise in the working environment, the employer shall establish a noise-prevention programme with the aim of eliminating the hazard or risk, or reducing it to the lowest practicable level by all appropriate means.

**Workers’ health surveillance, training and information:**

1. Workers who may be exposed to noise levels exceeding occupational standards shall receive regular audiometric testing.
2. The industry shall ensure that workers who may be exposed to significant levels of noise are trained in the effective use of hearing-protection devices and the role of audiometric examination.
3. If the elimination of noisy processes and equipment as a whole is impracticable, their individual sources shall be separated out and their relative contribution to the overall sound pressure level identified.
4. If reducing the noise at source or intercepting it does not sufficiently reduce workers’ exposure, then the final options for reducing exposure shall be to:
   a. Install an acoustical booth or shelter for those job activities where workers’ movement is confined to a relatively small area;
   b. Minimize by appropriate organizational measures the time workers spend in the noisy environment;
   c. Provide hearing protection;
   d. Offer audiometric testing.

### 6.1.2 Vibration

**Hazard Description:** Exposure of workers to hazardous vibration may be two types: Whole-body vibration when the body is supported on a surface that is vibrating or when working near vibrating industrial machinery and hand-transmitted vibration which enters the body through the hands is caused by various processes in which vibrating tools or work pieces are grasped or pushed by the hands or fingers.
Assessment of Risk (TOR No. 69): If workers or others are frequently exposed to hand-transmitted or whole-body vibration and obvious steps do not eliminate the exposure, employers shall assess the hazard and risk to safety and health resulting from the conditions, and the prevention and control measures to remove them or to reduce them to the lowest practicable level by all appropriate means.

The assessment will identify the ways in which vibrating tools are used, and determine in particular whether:

(a) The high-risk use of tools can be eliminated;
(b) Workers have had sufficient training in the use of the tools; and
(c) The use of tools can be improved by supports.

For the prevention of adverse effects of vibration on workers, employers will:

(a) Identify the sources of vibration and the tasks that give rise to exposure;
(b) Seek the advice of the supplier of vehicles and equipment about their vibration emissions.

Control Strategies:

1. Employers shall ensure that workers who are exposed to significant vibration hazards are informed about the hazards and risks of prolonged use of vibrating tools, correct handling and use of hand tools measures within the workers’ control.

2. Manufacturers shall provide vibration values for their tools, redesign processes to avoid the need to use vibrating tools, use, as far as practicable, anti-vibration handles.

3. Seating in vehicles, including static plant with integral seating, shall be designed to minimize transmission of vibration to the rider, and shall permit an ergonomically good working position.

4. Where workers are directly or indirectly exposed to vibration transmitted via the floor or other structures, the vibrating machines shall be mounted on vibration isolators (anti-vibration mounts) or designed and manufactured according to internationally recognized plant and equipment standards.
5. Machinery or vibrating tools shall be maintained regularly because worn components may increase vibration levels.

### 6.1.3 Heat and Cold Stress

**Hazard Description:** Risks arise when temperature and/or humidity are unusually high, high temperatures and/or humidity occur in combination with heavy protective clothing or a high work rate, or when the workers are exposed to high radiant heat.

**Assessment of Risk (TOR No. 69):** If workers are exposed in all or some of their tasks to any of above conditions and the hazard cannot be eliminated, employers shall assess the hazards and risks to safety and health from extreme temperatures, and determine the controls necessary to remove the hazards or risks or to reduce them to the lowest practicable level.

The assessment for the thermal environment shall take into account the risks arising from working with hazardous substances in work situations such as:

(a) The use of protective clothing against hazardous substances, thereby increasing the risk of heat stress;

(b) A hot environment that makes respiratory protectors un-comfortable and less likely to be used, and necessitates re-structuring of jobs in order to reduce the risks.

**Control Strategies:**

1. Workers exposed to heat or cold, as well as their supervisors, shall be trained to recognize symptoms which may lead to heat stress or hypothermia, in themselves or others, and the steps to be taken to prevent onset and/or emergencies, in the use of rescue and first-aid measures; and in action to be taken in the event of increased risks of accidents because of high or low temperatures.

2. The importance of physical fitness for work in hot environments.

3. The importance of drinking sufficient quantities of suitable liquid and the dietary requirements providing intake of salt and potassium and other elements that are depleted due to sweating.
4. When the assessment reveals that the workers may be at risk of heat stress or hypothermia, employers shall eliminate the need for work in such conditions or take measures to reduce the risks from extreme temperatures.

5. Where workers are at risk from exposure to radiant heat by working near hot surfaces the employer may increase the distance between the equipment to reduce the temperature of the surface by changing plant-operating temperatures, insulating the surfaces or reduce the emissivity of the surface.

6. Where the reduction of surface temperature is not practicable, industry shall consider the use of radiation barriers between the surface and the workplace, water cooling of surfaces or arranging for remote control operations.

7. The industry shall take particular care with ventilation design where work is undertaken in enclosed spaces or areas. When fail-safe systems are not in operation, there will be adequate supervision of workers at risk to ensure that they can be removed from danger.

8. Where part of the risk arises from the metabolic heat produced during work, and other methods of eliminating the risk are impracticable, employers shall arrange a work-rest cycle for exposed workers, either in the workplace or in a cooler restroom.

**6.2 Chemical Hazards (TOR No. 69)**

**6.2.1 Chemicals in the workplace**

**Hazard Description:** A chemical substance is a compound or mixture which may be present in the workplace in the form of a liquid, solid (including particles) or gas (vapor). These substances may present a hazard as the result of contact with the body or absorption into the body. Absorption can occur through the skin, by ingestion or by inhalation.

**Assessment of Risk (TOR No. 69):**

1. Workers may be exposed to chemicals in production work by addition to the process, as well as to chemicals generated by the process or used in maintenance activities, and to chemicals actively during their use in
laboratory work.

2. Exposure may occur passively due to the presence of chemicals in the workplace environment.

3. Material safety data sheets that include advice on the safe handling of any chemical to ensure adequate prevention and protection shall be readily available. All those concerned with the storage and handling of chemicals, and with general house-keeping, shall be trained and shall adopt safe systems of work at all times.

**Control Strategies:**

1. The industry shall ensure that workers involved are trained and competent in terms of proper laboratory techniques; informed about the hazards related to the chemicals they use; current material safety data sheets for those chemicals found in the workplace are readily available; and workers and/or trained first-aid personnel are aware of emergency procedures related to exposure to hazardous chemicals.

2. The industry shall ensure proper storage of chemicals by storing separately chemicals which react with one another; minimizing volumes of stored chemicals; providing for containment of spills; and ventilating storage areas.

3. The industry shall ensure that, where necessary, appropriate PPE is provided and workers are trained in its correct use, the provision of appropriate hygienic conditions in facilities where food is consumed.

**6.2.2 Inhalable agents (gases, vapors, dusts and fumes)**

**Hazard Description:** The production of ferroalloys and steel involves the consumption and generation of a variety of inhalable agents including, but not limited to, gases, vapors, dusts, fumes, smokes and aerosols. These agents comprise a variety of toxicological hazards including irritants, chemical asphyxiates, fibrogens, allergens, carcinogens and systemic toxicants. The pulmonary system (lungs) can be affected by exposure to harmful agents through acute (short-term) injury to lung tissue, the development of pneumoconiosis, pulmonary dysfunction
and the development of lung cancer. Specific agents that may be found in the iron and steel industry include heavy metals (e.g. lead, chromium, zinc, nickel and manganese) in the form of fumes, particulates and adsorbates on inert dust particles.

Control Strategies:

1. Workers and their representatives shall be made aware of the toxicological properties, technical means of prevention, safe working procedures, protective equipment and emergency procedures necessary to eliminate exposure. Where it is not possible, exposure to harmful inhalable agents with which they work or may come in contact shall be minimized.

2. Training shall be provided in advance of the work, including production or maintenance process changes that result in the use or generation of different inhalable agents.

3. The industry shall develop and implement engineering controls for harmful inhalable agents.

4. When engineering controls are not feasible or sufficiently effective to ensure that exposure to inhalable agents is maintained at or below exposure limits, work practices and procedural controls shall be applied.

6.2.3 Insulation Wools

Hazard description: The term “insulation wool” refers to that group of products that includes glass wool, rock wool, refractory ceramic fibres (RCFs), refractory fibres other than RCFs and special-purpose glass fibres. Insulation wools have mechanical irritant properties and may pose a threat of disease to the eyes, skin and upper respiratory tract. However, some of the effects of exposure to insulation wools may not become apparent for two or three decades, or even longer. RCFs, particularly those containing amorphous silica, have the potential to be converted to crystalline silica where they have been exposed to heat in excess of 1,000°C (1,800°F), for an extended period of time.

Assessment of Risk:

The industry shall, as far as practicable, select appropriate products or handling
methods so as to minimize the generation of fibres and dust, and shall keep them informed regarding the development of changing insulation technology.

The industry shall assess the hazards and risks, inform the workers about them and provide appropriate supervision. They shall ensure that all workers involved in the handling of insulation wools, including supervisors, receive adequate instructions and training in safe work practices, and, where necessary, in the selection, wearing and maintenance of PPE.

**Control Strategies:**

1. The industry shall provide the equipment, including PPE, necessary for the handling of insulation wools, and offer appropriate washing and changing facilities for workers exposed to insulation wools.

2. The industry shall ensure that exposures to fibres and dust are kept as low as reasonably achievable, and at least below the exposure limits set by the competent authority. Unnecessary exposures shall be avoided. Where reasonably practicable, respirable RCFs shall be replaced by less hazardous materials.

3. Material safety data sheets and labels, as well as other product information on safety and health in the use of insulation wools, conforming to the requirements of the competent authority, shall be prepared by manufacturers and made available to suppliers and users. The production of material safety data sheets in electronic format shall be encouraged.

4. The industry shall provide exposed workers information and training on the hazards and health risks of insulation wools and on safe handling procedures.

### 6.3 Safety Hazards (TOR No. 69)

#### 6.3.1 Confined Space

**Hazard Description:** A confined space is one that is large enough for the worker to enter bodily, has limited or restricted means of entrance or exit and is not designed for continuous employee occupancy, or a space which may accumulate a hazard
which is present. Confined spaces require additional safety and health precautions because their configurations hinder the activities of any workers who must enter, work in and exit from them. A confined space often has poor air quality. In addition, many fatalities occur to rescue personnel who respond without adequate planning and protection.

Assessment of Risk: The industry shall:

1. Identify, test and inspect the confined spaces in the work-place and determine if workers are required to enter and work in them;
2. Where entry is not required, prevent unauthorized or inadvertent entry into a confined space by posting warning signs, locking and securing, or other measures as necessary, to ensure that people do not enter without proper protection and supervision;
3. Where entry is required by a person, fully characterize, through testing and inspection, all existing and potential hazards in the confined space (hazards can be classified as mechanical, electrical, oxygen depletion or enrichment, flammable or combustible vapors and gases, and toxic gases and vapors), including blanking off or bleeding all supply systems to the confined space.

Control Strategies:

1. The industry shall inform and train workers entering and working in the confined space of the hazards, protective measures and emergency rescue procedures;
2. The industry shall ensure that all hazards in the space are eliminated or controlled, and provide PPE, including appropriate rescue devices, to ensure adequate protection of the worker; and purge, flush or ventilate the hazardous confined space, as necessary, to eliminate or control the hazards, and take adequate measures to ensure that no hazardous substances can enter the confined space while people are working there.
3. The industry shall develop a comprehensive programme and procedures to address work in a confined space; be aware of any work task to be performed
in a confined space, and implement the necessary procedures to monitor the work and its completion; provide adequate work permits for workers.

4. Potentially hazardous confined spaces shall be clearly marked with warning notices prohibiting unauthorized entry.

5. Because of the explosion hazard inherent in some confined spaces, compressed air shall not be used for artificial ventilation if there is a potential for sources of ignition.

6.3.2 Control of Hazardous Energy

**Hazard Description:** The industry uses different sources of energy (electric, mechanical, hydraulic, pneumatic, etc.). The safe control of energy shall be addressed by procedure and carried out by appropriately trained personnel in accordance with the nature of the energy source and the characteristics of the facilities. To the extent possible, the source of energy itself shall be isolated rather than the control mechanism. Energy sources for equipment shall be turned off or disconnected or de-energized and the switch locked or labeled with a warning tag.

**Control Strategies:**

1. The industry shall identify and implement specific procedures for the control of hazardous energy.

2. Workers working in the hazard area shall be trained in the hazard and the protective measures in place.

3. All electrical installations shall be appropriately designed and shall include appropriate protection systems, such as automatic shut-off systems, interlocks and emergency controls.

4. Facilities shall be installed and used in accordance with the requirements of the manufacturer and in compliance with the competent authority.

5. Energy sources and facilities shall be appropriately labeled.

6. A risk assessment shall be conducted before isolating the energy source to ensure that the consequences have been evaluated.
6.3.3 Work equipment and machinery guarding

**Hazard Description:** The use of work equipment, including machinery and hand portable power tools, may result in accidents, many of which are serious and some fatal. Of the many factors that can cause risk, particular areas of concern include:
A lack of guards or inadequate guards on machines which can lead to accidents caused by entanglement, sheering, crushing, trapping, cutting, etc.; Insufficient strength of materials and inappropriate design of machines; failure to provide the right information, instruction and training for those using the equipment; All power tools shall be used with appropriate shields, guards and attachments and in accordance with the recommendations of the manufacturers. Workers shall be trained in the use of power tools and safety requirements.

**Control Strategies:** Controlling risks often means guarding those parts of machines and equipment that could cause injury. Many accidents happen because of the failure to select the right equipment for the work to be done. Planning ahead can control risks and ensure that suitably protected equipment or machinery is available. Moreover, there are many machines, parts of machines or parts of work equipment which if not properly guarded can cause injury to the operator.

1. The industry shall ensure that fixed guards are used wherever necessary, and properly fastened in place with appropriate fasteners including, screws or nuts and bolts which need tools to remove them; workers will be trained to operate equipment before they are directed to do so;
2. Regular maintenance of machinery and equipment is required to ensure that they are in a safe condition, and maintenance records are kept;
3. Workers shall know how to operate the machine (following the operating manual instructions), including the emergency stopping procedures, before commencing operation;
4. Workers shall be authorized to immediately stop the machine if it is not working safely or if any guards or protective devices are faulty, and inform the supervisor as soon as possible.
6.4 Hazards in operating the furnace

6.4.1 Preventing fires and explosions

Fires and explosions in furnaces most often result from water coming into contact with molten metal. The water may be present in scrap material, damp moulds, from leaks in the furnace cooling systems or leaks in the building. Following precautions shall be taken to prevent fires:

a. Operators shall be trained in safe systems of work. The building shall be designed to be non-combustible, with automatic fire suppression engineered or designed into the process where appropriate.

b. Regular safety audits shall be undertaken to ensure that hazards are clearly identified and risk-control measures maintained at an optimum level. Furnaces shall not be operated beyond their safe lives.

6.4.2 Dusts and Fibres

When a furnace is stripped for maintenance purposes, particular care shall be taken to avoid inhaling dusts or fibres from the insulating material. Dust and fume collectors shall be incorporated into the furnace design.

6.4.3 Preventing steam explosion

Molten slag and metal shall be prevented from coming into contact with water, which will cause a steam explosion. Equipment and piping for furnace gas cleaning, and piping carrying gas in the air preheating system of the dry dust catchers, shall be built in such a way that they can be ventilated and cleaned.

6.4.4 Handling molten metal, dross or slag

Hazard Description: Burns may occur at many points in the steel-making process: at the front of the furnace during tapping from molten metal or slag; from spills, spatters or eruptions of hot metal from ladles or vessels during processing, teeming (pouring) or transporting; and from contact with hot metal as it is being formed into a final product.
Assessment of risk: The likelihood of injury in the handling of molten metal shall be assessed at all stages in the process. This includes the integrity, stability and use of the furnace and transport ladles, the nature and use of vehicle/crane transport, and the systems in place for pouring molten metal.

Control Strategies:

1. Personnel handling molten metal shall be trained in the proper procedures to adopt, and in the relevant safety and health precautions, including use of appropriate PPE.
2. Only essential personnel shall be in the vicinity of pouring operations.
3. Moulds and tundishes shall not be damp, nor shall there be any means whereby water may enter the melt because of the risk of explosion.
4. The area will be cordoned off prior to the transport of molten metal if there is a possibility of spillage.
5. A competent person shall regularly inspect ladle buckets and their supporting, locking and tipping mechanisms.
6. Corrective repair measures that are recommended shall be planned and implemented on a timely basis.

6.5 Rolling Mill

Hazard Description: In any rolling mill, there is a risk of trapping between the rolls. Severe injuries may be caused by shearing, cropping, trimming and guillotine machines, unless the dangerous parts are securely guarded. Injuries may occur, especially in hot-rolling, if workers attempt to cross roller conveyors at unauthorized points. Even in automated works, accidents occur in conversion work while changing heavy rollers in the stands. In hot-rolling, burns, eye injuries or other injuries may be caused by flying mill scale and dust particles or by whipping of cable slings. Eyes may also be affected by glare.
Control Strategies:

1. Nips of rolls shall be effectively guarded based on an appropriate risk assessment, and strict supervision exercised to prevent any work which is in motion.

2. Dangerous parts shall be securely guarded to prevent severe injuries caused by shearing, cropping, trimming and guillotine machines.

3. An adequate number of bridges with appropriate guardrails shall be installed and their use enforced.

4. Good planning often reduces the number of roll changes required. The change of heavy rollers in the stands shall not be done with time pressure and without suitable tools.

5. Water-based rolling oils, lubricants and coolants shall be replaced on a regular basis in order to avoid bacterial contamination. Where biocides are used for this purpose, they shall not be toxic to workers, either in themselves or in combination with other ingredients. Operating pulpits shall be ergonomically designed.

6.6 Internal Transport

Hazard Description: The hazards can be caused by interaction between vehicles, vehicles and other objects and personnel, or by loads falling off or from the vehicle.

Control strategies:

1. Operators of vehicles shall receive and maintain adequate training and the required certification according to the regulations established by the competent authority. Operators shall have the necessary knowledge of the hazards and potential risks concerning the transportation of cargo.

2. Operators of certain types of vehicles may require regular medical surveillance.

3. Contractors and other visitors shall be appropriately instructed about the hazards and potential risks. They shall be instructed about the rules of how to move in the area.
4. Transport routes shall be planned and constructed to minimize the risk of collision and with sufficient safe clearance to allow for aisles and turns, or other types of control area. Where appropriate, maps showing the proposed route shall be provided. Transport routes and work areas containing transport vehicles shall be visibly marked and segregated from walkways to the greatest extent possible.

5. The safe operating speed for vehicles shall be posted and enforced. The operator shall be protected from cargo, such as molten metal splashes, chemicals and unsecured cargo. Loads shall be lowered slowly and smoothly.

6. Forklift trucks used to transport molten material shall have solid tyres and their fuel tanks shall be protected and insulated from ignition. Lifting devices shall be made of steel that is not prone to hydrogen embrittlement and shall be shielded from radiant heat. Workstations shall not be located underneath the path of molten material.

6.7 Personal Protective Equipment (PPE)

6.7.1 General provisions

As a supplementary protection against exposure to hazardous conditions in the production of steel and ferroalloys where the safety of workers cannot be ensured by other means, such as eliminating the hazard, controlling the risk at source or minimizing the risk, suitable and sufficient PPE, having regard to the type of work and risks, and in consultation with workers and their representatives, shall be used by the worker and provided and maintained by the industry, without cost to the workers. PPE shall be selected considering the characteristics of the wearer and additional physiological load or other harmful effects caused by the PPE. It shall be used, maintained, stored and replaced in accordance with the standards or guidance for each hazard identified at the facility and according to the information given by the manufacturer.

PPE shall be examined periodically to ensure that it is in good condition. Employers
shall ensure that the workers who are required to wear PPE are fully informed of the requirements and of the reasons for them, and are given adequate training in the selection, wearing, maintenance and storage of this equipment. When workers have been informed accordingly, they shall use the equipment provided throughout the time they may be exposed to the risk that requires the use of PPE for protection. Items of special PPE for use in proximity to molten metal shall protect the wearer from heat and shall withstand splashes of molten metal. It shall be possible to remove these items easily if molten matter gets between the body and the protective clothing.

The PPE shall not be used for longer than the time indicated by the manufacturer. Workers shall make proper use of the PPE provided, and maintain it in good condition, consistent with their training and be provided with the proper means for doing so. Before reissuing the clothing or equipment, employers shall provide for the laundering, cleaning, disinfecting and examination of protective clothing or equipment which has been used and may be contaminated by materials that are hazardous to health.

Protective equipment that may be contaminated by materials hazardous to health shall not be laundered, cleaned or kept at workers home. Employers shall ensure that workers do not take contaminated clothing home and shall provide for the cleaning of such clothing at no cost to the worker. PPE shall not contain hazardous substances, such as asbestos.

6.7.2 Head protection
Helmets intended for use in the metallurgical industry shall be subjected to a test for resistance to splashes of molten metal. Any helmet that has been submitted to a heavy blow, even if there are no evident signs of damage, shall be discarded. If splits or cracks appear, or if a helmet shows signs of ageing or deterioration of the harness, the helmet shall be discarded.
Where there is a hazard of contact with exposed conductive parts, only helmets made of non-conducting material shall be used. Helmets for persons working overhead shall be provided with chin straps. In addition to safety, consideration shall also be given to the physiological aspects of comfort for the wearer. The helmet shall be as light as possible, the harness shall be flexible and shall not irritate or injure the wearer and a sweatband shall be incorporated. All protective headgear shall be cleaned and checked regularly.

6.7.3 Face and eye protection

Face shields or eye protectors shall be used to protect against flying particles, fumes, dust and chemical hazards. Face shields shall be used in furnace operations and other hot work involving exposure to high-temperature radiation sources. Protection is also necessary against sparks or flying hot objects. Face protectors of the helmet type and the face-shield type are preferred.

Goggles, helmets or shields that give maximum eye protection for each welding and cutting process shall be worn by operators, welders and their helpers. Welding and cutting processes of furnaces emit radiation in the ultraviolet, visible and infrared bands of the spectrum, which are all able to produce harmful effects upon the eyes. In welding operations, helmet type protection and hand shield type protection shall be used. Protection is also necessary for the welder’s assistant and those who may be exposed to the hazards shall be appropriately protected.

With the use of face and eye protectors, due attention shall be paid to greater comfort and efficiency. The protectors shall be fitted and adjusted by a person who has received training in this task. Comfort is particularly important in helmet and hood type protectors as they may become almost intolerably hot during use. Air lines can be fitted to prevent this. Face and eye protectors shall give adequate protection at all times even with the use of corrective vision devices. Eye protectors, including corrective lenses, shall be made of appropriate high-impact material.
6.7.4 Upper and lower limb protection

Protective gloves or gauntlets, appropriate barrier creams and suitable protective clothing to protect upper and lower limbs, as required, shall be worn when exposed to heat radiation or while handling hot, hazardous or other substances which might cause injury to the skin. Hands and feet shall be protected against physical, chemical and other hazards.

Burns of the lower limbs from molten metals, sparks or corrosive chemicals may occur in the iron and steel industry. Safety footwear and other leg protection shall be used where appropriate. The height to which safety footwear covers the ankle, knee or thigh depends on the hazard, although comfort and mobility shall be considered.

Shoes or boots shall be without tongues and trouser legs shall be pulled over the top of the boot and not tucked inside. Slip-resistance properties shall be taken into account when choosing footwear. Rubber or metallic spats, gaiters or leggings shall be used to protect the leg above the shoe line, especially from risks of burns. Knee protectors may be necessary, especially where work involves kneeling. Aluminized heat-protective shoes, boots or leggings shall be used near sources of intense heat. All professional footwear shall be kept clean and dry when not in use and shall be replaced as soon as necessary.

6.7.5 Respiratory protective equipment

When the hazard and risk cannot be assessed with sufficient accuracy to define the appropriate level of respiratory protection, employers shall make positive pressure air-supplied respiratory protective devices available. Respirators shall be cleaned and sanitized periodically. Respirators intended for emergency use shall be cleaned and sanitized after each use.

The user shall be sufficiently trained and familiar with the respirator in order to be able to inspect the respirator immediately prior to each use to ensure that it is in proper working condition. Inspection may include the following:
a. Tightness of connections.
b. The condition of the respiratory inlet and outlet covering;
c. Head harness;
d. Valves;
e. Connecting tubes;
f. Harness assemblies;
g. Hoses;
h. Filters;
i. Cartridges;
j. End of service life indicator;
k. Electrical components;
l. Shelf life date;
m. The proper function of regulators, alarms and other warning systems.

6.7.6 Hearing protection

Hearing loss of speech frequencies may occur with elevated long-term exposure to noise. The use of hearing protectors gives the best results to users who are well informed of the risks and trained in their use. If earplugs are used, special attention shall be paid to the proper fitting technique.

Hearing protectors shall be made available at the entrance to the noisy area and they shall be put on before entering the noisy area. Noisy areas shall be indicated by appropriate signs.

The attenuation of hearing protectors works well only if they are well maintained. Good maintenance consists of cleaning, changing replaceable parts such as cushions, and over all monitoring of the state of the hearing protector.

Hearing protectors shall be evaluated through an audiometric test programme for exposed workers.
6.7.7 Protection from falls

When other measures do not eliminate the risk of falling, workers shall be provided with and trained in the use of appropriate fall protection equipment, such as harnesses and lifelines. Workplaces and traffic lanes in which there are fall hazards or which border on a danger zone shall be equipped with devices which prevent workers from falling into or entering the danger zone.

Devices shall be provided to prevent workers from falling through floors and openings. Safety harnesses shall be worn where required and the lifeline shall be attached to an adequate anchor point.

Harnesses shall be chosen that are safely used with other PPE that may be worn simultaneously. Appropriate and timely rescue shall be provided when using fall-arrest equipment to prevent suspension trauma.

6.7.8 Work clothing

Where required on the basis of a risk assessment, workers shall wear the appropriate protective clothing provided by the employer.

The selection of protective clothing shall take into account:

(a) The adequacy of the design and the fit of the clothing, allowing freedom of movement to perform tasks, and whether it is suitable for the intended use;
(b) The environment in which it will be worn, including the ability of the material from which it is made to resist penetration by chemicals, minimize heat stress, release dust, resist catching fire and not discharge static electricity; and
(c) The special requirements of workers exposed to molten metal and associated hazards, such as the need for reflective clothing or insulated clothing with reflective surfaces during exposure to high radiant heat and hot air.

Work clothes contaminated with a chemical substance or substances shall be washed (if reusable) or disposed of in a workplace facility. The employer shall ensure that a worker removes protective clothing before leaving the containment area or any
workplace exposed to asbestos dust, or any other substance that may pose a risk outside the containment area. Contaminated clothing shall be disposed of safely. Inspection of protective clothing shall be performed by the user before each use.