

**ISO TC IIW/SC C VIII N**

Date: 2009-06-11

**ISO/PDTR xxxxx**

ISO TC IIW/SC C VIII/WG

Secretariat:

## **Health and Safety in welding — Guideline to risk assessment of welding fabrication Activities**

-----

### **Warning**

This document is not an ISO International Standard. It is distributed for review and comment. It is subject to change without notice and may not be referred to as an International Standard.

Recipients of this draft are invited to submit, with their comments, notification of any relevant patent rights of which they are aware and to provide supporting documentation.

Document type: Technical Report  
Document subtype:  
Document stage: (20) Preparatory  
Document language: E

F:\IIW\Commissione VIII\Documenti\Originali\VIII-2081r2-09 (Draft TR Guideline h&S assessment).doc STD  
Version 2.1c2



### Copyright notice

This ISO document is a working draft or committee draft and is copyright-protected by ISO. While the reproduction of working drafts or committee drafts in any form for use by participants in the ISO standards development process is permitted without prior permission from ISO, neither this document nor any extract from it may be reproduced, stored or transmitted in any form for any other purpose without prior written permission from ISO.

Requests for permission to reproduce this document for the purpose of selling it should be addressed as shown below or to ISO's member body in the country of the requester:

[Indicate the full address, telephone number, fax number, telex number, and electronic mail address, as appropriate, of the Copyright Manger of the ISO member body responsible for the secretariat of the TC or SC within the framework of which the working document has been prepared.]

Reproduction for sales purposes may be subject to royalty payments or a licensing agreement.

Violators may be prosecuted.

## Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

In exceptional circumstances, when a technical committee has collected data of a different kind from that which is normally published as an International Standard ("state of the art", for example), it may decide by a simple majority vote of its participating members to publish a Technical Report. A Technical Report is entirely informative in nature and does not have to be reviewed until the data it provides are considered to be no longer valid or useful.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO/TR xxxxx was prepared by IIW, *International Institute of Welding*, C VIII, Health, safety and environment.

# Contents

Page

Foreword .....	2
Introduction.....	4
1 <b>Scope</b> .....	5
2 <b>References</b> .....	5
3 <b>Terms and definitions</b> .....	5
4 <b>Use of this document</b> .....	6
5 <b>Procedures</b> .....	7
6 <b>Risk assessment principles</b> .....	7
7 <b>Risk assessment for welding and allied activities</b> .....	8
8 <b>List for welding and allied activities</b> .....	9
<b>Bibliography</b> .....	14
<b>Annex A</b> (informative) <b>Preventive measures</b> .....	15
<b>Annex B</b> (informative) <b>List of activities associated with welding processes</b> .....	19
<b>Annex C</b> (informative) <b>Health and safety management systems and welding fabrication</b> .....	20
<b>Annex D</b> (informative) <b>List of applicable documents</b> .....	21
D.1 <b>International Standards</b> .....	21
D.2 <b>Other applicable documents</b> .....	21

## Introduction

This ISO Technical Report was prepared by the International Institute of Welding (IIW), Commission VIII: Health and Safety.

It constitutes the considered concerns of this expert group on the possible hazards and risks to be considered during arc welding and allied processes in order to help welding fabricators to identify countermeasures in order to minimise exposures to risk. The experts have drawn on views expressed in previous IIW Commission VIII documents on this topic and information published in papers in the scientific literature. The latter are listed in the Bibliography.

This Technical report provides tables of possible risks associated with welding and allied activities, focusing on possible consequent harm and damages. The lists contain the most common aspects of safety related to welding, but do not purport to be exhaustive.

In addition, Annex A reports information on possible actions to be implemented to reduce the risk, and Annex B suggest relations among processes typical allied activities.

# Health and Safety in welding — Guideline to risk assessment of welding fabrication Activities

## 1 Scope

This technical report provides lists for the assessment of the health and safety aspects of welding fabrication of metallic materials, including on-site and repair work.

It includes a list of hazards with reference to assessment procedures and a guide for possible preventive actions.

## 2 References

The following referenced documents are indispensable for the application of this document. The latest edition of the referenced document (including any amendments) applies.

ISO 10882, *Health and safety in welding and allied processes - Sampling of airborne particles and gases in the operator's breathing zone*

ISO 15011, *Health and safety in welding and allied processes - Laboratory method for sampling fumes and gases generated by arc welding*

ISO 15012, *Health and safety in welding and allied processes – Requirements for testing and marking of equipment for air filtration*

ISO TR xxxxx , *Health and safety aspects of welding – Non-consumable thoriated tungsten electrodes*

ISO TR xxxxx , *Health and safety aspects of welding – Health and safety aspects of welding – Fume composition related to welding processes and consumables*

ISO 14731

ISO 4063

## 3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/IEC Guide 2, ISO/IEC Guide 51, ISO/IEC Guide 73 as well as the following apply.

### 3.1

#### Welding and allied activities

Welding and allied activities (for the purpose of this document) includes the following activities and associated processes:

**Commento [Ab1]:** Only „safety“ defined as „freedom from unacceptable risks of harm“

- fusion welding (as defined in 3.2) and
- joint preparation, including thermal cutting, gouging (see 3.3) and grinding

Other processes such as the following may have similar health and safety aspects but are not directly covered by this document:

- soldering and brazing;
- thermal spraying;
- preheating and post weld heat treatments;
- flame straightening and mechanical straightening.

### 3.2

#### Fusion welding

This document is limited to the following fusion welding processes according to ISO 4063 numbering system:

- 1: Arc welding
- 3: Gas welding

### 3.3

#### Thermal cutting and gouging

This document is limited to the following cutting and gouging processes according to ISO 4063 and its numbering:

- 8 Cutting and gouging (excluding 84 Laser cutting)

### 3.4

#### Hazard

Source or situation with a potential for harm, which in this document comprises injury, occupational disease, death, material damage and/or other loss.

**Commento [Ab2]:** only used in the introduction (principles)

### 3.5

#### Risk

Combination of the likelihood and consequence(s) of a specified hazardous event, typically quantified by means of a risk assessment.

**Commento [Ab3]:** evt. no need to specify, terms commonly understood by typical users of this standard

### 3.6

#### OEL Occupational Exposure Limit

The Occupational Exposure Limit (OEL) of a chemical substance defines the reasonable level to which a worker can be exposed without adverse health effects. National regulations have to be respected.

**Commento [Ab4]:** only used in the introduction (principles), evt. delete if not used as a prev. measure

## 4 Use of this document

This technical report provides lists for the assessment of health and safety aspects of welding fabrication of metallic materials, including on-site and repair work. In order to perform such assessments an understanding of the following topics is required:

- occupational health and safety
- welding fabrication
- management systems

For the intended use of this document the support of welding coordination personnel is needed. Tasks and responsibilities of welding coordination personnel are defined in ISO 14731.

## 5 Procedures

It is in the employer's interest that personnel can work in a healthy and safe environment as this has a direct influence on productivity and motivation. Common sense should dictate measures to maintain the health and safety of operators in manufacturing environments. Beyond this, other requirements that ensure the health and safety of welding personnel during welding and allied activities can originate from a number of sources such as:

- legal requirements, often at the national and/or regional level;
- customer requirements;
- insurance requirements;
- certification requirements.

## 6 Risk assessment principles

Accidents and occupational diseases can ruin lives and affect business if output is lost, machinery or property is damaged, and can lead to an increase in insurance costs. Risk assessments are described in various national and international guidelines, which generally follow the same principal sequence:

**Commento [Ab5]:** does not form part of the principles, but can work as a kind of introduction.

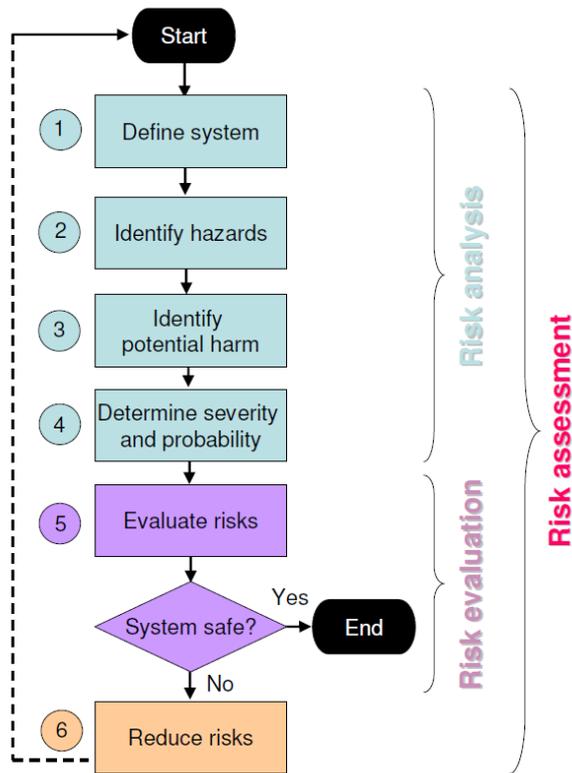
A risk assessment is a systematic examination of hazards in a specific activity, in order to consider precautions to prevent harm as depicted in Figure 1.

**Commento [Ab6]:** does not only refer to workers, but all harm. last sentence has no logical purpose here.

This document may help in identifying possible hazards related to and harm arising from welding and allied activities (steps 2 and 3 in Figure 1) as well as in reducing or even preventing the associated risks (step 6 in Figure 1).

Occupational Exposure Limits (OEL) or other reference levels may apply, but protection of the health and safety conditions is, as a general rule, a continuous process for which gradual improvements are targeted (see Annex C).

Figure 1 — Principle of risk assessment



## 7 Risk assessment for welding and allied activities

The lists in this document can be used as a tool for health and safety analysis and for the identification of possible problem areas. In general, this applies to the following situations:

- when planning a fabrication, the implementation of new fabrication methods or equipment;
- the identification of procedures that may require specific monitoring or checks of health and safety aspects;
- the specification of safety Procedures for welding and for handling, storing and disposing of welding-related substances that are may be hazardous to health and safety.

This assessment is based on the following steps:

- 1) Identify the hazards arising from the activity (as referred to in table 1).
- 2) Identify the potential harm arising from the hazard (as referred to in table 2).
- 3) Based on that preventive measures (substitute with a safer process, reduce or protect) can be implemented in order to minimise the probability and/or the severity of the harm. Appendix A lists possible preventive and corrective measures which can be typically applied.

**Commento [Ab7]:** only if required i.e. if risk is unacceptable

## 8 List for welding and allied activities

Table 1 — Hazard identification

A-No.	Activity	Hazard	H-No.
<b>Welding processes (W)</b>			
W1	Fusion welding in general	Ergonomic aspects (body work, body posture, climate etc.)	H1
		Fumes, gases, vapours and/or dust (explosive, inflammable, toxic, suffocating etc.)	H2.2
W2	Arc welding, cutting and joint preparation using an electrical arc	Optical radiation	H3
		Hot (incl. liquid) metal, spatter and/or slag	H4
		Hot surfaces	H5
		Electrical currents	H6
		Electromagnetic fields	H6.1
W3	Gas welding, cutting and joint preparation using a gas flame	Optical radiation	H3
		Hot (incl. liquid) metal, spatter and/or slag	H4
		Hot surfaces	H5
		Flame	H7
<b>General activities (G)</b>			
G1	Grinding / mechanical cutting and joint preparation	Projectiles	H8
		Sparks	H9
		Noise	H10
		Dust and fumes	H2.1
		Sharp edges	H11
		Vibration	H12
		Hot surfaces	H5
		Rotating parts	H13
G2	Cleaning	Hazardous materials (acids, solvents, gases etc.)	H14
		Sharp edges	H11
G3	Operating electrical tools	Electrical currents	H6
G4	Using compressed air	Projectiles	H8
G5	Cutting in general	Released parts or stresses	H15
G6	Mechanized, semi- and fully automated processes	Moving machinery	H16

A-No.	Activity	Hazard	H-No.
<b>Activities associated with specific welding processes (A)</b>			
A1	Slag removal	Hot (incl. liquid) metal, spatter and/or slag	H4
		Projectiles	H8
		Noise	H10
A2	Gas handling	Hazardous materials (acids, solvents, gases etc.)	H14
		Pressurized gas	H17
A3	Drying of electrodes and flux/powder	Hot surfaces	H5
A4	Flux/powder handling	Dust	H2
		Ergonomic aspects (body work, body posture, climate etc.)	H1
A5	Disposal of electrode stubs	Hot surfaces	H5
		Slipping	H18
A6	Regrinding of thoriated tungsten electrodes	Radioactive dust	H19
<b>Surroundings / welding environment (S)</b>			
S1	Welding in dangerous or sensitive environments	Explosive atmosphere	H20
		Combustible materials	H21
S2	Welding in confined spaces	Ergonomic aspects (body work, body posture, climate etc.)	H1
		Fumes, gases, vapours and/or dust (explosive, inflammable, toxic, suffocating etc.)	H2.2
		Exposure	H22
S3	Welding in electrically conducting surroundings	Electrical currents, elevated hazard	H6.2
S4	Welding under water	Ergonomic aspects (body work, body posture, climate etc.)	H1
		Electrical currents	H6
		Diving related hazards	H23

Table 2 — Identification of potential harm and damage

H-No.	Hazard	Harm	Material damage
H1	Ergonomic aspects (body work, body posture, climate etc.)	Musculo-skeletal diseases	
		Fatigue	
H2	Dust	Lung diseases	Sooting
		Eye irritation	
H2.1	Dust and fumes	Lung diseases	Sooting
		Poisoning	
		Eye irritation	
H2.2	Fumes, gases, vapours and/or dust (explosive, inflammable, toxic, suffocating etc.)	Lung diseases	Sooting
		Poisoning	
		Burns and scalds	
		Eye irritation	
H3	Optical radiation	Radiation burns	Embrittlement of sensitive components
		Blinding	
		Arc eye	
H4	Hot (incl. liquid) metal, spatter and/or slag	Burns	Fire
		Eye injuries	Melting of and adhesion to low-melting components
H5	Hot surfaces	Burns	Fire
			Melting of and adhesion to low-melting components
H6	Electrical currents	Electrical burns	Current spikes in electrical devices
		Shock	Tripping mains
		Muscle paralysis (suffocation)	
		Heart fibrillations	
H6.1	Electromagnetic fields	Interference with pace makers	Interference with electronic control systems
		Heating and induced currents in body	
H6.2	Electrical currents, elevated hazard	see H6	
H7	Flame	Burns	Fire
H8	Projectiles	Puncture wounds	
		Eye injuries	

H-No.	Hazard	Harm	Material damage
H9	Sparks	Burns	Fire
		Eye injuries	
H10	Noise	Hearing damage	
H11	Sharp edges	Lacerations	
H12	Vibration	Occupational diseases	Material fatigue
		Muscular diseases	Moving of loose objects
H13	Rotating parts	Lacerations	
		Crushing injuries	
H14	Hazardous materials (acids, solvents, gases etc.)	Poisoning	Corrosion
		Chemical burns	
		Occupational diseases	
		Suffocation	
H15	Released parts or stresses	Crushing injuries	Structural collapse
		Broken bones	
		Hearing damage	
		Concussion	
H16	Moving machinery	Crushing injuries	
		Lacerations	
		Broken bones	
		Concussion	
H17	Pressurized gas	Eye injuries	Explosion
		Suffocation	
		Bruises	
H18	Slipping	Concussion	
		Broken bones	
		Bruises	
H19	Radioactive dust	Cancer	
		Poisoning	

H-No.	Hazard	Harm	Material damage
H20	Explosive atmosphere	Burns	Fire
		Hearing damage	Melting
		Suffocation	Structural damage
H21	Combustible materials	Burns	Fire
		Poisoning	Melting
		Suffocation	
H22	Exposure	Occupational diseases	
		Shock	
H23	Diving related hazards	Occupational diseases	
		Shock	

## Bibliography

- [1] IIW document VIII-1901-00: Welding with non-consumable thoriated tungsten electrodes
- [2] IIW document VIII-1876-99: Fume composition related to welding process and consumables
- [3] IIW document VIII-1858-98: Health hazards from exposure to electro-magnetic fields in welding
- [4] IIW document VIII-1856-98: Welding adds hazards to work in confined spaces
- [5] IIW document VIII-1823-97: Statement on welding and cutting containers
- [6] IIW document VIII-1817-97: Occupational health in metal arc welding
- [7] IIW document VIII-1588-91: On the question of milk drinking of welders as a measure of health protection
- [8] IIW document VIII-1036-82: Interlaboratory calibration of a standardised analytical method for hexavalent and total chromium in welding fumes

## Annex A (informative)

### Preventive measures

Table A.1 — Preventive measures

H-No.	Hazard	Preventive measures
H1	Ergonomic hazards	Avoid excessive heat or cold, draughts, unergonomic positions
		Ergonomic gear and tools (welding helmet, welding torch, work bench etc.)
H2	Dust	Ensure ventilation and dust/fume extraction
		Individual protection (welding helmet with ventilation/air supply, extraction at source or integrated into the welding torch etc.) or general protection (work area ventilation, work outside etc.)
		Working under water if possible (e.g. cutting)
H2.1	Dust and fumes	Ensure adequate ventilation and extraction
		Individual protection (welding helmet with ventilation/air supply, extraction at source or integrated into the welding torch etc.) or general protection (work area ventilation, work outside etc.)
		Working under water if possible (e.g. cutting)
H2.2	Fumes, gases, vapours and/or dust (explosive, inflammable, toxic, suffocating etc.)	Ensure adequate ventilation and extraction
		Individual protection (welding helmet with ventilation/air supply, extraction at source or integrated into the welding torch etc.) or general protection (work area ventilation, work outside etc.)
		Working under water if possible (e.g. cutting)
		Ensure that all gas-containing parts are leak-free (bottles, valves, regulators, distribution systems, pipes, hoses, fittings etc.)
		Prevent accumulation of gases in dangerous amounts (extraction, burning/flaring excess gas)
H3	Optical Radiation	Welding helmet, welding goggles, welding shield
		Protective clothing covering the entire body
		Welding curtain, non-reflective surfaces
H4	Hot liquid metal, spatter and/or slag	leather apron, leather gloves, closed safety shoes
		Remove, cover or shield flammable and combustible materials
		Fire extinguishers, fire sentry

H-No.	Hazard	Preventive measures
H5	Hot surfaces	leather apron, leather gloves, closed safety shoes
		Cool down sensitive parts
H6	Electrical currents	Correctly maintained welding equipment (insulation etc.)
		Correctly installed welding circuits
		Appropriate welding equipment (IP-protection codes...)
		Protective (insulating) clothing (shoes, gloves etc.)
H6.1	Electromagnetic fields	Monitor exposure
		Pace makers not allowed in vicinity
H6.2	Electrical currents, elevated hazard	see H6
		Appropriate welding equipment ("S"-machines)
		insulating pad/layer
		Battery power and compressed air tools , insulating transformer
H7	Flame	Protective (flame resistant) clothing
		Remove, cover or shield inflammable and combustible materials
		Fire extinguishers, fire sentry
H8	Projectiles	Protective clothing (protective goggles, closed safety shoes...)
H9	Sparks	leather apron, leather gloves, closed safety shoes
		Remove, cover or shield inflammable and combustible materials
		Fire extinguishers, fire sentry
H10	Noise	noise-reduced machines, technical noise protection
		hearing protection
H11	Sharp edges	protective gloves
H12	Vibration	Uncoupling of vibrations
		Reduce exposure (operational hours)
H13	Rotating parts	Machine protection (screening, two-handed operation, access-protection, safety light barrier etc.)
		Protective clothing (gloves, safety-goggles, etc. )
H14	Hazardous materials	follow labelled safety instructions/precautions
H15	Released parts or stresses	Fasten parts to be sectioned (both sides of the cut)
		Take into account weight, residual stresses and stability of the sectioned parts

H-No.	Hazard	Preventive measures
H16	Moving machinery	Machine protection (screening, two-handed operation, access-protection, safety light barrier etc.)
		Only use safety-certified machinery (e.g. EU: EC machinery directive)
H17	Pressurized gas	follow labelled safety instructions/precautions
		Reduce gas pressure (use as little as possible, as much as necessary)
		Safety-goggles
H18	Slipping	Cleanliness and tidiness
		Dispose of electrode stubs in a fire-proof container
H19	Radioactive dust	Avoid the use of thoriated electrodes
		Wear appropriate dust protection
H20	Explosive atmosphere	Ensure that all gas-containing parts are leak-free (bottles, valves, regulators, distribution systems, pipes, hoses, fittings etc.)
		Prevent accumulation of gases in dangerous amounts (extraction, burning/flaring excess gas); prevent secondary flames
		Place gas bottles in use outside small enclosures/rooms
		Only work with a welding permit; measure explosivity of atmosphere
H21	Combustible materials	Only work with a welding permit
		Remove, cover or shield flammable and combustible materials
H22	Exposure	Only work with a welding permit; measure composition of atmosphere (oxygen content)
		Ensure ventilation and dust/fume extraction
		Individual protection (welding helmet with ventilation/air supply, extraction at source or integrated into the welding torch etc.) or general protection (work area ventilation, work outside etc.)
		Ensure that all gas-containing parts are leak-free (bottles, valves, regulators, distribution systems, pipes, hoses, fittings etc.)
		Prevent accumulation of gases in dangerous amounts (extraction, burning/flaring excess gas); prevent secondary flames

H-No.	Hazard	Preventive measures
H23		Voice contact with diver
		Power supply above water level
		Appropriate welding equipment ("S"-machines for diving)
		<b>Hyperbaric wet welding (Underwater welding)</b>
		DC only; U0 max.= 65 V
		Use of dry suits rather than wet suits
		<b>Hyperbaric dry welding (in an pressurised enclosure)</b>
		Personal breathing operators with an air intake independent of the welding environment
		Flame retardant protective clothing
		Gas cylinders outside the pressurised chamber

General preventive measures associated with welding
A welding permit and fire sentry (regular patrols) are recommended for all welding activities outside of a dedicated welding workplace (see activity no. 8-10).
Basic long sleeved protective clothing and closed safety shoes
Marking of all hazardous areas and using signs for compulsory protective measures

**Annex B**  
(informative)

**List of activities associated with welding processes**

**Table B.1 — Typical activities associated with welding processes**

Processes acc. to ISO 4063	Abbreviations	Process name	Activities
111	MMAW SMAW (USA)	Manual metal arc welding (metal arc welding with covered electrode); shielded metal arc welding (USA)	W1-W2, G1-G4, A1, S1-S3

**To do ! Presumably available in Singapore**

## **Annex C** (informative)

### **Health and safety management systems and welding fabrication**

Several national standards and guidelines are available to define criteria for Health and Safety management. The key elements to realise an adequate and acceptable Health and Safety management System are the following, at least:

- to define and implement a correct occupational health and safety policy;
- to appoint an occupational health and safety expert person, responsible to establish and
- maintain the system in the welding fabrication process;
- to perform a risk assessment analysis at the beginning of the system implementation and after any welding process significant change;
- to define a health and safety operating plan;
- to assure a continuous improvement of the implemented System.

In the specific case of welding fabrication activities, it shall be considered the importance that welding and allied activities are already appropriately controlled from the operational point of view, as the correct management of welding procedures, processes, techniques and consumables give assurance that the risks are reduced at the origin by avoidance of useless operations and that the technical conditions implemented are correct.

This ISO TR provides support for the performance of the risk assessment analysis, but it shall be considered that other activities have to be implemented in order to assure adequate control of the health and safety matter in welding fabrication.

## **Annex D** **(informative)**

### **List of applicable documents**

The following list of documents are reported in order to give guidance in the performance of the risk assessment.

#### **D.1 International Standards**

- EN ISO 10882- 1: Health and safety in welding and allied processes - Sampling of airborne particles and gases in the operator's breathing zone - Part 1: sampling of airborne particles
- EN ISO 10882- 2: Health and safety in welding and allied processes - Sampling of airborne particles and gases in the operator's breathing zone - Part 2: sampling of gases
- ISO 17846: Welding and allied processes — Health and safety — Wordless precautionary labels for equipment and consumables used in arc welding and cutting

#### **D.2 Other applicable documents**

The following documents can be used as further references to perform risk assessment:

- IIW document VIII-1858-98: Health hazards from exposure to electro-magnetic fields in welding
- IIW document VIII-1856-98: Welding adds hazards to work in confined spaces
- IIW document VIII-1823-97: Statement on welding and cutting containers
- IIW document VIII-1817-97: Occupational health in metal arc welding
- IIW document VIII-1588-91: On the question of milk drinking of welders as a measure of health protection