European and International Standards on health and safety in welding

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Abstract. A number of European and International Standards on health and safety in welding have been published in recent years and work on several more is nearing completion. These standards have been prepared jointly by the International Standards Organization (ISO) and the European Committee for Standardization (CEN). The standards development work has mostly been led by CEN/TC 121/SC 9, with excellent technical input from experts within Europe; but work on the revision of published standards, which has recently gathered pace, is now being carried out by ISO/TC 44/SC 9, with greater international involvement. This paper gives an overview of the various standards that have been published, are being revised or are under development in this field of health and safety in welding, seeking to (i) increase international awareness of published standards, (ii) encourage wider participation in health and safety in welding standards work and (iii) obtain feedback and solicit comments on standards that are currently under development or revision. Such an initiative is particularly timely because work is currently in progress on the revision of one of the more important standards in this field, namely EN ISO 10882:2001 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.

1. Background
Welding and allied processes are hazardous and pose various risks to the health and safety of persons who carry them out. In particular, precautions need to be taken to ensure electrical safety; safety from heat, light noise and mechanical hazards; and to avoid harm that can be caused by exposure to the fume and gases that welding processes generate.

The hazards associated with welding and allied processes are more or less identical wherever such processes are carried out, so measures taken to control the risks of harm should be the same in all countries. Ideally, therefore, agreement should be reached internationally on the best ways forward and on methods that can be adopted and applied with equal vigor the world over to help reduce risks and benefit workers and the industry alike. These are the objectives that European and International standardization in the field of health and safety in welding sets out to achieve.

2. Standards organizations
The most important organizations involved in international standards making in the field of health and safety in welding are the International Standards Organization (ISO) and the European Committee for Standardization (CEN). These are not-for-profit organizations that develop voluntary consensus
standards to meet the requirements of business and broader needs of society. Such standards only become mandatory when they are given the force of law by citation in laws, regulations, codes, etc.

The International Organization for Standardization (ISO) is the leading producer of international standards in the world and most widely recognized name in the field. It is a network of National Standards Bodies (NSBs) from 158 countries with a Central Secretariat in Geneva, Switzerland that organizes and oversees its activities. NSBs can decide to participate in a particular field of standardization, in which case they are referred to as a P-member and have full voting rights; or they can have observer status, but as an O-member, although they can vote and comment on draft standards, they have no direct role in the standards development process; or of course an NSB can decide to opt out of a given field of work altogether.

The European Committee for Standardization is known as CEN, which is an acronym of the French name of the organization. It is based in Brussels and was founded in 1961 to contribute to the objectives of the European Union (EU) and European Economic Area. CEN, works closely with ISO, often collaborating under the ‘Vienna agreement’ to produce parallel ISO and CEN standards. CEN also works closely with the EU, carrying out mandated work to produce standards that serve the requirements of European Commission Directives, i.e. one of the EU Directorate Generals funds method validation work to ensure that EU data quality objectives are met.

A third major international organization involved in standards making in the field of health and safety in welding is the American Welding Society (AWS). AWS, which is based in Miami, was founded in 1919 with the goal of advancing the science, technology and application of welding and related joining disciplines. It has developed many recommended practices and guides, following strict American National Standards Institute (ANSI) procedures, for consumption mainly in the USA and Canada, but these are not considered in this paper.

Finally, the role played by Commission VIII of the International Institute of Welding (IIW) should be mentioned. IIW was founded in 1948 by welding institutes or societies in 13 countries who felt the need to make more rapid scientific and technical progress. Its mission is "to act as the world-wide network for knowledge exchange of joining technologies to improve the global quality of life". Whilst not a standards organization per se, IIW has a special relationship with ISO wherein it can prepare and assist in the formulation of International Standards. IIW Commission VIII has to date mainly focused on preparing technical papers on the subject of health and safety aspects of welding. However, whilst it has yet to do so, it could be instrumental in promulgating International Standards in the field of health and safety in welding at some point in the future.

3. Standards committees

The committees with the lead role for European and International Standardization in the field of health and safety in welding are CEN/TC 121/SC 9 and ISO/TC 44/SC 9, both of which are entitled 'Health & safety in welding and allied processes'. These two subcommittees have generally collaborated, under the so-called Vienna Agreement (VA), to prepare joint European and International Standards, although each has also prepared a standard in its own right. The VA is an arrangement under which CEN and ISO co-operate on the development of a joint publication, with one or other of the two organizations taking the lead role.

In the past, development of joint European and International Standards in the field of health and safety in welding has been led by CEN/TC 121/SC 9. This subcommittee originally had five working groups, but the first two have now been disbanded and work on revising the standards they published transferred to their sister working groups within ISO/TC 44/SC 9. The working groups concerned are WG 1, which developed three European and International Standards that prescribe laboratory methods for sampling fume and gases generated by arc welding and WG 2, which developed two European and International Standards on sampling airborne particles and gases in the breathing zone of operators carrying out welding and allied processes. Two more CEN working groups have been set dormant: WG 3, which published a European Standards on transparent welding curtains; and WG 5, which developed a European and International Standard on fume data sheets and a European and
International Technical Specification on the identification of thermal-degradation products generated when welding or cutting through products composed wholly or partly of organic material. The only active working groups are WG 4, which is completing work on three European and International Standards on testing and marking of equipment for air filtration, and WG 6 which is developing a European and International Technical Specification on the quantitative determination of fume from resistance spot welding.

The parallel international standards committee, ISO/TC 44/SC 9, has not been active until recently, having delegated responsibility for the development of joint European and International Standards in the field of health and safety in welding to CEN/TC 121/SC 9 from the early 1990s until 2004. During that period, ISO/TC 44/SC 9 worked independently on one International Standard on ‘Wordless precautionary labels’ but, other than that, held only a watching brief. However, since 2004, when the subcommittee became rejuvenated under a new UK Secretariat, ISO/TC 44/SC 9/WG 1 and ISO/TC 44/SC 9/WG 2 have been actively engaged in the revision of the European and International Standards originally developed by CEN/TC 121/SC 9/WG 1 and CEN/TC 121/SC 9/WG 2; and ISO/TC 44/SC 9/WG 5 has been developing a European and International Standard based on the Technical Specification originally prepared by CEN/TC 121/SC 9/WG 5.

Other CEN and ISO technical committees have also prepared standards that prescribe safety requirements for equipment used in welding, e.g. EN 175:1997 'Personal protection — Equipment for eye and face protection during welding and allied processes, safe working procedures', which was prepared by CEN/TC 85 'Eye protective equipment', and product standards that include safety requirements. However, these are not included in the scope of this paper.

**Table 1.** List of European and International subcommittees and their working groups involved in the development of health and safety in welding standards.

| Subcommittee / Working Group | Title |
|-----------------------------|-------|
| CEN/TC 121/SC 9 | Health and safety in welding and allied processes |
| WG 1 (disbanded) | Laboratory methods for sampling fume and gases |
| WG 2 (disbanded) | Sampling of airborne particles and gases in the operator's breathing zone |
| WG 3 (dormant) | Transparent welding curtains |
| WG 4 (active) | Testing and marking of equipment for air filtration for welding and allied processes |
| WG 5 (dormant) | Fume data sheets |
| WG 6 (active) | Procedure for quantitative determination of fume from resistance spot welding |
| ISO/TC 44/SC 9 | Health and safety in welding and allied processes |
| WG 1 (active) | Laboratory methods for sampling fume and gases |
| WG 2 (active) | Sampling of airborne particles and gases in the operator's breathing zone |
| WG 3 (not assigned) | |
| WG 4 (not assigned) | |
| WG 5 (active) | Identification of thermal-degradation products generated when welding or cutting through products composed wholly or partly of organic material |
| WG 6 (not assigned) | |
4. Synopsis of published European and International Standards and Technical Specifications

Table 2 gives a synopsis of the eleven European and International Standards and Technical Specifications that have been published in the field of health and safety in welding and allied processes.

One European Standard, EN 1598:1998, was prepared by CEN/TC 121/SC 9, one International Standard, ISO 17846:2004, was prepared by ISO/TC 44/SC 9; and the other eight European and International Standards and one Technical Specifications were prepared jointly by CEN/TC 121/SC 9 and ISO/TC 44/SC 9 under the VA with a CEN lead.

Table 2. List of published European and International Standards and Technical Specifications

| Standard or Technical Specification | Title                                                                 |
|-------------------------------------|----------------------------------------------------------------------|
| EN 1598:1997 and amendment A1:2001  | Health and safety in welding and allied processes — Transparent      |
|                                     | welding curtains, strips and screens for arc welding processes       |
| EN ISO 10882-1:2001                 | 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 10882-2:2000                 | 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                                           |
| EN ISO 15011-1:2002                 | Health and safety in welding and allied processes — Laboratory       |
|                                     | method for sampling fume and gases generated by arc welding —      |
|                                     | Part 1: Determination of emission rate and sampling for analysis of  |
|                                     | particulate fume                                                    |
| EN ISO 15011-2:2003                 | Health and safety in welding and allied processes — Laboratory       |
|                                     | method for sampling fume and gases generated by arc welding —      |
|                                     | Part: 2 Determination of emission rates of gases, except ozone      |
| EN ISO 15011-3:2002                 | Health and safety in welding and allied processes — Laboratory       |
|                                     | method for sampling fume and gases generated by arc welding —      |
|                                     | Part: 3 Determination of ozone concentration using fixed point       |
|                                     | measurements                                                        |
| EN ISO 15011-4:2006                 | Health and safety in welding and allied processes — Laboratory       |
|                                     | method for sampling fume and gases — Part 4: Fume data sheets       |
| CEN/ISO TS 15011-5:2006             | Health and safety in welding and allied processes — Laboratory       |
|                                     | method for sampling fume and gases — Part 5: Identification of      |
|                                     | fume and gases generated during welding and cutting through         |
|                                     | products composed wholly and partly of organic materials            |
| EN ISO 15012-1:2004                 | Health and safety in welding and allied processes — Requirements,    |
|                                     | testing an marking of equipment for air filtration — Part 1: Testing |
|                                     | of the separation efficiency for welding fume                       |
| EN ISO 15012-2:2007                 | Health and safety in welding and allied processes — Requirements,    |
|                                     | testing an marking of equipment for air filtration — Part 2:        |
|                                     | Determination of the minimum air volume flow rate of captor hoods    |
|                                     | and nozzles                                                         |
| ISO 17846:2004                      | Welding and allied processes — Health and safety — Wordless         |
|                                     | precautionary labels for equipment and consumables used in arc       |
|                                     | welding and cutting                                                  |
5. Synopsis of European and International Standards and Technical Specifications under development, revision or amendment

Table 3 gives a synopsis of the ten European and International Standards and Technical Specifications that are under development, revision or amendment in the field of health and safety in welding and allied processes.

A new proposal (NP) for a work item to revise minor aspects of the methodology described in EN 1598 has recently been circulated for adoption.

Good progress is being made with the revision of Part 1 of EN ISO 10882-1, under an ISO lead, with the work item expected to progress from the working draft (WD) to committee draft (CD) stage before the end of 2008.

Work on the revision of Parts 1, 2 and 3 of EN ISO 15011, which has an ISO lead, is nearly finished. The approval stage is expected to be completed before the end of 2008 for each Final Draft International Standard (FDIS).

A draft amendment to EN ISO 15011-4 is currently available as an FDIS and the approval stage is expected to be completed before the end of 2008.

An approved work item (AWI) has recently been added to the ISO/TC 44/SC 9 work program to develop a full standard based on CEN ISO TS 15011-5.

An approved work item (AWI) has recently been added to the CEN/TC 121/SC 9 work program to develop a new Part 6 of EN ISO 15011.

A preliminary work item (PWI) has recently been proposed to revise EN ISO 15012-1, under the Vienna Agreement with a CEN lead.

Finally, a further PWI, also under the Vienna Agreement with a CEN lead, has recently been proposed to prepare a new Part 3 of EN ISO 15012.

Table 3. List of European and International Standards and Technical Specifications under development, revision or amendment

| Standard or Technical Specification | Title                                                                 |
|------------------------------------|----------------------------------------------------------------------|
| prEN/NP 1598:2008                 | Health and safety in welding and allied processes — Transparent welding curtains, strips and screens for arc welding processes (revision of EN 1598:1997) |
| prEN ISO/WD 10882-1:2008          | 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 (revision of EN ISO 10882-1:2001) |
| prEN ISO/FDIS 15011-1:2008        | Health and safety in welding and allied processes — Laboratory method for sampling fume and gases — Part 1: Determination of emission rate and sampling for analysis of particulate fume (revision of EN ISO 15011-1:2002) |
| prEN ISO/FDIS 15011-2:2008        | Health and safety in welding and allied processes — Laboratory method for sampling fume and gases — Part 2: Determination of emission rates of carbon monoxide (CO), carbon dioxide (CO₂), nitrogen monoxide (NO) and nitrogen dioxide (NO₂) in arc welding, cutting and gouging (revision of EN ISO 15011-2:2003) |
| prEN ISO/FDIS 15011-3:2008        | Health and safety in welding and allied processes — Laboratory method for sampling fume and gases generated by arc welding — Part 3: Determination of ozone emission rate (revision of EN ISO 15011-3:2002) |
6. Overview of European and International Standards and Technical Specifications

6.1. EN 1598
EN 1598, which was published in 1997, specifies safety requirements for the transparent welding curtains, strips, and screens that are used to protect people from the hazardous radiant emissions from welding arcs and from spatter.

The standard was recently confirmed at systematic review, but the responsible CEN technical committee decided that, nevertheless, it should be revised on the basis of comments received. Accordingly, a new work item has recently been proposed to revise the standard.

6.2. EN ISO 10882

6.2.1. Subdivision of the standard. EN ISO 10882 is a two-part standard entitled 'Health and safety in welding and allied processes — Sampling of airborne particles and gases in the operator's breathing zone'.

6.2.2. EN ISO 10882-1. Part 1 of EN ISO 10882-1, which was published in 2001, prescribes a gravimetric method for determination of personal exposure to airborne particles. This involves sampling in the breathing zone, which is considered to extend only behind the welder's face shield, when such personal protective equipment is worn. The standard gives a number of examples of suitable sampler mounting arrangements and includes a recommendation that the user collects separate samples for determination of exposure to welding fume and other airborne particles generated by welding related operations, such as grinding. It also provides guidance on the use of chemical analysis to determine personal exposure to specific chemical agents present to which welders are exposed, but it does not describe analytical methods.
Revision of the standard is now in progress but at present the work item is still at the working draft stage. The new draft includes revised requirements for positioning the sampler and new examples of suitable mounting arrangements including, most notably, a headset-mounted mini sampler[1]. Furthermore, the standard no longer attempts to estimate personal exposure to welding fume by excluding times of heavy grinding from sampling period, as this has been found to be impractical and most countries no longer have a separate limit value for welding fume in any case. The emphasis of the draft is also now very much on sampling, with gravimetric and chemical analysis moved to annexes and given equivalent standing. There is still considerable work to be carried out on the revised standard at this stage, however, so publication is not expected until the end of 2009.

6.2.3. EN ISO 10882-2. Part 2 of EN ISO 10882, which was published in 2000, provides guidance for the determination of personal exposure to gases and organic vapours and, as in Part 1 of the standard, sampling behind the welder's face shield is required when such personal protective equipment is worn.

This standard, which provides no detailed methodology, was confirmed at systematic review in 2005.

6.3. EN ISO 15011

6.3.1. Subdivision of the standard. EN ISO 15011 was originally a three-part standard entitled 'Health and safety in welding and allied processes — Laboratory method for sampling fume and gases generated by arc welding'. However, following its expansion into a six-part series, the title of the standard has been amended to take account of the fact that its scope now includes resistance spot welding as well as arc welding. The new series title is therefore now simply 'Health and safety in welding and allied processes — Laboratory method for sampling fume and gases'.

6.3.2. Rationale. Welding and allied processes generate fume and gases, which, if inhaled, can be harmful to human health. Knowledge of the composition and the emission rates of the fume and gases can be useful to occupational health professionals in assessing worker exposure and in determining appropriate control measures. Absolute exposure is dependent upon factors such as welder position with respect to the plume and draughts and cannot be predicted from emission rate data. However, in the same work situation, a higher emission rate is expected to correlate with a higher exposure and a lower emission rate with a lower exposure. Hence, emission rate data can be used to predict relative changes in exposure that might occur in the workplace under different welding conditions and to identify measures for reducing such exposure, but they cannot be used to calculate ventilation requirements.

6.3.3. EN ISO 15011-1. Part 1 of EN ISO 15011, which was published in 2002, specifies a method for measurement of welding fume emission rate and collection of welding fume for chemical analysis. The procedure set out in the standard involves welding in a test chamber, referred to as a 'fume box', and collecting the fume generated on a suitable filter. The procedure simply prescribes a methodology, leaving selection of the test parameters to the user, so that the effect of different variables can be evaluated. Emission rates vary considerably depending upon the exact test conditions, so test parameters have been prescribed in ISO 15011-4 for the generation of fume emission rate data that can be used for comparing emission rates of welding consumables.

In 2005, work commenced on extensive revision of the standard and, in particular, a more detailed method description and additional examples of suitable fume boxes were added. Publication of the revised standard, which is currently at the approval stage, is expected by end of 2008.

6.3.4. EN ISO 15011-2. Part 2 of EN ISO 15011, which was published in 2003, specifies a method for measurement of the emission rates of gases, except ozone. The standard provides guidance on how
to carry out tests using direct reading instruments for inorganic gases and indirect methods for organic vapours, but gives no detailed methodology. Like Part 1 of the standard, welding is carried out in a test chamber that is referred to as a 'fume box'. However, instead of capturing all the emissions, as is the case for fume, emission rates are calculated from the concentration of gases and vapours in the test chamber and the air flow rate through it.

In 2005, work commenced on extensive revision of the standard. Although the equipment used remains essentially unchanged, the standard now refers to the use of a ‘hood’, rather than a ‘fume box’, to more correctly describe both its function and physical design. The most significant changes, however, are exclusion of organic vapours from the scope of the standard, due to a lack of evidence to support the applicability of the method to these substances; and comprehensive revision of the normative text to provide a detailed method description. As in EN ISO 15011-1, the procedure simply prescribes a methodology, leaving selection of the test parameters to the user, so that the effect of different variables can be evaluated.

The revised standard, which has been given a new title to specifically identify the gases that are included within its scope, is now at the approval stage. Publication is expected by end of 2008.

6.3.5.  EN ISO 15011-3. Part 3 of EN ISO 15011, which was published in 2002, originally described a fixed-point measurement method for determination of ozone concentrations at three positions relative to the arc: one intended to corresponds to the typical position of the breathing zone of a welder; one where the ozone concentration was expected to be at a maximum; and a third more remote position intended to correspond to the background concentration in the workplace.

However, doubt about the relevance of results obtained using the method described in the published standard led to the commissioning of the EU project 'WELD-OZONE', the aim of which was to examine alternative methodology for the measurement ozone emissions during welding and allied processes. This work [2] established that fixed-point measurements of ozone concentration do not correlate well with workplace exposure measurements and recommended the drafting of a new standard using a fume box method, which was shown to have much better correlation.

Accordingly, in 2005, work commenced on the extensive revision of EN ISO 15011-3, the title of which was changed to reflect the move away from a method that prescribes the making of fixed-point measurements of ozone concentration to one that determines ozone emission rate. The revised standard defines a method for measuring the emission rate of ozone during arc welding using a hood technique. The procedure simply prescribes a methodology, leaving selection of the test parameters to the user, so that the effects of different variables can be evaluated. Publication of the revised standard, which is currently at the approval stage, is expected by end of 2008.

6.3.6.  EN ISO 15011-4. Part 4 of EN ISO 15011, which was published in 2006, prescribes test conditions for generating fume emission rate and chemical composition data for welding consumables using the method prescribed in EN ISO 15011-1. Results obtained may be used on safety data sheets, in risk assessment and/or for classification of welding consumables.

The method was validated in laboratory tests and in two fume emission rate round robins. It was shown [3] to be robust, to exhibit good repeatability (typically ~5% for fume emission rate measurements and in the range 4-10% for chemical composition measurements) and the reproducibility of fume emission rate measurements was deemed to be fit-for-purpose, with most of processes examined having 95% confidence limits in the range ±10% to ±40%. Minor technical changes made to the methodology as a result of the findings of the fume emission rate round robins are the subject of a draft amendment to the standard, which is currently at the approval stage. Publication of the amendment is expected by the end of 2008.

6.3.7. CEN ISO/TS 15011-5. Part 5 of EN ISO 15011, which was published in 2006, is a technical specification that describes test procedures for the identification of thermal degradation products generated when welding and cutting through products composed wholly or partly of organic materials.
A wide range of product types is covered, including paints, primers, sealants, adhesives, pressing lubricants, oils etc; and five test methods are described, using: TIG welding; resistance welding; flame cutting with an oxy-acetylene torch; heating in an oven; and pyrolysis.

Since CEN ISO/TS 15011-5 was published, a collaborative project has been undertaken to evaluate the methods described in the technical specification. The conclusion of this work [4] was that pyrolysis-GC-MS is capable of identifying the components of interest in one simple experiment, whilst the other methods require multiple sampling and analysis, which makes them more difficult, time consuming and costly to carry out. The recommendation of the project consortium was therefore that a full standard based on CEN ISO TS 15011-5 should be developed using the pyrolysis method alone. A new work item has recently been approved accordingly, with work due to start on development of the new standard in the second half of 2008.

6.3.8. CEN ISO/TS 15011-6. Part 6 of EN ISO 15011 will be a technical specification that describes a procedure for quantitative determination of fume from resistance spot welding.

A new work item has recently been approved to develop the proposed new technical specification, but work is at an early stage, with the precise methodology to be used still under discussion within the responsible CEN working group. Publication is expected by 2010.

6.4. EN ISO 15012

6.4.1. Subdivision of the standard. EN ISO 15012 is a three-part standard entitled 'Health and safety in welding and allied processes — Requirements, testing an marking of equipment for air filtration'.

6.4.2. Rationale. Welding and allied processes generate fume and gases, which, if inhaled, can be harmful to human health. Control is often required to maintain exposure at acceptable levels and this can be achieved by capturing the fume and gases using local exhaust ventilation (LEV), which consists of a capture device, such as a captor hood or nozzle, connected, via ducting, to an exhaust system, or by the use of an on-gun welding fume extraction device. Effective capture of welding fume and gases can only be achieved when the extracted air velocity at the emission point exceeds the resulting velocity of the plume of welding fume and any cross-draught; and effective removal of the fume from the extracted air can only be achieved if associated equipment for air filtration has adequate separation efficiency for the welding fume. This standard addresses these issues.

6.4.3. EN ISO 15012-1. Part 1 of EN ISO 15012, which was published in 2004, deals with testing of the separation efficiency of equipment for air filtration for welding fume. The method prescribed involves the measurement of welding fume concentrations in ducts upstream and downstream of welding fume separation equipment using isokinetic sampling, collection on a filter and gravimetry. Testing of welding fume separation equipment with an unducted outlet is carried out in a closed test cabin.

The standard was recently confirmed at systematic review, but the responsible ISO and CEN technical committees decided that, nevertheless, it should be revised on the basis of comments received. In particular, there was concern that the classification system for welding fume separation equipment prescribed in the standard was unsatisfactory. Accordingly, a preliminary work item has recently been proposed to revise the standard.

6.4.4. EN ISO 15012-2. Part 2 of EN ISO 15012, which was published in the first half of 2008, addresses determination of the minimum air volume flow rate of captor hoods and nozzles by determination of the air volume flow rate required to achieve an air velocity of 0.4 m s⁻¹ at defined test positions in front of the capture device.
6.4.5. **EN ISO 15012-3.** Part 3 of EN ISO 15012 was to have prescribed a method for determination of the capture efficiency of welding fume extraction devices using a tracer gas method. However, concern about the ability of a tracer gas to adequately mimic the behaviour of welding fume recently led to a decision to delete the existing approved work item from the CEN and ISO work programs and propose a new preliminary work item with a revised scope limited to determination of the capture efficiency of on-gun welding fume extraction devices.

6.5. **ISO 17846**

ISO 17846, which was published in 2004, lays down requirements for wordless precautionary labels for equipment and consumables used in arc welding and cutting. These are based on recognised hazard and safety symbols which achieved 95% - 100% comprehension rates in tests on 10000 experienced and inexperienced welders. The standard was confirmed at systematic review in 2007.

7. **Summary**

A number of European and International Standards on health and safety in welding have been published in recent years and work on several more is nearing completion. The standards development work has mostly been led by CEN/TC 121/SC 9, with excellent technical input from experts within Europe; but work on the revision of published standards, which has recently gathered pace, is now being carried out by ISO/TC 44/SC 9, with greater international involvement. This paper gives an overview of the various standards that have been published, are being revised or are under development in this field of health and safety in welding, seeking to (i) increase international awareness of published standards, (ii) encourage wider participation in health and safety in welding standards work and (iii) obtain feedback and solicit comments on standards that are currently under development or revision.

To find out more about ISO and CEN standards, see the websites of the organizations concerned:
- www.iso.org
- www.cen.eu

To purchase standards, or to get involved in standards work, contact your NSB, e.g.:
- www.bsi-global.com
- www.afnor.org
- www.din.de

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