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**Methods of measurement for gas
concentration in welding environment**

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Foreword

This translation has been made based on the original Japanese Industrial Standard revised by the Minister of Economy, Trade and Industry through deliberations at the Japanese Industrial Standards Committee as the result of proposal for revision of Japanese Industrial Standard submitted by The Japan Welding Engineering Society (JWES)/Japanese Standards Association (JSA) with the draft being attached, based on the provision of Article 12 Clause 1 of the Industrial Standardization Law applicable to the case of revision by the provision of Article 14.

Consequently JIS Z 3952 : 1990 is replaced with this Standard.

This revision has been made based on 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* for the purpose of making it easier to compare this Standard with International Standard; to prepare Japanese Industrial Standard conforming with International Standard; and to propose a draft of an International Standard which is based on Japanese Industrial Standard.

Attention is drawn to the possibility that some parts of this Standard may conflict with a patent right, application for a patent after opening to the public, utility model right or application for registration of utility model after opening to the public which have technical properties. The relevant Minister and the Japanese Industrial Standards Committee are not responsible for identifying the patent right, application for a patent after opening to the public, utility model right or application for registration of utility model after opening to the public which have the said technical properties.

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In the event of any doubts arising as to the contents,
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Methods of measurement for gas concentration in welding environment

Introduction This Japanese Industrial Standard has been prepared based on the first edition of *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* published in 2000. Although the corresponding International Standard specifies mainly the method of measurement for personal exposure gas concentration of a welding operator, this Standard has been prepared with some modifications of the technical content since it had been limited to the method of measurement for gas concentration in the working environment.

The portions given sidelines or dotted underlines are the matters in which the contents of the original International Standard have been modified. A list of modifications with the explanations is given in Annex 2 (informative).

1 Scope This Standard specifies the methods of measurement for gas concentration in the working environment and personal exposure gas concentration of an operator with regard to carbon monoxide (CO), carbon dioxide (CO₂), nitrogen monoxide (NO), nitrogen dioxide (NO₂) and ozone (O₃) in the environment of welding and welding related operations.

Remarks : The International Standard corresponding to this Standard is as follows.

In addition symbols which denote the degree of correspondence in the contents between the relevant International Standard and **JIS** are IDT (identical), MOD (modified), and NEQ (not equivalent) according to **ISO/IEC Guide 21**.

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* (MOD)

2 Normative references The following standards contain provisions which, through reference in this text, constitute provisions of this Standard. The most recent editions of the standards (including amendments) indicated below shall be applied.

JIS B 7951 Continuous analyzer for carbon monoxide in ambient air

JIS B 7953 Continuous analyzer for oxides of nitrogen in ambient air

JIS B 7957 Continuous analyzer for oxidants in ambient air

JIS B 7982 Automated measuring systems and analyzers for nitrogen oxides in flue gas

JIS K 0050 *General rules for chemical analysis*
 JIS K 0098 *Methods for determination of carbon monoxide in flue gas*
 JIS K 0104 *Methods for determination of nitrogen oxides in flue gas*
 JIS K 0114 *General rules for gas chromatographic analysis*
 JIS K 0115 *General rules for molecular absorptiometric analysis*
 JIS K 0122 *General rules for ion selective electrode method*
 JIS K 0127 *General rules for ion chromatographic analysis*
 JIS K 0304 *Methods for determination of carbon dioxide in air*
 JIS K 0804 *Gas detector tube measurement system*
 JIS K 8001 *General rule for test methods of reagents*
 JIS K 8913 *Potassium iodide*
 JIS K 9007 *Potassium dihydrogenphosphate*
 JIS K 9019 *Disodium hydrogenphosphate 12-water*
 JIS Z 3001 *Welding terms*

3 Definitions For the purpose of this Standard, the definitions given in JIS Z 3001 and the following definitions apply.

- a) **detector tube, diffusive** a detector tube, similar in construction to a pumped detector tube, and a glass tube containing chemical reagents in which a colour change may be produced when a sample of the atmosphere is permeated and diffused. The length of the stain produced provides a measure of the exposure dose of target gas for measurement.
- b) **diffusive sampler** a device which is capable of taking samples of target gas for measurement from the atmosphere at a rate controlled by a physical process such as gaseous diffusion through a static air layer or permeation through a membrane. A diffusive sampler is classified into two types according to the internal structure in which a sample of the atmosphere passes by permeation and diffusion to the sorbent. One is a tube type diffusive sampler with a cross-sectional area which is small in relation to the internal air space, across which a sample of the atmosphere passes to the sorbent. The other is a badge type diffusive sampler in which a sample of the atmosphere passes to the sorbent by permeation through a thin solid membrane or diffusion across a porous membrane, with a cross-sectional area which is large in relation to the internal air space. Any of them is called a passive sampler.
- c) **welding related operations** operations related to welding such as thermal cutting, grinding, chipping
- d) **detector tube, pumped** a glass tube containing chemical reagents in which a colour change may be produced when a fixed volume of sample of the atmosphere is drawn through it. The length of the stain produced provides a measure of concen-

tration of target gas for measurement in air.

- e) **pumped sampler** a device which is capable of taking samples of target gas for measurement from the atmosphere by drawing a fixed volume of sample of the atmosphere with a constant flow rate suction pump. There are the type of a metal tube or a glass tube filled with carriers in which activated absorbents or reagents are impregnated and the type of an absorbent solution tube containing a fixed amount of absorbent solution or reagent solution.
- f) **repeatability** the properties or degree of agreement of the individual measured value when the same target for measurement is repeatedly measured with the same method under the same conditions for a comparatively short period of time
- g) **limit value** reference figure ⁽¹⁾ for the concentration of a target gas for measurement in air

Note ⁽¹⁾ In Japan there are “standard control concentration” defined in Working Environment Evaluation Standards (Notification No. 79 of the Ministry of Labor in 1988) and “threshold limit value” recommended by Japan Society for Occupational Health, and in U.S.A. there are PEL (Permissible Exposure Limit) defined by OSHA (Occupational Safety and Health Administration, Department of Labor) and TLVs (Threshold Limit Values) recommended by ACGIH (American Conference of Governmental Industrial Hygienists).

- h) **breathing zone** the space around the worker's face from where he takes his breath
For technical purposes a more precise definition is as follows:

Hemisphere (generally accepted to be 30 cm in radius) extending in front of the human face, centered on a mid point of a line joining the ears; the base of the hemisphere is a plane through this line, the top of the head and the larynx. The definition is not applicable when respiratory protective equipment is used.

- i) personal exposure concentration of gas time-weighted average concentration of gas in the breathing zone
- j) **worst case measurements** screening measurements made to identify work activity during which highest exposure occurs
- k) minimum measuring range in the direct reading gas measurement apparatus, the possible measuring range of concentration when the maximum sensitivity has been adopted
- l) concentration of gas in the working environment concentration of a target gas for measurement in the atmosphere in the workplace for measurement
- m) **time-weighted average (TWA) concentration** concentration of a target gas for measurement in the atmosphere, averaged over the reference period
- n) **air sampling** sampling a part of working environment air in order to measure or analyze gas concentration.
- o) **sampler** a device for sampling

- p) **screening measurements** measurements performed to obtain relatively crude information on the exposure level

They can also be used to determine if the exposure is well below or well above the limit value.

- q) **workplace** the defined area or areas in which the concentration of a target gas for measurement is to be measured
- r) **short term detector tube** a detector tube that provides a means of obtaining a rapid measurement (typically up to 15 min) of the concentration of a target gas for measurement
- s) **warm-up time** after switching on the electric source, the time lapsed until the measuring instrument has attained a steady condition and the predetermined performance has been attained
- t) **direct reading gas measurement apparatus** apparatus in which the presence of a target gas for measurement causes a change that is manifest as an automatically generated electrical signal
- u) **long term detector tube** a detector tube that provides a means of obtaining a measurement of the time weighted average concentration of a target gas for measurement

There are the pumped type and the diffusive type.

- v) **systematic sampling method** the method to select the measuring points at regular intervals and without a bias in the unit working place

Usually the intersection point of a longitudinal line and a transverse line drawn at regular intervals of not more than 6 m on the floor is taken as the measuring point.

- w) **exposure** a situation in which a target gas for measurement is present in air which is inhaled by a person
- x) **90 % response time** when the concentration of a target gas for measurement instantaneously changes from a fixed value to another fixed value, the time until the indicated value of a measuring instrument becomes 90 % of the final value

4 Types of measuring methods for gas concentration For the measuring methods for the gas concentration, there are the direct reading measuring method for the gas concentration and the indirect measuring method for the gas concentration.

4.1 Types of direct reading measuring methods for gas concentration, and measuring instrument and detector tube The types of direct reading measuring methods for gas concentration, target gas for measurement to be applied and the performance of each measuring instrument and detector tube shall be as given in tables 1 a) and 1 b).

Table 1 Types of direct reading measuring methods for gas concentration, target gas for measurement to be applied, and performance of each measuring instrument and detector tube

a) Measuring instrument

Measuring method		Membrane electrolytic current method (Membrane controlled potential electrolysis method, membrane covered galvanic cell method)			
Target gas for measurement		Carbon monoxide (2)	Nitrogen monoxide	Nitrogen dioxide	Ozone
Performance of measuring instrument	Minimum measuring range	0 ppm to 100 ppm	0 ppm to 50 ppm	0 ppm to 100 ppm	0 ppm to 1 ppm
	Repeatability	± 2 ppm	± 1 ppm	± 2 ppm	± 0.02 ppm
	90 % response time	60 s max.			

Measuring method		Non-dispersive infrared absorption method		Chemiluminescence method		
Target gas for measurement		Carbon monoxide(3)	Carbon dioxide (4)	Nitrogen monoxide (5), (6)	Nitrogen dioxide (5), (6)	Ozone(8)
Performance of measuring instrument	Minimum measuring range	0 ppm to 100 ppm	0 % to 1 %	0 ppm to 50 ppm	0 ppm to 10 ppm	0 ppm to 0.2 ppm
	Repeatability	± 2 ppm	± 0.02 %	± 1 ppm	± 0.2 ppm	± 0.005 ppm
	90 % response time	20 s max.		60 s max.		

Measuring method		Membrane covered ion selective electrode method (7)	Ultraviolet absorption method (8)	Semiconductor detector method
Target gas for measurement		Carbon dioxide	Ozone	
Performance of measuring instrument	Minimum measuring range	0 % to 1 %	0 ppm to 0.2 ppm	0 ppm to 0.5 ppm
	Repeatability	± 30 % with respect to indicated value	± 0.005 ppm	± 0.05 ppm at 0.5 ppm in gas concentration
	90 % response time	120 s max.	120 s max.	60 s max.

b) **Detector tube**

Measuring method		Short term detector tube method ⁽⁹⁾ (pumped type)				
Target gas for measurement		Carbon monoxide	Carbon dioxide	Nitrogen monoxide	Nitrogen dioxide	Ozone
Performance of detector tube	Measuring range	1 ppm to 30 ppm	0.01% to 0.2 %	2.5 ppm to 200 ppm	2.5 ppm to 30 ppm	0.025 ppm to 0.6 ppm
	Repeatability	1/3 or over of scale range : ± 15 %, under 1/3 : ± 25 %				
	Suction time	1 min for 1 time (100 ml)		2 min for 2 times (200 ml)		10 min continuously for 10 times (1 L)

Measuring method			Long term detector tube method		
Target gas for measurement			Carbon monoxide	Carbon dioxide	Nitrogen monoxide
Performance of detector tube	Pumped type	Measuring range	6.25 ppm to 62.5 ppm	0.025 % to 0.15 %	1.25 ppm to 12.5 ppm
		Suction time	8 h continuously	4 h continuously	8 h continuously
	Diffusive type	Measuring range	0.4 ppm to 400 ppm	0.02 % to 12 %	0.1 ppm to 30 ppm
		Exposure time	0.5 h to 24 h continuously	0.5 h to 10 h continuously	1 h to 10 h continuously

Notes ⁽²⁾ As specified in **JIS K 0098**.

⁽³⁾ As specified in **JIS B 7951**.

⁽⁴⁾ As specified in **JIS K 0304**.

⁽⁵⁾ As specified in **JIS B 7982**.

⁽⁶⁾ As specified in **JIS B 7953**.

⁽⁷⁾ As specified in **JIS K 0122**.

⁽⁸⁾ As specified in **JIS B 7957**.

⁽⁹⁾ As specified in **JIS K 0804**.

4.2 Types of indirect measuring method of gas concentration The types of the indirect measuring method of gas concentration shall be as given in table 2.

Table 2 Types of indirect measuring method of gas concentration

Target gas for measurement	Carbon monoxide ⁽²⁾	Carbon dioxide ⁽⁴⁾	Nitrogen monoxide	Nitrogen dioxide	Ozone
Measuring method	Gas chromatography ⁽¹¹⁾		Ion chromatography ⁽¹⁰⁾ , ⁽¹³⁾ Absorptiometry ⁽¹²⁾ , ⁽¹³⁾		Absorptiometry ⁽¹⁴⁾

Notes ⁽¹⁰⁾ As specified in **JIS K 0127**.

⁽¹¹⁾ As specified in **JIS K 0114**.

⁽¹²⁾ As specified in **JIS K 0115**.

⁽¹³⁾ As specified in **JIS K 0104**.

⁽¹⁴⁾ As specified in Annex 1.