AWS A5.32M/A5.32:2011 (ISO 14175:2008 MOD)
An American National Standard

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Welding Consumables - Gases and Gas Mixtures for Fusion Welding and Allied Processes

2nd Edition

Supersedes ANSI/AWS A5.32/A5.32M-97 (R2007)

Prepared by the
American Welding Society (AWS) A5 Committee on Filler Metals and Allied Materials

Under the Direction of the
AWS Technical Activities Committee

Approved by the
AWS Board of Directors

Abstract

This standard prescribes the requirement for the classification of gases and gas mixtures for fusion welding and allied processes. Classification is based on composition of the more popular single and multi-component gases. Additional requirements are included for purity and moisture of individual gas components, testing, retesting, packaging, and cylinder or container labeling. An annex is appended to the standard as a source of information concerning the classification system and the intended use of the gases and gas mixtures.

This specification makes use of both U.S. Customary Units and the International System of Units (SI). Since these are not equivalent, each system must be used independently of the other.

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Foreword

This foreword is not part of AWS A5.32M/A5.32:2011 (ISO 14175:2008 MOD), *Welding Consumables — Gases and Gas Mixtures for Fusion Welding and Allied Processes*, but is included for informational purposes only.

This is the first edition of this specification with modified adoption of ISO 14175: 2008, *Welding Consumables — Gases and Gas Mixtures for Fusion Welding and Allied Processes*.

This document makes use of both U.S. Customary Units and the International System of Units (SI). The measurements are not exact equivalents; therefore, each system must be used independently of the other, without combining values in any way. In selecting rational metric units, ANSI/AWS A1.1, *Metric Practice Guide for the Welding Industry,* is used where suitable. Tables and figures make use of both U.S. Customary and SI units, which with the application of the specified tolerances provide for interchangeability of products in both the U.S. Customary and SI Units.

ISO uses comma (,) for decimal, but AWS uses period (.) for decimal. Decimal commas have been changed to decimal periods.

This specification developed as below:

ANSI/AWS A5.32/A5.32M-97	*Specification for Welding Shielding Gases*
ANSI/AWS A5.32/A5.32M-97R	*Specification for Welding Shielding Gases*

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Welding Consumables—Gases and Gas Mixtures for Fusion Welding and Allied Processes

1. Scope

This Standard specifies requirements for the classification of gases and gas mixtures used in fusion welding and allied processes including, but not limited to:

— gas tungsten arc welding — *GTAW*;
— gas metal arc welding — *GMAW*;
— *flux cored arc welding — FCAW*;
— plasma arc welding — *PAW*;
— plasma arc cutting — *PAC*;
— laser *beam* welding — *LBW*;
— laser *beam* cutting — *LBC*;
— arc braze welding — *ABW*;
— *electrogas welding — EGW*.

The purpose of this Standard is to classify and designate these gases and gas mixtures in accordance with their chemical properties and metallurgical behavior as the basis for correct selection by the user and to simplify the possible qualification procedures. *The modes of application for gas shielded welding processes include, but are not limited to: manual, semiautomatic, mechanized, and automatic weld methods*.

Gas purities and mixing tolerances are specified as delivered by the supplier (manufacturer) and not at the point of use.

Gases or gas mixtures may be supplied in either liquid or gaseous form, but when used for welding and allied processes, the gases are always used in the gaseous form.

Fuel gases, such as acetylene, natural gas, propane, etc., and resonator gases, as used in gas lasers, are not covered by this Standard.

Transportation and handling of gases and containers shall be in accordance with local, national, and regional standards and regulations as required.

Safety and health issues and concerns are beyond the scope of this standard and, therefore, are not fully addressed herein. Some safety and health information can be found in annex clause A5. Safety and health information is available from other sources, including, but not limited to: Safety and Health Fact Sheets listed in A8.3, ANSI Z49.1 Safety in Welding, Cutting and Allied Processes[1], and applicable federal and state regulations.

This specification makes use of both the International System of Units (SI) and U.S. Customary Units. The measurements are not exact equivalents; therefore, each system must be used independently of the other without combining in any way when referring to material properties. The specification A5.32M uses SI Units. The specification with the designation A5.32 uses U.S. Customary Units. The latter are shown within brackets [ ] or in appropriate columns in tables and figures. Standard dimensions based on either system may be used for packaging or both under A5.32M or A5.32 specifications.

[1] ANSI Z49.1 is published by the American Welding Society, 550 NW LeJeune Rd, Miami, FL 33126.

2. Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

2.1 AWS Standard[2]

AWS A3.0M/A3.0, *Standard Welding Terms and Definitions*

AWS A5.01M/A5.01 (ISO 14344), *Procurement Guidelines for Consumables—Welding and Allied Processes—Flux and Gas Shielded Electrical Welding Processes*

F3.2, *Ventilation Guide for Welding Fume*

2.2 ASTM Standards[3]

E 29, *Standard Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications*

E 260, *Standard Practice for Packed Column Gas Chromatography*

2.3 ISO Standards[4]
ISO 80000-1:2009, *Quantities and units—Part 1: General*

3. Terms and definitions

For the purposes of this document, *in addition to AWS A3.0M/A3.0*, the following terms and definitions apply:

3.1 base gas. Major or only component of a pure or mixed gas.

3.2 classification. Number of this Standard, followed by the symbol for the gas or gas mixture (main group and sub-group).

3.3 component. Gaseous substance that is essential to the performance of the gas mixture.
Example:
In a mixture containing 11% of CO_2 in argon, CO_2 is considered a component while argon is the base gas.

3.4 container. Vessel used for the shipment and/or storage of pure or mixed gases in a gaseous or liquid state.

3.5 designation. Classification plus the symbols for all chemical components plus the nominal composition in volume percent.

Note:
Symbols for chemical components are given in 5.2.

Example:
A mixture of argon containing 11% CO_2 is designated as *AWS A5.32 (ISO-14175)*-M20-ArC-11.

3.6 impurity. Gaseous substance with chemical composition different from the base gas, component, or gas mixture.

3.7 mixture. Gas consisting of two or more components.

3.8 nominal value. Percentage value of a component, quoted by the manufacturer or supplier, which corresponds to the general composition given by the designation.

3.9 symbol. Main group and sub-group of a gas mixture.

Note:
Symbols are given in Table 2 (see also 5.1).

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2 AWS standards are published by American Welding Society, 550 N.W. LeJeune road, Miami, FL 33126.
3 ASTM standards are published by ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.
4 ISO standards are published by the International Organization for Standardization, 1, rue de Verembé, Case postale 56, CH-1211 Geneva 20, Switzerland.

Example:
The symbol for a mixture of argon containing 11% CO_2 is M20.

3.10 trade name. *The commercial name or trademark by which a gas or gas mixture is known, in those cases when a manufacturer or supplier choses to do so.*

4. Properties of gases

4.1 General. Relevant physical and chemical properties of the gases considered in this Standard are given in Table 1.

4.2 Rounding-off procedure
For purposes of determining compliance with the requirements of this Standard, the actual test values obtained shall be subjected to the rounding-off rules *ASTM E 29, or* Rule A in Clause B.3 of ISO 80000-1:2009 (the results are the same). If the measured values are obtained by equipment calibrated in units other than those of this Standard, the measured values shall be converted to the units of this Standard before rounding off. If an average value is to be compared to the requirements of this Standard, rounding off shall be done only after calculating the average. In the case where the testing standard cited in the normative references of this Standard contains instructions for rounding off that conflict with the instructions of this Standard, the rounding-off requirements of the testing standard shall apply. The rounded-off results shall fulfill the requirements of the appropriate table for the classification under test.

5. Classification and designation

5.1 Classification

5.1.1 General. Gases and gas mixtures shall be classified by the number of this Standard, followed by the symbol for the gas in accordance with Table 2.

Note:
The classification is based on the reactivity of the gas or gas mixture.

The shielding gases and gas mixtures covered by this specification are classified using a system that is independent of U.S. Customary Units and the International System of Units (SI). Classification is according to chemical composition of the shielding gas and gas mixtures as specified in 5.1.2 and 5.1.3.

Gases and gas mixtures classified under one classification shall not be classified under any other classification in this specification. Individual gases shall meet or exceed the requirements of Table 4.

Table 1
Properties of Gas Components

Type of gas	Chemical symbol	Density[a] (air = 1.293) kg/m^3 *[lb/ft^3]*	Relative density[a] to air	Boiling point at 0.101 MPa °C *[°F]*	Reactivity during welding
Argon	Ar	1.784 *[0.11136]*	1.380	– 185.9 *[–302.6]*	Inert
Helium	He	0.178 *[0.01111]*	0.138	– 268.9 *[–452.0]*	Inert
Carbon dioxide	CO_2	1.977 *[0.1234]*	1.529	– 78.5[b] *[–109.3]*	Oxidizing
Oxygen	O_2	1.429 *[0.0892]*	1.105	– 183.0 *[–297.4]*	Oxidizing
Nitrogen	N_2	1.251 *[0.0781]*	0.968	– 195.8 *[–320.4]*	Low reactive[c]
Hydrogen	H_2	0.090 *[0.0056]*	0.070	– 252.8 *[–423.0]*	Reducing

[a] Specified at 0 °C and 0.101 MPa (1.013 bar) *[1 Atmosphere (14.7 psia) +32 °F]*
[b] Sublimation temperature (solid to gas transition temperature).
[c] The behaviour of nitrogen varies with different materials and applications. Possible influences must be considered by the user.

Table 2
Classification of process gases for fusion welding and allied processes

Symbol		Components in nominal percentage of volume					
Main group	Sub-group	Oxidizing		Inert		Reducing	Low reactivity
		CO_2	O_2	Ar	He	H_2	N_2
I	1			100			
	2				100		
	3			Balance	0.5 ≤He ≤95		
M1	1	$0.5 \le CO_2 \le 5$		Balance[a]		$0.5 \le H_2 \le 5$	
	2	$0.5 \le CO_2 \le 5$		Balance[a]			
	3		$0.5 \le O_2 \le 3$	Balance[a]			
	4	$0.5 \le CO_2 \le 5$	$0.5 \le O_2 \le 3$	Balance[a]			
M2	0	$5 < CO_2 \le 15$		Balance[a]			
	1	$15 < CO_2 \le 25$		Balance[a]			
	2		$3 < O_2 \le 10$	Balance[a]			
	3	$0.5 \le CO_2 \le 5$	$3 < O_2 \le 10$	Balance[a]			
	4	$5 < CO_2 \le 15$	$0.5 \le O_2 \le 3$	Balance[a]			
	5	$5 < CO_2 \le 15$	$3 < O_2 \le 10$	Balance[a]			
	6	$15 < CO_2 \le 25$	$0.5 \le O_2 \le 3$	Balance[a]			
	7	$15 < CO_2 \le 25$	$3 < O_2 \le 10$	Balance[a]			
M3	1	$25 < CO_2 \le 50$		Balance[a]			
	2		$10 < O_2 \le 15$	Balance[a]			
	3	$25 < CO_2 \le 50$	$2 < O_2 \le 10$	Balance[a]			
	4	$5 < CO_2 \le 25$	$10 < O_2 \le 15$	Balance[a]			
	5	$25 < CO_2 \le 50$	$10 < O_2 \le 15$	Balance[a]			
C	1	100					
	2	Balance	$0.5 \le O_2 \le 30$				
R	1			Balance[a]		$0.5 \le H_2 \le 15$	
	2			Balance[a]		$15 < H_2 \le 50$	
N	1						100
	2			Balance[a]			$0.5 \le N_2 \le 5$
	3			Balance[a]			$5 < N_2 \le 50$
	4			Balance[a]		$0.5 \le H_2 \le 10$	$0.5 \le N_2 \le 5$
	5					$0.5 \le H_2 \le 50$	Balance
O	1		100				
Z	Gas mixtures containing components not listed, or mixtures outside the composition ranges listed.[b]						

[a] For the purpose of this classification, argon may be substituted partially or completely by helium.
[b] Two gas mixtures with the same Z-classification may not be interchangeable.

The gases classified under this standard are intended for, but not limited to the fusion welding and allied processes listed in the Scope.

5.1.2 Main group. The letter codes and numbers used for the main groups are:

— I: inert gases and inert gas mixtures;

— M1, M2, and M3: oxidizing mixtures containing oxygen and/or carbon dioxide;

— C: highly oxidizing gas and highly oxidizing mixtures;

— R: reducing gas mixtures;

— N: low reactive gas or reducing gas mixtures, containing nitrogen;

— O: oxygen;

— Z: gas mixtures containing components not listed or mixtures outside the composition ranges listed in Table 2.

5.1.3 Sub-group. The main groups, except Z, are divided into sub-groups based on the presence and level of different components having an influence on the reactivity (see Table 2). The values indicated in Table 2 are nominal values.

5.1.4 Classification examples

EXAMPLE 1 For a gas mixture containing 6% carbon dioxide, 4% oxygen in argon:
Classification: *AWS A5.32* (ISO 14175) – M25
EXAMPLE 2 For a gas mixture containing 30% helium in argon:
Classification: *AWS A5.32* (ISO 14175) – I3
EXAMPLE 3 For a gas mixture containing 5% hydrogen in argon:
Classification: *AWS A5.32* (ISO 14175) – R1
EXAMPLE 4 For a gas mixture containing 0.05% of oxygen in argon:
Classification: *AWS A5.32* (ISO 14175) – Z

5.2 Designation

5.2.1 General. Gases and gas mixtures are designated by the classification (see 5.1) and the symbols of their chemical components as below, followed by the corresponding nominal composition in volume percent:

— Ar: argon

— C: carbon dioxide

— H: hydrogen

— N: nitrogen

— O: oxygen

— He: helium

The base gas symbol shall be followed by the symbols for the other components in decreasing order of percent, followed by the nominal composition values, in volume percent, which are separated by a forward slash.

5.2.2 Designation examples

EXAMPLE 1 For a gas mixture containing 6% carbon dioxide, 4% oxygen in argon:
Classification: *AWS A5.32* (ISO 14175) – M25
Designation: *AWS A5.32* (ISO 14175) – M25 – ArCO – 6/4
EXAMPLE 2 For a gas mixture containing 30% helium in argon:
Classification: *AWS A5.32* (ISO 14175) – I3
Designation: *AWS A5.32* (ISO 14175) – I3 – ArHe – 30
EXAMPLE 3 For a gas mixture containing 5% hydrogen in argon:
Classification: *AWS A5.32* (ISO 14175) – R1
Designation: *AWS A5.32* (ISO 14175) – R1 – ArH – 5
EXAMPLE 4 For a gas mixture containing 7.5% argon, 2.5% carbon dioxide in helium:
Classification: *AWS A5.32* (ISO 14175) – M12
Designation: *AWS A5.32* (ISO 14175) – M12 – HeArC – 7.5/2.5

For gas mixtures containing components listed, but outside the ranges in Table 2, the letter Z prefixes the symbol for the base gas and symbols for components as above, followed by the nominal composition values, in volume percent, which are separated by a dash.

EXAMPLE 5 For a gas mixture containing 0.05% of oxygen in argon:
Classification: *AWS A5.32* (ISO 14175) – Z
Designation: *AWS A5.32* (ISO 14175) – Z – ArO – 0.05

For gas mixtures containing components not listed in Table 2, the letter Z prefixes the symbol for the base gas and symbols for components as above, but with a plus sign preceding the unlisted component, followed by the nominal composition values, in volume percent, which are separated by a dash. *The unlisted component shall be designated by its chemical symbol or chemical formula*.

EXAMPLE 6 For a gas mixture containing 0.05% of xenon, chemical symbol Xe, in argon:
Classification: *AWS A5.32* (ISO 14175) – Z
Designation: *AWS A5.32* (ISO 14175) – Z – Ar+Xe – 0.05

6. Tolerances of mixtures

Mixture tolerances apply to the volumetric percentage of the components in accordance with Table 3.

EXAMPLE 1 An addition of 25% carbon dioxide nominal value shall not vary by more than ± 2.5% (from 22.5% to 27.5%).
EXAMPLE 2 An addition of 2.5% oxygen shall not vary by more than ± 0.5% (from 2.0% to 3.0%).

7. Purities and dew point

The purity and maximum dew point of base gases shall meet the requirements of Table 4. The maximum dew point of gas mixtures within the M1, M2, and M3 classifications shall meet the requirements of Table 4.

Sample gases for dew point analysis shall be drawn from the individual cylinder, vessel, or gas outlet source. Any standard dew point measurement method may be used.

Moisture can be expressed as concentration in ppm (parts per million), dew point °F at one atmosphere pressure (14.7 psia), or as dew point at 0.101 MPa in °C. The Dew Point Conversion Chart, see Table 5, may be used to convert dew point measurements to or from °F, °C, or ppm.

8. Testing

Samples of gas(es) for chemical analysis shall be drawn from an individual cylinder, vessel, or from the gas outlet source. Testing of gases and gas mixtures for composition and impurity may be carried out by the manufacturer or supplier using established standards for testing and control (see also Bibliography). The results of the testing shall fulfill the requirements given in Tables 2, 3, and 4.

Any special or additional testing requirements should be agreed between the purchaser and the manufacturer or supplier.

Table 3
Mixture tolerances

Component gas nominal concentration %	Allowable tolerance
> 5	± 10% of the nominal
1 to 5	± 0.5% absolute
< 1	Not specified in this International Standard

Table 4
Minimum requirements on purities and moisture contents of gases and gas mixtures

Main groups/gas		Purity % by volume minimum	Dew point at 0.101 MPa °C *[°F @ 14.7 psia]*	Moisture ppm max. volume
I	Inert	99.99	– 50 *[–58]*	40
M1 [a]	Gas mix	99.9	– 50 *[–58]*	40
M2 [a]	Gas mix	99.9	– 44 *[–48]*	80
M3 [a]	Gas mix	99.9	– 40 *[–40]*	120
C [a]	Carbon dioxide	99.8	– 40 *[–40]*	120
R	Reducing	99.95	– 50 *[–58]*	40
N	Nitrogen	99.9	– 50 *[–58]*	40
O	Oxygen	99.5	– 50 *[–58]*	40

[a] Nitrogen: 1000 ppm maximum. *See Annex A7.1.3 for additional information.*
Note: For certain applications a higher purity and/or lower dew point may be recommended to avoid possible oxidation and contamination.

9. Retesting

If any test fails to meet the requirement, that test shall be repeated twice. The results of both retests shall meet the requirement. Samples for the retest may be taken from the original container or from a new container. Retests need only be for those specific elements that failed to meet their test requirement. If the results of one or both retests fail to meet the requirement, the gas under test shall be considered as not meeting the requirements of this specification for that classification and designation.

In the event that, during preparation or after completion of any test, it is clearly determined that prescribed or proper procedures were not followed in preparing the sample(s) or in conducting the tests, the test shall be considered invalid, without regard to whether the test was actually completed, or whether the test results met, or failed to meet, the requirement. That test shall be repeated following proper prescribed procedures. In this case, the requirement for doubling the number of test samples does not apply.

10. Marking

The outside of each *cylinder or other* container (see 3.4) shall be clearly marked with at least the following information:
name of manufacturer or supplier;
trade name;
designation in accordance with this Standard (see 5.2);
health and safety warnings in accordance with local, national, and regional standards and regulations as required.

Example
The following example illustrates the minimum labeling requirement to comply with this specification.

XXX Welding Supply
Trade Name – TriMix

This product conforms to:
AWS A5.32 (ISO 14175) –M12-HeArC-7.5/2.5

Specific Health & Safety information

Table 5
Dew point conversion chart
(1 Atmosphere) [70 °F@14.7 psia/21 °C @ 760 mm Hg]

Dew Point			*Dew Point*			*Dew Point*		
°F	*°C*	*ppm*	*°F*	*°C*	*ppm*	*°F*	*°C*	*ppm*
–130	–90.0	0.10	–73	–58.3	13.3	–38	–38.9	144
–120	–84.4	0.25	–72	–57.8	14.3	–37	–38.3	153
–110	–78.9	0.63	–71	–57.2	15.4	–36	–37.8	164
–105	–76.1	1.00	–70	–56.7	16.6	–35	–37.2	174
–104	–75.6	1.08	–69	–56.1	17.9	–34	–36.7	185
–103	–75.0	1.18	–68	–55.6	19.2	–33	–36.1	196
–102	–74.4	1.29	–67	–55.0	20.6	–32	–35.6	210
–101	–73.9	1.40	–66	–54.4	22.1	–31	–35.0	222
–100	–73.3	1.53	–65	–53.9	23.6	–30	–34.4	235
–99	–72.8	1.66	–64	–53.3	25.6	–29	–33.9	250
–98	–72.2	1.81	–63	–52.8	27.5	–28	–33.3	265
–97	–71.7	1.96	–62	–52.2	29.4	–27	–32.8	283
–96	–71.1	2.15	–61	–51.7	31.7	–26	–32.2	300
–95	–70.6	2.35	–60	–51.1	34.0	–25	–31.7	317
–94	–70.0	2.54	–59	–50.6	36.5	–24	–31.1	338
–93	–69.4	2.76	–58	–50.0	39.0	–23	–30.6	358
–92	–68.9	3.00	–57	–49.4	41.8	–22	–30.0	378
–91	–68.3	3.28	–56	–48.9	44.6	–21	–24.4	400
–90	–67.8	3.53	–55	–48.3	48.0	–20	–28.9	422
–89	–67.2	3.84	–54	–47.8	51	–19	–28.3	448
–88	–66.7	4.15	–53	–47.2	55	–18	–27.8	475
–87	–66.1	4.50	–52	–46.7	59	–17	–27.2	500
–86	–65.6	4.78	–51	–46.1	62	–16	–26.7	530
–85	–65.0	5.3	–50	–45.6	67	–15	–26.1	560
–84	–64.4	5.7	–49	–45.0	72	–14	–25.6	590
–83	–63.9	6.2	–48	–44.4	76	–13	–25.0	630
–82	–63.3	6.6	–47	–43.9	82	–12	–24.4	660
–81	–62.8	7.2	–46	–43.3	87	–11	–23.9	700
–80	–62.2	7.8	–45	–42.8	92	–10	–23.3	740
–79	–61.7	8.4	–44	–42.2	98	–9	–22.8	780
–78	–61.1	9.1	–43	–41.7	105	–8	–22.2	820
–77	–60.6	9.8	–42	–41.1	113	–7	–21.7	870
–76	–60.0	10.5	–41	–40.6	119	–6	–21.1	920
–75	–59.4	11.4	–40	–40.0	128	–5	–20.6	970
–74	–58.9	12.3	–39	–39.4	136	–4	–20.0	1020

11. Certification

By affixing the AWS specification and classification designations on the packaging enclosing the product, the supplier (manufacturer) certifies that the product meets all of the requirements of the specification.[5]

[5] See Clause A4 (in the Annex) for further information concerning certification and the testing called for to meet this requirement.

12. Cylinder Residual Gases

–All gas containers shall either be evacuated or, if not evacuated, residual gases shall be analyzed for composition and purity prior to filling except as described below.[6]

Containers permanently equipped with a backflow prevention device are exempt from this requirement except when being filled for the first time after maintenance and testing, or if the gas or gas mix to be placed in the container is different from the gas or gas mix that is currently in the container.

Containers of liquid gases or gas mixtures are exempt from this requirement except when being filled for the first time after maintenance and testing, or if the gas or gas mix to be placed in the container is different from the gas or gas mix that is currently in the container.

13. Packaging

Gases and gas mixtures shall be packaged in accordance with Department of Transportation (DOT) regulations for protection during shipment and normal storage conditions.[7] *Cylinder sizes shall be as agreed upon between purchaser and supplier. Cylinders shall be labeled in accordance with Clauses 10 and 11.*

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[6] CGA P-15, *Filling of Industrial and Medical Nonflammable Compressed Gas Cylinders*, is published by the Compressed Gas Association, Inc., 1725 Jefferson Davis Highway, Suite 1004, Arlington, VA 22202–4102.

[7] DOT regulations are published by the Department of Transportation, NASSIF Building, 400 7th Street S.W., Washington, DC 20590.

National Annexes

Annex A (Informative)

Guide to Welding Consumables – Gases and Gas Mixtures for Fusion Welding and Allied Processes

This annex is not part of AWS A5.32M/A5.32:2011 (ISO 14175:2008 MOD), Welding Consumables – Gases and Gas Mixtures for Fusion Welding and Allied Processes, but is included for informational purposes only.

A1. Introduction

The purpose of this guide is to correlate the gases and gas mixtures with their intended use so the specification can be used effectively. The processes that use these gases are referred to whenever that can be done and when it would be helpful. Such references are intended only as examples rather than complete listings of the processes using these gases and gas mixtures.

A2. Classification System

A2.1 *The system for identifying the shielding gas classifications in this specification follows the standard pattern used in AWS filler metal specifications.*

For shielding gas mixtures, the letter designators immediately following the base gas designator indicate minor individual gas components in decreasing order of percent. These letters are followed by a hyphen and nominal composition value of each minor gas volumetric percentage. When there are more than one minor gas component, each numeric value in decreasing order is separated by a forward slash (/).

A2.2 "Z" Classification

A2.2.1 *This standard includes gases and gas mixtures classified as AWS A5.32 (ISO 14175)-Z. The last "Z" indicates that the gas or gas mixture is of a "General" classification. It is "General" because not all of the particular requirements specified for each of the other classifications are met. The intent in establishing this classification is to provide a means for when a gas mixture differs, for example, in chemical composition from other classifications and does not meet the composition specified for any of the classifications in this document can still be classified. This is to allow a gas mixture—that otherwise would have to await a revision of the specification—to be classified immediately under the existing document. This means that two gas mixtures—each bearing the same "Z" classification—may be quite different in some respect, for example, chemical composition.*

A2.2.2 *Point of difference (although not necessarily the amount of that difference) between a gas mixture of a "Z" classification and a gas mixture of a similar classification without the "Z" (or even with it, for that matter) will be readily apparent from the use of the words "not required" and "not specified" in the specification. The use of these words is as follows:*

"Not Specified" is used in those areas of the specification that refer to the results of some particular test. It indicates that the requirements for that test are not specified for that particular classification.

"Not Required" is used in those areas of the specification that refer to the tests that must be conducted in order to classify a gas or gas mixture. It indicates that that test is not required because the requirements (results) for the test have not been specified for that particular classification.

Restating the case, when a requirement is not specified, it is not necessary to conduct the corresponding test in order to classify a gas or gas mixture to that classification. When a purchaser wants the information provided by that test, in order to consider a particular product of that classification for a certain application, the purchaser will have to arrange for that information with the supplier of the product. The purchaser will have to establish with that supplier just what the testing procedures and the acceptance requirements are to be for that test. The purchaser should specify that information in the purchase order.

A2.2.3 Request for Gas Classification

A2.2.3.1 *When a gas mixture cannot be classified according to some classification other than a "Z" classification, the manufacturer may request that a classification be established for the gas mixture. The manufacturer may do this by following the procedure given here. When the manufacturer elects to use the "Z" classification, the AWS A5 Committee on Filler Metals and Allied Materials recommends that the manufacturer still request that a classification be established for that gas mixture, as long as the gas mixture is of commercial significance.*

A2.2.3.2 *A request to establish a new gas mixture classification shall be a written request and it needs to provide sufficient detail to permit the AWS A5 Committee on Filler Metals and Allied Materials and the appropriate subcommittee to determine whether a new classification or the modification of an existing classification is more appropriate, and whether either is necessary to satisfy the need. The request needs to state the variables and their limits, for such a classification or modification. The request should contain some indication of the time by which completion of the new classification or modification is needed.*

A2.2.3.3 *The request should be sent to the Secretary of the AWS A5 Committee on Filler Metals and Allied Materials at AWS Headquarters. Upon receipt of the request, the Secretary will do the following:*

(1) Assign an identifying number to the request. This number shall include the date the request was received.

(2) Confirm receipt of the request and give the identification number to the person who made the request.

(3) Send a copy of the request to the Chair of the AWS A5 Committee on Filler Metals and Allied Materials and the Chair of the particular Subcommittee involved.

(4) File the original request.

(5) Add the request to the log of outstanding requests.

A2.2.3.4 *All necessary action on each request will be completed as soon as possible. If more than 12 months lapse, the Secretary shall inform the requestor of the status of the request, with copies to the Chairpersons of the Committee and Subcommittee. Any request outstanding after 18 months shall be considered not to have been answered in a "timely manner" and the Secretary shall report it to the Chair of the AWS A5 Committee on Filler Metals and Allied Materials for action.*

A2.2.3.5 *The Secretary shall include a copy of the log of all requests pending and those completed during the preceding year with the agenda for each AWS A5 Committee on Filler Metals and Allied Materials meeting. Any other publication of requests that have been completed will be at the option of the American Welding Society, as deemed appropriate.*

A3. Acceptance

Acceptance of all gases or gas mixtures classified under this specification is in accordance with the tests and requirements of this specification. Any testing a purchaser requires of the supplier, for gases shipped in accordance with this specification, shall be clearly stated in the purchase order. In the absence of any such statement in the purchase order, the supplier may ship the gases with whatever testing the supplier normally conducts on gases of that classification. In such cases, acceptance of the material shipped will be in accordance with those requirements.

A4. Certification

The act of placing the AWS specification and classification designations on the packaging enclosing the product, constitutes the supplier's (manufacturer's) certification that the product meets all of the requirements of the specification.

The only testing requirement implicit in this "certification" is that the manufacturer has actually conducted and documented the tests required by the specification on product that is representative of that being shipped, and that that product met the requirements of the specification. "Certification" is not to be construed to mean that tests of any kind were necessarily conducted on samples of the specific product shipped. Tests on such material may or may not have been conducted. The basis for the "certification" required by the specification is the classification test of "representative product" cited above, and the "Manufacturer's Quality Assurance Program" in AWS A5.01M/A5.01, Procurement Guidelines for Consumables—Welding and Allied Processes—Flux and Gas Shielded Electrical Welding Processes.[8]

A5. Ventilation During Welding

A5.1 *Five major factors govern the quantity of fumes and gas emissions in the atmosphere to which welders and welding operators are exposed during welding. They are the following:*

(1) Dimensions of the space in which the welding is done (with special regard to the height of the ceiling).

(2) Number of welders and welding operators working in that space.

(3) Rate of evolution of fumes, gases, or dust, according to the materials and processes used.

(4) The proximity of the welders or welding operators to the fumes, as these fumes issue from the welding zone, and to the gases and dusts in the space in which they are working.

(5) The ventilation provided to the space in which the welding is done.

A5.2 *American National Standard ANSI Z49.1, Safety in Welding, Cutting, and Allied Processes (published by the American Welding Society), discusses the ventilation that is required during welding and should be referred to for details. Attention is drawn particularly to the sections on "Health Protection and Ventilation." Further details about ventilation can be found in AWS F3.2, Ventilation Guide for Welding Fume.*

A6. Welding Considerations

The properties of gases affect the performance of all arc welding processes. The ionization potential of the shielding gas influences the ease of arc initiation and stability. Thermal conductivity of a gas determines the voltage and energy constant of the arc. Gases such as carbon dioxide can have higher heat conductivity than helium at arc temperatures because of the effects of dissociation and recombination.

Reactive and oxidizing gases such as carbon dioxide (CO_2) and oxygen (O_2) can have detrimental effects on base metals such as aluminum, nickel, titanium, zirconium, and tungsten. For this reason, carbon dioxide or oxygen cannot be used as the shielding gas for gas tungsten arc welding.

Proper gas selection is crucial to efficient welding in the most cost-effective manner. Many factors must be considered. These are not limited to the following:

(1) Type and thickness of base metal being welded

(2) Arc characteristics

(3) Metal transfer

(4) Travel speed

(5) Depth and width of fusion

(6) Cost of welding

(7) Mechanical properties

[8] AWS standards are published by American Welding Society, 550 N.W. LeJeune road, Miami, FL 33126.

(8) *Root opening*

(9) *Cleanliness of the base material*

(10) *Spatter*

(11) *Arc cleaning action*

(12) *Gas purity*

(13) *Joint configuration*

(14) *Welding position*

(15) *Fume generation*

A7. Description and Intended Use of the Shielding Gases

A7.1 Single Gases

All single gases described in this specification may be purchased either as a liquid or as a gas. If liquid, the material must be gasified prior to being supplied to the welding area.

A7.1.1 AWS A5.32 (ISO 14175)—I1—Ar (100% Argon). *Argon is a chemically inert gas which is used both singularly and in combination with other gases to achieve desired arc characteristics for the welding of both ferrous and nonferrous metals. Almost all arc welding processes can use argon or mixtures containing argon to achieve good weldability, mechanical properties, arc characteristics and productivity. Argon is used for welding of nonferrous materials such as aluminum, nickel, copper, magnesium alloys, and reactive metals, which include zirconium and titanium. The low ionization potential of argon creates an excellent current path and superior arc stability. In the GMAW process, argon produces a constricted arc column at a high current density which causes the arc energy to be concentrated in a small central area of the weld pool. The result is a depth of fusion profile which may have a distinct fingerlike shape. Argon is also used for single-side melt-through welding with or without consumable inserts. Argon is often used as the shielding gas for solid state lasers (wavelength of ~1.06 μm).*

A7.1.2 AWS A5.32 (ISO 14175)– C1—C (100% Carbon Dioxide). *Carbon dioxide is an active gas used primarily for GMAW and FCAW. The heat of the arc dissociates the carbon dioxide into carbon monoxide and free oxygen. This oxygen will combine with elements transferring across the arc to form oxides which are released from the weld pool in the form of slag and scale. Although carbon dioxide is an active gas and produces an oxidizing effect, sound welds and acceptable mechanical properties can be achieved in many, but not all, metals and alloys. An electrode having higher amounts of deoxidizing elements is sometimes needed to compensate for the reactive nature of the gas. Carbon dioxide can be used for solid electrode GMAW with short circuiting and globular transfer and FCAW of carbon and stainless steel. Carbon dioxide cannot be used for spray transfer with GMAW.*

The popularity of carbon dioxide is due to common availability as well as its lower cost per unit volume. The lower cost per unit of gas does not automatically translate to lowest cost per foot of deposited weld and is greatly dependent on the welding application. The final weld cost with carbon dioxide shielding gas is influenced by bead contour, electrode spatter, and spatter removal. The lower deposition efficiency for carbon dioxide caused by fume and spatter loss will influence the final weld cost.

Argon is often mixed with carbon dioxide to improve the operating characteristics. If mechanical properties are to be maximized, a carbon dioxide and argon mixture is often recommended.

A7.1.3 AWS A5.32 (ISO 14175)– N1—N (100% Nitrogen). *Shielding gases containing nitrogen are not recommended for welding carbon steel. Nitrogen will combine with other elements at high temperatures which is why it is not recommended as a primary gas, but is used in combination with other gases for selected applications.*

Nitrogen is often used as a backing gas to protect the weld root from atmospheric contamination. Nitrogen root shielding of stainless steel welds may cause problems in those applications where control of the ferrite content is critical. Increased nitrogen content of the weld may reduce the ferrite level. Small additions (up to 3%) of nitrogen have been combined with argon for GMA and GTA welding of duplex stainless steel.

For plasma cutting, nitrogen is often used as the plasma and/or shielding gas on nonferrous materials, or when minimal cut edge oxide is desired.

A7.1.4 AWS A5.32 (ISO 14175)—I2—He (100% Helium). *Helium, a chemically inert gas, is used for weld applications requiring higher heat inputs. Helium may improve wetting action, depth of fusion, and travel speeds. It does not produce the stable arc provided by argon. Helium has higher thermal conductivity and a wider arc column than argon. The higher voltage gradient increases heat input compared with argon, promoting increased weld pool fluidity and better wetting action. This is an advantage when welding aluminum-based, magnesium-based, and copper-based alloys. Using GMAW, 100% helium will only produce globular transfer. The argon percentage must be at least 20% when mixed with helium to produce and maintain a stable spray transfer. Helium is often used as the shielding gas for gas (CO_2) lasers (wavelength of ~10.6 μm).*

A7.1.5 AWS A5.32 (ISO 14175)—O1—O (100% Oxygen). *Oxygen is never used as a base component of a shielding gas. It can be used as a minor component. Oxygen is often used as the assist gas for cutting ferrous materials, or when oxide on the edge is not a concern. The oxygen is usually used at relatively low pressure (~75 psi [7.2 bar]) and low flow rate (~150 SCFH [70.81/min]). Oxygen may also be used as the plasma gas for plasma arc cutting.*

A7.1.6 AWS A5.32 (ISO 14175)—R1—H (Hydrogen). *Hydrogen (H_2) is chemically active and most commonly used at low percentages (1 to 35%) as the minor component in a gas mixture (see Clause A8, General Safety Considerations). Mixtures of 1–15% hydrogen in argon can be used for GTAW and PAW of austenitic stainless steels. Mixtures of 20–35% hydrogen in argon is commonly used for PAC (plasma arc cutting) and PAG (plasma arc gouging).*

A7.2 Binary Shielding Gas Mixtures

A7.2.1 AWS A5.32 (ISO 14175)—Mx—ArO (Argon + Oxygen Mixtures). *The addition of oxygen to argon with the GMAW process improves the arc characteristics and increases weld pool fluidity by reducing the surface tension of the weld metal. Oxygen is an active gas which intensifies the arc plasma, increasing heat input, travel speed, depth of fusion, and wetting. In GMAW, the addition of small amounts (1 to 8%) of oxygen to argon stabilizes the welding arc, increases the filler metal droplet transfer rate, lowers the spray arc transition current, and influences bead shape. The weld pool is more fluid allowing improved weld bead wetting. Oxygen is not used with GTAW because of its detrimental effect on the tungsten electrode.*

A7.2.1.1 AWS A5.32 (ISO 14175) – M13 – ArO-1 (Ar + 1% O_2). *This mixture is primarily used for spray transfer on stainless steels. One percent oxygen is usually sufficient to stabilize the arc, increase the droplet rate, and provide good fluidity of the weld pool.*

A7.2.1.2 AWS 5.32 (ISO 14175) – M13 – ArO-2 (Ar + 2% O_2). *This mixture is used for spray arc welding on carbon steels, low-alloy steels, and stainless steels. It provides additional wetting action over AWS A5.32 (ISO 14175) – M13 – ArO-1. Weld mechanical properties and corrosion resistance (stainless steels) of welds made using the AWS A5.32 (ISO 14175) – M13 -AO-2 and AWS A5.32 (ISO 14175) – M13 -ArO-1 shielding gases are comparable.*

A7.2.1.3 AWS A5.32 (ISO 14175) – M22 – AO-5 (Ar + 5% O_2). *This mixture provides a more fluid but controllable weld pool. It is the most commonly used argon plus oxygen mixture for general carbon steel welding.*

A7.2.1.4 AWS A5.32 (ISO 14175) – M22 – AO-8 (Ar + 8% O_2). *This mixture provides additional depth of fusion over AWS A5.32 (ISO 14175) M22 – ArO-5. Slightly lower arc voltage or increased wire feed speed should be used. The higher weld pool fluidity and lower spray transition current of this mixture are advantageous on some applications. This mixture can be used in the short circuiting and spray modes of transfer. Greater oxidation of the weld metal, with increased loss of manganese and silicon, should be expected.*

A7.2.2 AWS A5.32 (ISO 14175) – Mx – ArC (Argon + Carbon Dioxide Mixtures). *The additions of carbon dioxide to argon can produce a wide range of welding characteristics from high-current traditional spray transfer to low-current short circuiting transfer.*

The dissociation of carbon dioxide in the arc provides oxygen for improved wetting and arc stabilization. The high thermal conductivity of carbon dioxide tends to increase the width of fusion as compared to AWS A5.32 (ISO 14175) – Mx – ArO mixtures.

When using GMAW with solid carbon steel wires, AWS A5.32 (ISO 14175) M21 – ArC-20+ mixtures containing more than 20% carbon dioxide will not support spray transfer, but rather, starts to transition into more of a globular type transfer.

A7.2.2.1 AWS A5.32 (ISO 14175) M12 or M20 or M21 – ArC-.5 through 10 (Ar + 1 to 10% CO_2) *Mixtures in this range may produce all modes of metal transfer useful on a variety of steel thicknesses. Depth of fusion is slightly improved and porosity may be reduced when using AWS A5.32 (ISO 14175) – Mx – ArC compared to AWS A5.32 (ISO 14175) – Mx -ArO.*

In the 5 to 10% carbon dioxide range the arc column becomes more defined. These mixtures are effective on material with mill scale. AWS A5.32 (ISO 14175) – M12 – ArC-5 is commonly used with GMAW for heavy-section low-alloy steel welding.

A7.2.2.2 AWS A5.32 (ISO 14175) – M20 or M21 – ArC-11 through 20 (Ar + 11 to 20% CO_2). *This mixture range has been used with various GMAW and FCAW applications. Most applications are on carbon and low-alloy steels. The lower carbon dioxide percentages increase deposition efficiency by lowering spatter loss. Higher percentage of* CO_2 *will increase penetration.*

A7.2.2.3 AWS A5.32 (ISO 14175) – M21 or M31 – ArC-21 through 50 (Ar + 21 to 50% CO_2). *Mixtures in this range are used for GMAW operating in the short circuiting mode of metal transfer and for all position welding with flux cored arc welding (FCAW).*

AWS A5.32 (ISO 14175) – M21-AC-25 is widely used to replace pure carbon dioxide. When used with GMAW in the short circuiting mode of transfer, these mixes operate well on 1.5 mm to 3.2 mm [16 gauge to 10 gauge] material with minimal amounts of spatter. When used with flux cored arc welding at higher current levels, heavier thickness can be welded with good arc stability and smooth bead appearance.

A7.2.2.4 AWS A5.32 (ISO 14175) – M31 – ArC-50 (Ar + 50% CO_2). *This mixture (not supplied at full cylinder pressure because the* CO_2 *would liquefy a full pressure) is used where increased heat input and depth of fusion are needed. Recommended material thickness is 3 mm [1/8 in] minimum for the globular mode of metal transfer. This mixture is satisfactory for pipe welding using the short circuiting transfer mode. Good wetting and bead shape without excessive weld pool fluidity are the main advantages for the pipe welding application. When welding at high current levels, the metal transfer is more like welding in pure carbon dioxide than other previously described argon mixtures, but some reduction in spatter loss can be realized due to the argon addition.*

A7.2.3 AWS A5.32 (ISO 14175) – Ix – ArHe Gases (Argon + Helium Mixtures). *These mixtures are often recommended for GMA and GTA welding of aluminum where an increased width of fusion is required and bead appearance is of primary importance. Generally, the heavier the material the higher is the percentage of helium. Small percentages of helium, as low as 10%, will affect the arc. In GMAW, as the helium percentage is increased, the arc voltage and depth of fusion will increase while minimizing porosity.*

A7.2.3.1 AWS A5.32 (ISO 14175) – I3 – ArHe-10 through 50 (Ar + 10 to 50% He). *These mixtures are used for welding nonferrous base metals. Mixtures in this range provide an increase in heat input and travel speed, with improved bead appearance.*

A7.2.4 AWS A5.32 (ISO 14175) – I3 – HeAr (Helium + Argon Mixtures). *Helium and argon mixtures are used primarily for GMA and GTA welding of nonferrous base metals, such as reactive metals, aluminum, copper, nickel, magnesium, and their alloys. They are also used for welding some carbon steels. These mixtures are used on thicker base metals. Argon addition to a helium base gas will decrease the heat input and improve arc starting characteristics. As argon percentages increase, the arc voltage and spatter will decrease. In GMAW, the argon content must be at least 20% to produce and maintain a stable spray transfer.*

A7.2.4.1 AWS A5.32 (ISO 14175) – I3 – HeAr-10 through 25 (He + 10 to 25% Ar). *These mixtures are used for welding copper over 1/2 in [13 mm] thick and aluminum over 75 mm [3 in] thick. The higher heat input resulting from the use of these gas mixtures tend to improve weld fusion. They may be used for short circuiting transfer with nickel filler metals.*

A7.2.4.2 AWS A5.32 (ISO 14175) – I3 – HeAr-25 through 50 (He + 25 to 50% Ar). *The higher heat input resulting from the use of these gas mixtures tends to reduce porosity of welds in copper, aluminum, and magnesium. They are used for welding aluminum and magnesium more than 13 mm [1/2 in] thick in the flat position.*

A7.2.5 AWS A5.32 (ISO 14175) – Rx – ArH (Argon + Hydrogen Mixtures) *(see Clause A8, General Safety Considerations). Commercial argon–hydrogen gas mixtures produce a reducing atmosphere which reduces surface oxidation of the weld metal during welding. AWS A5.32 (ISO 14175) – R1 – ArH-1, AWS A5.32 (ISO 14175) – R1 -ArH-2,* *or AWS A5.32 (ISO 14175) – R1 – ArH-5 is used for GTAW, GMAW, and PAW on a variety of base metals including the following:*

(1) nickel and nickel alloys

(2) Austenitic chromium-nickel stainless steels

(3) low-alloy steels (PAW only)

Mixtures containing up to 15% hydrogen (AWS A5.32 (ISO 14175) – R2 – ArH-15) are used for GTAW of – chrome–nickel stainless steels. Its high heat conductivity makes these mixtures useful in selected GTAW applications. Additions of hydrogen increase weld heat input permitting faster travel speeds, increased depth of fusion, improved bead wetting, and broader weld bead profile. Hydrogen additions to argon provide a reducing atmosphere which removes oxygen and oxides from the weld area. Argon/hydrogen mixtures are often used for a plasma gas when cutting heavy stainless or aluminum materials.

A7.2.6 AWS A5.32 (ISO 14175) – Nx – NH (Nitrogen + Hydrogen Mixtures) *(see Clause A8, General Safety Considerations). This root shielding gas may be used in the fabrication of chrome–nickel stainless steels. The ferrite precaution outlined in A7.1.3 applies also to applications using AWS A5.32 (ISO 14175) – N2-NH-5, or higher, as a root shielding medium.*

A7.3 Ternary Shielding Gas Mixtures

A7.3.1 AWS A5.32 (ISO 14175) – Mx – ArCO (Argon + Carbon Dioxide + Oxygen Mixtures). *Mixtures containing these three components are versatile due to their ability to operate using the GMAW process in the short circuiting, globular, spray, and high-current-density spray transfer modes. Several ternary compositions are available, and their application will depend on the desired metal transfer.*

A7.3.1.1 AWS A5.32 (ISO 14175) – M25 – ArCO – 5 through 15/3 through 10 (Ar + 5 to 15% CO_2 + 3 to 10% O_2). *The advantage of these mixtures is their ability to shield carbon steel and low-alloy steel of all thicknesses using any mode of metal transfer. These mixtures produce good welding characteristics and mechanical properties on carbon and low-alloy steels. On thin-gauge base metals, the oxygen constituent improves arc stability at low current levels (30 to 60 A) permitting the arc to be kept short and controllable. This helps minimize excessive melt-through and distortion by lowering the total heat input into the weld zone.*

A7.3.2 AWS A5.32 (ISO 14175) – Mx – ArHeC and AWS 5.32 (ISO 14175) – Mx – HeArC (Argon + Helium + Carbon Dioxide Mixtures). *Helium and carbon dioxide additions to argon increase the heat input to the weld, increasing bead wetting and fluidity. The weld bead profile becomes flatter and wider.*

A7.3.2.1 AWS A5.32 (ISO 14175) – Mx – ArHeC – 10 through 40/1 through 15 (Ar + 10 to 40% He + 1 to 15% CO_2). *Mixtures in this range have been developed for pulsed spray welding of carbon, low-alloy, and stainless steels. These mixtures are most often used on heavy sections, in positions other than flat. Good mechanical properties and weld pool control are characteristic of these mixtures.*

A7.3.2.2 AWS A5.32 (ISO 14175) – M12 – HeArC – 25 through 35/1 through 5 (He + 25 to 35% Ar + 1 to 5% CO_2). *These mixtures are used for short circuit GMAW of high-strength steels and stainless steels, especially for welding positions other than flat. The carbon dioxide content is kept low to ensure good weld metal toughness. The helium provides the heat necessary for good weld pool fluidity.*

A7.3.2.3 AWS A5.32 (ISO 14175) – M12 – HeArC-7.5/2.5 (90% He + 7.5% Ar + 2.5% CO_2). *This mixture is widely used for short circuit GMAW of stainless steel in all positions. The carbon dioxide content is kept low to minimize carbon pickup and ensure good corrosion resistance, especially in multipass welds. The carbon dioxide plus argon addition provides good arc stability and depth of fusion. The high helium content provides higher heat input to overcome the high-viscosity nature of the stainless steel weld pool. Applications include welding carbon steel, stainless, and alloy steels.*

A7.3.3 AWS A5.32 (ISO 14175) – Mx – ArHeO (Argon + Helium + Oxygen). *Helium additions to argon plus oxygen mixtures increase arc energy with the GMAW process on ferrous base metals. Argon/helium/oxygen mixtures have been used for spray arc welding and surfacing low-alloy and stainless steels to improve the fluidity of the weld pool and the resultant bead shape as well as reduce porosity.*

A7.4 Quaternary Shielding Gas Mixtures

AWS A5.32 (ISO 14175) Mx – ArHeCO (Argon + Helium + CO_2 + O_2 Mixtures). *This combination may be used for high-deposition GMAW using the high-current-density transfer mode. These mixtures produce weld metal with good mechanical properties, and can be used throughout a wide range of deposition rates. Their major application is welding low-alloy, high-strength steel base metals, and they have been used on carbon steel for high-productivity welding.*

A8. General Safety Considerations

A8.1 *Safety and health issues and concerns are beyond the scope of this standard and, therefore, are not fully addressed herein. Some safety and health information can be found in annex clause A5. Safety and health information is available from other sources, including, but not limited to: Safety and Health Fact Sheets listed in A8.3, ANSI Z49.1 Safety in Welding, Cutting and Allied Processes,*[9] *and applicable federal and state regulations.*

A8.2 Safety and Health Fact Sheets. *The Safety and Health Fact Sheets listed below are published by the American Welding Society (AWS). They may be downloaded and printed directly from the AWS website at http://www.aws.org. The Safety and Health Fact Sheets are revised and additional sheets added periodically.*

A8.3 AWS Safety and Health Fact Sheets Index (SHF)[10]

No.	***Title***
1	*Fumes and Gases*
2	*Radiation*
3	*Noise*
4	*Chromium and Nickel in Welding Fume*
5	*Electrical Hazards*
6	*Fire and Explosion Prevention*
7	*Burn Protection*
8	*Mechanical Hazards*
9	*Tripping and Falling*
10	*Falling Objects*
11	*Confined Spaces*
12	*Contact Lens Wear*
13	*Ergonomics in the Welding Environment*
14	*Graphic Symbols for Precautionary Labels*
15	*Style Guidelines for Safety and Health Documents*
16	*Pacemakers and Welding*
17	*Electric and Magnetic Fields (EMF)*
18	*Lockout/Tagout*
19	*Laser Welding and Cutting Safety*
20	*Thermal Spraying Safety*
21	*Resistance Spot Welding*
22	*Cadmium Exposure from Welding and Allied Processes*
23	*California Proposition 65*
24	*Fluxes for Arc Welding and Brazing: Safe Handling and Use*
25	*Metal Fume Fever*
26	*Arc Welding Distance*
27	*Thoriated Tungsten Electrodes*
28	*Oxyfuel Safety: Check Valves and Flashback Arrestors*

[9] ANSI Z49.1 is published by the American welding Society, 550 NW LeJeune Rd, Miami, FL 33126.
[10] AWS standards are published by the American welding Society, 550 NW LeJeune Rd, Miami, FL 33126.

29 Grounding of Portable and Vehicle Mounted Welding Generators
30 Cylinders: Safe Storage, Handling, and Use
31 Eye and Face Protection for Welding and Cutting Operations
33 Personal Protective Equipment (PPE) for Welding and Cutting
34 Coated Steels: Welding and Cutting Safety Concerns
36 Ventilation for Welding and Cutting
37 Selecting Gloves for Welding & Cutting

A8.4 Argon, Carbon Dioxide, Helium, and Nitrogen Hazard:

- *Argon, carbon dioxide, helium, and nitrogen can displace oxygen in a worker's breathing zone which can result in asphyxiation, and possibly death, when released in poorly vented, confined work areas. Argon and carbon dioxide cause a special concern since they are heavier than air and may concentrate in low areas such as in the bottom of pressure vessels, tanks, pits, and ships.*
- *Unless adequate ventilation and breathing air are supplied, care must be taken with any of these gases when they are released in enclosed areas or confined spaces. A safety watch should be provided and in attendance anytime a worker is using any of these gases in a vessel.*
- *Additional information can be found in ANSI Z49.1, Safety in Welding, Cutting, and Allied Processes, CGA publications, and from suppliers of the aforementioned gases.*

HYDROGEN WARNING:

- *Hydrogen is a highly flammable gas. A mixture of hydrogen with oxygen or air in a confined area will explode when brought in contact with a flame or other source of ignition. Concentrations of hydrogen between 4 and 75% by volume in air are relatively easy to ignite by a low-energy spark and may cause an explosion. Smoking, open flames, unapproved electrical equipment, and other ignition sources must not be permitted in hydrogen areas. Store containers outdoors or in other well-ventilated areas.*
- *Before making any installation, become thoroughly familiar with NFPA (National Fire Protection Association) Standards No. 50-A, Standard for Gaseous Hydrogen Systems at Consumer Sites; and 50-B, Standard for Liquefied Hydrogen Systems at Consumer Sites; and with all local safety codes. For further safety information, refer to supplier MSDS sheets on hydrogen safety.*
- *Take every precaution against hydrogen leaks. Escaping hydrogen cannot be detected by sight, smell, or taste.*

Annex B (Informative)

Guidelines for the Preparation of Technical Inquiries

This annex is not part of AWS A5.32M/A5.32:2011 (ISO 14175:2008 MOD), Welding Consumables – Gases and Gas Mixtures for Fusion Welding and Allied Processes, but is included for informational purposes only.

B1. Introduction

The American Welding Society (AWS) Board of Directors has adopted a policy whereby all official interpretations of AWS standards are handled in a formal manner. Under this policy, all interpretations are made by the committee that is responsible for the standard. Official communication concerning an interpretation is directed through the AWS staff member who works with that committee. The policy requires that all requests for an interpretation be submitted in writing. Such requests will be handled as expeditiously as possible, but due to the complexity of the work and the procedures that must be followed, some interpretations may require considerable time.

B2. Procedure

All inquiries shall be directed to:

Managing Director
Technical Services Division
American Welding Society
550 N.W. LeJeune Road
Miami, FL 33126

All inquiries shall contain the name, address, and affiliation of the inquirer, and they shall provide enough information for the committee to understand the point of concern in the inquiry. When the point is not clearly defined, the inquiry will be returned for clarification. For efficient handling, all inquiries should be typewritten and in the format specified below.

B2.1 Scope. *Each inquiry shall address one single provision of the standard unless the point of the inquiry involves two or more interrelated provisions. The provision(s) shall be identified in the scope of the inquiry along with the edition of the standard that contains the provision(s) the inquirer is addressing.*

B2.2 Purpose of the Inquiry. *The purpose of the inquiry shall be stated in this portion of the inquiry. The purpose can be to obtain an interpretation of a standard's requirement or to request the revision of a particular provision in the standard.*

B2.3 Content of the Inquiry. *The inquiry should be concise, yet complete, to enable the committee to understand the point of the inquiry. Sketches should be used whenever appropriate, and all paragraphs, figures, and tables (or annex) that bear on the inquiry shall be cited. If the point of the inquiry is to obtain a revision of the standard, the inquiry shall provide technical justification for that revision.*

B2.4 Proposed Reply. *The inquirer should, as a proposed reply, state an interpretation of the provision that is the point of the inquiry or provide the wording for a proposed revision, if this is what the inquirer seeks.*

B3. Interpretation of Provisions of the Standard

Interpretations of provisions of the standard are made by the relevant AWS technical committee. The secretary of the committee refers all inquiries to the chair of the particular subcommittee that has jurisdiction over the portion of the standard addressed by the inquiry. The subcommittee reviews the inquiry and the proposed reply to determine what the response to the inquiry should be. Following the subcommittee's development of the response, the inquiry and the response are presented to the entire committee for review and approval. Upon approval by the committee, the interpretation is an official interpretation of the Society, and the secretary transmits the response to the inquirer and to the Welding Journal *for publication.*

B4. Publication of Interpretations

All official interpretations will appear in the Welding Journal *and will be posted on the AWS web site.*

B5. Telephone Inquiries

Telephone inquiries to AWS Headquarters concerning AWS standards should be limited to questions of a general nature or to matters directly related to the use of the standard. The AWS Board Policy Manual *requires that all AWS staff members respond to a telephone request for an official interpretation of any AWS standard with the information that such an interpretation can be obtained only through a written request. Headquarters staff cannot provide consulting services. However, the staff can refer a caller to any of those consultants whose names are on file at AWS Headquarters.*

B6. AWS Technical Committees

The activities of AWS technical committees regarding interpretations are limited strictly to the interpretation of provisions of standards prepared by the committees or to consideration of revisions to existing provisions on the basis of new data or technology. Neither AWS staff nor the committees are in a position to offer interpretive or consulting services on (1) specific engineering problems, (2) requirements of standards applied to fabrications outside the scope of the document, or (3) points not specifically covered by the standard. In such cases, the inquirer should seek assistance from a competent engineer experienced in the particular field of interest.

Annex C (Informative)
List of Deviations from ISO 14175:2008

This annex is not part of AWS A5.32M/A5.32:2011 (ISO 14175:2008 MOD), Welding Consumables — Gases and Gas Mixtures for Fusion Welding and Allied Processes, but is included for informational purposes only.

Changed "International standard" to "Standard" globally

Added names and addresses of the publishers whose documents are referred to in this specification

ISO uses comma (,) for decimal, but AWS uses period (.) for decimal. Decimal commas have been changed to decimal periods.

Numbered all clauses
Changed "tungsten arc welding" to "gas tungsten arc welding" and "(process 141)" to GTAW in Clause"
Changed "gas-shielded metal arc welding" to "gas metal arc welding" and "(process 13)" to 'GMAW in Clause 1
Changed "(process 15)" to "PAW" in Clause 1
Added "flux cored arc welding – FCAW" in Clause 1
Changed "(process 83)" to "PAC" in Clause 1
Changed "(process 52)" to "LBW" in Clause 1
Changed "(process 84)" to "LBC" in Clause 1
Changed "(process 972)" to "ABW" in Clause 1
Added "electrogas welding – "EGW" in Clause 1

Deleted "NOTE Process numbers are in accordance with ISO 4063, Welding and allied processes —Nomenclature of processes and reference numbers" from Clause 1.

Added "Gas shielded welding processes include, but are not limited to: manual, semiautomatic, mechanized, and automatic weld methods" in Clause 1.

Added "Safety and health issues and concerns are beyond the scope of this standard and, therefore, are not fully addressed herein. Some safety and health information can be found in annex clause A5. Safety and health information is available from other sources, including, but not limited to: Safety and Health Fact Sheets listed in A8.3, ANSI Z49.1 Safety in Welding, Cutting and Allied Processes,[11] and applicable federal and state regulations" in Clause 1.

Added "This specification makes use of both the International System of Units (SI) and U.S. Customary Units. The measurements are not exact equivalents; therefore, each system must be used independently of the other without combining in any way when referring to material properties. The specification A5.32M uses SI Units. The specification with the designation A5.32 uses U.S. Customary Units. The latter are shown within brackets [ ] or in appropriate columns in tables and figures. Standard dimensions based on either system may be used for packaging or both under A5.32M or A5.32 specifications." in Clause 1.

[11] ANSI Z49.1 is published by the American welding Society, 550 NW LeJeune Rd, Miami, FL 33126.

*Added "**2.1 ASTM Standards***

E 29, Standard Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications

E 260, Standard Practice for Packed Column Gas Chromatography

***2.2 ISO Standards"** in Clause 2*
Added "The shielding gases covered by this specification are classified using a system that is independent of U.S. Customary Units and the International System of Units (SI). Classification is according to chemical composition of the shielding gas as specified in 5.2.1.

Gases classified under one classification shall not be classified under any other classification in this specification. Individual gases shall meet or exceed the requirements of Table 4.

The gases classified under this standard are intended for, but not limited to, use with the gases and gas mixtures used for the fusion welding and allied processes listed in the Scope." in 5.1.1.

Added "AWS 5.32" in 5.1.4 at four places.

Added "AWS 5.32" in 5.2.2 at 12 places; and "The unlisted component shall be designated by its chemical symbol or chemical formula" in Example 5 of 5.2.2.

Added "in addition to AWS A3.0M/A3.0," in Clause 3.

Added Sub-clause 3.10

Sub-clause 4.2: Added "or ASTM E 29"in the end of first sentence.

Clause 5.1.1: Added "The shielding gases and gas mixtures covered by this specification are classified using a system that is independent of U.S. Customary Units and the International System of Units (SI). Classification is according to chemical composition of the shielding gas and gas mixtures as specified in 5.1.2 and 5.1.3.

Gases and gas mixtures classified under one classification shall not be classified under any other classification in this specification. Individual gases shall meet or exceed the requirements of Table 4.

The gases classified under this standard are intended for, but not limited to the fusion welding and allied processes listed in the Scope."

Clause 7: Replaced "The purity and dew point of gas components and gas mixtures shall meet the requirements of Table 4. Moisture can be expressed as concentration in ppm (parts per million) or as dew points at 0.101 MPa in °C. Purities and moisture contents for special gas mixtures are not specified in this International Standard" with the currently shown verbiage.

Clause 8: Added "Samples of gas(es) for chemical analysis shall be drawn from an individual cylinder, vessel, or from the gas outlet source" as first sentence.

Added Example in Clause 10 Marking
Added Clauses 11, 12, & 13
Added Table 5

[3] *Bibliography: Deleted* 'ISO 4063, *Welding and allied processes — Nomenclature of processes and reference numbers*

"Added Informative Annexes A, B and C"

Bibliography

[1] ASTM E 260, *Standard Practice for Packed Column Gas Chromatography.*
[2] JIS Z 3253, *Shielding Gases for Arc Welding and Plasma Arc Cutting.*

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Personnel

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AWS Filler Metal Specifications by Material and Welding Process

	OFW	SMAW	GTAW GMAW PAW	FCAW	SAW	ESW	EGW	Brazing
Carbon Steel	A5.2	A5.1	A5.18	A5.20	A5.17	A5.25	A5.26	A5.8, A5.31
Low-Alloy Steel	A5.2	A5.5	A5.28	A5.29	A5.23	A5.25	A5.26	A5.8, A5.31
Stainless Steel		A5.4	A5.9, A5.22	A5.22	A5.9	A5.9	A5.9	A5.8, A5.31
Cast Iron	A5.15	A5.15	A5.15	A5.15				A5.8, A5.31
Nickel Alloys		A5.11	A5.14	A5.34	A5.14	A5.14		A5.8, A5.31
Aluminum Alloys		A5.3	A5.10					A5.8, A5.31
Copper Alloys		A5.6	A5.7					A5.8, A5.31
Titanium Alloys			A5.16					A5.8, A5.31
Zirconium Alloys			A5.24					A5.8, A5.31
Magnesium Alloys			A5.19					A5.8, A5.31
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Consumable Inserts			A5.30					
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