TECHNICAL SPECIFICATION FOR GASES AND GAS MIXTURES FOR FUSION WELDING AND ALLIED PROCESSES – CYLINDER GASES

SUMMARY OF REVISIONS

First Issue – 21 May 2018 Document No.: PD_WE_NAT_SPEC_013

Second Issue – 26 February 2019 Document No.: PD_WE_NAT_SPEC_013

Third Issue – 28 October 2019 Document No.: PD_WE_NAT_SPEC_013

Forth Issue – 14 October 2020 Document No.: PD_WE_NAT_SPEC_013

The following revisions have been made in this version:

Change	Description
Paragraph 4b: Fuel Gases	Table 2, Gas 029 added.
Annexure A	Description for Gas 029 added.
Clause 7	Point added
Annexure A	Added SANS designation for Gas 001, 003, 004, 006, 007, 022, 026, 029
Paragraph 5	Amended
Paragraph 6	Amended

Document Control

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1. SCOPE

The specification details requirements for shielding gases, fuel gases, and atmospheric gases supplied to Transnet Engineering. These gases are only supplied in a cylinder container of varying capacities.

NOTE: The application of this specification is restricted ONLY to the product contained *inside* the cylinder. In view of this, the technical requirements of the cylinder are not mentioned. This specification must be read in conjunction with the relevant SANS specification guidelines.

2. REFERENCES

ASME IX:2010 – *Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators*

AWS A5.32 – *Specification for Welding Shielding Gases*

EN 10204:2004 – *Metallic products, Types of inspection documents*

BS EN ISO 14175:2008 – *Welding consumables – Gases and gas mixtures for fusion welding and allied processes*

EN ISO 15085:2007 – *Railway applications – Welding of railway vehicles and components*

BS EN ISO 15614-1:2017 – *Specification and qualification of welding procedures for metallic materials — Welding procedure test*

SANS 532:2001 Edition 1 – Standard and specifications for industrial, medical, propellant, food and beverage gases, refrigerants and breathing gases

SANS 1774:2018 Edition 2.1 – Liquefied petroleum gases

3. DEFINITIONS

It is noted that the interpretation of certain terms may bring ambiguity, and as such the following definitions apply. NOTE: This is not an exhausted list, and as such should clarification be sought during the interpretation of this technical specification, this must be requested via the supply chain office.

- **Atmospheric gases** – *gases which comprises the earth's atmosphere. Included in this category is Argon (Ar), Nitrogen (N_2) and Oxygen (O_2).*
- **Batch certificate** – *when a defined quantity of a specific gas is produced under similar conditions, a certificate of analysis for that specific quantity is referred to as a batch certificate. (NB: Compare with sample certificate)*
- **Container** – *refers to a cylinder*
- **Cylinder** – *a pressurized container which can be moved used to contain gas; ranges in size and capacity, can be color coded to distinguish the contents thereof.*
- **FCAW** – *Flux Cored Arc Welding.*
- **Fuel gases** – *refers to gases used during thermal cutting and preheating operations such as Acetylene and LPG.*
- **GMAW** – *Gas Metal Arc Welding.*
- **Other gases** – *Gases which cannot be classified as either atmospheric, bulk gases, fuel gases or shielding gases.*
- **Product** – *refers to any of the gases contained in ANNEXURE A.*
- **Sample certificate** – *refers to an analysis performed on a specific gas product.*
- **Shielding gases** – *Shielding gases are gases used primarily for protecting the molten weld pool from atmospheric contamination. Shielding gases are specified in AWS A5.32 and ISO 14175 specifications.*
- **Transnet Engineering** – *an engineering division of Transnet SOC Ltd, based in South Africa, comprising a group of product focused businesses in manufacture, upgrading conversion, repair and maintenance of railway rolling stock, as well as spares and associated transport equipment.*

4. IDENTIFICATION OF GASES

For the purpose of this specification and to avoid ambiguity, the following steps are used to identify the gases. NOTE: This paragraph must be read in conjunction with ANNEXURE A.

- Step 1: The common name for the gas is given; which in some instances is followed by two parentheses and the words 'high purity' or 'technical/industrial' inside the parentheses. The difference between 'high purity' and 'technical/industrial' is contained in ANNEXURE A.
- Step 2: Type of gas is given which can either be atmospheric gases, fuel gases, shielding gases or other gases.
- Step 3: Purity of gas is indicated as a percentage. NOTE: The gas must meet or exceed the purity level specified.
- Step 4: Chemical formula of the common gas name is given with reference to the Periodic Table of Elements; otherwise this is not specified.
- Step 5: The type of container used to store/contain the gas is specified. The container type is specified as "cylinder"
- Step 6: The capacity of the container type described in step 5 is given in the units of kilograms (kg). It was noted that the capacity of the container may vary depending on the bidder, and as such this section is not specified in this specification. The bidder must indicate the container capacity they are willing to offer to Transnet Engineering.
- Step 7: The physical form in which the gas is delivered is given. The physical form can be liquid or gas.
- Step 8: If the gas is assigned according to ISO 14175, the designation of the gas in accordance with this specification is given; otherwise this is not specified.

a. Atmospheric gases

Atmospheric gases include Argon, Nitrogen, and Oxygen. Table 1 provides details of the atmospheric gases this specification refers to. See ANNEXURE A for details on the item numbers. **NOTE: Atmospheric gases such as Argon and Nitrogen can also be used as shielding gases.**

Table 1 – Atmospheric gases, application and item numbers

Atmospheric gas	Item number	Application
Argon	Gas 004, Gas 006	Argon is an inert gas which can be used in singular or in combination with other gases for welding ferrous and non-ferrous materials.
Nitrogen	Gas 017, Gas 018	Nitrogen is primarily used for root pass shielding and generally not recommended for welding carbon steels.
Oxygen	Gas 022	Oxygen can be used in singular, when combined with Acetylene/LPG during the thermal cutting/preheating process. The use of Oxygen during shielding is restricted to quantities smaller than 5%.

b. Fuel gases

Fuel gases include Acetylene and LP gas. Table 2 provides details of the fuel gases this specification refers to. See ANNEXURE A for details on the item numbers.

Table 2 – Fuel gases, application and item numbers

Fuel gas	Item number	Application
Acetylene	Gas 001	Acetylene gas is used with Oxygen gas primarily for thermal cutting and preheating for welding purposes.
LP gas	Gas 026	Liquefied Petroleum gas (LPG) is used with Oxygen gas primarily for thermal cutting and preheating for welding purposes.
Propane	Gas 029	Propane is used with Oxygen gas primarily for thermal cutting and preheating for welding purposes.

c. Shielding gases

Shielding gases include single mixture, binary mixtures and ternary mixtures. Single mixture refers to gases whose composition consist of one element; binary mixture refers to gases whose composition consist of two elements; and ternary mixture refer to gases whose composition consist of three elements. Table 3 provides details of shielding gases this specification refers to. See ANNEXURE A for details on the item numbers.

Table 3 – Shielding gases, application and item numbers

Shielding gas	Item number	Application
Helium	Gas 007	Helium is an inert gas with similar applications as Argon gas. Helium gas is used primarily for applications requiring relatively high heat inputs such as welding aluminium and magnesium based alloys.
Argon 50, Helium 50	Gas 008	Gas mixture formulated for welding non-ferrous alloys resulting in improved weld bead appearance.
Argon 98, Carbon Dioxide 2	Gas 009	Gas mixture formulated for welding stainless steels with thicknesses great than/equal to 3 mm.
Argon 98, Oxygen 2	Gas 010	Gas mixture formulated for welding stainless steels with thicknesses less than 3 mm.
Argon 96, Carbon Dioxide 3, Oxygen 1	Gas 011	Gas mixture formulated for welding 3Cr12/carbon steel less than 3 mm with the GMAW process
Argon 86, Carbon Dioxide 12, Oxygen 2	Gas 012	Gas mixture formulated for welding carbon steel in spray, globular, short circuit and pulsed transfer mode with the GMAW process.
Argon 93, Carbon Dioxide 5, Oxygen 2	Gas 013	Gas mixture formulated for welding 3Cr12/carbon steel greater than 3 mm with the GMAW process.
Argon 75, Carbon Dioxide 25	Gas 014	Gas mixture formulated for welding carbon steel with the FCAW process.
Argon 90, Carbon Dioxide 5, Oxygen 5	Gas 015	Gas mixture formulated for welding carbon steel greater than 3 mm with the GMAW process.
Argon 85, Carbon Dioxide 13, Oxygen 2	Gas 027	Gas mixture formulated for welding carbon steel in spray, globular, short circuit and pulsed transfer mode with the GMAW process.

d. Other gases

This paragraph is included for those gases which cannot be categorized as atmospheric gases, bulk gases, fuel gases or shielding gases. Table 4 provides details of other gases this specification refers to. See ANNEXURE A for details on the item numbers.

Table 4 – Other gases, application and item numbers

Other gas	Item number	Application
Carbon Dioxide	Gas 003	Carbon dioxide is an active gas which can be used in singular or in combination with other gases for shielding during GMAW and FCAW of carbon steels.
Nitrogen 65, Hydrogen 35	Gas 019	Special gas formulated for laser cutting machine.
Nitrogen 95, Hydrogen 5	Gas 020	Special gas formulated for laser cutting machine.
Argon 65, Hydrogen 35	Gas 023	Special gas formulated for laser cutting machine.
Helium 61, Nitrogen 34, Carbon Dioxide 5	Gas 024	Special gas formulated for laser cutting machine.
Carbon Dioxide	Gas 028	Special gas formulated for laser cutting machine.

5. SPECIFICATION AND TECHNICAL REQUIREMENTS

This section details the criteria with which the gases and gas mixtures specified in section 4 and ANNEXURE A shall conform to. The classification and designation of gases are in accordance with section 5 and Table 2 of ISO 14175. The testing of gases shall comply with section 8 and Table 4 of ISO 14175. In the event that the test results fails to meet the requirements, section 9 of ISO 14175 shall apply. The allowable ranges on gas composition shall meet the requirements of section 8.5.2.1 of BS EN ISO 15614-1:2017 including Table 5 of this specification. For all gases that are not high purity gases, they shall comply with section 5.2 and Table 1 of SANS 532:2001 Edition 1 specification (**Both ISO 14175 and SANS 532 shall be satisfied**). Liquefied petroleum gas shall comply with the section 4.1.1 of SANS 1774:2018 Edition 2.1.

Table 5 – Acceptable composition ranges for gas mixtures in ANNEXURE A

Gas Item No.	Composition (%)	Allowable ranges on gas mixtures composition (%)
Gas 008	Ar = 50	Ar = 45 − 55
	He = 50	He = 45 − 55
Gas 009	Ar = 98	Ar = Balance
	CO_2 = 2	CO_2 = 1.5 − 2.5
Gas 010	Ar = 98	Ar = Balance
	O_2 = 2	O_2 = 1.5 − 2.5

Gas 011	Ar = 96	Ar = Balance
	CO_2 = 3	CO_2 = 2.5 − 3.5
	O_2 = 1	O_2 = 0.9 − 1.1
Gas 012	Ar = 86	Ar = 85.9 − 86.1
	CO_2 = 12	CO_2 = 9.6 − 14.4
	O_2 = 2	O_2 = 1.9 − 2.1
Gas 013	Ar = 93	Ar = Balance
	CO_2 = 5	CO_2 = 4.5 − 6.5
Gas 014	O_2 = 2	O_2 = 1.5 − 2.5
	Ar = 75	Ar = Balance
	CO_2 = 25	CO_2 = 22.5 − 27.5
Gas 015	Ar = 90	Ar = Balance
	CO_2 = 5	CO_2 = 4.5 − 5.5
Gas 019	O_2 = 5	O_2 = 4.5 − 5.5
	N_2 = 65	N_2 = 58.5 − 71.5
Gas 020	H_2 = 35	H_2 = 31.5 − 38.5
	N_2 = 95	N_2 = Balance
Gas 023	H_2 = 5	H_2 = 4.5 − 5.5
	Ar = 65	Ar = Balance
	H_2 = 35	H_2 = 31.5 − 38.5
Gas 024	He = 61	He = 54.9 − 67.1
	N_2 = 34	N_2 = 30.6 − 37.4
	CO_2 = 5	CO_2 = 4.5 − 5.5
Gas 027	Ar = 85	Ar = Balance
	CO_2 = 13	CO_2 = 11.7 − 14.3
	O_2 = 2	O_2 = 1.5 − 2.5

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6. DELIVERY CONDITIONS

The gases and gas mixtures in ANNEXURE A must be delivered in accordance with EN 10204 type 3.1 requirements. The bidder shall provide a certificate of analysis, in the form of a batch certificate or sample certificate, as proof that the gases in ANNEXURE A comply with section 8 and Table 4 of ISO 14175 This section details the criteria with which the gases and gas mixtures specified in section 4 and ANNEXURE A shall conform to. The classification and designation of gases are in accordance with section 5 and Table 2 of ISO 14175. The testing of gases shall comply with section 8 and Table 4 of ISO 14175. In the event that the test results fails to meet the requirements, section 9 of ISO 14175 shall apply. The allowable ranges on gas composition shall meet the requirements of section 8.5.2.1 of BS EN ISO 15614-1:2017 including Table 5 of this specification. For all gases that are not high purity gases, they shall comply with section 5.2 and Table 1 of SANS 532:2001 Edition 1 specification (**Both ISO 14175 and SANS 532 shall be satisfied**). Liquefied petroleum gas shall comply with the section 4.1.1 of SANS 1774:2018 Edition 2.1.

Table 5 of this specification. For all gases that are not high purity gases, they shall comply with section 5.2 and Table 1 of *SANS 532:2001 Edition 1* specification. Liquefied petroleum gas shall comply with the section 4.1.1 of *SANS 1774:2018 Edition 2.1.* MSDS for gases shall be duly provided. The bidder shall ensure that the gases comply with Occupational Health and Safety Act No 85 of 1993. The marking on the outside of the container shall meet the requirements of section 10 of ISO 14175.

7. ACKNOWLEDGEMENT AND ACCEPTANCE OF SPECIFICATION

- Respondents are to indicate whether they comply to each of the listed gases in Annexure A (Page 13 – Page 36).

| YES | | | NO | |

- It is hereby acknowledged that the bidder has read and understood all the contents of this specification. Furthermore, the bidder certifies and guarantees acceptance and compliance with this specification.

SIGNED THIS DAY _____ AT_____

BY_____ (Full name in block letters)

IN MY CAPACITY AS _____ (Official designation)

FOR THE COMPANY _____

SIGNED _____

ANNEXURE A

Group	Item number to be used on tender	Long description	Container
Acetylene	GAS_001	Gas - Acetylene(Technical/Industrial) Type – Fuel gas Purity - ≥ 98.0% Chemical formula - C_2H_2 Container type – Cylinder Container capacity (kg) - Not specified Physical form – Gas ISO 14175 designation – Unassigned SANS 532:2001 Edition 1 (section 5.2 , Table 1)	Cylinder

Carbon Dioxide	GAS_003	Gas - Carbon Dioxide (Technical/Industrial) Type - Other gases Purity - ≥ 99.0 % Chemical formula - CO_2 Container type – Cylinder Container capacity (kg) - Not specified Physical form – Gas ISO 14175 designation - ISO 14175-C1 SANS 532:2001 Edition 1 (section 5.2 , Table 1)	Cylinder

Argon	GAS_004	Gas - Argon (High Purity) Type - Atmospheric gas Purity - ≥ 99.998 % Chemical formula – Ar Container type – Cylinder Container capacity (kg) - Not specified Physical form - Gas ISO 14175 designation - ISO 14175-I1	Cylinder

Argon	GAS_006	Gas - Argon (Technical/Industrial)	Cylinder
		Type - Atmospheric gas	
		Purity - ≥ 99.9 %	
		Chemical formula – Ar	
		Container type – Cylinder	
		Container capacity (kg) - Not specified	
		Physical form – Gas	
		ISO 14175 designation - ISO 14175-I1	
		SANS 532:2001 Edition 1 (section 5.2 , Table 1)	

| Helium | GAS_007 | Gas - Helium (Technical/Industrial) Type - Shielding gas Purity - Not specified Chemical formula – He Container type – Cylinder Container capacity (kg) - Not specified Physical form – Gas ISO 14175 designation - ISO 14175-I2 SANS 532:2001 Edition 1 (section 5.2 , Table 1) | Cylinder |

Argon 50, Helium 50	GAS_008	Gas - Argon, Helium mixture Type - Shielding gas Purity - Not specified Chemical formula (Composition) - Ar (50%), He (50%) Container type – Cylinder Container capacity (kg) - Not specified Physical form – Gas ISO 14175 designation - ISO 14175-I3	Cylinder

Argon 98, Carbon Dioxide 2	GAS_009	Gas - Argon, Carbon Dioxide mixture Type - Shielding gas Purity - Not specified Chemical formula (Composition) - Ar (98%), CO_2 (2%) Container type – Cylinder Container capacity (kg) - Not specified Physical form - Gas ISO 14175 designation - ISO 14175-M12-ArC-2	Cylinder

Argon 98, Oxygen 2	GAS_010	Gas - Argon, Oxygen mixture	Cylinder
		Type - Shielding gas	
		Purity - Not specified	
		Chemical formula (Composition) - Ar (98%), O_2 (2%)	
		Container type – Cylinder	
		Container capacity (kg) - Not specified	
		Physical form – Gas	
		ISO 14175 designation - ISO 14175-M13-ArO-2	

Argon 96, Carbon Dioxide 3, Oxygen 1	GAS_011	Gas - Argon, Carbon Dioxide, Oxygen mixture Type - Shielding gas Purity - Not specified Chemical formula (Composition) - Ar (96%), CO_2 (3%), O_2 (1%) Container type - Bulk Tank Container capacity (kg) - Not specified Physical form – Gas ISO 14175 designation - ISO 14175-M14-ArCO-3/1	Cylinder

Argon 86, Carbon Dioxide 12, Oxygen 2	GAS_012	Gas - Argon, Carbon Dioxide, Oxygen mixture Type - Shielding gas Purity - Not specified Chemical formula (Composition) - Ar (86%), CO_2 (12%), O_2 (2%) Container type – Cylinder Container capacity (kg) - Not specified Physical form – Gas ISO 14175 designation - ISO 14175-M24-ArCO-12/2	Cylinder

Argon 93, Carbon Dioxide 5, Oxygen 2	GAS_013	Gas - Argon, Carbon Dioxide, Oxygen mixture	Cylinder
		Type - Shielding gas	
		Purity - Not specified	
		Chemical formula (Composition) - Ar (93%), CO_2 (5%), O_2 (2%)	
		Container type – Cylinder	
		Container capacity (kg) - Not specified	
		Physical form - Gas	
		ISO 14175 designation - ISO 14175-M14-ArCO-5/2	

Argon 75, Carbon Dioxide 25	GAS_014	Gas - Argon, Carbon Dioxide mixture Type - Shielding gas Purity - Not specified Chemical formula (Composition) - Ar (75%), CO_2 (25%) Container type – Cylinder Container capacity (kg) - Not specified Physical form – Gas ISO 14175 designation - ISO 14175-M21-ArC-25	Cylinder

Argon 90, Carbon Dioxide 5, Oxygen 5	GAS_015	Gas - Argon, Carbon Dioxide, Oxygen mixture Type - Shielding gas Purity - Not specified Chemical formula (Composition) - Ar (90%), CO_2 (5%), O_2 (5%) Container type – Cylinder Container capacity (kg) - Not specified Physical form – Gas ISO 14175 designation - ISO 14175-M23-ArCO-5/5	Cylinder

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Nitrogen	GAS_017	Gas - Nitrogen (High Purity) Type - Atmospheric Gases Purity - ≥ 99.997 % Chemical formula - N_2 Container type – Cylinder Container capacity (kg) - Not specified Physical form - Gas ISO 14175 designation - ISO 14175-N1	Cylinder

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| Nitrogen | GAS_018 | Gas - Nitrogen (Technical/Industrial)

Type - Atmospheric Gases

Purity - ≥ 99.5 %

Chemical formula - N_2

Container type – Cylinder

Container capacity (kg) - Not specified

Physical form – Gas

ISO 14175 designation - ISO 14175-N1

SANS 532:2001 Edition 1 (section 5.2 , Table 1) | Cylinder |

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Nitrogen 65, Hydrogen 35	GAS_019	Gas - Nitrogen, Hydrogen mixture	Cylinder
		Type - Special gas formulated for laser cutting machine	
		Purity - Not specified	
		Chemical formula (Composition) - N_2 (65%), H_2 (35%)	
		Container type – Cylinder	
		Container capacity (kg) - Not specified	
		Physical form – Gas	
		ISO 14175 designation - ISO 14175-N5-NH-35	

Nitrogen 95, Hydrogen 5	GAS_020	Gas - Nitrogen, Hydrogen mixture Type - Special gas formulated for laser cutting machine Purity - Not specified Chemical formula (Composition) - N_2 (95%), H_2 (5%) Container type – Cylinder Container capacity (kg) - Not specified Physical form – Gas ISO 14175 designation - ISO 14175-N5-NH-5	Cylinder

Oxygen	GAS_022	Gas - Oxygen (Technical/Industrial) Type - Atmospheric Gases Purity - ≥ 99.5 % Chemical formula - O_2 Container type – Cylinder Container capacity (kg) - Not specified Physical form – Gas ISO 14175 designation - ISO 14175-O1 SANS 532:2001 Edition 1 (section 5.2 , Table 1)	Cylinder

Argon 65, Hydrogen 35	GAS_023	Gas - Argon, Hydrogen mixture Type - Special gas formulated for laser cutting machine Purity - Not specified Chemical formula (Composition) - Ar (65%), H_2 (35%) Container type – Cylinder Container capacity (kg) - Not specified Physical form – Gas ISO 14175 designation - ISO 14175-R2-ArH-35	Cylinder

Helium 61, Nitrogen 34, Carbon Dioxide 5	GAS_024	Gas - Helium, Nitrogen, Carbon Dioxide mixture Type - Special gas formulated for laser cutting machine Purity - Not specified Chemical formula (Composition) - He (61%), N_2 (34%), CO_2 (5%) Container type – Cylinder Container capacity (kg) - Not specified Physical form - Gas ISO 14175 designation - ISO 14175-Z	Cylinder

LP Gas	GAS_026	Gas - Liquefied Petroleum Gas Type - Liquefied Gas Purity - Not specified Chemical formula (Composition) - C_3H_8 (60%), C_4H_{10} (40%) Container type – Cylinder Container capacity (kg) - Not specified Physical form - Liquid ISO 14175 designation - Not specified. Shall meet ISO 9162 requirements. SANS 1774:2018 Edition 2.1 (section 4.1.1)	Cylinder

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Argon 85, Carbon Dioxide 13, Oxygen 2	GAS_027	Gas - Argon, Carbon Dioxide, Oxygen mixture Type - Shielding gas Purity - Not specified Chemical formula (Composition) - Ar (85%), CO_2 (13%), O_2 (2%) Container type – Cylinder Container capacity (kg) - Not specified Physical form – Gas ISO 14175 designation - ISO 14175-M24-ArCO-13/2	Cylinder

Carbon Dioxide	GAS_028	Gas - Carbon Dioxide (High Purity) Type - Special gas formulated for laser cutting machine Purity - ≥ 99.995 % Chemical formula - CO_2 Container type – Cylinder Container capacity (kg) - Not specified Physical form – Gas ISO 14175 designation - ISO 14175-C1	Cylinder

| Propane | GAS_029 | Gas - Propane

Type - Liquefied Gas

Purity - Not specified

Chemical formula (Composition) - C_3H_8

Container type – Cylinder

Container capacity (kg) - Not specified

Physical form - Liquid

ISO 14175 designation - Not specified. Shall meet ISO 9612 requirements.

SANS 1774:2018 Edition 2.1 (section 4.1.2) | Cylinder |

DOCUMENT AUTHORITIES

COMPILED BY   **Tys Thai (IWE)**

SIGNATURE   **14 October 2020**

DATE

REVIEWED/APPROVED BY   **Orifuna Netshifamadi (Pr.Eng, IWE)**

SIGNATURE

DATE   **14 October 2020**

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