

# SEMI C3.5-93 (Withdrawn 0303) STANDARD FOR NITROGEN (N<sub>2</sub>), BULK LIQUID, 99.998% QUALITY

This Standard was technically approved by the Gases Global Technical Committee. This edition was approved for publication by the global Audits and Reviews Subcommittee on April 15, 1999. Available at [www.semi.org](http://www.semi.org) in September 1999; originally published in 1981; previously published in 1993.

**NOTICE:** This Document was balloted and approved for withdrawal in 2003; it has been replaced by SEMI C59.

## 1 Description

1.1 Nitrogen is an odorless, tasteless, diatomic gas comprising approximately 78% of the earth's atmosphere; colorless liquid. Noncombustible; a cryogenic gas derived from liquid air by fractional distillation.

## 2 Specifications

QUALITY: 99.998%

| <i>Impurities</i>                             | <i>Maximum Acceptable Level (ppm)<sup>#1</sup></i> |
|-----------------------------------------------|----------------------------------------------------|
| Carbon dioxide (CO <sub>2</sub> )             | 1                                                  |
| Carbon monoxide (CO)                          | 5                                                  |
| Hydrogen (H <sub>2</sub> )                    | 2                                                  |
| Oxygen (O <sub>2</sub> )                      | 3                                                  |
| Particles                                     | #2                                                 |
| Total Hydrocarbons expressed as Methane (THC) | 1                                                  |
| Water (H <sub>2</sub> O) (v/v)                | 1                                                  |
| TOTAL SPECIFIED IMPURITIES                    | 13                                                 |

#1 An analysis of significant figures has not been considered. The number of significant figures will be based on analytical accuracy and the precision of the provided procedure.

#2 To be determined between supplier and user.

## 3 Physical Constants (for information only)

|                                                       | <i>Metric Units</i>      | <i>US Units</i>            |
|-------------------------------------------------------|--------------------------|----------------------------|
| Molecular weight                                      | 28.013                   | 28.013                     |
| Boiling point at 1 atm                                | -195.8°C                 | -320.4°F                   |
| Density of gas at 21.1°C (70°F) and 1 atm             | 1.1605 kg/m <sup>3</sup> | 0.07245 lb/ft <sup>3</sup> |
| Specific gravity of gas at 21.1°C and 1 atm (air = 1) | 0.967                    | 0.967                      |
| Density of liquid at boiling point                    | 808.8 kg/m <sup>3</sup>  | 50.49 lb/ft <sup>3</sup>   |

## 4 Analytical Procedures (See Notes 1, 2)

4.1 *Carbon Monoxide and Carbon Dioxide* — This procedure is for the determination of carbon monoxide and carbon dioxide in nitrogen using a gas chromatograph with a flame ionization detector and methanizer. (See Note 3.)

4.1.1 *Detection Limit* — 100 ppb (mole/mole).

#### 4.1.2 Instrument Parameters

##### 4.1.2.1 Column

- Porapak T or Q, 3 m (9.8 ft.) by 3.2 mm (1/8 in.) OD by 2.2 mm (0.085 in.) ID ss; or
- Chromosorb 102, 2 m (6.6 ft.) by 3.2 mm (1/8 in.) OD by 2.2 mm (0.085 in.) ID ss; or equivalent.

##### 4.1.2.2 Carrier Flow — 30 mL/min helium.

##### 4.1.2.3 Sample Volume — 0.5 mL to 2.0 mL.

##### 4.1.2.4 Temperatures

- Detector — 280°C.
- Column Oven — 60°C.
- Methanizer — 350°C.

#### 4.1.3 Calibration Standards — 1 ppm to 5 ppm (mole/mole) carbon monoxide, 1 ppm to 5 ppm (mole/mole) carbon dioxide, balance nitrogen.

##### 4.1.4 Operating Procedure

4.1.4.1 Inject the calibration standard into the column using a gas sampling valve. Record the retention times and peak areas. Order of elution is carbon monoxide, carbon dioxide.

4.1.4.2 Inject the sample to be tested in same manner as the calibration standard. Record the retention times and peak areas.

4.1.4.3 Repeat ¶ 4.1.4.1.

4.1.4.4 Compare the average peak area of the calibration standard to that of the nitrogen sample being tested. Calculate the concentrations of carbon monoxide and carbon dioxide, using the formula below. The results may not exceed the specifications in § 2 of this Standard.

$$\frac{\text{Sample Peak Area}}{\text{Standard Peak Area}} \times \frac{\text{Concentration of Standard}}{\text{Concentration of Sample}} = \text{Concentration of Sample} \quad (1)$$

4.2 Hydrogen — This procedure is for the determination of hydrogen in nitrogen using a gas chromatograph with a helium ionization detector.

##### 4.2.1 Detection Limit — 500 ppb (mole/mole).

##### 4.2.2 Instrument Parameters

##### 4.2.2.1 Column — 5A molecular sieve, 1.9 m (6 ft.) by 3.2 mm (1/8 in.) OD by 2.2 mm (0.085 in.) ss or equivalent.

##### 4.2.2.2 Carrier Flow — 30 mL/min helium.

##### 4.2.2.3 Sample Volume — 3.0 mL.

##### 4.2.2.4 Temperatures

- Detector — 125°C.
- Column Temperature — 65°C.

#### 4.2.3 Calibration Standard — 1 ppm to 5 ppm (mole/mole) hydrogen in nitrogen.

##### 4.2.4 Operating Procedure

4.2.4.1 Inject the calibration standard into the column using a gas sampling valve. Record the retention time and peak area.

4.2.4.2 Inject the sample to be tested in same manner as the calibration standard. Record the retention time and peak area.