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<p align="center"><b>DLI-QD-210 Measurement of nitrogen oxides (NO, NO<sub>2</sub>) in the DLI Air Quality Monitoring Network</b></p>			<p>Page #:  <b>1 of 6</b></p>

Prepared by:\_\_\_\_\_ Date:\_\_\_\_\_


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Approved by:\_\_\_\_\_ Date:\_\_\_\_\_

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## Purpose

To describe the performance of measurements of nitrogen oxides in the national air quality monitoring network of Cyprus.

Such measurements are performed e.g. for checking compliance with European Union limit values for nitrogen dioxide:

- 200 µg.m<sup>-3</sup> (104.55ppb) with a reference period of 1 hour
- 40 µg.m<sup>-3</sup> (20.91ppb) with a reference period of 1 year for the protection of human health
- 30 µg.m<sup>-3</sup> (15.68ppb) with a reference period of 1 year for the protection of vegetation.

The procedures described are in conformity with the relevant clauses of EN 14211.

## Principle


Nitrogen oxides (NO<sub>x</sub>) are measured continuously by chemiluminescence, after reaction of nitrogen monoxide with ozone. Nitrogen monoxide (NO) is measured directly; nitrogen dioxide (NO<sub>2</sub>) is first converted to nitrogen monoxide, after which the sum of the concentrations of both oxides is measured. By assuring that the conversion efficiency is above 98%, the concentration of nitrogen dioxide can then be calculated by subtraction of the independently measured concentration of nitrogen monoxide.

The concentrations of nitrogen monoxide and nitrogen dioxide are measured in units of ppb<sub>v</sub>. For reporting these are converted to units of µg.m<sup>-3</sup> at standard temperature and pressure (20 °C, 101,325 kPa) using standard conversion factors.

The measurement ranges are 0-1200 µg.m<sup>-3</sup> for nitrogen monoxide and 0-500 µg.m<sup>-3</sup> for nitrogen dioxide.

Measurement results are fully traceable to internationally accepted standards. The expanded measurement uncertainties for nitrogen dioxide, referred to the reference periods of the EU air quality limit values, have been calculated in conformity with EN 14211 to be:

- 15 % for a one-hour period
- 15 % for a one-year period, both at the 95% confidence level.

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### Staff involved

This SOP is intended for the staff of DLI and of the contracted maintenance company who perform (part of) the activities described.

### Equipment

- Nitrogen oxides monitor (Ecotech EC9841B)
- Sample manifold (Central sampling line)
- Sampling pump (Thomas)
- Dynamic dilution system (Sabio 4010)
- Zero Air Source (Sabio 1001)
- Calibration gas mixture, NO in nitrogen, certified every 6 months against primary reference gas standard (Certification body) (see DLI-SOP-104)
- Primary reference gas standard (PRM), NO in nitrogen (Certification body)
- Calibrated flow meters, ranges 5-500 mL/min and 0.5-50 L/min (BIOS)
- Station data logger (Ecotech).

### Housing

For field monitoring, monitors, dilution systems and reference gases are housed in special caravans, equipped with air conditioning units. For a description of the caravans see DLI-QD-101.

The reference monitor and dilutor in the Central Calibration Laboratory are kept in Reference Laboratory.

### Acceptance and installation of equipment


The monitors purchased fulfill the minimum requirements given in EN 14211. After receipt, they undergo a brief performance test (see DLI-QD-102). The acceptance test includes a full calibration and linearity test.

After acceptance, the monitors are installed in the monitoring caravan in accordance with the manufacturer's instructions and put into operation (see DLI-QD-102).

### Procedure

#### *General*

The NO<sub>x</sub> monitor produces 1-minute-average measurement results for NO<sub>x</sub>, NO and NO<sub>2</sub>. These results are acquired by the station data processor and digitally transmitted to the central acquisition system located in the DLI, Air Quality Section building. In addition, monitor status parameters listed below are acquired and transmitted.

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Default ranges are indicated.

List of status parameters
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After each full hour of measuring, all non-flagged 60-seconds results are averaged to hourly values and transmitted to the DLI internet website.

#### **Data validation**

Centrally acquired data are checked for anomalies using DLI-SOP-016. Validated data are transmitted to a database on a daily basis for further reporting if necessary (see DLI-SOP-017).

#### **Calibration of analysers**

Analysers are fully calibrated and tested for linearity

- Upon receipt (new)
- Every 3 months
- After corrective maintenance.

The calibrations upon receipt and after corrective maintenance are performed in the DLI National Reference Laboratory (DLI-SOP-211); the 3-monthly calibration is performed at the station.

For this purpose, calibration gas mixtures are produced from certified concentrated calibration gas mixture at various levels (see DLI-F-QD-210.1), using the dynamic dilutor (see Work Instruction for the operation of the Sabio dilutor, DLI-SOP-104). A calibration function and residuals are calculated in accordance with Annex B of EN 14211. The calibration function is used to calculate the NO response factor to be used for further calculations.

In addition, a converter efficiency test is performed at concentration levels of 400, 300, 200 and 100 ppb NO<sub>2</sub>.


The full procedure for the performance of the linearity and converter efficiency tests is given in DLI-SOP-211.

#### **Calculation of results**

Monitor results are expressed in units of ppb<sub>v</sub>. For reporting, these are converted into units of µg.m<sup>-3</sup> at standard temperature and pressure (20 °C, 101,325 kPa) as follows:

$$\text{NO } (\mu\text{g.m}^{-3}, \text{STP}) = \text{NO (ppb}_v) \cdot 1,25$$

$$\text{NO}_2 (\mu\text{g.m}^{-3}, \text{STP}) = \text{NO}_2 (\text{ppb}_v) \cdot 1,913$$

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$$\text{NO}_x (\mu\text{g}.\text{m}^{-3}, \text{STP}) = \text{NO} (\mu\text{g}.\text{m}^{-3}, \text{STP}) + \text{NO}_2 (\mu\text{g}.\text{m}^{-3}, \text{STP})$$

## Reporting

Reporting is described in DLI-SOP-017 <Data Reporting>.

## Quality control

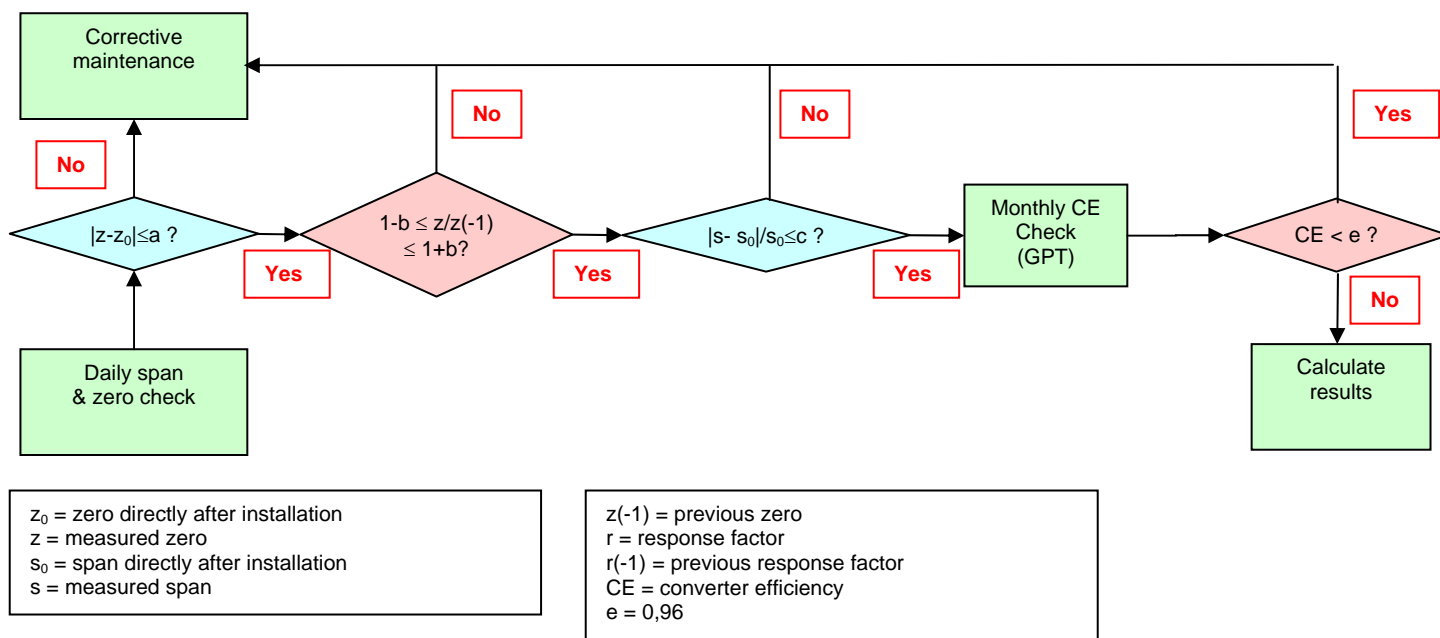
### Zero and span checks

Zero and span checks are performed automatically every 24 hours by the dynamic dilution system. In addition, a converter-efficiency check is performed every three month using the GPT unit of the dilutor.

The decision scheme associated with the results of the checks is given below.


Values for a, b and c are:

- a = 5 ppb<sub>v</sub>
- b = 0,025
- c = 0,05



### Linearity check

Calibrations and linearity tests are performed by comparison with the certified transfer standard (see DLI-SOP-211).

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## Maintenance

### *Preventive maintenance*

Information about the maintenance schedule and the performance of the maintenance can be found in DLI-QD-103, DLI-SOP-101, DLI-SOP-102 and DLI-SOP-213.

### *Corrective maintenance*

See DLI-SOP-214.

## Relevant documentation

DLI-QD-101; DLI-QD-102; DLI-SOP-101; DLI-SOP-102; DLI-SOP-104; DLI-SOP-016; DLI-SOP-017; DLI-SOP-211, DLI-SOP-213 & 214.

## Reference Procedures

Ecotech EC9841B manual  
Sabio 4010 manual

## References

CYS-EN 14211: 2005. Ambient Air Quality-Standard method for the measurement of the concentration of nitrogen dioxide and nitrogen monoxide by chemiluminescence

## Revision History

Revision 0