	<p align="center">Quality Document DLI Air Quality Section Department of Labour Inspection</p>	<p>Issue Date: 15/10/2010</p>	<p>Rev.: 0</p>
<p align="center">DLI-QD-230 – Measurement of carbon monoxide (CO) in the DLI Air Quality Monitoring Network</p>			<p>Page #: 1 of 6</p>

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Purpose

To describe the performance of measurements of carbon monoxide concentration in the national air quality monitoring network of Cyprus.

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

- 10 mg.m⁻³ with a reference period of 8 hour for the protection of human health

The procedures described are in conformity with the relevant clauses of EN 14626.

Principle

Carbon monoxide (CO) concentration is measured with use of non-dispersive infrared method. The attenuation of infrared light passing through a sample cell is a measure of the concentration of carbon monoxide in the cell, according to the Lambert-Beer law.

The concentration of carbon monoxide is measured in units of ppm_v. For reporting these are converted to units of mg.m⁻³ at standard temperature and pressure (20 °C, 101,325 kPa) using standard conversion factors.


The measurement ranges are 0-100 mg.m⁻³ for carbon monoxide.

Measurement results are fully traceable to internationally accepted standards. The expanded measurement uncertainties for carbon monoxide, referred to the reference periods of the EU air quality limit values, have been calculated in conformity with EN 14626 to be:

- 15 % at the 95% confidence level.

Staff involved

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

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Equipment

- Carbon monoxide monitor (Ecotech EC9830B)
- Sample manifold (Central sampling line)
- Sampling pump (Thomas)
- Dynamic dilution system (Sabio 4010)
- Zero Air Source (Sabio 1001)
- Calibration gas mixture, CO in nitrogen, certified every 6 months against primary reference gas standard (Certification Body) (see DLI-SOP-102)
- Primary reference gas standard (PRM), CO in nitrogen
- Calibrated flow meters, ranges 5-500 mL/min and 0.5-50 L/min (BIOS)
- Station data processor (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 analysers, the reference dilutor and the primary gas standard cylinders are kept in the Central Calibration Laboratory.

Acceptance and installation of equipment

The monitors purchased fulfill the minimum requirements given in EN 14626. 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 CO monitor produces 1-minute average measurement results for CO. These results are acquired by the station data processor and digitally transmitted to the central acquisition system located in the Air Quality Section building.

In addition, monitor status parameters listed below are acquired and transmitted. Default ranges are indicated.

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List of status parameters

After each full hour of measuring, all non-flagged 1-minute 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 monitors

Monitors 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 Central Laboratory (DLI-SOP-232); the 6-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 A and F of EN 14626. The calibration function is used to calculate the CO response factor to be used for further calculations.


Calculation of results

Monitor results are expressed in units of ppm_v. For reporting, these are converted into units of mg.m⁻³ at standard temperature and pressure (20 °C, 101,325 kPa) as follows:

$$\text{CO (mg.m}^{-3}\text{, STP)} = \text{CO (ppm}_v\text{)} \cdot 1.16$$

Reporting

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

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Quality control

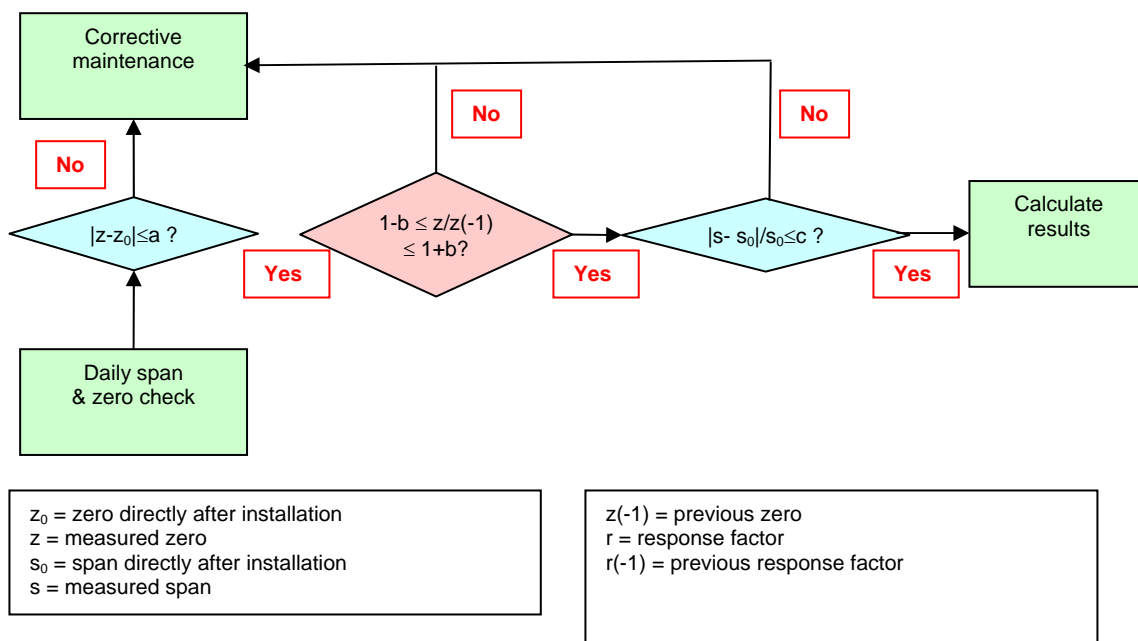
Zero and span checks

Zero and span checks are performed automatically at least every two weeks (recommended every 23 or 25 hours) by the dynamic dilution system.

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

Values for a, b and c are:

- $a = 5 \text{ ppb}_v$
- $b = 0,025$
- $c = 0,05$




Linearity check

Calibrations and linearity tests are performed by comparison with the certified transfer standard (see DLI-SOP-232).

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-104 and DLI-SOP-233.

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Corrective maintenance

See DLI-SOP-234.

Relevant documentation

DLI-QD-102; DLI-QD-103; DLI-SOP-101; DLI-SOP-102; DLI-SOP-104; DLI-SOP-016; DLI-SOP-017 & DLI-SOP-231 - 234.

Reference Procedures

Ecotech EC9830B manual
Sabio 4010 manual

References

CYS-EN 14626: 2005. Ambient Air Quality – Standard method for the measurement of the concentration of carbon monoxide by nondispersive infrared spectroscopy.

Revision History

Revision 0