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DLI-SOP-232 Calibration and linearity testing of CO analysers			Page #: 1 of 6

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Purpose

To describe the procedure to be followed for performing calibrations, linearity tests and converter efficiency tests of the ML/EC 9830 CO analysers.

Principle

This SOP applies to ML/EC 9830 CO analysers. The procedures described are in conformity with EN 14626.

Staff involved

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

Equipment

- Carbon monoxide monitor (Ecotech ML/EC 9830)
- Sabio 4010 Dynamic Calibrator
- Zero Air Source (Sabio 1001).
- Certified gas standard of CO in nitrogen
- Station data processor (Ecotech)

Documentation and forms

For calibration and linearity testing the form *DLI-F-2 CO Analyser Calibration Report* is required.

The completed form is stored in electronic form in the file *DLI-F-2 CO Analyser Calibration Report-sn-yyyy-mm-dd.xls*, where *sn* denotes the analyser serial number, *yyyy* the year, *mm* the month and *dd* the date of the calibration.

Paper copies of the forms are stored in the history log book of the analyser.


Procedure

General

Perform the scheduled activities as required by the maintenance schedule (DLI-QD-102).

Registration of general information and status parameters

Registration of general information:

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- Enter name of customer, analyser model, analyser serial number and job number in **Customer**, **Instrument**, **ID No.** and **System/Job No.** fields respectively.
- Enter name of operator, date of test, start time and where the test was performed in **Calibration Performed by**, **Date**, **Time Begin** (left field) and **Location** fields respectively.

Registration of reference information (section Calibration Equipment, where applicable):

- Enter calibrator model, calibrator serial number, zero air generator model and zero air generator serial number in **Calibrator Model**, **ID/Serial No.**, **Zero Air Source Model** and **ID/Serial No.** fields respectively.
- Enter gas cylinder serial number and cylinder concentration in **Gas Std. Cylinder Serial No.** and **Cylinder concentration** fields.
- Observe the cylinder expiry date on the cylinder certificate and enter it into the **Cylinder Expiry Date** field.
- Observe the cylinder pressure (right gauge) and enter the reading including its unit in the **Cylinder Pressure** field. Remember to read on the Bar scale.

Registration of analyser status parameters (section Displayed Instrument Parameters):

- On the analyser keyboard hit <Exit> to return to the primary screen.
- Push the Select button to enter the main menu. Use the Up and Down arrows on the keyboard to navigate in the main menu. Push <Return> to select a menu item.
- Choose **INSTRUMENT STATUS**.
- From the **INSTRUMENT STATUS** menu read the status parameters and enter them into their respective fields in the **Displayed Instrument Parameters** section of the form.
- Hit <Exit> to return to the primary screen.
- Hit Select to enter the main menu, choose **SYSTEM TEMPERATURES**.
- From the **SYSTEM TEMPERATURES** menu read the status parameters and enter them into their respective fields in the **Displayed Instrument Parameters** section of the form.
- Hit <Exit> to return to the primary screen.
- Hit Select to enter the main menu, choose **TEST MENU**.
- In the **TEST MENU** choose **OUTPUT TEST** menu.
- In the **OUTPUT TEST** menu choose **PREPROCESSOR POTS**.
- From the **PREPROCESSOR POTS** menu read the status parameters and enter them into their respective fields in the **Displayed Instrument Parameters** section of the form.
- Hit <Exit> to return to the primary screen.
- From the primary screen record the measurement units in the **Instrument units** field.
- Compare the recorded values with the acceptance limits. If any values are outside the limits the cause must be investigated.

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Single point calibration

Pre-calibration check:

- Make sure that the analyser reports measurement values in ppm (not mg/m³).
- Hit <Exit> to return to the primary screen.
- From the primary screen read the **INSTRUMENT GAIN** and record it in the **Initial Span Instrument Gain** field in the **Single Point Calibration** section of the form.
- Enter the expected measurement range at the particular site in the **Full Scale** field.
- Let the calibrator generate zero air only at approx. 5 LPM.
- Let the analyser measure zero air for at least 20 minutes and until the reading is stable. The first 10min will be used for the stabilization of the analyzer. For the next 10min we will take 5 measurements (one every two minutes). The average of the five values will be recorded.
- Enter the zero air flow rate in the **Precalibration Check – Zero** field of the **Zero flow** column.
- Enter the concentration as measured by the analyser in the **Measured CO** field. Remember to include the unit.
- If the reported Error in the column is larger than ± 50 ppb the analyzer CO offset should be adjusted.
- Let the calibrator generate a concentration of 8 ppm CO (80% of the measurement range).
- Let the analyser measure span gas air for at least 20 minutes. The first 10min will be used for the stabilization of the analyzer. For the next 10min we will take 5 measurements (one every two minutes). The average of the five values will be recorded.
- Enter the zero flow rate in the **80% FS** field of the **Zero flow** column.
- Enter the span gas flow rate in the **80% FS** field of the **Span flow** column.
- The concentration is calculated by the spreadsheet and shown in column **Calculated**.
- Enter the concentration as measured by the analyser in the **Measured CO** field. Remember to include the unit. to the **Expected** field.
- If the error reported in the **Error** column is larger than 2%, then the measured value of the analyser should be adjusted accordingly.
- From the instrument screen read the instrument new gain and record it as a final span instrument gain in the **Single Point Calibration** section of the form.
- If both Pre-Calibrations (Zero and Span – 80% FS) are within the limits then skip the post-calibration and proceed with the Multipoint Calibration.

Post-calibration check:

- While continuing to measure the span gas hit <Down arrow> in the primary screen to initiate a calibration of the analyser.
- The display prompts **START MANUAL CALIBRATION? SPAN**. Press <Enter>.

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- Enter the span calibration gas concentration value by using the **<Select>** key to move the position of the backlit cursor, and the **<Up arrow>** and **<Down arrow>** keys to increment and decrement the value of the backlit digit. When the desired concentration is displayed, press **<Enter>**.
- Move the backlit cursor to the **INSTRUMENT GAIN** field. Press **<Enter>** to confirm the new value and **<Exit>** to return to the primary screen.
- Enter the zero flow rate in the **Postcalibration Check - 80% FS** field of the **Zero flow** column.
- Enter the span gas flow rate in the **80% FS** field of the **Span flow** column.
- Enter the concentration as measured by the analyser in the **Measured CO** field. Remember to include the unit.
- Copy the calculated concentration into the **Expected** field.
- If the error reported in the **Error** column still is larger than 2% the problem must be investigated.
- If a linearity check will be performed leave the calibrator on and continue with the next section. If not enter **N** in the **Multipoint Linearity Check – Relevant?** field and skip the next section.

Linearity test

- Enter **Y** in the **Multipoint Linearity Check – Relevant?** field.
- Generate concentrations at 80%, 40%, 0%, 60%, 20% and 95% of the measurement range at the site.
- After each change in concentration at least 4 response time shall be taken into account before the next measurement is performed.
- Enter gas flows, expected concentrations and readings in the **Zero flow**, **Span flow**, **Expected** and **Measured** fields respectively.
- Turn of the generation of calibration gas and switch the analyser back to measuring ambient air.
- The regression line is drawn automatically and some statistics calculated.
- The linearity test fails if the largest relative residual is >5% of its measured value.
- Compare the recorded values with the acceptance limits. If any values are outside the limits the cause must be investigated.

Finalizing the visit and completing the form

- Enter the end time of the calibration in the **Time Begin/End** field (right field) in the form.
- Sign the form in the **Technicians Signature** and **Date** fields.
- Before leaving the station record the visit in the station visit log.
- After returning to the lab store the form in the instrument history log book.

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Relevant documentation

Maintenance schedule
Form *DLI-F-2 CO Analyser Calibration Report*

Reference Procedures

Carbon monoxide monitor (Ecotech ML/EC 9830) manual
Sabio 4010 Dynamic Calibrator manual.

Revision History

Revision 0