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DLI-SOP-211 Calibration, linearity testing and converter efficiency testing of NOx analysers			Page #: 1 of 8

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Purpose

To describe the procedure to be followed for performing calibrations, linearity tests and converter efficiency tests of the EC9841B NO_x analysers.

Principle

This SOP applies to EC9841B NO_x analysers. The procedures described are in conformity with EN 14211.

Staff involved

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

Equipment

- Nitrogen oxides monitor (Ecotech EC9841B)
- Sabio 4010 Dynamic Calibrator
- Zero Air Source (Sabio 1001)
- Certified gas standard of NO in nitrogen
- Station data processor (Ecotech)

Documentation and forms

For calibration and linearity testing the form *DLI-F-3 NO_x Analyser Calibration Report* is required.


The completed form is stored in electronic form in the file *DLI-F-3 NO_x 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.

For the converter efficiency test, the form *DLI-F-4 NO_x GPT Analyser Calibration Report* is required. The completed form is stored in electronic form in the file *DLI-F-4 NO_x GPT Analyser Calibration Report -sn-yyyy-mm-dd.xls*.

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

Procedure

General

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Perform the scheduled activities as required by the maintenance schedule (DLI-QD-103).

Registration of general information and status parameters

Registration of general information:


- 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**.


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- 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.

Single point calibration

Pre-calibration check (manually):


- Make sure that the analyser reports measurement values in ppb (not µg/m³).
- Press **<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.
- Start calibration from the logger manual/start calibration, NO, “single point all”, select zero point and then press run point.
- Let the analyser measure zero air for 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.
- From the Primary Screen, start the calibration sequence by pressing either the **Up** or **Down** arrow key until the display prompts, **START MANUAL CALIBRATION? ZERO**. Confirm that the display reads **ZERO** and press **<Enter>**. A backlit cursor will be displayed on the NO concentration display.
- Use the **<Select>** key to move the position of the backlit cursor, and the **Up** and **Down** arrow keys to increment and decrement the value of the backlit digit until the NO zero value is displayed (e.g., 0.000 ppb). When the desired concentration is displayed, press **<Enter>**.
- 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 NO** field. Remember to include the unit.
- Start calibration from the logger manual/start calibration, NO, “single point all”, select zero point and then press run point.
- Start calibration from the logger manual/start calibration, NO, “single point all”, select span point and then press run sequence.

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- From the primary screen, start the calibration sequence by pressing either the **Up** or **Down** arrow key until the display prompts **START MANUAL CALIBRATION**. Pressing the <Select> key will allow you to choose from: **NO**, **SPAN** or **ZERO**. Confirm that the display reads **SPAN** and press <Enter>.
- Use the <Select> key to move the position of the backlit cursor, and the **Up** and **Down** arrow keys to increment and decrement the value of the backlit digit until the span calibration gas concentration value is displayed. When the desired concentration is displayed, press <Enter>.
- Let the calibrator generate a concentration of 80% of the NO measurement range.
- Let the analyser measure span gas air for 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 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 NO** field. Remember to include the unit.
- Copy the calculated concentration into the **Expected** field.
- If the error reported in the **Error** column is larger than 2% the analyser gain should be adjusted. If so continue with the next section. If not skip it.

Calibration – Gain adjustment:

- While continuing to measure the span gas press <**Down arrow**> in the primary screen to initiate a calibration of the analyser.
- The display prompts **START MANUAL CALIBRATION? SPAN**. Press <Enter>.
- 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. The concentration on the *primary screen* should now read the same as the concentration of the calibration gas.
- 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 NO** field. Remember to include the unit.
- Copy the calculated concentration into the **Expected** field.

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- If the error reported in the **Error** column still is larger than 2% the problem must be investigated.
- Repeat the zero test and enter the results into the form.
- Record the new instrument gain in the **Final Span Instrument Gain** field.
- 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.
- At each 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 off 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.
- If a converter efficiency test will be performed, leave the calibrator on and return to the **START MANUAL CALIBRATION? SPAN** menu. Confirm that the display reads **SPAN** and press <Enter>.
- Read the converter efficiency and enter it into the **Initial Converter Efficiency** field.
- Compare the recorded values with the acceptance limits. If any values are outside the limits the cause must be investigated.

Converter efficiency test

- The converter efficiency test is performed at concentrations of 95% of the measurement range of NO₂.
- Press <Exit> to return to the primary screen. Press <Up arrow> in the primary screen, press select, Press <Up arrow> twice, press enter. Press <down arrow>, select, Press <Up arrow> change the value to 100%.
- Press <Exit> to return to the primary screen.
- Go to the calibrator screen select **Sequence, run, operator stepper, GPT**, press enter, select point 200ppb NO with zero ozone and press enter.
- Let the calibrator generate a NO concentration of approx. 80% of the NO measurement range.

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- Go to the analyser screen, press enter, **calibration menu**, enter, **calibration mode**, enter, **arrow up** to select **span**, enter, exit
- Let the analyser measure the span gas for at least 20 minutes and until the reading is stable.
- Record the NO, NO₂ and NO_x readings in the first line of columns **NO**, **NO₂** and **NO_x** respectively on the GPT Analyser Calibration Report form.
- While keeping the NO concentration unchanged let the calibrator generate an O₃ concentration equal to 90% of the expected NO₂ measurement range, typically 180 ppb.
- Let the analyser measure the span gas for at least 20 minutes and until the reading is stable.
- Record the NO, NO₂ and NO_x readings in the second line of columns **NO**, **NO₂** and **NO_x** respectively. The converter efficiency is calculated automatically in the spread sheet.
- The converter must have an efficiency better than or equal to 96%. If the converter efficiency is less than 96% the converter should be replaced.
- While keeping the NO concentration unchanged let the calibrator generate an O₃ concentration equal to 60% of the expected NO₂ measurement range, typically 100 ppb.
- Let the analyser measure the span gas for at least 20 minutes and until the reading is stable.
- Record the NO, NO₂ and NO_x readings in the second line of columns **NO**, **NO₂** and **NO_x** respectively. The converter efficiency is calculated automatically in the spread sheet.
- While keeping the NO concentration unchanged let the calibrator generate an O₃ concentration equal to 30% of the expected NO₂ measurement range, typically 50 ppb.
- Let the analyser measure the span gas for at least 20 minutes and until the reading is stable.
- Record the NO, NO₂ and NO_x readings in the second line of columns **NO**, **NO₂** and **NO_x** respectively. The converter efficiency is calculated automatically in the spread sheet.
- The analyser passes the converter test if the converter efficiency is larger than or equal to 96%. If the converter efficiency is less than 96% the converter should be replaced.
- Set the new converter efficiency on the analyser.
- Stop the calibrator by pressing end sequence until exit.
- Go to the analyser screen, press enter, **calibration menu**, enter, **calibration mode**, enter, **arrow up** to select **measure**, enter, exit

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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.

Relevant documentation

Maintenance schedule

Form *DLI-F-3 NOx Analyser Calibration Report*

Form *DLI-F-4 NOx Analyser GPT Calibration Report*.

Reference Procedures

Nitrogen oxides monitor (Ecotech EC9841B) manual

Sabio 4010 Dynamic Calibrator manual.

Revision History

Revision 0