

Section II: Operator Responsibilities
Trace Level Sulfur Dioxide QA Plan
Revision 0

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2.34.2.1 Procedures for Operation/Calibration of the Model 43C-Trace Level Enhanced (TLE) - SO₂ Monitor

The State of North Carolina operates sulfur dioxide monitors across the state for the purpose of monitoring the potential exposure of the general population to ambient levels of sulfur dioxide (SO₂). The standard ambient level SO₂ monitors (TEI 43C), currently being used within the state monitoring network, have historically been operated at the very low end of their detection range. Higher sensitivity (“Trace Level”) SO₂ monitors are now being required for the developing network of the U.S. EPA. National Core (NCore) monitoring sites. The NCore initiative is the debut of an EPA shift towards new data quality objectives that emphasize a performance-based quality system that shows a tight control of precision and bias. The “Trace Level Enhanced” monitor(s) support(s) these initiatives and will be deployed at one or more designated sites. The 43C-TLE was granted the status of “Federal Equivalent Method” (FEM) by the EPA on July 22, 2005.

In order to collect accurate, meaningful data, the monitors must be operated in a consistent manner. The goal of this document is to establish a continuous, verifiable, defensible record of events with regard to the site and the instrument as required by US EPA, 40 CFR Part 58.

All original records (records documenting observations, i.e. calibration logbook, electronic log, and site logbook) must be legible, complete, dated, and signed (name/initials provided on the e:log) by the operator and retained as part of the permanent analyzer calibration record. The operator’s signature (initials) on the calibration logbook form certifies that the calibration has been performed in accordance with this QA/SOP and that the information contained on the form is accurate. All records will be reviewed and verified by the Regional Chemist and audited by Raleigh Headquarters.

This document includes updates as given in 40 CFR Parts 53 and 58, “Revisions to Ambient Air Monitoring Regulations; Final Rule” posted in the Federal Register on Tuesday, October 17, 2006 and effective on December 18, 2006.

2.34.2.1.1 Instrumentation and Equipment for Continuous SO₂ Monitoring:

Thermo Environmental 43C-TLE SO₂ Analyzer;
Thermo Environmental 146C Dynamic Gas Calibrator;
Certified SO₂ cylinder (Protocol Gas);
Zero Air Pack;
ESC model 8816(and/or 8832) Data Loggers (primary and secondary);
A dedicated site PC; and
Modem.

The operation of the 43C-TLE is very similar to the 43C instrument.

2.34.2.1.2 Common Continuous Monitoring Principles Applicable to the SO₂ System:

- An initial, manual, adjusted calibration (“CALIBRATION” from this point forward) must be performed during the site start-up (See Section 2.34.2.2.7);
- Visit the site at least once every two weeks (EVERY 14 DAYS OR LESS);
- During the 14-day visit, perform a CALIBRATION CHECK (formerly “precision check” or “unadjusted calibration”). A CALIBRATION CHECK is to be performed *before* any changes are made to the system. CALIBRATION is required when a CALIBRATION CHECK (formerly “precision check”/ “unadjusted calibration”) fails;
- CALIBRATION (formerly “adjusted calibration”) is required whenever a system’s operation is interrupted (i.e. more than two days without power, physical removal/replacement of system components, or major repairs/maintenance as described in “Calibration” (Section 2.34.2.2.7). A “closing calibration” is required at the closure of a site. The instrument should be calibrated at a minimum of once per year (even if running smoothly over that time span);
- The clock times of the components at the site are to be verified, and if needed – corrected, during the 14-day visit. The PDL and BUDL should be within one minute of each other and match NIST clock time (± 1 minute, EST) as provided by the NIST time provider in Colorado. The NIST time can be verified by several methods:
 1. set a watch according to the NIST time the morning a site is visited, NIST time is available at: <http://nist.time.gov/>;
 2. call Colorado (303) 499-7111 for the time, a long distance call not recommended;
 3. use the time displayed on a cell phone, most are synchronized to local NIST time (check against the NIST time before using);
 4. call ECB and ask for the NIST time.

In addition to the data loggers, the site computer must be set 5 minutes *slower* than the data loggers to ensure that a full hour of data is retrieved/stored by the computer, and in turn by the Head Quarters (HQ) polling computer during regularly scheduled polls. The site computers *will not* be automatically synchronized to/by the HQ polling computer, nor should they be synchronized to a region’s polling computer;

- The site is to be inspected for required maintenance such as: shelter condition, condition of plumbing/lines, compressor and silica gel condition, filter changes, leak testing, backup data collection, data review; and
- No checks, that affect data, are to be made during periods when the NAAQS for SO₂ may be exceeded.

2.34.2.2 OPERATIONAL Checks and CALIBRATION for SO₂ Monitoring Sites

The following activities will be performed as described below (see Appendix A for a Summary of Activities and Schedule). Document all checks and adjustments in the elog and site logbook.

2.34.2.2.1 Site Checks

Upon arrival at the site, observe the outside of the sampling building and probe, looking for vandalism or security breaches. Check the probe outside for an intact screen and any insect nests inside the probe funnel or sample line. **Document all actions in the site logbook.** If there is any evidence of vandalism contact the appropriate law enforcement department (generally this is the city police department if the monitor is within city limits, and the county sheriff's department if outside city limits) and headquarters. Check the data loggers for appropriate date/time and concentration readings (see Section 2.34.2.2.3 for specifics). Measure the internal temperature of the building in °C and record in the site log book. **Adjust the site thermostat as necessary to select a target shelter temperature within the 20° to 30°C range. The temperature should not be allowed to vary by more than ± 5 degrees over a 24-hour period.** If the temperature cannot be stabilized and controlled within this range, notify the regional chemist and the ECB that corrective action is required. The regional chemist and the Projects and Procedures Branch Supervisor should review the data generated during any “out-of-control” period to determine if the data should be flagged or invalidated.

Power On and Sample Line Check. Observe the analyzer, calibrator, computer, and data loggers for indications of power failure, and if needed, correct the cause. If the analyzer or calibrator lost power, allow an equilibration period of at least an hour for the instrument(s) to stabilize. Visually inspect the tubing, especially at any bends, to ensure that it has not been accidentally kinked, crimped, cut, or to ensure that insects have not nested in the lines. Particulate matter may also collect in the sample line leading to the instrument. Such restrictions can usually be determined by disconnecting the inlet line leading to the instrument. If pump performance is significantly improved and the inlet filter itself is not loaded with particulate matter, the sample line will require cleaning or replacement. **Record all events in the site logbook.** Notify supervisor and call the ECB for instructions on length of stabilization period and restarting/resetting the data logger if necessary.

Check on Gas Cylinder and 146C Calibrator. Verify that the calibration gas cylinder and calibrator are in certification (calibrator certification is valid for *nine (9) months* and Protocol SO₂ cylinders with a concentration between 10 and 40 ppm are certified for *six (6) months*) and document certification dates in the elog. [If the pressure **is less than 500 psig**, the ECB should be notified that a new cylinder is required. The delivery of a new cylinder must be coordinated with the region to allow time for the region to perform a calibration check just prior to the installation of the new cylinder. Immediately following the installation of a new cylinder, the region must perform a new calibration (see Section 2.34.2.2.7)]. Verify that the 146C has the correct cylinder SO₂ concentration stored in memory. It should be noted that the 146C calibrators used with the 43C-TLE analyzers have been modified to allow the generation of low ppb (<10 ppb) concentrations of SO₂. The modifications include the use of a 50 cc gas MFC and a 20 LPM air MFC. **Record all events in the site log book.**

2.34.2.2.2 43C-TLE Analyzer and 146C Calibrator Operational Checks

Basic checks of the instrumentation (refer to Figures 1 and 2 for a MENU flow diagram of the 43C-TLE and 146C respectively.)

Alarm Checks (43C-TLE Analyzer and 146C Calibrator)

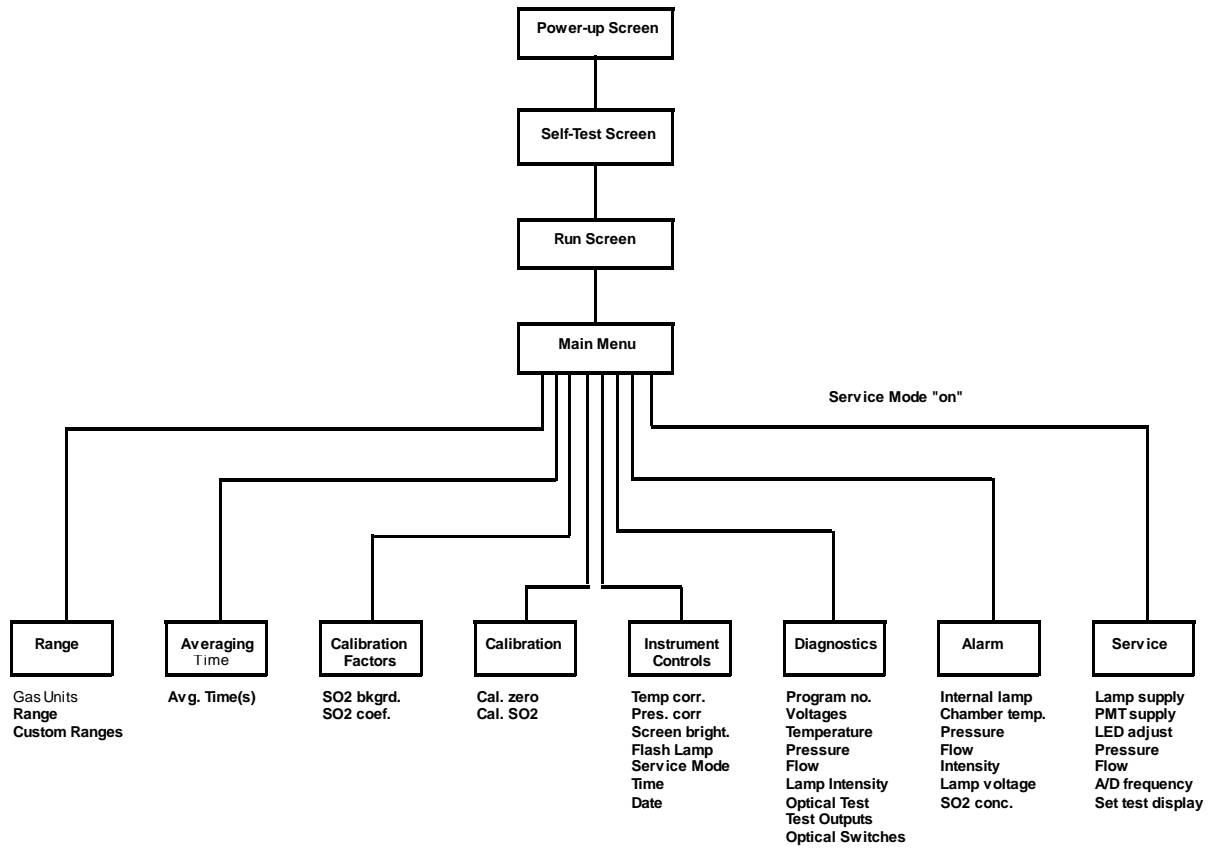
Check the 43C-TLE Run Screen. If the word “**Remote**” is displayed, press <ENTER> to place in “**Local**” mode. Check the 146C Run Screen. If the word “**Remote**” is not displayed, press <ENTER> to place it in “**Remote**” mode (The 146C has to be in the REMOTE MODE in order to activate the internal span solenoid inside the 43C-TLE).

[The Main Menu contains many submenus. Instrument parameters and settings can be found within the submenus according to their function. To select a submenu screen, use the up/down (↑ or ↓) pushbuttons to move cursor up or down, select the submenu and press <ENTER>. No values are to be changed without calling the ECB and getting their approval. If the ECB approves changing a value, document the change in the logbook and follow these steps: To change an incorrect digit (Note: cannot change a value in a view only screen), press the left/right (← or →) pushbuttons to move the underscore to the digit to be changed, and press the ↑ or ↓ pushbuttons to increment or decrement the underscored digit. Press <ENTER> to accept the revised output. To exit a screen, press <MENU> to return to Main Menu and choose another submenu or press <RUN> to return to the Run Screen.]

Check for “**Alarm**” on the displays. If no alarms are present, record the “Alarm On” checks in the logbook as “**no**” and continue. If either screen shows an alarm, record the “Alarm On” check as “**yes**” in the logbook for the appropriate instrument/s. View the Alarm menu to determine the cause:

- 1) Press the <MENU> button on the front of the instrument. (Make sure the 146C is in “**Remote**” mode and the 43C-TLE is in “**Local**” mode.)
- 2) Use the ↑ or ↓ menu pushbuttons to select the **Alarm Submenu**.
- 3) Press the <ENTER> button.
- 4) Use the ↑ or ↓ menu pushbuttons to select the item that is in Alarm Status.
NOTE: Items that are not in alarm status are labeled “OK”.
- 5) Press the <ENTER> button.

Figure 1 **TEI Model 43C-TLE Flow Chart**



The following Alarm Limit is used in SO₂ operation of the 146C Calibrators:

<u>Parameter</u>	<u>Min.</u>	<u>Max.</u>
Internal Temperature	18.5 °C	47.0 °C

The following Alarm Limits are used in 43C-TLE Analyzers:

<u>Parameter</u>	<u>Min.</u>	<u>Max.</u>
Internal Temperature	15 °C	48 °C
Chamber Temperature	43 °C	47 °C
Pressure	400 mm Hg	1000 mm Hg

Flow	0.35 LPM	0.750 LPM
Lamp Intensity	10,000 Hz	20,000 Hz
Lamp Voltage	950 V	1200 V
SO ₂ Concentration	0 ppb	100 ppb

- 6) Determine the cause of the alarm. Consult with the ECB prior to performing calibrations or maintenance.
- 7) Press the <MENU> button twice to return the main menu screen.

Operational Checks (43C-TLE Analyzer and 146C Calibrator)

Begin by checking the **Range** the analyzer is set to. It must be set at 0.1 ppm (100 ppb). Choose **Range** from the Main Menu (<MENU>, ↑ or ↓) on the 43C-TLE display. The range should be in **Single Range** mode. This range should be identified on red tape on front of monitor. If the monitor range is different than the range specified for the site, contact ECB for the correct instrument/calibration status. (If needed, choose the correct range and calibrate the monitor at that range. Write "**CALIBRATED RANGE "100 PPB"**" on a piece of tape and affix it to the front of the monitor.)

Select the **Diagnostics Menu** (View only screen) and record in the logbook.

Diagnostic checks for the 146C Calibrator:

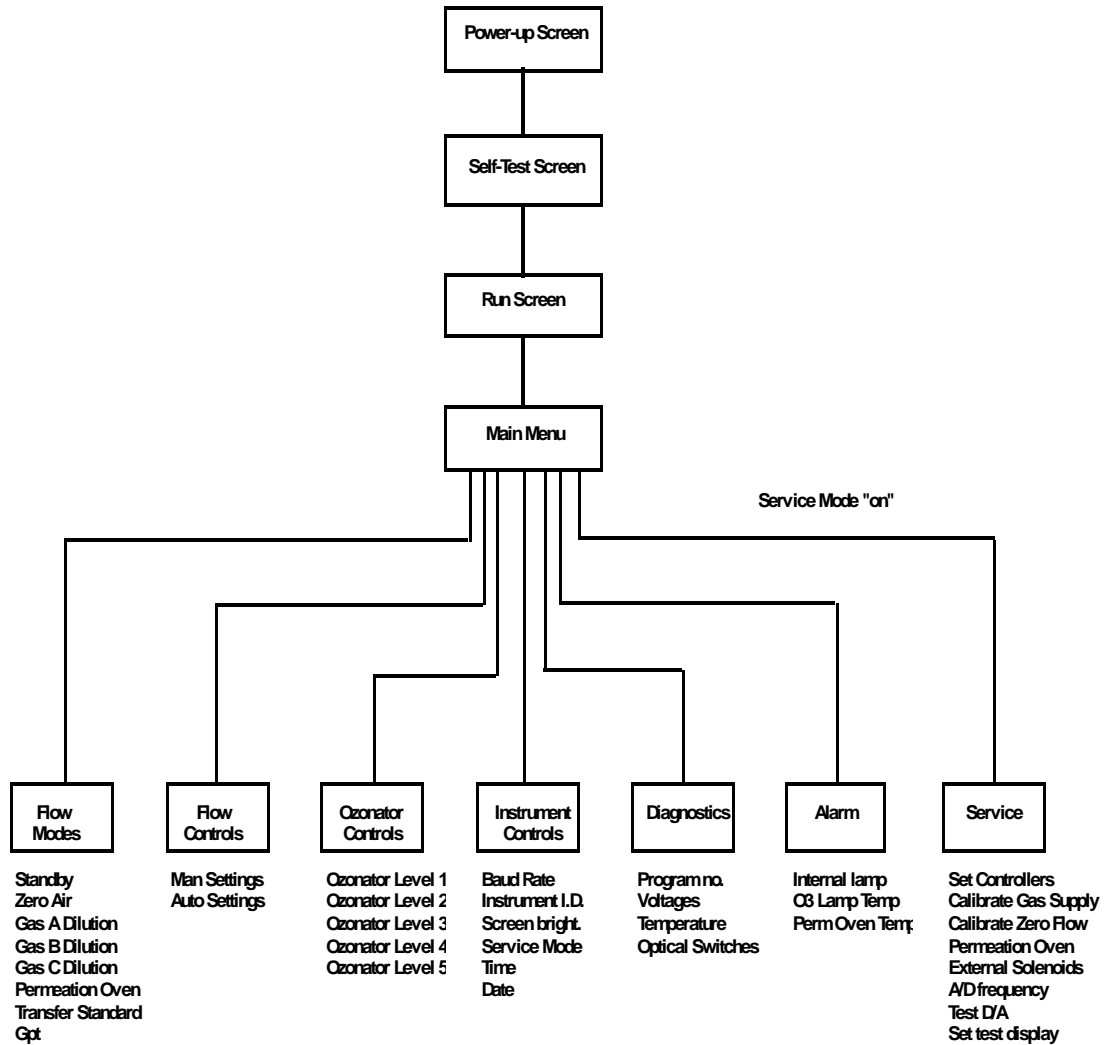
1. Check current DC voltages for the +5 (±1 volt), +15 (±1 volt), and -15 (±1 volt) power supplies and 3.0 (±0.2) volt for battery.
2. Check internal temperature. (**Note:** Temperature should be between 15 and 35°C, if outside of these limits the Alarm would also be triggered.)

Diagnostic checks for the 43C-TLE Analyzer:

1. Check current DC voltages for the +5 (±1 volt), +15 (±1 volt), and -15 (±1 volt) power supplies and 3.0 (±0.2) volt for battery.
2. Check internal temperature and chamber temperature under **Temperature**. (**Note:** Internal temperature should be between 15.0 and 48.0°C and chamber temperature should be between 43.0 and 47.0°C. If outside of these limits the Alarm will be triggered.)
3. Check pressure (acceptable range is 400 to 1000 mmHg).
4. Check the flow (acceptable range 0.350 to 0.750 Liters/minute).
5. Check lamp intensity (acceptable range 10 Khz to 20 Khz).
6. Check the lamp voltage (under **Voltage**) (acceptable range 950 to 1200 V).
7. Check the PMT voltage (also under **Voltage**) to make sure PMT is on (acceptable range -400 to -1200 V).
8. If outside of specified ranges contact ECB. (**Note:** If the lamp voltage is running at or very near to 1200 V it has degraded to it's highest point and may need to be adjusted or changed out. Contact ECB).

- Verify the averaging time (for the 43C-TLE) by pressing <MENU>, select **Averaging Time**. Press <ENTER>, verify that AVG Time is set to 60 sec. Press <MENU>, press <RUN>.

Figure 2 TEI Model 146C Flowchart



Zero Air Pack (TEI Model 111) and Compressor Checks

The purpose of the Model 111 is to supply pollutant-free air ("zero air") for proper instrument zeroing and to provide clean diluent air for use with the 146C calibrators. Ambient air is drawn into the system, which removes water vapor, SO₂, NO, NO₂, O₃, CO and hydrocarbons. In order to achieve the enhanced lower level of detection, consistently clean, zero air is essential to the

operation of the trace level SO₂ instrument. Because the instrument is to detect/characterize SO₂ concentrations at very low levels (0-10 ppb), producing clean air (and hence the baseline of the instrument) is vital for collecting defensible data. "Zero Air" should contain a concentration of SO₂ that is less than the lower detectable level (LDL) for the instrument or approximately 0.1 ppb. It is the responsibility of the ECB to test the "Zero Air" systems before deployment to ensure that they meet this requirement (per the ECB 43C-TLE QA/SOP). The ECB is also responsible for performing an annual audit of the zero air system.

The operator must verify that the silica gel is not spent as indicated by color change. When the gel is new it is a dark blue or purple color. If the gel is spent, it is a lighter blue or purple color with white crystals. If the gel is spent, replace it and return it to the ECB for regeneration. Verify that the pressure gauge on the Zero Air Supply is reading 30 psi \pm 2 psi. Record reading. Verify and record that the outlet pressure on the air compressor is reading between 35 and 40 psi. If either pressure reading is outside of these ranges, contact the ECB and record corrective action. Also, check and drain any water from the compressor (do this at every site visit). The operator must also verify that the "Zero Air" system does not exceed the one-year period of certification.

Cooling Fan and Fan Filters on the 146C and 43C-TLE

On the back of the instruments there are cooling fans with sponge filters inside. Check to ensure the fans are running. Check to see if the filters are clean during every site visit and clean the filters at least once a month. The fan housing can be popped off the back of the instrument and the filter may be removed and cleaned if necessary (either by rubbing with a cloth or between your hands to remove any dust or with compressed air). After cleaning, replace the filter and the housing. Record in the logbook.

2.34.2.2.3 Data Logger Time and Date Checks and Adjustments

The times for the PDL, BUDL, and computer must be EASTERN STANDARD TIME. **The PDL and BUDL must have the same time *and* be synchronized to the NIST time provider in Colorado (\pm 1 minute).** Sources of the NIST time include:

- cell phones (most are synchronized to local NIST time, not necessarily "standard" time);
- calling Colorado (303-499-7111);
- setting a watch to the NIST website (<http://nist.time.gov/>) within 24 hrs of visiting the site;
- calling ECB and asking for the NIST time.

The site computer must be set 5 minutes *slower* than the data loggers to ensure that a full hour of data is retrieved/stored during regularly scheduled polling.

Check the data logger time first, then the site computer time (and date). If the data logger time is correct, and the PC time is correct (minus 5 minutes), continue on to the next activity. If time or date *is not* within parameters (\pm 1 minute DL's, -5 minutes PC), reset the offending component(s).

For the PC, “right click” the time in the lower right corner of the windows screen and select <Adjust Date/Time> from the menu options. Correct the time/day and ensure that the time is in “EASTERN STANDARD TIME”. Click <OK> to finish.

Open the Primary and Backup Data Logger screens on the computer (shortcut to split screen option on Windows desktop). For the PDL, type in the two-letter site code (front of the PDL) and “AQM” (___ AQM). For the BUDL, type in its two-letter site code (front of the BUDL) and “AQM” (___ AQM). **Note:** the PDL and BUDL have different codes.

For the PDL, log in, <esc><esc><esc>:

- 1) Select “**L**”, (login)
- 2) Type password “**██████████**” (*highest level password*, this will allow calibration options not otherwise viewable in subsequent steps)
- 3) <**ENTER**>
- 4) Select “**C**”, (configuration menu)
- 5) Select “**S**”, (system configuration parameters)
- 6) Select “**Date-Time**”
- 7) <**ENTER**>

If the date and time is correct continue on to the next task. If it needs to be corrected, type in the correct values and press <**ENTER**>.

For the BUDL, log in:

- 1) Select “**L**”, (login)
- 2) Type password “**██████████**”
- 3) <**ENTER**>
- 4) Select “**C**”, (configuration menu)
- 5) Select “**S**”, (system configuration parameters)
- 6) Select “**Date-Time**”
- 7) <**ENTER**>

If the date and time is correct continue on to the next task. If it needs to be corrected, type in the correct values and press <**ENTER**>.

If a correction to the time and date are made for the computer, PDL, and/or BUDL, document it in the logbook and/or electronic log, including how far off the values were.

2.34.2.2.4 Disabling or Marking the Channels “Down”

Before performing any maintenance activities, the EDAS channels should be marked as “Down” (“D”) to prevent any erroneous data from being polled by the headquarter’s computer. To “Down” the channels, perform the following:

- 1) Log into the computer if needed (type your user name, “*initials*”; and password, “**██████████**”). Choose “Shortcut to Split Screen” on the Windows desktop or from the ESC main menu select “**Utilities**”. Select “**Login**”, Double Click on “**SPLIT**”

SCREEN", the PDL should be displayed on the top half of the monitor and the BUDL on the lower half.

- 2) Log into the PDL.
<Esc>
type "site code AQM" (example **MLAQM**)
<ENTER>
select "**L**"
type password "██████" (*highest level password*)
<ENTER>
- 3) Down the PDL.
<Esc> back to return to Home Menu
select "**C**" (configuration menu)
select "**D**" (configure data channels)
select "**M**" (mark channels down/ off)
highlight SO₂ (SO₂ ppb etc.)
<ENTER>
- 4) Log into the BUDL.
<Esc>
type "site code AQM" (example **MLAQM**)
<ENTER>
select "**L**"
type password "██████"
<ENTER>
- 5) Down the BUDL.
<Esc> back to return to Home Menu
select "**C**" (configuration menu)
select "**D**" (configure data channels)
select "**M**" (mark channels down/ off)
highlight SO₂ (SO₂ ppb etc.)
<ENTER>
- 6) View the PDL.
<Esc> back to return to Home Menu
select "**D**" (display real-time)
select "**B**" (base average one minute)
updated data should display a (D) indicating the 'downed' channel
- 7) View BUDL.
<Esc> back to return to Home Menu
select "**D**" (display real-time)

select “**B**” (base average one minute)
updated data should display a (D) indicating the ‘downed’ channel.

To enable or “Up” the channels, perform the following:

ENABLE CHANNELS ON PDL & BUDL

highlight the PDL,
select “**C**” (Configuration Menu)
select “**D**” Configure (Data Channels)
Select “**E**” Enable/Mark Channel Online
Select “**SO2**” (**SO2 ppb etc.**) and Press <**ENTER**>
highlight BUDL, and repeat the instructions for enabling the SO2 channel

2.34.2.2.5 Filter Change Procedure

During normal operation throughout the season, the Teflon filter must be *replaced at a minimum of once per month* with biweekly/14-day changes being recommended. **Always change the filter before running a Calibration, but always after performing a Calibration Check.** The filter used is a 5.0-micron Teflon filter, the purpose of which is to prevent any particulate matter from entering the optical path.

1. Remove the filter holder (if necessary) and disassemble.
2. Remove the existing filter and discard. Remove any extraneous material from filter housing.
3. Touching only the outer edges, place the new filter in the holder (orientation is not critical).
4. Reassemble the filter holder and reattach to instrument in same orientation as before removal (i.e., filter inlet/outlet connected to proper lines). **Do not over tighten the filter holder for this can tear the filter and/or damage the holder.**
5. Perform a leak check to test the integrity of the filter assembly.

2.34.2.2.6 Leak Check Procedure

A Leak Check must be performed at a minimum of once per month, after a filter change and/or before a Calibration.

For the Monitor SAMPLE port, the following leak test procedure below should be performed:

1. Disconnect the sample line from the “sample inlet port” on the rear of the instrument and block the opening with a leak-tight cap. (Do not disconnect the lines going to the filter inlet or the filter outlet.)
2. Press “**Menu**” and move ↑ or ↓ buttons to enter the “**Diagnostics**” menu and use the ↑ or ↓ buttons to select “**Pressure**” and press “**Enter**”. The pressure reading should drop (flow should also be at or near zero). Wait until pressure drops below 180 mm Hg.

NOTE: If the pressure has not dropped below 180 mm Hg within three minutes, immediately remove the cap. Check to see that all fittings (leak-tight cap, filter housing, and filter inlet/outlet fittings) are tight and input lines are not cracked or broken and retest. Do not cap off the line for more than three minutes or the system may pressurize. If flow or pressures are not acceptable, the *leak check fails*. Contact the ECB.

3. Remove the cap and document in the logbook.

For the Monitor SPAN port begin the test by running a zero. [using the EDAS: select "C", (configure menu); select "C", (configuration calibration menu); select "1", (single phase phase cal); select "SO2CAL"; select "ZERO"; scroll down to "Phase Duration" and change to 30m; select "Start Single Cal NOW"] The zero should begin. **The zero must be active to conduct this check.** Then perform the following steps:

1. Disconnect the calibrator line from the calibration gas inlet port on the rear of the 43C-TLE and connect it to the sample inlet port on the rear of 43C-TLE. Block off the calibration gas inlet port on the back of the 43C-TLE with a leak-tight cap.
2. Press **Menu** and move ↑ and ↓ buttons to enter the "Diagnostics" menu and use the ↑ or ↓ buttons to select "Pressure" and press "Enter". The pressure reading should be dropping (flow should also go to zero). Wait until pressure drops below 180 mm Hg .

NOTE: If the pressure has not dropped below 180 mm Hg within three minutes, the leak check has failed. Immediately remove the cap. Check to see that all fittings (leak-tight cap, filter housing, and filter inlet/outlet fittings) are tight and input lines are not cracked or broken and re-test. **Do not cap off the line for more than three minutes or the system may pressurize.** If flow or pressures are not acceptable, and/or the *leak check fails* for any reason, contact the ECB before proceeding with the calibration procedure.

3. If the leak check passes, remove the cap, reconnect the calibrator line to the span port and the sample line to the sample inlet. Clear the zero mode by aborting the zero cal.
4. Document in the logbook.

2.34.2.2.7 Calibration (see Item #3 in this section for Calibration Check)

A CALIBRATION is performed: 1) at start-up; 2) a minimum of once per year; 3) **after** a failed CALIBRATION CHECK; and 4) after changing out a major component. Document all checks and adjustments in the logbook / e-log.

A CALIBRATION *must* be performed when a major system or component is replaced or fixed/maintained. Major systems are defined as:

- the analyzer,
- the calibrator, and
- the SO₂ cylinder.

Major components that can be replaced and/or maintained include flow controllers, circuit boards, lamps, and solenoids. If the zero air system is replaced, a zero-precision-span check must be performed and compared to the last z-p-s to verify that the points are equivalent. The zero check should be ± 2 ppb for the 100 ppb range. For cylinder replacement, a calibration check must be performed before change-out followed by a re-calibration. Therefore, arrangements with the ECB for delivery should be scheduled in advance.

A CALIBRATION must be performed when the monitoring system's operation has been interrupted for more than 2 days (as in the case of power outages, or precautionary shutdowns such as hurricanes).

NOTE: The PDL and BUDL channels should be "down" before any calibration/calibration checks are performed.

1) **Zero Check:** Run the **Zero Check** as follows:

From the EDAS...
select "C" (Configuration Menu)
select "C" (Calibration Menu)
select "1" (start single phase calibration)
select "SO2CAL"
select "ZERO"
scroll down to "Phase Duration" and change from 10m to 60m
select "Start Single Cal NOW"
<Esc> <Esc> back to home menu
select "D" (display real-time)
select "C" (continuous average report)

Introduce "zero Air" from the 146C and allow the monitor and calibrator to stabilize until the primary data logger (PDL) and backup data logger (BUDL) read 0.0 ± 2 ppb on the SO₂ channel. **If this criteria is not met, adjust analyzer zero setting by doing the following:**

1. Press the **Menu** button on the front of the Model 43C-TLE analyzer and, using the \uparrow or \downarrow push buttons, move the cursor to select **calibration** menu. Press the **ENTER** button to display the Calibration menu.
2. Select "**Calibrate Zero**" and press the **ENTER** button. The Calibrate Zero screen will appear with the first line of the display showing the current SO₂ reading. With the analyzer producing a stable reading on "zero air", press the **ENTER** button to set the SO₂ reading to zero. The lower left-hand corner of the display flashes the

message “**Saving Parameter(s)**” and the SO₂ reading is added to the background correction.

3. Press the “**Run**” push-button to return to the sample mode.
4. Allow the monitor to stabilize and then **record in the logbook/e-log** the next five one- minute Primary Data Logger (PDL) and Back-up Data Logger (BUDL) concentration values (then compute and record the averages of those one-minute times and in the elog (the elog automatically calculates the averages).

NOTE: If the PDL is within 0.0 ± 2 ppb on the SO₂ channel for the 100 ppb monitor range and the BUDL is not, make a note of it and call the ECB.

2) **Span Procedure:**

Span Check: Introduce **SPAN 1 gas** (nominally 85 ppb) from the 146C calibrator. The span 1 setting is preset to a concentration within the range of "80 to 90% of full scale" of the analyzer's range setting. Allow the 43C-TLE to stabilize for a minimum of 20 minutes. After the monitor has stabilized, the PDL, BUDL, and analyzer outputs should read approximately the “**true (146C output display) concentration**” within ± 3 ppb. **If the 43C-TLE analyzer does not meet this criteria, follow the steps below to adjust the span:**

1. Press the “**Menu**” button and select “**Calibration**”. Use the \uparrow and \downarrow to select “**Calibrate SO₂**” and press “**Enter**”. The first line of the display shows the current SO₂ reading, the second line shows the current range and the third line is where the calibration gas concentration is entered.
2. To enter the calibration gas concentration, use the \leftarrow or \rightarrow pushbuttons to move the cursor left and right to select each digit of the SO₂ span concentration. Use the \uparrow and \downarrow buttons to increment and decrement (adjust) each digit to the true SO₂ span concentration as displayed by the 146C calibrator.
3. Press “**Enter**” to calibrate the analyzer to the **true** 146C “**Output PPM**” display for the SO₂ calibration gas concentration. The lower left-hand corner of the display will flash the message “Saving Parameter(s)” and the corrected SO₂ reading is displayed. Press “**Run**” to return to the Run screen.
4. Ensure data logger readings and the 43C-TLE display are all reading the true SO₂ concentration ± 3 ppb. If not, make further adjustments by repeating steps 1-3.

After the data logger readings and the 43C-TLE display are all reading the true SO₂ concentration ± 3 ppb, allow the monitor to stabilize (a minimum of 10 minutes) and record the next five one-minute Primary Data Logger (PDL) values, Back-up Data Logger (BUDL) values, 43C-TLE values, and their averages (averages are automatically calculated by the elog).

CAUTION: DO NOT ADJUST THE SPAN BY ADJUSTING THE PMT! ECB Technicians are the only personnel authorized to make any

adjustments to the PMT. Site Technicians MUST adjust the Span by using the “Calibrate SO₂” button (NO EXCEPTIONS).

Re-Run Zero Check: Allow the analyzer to stabilize for a minimum of 10 minutes. After the analyzer has stabilized, the PDL should read 0.0 ± 2 ppb for the 100 ppb range. If not, adjust analyzer zero setting by repeating the section on “**Zero Check**”.

Re-Run the Span Check: Allow the analyzer to stabilize for a minimum of 10 minutes. After the analyzer has stabilized, the PDL should read ± 3 ppb of the expected value for 100 ppb range. Record data in the logbook. If the value is not acceptable, then repeat the section on “**Span Check**”.

NOTE: The zero and span interact and may require more than one attempt to meet the above specifications. However, the new combination of the 43C-TLE and 146C are more stable than past equipment and therefore the documentation of the adjusted zero and span in this QA/SOP is taken after the initial zero and span adjustments. In most cases, the initial zero and span adjustments will be sufficient for the calibration to pass and additional adjustments will not be necessary. If several (4 or more) zero-span adjustments fail to obtain acceptable responses, call the ECB.

If the **BUDL Zero** does **NOT** agree to within 0.0 ± 2 ppb on the 100 ppb monitor range, call the ECB.

If **BUDL span** does **NOT** agree with the actual concentration to within ± 3 ppb and if PDL and BUDL values do not agree within ± 3 % of each other; log in to BUDL using the highest level password, then make the following BUDL adjustments:

1. Press **Esc** and **Esc**, slowly.
2. Press “**C**” (Configuration Menu), then press “**D**” (Configure Data Channels), then press “**C**” (Change Old Configuration). If these options are not available, you have not logged in with the highest password. Press **Esc** until you reach home menu, then log in again using the highest-level password. **MAKE SURE SCROLL LOCK FUNCTION IS OFF.**
3. Select SO₂ channel and press **Enter**. Select “**High Output**” for span (calibration) upper range limit. The Engineering Units (or E.U.) entered here are concentrations units such as ppm or ppb.
4. To determine a new value to enter here consider the following example:
If the instrument is calibrated on a 0 to 5 ppb range the “zero” and “high” outputs on the PDL should be set to 0 and 5 respectively as well as the BUDL. If the BUDL output, in normal running mode, displays different concentration values than the PDL, such as -0.1 and 4.9 for zero and span, then new E.U. values need to be entered in the BUDL. Considering the calibration range to be a sliding fixed scale, the difference between 0 and 5 is 5 as is the difference between -0.1 and

- 4.9. The difference between the two zero readings is 0.1 and the difference between the two span readings is 0.1. To adjust the BUDL, change the **Zero Output** from 0.0 to 0.1 and change the **High Output** from 5.0 to 5.1.
5. Press **Enter** several times until **Finished Configuration** is highlighted and press **Enter**. Turn **ON** the Scroll Lock function key on the keyboard, and press **“Page Up”** until the full “Channel Configuration Menu” is visible.
 6. Press **“Scroll Lock”** to turn off the scroll lock function, then press **“Esc”** and **“Esc”**. Review and retest zero and span concentrations as needed. This BUDL adjustment may need to be repeated until the BUDL SO₂ channel is reading the true SO₂ concentration. **(After several tries, call the ECB if you still do not get acceptable BUDL values.)**
 7. If finished, Select **“D”** (real time data), and Press **“B”** (last base averages).

3) Multi-Point “Calibration Check” Procedure:

The purpose of calibration is to correlate the output of a monitoring system with known, traceable concentrations of SO₂. The “Calibration Check” is a manually initiated response check of the instrument’s calibration. At a minimum, the EPA requires a “One Point QC Check” using the Span 3 concentration (nominally 5-10 ppb) plus “zero”. With the advent of the NCore program and the use of trace level instrumentation, the EPA is recommending that a **Multi-Point Calibration Check** be performed.

Visit the site at least once every two weeks (EVERY 14 DAYS OR LESS) to perform a CALIBRATION CHECK. Perform a “CALIBRATION CHECK” prior to any maintenance or scheduled interruption of monitor operation lasting more than 48 hours. (Maintenance activities that *do not* affect calibration are sample inlet line replacement and particulate filter replacement.) If a “CALIBRATION CHECK” *fails*, a CALIBRATION *must be* performed. **No checks that affect data are to be made during periods of ambient exceedances.**

Begin Multi-Point CALIBRATION CHECK :

Press **Menu** as required, to return to the “Main Menu”. Use the ↑ and ↓ buttons to select **Calibration Factors**, press **Enter**. **NOTE: Make no adjustments.** Record **SO₂ bkg** (background) and **SO₂ coef** (coefficient) in the e:log. Press **Menu**, press **Run**.

Introduce “ZERO gas” and allow the instruments to stabilize for a minimum of 10 minutes. If the PDL reads 0.0 ± 2 ppb on the monitor, record in the e:log the next 5 one-minute zero values (Note: The zero values from the “zero-check” and the span values from the “span-check” discussed above under Items 1 and 2 may be used if “passing”).

Introduce other Calibration Points: Sequentially, introduce Span 3 and Span 2 (nominally 8 ppb and 45 ppb, respectively). Allow a minimum of 10 minutes for each

point to stabilize. Record the 146C “Output PPM” [the displayed SO₂ Actual Concentration (Ca)], and the five one-minute PDL, and BUDL responses in the e:log.

Review each SO₂ Calibration Point result from the data logger and record each result in the e:log. **The zero and Span 3 values on the PDL and BUDL must be within ± 2 ppb of the true value on the 100 ppb range. The concentration displayed on PDL and BUDL for Span 1 and Span 2 must be within ± 3 ppb for the 100 ppb range.** (See Table 1 for a Summary of the Acceptance Criteria and Table 2 for Calibration Concentration Ranges)

Table 1. Acceptance Criteria for Calibrations and Calibration Checks

Calibration Gas	Zero	Span 1	Span 2	Span 3
Instrument Range, ppb	100	100	100	100
Full Calibration	±2 ppb	± 3 ppb	± 3 ppb	± 2 ppb
14 Day Calibration Check	±2 ppb	± 3 ppb ^A	± 3 ppb ^A	± 2 ppb

^A Span 1 and Span 2 are not required, but should be run as additional QC

If any calibration points are not within specification, the calibration is not acceptable and must be re-run to identify and correct any problems.

Table 2. SO₂ Calibration Levels for 100 ppb Range

Span Levels	Concentration Range, ppb	Target Concentration, ppb
Span 1 (70-90 % of Full Scale)	80-90	85
Span 2 (40-50% of Full Scale)	40-50	45
Span 3 (16-20% of Full Scale)	5-10 ^A	8
Zero	0.0	0

^A Appendix A of 40 CFR Part 58 requires Span 3 (Precision/Single Point Calibration Check) to be between 10 and 100 ppb regardless of % of span, but NCore requires this point to be between 5 and 10 ppb.

2.34.2.2.8 Back-up Data

Every month, the Data Management and Statistical Services Branch (DMSSB) initiates a data review by printing a raw data report for each field office. Each month, it may be requested of the Regional Offices to send additional instances of BUDL data that are needed beyond what DMSSB requires for verifying the missing value imputations supplied by the field office. Whichever files are summoned, these files will be FTP'd to the central office by the same

deadline that is established for returning the raw data review. **Backup data loggers are to be stored to disk as follows:**

1. Open the BUDL window,
2. Log in, password <[REDACTED]>.
3. Select <Utilities>.
4. Select <Copy File>.
5. Select <Data Files>.
6. Select <Minute Data>.
7. Select <Range>.
8. Select the <Start Date>.
9. Select the <End Date>.
10. Select the drive to copy the data to.
11. Use either a CD or a "Flash Drive" for data storage.
12. Select <Copy>.

Label the storage medium with the following information: site, month data was recorded, date backup was created, operator name.

2.34.2.2.9 END

Review the logbook calibration numbers and "up" the PDL and BUDL channels. Go to the Home Menu (by pressing "ESC" several times if needed);

1. Highlight the PDL or BUDL,
2. Select "C" (Configuration Menu)
3. Select "D" Configure (Data Channels)
4. Select "E" Enable/Mark Channel Online
5. Select "SO₂" (SO₂ppb) and Press <ENTER>

When finished, exit to the "Home Menu", by pressing <Esc> and <Esc>. Verify the flags are cleared and the channel is enabled by pressing "D" and then "F". If the flags are cleared, press ESC and ESC to go back to the home menu, press "O" (Log out) and CTRL-ESC to exit. Exit the Split Screen operation.

Note: In the split screen operation, the data loggers can be accessed by pressing CTRL and ESC to access the TASK list, you can enter onto either of the two data loggers by highlighting the data logger and pressing enter. Also, while in the "split screen" mode, the scheduler is automatically disabled and upon exit of the "split screen" mode the scheduler is automatically enabled.

2.34.2.2.10 Method Detection Limit (MDL)

With the assistance of the ECB, each trace level SO₂ monitor (43C-TLE) that is placed in service at a NCore site will have an initial MDL determined and subsequent MDL determinations performed annually thereafter. The MDL is the lowest concentration of a substance that can be reliably determined (99% confidence) by a given procedure. Any measurement falling at or above

the MDL reflects a concentration that is significantly different from zero at a 1% percent false positive rate. The MDL should be 0.30 ppb or lower (for an averaging time of no more than 5 minutes per EPA *Technical Assistance Document (TAD) for Precursor Gas Measurements, Version 4 (EPA-454/R-05-003, September, 2005)*).

EPA specifies that the MDL must be established (initially at the ECB or on-site) at the time the instrument is being brought on-line for data collection. Generally, this is accomplished by supplying the analyzer at least seven times with a test atmosphere of SO₂ at 2.5 to 5.0 times the instrument noise level as provided by the manufacturer and performing a statistical calculation on the results. During initial ECB bench testing of a 43C TLE, a test atmosphere of 0.25 ppb was supplied to the analyzer over the course of seven days. Using the results of 32 data points, an MDL of 0.027 ppb was calculated, demonstrating that the 0.30 ppb MDL is achievable. The initial instrument MDL test can be performed at the ECB and then placed in service. Alternatively, a new or reconditioned instrument can be placed in service per standard procedures (i.e., leak check, full calibration etc.), followed by a MDL determination within the first month of being placed in service.

The details of this procedure are given in the EPA TAD and summarized below:

- a) Determine the concentration of the challenge gas to be introduced to the analyzer. This is defined as a value that is 2.5 to 5 times the noise as provided by the manufacturer (see instrument manual). Since this is a *Method* Detection Limit, the gases must be introduced at the sample inlet.
- b) Establish and set the instrument “zero” using a source of pollutant free air (see Zero Air Supply discussion in Section 2.34.2.2.2). This is performed immediately prior to performing the MDL and can be associated with an instrument “Calibration”. Performing a “Calibration” is not required before performing the MDL study. **However, no adjusts to the instrument are allowed during the MDL study.** If adjustments or maintenance is required for routine data collection, the MDL determination must be restarted.
- c) Introduce the challenge gas to the analyzer through the sample inlet for a time sufficient to allow the readings to stabilize plus at least 25 additional minutes. Total time required is approximately 45 minutes.
- d) Collect, record and calculate the average of the last 20 sixty-second averages using a spread sheet such as Excel. This will be data point number one. The spread sheet should have data entry areas allocated for up to 10 sets (two per each 24-hour period) of data (a minimum of seven data sets is required).
- e) Repeat item “d” above once every 12 hours for 5 days. This will result in ten data points. If the instrument is in service for ambient data collection, these events should be scheduled such that they do not interfere with other calibration check activities. The routine daily calibration checks **will be suspended** during this study since a separate, low concentration gas cylinder (nominally 1 ppm, non-protocol) will be required. Data is to be collected over no less than a 5-day period with at least 12- hours between data sets.

- f) **The performance of the MDL study is the primary responsibility of the regional office.** However, the ECB will provide on-site assistance at the beginning of the MDL study. The data logger and calibrator will be programmed by the ECB as required to perform the MDL determination. At the completion of the MDL test, the ECB will return to the site to verify that the necessary data has been collected and return the data logger and calibrator to normal operation. After all 10 sets of data have been entered into the spread sheet (by the ECB) and the average value for each data set has been calculated, the MDL will be calculated (by the ECB) following the example provided in Appendix A of the “ECB QA/SOP for Trace Level Sulfur Dioxide”.

Appendix A

Summary of Tasks and Schedule

Summary of Tasks and Schedule

Item #	Activity	Frequency	Details Found in Section
1	Site Checks	Every 14 Days	2.34.2.2.1
2	Analyzer/Calibrator Checks	Every 14 Days	2.34.2.2.2
3	Zero Air Pack/Compressor Checks	Every 14 Days	2.34.2.2.2
4	Date/Time Verification	Every 14 Days	2.34.2.2.3
5	Calibration Check	Every 14 Days	2.34.2.2.7
6	Filter Change	Monthly	2.34.2.2.5
7	Leak Check	Monthly	2.34.2.2.6
8	Back-up BUDL Data	Monthly	2.34.2.2.8
9	Calibration	Annually or as Otherwise Required	2.34.2.2.7
10	MDL Test	At Start-up and Annually	2.34.2.2.10

Appendix B

Example of E:LOG (Applicable to trace and non-trace analyzers)

SO ₂ LOGBOOK				(Version 4, April, 2008)	
Site: <input style="width: 50px;" type="text"/>	Time: <input style="width: 50px;" type="text"/>	Date: <input style="width: 50px;" type="text"/>	Operator: <input style="width: 100px;" type="text"/>		
Routine Site Inspection					
Bldg Secure ? (Y/N): <input style="width: 50px;" type="text"/>	Bldg Power On (Y/N): <input style="width: 50px;" type="text"/>	Date <input style="width: 50px;" type="text"/> Time <input style="width: 50px;" type="text"/>			
Funnel in Place? (Y/N): <input style="width: 50px;" type="text"/>	Bldg Temp (Deg. C): <input style="width: 50px;" type="text"/>	Computer PDL: <input style="width: 50px;" type="text"/>	BUDL: <input style="width: 50px;" type="text"/>		
Screen in Place? (Y/N): <input style="width: 50px;" type="text"/>	(+/- 1 min. on loggers)				
Sample Line OK/Heated?(Y/N): <input style="width: 50px;" type="text"/>					
TEI SO₂ Analyzer					
Model Type: <input style="width: 50px;" type="text"/> <small>(43C/43C-TLE)</small>	Serial No. <input style="width: 50px;" type="text"/>	Range: <input style="width: 50px;" type="text"/> 0.100 <small>(ppm)</small>			
Cooling Fan/Filter OK? (Y/N): <input style="width: 50px;" type="text"/>	SO ₂ Background Calibration Factor: <input style="width: 50px;" type="text"/>				
Date Fan Filter Cleaned: <input style="width: 50px;" type="text"/>	SO ₂ Coefficient Calibration Factor: <input style="width: 50px;" type="text"/>				
Date Particulate Filter Changed: <input style="width: 50px;" type="text"/>	Filter inlet Leak Check OK ? (<180mmHg and 0.0 lpm) (Y/N): <input style="width: 50px;" type="text"/>				
Internal Temp.(15-35C) <input style="width: 50px;" type="text"/>	Span Port Leak Check OK ? (<180mmHg and 0.0 lpm) (Y/N): <input style="width: 50px;" type="text"/>				
Chamber Temp.(43-47C) <input style="width: 50px;" type="text"/>	Alarms? <input style="width: 100px;" type="text"/>				
Pressure (650-800mmHg) <input style="width: 50px;" type="text"/>					
Flow (0.35-0.65 Lpm) <input style="width: 50px;" type="text"/>					
TEI 146C Calibrator					
Serial No.: <input style="width: 50px;" type="text"/>	Cylinder No.: <input style="width: 50px;" type="text"/>	Cylinder Press. (>500 psig): <input style="width: 50px;" type="text"/>			
Expiration Date: <input style="width: 50px;" type="text"/>	Expiration Date: <input style="width: 50px;" type="text"/>	Delivery Press.(30 psig): <input style="width: 50px;" type="text"/>			
Days Left: <input style="width: 50px;" type="text"/> -39722	Days Left: <input style="width: 50px;" type="text"/> -39722				
Cooling Fan/Filter OK? (Y/N): <input style="width: 50px;" type="text"/>	Concentration: (ppm) <input style="width: 50px;" type="text"/>				
Date Fan Filter Cleaned: <input style="width: 50px;" type="text"/>	Alarms?: <input style="width: 100px;" type="text"/>				
Zero Air Pack					
Serial No.: <input style="width: 50px;" type="text"/>	Delivery Air Press. (30 psig): <input style="width: 50px;" type="text"/>				
Expiration Date: <input style="width: 50px;" type="text"/>	Compressor Press. (40 psig): <input style="width: 50px;" type="text"/>				
Days Left: <input style="width: 50px;" type="text"/> -39722					
Silica Gel Checked (Y/N): <input style="width: 50px;" type="text"/>	Air Compressor drained ? (Y/N): <input style="width: 50px;" type="text"/>				
Date Silica Gel Changed: <input style="width: 50px;" type="text"/>					
Data Loggers					
Primary Data Logger OK? (Y/N): <input style="width: 50px;" type="text"/>	Data Backed-up? (Y/N): <input style="width: 50px;" type="text"/>				
Back-up Data Logger OK? (Y/N): <input style="width: 50px;" type="text"/>	Date of last back-up: <input style="width: 100px;" type="text"/>				
Notes					

SO ₂ CALIBRATION [formerly "adjusted calibration"]														
Site: <input style="width: 40px;" type="text" value="0"/>			Date: <input style="width: 40px;" type="text" value="1/0/1900"/>			Operator: <input style="width: 40px;" type="text" value="0"/>								
From 146C Readings														
Instrument Scale: <input style="width: 40px;" type="text" value="0.100"/> <small>(0.100, 0.200, 0.500 or 1.0 ppm)</small>			Span		Flow Rate		Flow Rate		146C					
			<small>(Gas, sccm)</small>		<small>(Air, sccm)</small>		<small>(SO₂, ppm)</small>							
Cylinder Conc., ppm: <input style="width: 40px;" type="text" value="0.00"/>			0						#DIV/0!					
			1						#DIV/0!					
			2						#DIV/0!					
			3						#DIV/0!					
record 5 consecutive 1-minute average values from the PDL, BUDL														
SO ₂	ZERO			SPAN 1 (70-90%)			ZERO			SPAN 1 (70-90%)				
Reading Number	Time Hrs:mins	PDL	BUDL	Time Hrs:mins	PDL	BUDL	Time Hrs:mins	PDL	BUDL	Time Hrs:mins	PDL	BUDL		
1														
2														
3														
4														
5														
Avg ppm		#DIV/0!	#DIV/0!		#DIV/0!	#DIV/0!		#DIV/0!	#DIV/0!		#DIV/0!	#DIV/0!		
PDL diff		#DIV/0!			#DIV/0!			#DIV/0!			#DIV/0!			
BUDL diff			#DIV/0!			#DIV/0!			#DIV/0!			#DIV/0!		
% Diff					#DIV/0!	#DIV/0!			#DIV/0!			#DIV/0!		
Acceptable (Yes/No):												#REF!		
Acceptable Range:														
			(diff +/- 2 ppb)			(diff +/- 3 ppb)			(diff +/- 2 ppb)			(diff +/- 3 ppb)		
record 5 consecutive 1-minute average values from the PDL, BUDL														
SO ₂	ZERO			SPAN 1 (70-90%)			SPAN 2 (40-60%)			SPAN 3 (precision pt)				
Reading Number	Time Hrs:mins	PDL	BUDL	Time Hrs:mins	PDL	BUDL	Time Hrs:mins	PDL	BUDL	Time Hrs:mins	PDL	BUDL		
1														
2														
3														
4														
5														
Avg ppm		#DIV/0!	#DIV/0!		#DIV/0!	#DIV/0!		#DIV/0!	#DIV/0!		#DIV/0!	#DIV/0!		
PDL diff		#DIV/0!			#DIV/0!			#DIV/0!			#DIV/0!			
BUDL diff			#DIV/0!			#DIV/0!			#DIV/0!			#DIV/0!		
% Diff					#DIV/0!	#DIV/0!			#DIV/0!	#DIV/0!		#DIV/0!		
Acceptable (Yes/No):														
Acceptable Range:														
			(diff +/- 2 ppb)			(diff +/- 3 ppb)			(diff +/- 3 ppb)			(diff +/- 2 ppb)		

SO ₂ CALIBRATION CHECK <small>[formerly "unadjusted calibration"]</small>																																
Site: <input style="width: 50px;" type="text" value="0"/>			Date: <input style="width: 50px;" type="text" value="1/0/1900"/>			Operator: <input style="width: 50px;" type="text" value="0"/>																										
Instrument Scale: <input style="width: 50px;" type="text" value="0.100"/> <small>(0.100, 0.200, 0.500 or 1.0 ppm)</small>			From 146C Readings																													
Cylinder Conc., ppm: <input style="width: 50px;" type="text" value="0.00"/>			<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th>Span</th> <th>Flow Rate (Gas, sccm)</th> <th>Flow Rate (Air, sccm)</th> <th>146C (SO₂, ppm)</th> </tr> </thead> <tbody> <tr><td>0</td><td></td><td></td><td>#DIV/0!</td></tr> <tr><td>1</td><td></td><td></td><td>#DIV/0!</td></tr> <tr><td>2</td><td></td><td></td><td>#DIV/0!</td></tr> <tr><td>3</td><td></td><td></td><td>#DIV/0!</td></tr> </tbody> </table>			Span	Flow Rate (Gas, sccm)	Flow Rate (Air, sccm)	146C (SO ₂ , ppm)	0			#DIV/0!	1			#DIV/0!	2			#DIV/0!	3			#DIV/0!							
Span	Flow Rate (Gas, sccm)	Flow Rate (Air, sccm)	146C (SO ₂ , ppm)																													
0			#DIV/0!																													
1			#DIV/0!																													
2			#DIV/0!																													
3			#DIV/0!																													
<small>record 5 consecutive 1-minute average values from the PDL, BUDL</small>																																
SO ₂	ZERO			SPAN 1 (70-90%)			SPAN 2 (40-60%)			SPAN 3 (precision pt)																						
Reading Number	Time Hrs:mins	PDL	BUDL	Time Hrs:mins	PDL	BUDL	Time Hrs:mins	PDL	BUDL	Time Hrs:mins	PDL	BUDL																				
1																																
2																																
3																																
4																																
5																																
Avg ppm		#DIV/0!	#DIV/0!		#DIV/0!	#DIV/0!		#DIV/0!	#DIV/0!		#DIV/0!	#DIV/0!																				
PDL diff		#DIV/0!			#DIV/0!			#DIV/0!			#DIV/0!																					
BUDL diff			#DIV/0!			#DIV/0!			#DIV/0!			#DIV/0!																				
% Diff					#DIV/0!	#DIV/0!		#DIV/0!	#DIV/0!		#DIV/0!	#DIV/0!																				
Acceptable (Yes/No):	<input style="width: 50px;" type="text"/>		<input style="width: 50px;" type="text"/>		<input style="width: 50px;" type="text"/>		<input style="width: 50px;" type="text"/>		<input style="width: 50px;" type="text"/>		<input style="width: 50px;" type="text"/>																					
Acceptable Range:	(diff +/- 2 ppb)		(diff +/- 3 ppb)		(diff +/- 3 ppb)		(diff +/- 3 ppb)		(diff +/- 3 ppb)		(diff +/- 2 ppb)																					