This SOP is subject to
review and revision in 2015.

BAY AREA
AIR QUALITY
MANAGEMENT
DISTRICT

TECHNICAL SERVICES DIVISION

QUALITY ASSURANCE PROJECT PLAN

STANDARD OPERATING PROCEDURE

AIRMON SOP 214

THERMO 48I-TLE

REVISION 214.2.00 08/27/2012

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1. PURPOSE

This Standard Operating Procedure (SOP) describes the installation, setup, general operation, calibration, maintenance, data collection, troubleshooting and repair of the Thermo Fischer Scientific, Inc. (THERMO) Model 48i-TLE (Trace Level) CO (Carbon monoxide) analyzer. This SOP supplements the procedures located in the THERMO Instrument Manual.

2. SUMMARY OF METHOD

The THERMO Model 48i-TLE operates on the principle of gas filter correlation (GFC) which measures the amount of infrared light absorbed by CO in a sample of ambient air. The quantity of light absorbed is proportional to the concentration of CO in the air sample. Please refer to the appropriate THERMO Instrument manual for a further explanation.

The THERMO Model 48i-TLE is designated by the United States Environmental Protection Agency (EPA) as a Reference or Equivalent Method for CO.

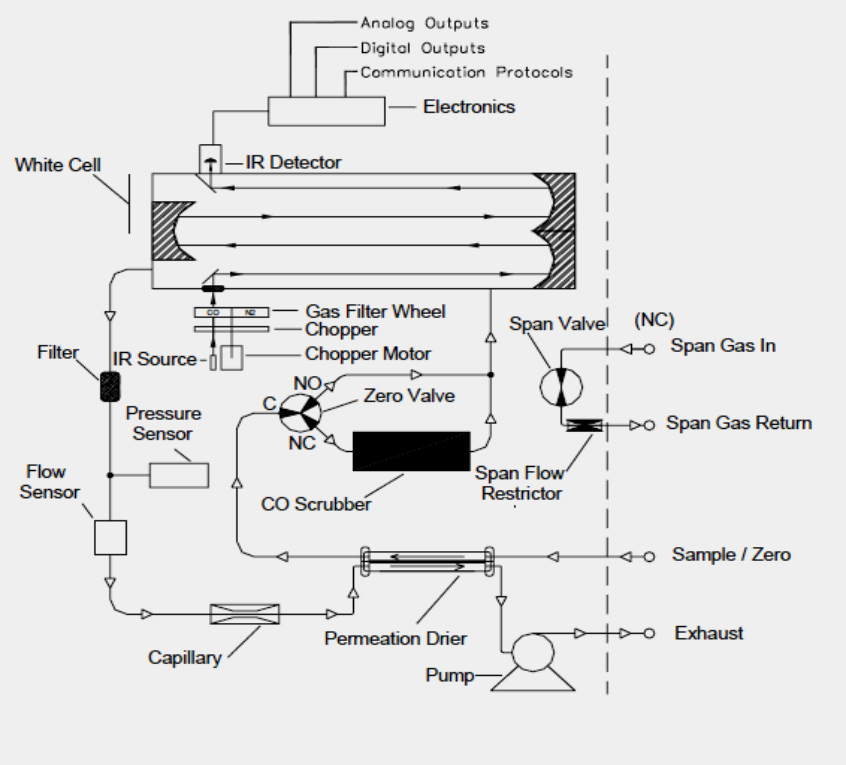


Figure 1**:** THERMO 48i-TLE Schematic

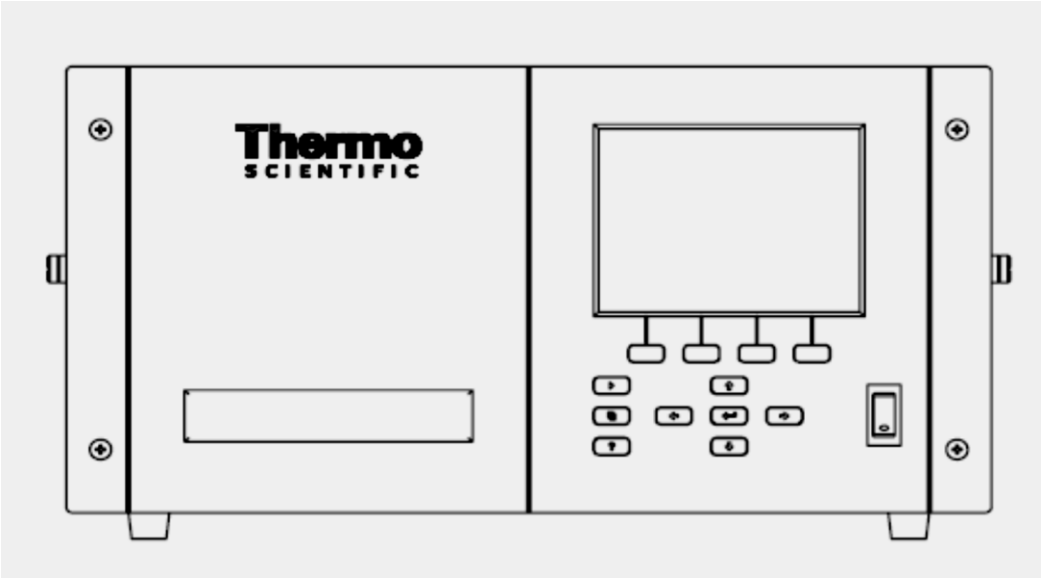


Figure 2: THERMO 48i-TLE Front Panel

3. DEFINITIONS

AQIS	Air Quality Instrument Specialist
BAAQMD	Bay Area Air Quality Management District
BKG	Background
CARB	California Air Resources Board
CFR	Code of Federal Regulations
CO	Carbon monoxide
COEF	Coefficient
DAS	Data Acquisition System
DMS	Data Management System
EPA	Environmental Protection Agency
GFC	Gas filter Correlation
IR	Infrared
MQO	Measurement Quality Objective
NAAQS	National Primary And Secondary Ambient Air Quality Standards
NDIR	Non-Dispersive Infrared Spectro-photometry
NIST	National Institute of Standards and Technology
PMT	Photo Multiplier Tube
ppb	Parts per billion
ppm	Parts per million
pptm	Parts per ten million
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QC	Quality Control
SOP	Standard Operating Procedure
THERMO	Thermo Fischer Scientific, Inc.
TLE	Trace Level

4. HEALTH AND SAFETY WARNINGS

NOTE: Consult the THERMO Instrument Manual ‘Safety Precautions’ Sections for Preventive Maintenance, Troubleshooting, and Servicing in Chapters 5, 6, and 7, respectively.

5. CAUTIONS

NOTE: Consult the THERMO Instrument Manual ‘Safety Precautions’ Sections for Preventive Maintenance, Troubleshooting, and Servicing in Chapters 5, 6, and 7, respectively.

6. INTERFERENCES AND LIMITATIONS

Reactive materials, solvents and excessive particulates in the probe and sample inlet tubing could be possible interferences. Monitoring should be temporarily stopped if local sources of potential interferences are detected (i.e. paving, painting, etc.). Probe inlet tubing and manifold should be cleaned if contamination is suspected.

Studies have shown conclusively that NDIR analyzers have interference from water vapor. Water absorbs very strongly across several bands of IR spectra. Water vapor interference occurs because water vapor absorption of light in the region of 3.1, 5.0 -5.5 and 7.1 -10.0 *u*m in the IR region. Since water vapor absorbs light in this region, this has a quenching effect on the reaction of CO.

CO2 absorbs in the IR spectrum at 2.7, 5.2, and 8.0 to 12.0 *u*m. This is very close to the regions that CO absorbs within as well. However, since atmospheric carbon dioxide is much higher in concentration than CO, this UV spectral range must be avoided. To prevent light in this spectral region, the THERMO 48i-TLE analyzer has a band pass filter that blocks these wavelengths.

Lower detectable limit: 0.04 ppm (60 second averaging time)

7. PERSONNEL QUALIFICATIONS AND RESPONSIBILITIES

Installation, operation, maintenance, repair or calibration of the instrument and all support equipment should only be performed by properly trained personnel. Personnel should meet all minimum BAAQMD requirements and qualifications for an Air Quality Instrument Specialist (AQIS) I or II, Senior AQIS, and/or Supervising AQIS.

- The station operator AQIS is responsible for the operation and oversight of the instrument and all support equipment. The operator shall complete any required or recommended maintenance, minor repairs and/or occasional calibration of the instrument and all support equipment. The station operator AQIS is responsible for first level DMS data review and validation. The station operator AQIS may occasionally install or replace an instrument or support equipment. The Senior AQIS and Supervisor AQIS complete major installations, repairs and calibrations.

- BAAQMD MQA personnel manage the DMS and complete all final data review and submittal.

- BAAQMD PEG staff may conduct periodic performance and/or system's audits.

- CARB staff may conduct periodic performance and/or system's audits.

- EPA staff may conduct periodic performance and/or system's audits.

8. EQUIPMENT AND SUPPLIES

The THERMO 48i-TLE is normally installed and operated with the following equipment:

- THERMO Instrument Manual
- Instrument bench or instrument rack. **NOTE**: Rack installation requires the use of the appropriate instrument sliders securely attached to the analyzer.
- Grounded 3-wire plug
- 10-micron Teflon filters and a Teflon filter holder assembly with appropriate fittings
- ¼" Teflon sample line tubing. The length of the tubing should be less than 10 feet
- Inlet probe and probe line material installed following EPA siting requirements
- external diaphragm pump (Thomas or other)
- glass manifold
- magnehelic gauge (NOTE: for partial stations use a -2" to + 2" magnehelic)
- OPTIONAL: kicker pump (Thomas or other)
- Calibrator
- Zero-air supply
- Certified multi-blend cylinder with CO component (full station) and regulator
- 1/8" SS tubing (from cylinder to the calibrator) and appropriate fittings; **NOTE**: All gas delivery connections should be leak tested with SNOOP upon installation!
- OPTIONAL: Climate-controlled instrument shelter
- Date Acquisition System (DAS) with appropriate cables and adaptors (RS-232, DB9, CAT-5, etc) with connection to the District's Data Management System (DMS)

9. PROCEDURES

9.1 INITIAL SETUP

(**NOTE**: Please refer to the appropriate THERMO Instrument Manual for further information)

1. Inspect a new analyzer for any external damage. Carefully remove the instrument cover and check for any internal damage or missing parts. Check that all connectors and printed circuit boards are firmly attached. Remove any shipping screws inside the chassis and packing materials.

NOTE: For most applications, instruments must be installed and operated following EPA requirements for siting and location.

2. Connect a sample line and external filter assembly to the **SAMPLE IN** bulkhead on the rear panel of the analyzer. (Figures 3)
3. **OPTIONAL:** Disconnect internal pump**;** connect the **EXHAUST** bulkhead to an external pump. The line should be ¼ " OD. The length of the exhaust line should be as short as possible. Verify that there is no restriction in this line.
4. Plug the analyzer into an outlet of the appropriate voltage and frequency.
5. Press power switch to 'ON'.
6. Adjust all appropriate analyzer settings for range, averaging time, alarms, internal data logging and communications:
    a. Auto Range Mode: Low Range 5.0 ppm; High Range 50 ppm
    b. Average Time 60 seconds
    c. Span Coefficient = 1.000
    d. Pressure Compensation on
    e. Temperature Compensation on
    f. 48i-TLE: data-logging and communications. Contact Senior AQIS or Supervisor AQIS for instructions
7. **NOTE**: If installing at a station, connect to a DAS; if the DAS is connected to the DMS, move the instrument to the appropriate site location and activate the instrument.
8. Allow at least one hour for the analyzer to stabilize;
9. **NOTE: If installed at a station, complete a full calibration**.
10. Enter any pertinent information into the appropriate DMS instrument e-log.

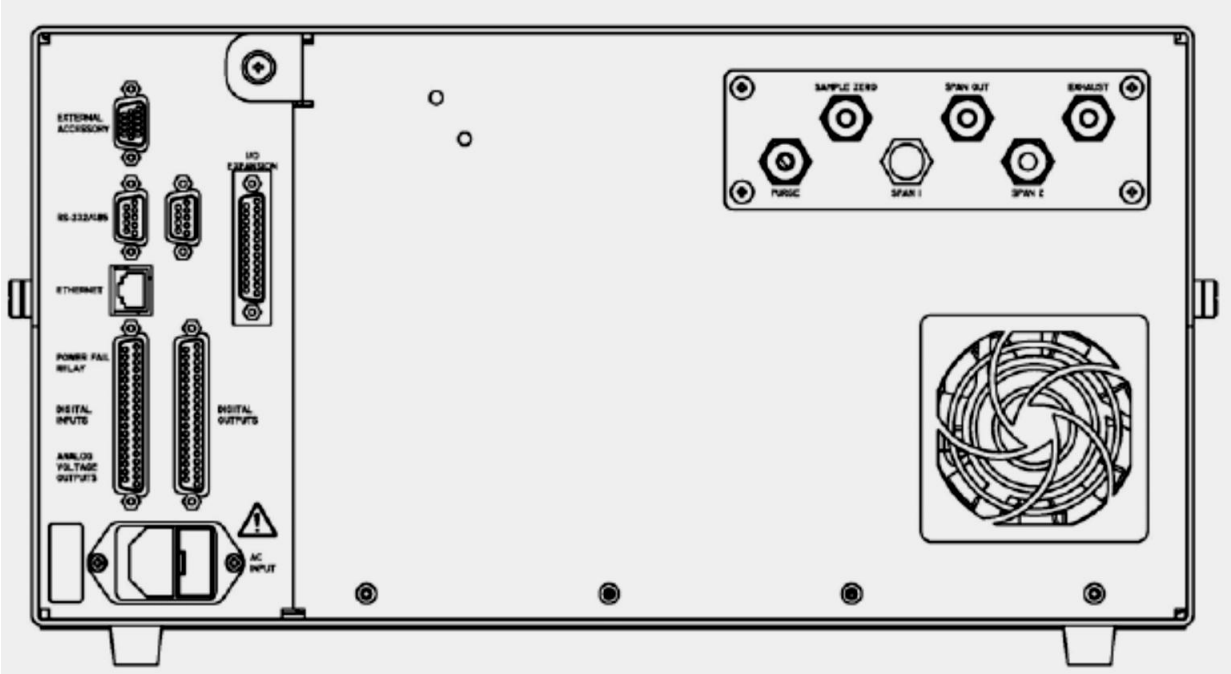


Figure 3: THERMO 48i-TLE Rear Panel

9.2 ACCEPTANCE TESTING

(**NOTE**: Please refer to the appropriate THERMO Instrument Manual for further information)

Staff will conduct acceptance testing on new instruments prior to deployment in the field. Setup analyzer following steps in Section 9.1 of this SOP in a mock station setting which includes an ultra-pure zero-air supply, a stable calibrator, certified multi-blend cylinder, regulator and a DAS connected to the DMS.

1. Calibrate analyzer (Section 9.3 of this SOP)
2. Check linearity by running a gas span, mid-high, mid-low, and precision level calibrations, allowing at least 20 minutes for all points;
3. Allow to run for a minimum of 1 week in a simulated station setup running automated nightly calibrations.
4. Check 1-minute and hourly data and parameters for stability, repeatability, flags and/or alarms, or any other atypical performance.
5. Enter any pertinent information into the appropriate DMS instrument e-log.
6. New instruments should have a BAAQMD barcode number assigned.

9.3 CALIBRATION

(**NOTE**: Please refer to the appropriate THERMO Instrument Manual for further information)

NOTE: TLE model operating in Auto Range mode may require Low Range and High Range multi-point calibration. Refer to Instruction Manual Chapter 3-77 for procedure. Be sure to save re-calculated coefficients.

District policy and EPA regulations typically require zero/span calibration when the instrument is newly installed, moved, repaired, interrupted for more than a few days, or when there is a span calibration response ≥ +/- 10 % or a zero calibration response ≤ ± 0.05 ppm or a QC 1-point precision shift by ≥ +/- 15 %.

9.3.1 Procedure: Full Calibration (Including Adjustments)

1. Set initial SPAN COEF = 1.000 for all new instruments
2. Start a manual zero-air calibration.
3. Allow the analyzer to sample zero air for a minimum of 10 minutes;
4. If the analyzer is indicating 0.0 ppm no further adjustment is necessary. If the analyzer is indicating +/ > or < 0.05 ppm then a zero calibration is required. **NOTE**: After replacement

or cleaning of a correlation wheel, re-set the initial S/R value to match the indicated thru the SERVICE menu.

5. Start a DAS-controlled gas span;
6. **OPTIONAL**: Start flow from a NIST traceable certified CO span cylinder:
    a. Start flow to the analyzer introduced at low pressure and low flow (~30% greater than sampler flow rate)
    b. Ensure that the flow path from cylinder to the analyzer is vented to atmosphere using a suitable rotometer, Tee, and tubing rig
7. Allow the analyzer to sample calibration or cylinder gas for 20 minutes;
8. If the value is ≤ +/- 5 % of the true concentration, no further adjustment is required. If the value is > +/- 5 %, or if the analyzer is new or recently repaired, a calibration is required.
9. **OPTIONAL**: Perform a multipoint calibration using three (span, mid and precision level) NIST traceable certified CO span cylinders following instructions in the instrument manual.
10. **OPTIONAL**: Check and re-zero the analyzer.
11. **OPTIONAL**: When the analyzer is calibrated and has remained stable for at least 15 minutes, the operator may elect to run mid-high, mid-low and/or precision level calibration points to check linearity.
12. After the calibration is completed, stop the DAS-controlled calibration Allow the reading to stabilize. Check that the analyzer is out of Service mode and back in the **REMOTE** mode.
13. Record all pertinent information onto the instrument e-log.
14. Visually check the entire system prior to leaving the station to verify correct operation.

9.3.2 Procedure: Manual Span and Zero Verification

In the absence of automated calibrations, the operator must test the CO analyzer in the field at concentrations of 0.0 and 4.5 ppm for TLE model. The test must be performed, at a minimum, once every two weeks.

1. Start a DAS-controlled manual zero-air calibration. If there is a kicker pump at the station, disconnect.
2. Allow the analyzer to sample zero air from a manifold that is at near atmospheric pressure for a minimum of 15 minutes.
3. Start a DAS-controlled manual gas span. Allow the analyzer to sample calibration gas from a manifold that is at near atmospheric pressure for a minimum of 20 minutes.
4. If the value is within 5 % for TLE of the true concentration, no further adjustment is required. If the value is > +/- 5% for TLE, the operator should adjust the analyzer.
5. When the analyzer is calibrated and has drawn a stable trace for at least 15 minutes, the calibrator can be switched back to zero-air.
6. After the calibration is completed, stop the DAS-controlled calibration. If there is a kicker pump at the station, reconnect. Allow the reading to stabilize. Check that the analyzer is back in the **REMOTE** mode.
7. Record all pertinent information into the instrument e-log.
8. Visually check the entire system prior to leaving the station to verify correct operation.
9. The operator must validate the appropriate DMS 1-minute data.

9.3.3 Procedure: Manual Precision

Precision is defined as the measure of agreement among individual measurements of the same property taken under the same conditions. In the absence of automated calibrations, the operator must test the CO analyzer in the field at a concentration ~0.4 ppm for TLE. The test must be performed, at a minimum, once every two weeks. **NOTE**: Do not adjust the analyzer while running a precision!

1. Start a DAS-controlled manual gas precision calibration. If there is a kicker pump at the station, disconnect.
2. Allow the analyzer to sample calibration gas from a manifold that is at near atmospheric pressure for a minimum of 20 minutes.
3. If the value is within 10% of the true concentration, start a manual DAS 'abort' calibration script.
4. If the value is > +/- 10% for TLE, the operator should adjust the analyzer by running a zero and span, followed by another precision.
5. After the calibration is completed, stop the DAS-controlled calibration. If there is a kicker pump at the station, reconnect. Allow the reading to stabilize. Check that the analyzer is back in the **REMOTE** mode.
6. Record all pertinent information into the instrument e-log.
7. Visually check the entire system prior to leaving the station to verify correct operation!
8. The operator must validate the appropriate DMS 1-minute data.

9.4 AUTO-CALIBRATION, 'AUTO-CALS'

At most District air-monitoring locations, DAS-controlled nightly automated calibrations (auto-cals) are completed on a regular schedule. This may include the completion of precision, mid-low, mid-high, span and zero level calibrations on a rotational basis following all EPA requirements. The operator is responsible for reviewing nightly auto-cal results on the District DMS and taking any appropriate actions if the auto-cal results are unacceptable. **NOTE**: Please refer to Section 10 of this SOP, "*DATA AND RECORDS MANAGEMENT*"; and Section 11 of this SOP, "*QUALITY CONTROL AND QUALITY ASSURANCE*".

1. Log onto DMS.
2. Check that the analyzer nightly auto cal response is within its recommended Quality Control (QC) limits. If the instrument response is outside the specified quality control limit, the source of the problem is to be investigated and corrected. Violation of a QC limit does not require data action as long as an MQO is not also exceeded.
3. The operator will adjust the analyzer if the nightly auto-cal results or manual calibrations results are outside of the acceptable BAAQMD QC limits. QC limits are developed to provide an early warning of instrument problems prior to the exceedance of a Measurement Quality Objective (MQO).
4. If any MQO's are exceeded, the source of the problem is to be investigated and corrected and the operator shall invalidate all suspect or questionable 1-minute DMS data **unless** the error is a result of other equipment (i.e., malfunctioning calibrator, power-failure, etc) **and** the

operator has demonstrated that the instrument is functioning within its specified operating parameters.

5. Record all pertinent information into the instrument e-log.

9.5 SERVICE AND MAINTENANCE

The operator shall perform all recommended or required diagnostic checks, service and maintenance. The following table is a suggested general guideline for service and maintenance. **NOTE**: Please refer to the appropriate THERMO instrument manual for further information:

Maintenance Item	Suggested Period	SOP Section
Change Inlet Filter	**2-3 weeks**	9.5.1
Cooling Fan Filter Servicing	**Monthly**	9.5.2
Instrument Internal Cleaning	**6 months**	9.5.3
Capillary Inspection And Cleaning	**6 months**	9.5.4
IR Source Replacement	**Annually***	9.5.6
External Pump Rebuild	**Annually***	9.5.7
Internal Pump Rebuild	**Annually***	9.5.8
Full Calibration	**Annually***	9.3
Method Detection Limit (MDL) tests	**Annually**	9.5.9

***These items may be performed more often as required.

Figure 4: Suggested Maintenance Schedule

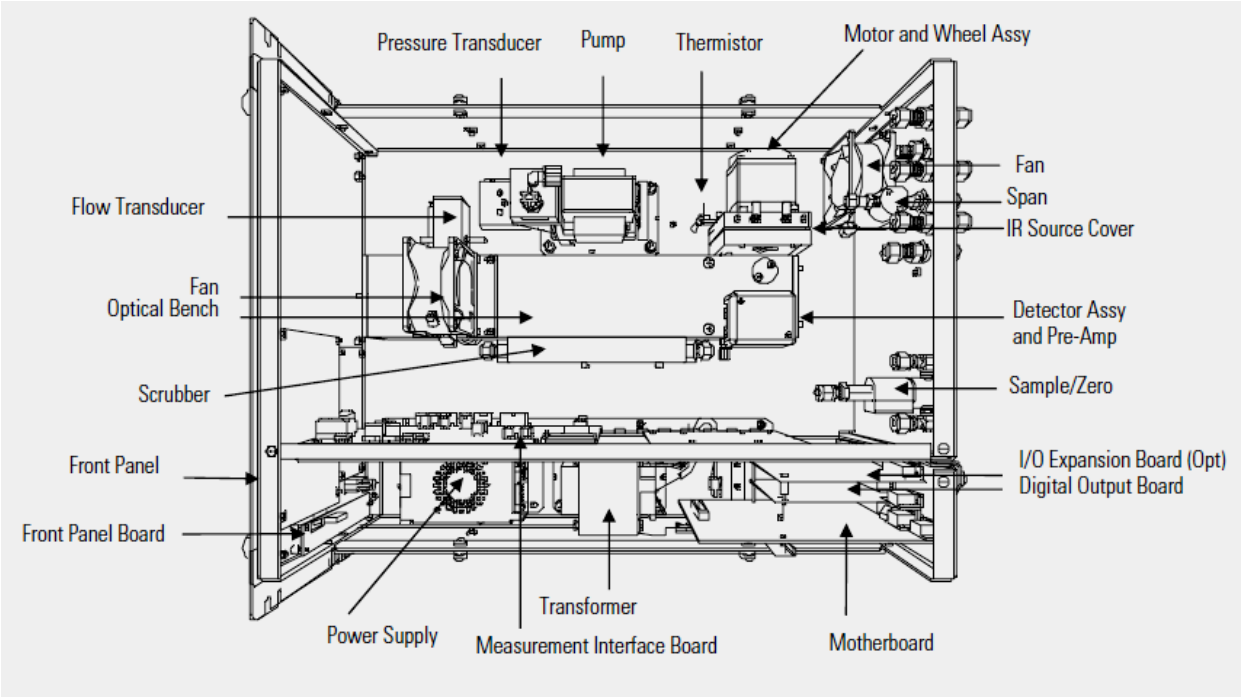


Figure 5: Internal Components 48i-TLE

9.5.1 Procedure: Change Inlet Filter

An in-line Teflon filter protects the analyzer from dirt and contaminants. Filters should be changed on a regular schedule. Use 10.0 Teflon filters.

1. Carefully open filter holder assembly;
2. Remove old filter, replace with new filter;
3. Carefully close filter holder assembly;
4. Enter the appropriate information into the DMS e-log for the instrument

9.5.2 Procedure: Cooling Fan Filter Servicing

1. Remove the fan guard from the fan and remove the filter.
2. Flush the filters with warm water and let dry (a clean, oil-free purge will help the drying process) or blow the filters clean with compressed air.
3. Re-install the filter and fan guard.
4. Enter the appropriate information into the DMS e-log for the instrument

9.5.3 Procedure: Instrument Internal Cleaning

1. Disable the appropriate DAS channel.
2. Turn the instrument OFF and unplug the power cord.
3. Carefully open instrument cover;
4. Vacuum the instrument interior;
5. Carefully blow out remainder of dust with compressed air;
6. Carefully replace instrument cover;
7. Plug in analyzer and switch on.
8. After readings have stabilized, enable the appropriate DAS channel.
9. Enter the appropriate information into the DMS e-log for the instrument

9.5.4 Procedure: Capillary Inspection and Cleaning

1. Disable the appropriate DAS channel.
2. Turn the instrument OFF and unplug the power cord.
3. Remove the instrument cover.
4. Locate the capillary holder.
5. Remove the glass capillary and o-ring. Inspect o-ring for cuts or abrasion, and replace as necessary.
6. Check capillary for particulate deposits. Clean or replace as necessary.
7. Replace capillary making sure the o-ring is around the capillary before inserting it into the body.
8. Finger-tighten the capillary nut enough to ensure a tight seal.
9. Carefully replace instrument cover;
10. Plug in analyzer and switch on.
11. After readings have stabilized, enable the appropriate DAS channel. Enter the appropriate information into the DMS e-log for the instrument.

9.5.5 Procedure: Clean/Replace Correlation Wheel

1. Disable the appropriate DAS channel.
2. Turn the instrument OFF and unplug the power cord.
3. Remove the instrument cover.
4. Loosen 4 screws holding the optical bench.
   Remove the chopper motor and wheel assembly by removing the three motor plate's Allen screws holding the motor plate to the optical bench. TLE models disconnect purge tube from wheel housing.
5. Insert a 5/64-inch Allen wrench through the access hole in the bottom of the motor plate, loosen the set screw holding the filter wheel to the motor shaft, and carefully pry the filter wheel off the motor shaft. When removing filter wheel from motor shaft, loosen set screw ½ turn only.
6. Make a small mark on the front of the filter wheel mask.
7. Remove filter wheel mask.

8. Carefully clean correlation wheel with distilled water and compressed air. Do not leave fingerprints or lint on wheel.
9. Inspect wheel for leaking by holding up to a light source. If a leaky correlation wheel is suspected, replace with a known good correlation wheel.
10. Clean sapphire filter lens with DI H20 and paper towel.
11. Carefully re-install the filter wheel mask noting alignment.
12. Carefully re-install the filter wheel by following the previous steps in reverse. Make sure that the set screw seats on the flat of the motor shaft.
13. After the filter wheel is installed, spin the wheel and observe that it runs.
14. Carefully replace instrument cover;
15. Plug in analyzer and switch on.
16. Let the instrument sample zero air for about 90 minutes.
17. Place into SERVICE MODE.
18. From the Main Menu, press to scroll to Service > press > to scroll to Initial S/R Ratio and press enter. The Initial S/R Ratio screen appears.
19. At the Initial S/R Ratio screen, press to select set the initial S/R ratio to the value of the current ratio and press to store the value. The initial S/R ratio should be between 1.14 and 1.18.
20. Calibrate the instrument.
21. Re-enable the appropriate DAS channel.
22. Enter the appropriate information into the DMS e-log for the instrument

9.5.6 Procedure: IR Source Replacement

It is not necessary to recalibrate the Model 48i-TLE after replacing the Infrared (IR) source since the Model 48 is a ratio instrument, and replacing the IR source does not affect the calibration.

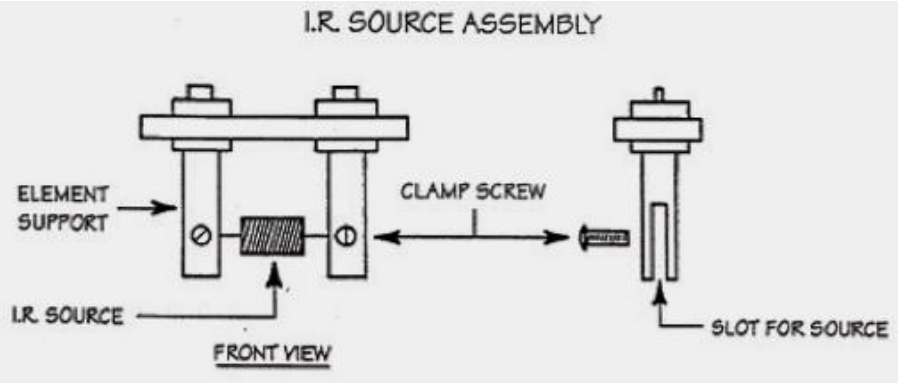


Figure 6: IR Source

1. Disable the appropriate DAS channel.

2. Turn the instrument OFF and unplug the power cord.
3. Remove the instrument cover.
4. Disconnect the IR source cable from source cover.
5. Remove the IR source assembly by removing two screws that hold the source cover to chopper motor plate.
6. Replace the old IR source with a new one by loosening the two screws that screw the IR source to the element support standoffs.
7. Reinstall the source assembly, reconnect the source cable.
8. Carefully replace instrument cover;
9. Plug in analyzer and switch on.
10. After readings have stabilized, enable the appropriate DAS channel.
11. Enter the appropriate information into the DMS e-log for the instrument

9.5.7 Procedure: External Pump Rebuild

Most stations use an external Thomas vacuum pump. The pump should be checked and re-built annually or when flow/vacuum issues arise. The pump should pull at least 15 "Hg and be steady. Other pumps may be used, in which case, refer to the instructions that are provided with the pump rebuild kit. Noisy bearings should be replaced. Pumps that run hot, are excessively noisy, or fail to deliver a steady vacuum should be replaced.

OPTIONAL: In order to decrease instrument down-time, the operator may elect to switch in a new or rebuilt pump.

1. Disable the appropriate DAS channel.
2. Unplug pump; disconnect the ¼" line from the pump.
3. Place a mark on the pump head to indicate proper re-positioning.
4. Remove the 4 screws holing the pump top valve assembly; remove the top valve assembly.
5. Remove and inspect the pump diaphragm. If cracked, hardened, torn or damaged, replace diagram.
6. Remove valve plate assembly from the top valve plate, noting alignment.
7. Carefully inspect plate assembly. Remove the flapper valves and clean. Replace if corroded or damaged. Inspect the gasket. Replace if damaged.
8. Replace the valve plate assembly to the top valve plate, noting alignment.
9. Replace the pump top valve assembly;
10. Clean out windings with compressed air.
11. Plug in pump. Check with vacuum gauge.
12. Re-connect the ¼" line to the pump.
13. Check/re-calibrate analyzer.
14. After readings have stabilized, enable the appropriate DAS channel.
15. Enter the appropriate information into the DMS e-log for the instrument

9.5.8 Procedure: Internal Pump Rebuild

1. Disable the appropriate DAS channel.
2. Turn the instrument OFF and unplug the power cord.
3. Remove the instrument cover.
4. Unplug pump from power supply; disconnect the ¼" fittings from top of the pump.
5. Place a mark on the pump head to indicate proper re-positioning.
6. Remove the 4 screws holing the pump top valve assembly; remove the top valve assembly.
7. Remove and inspect the pump diaphragm and valve plate. If cracked, hardened, torn or damaged, replace diagram and valve plate.
8. Replace the pump top valve assembly;
9. Re-connect ¼" fittings to top of the pump
10. Plug in pump.
11. Carefully replace instrument cover;
12. Plug in analyzer and switch on.
13. After readings have stabilized, enable the appropriate DAS channel.
14. Enter the appropriate information into the DMS e-log for the instrument

9.5.9 Procedure: Annual Method Detection Limit tests

The MDL should be established on-site by supplying the analyzer at least seven times with a test atmosphere containing CO at a concentration that is approximately one to five times greater than the estimated MDL, and recording the response. To perform the MDL test, run zero air through the analyzer and establish an acceptable zero; dilute pollutant gas to the targeted concentration (one to five times the estimated MDL) and collect 20 to 25 one minute observations. Repeat this seven times over the course of 5 to 14 days. Average the concentration from the 20-25 readings; calculate the standard deviation (S) of the average readings and compute the MDL. The MDL is then calculated as the standard deviation of the response values times the Student's t-value for the number of test measurements (40 CFR Part 136, Appendix B).
The MDL for high sensitivity CO analyzers should be established prior to putting the analyzers into service, and should be 0.080 ppm (80 ppb) or lower over an averaging time of no more than 5 minutes.

1. Start trace level "manual_MDL_Full_CO" script in the morning after a 06:30 trace level CO auto zero check is finished.
2. Run another "manual_MDL_Full_CO" script in the afternoon after a 12:30 trace level CO auto zero check is finished.
3. Repeat this procedure over a 2 week period until 11 acceptable tests are completed.
4. Export the Op Code 30 response values into a spreadsheet. Refer to "How to create a MDL Export File" procedure.
5. Copy Op Code 30 response values from export file into "2012 CO MDL tests" spreadsheet. Calculate the MDL using the formulas in the spreadsheet.

Save the MDL spreadsheet locally and copy in the AM Work files folder.

6. Enter the appropriate information into the DMS e-log for the instrument.

9.6 TROUBLESHOOTING

NOTE: Please refer to the appropriate THERMO Instrument Manual troubleshooting guide for further information.

NOTE: The operator should utilize the DMS to track and record various parameters (parametric data) which may be helpful for troubleshooting.

NOTE: 1-minute DMS data also includes instrument flags. For diagnostic flag codes, please refer to Appendix B of this SOP.

The operator should be aware of the following:

- Abnormal or out-of-range concentration values on instrument front display;
- 'Alarm' or alarm icon present on the analyzer front display;
- Abnormal or out-of-range diagnostic's values (i.e., flow, pressure, chamber temperature, frequency, etc.);
- Abnormal or out-of-range DAS or DMS parametric data (i.e., flow, pressure, chamber temperature, frequency, etc.);
- Abnormal DAS or DMS instrument diagnostic flags;
- Abnormal or unusual auto calibration and/or manual calibration results;
- Unusual sounds (pump, kicker pump, etc.)

The operator should take the appropriate steps to resolve any instrument issue:

- Troubleshoot to identify faulty component or support equipment
- Repair instrument or support equipment;
- Check and verify instrument's performance; re-calibrate if needed;
- Review and invalidate any data that does not meet the criteria in Section 11 of this SOP;
- Review and validate or invalidate any questionable data as 'suspect';
- Maintain the appropriate DMS instrument and/or station e-log. The operator must enter the appropriate information after the completion of any repairs, maintenance, or adjustments. The operator should note any data gaps.
- In cases of instrument failure or inability to repair on-site, the operator should contact the Senior AQIS and/or the Supervising AQIS in order to coordinate replacement of the instrument.

SYMPTOM: Occasional rapid spiking between baseline and full scale

- Indications of an intermittent input or measurement interface board problem
- Sparking IR source will cause a noisy trace

SYMPTOM: Increased zero drift and/or decreased sensitivity

- A dirty filter wheel will affect analyzer performance as will leakage of gas within the wheel.
- Indications of these conditions would be s/r ratio outside of 1.14 and 1.18,
- A leaking filter wheel may have a rainbow appearance near the outer edges of the glass lens looking at wheel under florescent light.

SYMPTOM: IR source

- Failure indications are white ash color, no visible glow and very high resistance value.
- Sparking IR source will cause a noisy trace. IR resistance value is about 16 ohms for a new source.
- Measure 17vdc for IR source on top of mounting block. Mounting block is attached with two screws.

OTHER:

- Excessive moisture in the optic chamber will affect analyzer performance.
- Clean sapphire filter lens with DI H20 and paper towel.
- Clean mirrors with alcohol, KI and camel hair brush. Do not apply pressure against mirror surface because surface scratches easily.
- If the sample pump fails, simply connect a new or rebuilt single diaphragm Thomas pump to the exhaust port of the analyzer.
- Chopper motor does not require oiling of the bearings. The bearings are sealed.

9.7 COMPUTER HARDWARE AND SOFTWARE

The 48i-TLE is connected to a BAAQMD station DAS via its Serial RS-232 Port. The DAS collects 1-minute data. All 48i-TLE instrument parameters must be set accordingly. No further data calculations or reduction are required.

- DAS: The operator should be familiar with operation of the station's DAS and the DAS manual calibration script files
- DMS: Operator should be familiar with the operation of the DMS software including data review, auto-cal response data review, e-log entry, etc.
- iPort: The operator should be familiar with the use of THERMO iPort software

10. DATA AND RECORDS MANAGEMENT

- 1-minute concentration data (ppm) is collected by the station's DAS. The station DAS pushes data hourly to the BAAQMD DMS. Data is retained by the DMS for future review and usage.

- 1-minute analyzer parametric data are collected by the station's DAS. The station DAS pushes data hourly to the BAAQMD DMS. Data is retained by the DMS for future review and usage.

- Analyzer parametric data may include various instrument operating parameters such as flow rate, pressure, lamp temperature, instrument flags (please refer to the appropriate THERMO instrument manual and Appendix B and C of this SOP for an explanation of diagnostic flags), etc. The operator is encouraged to use the instrument parametric data as an aid to data review and validation and for troubleshooting

- District staff are responsible for data and records management including oversight of data capture into a station DAS, data ingestion into the District DMS, data review and validation, and data retention.

The operator is responsible for the following:

- Review and validate or invalidate any data that does not meet the criteria in Section 11 of this SOP
- Review and validate or invalidate any questionable data flagged as 'suspect' in DMS.
- Maintain the appropriate DMS instrument and/or station e-log. The operator must enter the appropriate information after the completion of any repairs, maintenance, or adjustments. The operator should note any data gaps. The operator may elect to manually collect data from the analyzer in the event of a DAS data collection error.

11. QUALITY CONTROL AND QUALITY ASSURANCE

Quality Control (QC) procedures include the completion of any required calibrations, service and maintenance. Quality Assurance (QA) procedures include the completion of any required audits.

11.1 QUALITY CONTROL

- DAS-controlled zero, span, mid-low span, mid-high span, and precision level auto-cals are automatically run nightly, alternating between the various auto-cals. The operator will adjust the analyzer if the nightly auto-cal results are outside of the acceptable BAAQMD QC limits. QC limits are developed to provide an early warning of instrument problems prior to the exceedance of a Measurement Quality Objective (MQO). If a QC measurement is outside the specified quality control limit, the source of the problem is to be investigated and corrected.
- If the analyzer is set up in a station without nightly auto-cals, the station operator will complete a weekly manual DAS controlled zero/span or precision verification of the 48i-TLE following the procedure located in Section 9.3.2 or 9.3.3 of this SOP;
- Violation of a QC limit does not require data action as long as an MQO is not also exceeded.
- If any MQO's are exceeded, the source of the problem is to be investigated and corrected and the operator shall invalidate all suspect or questionable 1-minute DMS data **unless** the error is a result of other equipment (i.e., malfunctioning calibrator, power-failure, etc.) **and** the operator has demonstrated that the instrument is functioning within its specified operating parameters.
- The operator shall perform all recommended or required diagnostic checks, service and maintenance. Please refer to Section 9.5 of this SOP and the appropriate instrument manual for more information.
- Hourly DMS data are manually invalidated by MQA if the station/shelter temperature range exceeds instrument certification limits. Data invalidations due to station temperature excursions are managed manually by MQA on a case-by-case basis per guidelines documented in Data Management SOP 601.

Parameter	Instrument	EPA Required Temp Range	BAAQMD Station/Shelter Out Of Range Criteria
CO	THERMO 48iTLE	20 -30 °C	≤ 19.5 °C or ≥ 30.5 °C

Figure 7: BAAQMD Station/Shelter Temperature Criteria

- **NOTE:** Operator should include comments regarding shelter temperatures, sensors, controls, etc. in DMS e-logs. Data quality/validity resolution resides with MQA.

- **NOTE:** Ambient data correction and adjustment will be performed on hourly data only, by MQA, with justification provided by AQIS (i.e. pump pressure shifts, instrument adjustment, data shift or data drift caused by instrument component failure).

Parameter	Requirement	Frequency	Acceptance Criteria
Carbon Monoxide Trace Level	Precision Check	Every 2 days	≤ ± 15%
	Zero/Span Check	Every 2 days	≤ ± 0.05 ppm Zero ≤ ± 7% Span diff
	Bias Validation	Annual	95% of PE points fall within 95% PL for QC Checks

Figure 8: BAAQMD QC Limits for CO Trace Level

Parameter	Requirement	Frequency	Acceptance Criteria
Carbon Monoxide [1] Trace Level	Precision Checks	Every 2 days	≤ ± 15%
	Precision (QC Checks)	Annual	≤ 15%
	Bias (QC Checks)	Annual	≤ ±10%
	Shelter Temperature	Hourly	20-30 °C

Figure 9: BAAQMD MQO's for CO Trace Level

[1]Precision and Bias MQO are taken from EPA QA Handbook Vol II, Appendix D, March 2008 revision.

11.2 QUALITY ASSURANCE

Quality Assurance activities include the following:

- District staff shall conduct performance and system's audits on a regular basis.
- CARB staff may conduct performance and/or systems audits
- EPA staff may conduct performance and/or systems audits

Parameter	Frequency	Acceptance Criteria
Carbon Monoxide Trace Level	Semi-Annual	≤ ± 15%

Figure 10: BAAQMD Internal Audit Acceptance Criteria

12. AUTHORS

- Original Author: Morris Erickson
- Revised By: Stan Yamaichi, 5/30/2008
- Revised By: Christopher Rumm, 11/16//2011; re-formatted SOP; added THERMO 'i' Model information
- Revised By: Lisle Rath and Stan Yamaichi, 2/29/12; added TLE information

13. REFERENCES

- Code of Federal Regulations, Title 40, Part 53
- Code of Federal Regulation, Title 40, Part 58
- EPA QA Handbook Vol. II, Quality Assurance Handbook for Air Pollution Measurement Systems
- EPA Air Quality Standards, 40 CFR Part 50, NAAQS for Criteria Pollutants
- Thermo Fischer Scientific, Inc. (THERMO 48i-TLE) CO Analyzer Instrument Manual: \\cifs-02\sections\Air_Mon\Instrument Manuals\THERMO
- Data Mgt SOP 601 Gaseous Pollutants

14. APPENDIXES

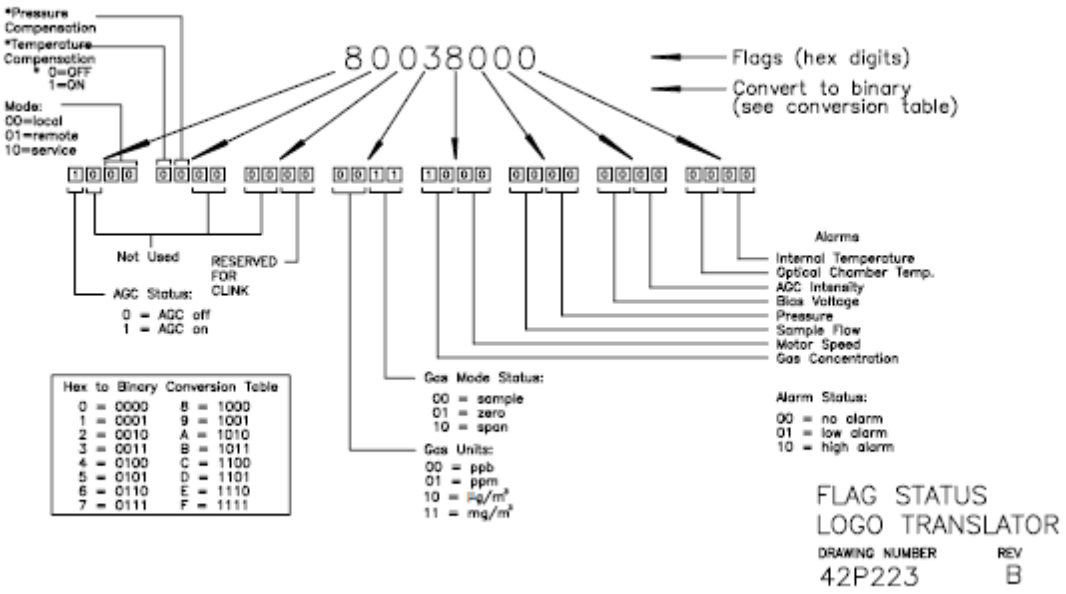
14.1 APPENDIX A: 48 SPECIFICATIONS

SPECIFICATIONS YELLOW = RECOMMENDED SETTING

Preset ranges:	0-1, 2, 5, 10, 20, 50, 100, 200 (ppm)
Zero noise	0.02 ppm RMS (60 second averaging time)
Lower detectable limit	0.04 ppm
Zero drift (24 hour)	< 0.1 ppm
Span drift	± 1% full-scale
Response time	60 seconds (30 second averaging time)
Linearity	± 1% full-scale or 0.04 ppm, whichever is greater
Sample flow rate	0.5 LPM
Operating temperature	20–30 °C (may be safely operated over the range of 0–45 °C)*
Power requirements	100 VAC @ 50/60 Hz, 115 VAC @ 50/60 Hz; 275 watts
Physical dimensions	16.75” (W) X 8.62” (H) X 23” (D)
Weight Approximately	49 lbs.
Serial Ports	1 RS-232 or RS-485 with two connectors, baud rate 1200–115200, data bits, parity, and stop bits, protocols: C-Link, MODBUS, and streaming data (all user selectable)
Ethernet connection	RJ45 connector for 10Mbs Ethernet connection, static or dynamic TCP/IP addressing

*In non-condensing environments.

14.2 APPENDIX B: 48I-TLE ALARM FLAGS



14.3 Appendix C: EXAMPLE OF 48I TLE MDL TEST RESULTS

				CO								
	01/26/12		01/27/12		01/30/12		01/31/12		02/01/12		02/02/12	
	1.94778	2.00316	2.01984	1.88441	1.84994	1.90919	1.84254	1.86903	1.99152	1.90284	1.9333	
	1.98171	1.99033	2.01615	1.94515	1.83822	1.88799	1.82905	1.89677	1.98245	1.87637	1.92505	
	1.97922	2.01449	1.9828	1.90334	1.87587	1.8681	1.8425	1.91406	1.95629	1.8319	1.91529	
	1.97324	1.9702	1.92871	1.90174	1.84707	1.87326	1.83072	1.88944	2.00675	1.84379	1.93888	
	1.92516	1.97607	1.96225	1.911	1.8567	1.88733	1.84747	1.90239	2.00561	1.83711	1.91679	
	1.98941	2.0072	1.92166	1.92468	1.87107	1.87278	1.83229	1.89829	1.97213	1.85699	1.93227	
	1.96741	2.02041	1.98882	1.95002	1.88469	1.89453	1.8249	1.87329	1.92311	1.86616	1.85947	
	1.99207	1.97766	1.96776	1.94981	1.85365	1.88448	1.83162	1.87913	1.95067	1.84249	1.92719	
	1.99517	2.01061	1.93788	1.95354	1.83568	1.88466	1.84584	1.93563	1.95077	1.86664	1.90326	
	2.01029	2.04974	1.9567	1.93199	1.83699	1.86898	1.82628	1.85181	1.95492	1.85892	1.90294	
	1.94257	1.98586	1.95319	1.93317	1.87125	1.84785	1.82714	1.88039	1.97418	1.82611	1.92666	
	1.96181	1.98985	1.955	1.95264	1.85224	1.89748	1.849	1.89882	1.92218	1.86498	1.89568	
	1.96527	2.02425	1.9463	1.98572	1.85332	1.88994	1.86075	1.83947	1.9027	1.84629	1.88238	
	1.98966	2.01043	1.98215	2.00588	1.86621	1.86486	1.83428	1.83319	1.97679	1.83223	1.92996	
	1.98286	2.02042	1.95605	2.01459	1.86138	1.83589	1.83817	1.90013	1.96872	1.85546	1.92141	
	1.93784	2.01376	1.94939	1.97432	1.86059	1.83804	1.81954	1.89901	1.95034	1.82212	1.94405	
	1.95232	1.95848	1.96129	2.00336	1.88186	1.87473	1.8355	1.8927	1.95541	1.821	1.98241	
	1.97286	2.02049	1.93407	2.01444	1.87306	1.86254	1.84536	1.89912	1.95907	1.84357	1.93826	
	1.95657	1.9816	1.9466	1.98913	1.85764	1.85998	1.8326	1.88807	1.90588	1.83577	1.94007	
	2.00455	1.96686	1.94732	2.00871	1.88447	1.85209	1.83184	1.87609	1.91353	1.84962	1.93907	
	2.00529	1.98546	1.9529	1.98091	1.84887	1.8717	1.81948	1.92842	1.93631	1.81945	1.94746	
	2.00113	1.98477	1.95263	2.01387	1.84658	1.88499	1.8385	1.84806	1.9023	1.78296	1.9421	
	1.99941	2.03264	1.96574	1.99915	1.86392	1.85433	1.83852	1.8402	1.93236	1.81998	1.92423	
	1.96687	2.01043	1.95255	2.02335	1.87184	1.81713	1.7891	1.88475	1.90411	1.81777	1.92428	
	1.98023	1.99752	1.97985	1.97644	1.86954	1.86417	1.8062	1.82884	1.8999	1.83557	1.96572	
Test Averages	1.975228	2.000108	1.960704	1.965254	1.860506	1.869881	1.832768	1.881884	1.94792	1.842244	1.926327	
STDEV	0.059038	pptm										
MDL	0.16318	pptm		MDL = (t) * S	(2.764) * 0.059038							
				Where:	t = student's "t" value for a 99% confidence level							
LDL	0.4	pptm			S= standard deviation of the 11 test average values							