# CASTNET

## Quality Assurance Project Plan

Appendix 3: Air Resource Specialists Standard Operating Procedures

# Clean Air Status and Trends Network

# Quality Assurance Project Plan

Revision 10.1

# Appendix 3:

# Air Resource Specialists Standard Operating Procedures

October 2023

## NPS GASEOUS POLLUTANT MONITORING PROGRAM
### List of Standard Operating Procedures and Technical Instructions to be Referenced from the CASTNET QAPP

**I.    NPS AIR MONITORING NETWORK FIELD OPERATOR PROCEDURES**

**3176    Station Operator Maintenance Procedures for Meteorological Monitoring Sites Using the DataView System**

| | |
|---|---|
| 3176-3100 | Checklist Instruction - Weekly Station Visit |
| | Wind Speed / Wind Direction Sensor (Climatronics) |
| 3176-3101 | Checklist Instruction - Weekly Station Visit |
| | Wind Speed / Wind Direction Sensor (R.M. Young Wind Monitor) |
| 3176-3103 | Checklist Instruction – Weekly Station Visit |
| | Wind Speed / Wind Direction Sensor (Climatronics – No Translator) |
| 3176-3110 | Checklist Instruction - Weekly Station Visit |
| | Temperature/ Delta Temperature Sensor (Climatronics) |
| 3176-3111 | Checklist Instruction - Weekly Station Visit |
| | Temperature/Delta Temperature Sensor (R.M. Young) |
| 3176-3115 | Checklist Instruction - Weekly Station Visit |
| | Air Temperature and Relative Humidity Sensor (Rotronics) |
| 3176-3116 | Checklist Instruction – Weekly Station Visit |
| | Air Temperature and Relative Humidity Sensor (Vaisala) |
| 3176-3120 | Checklist Instruction - Weekly Station Visit |
| | Relative Humidity Sensor (Rotronics) |
| 3176-3121 | Checklist Instruction – Weekly Station Visit |
| | Relative Humidity Sensor (Vaisala) |
| 3176-3130 | Checklist Instruction - Weekly Station Visit |
| | Solar Radiation Sensor (Climatronics) |
| 3176-3131 | Checklist Instruction - Weekly  Station Visit |
| | Solar Radiation Sensor (R.M. Young) |
| 3176-3132 | Checklist Instruction – Weekly Station Visit |
| | Solar Radiation Sensor (Licor) |
| 3176-3150 | Checklist Instruction - Weekly Station Visit |
| | Precipitation Sensor (Climatronics) |
| 3176-3151 | Checklist Instruction - Weekly Station Visit |
| | Precipitation Sensor (Texas Electronics) |
| 3176-3153 | Checklist Instruction - Weekly Station Visit |
| | Precipitation Sensor (RM Young) |

**3178    Station Operator Maintenance Procedures for Gaseous Monitoring Sites Using the DataView System**

**F_SITEOPERATOR_AQSITE_F_1.0** Site

Operator Routine Visits

3178-3116    Checklist Instruction - Weekly Station Visit

Ozone Analyzer (TEI 49C) Ozone Calibrator (TEI 49C)

CASTNet Dry Deposition

3178-3315    Checklist Instruction - Multipoint Calibration

Ozone Analyzer (TEI 49C) Ozone Calibrator (TEI 49C)

**II.    INFORMATION MANAGEMENT CENTER (IMC) PROCEDURES**

**I_IMC_DATACOLL_F_1.0**

Information Management Center - Data Collection

**I_IMC_DATAVAL_F_1.0**

Information Management Center - Data Validation

**I_IMC_RPTS_F_1.1**

Information Management Center - Data Reporting and Dissemination

## III. FIELD MAINTENANCE AND CALIBRATION PROCEDURES

**F_VISIT_MTCAL_AQSITE_F_1.1**

Maintenance and Calibration Visit to an Ambient Air Monitoring Station

**F_SITING_AQSITE_F_1.0**

Siting an Ambient Air Quality Monitoring Station

**F_GAS_MTCAL_Ozone-L2_F_1.0**

Verification, Calibration and Maintenance of Ozone Analyzers Using Traveling Level 2 Ozone Transfer Standards

**F_MET_MTCAL_ATbath_F_1.0**

Verification and Maintenance of Immersible Temperature Systems

**F_MET_MTCAL_ATRH_F_1.0**

Verification and Maintenance of Ambient Temperature/Relative Humidity Sensors by Collocated Comparison

**F_MET_MTCAL_RNF_2017Nov_F_1.0**

Verification and Calibration of Tipping Precipitation Gauge

**F_MET_MTCAL_SOL_F_1.0**

Verification and Maintenance of Solar Radiation Sensors

**F_MET_MTCAL_WD_F_1.0**

Verification and Maintenance of Wind Direction Sensors

**F_MET_MTCAL_WS_F_1.0**

Verification and Maintenance of Wind Speed Sensors

**F_GAS_MTCAL_O3TransferStd_F_1.0**

Certification of Ozone Transfer Standards

# Checklist Instruction - Weekly Station Visit

## • Wind Speed/Wind Direction Sensor (Climatronics)

**Checklist Instruction Number:**      3176-3100

**Revision Number / Date:**      3 / January 2011      (last reviewed Jan. 2011)

Objective:     Weekly checks of the wind speed and wind direction are performed to verify the operational integrity of the sensors and sampling system and to verify that collected data appear reasonable.

**1.     Inspect the wind sensors for damage. Report any damage to the OSC.**

From the ground, inspect the Climatronics wind vane and anemometer. Look for damage to the aluminum cups or direction vane and make certain that the sensors turn smoothly. Report any damage to the Operation Support Center.

**2.     Note the current wind speed and wind direction measurements and compare them to your observations of ambient conditions.**

From the Home Menu on the ESC datalogger, press <**D**> for Real-Time Display Menu.

```
ESC 88xx v5.31  ID:BL      Real-Time Display Menu      08/06/97  14:59:27

     V Display Raw Readings
     R Display Readings w/units
     F Display Readings w/flags
     B Display Last Base Avg
     C Continuous Avg Report
     L Show LARGE TEXT Display
     I Display Digital Inputs
     O Display Digital Outputs
     A Display Analog Outputs
```
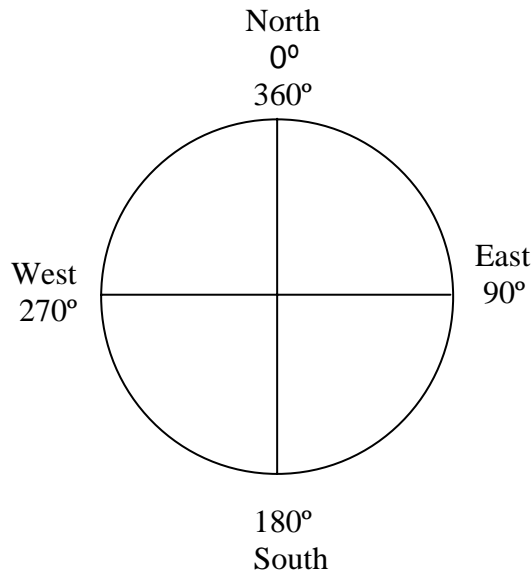
Press <**R**> for Display Readings w/units.

```
ESC 88xx v5.31  ID:BL     Real Time Engineering Units     08/06/97  14:59:27

     O3    = 38.23     (PPB    )
     O3 CAL= 1.434     (PPB    )
     O3 R8 = 38.23     (PPB    )
     VWD   = 46.61     (DEG    )
     SIG   = 46.61     (DEG    )
     VWS   = 0.6261    (M/S    )
     SWS   = 0.6261    (M/S    )
     PWS   = 2.036     (M/S    )
     TMP   = 3.399     (DGC    )
     DTP   = 0.06188   (DGC    )
     SOL   = 100.3     (WMS    )
     RNF   = 0         (MM     )
     RH    = 66.83     (%      )
     WET   = 100.4     (+/-    )
     FLW   = 3.008     (SLPM   )
     STP   = 21.48     (DGC    )
```

Watch the VWD (vector wind direction) and SWS (scalar wind speed) for several updates to identify any current trends. Then observe the conditions outside the shelter. Compare what you see with the readings on the datalogger. Does it make sense?  If not, call the Operation Support Center to report the discrepancy.

Remember: The VWD is reported as the direction the wind is blowing from.

Note:  With experience you will develop an "eye" for judging whether the wind readings are representative of ambient conditions. The following figure and table may help in your effort.



| Wind Speed | |
| --- | --- |
| m/s | mph |
| 1.0 | 2.2 |
| 5.0 | 11.2 |
| 10.0 | 22.4 |
| 15.0 | 33.6 |
| 20.0 | 44.7 |

Report conditions that affect data validity (e.g., ice or damage to the sensor) in the logbook.

**3.** **Take the VWD, VWS, and SWS offline in preparation to check the translator calibration responses.**

To ensure that only ambient winds are recorded, it is necessary to mark the VWD, VWS, and SWS channels offline. Wind data marked in this manner are automatically excluded from the hourly average.

Begin at the Home Menu as shown below. Remember, pressing <**Esc**> several times returns to the Home Menu.

```
ESC 88xx v5.31  ID:BL          Home Menu          08/06/97  14:59:27

     H  Help Screen
     L  Login/Set User Level
     C  Configuration Menu
     D  Real-Time Display Menu
     R  Report Generation Menu
     G  Graph Generation Menu
     S  Status Menu
     O  Log Out/Exit
     X  Serial Como to Port
```

Press <**C**> for Configuration Menu:

```
ESC 88xx v5.31  ID:BL        Configuration Menu      08/06/97  14:59:27

     P  Set Passwords
     S  Configure System Parameters
     D  Configure (Data) Channels
     C  Configure Calibrations
     A  Configure Alarms
     O  Configure Analog Outputs
     K  Configure Math Constants
     E  Configure Dig. Event Program
     R  Configure Digital I/O
     1  Configure Serial Protocols
```

Press <**D**> for Configure (Data) Channels:

```
ESC 88xx v5.31  ID:BL      Channel Configuration Menu     08/06/97  14:59:27


     N  Enter New Configuration
     C  Change Old Configuration
     D  Delete Old Configuration
     M  Disable/Mark Channel Offline
     E  Enable/Mark Channel Online
     I  Put Channel In Maint.
     O  Take Channel Out of Maint.
```

Press <**M**> for Disable/Mark Channel Offline:

---

```
ESC 88xx v5.31  ID:BL    Choose(Space Toggle/Enter Select)  08/06/97  14:59:27

      O3    [01]
      O3CAL [02]
      O3R8  [03]
      VWD   [04]
      SIG   [05]
      VWS   [06]
      SWS   [07]
      PWS   [08]
      TMP   [09]
      DTP   [10]
      SOL   [11]
      RNF   [12]
      RH    [13]
      WET   [14]
      FLW   [15]
      STP   [16]
```

Use the ↑ and ↓ keys to navigate and the spacebar to select the VWD, VWS, and SWS channels for offline status. The VWD, VWS, and SWS channels should be marked with a ">" indicating imminent offline status. Press <**Enter**> to take the marked channel offline.

```
ESC 88xx v5.31  ID:BL    Choose(Space Toggle/Enter Select)  08/06/97  14:59:27

      O3     [01]
      O3CAL  [02]
      O3R8   [03]
  >   VWD    [04]
      SIG    [05]
  >   VWS    [06]
  >   SWS    [07]
      PWS    [08]
      TMP    [09]
      DTP    [10]
      SOL    [11]
      RNF    [12]
      RH     [13]
      WET    [14]
      FLW    [15]
      STP    [16]
```

Check the status of the VWD, VWS, and SWS channels by pressing <**Esc**> several times until the Home Menu is displayed. Press <**D**> once to enter the Real-Time Display Menu**.** Press <**F**> to display the data channels with flags (or, press **<F6>** in any menu to display flags). VWD, VWS, and SWS should be flagged with a *D* to the right to indicate offline status. The offline time is automatically recorded in the logbook when this step is completed.

4.    **Set the mode switch on the F-460 wind translator from OPER. to ZERO. Verify that the VWD zero response is between –2º and +2º and the SWS zero response is between 0.2 and 0.3 m/s.**

The mode selector switch on the F-460 translator is normally in the OPER. position. The translator can be verified by setting the mode switch to ZERO and SPAN and comparing the responses to the limits above.

Set the F-460 mode selector switch to ZERO. Observe the VWD and SWS until both have stabilized. Compare the observation to the limits. VWD must be between -2º and +2º. SWS must be between 0.2 and 0.3 m/s. Call the Operation Support Center if the response is out of tolerance.

**5.** **Set the mode switch on the F-460 wind translator from ZERO to SPAN. Verify that the VWD span response is between 358º and 362º and the SWS span response is between 24 and 26 m/s.**

Set the F-460 mode selector switch to SPAN. Observe the VWD and SWS until both have stabilized. Compare the observation to the limits. VWD must be between 358º and 362º. SWS must be between 24 and 26 m/s. Call the Operation Support Center if the response is out of tolerance.

**6.** **Set the mode switch to OPER.**

**7.** **Bring the VWD, VWS, and SWS channels back online.**

Bring the VWD, VWS, and SWS channels online by beginning at the Home Menu of the ESC datalogger. Remember that pressing <**Esc**> several times will return you eventually to the Home Menu.

```
ESC 88xx v5.31  ID:BL         Home Menu          08/06/97  14:59:27

    H Help Screen
    L Login/Set User Level
    C Configuration Menu
    D Real-Time Display Menu
    R Report Generation Menu
    G Graph Generation Menu
    S Status Menu
    O Log Out/Exit
    X Serial Como to Port
```

Press <**C**> for Configuration Menu:

```
ESC 88xx v5.31  ID:BL        Configuration Menu       08/06/97    14:59:27

    P Set Passwords
    S Configure System Parameters
    D Configure (Data) Channels
    C Configure Calibrations
    A Configure Alarms
    O Configure Analog Outputs
    K Configure Math Constants
    E Configure Dig. Event Program
    R Configure Digital I/O
    1 Configure Serial Protocols
```

Press <**D**> for Configure (Data) Channels:

```
ESC 88xx v5.31  ID:BL     Channel Configuration Menu     08/06/97      14:59:27

    N Enter New Configuration
    C Change Old Configuration
    D Delete Old Configuration
    M Disable/Mark Channel Offline
    E Enable/Mark Channel Online
    I Put Channel In Maint.
    O Take Channel Out of Maint.
```

Press <**E**> for  Enable/Mark Channel Online. VWD, VWS, and SWS should be the only channels displayed.

```
ESC 88xx v5.31  ID:BL     Choose(Space Toggle/Enter Select)    08/06/97  14:59:27

  > VWD      [04]
    VWS      [06]
    SWS      [07]
```

Use the ↑ and ↓ keys to navigate and the spacebar to select a channel. Repeat the process until all channels are marked as shown below. Press <**Enter**> to put the selected channels online.

```
ESC 88xx v5.31  ID:BL     Choose(Space Toggle/Enter Select)    08/06/97  14:59:27


   > VWD      [04]
   > VWS      [06]
   > SWS      [07]
```

Check the status of the VWD, VWS, and SWS channels by pressing <**Esc**> several times until the Home Menu is displayed. Press <**D**> once to enter the Real-Time Display Menu. Press <**F**> once to display the data channels with flags (or, press **<F6>** in any menu to display flags). VWD, VWS, and SWS will no longer by marked with flags indicating online status; a *P* may be in the flag column for each channel indicating a purge period programmed to allow for the time it takes for ambient conditions to prevail. The *P* flag should clear within one minute. The online time is automatically recorded in the logbook when this step is completed.

# Checklist Instruction - Weekly Station Visit

## • Wind Speed/Wind Direction Sensor (R.M. Young Wind Monitor)

**Checklist Instruction Number:**     **3176-3101**

**Revision Number / Date:**     **3 / January 2011**          **(last reviewed Jan. 2011**)

---

Objective:   Weekly checks of the wind speed and wind direction are performed to verify the operational integrity of the sensors and sampling system and to verify that collected data appear reasonable.

---

1.      **Inspect the wind sensor for physical damage. Report any damage to the OSC.**

From the ground, inspect the R.M. Young wind sensor propeller/vane assembly. Look for damage to the plastic propeller and make certain that the propeller is turning smoothly. Look for other circumstances that could affect data validity such as an accumulation of ice. Report any damage to the Operation Support Center and enter your observations in the logbook.

2.      **Compare the current wind speed and wind direction measurements to your observations of ambient conditions.**

From the Home Menu on the ESC datalogger, press <**D**> for Real-Time Display Menu.

```
ESC 88xx v5.31  ID:BL      Real-Time Display Menu       08/06/97    14:59:27

    V  Display Raw Readings
    R  Display Readings w/units
    F  Display Readings w/flags
    B  Display Last Base Avg
    C  Continuous Avg Report
    L  Show LARGE TEXT Display
    I  Display Digital Inputs
    O  Display Digital Outputs
    A  Display Analog Outputs
```
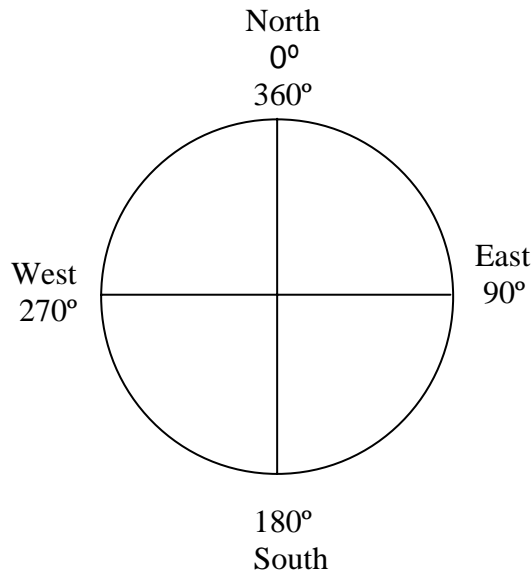
Press <**R**> for Display Readings w/units.

```
ESC 88xx v5.31  ID:BL    Real Time Engineering Units        08/06/97  14:59:27

          O3 = 38.23      (PPB    )
       O3CAL = 1.434      (PPB    )
        O3R8 = 38.23      (PPB    )
         VWD = 46.61      (DEG    )
         SIG = 46.61      (DEG    )
         VWS = 0.6261     (M/S    )
         SWS = 0.6261     (M/S    )
         PWS = 2.036      (M/S    )
         TMP = 3.399      (DGC    )
         DTP = 0.06188    (DGC    )
         SOL = 100.3      (WMS    )
         RNF = 0          (MM     )
          RH = 66.83      (%      )
         WET = 100.4      (+/-    )
         FLW = 3.008      (SLPM   )
         STP = 21.48      (DGC    )
```

Watch the VWD (vector wind direction) and SWS (scalar wind speed) for several updates to identify any current trends. Then observe the conditions outside the shelter. Compare what you see with the readings on the datalogger. Does it make sense?  If not, call the Operation Support Center to report the discrepancy.

Remember:  The VWD is reported as the direction wind is blowing from.

Note:  With experience you will develop an "eye" for judging whether the wind readings are representative of the ambient conditions. The following table and figure may help in your effort.
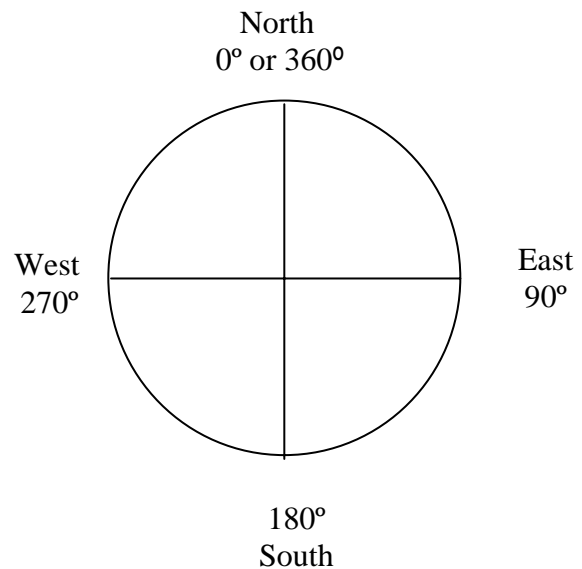
| Wind Speed | |
|---|---|
| m/s | mph |
| 1.0 | 2.2 |
| 5.0 | 11.2 |
| 10.0 | 22.4 |
| 15.0 | 33.6 |
| 20.0 | 44.7 |

North
0º or 360º

West
270º

East
90º

180º
South

# Checklist Instruction - Weekly Station Visit

## • Wind Speed/Wind Direction Sensor (Climatronics-No Translator)

**Checklist Instruction Number:**     **3176-3103**

**Revision Number / Date:**         **0 / April 2006**

---

Objective:     Weekly checks of the wind speed and wind direction are performed to verify the operational integrity of the sensors and sampling system and to verify that collected data appear reasonable.

---

1. **Inspect the wind sensors for damage. Report any damage to the OSC.**

   From the ground, inspect the Climatronics wind vane and anemometer. Look for damage to the aluminum cups or direction vane and make certain that the sensors turn smoothly. Report any damage to the Operation Support Center (OSC).

2. **Note the current wind speed and wind direction measurements and compare them to your observations of ambient conditions.**

   From the Home Menu on the ESC datalogger, press <**D**> for Real-Time Display Menu.

```
ESC 88xx v5.31  ID:BL       Real-Time Display Menu       08/06/97  14:59:27

    V Display Raw Readings
    R Display Readings w/units
    F Display Readings w/flags
    B Display Last Base Avg
    C Continuous Avg Report
    L Show LARGE TEXT Display
    I Display Digital Inputs
    O Display Digital Outputs
    A Display Analog Outputs
```

   Press <**R**> for Display Readings w/units.

```
ESC 88xx v5.31  ID:BL      Real Time Engineering Units    08/06/97  14:59:27

     O3    = 38.23      (PPB    )
     O3 CAL= 1.434      (PPB    )
     O3 R8 = 38.23      (PPB    )
     VWD   = 46.61      (DEG    )
     SIG   = 46.61      (DEG    )
     VWS   = 0.6261     (M/S    )
     SWS   = 0.6261     (M/S    )
     PWS   = 2.036      (M/S    )
     TMP   = 3.399      (DGC    )
     DTP   = 0.06188    (DGC    )
     SOL   = 100.3      (WMS    )
     RNF   = 0          (MM     )
     RH    = 66.83      (%      )
     WET   = 100.4      (+/-    )
     FLW   = 3.008      (SLPM   )
     STP   = 21.48      (DGC    )
```

Watch the VWD (vector wind direction) and SWS (scalar wind speed) for several updates to identify any current trends. Then observe the conditions outside the shelter. Compare what you see with the readings on the datalogger. Does it make sense? If not, call the OSC to report the discrepancy.

Remember: The VWD is reported as the direction the wind is blowing from.

Note: With experience you will develop an "eye" for judging whether the wind readings are representative of ambient conditions. The following figure and table may help in your effort.



| Wind Speed | |
|---|---|
| m/s | mph |
| 1.0 | 2.2 |
| 5.0 | 11.2 |
| 10.0 | 22.4 |
| 15.0 | 33.6 |
| 20.0 | 44.7 |

Report conditions that affect data validity (e.g., ice or damage to the sensor) in the logbook.

# Checklist Instruction - Weekly Station Visit

- **Temperature/Delta Temperature Sensor (Climatronics)**

**Checklist Instruction Number:**      **3176-3110**

**Revision Number / Date:**      **3 / January 2011**      **(last reviewed Jan. 2011)**

Objective:    Weekly checks of the temperature and delta temperature system are performed to verify the operational integrity of the temperature sensors and aspirators, and to verify that collected data appear reasonable.

**1.    Verify that the lower temperature sensor housing aspirator fan is operational.**

Two ambient air temperature sensor housings are on the meteorological tower. The first is positioned at 10 meters above ground level and houses the primary temperature sensor represented by the channel name TMP in the datalogger. The second housing contains the sensor that measures air temperature at 2 meters above ground level. The delta temperature, or DTP as labeled in the datalogger, is derived from subtracting 2-meter temperature from 10-meter temperature (top minus bottom).

Both temperature sensors have a fan aspirated housing. The 2-meter housing is close enough to the ground that the fan can be heard. Listen for the sound of the fan. If it has failed, call the Operation Support Center.

**2.    Note the current temperature and delta temperature measurements and compare to your observation of ambient conditions.**

From the Home Menu on the ESC datalogger, press <**D**> for Real-Time Display Menu.

```
ESC 88xx v5.31  ID:BL      Real-Time Display Menu        08/06/97  14:59:27

     V Display Raw Readings
     R Display Readings w/units
     F Display Readings w/flags
     B Display Last Base Avg
     C Continuous Avg Report
     L Show LARGE TEXT Display
     I Display Digital Inputs
     O Display Digital Outputs
     A Display Analog Outputs
```

Press <**R**> for Display Readings w/units:

```
ESC 88xx v5.31  ID:BL    Real-Time Engineering Uints    08/06/97  14:59:27

      O3= 38.23          (PPB    )
      O3 CAL= 1.434      (PPB    )
      O3 R8= 38.23       (PPB    )
      VWD= 46.61         (DEG    )
      SIG= 46.61         (DEG    )
      VWS= 0.6261        (M/S    )
      SWS= 0.6261        (M/S    )
      PWS= 2.036         (M/S    )
      TMP= 3.399         (DGC    )
      DTP= 0.06188       (DGC    )
      SOL= 100.3         (WMS    )
      RNF= 0             (MM     )
      RH= 66.83          (%      )
      WET= 100.4         (+/-    )
      FLW= 3.008         (SLPM   )
      STP= 21.48         (DGC    )
```

Watch the TMP and DTP reading for several updates to identify the current values. Delta temperature should be between -5º C and +5º C or beyond at some sites. Negative values are typical on bright sunny days, closer to zero on cloudy days, and positive numbers at night. Snow cover, complex terrain, and high winds will affect typical values.

Observe the conditions outside the shelter. Compare what you see with the reading on the datalogger. Does it make sense?  If not, call the Operation Support Center to report the discrepancy.

Note:  With experience you will develop a feel for judging whether the TMP reading is representative of the ambient observation. Remember that the sun can make it seem warmer and wind can make it seem cooler. Use the conversion chart below for help.

| Temperature | |
| --- | --- |
| ºC | ºF |
| -30 | -22 |
| -20 | -4 |
| -10 | 14 |
| 0 | 32 |
| 10 | 50 |
| 20 | 68 |
| 30 | 86 |
| 40 | 104 |

Report conditions that affect validity (e.g., aspirator fan failure) in the logbook.

**3. Take the TMP and DTP offline in preparation to check the translator calibration responses.**

To ensure that only ambient temperatures are recorded in the hourly average, it is necessary to mark the TMP and DTP channels offline. Temperature data marked in this manner are automatically excluded from the hourly average.

Begin at the Home Menu as shown below. Remember, pressing <**Esc**> several times returns to the Home Menu.

```
ESC 88xx v5.31  ID:BL          Home Menu          08/06/97  14:59:27

     H Help Screen
     L Login/Set User Level
     C Configuration Menu
     D Real-Time Display Menu
     R Report Generation Menu
     G Graph Generation Menu
     S Status Menu
     O Log Out/Exit
     X Serial Como to Port

```

Press <**C>** for Configuration Menu:

```
ESC 88xx v5.31  ID:BL        Configuration Menu      08/06/97  14:59:27

     P Set Passwords
     S Configure System Parameters
     D Configure (Data) Channels
     C Configure Calibrations
     A Configure Alarms
     O Configure Analog Outputs
     K Configure Math Constants
     E Configure Dig. Event Program
     R Configure Digital I/O
     1 Configure Serial Protocols

```

Press <**D>** for Configure (Data) Channels:

```
ESC 88xx v5.31  ID:BL     Channel Configuration Menu     08/06/97  14:59:27

     N Enter New Configuration
     C Change Old Configuration
     D Delete Old Configuration
     M Disable/Mark Channel Offline
     E Enable/Mark Channel Online
     I Put Channel In Maint.
     O Take Channel Out of Maint.

```

Press <**M**> for Disable/Mark Channel Offline:

```
ESC 88xx v5.31  ID:BL    Choose(Space Toggle/Enter Select)    08/06/97 14:59:27

     O3    [01]
     O3CAL [02]
     O3R8  [03]
     VWD   [04]
     SIG   [05]
     VWS   [06]
     SWS   [07]
     TMP   [08]
     DTP   [09]
     SOL   [10]
     RNF   [11]
     WET   [12]
     FLW   [13]
     STP   [14]
```

Use the ↑ and ↓ keys to navigate and the spacebar to select the TMP and DTP channels for offline status. The TMP and DTP channels should be marked with a ">" indicating imminent offline status. Press <**Enter**> to take the marked channel offline.

```
ESC 88xx v5.31  ID:BL    Choose(Space Toggle/Enter Select)    08/06/97  14:59:27

      O3      [01]
      O3CAL   [02]
      O3R8    [03]
      VWD     [04]
      SIG     [05]
      VWS     [06]
      SWS     [07]
   >  TMP     [08]
   >  DTP     [09]
      SOL     [10]
      RNF     [11]
      WET     [12]
      FLW     [13]
      STP     [14]
```

Check the status of the TMP and DTP channels by pressing <**Esc**> several times until the Home Menu is displayed. Press <**D**> once to enter the Real-Time Display Menu**.** Press <**F**> to display the data channels with flags (or, press **<F6>** in any menu to display flags). TMP and DTP should be marked with a *D* flag to the right to indicate offline status. The offline time is automatically recorded in the logbook when this step is completed.

4.  **Set the mode switch on the TEMP/DELTA TEMP translator from OPER. to ZERO. Verify that the TMP and DTP zero responses are within the ranges indicated on the sticker affixed to the translator.**

The mode selector switch on the temp/Δtemp translator is normally in the OPERATE position. The calibration of the translator can be verified by setting the mode switch to ZERO and SPAN and comparing the responses to the limits below.
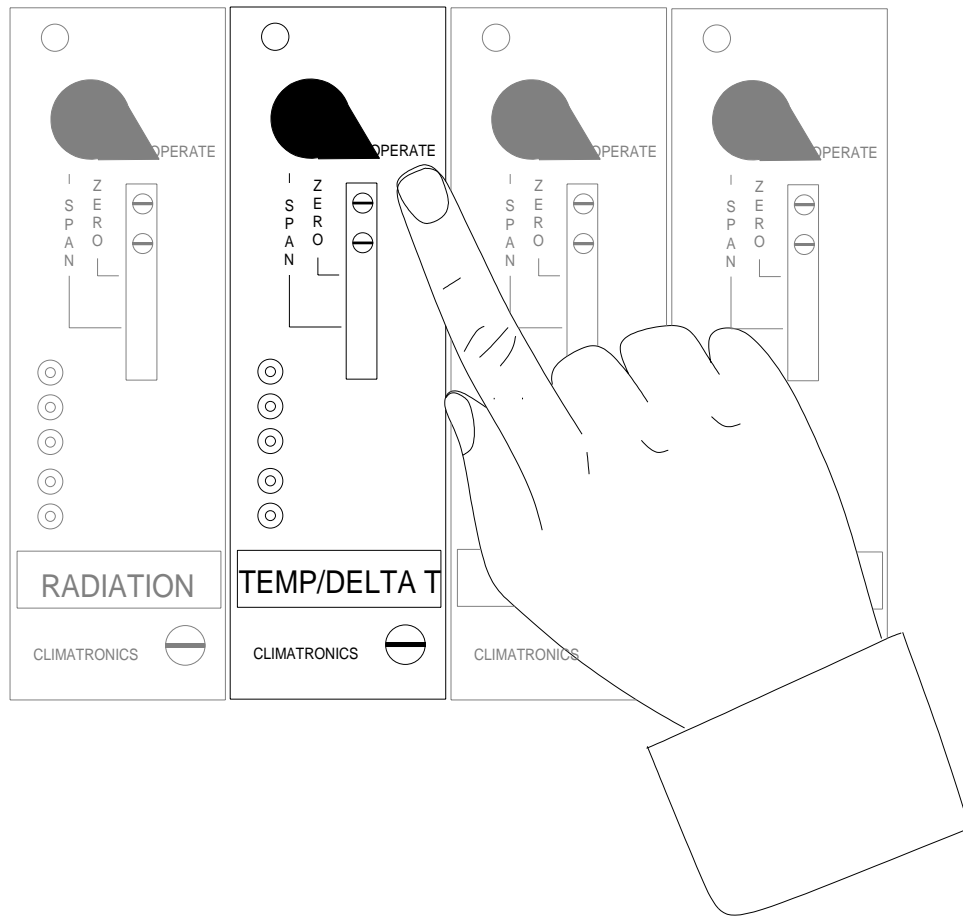
Set the temp/Δtemp mode selector switch to ZERO. Observe the TMP and DTP until both have stabilized. Compare the values to those indicated on the sticker affixed to the translator card. Call the Operation Support Center if the response is out of tolerance.

5. **Set the mode switch on the TEMP/DELTA TEMP translator from ZERO to SPAN. Verify that the TMP and DTP span responses are within the ranges indicated on the calibration sticker affixed to the front of the translator.**

Set the temp/delta temp mode selector switch to SPAN. Observe the TMP and DTP until both have stabilized. Compare the observation to the limits. The ranges are indicated on the sticker affixed to the front of the translator. Call the Operation Support Center if the response is out of tolerance.

6. **Set the mode switch to OPER.**

7. **Bring the TMP and DTP channels back online.**

Bring the TMP and DTP channels online by beginning at the Home Menu of the ESC datalogger. Remember that pressing <**Esc**> several times you will eventually return to the Home Menu.

```
ESC 88xx v5.31  ID:BL            Home Menu            08/06/97  14:59:27

     H  Help Screen
     L  Login/Set User Level
     C  Configuration Menu
     D  Real-Time Display Menu
     R  Report Generation Menu
     G  Graph Generation Menu
     S  Status Menu
     O  Log Out/Exit
     X  Serial Como to Port
```

Press <**C**> for Configuration Menu:

```
ESC 88xx v5.31  ID:BL        Configuration Menu       08/06/97  14:59:27

     P  Set Passwords
     S  Configure System Parameters
     D  Configure (Data) Channels
     C  Configure Calibrations
     A  Configure Alarms
     O  Configure Analog Outputs
     K  Configure Math Constants
     E  Configure Dig. Event Program
     R  Configure Digital I/O
     1  Configure Serial Protocols
```

Press <**D**> for Configure (Data) Channels:

```
ESC 88xx v5.31  ID:BL      Channel Configuration Menu    08/06/97  14:59:27

     N  Enter New Configuration
     C  Change Old Configuration
     D  Delete Old Configuration
     M  Disable/Mark Channel Offline
     E  Enable/Mark Channel Online
     I  Put Channel In Maint.
     O  Take Channel Out of Maint.
```

Press <**E**> for  Enable/Mark Channel Online. TMP and DTP should be the only channels
displayed.

```
ESC 88xx v5.31  ID:BL     Choose(Space Toggle/Enter Select)     08/06/97  14:59:27

  > TMP      [04]
    DTP      [06]



```

Use the ↑ and ↓ keys to navigate and the spacebar to select a channel. Press the <**Spacebar**> to select both for online status. Press <**Enter**> to put the selected channels online.

```
ESC 88xx v5.31  ID:BL     Choose(Space Toggle/Enter Select)     08/06/97  14:59:27

   >TMP      [04]
   >DTP      [06]



```

Check the status of the TMP and DTP channels by pressing <**Esc**> several times until the Home Menu is displayed. Press <**D**> once to enter the Real-Time Display Menu. Press <**F**> once to display the data channels with flags (or, press **<F6>** in any menu to display flags). TMP and DTP will no longer by marked with a flag indicating online status, or a *P* will be in the flag column for each indicating a purge period programmed to allow for the time it takes for ambient conditions to prevail. The *P* flag should clear within one minute. The online time will automatically recorded in the logbook when this step is completed.

# Checklist Instruction - Weekly Station Visit

- **Temperature/Delta Temperature Sensor (R.M. Young)**

**Checklist Instruction Number:**      3176-3111

**Revision Number / Date:**      2 /January 2006      **(last reviewed Jan. 2011)**

---

Objective:    Weekly checks of the temperature/delta temperature system are performed to verify the operational integrity of the temperature sensors and aspirators, and to verify that collected data appear reasonable.

---

1. **Verify that the lower temperature sensor housing aspirator fan is operational.**

   Two ambient air temperature sensor housings are mounted to the meteorological tower. The first is positioned at 10 meters above ground level and houses the primary temperature sensor represented by the channel name TMP in the datalogger. The second housing contains the sensor that measures air temperature at 2 meters above ground level. The delta temperature is derived by subtracting 2-meter temperature from 10-meter temperature (top minus bottom) and is represented by the channel name DTP in the datalogger.

   Both temperature sensors have a fan aspirated housing. The 2-meter housing is close enough to the ground that the fan can be heard. Listen for the sound of the fan. If it has failed, call the Operation Support Center and enter your observations in the logbook.

2. **Compare current TMP and DTP measurements to your observation of ambient conditions.**

   From the Home Menu on the ESC datalogger, press <**D**> for Real-Time Display Menu:

```
ESC 88xx v5.31  ID:BL      Real-Time Display Menu      08/06/97  14:59:27

     V  Display Raw Readings
     R  Display Readings w/units
     F  Display Readings w/flags
     B  Display Last Base Avg
     C  Continuous Avg Report
     L  Show LARGE TEXT Display
     I  Display Digital Inputs
     O  Display Digital Outputs
     A  Display Analog Outputs
```

Press <**R**> for Display Readings w/units:

```
ESC 88xx v5.31  ID:BL    Real-Time Engineering Uints     08/06/97  14:59:27

          O3 = 38.23     (PPB    )
       O3CAL = 1.434     (PPB    )
        O3R8 = 38.23     (PPB    )
         VWD = 46.61     (DEG    )
         SIG = 46.61     (DEG    )
         VWS = 0.6261    (M/S    )
         SWS = 0.6261    (M/S    )
         PWS = 2.036     (M/S    )
         TMP = 3.399     (DGC    )
         DTP = 0.06188   (DGC    )
         SOL = 100.3     (WMS    )
         RNF = 0         (MM     )
          RH = 66.83     (%      )
         WET = 100.4     (+/-    )
         FLW = 3.008     (SLPM   )
         STP = 21.48     (DGC    )
```

Watch the TMP and DTP reading for several updates to identify the current values. Delta temperature should be between -5º C and +5º C. Negative values are typical on bright sunny days, closer to zero on cloudy days, and positive values at night. Snow cover, complex terrain, and high winds will affect typical values.

Observe the conditions outside the shelter. Compare what you see with the reading on the datalogger. Does it make sense? If not, call the OSC to report the discrepancy and enter your observations in the logbook.

Note: With experience you will develop a feel for judging whether the TMP reading is representative of the ambient observation. Remember that the sun can make it seem warmer and wind can make it seem cooler. Use the conversion chart below for assistance.

| Temperature | |
|---|---|
| ºC | ºF |
| -30 | -22 |
| -20 | -4 |
| -10 | 14 |
| 0 | 32 |
| 10 | 50 |
| 20 | 68 |
| 30 | 86 |
| 40 | 104 |

Report any conditions that affect validity (e.g., aspirator fan failure) in the logbook.

# Checklist Instruction - Weekly Station Visit

## • Air Temperature and Relative Humidity Sensor (Rotronics)

**Checklist Instruction Number:**     3176-3115

**Revision Number / Date:**     1 / January 2006     (last reviewed Jan. 2011)

---

Objective:   Weekly checks of the air temperature and relative humidity system are performed to verify the operational integrity of the relative humidity sensor and aspirator, and to verify that collected data appear reasonable.

---

**1.     Verify the air temperature and relative humidity sensor housing is operational.**

An air temperature/relative humidity sensor aspirator housing is mounted to the meteorological tower.  In most cases this aspirator is forced-aspirated by a fan.  If the aspirator is the fan-type, listen for the fan's operation.

If a "natural aspirated" fan is in use, make sure it is secure and in good condition.  Call the Operation Support Center if problems are detected.

**2.     Compare the current air temperature and relative humidity measurement to your observation of ambient conditions.**

From the Home Menu on the ESC datalogger, press <**D**> for Real-Time Display Menu:

```
ESC 88xx v5.31  ID:BL       Real-Time Display Menu        08/06/97  14:59:27

    V  Display Raw Readings
    R  Display Readings w/units
    F  Display Readings w/flags
    B  Display Last Base Avg
    C  Continuous Avg Report
    L  Show LARGE TEXT Display
    I  Display Digital Inputs
    O  Display Digital Outputs
    A  Display Analog Outputs
```

Press <**R**> for Display Readings w/units:

```
ESC 88xx v5.31  ID:BL    Real-Time Engineering Units    08/06/97  14:59:27

          O3 = 38.23     (PPB    )
       O3CAL = 1.434     (PPB    )
        O3R8 = 38.23     (PPB    )
         VWD = 46.61     (DEG    )
         SIG = 46.61     (DEG    )
         VWS = 0.6261    (M/S    )
         SWS = 0.6261    (M/S    )
         PWS = 2.036     (M/S    )
         TMP = 3.399     (DGC    )
         SOL = 100.3     (WMS    )
         RNF = 0         (MM     )
          RH = 66.83     (%      )
         STP = 21.48     (DGC    )
```

Watch the TMP (air temperature) and RH (relative humidity) reading for several updates to identify any current trends. Observe the conditions outside the shelter. Compare what you see with the reading on the datalogger. Does it make sense? If not, call the Operation Support Center to report any discrepancy and enter your observations in the logbook. Also note any other conditions that could affect validity of the air temperature or relative humidity data and enter your observations in the logbook.

# Checklist Instruction - Weekly Station Visit

## • Air Temperature and Relative Humidity Sensor (Vaisala)

**Checklist Instruction Number:**     3176-3116

**Revision Number / Date:**     1 / January 2006          (last reviewed Jan. 2011)

---

Objective:   Weekly checks of the air temperature and relative humidity system are performed to verify the operational integrity of the relative humidity sensor and aspirator, and to verify that collected data appear reasonable.

---

1.     **Verify the air temperature and relative humidity sensor housing is operational.**

An air temperature/relative humidity sensor aspirator housing is mounted to the meteorological tower.  In most cases this aspirator is forced-aspirated by a fan.  If the aspirator is the fan-type, listen for the fan's operation.

If a "natural aspirated" fan is in use, make sure it is secure and in good condition.  Call the Operation Support Center if problems are detected.

2.     **Compare the current air temperature and relative humidity measurement to your observation of ambient conditions.**

From the Home Menu on the ESC datalogger, press <**D**> for Real-Time Display Menu:

```
ESC 88xx v5.31  ID:BL       Real-Time Display Menu       08/06/97  14:59:27

     V  Display Raw Readings
     R  Display Readings w/units
     F  Display Readings w/flags
     B  Display Last Base Avg
     C  Continuous Avg Report
     L  Show LARGE TEXT Display
     I  Display Digital Inputs
     O  Display Digital Outputs
     A  Display Analog Outputs
```

Press <**R**> for Display Readings w/units:

```
ESC 88xx v5.31  ID:BL    Real-Time Engineering Units    08/06/97  14:59:27

           O3 = 38.23    (PPB     )
        O3CAL = 1.434    (PPB     )
         O3R8 = 38.23    (PPB     )
          VWD = 46.61    (DEG     )
          SIG = 46.61    (DEG     )
          VWS = 0.6261   (M/S     )
          SWS = 0.6261   (M/S     )
          PWS = 2.036    (M/S     )
          TMP = 3.399    (DGC     )
          SOL = 100.3    (WMS     )
          RNF = 0        (MM      )
           RH = 66.83    (%       )
          STP = 21.48    (DGC     )
```

Watch the TMP (air temperature) and RH (relative humidity) reading for several updates to identify any current trends. Observe the conditions outside the shelter. Compare what you see with the reading on the datalogger. Does it make sense? If not, call the Operation Support Center to report any discrepancy and enter your observations in the logbook. Also note any other conditions that could affect validity of the air temperature or relative humidity data and enter your observations in the logbook.

# Checklist Instruction - Weekly Station Visit

## • Relative Humidity Sensor (Rotronics)

**Checklist Instruction Number:**     **3176-3120**

**Revision Number / Date:**          **2 / January 2011**          **(last reviewed Jan. 2011)**

---

Objective:  Weekly checks of the relative humidity system are performed to verify the operational integrity of the relative humidity sensor and aspirator, and to verify that collected data appear reasonable.

---

**1.     Verify the air temperature and relative humidity sensor housing is operational.**

An air temperature/relative humidity sensor aspirator housing is mounted to the meteorological tower. In most cases this aspirator is forced-aspirated by a fan. If the aspirator is the fan-type, listen for the fan's operation.

If a "natural aspirated" fan is in use, make sure it is secure and in good condition. Call the Operation Support Center if problems are detected.

**2.     Compare the current relative humidity measurement to your observation of ambient conditions.**

From the Home Menu on the ESC datalogger, press <**D**> for Real-Time Display Menu:

```
ESC 88xx v5.31  ID:BL      Real-Time Display Menu      08/06/97  14:59:27

    V  Display Raw Readings
    R  Display Readings w/units
    F  Display Readings w/flags
    B  Display Last Base Avg
    C  Continuous Avg Report
    L  Show LARGE TEXT Display
    I  Display Digital Inputs
    O  Display Digital Outputs
    A  Display Analog Outputs
```

Press <**R**> for Display Readings w/units:

```
ESC 88xx v5.31  ID:BL    Real-Time Engineering Uints     08/06/97  14:59:27

         O3 = 38.23     (PPB     )
      O3CAL = 1.434     (PPB     )
       O3R8 = 38.23     (PPB     )
        VWD = 46.61     (DEG     )
        SIG = 46.61     (DEG     )
        VWS = 0.6261    (M/S     )
        SWS = 0.6261    (M/S     )
        PWS = 2.036     (M/S     )
        TMP = 3.399     (DGC     )
        DTP = 0.06188   (DGC     )
        SOL = 100.3     (WMS     )
        RNF = 0         (MM      )
         RH = 66.83     (%       )
        WET = 100.4     (+/-     )
        FLW = 3.008     (SLPM    )
        STP = 21.48     (DGC     )
```

Watch the RH (relative humidity) reading for several updates to identify any current trends. Observe the conditions outside the shelter. Compare what you see with the reading on the datalogger. Does it make sense?  If not, call the Operation Support Center to report any discrepancy and enter your observations in the logbook. Also note any other conditions that could affect validity of the relative humidity data and enter your observations in the logbook.

# Checklist Instruction - Weekly Station Visit

- **Relative Humidity Sensor (Vaisala)**

**Checklist Instruction Number:**        3176-3121

**Revision Number / Date:**        **2 / January 2011**        **(last reviewed Jan. 2011)**

___

Objective:   Weekly checks of the relative humidity system are performed to verify the operational integrity of the relative humidity senso and aspirator, and to verify that collected data appear reasonable.

___

1.      **Verify the air temperature and relative humidity sensor housing is operational.**

An air temperature/relative humidity sensor aspirator housing is mounted to the meteorological tower. In most cases this aspirator is forced-aspirated by a fan. If the aspirator is the fan-type, listen for the fan's operation.

If a "natural aspirated" fan is in use, make sure it is secure and in good condition. Call the Operation Support Center if problems are detected.


2.      **Compare the current relative humidity measurement to your observation of ambient conditions.**

From the Home Menu on the ESC datalogger, press <**D**> for Real-Time Display Menu:

```
ESC 88xx v5.31  ID:BL      Real-Time Display Menu      08/06/97  14:59:27

     V  Display Raw Readings
     R  Display Readings w/units
     F  Display Readings w/flags
     B  Display Last Base Avg
     C  Continuous Avg Report
     L  Show LARGE TEXT Display
     I  Display Digital Inputs
     O  Display Digital Outputs
     A  Display Analog Outputs
```

Press <**R**> for Display Readings w/units:

```
ESC 88xx v5.31  ID:BL     Real-Time Engineering Units      08/06/97  14:59:27

           O3 = 38.23      (PPB     )
        O3CAL = 1.434      (PPB     )
         O3R8 = 38.23      (PPB     )
          VWD = 46.61      (DEG     )
          SIG = 46.61      (DEG     )
          VWS = 0.6261     (M/S     )
          SWS = 0.6261     (M/S     )
          PWS = 2.036      (M/S     )
          TMP = 3.399      (DGC     )
          DTP = 0.06188    (DGC     )
          SOL = 100.3      (WMS     )
          RNF = 0          (MM      )
           RH = 66.83      (%       )
          WET = 100.4      (+/-     )
          FLW = 3.008      (SLPM    )
          STP = 21.48      (DGC     )
```

Watch the RH (relative humidity) reading for several updates to identify any current trends. Observe the conditions outside the shelter. Compare what you see with the reading on the datalogger. Does it make sense? If not, call the Operation Support Center to report any discrepancy and enter your observations in the logbook. Also note any other conditions that could affect validity of the relative humidity data and enter your observations in the logbook.

# Checklist Instruction - Weekly Station Visit

- **Solar Radiation Sensor (Climatronics)**

**Checklist Instruction Number:**     3176-3130

**Revision Number / Date:**     **2 / January 2011**     **(last reviewed Jan. 2011)**

Objective:     Weekly checks of the solar radiation system are performed to verify the operational integrity of the solar radiation system, to clean the sensor, and to verify that collected data appear reasonable.

1. **Inspect the solar radiation sensor for dirt or snow if your sensor is at a height to reach. Clean the sensor if required.**

   Locate your solar radiation sensor; most air quality station sensors are on the tower. Inspect the sensor for dirt, snow, etc. The sensor can be cleaned with a broom to remove snow or a Kimwipe with water to remove dirt.

2. **Note the current solar radiation measurement and compare it to your observations of ambient conditions.**

   From the Home Menu on the ESC datalogger, press <**D**> for Real-Time Display Menu:

```
ESC 88xx v5.31  ID:BL       Real-Time Display Menu        08/06/97  14:59:27


        V       Display Raw Readings
        R       Display Readings w/units
        F       Display Readings w/flags
        B       Display Last Base Avg
        C       Continuous Avg Report
        L       Show LARGE TEXT Display
        I       Display Digital Inputs
        O       Display Digital Outputs
        A       Display Analog Outputs
```

   Press <**R**> for Display Readings w/units:

```
ESC 88xx v5.31  ID:BL     Display Last Base Avg.     08/06/97     14:59:27

        O3= 38.23          (PPB     )
        O3 CAL= 1.434      (PPB     )
        O3 R8= 38.23       (PPB     )
        VWD= 46.61         (DEG     )
        SIG= 46.61         (DEG     )
        VWS= 0.6261        (M/S     )
        SWS= 0.6261        (M/S     )
        PWS= 2.036         (M/S     )
        TMP= 3.399         (DGC     )
        DTP= 0.06188       (DGC     )
        SOL= 100.3         (WMS     )
        RNF= 0             (MM      )
        RH= 66.83          (%       )
        WET= 100.4         (+/-     )
        FLW= 3.008         (SLPM    )
        STP= 21.48         (DGC     )
```

Watch the SOL (solar radiation) reading for several updates to identify any current trends. Observe the conditions outside the shelter. Compare what you see with the reading on the datalogger. Does it make sense?  If not, call the Operation Support Center to report the discrepancy.

Note:  With experience you will develop and "eye" for judging whether the SOL reading is representative of the ambient observation. Remember that the solar radiation varies with time of day, sky conditions, and season.

Report conditions that affect data validity (e.g., snow found on the sensor) in the logbook.

**3.**    **Take the SOL offline in preparation to check the translator responses.**

To ensure that only ambient solar conditions are included in the hourly average, it is necessary to mark the SOL channel offline. Solar radiation data marked in this manner are automatically excluded from the hourly averages.

Begin at the Home Menu as shown below. Remember, pressing <**Esc**> several times returns to the Home Menu.

```
ESC 88xx v5.31  ID:BL          Home Menu          08/06/97     14:59:27

        H       Help Screen
        L       Login/Set User Level
        C       Configuration Menu
        D       Real-Time Display Menu
        R       Report Generation Menu
        G       Graph Generation Menu
        S       Status Menu
        O       Log Out/Exit
        X       Serial Como to Port
```

Press <**C**> for Configuration Menu:

```
ESC 88xx v5.31  ID:BL        Configuration Menu      08/06/97  14:59:27

        P       Set Passwords
        S       Configure System Parameters
        D       Configure (Data) Channels
        C       Configure Calibrations
        A       Configure Alarms
        O       Configure Analog Outputs
        K       Configure Math Constants
        E       Configure Dig. Event Program
        R       Configure Digital I/O
        1       Configure Serial Protocols
```

Press <**D**>, for Configure (Data) Channels:

```
ESC 88xx v5.31  ID:BL     Channel Configuration Menu     08/06/97  14:59:27

        N       Enter New Configuration
        C       Change Old Configuration
        D       Delete Old Configuration
        M       Disable/Mark Channel Offline
        E       Enable/Mark Channel Online
        I       Put Channel In Maint.
        O       Take Channel Out of Maint.
```

Press <**M**> for Disable/Mark Channel Offline:

```
ESC 88xx v5.31  ID:BL    Choose(Space Toggle/Enter Select)    08/06/97  4:59:27

        O3    [01]
        O3CAL [02]
        O3R8  [03]
        VWD   [04]
        SIG   [05]
        VWS   [06]
        SWS   [07]
        TMP   [08]
        DTP   [09]
        SOL   [10]
        RNF   [11]
        WET   [12]
        FLW   [13]
        STP   [14]
```

Use the ↑ and ↓ keys to navigate and the spacebar to select the SOL channel for offline status. The channel should be marked with a ">" indicating imminent offline status. Press <**Enter**> to take the marked channel offline.

```
ESC 88xx v5.31  ID:BL    Choose(Space Toggle/Enter Select)    08/06/97  4:59:27

        O3            [01]
        O3CAL         [02]
        O3R8          [03]
        VWD           [04]
        SIG           [05]
        VWS           [06]
        SWS           [07]
        TMP           [08]
        DTP           [09]
    >   SOL           [10]
        RNF           [11]
        WET           [12]
        FLW           [13]
        STP           [14]
```

Check the status of the SOL channel by pressing <**Esc**> several times until the Home Menu is displayed. Press <**D**> once to enter the Real-Time Display Menu**.** Press <**F**> to display the data channels with flags (or, press **<F6>** in any menu to display flags). SOL should be marked with a *D* flag to the right to indicate offline status. The offline time will be recorded in the logbook automatically when this step is complete.

4.  **Set the mode selector switch on the RADIATION translator from OPER. to ZERO. Verify that the SOL zero response is between –5 and +5.**

    The mode selector switch on the radiation translator is normally in the OPER. position. The calibration of the translator can be verified by setting the mode selector switch to ZERO and SPAN and comparing the responses to the limits below.

    Set the mode selector switch to ZERO. Observe the SOL until stabilized. Compare the observation to the limits. SOL must be between -5 and +5.

5.    **Set the mode switch on the RADIATION translator from ZERO to SPAN. Verify that the SOL span response is between 1391 and 1401.**

Set the mode selector switch to SPAN. Observe until stabilized. Compare the observation to the limits. SOL must be within 1391 and 1401. Call the Operation Support Center if the response is out of tolerance.
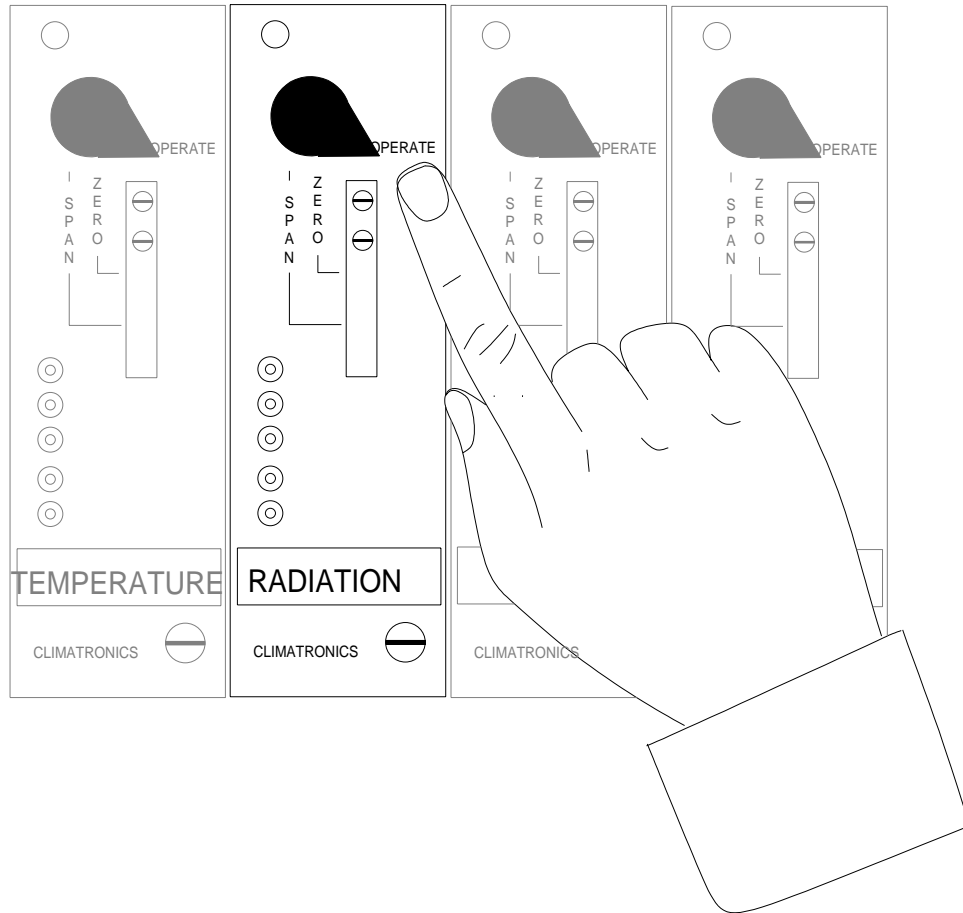


6.    **Set the mode switch to OPER.**

7.    **Bring the SOL channel back online.**

Bring the SOL channel online by beginning at the Home Menu of the ESC datalogger. Remember that pressing <**Esc**> several times you will return eventually to the Home Menu.

```
ESC 88xx v5.31  ID:BL         Home Menu          08/06/97  14:59:27

        H       Help Screen
        L       Login/Set User Level
        C       Configuration Menu
        D       Real-Time Display Menu
        R       Report Generation Menu
        G       Graph Generation Menu
        S       Status Menu
        O       Log Out/Exit
        X       Serial Como to Port
```

Press <**C**> for Configuration Menu:

```
ESC 88xx v5.31  ID:BL        Configuration Menu      08/06/97  14:59:27

        P       Set Passwords
        S       Configure System Parameters
        D       Configure (Data) Channels
        C       Configure Calibrations
        A       Configure Alarms
        O       Configure Analog Outputs
        K       Configure Math Constants
        E       Configure Dig. Event Program
        R       Configure Digital I/O
        1       Configure Serial Protocols
```

Press <**D**> for Configure (Data) Channels:

```
ESC 88xx v5.31  ID:BL     Channel Configuration Menu     08/06/97  14:59:27

        N       Enter New Configuration
        C       Change Old Configuration
        D       Delete Old Configuration
        M       Disable/Mark Channel Offline
        E       Enable/Mark Channel Online
        I       Put Channel In Maint.
        O       Take Channel Out of Maint.
```

Press <**E**> for Enable/Mark Channel Online. SOL should be the only channel displayed.

```
ESC 88xx v5.31  ID:BL     Choose(Space Toggle/Enter Select)   08/06/97   4:59:27

   >    SOL     [04]
```

Use the ↑ and ↓ keys to navigate and the spacebar to select a channel. Press <**Enter**> to put the selected channel online.

Check the status of the SOL channel by pressing <**Esc**> several times until the Home Menu is displayed. Press <**D**> once to enter the Real-Time Display Menu. Press <**F**> once to display the data channels with flags (or, press **<F6>** in any menu to display flags). SOL will no longer by marked with a flag indicating online status; a *P* may be in the flag column indicating a purge period programmed to allow for the time it takes for ambient conditions to prevail. The *P* flag should clear within one minute. The online time will automatically recorded in the logbook when this step is completed.

# Checklist Instruction - Weekly Station Visit

## • Solar Radiation Sensor (R.M. Young)

**Checklist Instruction Number:**      3176-3131

**Revision Number / Date:**      2 / January 2011      (last reviewed Jan. 2011)

___

Objective:    Weekly checks of the solar radiation system are performed to verify the operational integrity of the solar radiation system, to clean the sensor, and to verify that collected data appear reasonable.

___

1. **Inspect the solar radiation sensor for dirt or snow if your sensor is at a height to reach. Clean the sensor if required. Also check the leveling bubble.**

   Locate your solar radiation sensor; most air quality station sensors are on a tower. Inspect the sensor for dirt, snow, etc. If the sensor can be reached, carefully remove snow from the sensor and clean the sensor with a water-dampened Kimwipe to remove dust and dirt. Also check the leveling bubble to verify it is level.

2. **Compare the current solar radiation measurement to your observations of ambient conditions.**

   From the Home Menu on the ESC datalogger, press <**D**> for Real-Time Display Menu:

```
ESC 88xx v5.31  ID:BL     Real-Time Display Menu      08/06/97  14:59:27

    V  Display Raw Readings
    R  Display Readings w/units
    F  Display Readings w/flags
    B  Display Last Base Avg
    C  Continuous Avg Report
    L  Show LARGE TEXT Display
    I  Display Digital Inputs
    O  Display Digital Outputs
    A  Display Analog Outputs
```

   Press <**R**> for Display Readings w/units:

___

```
ESC 88xx v5.31  ID:BL     Display Last Base Avg.    08/06/97  14:59:27

          O3 = 38.23      (PPB    )
       O3CAL = 1.434      (PPB    )
        O3R8 = 38.23      (PPB    )
         VWD = 46.61      (DEG    )
         SIG = 46.61      (DEG    )
         VWS = 0.6261     (M/S    )
         SWS = 0.6261     (M/S    )
         PWS = 2.036      (M/S    )
         TMP = 3.399      (DGC    )
         DTP = 0.06188    (DGC    )
         SOL = 100.3      (WMS    )
         RNF = 0          (MM     )
          RH = 66.83      (%      )
         WET = 100.4      (+/-    )
         FLW = 3.008      (SLPM   )
         STP = 21.48      (DGC    )
```

Watch the SOL (solar radiation) reading for several updates to identify any current trends. Observe the conditions outside the shelter. Compare what you see with the reading on the datalogger. Does it make sense? If not, call the Operation Support Center to report the discrepancy and enter your observations in the logbook.

Note: With experience you will develop and "eye" for judging whether the SOL reading is representative of the ambient observation. Remember that the solar radiation varies with time of day, sky conditions, and season.

Report any conditions that affect data validity (e.g., snow found on the sensor) in the logbook.

# Checklist Instruction - Weekly Station Visit

- **Solar Radiation Sensor (Licor)**

**Checklist Instruction Number:**    3176-3132

**Revision Number / Date:**    **2 / January 2011**    **(last reviewed Jan. 2011)**

---

Objective:    Weekly checks of the solar radiation system are performed to verify the operational integrity of the solar radiation system, to clean the sensor, and to verify that collected data appear reasonable.

---

1.    **Inspect the solar radiation sensor for dirt or snow if your sensor is at a height to reach. Clean the sensor if required. Also check leveling bubble.**

      Locate your solar radiation sensor; most air quality station sensors are on a tower. Inspect the sensor for dirt, snow, etc. If the sensor can be reached, carefully remove snow from the sensor and clean the sensor with a water-dampened Kimwipe to remove dust and dirt. Also check the leveling bubble to verify it is level.

2.    **Compare the current solar radiation measurement to your observations of ambient conditions.**

      From the Home Menu on the ESC datalogger, press <**D**> for Real-Time Display Menu:

```
ESC 88xx v5.31  ID:BL      Real-Time Display Menu      08/06/97  14:59:27

    V Display Raw Readings
    R Display Readings w/units
    F Display Readings w/flags
    B Display Last Base Avg
    C Continuous Avg Report
    L Show LARGE TEXT Display
    I Display Digital Inputs
    O Display Digital Outputs
    A Display Analog Outputs
```

Press <**R**> for Display Readings w/units:

---

```
ESC 88xx v5.31  ID:BL    Display Last Base Avg.    08/06/97  14:59:27

          O3 = 38.23      (PPB    )
       O3CAL = 1.434      (PPB    )
        O3R8 = 38.23      (PPB    )
         VWD = 46.61      (DEG    )
         SIG = 46.61      (DEG    )
         VWS = 0.6261     (M/S    )
         SWS = 0.6261     (M/S    )
         PWS = 2.036      (M/S    )
         TMP = 3.399      (DGC    )
         DTP = 0.06188    (DGC    )
         SOL = 100.3      (WMS    )
         RNF = 0          (MM     )
          RH = 66.83      (%      )
         WET = 100.4      (+/-    )
         FLW = 3.008      (SLPM   )
         STP = 21.48      (DGC    )
```

Watch the SOL (solar radiation) reading for several updates to identify any current trends. Observe the conditions outside the shelter. Compare what you see with the reading on the datalogger. Does it make sense?  If not, call the Operation Support Center to report the discrepancy and enter your observations in the logbook.

Note:  With experience you will develop and "eye" for judging whether the SOL reading is representative of the ambient observation. Remember that the solar radiation varies with time of day, sky conditions, and season.

Report any conditions that affect data validity (e.g., snow found on the sensor) in the logbook.

# Checklist Instruction - Weekly Station Visit

- **Precipitation Sensor (Climatronics)**

**Checklist Instruction Number:**      **3176-3150**

**Revision Number / Date:**      **3 / January 2011**      **(last reviewed Jan. 2011)**

Objective:    Weekly checks of the precipitation system (tipping bucket rain gauge) are performed to verify the operational integrity of the system, inspect and clean the funnel if necessary, verify the operation of the tipping mechanism and heater, and to verify that collected data appear reasonable.

**1.**      **Take the RNF (rainfall or precipitation) channel offline for operational checks.**

The checks required to assure proper precipitation gauge operation will generate false RNF readings; therefore, the RNF channel must be taken offline.

From the Home Menu on the ESC datalogger, press <**C**> for Configuration Menu:

```
ESC 88xx v5.31  ID:BL      Configuration Menu        08/06/97  14:59:27


    P  Set Passwords
    S  Configure System Parameters
    D  Configure (Data) Channels
    C  Configure Calibrations
    A  Configure Alarms
    O  Configure Analog Outputs
    K  Configure Math Constants
    E  Configure Dig. Event Program
    R  Configure Digital I/O
    1  Configure Serial Protocols
```

Press <**D**> for Configure (Data) Channels:

```
ESC 88xx v5.31  ID:BL     Channel Configuration Menu      08/06/97  14:59:27


    N  Enter New Configuration
    C  Change Old Configuration
    D  Delete Old Configuration
    M  Disable/Mark Channel Offline
    E  Enable/Mark Channel Online
    I  Put Channel In Maint.
    O  Take Channel Out of Maint.
```

Press <**M**> for Disable/Mark Channel Offline:

```
ESC 88xx v5.31  ID:BL    Choose(Space Toggle/Enter Select)    08/06/97  4:59:27

      O3     [01]
      O3CA   [02]
      O3R8   [03]
      VWD    [04]
      SIG    [05]
      VWS    [06]
      SWS    [07]
      TMP    [08]
      DTP    [09]
      SOL    [10]
      RNF    [11]
      WET    [12]
      FLW    [13]
      STP    [14]
```

Use the ↑ and ↓ keys and the spacebar to select the RNF channel for offline status. The RNF channel should be marked with a ">" indicating imminent offline status. Press <**Enter**> to take the marked channel offline.

```
ESC 88xx v5.31  ID:BL    Choose(Space Toggle/Enter Select)    08/06/97  4:59:27

      O3     [01]
      O3CA   [02]
      O3R8   [03]
      VWD    [04]
      SIG    [05]
      VWS    [06]
      SWS    [07]
      TMP    [08]
      DTP    [09]
      SOL    [10]
   >  RNF    [11]
      WET    [12]
      FLW    [13]
      STP    [14]
```

Check the status of the RNF channel by pressing <**Esc**> several times until the Home Menu is displayed. Press <**D**> once to enter the Real-Time Display Menu. Press <**F**> to display the data channels with flags (or, press **<F6>** in any menu to display flags). RNF should be marked with a *D* flag to the right to indicate offline status. The offline time will automatically be recorded in the logbook when this step is completed.

2.    **Inspect the precipitation gauge collection funnel for snow or debris.**

Inspect the collection funnel and remove any foreign objects (e.g., leaves, bugs, etc.) call the Operation Support Center if there is unmelted snow in the funnel. This indicates a failure of the heating system. Record significant findings in the logbook.

**3. Once a month perform a calibration check.**

Verify the channel is still down and start the check just after the top of the hour. Fill the graduated cylinder with water. Place the black calibration funnel into the sensor and pour water from the graduated cylinder into the black funnel. At the completion of the check and in the next hour, log into the datalogger and check the RNF total. The value/result should be between 9.1 and 11.1. Remove the funnel after the check has completed.

**4. Bring the RNF back online and record the value.**

From the Home Menu press <**C**> for Configuration Menu:

```
ESC 88xx v5.31  ID:BL      Configuration Menu      08/06/97  14:59:27

    P  Set Passwords
    S  Configure System Parameters
    D  Configure (Data) Channels
    C  Configure Calibrations
    A  Configure Alarms
    O  Configure Analog Outputs
    K  Configure Math Constants
    E  Configure Dig. Event Program
    R  Configure Digital I/O
    1  Configure Serial Protocols
```

Press <**D**> for Configure (Data) Channels:

```
ESC 88xx v5.31  ID:BL    Channel Configuration Menu    08/06/97  14:59:27

    N  Enter New Configuration
    C  Change Old Configuration
    D  Delete Old Configuration
    M  Disable/Mark Channel Offline
    E  Enable/Mark Channel Online
    I  Put Channel In Maint.
    O  Take Channel Out of Maint.
```

Press <**E**> for Enable/Mark Channel Online:

```
ESC 88xx v5.31  ID:BL    Choose(Space Toggle/Enter Select)    08/06/97  14:59:27

    RNF     [11]
```

Press ↑ and ↓ to highlight a channel(s). Press the <**Spacebar**> to select it for online status. Press <**Enter**> to put the marked channel(s) online.

Check the status of the RNF channel by pressing <**Esc**> several times until the Home Menu is displayed. Press <**D**> once to enter the Real-Time Display Menu. Press <**F**> to display the data channels with flags. RNF should be marked with a *D* flag to the right to

indicate offline status that will clear after one minute. The online time will automatically be recorded in the logbook when this task is completed. Enter the total value of the 10-tip check onto the checklist. The value will automatically be entered into the logbook when this step is completed.

# Checklist Instruction - Weekly Station Visit

## • Precipitation Sensor (Texas Electronics)

**Checklist Instruction Number:** 3176-3151

**Revision Number / Date:** 2 / January 2011 **(last reviewed Jan. 2011)**

---

Objective: Weekly checks of the precipitation system (tipping bucket rain gauge) are performed to verify the operational integrity of the system, inspect and clean the funnel if necessary, verify the operation of the tipping mechanism and heater, and to verify that collected data appear reasonable.

---

**1. Take the RNF (rainfall or precipitation) channel offline for operational checks.**

The checks required to assure proper precipitation gauge operation will generate false RNF readings; therefore, the RNF channel must be taken offline.

From the Home Menu on the ESC datalogger, press <**C**> for Configuration Menu:

```
ESC 88xx v5.31  ID:BL       Configuration Menu        08/06/97  14:59:27


    P  Set Passwords
    S  Configure System Parameters
    D  Configure (Data) Channels
    C  Configure Calibrations
    A  Configure Alarms
    O  Configure Analog Outputs
    K  Configure Math Constants
    E  Configure Dig. Event Program
    R  Configure Digital I/O
    1  Configure Serial Protocols
```

Press <**D**> for Configure (Data) Channels:

```
ESC 88x v5.31  ID:BL     Channel Configuration Menu     08/06/97  14:59:27


    N  Enter New Configuration
    C  Change Old Configuration
    D  Delete Old Configuration
    M  Disable/Mark Channel Offline
    E  Enable/Mark Channel Online
    I  Put Channel In Maint.
    O  Take Channel Out of Maint.
```

Press <**M**> for Disable/Mark Channel Offline:

```
ESC 88xx v5.31  ID:BL    Choose(Space Toggle/Enter Select)   08/06/97  4:59:27

     O3     [01]
     O3CA   [02]
     O3R8   [03]
     VWD    [04]
     SIG    [05]
     VWS    [06]
     SWS    [07]
     TMP    [08]
     DTP    [09]
     SOL    [10]
     RNF    [11]
     WET    [12]
     FLW    [13]
     STP    [14]
```

Use the ↑ and ↓ keys and the spacebar to select the RNF channel for offline status. The RNF channel should be marked with a ">" indicating imminent offline status. Press <**Enter**> to take the marked channel offline.

```
ESC 88xx v5.31  ID:BL    Choose(Space Toggle/Enter Select)   08/06/97  14:59:27

     O3     [01]
     O3CA   [02]
     O3R8   [03]
     VWD    [04]
     SIG    [05]
     VWS    [06]
     SWS    [07]
     TMP    [08]
     DTP    [09]
     SOL    [10]
   > RNF    [11]
     WET    [12]
     FLW    [13]
     STP    [14]
```

Check the status of the RNF channel by pressing <**Esc**> several times until the Home Menu is displayed. Press <**D**> once to enter the Real-Time Display Menu. Press <**F**> to display the data channels with flags (or, press **<F6>** in any menu to display flags). RNF should be marked with a *D* flag to the right to indicate offline status. The offline time will automatically be recorded in the logbook when this step is completed.

**2.    Inspect the precipitation gauge collection funnel for snow or debris.**

Inspect the collection funnel and remove any foreign objects (e.g., leaves, bugs, etc.) call the Operation Support Center if there is unmelted snow in the funnel. This indicates a failure of the heating system. Record significant findings in the logbook.

**3. Once a month perform a calibration check.**

Verify the channel is still down and start the check just after the top of the hour. Fill the graduated cylinder with water. Place the black calibration funnel into the sensor and pour water from the graduated cylinder into the black funnel. At the completion of the check and in the next hour, log into the datalogger and check the RNF total. The value/result should be between 9.1 and 11.1. Remove the funnel after the check has completed.

**4. Bring the RNF back online and record the value.**

From the Home Menu press <**C**> for Configuration Menu:

```
ESC 88xx v5.31  ID:BL       Configuration Menu       08/06/97  14:59:27

    P  Set Passwords
    S  Configure System Parameters
    D  Configure (Data) Channels
    C  Configure Calibrations
    A  Configure Alarms
    O  Configure Analog Outputs
    K  Configure Math Constants
    E  Configure Dig. Event Program
    R  Configure Digital I/O
    1  Configure Serial Protocols
```

Press <**D**> for Configure (Data) Channels:

```
ESC 88xx v5.31  ID:BL    Channel Configuration Menu    08/06/97  14:59:27

    N  Enter New Configuration
    C  Change Old Configuration
    D  Delete Old Configuration
    M  Disable/Mark Channel Offline
    E  Enable/Mark Channel Online
    I  Put Channel In Maint.
    O  Take Channel Out of Maint.
```

Press <**E**> for Enable/Mark Channel Online:

```
ESC 88xx v5.31  ID:BL    Choose(Space Toggle/Enter Select)    08/06/97  4:59:27

    RNF     [11]
```

Press ↑ and ↓ to highlight a channel(s). Press the <**Spacebar**> to select it for online status. Press <**Enter**> to put the marked channel(s) online.

Check the status of the RNF channel by pressing <**Esc**> several times until the Home Menu is displayed. Press <**D**> once to enter the Real-Time Display Menu. Press <**F**> to display the data channels with flags. RNF should be marked with a *D* flag to the right to indicate offline status that will clear after one minute. The online time will automatically be recorded in the logbook when this task is completed. Enter the total value of the 10-tip check onto the checklist. The value will automatically be entered into the logbook when this step is completed.

# Checklist Instruction - Weekly Station Visit

- ### Precipitation Sensor (RM Young)

**Checklist Instruction Number:**      3176-3153

**Revision Number / Date:**      1 / March 2011       (last reviewed Mar. 2011)

---

Objective:    Weekly checks of the precipitation system (tipping bucket rain gauge) are performed to verify the operational integrity of the system, inspect and clean the funnel if necessary, and to verify that collected data appear reasonable.

---

1. **Review RNF data since last visit and compare values with known precipitation events.**

   Verify actual precipitation events (rain or snow) that have occurred since your last visit were recorded by the ESC datalogger, and/or displayed on STKPLOT in DataView.

   If the data appear reasonable, complete Step 2 of this checklist and bypass Steps 3 through 5. If data appear to be missing, complete all steps of this checklist.

2. **Inspect the precipitation gauge collection funnel for snow or debris.**

   Inspect the collection funnel and remove any foreign objects (e.g., leaves, bugs, etc.) call the Operation Support Center if there is unmelted snow in the funnel. This indicates a failure of the heating system. Record significant findings in the logbook.

3. **Take the RNF channel offline for operational checks.**

   If data appear to be missing verify rain gauge operations, but first the RNF channel must be taken offline.

   From the Home Menu on the ESC datalogger, press <**C**> for Configuration Menu:

```
ESC 88xx v5.31  ID:BL      Configuration Menu      08/06/97  14:59:27


    P  Set Passwords
    S  Configure System Parameters
    D  Configure (Data) Channels
    C  Configure Calibrations
    A  Configure Alarms
    O  Configure Analog Outputs
    K  Configure Math Constants
    E  Configure Dig. Event Program
    R  Configure Digital I/O
    1  Configure Serial Protocols

```

---

Press <**D**> for Configure (Data) Channels:

```
ESC 88xx v5.31  ID:BL     Channel Configuration Menu     08/06/97  14:59:27

      N  Enter New Configuration
      C  Change Old Configuration
      D  Delete Old Configuration
      M  Disable/Mark Channel Offline
      E  Enable/Mark Channel Online
      I  Put Channel In Maint.
      O  Take Channel Out of Maint.



```

Press <**M**> for Disable/Mark Channel Offline:

```
ESC 88xx v5.31  ID:BL     Choose(Space Toggle/Enter Select)     08/06/97   4:59:27

      O3      [01]
      O3CA    [02]
      O3R8    [03]
      VWD     [04]
      SIG     [05]
      VWS     [06]
      SWS     [07]
      TMP     [08]
      DTP     [09]
      SOL     [10]
      RNF     [11]
      WET     [12]
      FLW     [13]
      STP     [14]
```

Use the ↑ and ↓ keys and the spacebar to select the RNF channel for offline status. The RNF channel should be marked with a ">" indicating imminent offline status. Press <**Enter**> to take the marked channel offline.

```
ESC 88xx v5.31  ID:BL     Choose(Space Toggle/Enter Select)     08/06/97   4:59:27

      O3      [01]
      O3CA    [02]
      O3R8    [03]
      VWD     [04]
      SIG     [05]
      VWS     [06]
      SWS     [07]
      TMP     [08]
      DTP     [09]
      SOL     [10]
    > RNF     [11]
      WET     [12]
      FLW     [13]
      STP     [14]
```

Check the status of the RNF channel by pressing <**Esc**> several times until the Home Menu is displayed. Press <**D**> once to enter the Real-Time Display Menu. Press <**F**> to display the data channels with flags (or, press **<F6>** in any menu to display flags). RNF should be marked with a *D* flag to the right to indicate offline status. The offline time will automatically be recorded in the logbook when this step is completed.

**4.    Pour water into the precipitation gauge, observe results.**

From the Home Menu select <**D**> for Real-Time Display Menu:

```
ESC 88xx v5.31  ID:BL      Real Time Display Menu       08/06/97  14:59:27

    V  Display Raw Readings
    R  Display Readings w/units
    F  Display Readings w/flags
    B  Display Last Base Avg
    C  Continuous Avg Report
    L  Show LARGE TEXT Display
    I  Display Digital Inputs
    O  Display Digital Outputs
    A  Display Analog Outputs
```

Press <**C**> for Continuous Avg Report:

```
ESC 88xx v5.31  ID:BL     Continuous Avg Report Setup      08/06/97  14:59:27


    Average Interval                 :  1m
    Show Channels                    :  O3,O3CAL,RNF



    # of Flags to Report             :  02
    Use Decimal Positioner?          :  Y
    Start Continuous Report
```

Enter a **1** and then **m** for the Average Interval if it has not defaulted to the 1m.  Use the ↑ and ↓ keys and the spacebar to select Show Channels. Type **RNF** if it is not already displayed. Navigate down to Start Continuous Report and press <**Enter**>.

```
          TIME          O3          O3CAL        RNF

     10/19 11:19       41.            -1.         0.0
```

The data line will update and append once per minute.  This screen allows the operator to leave the shelter, pour water into the rain gauge and return to the shelter to read the resulting "precipitation."

Slowly pour a small volume of water (~20ml) into the rain gauge. Listen carefully for the buckeyes to tip. Attempt to count the number of tips. 20ml of water should result in 10 tips (2 ml/tip).

Back in the shelter, the ESC screen will have updated and will report the tips as precipitation.

```
        TIME            O3    O3CAL     RNF

        10/19 11:30    41.    -1.       0.0
        10/19 11:31    41.    -1.       0.0
        10/19 11:32    40.    -1.       0.0
        10/19 11:33    42.    -1.       1.0
        10/19 11:34    41.    -1.       0.0
```

To be certain that all the tips were collected in the displayed one minute updates, wait long enough for an update of 0.0 to appear for RNF. The tips may have been recorded over one or two minutes. The total precipitation response is the sum of the one minute updates. The total should be 1.0mm (.1mm/tip) for 20ml of water. Call the OSC if the results are different than above.



10 tips = 2.5 mm          10 tips = 1.0 mm
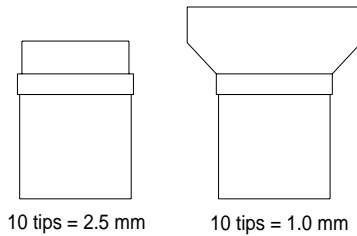
**5.      Bring the RNF back online and record the results.**

From the Home Menu press <**C**> for Configuration Menu:

```
ESC 88xx v5.31  ID:BL      Configuration Menu      08/06/97  14:59:27

    P  Set Passwords
    S  Configure System Parameters
    D  Configure (Data) Channels
    C  Configure Calibrations
    A  Configure Alarms
    O  Configure Analog Outputs
    K  Configure Math Constants
    E  Configure Dig. Event Program
    R  Configure Digital I/O
    1  Configure Serial Protocols
```

Press <**D**> for Configure (Data) Channels:

```
ESC 88xx v5.31  ID:BL    Channel Configuration Menu    08/06/97  14:59:27

    N  Enter New Configuration
    C  Change Old Configuration
    D  Delete Old Configuration
    M  Disable/Mark Channel Offline
    E  Enable/Mark Channel Online
    I  Put Channel In Maint.
    O  Take Channel Out of Maint.
```

Press <**E**> for Enable/Mark Channel Online:

```
ESC 88xx v5.31  ID:BL    Choose(Space Toggle/Enter Select)   08/06/97  14:59:27

    RNF    [11]
```

Press ↑ and ↓ to highlight a channel(s). Press the <**Spacebar**> to select it for online status. Press <**Enter**> to put the marked channel(s) online.

Check the status of the RNF channel by pressing <**Esc**> several times until the Home Menu is displayed.  Press <**D**> once to enter the Real-Time Display Menu.  Press <**F**> to display the data channels with flags (or, press **<F6>** in any menu to display flags). RNF should be marked with a *D* flag to the right to indicate offline status that will clear after one minute. The online time will automatically be recorded in the logbook when this task is completed. Enter the results of the test in the logbook.

# Approvals

The purpose of this review and approval is to evaluate this Standard Operating Procedure (SOP) for adequacy prior to issuance. The signatories below are stating that the approach defined within this document is acceptable and that the affected company interests have been represented.

Author Signature:

Program: QA Manager – Genevieve Lariviere

Approval Signature:

Program: Field Operations Manager – Mark Tigges

# REVISION HISTORY

| Review date: | Changes made: | Changes made by: |
| --- | --- | --- |
| 10/24/2016 | Initial Version 1.0 | E. Vanden Hoek |
| 10/29/2018 | Removed date reference from file name | E. Vanden Hoek |
| 10/12/2019 | No changes necessary | E. Vanden Hoek |
| 10/28/2020 | Added ARS contact information to Section 6.5<br><br>Removed empty Section 7.0 REFERENCES | E. Vanden Hoek |
| 10/6/2021 | Removed 10-tip test from Section 6.2 and updated to reflect site operator performs known volume precipitation checks. | E. Vanden Hoek |
| 10/5/2022 | Updated personnel. .Minor text edits | E. Vanden Hoek |
| | | |

# ANNUAL REVIEW

The undersigned attests that this standard operating procedure has undergone annual review for adherence to current practices and the latest QA/QC protocols:

| Signature | Title | Date |
|---|---|---|
| *(signature)* | QA Manager | 10/29/2018 |
| *(signature)* | QA Manager | 10/12/2019 |
| *(signature)* | Network Operations Manager/Field Specialist | 10/28/2020 |
| Chad Cole | Field Specialist | 10/6/2021 |
| Max Abrahamson | Field Specialist | 9/30/2022 |

## 1.0 PURPOSE

Instructions provided herein outline the steps of routine site operator maintenance visits using the DataView system for ambient air monitoring stations operated by Air Resource Specialists, Inc. (ARS).

## 2.0 SUMMARY OF METHOD

The primary purpose of routine site operator visits is to assure quality data capture and minimize data loss by performing routine operational checks and system integrity checks of equipment. The observations recorded during these visits verify the operations of the monitoring system. The site operator may also be asked to perform troubleshooting, simple maintenance, and sensor replacements in consultation with the field specialist.

## 3.0 SCOPE

Activities described in this document are performed by local site operators during routine and emergency site visits. Local operators have been appropriately trained in site operations by ARS field staff and possess the required technical knowledge and abilities to perform the activities described below.

## 4.0 ROLES AND RESPONSIBILITIES

### Program or Project Manager

- Coordinate with site operator, his/her supervisor, and ARS field specialist, concerning the schedule and requirements for routine and emergency maintenance.

### Fields Operations Manager

- Review with the field specialist site operator training requirements.

### Field Technician or Specialist

- Coordinate with site operator, his/her supervisor, and ARS field specialist, concerning the schedule and requirements for routine and emergency maintenance
- Train the site operator in all phases of the routine and emergency maintenance visits.
- Provide technical support to the station operator via telephone or email to identify instrument problems and initiate instrument repairs.
- Document all technical support given to the site operator via the ARS site status log (www.arssitestatuslog.com).

### Local Site Contact

- Coordinate with his/her supervisor, project manager, and ARS field specialist concerning the schedule and requirements for routine and emergency maintenance.
- Perform all procedures described in site or network specific Checklist Instructions (CIs).
- Thoroughly document all procedures performed during each site visit.
- Report any noted inconsistencies immediately to the field specialist.

## 5.0 REQUIRED EQUIPMENT AND MATERIALS

- Keys for the shelter or support system internal lock and padlocks.

## 6.0 PROCEDURES

### 6.1 ROUTINE VISITS – AIR QUALITY INSTRUMENTS

The station operator will make routine observations at the site. Sites may have different configurations and DataView is customized for each site's instrumentation. While completing the DataView CIs, the operator will make some or all of the following observations:

| | |
|---|---|
| OZONE ($O_3$) | Verify that the ozone analyzer is functioning properly. Check the ozone particulate filter weekly and change if necessary (at least monthly). |
| SULFUR DIOXIDE ($SO_2$) | Verify that the sulfur dioxide analyzer is functioning properly. Verify that the gas dilution calibrator is functioning properly. Change the sulfur dioxide filter every two weeks. |
| CARBON MONOXIDE (CO) | Verify that the carbon monoxide analyzer is functioning properly. Verify that the gas dilution calibrator is functioning properly. Change the carbon monoxide filter every two weeks. |
| OXIDES OF NITROGEN ($NO_X$) | Verify that the oxides of nitrogen analyzer is functioning properly. Verify that the gas dilution calibrator is functioning properly. Change the oxides of nitrogen filter every two weeks. |
| PARTICULATE MONITOR ($PM_{10}$ or $PM_{2.5}$) | Perform monthly leak check and flow verification. Clean inlet nozzle and nozzle area. Clean $PM_{10}$ inlet and/or $PM_{2.5}$ Very Sharp Cut Cyclone (VSCC). Replace tape as necessary. |

### 6.2    ROUTINE VISITS – METEOROLOGICAL SENSORS

The station operator will make weekly observations at the site. Sites may have different configurations and DataView is customized for each site's instrumentation. While completing the DataView CIs, the operator will make some or all of the following observations:

| | |
|---|---|
| WIND SPEED AND DIRECTION | Inspect the wind sensor for damage. Compare current wind speed and direction measurements to observed ambient conditions. |
| TEMPERATURE/ DELTA TEMPERATURE | Verify that the temperature sensor housing aspirator fan is operational. Compare current temperature and delta temperature measurements to observed ambient conditions. |
| RELATIVE HUMIDITY | Compare the current relative humidity measurement to observed ambient conditions. |
| SOLAR RADIATION | Inspect the solar radiation sensor for dirt or snow and clean if necessary. Compare the current solar radiation measurement to observed ambient conditions. |
| PRECIPITATION | Inspect the precipitation gauge collection funnel for snow or debris. Perform a verification check of the sensor using a known volume of water monthly. |
| BAROMETRIC PRESSURE | Compare the current barometric pressure to trends from recent weather activity. Inspect the sensor and tubing for abrasions, cracks, or other defects. |

The station operator should promptly report any noted inconsistencies to the field specialist.

### 6.4    TROUBLESHOOTING, MAINTENANCE, INSTRUMENT REPLACEMENT

If a malfunction of any monitoring component occurs, or if any of the readings do not make sense, the station operator should call ARS (970-484-7941) to report any discrepancy. A field technician will instruct the station operator on troubleshooting procedures.

TROUBLESHOOTING  If a potential malfunction or other inconsistency is noted, the station operator will be directed to perform a series of troubleshooting procedures. The use of certain tools or diagnostic equipment (most frequently a digital voltmeter) will be required. The field specialist will step the station operator through the proper procedures by telephone or email. Typical procedures may include continuity checks, supply voltage checks, bearing observations, datalogger interrogation, or specific instrument performance observations. The operator will be asked to thoroughly record his/her findings and relate them to the field specialist for further action.

MAINTENANCE  The station operator may be asked to perform certain mechanical, electrical, electronic, or datalogger program maintenance as directed by the field specialist. Typical maintenance tasks could include tightening tower guy wires, replacing backup batteries, resetting a power line breaker, or restarting system components. All maintenance must be thoroughly documented and the results related to the field specialist.

EQUIPMENT REPLACEMENT  Under the field specialist's direction, the station operator may be asked to replace a malfunctioning instrument or sensor with a field-ready unit. The unit would be calibrated on-site at a later date by the field specialist. All replacement steps will be reviewed by telephone with the station operator. Instrument-specific manuals or other diagrams or descriptions will be referenced as appropriate. All instrument replacement procedures including the equipment type, make, serial number, and date and time of replacement must be documented.

### 6.5 SITE DOCUMENTATION

Routine operator checks entered in the Checklist Instructions are automatically documented in the DataView station log. Any additional troubleshooting, maintenance, or equipment replacement actions must be documented in the station log using DataView.

In the event of a DataView computer malfunction, or if DataView is not in operation at the site, the operator must manually complete a hard copy version of the Checklist Instruction. Upon completion, the site operator must mail or email the completed form to:

**Air Resource SPECIALISTS**

1901 Sharp Point Dr., Suite F
Fort Collins, CO 80525
Fax: 970-484-3423
imc-team@air-resource.com

*Notify ARS if hard copies are not available on site and they will be provided.*

## 7.0    DEFINITIONS AND ACRONYMS

ARS        Air Resource Specialists, Inc.
AQDB       Air Quality Database
CFR        Code of Federal Regulations
DAS        Data Acquisition System
EPA        U.S. Environmental Protection Agency
IMC        Information Management Center
MS         Microsoft
NIST       National Institute of Standards and Technology
PDF        Portable Document Format
QA         Quality Assurance
QAPP       Quality Assurance Project Plan
QC         Quality Control
SLAMS      State and Local Air Monitoring Stations
SOP        Standard Operating Procedure


**Verification**: establishes the quantitative relationship between the value of a known traceable standard and the instrument's response

**Calibration**: adjustment of the instrument or analyzer so it operates within established acceptance criteria (defined in the network of project specific QAPP.

# Checklist Instruction - Weekly Station Visit

- **Ozone Analyzer ( TEI 49C)**
- **Ozone Calibrator (TEI 49C)**
- **CASTNet Dry Deposition**

**Checklist Instruction Number:**      **3178-3116**

**Revision Number / Date:**      **4 / January 2006**      **(last reviewed Jan. 2006)**

_____

Objective:  Weekly checks of the ozone instrumentation and the CASTNet dry deposition filter pack are to:

- Verify that the ozone analyzer is functioning properly.
- Check the analyzer particulate filter in the orange holder and change if necessary. The filter must be changed no less than every two weeks.
- Change the CASTNet dry deposition filter pack, verify the operational integrity of the filter pack system, complete the SSRF, and return the exposed filter pack and SSRF to the CASTNet contractor.

_____

1.      **Check  for an  alarm condition on the front panel of the ozone analyzer.  Report alarms to the OSC.**

Alarm conditions are indicated on the TEI 49C ozone analyzer front panel display,  as shown below:

```
┌─────────────────────────────────────────┐
│                                          │
│  O3 PPB                           67.0   │
│                                          │
│                   ALARM        REMOTE    │
│                                          │
└─────────────────────────────────────────┘
```

To list specific alarms, press the **MENU** button on the analyzer once to access the Main Menu*:*

```
┌─────────────────────────────────────────┐
│  MAIN MENU:                      10:25   │
│  > RANGE                                 │
│     AVERAGING TIME                       │
│     CALIBRATION FACTORS                  │
│                                          │
└─────────────────────────────────────────┘


     CALIBRATION
     INSTRUMENT CONTROLS
     DIAGNOSTICS
     ALARM
```

Use the ↑ and ↓ buttons to move the cursor and press <**Enter**> once to access the Alarm Menu*:*

```
┌─────────────────────────────────────────────┐
│ ALARMS DETECTED:                    1        │
│ > BENCH TEMP                        OK       │
│    BENCH LAMP TEMP                  LOW      │
│    PRESSURE                         OK       │
│                                              │
└─────────────────────────────────────────────┘

     FLOW A                          OK
     FLOW B                          OK
     INTENSITY A                     OK
     INTENSITY B                     OK
     O3 CONC                         OK
```

Call the Operation Support Center to report and resolve the alarms that have been flagged on the right side of the display.  Record the significant actions related to the alarms in the site logbook.  Press the **RUN** button once to return to the Run mode when diagnostics are completed.

**2.     Take the ozone analyzer and flow offline and shut off the CASTNet flow pump and hour meter.**

To ensure that only ambient and flow data are recorded in the hourly average, it is necessary to mark the O$_3$, O3CAL, and FLW channels offline.  Data marked in this manner are automatically excluded from the valid data set.

To access the Login Screen of the ESC datalogger press <**Esc**> on the keyboard a couple of times until the Home Menu is displayed:

```
ESC 88XX v5.31  ID:RM            Home Menu              04/26/02  11:30:27

    H   Help Screen
    L   Login/Set User Level



    O   Log Out/Exit


```

Press <**L**> for Login/Set User Level:

```
ESC 88XX v5.31  ID:RM            Login Screen           04/26/02  11:30:27

    Enter Password              **************




```
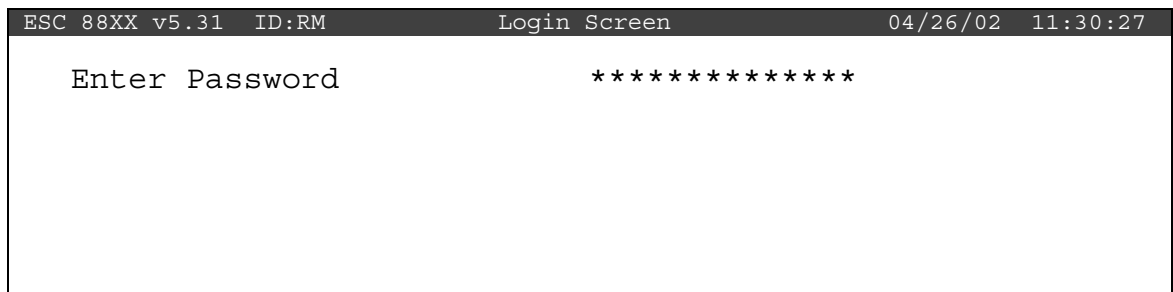
Login by typing user name and password on the keyboard then press <**Enter**>. The datalogger display will look similar to:

```
ESC 88XX v5.31  ID:RM            Home Menu            04/26/02  11:30:27

    H Help Screen
    L Login/Set User Level
    C Configuration Menu
    D Real-Time Display Menu
    R Report Generation Menu
    G Graph Generation Menu
    S Status Menu
    O Log Out/Exit
    X Serial Como to Port
```

Press <**C**> for Configuration Menu:

```
ESC 88XX v5.31  ID:RM          Configuration Menu     04/26/02  11:30:27

    P Set Passwords
    S Configure System Parameters
    D Configure (Data) Channels
    C Configure Calibrations
    A Configure Alarms
    O Configure Analog Outputs
    K Configure Math Constants
    E Configure Dig. Event Program
    R Configure Digital I/O
    1 Configure Serial Protocols
```

Press <**D**> for Configure (Data) Channels:

```
ESC 88XX v5.31  ID:RM       Channel Configuration Menu   04/26/02   11:30:27

    N Enter New Configuration
    C Change Old Configuration
    D Delete Old Configuration
    M Disable/Mark Channel Offline
    E Enable/Mark Channel Online
    I Put Channel In Maint.
    O Take Channel Out of Maint.
```

Press <**M**> for Disable/Mark Channel Offline:

```
ESC 88XX v5.31  ID:RM    Choose(Space Toggle/Enter Select)  04/26/02  11:30:27

    O3     [01]
    O3CAL  [02]
    O3R8   [03]
    VWD    [04]
    SIG    [05]
    VWS    [06]
    SWS    [07]
    TMP    [08]
    DTP    [09]
    SOL    [10]
    RNF    [11]
    WET    [12]
    FLW    [13]
    STP    [14]
```

Use the ↑ and ↓ keys to navigate and the spacebar to select the O3, O3CAL, and FLW channels for offline status. The channels should be marked with a ">" indicating imminent offline status. Press <**Enter**> to take the marked channels offline.

Check the status of the channels by pressing <**Esc**> several times until the Home Menu is displayed. Press <**D**> once to enter the Real-Time Display Menu**.** Press <**F**> to display the data channels with flags. O3, O3CAL, FLW should be marked with a *D* flag to the right to indicate offline status. The offline time is automatically recorded in the logbook when this step is complete.

Switch off the pump and the hour meter for the CASTNet flow system. The labeled switches are located below the CASTNet flow box.

3. **Tip the dry deposition tower and replace the analyzer particulate filter in the orange holder every two weeks or as needed.**

Lower the flow tower only during good weather (e.g., no electrical storms, high winds, heavy ice buildup, or obvious tower damage). First remove the locking pin to allow the tower to be lowered. Then gently control its descent with the attached rope. Secure the tower by tying the rope to the base.

The dry deposition filter and particulate filter resides in the "pothead" at the top of the tower. The particulate filter is in a Teflon housing with an orange tightening ring. Look through the "T" at the bottom for obvious fine debris or discoloration on the filter. If the filter is unfit for another week of service, it must be changed. Install a clean filter when it is visibly dirty or once every 2 weeks, whichever comes first.

The filter protects the sample inlet system from particulate that could contaminate and subsequently reduce the ambient ozone concentrations. Proper filter inspection and replacement is key in maintaining accurate readings of ambient ozone concentrations.

To open the particulate filter holder, loosen the orange tightening ring from the filter housing using the dark green filter wrenches supplied by the Operation Support Center.

Begin a filter change by removing and discarding the exposed filter. Using the provided tweezers remove a new 5μ Teflon filter from the envelope and install it into the filter housing. The 5μ filter envelope has an orange color code. Ensure that the filter remains clean during this process since contamination reduces the ozone concentrations in the sampling stream. Reassemble the filter holder and tighten the orange ring securely using the filter wrenches.

4. **If a new analyzer particulate filter (orange holder) was installed, condition it by starting a DIAGSZ**.

Following a filter change, a DIAGSZ is required to verify the integrity of the sampling system and to condition the new filter. From the ESC datalogger Home Menu, press <**C**> for Configuration Menu:

```
ESC 88XX v5.31  ID:RM           Configuration Menu          04/26/02  11:30:27


    P  Set Passwords
    S  Configure System Parameters
    D  Configure (Data) Channels
    C  Configure Calibrations
    A  Configure Alarms
    O  Configure Analog Outputs
    K  Configure Math Constants
    E  Configure Dig. Event Program
    R  Configure Digital I/O
    1  Configure Serial Protocols
```

Press <**C**> again for Configure Calibrations:

```
ESC 88XX v5.31  ID:RM          Cal Configuration Menu       04/26/02  11:30:27

    N  Enter New Cal Configuration
    C  Change Old Cal Configuration
    D  Delete Old Cal Configuration
    S  Start a Calibration Program
    1  Start a Single Phase Cal
    A  Abort a Calibration Program
    Q  Quick Expected Value Editor
    I  Return to Interactive Cal
```

Press <**S**> for Start a Calibration Program:

```
ESC 88XX v5.31  ID:RM       Choose List (Enter to Select)   04/26/02  11:30:27


    PSZ
    DIAGSPAN
    DIAGZERO
    DIAGPREC
    DIAGSZ


   Refresh   Exit       GOTO END  GOTO TOP   Clr Keys    Select
```

From the Choose List Menu, use the ↑ and ↓ keys to highlight DIAGSZ. This is an
ozone calibration sequence that begins with a 15-minute span phase and concludes with a
5-minute zero phase. The control of the calibration sequence is automatic. Press
<**Enter**> and several things occur immediately. Pump noise in the shelter increases
dramatically as the ozone calibrator (O3CAL) sample pump and the zero air pumps
switch to on.

After 15 minutes the span phase will conclude and the zero phase will commence.

After 5 additional minutes, the zero will turn off and ambient collection will resume
automatically. Before leaving the station, you will be asked to find and record the stored
results.

**5.** **Remove the exposed CASTNet dry deposition filter cartridge, perform a flow system leak check and complete last week's SSRF.**

To confirm that all systems are in good operational condition and that filters are handled correctly, the operator is required to check each component and change filters weekly.

A mailing tube is sent to your site weekly by MACTEC E&C, in Gainesville, Florida. Each tube contains a sample filter pack enclosed in a Ziplock® bag and a Site Status Report Form (SSRF). Filters are generally changed each Tuesday. Call the Operation Support Center for exceptions.

Begin this week's filter change by completing last weeks SSRF. In the FILTER OFF column on last week's SSRF, record the dry deposition flow box rotameter reading observed at the middle of the ball.

Obtain the most recent Hourly Average for flow by starting at the Home Menu of the datalogger. Press <**R**> for Report Generation Menu. Then press <**R**> for Daily Averages Report. In the highlighted Show Channels field type "FLW" and press **<Enter>** four times to view the Daily Report to Screen.

```
ESC 88XX v5.31  ID:RM            Daily Report Screen      04/26/02  11:30:27


    Show Channels           :        FLW



    Start Time              :        04/26/02 00:00:00
    # of Flags to Report    :        02
    Daily Report to Screen  :
    Daily Report to Printer :

```

```
 Daily Average          04/26/02 11:30:27       JDay:  116    Logger ID: BL
    Report                      ROCKY MOUNTAIN NATIONAL PARK
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
- -
Name:                   FLW
Channel Num:            15
Analog Input:           10
Units:                  SLPM
Full Scale:                 5 V
High Output:            5.89
Low Output:             0.00
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
      - -
04/26 00:00                 3.00
04/26 01:00                 3.00
04/26 02:00                 3.00
04/26 03:00                 3.00
04/26 04:00                 3.00
04/26 05:00                 3.00
04/26 06:00                 3.00
04/26 07:00                 3.00
04/26 08:00                 3.00
04/26 09:00                 3.00
04/26 10:00                 3.00
04/26 11:00             -9999.<N
04/26 12:00             -9999.<N
04/26 13:00             -9999.<N
04/26 14:00             -9999.<N
```

Obtain the most recent datalogger HOURLY AVERAGE for FLW and record it in the FILTER OFF DAS FLOW (LPM) entry cell on the SSRF. In this example the most recent hourly average occurs at 10:00 and is 3.00.

**Remove the CASTNet dry deposition filter.**

A) Wearing clean vinyl gloves (provided by the Operation Support Center), remove the dry deposition filter pack from the tower by pulling back on the locking ring of the quick-disconnect. Once the filter is removed the quick-disconnect provides an airtight seal.

B) Insert the plastic caps that were saved in the shipping container to avoid contamination to the filter.

C) Place the filter pack in its Ziplock® bag.

D) Enter the date and time for FILTER OFF on last week's SSRF.

E) Remove your gloves and discard them.

F) Observe the current reading of the Mass Flow Controller (MFC) display. It should be close to zero. Record this value as the MFC (pump off) under FILTER OFF on last week's SSRF.

G) Turn on the pump to leak check the sampling system. Let the MFC value stabilize and record the value in the MFC LEAK CHECK box on last week's SSRF. The new value should also be close to zero. Call the OSC if the MFC (pump off) and the MFC LEAK CHECK are more than ± 0.03 different. Turn off the pump.

H) Record the hour meter reading as the ELAPSED TIME (HRS).

I) Record the expected ship date, then sign and date the form on the PREPARED BY line. At this point, last week's SSRF should be complete; the white, yellow, and gold copies and the filter you just removed can be packed in last week's mailing tube for shipment to MACTEC E&C. The pink copy <u>remains</u> in your stations file cabinet.

Inspect the plumbing for signs of obvious deterioration or moisture. If either is discovered, report your finding to the OSC.

6. **Install new CASTNet dry deposition cartridge, raise the tower, and reset hour meter. Begin the new SSRF and turn on pump and hour meter.**

Open the mailing tube containing this week's filter and a new SSRF. Enter the codes for the site name and number. The codes are found on the side of the filter housing and on the Chain of Custody label. Enter the date, followed by the day of the week in the VISIT DATE/DAY field. If the plumbing has not been disturbed you may enter your previous leak check results in the MFC LEAK CHECK cell in the FILTER ON column. Enter your name and the date on the SHIPMENT OPENED BY line.

Enter the filter pack number from the label on the filter pack housing.  Back outside, release the vacuum at the filter quick-disconnect by pressing into the center of the connector until you hear a faint rush of air.  Use a small clean screwdriver.

Put on clean vinyl gloves and remove the caps from the new filter pack.  Seal the caps in the Ziplock® bag and store the bag in the mailing tube until next week.

Install the filter pack by pressing it into the fitting until you hear a "snap," indicating a secure connection.  Discard the gloves.

Raise the tower slowly and secure it by inserting the locking pin.

Reset the hour meter to zero.  Turn on the flow pump and the hour meter.

Enter the FILTER ON date and time on the new SSRF, using the Local Standard Time (LST) displayed by the datalogger.  Ensure that the readout box LED display reaches the set point recorded on the calibration label affixed to the case.

**7.**     **Bring the O3, O3CAL, and FLW channels back online.**

Bring the O3, O3CAL, and FLW channels online by beginning at the Home Menu of the ESC datalogger.  Remember that pressing <**Esc**> several times will return you eventually to the Home Menu.

```
ESC 88XX v5.31  ID:RM              Home Menu              04/26/02  11:30:27


    H  Help Screen
    L  Login/Set User Level
    C  Configuration Menu
    D  Real-Time Display Menu
    R  Report Generation Menu
    G  Graph Generation Menu
    S  Status Menu
    O  Log Out/Exit
    X  Serial Como to Port


```

Press <**C**> for Configuration Menu:

```
ESC 88XX v5.31  ID:RM            Configuration Menu        04/26/02  11:30:27


    P  Set Passwords
    S  Configure System Parameters
    D  Configure (Data) Channels
    C  Configure Calibrations
    A  Configure Alarms
    O  Configure Analog Outputs
    K  Configure Math Constants
    E  Configure Dig. Event Program
    R  Configure Digital I/O
    1  Configure Serial Protocols

```

Press <**D>** for Configure (Data) Channels:

```
ESC 88XX v5.31  ID:RM        Channel Configuration Menu    04/26/02  11:30:27

    N  Enter New Configuration
    C  Change Old Configuration
    D  Delete Old Configuration
    M  Disable/Mark Channel Offline
    E  Enable/Mark Channel Online
    I  Put Channel In Maint.
    O  Take Channel Out of Maint.
```

Press <**E**> for  Enable/Mark Channel Online.  O3 and FLW should be the only channels displayed.

```
ESC 88XX v5.31  ID:RM    Choose(Space Toggle/Enter Select)  04/26/02  11:30:27

  > O3      [01]
    O3CAL   [02]
    FLW     [15]
```

Use the ↑ and ↓ keys to navigate and the spacebar to select a channel.  Press the <**Spacebar**> to select both channels for online status.  Press <**Enter**> to put the selected channels online.

```
ESC 88XX v5.31  ID:RM    Choose(Space Toggle/Enter Select)  04/26/02  11:30:27

  > O3      [01]
  > O3CAL   [02]
  > FLW     [15]
```

Check the status of the O3, O3CAL, and FLW channels by pressing <**Esc**> several times until the Home Menu is displayed.  Press <**D**> once to enter the Real-Time Display Menu.  Press <**F**> once to display the data channels with flags.  O3, O3CAL, O3R8, and FLW will no longer be marked with a flag indicating online status; a *P* may be in the flag column for each indicating a purge period programmed to allow for the time it takes for ambient conditions to prevail.  The *P* flag should clear within one minute.  The online time will be recorded in the logbook when this step is complete.

Note:  If the calibration sequence, DIAGSZ, is still active, O3, O3CAL, and O3R8 will be flagged with a *C*.

**8-9.** **If a new analyzer particulate filter (orange holder) was installed and a DIAGSZ was activated enter the filter conditioning results for O3 and O3CAL.**

From the Home Menu press <**R**> for Report Generation Menu:

```
ESC 88XX v5.31  ID:BL          Report Menu          08/06/97  14:59:27

     A Report Averages
     C Report Calibrations
     L Summarize Last Cals
     Q Autoprint Data Channel(s)
     D Autopring Daily Report
     Z Autoprint Calibration(s)
     R Daily Averages Report
     T Daily Calibrations Report
```

Press <**L**> for Summarize Last Cals.  Navigate through the Last Cals using the <**D**> (down) or <**U**> (up) keys to find the DIAGSZ:

| DIAGSZ | 08/14  08:00 | EXPECTED | ACTUAL | ERROR | UNITS | FLAGS |
|--------|--------------|----------|--------|-------|-------|-------|
| O3 | SPAN | 400 | 406.1 | 6.1 | PPB | DC |
|  | ZERO | 0 | -0.1956 | 0 | PPB | DC |
| O3 CAL | SPAN | 400 | 403.9 | 3.9 | PPB | DC |
|  | ZERO | 0 | 1.0100 | 1.01 | PPB | DC |

Record the O3 and O3CAL from the ACTUAL column into the appropriate cells of the checklist.  The result location has been highlighted in the graphic above.

O3ZERO          Value between -5 and +5 ppb
O3SPAN          Value within 10% of O3CAL SPAN
O3CAL ZERO   Value between -5 and +5 ppb
O3CAL SPAN   Value between 350 and 450 ppb

*The checklist will prompt you to call the OSC if the results were not within tolerance.*

# Checklist Instruction - Multipoint Calibration

- **Ozone Analyzer (TEI 49C)**
- **Ozone Calibrator (TEI 49C)**

**Checklist Instruction Number:**     **3178-3315**

**Revision Number / Date:**          **1 / January 2006**          **(last reviewed Jan. 2006)**

Objective:   Monthly multipoint calibrations are performed to provide a more comprehensive check of the instrument's condition and verify the ozone analyzer's response to ozone free (zero) air and three (3) upscale ozone concentrations:

- 360 to 440 ppb
- 150 to 200 ppb
- 50 to 80 ppb

1.     **Start a DIAGZERO sequence from the ESC datalogger.**

From the ESC datalogger Home Menu, press <**C**> for Configuration Menu:

```
ESC 88xx v5.31  ID:BL      Configuration Menu      08/06/97  14:59:27

    P Set Passwords
    S Configure System Parameters
    D Configure (Data) Channels
    C Configure Calibrations
    A Configure Alarms
    O Configure Analog Outputs
    K Configure Math Constants
    E Configure Dig. Event Program
    R Configure Digital I/O
    1 Configure Serial Protocols
```

Press <**C**> again for Configure Calibrations:

```
ESC 88xx v5.31  ID:BL      Cal Configuration Menu   08/06/97  14:59:27

    N Enter New Cal Configuration
    C Change Old Cal Configuration
    D Delete Old Cal Configuration
    S Start a Calibration Program
    1 Start a Single Phase Cal
    A Abort a Calibration Program
    Q Quick Expected Value Editor
    I Return to Interactive Cal
```

Press <**S**> for Start a Calibration Program:

```
ESC 88xx v5.31  ID:BL     Choose List (Enter to Select)      08/06/97  14:59:27


     PSZ
     DIAGSPAN
     DIAGZERO
     DIAGPREC
     DIAGSZ


     F2          <ESC>        TAB          CTRL-K       CTRL-R       Arrows
     Refresh     Exit         GOTO END     GOTO TOP     Clr Keys     Select
```

From the Choose List Menu, use the ↑ and ↓ keys to highlight DIAGZERO. This is an ozone calibration sequence that initiates a 30-minute zero. The control of the calibration sequence is automatic. Press <**Enter**> and several things occur immediately. Pump noise in the shelter increases dramatically as the ozone calibrator (O3CAL) sample pump and the zero air pump switch on. The alarm on the front panel of the ozone calibrator should go off within a few seconds. Inspect the front panel of the ozone analyzer and the ozone calibrator. If either panel is displaying an alarm, abort the multipoint calibration and call the Operation Support Center for diagnostic support. Restart the multipoint when the alarms have been resolved.

Press <**Esc**> several times to return to the datalogger Home Menu.

From the Home Menu, select <**D**> for Real-Time Display Menu:

```
ESC 88xx v5.31  ID:BL        Real-Time Display Menu         08/06/97  14:59:27

     V Display Raw Readings
     R Display Readings w/units
     F Display Readings w/flags
     B Display Last Base Avg
     C Continuous Avg Report
     L Show LARGE TEXT Display
     I Display Digital Inputs
     O Display Digital Outputs
     A Display Analog Outputs
```

Press <**C**> for Continuous Avg Report:

```
ESC 88xx v5.31  ID:BL       Continuous Avg Report Setup      08/06/97  14:59:27


     Average Interval                 : 1m
     Show Channels                    : O3,O3CAL,RNF


     # of Flags to Report             : 02
     Use Decimal Positioner?          : Y
     Start Continuous Report
```

Enter a <**1**> and then <**m**> for the Average Interval if it has not defaulted to the 1m. Arrow down to Show Channels. Type **O3** and **O3CAL** if it is not already displayed. Arrow down to Start Continuous Report and press <**Enter**>.

```
        TIME                  O3          O3CAL        RNF

        08/06 14:59           41.<C        -1.<C        0.0
```

**2.    Check for an alarm condition on the front panel of the ozone analyzer. Report alarms to the OSC before proceeding with the multipoint calibration.**

Alarm conditions are indicated on the TEI 49C ozone analyzer front panel display, as shown below:

```
┌──────────────────────────────────────┐
│                                      │
│  O3 PPB                      0.0     │
│                                      │
│  ZERO          ALARM         REMOTE  │
└──────────────────────────────────────┘
```

**3.    Check for an alarm condition on the display of the ozone calibrator. The display should not show an alarm condition during the DIAGZERO. Report alarms to the OSC before proceeding with the multipoint calibration.**

Previous to the initiation of the DIAGZERO sequence, the normal TEI 49C ozone calibrator front panel will display an alarm condition as shown below:

```
┌──────────────────────────────────────┐
│                                      │
│  O3 PPB                      0.0     │
│                                      │
│                ALARM         REMOTE  │
└──────────────────────────────────────┘
```

When the DIAGZERO sequence has been initiated, the ozone calibrator sample pump will start and the alarm condition will no longer be met. As the flow rate approaches its set point, the ALARM indicator will be replaced with and indication of the time of day as shown below:

```
┌──────────────────────────────────────┐
│                                      │
│  O3 PPB                      0.0     │
│                                      │
│                10:25         REMOTE  │
└──────────────────────────────────────┘
```

Note:  The time of day need not be correct for the calibrator to operate properly.

If the alarm condition persists after one minute into the DIAGZERO calibration sequence, call the Operation Support Center.

**4.** **Observe the continuous average report for several minutes. When five or more one-minute updates indicate a stable zero response, +5ppb to –5ppb, record the last one-minute averages for O3 and O3CAL.**

After several minutes the Continuous Average Report will display the arrays of one-minute updates for O3 and O3CAL.

```
        TIME                    O3    O3CAL    RNF

        10/19 11:30           41.<C -1.<C      0.0
        10/19 11:31            4.<C -0.<C      0.0
        10/19 11:32            0.<C -1.<C      0.0
        10/19 11:33           -1.<C  1.<C      0.0
        10/19 11:34            0.<C  1.<C      0.0
```

Once the following conditions have been met:

1. The last three one-minute averages of O3 are in the range of +5ppb to –5ppb.
2. The last three one-minute averages of O3CAL are in the range of +5ppb to –5ppb.

Record the last one-minute average of O3 and O3CAL. If the conditions are not met, even after several more minutes, do not proceed further with the multipoint calibration. Call the OSC for diagnostic support.

If the zero values were successful and recorded, abort the DIAGZERO.

Press <**Esc**> several times to return to the Home Menu. Press <**C**> for the Configuration Menu:

```
ESC 88xx v5.31  ID:BL       Configuration Menu       08/06/97  14:59:27

     P  Set Passwords
     S  Configure System Parameters
     D  Configure (Data) Channels
     C  Configure Calibrations
     A  Configure Alarms
     O  Configure Analog Outputs
     K  Configure Math Constants
     E  Configure Dig. Event Program
     R  Configure Digital I/O
     1  Configure Serial Protocols
```

Press <**C**> again for Configure Calibrations:

```
ESC 88xx v5.31  ID:BL      Cal Configuration Menu       08/06/97  14:59:27

     N Enter New Cal Configuration
     C Change Old Cal Configuration
     D Delete Old Cal Configuration
     S Start a Calibration Program
     1 Start a Single Phase Cal
     A Abort a Calibration Program
     Q Quick Expected Value Editor
     I Return to Interactive Cal
```

Press <**A**> for Abort a Calibration Program:

```
ESC 88xx v5.31  ID:BL     Choose List (Enter to Select)      08/06/97  14:59:27


     PSZ
     DIAGSPAN
     DIAGZERO
     DIAGPREC
     DIAGSZ


     F2          <ESC>       TAB         CTRL-K      CTRL-R      Arrows
     Refresh     Exit        GOTO END    GOTO TOP    Clr Keys    Select
```

From the Choose List Menu, use the ↑ and ↓ keys to highlight DIAGZERO.

Press <**Enter**> and the zero air pump and ozone calibrator pump turn off.  The alarm condition should reappear on the front panel of the ozone calibrator.

## 5.    Start a DIAGSPAN.

From the ESC datalogger Home Menu, press <**C**> for Configuration Menu:

```
ESC 88xx v5.31  ID:BL       Configuration Menu       08/06/97  14:59:27

     P Set Passwords
     S Configure System Parameters
     D Configure (Data) Channels
     C Configure Calibrations
     A Configure Alarms
     O Configure Analog Outputs
     K Configure Math Constants
     E Configure Dig. Event Program
     R Configure Digital I/O
     1 Configure Serial Protocols
```

Press <**C**> again for Configure Calibrations:

```
ESC 88xx v5.31  ID:BL      Cal Configuration Menu      08/06/97  14:59:27

    N Enter New Cal Configuration
    C Change Old Cal Configuration
    D Delete Old Cal Configuration
    S Start a Calibration Program
    1 Start a Single Phase Cal
    A Abort a Calibration Program
    Q Quick Expected Value Editor
    I Return to Interactive Cal
```

Press <**S**> for Start a Calibration Program:

```
ESC 88xx v5.31  ID:BL     Choose List (Enter to Select)     08/06/97  14:59:27


    PSZ
    DIAGSPAN
    DIAGZERO
    DIAGPREC
    DIAGSZ


    F2          <ESC>       TAB         CTRL-K      CTRL-R      Arrows
    Refresh     Exit        GOTO END    GOTO TOP    Clr Keys    Select
```

From the Choose List Menu, use the ↑ and ↓ keys to highlight DIAGSPAN.  This is an ozone calibration sequence that initiates an ozone span.  The control of the calibration sequence is automatic.  Press <**Enter**>.

Note:  Incase of MDI error message, wait 1 minute before starting DIAGSPAN.

**6.  Observe the Continuous Average Report for several minutes.  When five or more one-minute updates indicate a stable span response, 360ppb to 440ppb, record the last one-minute averages for O3 and O3CAL.**

From the Home Menu, press <**D**> for the Real-Time Display Menu:

Press <**C**> for Continuous Avg Report:

```
ESC 88xx v5.31  ID:BL      Continuous Avg Report Setup      08/06/97  14:59:27


    Average Interval              : 1m
    Show Channels                 : O3,O3CAL,RNF


    # of Flags to Report          : 02
    Use Decimal Positioner?       : Y
    Start Continuous Report
```

Enter a <**1**> and then <**m**> for the Average Interval if it has not defaulted to the 1m. Arrow down to Show Channels.  Type **O3** and **O3CAL** if it is not already displayed. Arrow down to Start Continuous Report and press <**Enter**>.

```
     TIME                    O3         O3CAL        RNF

     08/06/99 14:59:27       41.<C         -1.<C        0.0
```

After several minutes the Continuous Average Report will display the arrays of one-minute updates for O3 and O3CAL.

```
     TIME                   O3    O3CAL     RNF

     10/19 11:30            41.<C   -1.<C    0.0
     10/19 11:31           350.<C  361.<C    0.0
     10/19 11:32           401.<C  400.<C    0.0
     10/19 11:33           402.<C  400.<C    1.0
     10/19 11:34           401.<C  401.<C    0.0
```

Once the following conditions have been met:

1.  The last three one-minute averages of O3 are within the range of 360ppb to 440ppb.
2.  The difference between O3 and O3CAL for each of the last three averages is less than 25ppb.

Record the last one-minute average of O3 and O3CAL on the checklist.  If the conditions are not met, even after several more minutes, call the Operation Support Center for assistance.

**7.**     **Adjust the O3 analyzer LEVEL2, downward to generate a concentration between 150ppb and 200ppb.  Record the results from the Continuous Average Reports after the event has stabilized.**

From the front panel of the O3 analyzer, navigate through the menus to reduce the ozone concentration.  Start from the Run screen.

```
O3 PPB                            401.

             ALARM           REMOTE
```

Press the **MENU** button once.

```
MAIN MENU: 10:25
> RANGE
   AVERAGING TIME
   CALIBRATION FACTORS
```

```
   CALIBRATION
   INSTRUMENT CONTROLS
   DIAGNOSTICS
   ALARM
```

Use the ↑ and ↓ buttons to navigate and position the cursor next to INSTRUMENT CONTROLS. Press <**Enter**> once to enter the Instrument Controls Menu.

```
INSTRUMENT CONTROLS:
> TEMP CORRECTION
   PRESSURE CORRECTION
   OZONATOR SOLENOID
   OZONATOR LEVEL 1
   OZONATOR LEVEL2
```

```
   SCREEN BRIGHTNESS
   SERVICE MODE
   TIME
   DATE
```

Use the ↑ and ↓ buttons to navigate and position the cursor next to LEVEL2. Press <**Enter**> once to enter the LEVEL2 adjustment screen.

```
   O3PPB                         401.
   LEVEL2                        44.1%

     ↑↓    INC/DEC
```

Use the ↑ and ↓ buttons to decrease the power to the ozone generator. The power is expressed as a percentage. Normal lag time between and adjustment and a stable ozone reading is about one minute. Wait for the ozone reading to stabilize. Further adjust the power up or down until the ozone concentration stabilizes between 150ppb and 200ppb.

Watch the Continuous Average Report on the datalogger for several minutes. When three or more one-minute updates indicate a stable response, record the last one-minute updates for O3 and O3CAL on the checklist.

**8.** **Adjust the O3 analyzer LEVEL2, downward to generate a concentration between 50ppb and 80ppb. Record the results from the Continuous Average Reports after the event has stabilized.**

Use the ↑ and ↓ buttons to decrease the power to the ozone generator. The power is expressed as a percentage. Normal lag time between and adjustment and a stable ozone reading is about one minute. Wait for the ozone reading to stabilize. Further adjust the power up or down until the ozone concentration stabilizes between 50ppb and 80ppb.

Watch the Continuous Average Report on the datalogger for several minutes. When three or more one-minute updates indicate a stable response, record the last one-minute updates for O3 and O3CAL on the checklist.

The multipoint is complete.

**9.** **Press the RUN button on the O3 analyzer to return to the RUN screen. Abort the DIAGSPAN on the datalogger.**

Press the **RUN** button once on the O3 analyzer. This returns the analyzer to the Run screen and resets LEVEL2 to the previous set point percentage for normal spans.

Abort to DIAGSPAN and return the analyzer to ambient sampling by pressing <**Esc**> on the datalogger keyboard several times, to return to the Home Menu. From the ESC datalogger Home Menu, press <**C**> for Configuration Menu.

```
ESC 88xx v5.31  ID:BL      Configuration Menu      08/06/97  14:59:27

     P Set Passwords
     S Configure System Parameters
     D Configure (Data) Channels
     C Configure Calibrations
     A Configure Alarms
     O Configure Analog Outputs
     K Configure Math Constants
     E Configure Dig. Event Program
     R Configure Digital I/O
     1 Configure Serial Protocols
```

Press <**C**> again for Configure Calibrations:

```
ESC 88xx v5.31  ID:BL      Cal Configuration Menu   08/06/97  14:59:27

     N Enter New Cal Configuration
     C Change Old Cal Configuration
     D Delete Old Cal Configuration
     S Start a Calibration Program
     1 Start a Single Phase Cal
     A Abort a Calibration Program
     Q Quick Expected Value Editor
     I Return to Interactive Cal
```

Press <**A**> for Abort a Calibration Program:

```
ESC 88xx v5.31  ID:BL    Choose List (Enter to Select)     08/06/97  14:59:27


     PSZ
     DIAGSPAN
     DIAGZERO
     DIAGPREC
     DIAGSZ



     F2          <ESC>       TAB         CTRL-K      CTRL-R      Arrows
     Refresh     Exit        GOTO END    GOTO TOP    Clr Keys    Select
```

From the Choose List Menu, use the ↑ and ↓ keys to highlight DIAGSPAN.    The DIAGSPAN ceases immediately.

**10.** **Review the results.  Call the Operation Support Center to discuss the multipoint results.**

Select View Results on the checklist.

The multipoint calibration summary, displays the zero and three upscale point results, an X-Y plot of the results, the linear regression results and a pass/fail indicator.  Call the Operation Support Center to discuss the results of the multipoint check.

# Approvals

The purpose of this review and approval is to evaluate this Standard Operating Procedure (SOP) for adequacy prior to issuance. The signatories below are stating that the approach defined within this document is acceptable and that the affected company interests have been represented.

Author Signature:

Program:      QA Manager

Approval Signature:

Program:      IMC Section Manager

# REVISION HISTORY

| Review date: | Changes made: | Changes made by: |
|---|---|---|
| 6/13/2018 | Minor text edits | G. Lariviere |
| 6/25/2019 | Removed date reference from file name | E. Vanden Hoek |
| 3/31/2022 | Minor text edits | E. Vanden Hoek |
| | | |
| | | |
| | | |
| | | |

# ANNUAL REVIEW

The undersigned attests that this standard operating procedure has undergone annual review for adherence to current practices and the latest QA/QC protocols:

| | | |
|---|---|---|
| _signature_ | QA Manager | 6/25/2019 |
| Signature | Title | Date |
| _Matt Smith_ | Air Quality Technician | 3/29/2022 |
| Signature | Title | Date |
| | | |
| Signature | Title | Date |
| | | |
| Signature | Title | Date |

## 1.0    PURPOSE

This standard operating procedure (SOP) outlines the steps taken by Air Resource Specialists', Inc. (ARS) Information Management Center (IMC) to collect ambient air quality and meteorological data and quality control documentation from network dataloggers, DataView computers, manual operational logs, and other data compilation systems. This information includes:

- Criteria pollutant parameters
- Meteorological parameters
- Diagnostic parameters and calibration results
- DataView or manual station logs

Successful data collection is the first step in the network data collection, validation, and reporting process illustrated in Figure 1-1.

## 2.0    SUMMARY OF METHOD

To assure complete, error-free data collection, data are primarily logged by an on-site datalogger and automatically collected hourly via telephone modem or satellite modem (see the Data Collection section of Figure 1-1). Additionally, where available, DataView software runs on laptop computers to perform redundant data storage, among other tasks such as collection and storage of station logs. Station logs are collected once each week via telephone modem (see the Data Collection section of Figure 1-1). Occasionally, telephone lines to a site are not available or data cannot be directly collected by modem due to problems such as modem or telephone line malfunctions, requiring manual data collection processes. Manual data collection is performed by the IMC to obtain data from the on-site DataView laptop or on-site data storage modules. Data can also be retrieved by connecting directly to a gas analyzer or particulate monitor and downloading files from the instrument(s) internal memory. In the event of DataView failure or at sites where manual logs are most practical, station logs and other quality assurance documentation can be manually completed and mailed, scanned and emailed, or faxed to the IMC.

To summarize, the IMC collects data by one of these methods:

- From a datalogger via telephone or satellite modem (primary collection process)
- From an FTP site
- Directly from the instrument
- From the on-site DataView laptop
- On-site data storage devices (i.e., storage modules)
- Digital transmission from a third-party source

**Data Collection**

- Modem
- On-site datalogger data and station logs
- Other data sources
- Poll site again to collect new file
- Raw unprocessed ASCII Files
- Reset connections and try connecting to modem again
- Poll site again to collect new file
- Raw data screening and uploads to required Web sites
- Daily site call diagnostic reports
- Update site configuration and load file
- Modem or file?
- Process ASCII files for loading into database
- Errors in raw ASCII File
- Error in transmission
- Errors in processing?

**Level 0 Validation**

- Error in loading?
- Anomaly and max/min screening of data
- Daily review of Weekly Stackplots
- Load data into the database
- Communicate any problems with maintenance group
- Blank-fill data using data filling function in database
- Electronic data missing?
- Electronic site status log entry
- Documentation for entire month collected?
- Flag file and polling report
- Raw data available on client Web site
- Locate data and/or documentation
- Month Complete?
- Enter Level 0 data in Validation Log

**Preliminary Validation**

- Review other site documentation
- Review station logs
- Data missing in database
- Enter from hard copy or other source
- Review, verify, and update validation codes in validation screen
- Update source codes and enter data via control values
- Enter Preliminary Validation date in Validation Log
- 3rd level validation
- Review of validated data
- Group Plot Review
- Enter report delivery date in Validation Log
- Validation corrections based on plot review

**Final (Level 1) Validation/Reporting**

- Monthly Data Reports
- Data available for data requests
- Data ready for report
- Enter Final Validation date in Validation Log
- Archive validated monthly files
- Submit data to AQD

Figure 1-1.  General Data Collection, Validation, and Reporting Flow Diagram.
(Specific processes may vary by monitoring network).

### 3.0 SCOPE

Activities described in this document are performed by members of ARS' Information Management Center, field specialists and site operators. Aforementioned parties have been appropriately trained to perform the responsibilities associated with their roles as described below.

### 4.0 ROLES AND RESPONSIBILITIES

Staff positions that have data collection responsibilities are:

**Data Analyst/Technician**

On a daily basis:

- Set up and maintain the automatic data collection programs and support information.
- Ensure that the virtual machines used for automatic data collection are fully operational, with both the necessary hardware and software running.
- Review the status of the automatic data collection each morning (including reviewing the Data Collection Status Report) to verify complete, error-free data collection, assure the integrity of the monitoring systems, or to identify problems and initiate corrective actions.
- If the Data Collection Status Report indicates an on-site datalogger time has drifted by more than two minutes, the data analyst/technician will update the datalogger clock.
- Perform required daily retries.
- Provide technical support to site operators via telephone.
- Ensure proper archive and storage of final raw data files.

**Field Specialist**

- Inform data analyst/technicians of any changes in site configurations resulting from maintenance visits.
- Inform data analyst/technicians of any equipment or data acquisition systems malfunction, replacements, additions, or inconsistencies.
- Inform data analyst/technicians of any data acquisition system program changes.
- Review stackplots and troubleshoot inconsistencies observed on the stackplots or identified by data analyst/technicians.
- Provide assistance to the IMC for troubleshooting data collection problems.
- Provide assistance in troubleshooting on-site instrument problems.

**Site Operator**

- Telephone the IMC or field specialist if data collection problems are noted on-site.
- Provide on-site assistance for troubleshooting data collection problems.

### 5.0 REQUIRED EQUIPMENT AND MATERIALS

Detailed descriptions of all IMC hardware and software and monitoring station hardware requirements are presented by category in SOP 3341, *Air Resource Specialists', Inc. (ARS) Information Management*

*Center (IMC) Concept and Configuration*. The IMC requires the following hardware and software to collect data from the dataloggers in the field:

- DataView on-site system including a laptop computer and modem
- Monitoring site data collection hardware

- IMC hardware:
    - Hardware specifications for IMC servers
    - Hardware specifications for workstations
    - Support hardware:
        - High-quality laser printer
        - Write-capable DVD drive

- IMC software:
    - AQDBMS custom software
    - V3 Data Collection software
    - V3 Data Loading software
    - Network operating system and support software

## 6.0    PROCEDURES

This section includes six major subsections:

6.1    Automatic Data Collection
6.2    Manual Data Collection
6.3    Data Files Generated by V3 Data Collection
6.4    Configuring Data Collection
6.5    Daily Review of Data Directory Contents
6.6    Biweekly Station Log Collection
6.7    Monthly Archival of Final Raw Data Files

## 6.1    AUTOMATIC DATA COLLECTION

Hourly data are collected and loaded through a series of automated processes. The in-house data collection software, V3 Data Collection, continuously queues necessary data collection jobs. As resources become available, data collection begins to complete necessary jobs using methods specific to the data source. The V3 data collection application lists the last successful poll time of each site as presented in Figure 6.1.

Most IMC data are collected directly from the datalogger in the field using cellular or satellite modem. Upon successful connection to the site, data collection prompts the datalogger for needed data, including historical data that may be missing in the database. If a viable raw data file is collected, reformatted data are appended to the top of the file for database consumption. In the event that the data collection does not yield a viable raw data file, retries are continued a configured number of times. Raw data files are then stored on the network for data loading and raw data file archiving. Particulate matter (PM) data are collected directly from the BAM instrument using a similar technique. Data can also be manually collected by entering needed dates and times directly into the interface. After dates and times are provided, the job is added to the queue and acquired with the same procedure as noted above.

The data loading application, shown in Figure 6-2, runs concurrently with data collection. Data loading occurs as soon as data collection has completed successfully and a raw data file is placed on the network. The list of the generated file names and their network location is presented in Table 6-1. Once the files are on the network, the data loading routine loads data into the database. Data can also be hand-entered or blank-filled in the Data Validation interface. Data entry forms for entering non-hourly aerosol data, precision check data, and data from audit reports are also available.

Table 6-1

File Name and Directory Organization of Files Generated by AQDBMS Routines

| File Description | Source(s) | File Name(s)[1] | Directory Location[2] | Destination |
|---|---|---|---|---|
| Data Collection Status Report | AQDBMS | yyyymmddDailyCollectionStatusReport.txt | \sitecall\logs | e-mail |
| Raw ESC Hourly Data File | Data Collection.exe | ssss-ss_ins_01H_.R | \ESC | data loading |
| Raw ESC Minute Data File | Data Collection.exe | ssss-ss_ins_01M_.R | \ESC | data loading |
| Raw ESC Daily Data File | Data Collection.exe | ssss-ss_ins_24H_.R | \ESC | data loading |
| Loaded ESC Hourly Data File | ARSDataLoadingV3.exe | ssss-ss_ins_01H_yyyymmddhhmiss.R | \ESC\success\HOURLY <u>or</u> <br>\ESC\failed\HOURLY | archiving |
| Loaded ESC Minute Data File | ARSDataLoadingV3.exe | ssss-ss_ins_01M_yyyymmddhhmiss.R | \ESC\success\1MINUTE <u>or</u> <br>\ESC\failed\1MINUTE | archiving |
| Loaded ESC Daily Data File | ARSDataLoadingV3.exe | ssss-ss_ins_24H_yyyymmddhhmiss.R | \ESC\success\DAILY <u>or</u> <br>\ESC\failed\DAILY | archiving |
| Archived ESC Hourly Data File | ARSDataLoadingV3.exe | ssss-ss_ins_01H_yyyymmddhhmiss.R | archive\ESC\success\HOURLY <u>or</u> <br>archive\ESC\failed\HOURLY | archiving |
| Archived ESC Minute Data File | ARSDataLoadingV3.exe | ssss-ss_ins_01M_yyyymmddhhmiss.R | archive\ESC\success\1MINUTE <u>or</u> <br>archive\ESC\failed\1MINUTE | archiving |
| Archived ESC Daily Data File | ARSDataLoadingV3.exe | ssss-ss_ins_24H_yyyymmddhhmiss.R | archive\ESC\success\DAILY <u>or</u> <br>archive\ESC\failed\DAILY | archiving |
| Data loading log files | ARSDataLoadingV3.exe | yyyymmdd_machine_Loading.log | \logs | reference |
| Data loading error log files | ARSDataLoadingV3.exe | yyyymmdd_machine_LoadingError.log | \logs | reference |
| Daily raw stackplot configuration and data files | AQDBMS | site.STK <br>site.DAT | Stkplots\DailyReview <br>Stkplots\DailyReview | Stackplot <br>Stackplot |

Notes:
[1] File naming convention:

| | |
|---|---|
| yyyy = 4-digit year | ssss-ss = 6 character site code |
| mm = 2-digit month | ins = 3 character instrument abbreviation |
| dd = 2-digit day | machine = data loading machine name |
| hh = 2-digit 24hour | |
| mi = 2-digit minute | |
| ss = 2-digt second | |
| site = 4 character site code | |
| STK = stackplot file | DAT = stackplot data file |

[2] Directory Location:The *AQDBMS* directory is currently located under N:\PROJECT\IMC\sitecall\V3.

Figure 6-1. Example of V3 Data Collection Application.
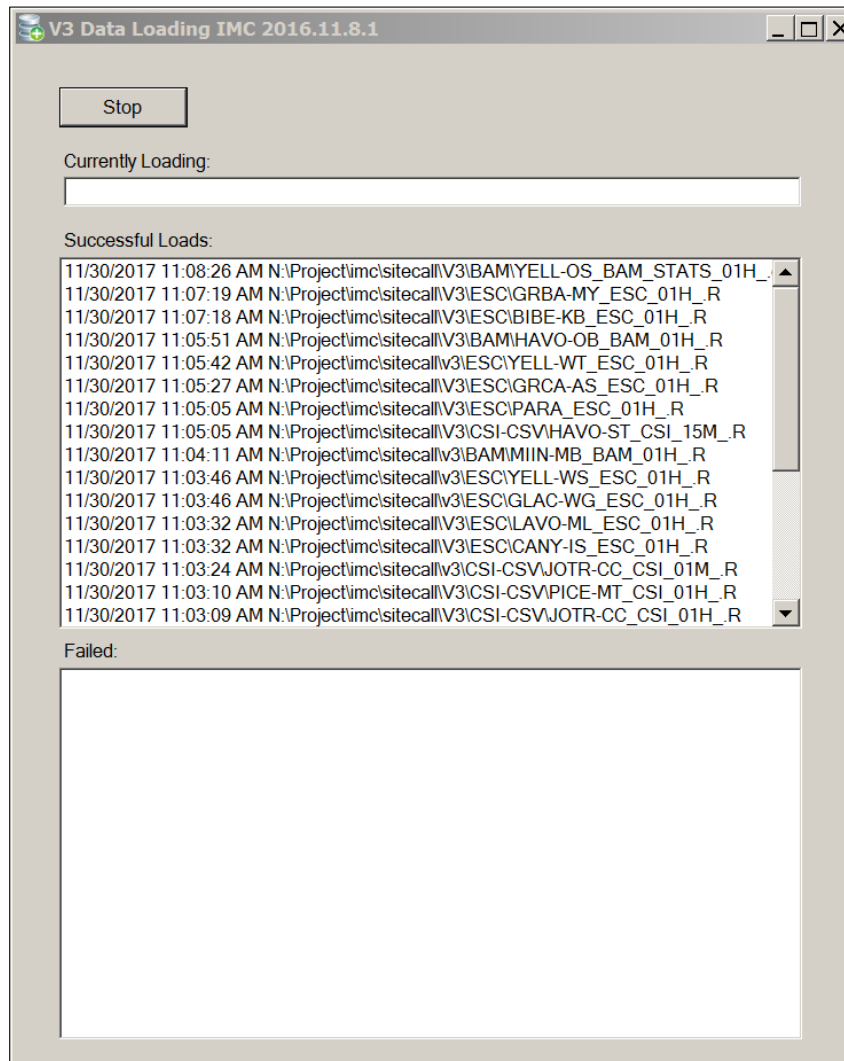
Figure 6-2. Example V3 Data Loading Application.

### 6.1.1  Starting the Auto Poll Process

The V3 Data Collection and the V3 Data Loading applications are always running on the data collection machines. V3 Data Collection is continually looking for data collection jobs to queue and V3 Data Loading is always looking for raw data files to be loaded. If the application stops running, an automatic notification is sent and the process is manually restarted.

### 6.1.1.1  Polling Order

The order in which the sites are polled is determined by the following:

1. Polling time specified in site configuration records.
2. Last data collection attempt time.

**6.1.1.2  Reviewing the Data Loading Log Files**

The V3 Data Loading program continually logs messages regarding data loading progress and errors. The log files are called *yyyymmdd_machine_Loading.log,* where *yyyy* is the year, *mm* the month number, *dd* the day number and *machine* the name of the machine that completed the data loading (for example, the file 20171130_DataCollB.log holds the log entries for November 30, 2017 on the machine named DataCollB). Similarly, the error files are called *yyyymmdd_machine_LoadingError.log.* Both files are stored in the *N:\project\IMC\sitecall\V3\logs* directory and can be viewed by opening directly in any text editor. Figure 6-3 is a sample log file and Figure 6-4 is a sample error log file.
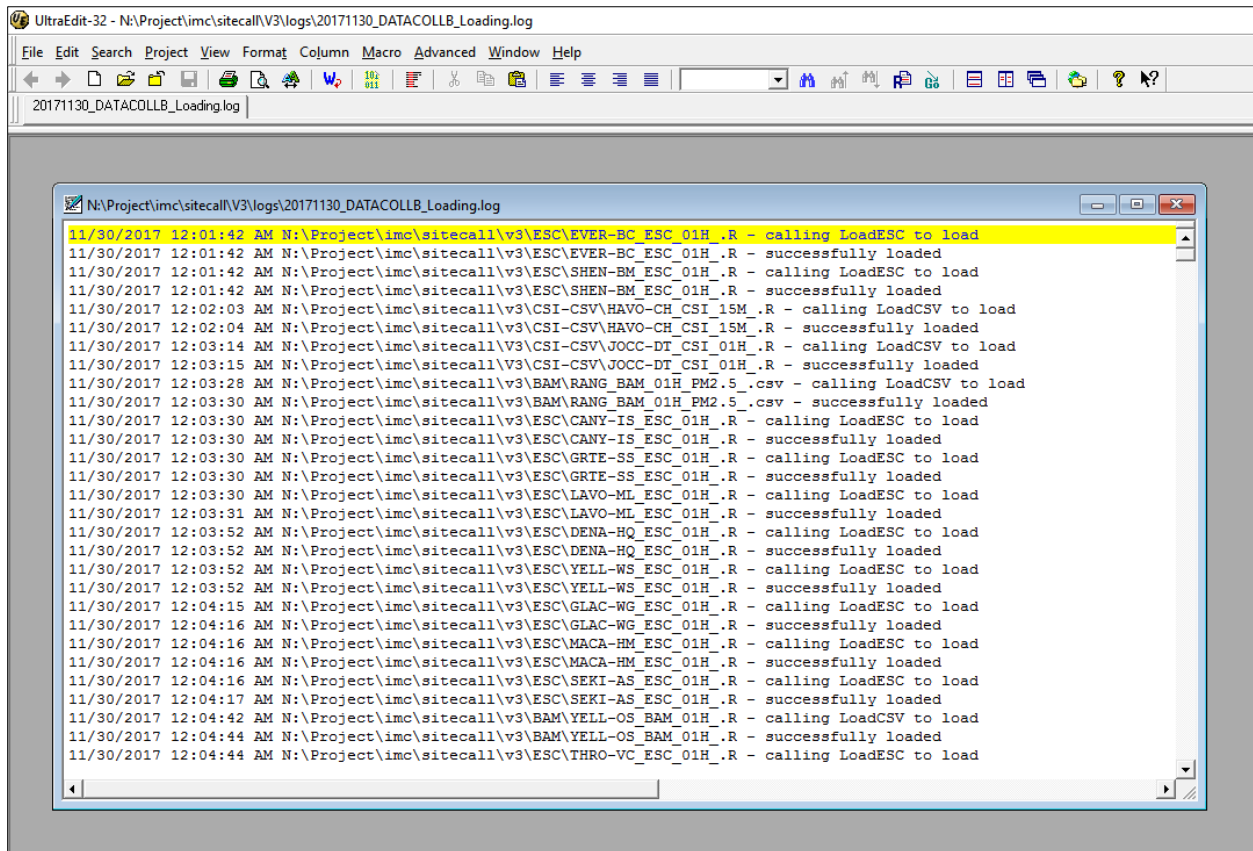


Figure 6-3.  Example Data Loading Log.
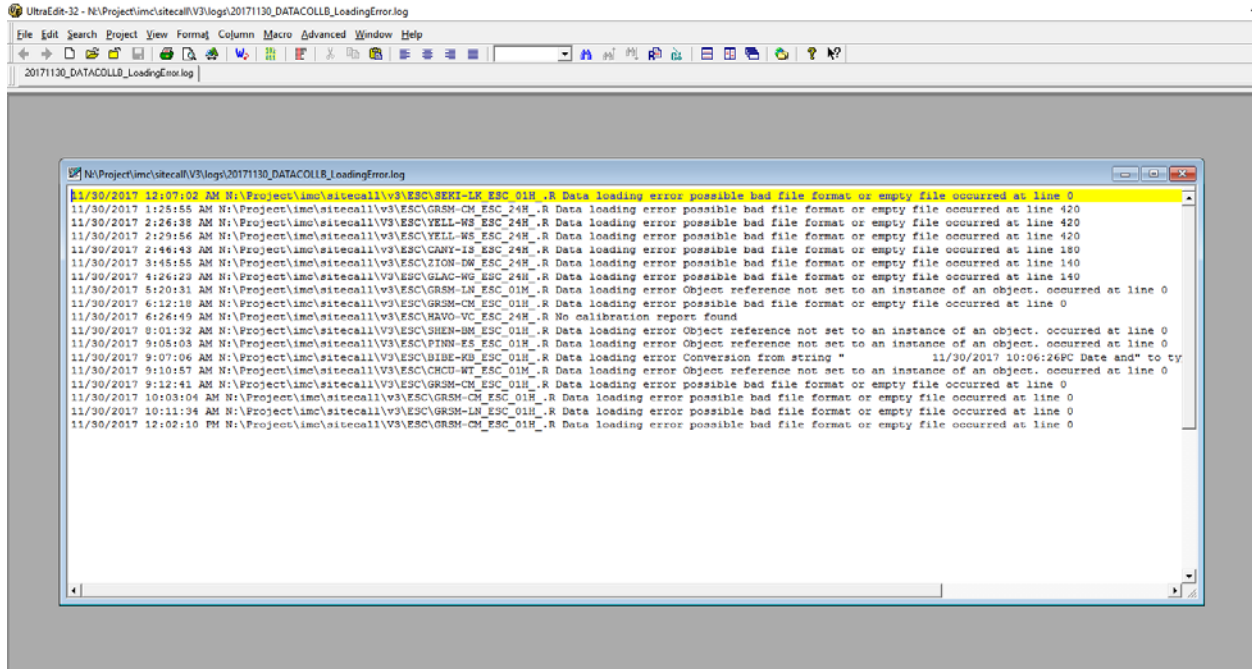
Figure 6-4.  Example Data Loading Error Log.

### 6.1.2   Data Collection Status Report

The Data Collection Status Report is automatically e-mailed each morning and is subsequently examined by the data analyst/technician each working day, to determine the success or failure of the automatic data collection routines. An example of this report is shown in Figure 6-5. This report is intended to summarize the diagnostic information and prompting the data technician to investigate and remedy any errors. For example, if the report indicates the date and time on the logger are incorrect by more than two (2) minutes, the data technician logs into the on-site datalogger and manually adjusts the on-site date and time. If the status report indicates data have not been loaded into the database, the data technician will initiate manual data collection and/or loading as appropriate.

Figure 6-5.  Example Data Collection Status Report.


## 6.2    MANUAL DATA COLLECTION

### 6.2.1   Manual Data Polling

Manual data collection is used in the following situations:

- When automatic data collection from a site has failed.
- When recent data are needed for immediate use.

The data analyst/technician examines the *Data Collection Status Report* to determine which sites failed to poll correctly. If V3 Data Collection is unable to correctly retrieve error-free data, the data analyst/ technician manually retrieves as much data as possible as soon as possible using one of the following methods:

- Manual data retrieval using V3 Data Collection polling software.
- Manual data retrieval from DataView.
- Data received via e-mail or USB drive.
- Third party data report.

To manually poll (or re-poll) an individual site:

- Select the necessary site and collection configuration needed in the V3 Polling Configuration application.
- Select the Submit Manual Job tab.
- Enter a data collection start date and click OK.
- Enter a data collection end date and click OK.
- The specified site and collection configuration will be added to the queue immediately and the data will be loaded after collection has completed.

To manually re-poll all sites:

- Click the Reset Attempts and Re-Poll button on the V3 Data Collection application.

Manual data loading is used (1) when archived or edited raw data need to be written to the database without polling the site, or (2) when automated data collection has failed for an individual site.

To manually load a site:

- Put the file to be loaded in the appropriate network folder, as specified in the polling application.
- For example, ESC files are found on the network at *N:\project\IMC\sitecall\V3\ESC*.

### 6.2.2  Manual Data Retrieval from DataView

DataView communicates directly with the datalogger, retrieving minute data every minute, hourly data every hour, and calibration data every day. These data are stored in a database on the DataView laptop at sites where DataView is in use. These data cannot be viewed outside of DataView unless they are exported to a comma-delimited ASCII file (.csv). This can be accomplished in two ways:

- An IMC data analyst/technician can configure DataView to automatically and continuously save minute, hourly, and/or calibration data to an ASCII file. This is normally done only in situations where continuous data availability from the datalogger is not available.

- The DataView user can interactively export specific data to the ASCII files. To retrieve data from the on-site DataView laptop:

  - Connect to the site's laptop with remote access software and log on to DataView. If DataView has been configured to automatically generate the .csv files, skip to "Transfer Files" below.
  - Manually export the data needed to .csv files. From dropdown boxes along the top of the screen, select **Data Tables** then **Data Export**. The Data Export form will appear.

- Choose the export file destination. The default is *C:\DataView2\Poll_data*. Change this setting only if creating files that will not be sent to the IMC. If performing export on site, it is recommended that data be exported onto *C:\drive* and transferred to a CD, DVD, or other media.
- Select the appropriate *data type* (Hourly/Minute/Cals) and a parameter list will appear. If fulfilling an IMC request to recover missing datalogger data, select **Hourly** and **Cals**. Click the **Select All** button.
- Select the appropriate dates. Click in the **Start Date** box and a calendar will appear. Select the start and end dates and click the button labeled **Go**. When the message Export Complete is displayed, click the **Done** button. Log off from DataView.
- Transfer the files to the IMC using PC Anywhere. The following steps will transfer both the data files and the station log files to *N:\project\IMC\DataView\poll_data*.

  - On an IMC computer setup to automatically collect station logs with PC Anywhere:
    - Click the **File Transfer** button at the top of the screen. (The button looks like a page with a lightning bolt).
    - Click the **Auto Transfer** button, then **OK**, then **Yes**.
    - This will transfer the files from the site's laptop to the correct location on the server and then will disconnect from the site. To remain connected, uncheck the **End session when finished** button when the File Transfer Status window appears.

  - On any other computer with PC Anywhere:

    - Click on the **File Transfer** button at the top of the screen. (The button looks like a page with a lightning bolt).
    - On your side of the file transfer screen, navigate to *N:\project\IMC\DataView\Poll_data\*.
    - On the DataView laptop side of the file transfer screen, navigate to: *C:\DataView2\poll_data\*.
    - Select the files to transfer.
    - Click the appropriate arrow.

    This will transfer the files from the site's laptop to the correct location on our server to be loaded into the database (station logs) and afterwards, disconnect you from the site. If you wish to stay connected, uncheck the **End session when finished** button when the File Transfer Status window appears.

## 6.3    DATA FILES GENERATED BY V3 DATA COLLECTION

Data from the raw data files are automatically saved. Figure 6-6 shows an example of a hourly raw datalogger data file. If data loading is successful, V3 Data Loading automatically moves files to the *\success* directory. If loading is not successful it is indicated in the data collection status report and investigated by the data technician.
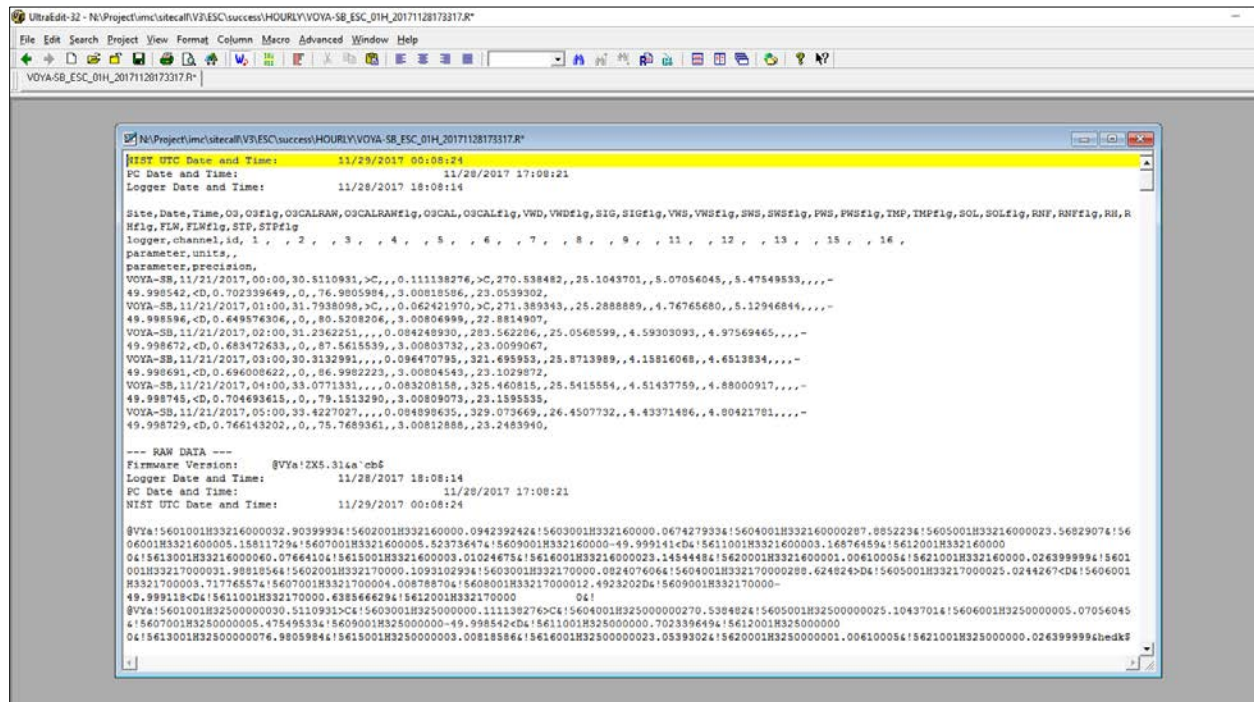
Figure 6-6.  Example ESC Datalogger Raw Hourly Data File.

## 6.4    CONFIGURING DATA COLLECTION

Data Collection configurations are set up using the V3 Polling Configuration application (Figure 6-8).
To set up a polling configuration:

- Select the necessary site from the dropdown box in the V3 Data configuration application.
- Select the datalogger type or instrument type in the datalogger dropdown box.
- Select the Comm Type in the dropdown box (IP or Dial Up).
- Enter the IP, port numbers, passwords, and time zone in the respected fields.
- Add a polling configuration by selecting the (+) button. Then name the configuration based on the naming convention listed in Table 6-1.
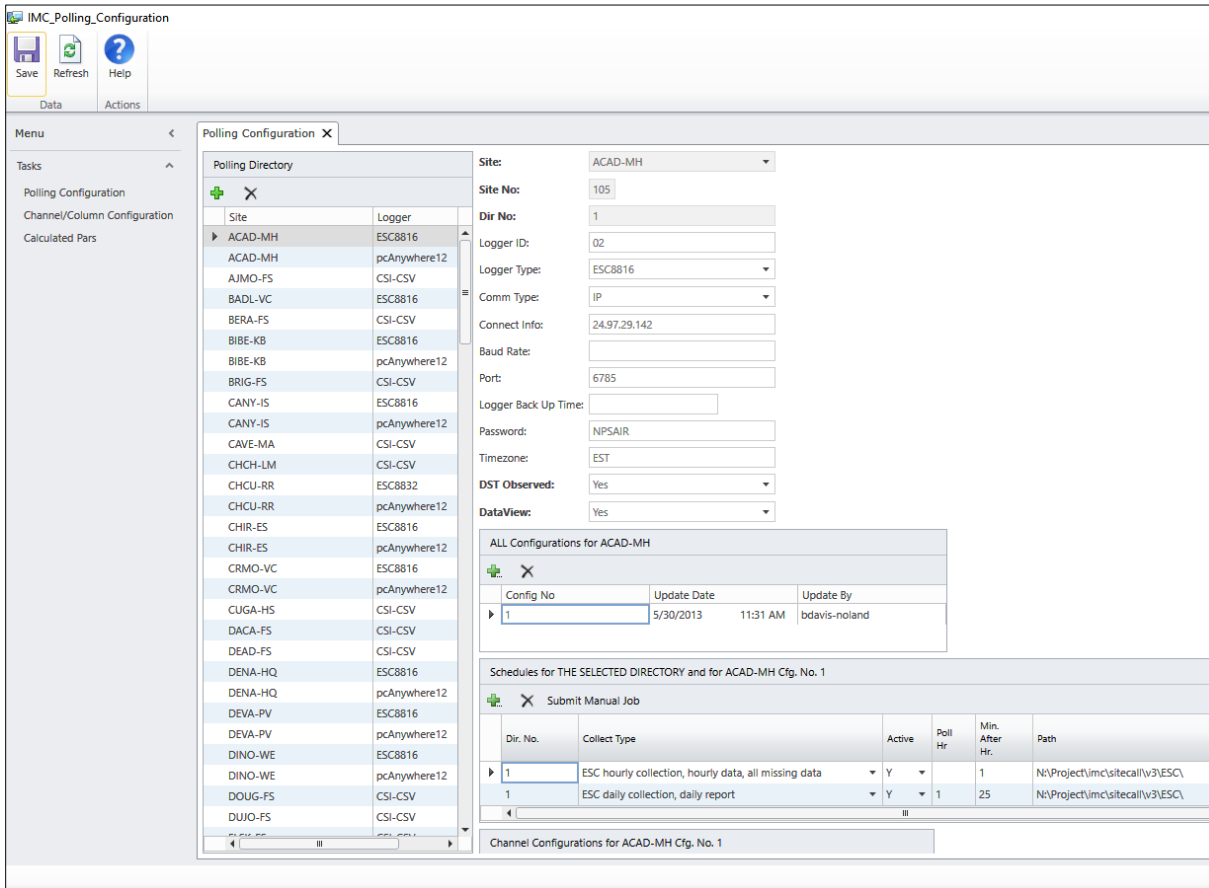
Figure 6-8.  Example of V3 Polling Configuration Application.

## 6.5     DAILY REVIEW OF DATA DIRECTORY CONTENTS

Daily review of file sizes and locations is useful for error control. Data directories will be visually scanned for the following:

- Ballooning file sizes - these may indicate unplanned or unintentional configuration changes
- Small file sizes - these may indicate connection issues that are limiting collection times while connected
- Loading failures - these may indicate unexpected data characters in raw data files or other polling and/or loading issues
- Duplicate files for the same time periods - these may coincide with any of the issues above and may indicate any number of polling and/or loading issues

## 6.6     BIWEEKLY STATION LOG COLLECTION

A flowchart of the station log process is provided in Figure 6-9. Files generated by this process and their distribution are shown in Table 6-2.
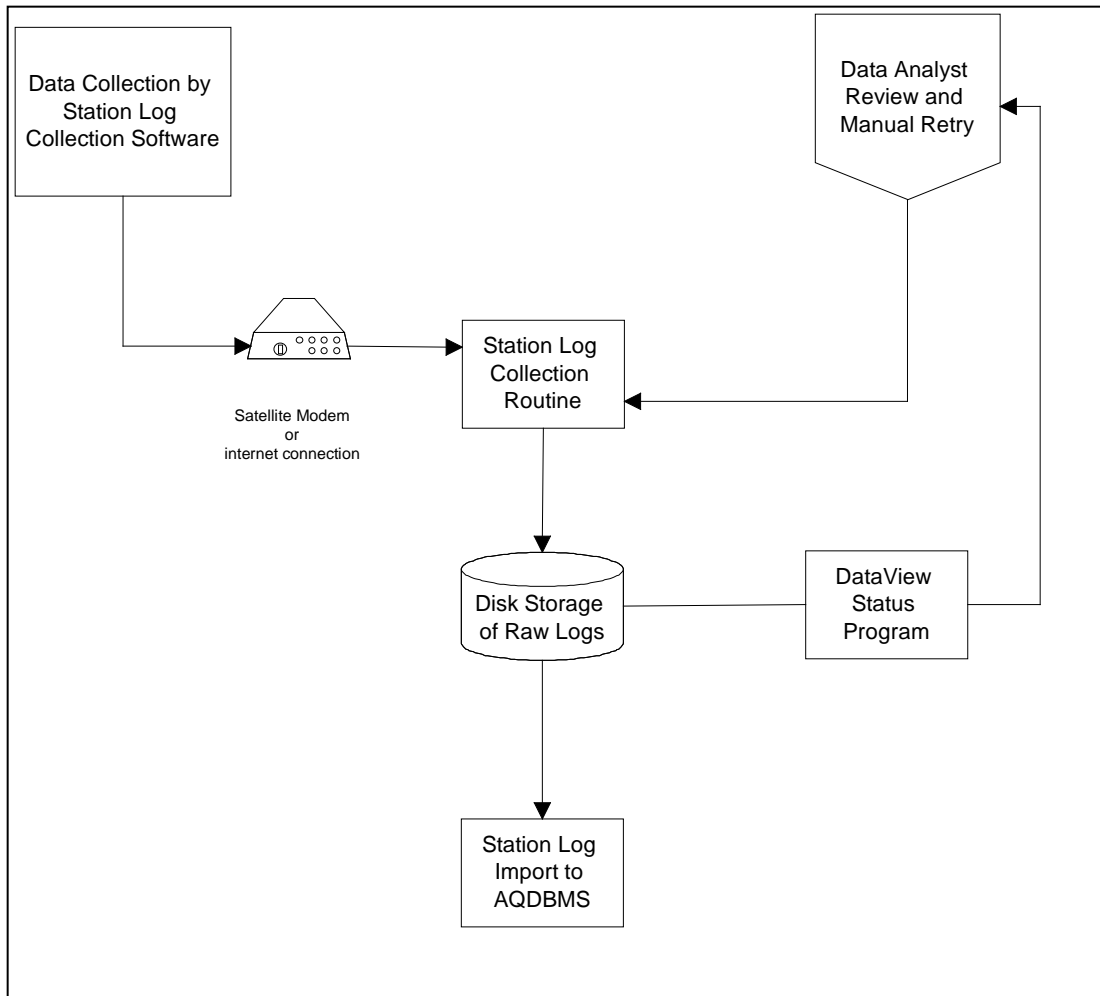
Figure 6-9.  AQDBMS Station Log Acquisition and Processing Flowchart

Table 6-2

File Name and Directory Organization of Files Generated by Station Log Collection Routines

| File Type | File Description | Source(s)[1] | File Name(s)[2] | Directory Location[3] | Destination |
|---|---|---|---|---|---|
| Station Logs | Comma-delimited ASCII text files | Station log collection software | sitemmddyyyylog.csv | DATAVIEW\POLL_DATA | Archived and imported to AQDBMS |

Notes:
[1] Refers to routines defined in Figure 4-1.

[2] File naming convention: (based on MS-DOS 8.3 file name format)

| | | |
|---|---|---|
| mm = 2-digit month | site = 4-character site code | |
| dd = 2-digit day | RET = retry file | |
| yyyy = 4-digit year | SPN = span file | |
| ERR = error report | DAT = stackplot data file | |
| MES = detailed message report | D = hourly data import file | |
| SUM = summary report | L = calibration data import file | |
| CSV = Excel import format file | | |

[3] Directory Location:The *AQDBMS* directory is currently located under N:\PROJECT\IMC\.

### 6.6.1    Automatic Station Log Collection

The station logs are collected by several methods. At sites with reliable communications, the station logs are automatically acquired by the station log collection software and stored in comma-delimited ASCII files. If the automatic collection fails, the data analyst/technician may also run the software manually. Station logs at sites that do not have reliable internet service are collected by the site operator onto a CD or thumb drive using a DataView utility and then transmitted to the IMC by e-mail or regular mail/shipping. Logs may also be hand-entered from printed copies of the logs. Logs are loaded into the database for permanent archive and are used in the data validation process.

#### 6.6.1.1  Starting the Automatic Station Log Software

The automatic station log collection software is loaded onto a computer with a modem. The software uses a continuous clock/timer function and is configured to begin execution at 2:30 a.m. each Wednesday. This program calls each DataView site and downloads the most recent station log files to the IMC as comma-delimited ASCII files.

#### 6.6.1.2  Polling Order

The order in which the sites are polled is determined by the time specified in the automatic station log collection software setup, and generally polls according to time zone. The sites are polled in 15-minute intervals with four (4) automatic retries built in to each polling session. To change the polling time of a site, the polling configuration can be directly edited.

#### 6.6.1.3  Reviewing the Station Log Acquisition Status

The current availability of station logs may be reviewed at any time by running the DataView Status Summary program. A sample of the status summary output is provided as Figure 4-2. This program lists by site, the date of the last station log acquired and the age of the file. Station log files older than 7 days are highlighted. Several columns of information are presented in this table for troubleshooting purposes.

The data analyst/technician should review the last three columns of the report daily and take action to recover station logs older than 7 days.



Figure 6-10.  Example DataView Status Report.

## 6.6.2    Manual Station Log Collection

### 6.6.2.1  Manually Retrieving Digital Station Logs

If automatic acquisition of the digital station logs fails, the data analyst/technician should attempt to manually retrieve the file by running the station log collection software. After the program begins, the analyst should select the site that has failed and choose the **Run** button. If several manual attempts fail, the problem must be reported to network operations for troubleshooting.

### 6.6.2.2  Manually Retrieving Hardcopy Station Logs

If, after all attempts at acquiring the digital station logs fail, including on-site remedies, the data analyst/technician must contact the site operator and request that a copy of the missing pages be printed and/or copied from the DataView computer and mailed to the IMC.

### 6.6.3    Automatic Import of Station Logs to the AQDBMS

Newly acquired station log files are automatically imported into the AQDBMS daily during the automatic data collection process.

### 6.6.4    Monthly Archive of Raw Station Log Files

All collected raw station log files are archived monthly with the other raw data files. Each quarter, the station log files are checked for completeness and organization. They are then written to DVD once per year. This process is accomplished in the following steps:

- The data analyst/technician ensures that a complete month of station logs have been collected and resides in the \*poll_data* directory.
- Create two (2) copies of the DVD and store one copy on-site in the IMC and one in an off-site location other than the IMC. Additional copies may be provided to the client if requested.

### 6.7    MONTHLY ARCHIVAL OF FINAL RAW DATA FILES

Raw data files must be archived for possible future reference. The previous sections in this document describes the process to collect and load the data. At the end of each month, the data files are reorganized and moved into a data archiving directory structure. On a quarterly basis the previously archived files are written to DVD. Files remain on the network for approximately one year after they have been archived to DVD.

To archive data files:
- Navigate to the N:\project\IMC\sitecall\V3\archive directory.
- Open the DataFileArchive application.
- As necessary, change any of the default data.
- Click the GO Archive! button. This process may take a considerable amount of time and time must be allowed for completion.
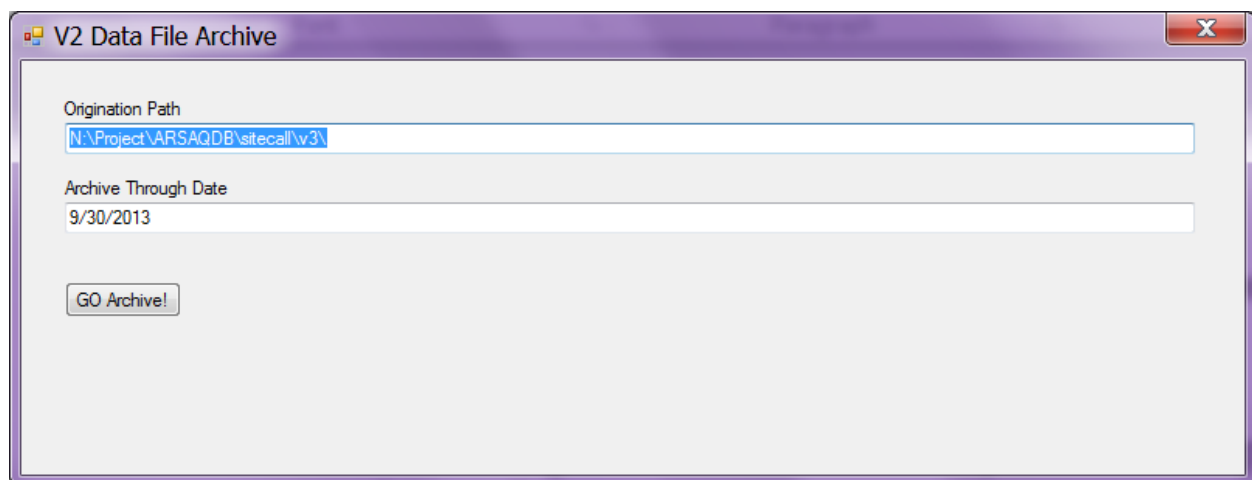


Figure 6-11.  Example Data File Archive Application.

**7.0    REFERENCES**

Air Resource Specialists, Inc. (ARS), 2012, Air Quality Data Base Management System (AQDBMS) User's Guide.

**8.0    DEFINITIONS AND ACRONYMS**

| | |
|---|---|
| AQDBMS | Air Quality Database Management System |
| ARS | Air Resource Specialists, Inc. |
| ASCII | American Standard Code for Information Interchange |
| BAM | Beta Attenuation Monitor |
| DVD | Digital Versatile Disc |
| FTP | File Transfer Protocol |
| IMC | Information Management Center |
| PM | Particulate Matter |
| SOP | Standard Operating Procedure |

# Approvals

The purpose of this review and approval is to evaluate this Standard Operating Procedure (SOP) for adequacy prior to issuance. The signatories below are stating that the approach defined within this document is acceptable and that the affected company interests have been represented.


Author Signature:


Program:      Genevieve Lariviere - QA Manager


Approval Signature:


Program:      Jessica Ward - IMC Section Manager

# REVISION HISTORY

| Review date: | Changes made: | Changes made by: |
|---|---|---|
| 7/18/2019 | Initial Version | E. Vanden Hoek |
| 11/27/2020 | Minor text edits | E. Vanden Hoek |
| 10/27/2021 | Minor text edits | E. Vanden Hoek |
| 10/25/2022 | Updated personnel, minor text edits | E. Vanden Hoek |
| | | |
| | | |
| | | |

# ANNUAL REVIEW

The undersigned attests that this standard operating procedure has undergone annual review for adherence to current practices and the latest QA/QC protocols:

| | | |
|---|---|---|
| *Jessica Ward* | IMC Section Manager | 10/15/2020 |
| Signature | Title | Date |
| *Jessica Ward* | IMC Section Manager | 3/1/2021 |
| Signature | Title | Date |
| *Emily E. Wiehen* | IMC Team Lead | 3/10/2022 |
| Signature | Title | Date |
| | | |
| Signature | Title | Date |

## 1.0    PURPOSE

This standard operating procedure (SOP) outlines the steps of ambient air quality and meteorological data validation, to assure quality data and to ensure that data are validated to meet Environmental Protection Agency (EPA) guidelines for successful submission to the EPA AQS (Air Quality System) database. The steps outlined apply to all ambient air quality and meteorological parameters that are monitored and loaded into the Information Management Center (IMC) database, regardless of whether the data for a specific parameter are uploaded to the EPA AQS database.

## 2.0    SUMMARY OF METHOD

The validation process consists of the following major steps:

- Review of raw data visually on a daily basis for data acquisition errors, and for details on instrument performance. Process data through Level 0 validation to ensure that all possible data have been collected and are correctly loaded into the permanent table of the database.
- Process data through Preliminary validation to identify values that do not meet acceptance criteria.
- Process data through Final validation that includes input from air quality specialists, field specialists, and site operators to resolve all questionable validation issues.
- Accommodate post-final validation changes when necessary.

Successful validation at each level requires completion of a set of automatic (computer program) and manual checkpoints as shown in the data collection, validation, and reporting flow diagram (Figure 2-1).

**Data Collection**

- Modem
- On-site datalogger data and station logs
- Other data sources
- Poll site again to collect new file
- Raw unprocessed ASCII Files
- Raw data screening and uploads to required Web sites
- Reset connections and try connecting to modem again
- Poll site again to collect new file
- Daily site call diagnostic reports
- Update site configuration and load file
- Modem or file? → Modem / File
- Process ASCII files for loading into database
- Errors in raw ASCII File → Yes / No
- Error in transmission → Yes
- Errors in processing? → Yes / No

**Level 0 Validation**

- Error in loading? → Yes / No
- Anomaly and max/min screening of data
- Daily review of Weekly Stackplots
- Load data into the database
- Communicate any problems with maintenance group
- Blank-fill data using data filling function in database → Yes
- Electronic data missing? → Yes / No
- Electronic site status log entry
- Flag file and polling report
- Raw data available on client Web site
- Documentation for entire month collected? → Yes / No
- Month Complete? → No / Yes
- Locate data and/or documentation
- Enter Level 0 data in Validation Log

**Preliminary Validation**

- Review other site documentation
- Review station logs
- Data missing in database → Yes / No
- Enter from hard copy or other source
- Review, verify, and update validation codes in validation screen
- Update source codes and enter data via control values
- Enter Preliminary Validation date in Validation Log
- 3rd level validation
- Review of validated data
- Group Plot Review
- Validation corrections based on plot review

**Final (Level 1) Validation/Reporting**

- Monthly Data Reports
- Data available for data requests
- Enter Final Validation date in Validation Log
- Data ready for report
- Archive validated monthly files
- Submit data to AQS

Figure 2-1.   General Data Collection, Validation, and Reporting Flow Diagram. (Specific processes may vary by monitoring network).

### 3.0    SCOPE

Activities described in this document are performed by members of ARS' Information Management Center, field specialists, technical assistants, site operators and sponsoring organization staff members. Aforementioned parties have been appropriately trained to perform the responsibilities associated with their roles as described below.

### 4.0    ROLES AND RESPONSIBILITIES

Staff positions that have data validation responsibilities are:

**Information Management Section Manager**

- The information management section manager shall oversee validation procedures to ensure timely and proper validation. The manager shall update the Data Validation Log in the AQDBMS with the Final validation date after performing a final review of the data.

**IMC Team Lead**

- Review all calibration results and verify that all affected data are properly dealt with.
- Update information in the Site Configuration Table of the AQDBMS and stackplot configuration files as needed.
- Review stackplots of raw data.
- Verify Data Validation Log updates.
- Update the Data Validation Log with detailed data validation notes.
- Blank-fill missing data as necessary.
- Collect and log field documentation.
- File all hardcopy documentation and maintain hardcopy site files.
- Identify collection or monitoring system problems and initiate corrective actions.
- Review preliminary validations performed by the data analysts/technician.
- Participate in the monthly plot review and respond to questions posed during the plot review.

**Data Analyst/Technician (IMC Team Lead may also assist with these duties)**

- Update information in the Site Configuration Table of the AQDBMS and stackplot configuration files as needed.
- Review stackplots of raw data.
- Verify Data Validation Log updates.
- Update the Data Validation Log with detailed data validation notes.
- Update the Data Validation Log in the AQDBMS with the Level 0 and Preliminary validation dates.
- Collect digital data and load it into the database.
- Blank-fill missing data as necessary.
- Collect and log field documentation.
- File all hardcopy documentation and maintain hardcopy site files.
- Identify collection or monitoring system problems and initiate corrective actions.
- Review validation codes applied by the Auto Validation tool.
- Review and annotate stackplots using field documentation and Auto Validation codes.

- Review plots of the validated data to check for errors.
- Review annotated stackplots with the field specialist.
- Participate in the monthly plot review and respond to questions posed during the plot review.
- Review validated stackplots.
- Generate the data reports.

**Field Specialist**

- The field specialist shall review stackplots and troubleshoot inconsistencies observed on the stackplots or identified by IMC staff.
- Participate in the monthly plot review.

**Site Operator**

- The site operator shall respond to any questions regarding site documentation or data events, and forward any additional comments or observations to the IMC.
- Telephone the IMC or field specialist if data collection problems are noted on site.
- Provide on-site assistance for troubleshooting data collection problems.

**Technical Assistant**

- Review/edit/format/PDF/print out trip reports and give them to the IMC.
- File all hardcopy documentation.

**5.0    REQUIRED EQUIPMENT AND MATERIALS**

All IMC equipment and materials are fully described in SOP 3341, *Air Resource Specialist's, Inc. (ARS) Information Management Center (IMC) Concept and Configuration*. The IMC requires the following hardware and software for validation of ambient air quality and meteorological data:

- IMC hardware:
    - Hardware specifications for IMC servers
    - Hardware specifications for workstations
    - IMC computer support hardware:
        - High-quality laser printer

- IMC AQDBMS software:
    - Oracle Database System
    - AQDBMS custom software:
        - Data validation and reporting software
        - Network operating system and support software
        - V3 data collection software
        - V3 data loading software

## 6.0 PROCEDURES

This section is comprised of five major subsections:

> 6.1 Validation Logging
> 6.2 Level 0 Validation Procedures
> 6.3 Preliminary Validation Procedures
> 6.4 Third Level Validation Procedures
> 6.5 Final Validation Procedures

## 6.1 VALIDATION LOGGING

### 6.1.1 THE DATA VALIDATION LOG

The Data Validation Log is used to track the completion of each major step of the validation process. A log is created in the AQDBMS for each site by month and year. The master record logs the initials of the data analyst/technician completing each validation step and when it occurred. The validation log also provides a summary of the decision-making process that went into validating the data. The data analyst/technician provides justification for the validation codes that were applied to the data. See Section 4.0, Using the Data Validation Log, in the *Air Quality Data Base Management System (AQDBMS) User's Guide* (ARS, 2012) for detailed instructions.

To use the Data Validation Log:
- Select **Logs-> Data Validation Log** from the AQ and Met Processing frame.
- Select a *site* from the Site drop-down box. If no records for the selected site exist, a "Site not Found" message is displayed. Click **OK**. Otherwise, the most recent Master Table record and related comments for the selected site are displayed.
- Select a different *month* and/or *year* from the drop-down list boxes to display previous month's records for the site.
- Records can be added by right-clicking and selecting **Add**.

### 6.1.2 THE SITE STATUS LOG
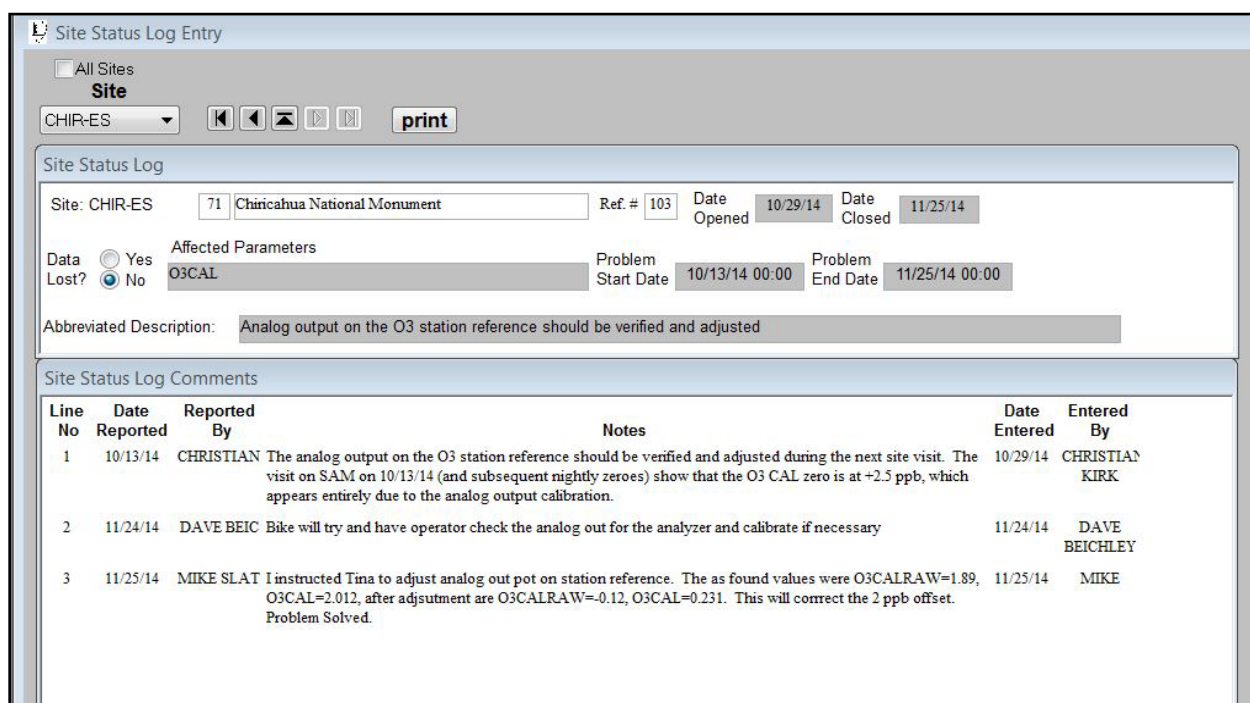
The electronic Site Status Log is an electronic bulletin board that provides a convenient and permanent record of field instrumentation problems, solutions, and other conditions that affect data quality. The Site Status Log is a component of the IMC Air Quality Database Management System (AQDBMS), and problems are entered as needed by network operations or IMC staff. The Site Status Log is available at http://www.arssitestatuslog.com, via authorized username and password, to allow field specialists access to data entries while on-site at a monitoring location.

Any inconsistency in the data or any other information pertinent to data validity noted by the field specialists (or TOW), IMC, or site operator will be manually documented in the electronic Site Status Log. An example Site Status Log is provided as Figure 6-1. It is the TOW's (or other field specialist's) or IMC staff's responsibility to complete a Site Status Log entry for every identified data anomaly or action that affects network operations and/or data validity. The entries should be clear, concise, and provide sufficient detail to accurately describe each problem or action.

Entries and updates will:

- Identify and document an ARS- or site operator recognized problem.
- Record the shipping of replacement parts or sensors.
- Document and explain results of adjustments or repairs.
- Provide an up to date record of actions leading to the rectification of a problem.
- Provide a historical record of problems to assist in data validation.

Brief, informational trip reports will also be entered to highlight significant or unusual findings or to document instrument replacements or repairs after a semiannual or emergency site repair.



Figure 6-1. Example Electronic Site Status Log Display.

A basic description of each event is entered as a record in the Master Table. The master record contains the site number and name, a reference number assigned by the program, date started and stopped fields to define the period of time involved, and an affected parameters field to indicate which data parameters may be affected by the event. Another field indicates if the event is considered to be a problem or not. This field is used to quickly create a list of current problems found in the log. The Detail Table holds as many records as needed to record notes about each event. Normally, a master record will have at least one detail record. Entries can be added, modified, or deleted in both the Master Table and the Detail Table. See Section 5.0, Using the Site Status Log, in the *Air Quality Data Base Management System (AQDBMS) User's Guide* (ARS, 2012) for detailed instructions.

## 6.2    LEVEL 0 VALIDATION PROCEDURES

### 6.2.1    LOADING AND ENTERING DATA INTO THE AQDBMS DATABASE

Data are collected hourly via modem or TCP/IP and stored digitally as explained in SOP I_IMC_DATACOLL_F_1.0, *Information Management Center - Data Collection*.

#### 6.2.1.1    Correcting Data Loading Errors

The AQDBMS program writes messages to a folder indicating reasons for loading failures and records of loading successes. This folder is located in the *\\ARSLS2\data\Ndrive\Project\imc\sitecall\V3\logs* directory and can be viewed in any text editor. The folder contains success logs (...Loading.logs) and failure logs (...LoadingError.logs). These logs are reviewed by the data technician who initiate corrective action as appropriate.

### 6.2.2    DATA REVIEW

The IMC data analyst/technicians review data daily and inform the network operations staff immediately of any noted anomalies. Notification of network operations is performed using the electronic Site Status Log. The procedures applied to review data daily are:

• Data Collection Status Report – Stations not successfully polled automatically will be retried or manually polled by the IMC. This effort is the first priority of the IMC team every day. Stations that cannot be polled or require repeated manual polling will be reported to network operations for further investigation. Stations with datalogger times drifting beyond two minutes of NIST time will be reported to network operations for correction.

• Primary Data Stackplot – The stackplot for each site is reviewed on screen. Any noted anomalies are reported to network operations. This review is performed to identify unusual variations in hourly data or logger data flags. Specific types of data review that would indicate issues for further investigation by network operations are:

- o   Solar Radiation – Nighttime values $\geq 14$ W/m2 or $\leq$ -14 W/m2
- o   RH – Values >105 or <0
- o   Ozone – Values $\leq$ -5ppb
- o   Instrument stuck at either zero or full scale
- o   Instrument readings that do not vary for extended periods of time

• Calibration Results Summary Stackplots – The data analyst/technicians review the plots to verify that all results are within acceptable limits. Any noted anomalies are reported to network operations.

Data analyst/technicians (or field specialists) enter site data issues into the electronic Site Status Log for documentation and evaluation. An entry will be made for each confirmed anomaly or inconsistency.

An ARS field specialist is assigned to review data, recognize problems, and initiate corrective action. This technician-of-the-week (TOW) has primary troubleshooting and telephone assistance responsibility for the entire assigned period, typically one week. Rotating this responsibility allows all network operations

personnel to keep current on network concerns, while having time to encounter and resolve a range of problems and maintain contact with the site operators. This builds a more dynamic staff and adds to the depth of the institutional memory of the network operations staff. The loss of a staff member is far less crippling to the program with this broad level of cross-training. The TOW, section manager, or other assigned field specialist will review the following data summaries and plots daily. Any inconsistencies or anomalies noted by network operations review or identified by the IMC will be investigated by network operations.

- • Primary Data Stackplot – The stackplot for each site is reviewed on-screen for data completeness, tolerance, and reasonability. Any noted inconsistencies initiate corrective actions by network operations.

- • Calibration Results Summary Stackplots – These plots are reviewed for calibration timing and to verify that all results are within acceptable limits. Noted anomalies initiate corrective actions.

Field specialists or data analyst/technicians enter site data issues into the electronic Site Status Log for documentation and evaluation. An entry will be made for each confirmed anomaly or inconsistency.

Data flags generated by the dataloggers are also stored. Table 6-1 is a list of datalogger flags. The data and flags are then loaded into the AQDBMS database and visually reviewed by the data analyst/technician in graphical format for data acquisition errors and for details on instrument performance.

Table 6-1

ESC 8816 Datalogger Data Flags[1]
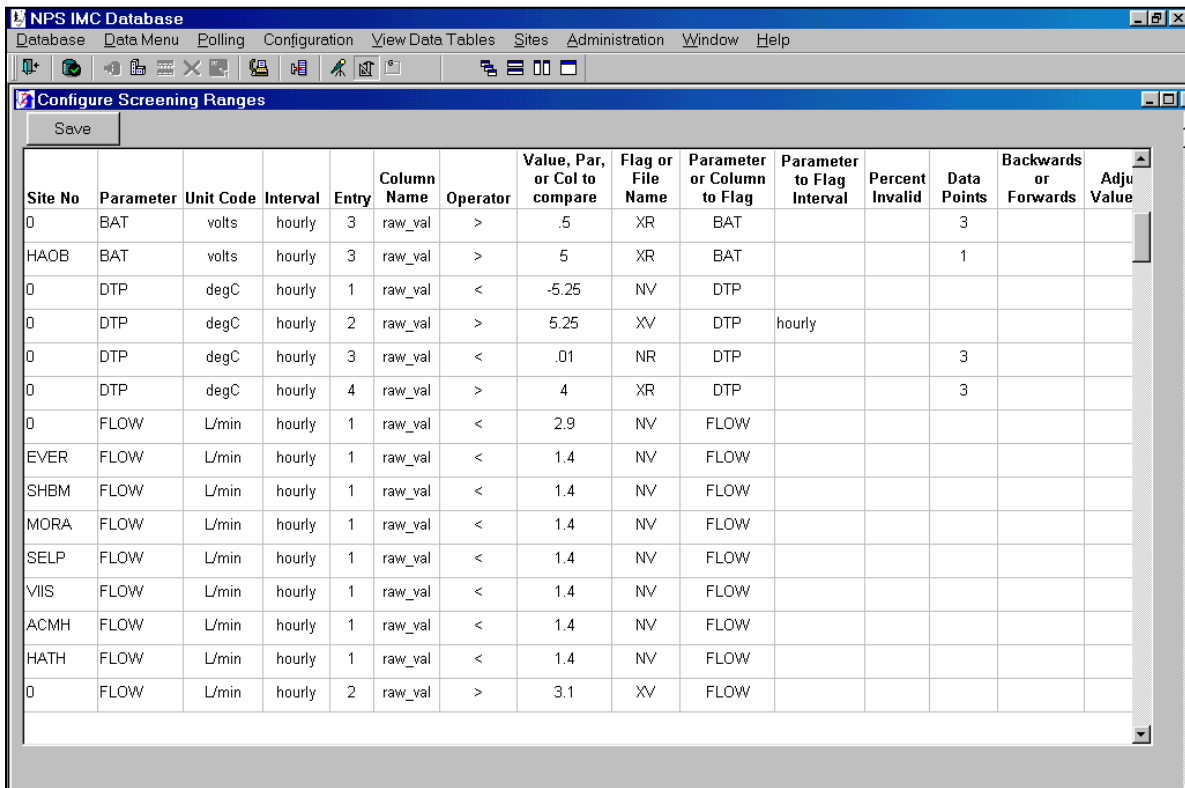
| Flag | Description |
|---|---|
| P | Power failure |
| D | Channel Disabled/Off-line |
| B | Bad status |
| C | Calibration |
| M | Maintenance |
| + | Maximum exceeded |
| - | Minimum exceeded |
| > | Some missing data, but meets requirement for valid average |
| < | Does not meet requirement for valid average |
| H | High-high alarm threshold exceeded |

[1] These flags are replaced by permanent validation codes later in the validation process.

### 6.2.3 ANOMALY SCREENING

As data are loaded into the AQDBMS they are automatically screened for anomalies by an AQDBMS program. This program applies anomaly flags (Level 0 validation codes). These flags are added in a separate screening flag field. The screening program uses values stored in the AQDBMS Screening Ranges Table. Figure 6-1 shows example records from this table. It contains the screening ranges for each current site and parameter code, which allows each screening element to be defined independently from the other.

Figure 6-1.  Example Records in the Screening Ranges Table.

To manually screen the data for anomalies, click the **Screen** button. The program looks up acceptable ranges of values in the Screening Ranges Table and flags anomalies. The program also compares the values of certain parameters and applies flags as needed. Table 6-2 is a list of anomaly flags. The program stops and a message is displayed if screening ranges have not been defined for a site/parameter combination. In this case, request that the data analyst/technician make appropriate changes to the Screening Ranges Table, as described in SOP 3650, *Maintenance Responsibilities for the Ambient Air Quality Data Base Management System (AQDBMS)*. After the data analyst/technician makes the changes, run the screening program again.

After screening, the data analyst/technician notifies the field specialist by opening a site status log if any of the following are true:

- Data for any parameter are at a full scale or zero scale values for an uncommonly long time. This indicates an instrument may have been left in zero or span mode inadvertently.
- Daily calibration data (zero and span values from the analyzer) are not within the expected range.
- Other unusual and noteworthy data flags that would call attention to either a needed repair of an instrument or correction of a condition by the site operator.

Table 6-2

Anomaly Screening Flags

| Flag | Description |
|------|-------------|
| XV | > the maximum value in the Screening Ranges Table. |
| NR | Rate-of-change < minimum value in the Screening Ranges Table. |
| NV | < minimum value in the Screening Ranges Table. |
| WS | Scalar wind speed > Vector wind speed - generated by the screening program |
| IM | Set in VWS, VWD, and SDWD when SWS < minimum expected (NV) |
| XR | Rate-of-change > the maximum value in the Screening Ranges Table. |
| TH | Data invalid for ozone when station temp is ≥ 30.5ºC. |
| TL | Data invalid for ozone when station temperature < 19.5ºC. |
| VM | Valid but the validated value has been adjusted for the max value by the screening program based on the max_adj, max_adj_to, and max_val fields of the Screening Ranges Table. |
| VZ | Valid but the validated value has been adjusted for zero by the screening program based on the zero adjustment value in the Screening Ranges Table. |

Corrective action is initiated to resolve any noted inconsistencies and the problem and actions are entered in the AQDBMS Site Status Log.

### 6.2.4    USING THE AQDB UPLOAD INTERFACE TO FLAG DATA

The Data Upload Configuration Lightswitch application provides a method to exclude suspect data from automated data dissemination processes. Following the data review process, any parameters that are found to have instrument malfunctions or reporting errors that aren't already flagged on the logger should be flagged down using this tool in order to prevent bad data from being distributed. A flag should be applied beginning with the first hour of suspect data. If the problem was short-lived or has already been resolved at the time the flag is applied, an end date can be entered into the application so only the affected hours are flagged. If the problem is persistent and has yet to be resolved, the end date should be left blank. This will ensure that each new hour of data that is collected for the particular site and parameter where the flag is applied will continue to be flagged and removed from data uploads until the issue has been resolved and an end date applied.

### 6.2.5    REVIEW OF RAW DATA STACKPLOTS

A stackplot may include single or multiple user-selected parameters on line or bar graphs plotted against time on the X-axis. Up to 20 parameters may be plotted on up to 10 separate graphs (1 or 2 parameters per graph) in a stack. Temporal data variations are then easy to compare. Stackplots are used throughout the validation process. Raw data are graphed on stackplots on a weekly basis for each site for the following time periods each month:

- Days 1 – 7
- Days 8 – 15
- Days 16 – 23
- Days 24 – end of month

One copy of each plot is generated weekly. This copy is then filed in a temporary file box in order to receive further comments later in the validation process. For instructions on running the stackplot graphics program, see *the Air Quality Data Base Management System (AQDBMS) User's Guide* (ARS, 2012).

### 6.2.6   SITE DOCUMENTATION

Site operators are required to complete station checklists in DataView during every station visit. The station checklists are downloaded and stored in the AQDBMS. At times, manual checklists must be completed by the site operators and faxed or e-mailed to the IMC. When this is necessary, the manually collected information is filed with other site documentation in the IMC.

Level 0 validation is complete for a site/month on the date all possible data for the month has been collected and loaded into the AQDBMS database and all site documentation has been received. This date is entered in the AQDBMS Data Validation Log.

### 6.3   PRELIMINARY VALIDATION PROCEDURES

Data for a site/month must be at Level 0 validation before beginning Preliminary validation. The Monthly Validation Checklist, shown in Figure 6-2, is used as a guide for the Preliminary validation procedure. The checklist identifies the major steps taken during Preliminary validation and provides a record of the date each step was completed and the initials of the analyst completing it. Preliminary data validation is accomplished by the following:

- Review the previous months' stackplots and Data Validation Log.
- Review and validate calibration plots.
- Print and review precision plots.
- Print and review station log and Site Status Log.
- Review SSRF forms, trip reports and check RH calibration results.
- 'Auto validate' data.
- Run "datalogger flags listing" report from database, verify all flags are coded.
- Check minimum and maximum thresholds for all parameters.
- Review minute trace for all gases.
- Apply additional validation codes if necessary.
- Record annotations on weekly stackplots.
- Run and print "Stackplots for Validation Review;" review and change codes as needed.
- Update Data Validation Log.

Validation acceptance criteria and the methods for determining if a data value meets the criteria are usually related to one of the following events or limitations (examples of specific criteria for each parameter are presented in Appendix A. These criteria may vary based on specific project requirements):

- Data are out of instrument specifications.
- Data exceed minimum or maximum expected value.
- Data exceed minimum or maximum expected rate-of-change.
- Station temperature is out of specified limits. (See the Appendix of this SOP for a list of instruments and their approved station temperature operating ranges.)

- Data are affected by calibration check.
- Zero and span check data are not within specified limits.
- Less than 45 minutes of data are available (hourly averaging period).
- Instrument or datalogger was affected by acts of nature.
- Instrument or datalogger was affected by power failure.
- Data capture was affected by a datalogger failure.
- Data were affected by operator maintenance or calibration check.
- Data were affected by site operator error.
- Data were affected by instrument malfunction or failure.
- Data were below lower detectable limit.

The Appendix of this SOP provides additional details on what types of failures and specific criteria to look for by parameter. The Appendix also lists project-specific validation acceptance criteria by parameter.

## MONTHLY VALIDATION CHECKLIST

Site_____

Month/Year_____

PRELIMINARY   (AND LEVEL 0 VERIFICATION)                                     Date___        Initials

1.   Review previous months' **Stackplots** and **Data Validation Log.**         _____        _____

2.   Review and validate **Calibration Plots.**

3.   Print and review **Precision Plots.**                                              _____        _____

4.   Print and review **Station Log, Site Status Log and Power Failures Listing.**                                                                   _____        _____

      Monthly RNF    Monthly PM flow check    Weekly station checks
      ☐          ☐        ☐ ☐ ☐ ☐ ☐

5.   Review **SSRF Forms, Trip Reports** & check **RH Cal Results.**            _____        _____

6.   **'Auto Validate'** data.                                                        _____        _____

7.   Run **"datalogger flags listing"** report from database, verify all flags are coded.

8.   Check **minimum** and **maximum thresholds** for all parameters, including station temperature. ☐☐                                 _____        _____
                Min   Max

9.   Review **minute trace** for all gases.                                         _____        _____

10.  Apply **additional validation codes** if necessary.                          _____        _____

11.  Record **annotations** on weekly stackplots.                                 _____        _____

12.  Run and print **"Stackplots for Validation Review"**– review & change codes as needed.

13.  Update **Data Validation Log.**                                               _____        _____

**3rd LEVEL**

14.  Review **Site Status Log, Field Station Logs, Power Failure Listing, Calibration Plots, Calibration Check Validation Codes** and **Precision Plots** to verify annotations on plots.                                                 _____        _____

15.  Check **minimum** and **maximum thresholds** for all parameters.

16.  Review **Validated Stackplots**, investigate suspect data if necessary.      _____        _____

17.  Verify preliminary **Validation Codes** in database.                         _____        _____

18.  Update **Data Validation Log.**                                              _____        _____

Figure 6-2.   The Monthly Validation Checklist.

### 6.3.1   REVIEW THE PREVIOUS MONTHS' STACKPLOTS AND DATA VALIDATION LOG

Review the previous months' annotated stackplots as well as the data validation log to see what issues occurred that may carry over into the current month being validated. Data should continue to be invalidated using the same validation code for any issue that was not resolved the previous month.

### 6.3.2   REVIEW AND VALIDATE CALIBRATION PLOTS

For all gas parameters the monthly calibration plot is reviewed. This plot displays the results of the daily automated zero, precision, and span. Acceptance criteria for all relevant parameters can be found in the Appendix of this SOP. When checks fall outside of acceptable limits, data are invalidated back to the last good check until the issue is resolved. Zero drift can be corrected by zero-correcting data based on the zero checks.

Each gaseous parameter should run a zero, span, and precision on a regular basis.  The results from these calibration events must be reviewed as a part of the data validation process to verify that the data are accurate.  Refer to the acceptance criteria for each event by parameter in the Appendix of this SOP.

To review the calibration results, run a calibration plot for each gaseous pollutant from the reports interface of the AQDBMS. These plots display the result of each event as well as the percent difference for comparison to the acceptance criteria. Identify events that are outside of the acceptable limits. Data outside of these limits are not necessarily invalid.  Checks found outside of limits should be investigated to determine if the poor response is an accurate reflection of the analyzer response or if there was an issue with the event running correctly. Once it is determined which checks are valid and which are invalid, validation codes should be applied to each calibration check using the 'Data Validation for Calibration Data' window of the AQDBMS. If the analyzer is the one that is not responding correctly then ambient data must be invalidated.  Data are invalidated beginning the hour after the last known good calibration event until the next good calibration event.

Sometimes data can be adjusted when the zero results are not within the acceptance criteria.  Procedures for adjusting data in this situation are as follows:

1.  Data are not adjusted until the zero results are outside of the criteria listed in the Appendix of this SOP.
2.  Data are adjusted from the point at which the zero drifted outside of limits until the next zero that is within limits.
3.  Data are adjusted by subtracting the result of the zero from the raw values.

Refer to the Appendix of this SOP for further instructions on how to zero adjust data.

Note:  In general regulatory data are not adjusted when zero results are outside of tolerance, rather the data are invalidated.

### 6.3.3   PRINT AND REVIEW PRECISION PLOTS

A precision plot shows the percent difference of each valid 1-point QC check on a bar chart. This plot can be generated from the reports interface of the AQDBMS and should be run to verify that all valid checks are within limits and that sufficient checks were performed during the month. Refer to the Appendix of

this SOP for criteria on how often a 1-point QC check needs to occur. If checks do not occur at the required frequency, a qualifier code of 'QX' should be applied to the data beginning the hour after the last valid check occurred until the next 1-point QC check runs.

### 6.3.4 PRINT AND REVIEW STATION LOG AND SITE STATUS LOG

Site operators are required to complete site station logs when performing checks at the site. These station logs are collected and loaded into the AQDBMS. Station logs can be printed by selecting this report product from the reports interface. These logs should be generated and reviewed to determine when maintenance was performed at the site. Site operator comments are reviewed to determine if any issues occurred at the site that may have affected data.

After reviewing the station logs, check off site visits on the validation checklist to document whether or not all required visits are being performed each month. Also mark on the checklist if a precipitation check or flow check (PM instruments only) was performed for the month.

The Site Status Log is a summary of site-related events such as instrument malfunctions and repairs, special site visits, unusual events, etc. that may affect data validation. Print and review all site status logs that pertain to the month and site that is being validated to determine periods of data that may need to be invalidated. The field group should be consulted if there is any information in the Site Status Log that is not clear on how it may affect data.

### 6.3.5 REVIEW SSRF FORMS, TRIP REPORTS AND CHECK RH CALIBRATION RESULTS

All CASTNET sites will have SSRF forms associated with the filter pack system. These forms should be reviewed to determine if any leaks are present in the system.

Trip reports are reviewed to verify that all calibration results are within data validation acceptance criteria. Refer to the Appendix of this SOP for a list of acceptance criteria by parameter. Any results outside of tolerance should be reviewed with the field technician that performed the work in order to understand what caused the failure. If the failure is determined to be accurate, data should either be invalidated or adjusted back to the last good check.

Relative humidity sensors are routinely changed out during semi-annual maintenance visits and are brought back to the ARS lab for calibration. Results from the calibration in the lab should be reviewed to determine whether or not data collected from that particular relative humidity sensor were within acceptance criteria. Figure 6-3 presents a sample report of RH calibration results.

# AT/RH Sensor Calibration Form

| | | | |
|---|---|---|---|
| Serial Number: | 75277 | Owner: | NPSAIR |
| Model Number: | Rotronic MP-101A | Date of Last Operation: | 3/15/2005 to 7/12/2006 |
| Calibration Date: | 7/25/2006 | Last Operational Site: | ZION |
| Service Technician: | Marty Mills | | |
| Service Type: | Scheduled | | |
| Comments: | | | |

## Pre - Calibration Relative Humidity:

| Check Point | Nominal Time | NIST Traceable | Sensor | Deviation |
|---|---|---|---|---|
| 10% | 10 min. | 10.0% | 9.4% | -0.6% |
| 35% | 10 min. | 35.1% | 33.8% | -1.3% |
| 50% | 10 min. | 50.1% | 48.4% | -1.7% |
| 60% | 10 min. | 60.1% | 57.9% | -2.2% |
| 70% | 10 min. | 70.1% | 67.5% | -2.6% |
| 80% | 10 min. | 80.1% | 77.0% | -3.1% |
| 90% | 10 min. | 90.1% | 87.6% | -2.5% |
| 95% | 10 min. | 95.2% | 92.9% | -2.2% |

| RMS<br>Error | Minimum<br>Error | Maximum<br>Error | Within Mfg<br>Specifications | |
|---|---|---|---|---|
| 2.2% | 0.6% | 3.1% | False | |

## Pre - Calibration Temperature:

| Check Point | Nominal Time | NIST Traceable | Sensor | Deviation |
|---|---|---|---|---|
| 15 degrees | 10 min. | 15.4 | 14.4 | -1.0 |
| 25 degrees | 10 min. | 25.1 | 25.2 | 0.1 |
| 35 degrees | 10 min. | 34.8 | 36.0 | 1.2 |

| RMS<br>Error | Minimum<br>Error | Maximum<br>Error | Within Mfg<br>Specifications | |
|---|---|---|---|---|
| 0.9 | 0.1 | 1.16 | False | |

Figure 6-3.  Sample Report of RH Calibration Results (Page 1)

# AT/RH Sensor Calibration Form

**Serial Number:** 75277        **Calibration Date:** 7/25/2006

**Post - Calibration Relative Humidity:**

| Check Point | Nominal Time | NIST Traceable | Sensor | Deviation |
|---|---|---|---|---|
| 10% | 10 min. | 10.014% | 9.370% | -0.644% |
| 35% | 10 min. | 35.100% | 34.945% | -0.155% |
| 50% | 10 min. | 50.141% | 50.342% | 0.201% |
| 60% | 10 min. | 60.075% | 60.105% | 0.030% |
| 70% | 10 min. | 70.110% | 70.008% | -0.102% |
| 80% | 10 min. | 80.120% | 79.880% | -0.240% |
| 90% | 10 min. | 90.110% | 90.500% | 0.390% |
| 95% | 10 min. | 95.170% | 95.810% | 0.640% |

| RMS Error | Minimum Error | Maximum Error | Within Mfg Specifications |
|---|---|---|---|
| 0.4% | 0.030% | 0.640% | True |

**Post - Calibration Temperature:**

| Check Point | Nominal Time | NIST Traceable | Sensor | Deviation |
|---|---|---|---|---|
| 15 degrees | 10 min. | 15.4 | 14.6 | -0.8 |
| 25 degrees | 10 min. | 25.2 | 25.2 | 0.1 |
| 35 degrees | 10 min. | 34.8 | 35.5 | 0.7 |

| RMS Error | Minimum Error | Maximum Error | Within Mfg Specifications |
|---|---|---|---|
| 0.6 | 0.08 | 0.76 | True |

**Calibration Equipment:**

| Manufacturer | Model Number | Serial Number | Last Date Calibrated | Minimum Error RH | Maximum Error RH | Minimum Error | Maximum Error |
|---|---|---|---|---|---|---|---|
| Rotronic | Hygroclip R | 29206015/97431 | 5/9/2006 | -2.03 | 2.03 | -1 | 1 |

**Adjustments / Repair:**

RH Adjustments Made at Set Points:    ☑ 10%    ☑ 35%    ☑ 80%

Temperature Adjustments Made Set Points:    ☑ 25 Degrees Celsius

Repairs Made:

Figure 6-3. Sample Report of RH Calibration Results (Page 2)

### 6.3.6  'AUTO VALIDATE' DATA

During the preliminary validation process, data validation codes are applied to every record of data using the 'Auto Validate' button within the data validation window. First select the site, date range and parameters to be validated then click the 'Auto Validate' button. Codes are then automatically applied to each record of data selected. These codes are guided by the datalogger and anomaly flags that are already in the database from the data collection process. A validation code is entered for each data point in a field separate from the datalogger and anomaly screening flags. A list of datalogger and anomaly screening flags and most common actions taken based on the flags can be found in the Appendix of this SOP; as can a list of validation codes and conditions.

### 6.3.7  RUN "DATALOGGER FLAGS LISTING" REPORT FROM DATABASE, VERIFY ALL FLAGS ARE CODED

The "datalogger flags listing" report product provides a list of all hours by parameter that were invalidated during the auto validation process. This product displays the code that was automatically applied to each record of flagged data.

Generate this report from the reporting interface to review the data records and parameters that were flagged down for the month and to determine whether or not the validation codes that were automatically applied need to be manually changed or updated. Validation codes should be manually changed as needed only after reviewing other pieces of information such as the station logs, site status logs, stackplots, etc. Figure 6-4 displays a sample datalogger flags listing report.

### 6.3.8  CHECK MINIMUM AND MAXIMUM THRESHOLDS FOR ALL PARAMETERS

Check that each parameter is within minimum and maximum acceptance limits. This is done by viewing each parameter, one parameter at a time, in the data validation window. Right click to sort by the display value. This will sort each record for the month from lowest to highest value allowing the user to quickly check that no validated data points are outside of the acceptable limits for each parameter. See the Appendix of this SOP for a list of acceptable minimum and maximum values by parameter.

Datalogger Flag Listing
12/01/2018 - 12/31/2018
Site: ZION-DW

Parameter: O3-3
| | |
|---|---|
| 12/04/2018 09:00 | <DC (ZS) |
| 12/18/2018 09:00 | <DC (ZS) |
| 12/21/2018 09:00 | <PDC (ZS) |

Parameter: RNF-2
| | |
|---|---|
| 12/21/2018 09:00 | P (MT) |

Parameter: SDWD-2
| | |
|---|---|
| 12/21/2018 09:00 | <POU (MT) |
| 12/22/2018 15:00 - 12/22/2018 16:00 | <O (IM) |
| 12/26/2018 11:00 - 12/26/2018 16:00 | <O (IM) |
| 12/26/2018 18:00 | <O (IM) |
| 12/26/2018 20:00 | <O (IM) |
| 12/26/2018 22:00 | <O (IM) |
| 12/28/2018 02:00 - 12/28/2018 06:00 | <O (IM) |
| 12/28/2018 08:00 | <O (IM) |
| 12/28/2018 10:00 - 12/28/2018 22:00 | <O (IM) |
| 12/31/2018 02:00 | <O (IM) |
| 12/31/2018 07:00 | <O (IM) |
| 12/31/2018 11:00 | <O (IM) |
| 12/31/2018 13:00 - 12/31/2018 23:00 | <O (IM) |

Parameter: SOL-1
| | |
|---|---|
| 12/21/2018 09:00 | <PU (MT) |

Parameter: STP-1
| | |
|---|---|
| 12/21/2018 09:00 | <POU (V) |

Parameter: SWS-1
| | |
|---|---|
| 12/21/2018 09:00 | <P (MT) |

Parameter: TMP-1
| | |
|---|---|
| 12/21/2018 09:00 | <P (MT) |

Parameter: VWD-1
| | |
|---|---|
| 12/21/2018 09:00 | <P (MT) |

Parameter: VWS-2
| | |
|---|---|
| 12/21/2018 09:00 | <P (MT) |

Figure 6-4.   Sample Datalogger Flags Listing Report

### 6.3.9   REVIEW MINUTE TRACE FOR ALL GASES

The minute trace from each gas analyzer should be reviewed either in DataView or by running the 1-minute stackplot for the AQDBMS to determine if any dropouts, spikes, or noise in the data may have occurred that would affect the hourly averages. The corresponding data record should be invalidated where any spike or dip that is determined to be an anomaly affects the hourly average (e.g. the value would have been larger or smaller than recorded had it not been for the anomaly). The appropriate data records should also be invalidated if qualitative review of any noise is seen that affects the hourly average. A Site Status Log should be opened if the noise is persistent. See the Appendix of this SOP for more detail on what to look for in the minute trace.

The minute trace should also be viewed to determine what types of calibrations occurred in order to accurately select the validation code that should be applied during each event. See the Appendix of this SOP for a list of calibration shapes by type of event.

### 6.3.10   APPLY ADDITIONAL VALIDATION CODES IF NECESSARY

After the data technician/analyst has completed the previous steps of the preliminary validation process, there may be a need to override some of the validation codes previously applied during the 'autovalidate' process. This is done by manually updating the codes through the Data Validation Window.

#### 6.3.10.1  The Initial Data Validation Window

To open the Data Validation window, select Validate from the AQ and Met Processing frame. Validation codes may be applied automatically by using the "Auto Validation" button in the Data Validation window, or they may be applied manually by the data analyst/technician when there is a need to override the codes applied by the database. When entering the data validation interface, the initial Data Validation window can be used to list missing data, blank-fill data, auto validate data, display a data grid, or enter the interface to manually apply validation codes.  This window is shown in Figure 6-5.
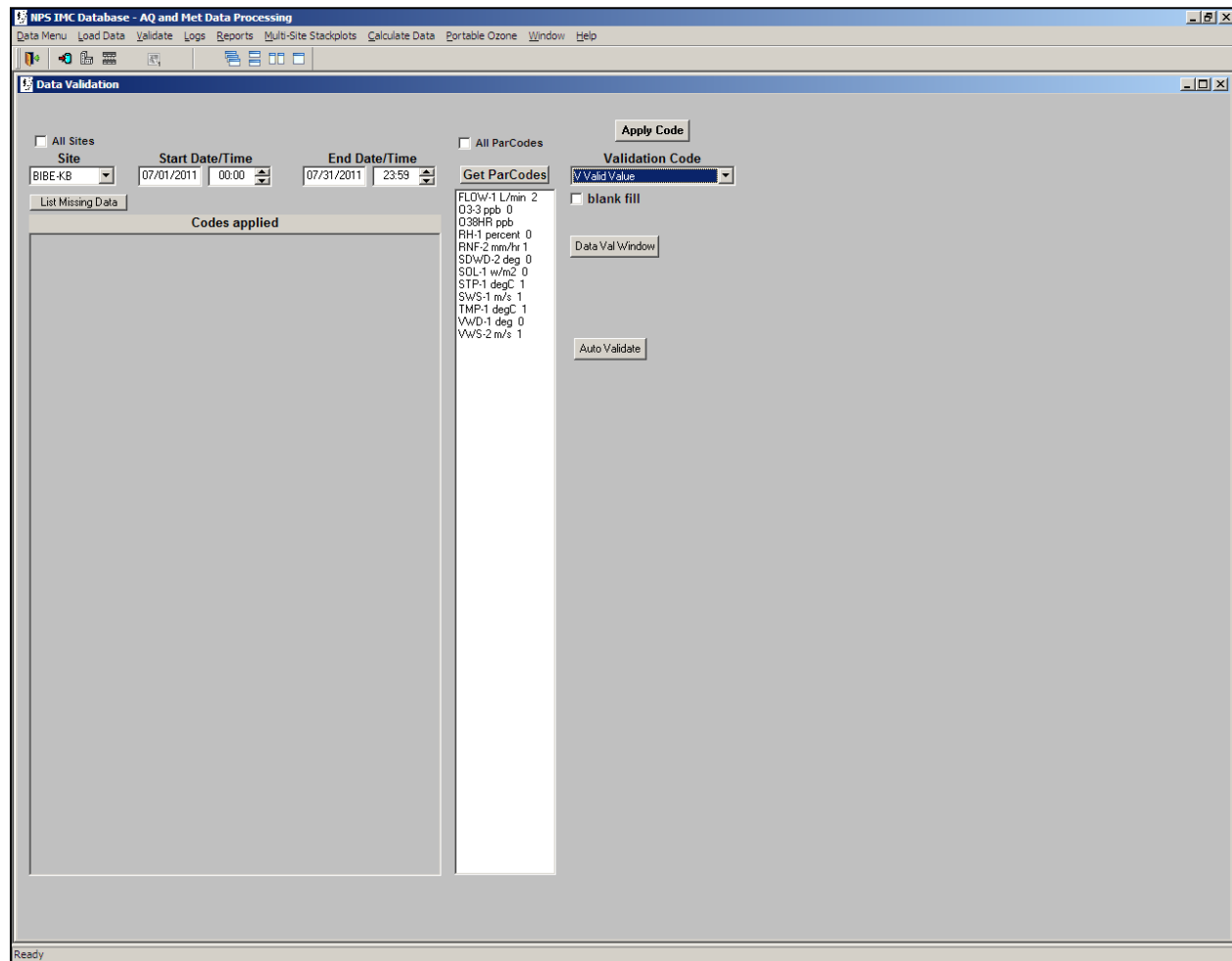
Figure 6-5. The Initial Validation Window.

To apply validation codes manually:

- Select the *site* to validate.
- Enter the *Start Date/Time* of the data set to validate.
- Enter the *End Date/Time* of the data set to validate.
- Click the **Get ParCodes** button. The program queries the database and returns all the parameter codes found for the selected site and period in the list box.
- Select (highlight) one or more *parameter codes* in the list box.
- Select a *validation code* from the Validation Code drop-down box.
- Click the **Apply Code** button. The process window displays a message listing the number of updated records.
  *Important Note: When using this method, validation codes are committed to the database table immediately. This method should only be used for power failures or when blank-filling data (see instructions on blank-filling below).*

To search for missing data:

- Select the *site* to validate.
- Enter the *Start Date/Time* of the data set to validate.
- Enter the *End Date/Time* of the data set to validate.
- Click the **Get ParCodes** button. The program queries the database and returns all the parameter codes found for the selected site and period in the list box.
- Select (highlight) one or more *parameter codes* in the list box.
- Click the **List Missing Data** button. The cursor changes to an hourglass. When the cursor changes back to a pointer, the process has completed. Missing data within the selected data set will be listed in the process box.

To blank-fill data:

- Select the *site* to validate.
- Enter the *Start Date/Time* of the data set to review.
- Enter the *End Date/Time* of the data set to review.
- Click the **Get ParCodes** button. The program queries the database and returns all the parameter codes found for the selected site and period in the list box.
- Check the **blank fill** box.
- Check the **All** box and click **Get ParCodes** to retrieve a list of all parameter codes. Select the parameter codes to be blank-filled for the selected site and time period.
  **-or-**
- Check the pattern date and enter a *date* that contains the parameter codes that need to be blank-filled for the selected period.
  **-or-**
- Enter an end date just beyond the period of time to be blank-filled that contains all parameter codes that need to be blank-filled. Click the **Get Par Cod**es button and highlight all parameters listed.
- Select a *code* from the Validation Code drop-down list box.
- Click the **Apply Code** button. Data will be blank-filled with a value of "-999" in the raw value and validated value fields, the selected code in the validation code field, and a "B" in the source code field. NOTE: The program will not overwrite existing data. When the process is complete, the number of blank-filled rows will be indicated in the process box.

To display the data grid:

- Select the *site* to validate.
- Enter the *Start Date/Time* of the data set to review.
- Enter the *End Date/Time* of the data set to review.
- Click the **Get ParCodes** button. The program queries the database and returns all the parameter codes found for the selected site and period in the list box.
- Select the *parameter code* to display. NOTE: If more than one parameter code is selected, only data for the first code will be displayed.
- Click the **24x31** button. The data will be displayed in a grid of 24 hours across by days down (optimally one month). For each data point, if any code other than a "V", "VA", "VM", or "VZ" exists in the validation code field, the code will be displayed in red. Otherwise, the value found in the validated value field is displayed.

- Select the **Print** button to print a copy of the data grid.
- Click the **X** button to close the window and return to the validation window.

### 6.3.10.2  The Data Validation Data Window

The Data Validation Window provides an interface for applying validation codes to specific, individually selected data points when the data analyst/technician needs to override the codes applied during the Auto Validation process. For example, the Auto Validate process cannot determine what type of calibration was performed or if the wind sensors were frozen due to weather conditions. In these cases the data analyst/technician will update the validation codes that were applied during this process. Data from all columns of the database table are displayed in tabular form as shown in Figure 6-6. The data window data can be sorted and/or filtered. The interface also provides a means for re-screening data and for hand entering data values when necessary.

To open the Data Validation data window:

- In the Initial Data Validation window, select the *site* to validate.
- Enter the *Start Date/Time* of the data set to validate.
- Enter the *End Date/Time* of the data set to validate.
- Click the **Get ParCodes** button. The program queries the database and returns all the parameter codes found for the selected site and period in the list box.
- Select (highlight) one or more *parameter codes* in the list box.
- Click the *data table* picture button. The Data Validation data window is opened and displays the selected set of data in a tabular data window.

To apply validation codes:

- Open the Data Validation data window.
- Highlight the data points to apply the code to.
- Select a *code* from the Validation Code drop-down list box.
- Click the **Apply Code** button.

To sort and filter data:

- Open the Data Validation data window.
- **Right-click** anywhere in the data window.
- Select **Filter** or **Sort** from the pop-up menu. A dialog box is displayed. Follow the dialog box instructions to apply filter or sorting options. Click the **Help** button to access specific help on the dialog boxes.

Figure 6-6. Example Data Validation Data Window.

### 6.3.10.3 Entering Qualifier Codes

Qualifier codes can be entered in the Data Validation data window. Qualifier codes are used to flag data where there is an issue, but data should remain valid. An example of this is when a valid precision check was not completed for more than 14 days; in this case, a 'QX' code should be applied.

To apply qualifier codes:

- Open the Data Validation data window
- Select (highlight) the data points to apply the Qualifier code to. Note this is a multi-select data window and rows can be selected with shift-click and ctrl-click.
- Enter the qualifier code in the **Qualifier Code** box.
  - o A list of qualifier codes can be found at:
    https://aqs.epa.gov/aqsweb/documents/codetables/qualifiers.html

- Click the Apply **Qual Code** button.
- Multiple qualifier codes can be applied by putting a space between codes.

#### 6.3.10.4  Entering Control Values

Control values can be entered in the Data Validation data window. Control values are arithmetic expressions that are applied to or replace raw values and result in adjusted validated values. The first character in the control value field must be an arithmetic operator. For example, if raw data values for wind speed were determined to be 10 m/s less than actual conditions (based on verification checks performed in the field and/or in the laboratory) enter +**10** in each control value field. This action will add 10 to the raw data values and place the result in the validated data fields. When the control value field is used, the final data validation code must equal "VA" which means valid, but value adjusted.

Acceptable operators for control values:

| Operator | Result |
| :---: | :--- |
| + | adds the control value to the raw value |
| - | subtracts the control value from the raw value |
| * | multiplies the raw value by the control value |
| / | divides the raw value by the control value |
| = | substitutes the control value for the raw value |

To enter control values:

- Open the Data Validation data window.
- Select (highlight) the *data points* to apply the VA code to. Note this is a multi-select data window and rows can be selected with shift-click and ctrl-click.
- Select the **VA** code from the Validation Code drop-down list box.
- Enter the *value* to apply in the Control Value box.

Click the **Apply Code** button.

### 6.3.11  RECORD ANNOTATIONS ON WEEKLY STACKPLOTS

To determine if a data value meets validation acceptance criteria, the data analyst/technician reviews the site documentation and weekly stackplots for the site/month being validated, then annotates the plots during any period where data were affected. Comments on plots are based on information from the site documentation, communication with field personnel and site operators, datalogger flags, and anomaly screening flags and reflect the codes in the AQDBMS as applied using the Auto Validation tool. A commented plot is shown in Figure 6-7. The following guidelines are used when commenting plots:

- Comments are written within the outline of the day of the affected data and in close proximity to the data point affected.
- Comments include the hours affected, the parameters affected, and the corresponding invalid code which provides the reason for invalidating the data.
- Explanations of valid but unusual data are also included.
- Data points invalidated by the Auto Validation tool are noted on the stackplot when appropriate.

- Site visits are identified at the top of the plot above the corresponding date with date, time, and duration of the visit.
- Normal actions that occur during a site visit and do not invalidate data are also identified on the plot (for example, meteorological instrument checks that last less than 15 minutes). This indicates that a required maintenance check was completed and further establishes validity of the data.
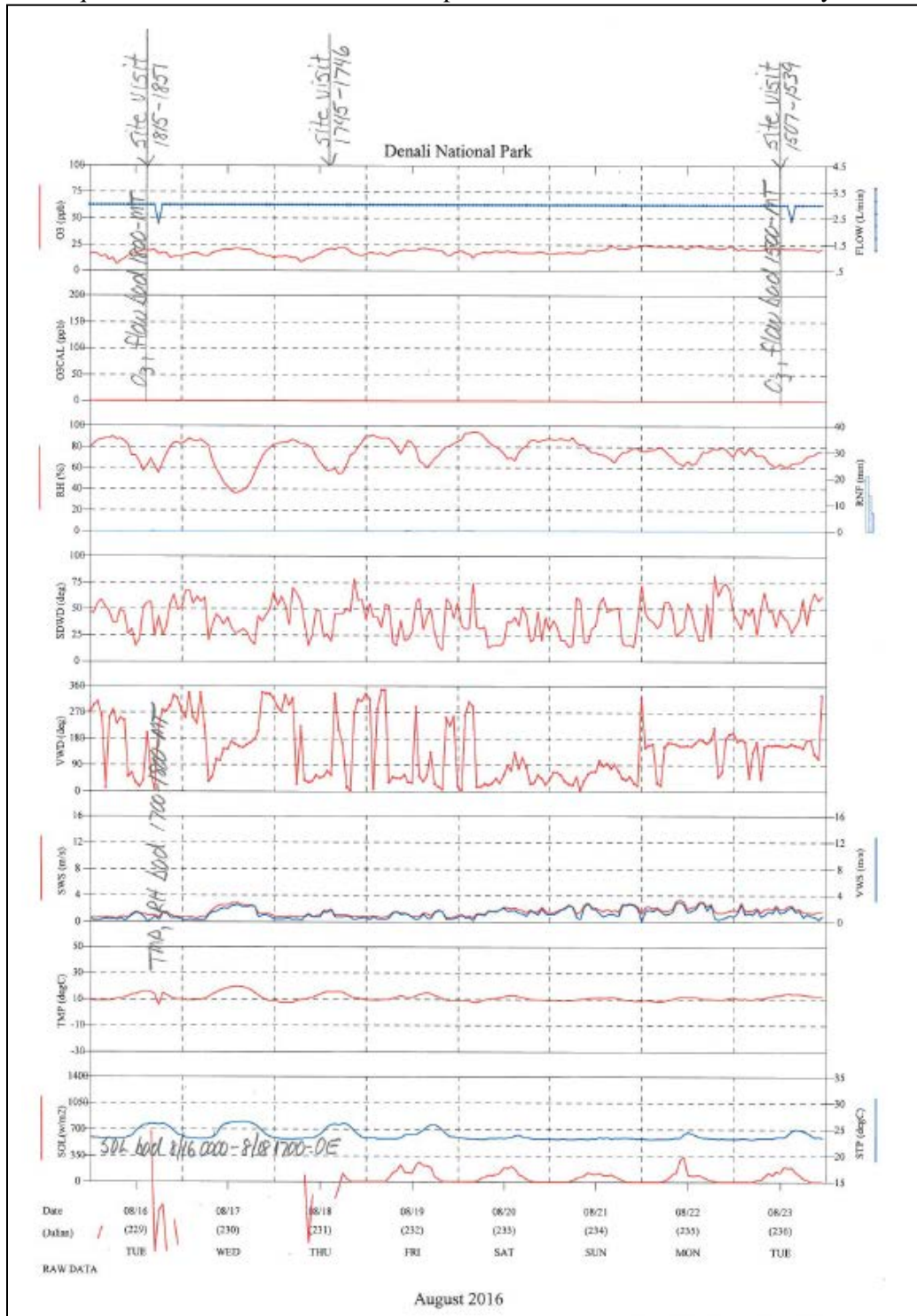


Figure 6-7.    Example of a Commented Stackplot.

## 6.3.12 RUN AND PRINT "STACKPLOTS FOR VALIDATION REVIEW;" REVIEW AND CHANGE CODES AS NEEDED

Validation review stackplots (stackplots of the raw data overlaid with the validated data) are reviewed to verify that all anomalies and suspect data have been properly invalidated. Any suspect data points found that have not already been reviewed are thoroughly investigated and data are invalidated if deemed necessary. In the event that additional data are invalidated, the validation review plots should be re-run and reviewed again. This process is repeated until all suspect data have been thoroughly reviewed to determine their validity.

## 6.3.13 UPDATE DATA VALIDATION LOG

Once preliminary validation is complete, the data validation log is updated with the date this step was completed as well as the initials of the data analyst/technician that performed this step in the validation process. Data validation notes are added to provide documentation of the decision-making process that went into validating the data.

## 6.4 THIRD LEVEL VALIDATION PROCEDURES

During Third Level validation, annotated stackplots and site documentation are reviewed to verify that all annotations on the plots are complete and accurate. Codes are cross-checked by the data analyst/technicians to verify they were applied correctly and to each data record. The AQDBMS Data Validation Log is then updated by entering the date completed and the analyst's initials into the log record for the site/month. Refer to the list of "3rd Levels Common Mistakes to Check For" in the Appendix of this SOP

## 6.4.1 REVIEW SITE STATUS LOG, FIELD STATION LOGS, CALIBRATION PLOTS, AND PRECISION PLOTS TO VERIFY ANNOTATIONS OF PLOTS

The site status log is reviewed to verify any equipment issues were addressed and properly documented in the data validation log. Any issues affecting data that have not already been resolved are discussed with the project manager, data manager, field staff, or QA manager to determine final data validity. Calibration plots and precision plots are reviewed to verify that all checks were within limits for the month. If any checks are found outside of acceptance criteria, verify either the ambient data were invalidated as needed or the checks were invalidated if it was determined the check(s) in question did not run correctly.

Field station logs are reviewed to verify that all sites visits were properly annotated on the stackplots. Verify that the correct hours were annotated on the plots if there were instrument problems that led to data loss and check that the correct validation code was used for each situation that resulted in data loss.

## 6.4.2 CHECK MINIMUM AND MAXIMUM THRESHOLDS FOR ALL PARAMETERS

To verify the value for each parameter falls within minimum and maximum acceptance limits review each parameter, one at a time, in the data validation window. Right click to sort by the display value. This will sort each record for the month from lowest to highest value allowing the user to quickly check that no validated data points are outside of the acceptable limits for each parameter.

### 6.4.3 REVIEW VALIDATED STACKPLOTS, INVESTIGATE SUSPECT DATA IF NECESSARY

Validation review stackplots (stackplots of the raw data overlaid with the validated data) are reviewed to verify that all anomalies and suspect data have been properly invalidated. Any suspect data points found that have not been properly addressed are thoroughly investigated and corrections are made if necessary.

### 6.4.4 VERIFY PRELIMINARY VALIDATION CODES IN DATABASE

All validation codes as annotated on the stackplots should be checked to verify they were entered correctly in the database. This is done by reviewing the monthly data grid.

**Basin**

**WARMS Network**                                        Ozone hourly averages  (ppb)                                        10/01/18 - 10/31/18

HOUR (LOCAL STANDARD TIME)

| Date | 00 | 01 | 02 | 03 | 04 | 05 | 06 | 07 | 08 | 09 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 14 | 11 | 11 | 10 | 8 | 8 | 8 | 8 | 11 | 13 | 18 | 24 | 29 | 31 | 31 | 27 | 30 | 32 | 28 | 27 | 26 | 22 | SC | 17 |
| 2 | 15 | 8 | 10 | 15 | 8 | 9 | 9 | 7 | 11 | 21 | 31 | 40 | 41 | 39 | 39 | 40 | 37 | 33 | 35 | 33 | 31 | 28 | SC | 18 |
| 3 | 24 | 21 | 23 | 25 | 27 | 27 | 25 | 21 | 27 | 32 | 35 | 41 | 43 | 41 | 39 | 39 | 38 | 35 | 30 | 27 | 28 | 27 | SC | 25 |
| 4 | 22 | 21 | 19 | 19 | 20 | 20 | 16 | 15 | 18 | 25 | 28 | 29 | 30 | 32 | 33 | 34 | 34 | 32 | 30 | 27 | 23 | 21 | SC | 24 |
| 5 | 23 | 28 | 28 | 26 | 33 | 43 | 39 | 38 | 40 | 43 | 43 | 45 | 46 | 46 | 46 | 45 | 45 | 42 | 43 | 39 | 43 | 36 | SC | 23 |
| 6 | 23 | 17 | 19 | 18 | 14 | 18 | 9 | 8 | 15 | 19 | 29 | 35 | 38 | 43 | 46 | 47 | 47 | 43 | 43 | 46 | 42 | 39 | SC | 34 |
| 7 | 32 | 30 | 31 | 29 | 27 | 27 | 28 | 29 | 29 | 30 | 31 | 32 | 34 | 39 | 43 | 39 | 34 | 33 | 32 | 29 | 27 | 28 | SC | 28 |
| 8 | 34 | 30 | 30 | 29 | 28 | 29 | 29 | 30 | 33 | 35 | 35 | 36 | 37 | 37 | 35 | 37 | 36 | 36 | 36 | 35 | 33 | 28 | SC | 25 |
| 9 | 25 | 25 | 23 | 22 | 23 | 25 | 25 | 25 | 24 | 24 | 28 | 32 | 35 | 35 | 36 | 36 | 34 | 30 | 32 | 34 | 36 | 36 | SC | 30 |
| 10 | 30 | 26 | 23 | 21 | 20 | 20 | 20 | 21 | 22 | 24 | 25 | 26 | 27 | 28 | 28 | 29 | 28 | 25 | 23 | 22 | 20 | 16 | SC | 31 |
| 11 | 30 | 31 | 28 | 28 | 26 | 19 | 17 | 16 | 18 | 23 | 28 | 30 | 30 | 32 | 31 | 31 | 29 | 31 | 30 | 28 | 27 | 26 | SC | 18 |
| 12 | 16 | 14 | 15 | 20 | 21 | 19 | 18 | 18 | ZS | CA | CA | ZS | ZS | CA | CA | ZS | IM | IM | IM | IM | IM | IM | SC | IM |
| 13 | IM | IM | IM | IM | IM | IM | IM | IM | IM | IM | IM | IM | IM | IM | IM | IM | IM | IM | IM | IM | IM | IM | SC | IM |
| 14 | IM | IM | IM | IM | IM | IM | IM | IM | IM | IM | IM | IM | IM | IM | IM | IM | IM | IM | IM | IM | IM | IM | SC | IM |
| 15 | IM | IM | IM | IM | IM | IM | IM | IM | IM | IM | IM | IM | IM | IM | ZS | ZS | IM | IM | IM | IM | IM | IM | SC | IM |
| 16 | IM | IM | IM | IM | IM | IM | IM | MT | 7 | 12 | 18 | 26 | 32 | 34 | ZS | 39 | 38 | 35 | 33 | 29 | 26 | 22 | SC | 8 |
| 17 | 15 | 15 | 11 | 6 | 4 | 6 | 6 | 5 | 8 | 12 | 18 | 26 | 35 | 39 | 40 | 41 | 38 | 37 | 35 | 33 | 24 | 21 | SC | 19 |
| 18 | 21 | 17 | 9 | 15 | 12 | 10 | 4 | 7 | 10 | 14 | 19 | 31 | 37 | 40 | 41 | 41 | 39 | 33 | 35 | 30 | 26 | 27 | SC | 19 |
| 19 | 14 | 10 | 6 | 9 | 9 | 8 | 4 | 5 | 11 | 16 | 21 | 31 | 39 | 41 | 41 | 41 | 38 | 39 | 35 | 32 | 29 | 22 | SC | 12 |
| 20 | 12 | 11 | 9 | 12 | 10 | 7 | 6 | 5 | 12 | 17 | 25 | 32 | 39 | 42 | 42 | 42 | 38 | 34 | 34 | 31 | 27 | 25 | SC | 22 |
| 21 | 19 | 15 | 12 | 7 | 13 | 8 | 4 | 7 | 12 | 16 | 22 | 28 | 32 | 35 | 36 | 38 | 36 | 37 | 28 | 28 | 27 | 23 | SC | 22 |
| 22 | 17 | 14 | 8 | 7 | 12 | 3 | 3 | 3 | 7 | 16 | 29 | 33 | 36 | 37 | 38 | 40 | 37 | 37 | 34 | 31 | 30 | 27 | SC | 21 |
| 23 | 19 | 17 | 17 | 9 | 5 | 11 | 5 | 4 | 9 | 12 | 23 | 28 | 34 | 37 | 39 | 41 | 39 | 35 | 34 | 31 | 25 | 26 | SC | 23 |
| 24 | 22 | 21 | 21 | 17 | 9 | 7 | 5 | 4 | 7 | 17 | 26 | 33 | 36 | 38 | 40 | 40 | 37 | 38 | 33 | 31 | 31 | 31 | SC | 13 |
| 25 | 9 | 11 | 11 | 12 | 10 | 6 | 5 | 4 | 10 | 15 | 23 | 28 | ZS | 36 | 37 | 38 | 38 | 36 | 35 | 33 | 32 | 32 | SC | 30 |
| 26 | 16 | 19 | 13 | 15 | 18 | 23 | 16 | 8 | 12 | 20 | 29 | 36 | 39 | 40 | 40 | 39 | 35 | 38 | 37 | 30 | 28 | 22 | SC | 25 |
| 27 | 21 | 18 | 17 | 19 | 20 | 17 | 18 | 19 | 14 | 20 | 33 | 38 | 37 | 40 | 40 | 40 | 38 | 35 | 33 | 30 | 29 | 27 | SC | 25 |
| 28 | 24 | 23 | 23 | 27 | 22 | 21 | 23 | 19 | 18 | 26 | 27 | 31 | 33 | 34 | 34 | 32 | 30 | 30 | 26 | 24 | 21 | 18 | SC | 23 |
| 29 | 27 | 31 | 30 | 29 | 27 | 14 | 11 | 20 | 36 | 38 | 39 | 43 | 45 | 41 | 40 | 39 | 37 | 34 | 39 | 32 | 28 | 22 | SC | 21 |
| 30 | 23 | 25 | 31 | 30 | 26 | 29 | 21 | 12 | 15 | 28 | 36 | 38 | 38 | 38 | 38 | 39 | 37 | 37 | 33 | 30 | 29 | 29 | SC | 12 |

Figure 6-8.   Monthly Data Grid

The monthly data grid is accessed by selecting the site, month, and a parameter in the data validation window and then by clicking on the "24x31" button. All records that were coded valid will display with the validated value for that hour and each record coded as invalid will display in red with the invalidation code that was used.

The following items should be checked when verifying the validation codes on the monthly data grid:
- Check for missing records (if a record is missing the last hour in the grid will be missing) and blank-fill if necessary.
- Verify that the correct validation code was applied.
- Verify that validation codes were applied to the correct hours as annotated on the stackplots.

- Verify that codes used for nightly calibration events are consistent with the previous month. The same codes should be used each month unless the program/event timing was changed.
- Verify that validation codes applied to issues that carried over from the previous month are consistent.
- Verify that parameters that should be validated versus coded as 'NA' are consistent with the previous month.

### 6.4.5 UPDATE DATA VALIDATION LOG

Once 3rd level validation is complete, the data validation log is updated with the date this step was completed as well as the initials of the data analyst/technician that performed this step in the validation process. If any corrections were made to the data, the data validation notes are updated accordingly.

## 6.5 FINAL VALIDATION PROCEDURES

Data for a site/month must be at Third Level validation before beginning Final validation.

### 6.5.1 REVIEW OF VALIDATED DATA

During the Final validation process, a review of all validated data is completed by the IMC Manager. This is accomplished by reviewing stackplots of the raw data overlaid with the validated data. These plots allow the IMC Manager to see the validated dataset as well as which data points were determined to be invalid. Plots are reviewed to verify that validation is complete and accurate. Any discrepancies found are thoroughly investigated and corrections are made if necessary. Notes from the data validation log are also reviewed during this process.

### 6.5.2 PLOT REVIEW

After all levels of validation are complete, and before data are considered final, a joint review of the validated data is held among IMC staff, field staff, and project participants such as the project manager or the client. An interactive Web interface or hard copy plots of data are used to review the data. In some cases, historical summaries and deviations from normal are reviewed to determine if all data fall within normal limits for the month in review. Other materials that are reviewed may include contour maps of the country, smoke plume maps, pollution maps, or multi-site plots that allow for a comparison of pollutants within a similar region. Any questionable periods of data discovered during the group plot review are thoroughly investigated and changes to data are made if warranted.

### 6.5.3 MAKING VALIDATION CODE CORRECTIONS AND COMPLETING FINAL VALIDATION

After the monthly plot review and after review of the validated stackplots and after problems have been resolved, necessary validation code changes are made in the database. To make validation code changes, the Data Validation data window is used, which displays a tabular data window of selected data. It provides a way to hand-enter and apply validation codes to selected data points within a window.

#### 6.5.3.1 Completing Final Validation

After making validation code changes, the following steps are taken to complete Final validation:

- The changed data are regenerated into a new stackplot data file to replace the old.
- The validated stackplots are again reviewed; changes are made if necessary and are entered into the database.
- The Data Validation Log entry for the site/month is updated with the Final validation date and initials of the IMC Manager.

After completing these steps, Final validation is complete and data are ready to be uploaded to AQS, included in data requests, and provided in monthly, quarterly, or annual data summary reports.

### 6.5.4  POST-FINAL VALIDATION PROCEDURES

If a validation error is found after the data are labeled as final, the following steps are taken:

- The necessary changes are made in the AQDBMS database.
- Changes made are logged within the database and reports are generated that list the corrections that were made.
- If the affected data have been submitted to the Environmental Protection Agency's (EPA) Air Quality System (AQS) database, they must be resubmitted.
- If the affected data have been submitted to other data depositories (e.g., CASTNET or other project-specific databases or Web sites), they must be resubmitted.

### 6.5.5  ANNUAL DATA REVIEW

Although preliminary and final validation occurs on a monthly basis, ARS believes an annual review of all data is critical to produce a quality final data set. This review includes a visual inspection of the data on annual time series plots, which can help identify areas where values may have shifted or drifted throughout the year. These shifts are not as obvious when reviewing data on a smaller time scale.

Another component of the annual data review involves comparing the year's concentrations to historical values from that station. Statistical computations such as the rolling mean and standard deviations from the mean are reviewed graphically. Values outside of historical ranges or visually anomalous are identified and are subjected to additional review in order to determine the cause of the deviation. All calibrations and on-site maintenance are reviewed in detail as well as synoptic meteorological conditions and data from nearby sites in order to determine if the deviation is real or due to atmospheric conditions for that year. If data are found to be unreasonable based on comparisons with these records, data will be invalidated and the validation codes in the AQDBMS updated to reflect this change. All changes to data are logged in a table within the AQDBMS and corrected values are uploaded to the AQS.

Figure 6-9 shows a rolling 28-day average of all hourly data and time stamps the average as time beginning. The dark gray lines represent the overall mean across all years (middle dark gray line) and ± 2 standard deviations (top and bottom dark gray lines). The light gray lines represent each year, with the red line highlighting the year in review. This product can be generated for any parameter from any station with multiple years highlighted or any single year highlighted in color.

Following the Annual Data Review, all data for the year are locked within the AQDBMS in order to ensure that changes to final validated data cannot be made inadvertently. Only the Database Administrator and IMC Manager have the ability to change validation codes once data have been locked. In addition, these changes

can only be made intentionally as the Database Administrator or IMC Manager must first unlock the data in order to make updates. This process ensures that the integrity of all final validation codes is maintained indefinitely.
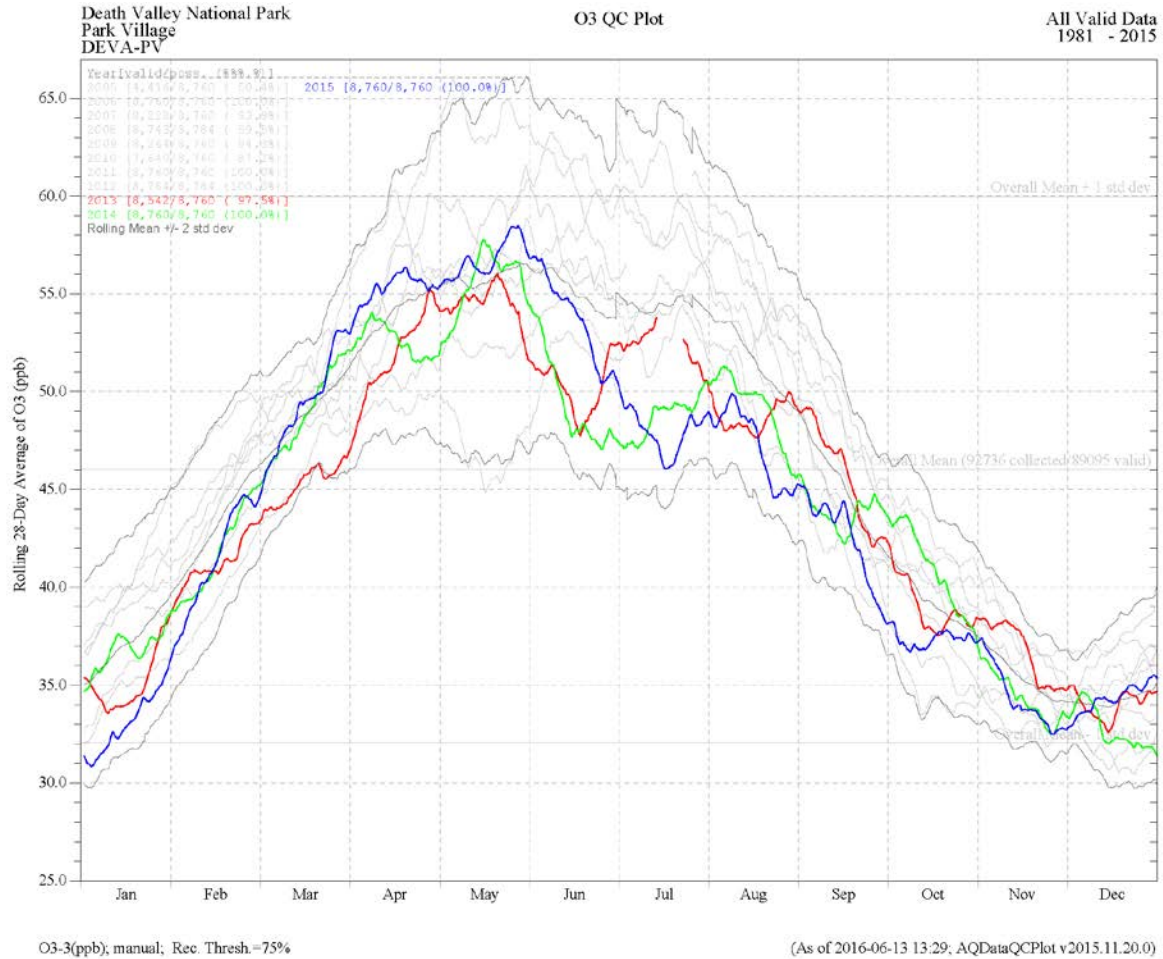


Figure 6-9. Example Historical Data Comparison Stackplot.

**7.0    REFERENCES**

Air Resource Specialists, Inc. (ARS), 2012, Air Quality Data Base Management System (AQDBMS) User's Guide.

**8.0    DEFINITIONS AND ACRONYMS**

| | |
|---|---|
| AQDB | Air Quality Database |
| AQDBMS | Air Quality Database Management System |
| AQS | Air Quality System |
| ARS | Air Resource Specialists |
| | |
| EPA | Environmental Protection Agency |
| IMC | Information Management Center |
| | |
| QA | Quality Assurance |
| QAPP | Quality Assurance Project Plan |
| QC | Quality Control |
| | |
| RH | Relative Humidity |
| SOP | Standard Operating Procedure |
| SSRF | Site Status Report Form |
| TCP/IP | Transmission Control Protocol/Internet Protocol |
| TOW | Technician of the Week |

**APPENDIX**

Analyst's Actions Based on Datalogger and Anomaly Screening Flags

Validation Codes

EPA Validation Acceptance Criteria (from EPA QA Handbook Vol. II, Appendix D. Rev. 1)

3rd Levels – Common Mistakes to Check For

Calibration Shapes

Items to Check for Evidence of Moisture in a BAM

Minute Trace Drop

Noise Example

Notes on NO, $NO_x$, $NO_2$ Data Validation

Min/Max Adjustments

Temperature Limits – Gas

Validation Acceptance Criteria by Project

Validation Rules by Parameter (Update flow)

Zero-Adjust Thresholds

Procedures for Zero Corrections of Data from non-Trace Analyzers

Procedures for Zero Corrections of Data from Trace Analyzers

Memorandum on Revision to the Zero Drift Acceptance Criteria in the QA Handbook

**Analyst's Actions Based on Datalogger and Anomaly Screening Flags**

| Flag | Type | Description | Action |
|---|---|---|---|
| - | Datalogger | Low alarm | Investigate |
| # | Datalogger | Insufficient data | Investigate |
| * | Datalogger | Out of calibration | Investigate |
| / | Datalogger | Rate-of-change alarm | Investigate |
| \ | Datalogger | Rate-of-change alarm | Investigate |
| ^ | Datalogger | High alarm | Investigate |
| _ | Datalogger | Low alarm | Investigate |
| < | Datalogger | Missing data | Invalidate with PF or RF |
| B | Datalogger | Bad status | Investigate |
| C | Datalogger | Calibration | Invalidate with ZS, PC, CA, SC, PA, or MT |
| D | Datalogger | Channel disabled/off-line | Investigate; can be valid or invalid |
| P | Datalogger | Power failure | Investigate; may be erroneous or true power failure |
| Z | Datalogger | Zero/span | Investigate |
| IM | Screening | Set in VWS, VWD, and SDWD when SWS < min. expected (NV) | Invalidate keeping IM |
| NR | Screening | Rate-of-change less than minimum value in the Screening Ranges Table | Investigate |
| NV | Screening | Less than minimum value in the Screening Ranges Table | Investigate |
| TH | Screening | Ozone data suspect when station temp is too high | Investigate |
| TL | Screening | Ozone data suspect when station temp too low | Investigate |
| VM | Screening | Valid but the validated value has been adjusted for the max value by the screening program based on the max adj, max adj to, and max val fields of the Screening Ranges Table | None |
| VZ | Screening | Valid but the validated value has been adjusted for zero by the screening program based on the zero adjustment value in the Screening Ranges Table | None |
| WS | Screening | Vector wind speed greater than Scalar wind speed – generated by the screening program | Invalidate VWS, VWD, SDWD with IM |
| XR | Screening program | Rate-of-change greater than the maximum value in the Screening Ranges Table | Investigate |
| XV | Screening program | Greater than the maximum value in the Screening Ranges Table | Investigate |

**Validation Codes**

| Code | Description |
|---|---|
| AB | Aberrant value |
| AP | Vandalism |
| BL | Value below limit |
| BM | Begin monitoring. For a new site or instrument, place in only one hour before valid data. |
| CA | Multipoint calibration of an AQ instrument, > 15 min/hour. |
| CR | Construction/repairs |
| EM | End monitoring. When a site or instrument is discontinued, place in only one hour after valid data. |
| IM | Instrument malfunction. Problem was not discovered until after data had been collected, instrument failure or other problem was not identified until the data validation occurred, may or may not be related to a problem listed on the status board. |
| IN | Acts of nature. |
| IW | Instrument warm-up. After the instrument was off or a power failure long enough to cause the instrument to go through a warm-up cycle. Some indicators: dpt > temp, noisy signal or drift shown on chart. Usually only used for 1 – 2 hours. |
| LI | Local interference. Human interference directly or indirectly that was local and not under the control of the operator. Examples: dust, particulates, construction. |
| MT | Maintenance. Someone on-site actively attempting repairs or doing preventive maintenance (changing chart paper, replacing instrument parts). Can be the site operator or repair person or remote activation or programming of the datalogger. |
| NA | Monitoring out for the month, before or after an analyzer is placed at a site, no intent of collecting data, unable to calculate value. |
| OE | Mistake by operator or anybody else at the station that leads to a loss in data. Example.: switches left in incorrect positions after repairs or calibrations, lines not returned to the manifold after an audit, open manifold ports, etc. |
| OR | Instrument in process of being repaired, often off-site. Incapable of getting good values, more than 1-hour of data, problem identified on site & status log or log book record would normally be present. MT must follow. Often a cal must follow. |
| OS | Signal is off the top of the chart, data are presumed good. |
| PA | Calibration on-site by an external agency person. May be several hours. (Gaseous parameters only.) |
| PC | Precision Check. Normally once per week. |
| PF | Power failure >15 minutes/hour, instrument warm-up and data loss at the top of the hour may also be an issue (RF). |
| PQ | Poor QA results |
| RF | Datalogger system fails and chart record is unavailable. |
| SA | External agency person on-site which leads to data loss (Met parameters only.) |
| SC | Use when both a precision check and a zero/span check are done within the same hour. |
| TH | Data invalid for ozone when station temp is ≥30.5ºC. |
| TL | Data invalid for ozone when station temperature < 19.5ºC. |
| TO | When time is off by more than 5 minutes. |
| V | Valid Value. |
| VA | Valid value, but the validated value has been adjusted from the raw value by the data analyst/technician. The control value field must contain the offset. |
| VM | Valid but the validated value has been adjusted for the max value by the analyst based on the parameter criteria. |
| VZ | Valid but the validated value has been adjusted for zero. |
| WD | Wildlife damage |
| ZS | Invalid data for the hour if zero/span takes longer than 15 minutes or the hour. |

# EPA Validation Acceptance Criteria
## (from EPA QA Handbook Vol. II, Appendix D. Rev. 1)

### Ozone Validation Template

| 1) Requirement (O₃) | 2) Frequency | 3) Acceptance Criteria | Information /Action |
|---|---|---|---|
| **CRITICAL CRITERIA-OZONE** | | | |
| *Monitor* | NA | *Meets requirements listed in FRM/FEM designation* | 1) 40 CFR Part 58 App C Sec. 2.1<br>2) NA<br>3) 40 CFR Part 53 & FRM/FEM method list |
| *One Point QC Check Single analyzer* | *Every 14 days* | $< \pm 7.1\%$ (percent difference) or $< \pm 1.5$ ppb difference whichever is greater | 1 and 2) 40 CFR Part 58 App A Sec. 3.1<br>3) Recommendation based on DQO in 40 CFR Part 58 App A Sec. 2.3.1.2. QC Check Conc range 0.005 - 0.08 ppm and 05/05/2016 Technical Note on AMTIC |
| Zero/span check | Every 14 days | Zero drift $< \pm 3.1$ ppb (24 hr)<br>$< \pm 5.1$ ppb (>24hr-14 day)<br>Span drift $< \pm 7.1$ % | 1 and 2) QA Handbook Volume 2 Sec. 12.3<br>3) Recommendation and related to DQO |
| **OPERATIONAL CRITERIA -OZONE** | | | |
| Shelter Temperature Range | Daily (hourly values) | 20.0 to 30.0º C. (Hourly avg)<br>or<br>per manufacturers specifications if designated to a wider temperature range | 1, 2 and 3) QA Handbook Volume 2 Sec. 7.2.2<br><br>Generally, the 20-30.0º C range will apply but the most restrictive operable range of the instruments in the shelter may also be used as guidance. FRM/FEM list found on AMTIC provides temp. range for given instrument. FRM/FEM monitor testing is required at 20-30º C range per 40 CFR Part 53.32 |
| Shelter Temperature Control | Daily (hourly values) | $< 2.1º$ C SD over 24 hours | 1, 2 and 3) QA Handbook Volume 2 Sec. 7.2.2 |
| Shelter Temperature Device Check | Every 182 days and 2/ calendar year | $< \pm 2.1º$ C of standard | 1, 2 and 3) QA Handbook Volume 2 Sec. 7.2.2 |
| *Annual Performance Evaluation Single analyzer* | *Every site every 365 days and 1/ calendar year within period of monitor operation,* | Percent difference of audit levels 3-10 $< \pm 15.1\%$<br>Audit levels 1&2 $< \pm 1.5$ ppb difference or $< \pm 15.1\%$ | 1 and 2) 40 CFR Part 58 App A Sec. 3.1.2<br>3) Recommendation- 3 audit concentrations not including zero. AMTIC guidance 2/17/2011<br>AMTIC Technical Memo |
| *Federal Audits (NPAP)* | *20% of sites audited in calendar year* | Audit levels 1&2 $< \pm 1.5$ ppb difference all other levels percent difference $< \pm 10.1\%$ | 1 and 2) 40 CFR Part 58 App A Sec. 3.1.3<br>3) NPAP QAPP/SOP |
| **Verification/Calibration** | Upon receipt/adjustment/repair/ installation/moving and repair and recalibration of standard of higher level<br>Every 182 day and 2/ calendar year if manual zero/span performed biweekly<br>Every 365 day and 1/ calendar year if continuous zero/span performed daily | All points $< \pm 2.1$ % or $< \pm 1.5$ ppb difference of best-fit straight line whichever is greater and Slope 1 $\pm$ .05 | 1) 40 CFR Part 50 App D<br>2) Recommendation<br>3) 40 CFR Part 50 App D Sec 4.5.5.6<br><br>Multi-point calibration (0 and 4 upscale points)<br><br>Slope criteria is a recommendation |
| *Zero Air/Zero Air Check* | Every 365 days and 1/calendar year | Concentrations below LDL | 1) 40 CFR Part 50 App D Sec. 4.1<br>2 and 3) Recommendation |
| **Ozone Level 2 Standard** | | | |

| 1) Requirement (O$_3$) | 2) Frequency | 3) Acceptance Criteria | Information /Action |
|---|---|---|---|
| *Certification/recertification to Standard Reference Photometer (Level 1)* | Every 365 days and 1/calendar year | single point difference $< \pm$ 3.1% | 1) 40 CFR Part 50 App D Sec. 5.4<br>2 and 3) Transfer Standard Guidance EPA-454/B-10-001<br><br>Level 2 standard (formerly called primary standard) usually transported to EPA Regions SRP for comparison |
| *Level 2 and Greater Transfer Standard Precision* | Every 365 days and 1/calendar year | *Standard Deviation less than 0.005 ppm or 3.0% whichever is greater* | 1) 40 CFR Part 50 Appendix D Sec. 3.1<br>2) Recommendation, part of reverification<br>3) 40 CFR Part 50 Appendix D Sec. 3.1 |
| (if recertified via a transfer standard) | Every 365 days and 1/calendar year | Regression slopes = 1.00 $\pm$ 0.03 and two intercepts are 0 $\pm$ 3 ppb | 1, 2 and 3) Transfer Standard Guidance EPA-545/B-10-001 |
| **Ozone Transfer standard (Level 3 and greater)** | | | |
| Qualification | Upon receipt of transfer standard | $< \pm$4.1% or $< \pm$4 ppb (whichever greater) | 1, 2 and 3) Transfer Standard Guidance EPA-545/B-10-001 |
| Certification | After qualification and upon receipt/adjustment/repair | RSD of six slopes $\leq$ 3.7%<br>Std. Dev. of 6 intercepts $\leq$ 1.5 | 1, 2 and 3) Transfer Standard Guidance EPA-545/B-10-001 1 |
| Recertification to higher level standard | Beginning and end of O3 season or every 182 days and 2/calendar year whichever less | New slope = $\pm$ 0.05 of previous and RSD of six slopes $\leq$3.7%<br>Std. Dev. of 6 intercepts $\leq$ 1.5 | 1, 2 and 3) Transfer Standard Guidance EPA-545/B-10-001 recertification test that then gets added to most recent 5 tests. If does not meet acceptability certification fails |
| **Detection (FEM/FRMs)** Noise and Lower Detectable Limits (LDL) are part of the FEM/FRM requirements. It is recommended that monitoring organizations perform the LDL test to minimally confirm and establish the LDL of their monitor. Performing the LDL test will provide the noise information. | | | |
| *Noise* | Every 365 days and 1/ calendar year | $\leq$ *0.0025 ppm (standard range)*<br>$\leq$ *0.001 ppm (lower range)* | 1) 40 CFR Part 53.23 (b) (definition & procedure)<br>2) Recommendation- info can be obtained from LDL<br>3) 40 CFR Part 53.20 Table B-1 |
| *Lower detectable limit* | Every 365 days and 1/calendar year | $\leq$ *0.005 ppm (standard range)*<br>$\leq$ *0.002 ppm (lower range)* | 1) 40 CFR Part 53.23 (b) (definition & procedure)<br>2) Recommendation<br>3) 40 CFR Part 53.20 Table B-1 |

# CO Validation Template

| 1) Requirement (CO) | 2) Frequency | 3) Acceptance Criteria | Information /Action |
|---|---|---|---|
| **CRITICAL CRITERIA-CO** | | | |
| *Sampler/Monitor* | NA | *Meets requirements listed in FRM/FEM designation* | 1) 40 CFR Part 58 App C Sec. 2.1<br>2) NA<br>3) 40 CFR Part 53 & FRM/FEM method list |
| *One Point QC Check Single analyzer* | *Every 14 days* | < ±10.1% (percent difference) | 1 and 2) 40 CFR Part 58 App A Sec. 3.1.1<br>3) Recommendation based on DQO in 40 CFR Part 58 App A Sec. 2.3.1. QC Check Conc range 0.5 – 5 ppm |
| Zero/span check | Every 14 days | Zero drift < ± 0.41 ppm (24 hr)<br>< ± 0.61 ppm (>24hr-14 day)<br>Span drift < ± 10.1 % | 1 and 2) QA Handbook Volume 2 Sec. 12.3<br>3) Recommendation |
| **OPERATIONAL CRITERIA-CO** | | | |
| Shelter Temperature range | Daily<br>(hourly values) | 20.0 to 30.0º C. (Hourly avg)<br>or<br>per manufacturers specifications if designated to a wider temperature range | 1, 2 and 3) QA Handbook Volume 2 Sec. 7.2.2<br><br>Generally, the 20-30.0 º C range will apply but the most restrictive operable range of the instruments in the shelter may also be used as guidance. FRM/FEM list found on AMTIC provides temp. range for given instrument. FRM/FEM monitor testing is required at 20-30 º C range per 40 CFR Part 53.32 |
| Shelter Temperature Control | Daily (hourly values) | < 2.1º C SD over 24 hours | 1, 2 and 3) QA Handbook Volume 2 Sec. 7.2.2 |
| Shelter Temperature Device Check | Every 182 days and 2/ calendar year | < ± 2.1º C of standard | 1, 2 and 3) QA Handbook Volume 2 Sec. 7.2.2 |
| *Annual Performance Evaluation Single Analyzer* | *Every site every 365 days and 1/ calendar year* | Percent difference of audit levels 3-10 < ±15.1%<br>Audit levels 1&2 < ± 0.031 ppm difference or < ±15.1% | 1 and 2) 40 CFR Part 58 App A Sec. 3.1.2<br>3) Recommendation- 3 audit concentrations not including zero. AMTIC Technical Memo |
| *Federal Audits (NPAP)* | *20% of sites audited in a calendar year* | Audit levels 1&2 < ± 0.031 ppm difference all other levels percent difference < ± 15.1% | 1 and 2) 40 CFR Part 58 App A Sec. 3.1.3<br>3) NPAP QAPP/SOP |
| *Verification/Calibration* | Upon receipt/adjustment/repair/ installation/moving<br>Every 182 day and 2/ calendar year if manual zero/span performed biweekly<br>Every 365 days and 1/ calendar year if continuous zero/span performed daily | All points < ± 2.1 % or < ± 0.03 ppm difference of best-fit straight line. whichever is greater and Slope 1 ± .05 | 1) 40 CFR Part 50 Appendix C Sec. 4<br>2 and 3) Recommendation<br><br>See details about CO2 sensitive instruments Multi-point calibration (0 and 4 upscale points)<br><br>Slope criteria is a recommendation |
| | | | |

| 1) Requirement (CO) | 2) Frequency | 3) Acceptance Criteria | Information /Action |
|---|---|---|---|
| *Gaseous Standards* | All gas cylinders | **NIST Traceable**<br>(e.g., EPA Protocol Gas) | 1) 40 CFR Part 50 Appendix C Sec. 4.3.1<br>2) NA Green Book<br>3) 40 CFR Part 50 Appendix C Sec. 4.3.1 See details about CO2 sensitive instruments<br>Gas producer used must participate in EPA Ambient Air Protocol Gas Verification Program<br>40 CFR Part 58 App A Sec. 2.6.1 |
| *Zero Air/Zero Air Check* | Every 365 days and 1/ calendar year | *< 0.1 ppm CO* | 1) 40 CFR Part 50 App C Sec. 4.3.2<br>2) Recommendation<br>3) 40 CFR Part 50 App C Sec. 4.3.2 |
| Gas Dilution Systems | Every 365 days and 1/ calendar year or after failure of 1 point QC check or performance evaluation | Accuracy < $\pm$ 2.1 % | 1, 2 and 3) Recommendation based on SO2 requirement in 40 CFR Part 50 App A-1 Sec. 4.1.2 |
| **Detection (FEM/FRMs)** Noise and Lower Detectable Limits (LDL) are part of the FEM/FRM requirements. It is recommended that monitoring organizations perform the LDL test to minimally confirm and establish the LDL of their monitor. Performing the LDL test will provide the noise information. | | | |
| *Noise* | Every 365 days and 1/ calendar year | $\leq$ *0.2 ppm (standard range)*<br>$\leq$ *0.1 ppm (lower range)* | 1) 40 CFR Part 53.23 (b) (definition & procedure)<br>2) Recommendation- info can be obtained from LDL<br>3) 40 CFR Part 53.20 Table B-1 |
| *Lower detectable level* | Every 365 days and 1/ calendar year | $\leq$ *0.4 ppm (standard range)*<br>$\leq$ *0.2 ppm (lower range)* | 1) 40 CFR Part 53.23 (c) (definition & procedure)<br>2) Recommendation<br>3) 40 CFR Part 53.20 Table B-1 |

# NO₂, NOx, NO Validation Template

| 1) Requirement (NO₂) | 2) Frequency | 3) Acceptance Criteria | Information /Action |
|---|---|---|---|
| **CRITICAL CRITERIA- NO₂** | | | |
| | | | |
| *Sampler/Monitor* | *NA* | *Meets requirements listed in FRM/FEM designation* | 1) 40 CFR Part 58 App C Sec. 2.1<br>2) NA<br>3) 40 CFR Part 53 & FRM/FEM method list |
| *One Point QC Check Single analyzer* | *Every 14 days* | < ±15.1% (percent difference) or < ± 1.5 ppb difference whichever is greater | 1 and 2) 40 CFR Part 58 App A Sec. 3.1.1<br>3) Recommendation based on DQO in 40 CFR Part 58 App A Sec. 2.3.1.5 QC Check Conc range 0.005 - 0.08 ppm and 05/05/2016 Technical Note on AMTIC |
| Zero/span check | Every 14 days | Zero drift < ± 3.1 ppb (24 hr)<br>< ± 5.1 ppb (>24hr-14 day)<br>Span drift < + 10.1 % | 1 and 2) QA Handbook Volume 2 Sec. 12.3<br>3) Recommendation and related to DQO |
| *Converter Efficiency* | During multi-point calibrations, span and audit<br>Every 14 days | *(≥96%)*<br>96% – 104.1% | 1) 40 CFR Part 50 App F Sec. 1.5.10 and 2.4.10<br>2) Recommendation<br>3) 40 CFR Part 50 App F Sec. 1.5.10 and 2.4.10 Regulation states ≥ 96%, 96 – 104.1% is a recommendation. |
| **OPERATIONAL CRITERIA- NO₂** | | | |
| Shelter Temperature Range | Daily<br>(hourly values) | 20.0 to 30.0º C. (Hourly avg)<br>or<br>per manufacturers specifications if designated to a wider temperature range | 1, 2 and 3) QA Handbook Volume 2 Sec. 7.2.2<br><br>Generally, the 20-30.0 º C range will apply but the most restrictive operable range of the instruments in the shelter may also be used as guidance. FRM/FEM list found on AMTIC provides temp. range for given instrument. FRM/FEM monitor testing is required at 20-30 º C range per 40 CFR Part 53.32 |
| Shelter Temperature Control | Daily (hourly values) | < 2.1º C SD over 24 hours | 1, 2 and 3) QA Handbook Volume 2 Sec. 7.2.2 |
| Shelter Temperature Device Check | every 182 days and 2/calendar year | < ± 2.1º C of standard | 1, 2 and 3) QA Handbook Volume 2 Sec. 7.2.2 |
| *Annual Performance Evaluation Single Analyzer* | *Every site every 365 days and 1/ calendar year* | Percent difference of audit levels 3-10 < ±15.1%<br>Audit levels 1&2 < ± 1.5 ppb difference or < ±15.1% | 1) 40 CFR Part 58 App A Sec. 3.1.2<br>2) 40 CFR Part 58 App A Sec. 3.1.2<br>3) Recommendation - 3 audit concentrations not including zero. AMTIC Technical Memo |
| *Federal Audits (NPAP)* | 20% of sites audited in calendar year | Audit levels 1&2 < ± 1.5 ppb difference all other levels percent difference < ± 15.1% | 1 & 2) 40 CFR Part 58 App A Sec. 3.1.3<br>3) NPAP QAPP/SOP |

| 1) Requirement (NO$_2$) | 2) Frequency | 3) Acceptance Criteria | Information /Action |
|---|---|---|---|
| *Verification/Calibration* | Upon receipt/adjustment/repair/ installation/moving<br>Every 182 day and 2/ calendar year if manual zero/span performed biweekly<br>Every 365 day and 1/ calendar year if continuous zero/span performed daily | Instrument residence time $\leq$ 2 min<br>Dynamic parameter $\geq$ 2.75 ppm-min<br>All points $<\pm$ 2.1 % or $\leq\pm$ 1.5 ppb difference of best-fit straight line whichever is greater and Slope 1 $\pm$ .05 | 1) 40 CFR Part 50 App F<br>2 and 3) Recommendation<br><br>Multi-point calibration (0 and 4 upscale points)<br><br>Slope criteria is a recommendation |
| *Gaseous Standards* | All gas cylinders | **NIST Traceable**<br>(e.g., EPA Protocol Gas)<br>50-100 ppm of NO in Nitrogen with < 1 ppm NO$_2$ | 1) 40 CFR Part 50 App F Sec. 1.3.1<br>2) NA Green Book<br>3) 40 CFR Part 50 App F Sec. 1.3.1. A technical memo may change the concentration requirement.<br><br>Gas producer used must participate in EPA Ambient Air Protocol Gas Verification Program 40 CFR Part 58 App A Sec. 2.6.1 |
| *Zero Air/ Zero Air Check* | Every 365 days and 1/ calendar year | Concentrations below LDL | 1) 40 CFR Part 50 App F Sec. 1.3.2<br>2 and 3) Recommendation |
| Gas Dilution Systems | Every 365 days and 1/ calendar year or after failure of 1 point QC check or performance evaluation | Accuracy < $\pm$ 2.1 % | 1, 2 and 3) Recommendation based on SO2 requirement in 40 CFR Part 50 App A-1 Sec. 4.1.2 |
| **Detection (FEM/FRMs)** Noise and Lower Detectable Limits (LDL) are part of the FEM/FRM requirements. It is recommended that monitoring organizations perform the LDL test to minimally confirm and establish the LDL of their monitor. Performing the LDL test will provide the noise information. | | | |
| *Noise* | Every 365 days and 1/ calendar year | *$\leq$ 0.005 ppm* | 1) 40 CFR Part 53.23 (b) (definition & procedure)<br>2) Recommendation- info can be obtained from LDL<br>3) 40 CFR Part 53.20 Table B-1 |
| *Lower detectable level* | Every 365 days and 1/ calendar year | *$\leq$ 0.01 ppm* | 1) 40 CFR Part 53.23 (c) (definition & procedure)<br>2) Recommendation<br>3) 40 CFR Part 53.20 Table B-1 |

# SO₂ Validation Template

| 1) Requirement (SO₂) | 2) Frequency | 3) Acceptance Criteria | Information /Action |
|---|---|---|---|
| **CRITICAL CRITERIA- SO₂** | | | |
| *Sampler/Monitor* | NA | *Meets requirements listed in FRM/FEM designation* | 1) 40 CFR Part 58 App C Sec. 2.1 2) NA<br>3) 40 CFR Part 53 & FRM/FEM method list |
| *One Point QC Check Single analyzer* | *Every 14 days* | < +10.1% (percent difference) or < + 1.5 ppb difference whichever is greater | 1 and 2) 40 CFR Part 58 App A Sec. 3.1.1<br>3) Recommendation based on DQO in 40 CFR Part 58 App A Sec. 2.3.1.2 QC Check Conc range 0.005 - 0.08 ppm and 05/05/2016 Technical Note on AMTIC |
| Zero/span check | Every 14 days | Zero drift < + 3.1 ppb (24 hr)<br>< + 5.1 ppb (>24hr-14 day)<br>Span drift < + 10.1 % | 1 and 2) QA Handbook Volume 2 Sec. 12.3<br>3) Recommendation and related to DQO |
| **OPERATIONAL CRITERIA- SO₂** | | | |
| Shelter Temperature Range | Daily<br>(hourly values) | 20.0 to 30.0º C. (Hourly avg)<br>or<br>per manufacturers specifications if designated to a wider temperature range | 1, 2 and 3) QA Handbook Volume 2 Sec. 7.2.2<br><br>Generally, the 20-30.0 º C range will apply but the most restrictive operable range of the instruments in the shelter may also be used as guidance. FRM/FEM list found on AMTIC provides temp. range for given instrument. FRM/FEM monitor testing is required at 20-30 º C range per 40 CFR Part 53.32 |
| Shelter Temperature Control | Daily (hourly values) | < 2.1º C SD over 24 hours | 1, 2 and 3) QA Handbook Volume 2 Sec. 7.2.2 |
| Shelter Temperature Device Check | every 180 days and 2/calendar year | < + 2.1º C of standard | 1, 2 and 3) QA Handbook Volume 2 Sec. 7.2.2 |
| *Annual Performance Evaluation Single Analyzer* | *Every site every 365 days and 1/ calendar year* | Percent difference of audit levels 3-10 < +15.1%<br>Audit levels 1&2 < + 1.5 ppb difference or < +15.1% | 1 and 2) 40 CFR Part 58 App A Sec. 3.1.2<br>3) Recommendation - 3 audit concentrations not including zero. AMTIC Technical Memo |
| *Federal Audits (NPAP)* | 20% of sites audited in calendar year | Audit levels 1&2 < + 1.5 ppb difference all other levels percent difference < + 15.1% | 1&2) 40 CFR Part 58 App A Sec. 3.1.3<br>3) NPAP QAPP/SOP |
| *Verification/Calibration* | Upon receipt/adjustment/repair/ installation/moving<br>Every 182 day and 2/ calendar year if manual zero/span performed biweekly<br>Every 365 day and 1/ calendar year if continuous zero/span performed daily | All points < + 2.1 % or < + 1.5 ppb difference of best-fit straight line whichever is greater and Slope 1 + .05 | 1) 40 CFR Part 50 App A-1 Sec. 4<br>2 and 3) Recommendation<br><br>Multi-point calibration (0 and 4 upscale points)<br><br>Slope criteria is a recommendation |
| *Gaseous Standards* | *All gas cylinders* | *NIST Traceable*<br>*(e.g., EPA Protocol Gas)* | 1) 40 CFR Part 50 App A-1 Sec. 4.1.6.1<br>2) NA Green Book<br>3) 40 CFR Part 50 App F Sec. 1.3.1<br>Producers must participate in Ambient Air Protocol Gas |

| 1) Requirement (SO₂) | 2) Frequency | 3) Acceptance Criteria | Information /Action |
|---|---|---|---|
| | | | Verification Program 40 CFR Part 58 App A Sec. 2.6.1 |
| *Zero Air/ Zero Air Check* | Every 365 days and 1/ calendar year | Concentrations below LDL < 0.1 ppm aromatic hydrocarbons | 1) 40 CFR Part 50 App A-1 Sec. 4.1.6.2 2) Recommendation 3) Recommendation and 40 CFR Part 50 App A-1 Sec. 4.1.6.2 |
| *Gas Dilution Systems* | Every 365 days and 1/ calendar year or after failure of 1point QC check or performance evaluation | *Accuracy < ± 2.1 %* | 1) 40 CFR Part 50 App A-1Sec. 4.1.2 2) Recommendation 3) 40 CFR Part 50 App A-1 Sec. 4.1.2 |
| **Detection (FEM/FRMs)** Noise and Lower Detectable Limits (LDL) are part of the FEM/FRM requirements. It is recommended that monitoring organizations perform the LDL test to minimally confirm and establish the LDL of their monitor. Performing the LDL test will provide the noise information. | | | |
| *Noise* | Every 365 days and 1/ calendar year | *≤ 0.001 ppm (standard range)* *≤ 0.0005 ppm (lower range)* | 1) 40 CFR Part 53.23 (b) (definition & procedure) 2) Recommendation- info can be obtained from LDL 3) 40 CFR Part 53.20 Table B-1 |
| *Lower detectable level* | Every 365 days and 1/ calendar year | *≤ 0.002 ppm (standard range)* *≤ 0.001 ppm (lower range)* | 1) 40 CFR Part 53.23 (c) (definition & procedure) 2) Recommendation 3) 40 CFR Part 53.20 Table B-1 |

# PM$_{2.5}$ Filter Based Local Conditions Validation Template

| 1) Criteria (PM2.5 LC) | 2) Frequency | 3) Acceptable Range | Information /Action |
|---|---|---|---|
| **CRITICAL CRITERIA- PM$_{2.5}$ Filter Based Local Conditions** | | | |
| **Field Activities** | | | |
| ***Sampler/Monitor*** | NA | ***Meets requirements listed in FRM/FEM/ARM designation*** | 1) 40 CFR Part 58 App C Sec. 2.1<br>2) NA<br>3) 40 CFR Part 53 & FRM/FEM method list |
| **Filter Holding Times** | | | |
| ***Pre-sampling*** | ***all filters*** | ***< 30 days before sampling*** | 1, 2 and 3) 40 CFR Part 50, App. L Sec. 8.3.5 |
| ***Sample Recovery*** | ***all filters*** | ***< 7 days 9 hours from sample end date*** | 1, 2 and 3) 40 CFR Part 50, App. L 10.10 |
| ***Sampling Period (including multiple power failures)*** | ***all filters*** | ***1380-1500 minutes, or<br>if value < 1380 and exceedance of NAAQS [1]<br>midnight to midnight local standard time*** | 1, 2 and 3) 40 CFR Part 50 App L Sec. 3.3 and 40 CFR Part 50 App N Sec. 1 for the midnight to midnight local standard time requirement<br><br>See details if less than 1380 min sampled |
| **Sampling Instrument** | | | |
| ***Average Flow Rate*** | ***every 24 hours of op*** | ***average within 5% of 16.67 liters/minute*** | 1, 2 and 3) Part 50 App L Sec. 7.4.3.1 |
| ***Variability in Flow Rate*** | ***every 24 hours of op*** | ***CV < 2%*** | 1, 2 and 3) 40 CFR Part 50, App L Sec. 7.4.3.2 |
| ***One-point Flow Rate Verification*** | ***every 30 days each separated by 14 days*** | ***< ± 4.1% of transfer standard<br>< ± 5.1% of flow rate design value*** | 1, 2 and 3) 40 CFR Part 50, App L, Sec. 9.2.5 and 7.4.3.1 and 40 CFR Part 58, Appendix A Sec. 3.2.1 |
| ***Design Flow Rate Adjustment*** | ***After multi-point calibration or verification*** | ***< ± 2.1% of design flow rate*** | 1, 2 and 3) 40 CFR Part 50, App. L, Sec. 9.2.6 |
| ***Individual Flow Rates*** | ***every 24 hours of op*** | ***no flow rate excursions > ±5% for > 5 min. [1]*** | 1, 2 and 3) 40 CFR Part 50, App. L Sec. 7.4.3.1 |
| ***Filter Temp Sensor*** | ***every 24 hours of op*** | ***no excursions of > 5º C lasting longer than 30 min [1]*** | 1, 2 and 3) 40 CFR Part 50, App. L Sec. 7.4.11.4 |
| ***External Leak Check*** | ***Before each flow rate verification/calibration* and before and after PM$_{2.5}$ separator maintenance** | ***< 80.1 mL/min*** (see comment #1) | 1) 40 CFR Part 50 App L, Sec. 7.4.6.1<br>2) 40 CFR Part 50 App L Sec. 9.2.3 and Method 2-12 Sec. 7.4.3<br>3) 40 CFR Part 50, App. L, Sec. 7.4.6.1 |
| ***Internal Leak Check*** | If failure of external leak check | ***< 80.1 mL/min*** | 1) 40 CFR Part 50, App. L, Sec. 7.4.6.2<br>2) Method 2-12, Sec. 7.4.4<br>3) 40 CFR Part 50, App. L, Sec. 7.4.6.2 |

| | Laboratory Activities | | | |
|---|---|---|---|---|
| **1) Criteria (PM2.5 LC)** | **2) Frequency** | **3) Acceptable Range** | | **Information /Action** |
| *Post-sampling Weighing* | *all filters* | *Protected from exposure to temperatures above 25C from sample retrieval to conditioning*<br><br>*≤10 days from sample end date if shipped at ambient temp, or*<br>*≤ 30 days if shipped below avg ambient (or 4º C or below for avg sampling temps < 4º C ) from sample end date* | | 1, 2 and 3) 40 CFR Part 50 App L Sec. 8.3.6 and L Sec. 10.13.<br><br>See technical note on holding time requirements at :<br>https://www3.epa.gov/ttn/amtic/pmpolgud.html |
| *Filter Visual Defect Check (unexposed)* | *all filters* | *Correct type & size and for pinholes, particles or imperfections* | | 1, 2 and 3) 40 CFR Part 50, App. L Sec. 10.2 |
| Filter Conditioning Environment | | | | |
| *Equilibration* | *all filters* | *24 hours minimum* | | 1, 2 and 3) 40 CFR Part 50, App. L Sec. 8.2.5 |
| *Temp. Range* | *all filters* | *24-hr mean 20.0-23.0º C* | | 1, 2 and 3) 40 CFR Part 50, App. L Sec. 8.2.1 |
| *Temp. Control* | *all filters* | *< 2.1º C SD\* over 24 hr.* | | 1, 2 and 3) 40 CFR Part 50, App. L Sec. 8.2.2 SD use is a recommendation |
| *Humidity Range* | *all filters* | *24-hr mean 30.0% - 40.0% RH or*<br>*Within ±5.0 % sampling RH but ≥ 20.0%RH* | | 1, 2 and 3) 40 CFR Part 50, App. L Sec. 8.2.3 |
| *Humidity Control* | *all filters* | *< 5.1 % SD\* over 24 hr.* | | 1, 2 and 3) 40 CFR Part 50, App. L Sec. 8.2.4 SD use is recommendation |
| *Pre/post Sampling RH* | *all filters* | *difference in 24-hr means < ± 5.1% RH* | | 1, 2 and 3) 40 CFR Part 50, App. L Sec. 8.3.3 |
| *Balance* | *all filters* | *located in filter conditioning environment* | | 1, 2 and 3) 40 CFR Part 50, App. L Sec. 8.3.2 |
| *Microbalance Auto-Calibration* | *Prior to each weighing session* | Manufacturer's specification | | 1) 40 CFR Part 50, App. L, Sec. 8.1<br>2) 40 CFR Part 50, App. L, Sec. 8.1 and Method 2.12 Sec. 10.6<br>3) NA |
| | **OPERATIONAL EVALUATIONS TABLE PM$_{2.5}$ Filter Based Local Conditions** | | | |
| | **Field Activities** | | | |
| *One-point Temp Verification* | every 30 days | < ± 2.1ºC | | 1) 40 CFR Part 50, App. L, Sec. 9.3<br>2) Method 2.12 Sec. 7.4.5 and Table 6-1<br>3) Recommendation |
| *Pressure Verification* | every 30 days | < ± 10.1 mm Hg | | 1) 40 CFR Part 50, App. L, Sec. 9.3<br>2) Method 2.12 Sec. 7.4.6 and Table 6-1<br>3) Recommendation |
| **Annual Multi-point Verifications/Calibrations** | | | | |
| *Temperature multi-point Verification/Calibration* | on installation, then every 365 days and once a calendar year | < ± 2.1ºC | | 1) 40 CFR Part 50, App. L, Sec. 9.3<br>2 and 3) Method 2.12 Sec. 6.4.4 Table 6-1 |

| 1) Criteria (PM2.5 LC) | 2) Frequency | 3) Acceptable Range | Information /Action |
|---|---|---|---|
| *Pressure Verification/Calibration* | on installation, and on one-point verification failure | < $\pm$ 10.1 mm Hg | 1) 40 CFR Part 50, App. L, Sec. 9.3<br>2 and 3) Method 2.12 Sec. 6.5<br>Sampler BP verified against independent standard verified against a lab primary standard that is certified as NIST traceable 1/year |
| *Flow Rate Multi-point Verification/ Calibration* | *Electromechanical maintenance or transport* or every 365 days and once a calendar year | < $\pm$ 2.1% of transfer standard | 1) 40 CFR Part 50, App. L, Sec. 9.2.<br>2) 40 CFR Part 50, App. L, Sec. 9.1.3, Method 2.12 Sec. 6.3 & Table 6-1<br>3) Recommendation |
| Other Monitor Calibrations | per manufacturers' op manual | per manufacturers' operating manual | 1, 2 and 3) Recommendation |
| **Precision** | | | |
| *Collocated Samples* | *every 12 days for 15% of sites by method designation* | CV < 10.1% of samples $\geq$ 3.0 µg/m$^3$ | 1) and 2) Part 58 App A Sec. 3.2.3<br>3 Recommendation based on DQO in 40 CFR Part 58 App A Sec. 2.3.1.1 |
| **Accuracy** | | | |
| Temperature Audit | every 180 days and at time of flow rate audit | < $\pm$ 2.1ºC | 1, 2 and 3) Method 2.12 Sec. 11.2.2 |
| Pressure Audit | every 180 days and at time of flow rate audit | < $\pm$10.1 mm Hg | 1, 2 and 3) Method 2.12 Sec. 11.2.3 |
| *Semi Annual Flow Rate Audit* | *Twice a calendar year and between 5-7 months apart* | < $\pm$ 4.1% of audit standard<br>< $\pm$ 5.1% of design flow rate | 1 and 2) Part 58, App A, Sec. 3.2.2<br>3) Method 2.12 Sec. 11.2.1 |
| **Monitor Maintenance** | | | |
| PM$_{2.5}$ Separator (WINs) | every 5 sampling events | cleaned/changed | 1, 2, and 3) Method 2.12 Sec. 8.2.2 |
| PM$_{2.5}$ Separator (VSCC) | every 30 days | cleaned/changed | 1, 2 and 3) Method 2.12 Sec. 8.3.3 |
| Inlet Cleaning | every 30 days | cleaned | 1, 2 and 3) Method 2.12 Sec. 8.3 |
| Downtube Cleaning | every 90 days | cleaned | 1, 2 and 3) Method 2.12 Sec. 8.4 |
| Filter Housing Assembly Cleaning | every 30 days | cleaned | 1, 2 and 3) Method 2.12 Sec. 8.3 |
| Circulating Fan Filter Cleaning | every 30 days | cleaned/changed | 1, 2 and 3) Method 2.12 Sec. 8.3 |
| Manufacturer-Recommended Maintenance | per manufacturers' SOP | per manufacturers' SOP | |
| **Laboratory Activities** | | | |
| **Filter Checks** | | | |
| Lot Blanks | 9 filters per lot | < $\pm$15.1 µg change between weighings | 1, 2, 3) Recommendation and used to determine filter stability of the lot of filters received from EPA or vendor. Method 2.12 Sec. 10.5 |
| Exposure Lot Blanks | 3 filters per lot | < $\pm$15.1 µg change between weighings | 1, 2 and 3) Method 2.12 Sec. 10.5<br>Used for preparing a subset of filters for equilibration |
| Filter Integrity (exposed) | each filter | no visual defects | 1, 2 and 3) Method 2.12 Sec. 10.7 and 10.3 |
| **Lab QC Checks** | | | |

| 1) Criteria (PM2.5 LC) | 2) Frequency | 3) Acceptable Range | Information /Action |
|---|---|---|---|
| *Field Filter Blank* | 10% or 1 per weighing session | $<\pm$ 30.1 µg change between weighings | 1) 40 CFR Part 50, App. L Sec. 8.3.7.1<br>2 and 3) Method 2.12 Table 7-1 & Sec.10.5 |
| *Lab Filter Blank* | 10% or 1 per weighing session | $<\pm$ 15.1 µg change between weighings | 1) 40 CFR Part 50, App. L Sec. 8.3.7.2<br>2 and 3) Method 2.12 Sec. 10.5 |
| Balance Check (working standards) | beginning, 10th sample, end | $<\pm 3.1$ µg from certified value | 1, 2 and 3) Method 2.12 Sec. 10.6<br>Standards used should meet specifications in Method 2.12, Sec. 4.3.7 |
| Routine Filter re-weighing | 1 per weighing session | $<\pm$ 15.1 µg change between weighings | 1, 2 and 3) Method 2.12 Sec. 10.8 |
| Microbalance Audit | every 365 days and once a calendar year | $<\pm$ 0.003 mg or manufacturers specs, whichever is tighter | 1, 2 and 3) Method 2.12 Sec. 11.2.7 |
| Lab Temp Check | Every 90 days | $<\pm$ 2.1ºC | 1, 2 and 3) Method 2.12 Sec. 10.10 |
| Lab Humidity Check | Every 90 days | $<\pm$ 2.1% | 1, 2 and 3) Method 2.12 Sec. 10.10 |
| **Verification/Calibration** | | | |
| *Microbalance Calibration* | *At installation* every 365 days and once a calendar year | Manufacturer's specification | 1) 40 CFR Part 50, App. L, Sec. 8.1<br>2) 40 CFR Part 50, App. L, Sec. 8.1 and Method 2.12 Sec. 10.11<br>3) NA |
| Lab Temperature Certification | every 365 days and once a year | $<\pm$ 2.1ºC | 1, 2 and 3) Method 2.12 Sec. 4.3.8 and 9.4 |
| Lab Humidity Certification | every 365 days and once a year | $<\pm$ 2.1% | 1, 2 and 3) Method 2.12 Sec. 4.3.8 and 9.4 |
| **Calibration & Check Standards -** | | | |
| Working Mass Stds. Verification Compared to primary standards | Every 90 days | $<\pm$ 2.1 ug | 1, 2 and 3) Method 2.12 Sec. 9.7 |
| Primary standards certification | every 365 days and once a calendar year | 0.025 mg tolerance (Class 2) | 1, 2 and 3) Method 2.12 Sec. 4.3.7 |

# Continuous PM2.5 Local Conditions Validation Template

| 1) Criteria (PM2.5 Cont) | 2) Frequency | 3) Acceptable Range | Information /Action |
|---|---|---|---|
| **CRITICAL CRITERIA- PM$_{2.5}$ Continuous, Local Conditions** | | | |
| ***Sampler/Monitor Designation*** | NA | ***Meets requirements listed in FRM/FEM/ARM designation*** <br> Confirm method designation on front panel or just inside instrument. | 1) 40 CFR Part 58 App C Sec. 2.1 <br> 2) NA <br> 3) 40 CFR Part 53 & FRM/FEM method list |
| Firmware of monitor | At setup | 1. Must be the firmware (or later version) as identified in the published method designation summary. <br><br> 2. ***Firmware settings must be set for flowrate to operate and report at "local conditions" (i.e., not STP).*** | 40 CFR Part 50 App N. sec. 1 (c) |
| Data Reporting Period | Report every hour | 1. The calculation of an hour of data is dependent on the design of the method. <br><br> 2. ***A 24-hour period is calculated in AQS if 18 or more valid hours are reported for a day [1].*** | See operator's manual. Hourly data are always reported as the start of the hour on local standard time <br> 40 CFR Part 50 App N. Sec 3 (c) |
| **Sampling Instrument** | | | |
| PM10 Inlet (if applicable to method designated) | At Setup | Must be a Louvered PM10 size selective inlet as specified in 40 CFR 50 appendix L, Figures L-2 through L-19 | |
| PM2.5 second stage separator (if applicable to method designated) | At Setup | Must be a BGI Inc. Very Sharp Cut Cyclone (VSCC$^{TM}$) or equivalent second stage separator approved for the method. | The other approved second stage separator option for select FEMs is the Dichot. Only the GRIMM 180 and Teledyne T640 and T640X are known to not have a second stage separator as part of the method. |
| ***Average Flow Rate*** | ***every 24 hours of operation; alternatively, each hour can be checked*** | ***average within 5% of 16.67 liters/minute at local conditions*** | 1, 2 and 3) Part 50 App L Sec. 7.4.3.1 |
| ***Variability in Flow Rate*** | ***every 24 hours of op*** | ***CV < 2%*** | 1, 2 and 3) 40 CFR Part 50, App L Sec. 7.4.3.2 |
| ***One-point Flow Rate Verification*** | ***every 30 days each separated by 14 days*** | ***< ± 4.1% of transfer standard*** <br> < ± 5.1% of flow rate design value | 1, 2 and 3) 40 CFR Part 50, App.L, Sec. 9.2.5, 40 CFR Part 58, Appendix A Sec. 3.2.3 & 3.3.2 |
| ***Design Flow Rate Adjustment*** | ***After multi-point calibration or verification*** | ***< ± 2.1% of design flow rate*** | 1,2 and 3) 40 CFR Part 50, App. L, Sec. 9.2.6 |
| ***External Leak Check*** | ***Before each flow rate verification/calibration*** and before and after PM$_{2.5}$ separator maintenance | Method specific. See operator's manual. | 1) 40 CFR Part 50 App L, Sec. 7.4.6.1 <br> 2) 40 CFR Part 50 App L Sec.t 9.2.3 and Method 2-12 Sec. 7.4.3 <br> 3) 40 CFR Part 50, App. L, Sec. 7.4.6.1 |
| ***Internal Leak Check*** | If failure of external leak check | Method specific. See operators manual. | 1) 40 CFR Part 50, App. L, Sec. 7.4.6.2 <br> 2) Method 2-12 7.4.4 <br> 3) 40 CFR Part 50, App. L, Sec. 7.4.6.2 |

| 1) Criteria (PM2.5 Cont) | 2) Frequency | 3) Acceptable Range | Information /Action |
|---|---|---|---|
| **Annual Multi-point Verifications/Calibrations** | | | |
| *Leak Check* | every 30 days | < 1.0 lpm BAM (Not Thermo BAMS) $\pm$ 0.15 lpm TEOM | 1) 40 CFR Part 50 App L, Sec. 7.4.6.1 2) Recommendation 3) BAM SOP Sec. 10.1.2    TEOM SOP Sec. 10.1.6 Thermo BAM leak check should not be attempted. Foils could be ruptured. |
| *Temperature multi-point Verification/Calibration* | on installation, then Every 365 days and 1/ calendar year | < $\pm$ 2.1ºC | 1) 40 CFR Part 50, App.L, Sec. 9.3 2 and 3) Method 2.12 Sec. 6.4.4 |
| *One-point Temp Verification* | every 30 days | < $\pm$ 2.1ºC | 1) 40 CFR Part 50, App.L, Sec. 9.3 2) Method 2.12 Sec. 7.4.5 and Table 6-1 3) Recommendation |
| *Pressure Verification/Calibration* | on installation, then Every 365 days and 1/ calendar year | < $\pm$ 10.1 mm Hg | 1) 40 CFR Part 50, App.L, Sec. 9.3 2 and 3) Method 2.12 Sec. 6.5 BP verified against independent standard verified against a lab primary standard that is certified NIST traceable 1/year |
| *Flow Rate Multi-point Verification/ Calibration* | *Electromechanical maintenance or transport or* Every 365 days and 1/ calendar year | < $\pm$ 2.1% of transfer standard | 1) 40 CFR Part 50, App.L, Sec. 9.2. 2) 40 CFR Part 50, App.L, Sec. 9.1.3, Method 2.12 Sec. 6.3 & Table 6-1 3) Recommendation |
| Other Monitor Calibrations/checks | per manufacturers' op manual | Annual zero test on Met One BAM 1020 and BAM 1022 | per manufacturers' operating manual. Note: more frequent zero tests may be appropriate in areas with seasonal changes in dew-points. |
| **Precision** | | | |
| *Collocated Samples* | *every 12 days for 15% of sites by method designation* | CV < 10.1% of samples $\geq$ 3 µg/m$^3$ | 1) and 2) Part 58 App A Sec. 3.2.3 3 Recommendation based on DQO in 40 CFR Part 58 App A Sec. 2.3.1.1 |
| **Accuracy** | | | |
| Temperature Audit | every 180 days and at time of flow rate audit | < $\pm$ 2.1ºC | 1, 2 and 3) Method 2.12 Sec. 11.2.2 |
| Pressure Audit | every 180 days and at time of flow rate audit | < $\pm$10.1 mm Hg | 1, 2 and 3) Method 2.12 Sec. 11.2.3 |
| *Semi Annual Flow Rate Audit* | *Twice a calendar year and 5-7 months apart* | < $\pm$ 4.1% of audit standard < + 5.1% of design flow rate | 1 and 2) Part 58, App A, Sec. 3.3.3 3) Method 2.12 Sec. 11.2.1 |
| **Shelter Temperature** | | | |
| Temperature range | At setup | per operator manual | |
| Temperature Control | Daily (hourly values) | < 2.1º C SD over 24 hours | 1, 2 and 3) QA Handbook Volume 2 Sec. 7.2.2 |
| Temperature Device Check | every 180 days and twice a calendar year | < $\pm$ 2.1º C | 1, 2 and 3) QA Handbook Volume 2 Sec. 7.2.2 |

| 1) Criteria (PM2.5 Cont) | 2) Frequency | 3) Acceptable Range | Information /Action |
|---|---|---|---|
| **Monitor Maintenance** | | | |
| PM$_{2.5}$ Separator (WINS) | every 5 sampling events | cleaned/changed | 1, 2,and 3) Method 2.12 Sec. 8.2.2 |
| PM$_{2.5}$ Separator (VSCC) | every 30 days | cleaned/changed | 1,2 and 3) Method 2.12 Sec. 8.3.3 |
| Inlet Cleaning | every 30 days | cleaned | 1,2 and 3) Method 2.12 Sec. 8.3 |
| Downtube Cleaning | every 90 days | cleaned | 1,2 and 3) Method 2.12 Sec. 8.4 |
| Filter Housing Assembly Cleaning | every 30 days | cleaned | 1, 2 and 3) Method 2.12 Sec. 8.3 |
| Circulating Fan Filter Cleaning | every 30 days | cleaned/changed | 1, 2 and 3) Method 2.12 Sec. 8.3 |
| Manufacturer-Recommended Maintenance | per manufacturers' SOP | per manufacturers' SOP | |
| **TEOM-FDMS Specific Operational Criteria** | | | |
| Total Flow Verification | every 30 days | Sum of flow rates from 3 paths equal design flow rate < + 5.1% | 1,2 and 3) TEOM SOP Sec. 10.1.2 |
| Bypass leak check (TEOM) | every 30 days | $\pm$ 0.60 lpm | 1,2 and 3) TEOM SOP Sec. 10.1.6 or TEOM Operating Manual Sec. 5-4 |
| Replace TEOM filters | as needed | Change TEOM filter as filter loading approaches 90%, but must be changed before reaching 100%. | 1,2 and 3) TEOM SOP Sec. 10.1.8 |
| Replace the 47-mm FDMS (Purge) filters | every 30 days or any time TEOM filters are replaced | replaced | 1,2 and 3) TEOM SOP Sec. 10.1.10 |
| Internal/External Data Logger Data | Every 30 days 10 randomly selected values | agree exactly (digital) and $\pm$ 1 µg/m$^3$ (analog). Note: digital is expected and should be used unless there is no capacity to utilize digital in the monitoring agencies' data system. | 1, 2 and 3) TEOM SOP Sec. 10.1.24 |
| Replace In-line filters | every 180 days and twice a calendar year | replaced | 1, 2 and 3) TEOM SOP Sec. 10.2 |
| Clean cooler assembly | every 365 days and once a calendar year | cleaned | 1, 2 and 3) TEOM SOP Sec. 10.3.1 |
| Clean/Maintain switching valve | every 365 days and once a calendar year | cleaned | 1, 2 and 3) TEOM SOP Sec. 10.3.2 |
| Clean air inlet system of mass transducer enclosure | every 365 days and once a calendar year | cleaned | 1, 2 and 3) TEOM SOP Sec. 10.3.3 |
| Replace the dryers | 1/yr or due to poor performance | Review dryer dew point data to determine acceptable performance of dryer | 1, 2 and 3) TEOM SOP Sec. 10.3.4 |
| Calibration (KO) constant verification | every 365 days and once a calendar year | Pass or Fail ($\leq$ 2.5%) | 1, 2 TEOM SOP Sec. 10.3.6 3) 1405-DF operating guide. Verification software either passes or fails the verification. Acceptance criteria is < 2.5 % |
| Rebuild sampling pump | 18 months | < 66% of local pressure | 1, 2 and 3) TEOM SOP Sec. 10.4 |

| 1) Criteria (PM2.5 Cont) | 2) Frequency | 3) Acceptable Range | Information /Action |
|---|---|---|---|
| **GRIMM Specific Operational Criteria** | | | |
| Internal rinsing air filter | After a few years | Changed | 1, 2 and 3) GRIMM SOP Sec. 12.4 May require a trained service staff to change. May only require changing if a message reads "check nozzle and air inlet" |
| Change Dust Filter | Every 365 days and 1/ calendar year | Changed | 1, 2 and 3) GRIMM SOP Sec. 12.3 |
| Relative Humidity Setting | At Setup | Per Operators manual (55%) unless otherwise directed and approved to use at a different value | |
| Calibration of spectrometer | Yearly | +/- 5% for mass | Operators' Manual section 5.2 |
| Cleaning or changing of the Nafion in inlet | As needed | We are seeking clarification from GRIMM on this | Operators' Manual section 11.4.2 |
| **Thermo BAM Specific Operational Criteria** | | | |
| Cleaning Nozzle and Vane (BAM) | Minimally every 30 days | cleaned | 1, 2 and 3) BAM SOP Sec. 10.1.3 |
| Leak Check | every 30 days | $\leq 0.42$ L/min | 1) BAM 5014i Instruction Manual 2) 3) BAM 5014i Instruction Manual |
| Replace or clean pump muffler | every 180 days and twice a calendar year | Cleaned or changed | |
| Internal/External Data Logger Data (BAM) | Every 30 days 10 randomly selected values | agree exactly (digital) and $\pm 1$ µg/m$^3$ (analog). Note: digital is expected and should be used unless there is no capacity to utilize digital in the monitoring agencies' data system. | 1, 2 and 3) BAM SOP Sec. 10.1.9 |
| Clean/replace internal debris filter | Every 365 days and 1/ calendar year | | |
| **MetOne BAM Specific Operational Criteria** | | | |
| BAM check of membrane span foil | Daily | Avg. $< \pm 5.1\%$ of ABS | 1, 2 and 3) BAM SOP Sec. 10.4.3. Applies on the BAM 1020 |
| BAM electrical grounding | At setup | 1. Is the chassis of the BAM grounded? Is the downtube grounded to the chassis at the collar (i.e., with setscrews) | Per operator manual |
| Nozzle cleaning | Every 30 days, or more often as needed | cleaned | Per operator manual |
| Zero test | Yearly | Standard deviation of the data from a 72-hour zero test $< 2.4$ µg/m$^3$ | Per operator manual |

# PM10c for PM$_{10\text{-}2.5}$ Low –Volume, Filter-Based Local Conditions Validation Template

| 1) Criteria (PM10c) | 2) Frequency | 3) Acceptable Range | Information /Action |
|---|---|---|---|
| **CRITICAL CRITERIA- PM10c Filter Based Local Conditions** | | | |
| **Field Activities** | | | |
| *Sampler/Monitor* | NA | *Meets requirements listed in FRM/FEM/ARM designation* | 1) 40 CFR Part 58 App C Sec. 2.1<br>2) NA<br>3) 40 CFR Part 53 & FRM/FEM method list |
| **Filter Holding Times** | | | |
| *Pre-sampling* | *all filters* | *$\leq$ 30 days before sampling* | 1, 2 and 3) 40 CFR Part 50, App. L Sec. 8.3.5 |
| *Sample Recovery* | *all filters* | *$\leq$7 days 9 hours from sample end date* | 1, 2 and 3) 40 CFR Part 50 App L Sec. 10.10 |
| *Sampling Period (including multiple power failures)* | *all filters* | *1380-1500 minutes, or value if < 1380 and exceedance of NAAQS [1] midnight to midnight local standard time* | 1, 2 and 3) 40 CFR Part 50 App L Sec. 3.3<br><br>See details if less than 1380 min sampled |
| **Sampling Instrument** | | | |
| *Average Flow Rate* | *every 24 hours of op* | *average within 5% of 16.67 liters/minute* | 1, 2 and 3) Part 50 App L Sec. 7.4.3.1 |
| *Variability in Flow Rate* | *every 24 hours of op* | *CV $\leq$ 2%* | 1, 2 and 3) 40 CFR Part 50, App. L Sec. 7.4.3.2 |
| *One-point Flow Rate Verification* | *every 30 days each separated by 14 days* | *$\pm$ 4% of transfer standard*<br>$\pm$ 5% of flow rate design value | 1, 2 and 3) 40 CFR Part 50, App. L, Sec. 9.2.5, 40 CFR Part 58 App A Sec. 3.3.1 |
| *Design Flow Rate Adjustment* | *After multi-point calibration or verification* | *< $\pm$ 2.1% of design flow rate* | 1, 2 and 3) 40 CFR Part 50, App. L, Sec. 9.2.6 |
| *Individual Flow Rates* | *every 24 hours of op* | *no flow rate excursions > $\pm$5% for > 5 min. [1]* | 1, 2 and 3) 40 CFR Part 50, App. L Sec. 7.4.3.1 |
| *Filter Temp Sensor* | *every 24 hours of op* | *no excursions of > 5º C lasting longer than 30 min [1]* | 1, 2 and 3) 40 CFR Part 50, App. L Sec. 7.4.11.4 |
| *External Leak Check* | *Before each flow rate verification/calibration and before and after PM$_{2.5}$ separator maintenance* | *< 80.1 mL/min (see comment #1)* | 1) 40 CFR Part 50 App L, Sec. 7.4.6.1<br>2) 40 CFR Part 50 App L Sec.t 9.2.3 and Method 2-12 Sec. 7.4.3<br>3) 40 CFR Part 50, App. L, Sec. 7.4.6.1 |

| 1) Criteria (PM10c) | 2) Frequency | 3) Acceptable Range | Information /Action |
|---|---|---|---|
| *Internal Leak Check* | If failure of external leak check | *< 80.1 mL/min* | 1) 40 CFR Part 50, App. L, Sec. 7.4.6.2<br>2) Method 2-12, Sec. 7.4.4<br>3) 40 CFR Part 50, App. L, Sec. 7.4.6.2 |
| **Laboratory Activities** | | | |
| **Post-sampling Weighing** | *all filters* | *Protected from exposure to temperatures above 25C from sample retrieval to conditioning*<br><br>*≤10 days from sample end date if shipped at ambient temp, or*<br>*≤30 days if shipped below avg ambient (or 4º C or below for avg sampling temps < 4º C ) from sample end date* | 1, 2 and 3) 40 CFR Part 50 App L Sec. 8.3.6 |
| *Filter Visual Defect Check (unexposed)* | *all filters* | *Correct type & size and for pinholes, particles or imperfections* | 1, 2 and 3) 40 CFR Part 50, App. L Sec. 10.2 |
| Filter Conditioning Environment | | | |
| *Equilibration* | *all filters* | *24 hours minimum* | 1, 2 and 3) 40 CFR Part 50, App. L Sec. 8.2.5 |
| *Temp. Range* | *all filters* | *24-hr mean 20.0-23.0º C* | 1, 2 and 3) 40 CFR Part 50, App. L Sec. 8.2.1 |
| *Temp.Control* | *all filters* | *< 2.1º C SD\* over 24 hr* | 1, 2 and 3) 40 CFR Part 50, App. L Sec. 8.2.2 SD use is a recommendation |
| *Humidity Range* | *all filters* | *24-hr mean 30.0% - 40.0% RH or within ±5.0% sampling RH but > 20.0%RH* | 1, 2 and 3) 40 CFR Part 50, App. L Sec. 8.2.3 |
| *Humidity Control* | *all filters* | *< 5.1% SD\* over 24 hr.* | 1, 2 and 3) 40 CFR Part 50, App. L Sec. 8.2.4 SD use is recommendation |
| *Pre/post Sampling RH* | *all filters* | *difference in 24-hr means ≤ ± 5.1% RH* | 1, 2 and 3) 40 CFR Part 50, App. L Sec. 8.3.3 |
| *Balance* | *all filters* | *located in filter conditioning environment* | 1, 2 and 3) 40 CFR Part 50, App. L Sec. 8.3.2 |
| **OPERATIONAL EVALUATIONS TABLE- PM10c Filter Based Local Conditions** | | | |
| **Field Activities** | | | |
| **Sampling Instrument** | | | |
| **Routine Verifications** | | | |
| *One-point Temp Verification* | every 30 days | *≤± 2.1ºC* | 1) 40 CFR Part 50, App. L, Sec. 9.3<br>2) Method 2.12 Sec. 7.4.5 and Table 6-1<br>3) Recommendation |
| *Pressure Verification* | every 30 days | *< ± 10.1 mm Hg* | 1) 40 CFR Part 50, App. L, Sec. 9.3<br>2) Method 2.12 Sec. 7.4.6 and Table 6-1<br>3) Recommendation |
| **Annual Multi-point Verifications/Calibrations** | | | |
| *Temperature multi-point Verification/Calibration* | on installation, then every 365 days and once a calendar year | *≤± 2.1ºC* | 1) 40 CFR Part 50, App. L, Sec. 9.3<br>2 and 3) Method 2.12 Sec. 6.4.4 Table 6-1 |

| 1) Criteria (PM10c) | 2) Frequency | 3) Acceptable Range | Information /Action |
|---|---|---|---|
| *Pressure Verification/Calibration* | on installation, then every 365 days and once a calendar year | $\leq \pm$ 10.1 mm Hg | 1) 40 CFR Part 50, App. L, Sec. 9.3 <br> 2 and 3) Method 2.12 Sec. 6.5 <br> Sampler BP verified against independent standard verified against a lab primary standard that is certified as NIST traceable 1/year |
| *Flow Rate Multi-point Verification/ Calibration* | *Electromechanical maintenance or transport or* every 365 days and once a calendar year | $\leq \pm$ 2.1% of transfer standard | 1) 40 CFR Part 50, App. L, Sec. 9.2. <br> 2) 40 CFR Part 50, App. L, Sec. 9.1.3, Method 2.12 Sec. 6.3 & Table 6-1 <br> 3) Recommendation |
| Other Monitor Calibrations | per manufacturers' op manual | per manufacturers' operating manual | 1, 2 and 3) Recommendation |
| **Precision** | | | |
| *Collocated Samples* | *every 12 days for 15% of sites by method designation* | CV < 10.1% of samples $\geq$ 3.0 µg/m$^3$ | 1) and 2) Part 58 App A Sec. 3.2.3 <br> 3 Recommendation based on DQO in 40 CFR Part 58 App A Sec. 2.3.1.1 |
| **Accuracy** | | | |
| Temperature Audit | every 180 days and at time of flow rate audit | $\leq \pm$ 2.1ºC | 1, 2 and 3) Method 2.12 Sec. 11.2.2 |
| Pressure Audit | every 180 days and at time of flow rate audit | $\leq \pm$ 10.1 mm Hg | 1, 2 and 3) Method 2.12 Sec. 11.2.3 |
| *Semi Annual Flow Rate Audit* | *Twice a calendar year and 5-7 months apart* | $\leq \pm$ 4.1% of audit standard <br> $\leq \pm$ 5.1% of design flow rate | 1 and 2) Part 58, App A, Sec. 3.2.2 <br> 3) Method 2.12 Sec. 11.2.1 |
| **Monitor Maintenance** | | | |
| PM$_{2.5}$ Separator (WINs) | every 5 sampling events | cleaned/changed | 1, 2 and 3) Method 2.12 Sec. 8.2.2 |
| PM$_{2.5}$ Separator (VSCC) | every 30 days | cleaned/changed | 1, 2 and 3) Method 2.12 Sec. 8.3.3 |
| Inlet Cleaning | every 30 days | cleaned | 1, 2 and 3) Method 2.12 Sec. 8.3 |
| Downtube Cleaning | every 90 days | cleaned | 1, 2 and 3) Method 2.12 Sec. 8.4 |
| Filter Housing Assembly Cleaning | every 30 days | cleaned | 1, 2 and 3) Method 2.12 Sec. 8.3 |
| Circulating Fan Filter Cleaning | every 30 days | cleaned/changed | 1, 2 and 3) Method 2.12 Sec. 8.3 |
| Manufacturer-Recommended Maintenance | per manufacturers' SOP | per manufacturers' SOP | |
| **Laboratory Activities** | | | |
| **Filter Checks** | | | |
| Lot Blanks | 9 filters per lot | < $\pm$ 15.1 µg change between weighings | 1, 2, 3) Recommendation and used to determine filter stability of the lot of filters received from EPA or vendor. Method 2.12 Sec. 10.5 |
| Exposure Lot Blanks | 3 filters per lot | < $\pm$ 15.1 µg change between weighings | 1, 2 and 3) Method 2.12 Sec. 10.5 <br> Used for preparing a subset of filters for equilibration |
| Filter Integrity (exposed) | each filter | no visual defects | 1, 2 and 3) Method 2.12 Sec. 10.7 and 10.3 |
| **Lab QC Checks** | | | |

| 1) Criteria (PM10c) | 2) Frequency | 3) Acceptable Range | Information /Action |
|---|---|---|---|
| **Field Filter Blank** | 10% or 1 per weighing session | $<\pm$ 30.1 µg change between weighings | 1) 40 CFR Part 50, App. L Sec. 8.3.7.1<br>2 and 3) Method 2.12 Table 7-1 & Sec.10.5 |
| **Lab Filter Blank** | 10% or 1 per weighing session | $<\pm$ 15.1 µg change between weighings | 1) 40 CFR Part 50, App. L Sec. 8.3.7.2<br>2 and 3) Method 2.12 Sec. 10.5 |
| Balance Check (working standards) | beginning, 10th sample, end | $<\pm 3.1$ µg from certified value | 1, 2 and 3) Method 2.12 Sec. 10.6<br>Standards used should meet specifications in Method 2.12, Sec. 4.3.7 |
| Routine Filter re-weighing | 1 per weighing session | $<\pm$ 15.1 µg change between weighings | 1, 2 and 3) Method 2.12 Sec. 10.8 |
| Microbalance Audit | every 365 days and once a calendar year | $<\pm$ 0.003 mg or manufacturers specs, whichever is tighter | 1, 2 and 3) Method 2.12 Sec. 11.2.7 |
| Lab Temp Check | Every 90 days | $< + 2.1$ºC | 1, 2 and 3) Method 2.12 Sec. 10.10 |
| Lab Humidity Check | Every 90 days | $< + 2.1$% | 1, 2 and 3) Method 2.12 Sec. 10.10 |
| **Verification/Calibration** | | | |
| **Microbalance Calibration** | **At installation** every 365 days and once a calendar year | Manufacturer's specification | 1) 40 CFR Part 50, App. L, Sec. 8.1<br>2) 40 CFR Part 50, App. L, Sec. 8.1 and Method 2.12 Sec. 10.11<br>3) NA |
| Lab Temperature Certification | every 365 days and once a year | $<\pm 2.1$ºC | 1, 2 and 3) Method 2.12 Sec. 4.3.8 and 9.4 |
| Lab Humidity Certification | every 365 days and once a year | $<\pm 2.1$% | 1, 2 and 3) Method 2.12 Sec. 4.3.8 and 9.4 |
| **Calibration & Check Standards -** | | | |
| Working Mass Stds. Verification Compared to primary standards | Every 90 days | $<\pm 2.1$ ug | 1, 2 and 3) Method 2.12 Sec. 9.7 |
| Primary standards certification | every 365 days and once a calendar year | 0.025 mg tolerance (Class 2) | 1, 2 and 3) Method 2.12 Sec. 4.3.7 |

# PM$_{10}$ Filter Based Dichot STP Conditions Validation Template

| 1) Criteria (PM10 Dichot STP) | 2) Frequency | 3) Acceptable Range | Information /Action |
|---|---|---|---|
| **CRITICAL CRITERIA- PM$_{10}$ Filter Based Dichot** | | | |
| **Field Activities** | | | |
| | | | |
| *Sampler/Monitor* | NA | *Meets requirements listed in FRM/FEM/ARM designation* | 1) 40 CFR Part 58 App C Sec. 2.1<br>2) NA<br>3) 40 CFR Part 53 & FRM/FEM method list |
| *Sample Recovery* | *all filters* | *ASAP* | 1, 2 and 3) 40 CFR Part 50 App J Sec. 9.15 |
| *Sampling Period* | *all filters* | *1440 minutes $\pm$ 60 minutes midnight to midnight local standard time* | 1, 2 and 3) 40 CFR Part 50 App J Sec. 7.1.5 |
| Sampling Instrument | | | |
| Average Flow Rate | every 24 hours of op | average 16.67 liters/minute | 1, 2 and 3) Method 2.10 Sec. 2.1 |
| Verification/Calibration | | | |
| *One-point Flow Rate Verification* | *every 30 days each separated by 14 days* | $< \pm$ 7.1% of transfer standard | 1, 2 40 CFR Part 58 App A Sec. 3.3.1 and 3) Method 2.10 Table 3-1 |
| **Lab Activities** | | | |
| Filter | | | |
| Visual Defect Check (unexposed) | all filters | see reference | 1, 2 and 3) Method 2.10 Sec. 4.2 |
| *Collection efficiency* | *all filters* | *$\geq$ 99 %* | 1, 2 and 3) Part 50, App J Sec. 7.2.2 |
| *Alkalinity* | *all filters* | *< 25.0 microequivalents/gram* | 1, 2 and 3) 40 CFR Part 50, App J Sec. 7.2.4 |
| Filter Conditioning Environment | | | |
| *Equilibration* | *all filters* | *24 hours minimum* | 1, 2 and 3) 40 CFR Part 50, App. J Sec. 9.3 |
| *Temp. Range* | *all filters* | *15-30.0º C* | 1, 2 and 3) 40 CFR Part 50, App. J Sec. 7.4.1 |
| *Temp.Control* | *all filters* | *< 3.1º C SD\** over 24 hr | 1, 2 and 3) 40 CFR Part 50, App. J Sec. 7.4.2 SD use is recommendation |
| *Humidity Range* | *all filters* | *20% - 45.0% RH* | 1, 2 and 3) 40 CFR Part 50, App. J Sec. 7.4.3 |
| *Humidity Control* | *all filters* | *<5.1% SD\** over 24 hr | 1, 2 and 3) 40 CFR Part 50, App. J Sec. 7.4.4 SD use is recommendation |
| Pre/post Sampling RH | all filters | difference in 24-hr means $< \pm$ 5.1% RH | 1, 2 and 3) Recommendation based on 40 CFR Part 50, App. L Sec. 8.3.3 |
| Balance | all filters | located in filter conditioning environment | 1, 2 and 3) Recommendation based on 40 CFR Part 50, App. L Sec. 8.3.2 |
| **OPERATIONAL EVALUATIONS TABLE PM$_{10}$ Filter Based Dichot** | | | |
| **Field Activities** | | | |
| Verification/Calibration | | | |
| System Leak Check | During precalibration check | Vacuum of 10 to 15 in. & rate of decline to 0 in >60 seconds | 1, 2 and 3) Method 2.10 Sec. 2.2.1 |

| 1) Criteria (PM10 Dichot STP) | 2) Frequency | 3) Acceptable Range | Information /Action |
|---|---|---|---|
| *FR Multi-point Verification/Calibration* | every 365 days and once a calendar year | Correlation coefficient of >.990 with no point deviating more than 0.5 L/min for total or 0.05 L/min for coarse | 1) 40 CFR Part 50, App. J, Sec. 8.0<br>2 and 3) Method 2.10 Sec. 2.2.4 |
| Field Temp M-point Verification | on installation, then every 365 days and once a calendar year | $< \pm 2.1^oC$ | 1, 2 and 3) Recommendation based on Part 50, App. L |
| **Precision** | | | |
| *Collocated Samples* | *every 12 days for 15% of sites* | *<5.1 µg/m$^3$ for concentrations below 80µg/m$^3$ and <7.1% for concentrations above 80µg/m$^3$* | 1 and 2) 40 CFR Part 58 App A Sec. 3.3.4<br>3) Part 50, App J Sec. 4.1 |
| *Semi Annual Flow Rate Audit* | every 180 days and twice a calendar year | $< \pm 10.1\%$ of audit standard | 1 and 2) 40 CFR Part 58, App A, Sec. 3.3.3<br>3) Method 2.10 Sec. 7.1.5 |
| **Monitor Maintenance** | | | |
| Impactor | every 90 days and 4 times a calendar year | cleaned/changed | 1, 2 and 3) Method 2.10 Sec. 6.1.2 |
| Inlet/downtube Cleaning | every 90 days and 4 times a calendar year | cleaned | 1, 2 and 3) Method 2.10 Sec. 6.1.2 |
| Vacuum pump | every 365 days and once a calendar year | Replace diaphragm and flapper valves | 1, 2 and 3) Method 2.10 Sec. 6.1.3 |
| Manufacturer-Recommended Maintenance | per manufacturers' SOP | per manufacturers' SOP | |
| **Lab Activities** | | | |
| Balance Check | beginning, 10th sample, end | < 4.1 µg of true zero<br>< 2.1 µg of 10 mg check weight | 1, 2 and 3) Method 2.10 Sec. 4.5 |
| "Standard" filter QC check | 10% | $< \pm 20.1$ µg change from original value | 1, 2 and 3) Method 2.10 Sec. 4.5<br>From standard non-routine filter |
| "Routine" duplicate weighing | 5-7 per weighing session | $< \pm 20.1$ µg change from original value | 1, 2 and 3) Method 2.10 Sec. 4.5<br>From routine filter set |
| *Integrity-* Random sample of test field blank filters | 10% | *$\pm 5$ µg/m$^3$* | 1) 40 CFR Part 50 App J Sec. 7.2.3 2 and<br>2) Recommendation<br>3) 40 CFR Part 50 App J Sec. 7.2.3 |
| Lab Temperature Calibration | every 180 days and twice a calendar year | $\pm 2^oC$ | 1, 2 and 3) Recommendation related to 40 CFR Part 50, App .L |
| Lab Humidity Calibration | every 180 days and twice a calendar year | $\pm 2\%$ | 1, 2 and 3) Recommendation related to 40 CFR Part 50 App L Sec. 5.8.1 |
| Microbalance Calibration | every 365 days and once a calendar year | Manufacturer's specification | 1, 2 and 3) Recommendation related to 40 CFR Part 50 App L |
| Filter Weighing Audit | every 365 days and once a calendar year | $< \pm 20.1$ µg change from original value | 1, 2 and 3) Method 2.10 Table 7-1 |
| Balance Audit | every 365 days and once a calendar year | Observe weighing technique and check balance with ASTM Class 1 standard | 1, 2 and 3) Method 2.10 Table 7-1 Sec. 7.2.2 |

| 1) Criteria (PM10 Dichot STP) | 2) Frequency | 3) Acceptable Range | Information /Action |
|---|---|---|---|
| Primary Mass Stds. (compare to NIST-traceable standards) | every 365 days and once a calendar year | NIST traceable (e.g., ANSI/ASTM Class 1, 1.1 or 2) | 1, 2 and 3) Method 2.10 Sec. 9 |

# PM$_{10}$ Filter Based High Volume (HV) STP Conditions Validation Template

| 1) Criteria (PM10 Hi-Vol STP) | 2) Frequency | 3) Acceptable Range | Information /Action |
|---|---|---|---|
| **CRITICAL CRITERIA- PM$_{10}$ Filter Based Hi-Vol** | | | |
| **Field Activities** | | | |
| *Sampler/Monitor* | NA | *Meets requirements listed in FRM/FEM/ARM designation* | 1) 40 CFR Part 58 App C Sec. 2.1<br>2) NA<br>3) 40 CFR Part 53 & FRM/FEM method list |
| **Filter Holding Times** | | | |
| *Sample Recovery* | *all filters* | *ASAP* | 1, 2 and 3) 40 CFR Part 50 App J Sec. 9.15 |
| *Sampling Period* | *all filters* | *1440 minutes $\pm$ 60 minutes midnight to midnight local standard time* | 1, 2 and 3) 40 CFR Part 50 App J Sec. 7.1.5 |
| Average Flow Rate | every 24 hours of op | ~1.13 m$^3$/min (varies with instrument) | 1, 2 and 3) Method 2.11 |
| **Verification/Calibration** | | | |
| *One-point Flow Rate Verification* | *every 90 days and 4 times a calendar year* | *$< \pm$ 7.1% of transfer standard and $< \pm$10.1% from design* | 1 and 2) 40 CFR Part 58, App A, Sec. 3.3.2<br>3) Method 2.11 Sec. 3.5.1, Table 2-1 |
| **Lab Activities** | | | |
| **Filter** | | | |
| Visual Defect Check (unexposed) | *all filters* | *see reference* | Method 2.11 Sec. 4.2 |
| *Collection efficiency* | *all filters* | *99 %* | 1, 2 and 3) 40 CFR Part 50, App J Sec. 7.2.2 |
| *Alkalinity* | *all filters* | *< 25.0 microequivalents/gram* | 1, 2 and 3) 40 CFR Part 50, App J Sec. 7.2.4 |
| **Filter Conditioning Environment** | | | |
| *Equilibration* | *all filters* | *24 hours minimum* | 1, 2 and 3) 40 CFR Part 50, App.J Sec. 9.3 |
| *Temp. Range* | *all filters* | *15.0-30.0º C* | 1, 2 and 3) 40 CFR Part 50, App.J Sec. 7.4.1 |
| *Temp.Control* | *all filters* | *< 3.1º C SD\* over 24 hr* | 1, 2 and 3) 40 CFR Part 50, App.J Sec. 7.4.2 SD use is recommendation |
| *Humidity Range* | *all filters* | *20.0% - 45.0% RH* | 1, 2 and 3) 40 CFR Part 50, App.J Sec. 7.4.3 |
| *Humidity Control* | *all filters* | *< 5.1% SD\* over 24 hr* | 1, 2 and 3) 40 CFR Part 50, App.J Sec. 7.4.4 SD use is recommendation |
| Pre/post Sampling RH | all filters | difference in 24-hr means < $\pm$ 5.1% RH | 1, 2 and 3) Recommendation based on Part 50, App. L Sec. 8.3.3 |
| Balance | all filters | located in filter conditioning environment | 1, 2 and 3) Recommendation based on Part 50, App. L Sec. 8.3.2 |
| **OPERATIONAL EVALUATIONS TABLE PM$_{10}$ Filter Based Hi-Vol** | | | |
| **Field Activities** | | | |
| **Verification/Calibration** | | | |
| System Leak Check | During precalibration check | Auditory inspection with faceplate blocked | 1, 2 and 3) Method 2.11 Sec. 2.3.2 |
| FR Multi-point Verification/Calibration | every 365 days and once a calendar year | 3 of 4 cal points within < $\pm$ 10.1% of design | 1, 2 and 3) Method 2.11 Sec. 2.3.2 |
| Field Temp M-point Verification | on installation, then every 365 days and once a calendar year | < $\pm$ 2.1ºC | 1, 2 and 3) Recommendation |
| **Precision** | | | |

| 1) Criteria (PM10 Hi-Vol STP) | 2) Frequency | 3) Acceptable Range | Information /Action |
|---|---|---|---|
| *Collocated Samples* | *every 12 days for 15% of sites* | CV < 10.1% of samples $\geq$ 15 µg/m$^3$ | 1) and 2) 40 CFR Part 58 App A Sec. 3.3.4<br>3) Recommendation |
| *Semi Annual Flow Rate Audit* | *every 180 days and twice a calendar year* | < $\pm$ 7.1% of transfer standard and< $\pm$ 10.1% from design | 1 and 2) 40 CFR Part 58, App A, Sec. 3.3.3<br>3) Method 2.11 Sec. 7 Table 7-1 |
| **Monitor Maintenance** | | | |
| Inlet/downtube Cleaning | every 90 days and 4 times a calendar year | cleaned | 1, 2 and 3) Method 2.11 Sec. 6 |
| Motor/housing gaskets | every 90 days and 4 times a calendar year | Inspected replaced | 1, 2 and 3) Method 2.11 Sec. 6 |
| Blower motor brushes | 600-1000 hours | Replace | 1, 2 and 3) Method 2.11 Sec. 6 |
| Manufacturer-Recommended Maintenance | per manufacturers' SOP | per manufacturers' SOP | NA |
| **Lab Activities** | | | |
| **Lab QC Checks** | | | |
| Balance Check (Standard Weight Check and Calibration Check) | beginning, 15th sample, end | < $\pm$ 0.51 mg of true zero and < $\pm$ 0.51 mg 1-5 g check weight | 1, 2, and 3) Method 2 .11 Sec. 4.5.1 and 4.5.2 |
| "Routine" duplicate weighing | 5-7 per weighing session | < $\pm$ 2.8 mg change from original value | 1, 2 and 3) Method 2.11 Sec. 4.5.3<br>From routine filter set |
| *Integrity-* Random sample of test field blank filters | 10% | ***< $\pm$ 5.1 µg/m$^3$*** | 1) 40 CFR Part 50 App J Sec. 7.2.3<br>2) Recommendation<br>3) 40 CFR Part 50 App J Sec. 7.2.3 |
| Lab Temperature Calibration | every 180 days and twice a calendar year | < $\pm$ 2.1°C | 1, 2 and 3) Recommendation related to 40 CFR Part 50, App. L |
| Lab Humidity Calibration | every 180 days and twice a calendar year | < $\pm$ 2.1% | 1, 2 and 3) Recommendation related to 40 CFR Part 50 App L |
| Microbalance Calibration | every 365 days and once a calendar year | Manufacturer's specification | |
| Primary Mass Stds. (compare to NIST-traceable standards) | every 365 days and once a calendar year | NIST traceable<br>(e.g., ANSI/ASTM Class 1, 1.1 or 2) | 1, 2 and 3) Method 2.11 Sec. 9 |
| **Audits** | | | |
| Filter Weighing | every 365 days and once a calendar year | < $\pm$ 5.1 mg change from original value | 1) Method 2.11 Table 7-1<br>2) Recommendation<br>3) Method 2.11 Table 7-1 |
| Balance Audit | every 365 days and once a calendar year | Observe weighing technique and check balance with ASTM Class 1 standard | 1) Method 2.11 Table 7-1<br>2) Recommendation<br>3) Method 2.11 Table 7-1 |

# Continuous PM10 STP Conditions Validation Template

| 1) Criteria (PM$_{10}$ Cont) | 2) Frequency | 3) Acceptable Range | Information /Action |
|---|---|---|---|
| **CRITICAL CRITERIA- PM$_{10}$ Continuous** | | | |
| *Sampler/Monitor* | NA | *Meets requirements listed in FRM/FEM/ARM designation* | 1) 40 CFR Part 58 App C Sec. 2.1<br>2) NA<br>3) 40 CFR Part 53 & FRM/FEM method list |
| **Sampling Period** | **all filters** | **1440 minutes ± 60 minutes midnight to midnight local standard time** | 1, 2 and 3) 40 CFR Part 50 App J Sec. 7.1.5 |
| Average Flow Rate | every 24 hours of op | Average within < ± 5.1% of design | recommendation |
| **Verification/Calibration** | | | |
| *One-point Flow Rate Verification* | *every 30 days each separated by 14 days* | < ± 7.1% of transfer standard | 1 and 2) 40 CFR Part 58, App A, Sec. 3.3<br>3) Method 2.10 Table 3-1 |
| **OPERATIONAL EVALUATIONS TABLE PM$_{10}$ Continuous** | | | |
| **Verification/Calibration** | | | |
| System Leak Check | During precalibration check | Auditory inspection with faceplate blocked | 1, 2 and 3) Method 2.11 Sec. 2.3.2 |
| *FR Multi-point Verification/Calibration* | every 365 days and once a calendar year | 3 of 4 cal points within < ± 10.1% of design | 1) 40 CFR Part 50 App J Sec. 8.0<br>2 and 3) Method 2.10 Sec. 2.2.4 |
| **Audits** | | | |
| *Semi Annual Flow Rate Audit* | *Twice a calendar year and 5-7 months apart* | < ± 10.1% of audit standard | 1, 2) Part 58, App A, Sec. 3.3.3<br>3) Method 2.10 Sec. 7.1.5 |
| **Monitor Maintenance** | | | |
| Inlet/downtube Cleaning | every 90 days and 4 times a calendar year | cleaned | 1, 2 and 3) Method 2.10 Sec. 6.1.2 |
| Manufacturer-Recommended Maintenance | per manufacturers' SOP | per manufacturers' SOP | |

# PM$_{10}$ Low Volume STP Filter-Based Local Conditions Validation Template

| 1) Criteria (PM10 Lo-Vol STP) | 2) Frequency | 3) Acceptable Range | Information /Action |
|---|---|---|---|
| **CRITICAL CRITERIA- PM$_{10}$ Lo-Vol Filter Based STP** | | | |
| **Field Activities** | | | |
| *Sampler/Monitor* | NA | *Meets requirements listed in FRM/FEM/ARM designation* | 1) 40 CFR Part 58 App C Sec. 2.1<br>2) NA<br>3) 40 CFR Part 53 & FRM/FEM method list |
| *Sample Recovery* | *all filters* | *$\leq$7 days 9 hours from sample end date* | 1, 2 and 3) 40 CFR Part 50 App L Sec. 10.10 |
| *Pre-sampling* | *all filters* | *$\leq$ 30 days before sampling* | 1, 2 and 3) 40 CFR Part 50, App. L Sec. 8.3.5 |
| Sampling Instrument | | | |
| *Average Flow Rate* | *every 24 hours of op* | *average within < 5.1% of 16.67 liters/minute* | 1, 2 and 3) Part 50 App L Sec. 7.4.3.1 |
| *Variability in Flow Rate* | *every 24 hours of op* | *CV < 2.1%* | 1, 2 and 3) 40 CFR Part 50, App. L Sec. 7.4.3.2 |
| *One-point Flow Rate Verification* | *every 30 days each separated by 14 days* | *< $\pm$ 4.1% of transfer standard*<br>< $\pm$ 5.1% of flow rate design value | 1) 40 CFR Part 50, App. L, Sec. 9.2.5, 40 CFR Part 58, App A Sec. 3.3.1<br>2) Part 58, App A, Sec. 3.3.1<br>3) 40 CFR Part 50, App. L, Sec. 9.2.5 & 7.4.3.1 |
| *Design Flow Rate Adjustment* | *at one-point or multi-point verification/calibration* | *< $\pm$ 2.1% of design flow rate* | 1, 2 and 3) 40 CFR Part 50, App. L, Sec. 9.2.6 |
| *Individual Flow Rates* | *every 24 hours of op* | *no flow rate excursions > $\pm$5.1% for > 5 min.* [1/] | 1, 2 and 3) 40 CFR Part 50, App. L Sec. 7.4.3.1 |
| *Filter Temp Sensor* | *every 24 hours of op* | *no excursions of > 5$^o$ C lasting longer than 30 min* [1/] | 1, 2 and 3) 40 CFR Part 50, App. L Sec. 7.4.11.4 |
| *External Leak Check* | *Before each flow rate verification/calibration* and before and after maintenance | *< 80.1 mL/min* (see comment #1) | 1) 40 CFR Part 50 App L, Sec. 7.4.6.1<br>2) 40 CFR Part 50, App. L Sec. 9.2.3 Method 2-12 Sec. Table 8-1<br>3) 40 CFR Part 50, App. L, Sec. 7.4.6.1 |
| *Internal Leak Check* | every 5 sampling events | *< 80.1 mL/min* | 1) 40 CFR Part 50, App. L, Sec. 7.4.6.2<br>2) Method 2-12 Table 8-1<br>3) 40 CFR Part 50, App. L, Sec. 7.4.6.2 |
| **Laboratory Activities** | | | |

| 1) Criteria (PM10 Lo-Vol STP) | 2) Frequency | 3) Acceptable Range | Information /Action |
|---|---|---|---|
| *Post-sampling Weighing* | *all filters* | *Protected from exposure to temperature $\leq$10 days from sample end date if shipped at ambient temp, or*<br>*$\leq$30 days if shipped below avg ambient (or 4º C or below for avg sampling temps < 4º C ) from sample end date* | 1, 2 and 3) 40 CFR Part 50 App L Sec. 8..3.6 |
| *Filter Visual Defect Check (unexposed)* | *all filters* | *Correct type & size and for pinholes, particles or imperfections* | 1, 2 and 3) 40 CFR Part 50, App. L Sec. 10.2 |
| Filter Conditioning Environment | | | |
|    *Equilibration* | *all filters* | *24 hours minimum* | 1, 2 and 3) 40 CFR Part 50, App. L Sec. 8.2.5 |
|    *Temp. Range* | *all filters* | *24-hr mean 20.0-23.0º C* | 1, 2 and 3) 40 CFR Part 50, App. L Sec. 8.2.1 |
|    *Temp.Control* | *all filters* | *< 2.1º C SD* over 24 hr* | 1, 2 and 3) 40 CFR Part 50, App. L Sec. 8.2.2 SD use is recommendation |
|    *Humidity Range* | *all filters* | *24-hr mean 30.0% - 40.0% RH or*<br>*<5.1% sampling RH but $\geq$ 20.0%RH* | 1, 2 and 3) 40 CFR Part 50, App. L Sec. 8.2.3 |
|    *Humidity Control* | *all filters* | *< 5.1% SD* over 24 hr.* | 1, 2 and 3) 40 CFR Part 50, App. L Sec. 8.2.4 SD use is recommendation |
|    *Pre/post Sampling RH* | *all filters* | *difference in 24-hr means < $\pm$ 5.1% RH* | 1, 2 and 3) 40 CFR Part 50, App. L Sec. 8.3.3 |
|    *Balance* | *all filters* | *located in filter conditioning environment* | 1, 2 and 3) 40 CFR Part 50, App. L Sec. 8.3.2 |
| **OPERATIONAL EVALUATIONS TABLE PM₁₀ Lo-Vol Filter Based STP** | | | |
| **Field Activities** | | | |
| **Sampling Instrument** | | | |
| **Routine Verifications** | | | |
| *One-point Temp Verification* | every 30 days | < $\pm$ 2.1ºC | 1) 40 CFR Part 50, App. L, Sec. 9.3<br>2) Method 2.12 Sec. 7.4.5 and Table 6-1<br>3) Recommendation |
| *Pressure Verification* | every 30 days | < $\pm$ 10.1 mm Hg | 1) 40 CFR Part 50, App. L, Sec. 9.3<br>2) Method 2.12 Sec 7.4.6 and Table 6-1<br>3) Recommendation |
| **Annual Multi-point Verifications/Calibrations** | | | |
| *Temperature multi-point Verification/Calibration* | on installation, then every 365 days and once a calendar year | < $\pm$ 2.1ºC | 1) 40 CFR Part 50, App. L, Sec. 9.3<br>2 and 3) Method 2.12 Sec. 6.4.4 and Table 6-1 |
| *Pressure Verification/Calibration* | on installation, then every 365 days and once a calendar year | < $\pm$ 10.1 mm Hg | 1) 40 CFR Part 50, App. L, Sec. 9.3<br>2 and 3) Method 2.12 Sec. 6.5<br>Sampler BP verified against independent standard verified against a lab primary standard that is certified as NIST traceable 1/year |

| 1) Criteria (PM10 Lo-Vol STP) | 2) Frequency | 3) Acceptable Range | Information /Action |
|---|---|---|---|
| *Flow Rate Multi-point Verification/ Calibration* | *Electromechanical maintenance or transport or* every 365 days and once a calendar year | $< \pm 2.1\%$ of transfer standard | 1) 40 CFR Part 50, App. L, Sec. 9.2.<br>2) 40 CFR Part 50, App. L, Sec. 9.1.3, Method 2.12 Sec. 6.3 Table 6-1<br>3) Recommendation |
| Other Monitor Calibrations | per manufacturers' op manual | per manufacturers' operating manual | 1, 2 and 3) Recommendation |
| **Precision** | | | |
| *Collocated Samples* | *every 12 days for 15% of sites* | $CV < 10.1\%$ of samples $\geq 3.0$ µg/m$^3$ | 1) and 2) 40 CFR Part 58 App A Sec. 3.3.4<br>3) Recommendation |
| **Accuracy** | | | |
| Temperature Audit | every 180 days and at time of flow rate audit | $< \pm 2.1$°C | 1, 2 and 3) Method 2.12 Sec. 11.2.2 |
| Pressure Audit | every 180 days and at time of flow rate audit | $< \pm 10.1$ mm Hg | 1, 2 and 3) Method 2.12 Sec. 11.2.3 |
| *Semi Annual Flow Rate Audit* | *Twice a calendar year and 5-7 months apart* | $< \pm 4.1\%$ of audit standard<br>$< \pm 5.1\%$ of design flow rate | 1 and 2) Part 58, App A, Sec. 3.3.3<br>3) Method 2.12 Sec. 11.2.1 |
| **Monitor Maintenance** | | | |
| Inlet Cleaning | every 30 days | cleaned | 1, 2 and 3) Method 2.12 Sec. 8.3 |
| Downtube Cleaning | every 90 days | cleaned | 1, 2 and 3) Method 2.12 Sec. 8.4 |
| Filter Chamber Cleaning | every 30 days | cleaned | 1, 2 and 3) Method 2.12 Sec. 8.3 |
| Circulating Fan Filter Cleaning | every 30 days | cleaned/changed | 1, 2 and 3) Method 2.12 Sec. 8.3 |
| Manufacturer-Recommended Maintenance | per manufacturers' SOP | per manufacturers' SOP | |
| **Laboratory Activities** | | | |
| **Filter Checks** | | | |
| Lot Blanks | 9 filters per lot | $< \pm 15.1$ µg change between weighings | 1, 2, 3) Recommendation and used to determine filter stability of the lot of filters received from EPA or vendor. Method 2.12 Sec. 10.5 |
| Exposure Lot Blanks | 3 filters per lot | $< \pm 15.1$ µg change between weighings | 1, 2 and 3) Method 2.12 Sec. 10.5<br>Used for preparing a subset of filters for equilibration |
| Filter Integrity (exposed) | each filter | no visual defects | 1, 2 and 3) Method 2.12 Sec. 10.3 and 10.7 |
| **Lab QC Checks** | | | |
| *Field Filter Blank* | 10% or 1 per weighing session | $< \pm 30.1$ µg change between weighings | 1) 40 CFR Part 50, App. L Sec. 8.3.7.1<br>2 and 3) Method 2.12 Table 7-1 & Sec. 10.5 |
| *Lab Filter Blank* | 10% or 1 per weighing session | $< \pm 15.1$ µg change between weighings | 1) 40 CFR Part 50, App. L Sec. 8.3.7.2<br>2 and 3) Method 2.12 Sec. 10.5 |
| Balance Check (working standards) | beginning, 10th sample, end | $< \pm 3.1$ µg from certified value | 1, 2 and 3) Method 2.12 Sec. 10.6<br>Standards used should meet specifications in Method 2.12, Sec. 4.3.7 |
| Routine Filter re-weighing | 1 per weighing session | $< \pm 15.1$ µg change between weighings | 1, 2 and 3) Method 2.12 Sec. 10.8 |

| 1) Criteria (PM10 Lo-Vol STP) | 2) Frequency | 3) Acceptable Range | Information /Action |
|---|---|---|---|
| Microbalance Audit | every 365 days and once a calendar year | < ± 0.003 mg or manufacturers specs, whichever is tighter | 1, 2 and 3) Method 2.12 Sec. 11.2.7 |
| Lab Temp Check | Every 90 days | < + 2.1ºC | 1, 2 and 3) Method 2.12 Sec. 10.10 |
| Lab Humidity Check | Every 90 days | < ± 2.1% | 1, 2 and 3) Method 2.12 Sec. 10.10 |
| **Verification/Calibration** | | | |
| *Microbalance Calibration* | *At installation* every 365 days and once a calendar year | Manufacturer's specification | 1) 40 CFR Part 50, App. L, Sec. 8.1<br>2) 40 CFR Part 50, App. L, Sec. 8.1 and Method 2.12 Sec. 10.11<br>3) NA |
| | | | |
| Lab Temperature Certification | every 365 days and once a year | < ± 2.1ºC | 1, 2 and 3) Method 2.12 Sec. 4.3.8 and 9.4 |
| Lab Humidity Certification | every 365 days and once a year | < ± 2.1% | 1, 2 and 3) Method 2.12 Sec.4.3.8 and 9.4 |
| **Calibration & Check Standards -** | | | |
| Working Mass Stds. Verification Compared to primary standards | Every 90 days | < ± 2.1 ug | 1, 2 and 3) Method 2.12 Sec. 9.7 |
| Primary standards certification | every 365 days and once a calendar year | 0.025 mg tolerance (Class 2) | 1, 2 and 3) Method 2.12 Sec. 4.3.7 |

# Pb High Volume (TSP) Local Conditions Validation Template

| 1) Criteria | 2) Frequency | 3) Acceptable Range | 4) Information/Action |
|---|---|---|---|
| **CRITICAL CRITERIA- Pb in TSP Local Conditions** | | | |
| **Field Activities** | | | |
| *Sampler/Monitor* | NA | *Meets requirements listed in FRM/FEM/ARM designation* | 1) 40 CFR Part 58 App C Sec. 2.1<br>2) NA<br>3) 40 CFR Part 53 & FRM/FEM method list<br>Also described in 40 CFR Part 50 App B Sec. 7.2 |
| **Filter Holding Times** | | | |
| **Sample Recovery** | *all filters* | *ASAP* | 1, 2 and 3) 40 CFR Part 50 App B Sec. 6.3 |
| **Sampling Period** | *all filters* | *1440 minutes $\pm$ 60 minutes midnight to midnight local standard time* | 1, 2 and 3) 40 CFR Part 50 App B Sec. 8.15 |
| **Sampling Instrument** | | | |
| *Average Flow Rate* | *every 24 hours of op* | *1.1-1.70 m³/min (varies with instrument) in actual condition* | 1, 2 and 3) 40 CFR Part 50 App B Sec. 8.8 |
| *One-point Flow Rate Verification* | *every 90 days and 4 times a calendar year* | *< $\pm$7.1% from transfer standard* | 1 and 2) 40 CFR Part 58 App A Sec. 3.4.2<br>3) Method 2.2 Sec. 2.6 |
| **Lab Activities** | | | |
| **Filter** | | | |
| *Visual Defect Check (unexposed)* | *all filters* | *Initial backlight inspection- no pinholes or imperfections. Visual inspection prior to shipping to analytical lab* | 1, 2 and 3) 40 CFR Part 50 App B Sec. 8.2 |
| *Collection Efficiency* | *all filters* | *99 %* | 1, 2 and 3) 40 CFR Part 50 App B Sec. 7.1.4 |
| *Pressure Drop Range* | *all filters* | *42-54 mm Hg* | 1, 2 and 3) 40 CFR Part 50 App B Sec. 7.1.5 |
| *pH* | *all filters* | *6-10* | 1, 2 and 3) 40 CFR Part 50, App B Sec. 7.1.6 |
| *Pb Content* | *all filters pre-sampling batch check* | *< 75 µg/filter* | 1, 2 and 3) 40 CFR Part 50, App G Sec. 6.1.1.1<br>Method 2.8 Sec. 6.2.1. More information relative to whether filters should be corrected for blanks. |
| *Calibration Reproducibility Checks* | *Beginning, every 10 samples and end* | *$\pm$ 5% of value predicted by calibration curve* | 1, 2 and 3) 40 CFR Part 50, App G Sec. 9.3<br>May be FEM dependent |
| *Initial Calibration Blank* | *Before first sample* | *< 0.001 µg/mL* | 1, 2 and 3) 40 CFR Part 50, App G Sec.8.8 |
| | | | |

| 1) Criteria | 2) Frequency | 3) Acceptable Range | 4) Information/Action |
|---|---|---|---|
| Reagent Blank | Every analytical batch | < LDL | 1, 2 and 3) Recommendation |
| Daily Calibration | Daily (on day of analysis) | until good agreement is obtained among replicates | 1, 2 and 3) Method 2.8 Sec. 2.8.5 |
| **OPERATIONAL EVALUATIONS TABLE Pb in TSP Local Conditions** | | | |
| **Field Activities** | | | |
| **Verification/Calibration** | | | |
| System Leak Check | During precalibration check | Visual and Auditory inspection with faceplate blocked | 1, 2 and 3) Recommendation |
| FR Multi-point Verification/Calibration | After receipt, after motor maintenance or failure of 1-point check and every 365 days and once a calendar year | 5 points over range of 1.1 to 1.7 m$^3$/min $\leq \pm$ 5.1% limits of linearity | 1, 2 and 3) Method 2.2 Sec. 2.6 |
| **Precision** | | | |
| *Collocated Samples* | *15% of each method code in PQAO Frequency - every 12 days* | CV < 20.1% of samples $\geq$ 0.02 µg/m$^3$ (cutoff value) | 1 and 2) 40 CFR Part 58 App A Sec. 3.3.4.3 3) Recommendation for early evaluation of DQOs |
| *Semi Annual Flow Rate Audit* | *every 180 days and twice a calendar year* | < $\pm$ 7.1% of audit standard | 1 and 2) 40 CFR Part 58, App A, Sec. 3.4.3 3) Method 2.2 Table 8.2 |
| **Monitor Maintenance** | | | |
| Inlet cleaning | every 90 days and 4 times a calendar year | cleaned | 1, 2 and 3) Recommendation |
| Motor/housing gaskets | ~400 hours | Inspected replaced | 1, 2 and 3) Method 2.2 Sec. 7 |
| Blower motor brushes | 400-500 | Replace | 1, 2 and 3) Method 2.2 Sec. 7 |
| Manufacturer-Recommended Maintenance | per manufacturers' SOP | per manufacturers' SOP | NA |
| **Lab Activities** | | | |
| *Analysis Audits* | *6 strips/quarter 3 at each concentration range* | <10.1% (percent difference) | 1 and 2) 40 CFR Part 58, App A, Sec. 3.4.6 3) Recommendation |
| Field Filter Blank | 1/quarter | < LDL | 1, 2 and 3) Recommendation |
| Lab Blanks | 1/ sample run | < LDL | 1, 2 and 3) Recommendation |
| Control Standards ( 1 µg Pb/ml and a standard between 1-10 µg Pb/ml) | 1st, every 10 samples and last sample. | Deviation of < 5.1% from value predicted by calibration curve | 1, 2 and 3) Method 2.8 Sec. 5.7.3 |

# PM$_{10}$ -Pb Low Volume Filter-Based Local Conditions Validation Template

| 1) Criteria (PM10-Pb Lo-Vol ) | 2) Frequency | 3) Acceptable Range | Information /Action |
|---|---|---|---|
| **CRITICAL CRITERIA- PM10-Pb Filter Based Local Conditions** | | | |
| **Field Activities** | | | |
| *Sampler/Monitor* | NA | *Meets requirements listed in FRM/FEM designation* | 1) 40 CFR Part 58 App C Sec. 2.1<br>2) NA<br>3) 40 CFR Part 53 & FRM/FEM method list |
| **Filter Holding Times**<br>*Sample Recovery* | *all filters* | *ASAP* | 1, 2 and 3) 40 CFR part 50 App B Sec. 6.3<br><br>If filters are used for more than one purpose (i.e.,Pb and PM10) the sample recovery is dictated by the most stringent requirement. |
| **Filter Holding Times**<br>*Pre-sampling* | *all filters* | *≤ 30 days before sampling* | 1, 2 and 3) 40 CFR Part 50, App. L Sec. 8.3.5<br><br>Required only if filters will be used for PM10c mass as well as Pb. If only used for Pb then 30 day pre-sampling holding time not required |
| *Sampling Period (including multiple power failures)* | *all filters* | *1440 minutes + 60 minutes midnight to midnight local standard time* | 1, 2 and 3) 40 CFR Part 50 App B Sec. 8.15<br><br>If filters are used for more than one purpose (i.e.,Pb and PM10) the sample recovery is dictated by the most stringent requirement. |
| **Sampling Instrument** | | | |
| *Average Flow Rate* | *every 24 hours of op* | *average within 5% of 16.67 liters/minute* | 1, 2 and 3) 40 CFR Part 50 App L Sec. 7.4.3.1 |
| *Variability in Flow Rate* | *every 24 hours of op* | *CV < 2%* | 1, 2 and 3) 40 CFR Part 50, App. L Sec. 7.4.3.2 |
| *One-point Flow Rate Verification* | every 30 days | *< + 4.1% of transfer standard*<br>*< + 5.1% of flow rate design value* | 1) 40 CFR Part 50, App. L, Sec. 9.2.5, 40 CFR Part 58, Appendix A Sec. 3.4.1<br>2) Recommendation<br>3) 40 CFR Part 50, App. L, Sec. 9.2.5 |
| *Design Flow Rate Adjustment* | *After multi-point calibration or verification* | *< + 2.1% of design flow rate* | 1, 2 and 3) 40 CFR Part 50, App. L, Sec. 9.2.6 |

| 1) Criteria (PM10-Pb Lo-Vol ) | 2) Frequency | 3) Acceptable Range | Information /Action |
|---|---|---|---|
| *Individual Flow Rates* | *every 24 hours of op* | *no flow rate excursions > +5% for > 5 min.* [1/] | 1, 2 and 3) 40 CFR Part 50, App. L Sec. 7.4.3.1 |
| *Filter Temp Sensor* | *every 24 hours of op* | *no excursions of > 5º C lasting longer than 30 min* [1/] | 1, 2 and 3) 40 CFR Part 50, App. L Sec. 7.4.11.4 |
| *External Leak Check* | *Before each flow rate verification/calibration* and before and after $PM_{2.5}$ separator maintenance | *< 80.1 mL/min* (see comment #1) | 1) 40 CFR Part 50 App L, Sec. 7.4.6.1 2) 40 CFR Part 50 App L Sec. 9.2.3 and Method 2-12 Sec. 7.4.3 3) 40 CFR Part 50, App. L, Sec. 7.4.6.1 |
| *Internal Leak Check* | If failure of external leak check | *< 80.1 mL/min* | 1) 40 CFR Part 50, App. L, Sec. 7.4.6.2 2) Method 2-12 7.4.4 3) 40 CFR Part 50, App. L, Sec. 7.4.6.2 |
| **Laboratory Activities (XRF Analysis)** | | | |
| | | | |
| *Filter Visual Defect Check (unexposed)* | *all filters* | *Correct type & size and for pinholes, particles or imperfections* | 1, 2 and 3) 40 CFR Part 50, App. L Sec. 10.2 |
| *Pb blank filter Acceptance Testing* | *~ 20 test filters per lot* | *90% of filters < 4.8 ng Pb/cm$^2$* | 1, 2 and 3) 40 CFR Part 50 App Q Sec. 6.1.2 |
| **OPERATIONAL EVALUATIONS TABLE- PM10-Pb Filter Based Local Conditions** | | | |
| **Field Activities** | | | |
| **Routine Verifications** | | | |
| *One-point Temp Verification* | every 30 days | $<\pm$ 2.1ºC | 1) 40 CFR Part 50, App. L, Sec. 9.3 2) Method 2.12 Table 6-1 3) Recommendation |
| *Pressure Verification* | every 30 days | $<\pm$ 10.1 mm Hg | 1) 40 CFR Part 50, App. L, Sec. 9.3 2) Method 2.12 Table 6-1 3) Recommendation |
| **Annual Multi-point Verifications/Calibrations** | | | |
| *Temperature multi-point Verification/Calibration* | on installation, then every 365 days and once a calendar year | $<\pm$ 2.1ºC | 1) 40 CFR Part 50, App. L, Sec. 9.3 2 and 3) Method 2.12 Sec. 6.4 |
| *Pressure Verification/Calibration* | on installation, then every 365 days and once a calendar year | $<\pm$ 10.1 mm Hg | 1) 40 CFR Part 50, App. L, Sec. 9.3 2 and 3) Method 2.12 Sec. 6.5 Sampler BP verified against independent standard verified against a lab primary standard that is certified as NIST traceable 1/year |
| *Flow Rate Multi-point Verification/ Calibration* | *Electromechanical maintenance or transport or* every 365 days and once a calendar year | $<\pm$ 2.1% of transfer standard | 1) 40 CFR Part 50, App. L, Sec. 9.2. 2) 40 CFR Part 50, App. L, Sec. 9.1.3, Method 2.12 Sec. 6.3 and Table 6-1 3) Recommendation |
| Other Monitor Calibrations | per manufacturers' op manual | per manufacturers' operating manual | 1, 2 and 3) Recommendation |
| **Precision** | | | |

| 1) Criteria (PM10-Pb Lo-Vol ) | 2) Frequency | 3) Acceptable Range | Information /Action |
|---|---|---|---|
| *Collocated Samples* | *15% of each method code in PQAO Frequency - every 12 days* | CV < 20.1% of samples $\geq$ 0.02 µg/m$^3$ (cutoff value) | 1 and 2) 40 CFR Part 58 App A Sec. 3.4.4 3) Recommendation for early evaluation of DQOs |
| **Accuracy** | | | |
| Temperature Audit | every 365 days and once a calendar year | $\leq \pm$ 2.1ºC | 1, 2 and 3) Method 2.12 Sec. 11.2.2 |
| Pressure Audit | every 365 days and once a calendar year | $\leq \pm$10.1 mm Hg | 1, 2 and 3) Method 2.12 Sec. 11.2.3 |
| *Semi Annual Flow Rate Audit* | *Twice a calendar year and 5-7 months apart* | $\leq \pm$ 4.1% of audit standard $\leq \pm$ 5.1% of design flow rate | 1 and 2) 40 CFR Part 58 App A, Sec. 3.4.3 3) Method 2.12 Sec. 11.2.1 |
| **Monitor Maintenance** | | | |
| Impactor (WINs) | every 5 sampling events | cleaned/changed | 1, 2, and 3) Method 2.12 Sec. 8.2.2 |
| Very Sharp Cut Cyclone | every 30 days | cleaned/changed | 1, 2 and 3) Method 2.12 Sec.8.3.3 |
| Inlet Cleaning | every 30 days | cleaned | 1, 2 and 3) Method 2.12 Sec. 8.3 |
| Downtube Cleaning | every 90 days | cleaned | 1, 2 and 3) Method 2.12 Sec. 8.4 |
| Filter Chamber Cleaning | every 30 days | cleaned | 1, 2 and 3) Method 2.12 Sec. 8.3 |
| Circulating Fan Filter Cleaning | every 30 days | cleaned/changed | 1, 2 and 3) Method 2.12 Sec. 8.3 |
| Manufacturer-Recommended Maintenance | per manufacturers' SOP | per manufacturers' SOP | |
| **Laboratory Activities (XRF Analysis)** | | | |
| *Analysis Audits* | *6 filters/quarter 3 at each concentration range* | <10.1% (percent difference) | 1 and 2) 40 CFR Part 58, App A, Sec. 3.4.6 3) Recommendation |
| *Field Filter Blank* | 1/quarter | < 0.01 µg/m$^3$ | 1) 40 CFR Part 50 App Q Sec. 6.1.2.1 2 and 3) Recommendation |
| *Lab Filter Blank* | 1/ sample run | <.003 µg/m$^3$ | 1 40 CFR part 50 App Q Sec. 6.1.2.1 2 and 3) Recommendation |
| *Thin Film Standards (standard reference materials)* | Beginning and end of each analytical run | XRF conc. $\pm$ 3x the 1 sigma uncertainty overlaps the NIST certified conc. + 1x its reported uncertainty. | 1) 40 CFR Part 50 App Q Sec. 6.2.3 2 and 3) recommendation |
| Run time quality control standards Checking peak areas, background areas, centroid and FWHM | Beginning and end of each analytical run | Target value 3 SD | 1, 2,and 3) Recommendation Target values and SD of QC samples established prior to analysis. |
| *XRF analyzer calibration* | *Every 365 days and 1/ calendar year or when significant repairs or changes occur or QC limits exceeded* | XRF conc. $\pm$ 3x the 1 sigma uncertainty overlaps the NIST certified conc. + 1x its reported uncertainty. | 1 and 2) 40 CFR Part 50 App Q Sec. 6.2.4 3) Recommendation |
| *Background Measurement and Correction* | *20 clean blank filters for each filter lot used* | NA | 1 and 2) 40 CFR Part 50 App Q Sec. 6.2.4.2 |

# Data Validation "Rules of Thumb" by Parameter

**Calibration Checks**
- If a nightly 1-point QC check for ozone is outside of tolerance and it was because the ozone value shifted and not the calibrator, assume the ambient ozone data are invalid if there is no other information to go on regarding the poor check.
- If only one or just a few O3 precision checks drift outside of acceptance criteria (7%), review the minute data to make sure that the check ran correctly. It's possible a check ended too soon or ran too long, causing it to be "bad".

**Flow**
- If flow dips while an operator is on site but is flagged >D, flow is left valid. If flow dips while an operator/person is on site and has no flag at all, invalidate the dip if the filter pack is being changed. Follow the flag.
- It is OK to not invalidate flow during a PF because it has a different threshold for number of minutes needed to make a valid average (5-8%??). The flag will indicate whether or not it's valid.

**Hydrocarbons**
- For sites with hydrocarbons that aren't uploaded to AQS, a negative NMHC value of -0.3 ppmC or less should be invalidated with IM. THC should be invalidated the same hour if there's a noticeable dip (>0.2 ppmC) compared to the hour before and after. CH4 is always left valid in these instances. (Sites with hydrocarbons that aren't upload to AQS include the WYMO sites and WAMS. Hydrocarbons from GACO-BM are uploaded to AQS.)

**RNF**
- RNF should be invalidated if winds are high/strong, relative humidity is low and the site does not have a wind screen.

**SO$_2$**
- Extend the nightly calibration code on 5-minute SO2 data if the record after the event ends is >1 ppb and the difference between it and the next data record is >0.5 ppb.

**Winds**
- Winds should be invalidated due to freezing conditions only if they are obviously frozen (PWS is at zero for multiple hours, temperatures are below freezing, and precip or high humidities occurred). Try not to get carried away with taking winds out due to freezing conditions as it is common for winds to be very light during cold periods. And some sites have lesser quality wind sensors with lower starting thresholds, so we would expect winds to be at zero in stagnant conditions. Also, if WD is at 90 degrees or 0 that doesn't necessarily mean winds are frozen. If there is no wind speed, many logger programs can't or won't calculate a WD for the hour because you can't have direction without speed.
- If only WD appears to be frozen but the site has an RM Young sensor, WS should be taken out with IN as well because the propeller is on the wind vane. They are separate on Climatronics sensors. (As of 10/25/21 the only sites operated by ARS that have Climatronics wind sensors are YELL-WT, DENA, SPCR and CASP-SR. There are plans to convert SPCR and CASP-SR to RM Young in the future.)

- If SDWD is flagged down during a site visit, it is OK to invalidate just SDWD. Same for a power failure. It is OK to invalidate only SDWD with PF because it has a different averaging time than other parameters (15-minute increments).

**Rules of thumb by Site:**
- Newcastle WARMS EBAM – We've noticed spikes often follow precip events. Historically we have left these valid, but in 2021 these spikes seem to have gotten bigger at times. We decided as a rule of thumb that any PM spikes that look to be attributed to precipitation events will be left valid if they are under 50 ug/m3.

**Calibration Examples:**
- ROMO 10/2020

DVL: On 10/21 there was a poor cal response that was determined likely to be due to effects of the wildfires. It was determined that the 10/21 cal was a valid response and the fire conditions likely affected the response. Due to this I left the cal valid and invalidated the ambient O3 using PQ code from the 10/21 cal until the next good cal on 10/22.
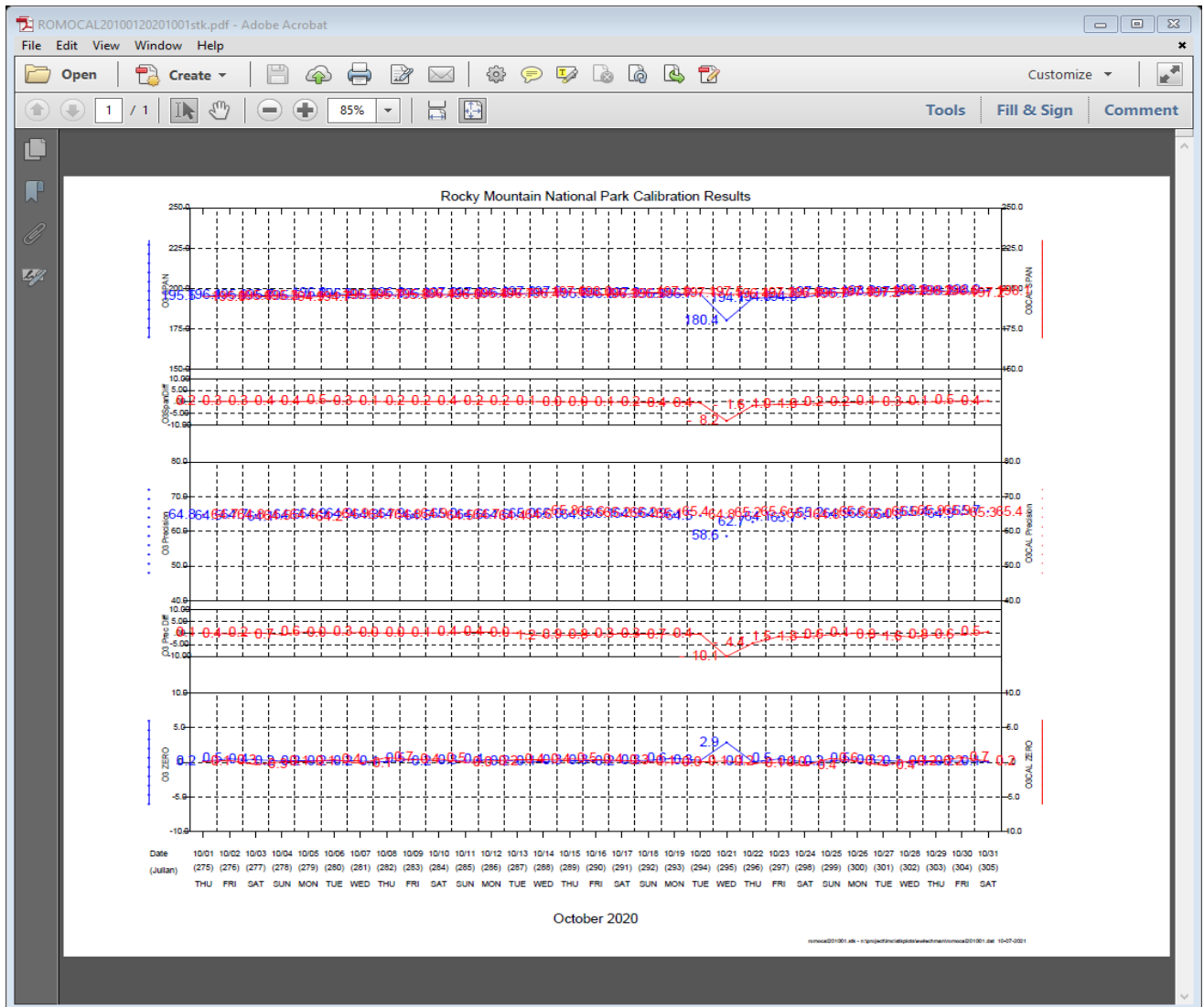
This is an example of the calibrations being valid and therefore ambient O3 data were invalidated during the time the checks were outside of data acceptance criteria.

- ZION 10/2019

DVL: The circuit breaker for the Panther zero air compressor tripped sometime on 10/13 which kept the nightly cals from running correctly. The operator visited on 10/15 and flipped the compressor breaker. Cals ran correctly on 10/16, but it popped again and cals did not run between 10/17 - 10/22. The operator visited on 10/22 to install a replacement Panther pump.
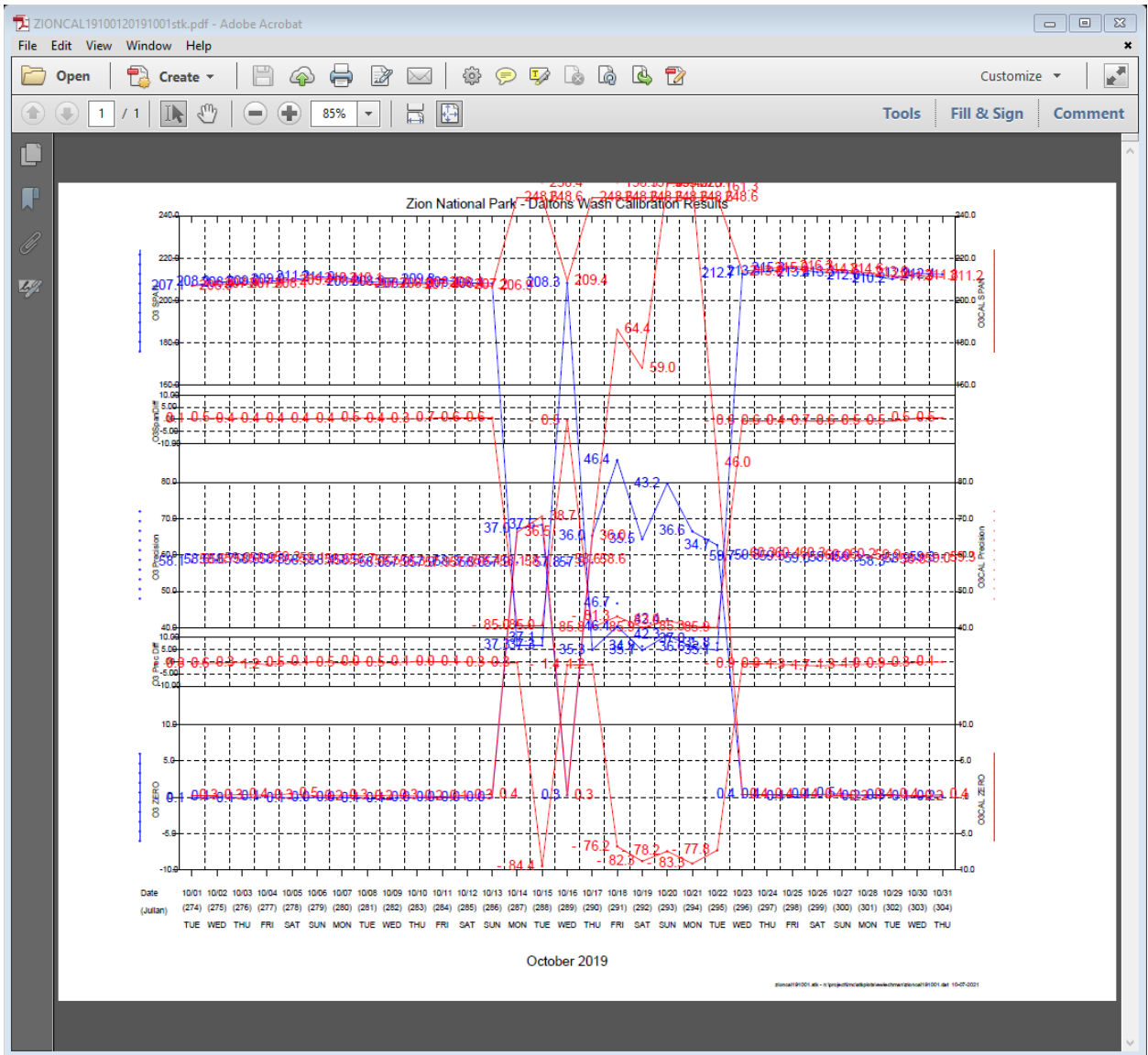
This is an example of the calibrations being invalid but ambient O3 data being valid.

- CASP-SR  2/2018

DVL: NO/NO2/NOx cals started to drift this month. A spare analyzer was shipped to the operator on 2/16. The operator installed the replacement analyzer on 2/26, but did not coordinate with ARS when they did so. I coded the gap with IW until ARS calibrated the instrument on 2/27.
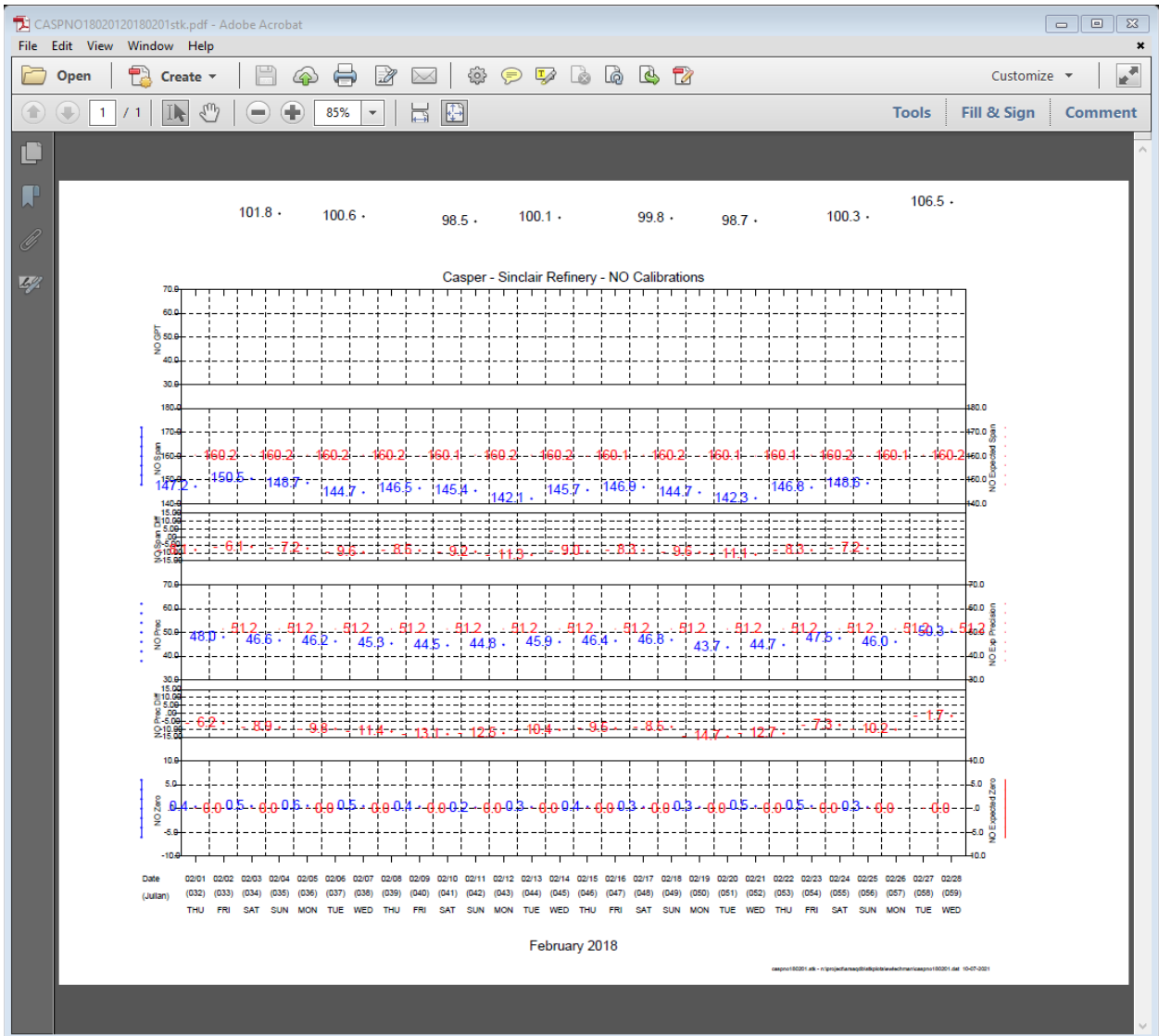
These calibrations stayed within data acceptance criteria for NO/NO$_2$/NO$_X$. However, if they had continued on the same path, data would have been invalidated. This is a good example of drifting nightly calibration checks.

- GRSM-CC 5/2019

DVL: Adding to line 2 (O3 precisions on 5/15 and 5/16), it looks to me like these two precision calibrations ran correctly for several minutes and then had a small uptick or spike at the end and that's the minute that was grabbed these two days. I think it was appropriate to invalidate these calibrations, but cals were a little all over the map this month, which is slightly worrysome. The analyzer was recalibrated by the site operator on 5/17 according to the SSL. Spans on 5/18 were 5% and 6.4% high on 5/18 and 5/22 for no apparent reason as well.
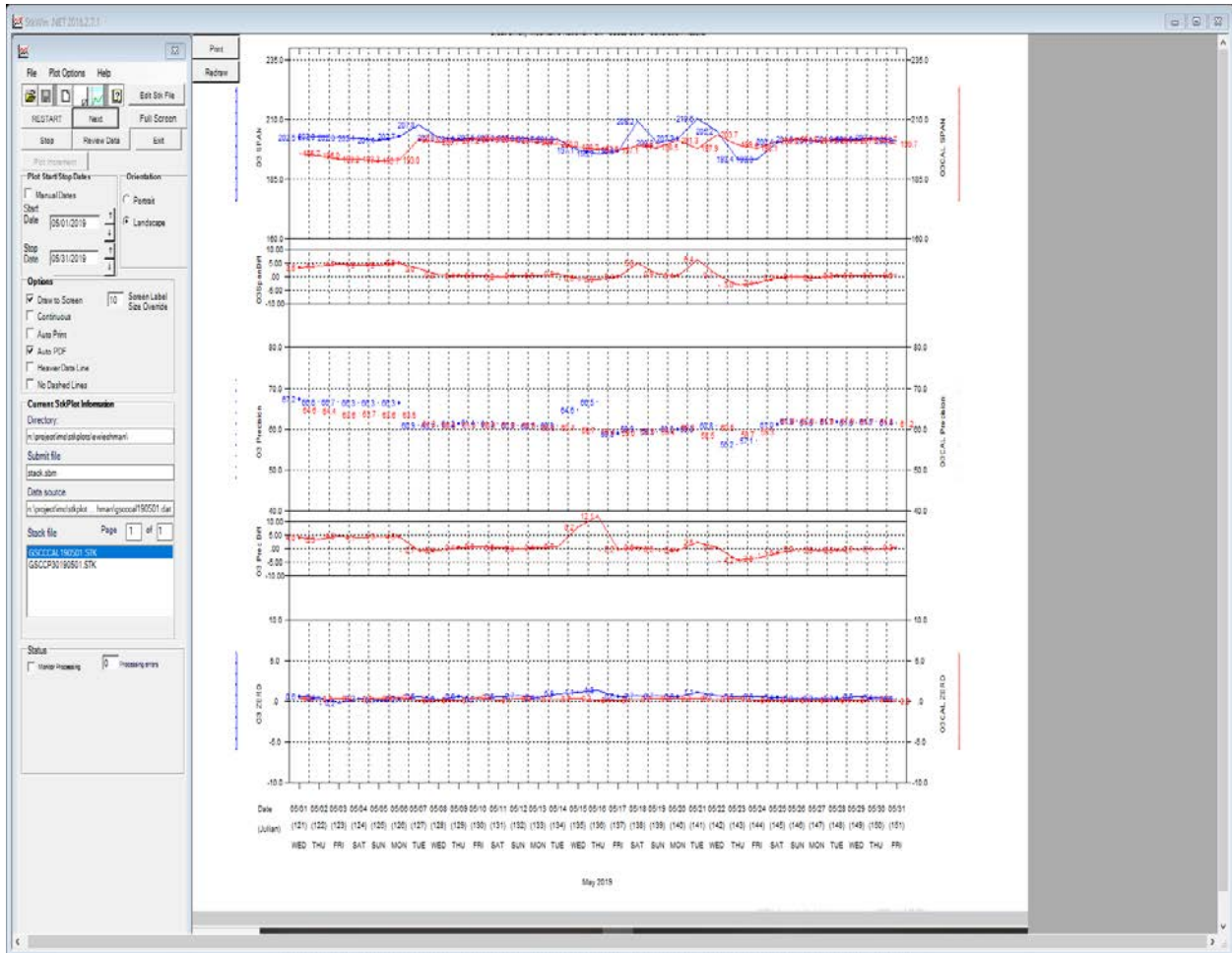
These "bad" precision checks were invalidated because the precision check changed suddenly at the end of the check and therefore we don't believe they ran correctly.
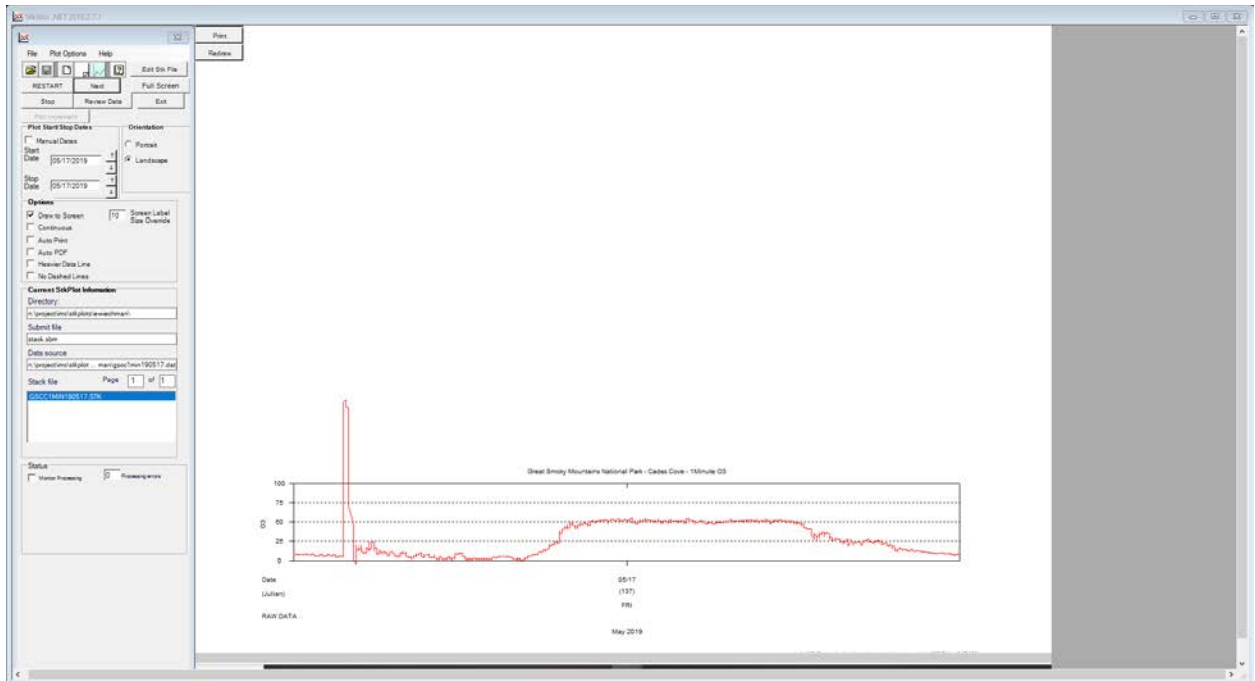
Good O3 precision check

- GRSM-CD 7/2021

DVL: O3 cals invalid 7/2 - 7/4 and 7/27. Mike Slate was in agreement that these poor cals were due to calibrations not having enough time to settle out that the cals should be invalid and ambient data left valid.
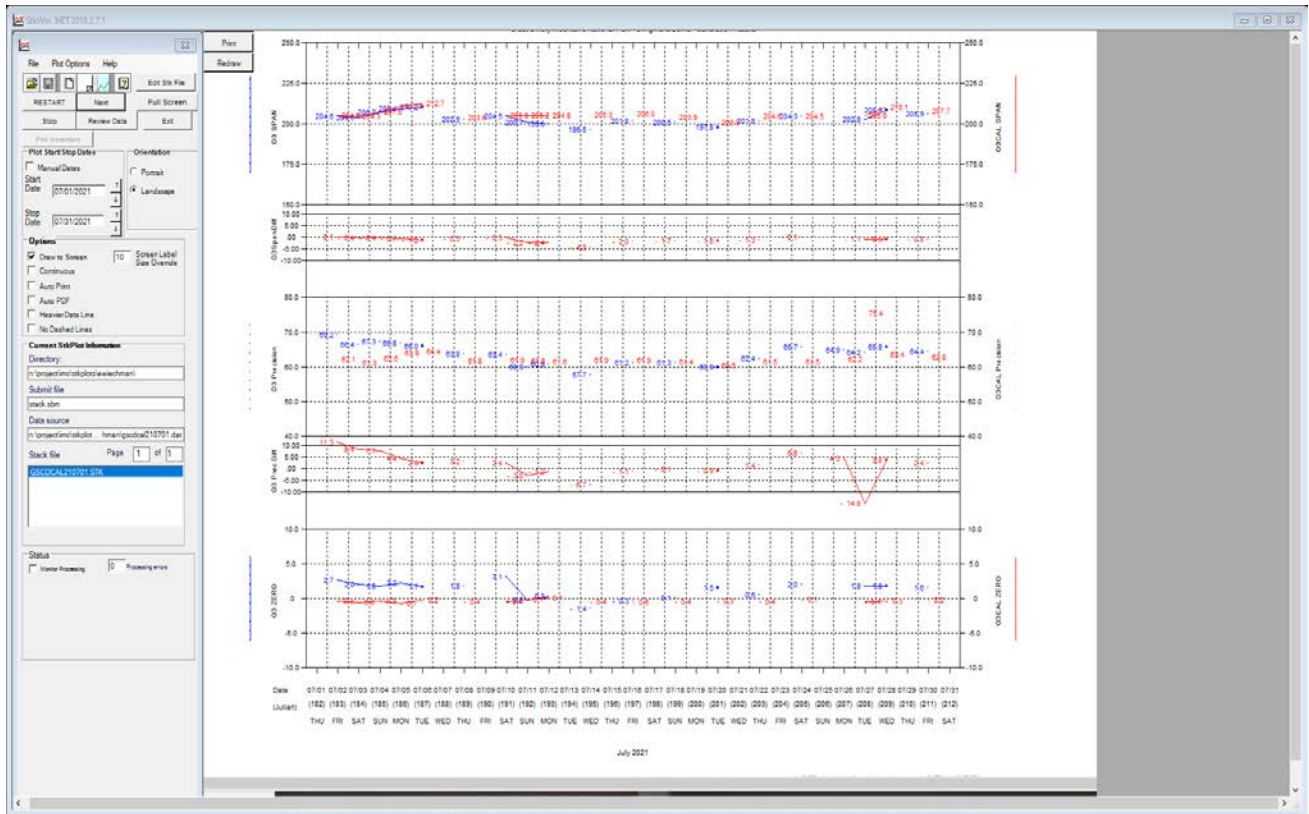
This is an example of the calibration checks being invalidated because ARS believed the calibration checks did not have enough time to "settle."
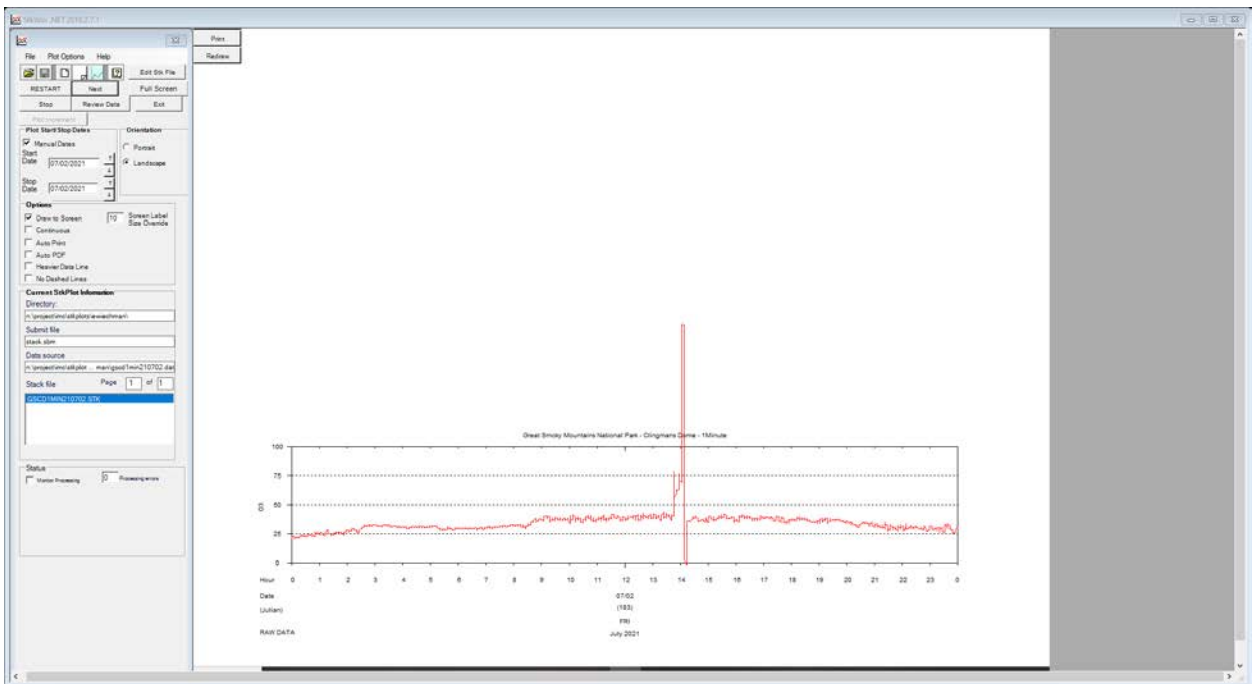


7/2/21 - Poor O3 precision check
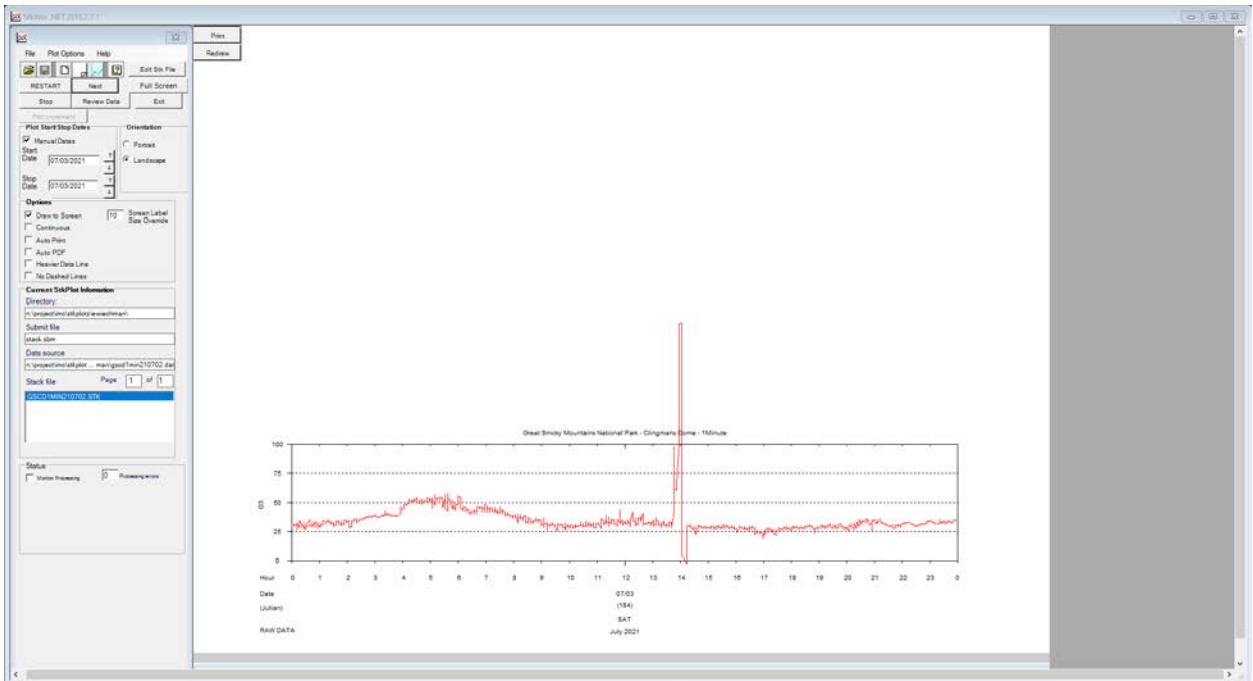
7/3/21 – Poor O3 precision check
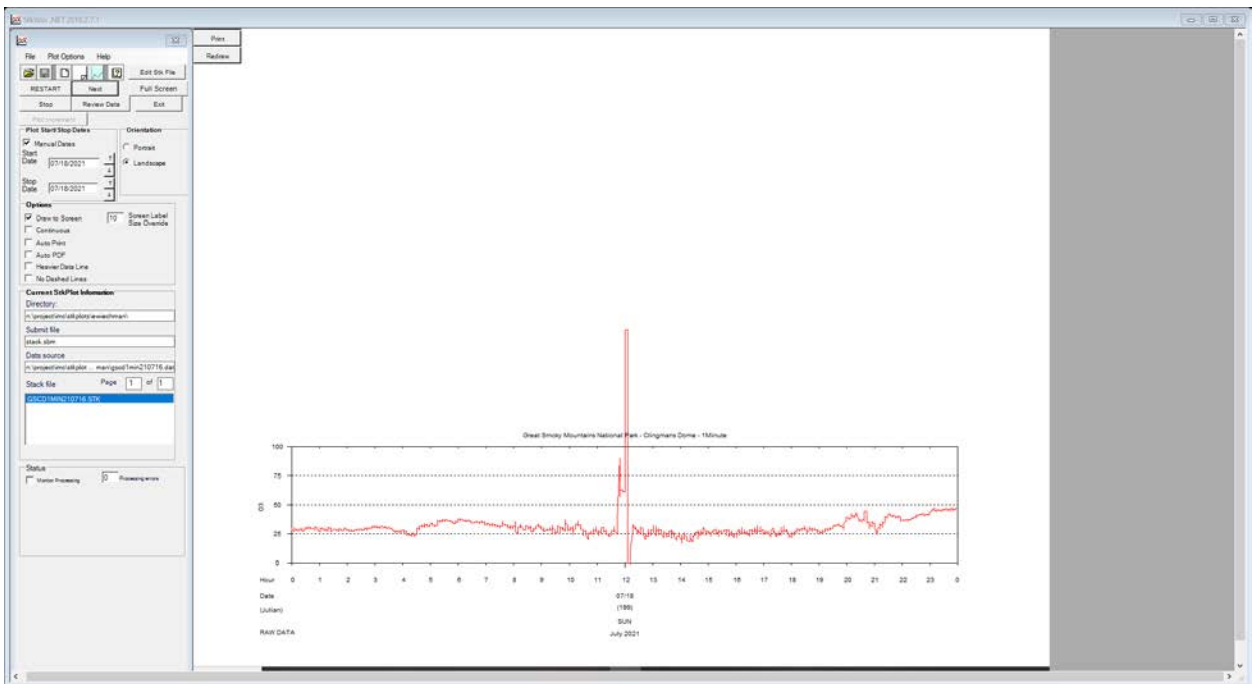


7/18/21 - Good O3 precision check

**Precip Examples:**

From Spring Creek August 2021 data validation log:

Precip looked somewhat suspicious for multiple hours this month (particularly on 8/8 and 8/23) as RH was relatively low, there was no drop in TMP or SOL, and there were some higher PWS values during these hours as well. I left these hours valid as there is a wind screen at this site and there has been a note made in the past that this site is situated in such a way that the winds should not influence the RNF tipper to tip.

Spring Creek - Wyoming
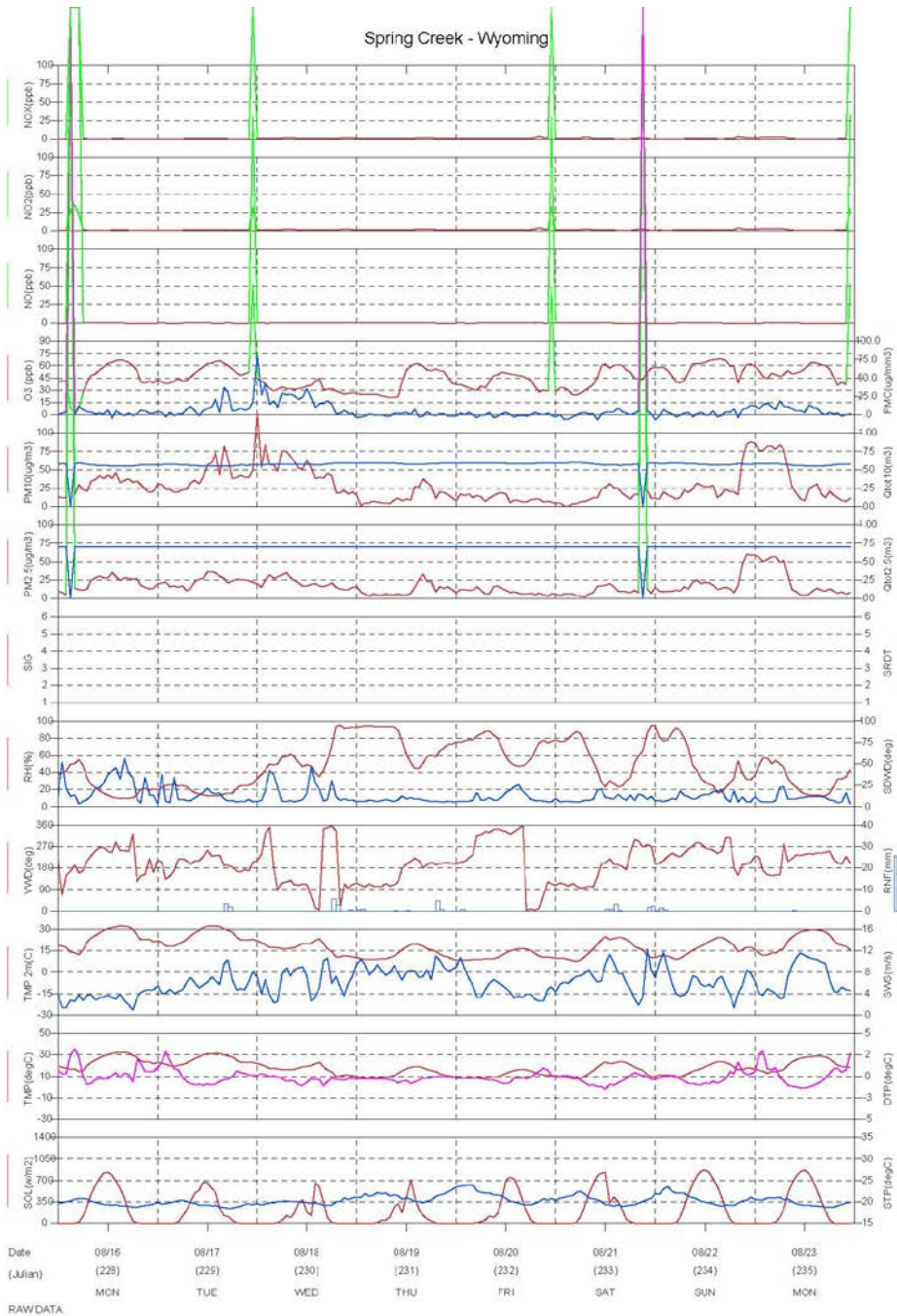
August 2021

Example from WYMO-LR of when to invalidate precip with IN.

I agree that lots of precip data looks suspect this month. I did a quick comparison to Laramie data in weather underground and found that each time precip looks real it matches this station very well. Each time it looks suspect no precip was recorded. Based on this I invalidated a lot of precip this month. There were times where the tip looked suspect but winds weren't that strong, but looking at PWS there were big gusts each time I questioned this. I compared July as well for good measure. I think July is fine.

Wyoming Mobile - Laramie I-80 - Val Review
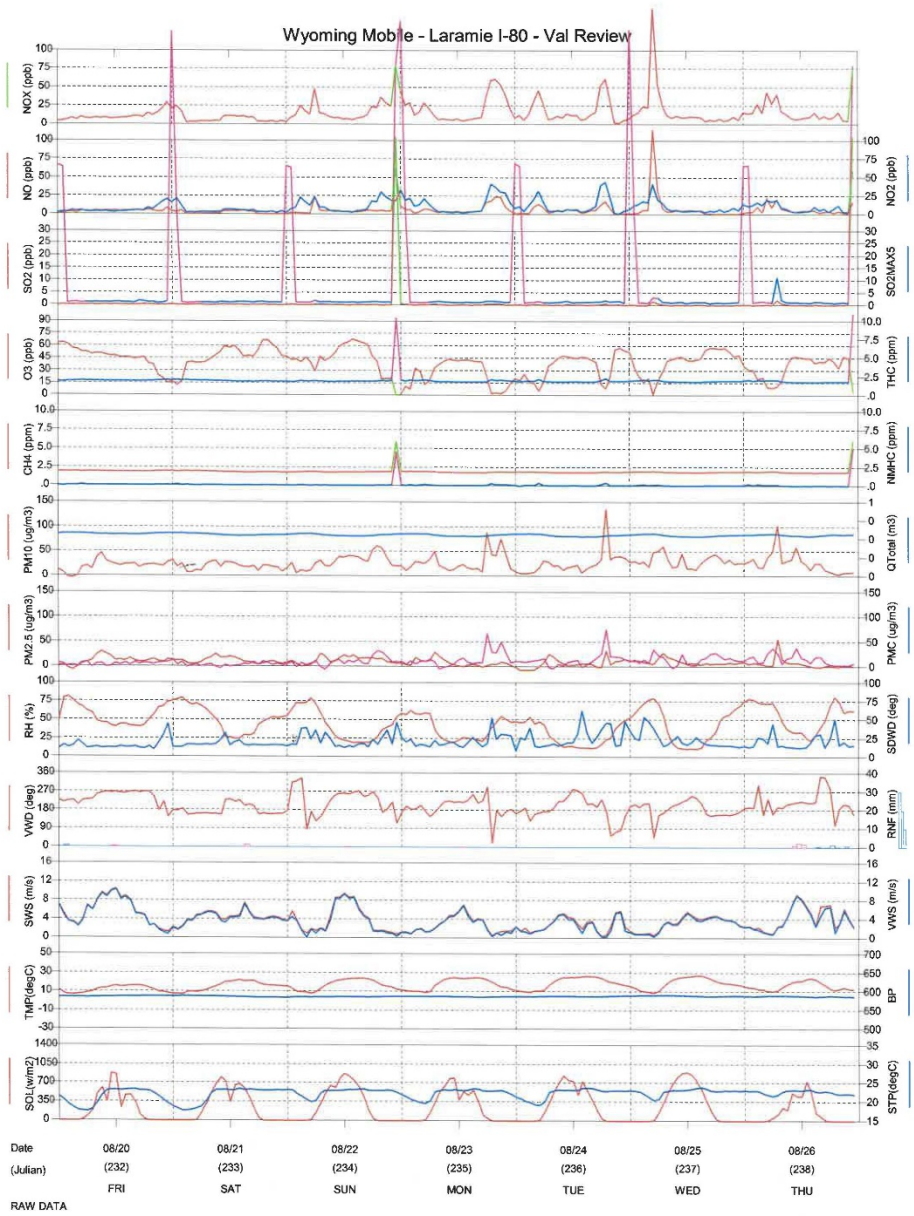
August 2021

**Frozen (or not so frozen) wind examples:**

Example of obvious case of frozen winds

Fortification Creek - WARMS Network Valid Review

March 2020
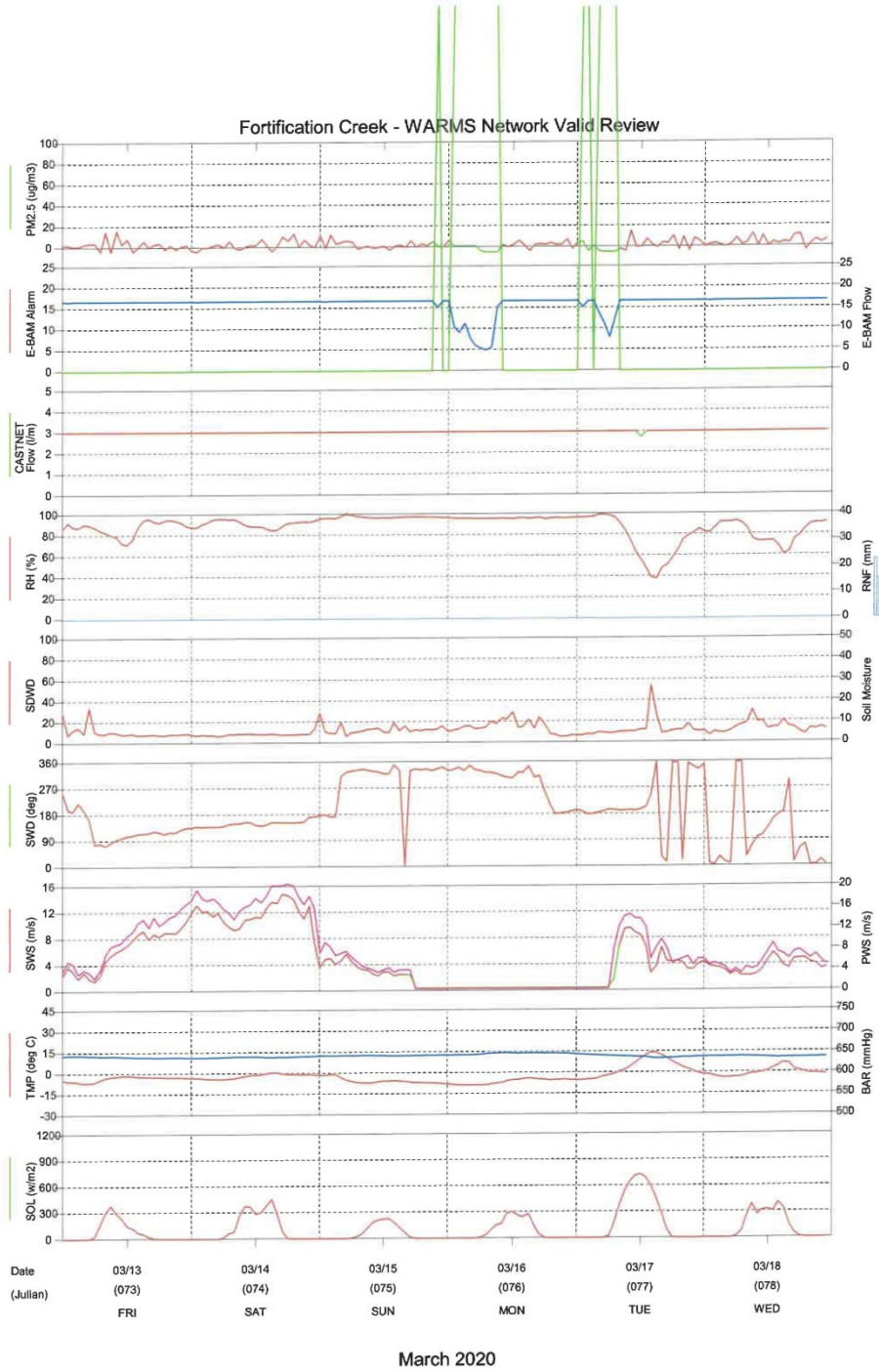
Example of a site that often has stale winds – summertime example

Glacier National Park

August 2021
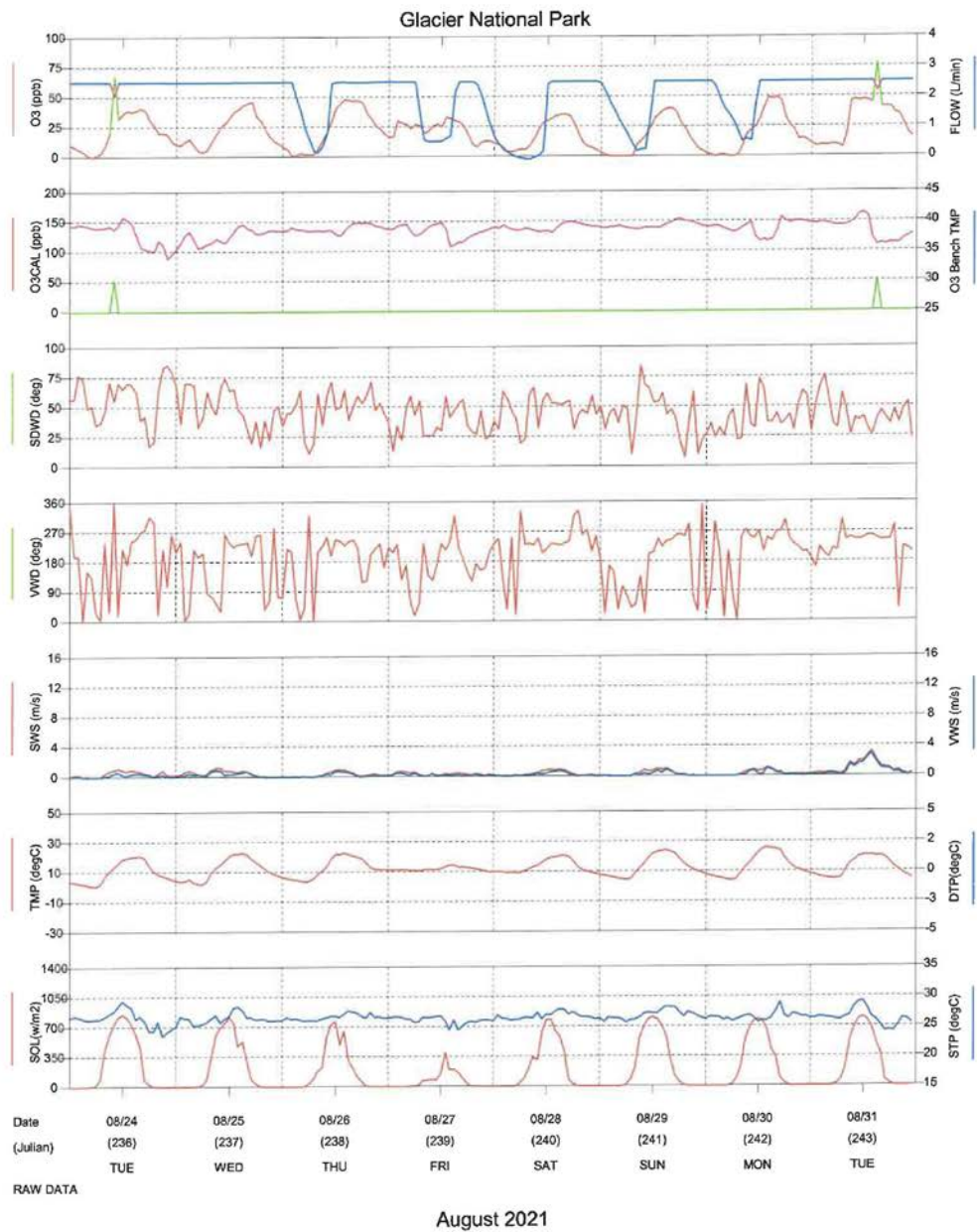
Example of a site that often has stale winds – wintertime example
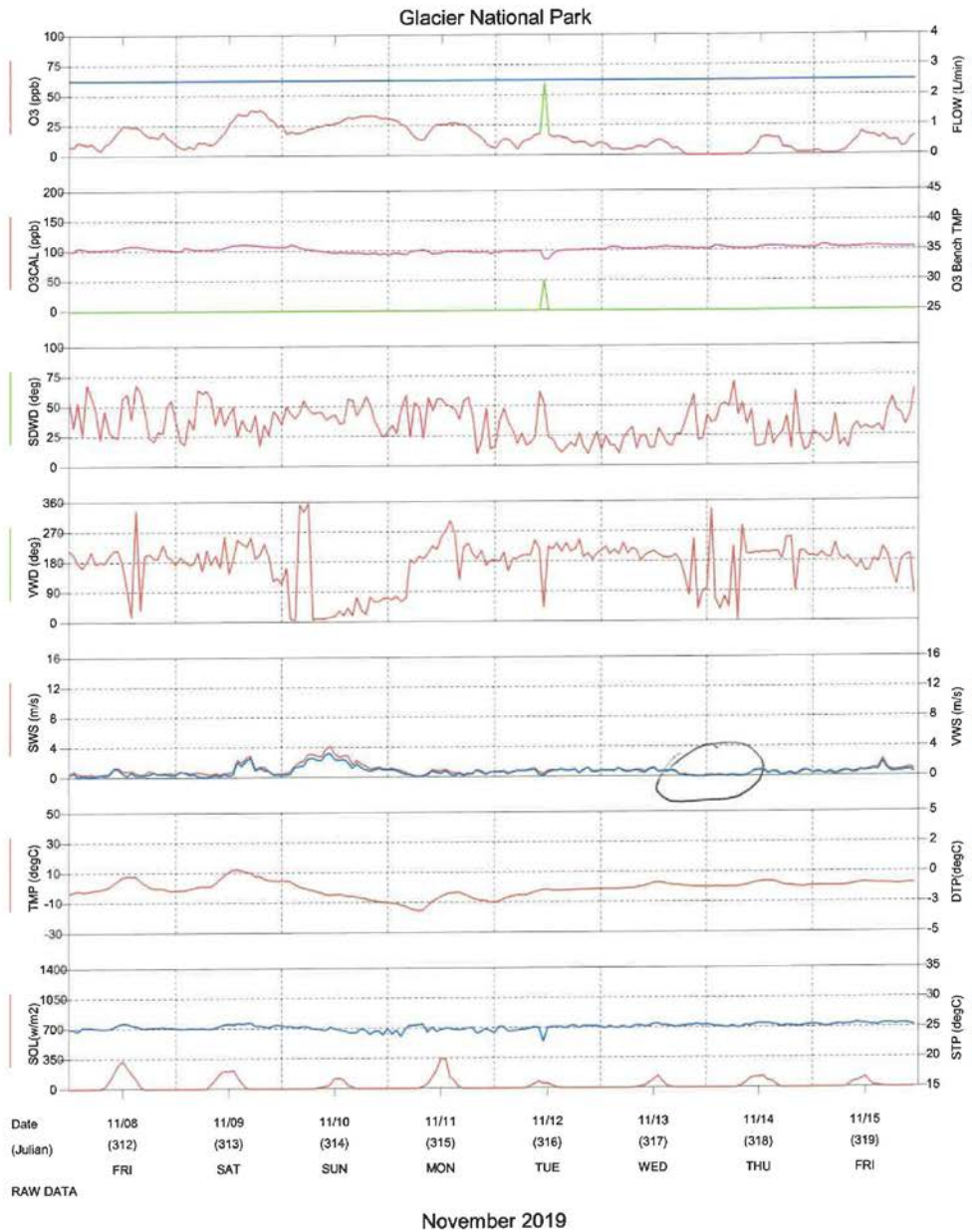
Example of s site with a lesser quality wind sensor that has a higher starting threshold
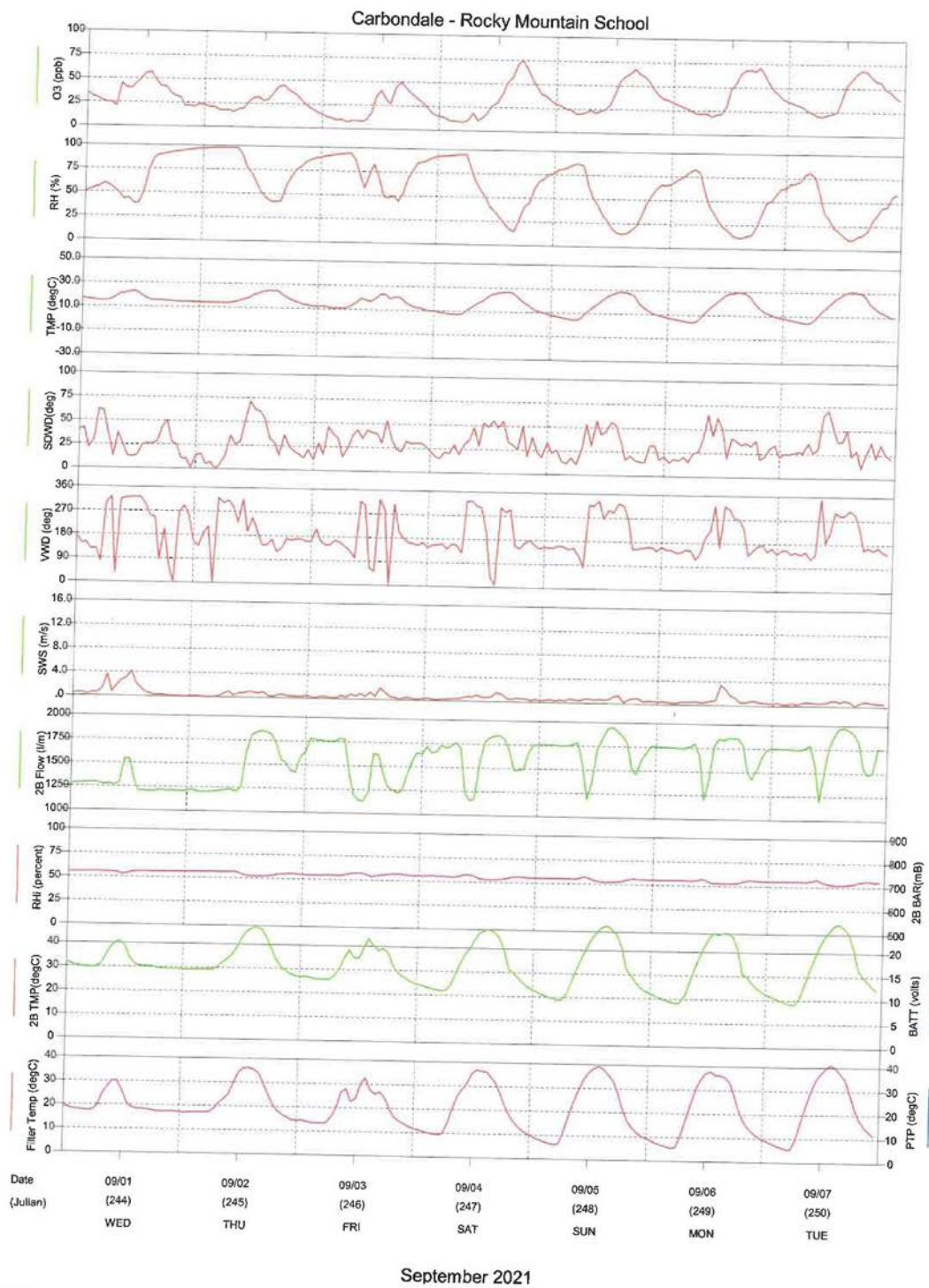
Example of a site where WD is frozen and WS is not, but WS still needs to be invalidated due to the type of sensor (RM Young)

# Copper King - Meteorological Station
## Raw Hourly Data



| Date | 05/08 | 05/09 | 05/10 | 05/11 | 05/12 | 05/13 | 05/14 | 05/15 |
|---|---|---|---|---|---|---|---|---|
| (Julian) | (128) | (129) | (130) | (131) | (132) | (133) | (134) | (135) |
| | SAT | SUN | MON | TUE | WED | THU | FRI | SAT |

RAW DATA
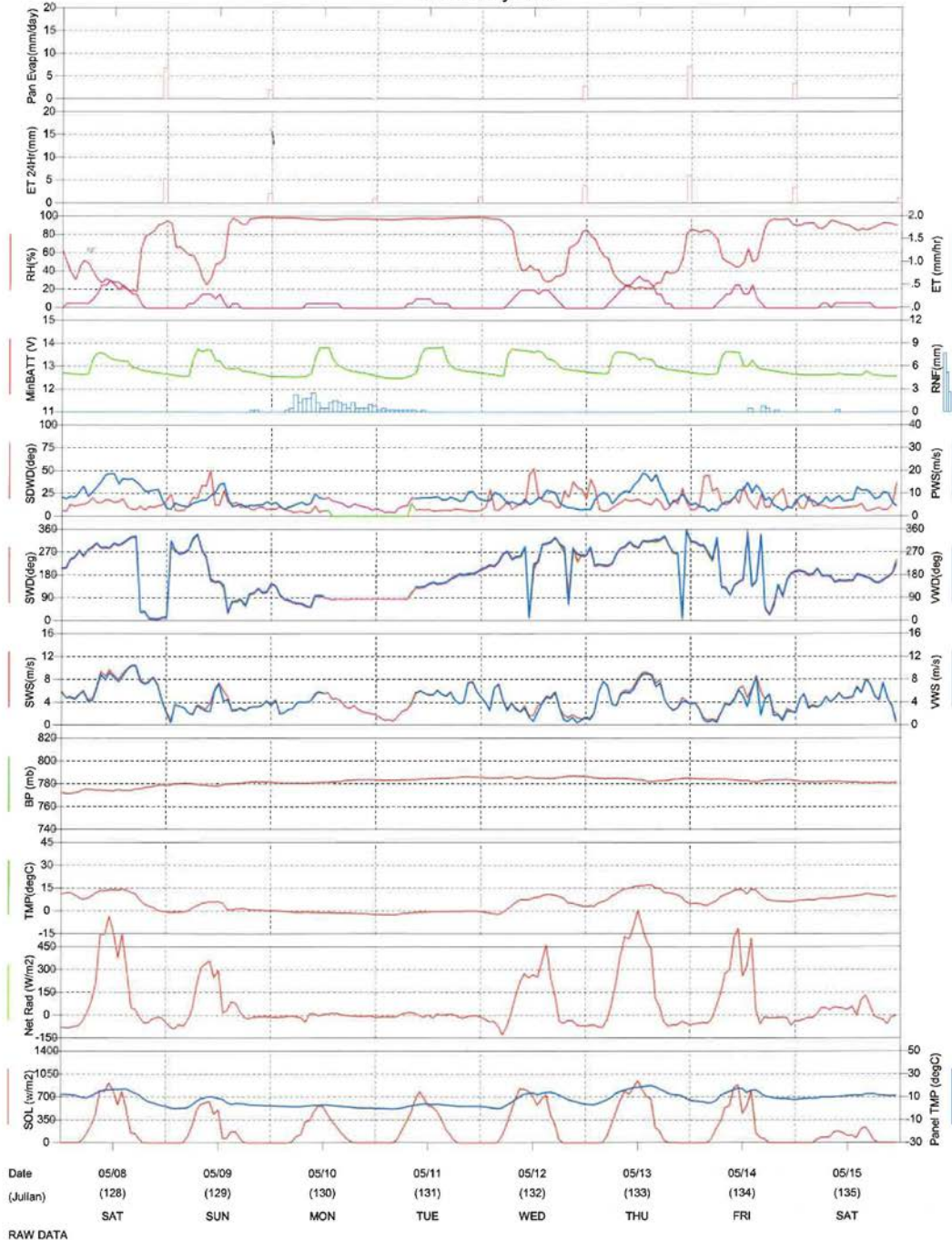
May 2021

## 3rd Levels – Common Mistakes to Check For

- If calibrations are poor verify that there's a note in the data validation log explaining why data were or were not invalidated based on calibration results.
- Verify that the data validation log has enough detail documenting issues. Don't just state that there was an issue, say why. Spell out your thought process behind invalidating data.
- Verify that times when it appears that the site operator was on site but it wasn't recorded in the station logs are annotated with "site visit?".
- Check that if a calibration was performed on a parameter during a SAM (such as winds) the parameter is invalidated during the appropriate hours even if it's not flagged.
- Check that codes are consistent from 1 month to the next (e.g nightly cals).
- Check that if a gaseous parameter was invalidated due to the minute trace the minute trace is printed and in the misc. folder.
- Check that all gases are above the minimum threshold and solar data are >= zero.
- Review power failure logs not just power failure flags to determine which hours to code with PF.
- Verify that the correct codes were used for an audit versus a regular site visit.
- Don't ignore comments in the station logs – thoroughly investigate and document. When done put a note in the data validation log as to what you discovered.
- Erase marks for level 0 review.
- Check station temperature limits and verify that all gaseous analyzer are operating within approved limits.
- Check validation codes to make sure they match the stackplot annotations.
- Make sure any calibration data that are -999 are invalidated in the calibration table in the AQDBMS.

*Data validation note – If you find a problem when working on a preliminary or 3rd level validation that would not be noticeable during daily stackplot review, check to see if the problem is still occurring and if so open a problem report.

# Calibration Shapes

Multipoint Calibration (CA)
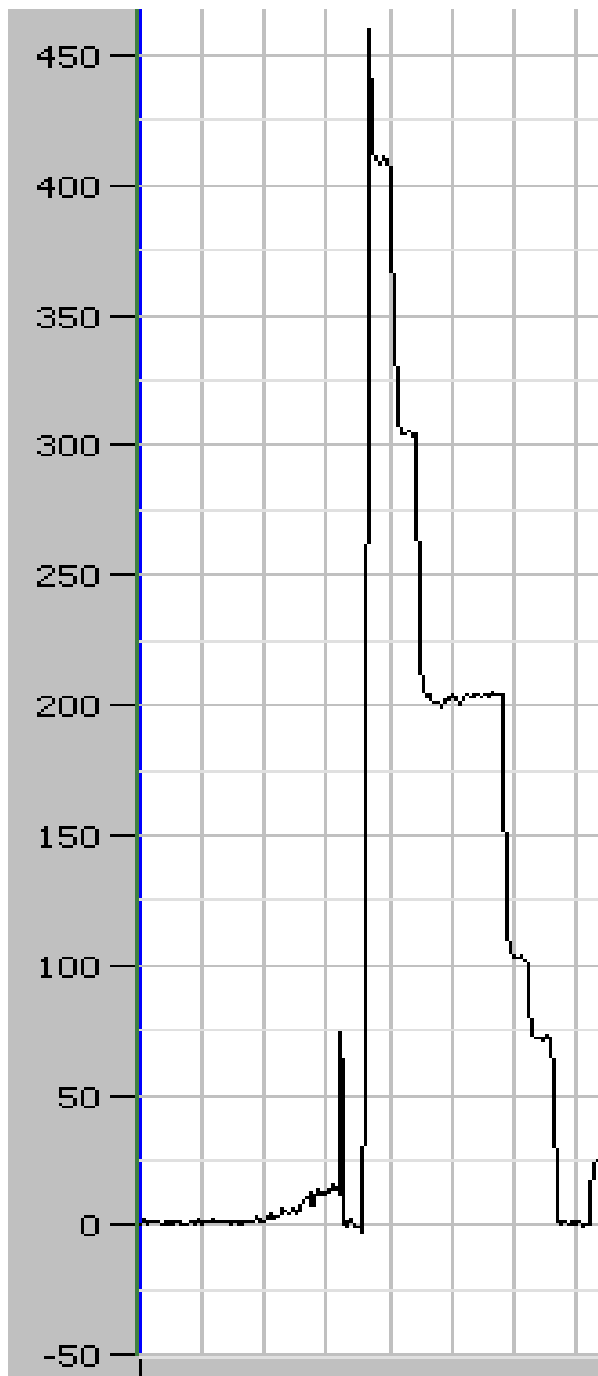
Span/Zero and Precision (ZS and PC)
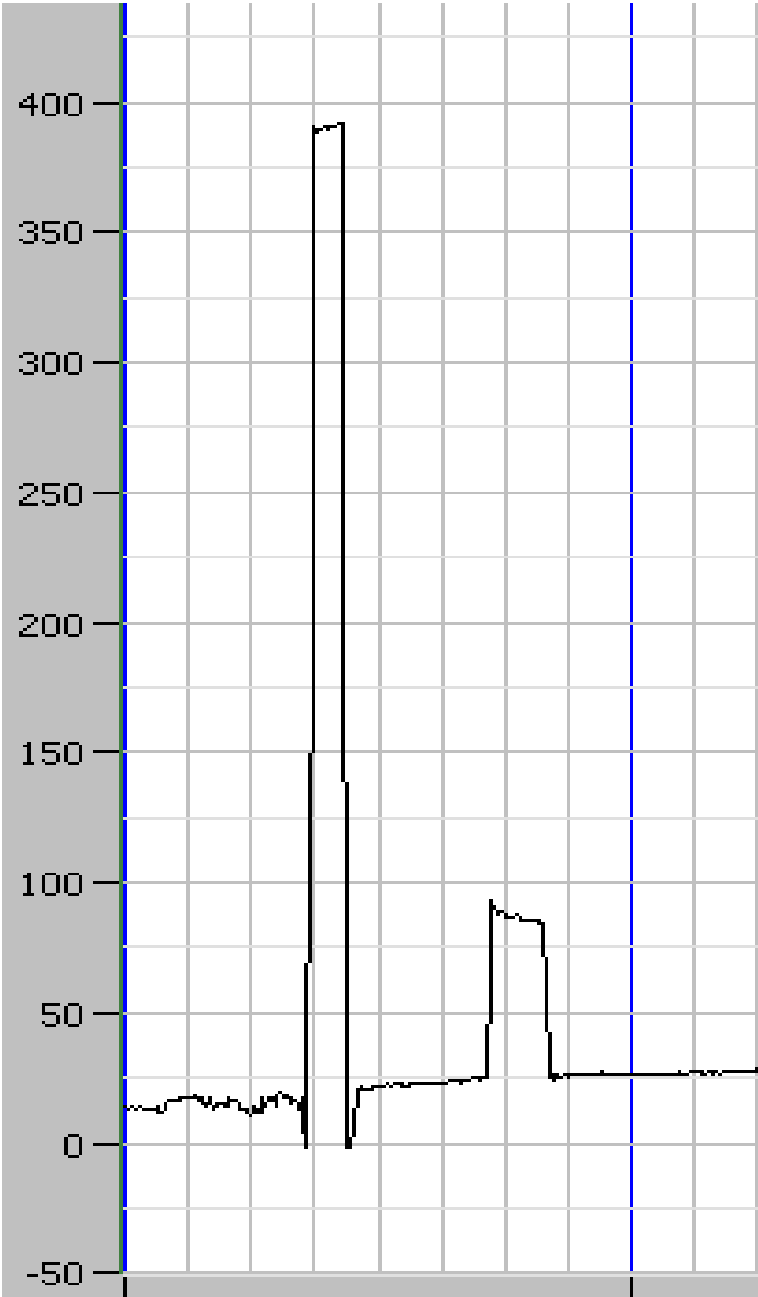
Precision/Span/Zero (SC)
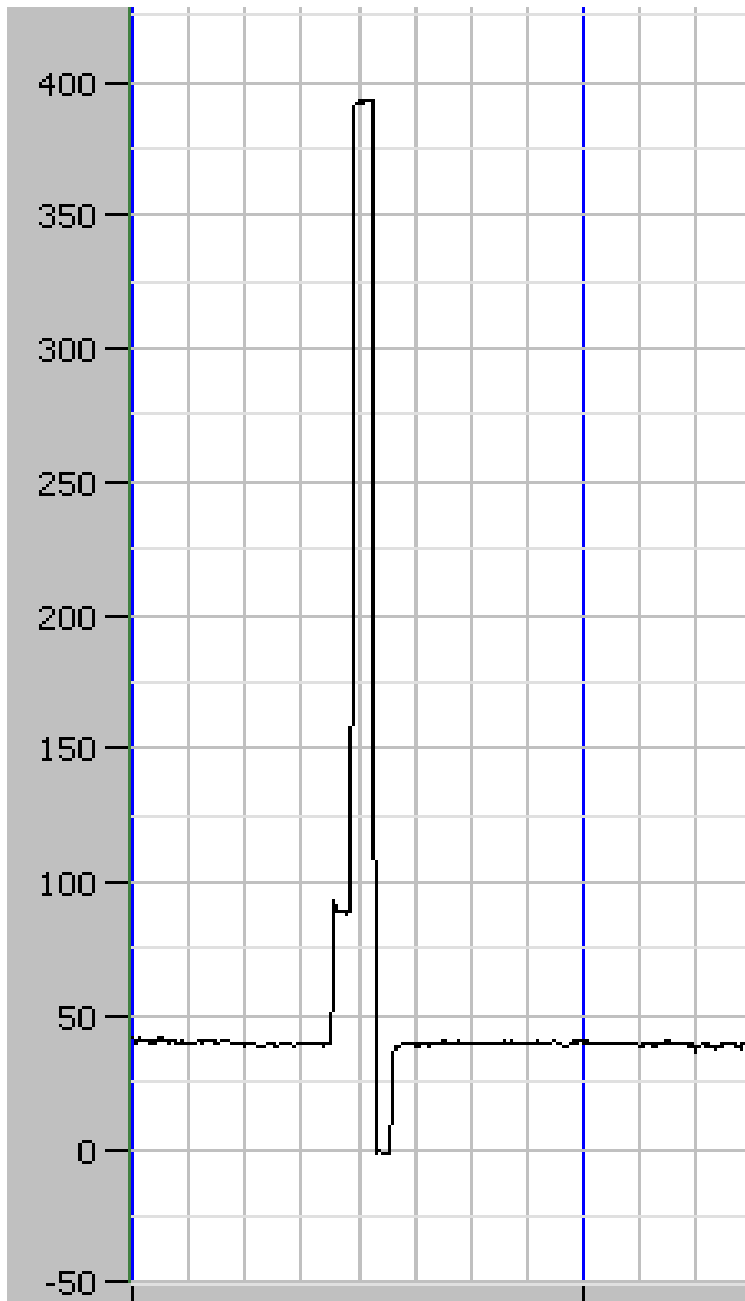
## Items to Check for Evidence of Moisture in a BAM

- Erratic readings or unusual spikes
- High RH or precipitation
- High winds
- Photos showing blowing snow or whiteout conditions
- Water in the inlet jar
- Increase or fluctuations in the BAM RH
- Error codes, especially any that are RH related
- Pictures of the inlet with snow or water in it
- Pictures of the BAM tape showing moisture damage

**Minute Trace Drop**
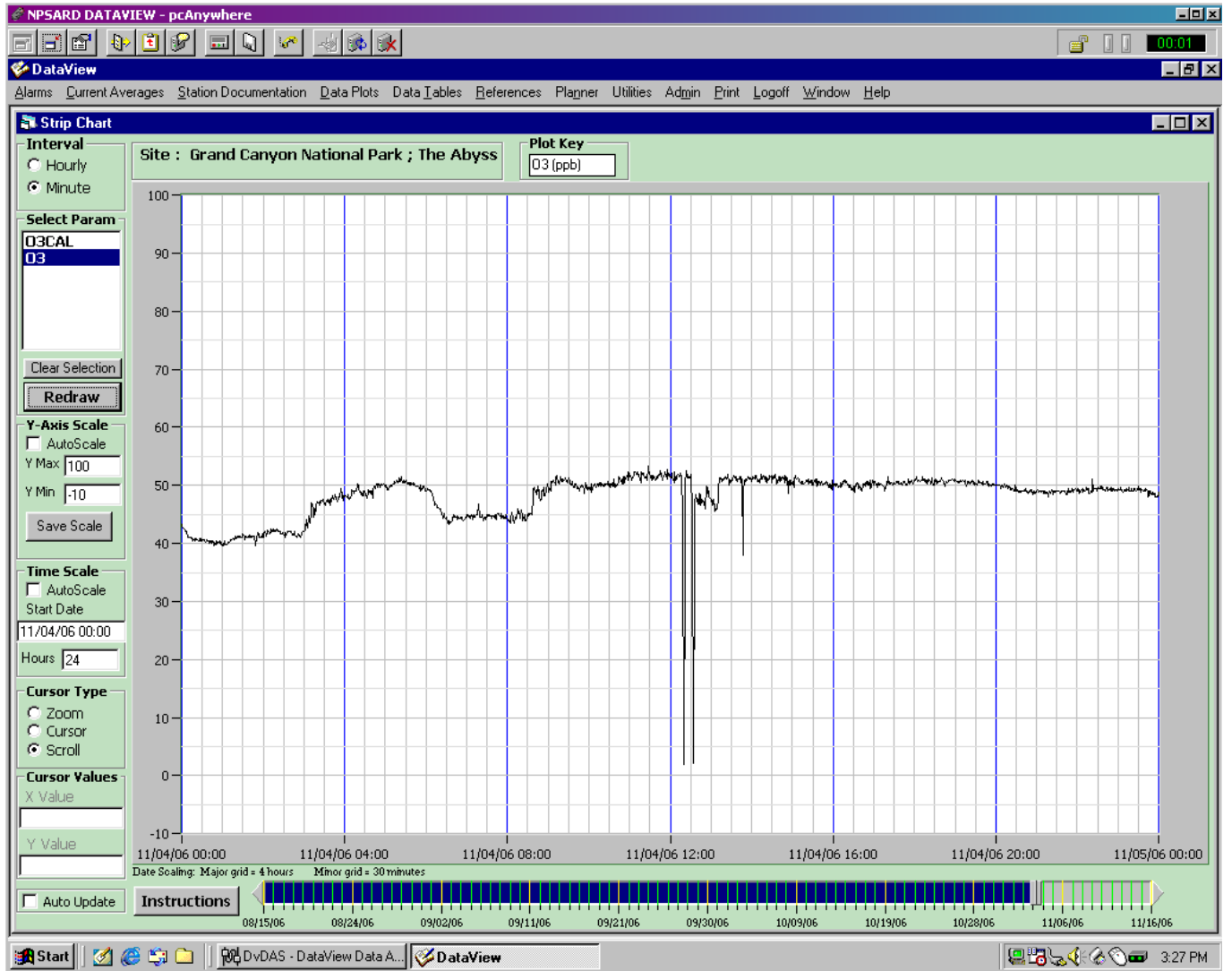
# Noise Example
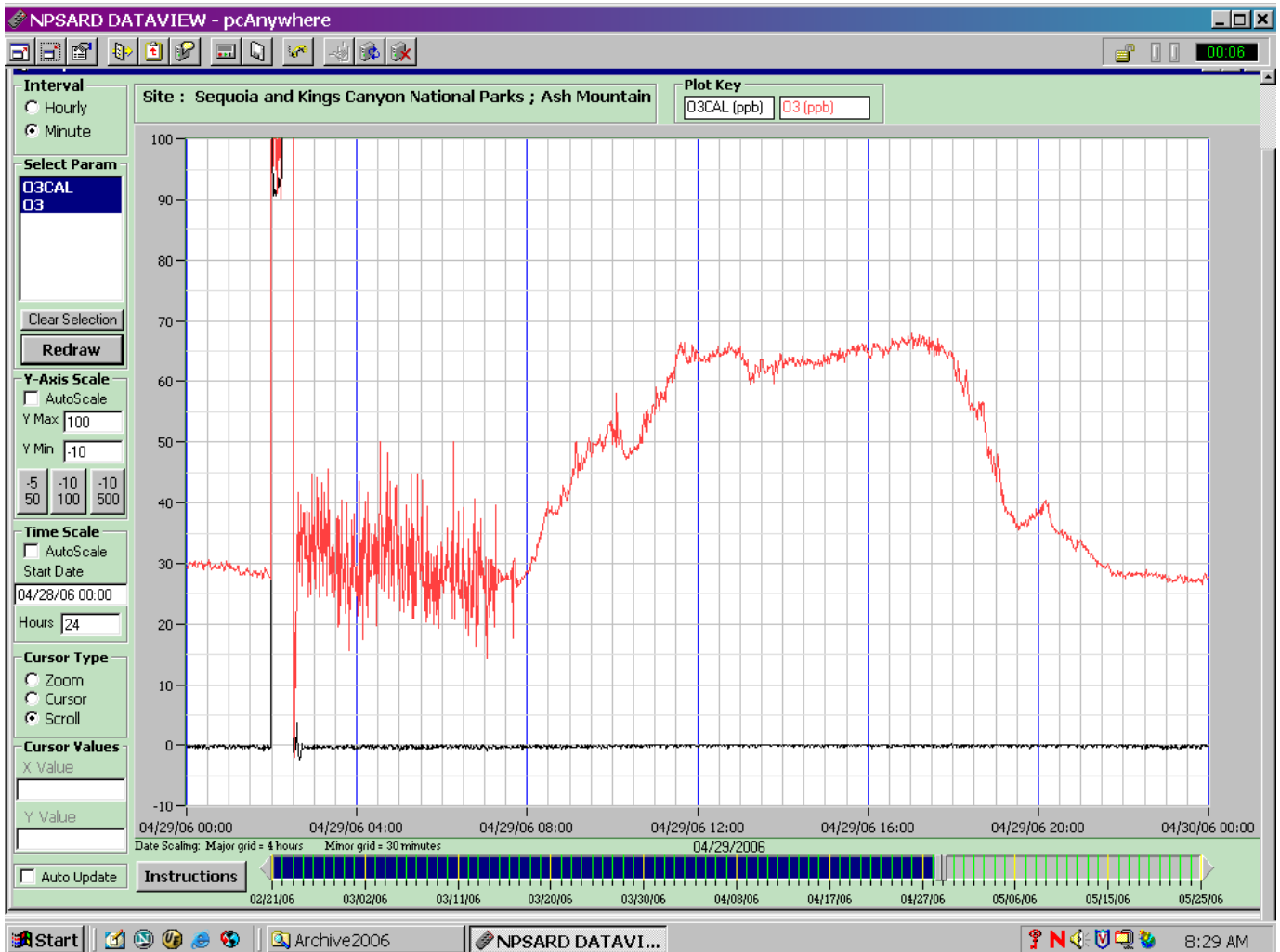
## Notes on NO, NO$_x$, NO$_2$ Data Validation

1.  The instrument is only capable of measuring NO. NO$_x$ is determined by converting any ambient NO$_2$ to NO. This converted NO is then combined with the original NO and measured as NO$_x$. NO$_2$ is a calculation (NO$_2$ = NO$_x$ – NO.) The instrument assumes anything it measures besides NO is NO$_2$.

2.  If NO is invalidated for any reason, NO$_x$ and NO$_2$ must be invalidated with the same invalidation code. NO$_x$ and NO$_2$ can be invalid but NO be valid.

3.  When making data adjustments to any one of these parameters (NO, NO$_x$ or NO$_2$) the relationship between the other parameters must be considered.

    Rule of thumb for NO, NO$_x$, and NO$_2$ data adjustments:
    *   When NO and NOx calibration results are both outside of acceptable limits both parameters should be adjusted by the same amount. NO$_2$ values do not need adjustment.
    *   If only one of the parameters (NO or NO$_x$) is outside of tolerance then that parameter plus NO$_2$ need to be adjusted.

4.  During a span calibration event the NO$_2$ response should be zero. The results should be NOx = 400, NO = 400, NO$_2$ = 0. The NO$_2$ output is challenged by adding ozone to an NO mixture, converting some of the NO to NO$_2$. This is known as a GPT (gas phase titration of NO with ozone). NO$_x$ values should remain stable throughout a GPT. NO and NO$_2$ values will be inverse (NO will fall, NO$_2$ will increase) as ozone is added to an NO gas dilution. A NO$_2$ precision check will result in NO$_x$ = 400, NO = 310, NO$_2$ = 90.

## Min/Max Adjustments

| Parameter | Max Value | Max Adjust | Min Value | Min Adjust |
|---|---|---|---|---|
| SWS (Climatronics) | none | none | 0.2 | none |
| SWS (RM Young) | none | none | 0 | none |
| VWS | none | none | 0 | none |
| VWD | 360 | none | 0 | none |
| SWD | 360 | none | 0 | none |
| SDWD | 104 | none | 0 | none |
| TMP | none | none | none | none |
| DTP | none | none | none | none |
| RH | 100 | 105 | 0 | -5 |
| RNF | none | none | 0 | none |
| STP | none | none | none | none |
| SOL | none | none | 0 | -14 |
| FLOW | none | none | 0 | -1 |
| O3CAL | none | none | 0 | -30 |
| WET | 100 | none | 0 | -5 |
| UV | none | none | none | none |
| O3 | none | none | see AQS | none |
| SO2 | none | none | see AQS | none |
| SO2 5-minute | none | none | see AQS | none |
| SO2 5-minute (trace level) | none | none | see AQS | none |
| NO/NO2/NOX | none | none | see AQS | none |
| PM (TEOM) | none | none | -50 | none |
| PM10 (METONE BAM) | none | none | -5 | none |
| PM2.5 (METONE BAM) | none | none | -10 | none |
| PMC (METONE BAM) | none | none | -10 | none |
| PM10 (TECO BAM) | none | none | -8 | none |
| PM10 (TEI BAM) | none | none | -8 | none |
| PM (E-Sampler) | none | none | -10 | none |
| PM (E-BAM) | none | none | -10 | none |

## Temperature Limits – Gas

| Parameter | Instrument Type | Lower Temperature Limit (°C) | Upper Temperature Limit (°C) |
|---|---|---|---|
| Ozone | Dasibi 1003 | 20 | 30 |
| | TECO 49 | 5 | 40 |
| | Teledyne API 400E | 5 | 40 |
| | Monitor Labs 8810 | 20 | 30 |
| | Meloy 0A325-2R | 20 | 30 |
| | McMillan 1100-1 | 20 | 30 |
| | 2B | N/A | N/A |
| Sulfur Dioxide | TECO 43 | 20 | 30 |
| | Thermo 43I-TLE | 20 | 30 |
| | API 100EU | 5 | 40 |
| | Monitor Labs 8850 | 20 | 30 |
| Oxides of Nitrogen | TECO 42, 42C | 15 | 35 |
| | TECO 42S | 20 | 30 |
| | Teledyne API Model 200A | 5 | 40 |
| | Teledyne API Model 200E | 5 | 40 |
| | Teledyne API Model 200EU | 20 | 30 |
| | Teledyne API T500U | 5 | 40 |
| Carbon Monoxide | Thermo Electron 48 or 48C | 20 | 30 |
| | Thermo 48I-TLE | 20 | 30 |
| | API 300EU | 10 | 40 |

## Validation Acceptance Criteria by Project

| | NPS | WDEQ-AQD Tier 1 | WDEQ-AQD Tier 2 | WDEQ-AQD PSD | WDEQ-AQD NCore | Garfield County | CDPHE-APCD | WARMS | Aethon Energy, Wyoming | Clean Harbors |
|---|---|---|---|---|---|---|---|---|---|---|
| T/dT Temperature (deg C) (immersible) | 1.0 | 1.0 | 0.54 | 0.54 | 0.54 | 1.0 | 0.54 | 1.0 | 1.0 | 1.0 |
| T/dT Vertical Temperature (deg C) | N/A | N/A | 0.14 | 0.14 | 0.14 | N/A | 0.14 | N/A | 0.14 | |
| Station Temperature (deg C) | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | | 2.0 | 2.0 | |
| Barometric Pressure (mmHg) | 3 | 2.25 | 2.25 | 2.25 | 2.25 | 2.25 | | 2.25 | 2.25 | |
| AT Temperature (deg C) (collocated) | 1.0 | 1.0 | N/A | N/A | N/A | 1.0 | 0.5 | 1.0 | N/A | |
| Relative Humidity (% RH) | 10% | 10% | 10% | 7% | 7% | 10% | | 10% | 10% | |
| Wind Speed (m/s) | 0.25 | 0.25 | 0.25 | 0.20 | 0.25 | 0.25 | 0.2 | 0.25 | 0.25 | 0.25 |
| Wind Speed (%) | 5% | 5% | 5% | N/A | 5% | 5% | 5% | 5% | 5% | 5% |
| WS Starting Threshold* | * | * | * | * | * | * | * | * | * | * |
| WD Maximum Total Alignment (degrees) | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 |
| Vertical Wind Speed (m/s) | N/A | N/A | N/A | 0.2 | 0.2 | | | | | |
| UV Mean Difference (%) | N/A | N/A | N/A | 5.0% | N/A | | | | | |
| Rainfall (%) | 10% | 10% | 10% | 10% | 10% | 10% | 10% | 10% | 10% | 10.0% |
| Solar Mean Difference (%) | 10% | 10% | 10% | 10% | 5% | | 10% | 10% | 10% | |

* Wind speed starting threshold acceptance criteria is sensor dependent

**Validation Acceptance Criteria by Project (continued)**

| | Evraz Rocky Mountain Steel | Sinclair Casper Refining Co | Mountain Cement | Colorado BLM-Paonia | Colorado BLM-White River | City of Aspen | US Forest Service | Extraction Oil & Gas | PSD | SLAMS |
|---|---|---|---|---|---|---|---|---|---|---|
| T/dT Temperature (deg C)  (immersible) | 0.54 | | 1.0 | 1.0 | | | | 0.54 | 0.54 | 1.0 |
| T/dT Vertical Temperature (deg C) | 0.14 | | | N/A | | | | 0.14 | 0.14 | 0.14 |
| Station Temperature (deg C) | 2.0 | 2.0 | | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 |
| Barometric Pressure (mmHg) | 2.25 | 2.25 | | 2.25 | 3 | | | 2.25 | 2.25 | 2.25 |
| AT Temperature (deg C) (collocated) | N/A | 1.0 | 1.0 | 1.0 | 1.0 | | 1.0 | 0.5 | 0.5 | 1.0 |
| Relative Humidity (% RH) | 7% | 10% | | 10% | 10% | | 10% | 7% | 7% | 10% |
| Wind Speed (m/s) | 0.20 | 0.25 | 0.25 | 0.25 | 0.25 | | 0.25 | 0.20 | 0.20 | 0.25 |
| Wind Speed (%) | N/A | 5% | 5% | 5% | 5% | | 5% | N/A | N/A | 5% |
| WS Starting Threshold* | * | * | * | * | * | * | * | * | * | * |
| WD Maximum Total Alignment (degrees) | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | | 5.0 | 5.0 | 5.0 | 5.0 |
| Vertical Wind Speed (m/s) | | | | | | | | 0.2 | 0.2 | |
| UV Mean Difference (%) | | | | | | | | | 5.0% | |
| Rainfall (%) | 10.0% | | | 10.0% | 10.0% | | 10.0% | | 10.0% | 10.0% |
| Solar Mean Difference (%) | 5.0% | | | 10.0% | 10.0% | | 10.0% | | 5.0% | 10.0% |

* Wind speed starting threshold acceptance criteria is sensor dependent

# Validation Rules by Parameter

| | |
|---|---|
| Scalar Wind Speed (SWS) | Acceptable values are 0.2 m/s and higher for Climatronics, 0.0 m/s and higher for RM Young. |
| | Value can be equal to, but never less than VWS. |
| | If SWS is invalidated for any reason VWS must be invalidated with the same invalidation code.  VWD and SDWD must also be invalidated with the same invalidation code.  If the SWS failure is due to a datalogger failure then all wind parameters are likely invalid. |
| Vector Wind Speed (VWS) | Acceptable values are 0.0 m/s and higher. |
| | VWS can never be greater than SWS since VWS has a directional component. |
| | VWS is calculated directly from VWD and SWS and cannot be invalidated by itself (unless due to a RF).  If invalidated it is because either SWS or VWD is invalid. |
| Scalar Wind Direction (SWD) | If SWD is invalidated for any reason VWS, VWD and SDWD must be invalidated with the same validation code. |
| Vector Wind Direction (VWD) | If VWD is invalidated for any reason VWS and SDWD must be invalidated with the same validation code (unless the site is also monitoring SWD and SWD is used to compute VWS). |
| Standard Deviation of Wind Direction (SDWD) | SDWD is not a direct measurement, it is a calculation of how much the wind direction deviates from the average for the hour and cannot be invalidated by itself (unless due to a RF). |
| | If SDWD is flagged <, but SWS and VWD are flagged >, SDWD is invalid for that hour (this can occur because the 75% rule works differently for this channel since it's a calculation). |
| | If WD is invalid for any reason, SDWD must be invalidated with the same invalidation code. |
| | SDWD has to have only one valid minute of VWD to calculate from a Campbell datalogger. |
| Temperature (TMP) | If TMP is invalidated for any reason DTP must be invalidated with the same invalidation code. |
| | Temperature sensor is generally located at a height 2m, but can vary by project and site. |
| Delta Temperature (DTP) | DTP is the difference between the upper and lower temperature probes (top - bottom). |
| | The lower temperature probe is generally located at a height 2m. |
| | DTP is invalid whenever either the upper or lower sensor is bad. |
| Relative Humidity (RH) | Values are accepted to a maximum of 105%.  If the value for an hour is greater than 105% that data point is invalidated with 'IM'.  Values between 100% and up to 105% are adjusted to 100%. |
| | Values are accepted to a minimum of -5%.  If the value for an hour is less than -5% that data point is invalidated with 'IM'.  Values between 0% and as low as -5% are adjusted to 0%. |
| Solar Radiation (SOL) | Night time values are accepted to within 1% of full scale of the instrument.  (In most cases full scale is 1396 w/m$^2$, so values are accepted to within +/- 14 w/m$^2$.) |
| | Any night time value that is outside of +/- 1% of full scale causes the entire day to be invalidated with 'IM' (or until a known point at which the issue was fixed). |
| | Night time values between 0 and -14 (or between 0 and -1% of full scale) are adjusted to 0.  Night time values between 0 and 14 (or between 0 and 1% of full scale) are not adjusted. |

| | |
|---|---|
| CASTNET Flow(FLOW) | Flow rates should be either 3.0 lpm or 1.5 lpm.  Flow rates lower than the expected value are left valid as long as the reported value is accurate. |
| | Flow values are invalidated with 'MT' when the operator is on site to the replace the filter, and the channel is not flagged.  If the channel is flagged, validate/invalidate based on the flag, regardless of the hourly average. |
| | Flow values are accepted to a minimum of -1.  Values between -1 and 0 are zero adjusted.  Values less than -1 are invalidated. |
| | Other than the reasons listed above, data are only invalidated if there is a known instrument malfunction that effects the accuracy of the value reported.  Instruments malfunctions that effect the flow rate but do not effect the accuracy of the reported value are left as valid. |
| | If the site operator forgets to turn the pump back on after a filter replacement the data are left as valid and the filter analyzed for passive flow. |
| | If a filter is not in place the data are coded as 'NA'. |
| | An acceptable leak check is an MFC display value no more than 0.10 |
| Station Temperature (STP) | Left valid unless there is a known instrument problem.  The 75% rule doesn't apply and therefore flags on this parameter are generally ignored unless they are caused by a problem that would provide an inaccurate hourly average. |
| | Station temperature is monitored only to verify that any gas analyzer on site is operating within manufacturer specifications. |
| Ozone (O3) | Negative values are accepted to the minimum acceptable limit defined in AQS by parameter and method. |
| | There is no maximum acceptance limit, although all high values are thoroughly investigated. |
| | Station temperature must be within the limits set by the manufacturer of the ozone analyzer for ozone to be valid. |
| Sulfur Dioxide (SO2) | Negative values are accepted to the minimum acceptable limit defined in AQS by parameter and method. |
| | Station temperature must be within the limits set by the manufacturer of the $SO_2$ analyzer for $SO_2$ to be valid. |
| Carbon Monoxide (CO) | Negative values are accepted to the minimum acceptable limit defined in AQS by parameter and method. |
| | Station temperature must be within the limits set by the manufacturer of the CO analyzer for CO to be valid. |
| Particulate Matter (PM2.5, PM10) | Negative values are accepted to the minimum acceptable limit defined in AQS by parameter and method. |
| Nitrous Oxides (NO, NOX, NO2) | Negative values are accepted to the minimum acceptable limit defined in AQS by parameter and method. |
| | Station temperature must be within the limits set by the manufacturer of the $NO_x$ analyzer for $NO_x$ to be valid. |
| | If NO is invalidated for any reason $NO_x$ and $NO_2$ must be invalidated with the same invalidation code. |

# Zero-Adjust Thresholds

## Non-Trace Level

| Pollutant | Analyzer | Method Code | MDL (in AQS) | min. value allowed in AQS | ARS adjust threshold (ppb) | Comments |
|-----------|----------|-------------|--------------|---------------------------|----------------------------|----------|
| NO | TECO 42C, 42i | 74 | 10 | -10 | 3 | |
| $NO_2$ | TECO 42C, 42i | 74 | 1 | -1 | 3 | |
| $NO_x$ | TECO 42C, 42i | 74 | 10 | -10 | 3 | |
| NO | API 200A, 200E | 99 | 5 | -5 | 3 | |
| $NO_2$ | API 200A, 200E | 99 | 2.7 | -2.7 | 3 | |
| $NO_x$ | API 200A, 200E | 99 | 5 | -5 | 3 | |
| $O_3$ | 2B | 901 | 0.0015 | -0.0015 | | I'm assuming these units are ppm |
| $O_3$ | TECO 49, 49C, 49i | 47 | 0.005 | -0.005 | 3 | I'm assuming these units are ppm |
| $O_3$ | API 400/400A/400E | 87 | 0.005 | -0.005 | 3 | I'm assuming these units are ppm |
| $SO_2$ | TECO 43C | 9 | 2 | -2 | 2 | |
| $SO_2$ | API T100 | 100 | 0.4 | -2 | 2 | |
| $SO_2$ | API 100 | 100 | 0.4 | -2 | 2 | |
| CO | API 300E | 93 | 0.5 | -0.5 | 0.5 ppm | |
| CO | TECO 48 | 54 | 0.5 | -0.5 | 0.5 ppm | |
| NMHC | Baseline-MOCON | 11 | 1 | -1 | | These units are ppb, which makes our cut-off -0.001 |
| $CH_4$ | Baseline-MOCON | 11 | 0.1 | -0.1 | | -0.0001 ppm |
| THC | Baseline-MOCON | 11 | 200 | -200 | | -0.2 ppm |

## Trace Level

| Pollutant | Analyzer | Method Code | MDL (in AQS) | min. value allowed in AQS |
|-----------|----------|-------------|--------------|---------------------------|
| NO | 200EU | 599 | 0.05 | -0.2 |
| NO2 | 200EU | 599 | 0.05 | -0.2 |
| NOx | 200EU | 599 | 0.05 | -0.2 |
| NO | TECO 42i TLE | 674 | 0.05 | -0.05 |
| NO2 | TECO 42i TLE | 674 | 0.05 | -0.05 |
| NOy | TECO 42i TLE | 674 | 0.05 | -0.05 |
| NO | API 200EU | 699 | 0.05 | -0.2 |
| NO2 | API 200EU | 699 | 0.05 | -0.05 |
| NOy | API 200EU | 699 | 0.05 | -0.05 |
| NO2 | API T500U | 212 | 0.04 | -0.04 |
| SO2 | API 100EU | 600 | 0.2 | -0.2 |
| SO2 | TECO 43i TLE | 560 | 0.2 | -0.2 |
| CO | API 300EU | 593 | 0.02 | -0.02 |
| CO | Thermo 48i TLE | 554 | 0.04 | -0.4 |

**Procedures for Zero Corrections of Data from non-Trace Analyzers**

- Review the baseline and zero checks for the month. If the zero checks and the baseline show a similar offset, and when these values are outside of the range described below, the data should be adjusted using an average of the zero response for the month.
  - NO/NOx zero/baseline acceptable range -3 to +3 ppb
  - SO2 zero/baseline acceptable range -2 to +2 ppb
  - O3 zero/baseline acceptable range -3 to +3 ppb
  - CO zero/baseline acceptable range -0.5 to +0.5 ppm
- If the zero response and the baseline are within these limits, but the precisions are outside of limits and would be within if a zero correction were applied, then apply the zero correction to both the ambient data and the precision result.
- When applying a correction, use whole numbers only (or 1 tenth of a decimal place for CO only).
-  When done applying the zero correction, sort the validated values to look for values below the negative cut-off (see N:\Project\imc\validation training\zero adjust thresholds2.xlsx). If there are values below the negative cut-off, review on the monthly data grid to see if these values are grouped around similar times. If so, review the zeros again. Was there an outlier around this time that should be excluded? If so, eliminate and apply a zero correction using the next closest zero to the period of time being adjusted.
- Sort validated values again to look for values below the negative threshold. If some still exist, these data points should be invalidated.
- Any time data are zero corrected, the analyzer response during the precision needs to be adjusted by the same amount.
- If the zero adjust you are trying to apply is more complicated than described here, please consult with Jessica before spending a lot of time on a zero adjust.

**Procedures for Zero Corrections of Data from Trace Analyzers**

- Review the minimum values recorded for the month. If the ambient data are less than -5x MDL (see N:\Project\imc\validation training\zero adjust thresholds2.xlsx) on a non-persistent basis, the data should be invalidated. For example, if a Teledyne-API T200U NOx analyzer reports a NOx value of -0.40, the data point should be invalidated because the MDL is 0.05 and -5x MDL is -0.25.

- If the ambient data are less than the –MDL but greater than -5x MDL on a non-persistent basis, the data should be adjusted (VZ'd) to the –MDL. (e.g. if the same analyzer reports -0.15, then it should be adjusted to -0.05 since -0.15 is within -0.25)

- If data are persistently below the –MDL, this is an indication that there is a baseline offset that should be corrected for. Nightly zeros should be reviewed to determine if a correction based on these can be applied. These should only be used if consistent for the month. Most likely results of the most recent calibration or some other method will need to be reviewed to determine an amount to adjust by. Please consult with Jessica and a field specialist or the project manager when determining the amount to adjust by.

- When applying a correction, the amount used to adjust by should contain no more decimal precision than is used when reporting the parameter you are adjusting for. If it is determined the nightly zeros can be used for the adjustment, an average for the month should be used.

- When done applying the initial zero correction, sort the validated values to look for values below the negative cut-off. If there are values below the negative cut-off, review on the monthly data grid to see if these values are grouped around similar times. If so, discuss with Jessica and the field group again to determine if a different adjustment should have been applied to this time period.

- If after applying an adjustment there are still values below the –MDL, apply the procedures described in the first 2 bullets to determine if the values should be invalidated or adjusted to the –MDL.

- Any time data are zero corrected, the analyzer response during the precision needs to be adjusted by the same amount.

- If the zero adjust you are trying to apply is more complicated than described here, please consult with Jessica before spending a lot of time on a zero adjust.

**UNITED STATES ENVIRONMENTAL PROTECTION AGENCY**
RESEARCH TRIANGLE PARK, NC
27711

6/3/2014

**MEMORANDUM**

**SUBJECT:**   Revision to the Zero Drift Acceptance Criteria in the QA Handbook

**FROM:**   Lewis Weinstock, Group Leader
Ambient Air Monitoring Group (C304-06)

**TO:**   Regional Air Program Managers and Staff

Monitoring organizations have expressed concern about the zero drift requirements in the validation templates in the *2013 QA Handbook for Air Pollution Measurement Systems Volume II Ambient Air Quality Monitoring Program.* Based on this feedback along with additional technical analyses, EPA will revise this Handbook to provide zero drift acceptance criteria guidance for 24-hour and 14-day intervals as follows in Table 1.

**Table 1. Revised 24-hour and 14-Day Zero Drift Criteria**

| Zero Drift | Units | $SO_2$ | $O_3$ | $NO_2$ | CO |
|---|---|---|---|---|---|
| 24-hour drift | ppm | 0.003 | 0.003 | 0.003 | 0.4 |
| 14-day drift | ppm | 0.005 | 0.005 | 0.005 | 0.6 |

**Background**

The zero/span implementation frequency and acceptance criteria are not identified in CFR and are considered guidance.  As such, during revision of QA Handbook guidance, the EPA is able to work with the monitoring organizations to change guidance as needed.   The zero guidance has changed in the following ways:

- **1985-1998**- No validation template developed but the EPA espoused a 0-30 ppb requirement and a 0-15 ppb requirement based on two different but acceptable calibration techniques.
- **1998-2008** - Creation and use of a measurement quality objectives (MQO) table. Acceptance was $\pm$20-30 ppb if calibration updated at each zero span or $\pm$10-15 ppb if fixed calibration used.
- **2008-2013**- First validation template and acceptance criterion of $\leq \pm$ 3% of full scale.
- **2013-present**- Due to the use of better technologies and  trace gas instruments the  zero drift guidance criterion was changed to $\pm$ 1.5 ppb. This acceptance criterion is under additional review based on monitoring organization comments to the EPA.

In 2008, the QA Handbook used a three percent of **full scale** criterion for the zero which relates to the concentration scale that the monitor operates.  As an example, many gaseous analyzers have scales of either 1000 ppb or 500 ppb.  Therefore 3% of full scale for 1000 ppb would provide an acceptance criterion of 30 ppb and at 500 ppb full scale would provide an acceptance criterion of 15 ppb (similar to older Handbook guidance).   So up until the 2013 document, the zero drift acceptance criteria were fairly wide.

For the 2013 QA Handbook revision, instead of using a percentage of the scale of the instrument, we used a straight ppb ($O_3$, $SO_2$ and $NO_2$) or ppm (CO) difference.  This seems to make sense since we should control zero drift at an absolute value rather than depending on instrument scale.  However, we drastically reduced the drift from 30 or 15 ppb to 1.5 ppb for $O_3$, $SO_2$ and $NO_2$.  In retrospect we may have been using 12- and 24-hour performance specifications described in 40 CFR Part 53 for Federal Reference Methods (FRMs) and Federal Equivalent Methods (FEMs) without considering that EPA guidance allows for bi-weekly (14-day) zero checks. Greater allowance for zero drift may be expected over two weeks than over a 12- or 24-hour time period. After the Handbook was posted, EPA received an email that the CO acceptance criterion was incorrect.  The criterion for CO was unintentionally listed at 0.03 ppm rather than 0.3 ppm.

Accordingly, the EPA reviewed the performance limit specifications for FRMs and FEMs shown in 40 CFR Part 53 Table B-1. Table 2 compares the current validation requirements to FRM/FEM performance specification for the years 2000 and 2013.

Table 2. Current Validation Template Zero Drift Requirements

| Zero Drift | Units | $SO_2$ | $O_3$ | CO | $NO_2$ |
|---|---|---|---|---|---|
| 2013 Validation Template | ppm | 0.0015 | 0.0015 | 0.03 | 0.0015 |
| 2013 CFR Table B-1 | ppm | 0.002 | 0.02 | 0.3 | 0.02 |
| 2000 CFR Table B-1 | ppm | 0.02 | 0.02 | 1.0 | 0.02 |

Table B-1 drift is for 12- to 24-hour drift period. The Table B-1 zero drift performance requirements for $O_3$ and $NO_2$ have not changed in 13 years.  ORD has talked about lowering the $O_3$ zero drift criterion in Part 53 during the next ozone promulgation but we are not sure when a change will be made to $NO_2$. The criterion for $SO_2$ has changed (in 2012) and is similar to the criterion in the validation template. CO has changed (2012) and as mentioned above, after reviewing some of our information in the QA Handbook, we inadvertently listed at 0.03 ppm and should have been listed as 0.3 ppm although we now plan to revise it to 0.4 ppm.

**Data Review**

EPA asked the EPA Regions and monitoring organizations to submit some zero data from instruments they operate.  EPA received data from monitoring organizations in Regions 1, 7, 8 and 9.
EPA reviewed the data submitted by the monitoring organizations and Regions and evaluated the data by two approaches. Tables 3-6 present the data.

**Approach 1**
1. For each site, take the absolute value of each zero result and calculate a site mean (Avg ABS Zero). In this manner positive values and negative values do not cancel each other out.
2. Calculate the standard deviation of the absolute value zero (ABS SD)

3. Multiply the standard deviation by 2 or 3 and add this value to the site mean. This is the biweekly zero acceptance criterion. (2*SD+Avg, or 3*SD+Avg)

**Approach 2**

1. For each site, take the absolute value of each zero result and calculate a site mean (Avg ABS Zero). In this manner positive values and negative values do not cancel each other out. This is the same as in approach #1
2. Calculate the standard deviation of the zero data using the positive and negative values (P/N SD).
3. Multiply the P/N SD by 2 or 3 and add this value to the site mean. This is the biweekly zero acceptance criterion.

In cases where there are positive and negative zero values, Approach 2 will create a higher biweekly acceptance value.

**Summary**

Realizing the data set is very limited and using Approach #2:

**CO (Table 3) -** The average zero daily drift is 0.09 ppm (within the 0.3 ppm 12- to 24-hour acceptance criterion) and the 3* SD of the positive/negative is 0.4 ppm. We propose to revise the 24-hour zero drift to 0.4 ppm and allow a bi-weekly drift of 0.6 ppm

**NO2 (Table 4)**- The average zero daily drift is 0.38 ppb (within the 1.5 ppb validation template acceptance criterion) and the 3* SD of the positive/negative is 2.14 ppb. We propose to revise the 24-hour zero drift to 3.0 ppb and allow a bi-weekly drift of 5.0 ppb.

**SO2 (Table 5)**-The average zero daily drift is 0.39 ppb (within the 1.5 ppb validation template acceptance criterion) and the 3* SD of the positive/negative is 1.73 ppb. We propose to revise the 24-hour zero drift to 3.0 ppb and allow a bi-weekly drift of 5.0 ppb.

**O3 (Table 6)**- The average zero daily drift is 0.58 ppb (within the 1.5 ppb validation template acceptance criterion) and the 3* SD of the positive/negative is 2.6. We propose to revise the 24-hour zero drift to 3.0 ppb and allow a bi-weekly drift of 5.0 ppb.

Based on the data received and adding for a small margin of error, we feel these are reasonable acceptance criteria. The new acceptance values take effect immediately but can be implemented by monitoring organizations within a reasonable timeframe if procedures and QA documentation need to be revised. Please provide this update to your monitoring organizations. Although we do not plan to open the QA Handbook to revise the validation template at this time, this memo and a spreadsheet called "Validation Template Tracking Table" on AMTIC at http://www.epa.gov/ttn/amtic/qalist.html will be used to update changes and will provide for an effective date on important and approved changes.

In addition, we strongly encourage monitoring networks to perform the zero/span checks (and one-point QC) more frequently than bi-weekly. Tables 3 to 6 show that most organizations are performing these checks at higher than the required minimum and with the advent of these automated delivery systems, it will help keep data quality within acceptable levels and reduce the potential for data invalidation.

**Table 3. CO Zero Data Evaluation**

| Pollutant- CO | CO Acceptance Criteria 0.3ppm | | | | | | Using SD Pos/Neg | | |
|---|---|---|---|---|---|---|---|---|---|
| Site | Avg ABS Zero | ABS SD | 2*SD+Avg | 3*SD+Avg | Frequency | | P/N SD | 2*SD+Avg | 3*SD =Avg |
| AIRS | 0.010 | 0.021 | 0.053 | 0.074 | D | | 0.024 | 0.058 | 0.081 |
| E. Providence | 0.013 | 0.013 | 0.039 | 0.052 | W | | 0.016 | 0.045 | 0.061 |
| Linn | 0.017 | 0.011 | 0.038 | 0.049 | D | | 0.019 | 0.054 | 0.073 |
| Carp | 0.015 | 0.008 | 0.031 | 0.038 | D | | 0.008 | 0.032 | 0.040 |
| Hawaii 2011 | 0.142 | 0.145 | 0.433 | 0.578 | W | | 0.145 | 0.433 | 0.578 |
| Hawaii 2012 | 0.094 | 0.116 | 0.326 | 0.443 | W | | 0.116 | 0.326 | 0.443 |
| Hawaii 2013 | 0.196 | 0.221 | 0.637 | 0.857 | W | | 0.257 | 0.709 | 0.966 |
| 080013001 | 0.145 | 0.136 | 0.417 | 0.553 | D | | 0.165 | 0.476 | 0.641 |
| 080310002 | 0.175 | 0.143 | 0.460 | 0.603 | D | | 0.193 | 0.561 | 0.755 |
| 080310025 | 0.043 | 0.099 | 0.240 | 0.339 | D | | 0.043 | 0.243 | 0.343 |
| 080310026 | 0.032 | 0.060 | 0.151 | 0.211 | D | | 0.061 | 0.154 | 0.215 |
| 080310027 | 0.000 | 0.006 | 0.012 | 0.017 | D | | 0.006 | 0.012 | 0.017 |
| 080410015 | 0.088 | 0.150 | 0.387 | 0.537 | D | | 0.150 | 0.387 | 0.537 |
| 080691004 | 0.149 | 0.137 | 0.423 | 0.560 | D | | 0.165 | 0.479 | 0.645 |
| 080770018 | 0.178 | 0.157 | 0.493 | 0.650 | D | | 0.237 | 0.653 | 0.890 |
| 081230010 | 0.157 | 0.154 | 0.464 | 0.617 | D | | 0.180 | 0.517 | 0.698 |
| **Average** | **0.091** | **0.098** | **0.288** | **0.386** | | | **0.112** | **0.321** | **0.436** |

**Table 4. NO2 Zero Data Evaluation**

| Pollutant-NO2 | NO2 Acceptance Criteria 1.5 ppb | | | | | | Using SD Pos/Neg | | |
|---|---|---|---|---|---|---|---|---|---|
| Site | Avg ABS Zero | ABS SD | 2*SD+Avg | 3*SD =Avg | Frequency | | P/N SD | 2*SD+Avg | 3*SD =Avg |
| Brown | 0.082 | 0.174 | 0.429 | 0.603 | W | | 0.174 | 0.429 | 0.603 |
| E Providence | 0.235 | 0.468 | 1.171 | 1.639 | W | | 0.468 | 1.171 | 1.639 |
| AJ | 0.047 | 0.205 | 0.456 | 0.661 | W | | 0.205 | 0.456 | 0.661 |
| 080013001 | 1.304 | 1.835 | 4.973 | 6.808 | D | | 1.953 | 5.210 | 7.164 |
| 080310002 | 1.125 | 1.232 | 3.589 | 4.821 | D | | 1.634 | 4.393 | 6.026 |
| 080310027 | 0.129 | 0.179 | 0.488 | 0.667 | D | | 0.180 | 0.489 | 0.669 |
| Wyoming Range | 0.058 | 0.058 | 0.173 | 0.231 | 3-D | | 0.064 | 0.186 | 0.250 |
| Murphy Ridge | 0.267 | 0.207 | 0.680 | 0.886 | 3-D | | 0.270 | 0.807 | 1.078 |
| Badlands | 0.149 | 0.311 | 0.770 | 1.081 | W | | 0.324 | 0.797 | 1.122 |
| **Average** | **0.377** | **0.519** | **1.414** | **1.933** | | | **0.586** | **1.549** | **2.135** |

**Table 5. SO2 Zero Data Evaluation**

| Pollutant-SO2 | SO2 Acceptance Criteria 1.5 ppb | | | | | | Using SD Pos/Neg | | |
|---|---|---|---|---|---|---|---|---|---|
| Site | Avg ABS Zero | ABS SD | 2*SD+Avg | 3*SD =Avg | Frequency | | P/N SD | 2*SD+Avg | 3*SD =Avg |
| Linn | 0.033 | 0.024 | 0.080 | 0.104 | D | | 0.024 | 0.081 | 0.105 |
| Clinton | 0.216 | 0.205 | 0.626 | 0.831 | D | | 0.246 | 0.709 | 0.955 |
| Davenport | 0.077 | 0.070 | 0.217 | 0.287 | D | | 0.077 | 0.231 | 0.308 |
| Lake Sugema | 0.255 | 0.099 | 0.452 | 0.550 | D | | 0.099 | 0.452 | 0.550 |
| Muscatine, Greenwood | 0.157 | 0.148 | 0.454 | 0.602 | D | | 0.215 | 0.587 | 0.801 |
| Muscatine, High School | 0.239 | 0.328 | 0.894 | 1.222 | D | | 0.406 | 1.050 | 1.456 |
| Muscatine, Musser Park | 0.143 | 0.267 | 0.678 | 0.945 | D | | 0.270 | 0.684 | 0.954 |
| Sioux City, Neal North | 0.188 | 0.152 | 0.492 | 0.645 | D | | 0.169 | 0.525 | 0.694 |
| 080013001 | 0.831 | 0.880 | 2.660 | 3.471 | D | | 0.901 | 2.633 | 3.533 |
| 080310002 | 0.940 | 0.915 | 2.769 | 3.684 | D | | 0.983 | 2.905 | 3.888 |
| 080310025 | 0.371 | 0.392 | 1.155 | 1.546 | D | | 0.468 | 1.307 | 1.775 |
| 080310026 | 0.957 | 1.447 | 3.851 | 5.297 | D | | 1.553 | 4.064 | 5.618 |
| 080410015 | 0.538 | 0.629 | 1.795 | 2.424 | D | | 0.700 | 1.938 | 2.638 |
| CU | 0.702 | 0.462 | 1.627 | 2.089 | W | | 0.462 | 1.627 | 2.089 |
| Badlands | 0.137 | 0.127 | 0.390 | 0.517 | W | | 0.161 | 0.459 | 0.621 |
| **Average** | **0.386** | **0.410** | **1.209** | **1.614** | | | **0.449** | **1.283** | **1.732** |

| Table 6. O3 Zero Data Evaluation | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Pollutant-O3** | **O3 Acceptance Criteria 1.5 ppb** | | | | | | **Using SD Pos/Neg** | | |
| **Site** | **Avg ABS Zero** | **ABS SD** | **2*SD+Avg** | **3*SD +Avg** | **Frequency** | | **P/N SD** | **2*SD+Avg** | **3*SD =Avg** |
| E. Prov | 0.491 | 0.224 | 0.939 | 1.162 | W | | 0.414 | 1.319 | 1.733 |
| AJ | 0.503 | 0.466 | 1.434 | 1.900 | W | | 0.571 | 1.645 | 2.216 |
| Narr | 0.084 | 0.090 | 0.263 | 0.353 | W | | 0.090 | 0.263 | 0.353 |
| Clinton | 0.707 | 0.511 | 1.730 | 2.241 | D | | 0.511 | 1.730 | 2.241 |
| Dav | 1.145 | 0.897 | 2.938 | 3.835 | D | | 0.980 | 3.105 | 4.086 |
| Emmetsburg | 0.213 | 0.104 | 0.422 | 0.526 | D | | 0.106 | 0.425 | 0.531 |
| Lake Ahquabi | 0.259 | 0.189 | 0.638 | 0.827 | D | | 0.315 | 0.889 | 1.204 |
| Lake Sugema | 0.555 | 0.310 | 1.176 | 1.486 | D | | 0.392 | 1.338 | 1.730 |
| Pisgah Forestry | 0.297 | 0.113 | 0.522 | 0.635 | D | | 0.113 | 0.522 | 0.635 |
| Pisgah Harrison | 0.631 | 0.528 | 1.687 | 2.215 | D | | 0.532 | 1.695 | 2.227 |
| Scott County | 0.225 | 0.197 | 0.619 | 0.816 | D | | 0.223 | 0.671 | 0.893 |
| Viking Lake | 0.552 | 0.420 | 1.391 | 1.810 | D | | 0.589 | 1.730 | 2.319 |
| Waverly Airport | 0.626 | 0.143 | 0.911 | 1.053 | D | | 0.143 | 0.911 | 1.053 |
| AIRS 1 | 0.289 | 0.188 | 0.665 | 0.853 | D | | 0.316 | 0.922 | 1.238 |
| AIRS 2 | 0.185 | 0.102 | 0.388 | 0.490 | D | | 0.107 | 0.399 | 0.507 |
| Batavia | 0.774 | 0.437 | 1.649 | 2.086 | D | | 0.437 | 1.649 | 2.086 |
| Colerain | 1.091 | 0.453 | 1.997 | 2.451 | D | | 0.453 | 1.997 | 2.451 |
| Hamilton | 0.103 | 0.305 | 0.714 | 1.019 | D | | 0.305 | 0.714 | 1.019 |
| Lebanon | 0.716 | 0.485 | 1.685 | 2.170 | D | | 0.485 | 1.685 | 2.170 |
| Middletown | 0.976 | 0.152 | 1.281 | 1.434 | D | | 0.152 | 1.281 | 1.434 |
| Sycamore | 0.579 | 0.496 | 1.570 | 2.066 | D | | 0.496 | 1.570 | 2.066 |
| Taft | 0.716 | 0.499 | 1.715 | 2.214 | D | | 0.499 | 1.715 | 2.214 |
| 080013001 | 0.622 | 0.752 | 2.125 | 2.876 | D | | 0.896 | 2.413 | 3.308 |
| 080050002 | 0.610 | 0.685 | 1.979 | 2.664 | D | | 0.872 | 2.354 | 3.227 |
| 080050006 | 0.528 | 0.751 | 2.030 | 2.781 | D | | 0.788 | 2.104 | 2.892 |
| 080130011 | 0.191 | 0.412 | 1.015 | 1.427 | D | | 0.415 | 1.021 | 1.437 |
| 080310002 | 0.295 | 0.479 | 1.253 | 1.732 | D | | 0.560 | 1.416 | 1.977 |
| 080310014 | 0.276 | 0.445 | 1.166 | 1.612 | D | | 0.523 | 1.322 | 1.845 |
| 080310025 | 0.425 | 1.210 | 2.846 | 4.056 | D | | 1.255 | 2.934 | 4.189 |
| 080310026 | 0.610 | 0.849 | 2.308 | 3.158 | D | | 0.859 | 2.328 | 3.187 |
| 080350004 | 0.975 | 1.161 | 3.297 | 4.458 | D | | 1.278 | 3.531 | 4.809 |
| 080410013 | 0.863 | 1.215 | 3.292 | 4.507 | D | | 1.354 | 3.570 | 4.924 |
| 080410016 | 1.398 | 1.546 | 4.489 | 6.035 | D | | 2.083 | 5.565 | 7.648 |
| 080590002 | 0.242 | 0.435 | 1.113 | 1.548 | D | | 0.435 | 1.113 | 1.548 |
| 080590005 | 0.701 | 0.817 | 2.336 | 3.153 | D | | 1.069 | 2.840 | 3.909 |
| 080590006 | 0.786 | 1.067 | 2.919 | 3.986 | D | | 1.320 | 3.427 | 4.747 |
| 080590011 | 0.913 | 1.033 | 2.979 | 4.012 | D | | 1.379 | 3.671 | 5.051 |
| 080590013 | 0.654 | 1.157 | 2.968 | 4.124 | D | | 1.325 | 3.304 | 4.629 |
| 080690011 | 0.380 | 0.642 | 1.664 | 2.305 | D | | 0.688 | 1.756 | 2.444 |
| 080690012 | 0.751 | 0.810 | 2.370 | 3.180 | D | | 1.036 | 2.822 | 3.858 |
| 080691004 | 0.451 | 0.625 | 1.701 | 2.327 | D | | 0.727 | 1.904 | 2.630 |
| 081230009 | 0.178 | 0.396 | 0.970 | 1.366 | D | | 0.433 | 1.044 | 1.477 |
| Pinedale | 0.664 | 0.664 | 1.456 | 1.853 | 3-D | | 0.644 | 1.952 | 2.596 |
| Wyoming Range | 2.304 | 1.224 | 4.753 | 5.977 | 3-D | | 2.165 | 6.634 | 8.799 |
| Murphy Ridge | 0.543 | 0.350 | 1.243 | 1.593 | 3-D | | 0.521 | 1.585 | 2.106 |
| Badlands | 0.308 | 0.466 | 1.240 | 1.706 | W | | 0.525 | 1.358 | 1.884 |
| Brookings | 0.132 | 0.342 | 0.816 | 1.158 | W | | 0.362 | 0.857 | 1.219 |
| **Average** | **0.585** | **0.571** | **1.716** | **2.282** | | | **0.675** | **1.936** | **2.612** |

# Approvals

The purpose of this review and approval is to evaluate this Standard Operating Procedure (SOP) for adequacy prior to issuance.  The signatories below are stating that the approach defined within this document is acceptable and that the affected company interests have been represented.

Author Signature:

Program:　　　　　　Genevieve Lariviere - QA Manager

Approval Signature:

Program:　　　　　　Jessica Ward - IMC Section Manager

# REVISION HISTORY

| Review date: | Changes made: | Changes made by: |
|---|---|---|
| 1/22/2019 | Minor text edits<br>Edits to reflect updated AQDBMS reporting interface<br>Added Section 6.3 "Compiling Data Reports"<br>Updated figures<br>Added Acronyms | E. Vanden Hoek |
| 5/19/2020 | Removed date reference from file name | E. Vanden Hoek |
| 10/26/2021 | Minor text edits | E. Vanden Hoek |
| 10/25/2022 | Updated personnel, minor text edits | E. Vanden Hoek |
| | | |
| | | |
| | | |

# ANNUAL REVIEW

The undersigned attests that this standard operating procedure has undergone annual review for adherence to current practices and the latest QA/QC protocols:

| | | |
|---|---|---|
| *[signature]* | QA Manager | 6/25/2019 |
| Signature | Title | Date |
| *[signature: Jessica Ward]* | IMC Section Manager | 3/1/2021 |
| Signature | Title | Date |
| *[signature: Emily E. Wiehen]* | IMC Team Lead | 3/10/2022 |
| Signature | Title | Date |
| | | |
| Signature | Title | Date |

## 1.0    PURPOSE

This standard operating procedure (SOP) outlines the steps of producing ambient air quality and meteorological data reports and data dissemination. Reporting includes preparation and distribution of the following report products:

- Weekly reports
- Monthly data reports
- Quarterly data reports
- Annual data reports
- Monthly ozone "hit list"

At the direction of the client, the IMC will also report criteria pollutant, meteorological, and precision and accuracy data to the Environmental Protection Agency's Air Quality System (AQS) database, and handle individual data requests as they are received.

## 2.0    SUMMARY OF METHOD

Reports will be generated and distributed to meet guidance and schedules as outlined in project QAPPs. A single report (of each selected type) will be prepared for each defined monitoring program. All reports are generated from data stored within ARS' AQDB (Air Quality Database) using a customized reporting interface to export products as specified by the user. Most data reports are generated after the completion of preliminary data validation, as is shown in Figure 5-1. The user will follow the basic steps outlined in Section 6 of this SOP to generate the aforementioned data reports.

## 3.0    SCOPE

Activities described in this document are performed by members of ARS' Information Management Center, technical assistants and database administrators/programmers. Aforementioned ARS staff members have been appropriately trained to perform the responsibilities associated with their roles as described below.

## 4.0    ROLES AND RESPONSIBILITIES

Staff positions that have data reporting responsibilities are:

**Information Management Section Manager**
- Oversee all reporting procedures and provide direction when required.
- Oversee the preparation of the monthly ozone "hit list."
- Submit data to the Environmental Protection Agency's (EPA) Air Quality System (AQS) database.
- Perform a final review of each quarterly report prior to delivery.
- Review final annual data reports for completeness and accuracy.
- Verify that completed annual reports are properly distributed.
- Maintain the required AQS codes for all sites and parameters within the monitoring network within the AQDBMS and in AQS.
- Verify that all data requests are handled in a timely manner.

- Be adequately trained in operating the EPA AQS interface and be familiar with the set of EPA-issued AQS documentation.
- Be responsible for generating and submitting hourly ambient and meteorological data and precision and accuracy data to the EPA AQS on at least a quarterly basis.

**IMC Team Lead**
- Verify that preliminary and final data validation has been successfully completed for each month.
- Oversee the preparation of the monthly data reports and forward the reports to the client.
- Verify that data validation has been successfully completed for the reporting period for quarterly and annual reports.
- Review draft and final quarterly and annual data reports for completeness and accuracy.
- Forward completed reports to IMC section manager for review.
- Verify that completed reports are properly distributed.
- Oversee all annual reporting preparation and provide direction as necessary.
- Communicate with the client regarding data requests.
- Maintain the required AQS codes for all sites and parameters within the monitoring network within the AQDBMS and in AQS.
- Be adequately trained in operating the EPA AQS interface and be familiar with the set of EPA-issued AQS documentation.
- Be responsible for generating and submitting hourly ambient and meteorological data and precision and accuracy data to the EPA AQS on at least a quarterly basis.

**Data Analyst/Technician**
- Prepare and forward the monthly ozone "hit list" to the client.
- Create monthly, quarterly, and annual data reports.
- Prepare electronic files of validated data for delivery with the quarterly and annual data reports.
- Compile data statistics and prepare plots and graphics for quarterly and annual data reports.
- Handle all data requests.

**Technical Assistant**
- Assemble and organize the information for quarterly and annual data reports.
- Compile quarterly and annual data reports and forward to the project manager and IMC team lead for review.
- Distribute quarterly and annual reports and associated data to the sponsoring agency and other project personnel as directed.

**Database Administrator/Programmer**

- The database administrator/programmer shall create custom data summaries, data listings, or graphics, for data requests requiring non-standard output.
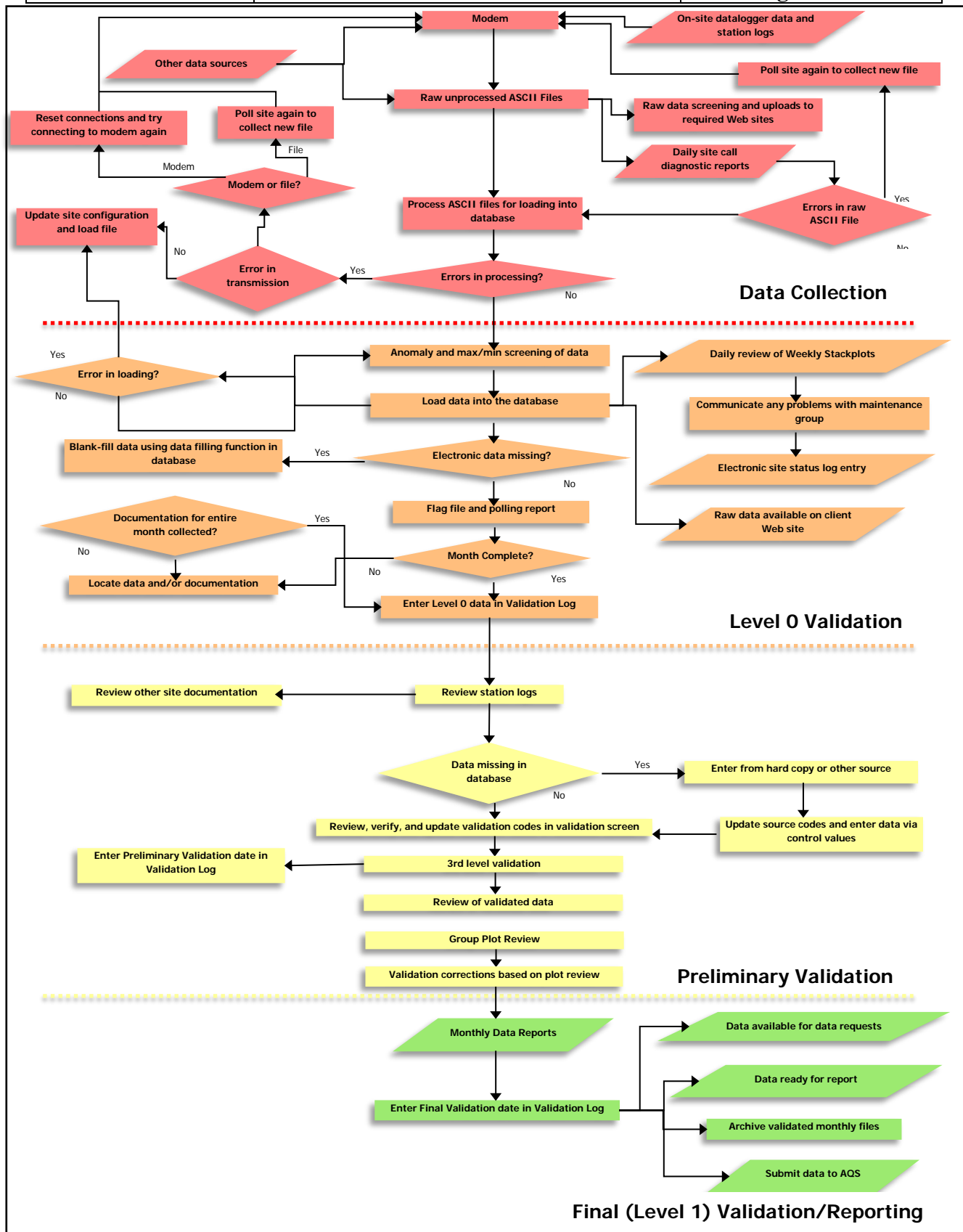
Figure 5-1. General Data Collection, Validation and Reporting Flow Diagram

## 5.0    REQUIRED EQUIPMENT AND MATERIALS

The IMC requires the following hardware and software for Level 0 validation of ambient air quality and meteorological data:

- IMC hardware:
  - Hardware specifications for IMC servers
  - Hardware specifications for workstations
  - IMC computer support hardware:
    - High-quality laser printer

- IMC AQDBMS software:
  - Oracle Database System
  - AQDBMS custom software:
    - Data validation and reporting software

## 6.0    PROCEDURES

Monthly, quarterly and annual reports are completed, when specified, in accordance with the provisions defined within a project QAPP. Each report is briefly described below and can be generated following the steps outlined in subsections 6.1 – 6.5. The generation of monthly ozone "hit lists" follows a separate procedure, which is outlined in Section 6.6. Examples of specific data products can be found in this SOP's appendix. Handling data requests and submitting data to the EPA AQS database are discussed in subsequent sections.

**Monthly Data Reporting** includes generating one data report for an entire monitoring network, or for individual stations within a network, as advised by the client. Data reports may contain the following products:

- Data collection statistics by site for all parameters
- Summary of pollutant data by site
- Summary of selected meteorological data by site
- Time series plots depicting all validated data for the month

**Quarterly Data Reporting** of ambient air quality and meteorological monitoring includes a discussion of the background of the monitoring program and its objectives, and a discussion of the locations and parameters measured. One quarterly data report for each site is generated for each three-month period or quarter. The monitoring quarters generally follow calendar quarters, but may differ for specific projects. Reports generally include the following products:

- Significant events (collection ≤ 90%) for each site
- Collection statistics for all parameters
- Stackplots of hourly averages of all monitored parameters
- Wind roses (for each monitoring height)
- Pollution roses for each monitored air quality parameter
- Summary of gaseous data by site
- Summary of particulate data by site
- Summary of meteorological data by site
- Summary of quality assurance/quality control documentation

**Annual Data Reporting** of ambient air quality and meteorological monitoring includes generating one data report for an entire network, or for individual stations within a network, as advised by the client. The report may include a discussion of the background of the monitoring program and its objectives, and a discussion of the locations and parameters measured. One annual data report for each site or network is generated for each year of operation. The annual reports generally follow calendar years, but may differ for specific projects. Reports generally include the following products:

- Significant events timeline for each site (collection ≤ 90%)
- Collection statistics for all parameters
- Stackplots of hourly averages of all monitored parameters
- Wind roses (for each monitoring height)
- Pollution roses for each monitored air quality parameter
- Summary of gaseous data by site
- Pollutant violation summaries
- Resource injury indices
- Maps displaying pollutant levels at sites within a network
- Bar charts displaying pollutant concentrations
- Summary of particulate data by site
- Summary of meteorological data by site
- Summary of quality assurance/quality control documentation

**The Monthly Ozone "Hit List"** is a list of site-specific ozone 8-hour averages that exceed the ozone standard (currently 70 ppb). The ozone hit list is generated from Level 0 data at the end of every month.

## 6.1    VERIFYING PRELIMINARY VALIDATION STATUS

Before a data report can be generated, Preliminary data validation must be complete. The validation status of each site is tracked in the AQDBMS Data Validation Log (see Figure 6-1).

The Data Validation Log is used to track the completion of each major step of the validation process. The master record logs the initials of the IMC staff member completing each validation step and when the step occurred. The Comments Table logs comments regarding data validation. Most of the output programs query the Data Validation Log so the correct level of validation can be applied to the output. To use the Data Validation Log:

- Select **Logs-> Data Validation Log** from the AQ and Met Processing frame.
- Select a *site* from the Site drop-down box. If no records for the selected site exist, a "Site not Found" message is displayed. Click **OK**. Otherwise, the most recent Master Table record and related comments for the selected site are displayed.
- Select a different *month* and/or *year* from the drop-down list boxes to display previous month's records for the site.
- Rick-click to add or deleted records.
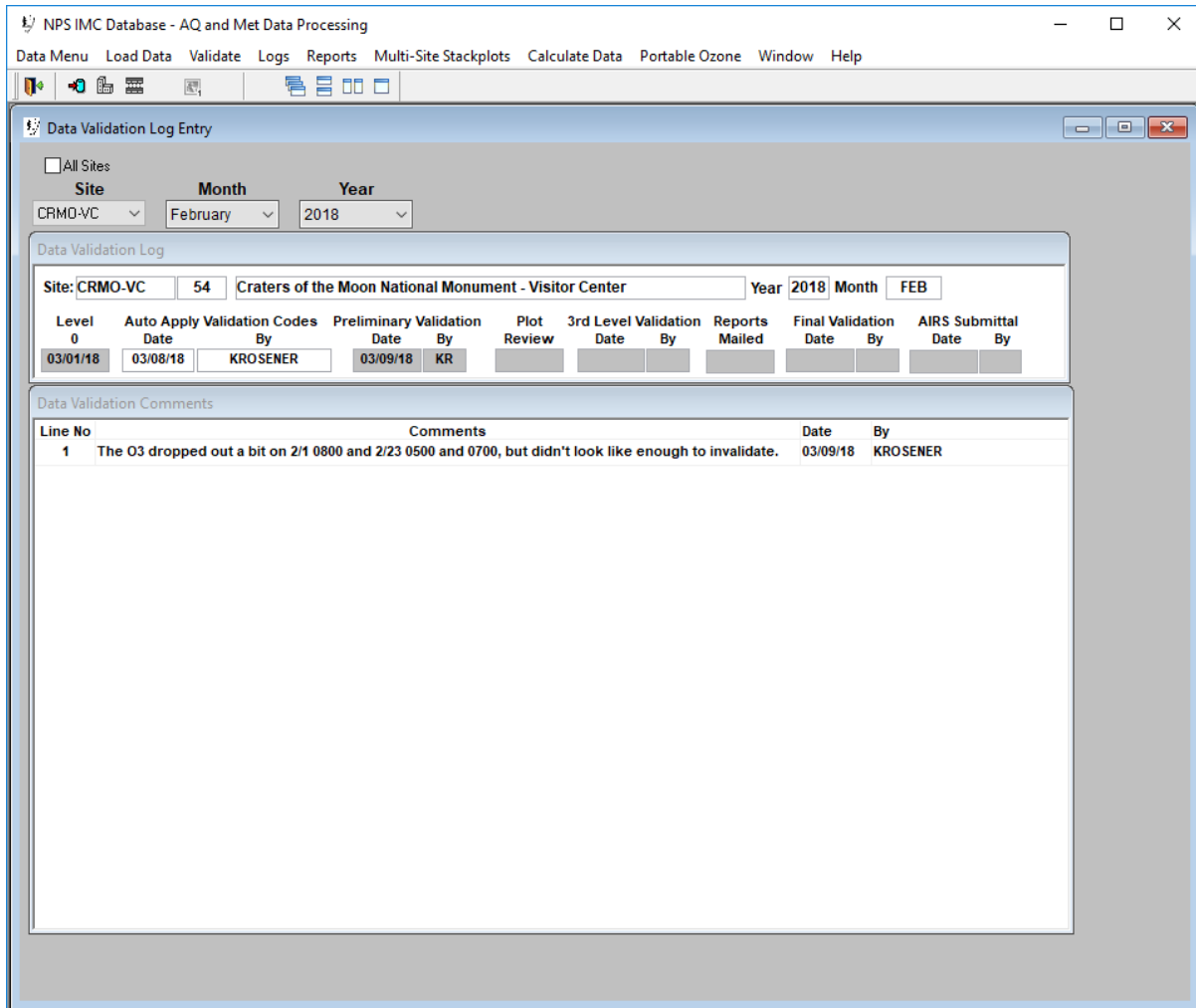
Figure 6-1. The Data Validation Log.

## 6.2     GENERATING REPORT PRODUCTS

First, determine the specific contents needed for the report. This is dependent upon the type of report desired and the project for which it is being generated. Refer to the project's QAPP for guidance on required report products.

### 6.2.1 STANDARD REPORT PRODUCTS

The Reports interface of the AQDBMS provides a single interface for producing various types of output products. The initial display of the reports interface is shown in Figure 6-2. A tab control is used to help the user select the specific input required for the selected product. The content of each tab updates dynamically to reflect the specific options available for the selected product.
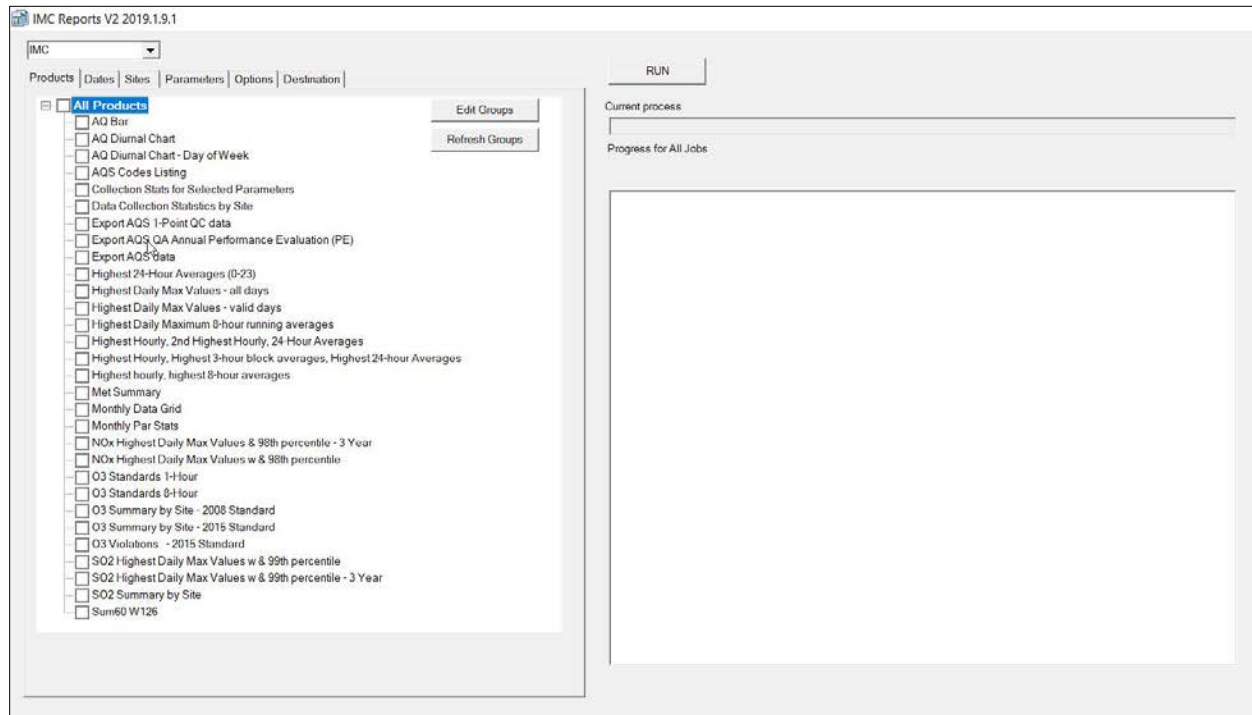


Figure 6-2. The Reports Interface.

To use the Reports interface:

- Open the reporting interface.
- Select which database to connect to (IMC or AQDB).
- Select a *product* to generate from the list displayed on the **Products** tab.
- Click on each *enabled tab* of the tab control (right side of screen) to input the required information and select *options* specific to the selected product.
- Click **Run** to run the job immediately.

The tab control on the right side of the Reports interface has six tab screens. Access to each screen is updated when the user selects a product in the Output Products list. If the tab is disabled, its content does not relate to the selected product. The tab screens are discussed below:

**The Dates Tab** displays one or more fields for the user to input the desired time period of data to be included in the output product. Usually, there are Start Date and End Date fields that require dates in mm/dd/yyyy format. Other products may need only a year to be entered. Figure 6-3 shows the Dates tab screen.

Figure 6-3. The Dates Tab.

**The Sites Tab** displays a tree view of site groups as configured. Groups and/or individual sites can be selected to be included in the output job. Figure 6-4 shows the Sites tab screen.
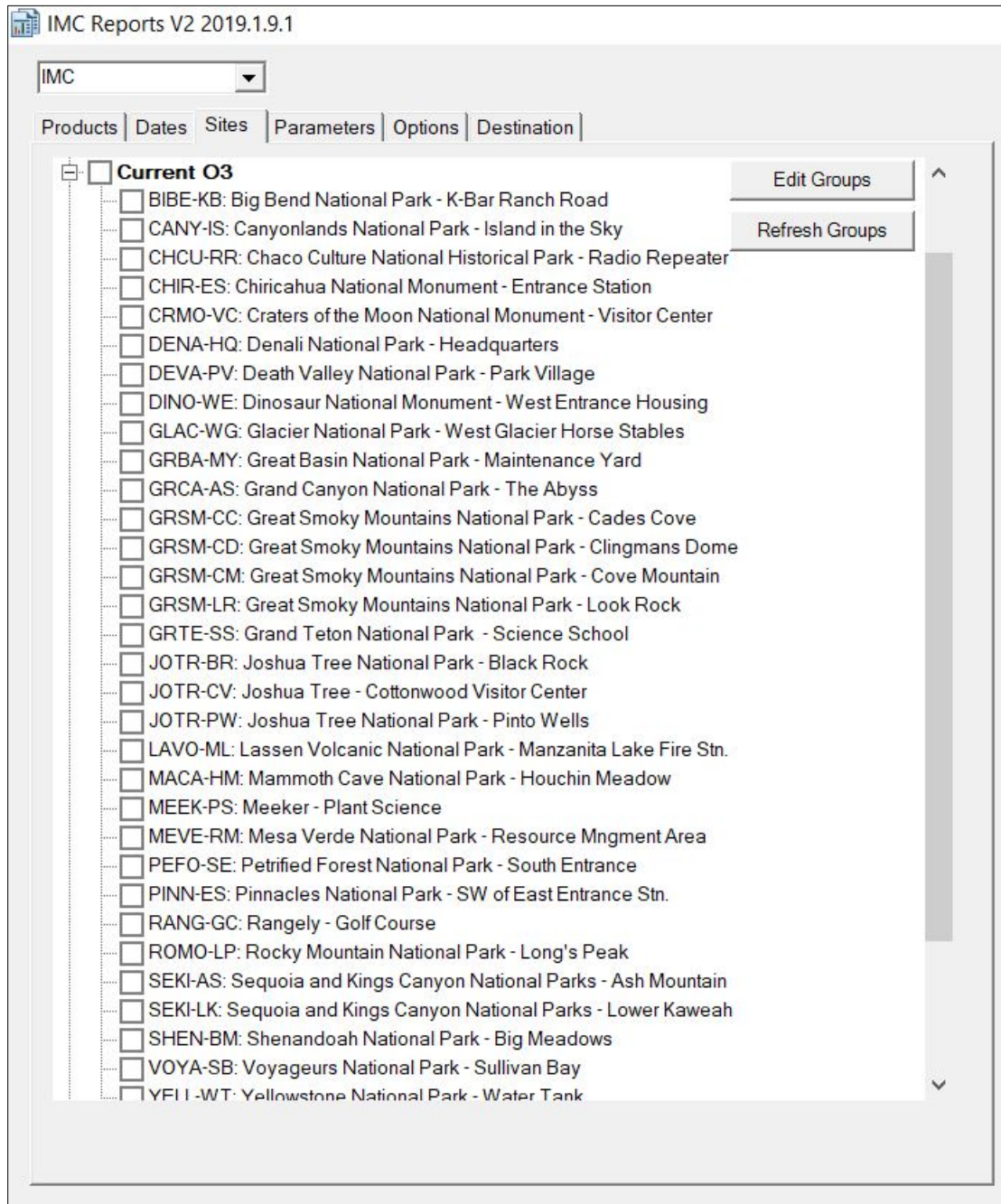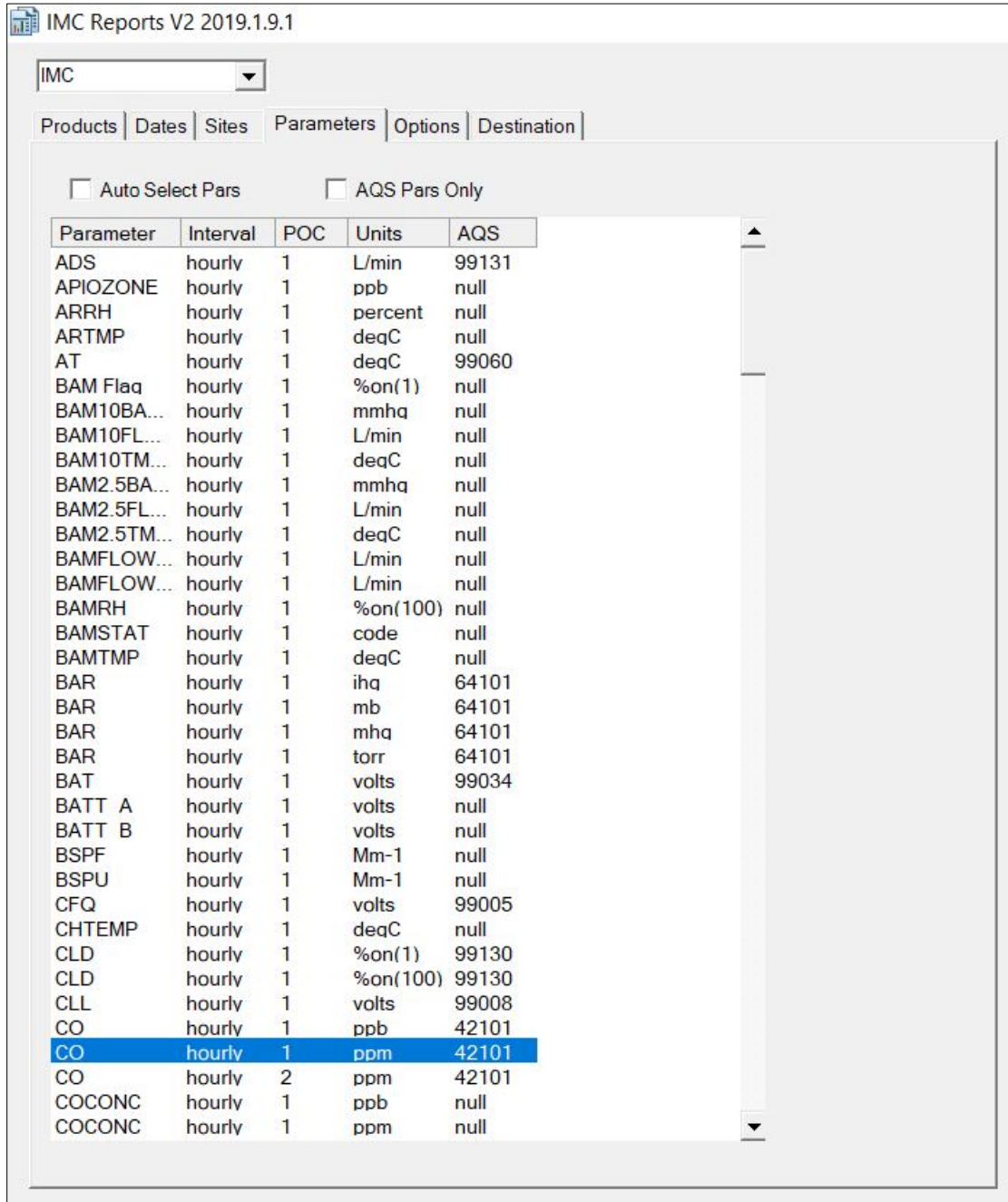


Figure 6-4. The Sites Tab.

**The Parameters Tab** displays a list of all parameters as shown in Figure 6-5. The list can be filtered for only the parameters available at the selected site for the selected dates. The user can use this list to select which parameters to include in the report product.



Figure 6-5. The Parameters Tab.

**The Options Tab** displays additional options for the selected product. An example of the Options tab when the "Data Collection Statistics – Selected Parameters" product is selected is shown in Figure 6-6. Options may include the following:

- Convert units to a standard reporting unit.
- Display the date the product was generated in the footer.
- Include a table or figure number.
- Number of values to report.



Figure 6-6. The Options Tab.

**The Destinations Tab** displays options on the type of output to produce as shown in Figure 6-7. This tab updates dynamically depending on the product selected. Only the possible options for the selected product are enabled. More than one option can be selected. Destination options are:

- Output to screen. This option causes the output generator to pause after each product has been created and display the product on the screen before going onto the next. Click the **Print** button to send the output product to the printer. Click the **Continue** button to close the on-screen display.
- Output to printer. This option sends the output directly to the currently selected printer.
- Output to PDF file. This option uses the Adobe Portable Document File (PDF) Writer to create PDF files of the output. When the checkbox is selected, an input field displays prompting the user to enter a destination folder for the generated PDF files.
- Output to text file. This option writes the output to ASCII text files. When the checkbox is selected, an input field displays prompting the user to enter a destination folder for the text files.
- Output to designer. This option causes the report product to open in the designer view where the user then has the ability to make formatting changes such as to the margins or the width of a field in a table.



Figure 6-7.  The Destinations Tab.

### 6.2.2 GENERATING REPORT MAPS *(GPMP Annual Report only)*

Maps are generated by importing the latitude and longitude coordinates of each site from the AQDBMS Site Configuration Table into MapViewer mapping software. The site locations are plotted on a map of the United States along with their corresponding values that are being summarized on the map.

### 6.2.3 AQDBMS GRAPHICS PRODUCTS

Four programs are available to create graphical representations of AQDBMS data directly from the database. The AQDBMS graphics programs provide the following common features:

- Execution directly from the AQDBMS or the Windows desktop
- Single-site plot vs. submit file option to create multiple-site plots
- Printer destination and setup selection
- Start and end date selection
- Monthly, quarterly, and annual plots (except One-Year and Three-Year Summary plots)
- Plot title customization
- Plotting scale adjustment
- Force Final Validation footnote for historical data
- Automatic printing option
- Windows metafile output

### 6.2.3.1 Description of AQDBMS Products

- A Rose Plot summarizes the relationship between wind speed or a user-selected pollutant parameter in a standard wind rose.
- The Three-Year Summary Plot summarizes user-selected pollutant parameters in a bar chart that compares the second highest 1-hour average on a monthly basis.
- The Diurnal Plot summarizes user-selected pollutant parameters in a line graph that bins the values by time of day.
- A Summary by Month Plot summarizes user-selected pollutant parameters in a bar chart that compares highest hourly averages, highest 8-hour or 24-hour averages, and monthly averages by month.

These graphics products query data directly from the AQDBMS. Options unique to each of these products are described in the subsections following this.

### 6.2.3.1.1 Creating Plots From the AQDBMS Graphics Programs

The AQDBMS graphics programs may be run directly from a Windows desktop icon.  To create a plot:

- Double-click the *icon* for the desired graphics product on the Windows desktop.
- Select a *site* from the Select Site drop-down list box.
- Enter the *start and end dates* for the period to be plotted in the Start and End boxes.
- Click the **Get Parameter List** button. The program retrieves a parameter code list for the selected site/period.
- Select the *parameter* to be plotted from the Available Parameter List drop-down list box.

- Select applicable *options*. Each type of plot has one or more options that can be changed.
- To print the plot automatically, click the **AutoPrint** checkbox.
- Click the **Draw Plot** button. The program retrieves and plots the data.
- If needed, modify the default graph scaling values, then click the **Redraw** button.
- Click the **Print** button to print the plot.

**6.2.3.1.2 Creating Plots for Multiple Sites from the AQDBMS Graphics Programs**

Plots can be created for multiple sites/parameters for the same time period. To create multiple plots in a single run, a submit file containing a list of the site/parameters to be plotted is created in advance. The sites/parameters included in a submit file will be plotted with common options. Sites with parameters that do not use common options – such as a scaling change – must be run in a single site mode. Create separate submit files for each of the graphics products.

To create a submit file:

- Open a new file in a text file editor such as Windows Notepad (do not use a word processor such as Microsoft Word).
- On the first line of this file:
  - Type a four-character *site abbreviation* followed by a comma **<,>**.
  - Type a *parameter abbreviation* followed by a hyphen **<->** and a comma **<,>**.
  - Type a **Y** followed by a comma **<,>**.
  - Type three more *commas*, then press **<Enter>**. For example, type **BIBE,O3-4,Y,,,,** to plot ozone data for Big Bend National Park.
- Repeat the above step for each combination of site/parameter that you want to include in the batch of plots.
- Select **Save As** from the File menu. Save the file in the folder and with the filename of your choice.

To create plots for multiple sites:

- Double-click the *icon* for the desired graphics product on the Windows desktop.
- To print to pdf (or to create pdfs):
  - Under the options box, choose **AutoPDF**.
  - Select the desired pdf *destination*.
  - Enter the *start and end dates* for the period to be plotted in the Start and End boxes.
  - Select applicable *options*. Each type of plot has one or more options that can be changed.
  - To not automatically print the plots, click the **AutoPrint** checkbox to deselect the auto printing feature.
  - From the File menu, select **Run a Submit File**.
  - Select the *submit file* you previously created and saved from the File-open dialogue box and click **OK**.
  - Click **Print**.

### 6.3    COMPILING DATA REPORTS

**Monthly Data Reports**

- A cover page is generated and saved as a .pdf file.
- Data products are exported as .pdf files from the AQDBMS.
- The cover page and data products are merged in Adobe Acrobat to compile the final report.

**Quarterly Data Reports**

- A word document template is utilized for most quarterly reports. A Technical Assistant will prepare word documents by updating the reporting period and making any other necessary changes to the text, tables and figures associated with parameter or instrumentation changes at monitoring sites, or the addition/removal of sites within a monitoring network at the discretion of the IMC Team Lead.
- A Data Analyst will update the word document to communicate significant events via an Operational Summary and check the entire document for accuracy.
- Data products are exported as .pdf files from the AQDBMS.
- The cover page and data products are merged in Adobe Acrobat to compile the final report.
- The Technical Assistant will proofread the document for spelling, grammar and formatting issues and make any necessary corrections. The document will be saved as a .pdf file and all data products will be appended. Page numbers will be added and the data summary will be submitted to the IMC Team Lead and/or Data Manager for review.

**Annual Data Reports**

- A word document template is utilized for most annual reports. A Technical Assistant will prepare word documents by updating the reporting period and making any other necessary changes to the text, tables and figures associated with parameter or instrumentation changes at monitoring sites, or the addition/removal of sites within a monitoring network at the discretion of the IMC Team Lead.
- A Data Analyst will update the word document to communicate significant events via an Operational Summary and check the entire document for accuracy.
- Data products are exported as .pdf files from the AQDBMS.
- The cover page and data products are merged in Adobe Acrobat to compile the final report.
- The Technical Assistant will proofread the document for spelling, grammar and formatting issues and make any necessary corrections. The document will be saved as a .pdf file and all data products will be appended. Page numbers will be added and the data summary will be submitted to the IMC Team Lead and/or Data Manager for review.

### 6.4    REVIEWING DATA REPORTS

Data summary reports are reviewed by multiple IMC staff or project-related personnel. If errors are found, corrections are made and the affected report contents are regenerated.

## 6.5    CORRECTING DATA REPORTS

Corrections are made by regenerating products as needed until all products are correct. Products that have been regenerated are given to the Technical Assistant to replace in the final report.

## 6.6    DISTRIBUTING DATA REPORTS

Once the reports have been compiled, assembled, and reviewed they are ready for distribution. Copies are distributed as designated by sponsoring organization personnel. Copies may be hard copy or electronic and delivered on CD or via an upload process. An electronic copy is also maintained by the project manager on the ARS network.

Where required by the sponsoring agency, a digital copy of all validated data (and also raw data if requested) will be delivered in conjunction with the reports. The data will be provided electronically unless another media is requested by the sponsoring agency.

## 6.7    GENERATING THE MONTHLY OZONE HIT LIST (GPMP ONLY)

The monthly ozone "hit list" is a list of site-specific ozone 8-hour averages greater than the standard (currently 70 ppb). The ozone hit list is generated from Level 0 data at the end of every month. The monthly ozone hit list is distributed by e-mail to the client by the 5th of the month.

Since the data have not yet been validated prior to delivering the report, the data analyst/technicians generate and review a list of high values to identify and exclude values recorded during obvious non-ozone events such as daily zero/span calibrations.  To generate the ozone hit list, launch the IMC application:

- From the Reports menu, select **Episodes with 1-Hour Ozone Concentrations $\geq 100$   ppb and > 124 ppb.**
  - Under the Dates tab, enter the *month* that just passed.
  - Under the Sites tab, select **Current IMC Sites**.
  - Under the Options tab, leave the defaults at *Validation Table* and *Place groups/sites on one report*.
  - Under the Output tab, select **Output to PDF File**.
- Review the report and check that all values in exceedance are real values and not calibrations, instrument warm-ups, or other problem. This is determined by viewing stackplots and looking at O3 and O3CAL values together in the validation area of the database. If there is an invalid exceedance, invalidate the hour(s) in the database temporarily with a "TI" (Temporarily Invalid) code.
- Run the report again. Double-check that all invalid values have been removed.
- Repeat the above three steps with the report **Episodes with 8-Hour Average Ozone Concentrations > 70 ppb**.
- Run the report **Ozone Hit List**. Direct the output to a text file on the network.
- Enter the values from the Ozone Hit List report into the .csv file on the network. Update any changes to previous months that may have occurred since the last revision.
- Incorporate values for client requested state-operated sites by exporting ozone data from AirNow.
- E-mail the .csv file that lists the ozone exceedances to the client.

- Continue updates at the beginning of each month until all data are final through the end of the year.

## 6.8 DATA REQUESTS

Data requests are received by the client or IMC and forwarded to the data analyst/technician to fill. The following subsections detail the steps taken to complete data requests.

### 6.8.1 THE DATA RETRIEVAL WEB SITE

Most requesters are directed to the project-specific data request Web site, where they can retrieve the data they need. Many data requests are filled this way. Non-standard methods, including download via FTP site, transmit via e-mail, or delivery via CD, are used on a case-by-case basis, depending on the nature of the request.

### 6.8.2 AUTHORIZATION OF DATA REQUESTS

Data requests that can be handled through the standard output interface require only that the client be advised. Some data requests, for example those made via the NPS ARD, have an implied authorization. The client must authorize each non-standard data request before processing the request. Otherwise, details of the data request are forwarded to the client for authorization.

Some data requests can be unusually complex or require large volumes of data or non-standard output. In these cases, the IMC section manager must estimate the amount of time and materials needed to fill the request and communicate this information to the client. Doing so will allow the client to judge if filling the request is an appropriate use of the data analyst/technicians' time or if the scope of the request needs to be negotiated with the requestor.

### 6.8.3 GENERATING DATA FILES FOR DATA REQUESTS

Data requests that are not processed through the Data Retrieval Web site are made by the data analyst/technician via the reporting interface following the same steps that are used to generate report products. See section 6.2 for detailed instructions on generating data files.

### 6.8.4 OTHER TYPES OF DATA REQUESTS

Some data requests may include requests for standard monthly or annual report tables or plots. Standard output can be generated by the reporting interface application at any time. Data requests may also include requests for custom data summaries or lists meeting certain criteria or graphics. In these cases, the data analyst/technicians work with the database administrator/programmer to generate the necessary output.

### 6.8.5 DELIVERING DATA REQUESTS

Data requests are delivered in one of the following ways depending on the volume of data and/or how the recipients want to receive the data:

- Downloaded by the recipient from the ARS FTP site.
- Transmitted via an e-mail attachment.
- Written to CD-ROM and mailed.

If the data files are to be downloaded from the ARS FTP site:

- The files are uploaded to the site.
- An-e-mail message is sent, which includes instructions for downloading the files.
- The files are removed from the FTP site after it is confirmed that the recipient has successfully retrieved them.

If the data files are transmitted via an e-mail attachment:

- The data file(s) are attached to the e-mail message and the message is sent.

If data files are written to CD:

- The data analyst/technician copies the files to the appropriate media and labels each piece as to its contents.
- The data analyst/technician prepares a cover letter and the package is sent first class mail unless directed otherwise by the client.

## 6.9 SUBMITTING DATA TO THE EPA AQS DATABASE

### 6.9.1 COMMUNICATIONS REQUIREMENTS

Submitting data to AQS requires connecting directly to AQS by accessing the Internet using DSL, cable, T1, or other high-speed connection.

### 6.9.2 EPA AQS TRAINING AND DOCUMENTATION

The EPA provides regularly scheduled training sessions on the EPA AQS. The IMC manager and/or IMC Team Lead will attend training sessions as needed to keep skills and knowledge current. In addition, the IMC holds a complete set of EPA issued documentation on AQS. The IMC manager and/or IMC Team Lead is familiar with and will use this documentation as a supplement to this SOP and when working within AQS.

### 6.9.3 METHODS

Hourly average ambient air quality and meteorological data at the Final validation level are submitted to AQS on a regular basis. Precision data from criteria pollutant analyzer precision checks and accuracy data from external audits of criteria pollutant analyzers are submitted as needed.

The steps required to submit data to the EPA AQS database are:

- Create and verify the accuracy of AQS transaction files for hourly average ambient air quality and meteorological data.
- Create and verify the accuracy of AQS transaction files for precision data from criteria pollutant analyzer precision checks.
- Create and verify the accuracy of AQS transaction files for accuracy data from audit reports on criteria pollutant analyzers.

- Transfer the files to AQS using ENSC (Exchange Network Services Center).
- Load data into the AQS database, successfully run the AQS statistical analysis programs, and post data to the AQS database (this is done automatically by the AQS system once a file is successfully transferred).

The following subsections provide detailed steps to complete data submittal to AQS. You may also refer to the *Air Quality System User Guide* (EPA, 2006) for comprehensive instructions.

### 6.9.3.1 GENERATING AQS FILES FROM THE AQDBMS

#### 6.9.3.1.1 Hourly Average Files

Hourly average ambient air quality and meteorological data must be formatted as AQS Type RD transactions to be submitted to AQS. A program in the AQDBMS generates Type RD transaction files.

To generate transaction Type RD AQS files:

- From the reporting interface, select either **AQDB** or **IMC** from the drop-down menu depending on which database the desired sites reside within.
- Under the **Products** tab, select **Export AQS data**.
- Select the *sites*, *parameters* (defaults to select all parameters with AQS codes), and *dates* of the data set to use.
- Under the **Destination** tab, select **Output to text file**.
- Click on **text file folder** to select a path to save the file on the network and enter the desired file name.
- Click the **Run** button.

**Notes:**

- The program looks up each selected site in the Site Configuration Table. This is where the AQS site code (state, county, and site number) is stored. If this information is not filled in, a message is displayed and that site will not be written to the AQS data file. If the information is wrong, problems will occur in AQS.

- If a site does not exist for the entire period that was selected, only the period where a record exists in the database will be written to the file (i.e., nothing will be written for the times when there are no records). If a record does exist, however, even if it's coded NA, it will be written to the file. Likewise, if a parameter is chosen and a site does not have that monitor, then that parameter will be skipped.

- Each parameter's associated AQS code, method code, and POC code is defined in the Parameter Codes Table, under *table maintenance*.

### 6.9.3.1.2 1-Point AQS Files

The routine precision (1-point QC) checks conducted on criteria pollutant instruments at sites are submitted to AQS as QA transactions. A product in the reporting interface generates QA transaction files.

To generate transaction Type QA AQS files:

- From the reporting interface, select either **AQDB** or **IMC** from the drop-down menu depending on which database the desired site resides within.
- Under the **Products** tab, select **Export AQS 1-Point QC data**.
- Select the *sites*, *parameters*, and *dates* of the data set to use.
- Under the **Destination** tab, select **Output to text file**.
- Click on **text file folder** to select a path to save the file on the network and enter the desired file name.
- Click the **Run** button.

### 6.9.3.1.3 Annual PE AQS Files

Data from audits conducted on criteria pollutant analyzers at sites are submitted to AQS as QA transactions. A program in the AQDBMS generates QA transaction files.

To generate transaction Type QA AQS files:

- From the reporting interface, select either **AQDB** or **IMC** from the drop-down menu depending on which database the desired site resides within.
- Under the **Products** tab, select **Export AQS QA Annual Performance Evaluation (PE)**.
- Select the *sites*, *parameters*, and *dates* of the data set to use.
- Under the **Destination** tab, select **Output to text file**.
- Click on **text file folder** to select a path to save the file on the network and enter the desired file name.
- Click the **Run** button.

### 6.9.3.2 TRANSFERRING AND POSTING DATA TO AQS VIA ENSC

Once the AQS data file is generated and deemed accurate by the IMC manager or IMC Team Lead, it is ready to be uploaded to the AQS database. Files are transferred using the program *ENSC*. To transfer files:

- Log in to your ENSC account on any high-speed Internet connection, using your current ID and password, at *https://enservices.epa.gov/login.aspx*.
- Select the 'Exchange Network Services' tab. Make sure the 'send information' option is selected and click 'continue'.
- Click on 'Browse Services Directory' and select the 'Send Info' option next to 'AQS' in the service transaction column. At this point the web site will confirm the selection you have made. Select 'Continue'.
- Using the 'Browse' button, select the file to be uploaded to AQS and click 'Continue'.
- A form will display; select the appropriate screening group, file type, final processing step, and whether or not you'd like the processing to stop if an error occurs. Click 'Continue'.
- Enter your e-mail address to be notified when the file has transferred and the records have posted to AQS.

- Select 'Continue' and then select 'send data'.

The system will send an e-mail confirming that the files have been successfully transferred to AQS. The AQS system automatically processes the file and posts the records. When this process is complete you will receive an e-mail from AQS summarizing the processing results (see Figure 6-8). If all records post successfully there is no need to login to AQS.
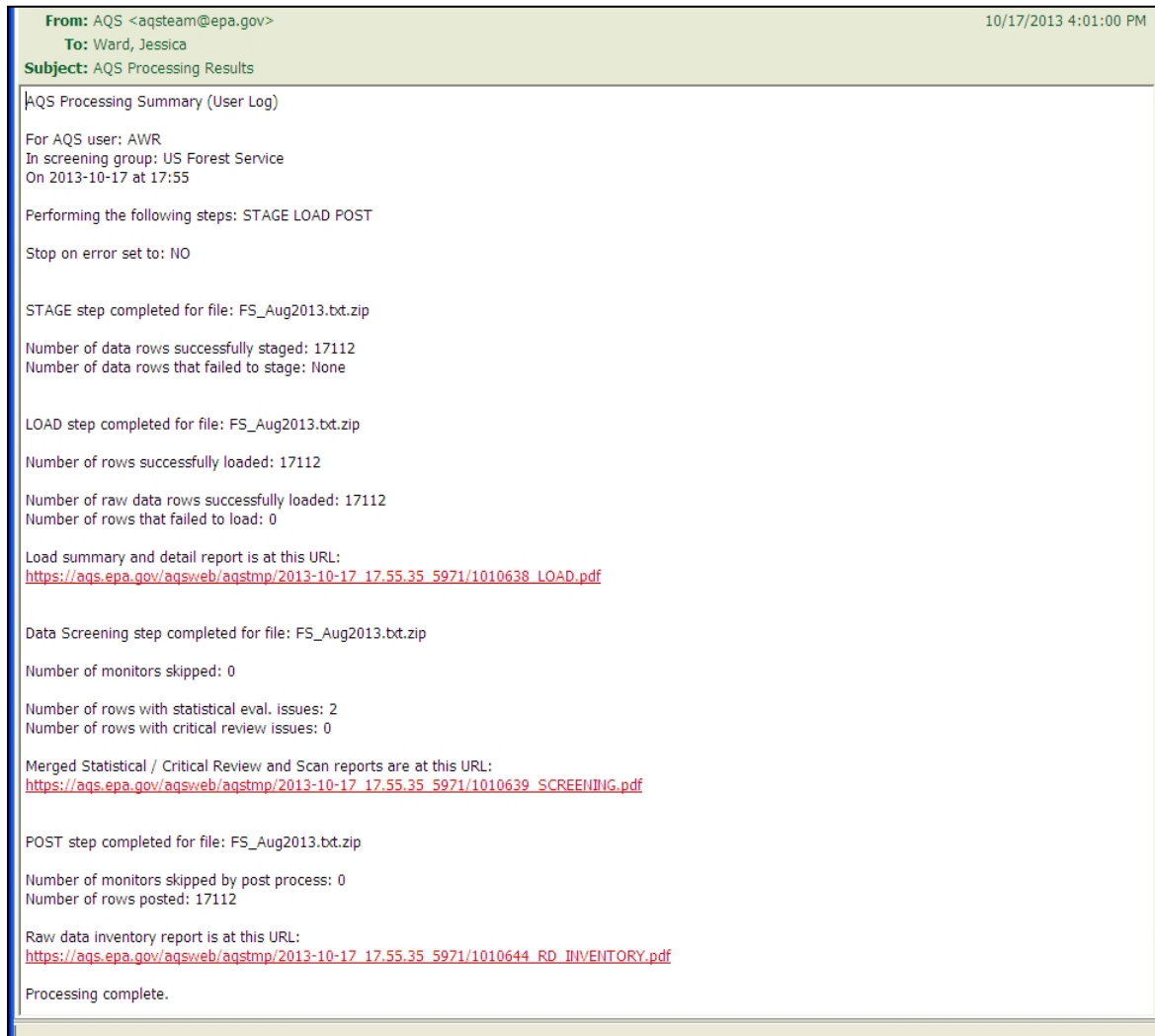


```
From: AQS <aqsteam@epa.gov>                                    10/17/2013 4:01:00 PM
  To: Ward, Jessica
Subject: AQS Processing Results

AQS Processing Summary (User Log)

For AQS user: AWR
In screening group: US Forest Service
On 2013-10-17 at 17:55

Performing the following steps: STAGE LOAD POST

Stop on error set to: NO


STAGE step completed for file: FS_Aug2013.txt.zip

Number of data rows successfully staged: 17112
Number of data rows that failed to stage: None


LOAD step completed for file: FS_Aug2013.txt.zip

Number of rows successfully loaded: 17112

Number of raw data rows successfully loaded: 17112
Number of rows that failed to load: 0

Load summary and detail report is at this URL:
https://aqs.epa.gov/aqsweb/aqstmp/2013-10-17_17.55.35_5971/1010638_LOAD.pdf


Data Screening step completed for file: FS_Aug2013.txt.zip

Number of monitors skipped: 0

Number of rows with statistical eval. issues: 2
Number of rows with critical review issues: 0

Merged Statistical / Critical Review and Scan reports are at this URL:
https://aqs.epa.gov/aqsweb/aqstmp/2013-10-17_17.55.35_5971/1010639_SCREENING.pdf


POST step completed for file: FS_Aug2013.txt.zip

Number of monitors skipped by post process: 0
Number of rows posted: 17112

Raw data inventory report is at this URL:
https://aqs.epa.gov/aqsweb/aqstmp/2013-10-17_17.55.35_5971/1010644_RD_INVENTORY.pdf

Processing complete.
```

Figure 6-8.  Example E-Mail Summarizing AQS Processing Results.

### 6.9.3.3 MANUALLY POSTING AND CORRECTING RECORDS IN AQS
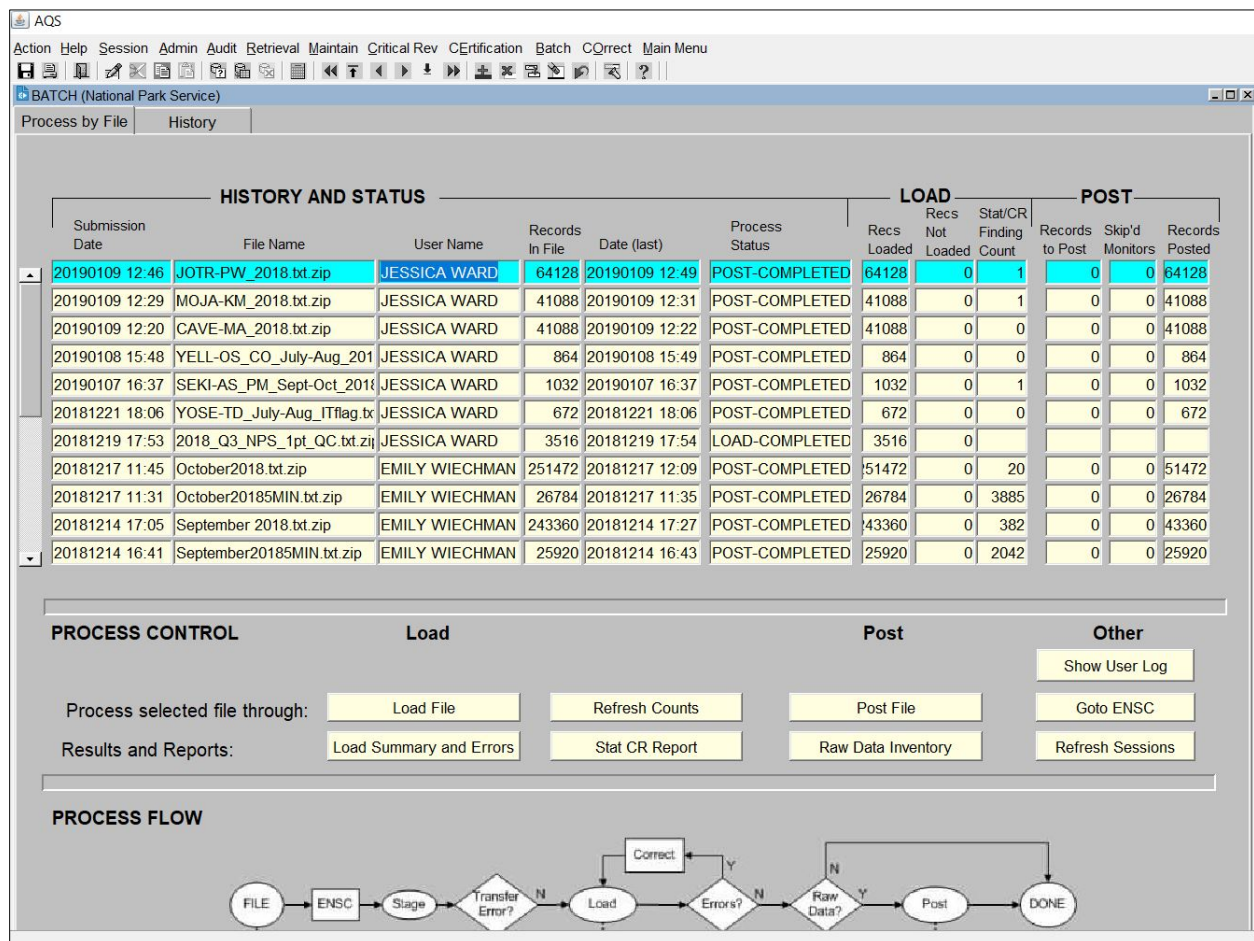
If the AQS Processing Summary e-mail shows that records failed to stage, load or post, the records will need to be manually processed or corrected in the AQS system.

#### 6.9.3.3.1 Loading Records into AQS

- Log in to your AQS account on any high-speed Internet connection.

- Enter your current *ID* and *password*, and *aqsprod* for database.
- Logging in will automatically take you to **Session.** Highlight the appropriate *screening group*, press **OK**, and then go to the Batch menu.
- Under the Batch Load tab, highlight the appropriate *file* from the list.

The buttons under the process control section of the batch window can be used to manually process a file in AQS. Under the Batch Load tab, highlight the appropriate *file* from the History and Status list and click **Load File**. When the file has loaded, the process status will display 'Load Completed'. Select the **Stat CR Report** button. Again, when the process is complete the process status will indicate this by displaying 'Stat CR Completed'. The final step is to select the **Post File** button. When the records are done posting, the process status will show 'Post Completed'.



Figure 6-9.  Batch Screen in AQS.

### 6.9.3.3.2 Correcting Records in AQS

The number of records that load and the number of records that fail to load will display under the load portion of the batch window. If records fail to load the following steps should be followed to correct the records and to ensure that they post successfully:

- Select 'Correct' from the main menu and then select the type of transaction record that you are attempting to correct. Next select the 'execute query' button. The query will return a list of all records that failed to load. (see figure 6-10) The error message at the bottom of the window will describe the problem with each record. Correct each record and then select the 'save' button.
- Return to the batch window and manually process the records using the process described above. If there are still errors, continue to make corrections until the data load completely without errors.



Figure 6-10. Correct Screen in AQS.

When complete, go to the Batch Reports tab, and click on **Raw Data Inventory**. This will provide you with a report of all posted data – keep this report for future reference. This report only works for raw data (not precision or accuracy data).

## 7.0    REFERENCES

Air Resource Specialists, Inc. (ARS), 2012, Air Quality Data Base Management System (AQDBMS) User's Guide.

Environmental Protection Agency (EPA), Air Quality System User Guide (Version 1.0.0, July 31, 2013).
*https://www.epa.gov/aqs/aqs-users-guide-0*

## 8.0    DEFINITIONS AND ACRONYMS

| | |
|---|---|
| AQDB | Air Quality Database |
| AQDBMS | Air Quality Database Management System |
| AQS | Air Quality System |
| ARS | Air Resource Specialists |
| ASCII | American Standard Code for Information Interchange |
| | |
| CD | Compact Disc |
| DSL | Digital Subscriber Line |
| ENSC | Exchange Network Services Center |
| EPA | Environmental Protection Agency |
| | |
| FTP | File Transfer Protocol |
| GPMP | Gaseous Pollutant Monitoring Program |
| IMC | Information Management Center |
| NPS ARD | National Park Service Air Resources Division |
| | |
| PDF | Portable Document Format |
| POC | Parameter of Occurrence |
| | |
| QA | Quality Assurance |
| QAPP | Quality Assurance Project Plan |
| QC | Quality Control |
| SOP | Standard Operating Procedure |

**APPENDIX**

**Report Products**

| | Standard Operating Procedure |
| | **Information Management Center -** |
| Air Resource SPECIALISTS | **Data Reporting and Dissemination** |

| **Version: 1.1** | *I_IMC_RPTS_F_1.1* | **Page 28 of 36** |

**Data Collections Statistics by Site**
**06/01/2016 - 06/30/2016**
**National Park Service Gaseous Pollutant Monitoring Program**

| National Park Unit | Site Name | O3 % valid[1] | SO2 % valid[1] | SO2Add % valid[1] | CO % valid[1] | NOx % valid[1] | PM2.5 % valid[1] | PM10 % valid[1] | VWD % valid[1] | SWS % valid[1] | TMP % valid[1] | RH % valid[1] | RNF % valid[1] | SOL % valid[1] | FLOW % valid[1] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Stones River | Beasley Field | 91.4 | — | — | — | — | — | — | — | 91.4 | 91.4 | 91.4 | 91.4 | 91.4 | — |
| Theodore Roosevelt | Painted Cany. VC | — | — | — | — | — | — | — | 100.0 | 100.0 | 96.5 | 100.0 | 100.0 | 100.0 | 99.9 |
| Voyageurs | Sullivan Bay | 25.1 | — | — | — | — | — | — | 10.3 | 100.0 | 100.0 | 100.0 | 100.0 | 0.0 | 99.6 |
| Wind Cave | Visitor Center | — | — | — | — | — | — | — | 92.1 | 92.1 | 99.7 | 99.7 | 99.4 | 99.7 | 99.2 |
| Yellowstone | Old Faithful Snow Lodge | — | — | — | 88.3 | — | 7.0 | — | 99.0 | 99.0 | 100.0 | 100.0 | — | — | — |
| Yellowstone | Water Tank | 98.3 | — | — | — | — | — | — | 98.8 | 98.8 | 99.4 | 98.5 | 98.8 | 99.2 |
| Yellowstone | West Entrance | — | — | — | 81.9 | 81.5 | 97.8 | — | 99.4 | 99.4 | 100.0 | 100.0 | — | — | — |
| Yosemite | Turtleback Dome | 99.4 | — | — | — | — | — | — | 99.9 | 99.9 | 100.0 | 100.0 | — | 100.0 | 99.6 |
| Zion | Dalton's Wash | 99.7 | — | — | — | — | — | — | 100.0 | 100.0 | 100.0 | — | 99.6 | 100.0 | — |
| **Average Network Data Collection** | | 91.1 | 78.0 | 95.8 | 77.3 | 91.9 | 84.7 | 92.8 | 95.4 | 97.9 | 97.4 | 97.1 | 95.4 | 95.8 | 97.4 |

Key:

| | | | Performance Goals: | |
|---|---|---|---|---|
| O3 = Ozone | NOX = Oxides of Nitrogen | TMP = Ambient Temperature | **Monthly Criteria:** | **Quarterly Criteria:** |
| SO2 = Sulfur Dioxide | PM2.5 = Particulate Matter 2.5 | RH = Relative Humidity | 100% of sites, >= 60% valid data capture | 100% of sites, >= 85% valid data capture |
| SO2Add = Sulfur Dioxide | PM10 = Particulate Matter 10 | RNF = Precipitation | 90% of sites, >= 75% valid data capture | 90% of sites, >= 90% valid data capture |
| CO = Carbon Monoxide | VWD = Vector Wind Direction | SOL = Solar Radiation | 80% of sites, >= 85% valid data capture | 80% of sites, >= 95% valid data capture |
| | SWS = Scalar Wind Speed | FLOW = Filter Pack Flow Rate | | |

1. Percent valid can be less than 100% due to calibrations, routine maintenance, power failures, audits or other circumstances where the instrument was not available to collect data. For example, automatic zeros and spans are performed daily on most ambient gas analyzers; therefore, no ambient gas data can be collected during this time. As a result, the maximum percent valid for ambient gas data typically cannot be greater than 95.8. Percent valid can also be less than 100% due to influencing factors such as instrument error, operator error, timing problems, flow issues, and other factors that affect instrument operation.

Color shading key:
- ☐ 85% - 100% data recovery
- ☐ 75% - 84.9% data recovery
- ☐ 60% - 74.9% data recovery
- ☐ 0% - 59.9% data recovery

Example Data Collection Statistics by Site for All Parameters.

**Summary of Ozone Data by Site**
**06/01/2016 - 06/30/2016**
**National Park Service Gaseous Pollutant Monitoring Program**

| National Park Unit | Site Name | 4 Highest Daily Maximum 8-Hour Average Concentrations[1] (ppb) | | | | | Highest Daily Maximum 1-Hour Average Concentrations (ppb) |
|---|---|---|---|---|---|---|---|
| | | 1st Highest | 2nd Highest | 3rd Highest | 4th Highest | # of Days with 8-Hour Average O3 Values > 70 ppb[2] | 1st Highest |
| Big Bend | K-Bar Ranch Road | 64 | 61 | 60 | 55 | 0 | 67 |
| Canyonlands | Island in the Sky | 62 | 60 | 60 | 58 | 0 | 65 |
| Chiricahua | Entrance Station | 62 | 61 | 59 | 58 | 0 | 69 |
| Death Valley | Park Village | 68 | 67 | 66 | 63 | 0 | 71 |
| Glacier | West Glacier Horse Stables | 50 | 49 | 47 | 43 | 0 | 55 |
| Great Smoky Mountains | Clingmans Dome | 69 | 65 | 61 | 61 | 0 | 93 |
| Grand Teton | Science School | 54 | 53 | 50 | 49 | 0 | 60 |
| Lassen Volcanic | Manzanita Lake Fire Stn. | 59 | 56 | 53 | 53 | 0 | 64 |
| Pinnacles | SW of East Entrance Stn. | 66 | 65 | 64 | 62 | 0 | 78 |
| Rocky Mountain | Long's Peak | 80 | 77 | 72 | 67 | 3 | 97 |
| Sequoia and Kings Canyon | Ash Mountain | 96 | 94 | 87 | 86 | 22 | 108 |
| Sequoia and Kings Canyon | Lower Kaweah | 87 | 86 | 81 | 80 | 15 | 101 |
| Yosemite | Turtleback Dome | 75 | 67 | 63 | 62 | 1 | 79 |
| Zion | Dalton's Wash | 66 | 62 | 62 | 61 | 0 | 72 |

[1]The primary and secondary National Ambient Air Quality Standard for ozone is 0.070 ppm over an 8-hour period. (Attainment of the primary standard is reached if the annual fourth highest daily maximum 8-hour ozone concentration, averaged over three years, does not exceed 0.070 ppm, 70 ppb, or 137 µg/m³.) (40 CFR 50.10 with reference to Appendix D and I.)

[2]An exceedance of the National Ambient Air Quality Standard for ozone occurs when an 8-hour average ozone concentration exceeds 0.075 ppm, 75 ppb, or 147µg/m³. (40 CFR 50.10 with reference to Appendix D and I.)
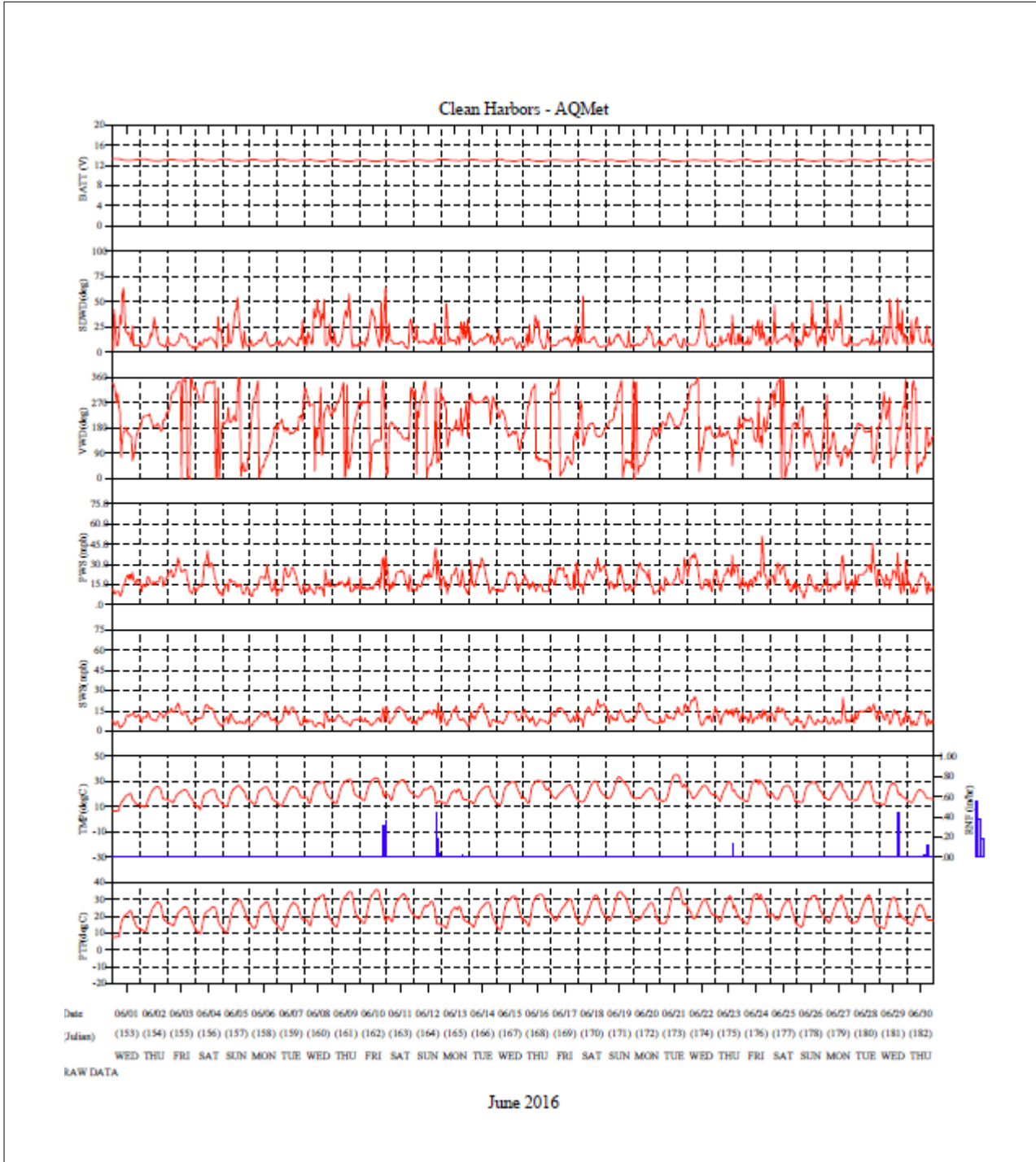
Example Summary of Ozone Data by Site.

Example Time Series Plot by Site.

**Summary of Selected Meteorological Data by Site**
**08/01/2013 - 08/31/2013**
**National Park Service Gaseous Pollutant Monitoring Program**

| National Park Unit | Site Name | Wind Speed (Scalar) (m/s) Average | Ambient Temperature (degrees C) Average | Maximum | Minimum | Relative Humidity (%) Average | Maximum | Minimum | Precipitation (mm) Accumulated during period |
|---|---|---|---|---|---|---|---|---|---|
| Sequoia and Kings Canyon | Ash Mountain | 3.1 | 26.9 | 35.9 | 17.2 | 32 | 62 | 15 | 3.6 |
| Sequoia and Kings Canyon | Lower Kaweah | 2.0 | 18.2 | 26.3 | 9.9 | 45 | 83 | 22 | 4.3 |
| Shenandoah | Big Meadows | 1.3 | 16.6 | 23.6 | 7.9 | 83 | 95 | 56 | 130.6 |
| Theodore Roosevelt | Painted Cany. VC | 4.6 | 21.2 | 34.1 | 10.5 | 62 | 99 | 18 | 25.8 |
| Voyageurs | Sullivan Bay | 2.3 | 19.2 | 32.3 | 8.4 | 73 | 100 | 32 | 58.1 |
| Walden - Colorado | Chandler Ranch | 2.4 | 14.5 | 27.1 | 0.2 | 62 | 98 | 12 | — |
| Wind Cave | Visitor Center | 3.7 | 22.1 | 32.7 | 13.0 | 58 | 95 | 20 | 1.6 |
| Yellowstone | Old Faithful Snow Lodge | 1.7 | 15.2 | 27.9 | 0.6 | 50 | 97 | 9 | — |
| Yellowstone | Water Tank | 1.7 | 14.8 | 24.7 | 6.8 | 53 | 98 | 8 | 21.7 |
| Yosemite | Turtleback Dome | 4.3 | 20.5 | 29.1 | 12.0 | 31 | 56 | 11 | — |
| Zion | Dalton's Wash | 4.0 | 27.0 | 37.0 | 16.5 | — | — | — | — |

Example Summary of Selected Meteorological Data by Site.

Data Collection Statistics
Big Bend National Park

Final Validation

06/01/2016 - 06/30/2016

| Parameter | Interval | Par Code | Data Recovery | | | Valid Data | |
|---|---|---|---|---|---|---|---|
| | | | No. Possible | No. Collected | % Collected | No. Valid | % Valid |
| Ozone Analyzer | hourly | O3 | 720 | 693 | 96.3 | 690 | 95.8 |
| Relative Humidity | hourly | RH | 720 | 700 | 97.2 | 700 | 97.2 |
| Precipitation | hourly | RNF | 720 | 700 | 97.2 | 700 | 97.2 |
| Standard Deviation for Wind Direction | hourly | SDWD | 720 | 697 | 96.8 | 697 | 96.8 |
| Solar Radiation | hourly | SOL | 720 | 700 | 97.2 | 700 | 97.2 |
| Scalar Wind Speed | hourly | SWS | 720 | 697 | 96.8 | 697 | 96.8 |
| Ambient Temperature | hourly | TMP | 720 | 700 | 97.2 | 700 | 97.2 |
| Vector Wind Direction | hourly | VWD | 720 | 697 | 96.8 | 697 | 96.8 |
| Vector Wind Speed | hourly | VWS | 720 | 697 | 96.8 | 697 | 96.8 |

Note: The percent valid is calculated against the number possible.

Automatic zeros and spans are performed daily on most ambient gas analyzers and ambient data can only be reported if the duration of these events is less than 25% of the hour. As a result, the maximum percent valid is generally less than 100%.
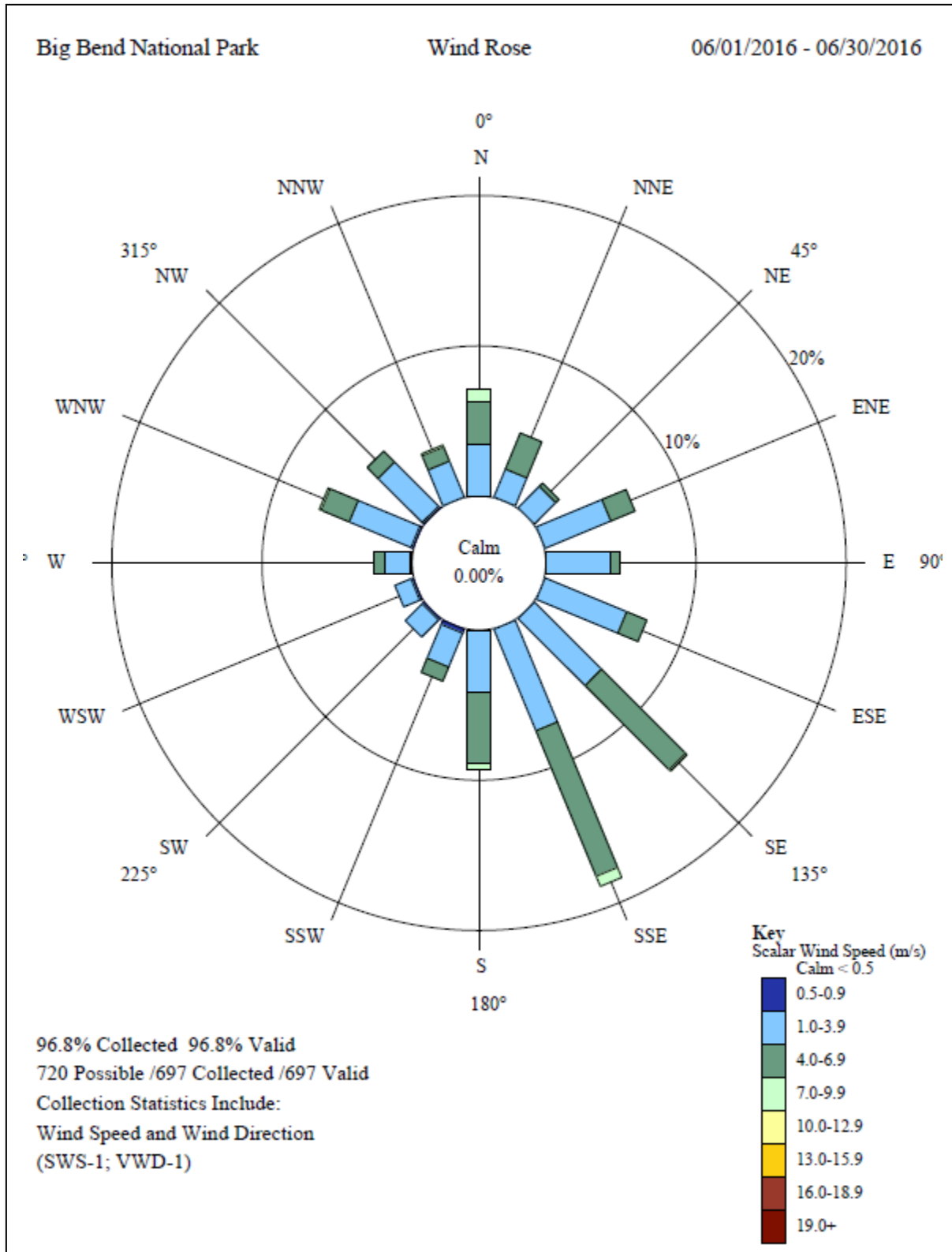
Example Collection Statistics Summary.

Example Wind Rose Summary.

Summary of Selected Meteorological Data

Big Bend National Park

Final Validation

06/01/2016 - 06/30/2016

| Parameter | Value | Units | Number | Std Dev |
|---|---|---|---|---|
| SCALAR WIND SPEED | | | | |
| Average | 3.7 | m/s | 697 | 1.5 |
| Maximum | 9.6 | m/s | | |
| Percent calm = 0.00 | | | | |
| | | | | |
| AMBIENT TEMPERATURE | | | | |
| Average | 27.9 | degC | 700 | 5.3 |
| Maximum | 41.3 | degC | | |
| Minimum | 15.9 | degC | | |
| | | | | |
| RELATIVE HUMIDITY | | | | |
| Average | 38 | percent | 700 | 19 |
| Maximum | 90 | percent | | |
| Minimum | 1 | percent | | |
| | | | | |
| PRECIPITATION (Rainfall or Snow melt) | | | | |
| Average non-zero rate | 1.1 | mm/hr | 15 | 1.3 |
| Maximum non-zero rate | 4.5 | mm/hr | | |
| Minimum non-zero rate | .1 | mm/hr | | |
| Accumulated during period | 17.1 | mm | | |
| | | | | |
| SOLAR RADIATION | | | | |
| Average Daily Total | 26,254,899 | joules/m2day | 26 | 4,126,960 |
| Maximum Daily Total | 31,613,612 | joules/m2day | | |
| Minimum Daily Total | 19,373,648 | joules/m2day | | |

Note: Calms are included in the average scalar wind speed and are defined as winds less than 0.5 m/s (1.0 mph).

Solar radiation terms are based on the calculation of the total amount of solar energy incident on a unit area during each day. The maximum and minimum daily totals are selected from the list of daily totals. The totals for all days are then added and divided by the number of days to yield the average daily total. Only days with 24 valid values are included in these statistics.

NA indicates instrument not available.

Example Meteorological Data Summary.

**Table 2. 2012 Summary of 8-hour average ozone concentrations (ppb).**

| National Park Unit | Site Name | Valid Number of Days | 1st Highest | 2nd Highest | 3rd Highest | 4th Highest[a] | 5th Highest | # Days with 8-Hour Average O$_3$ Values ≥76 ppb[a] |
|---|---|---|---|---|---|---|---|---|
| **Sites operated by the National Park Service (Gaseous Pollutant Monitoring Program)** | | | | | | | | |
| Big Bend | K-Bar Ranch Road | 349 | 69 | 68 | 68 | 67 | 67 | 0 |
| Canyonlands | Island in the Sky | 364 | 79 | 77 | 74 | 72 | 72 | 2 |
| Chiricahua | Entrance Station | 352 | 76 | 74 | 74 | 74 | 73 | 1 |
| Craters of the Moon | Visitor Center | 354 | 70 | 66 | 66 | 66 | 65 | 0 |
| Death Valley | Park Village | 358 | 77 | 75 | 74 | 73 | 71 | 1 |
| Denali | Headquarters | 364 | 57 | 56 | 53 | 52 | 52 | 0 |
| Glacier | West Glacier Horse Stables | 349 | 65 | 64 | 56 | 55 | 54 | 0 |
| Grand Canyon | The Abyss | 364 | 80 | 79 | 75 | 73 | 73 | 2 |
| Grand Teton | Science School | 362 | 72 | 70 | 69 | 67 | 66 | 0 |
| Great Basin | Maintenance Yard | 339 | 80 | 78 | 77 | 76 | 75 | 4 |
| Great Smoky Mountains | Clingmans Dome | 186 | 87 | 87 | 76 | 71 | 70 | 3 |
| Great Smoky Mountains | Cove Mountain | 360 | 81 | 77 | 73 | 72 | 69 | 2 |
| Great Smoky Mountains | Look Rock | 358 | 78 | 77 | 77 | 75 | 73 | 3 |
| Joshua Tree | Black Rock | 362 | 97 | 96 | 96 | 95 | 93 | 48 |
| Joshua Tree | Cottonwood Canyon | 233 | 82 | 77 | 76 | 75 | 74 | 3 |
| Lassen Volcanic | Manzanita Lake Fire Station | 356 | 81 | 79 | 77 | 71 | 69 | 3 |
| Mammoth Cave | Houchin Meadow | 362 | 90 | 81 | 81 | 81 | 79 | 9 |
| Mesa Verde | Resource Management Area | 354 | 72 | 71 | 70 | 69 | 68 | 0 |
| Mount Rainier | Tahoma Woods | 363 | 59 | 58 | 58 | 58 | 53 | 0 |
| Petrified Forest | South Entrance | 351 | 78 | 75 | 74 | 73 | 73 | 1 |
| Pinnacles | SW of East Entrance Station | 362 | 80 | 74 | 72 | 72 | 72 | 1 |
| Rocky Mountain | Long's Peak | 361 | 90 | 87 | 81 | 79 | 79 | 15 |
| Sequoia and Kings Canyon | Ash Mountain | 362 | 103 | 98 | 97 | 95 | 95 | 82 |
| Sequoia and Kings Canyon | Lower Kaweah | 359 | 90 | 89 | 88 | 87 | 87 | 41 |
| Shenandoah | Big Meadows | 349 | 82 | 82 | 73 | 72 | 71 | 2 |
| Voyageurs | Sullivan Bay | 354 | 74 | 68 | 64 | 63 | 63 | 0 |
| Yellowstone | Water Tank | 345 | 72 | 72 | 70 | 67 | 64 | 0 |
| Yosemite | Turtleback Dome | 361 | 91 | 84 | 81 | 81 | 78 | 8 |
| Zion | Dalton's Wash | 363 | 80 | 76 | 76 | 75 | 75 | 3 |
| **Sites operated by the NPS for the Bureau of Land Management** | | | | | | | | |
| Meeker | Plant Science Center | 351 | 68 | 67 | 65 | 64 | 64 | 0 |
| Rangely | Golf Course | 342 | 71 | 71 | 70 | 69 | 69 | 0 |
| **Sites operated by the NPS for the U.S. Forest Service** | | | | | | | | |
| Escalante | Visitor Center | 365 | 74 | 73 | 70 | 68 | 65 | 0 |
| Walden | Chandler Ranch | 322 | 60 | 60 | 60 | 59 | 59 | 0 |
| **Sites operated by cooperating state agencies** | | | | | | | | |
| Acadia | Cadillac Mountain | 210 | 71 | 70 | 69 | 66 | 66 | 0 |
| Acadia | McFarland Hill | 356 | 67 | 65 | 65 | 60 | 60 | 0 |
| Badlands | Visitor Center | 365 | 68 | 68 | 67 | 64 | 64 | 0 |
| Cape Cod | Cape Cod | 207 | 88 | 85 | 80 | 79 | 77 | 6 |
| Chamizal | Chamizal | 360 | 75 | 71 | 70 | 69 | 68 | 0 |
| Congaree | Congaree Bluff | 232 | 63 | 57 | 56 | 56 | 56 | 0 |
| Cowpens | State Monitor | 210 | 77 | 74 | 74 | 71 | 70 | 1 |

Example Pollutant Violation Summary.
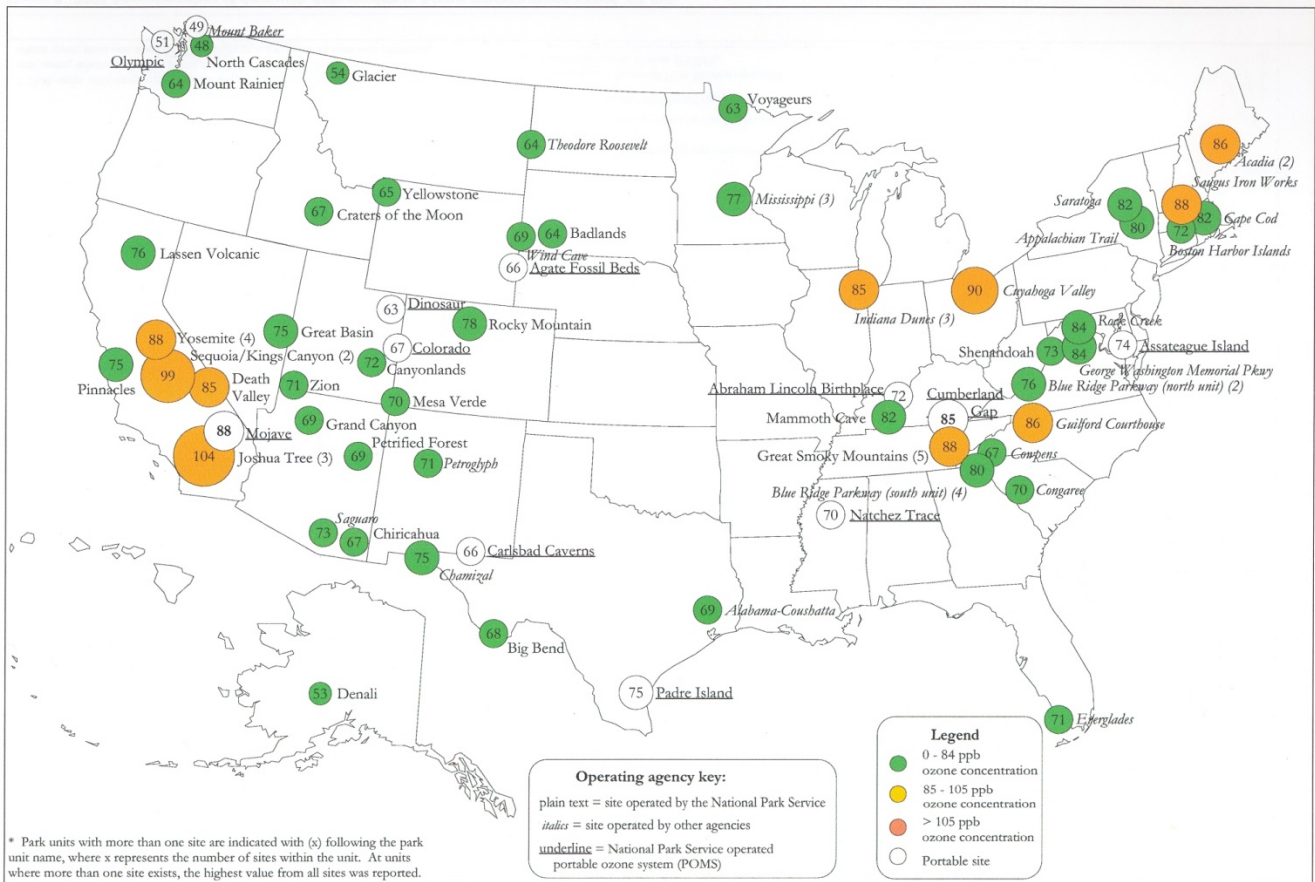
Example Map of Pollutant Levels at Network Sites.

| Park Code | Unit | Site | Apr | May | June | July | Aug. | Sept. | Oct. | Total | Max 8-hr | 4th highest 8-hr |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CACO | Cape Cod | State Site | 0 | 0 | 4 | 1 | 0 | 0 | 0 | 5 | 88 | 77 |
| CANY | Canyonlands | Island in the Sky | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 2 | 79 | 72 |
| CAVE | Carlsbad Caverns | Maintenance Area | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 76 | 72 |
| CHIR | Chiricahua | Entrance Station | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 76 | 74 |
| COWP | Cowpens | National Battlefield | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 77 | 66 |
| CUGA | Cumberland Gap | Hensley Settlement | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 2 | 80 | 74 |
| DEVA | Death Valley | Park Village | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 77 | 73 |
| DETO | Devil's Tower | Joyner Ridge Trail | 0 | 0 | 0 | 3 | 1 | 0 | 0 | 4 | 80 | 77 |
| DINO | Dinosaur | West Entrance Housing | 0 | 0 | 2 | 0 | 2 | 0 | 0 | 4 | 84 | 76 |
| GRCA | Grand Canyon | The Abyss | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 2 | 80 | 73 |
| GRBA | Great Basin | Maintenance Yard | 0 | 3 | 1 | 0 | 0 | 0 | 0 | 4 | 80 | 76 |
| GRSM | Great Smoky Mountains | Clingman's Dome | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 3 | 87 | 71 |
| GRSM | Great Smoky Mountains | Cove Mountain | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 2 | 81 | 72 |
| GRSM | Great Smoky Mountains | Look Rock | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 3 | 78 | 75 |
| GRSM | Great Smoky Mountains | Purchase Knob | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 2 | 78 | 70 |
| JOTR | Joshua Tree | Black Rock | 1 | 18 | 14 | 7 | 6 | 1 | 0 | 48 | 97 | 95 |
| JOTR | Joshua Tree | Cottonwood Canyon | 0 | 0 | 3 | 0 | 0 | 0 | 1 | 3 | 82 | 76 |
| JOTR | Joshua Tree | Pinto Wells | 0 | 3 | 5 | 0 | 0 | 0 | 0 | 8 | 80 | 79 |
| KIMO | Kings Mountain | Browns Mountain | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 2 | 77 | 72 |
| LAVO | Lassen Volcanic | Manzanita Lake Fire Stn. | 2 | 0 | 0 | 1 | 0 | 0 | 0 | 3 | 81 | 71 |
| MOJA | Mojave | Kelso Mountains | 0 | 7 | 6 | 0 | 0 | 0 | 0 | 13 | 83 | 80 |
| MACA | Mammoth Cave | Houchin Meadow | 0 | 0 | 5 | 2 | 3 | 0 | 0 | 10 | 90 | 81 |
| PEFO | Petrified Forest | South Entrance | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 78 | 73 |
| PINN | Pinnacles | SW of East Entrance Stn. | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 80 | 72 |
| ROMO | Rocky Mountain | Long's Peak | 2 | 4 | 3 | 4 | 1 | 0 | 0 | 14 | 90 | 79 |
| SCBL | Scott's Bluff National Monument | Visitor Center | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 86 | 68 |
| SEKI | Sequoia and Kings Canyon | Ash Mountain | 0 | 11 | 13 | 20 | 22 | 14 | 2 | 82 | 103 | 95 |
| SEKI | Sequoia and Kings Canyon | Lower Kaweah | 0 | 2 | 9 | 11 | 15 | 5 | 0 | 42 | 90 | 87 |
| SHEN | Shenandoah | Big Meadows | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 2 | 82 | 72 |
| WICA | Wind Cave | Visitor Center | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 76 | 67 |
| YOSE | Yosemite | Glacier Point | 0 | 0 | 0 | 5 | 0 | 3 | 0 | 8 | 89 | 80 |
| YOSE | Yosemite | Turtleback Dome | 0 | 0 | 1 | 5 | 1 | 1 | 1 | 10 | 92 | 81 |
| ZION | Zion | Dalton's Wash | 0 | 2 | 1 | 0 | 0 | 0 | 0 | 3 | 80 | 75 |

Example Ozone Hit List.

# Approvals

The purpose of this review and approval is to evaluate this Standard Operating Procedure (SOP) for adequacy prior to issuance. The signatories below are stating that the approach defined within this document is acceptable and that the affected company interests have been represented.

Author Signature:

_____

Program:        QA Manager – Genevieve Lariviere

Approval Signature:

_____

Program:        Field Operations Manager – Mark Tigges

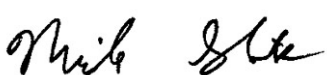| | Standard Operating Procedure<br>Maintenance and Calibration Visit to an<br>Ambient Air Monitoring Station |
|---|---|
| | |

| Version: 1 | *F_VISIT_MTCAL_AQSITE_F_2.0* | Page 2 of 8 |
|---|---|---|

# REVISION HISTORY

| Review date: | Changes made: | Changes made by: |
|---|---|---|
| 10/17/2016 | Initial Version 1.0 | E. Vanden Hoek |
| 9/25/2018 | Added fencing integrity checks to Section 6.2<br>Removed date reference from file name | E. Vanden Hoek |
| 10/29/2019 | Minor text edits | E. Vanden Hoek |
| 10/28/2020 | Version 2.0<br>Removed Appendix B (CASTNET Photo Documentation)<br>Information now provided in separate SOP | E. Vanden Hoek |
| 10/27/2021 | Removed Site Visitation Checklist<br>Revised Tailgate Safety Meeting Form | E. Vanden Hoek |
| 9/27/2022 | Updated personnel | E. Vanden Hoek |
| | | |

| | **Standard Operating Procedure** |
| :---: | :---: |
| *(logo)* Air Resource SPECIALISTS | **Maintenance and Calibration Visit to an** |
| | **Ambient Air Monitoring Station** |

| **Version: 1** | *F_VISIT_MTCAL_AQSITE_F_2.0* | **Page 3 of 8** |
| :--- | :--- | :---: |

# ANNUAL REVIEW

The undersigned attests that this standard operating procedure has undergone annual review for adherence to current practices and the latest QA/QC protocols:

| Signature | Title | Date |
| :---: | :---: | :---: |
| *(signature)* | QA Manager | 10/29/2018 |
| *(signature)* | Network Operations Manager/Field Specialist | 10/29/2019 |
| *(signature)* | QA Manager | 10/28/2020 |
| *(signature)* | Network Operations Manager/Field Specialist | 10/22/2021 |
| *(signature)* | Field Specialist | 9/27/2022 |

**1.0    PURPOSE**

Instructions provided herein outline the steps performed during a routine maintenance and calibration visit to an ambient air monitoring station operated by Air Resource Specialists, Inc. (ARS).

**2.0    SUMMARY OF METHOD**

The primary purpose of a site visit is to assure quality data capture and minimize data loss by performing routine maintenance and calibration of instrumentation, complying with applicable quality assurance requirements, and providing site operator training and support.

**3.0    SCOPE**

Activities described in this document are performed by ARS field technicians or specialists during routinely scheduled or emergency visits to monitoring stations. ARS field staff have been appropriately trained in site operations and possess the required technical knowledge and abilities to perform the activities described below.

**4.0    ROLES AND RESPONSIBILITIES**

**Program or Project Manager**

- Establish schedule of instrument maintenance and calibrations in accordance with the site or network specific QAPP
- Review with the field specialists the requirements of maintenance, known technical problems, and review of recently collected data

**Fields Operations Manager**
- Coordinate site visit schedules
- Conducts field technician/specialist training and assessments

**Field Technician or Specialist**
- Coordinate scheduled visit with client as directed by project manager or field supervisor
- Complete all required documentation
- Verify all transfer standards to be used are in current certification with appropriate documentation
- Perform as-found verification checks
- Perform any required instrument maintenance, repair and calibration
- Perform as-left verification checks
- Document all calibration results and maintenance procedures
- Verify and update site inventory and photographic documentation
- Complete equipment maintenance and repair records
- Summarize visit in written trip report within 30 days
- Train site operator and document training conducted on Tail Gate Safety Form
- Complete Site improvements and upgrades as needed

**Station Operator**

- Be available for assistance and training

## 5.0 REQUIRED EQUIPMENT AND MATERIALS

- All forms and documents presented in **Appendix A**
- Trip Report Template (MS Word) and Calibration Forms (MS Excel)
- Transfer standards in current certification
- Operation manuals for equipment in use
- Spare parts as required

## 6.0 PROCEDURES

### 6.1 PRE-VISIT PREPARATION

The field specialist will contact the station operator and discuss any special arrangements that need to be made. The field specialist will ensure all necessary parts and equipment are shipped ahead or brought with them for the visit. The field specialist will verify that all calibration standards are in current certification.

### 6.2 MAINTENANCE AND CALIBRATION VISIT PROCEDURES

Following completion of the as-found calibration verification checks, perform any scheduled or required maintenance or repair to the sensors, analyzers and/or monitors. Refer to the operations manual for the make and model of instrument in use for more specific information.

#### Pre-Maintenance Verification Checks

- Upon arrival and prior to any repairs or adjustments, a complete verification of the instrument is performed.

#### Preventative Maintenance or Repair

- Perform routine maintenance in accordance with the project schedule or manufacturer recommendations.
- Perform calibration or replacement of any instrumentation operating outside field acceptance criteria, as indicated by the calibration forms.

#### Post-Maintenance Verification Checks

- Following any modification to the system, a complete verification of instrument operation is required.

#### Shelter, Tower, and Support Systems

- Inspect integrity of monitoring shelter (internal and external) including the roof, siding, door, caulking, weather stripping, floor, walls, racks, etc.
- Inspect integrity of electrical outlets, lights, grounding, and polarity.
- Inspect heating/cooling systems for proper operations and check thermostat function.

- Inspect fencing around site, if applicable, to ensure livestock and/or wildlife are prevented from damaging equipment.
- Clean shelter interior (empty trash, wipe down surfaces, tidy wires, etc).
- Inspect meteorological tower, including supports, guys, hardware.
- **Correct any condition considered unsafe.**
- Verify proper operation of lightning protection system.
- Verify proper operation of cellular or satellite communication.
- Verify the condition of the intake and exhaust manifold (if applicable). Clean and maintain as necessary.
- Verify proper datalogger operation.

## 6.3    SITE OPERATOR TRAINING

Following the completion of all verification checks, maintenance, and calibration (if required), spend as much time as necessary with the station operator(s) to ensure that operators have a complete and working knowledge of their required duties.

- Observe operator perform a complete station check and review techniques for weekly checklist procedures.
- Review operator log notes, station checklists and overall station documentation.
- Review any new procedures with the operator, or procedures for which the operator needs assistance or clarification.
- Verify on-site SOPs are current. Notify the project manager and QA manager if there are any deficiencies or changes in instrumentation that would require updated SOPs.
- Verify the operator has an adequate supply of all required forms and consumable supplies
- Note any operator questions or comments.
- Obtain site operator signature on **Tailgate Form** (included in **Appendix A**), indicating training was conducted.
- Verify the QAPP is available on the on-site computer and inform the site operator on how to access it.

## 6.4    INVENTORY AND PHOTOGRAPHIC DOCUMENTATION

### Inventory

- Verify the manufacturer, description, model number, serial number, and property number of all monitoring site equipment against the equipment inventory database listing for the site.
- Document any inconsistencies or changes in system hardware.

### Site Documentation Photographs

- Take photographs in each cardinal direction facing shelter.
- Take photographs in each cardinal direction facing away from shelter.
- Take up-close photograph of shelter.

- Take photograph of meteorological tower(s) with instrumentation.
- Take photograph of interior instrumentation.
- See **Appendix B** for details on required photograph documentation procedures for CASTNET sites.

## 6.5 POST-VISIT PROCEDURES

Following the site visit, the field specialist will:

- Prepare a written report, using the current MS Word template (*Trip Report Template…..dotx*) available to all field staff, describing all activities performed during the visit.
- Include the MS Excel calibration forms completed in the field.
- Return the documentation to the QA Administrative Assistant (see **Appendix A**).
  - Tailgate Form
  - Asset Tracking Form
  - Whiteboard sheet
- Copy site photographs to site specific folder(s) on ARS network drives
- Submit written report and calibration forms (within 30 days) to the QA Manager and/or QA Officer for review.
- Submit any equipment removed from the site to laboratory personnel for service.
  - *Include a tag on all equipment describing any suspected issues with sensor/analyzer, or indicated routine servicing*
  - *Include name of Field Specialist and where the equipment was most recently in operation*
  - *Include Project Code and Project Manager*
  - *Complete instrument service order form*
- Follow up with laboratory and data personnel and on any equipment issues that may affect data validity.

## 8.0 DEFINITIONS AND ACRONYMS

| | |
|---|---|
| ARS | Air Resource Specialists, Inc. |
| AQDB | Air Quality Database |
| CFR | Code of Federal Regulations |
| DAS | Data Acquisition System |
| EPA | U.S. Environmental Protection Agency |
| IMC | Information Management Center |
| MS | Microsoft |
| NIST | National Institute of Standards and Technology |
| PDF | Portable Document Format |
| QA | Quality Assurance |
| QAPP | Quality Assurance Project Plan |

QC              Quality Control
SLAMS           State and Local Air Monitoring Stations
SOP             Standard Operating Procedure


**Verification**: establishes the quantitative relationship between the value of a known traceable standard and the instrument's response

**Calibration**: adjustment of the instrument or analyzer so it operates within established acceptance criteria (defined in the network of project specific QAPP)

**APPENDIX A**

**FORMS**

# Insert forms into pdf file here

# TAILGATE SAFETY MEETING FORM

**NAME, DATE, TYPE, LOCATION OF
PROJECT OR WORK ACTIVITY:** | **NEAREST HOSPITAL:**

|  |  |
| --- | --- |
|  | Is sheet with site coordinates and nearest hospital location visible in the shelter?  Yes ☐    No ☐ |

**TOPICS/HAZARDS DISCUSSED:**

|  |
| --- |
|  |
|  |
|  |
|  |
|  |
|  |
|  |
|  |

**INFORMAL TRAINING CONDUCTED (Name, topics):**

|  |
| --- |
|  |
|  |
|  |

**Suggested Training:**
☐ PM Monitor  ☐ DataView  ☐ Communications  ☐ Met Checks  ☐ Ozone  ☐ CASTNET
☐ QAPP Review  ☐ Rainfall Checks  ☐ Pump Replacement

**NAMES OF ATTENDEES:** | **SIGNATURE OF ATTENDEES:**

|  |  |
| --- | --- |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |

**Supervisors Signature/Date:** _____

| Category | Asset Code | Description | Model # | AS FOUND Property # | Mfg. Serial # | √= no change R=Removed (see status) | AS LEFT Model # | Property # | Mfg. Serial # |
|---|---|---|---|---|---|---|---|---|---|
| AIR QUALIT | 000010033 | ANALYZER - O3 - THERMO | 49C | 052001232S | NPS 90831 | | | | |
| | 000000006671 | ANALYZER - O3 - THERMO | 49C | 90565 | 59285-322 | | | | |
| | 0000008554 | MASS FLOW CONTROLLER - ALICAT | MC-10SLPM-D-f134658 | 134658 | | | | | |
| | 000000010289 | ZERO AIR SUPPLY - WERTHER | PC70/4 | 606489 | | | | | |
| | 000000002171 | SHELTER - EKTO | 8814 | 3129-1 | 3129-1 | | | | |
| | 000000007543 | ZERO AIR SUPPLY - WERTHER | PC70/48 | 90720 | 526293 | | | | |
| COMPUTER | 000000010694 | H-LPTP, HP SMARTBUY 6730B : 2.4GHZ HP6730B INTEL CORE 2 DUO 15.4IN | | CNU9335N72 | CNU9335N72 | | | | |
| DATA COLLE | 000000007962 | DATALOGGER - ESC | 8816 | NPS 90767 | 4592 | | | | |
| FACILITIES | 000000006539 | INSTRUMENT RACK - STEVE STUMBO SS101 | | | | | | | |
| | 000000006538 | INSTRUMENT RACK - STEVE STUMBO SS101 | | 90767 | | | | | |
| | 000000008022 | TOWER - FOLDING | AT-516 | EPA 923308 | N/A | | | | |
| | 000000008696 | TOWER - MET | N/A | N/A | N/A | | | | |
| METEOROLOG | 000000005075 | PPT SENSOR - CLIMATRONICS | 100508 | NPS 01474 | 417 | | | | |
| | 000009920 | SOLAR RAD SENSOR - APOGEE | CS300 | 60163 | 60163 | | | | |

Returned Item Status Codes: RSer-Removed for Servicing; RRep-Removed for Repair; RBon-Removed to Surplus; RAba-Abandoned on site, removed from inventory

Abandoned* Item Status Description: Unserviceable, Obsolete, Damaged (clarify w/condition code), Lost or Stolen (added report required),
Cannibalized or parts, Destroyed (clarify w/condition code), Other
Other - ARS inventory records were updated in 2015 to remove Expendable-Consumable items that should not be recorded as an Asset.
*Note: Any item valued over $5,000 cannot be Abandoned. We have to physically provide for Salvage.

LOCATION: **BIBE-KB**

DATE: **10/27/2021**

FIELD TECH:

Category: METEOROLOG

| Asset Code | Description | | | |
|---|---|---|---|---|

| | | | AS FOUND | | √= no change R=Removed (see status) | | AS LEFT | |
|---|---|---|---|---|---|---|---|---|
| Asset Code | Description | Model # | Property # | Mfg. Serial # | | Model # | Property # | Mfg. Serial # |
| 00000009593 | TEMP SENSOR - RM YOUNG | 41342VC | TS00014961 | TS00014961 | | | | |
| 000009970 | WIND MONITOR - RM YOUNG | 05305 | WM00165132 | WM00165132 | | | | |
| 000000005483 | WIND TRANSLATOR CARD - CLIMATRONICS | 100163 | | 688 | | | | |

**Cylinder Tracking Information:**

Cylinder #          Additional Description (Size, Gas type, etc. if known)          F/N

Returned Item Status Codes: RSer-Removed for Servicing; RRep-Removed for Repair; RBon-Removed to Surplus; RAba-Abandoned on site, removed from inventory
Abandoned* Item Status Description: Unserviceable, Obsolete, Damaged (clarify w/condition code), Lost or Stolen (added report required),
Cannibalized or parts, Destroyed (clarify w/condition code), Other
Other - ARS inventory records were updated in 2015 to remove Expendable-Consumable items that should not be recorded as an Asset.
*Note: Any item valued over $5,000 cannot be Abandoned.  We have to physically provide for Salvage.

# NPS Whiteboard Tracking Sheet

Site **BIBE-KB**                    Date of Visit: _____

| | Last Maintenance | Check Yes or No | |
|---|---|---|---|
| AQ Nose Cone Verification | 7/13/2021 | Yes | No |
| AT/RH Swap | 7/13/2021 | Yes | No |
| Tubing/Filter Replacement | 7/26/2017 | Yes | No |
| Hydrogen Filter | | Yes | No |
| Z-Air Media Replaced | 7/13/2021 | Yes | No |
| Zero-Air MFC Calibration Date | | Yes | No |
| Cal Gas 1 MFC Calibration Date | | Yes | No |
| Cal Gas 2 MFC Calibration Date | | Yes | No |
| Cylinder Expiration & Pressure | | Exp. Date:          Pressure: | |
| deltaCal Expiration | | | |
| BAM Background Test | | Yes | No |
| BAM Battery Replacement | | Yes | No |
| NOX Pump | | Rebuilt / Replaced? | No |
| O3 Pump | 1/22/2020 | Rebuilt / Replaced? | No |
| SO2 Pump | | Rebuilt / Replaced? | No |
| CO Pump | | Rebuilt / Replaced? | No |
| Particulate Pump | 7/13/2021   Rebuilt | Rebuilt / Replaced? | No |
| Shelter Roof Sealant Date | | Yes | No |
| Notes | | | |

**Guidelines**

- Tubing replacement based on line-loss test
- Internal pump replaced/rebuilt annually
- External pump replaced/rebuilt at 1.5 years
- Z-Air media replaced annually
- AT/RH replaced 2 times annually
- BAM battery replaced annually

# Approvals

The purpose of this review and approval is to evaluate this Standard Operating Procedure (SOP) for adequacy prior to issuance.  The signatories below are stating that the approach defined within this document is acceptable and that the affected company interests have been represented.


Author Signature:


Program:             QA Manager – Genevieve Lariviere


Approval Signature:


Program:             Field Operations Manager – Mark Tigges

# REVISION HISTORY

| Review date: | Changes made: | Changes made by: |
| :--- | :--- | :--- |
| 10/28/2020 | Initial Version 1.0 | E. Vanden Hoek |
| 10/15/2021 | Minor text edits | E. Vanden Hoek |
| 9/27/2022 | Updated personnel | |
| | | |
| | | |
| | | |
| | | |

# ANNUAL REVIEW

The undersigned attests that this standard operating procedure has undergone annual review for adherence to current practices and the latest QA/QC protocols:

| Signature | Title | Date |
| :---: | :---: | :---: |
| John Krolak | Field Specialist | 10/15/2021 |
| *Dave Buckley* | Field Specialist | 9/27/2022 |

### 1.0 PURPOSE

Instructions provided herein outline the steps performed to provide photo documentation of CASTNET stations during a routine maintenance and calibration visit by Air Resource Specialists, Inc. (ARS).

### 2.0 SUMMARY OF METHOD

The primary purpose of a site visit is to document site conditions during the maintenance and calibration visit.

### 3.0 SCOPE

Activities described in this document are performed by ARS field technicians or specialists during routinely scheduled visits to CASTNET monitoring stations. ARS field staff have been appropriately trained in site operations and possess the required technical knowledge and abilities to perform the activities described below.

### 4.0 ROLES AND RESPONSIBILITIES

**Program or Project Manager**

- Establish schedule of maintenance and calibration visits in accordance with the site or network specific QAPP
- Review with the field specialists the requirements of photographic documentation of the site

**Fields Operations Manager**
- Coordinate site visit schedules
- Conducts field technician/specialist training and assessments

**Field Technician or Specialist**
- Coordinate scheduled visit with client as directed by project manager or field supervisor
- Complete all required documentation
- Verify and update site inventory and photographic documentation
- Provide photo documentation along with written trip report within 30 days

**Station Operator**
- Be available for assistance and training

### 5.0 REQUIRED EQUIPMENT AND MATERIALS

- All forms and documents presented in this SOP

**6.0     PROCEDURES**

### CASTNET Monitor Stations Photo Documentation

*Verify that there is sufficient memory available on the memory card for recording the site photographs – nominally 300 MB, which will allow for extra photo documentation of site problems, if any.*

1) Take photographs during daylight hours. Do not take photos during precipitation events (rain, snow, fog, etc.).

2) Remove site ID card from the calibration folder, place it between the top of the door and the door jam, and close door, so that the ID card is held in place at the top of the door.

3) Set up and level the camera/tripod assembly at a position 8-10 meters directly in front of the shelter door. Take photograph number 1 (see Table 1 Photo Documentation Work Sheet) facing the door. Make sure the site ID card is visible. Move closer if it is not legible from that distance. Be sure to fill out the worksheet.

4) For the remaining photographs, do not focus the camera on the white monitoring shelter as this will cause a "bleaching" of other areas of the photograph.

5) **IMPORTANT**: Set up and **LEVEL** the camera/tripod assembly at a position 25 - 40 meters south (180° from the shelter pointed at 0° (north). Prior to taking the photographs, verify that all vehicles (including yours) will not be in the frame. If it is not possible to take the directional photographs directly south of the shelter (obstructions, landscape, would result in non-representative pictures, etc.) indicate in the comments of the Photo Documentation Worksheet and also on the site sketch the location where the pictures were taken. (e.g. 35 meters North East of shelter). In all cases begin directional photographs facing 0° (north). Take photograph number 2 (see Table 1), then advancing in 22.5° increments, swivel the camera clockwise taking photographs 3 through 17.

6) Photo 18: should be taken while you are standing behind the shelter, on the same radial used to photograph the shelter. This photograph will provide coverage of the area obscured by the shelter in the series of directional photographs.

7) Photo 19: Shelter.

8) Photo 20: Flow tower. Pictures should be taken with the camera turned to vertical format, so as to include the full vertical length of the tower. If a meteorological tower is present, include both towers in the frame. If the towers are too far separated for this to be practical, include a photograph of the meteorological tower in frames A-Z.

9) Photos 21 - 27: Inside the shelter and exterior of shelter door. Include the *entire area* stated. These pictures are used frequently for troubleshooting.

10) Photo 28: Include a picture of the site operator (and backup operator) if possible.

11) A - Z: Within reason, take as many photographs as may be necessary to document site or equipment-related problems. These pictures are not submitted to EPA, but are *critical* for future troubleshooting to verify pneumatic connections, wiring, placement, etc. and as such, should be as detailed as possible to convey this information.

12) Photo 29: Scenic photo of the general area. Additional scenic photographs can be recorded in frames A-Z. These photos are frequently used in reports. Please include the shelter, towers that are *not* leaning and omit vehicles and people.

13) Photo 30: Site ID card: again to show the end of the series of photographs

Alternatively, a panoramic camera can be used to document the station in one photo. If this method is used, center the monitoring shelter in the picture.

It is extremely important that the photos be taken in the order listed. On completion of the photo documentation procedures, review the frames on the camera viewer to verify that each photograph is clear, representative of site conditions, and in accordance with Table 1.

Before leaving the site, use Figure 1 to produce a reasonably accurate plan drawing of the CASTNET site out to approximately 50 yards radius. This drawing will be useful in correlating photographs with site layout. See Figure 2 (Sample Site Plan Field Sketch) for an example.

Photos are taken using individual cell phones. Copy the photographs to the ARS network.

**Table 1:** Photo Documentation Worksheet

Site Name and Number:                    Calibrator:                                        Date:

| Photo Taken? check for Yes | Frame Number | Direction | Azimuth | Comments |
|---|---|---|---|---|
| | 1 | Site ID Card | | |
| | 2 | North | 0° | |
| | 3 | North Northeast | 22° | |
| | 4 | Northeast | 45° | |
| | 5 | East Northeast | 67° | |
| | 6 | East | 90° | |
| | 7 | East Southeast | 112° | |
| | 8 | Southeast | 135° | |
| | 9 | South Southeast | 157° | |
| | 10 | South | 180° | |
| | 11 | South Southwest | 202° | |
| | 12 | Southwest | 225° | |
| | 13 | West Southwest | 247° | |
| | 14 | West | 270° | |
| | 15 | West Northwest | 292° | |
| | 16 | Northwest | 315° | |
| | 17 | North Northwest | 337° | |
| | 18 | View behind shelter | | |
| | 19 | Shelter | | |
| | 20 | Towers (incl. met if applicable) | | |
| **Inside Shelter** | | | | |
| | 21 | Left | | |
| | 22 | Center | | |
| | 23 | Right | | |
| | 24 | Ceiling | | |
| | 25 | Floor | | |
| | 26 | Door inside | | |
| | 27 | Door outside | | |
| | 28 | Site Operator | | |

-- continued --

| | Standard Operating Procedure |
|---|---|
| Air Resource SPECIALISTS | **Photo Documentation for CASTNET Monitoring Stations** |

| Version: 1 | *F_VISIT_MTCAL_SITEPHOTOS_F_1.0* | **Page 7 of 8** |
|---|---|---|

**Table 1 (continued):** Photo Documentation Worksheet

| Photos of any equipment or conditions you feel should be brought to the attention of AMEC. | | |
|---|---|---|
| | A | Compressor & canisters | |
| | B | Back of O3 analyzer | |
| | C | Back of O3 transfer | |
| | D | Pothead (O3 & filter pack inlets) | |
| | E | Backplane w/ MFC and Logger | |
| | F | NADP AMoN bucket | |
| | G | NADP raingage | |
| | H | NADP precip collector | |
| | I | | |
| | J | | |
| | K | | |
| | L | | |
| | M | | |
| | N | | |
| | O | | |
| | 29 | Scenic View of Site | |
| | 30 | Site ID Card (again) | |
| | | | |
| | | | |

**. CASTNET Site Plan Drawing – Field Sketch** (use the air sampling tower as the mid-point of the sketch)



10  15   20  25   30   35  40   45  50 yards
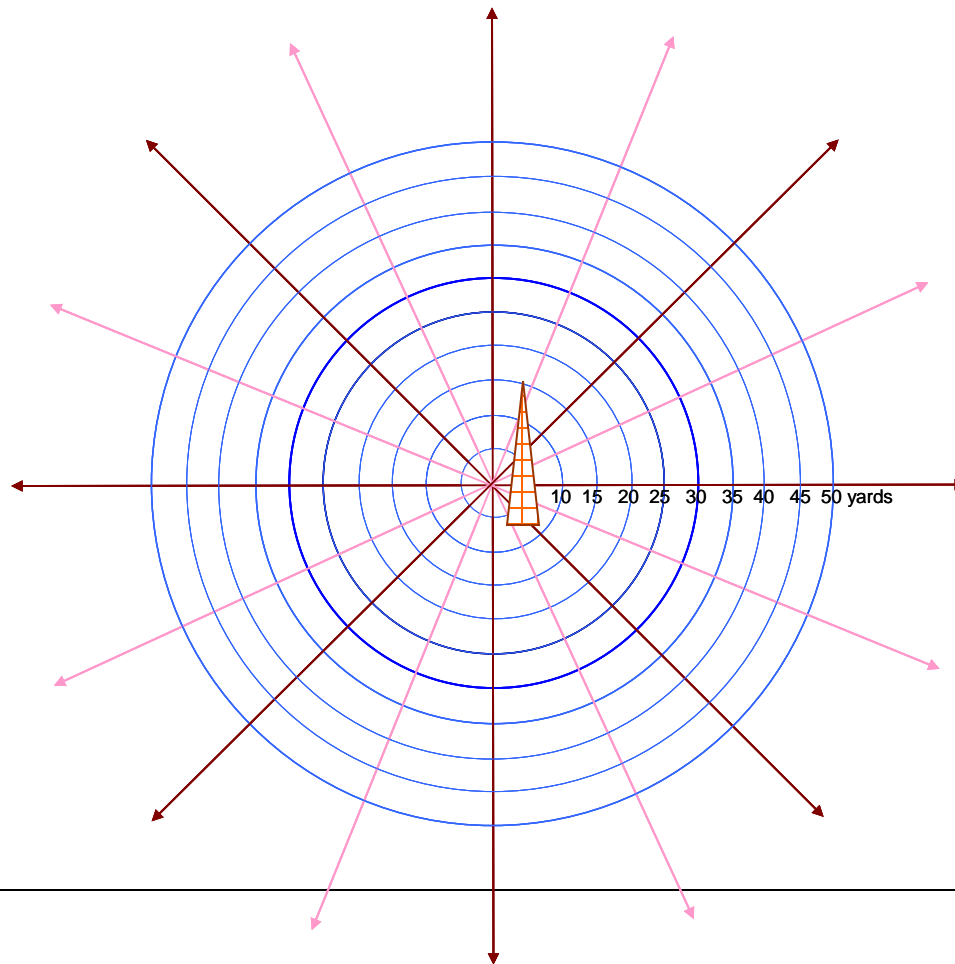
Air Sampling (Filter Pack) Tower

**Figure 2.** SAMPLE CASTNET Site Plan Drawing – Field Sketch (air sampling tower is the mid-point of the sketch).



Oak Trees
Approx. 50 feet high

Low Scrub

Shed

Open Pasture

Fence Line

Access Road (Gravel)

5  10  15  20  25  30  35  40  45  50 yards

Pine Trees
Approx. 20 feet high

Bean Field
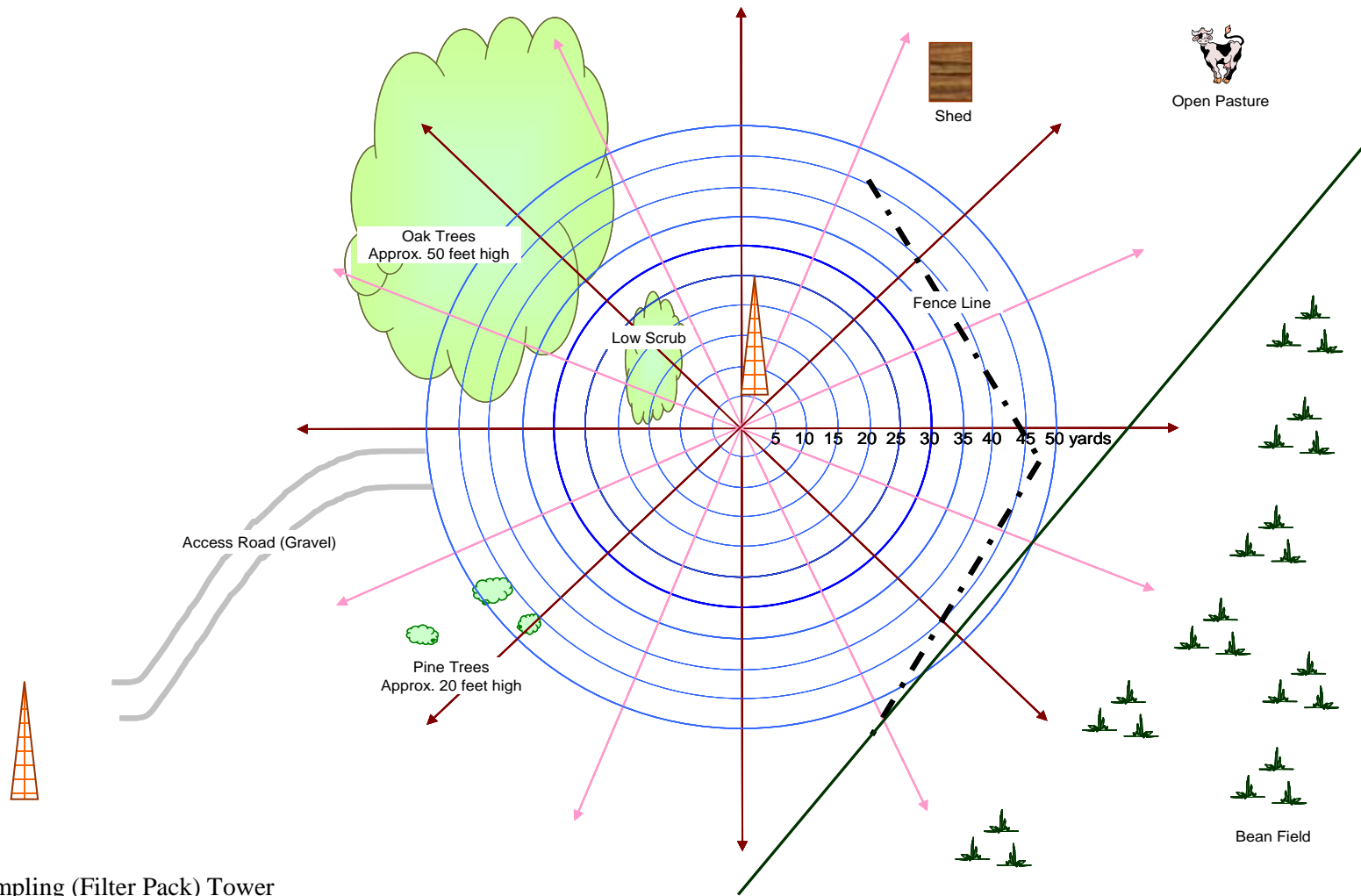
Air Sampling (Filter Pack) Tower

Photos 2-17 (Directionals for Panorama)

These photos are stitched together to form a panorama and published to an EPA website. Please take them carefully! Make sure all directions will be appropriate before beginning. Horizon and tower must be level, no vehicles or people in photos. Avoid trees/obstacles near camera position as these can distort significantly. Panorama should show siting as much as possible – lower edge should be just below shelter and upper edge should include the filter pack inlet and nearby obstructions. It may be necessary to position camera further from shelter (40-50m) and/or adjust height. Mark on the site sketch where the directional photos were taken. Take photos near noon if possible to avoid excessive shadows and glare.

STK138 – Level, but too low and too close



STK138 – Un-level



DCP114 – Too Low



COW137 – Bad

QAK172 – Clipping from levelling



KNZ184 – Good, remember to move vehicles



CKT136 – Good, further from the shelter would be better



CHE185 – Good, further from the shelter would be better, remember to move vehicles

# Approvals

The purpose of this review and approval is to evaluate this Standard Operating Procedure (SOP) for adequacy prior to issuance.  The signatories below are stating that the approach defined within this document is acceptable and that the affected company interests have been represented.

Author Signature:

_____

Program:         QA Manager – Genevieve Lariviere

Approval Signature:

_____

Program:         Field Operations Manager – Mark Tigges

# REVISION HISTORY

| Review date: | Changes made: | Changes made by: |
|---|---|---|
| 10/24/2016 | Initial Version 1.0 | E. Vanden Hoek |
| 10/29/2018 | Removed date reference from file name | E. Vanden Hoek |
| 10/12/2019 | No changes necessary | E. Vanden Hoek |
| 10/28/2020 | Minor text edits | E. Vanden Hoek |
| 10/18/2021 | No changes necessary | E. Vanden Hoek |
| 9/27/2022 | Updated personnel | E. Vanden Hoek |
| | | |
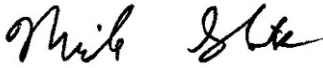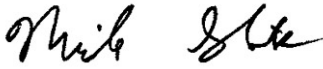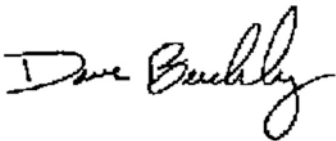
# ANNUAL REVIEW

The undersigned attests that this standard operating procedure has undergone annual review for adherence to current practices and the latest QA/QC protocols:

| Signature | Title | Date |
|---|---|---|
| | QA Manager | 10/29/2018 |
| | QA Manager | 10/12/2019 |
| | Network Operations Manager/Field Specialist | 10/28/2020 |
| | Network Operations Manager/Field Specialist | 10/18/2021 |
| | Field Specialist | 9/27/2022 |

### 1.0 PURPOSE

Instructions provided herein outline the site selection criteria required for ambient air monitoring stations operated by Air Resource Specialists, Inc. (ARS).

### 2.0 SUMMARY OF METHOD

Proper siting of a monitoring station can help ensure that collected on-site data are valid. The objective is to characterize the ambient air in proximity to the monitoring location.

### 3.0 SCOPE

Activities described in this document are performed by ARS field technicians or specialists during the site selection process. ARS field staff have been appropriately trained in site operations and possess the required technical knowledge and abilities to perform the activities described below.

### 4.0 ROLES AND RESPONSIBILITIES

**Program or Project Manager**

- As required, review the selected site with the project-specific Contracting Officer's Technical Representative (COTR)
- Prepare project-specific siting and operational objectives, guidelines, and considerations.

**Fields Operations Manager**
- Review with the field specialist photographic documentation, maps, and other information to determine the suitability of the site.
- Select the site based on the criteria outlined in this SOP and in accordance with the monitoring objectives outlines in the project or network specific QAPP.

**Field Technician or Specialist**
- Initiate the search for potential site by sending pertinent siting criteria and associated materials to a local contact (if available).
- Conduct a siting visit if required.
- Contact the local power and telephone companies for information concerning availability and installation.
- Obtain permission to perform any site preparation that may be required.
- Obtain permission from private or public landowners for permanent access to the monitoring location.
- Obtain permits or Environmental Impact Statements if required.
- Work with the local contact or sponsoring agency to identify a site operator, and local primary contact to service the equipment.
- Forward all site selection information to the Information Management Center (IMC) for input into the Air Quality Database Management System (AQDB).

**Local Site Contact**
- Locate and document potential sites upon receiving the siting criteria and associated materials from the field specialist.
- Provide the field specialist with any pertinent site-related information.
- Assist the field specialist in obtaining any site access and/or installation related clearances or permissions.

## 5.0 REQUIRED EQUIPMENT AND MATERIALS

- Topographic or Google Earth maps of the area of interest.
- Camera or Smart Phone to photograph the proposed site and area
- A list of monitoring objectives, requirements, and associated air quality monitoring equipment.
- A list of local sources affecting the air in the area of interest.
- Information about the availability of power and communications.
- New Site/Site Relocation Form (included in **Appendix A**).

## 6.0 PROCEDURES

### 6.1 GENERAL SITE CRITERIA

General site criteria to consider when location potential ambient air monitoring sites are:

- The site is representative of the air mass to be monitored.
- The site is representative of regional, not local meteorological conditions.
- The site has year-round accessibility.
- A power supply is available nearby.
- The site is in open space away from obstruction.
- The site is secure from vandalism or damage due to animals.
- The site's proximity to a nearby town.
- The monitoring station will be aesthetically pleasing and will blend in with the surrounding environment.
- The site is at least 500 meters (1,650 feet) from heavily traveled roadways.
- The site is at least 2 km (1.2 miles) from major highways, airports, navigable waterways, and railyards.
- The site is at least 200 meters (660 feet) from large parking lots and at least 100 meters from small parking lots.
- The site is at least 500 (1,650 feet) meters from intensive agriculture operations.
- The site is at least 200 meters (660 feet) from grazing animals or range used by livestock.
- The site is not close to local emissions sources, such as generators or furnace exhausts.

## 6.2    METEOROLOGICAL SITE CRITERIA

Site criteria to consider for meteorological monitoring instrumentation are:

- The standard exposure height of wind instruments should be 10 meters (33 feet).
- The distance between the instrument and an obstruction should be at least 10 times the height of that obstruction.
- Wind instruments should be mounted on booms at 90° to the predominant wind direction (for up-valley and down-valley flows).
- The recommended vertical heights for measuring temperature difference are 2 meters (6.6 feet) and 9 meters.
- The site elevation is between the highest and lowest elevations within the nearest Class I area.
- Aspirated shields should be used to ventilate instruments.
- Temperature sensors should be located at a distance of at least 4 times the height of any obstruction.
- Temperature sensors should be located at least 30 meters (100 feet) from large paved areas.
- Heated rain gauges should be used to properly measure frozen precipitation.
- Rain gauges should be located at 1-2 meters above ground level so the mouth is horizontal to the sky.
- Wind shields should be used where significant snowfall occurs.
- Pyranometers (measuring incoming solar radiation) should be located where no shadows are cast.
- Pyranometers should have an unrestricted view of the sky from all directions in all seasons at 1-2 meters above ground level.
- Barometric pressure sensors should be located at 2 meters above ground level.
- Wetness sensors should be located at 2 meters above ground level.
- Approval and/or permits are obtained to clear land for site installation.

## 6.3    GASEOUS MONITORING SITE CRITERIA

Monitoring site criteria to consider when locating gaseous instrumentation are detailed in the following subsections.

### 6.3.1    <u>Ozone Probe Site Criteria</u>

- Vertical probe placement is 3-15 meters above ground.
- Spacing from supporting structures is more than 1 meter.
- Obstacle distance is at least twice the height the obstacle protrudes above the probe.
- The probe must have unrestricted airflow. It must include the predominant wind; 270°, otherwise 180° if the probe is located on the side of a building.
- Spacing between the station and roadway.

Minimum Separation Distance Between Roadways and Probes or
Monitoring Paths for Monitoring Neighborhood and Urban Scale
Ozone and Nitrogen Dioxide

| Roadway average daily traffic, vehicles per day | Minimum separation distance[1] in meters |
|---|---|
| ≤ 10,000 | 10 |
| 15,000 | 20 |
| 20,000 | 30 |
| 40,000 | 50 |
| 70,000 | 100 |
| ≥ 110,000 | 250 |

[1] Distance from the edge of the nearest traffic lane. The distance for intermediate traffic counts should be interpolated from the table values based on the actual traffic count.

- Spacing from trees should be at least 20 meters from dripline, and must be at least 10 meters if blocking daytime wind from an urban core.
- The probe material must be of Teflon or Pyrex glass.
- Residence time must be less than 20 seconds.

### 6.3.2  Sulfur Dioxide Probe Site Criteria

- Horizontal and vertical probe placement is 3-15 meters above ground and more than 1 meter from a supporting structure.
- Probe placement must be away from dirty, dusty areas, and if on the side of a building, should be on the side of the prevailing winter wind.
- The probe should be at least 1 meter from walls, parapets, penthouses, etc.
- If neighborhood scale, the probe must be at a distance at least twice the height the obstacle protrudes above the probe.
- The probe must have at least a 270° arc of unrestricted airflow around vertical probes (180° if on the side of a building), and wind during the peak season must be included in the arc.
- No furnace or incineration flues or other minor sources of $SO_2$ should be nearby.
- Spacing from trees should be at least 20 meters from dripline, and must be at least 10 meters if trees act as an obstruction.

### 6.3.3  Carbon Monoxide Probe Site Criteria

- Horizontal and vertical probe placement is 3 (±1½) meters above ground for microscale and 3-15 meters above ground for middle and neighborhood scale.
- Spacing from obstructions is at least 270°, or 180° if the probe is located on the side of a

building.

- Spacing from roads is 2-10 meters from the edge of the nearest traffic lane for microscale, or at least 10 meters from an intersection, preferably at midblock. See Table 4-2 for middle and neighborhood scale.

Minimum Separation Distance Between Roadways and Probes or
Monitoring Paths for Monitoring Neighborhood Scale
Carbon Monoxide

| Roadway average daily traffic, vehicles per day | Minimum separation distance[1] for probes or 90% of a monitoring path (meters) |
|---|---|
| ≤ 10,000 | 10 |
| 15,000 | 25 |
| 20,000 | 45 |
| 30,000 | 80 |
| 40,000 | 115 |
| 50,000 | 135 |
| ≤ 60,000 | 150 |

[1] Distance from the edge of the nearest traffic lane. The distance for intermediate traffic counts should be interpolated from the table values based on the actual traffic count.

- Spacing from trees should be at least 10 meters from dripline, if tree is at least 5 meters above sampler and is between the probe and the road.

### 6.3.4    Nitrogen Dioxide Probe Site Criteria

- Vertical probe placement is 3-15 meters above ground.
- Spacing from supporting structures is more than 1 meter.
- Obstacle distance is at least twice the height the obstacle protrudes above the probe.
- The probe must have unrestricted airflow; 270° or 180° if the probe is located on the side of a building.
- Spacing between station and roadway.
- Spacing from trees should be at least 20 meters from dripline, if tree is above the height of the probe by 5 meters or more.
- Probe material must be of Teflon or Pyrex glass.
- Residence time must be less than 20 seconds.

## 6.4    SITE DOCUMENTATION

The IMC maintains records of the characteristics of the sites. These records are intended to provide a permanent history of the following site information

- Site identification
- Site classification
- Topographic characteristics
- Meteorology and climatology
- Obstructions that influence the site
- Characteristics of the sampling probes
- Pollutant parameter monitors
- Site and data record histories
- Site representativeness
- Custody and control of data

These records will be upgraded as changes occur and will be used to document compliance with the Part 58 network design and siting criteria.

## 7.0    REFERENCES

Environmental Protection Agency, 1994, Quality Assurance Handbook for Air Pollution Measurement Systems: Volume I: A Field Guide to Environmental Quality Assurance, EPA-600/R-94/038a, (April 1994).

Environmental Protection Agency, 2013, Quality Assurance Handbook for Air Pollution Measurement Systems: Volume II: Ambient Air Quality Monitoring Program,    EPA-454/B-13-003 (May 2013).

Environmental Protection Agency, 2008, Quality Assurance Handbook for Air Pollution Measurement Systems: Volume IV. Meteorological Measurements (Version 2.0), EPA-454/B-08-002 (March 2008).

Environmental Protection Agency, 2000, Meteorological Monitoring Guidance for Regulatory Modeling Applications, EPA-454/R-99-005 (February 2000).

Environmental Protection Agency, 2007, 40 CFR Part 58 Appendix D.

Environmental Protection Agency, 2006, 40 CFR Part 58 Appendix E.

**8.0    DEFINITIONS AND ACRONYMS**

|       |                                                |
|-------|------------------------------------------------|
| ARS   | Air Resource Specialists, Inc.                 |
| AQDB  | Air Quality Database                           |
| CFR   | Code of Federal Regulations                    |
| DAS   | Data Acquisition System                        |
| EPA   | U.S. Environmental Protection Agency           |
| IMC   | Information Management Center                   |
| MS    | Microsoft                                      |
| NIST  | National Institute of Standards and Technology |
| PDF   | Portable Document Format                        |
| QA    | Quality Assurance                              |
| QAPP  | Quality Assurance Project Plan                 |
| QC    | Quality Control                                |
| SLAMS | State and Local Air Monitoring Stations        |
| SOP   | Standard Operating Procedure                   |

**Verification**: establishes the quantitative relationship between the value of a known traceable standard and the instrument's response

**Calibration**: adjustment of the instrument or analyzer so it operates within established acceptance criteria (defined in the network of project specific QAPP)

# APPENDIX A

# NEW SITE/SITE RELOCATION FORM

**APPENDIX A**

**NEW SITE/SITE RELOCATION FORM**

| Today's Date: | | Change Effective Date: | | Submitted by: | |
|---|---|---|---|---|---|

| Site Name: | | | Site Abbrev: | | AQDB Site No. | |
|---|---|---|---|---|---|---|
| Street Address: | | | | | | |
| City: | | | County: | | | |
| State: | | Time Zone: | | AQS ID: (XX-XXX-XXXX) | | |
| Latitude: | | Longitude: | | | Elevation: | m / ft |
| Camera: | Y / N | If Y, azimuth: | ° | Station Type: (SLAMS/PSD/NCore/etc.) | | |

| Location Setting: (circle one) | Urban / Suburban / Rural | Method of determining lat/long: | | |
|---|---|---|---|---|
| Nearest Road: | Name: | | Approximate Traffic Count: | |
| Type: (circle one) | Arterial / Expressway / Freeway / Through Street or Highway  Local Street or Highway / Major Street or Highway | | | |
| | Predominant Land Use: | Obstructions: | Topographic Features: | General Terrain: |
| | (Industry, Residential, Commercial or Agriculture) | Height (m) | Distance (m) | (hills, valleys, rivers, etc.) | (flat, rolling, rough, etc.) |
| North | | | | | |
| East | | | | | |
| South | | | | | |
| West | | | | | |

| Datalogger Type: | | Comm Type: | |
|---|---|---|---|
| Telephone Number or IP Address(es): | | | |
| Logger IP Address: | | | |
| DataView IP Address: | | | |
| Camera IP Address: | | | |
| Other/phone number: | | | |

| Notes: |
|---|
| |

| Collected Parameters: | | | | | |
|---|---|---|---|---|---|
| Name: | Abbrev: | Units: | AQDB ParCode: | Channel Type: (analog, RS232, etc.) | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

**Cardinal Direction Photos From Site**

| | |
|---|---|
| From North | From East |
| From South | From West |

**Cardinal Direction Photos To Site**

| | |
|---|---|
| To North | To East |
| To South | To West |

## Minimum Separation Distance Between Roadways and Probes or Monitoring Paths for Monitoring Neighborhood Scale Carbon Monoxide

| Roadway average daily traffic, vehicles per day | Minimum separation distance[1] for probes or 90% of a monitoring path (meters) |
|---|---|
| ≤ 10,000 | 10 |
| 15,000 | 25 |
| 20,000 | 45 |
| 30,000 | 80 |
| 40,000 | 115 |
| 50,000 | 135 |
| ≤ 60,000 | 150 |

[1] Distance from the edge of the nearest traffic lane. The distance for intermediate traffic counts should be interpolated from the table values based on the actual traffic count.

## Minimum Separation Distance Between Roadways and Probes or Monitoring Paths for Monitoring Neighborhood and Urban Scale Ozone and Nitrogen Dioxide

| Roadway average daily traffic, vehicles per day | Minimum separation distance[1] in meters |
|---|---|
| ≤ 10,000 | 10 |
| 15,000 | 20 |
| 20,000 | 30 |
| 40,000 | 50 |
| 70,000 | 100 |
| 110,000 | 250 |

[1] Distance from the edge of the nearest traffic lane. The distance for intermediate traffic counts should be interpolated from the table values based on the actual traffic count.

## Separation Distance Between Pb Stations and Roadways (Edge of Nearest Traffic Lane)

| Roadway average daily traffiic, vehicles per day | Separation distance between roadways and stations, in meters | | |
|---|---|---|---|
| | Microscale | Middle Scale | Neighborhood urban regional scale |
| ≤10,000 | 5-15 | [1]> 15-50 | [1]>50 |
| 20,000 | 5-15 | > 15-75 | >75 |
| ≥40,000 | 5-15 | > 15-100 | >100 |

[1] Distances should be interpolated based on traffic flow.

Site Evaluation in Conformance with EPA Requirements:

Site Name: _____   Observed by: _____

Make and Model #:

Carbon Monoxide Monitor: _____

Nitrogen Dioxide Monitor: _____

| CRITERIA | REQUIREMENTS* | CRITERIA MET? | |
| --- | --- | --- | --- |
| | | Yes | No |
| **CARBON MONOXIDE** | | | |
| Horizontal and Vertical Probe Placement (Par. 4.1) | 3 ± 1 ½ m for microscale | | |
| | 3-15 m for middle and neighborhood scale | | |
| Spacing from Obstructions (Par. 4.2) | ≥ 270° or 180° if on side of building | | |
| Spacing from Roads (Par. 4.3) | 2-10 m from edge of nearest traffic lane for microscale; ≥ 10 m from intersection, preferably at midblock | | |
| | See Table 1 for middle and neighborhood scale | | |
| Spacing from Trees (Par 4.4) | Should be ≥ 10 m from dripline of trees, if tree is ≥ 5m above sampler and is between the probe and the road. | N/A | |
| Comments: | | | |

| NITROGEN DIOXIDE | | | |
| --- | --- | --- | --- |
| **NITROGEN DIOXIDE** | | | |
| Vertical Probe Placement (Par. 6.1) | 3-15 m above ground | | |
| Spacing from Supporting Structure (Par. 6.1) | Greater than 1 m | | |
| Obstacle Distance (Par. 6.2) | ≥ Twice the height the obstacle protrudes above probe | | |
| Unrestricted Airflow (Par. 6.2) | Must be 270° or 180° if on side of building | | |
| Spacing between Station and Roadway (Par. 6.3) | See Table 2 | | |
| Spacing from Trees (Par. 6.4) | Should be ≥ 20 m from dripline of trees | N/A | |
| | Must be ≥ 10 m from dripline, if trees are an obstruction ** | | |
| Probe Material (Par. 9) | Teflon or pyrex glass | | |
| Residence Time (Par. 9) | Less than 20 seconds | | |
| Comments: | | | |

* Citations from 40 CFR 58, Appendix E.

** A tree is considered an obstruction if it protrudes above the height of the probe by 5 meters or more.

Site Name: _____ Observed by: _____

Make and Model #:

Ozone Monitor: _____

Sulfur Dioxide Monitor: _____

| CRITERIA | REQUIREMENTS* | CRITERIA MET? | |
|---|---|---|---|
| | | Yes | No |
| **OZONE** | | | |
| Vertical Probe Placement (Par. 5.1) | 3-15 m above ground | | |
| Spacing from Supporting Structure (Par. 5.1) | Greater than 1 m | | |
| Obstacle Distance (Par. 5.2) | ≥ twice the height the obstacle protrudes above probe | | |
| Unrestricted Airflow (Par. 5.2) | Must include predominant wind. 180° if on side of building. Otherwise 270°. | | |
| Spacing between Station and Roadway (Par. 5.3) | See Table 3 | | |
| Spacing from Trees (Par. 5.4) | Should be ≥ 20 m from dripline | N/A | |
| | Must be ≥ 10 m if blocking daytime wind from urban core | | |
| Probe Material (Par. 9) | Teflon or pyrex glass | | |
| Residence time (Par. 9) | Less than 20 seconds | | |
| Comments: | | | |

| CRITERIA | REQUIREMENTS* | Yes | No |
|---|---|---|---|
| **SULFUR DIOXIDE** | | | |
| Horizontal and Vertical Probe Placement (Par. 3.1) | 3-15 m above ground | | |
| | > 1 m from supporting structure | | |
| | Away from dirty, dusty areas | | |
| | If on side of building, should be on side of prevailing winter wind | N/A | |
| Spacing from Obstructions (Par. 3.2) | ≥ 1 m from walls, parapets, penthouses, etc. | | |
| | If neighborhood scale, probe must be at a distance ≥ twice the height the obstacle protrudes above probe | | |
| | ≥ 270°arc of unrestricted airflow around vertical probes, and wind during peak season must be included in arc | | |
| | 180° if on side of building | | |
| | No furnace or incineration flues or other minor sources of $SO_2$ should be nearby | N/A | |
| Spacing from Trees (Par. 3.3) | Should be ≥ 20 m from dripline of trees | N/A | |
| | ≥ 10 m when trees act as an obstruction | | |
| Comments: | | | |

* Citations from 40 CFR 58, Appendix E.

# Approvals

The purpose of this review and approval is to evaluate this Standard Operating Procedure (SOP) for adequacy prior to issuance. The signatories below are stating that the approach defined within this document is acceptable and that the affected company interests have been represented.

Author Signature:

Program:        QA Manager – Genevieve Lariviere

Approval Signature:

Program:        Field Operations Manager – Mark Tigges

| | **Standard Operating Procedure** |
| :---: | :---: |
| *Air Resource SPECIALISTS* | **Verification, Calibration and Maintenance of Ozone Analyzers** |
| | **Using Traveling Level 2 Ozone Transfer Standards** |

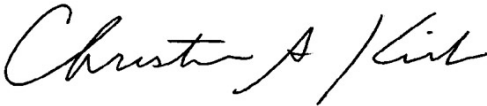| | | |
| :--- | :--- | :--- |
| **Version: 1** | *F_GAS_MTCAL_Ozone-L2_F_1.0* | **Page 2 of 18** |

# REVISION HISTORY

| Review date: | Changes made: | Changes made by: |
| :--- | :--- | :--- |
| 10/13/2016 | Initial Version 1.0 | E. Vanden Hoek |
| 12/15/2017 | No changes necessary | E. Vanden Hoek |
| 10/29/2018 | Removed date reference from file name | E. Vanden Hoek |
| 10/24/2019 | Corrected name on Approval Page (Mike Slate to Mark Tigges) | E. Vanden Hoek |
| 10/28/2020 | Minor text edits | E. Vanden Hoek |
| 10/27/2021 | Minor text edits | E. Vanden Hoek |
| 10/5/2022 | Updated personnel | E. Vanden Hoek |

| | **Standard Operating Procedure** | |
| :---: | :---: | :---: |
| | **Verification, Calibration and Maintenance of Ozone Analyzers** | |
| | **Using Traveling Level 2 Ozone Transfer Standards** | |

| **Version: 1** | *F_GAS_MTCAL_Ozone-L2_F_1.0* | **Page 3 of 18** |
| :--- | :--- | :---: |

# ANNUAL REVIEW

The undersigned attests that this standard operating procedure has undergone annual review for adherence to current practices and the latest QA/QC protocols:

| Signature | Title | Date |
| :---: | :---: | :---: |
| *[signature]* | QA Manager | 10/29/2018 |
| *[signature]* | QA Officer | 10/12/2019 |
| *[signature]* | QA Manager | 10/28/2020 |
| *[signature]* | QA Officer | 10/27/2021 |
| Jon Wenrick | Field Specialist | 9/9/2022 |

| | Standard Operating Procedure<br>Verification, Calibration and Maintenance of Ozone Analyzers<br>Using Traveling Level 2 Ozone Transfer Standards |
|---|---|

| Version: 1 | *F_GAS_MTCAL_Ozone-L2_F_1.0* | Page 4 of 18 |
|---|---|---|

### 1.0 PURPOSE

Instructions provided herein outline the steps for the proper verification, calibration, and maintenance of ozone analyzers operated by Air Resource Specialists, Inc. (ARS).

Results from the verifications checks constitute required quality control checks, which are used to measure the performance of the instrument against acceptance criteria established in the network or site specific Quality Assurance Project Plan (QAPP).

### 2.0 SUMMARY OF METHOD

The operation of an equivalent method ozone analyzer is based on the absorption of ultraviolet light at 254 nm by ozone molecules. Ozone concentrations are determined using the Beer-Lambert law by measuring the intensity of light passing through the absorption path with and without ozone present. Gaseous ozone standards are not stable, and therefore cannot be stored for any length of time. Ozone concentrations to assay analyzer response must be generated on-site and verified on-site using a certified ozone transfer standard. The results from the on-site analyzer, on-site station reference, and the independent transfer standard are entered into the calibration form. Results shown in the form dictate any required corrective action.

The ambient analyzer and Level 3 station reference photometer are checked against a Level 2 transfer standard on a schedule in accordance with the network requirements or site specific QAPP. The Level 2 transfer standards used are certified annually against the NIST standard reference photometer by EPA. All traveling Level 2 transfer standards used at ARS are Thermo 49i instruments that use internal scrubbers to generate reference air for the ozone measurements.
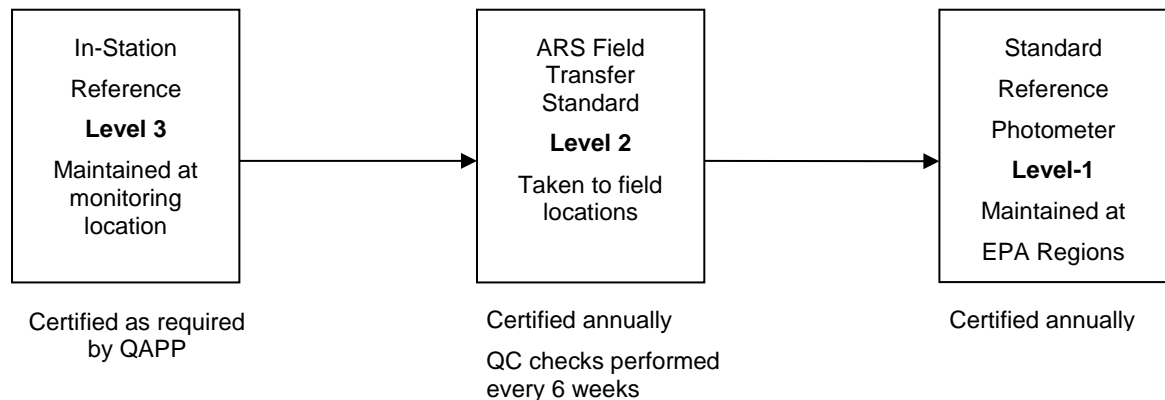


### 3.0 SCOPE

Activities described in this document are performed by ARS field technicians or specialists during routinely scheduled or emergency visits to monitoring stations. ARS field staff have been appropriately trained in site operations and possess the required technical knowledge and abilities to perform the activities described below.

| | Standard Operating Procedure |
| | Verification, Calibration and Maintenance of Ozone Analyzers |
| | Using Traveling Level 2 Ozone Transfer Standards |

| Version: 1 | *F_GAS_MTCAL_Ozone-L2_F_1.0* | Page 5 of 18 |

## 4.0 ROLES AND RESPONSIBILITIES

**Program or Project Manager**

- Establish project specific calibration and reporting schedule and requirements as documented in the network or site specific Quality Assurance Project Plan (QAPP)
- Review calibration results, identify inconsistencies and initiate corrective action

**Fields Operations Manager**
- Coordinate site visit schedules
- Conducts field technician/specialist training and assessments

**Field Technician or Specialist**
- Coordinate scheduled visit with client as directed by project manager or field supervisor
- Verify all transfer standards to be used are in current certification with appropriate documentation
- Perform as-found verification checks
- Perform any required instrument maintenance, repair and calibration
- Perform as-left verification checks
- Document all calibration results and maintenance procedures
- Summarize visit in written trip report within 30 days

## 5.0 REQUIRED EQUIPMENT AND MATERIALS

- Certified ozone transfer standard

- Replacement parts
  - o Ozone scrubber
  - o Solenoid valve
  - o UV photometer lamp
  - o Sample pump
  - o Ozone generator lamp
  - o Other parts as required

- Calibration forms in Excel format with site and standards information completed

- Ozone transfer standard certification form in Excel format for on-site station reference (if applicable)

- Instrument manual for specific analyzer(s) in use

## 6.0 PROCEDURES

### 6.1 "AS-FOUND" or "PRE-MAINTENANCE" VERIFICATION CHECKS

A complete verification check must be performed prior to any maintenance activity. No equipment maintenance or replacement should be performed prior to the verification checks. Any

| | **Standard Operating Procedure** |
| :---: | :---: |
| | **Verification, Calibration and Maintenance of Ozone Analyzers** |
| | **Using Traveling Level 2 Ozone Transfer Standards** |

| **Version: 1** | *F_GAS_MTCAL_Ozone-L2_F_1.0* | **Page 6 of 18** |
| :--- | :--- | :---: |

findings of as-found conditions shall be documented in the comments field of the calibration form.

**<u>Setup</u>**

- Plug in Level 2 transfer standard and allow to warm up for at least one hour
  - *Be sure sample pump is off so no ambient air enters transfer standard*

- If necessary, perform zero-air maintenance and replace zero-air media
  - *Zero-air should flow in the following order*

    *desiccant* ⟶ *Purafil* ⟶ *charcoal*

- Make notation in station logs and/or flag the ozone channel in the on-site datalogger indicating maintenance.
- Connect output of the ozone manifold on the back of the ozone source to the input of the Level 2 transfer standard. In most cases, ozone generation will be accomplished with the site analyzer. Please see the Appendix A for diagrams of station tubing plumbing for the various networks maintained by ARS.
- The length of tubing should be as short as reasonably possible, conditioned using high concentrations of ozone, and used for this designated purpose only.
- Initiate a zero event on ozone source. Reference the appropriate manual for the ozone source.
- Check the sample inlet for excess flow (should have ~1 LPM of excess flow)
- While all equipment is equilibrating, prepare the pre-maintenance, or "as-found" form in the Excel calibration workbook

**OZONE ANALYZER VERIFICATION & CALIBRATION**
**(AS FOUND)**

| ABBR. | ABCD | CLIENT | ACME | FIELD SPECIALIST | J. Smith | DATE | 1/1/2016 |
|---|---|---|---|---|---|---|---|
| SITE NAME | | Site A | | | | DATE OF LAST VISIT | |
| Network type | | SLAMS | | | | | |

| Logger Slope Correction | 0.9784 |
|---|---|
| Logger Intercept Correction | -0.2983 |

**AS FOUND**

| TRANSFER STANDARD | | AMBIENT ANALYZER | | STATION REFERENCE | |
|---|---|---|---|---|---|
| Manufacturer | Thermo | Manufacturer | - | Manufacturer | - |
| Model | 49i | Model | | Model | |
| Serial Number | 11320450197 | Serial Number | | Serial Number | |
| Coefficient | 1 | | | | |
| Background | 0 | | | | |
| | | | | | |
| Cell A Intensity (Hz) | | | | | |
| Cell B Intensity (Hz) | | | | | |
| Flow A (lpm) | | | | | |
| Flow B (lpm) | | | | | |
| Pressure (mmHg) | | | | | |
| | | | | | |
| Bench Temp (°C) | | | | | |
| Bench Lamp Temp (°C) | | | | | |
| Ozone Lamp Temp (°C) | | | | | |
| | | | | | |
| | | | | | |
| Transfer Standard Level | LEVEL 2 | | | Transfer Standard Level | LEVEL 3 |

Obtain logger slope and intercept correction from datalogger

Coefficient and Background must be set to one and zero when using Level 2 Transfer Standards as they are certified in this configuration.

- Complete diagnostic fields from **Level 2 transfer standard display**

```
DIAGNOSTICS:
>PROGRAM VERSION
 VOLTAGES
 TEMPERATURES
 PRESSURE
 FLOWS
 CELL A/B O3
 INTENSITIES

RANGE   AVG   DIAGS  ALARM
```

Select using analyzer menu and enter values in calibration form

- Enter Transfer Standard Correction Factors using EPA documentation accompanying the instrument

| | SLOPE | INT |
|---|---|---|
| **Transfer Standard Correction Factors** | 0.9878 | -0.2905 |

- Complete diagnostic fields from ambient analyzer and station reference. Reference the appropriate manual for the ambient analyzer and station reference.

- Perform multi-point verification checks using target concentrations from the Ozone Transfer Standard Certification Form (**Please see the instrument manual for detailed verification and calibration procedures**)

| POINT | TARGET | O3 LAMP % or mV | TRANSFER STANDARD Display | TRANSFER STANDARD Corrected | AMBIENT ANALYZER DAS | AMBIENT ANALYZER Diff | AMBIENT ANALYZER %Diff | AMBIENT ANALYZER Linearity % | | STATION REFERENCE DAS | STATION REFERENCE Diff | STATION REFERENCE %Diff | STATION REFERENCE Linearity % | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ZERO | 0 | 0 | -0.8 | -0.5 | 0.2 | 0.7 | N/A | -0.2% | PASS | -0.1 | 0.4 | N/A | 0.0% | PASS |
| 1 | 225 | 36.8 | 224 | 227.1 | 228.3 | 1.2 | 0.5% | 0.0% | PASS | 230.1 | 3.0 | 1.3% | 0.0% | PASS |
| 2 | 150 | 34.8 | 180.7 | 183.2 | 184.5 | 1.3 | 0.7% | -0.1% | PASS | 185.6 | 2.4 | 1.3% | 0.0% | PASS |
| 3 | 100 | 31.9 | 125 | 126.8 | 127.8 | 1.0 | 0.8% | 0.0% | PASS | 128.2 | 1.4 | 1.1% | 0.2% | PASS |
| 4 | 80 | 29.7 | 90.4 | 91.8 | 92.3 | 0.5 | 0.5% | 0.1% | PASS | 93.6 | 1.8 | 1.9% | -0.2% | PASS |
| 5 | 60 | 26.2 | 50.4 | 51.3 | 51.8 | 0.5 | 0.9% | 0.0% | PASS | 52.4 | 1.1 | 2.1% | -0.1% | PASS |
| ZERO | 0 | 0 | 0.1 | 0.4 | 0.1 | -0.3 | N/A | 0.2% | PASS | 0.4 | 0.0 | N/A | 0.1% | PASS |

| | | AMBIENT ANALYZER | | | STATION REFERENCE | |
|---|---|---|---|---|---|---|
| | | Mean ABS % Diff | 0.7% | PASS | Mean ABS % Diff | 1.6% | PASS |
| | | Max ABS % Difference | 0.9% | PASS | Max ABS % Difference | 2.1% | PASS |

| Analog Test | Analyzer DAS | Reference DAS | | Slope | 1.005 | | Slope | 1.012 | |
|---|---|---|---|---|---|---|---|---|---|
| Zero | 0.007 | 0.03 | | Y-Intercept | 0.21 | | Y-Intercept | 0.30 | |
| Full Scale | 250.1 | 250.1 | | Correlation | 1.0000 | | Correlation | 1.0000 | |

- Record concentration values for both the ambient analyzer and on-site station reference **FROM THE DATALOGGER DISPLAY** in the calibration forms. Record the concentration value for the transfer standard from the instrument display.
- If a 1x6 certification of the Level 3 station reference is required, record concentration values from the on-site station reference and transfer standard from the instrument displays in the Ozone Transfer Standard Certification form. This recertification occurs at the same time as the pre-maintenance verification check unless there is a problem with the Level 3 station reference (See **Section 6.2**).
- Review the results to determine if corrective action or calibration is required (if the form indicates **FAIL** or **ACTION**).
- Refer to the instrument manual for more detailed information on performing repairs and/or calibration.

| | **Standard Operating Procedure** |
|---|---|
| | **Verification, Calibration and Maintenance of Ozone Analyzers** |
| | **Using Traveling Level 2 Ozone Transfer Standards** |

| **Version: 1** | *F_GAS_MTCAL_Ozone-L2_F_1.0* | **Page 9 of 18** |
|---|---|---|

### 6.2 UPDATE OZONE TRANSFER STANDARD CERTIFICATION

The datalogger contains the verification relationship from the Ozone Transfer Standard Certification form. The datalogger uses the **RAWO3CAL** channel to calculate the **O3CAL** channel. The **O3CAL** channel is used to input the pre-maintenance and post-maintenance calibration checks, which is the corrected value from the Level 3 station reference. During each maintenance visit, a 1x6 certification of the on-site station reference is generally required by the site-specific QAPP or network requirements. This 1x6 certification is performed **simultaneously** with the pre-maintenance verification checks unless there is a problem with the Level 3 station reference.

To perform a 1x6 certification of the on-site station reference, use the following procedures:

- Complete the following fields on the Ozone Transfer Standard Certification Form

**Standard Operating Procedure**
**Verification, Calibration and Maintenance of Ozone Analyzers**
**Using Traveling Level 2 Ozone Transfer Standards**

| Version: 1 | *F_GAS_MTCAL_Ozone-L2_F_1.0* | Page 10 of 18 |

| CLIENT | |
|---|---|

| | DATE | |
|---|---|---|
| **CERTIFYING STANDARD** | **Manufacturer** | Thermo |
| **LEVEL**    2 | **Model** | |
| | **Serial Number** | |
| | **Personnel** | |
| | **Slope Correction** | |
| | **Intercept Correction** | |
| Level 2 LAB standards have slope correction and intercept correction factors of 1.000 and 0.000, respectively. | **Coefficient** | |
| | **Background** | |
| | **Cell A Intensity (Hz)** | |
| | **Cell B Intensity (Hz)** | |
| | **Flow A (lpm)** | |
| | **Flow B (lpm)** | |
| | **Pressure (mmHg)** | |
| | | |
| | **Bench Temp (°C)** | |
| | **Bench Lamp Temp (°C)** | |
| | **Ozone Lamp Temp (°C)** | |
| | | |
| | **Ozone Source** | |

| **STANDARD TO BE CERTIFIED** | | **Coefficient** | |
|---|---|---|---|
| **LEVEL** | 3 | **Background** | |
| | | **Cell A Intensity (Hz)** | |
| **Manufacturer** | Thermo | **Cell B Intensity (Hz)** | |
| | | **Flow A (lpm)** | |
| **Model** | | **Flow B (lpm)** | |
| **Serial Number** | | **Pressure (mmHg)** | |
| **Range** | 500 | | |
| Is this a Level 3 TRAVEL standard? Type YES or NO in the box. | | **Bench Temp (°C)** | |
| | | **Bench Lamp Temp (°C)** | |
| | | **Ozone Lamp Temp (°C)** | |
| NO | | | |
| | | **Ozone Source** | |

| | Standard Operating Procedure<br>**Verification, Calibration and Maintenance of Ozone Analyzers**<br>**Using Traveling Level 2 Ozone Transfer Standards** |
|---|---|

| **Version: 1** | *F_GAS_MTCAL_Ozone-L2_F_1.0* | **Page 11 of 18** |
|---|---|---|

- Generate concentrations of ozone (using the on-site analyzer) as indicated by the Ozone Transfer Standard Certification Form and record results on form.

| 225 | CERTIFYING STANDARD | 225.0 | 225.0 | 225.0 | 225.0 | 225.0 | 225.0 | 216.0 |
|---|---|---|---|---|---|---|---|---|
| | STANDARD TO BE CERTIFIED | 221.0 | 222.0 | 221.0 | 222.0 | 222.0 | 222.0 | 218.0 |

| 180 | CERTIFYING STANDARD | 179.9 | 180.1 | 180.0 | 180.4 | 180.1 | 180.1 | 169.4 |
|---|---|---|---|---|---|---|---|---|
| | STANDARD TO BE CERTIFIED | 175.9 | 176.2 | 177.4 | 176.9 | 177.3 | 177.3 | 170.6 |

| 125 | CERTIFYING STANDARD | 124.8 | 125.0 | 124.9 | 125.3 | 125.1 | 124.8 | 115.3 |
|---|---|---|---|---|---|---|---|---|
| | STANDARD TO BE CERTIFIED | 122.1 | 122.7 | 123.1 | 123.1 | 123.2 | 123.0 | 116.4 |

| 90 | CERTIFYING STANDARD | 90.1 | 90.1 | 90.1 | 90.0 | 90.3 | 90.0 | 90.9 |
|---|---|---|---|---|---|---|---|---|
| | STANDARD TO BE CERTIFIED | 88.1 | 88.2 | 88.4 | 88.4 | 88.4 | 89.0 | 92.6 |

| 50 | CERTIFYING STANDARD | 50.1 | 50.2 | 50.0 | 50.0 | 50.1 | 49.9 | 49.3 |
|---|---|---|---|---|---|---|---|---|
| | STANDARD TO BE CERTIFIED | 48.5 | 48.7 | 49.1 | 49.1 | 48.8 | 49.0 | 50.4 |

- The Ozone Transfer Standard Certification Worksheet will calculate the slope and intercept and new correction factors to be input in the on-site datalogger.

| SLOPE (m) | 0.9830 | 0.9848 | 0.9880 | 0.9868 | 1.0062 | 1.0384 | 1.0145 |
|---|---|---|---|---|---|---|---|
| INTERCEPT (I) | 0.0992 | 0.1324 | -0.5084 | -0.1392 | 0.5550 | -1.4258 | 0.0879 |
| Correlation | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 0.9992 | 1.0000 |

| | OLD | NEW |
|---|---|---|
| AVG SLOPE (m) | 0.9978 | 1.0031 |
| AVG INTERCEPT (I) | -0.2586 | -0.2605 |

**NEW CORRECTION FACTORS**

SLOPE = 1.0031

INTERCEPT = -0.2605

| < 3.7% | $S_m$ | 2.16% | 2.10% |
|---|---|---|---|
| | PASS/FAIL | PASS | PASS |
| < 1.5 | $S_I$ | 0.67 | 0.67 |
| | PASS/FAIL | PASS | PASS |

| < 0.05 | SLOPE Change | 0.017 |
|---|---|---|
| | PASS/FAIL | PASS |

- If the form indicates passing results, enter the new correction factors into the on-site datalogger.
- If the form indicates the certification was unsuccessful (**FAIL**), troubleshoot the instrument following procedures outlined in the instrument manual and repeat the certification process.
- If the station reference fails certification again, replace the instrument with a different certified station reference.
- Record all instrument serial numbers and document the issue and resolution.

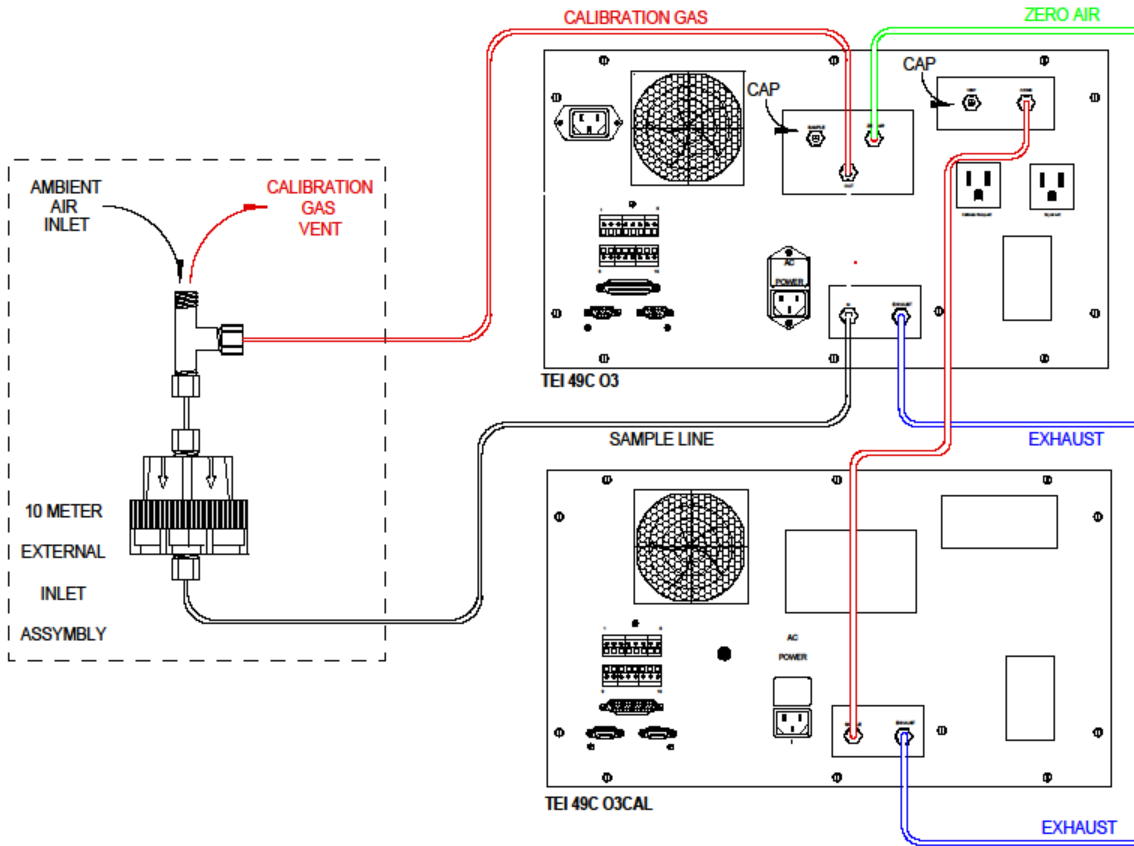| | Standard Operating Procedure<br>Verification, Calibration and Maintenance of Ozone Analyzers<br>Using Traveling Level 2 Ozone Transfer Standards |
|---|---|
| **Air Resource SPECIALISTS** | |

| Version: 1 | *F_GAS_MTCAL_Ozone-L2_F_1.0* | Page 12 of 18 |
|---|---|---|

## 6.3 PERFORM MAINTENANCE, AND CALIBRATION IF INDICATED

Following completion of the as-found calibration verification checks, perform any scheduled or required maintenance or repair to the ambient analyzer and/or station reference. Refer the instrument manual for the make and model of instrument in use for more specific information.

Maintenance procedures include and are not limited to the following activities:

- System leak check
- Sample pump replacement
- Absorption cell tube cleaning
- Ozone converter replacement
- UV lamp replacement
- Detector frequency adjustment

## 6.4 AS-LEFT" or "POST-MAINTENANCE" VERIFICATION CHECKS

A complete verification check must be performed following any maintenance activity or equipment exchange. Repeat the steps outlined in Section 6.1 and record the measurements in the "As-Left" calibration form

| POINT | TARGET | O3 LAMP<br>% or mV | TRANSFER STANDARD | | AMBIENT ANALYZER | | | | | STATION REFERENCE | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Display | Corrected | DAS | Diff | %Diff | Linearity % | | DAS | Diff | %Diff | Linearity % | |
| ZERO | 0 | 0 | -0.8 | -0.5 | 0.2 | 0.7 | N/A | -0.2% | PASS | -0.1 | 0.4 | N/A | 0.0% | PASS |
| 1 | 225 | 36.8 | 224 | 227.1 | 228.3 | 1.2 | 0.5% | 0.0% | PASS | 230.1 | 3.0 | 1.3% | 0.0% | PASS |
| 2 | 150 | 34.8 | 180.7 | 183.2 | 184.5 | 1.3 | 0.7% | -0.1% | PASS | 185.6 | 2.4 | 1.3% | 0.0% | PASS |
| 3 | 100 | 31.9 | 125 | 126.8 | 127.8 | 1.0 | 0.8% | 0.0% | PASS | 128.2 | 1.4 | 1.1% | 0.2% | PASS |
| 4 | 80 | 29.7 | 90.4 | 91.8 | 92.3 | 0.5 | 0.5% | 0.1% | PASS | 93.6 | 1.8 | 1.9% | -0.2% | PASS |
| 5 | 60 | 26.2 | 50.4 | 51.3 | 51.8 | 0.5 | 0.9% | 0.0% | PASS | 52.4 | 1.1 | 2.1% | -0.1% | PASS |
| ZERO | 0 | 0 | 0.1 | 0.4 | 0.1 | -0.3 | N/A | 0.2% | PASS | 0.4 | 0.0 | N/A | 0.1% | PASS |

| | | | Mean ABS % Diff | | 0.7% | PASS | Mean ABS % Diff | | 1.6% | PASS |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Max ABS % Difference | | 0.9% | PASS | Max ABS % Difference | | 2.1% | PASS |

| Analog Test | Analyzer DAS | Reference DAS | | Slope | 1.005 | | Slope | 1.012 | |
|---|---|---|---|---|---|---|---|---|---|
| Zero | 0.007 | 0.03 | | Y-Intercept | 0.21 | | Y-Intercept | 0.30 | |
| Full Scale | 250.1 | 250.1 | | Correlation | 1.0000 | | Correlation | 1.0000 | |

- Make notation in station logs and/or flag the ozone channel in the on-site datalogger indicating maintenance has been completed.

| | **Standard Operating Procedure** |
| :---: | :---: |
| | **Verification, Calibration and Maintenance of Ozone Analyzers** |
| | **Using Traveling Level 2 Ozone Transfer Standards** |

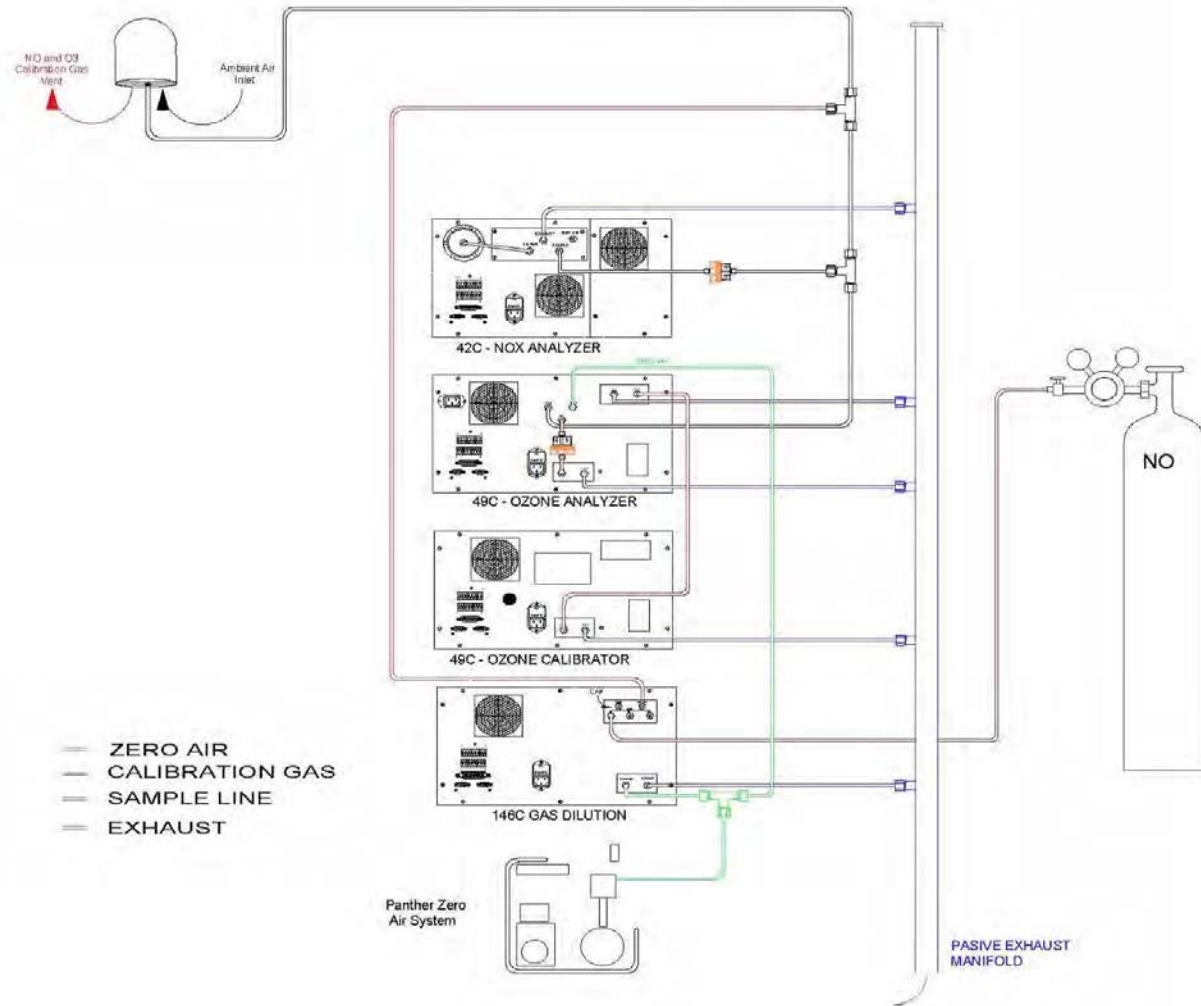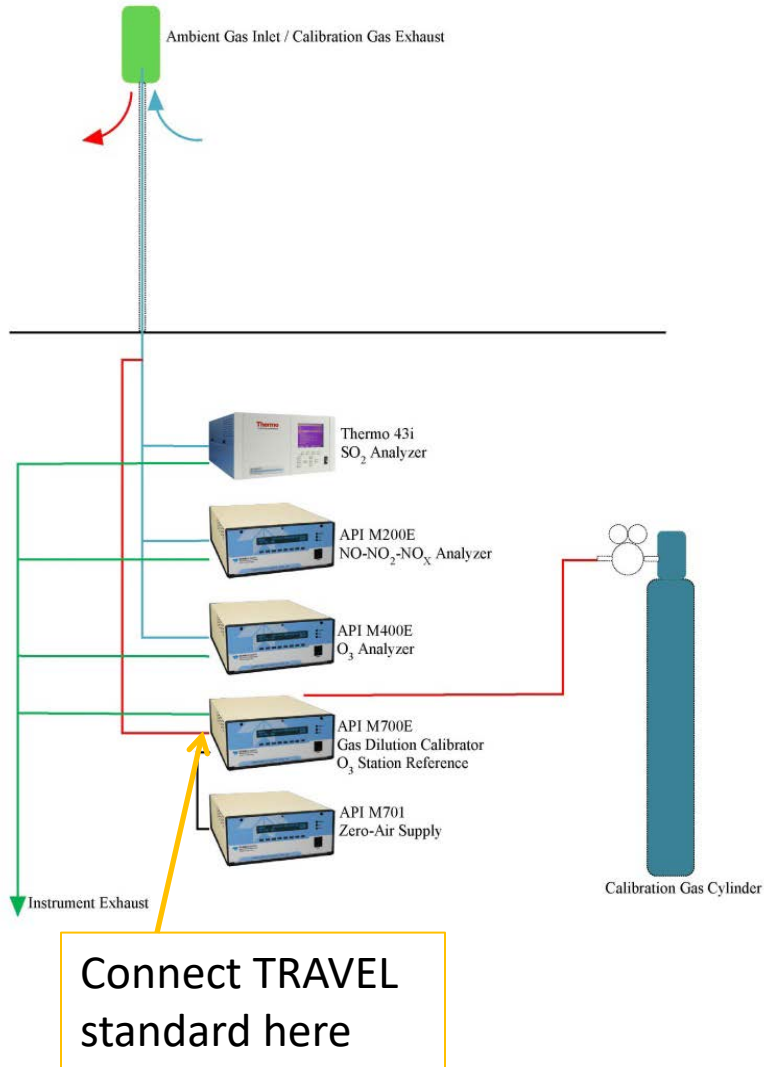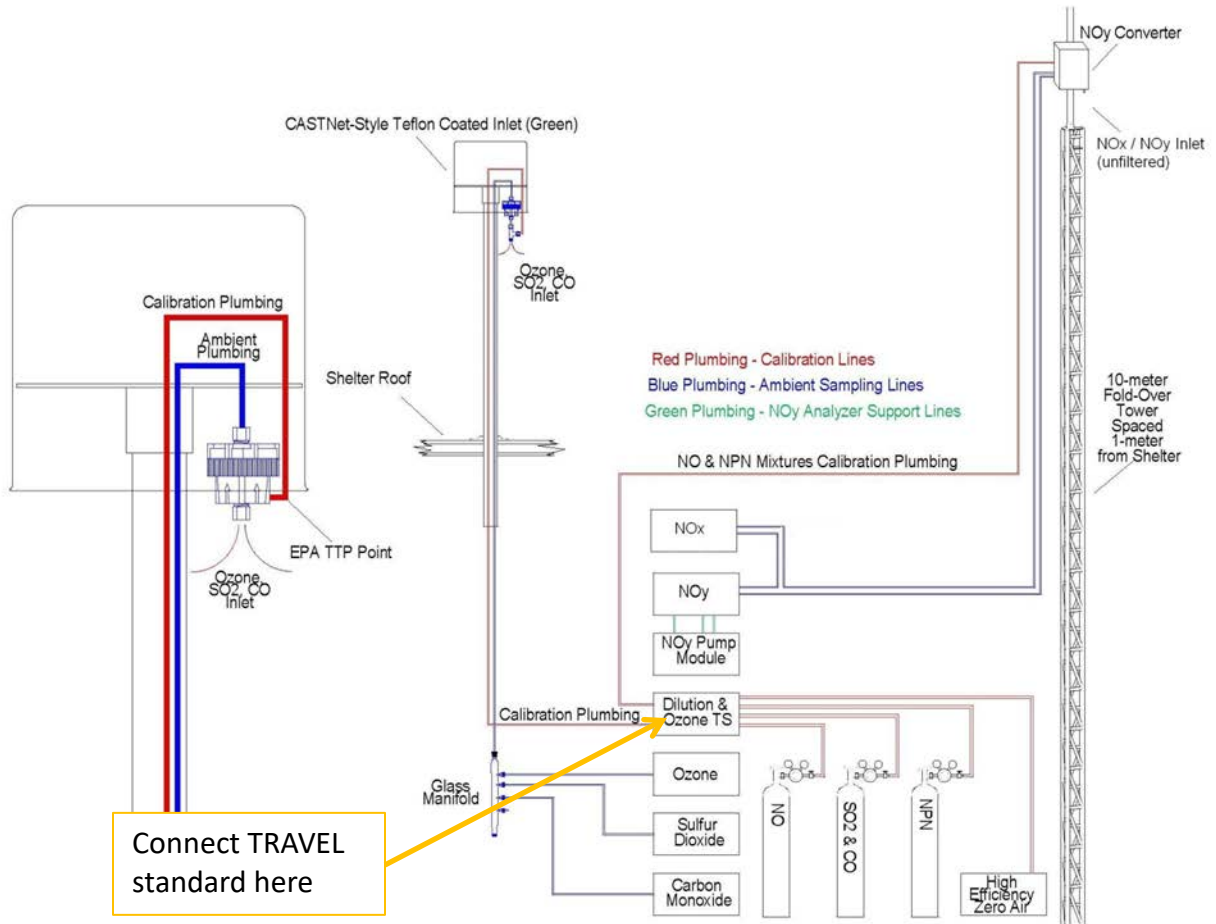| **Version: 1** | *F_GAS_MTCAL_Ozone-L2_F_1.0* | **Page 13 of 18** |
| :--- | :---: | :---: |

## 7.0    REFERENCES

Environmental Protection Agency, 2013, Quality Assurance Handbook for Air Pollution Measurement Systems, Volume II, Ambient Air Quality Monitoring Program, EPA-454/B-13-003 (May 2013).

Environmental Protection Agency, 2013, Transfer Standards for Calibration of Air Monitoring Analyzers for Ozone, Technical Assistance Document,   EPA-454/B-13-004 (October 2013).


## 8.0    DEFINITIONS AND ACRONYMS

| | |
| :--- | :--- |
| ARS | Air Resource Specialists, Inc. |
| AQDB | Air Quality Database |
| CFR | Code of Federal Regulations |
| DAS | Data Acquisition System |
| EPA | U.S. Environmental Protection Agency |
| IMC | Information Management Center |
| NIST | National Institute of Standards and Technology |
| PDF | Portable Document Format |
| QA | Quality Assurance |
| QAPP | Quality Assurance Project Plan |
| QC | Quality Control |
| SLAMS | State and Local Air Monitoring Stations |
| SOP | Standard Operating Procedure |

**Verification**: establishes the quantitative relationship between the value of a known traceable standard and the instrument's response

**Calibration**: adjustment of the instrument or analyzer so it operates within established acceptance criteria (defined in the network of project specific QAPP)

**Certification**: the procedure and methodology of transferring the authority of measurement from one device to another. In ozone monitoring, this procedure is commonly known as a "six-by-six" verification check consisting of 6 individual comparisons of the transfer standard to an authoritative standard. Each comparison must be conducted on a different day.

**Ozone Transfer Standard**: transportable device or apparatus which, together with associated operational procedures, is capable of accurately reproducing pollutant concentration standards or of producing accurate assays of pollutant concentrations which are quantitatively related to an authoritative standard.

| | **Standard Operating Procedure** |
| :---: | :---: |
| Air Resource SPECIALISTS | **Verification, Calibration and Maintenance of Ozone Analyzers** |
| | **Using Traveling Level 2 Ozone Transfer Standards** |

| Version: 1 | *F_GAS_MTCAL_Ozone-L2_F_1.0* | Page 14 of 18 |
| :--- | :--- | :---: |

# APPENDIX A

# SAMPLE SITE CONFIGURATION DIAGRAMS

**NPS-CASTNET CONFIGURATION**

| | **Standard Operating Procedure** **Verification, Calibration and Maintenance of Ozone Analyzers** **Using Traveling Level 2 Ozone Transfer Standards** |
|---|---|

| **Version:  1** | *F_GAS_MTCAL_Ozone-L2_F_1.0* | **Page 16 of 18** |
|---|---|---|

**WDEQ-AQD "STYLE A" CONFIGURATION**

| | Standard Operating Procedure |
|---|---|
| | **Verification, Calibration and Maintenance of Ozone Analyzers** |
| | **Using Traveling Level 2 Ozone Transfer Standards** |

| **Version: 1** | *F_GAS_MTCAL_Ozone-L2_F_1.0* | **Page 17 of 18** |
|---|---|---|

Connect TRAVEL standard here

**WDEQ-AQD "STYLE B" CONFIGURATION**

| | **Standard Operating Procedure** | |
|---|---|---|
| | **Verification, Calibration and Maintenance of Ozone Analyzers** | |
| | **Using Traveling Level 2 Ozone Transfer Standards** | |

| **Version: 1** | *F_GAS_MTCAL_Ozone-L2_F_1.0* | **Page 18 of 18** |

Connect TRAVEL standard here

## NCORE CONFIGURATION

# Approvals

The purpose of this review and approval is to evaluate this Standard Operating Procedure (SOP) for adequacy prior to issuance. The signatories below are stating that the approach defined within this document is acceptable and that the affected company interests have been represented.

Author Signature:

Program:        QA Manager – Genevieve Lariviere

Approval Signature:

Program:        Field Operations Manager

# REVISION HISTORY

| Review date: | Changes made: | Changes made by: |
|---|---|---|
| 10/17/2016 | Initial Version 1.0 | E. Vanden Hoek |
| 11/10/2017 | No changes necessary | E. Vanden Hoek |
| 10/29/2018 | Removed date reference from file name | E. Vanden Hoek |
| 10/14/2019 | Minor text edits | E. Vanden Hoek |
| 10/28/2020 | No changes necessary | E. Vanden Hoek |
| 10/6/2021 | Minor text edits | E. Vanden Hoek |
| 10/6/2022 | Updated personnel | E. Vanden Hoek |

| | **Standard Operating Procedure** | |
| --- | --- | --- |
| | **Verification and Maintenance of Immersible** | |
| | **Temperature Systems** | |

| **Version: 1** | *F_MET_MTCAL_ATbath_F_1.0* | **Page 3 of 8** |
| --- | --- | --- |
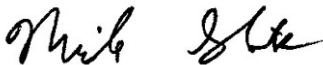
# ANNUAL REVIEW

The undersigned attests that this standard operating procedure has undergone annual review for adherence to current practices and the latest QA/QC protocols:

| Signature | Title | Date |
| --- | --- | --- |
| | QA Manager | 10/29/2018 |
| | Field Specialist | 10/14/2019 |
| | QA Manager | 10/28/2020 |
| Chad Cole | Field Specialist | 10/6/2021 |
| | Network Operations Manager/Field Specialist | 10/6/2022 |

## 1.0     PURPOSE

Instructions provided herein outline the steps for the proper verification and maintenance of immersible temperature systems operated by Air Resource Specialists, Inc. (ARS).

Results from the verifications checks constitute required quality control checks, which are used to measure the performance of the instrument against acceptance criteria established in the network or site specific Quality Assurance Project Plan (QAPP).

## 2.0     SUMMARY OF METHOD

The operation of an immersible temperature sensor is verified by the immersion of the on-site sensor(s) into a water bath with a transfer standard. The results from the on-site sensor and the transfer standard are entered into the calibration form. Results shown in the form dictate any required corrective action.

## 3.0     SCOPE

Activities described in this document are performed by ARS field technicians or specialists during routinely scheduled or emergency visits to monitoring stations. ARS field staff have been appropriately trained in site operations and possess the required technical knowledge and abilities to perform the activities described below.

## 4.0     ROLES AND RESPONSIBILITIES

### Program or Project Manager

- Establish project specific calibration and reporting schedule and requirements as documented in the network or site specific Quality Assurance Project Plan (QAPP)
- Review calibration results, identify inconsistencies and initiate corrective action

### Fields Operations Manager
- Coordinate site visit schedules
- Conducts field technician/specialist training and assessments

### Field Technician or Specialist
- Coordinate scheduled visit with client as directed by project manager or field supervisor
- Verify all transfer standards to be used are in current certification with appropriate documentation
- Perform as-found verification checks
- Perform any required instrument maintenance, repair and calibration
- Perform as-left verification checks
- Document all calibration results and maintenance procedures
- Summarize visit in written trip report within 30 days

| | Standard Operating Procedure |
| --- | --- |
| Air Resource SPECIALISTS | Verification and Maintenance of Immersible Temperature Systems |

| Version: 1 | *F_MET_MTCAL_ATbath_F_1.0* | Page 5 of 8 |
| --- | --- | --- |

## 5.0    REQUIRED EQUIPMENT AND MATERIALS

- Meteorological field kit

- One gallon of distilled water

- Crushed ice

- Thermos bottles

- Calibration forms in Excel format with site and standards information completed

- Instrument manual for specific sensor(s) in use

## 6.0    PROCEDURES

### 6.1    "AS-FOUND" or "PRE-MAINTENANCE" VERIFICATION CHECKS

A complete verification check must be performed prior to any maintenance activity. No equipment maintenance or replacement should be performed prior to the verification checks. Any findings of as-found conditions shall be documented in the comments field of the calibration form.

- Make notation in DataView and flag the temperature channel(s) in the on-site datalogger indicating maintenance.

- Prepare three water baths in insulated flasks: ice bath, ambient bath (~15-25°C) and high range bath (~40-50°C). These temperatures are measured with a NIST-traceable digital thermometer.

- Remove temperature probe(s) from the aspirator(s) and check the fans for proper operation and flow restrictions.

- Place probe(s) in the first bath along with a transfer standard. Agitate the water bath using a metal stir plate until the values indicated on the DAS and transfer standard stabilize (two-five minutes).

  - *Be careful to not submerge beyond the metal rod on the sensor, as the water can enter and damage the sensor*

- Record measurements in the calibration form under "as-found" checks.

| AS FOUND | 2m Temperature | | |
| --- | --- | --- | --- |
| Bath Temp (°C) | DAS | Difference | |
| 0.03 | 0.19 | 0.16 | PASS |
| 23.35 | 23.38 | 0.03 | PASS |
| 42.92 | 43.11 | 0.19 | PASS |
| MAX ABS Difference | | 0.19 | PASS |

- Repeat the above procedures for remaining baths.
- Note any additional findings in the comments field of the calibration form.

## 6.2    MAINTENANCE and EQUIPMENT EXCHANGE

If the sensor was <u>found to be operating outside of calibration acceptance criteria</u>, document findings in the ARS Site Status Log (www.arssitestatuslog.com).

| AS FOUND | 2m Temperature | | |
|---|---|---|---|
| Bath Temp (°C) | DAS | Difference | |
| 0.03 | 1.00 | 0.97 | FAIL |
| 23.35 | 23.38 | 0.03 | PASS |
| 42.92 | 43.11 | 0.19 | PASS |
| MAX ABS Difference | | 0.97 | FAIL |

Adjustments to the sensors should not be made.  Instead, adjustments to the datalogger or signal conditioning system should be made with project manager approval.

- Inspect the probe(s), wiring, and electrical connections for cleanliness and electrical continuity, and correct if necessary.
- Inspect aspirator housing(s) and clean if any dirt or cobwebs have accumulated.

If a spare sensor is available, install spare sensor and repeat the verification checks from Section 6.1 on the replacement sensor.

*Be sure to record the serial number(s) for each on-site sensor*

| AS FOUND | |
|---|---|
| **2m Temperature Sensor** | |
| Manufacturer | Climatronics |
| Model | 100093 |
| Serial Number | 8053 |

List sensors according to height on tower, from highest to lowest.

| AS LEFT | |
|---|---|
| **2m Temperature Sensor** | |
| Manufacturer | RM Young |
| Model | 41342VC |
| Serial Number | 18532 |

## 6.3 "AS-LEFT" or "POST-MAINTENANCE" VERIFICATION CHECKS

A complete verification check must be performed following any maintenance activity or equipment exchange. Repeat the steps outlined in Section 6.1 and record the measurements in the "As-Left" field of the calibration form.

| AS LEFT | 2m Temperature | | |
|---|---|---|---|
| Bath Temp (°C) | | | |
| 0.02 | 0.28 | 0.26 | PASS |
| 21.52 | 21.46 | -0.06 | PASS |
| 44.90 | 44.74 | -0.16 | PASS |
| MAX ABS Difference | 0.26 | | PASS |

- Make notation in station logs and unflag the temperature channel(s) in the on-site datalogger indicating maintenance has been completed.
- Pack up transfer standard and equipment and return to the meteorological field kit

## 7.0 REFERENCES

Environmental Protection Agency, 2008, Quality Assurance Handbook for Air Pollution Measurement Systems: Volume IV. Meteorological Measurements (Version 2.0), EPA-454/B-08-002 (March 2008).

Environmental Protection Agency, 2000, Meteorological Monitoring Guidance for Regulatory Modeling Applications, EPA-454/R-99-005 (February 2000).

## 8.0 DEFINITIONS AND ACRONYMS

| | |
|---|---|
| ARS | Air Resource Specialists, Inc. |
| AQDB | Air Quality Database |
| CFR | Code of Federal Regulations |
| DAS | Data Acquisition System |
| DVM | Digital Volt Meter |
| EPA | U.S. Environmental Protection Agency |
| IMC | Information Management Center |
| NIST | National Institute of Standards and Technology |
| PDF | Portable Document Format |
| QA | Quality Assurance |
| QAPP | Quality Assurance Project Plan |
| QC | Quality Control |
| SLAMS | State and Local Air Monitoring Stations |
| SOP | Standard Operating Procedure |

**Verification**: establishes the quantitative relationship between the value of a known traceable standard and the instrument's response

**Calibration**: adjustment of the instrument or analyzer so it operates within established acceptance criteria (defined in the network of project specific QAPP)

# Approvals

The purpose of this review and approval is to evaluate this Standard Operating Procedure (SOP) for adequacy prior to issuance.  The signatories below are stating that the approach defined within this document is acceptable and that the affected company interests have been represented.

Author Signature:

Program:            QA Manager – Genevieve Lariviere

Approval Signature:

Program:            Field Operations Manager

# REVISION HISTORY

| Review date: | Changes made: | Changes made by: |
|---|---|---|
| 10/21/2016 | Initial Version 1.0 | E. Vanden Hoek |
| 11/10/2017 | No changes necessary | E. Vanden Hoek |
| 10/29/2018 | Removed date reference from file name | E. Vanden Hoek |
| 10/14/2019 | Minor text edits | E. Vanden Hoek |
| 10/25/2020 | No changes necessary | E. Vanden Hoek |
| 10/6/2021 | No changes necessary | E. Vanden Hoek |
| 10/11/2022 | Updated personnel, minor text edits | E. Vanden Hoek |

| | **Standard Operating Procedure** **Verification and Maintenance of Ambient Temperature/** **Relative Humidity Sensors by Collocated Comparison** |
|---|---|

| **Version: 1** | *F_MET_MTCAL_ATRH_F_1.0* | **Page 3 of 10** |

# ANNUAL REVIEW

The undersigned attests that this standard operating procedure has undergone annual review for adherence to current practices and the latest QA/QC protocols:

| Signature | Title | Date |
|---|---|---|
| | QA Manager | 10/29/2018 |
| | Field Specialist | 10/14/2019 |
| | QA Manager | 10/28/2020 |
| Chad Cole | Field Specialist | 10/6/2021 |
| | Network Operations Manager/Field Specialist | 10/6/2022 |

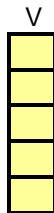| | **Standard Operating Procedure** |
| | **Verification and Maintenance of Ambient Temperature/** |
| | **Relative Humidity Sensors by Collocated Comparison** |

| Version: 1 | *F_MET_MTCAL_ATRH_F_1.0* | Page 4 of 10 |

## 1.0 PURPOSE

Instructions provided herein outline the steps for the proper verification and maintenance of non-immersible ambient temperature/relative humidity sensors operated by Air Resource Specialists, Inc. (ARS).

Results from the verifications checks constitute required quality control checks, which are used to measure the performance of the instrument against acceptance criteria established in the network or site specific Quality Assurance Project Plan (QAPP).

## 2.0 SUMMARY OF METHOD

The operation of a thermistor/capacitive resistance-type air temperature and relative humidity sensor is verified by collocation of a certified transfer standard with the on-site sensor and comparison of the results. The transfer standard must be aspirated or shielded in the same manner as the on-site sensor. The sensors should be collocated for a minimum of three (3) hours or per QAPP requirements. Ideally, comparisons can be made during periods of rapid humidity changes, such as sunrise or sunset. The results from the on-site sensor and the transfer standard are entered into the calibration form. Results shown in the form dictate any required corrective action.

## 3.0 SCOPE

Activities described in this document are performed by ARS field technicians or specialists during routinely scheduled or emergency visits to monitoring stations. ARS field staff have been appropriately trained in site operations and possess the required technical knowledge and abilities to perform the activities described below.

## 4.0 ROLES AND RESPONSIBILITIES

**Program or Project Manager**
- Establish project-specific calibration and reporting schedule and requirements as documented in the network or site specific Quality Assurance Project Plan (QAPP)
- Review calibration results, identify inconsistencies and initiate corrective action

**Fields Operations Manager**
- Coordinate site visit schedules
- Conducts field technician/specialist training and assessments

**Field Technician or Specialist**
- Coordinate scheduled visit with client as directed by project manager or field supervisor
- Verify all transfer standards to be used are in current certification with appropriate documentation
- Perform as-found verification checks
- Perform any required instrument maintenance, repair and calibration
- Perform as-left verification checks
- Document all calibration results and maintenance procedures
- Summarize visit in written trip report within 30 days

| | **Standard Operating Procedure** |
| :---: | :---: |
| Air Resource SPECIALISTS | **Verification and Maintenance of Ambient Temperature/** |
| | **Relative Humidity Sensors by Collocated Comparison** |

| | | |
| :--- | :---: | :---: |
| **Version: 1** | *F_MET_MTCAL_ATRH_F_1.0* | **Page 5 of 10** |

## 5.0    REQUIRED EQUIPMENT AND MATERIALS

- Meteorological field kit
- Calibration forms in Excel format with site and standards information completed
- Instrument manual for specific sensor(s) in use

## 6.0    PROCEDURES

### 6.1    "AS-FOUND" or "PRE-MAINTENANCE" VERIFICATION CHECKS

A complete verification check must be performed prior to any maintenance activity. No equipment maintenance or replacement should be performed prior to the verification checks. Any findings of as-found conditions shall be documented in the comments field of the calibration form.

#### Ambient Temperature

- Make notation in station logs and/or flag the ambient temperature channel in the on-site datalogger indicating maintenance only if the act of making the comparisons affects ambient measurements.
- Attach transfer standard as close as possible to on-site sensor using the provided mounting hardware and aspiration shield, as necessary.
- Ensure that the meteorological kit datalogger's time is synchronized with the on-site datalogger

    - Be aware that when reviewing the data in a Campbell datalogger the time stamp is time-ending. Data from an ESC datalogger is time-beginning. Because of this difference, the timestamps won't match the same averaging periods. (An alternative way to review the data that does not rely on matching up averaging period time stamps is to count back from the last averaging period. When using this method, *the datalogger times must still be synced prior to starting the comparison*.)

- Following/during at least three (3) full hours, or five (5) fifteen minutes, of collocated comparison, record measurements in the calibration form under "as-found" checks.

| AS FOUND | Temperature (°C) | | | | V |
|---|---|---|---|---|---|
| Hour | STD | DAS | Difference | | |
| 1100 | 22.10 | 22.00 | -0.1 | PASS | |
| 1200 | 23.40 | 23.20 | -0.2 | PASS | |
| 1300 | 23.70 | 22.90 | -0.8 | PASS | |
| | | | | | |
| | | | | | |
| | Average | | -0.4 | PASS | |

- Determine condition of aspirator fan (if site is passively aspirated, check N/A).

| Aspirator fan functional? | ☐ Yes ☐ No ☐ N/A |
|---|---|

- If any collocated hours should not be included in the calculation (due to sensor malfunction, wiring issues, etc.) enter an "X" into the yellow box under the valid or "V" column. This will exclude the comparison in the final calculations.
  - **IMPORTANT: Only use this field if the comparison is invalid. Do not use this field in an attempt to improve results.**
- Note any additional findings in the comments field of the calibration form.

| | **Standard Operating Procedure** |
|---|---|
| | **Verification and Maintenance of Ambient Temperature/** |
| | **Relative Humidity Sensors by Collocated Comparison** |

| **Version: 1** | *F_MET_MTCAL_ATRH_F_1.0* | **Page 7 of 10** |
|---|---|---|

### Relative Humidity

- Make notation in station logs and/or flag the relative humidity channel in the on-site datalogger indicating maintenance only if the act of making the comparisons affects ambient measurements.
- Attach transfer standard as close as possible to on-site sensor using the provided mounting hardware and aspiration shield, as necessary. Verify meteorlogical kit datalogger is recording data hourly intervals.
- Following/during at least three (3) full hours of collocated comparison, record measurements in the calibration form under "as-found" checks.

| AS FOUND | Relative Humidity (%) | | | | V |
|---|---|---|---|---|---|
| Hour | STD | DAS | Difference | | |
| 1100 | 55.0% | 54.5% | -0.5% | PASS | |
| 1200 | 49.4% | 50.0% | 0.6% | PASS | |
| 1300 | 51.2% | 53.0% | 1.8% | PASS | |
| | | | | | |
| | | | | | |
| | Average | | 0.6% | PASS | |

- Determine condition of aspirator fan (if site is passively aspirated, check N/A).

| **Aspirator fan functional?** | ☐ Yes  ☐ No  ☐ N/A |
|---|---|

- If any collocated hours should not be included in the calculation (due to sensor malfunction, wiring issues, etc.) enter an "X" into the yellow box under the valid or "V" column. This will exclude the comparison in the final calculations.
    - **IMPORTANT: Only use this field if the comparison is invalid. Do not use this field in an attempt to improve results**
- Note any additional findings in the comments field of the calibration form.

## 6.2    MAINTENANCE AND EQUIPMENT EXCHANGE

Inspect all wiring for abrasions, damage, or loose connections.    Inspect all connections for possible corrosion or damage and repair as necessary.

If the network or project schedule dictates a sensor exchange, replace the sensor and repeat the verification checks from Section 6.1 on the replacement sensor.

*Be sure to record the serial number(s) for each on-site sensor*

*Note if the serial number is missing or unreadable*

| AS FOUND | | AS LEFT | |
|---|---|---|---|
| Manufacturer | | Manufacturer | |
| Model | | Model | |
| Serial Number | | Serial Number | |

If the sensor was found to be operating outside of calibration acceptance criteria, replace the sensor and repeat the verification checks from Section 6.1 on the replacement sensor. On-site adjustments or calibrations are not recommended without project manager approval.

| AS FOUND | Temperature (°C) | | | | V |
|---|---|---|---|---|---|
| Hour | STD | DAS | Difference | | |
| 1100 | 22.10 | 23.00 | 0.9 | PASS | |
| 1200 | 23.40 | 24.90 | 1.5 | FAIL | |
| 1300 | 23.70 | 24.80 | 1.1 | FAIL | |
| | | | | | |
| | | | | | |
| | Average | 1.2 | FAIL | | |

| AS FOUND | Relative Humidity (%) | | | | V |
|---|---|---|---|---|---|
| Hour | STD | DAS | Difference | | |
| 1100 | 55.0% | 59.7% | 4.7% | PASS | |
| 1200 | 49.4% | 55.7% | 6.3% | FAIL | |
| 1300 | 51.2% | 56.3% | 5.1% | FAIL | |
| | | | | | |
| | | | | | |
| | Average | 5.4% | FAIL | | |

| | **Standard Operating Procedure**<br>**Verification and Maintenance of Ambient Temperature/**<br>**Relative Humidity Sensors by Collocated Comparison** |
|---|---|
| **Air Resource SPECIALISTS** | |

| **Version: 1** | *F_MET_MTCAL_ATRH_F_1.0* | **Page 9 of 10** |
|---|---|---|

**Any sensor removed from the site and returned to ARS should be returned to the instrument laboratory with a completed "Instrument Service Order Form".**

### 6.3 "AS-LEFT" or "POST-MAINTENANCE" VERIFICATION CHECKS

A complete verification check must be performed following any maintenance activity or equipment exchange. Repeat the steps outlined in Section 6.1 and record the measurements in the "As-Left" field of the calibration form

| AS LEFT | Temperature ($^{o}$C) | | | | V |
|---|---|---|---|---|---|
| Hour | STD | DAS | Difference | | |
| 1500 | 23.90 | 24.00 | 0.1 | PASS | |
| 1600 | 25.00 | 24.80 | -0.2 | PASS | |
| 1700 | 24.10 | 23.50 | -0.6 | PASS | |
| | | | | | |
| | | | | | |
| | Average | | -0.2 | PASS | |

| AS LEFT | Relative Humidity (%) | | | | V |
|---|---|---|---|---|---|
| Hour | STD | DAS | Difference | | |
| 1500 | 50.0% | 55.0% | 5.0% | PASS | |
| 1600 | 49.8% | 54.2% | 4.4% | PASS | |
| 1700 | 47.0% | 49.4% | 2.4% | PASS | |
| | | | | | |
| | | | | | |
| | Average | | 3.9% | PASS | |

- Verify all data were recorded by the meteorological kit datalogger.
- Make notation in station logs indicating that maintenance has been completed.
- Remove transfer standard from its mount and return equipment to the meteorological field kit.

| | **Standard Operating Procedure** |
| | **Verification and Maintenance of Ambient Temperature/** |
| | **Relative Humidity Sensors by Collocated Comparison** |

| **Version: 1** | *F_MET_MTCAL_ATRH_F_1.0* | **Page 10 of 10** |

## 7.0   REFERENCES

Environmental Protection Agency, 2008, Quality Assurance Handbook for Air Pollution Measurement Systems: Volume IV. Meteorological Measurements (Version 2.0), EPA-454/B-08-002 (March 2008).

Environmental Protection Agency, 2000, Meteorological Monitoring Guidance for Regulatory Modeling Applications, EPA-454/R-99-005 (February 2000).

## 8.0   DEFINITIONS AND ACRONYMS

| | |
|---|---|
| ARS | Air Resource Specialists, Inc. |
| AQDB | Air Quality Database |
| CFR | Code of Federal Regulations |
| DAS | Data Acquisition System |
| EPA | U.S. Environmental Protection Agency |
| IMC | Information Management Center |
| NIST | National Institute of Standards and Technology |
| PDF | Portable Document Format |
| QA | Quality Assurance |
| QAPP | Quality Assurance Project Plan |
| QC | Quality Control |
| SLAMS | State and Local Air Monitoring Stations |
| SOP | Standard Operating Procedure |

**Verification**: establishes the quantitative relationship between the value of a known traceable standard and the instrument's response

**Calibration**: adjustment of the instrument or analyzer so it operates within established acceptance criteria (defined in the network of project specific QAPP)

# Approvals

The purpose of this review and approval is to evaluate this Standard Operating Procedure (SOP) for adequacy prior to issuance. The signatories below are stating that the approach defined within this document is acceptable and that the affected company interests have been represented.

Author Signature:

Program:  QA Manager – Genevieve Lariviere

Approval Signature:

Program:  Field Operations Manager

# REVISION HISTORY

| Review date: | Changes made: | Changes made by: |
|---|---|---|
| 10/24/2016 | Initial Version 1.0 | E. Vanden Hoek |
| 11/14/2017 | No changes necessary | E. Vanden Hoek |
| 10/29/2018 | Removed date reference from file name | E. Vanden Hoek |
| 10/24/2019 | No changes necessary | E. Vanden Hoek |
| 10/28/2020 | No changes necessary | E. Vanden Hoek |
| 10/6/2021 | No changes necessary | E. Vanden Hoek |
| 10/6/2022 | Updated personnel | E. Vanden Hoek |

| | **Standard Operating Procedure** |
| :---: | :---: |
| | **Verification and Calibration of Tipping Precipitation Gauge** |

| **Version:  1** | *F_MET_MTCAL_RNF_F_1.0* | **Page 3 of 9** |
| :--- | :---: | :---: |

# ANNUAL REVIEW

The undersigned attests that this standard operating procedure has undergone annual review for adherence to current practices and the latest QA/QC protocols:

| Signature | Title | Date |
| :---: | :---: | :---: |
| *[signature]* | QA Manager | 10/29/2018 |
| *[signature]* | Field Specialist | 10/24/2019 |
| *[signature]* | QA Manager | 10/28/2020 |
| Chad Cole | Field Specialist | 10/6/2021 |
| *[signature]* | Network Operations Manager/Field Specialist | 10/6/2022 |

| | **Standard Operating Procedure** |
| :---: | :---: |
| | **Verification and Calibration of Tipping Precipitation Gauge** |

| **Version: 1** | *F_MET_MTCAL_RNF_F_1.0* | **Page 4 of 9** |

### 1.0    PURPOSE

Instructions provided herein outline the steps for the proper verification and calibration of precipitation gauge instruments operated by Air Resource Specialists, Inc. (ARS).

Results from the verifications checks constitute required quality control checks, which are used to measure the performance of the instrument against acceptance criteria established in the network or site specific Quality Assurance Project Plan (QAPP).

### 2.0    SUMMARY OF METHOD

A calibration bottle or funnel containing a known volume of water is used to introduce water at a controlled rate specified by the manufacturer into the tipping bucket rain gauge. The number of tips is recorded by the data logger, converted into a measurement, and compared to the designated value noted in the calibration form. Results shown in the form dictate any required corrective action or calibration.

### 3.0    SCOPE

Activities described in this document are performed by ARS field technicians or specialists during routinely scheduled or emergency visits to monitoring stations. ARS field staff have been appropriately trained in site operations and possess the required technical knowledge and abilities to perform the activities described below.

### 4.0    ROLES AND RESPONSIBILITIES

**Program or Project Manager**
- Establish project specific calibration and reporting schedule and requirements as documented in the network or site specific Quality Assurance Project Plan (QAPP)
- Review calibration results, identify inconsistencies and initiate corrective action

**Fields Operations Manager**
- Coordinate site visit schedules
- Conducts field technician/specialist training and assessments

**Field Technician or Specialist**
- Coordinate scheduled visit with client as directed by project manager or field supervisor
- Verify all transfer standards to be used are in current certification with appropriate documentation
- Perform as-found verification checks
- Perform any required instrument maintenance, repair and calibration
- Perform as-left verification checks
- Document all calibration results and maintenance procedures
- Summarize visit in written trip report within 30 days

| | **Standard Operating Procedure** |
| :---: | :---: |
| Air Resource SPECIALISTS | **Verification and Calibration of Tipping Precipitation Gauge** |

| **Version: 1** | *F_MET_MTCAL_RNF_F_1.0* | **Page 5 of 9** |
| :--- | :---: | :---: |

## 5.0 REQUIRED EQUIPMENT AND MATERIALS

- Manufacturer-provided drip bottle and plate *OR* funnel and graduated cylinder
- Distilled or bottled water
- Calibration forms in Excel format with site and standards information completed
- Instrument manual for specific sensor in use

## 6.0 PROCEDURES

### 6.1 "AS-FOUND" or "PRE-MAINTENANCE" VERIFICATION CHECKS

A complete verification check must be performed prior to any maintenance activity. No adjustments or cleaning should be performed prior to the verification checks. Any findings of as-found conditions shall be documented in the comments field of the calibration form. The calibration form calculates the target response when the volume used is entered on the Standards Table tab of the Excel form and the correct manufacturer and model are selected on the calibration form for precipitation checks.

Verification checks can be performed using a drip bottle and plate *OR* funnel and graduated cylinder

For either method, the following steps must be performed to complete a verification check of the precipitation gauge:

**Drip Bottle and Plate**

- Make notation in station logs and/or flag the precipitation channel in the datalogger indicating maintenance
- Fill bottle with known volume of water.
- Attach drip bottle and plate to bucket
- Once all water has been introduced to the instrument, record measurement from datalogger in the calibration form under "as-found" checks
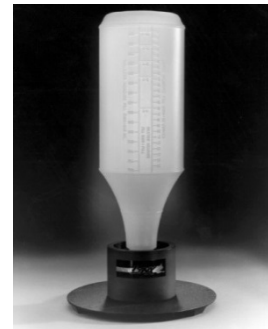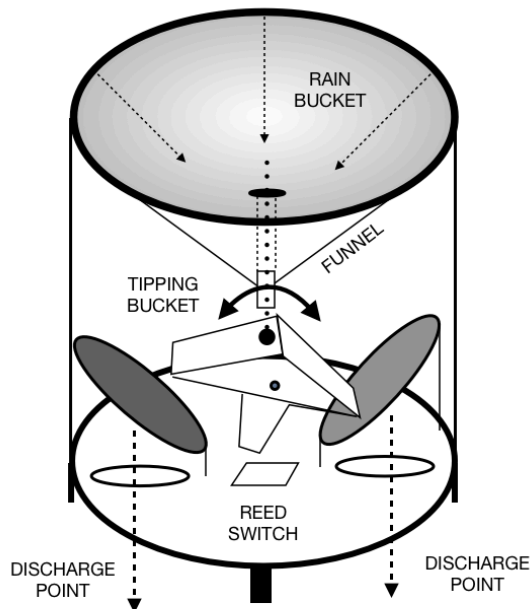
| AS FOUND | | Precipitation | |
| :---: | :---: | :---: | :---: |
| Reference (mL) | Target (mm) | DAS (mm) | Difference |
| 0 | 0.00 | | |
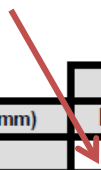
**Funnel and Graduated Cylinder**

- Make notation in station logs and/or flag the precipitation channel in the datalogger indicating maintenance
- Insert funnel into bucket



- Add known volume of water to funnel using the graduated cylinder.
- Once all water has been introduced to the instrument, record measurement from datalogger in the calibration form under "as-found" checks

| AS FOUND | | Precipitation | | |
|---|---|---|---|---|
| Reference (mL) | Target (mm) | DAS (mm) | Difference | |
| 0 | 0.00 | | | |

Following the completion of the "as-found" verification checks, the field specialist will assess the condition of the on-site instrument by performing the following tasks:

- If ambient temperatures are cold enough assess the heater functionality by touch
  - o Note in the comments if conditions are too warm to assess heater functionality

- Remove the outer housing of the precipitation gauge and:
  - o Examine the bubble levels to determine if the sensor is level
  - o Inspect the tipping mechanism for any debris or obstructions

- Record findings on calibration form

| Heater functional? | ☐ Yes ☐ No ☐ N/A |
|---|---|
| Sensor found level? | ☐ Yes ☐ No |
| Sensor found clean? | ☐ Yes ☐ No |

- Note any additional findings in the comments field of the calibration form

## 6.2    MAINTENANCE and CALIBRATION ADJUSTMENTS

Inspect all wiring for abrasions, damage or loose connections.    Inspect all connections for possible corrosion and repair as necessary.  Make sure that internal wiring does not interfere with the tipping mechanism.

If the sensor was not found clean and/or level, perform any cleaning, leveling and another verification check prior to any adjustments to the instrument.

If the results from the pre-maintenance verification check indicate "MAINTENANCE REQUIRED", a field calibration of the instrument MUST be performed

| AS FOUND | | Precipitation | | |
|---|---|---|---|---|
| Reference (mL) | Target (mm) | DAS (mm) | Difference | |
| 946 | 29.17 | 26.70 | -8.5% | MAINTENANCE REQUIRED |

**General adjustment procedures are described here. Refer to the instrument manual of the on-site gauge for specific adjustment and calibration procedures**

Using a pipette with the appropriate volume of water required for one tip (refer to calibration form or instrument manual for volume), introduce water one drop at a time until the mechanism tips.



CALIBRATING SCREW

In general, if the mechanism tips prior to the complete evacuation of the pipette, the calibration screws need to be lowered. If the mechanism does not tip after the introduction of all water in the pipette, the screws need to be raised.
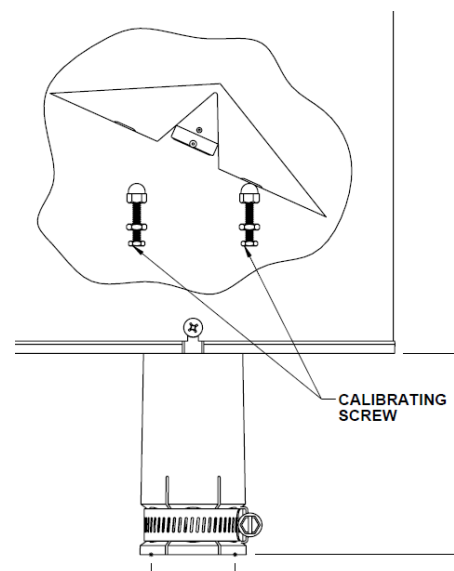
# *Refer to the instrument manual*
# *for detailed adjustment and calibration procedures*

### 6.3 "AS-LEFT" or "POST-MAINTENANCE" VERIFICATION CHECKS

A complete verification check must be performed following any maintenance activity or adjustments. Repeat the steps outlined in Section 6.1 and record the measurements in the "As-Left" field of the calibration form

| **AS LEFT** | | **Precipitation** | | |
|---|---|---|---|---|
| **Reference (mL)** | **Target (mm)** | **DAS (mm)** | **Difference** | |
| 0 | | | | |

- Make notation in station logs and/or unflag the precipitation channel in the datalogger indicating maintenance

## 7.0 REFERENCES

Environmental Protection Agency, 2008, Quality Assurance Handbook for Air Pollution Measurement Systems: Volume IV. Meteorological Measurements (Version 2.0), EPA-454/B-08-002 (March 2008).

## 8.0 DEFINITIONS AND ACRONYMS

| | |
|---|---|
| ARS | Air Resource Specialists, Inc. |
| AQDB | Air Quality Database |
| CFR | Code of Federal Regulations |
| DAS | Data Acquisition System |
| EPA | U.S. Environmental Protection Agency |
| IMC | Information Management Center |
| NIST | National Institute of Standards and Technology |
| PDF | Portable Document Format |
| QA | Quality Assurance |
| QAPP | Quality Assurance Project Plan |
| QC | Quality Control |
| SLAMS | State and Local Air Monitoring Stations |
| SOP | Standard Operating Procedure |

**Verification**: establishes the quantitative relationship between the value of a known traceable standard and the instrument's response

**Calibration**: adjustment of the instrument or analyzer so it operates within established acceptance criteria (defined in the network of project specific QAPP)

| | **Standard Operating Procedure** |
| :---: | :---: |
| | **Verification and Maintenance of** |
| | **Solar Radiation Sensors** |

| **Version:  1** | *F_MET_MTCAL_SOL_F_1.0* | **Page 1 of 7** |

# Approvals

The purpose of this review and approval is to evaluate this Standard Operating Procedure (SOP) for adequacy prior to issuance.  The signatories below are stating that the approach defined within this document is acceptable and that the affected company interests have been represented.

Author Signature:

Program:                 QA Manager - Genevieve Lariviere

Approval Signature:

Program:                 Field Operations Manager

# REVISION HISTORY

| Review date: | Changes made: | Changes made by: |
|---|---|---|
| 10/13/2016 | Initial Version 1.0 | E. Vanden Hoek |
| 11/14/2017 | No changes necessary | E. Vanden Hoek |
| 10/29/2018 | Removed date reference from file name | E. Vanden Hoek |
| 10/24/2019 | No changes necessary | E. Vanden Hoek |
| 10/28/2020 | No changes necessary | E. Vanden Hoek |
| 10/15/2021 | No changes necessary | E. Vanden Hoek |
| 10/5/2022 | Updated personnel | E. Vanden Hoek |

# ANNUAL REVIEW

The undersigned attests that this standard operating procedure has undergone annual review for adherence to current practices and the latest QA/QC protocols:

| Signature | Title | Date |
|---|---|---|
| | QA Manager | 10/29/2018 |
| | Field Specialist | 10/24/2019 |
| | QA Manager | 10/28/2020 |
| John Krolak | Field Specialist | 10/15/2021 |
| Brian Orth | Field Specialist | 8/26/2022 |

| | **Standard Operating Procedure** |
|---|---|
| | **Verification and Maintenance of** |
| | **Solar Radiation Sensors** |

| **Version: 1** | *F_MET_MTCAL_SOL_F_1.0* | **Page 4 of 7** |
|---|---|---|

### 1.0    PURPOSE

Instructions provided herein outline the steps for the proper verification and maintenance of solar radiation standards operated by Air Resource Specialists, Inc. (ARS).

Results from the verifications checks constitute required quality control checks, which are used to measure the performance of the instrument against acceptance criteria established in the network or site specific Quality Assurance Project Plan (QAPP).

### 2.0    SUMMARY OF METHOD

The operation of a solar radiation sensor is verified by collocation of a certified transfer standard with the on-site sensor and comparing the results. The results from the on-site sensor and the transfer standard are entered into the calibration form. Results shown in the form dictate any required corrective action.

### 3.0    SCOPE

Activities described in this document are performed by ARS field technicians or specialists during routinely scheduled or emergency visits to monitoring stations. ARS field staff have been appropriately trained in site operations and possess the required technical knowledge and abilities to perform the activities described below.

### 4.0    ROLES AND RESPONSIBILITIES

**Program or Project Manager**

- Establish project specific calibration and reporting schedule and requirements as documented in the network or site specific Quality Assurance Project Plan (QAPP)
- Review calibration results, identify inconsistencies and initiate corrective action

**Fields Operations Manager**
- Coordinate site visit schedules
- Conducts field technician/specialist training and assessments

**Field Technician or Specialist**
- Coordinate scheduled visit with client as directed by project manager or field supervisor
- Verify all transfer standards to be used are in current certification with appropriate documentation
- Perform as-found verification checks
- Perform any required instrument maintenance, repair and calibration
- Perform as-left verification checks
- Document all calibration results and maintenance procedures
- Summarize visit in written trip report within 30 days

| | **Standard Operating Procedure** |
| :---: | :---: |
| Air Resource SPECIALISTS | **Verification and Maintenance of** |
| | **Solar Radiation Sensors** |

| **Version: 1** | *F_MET_MTCAL_SOL_F_1.0* | **Page 5 of 7** |
| :--- | :---: | :---: |

## 5.0    REQUIRED EQUIPMENT AND MATERIALS

- Meteorological field kit
- Calibration forms in Excel format with site and standards information completed
- Instrument manual for specific sensor(s) in use

## 6.0    PROCEDURES

### 6.1    "AS-FOUND" or "PRE-MAINTENANCE" VERIFICATION CHECKS

A complete verification check must be performed prior to any maintenance activity. No equipment maintenance or replacement should be performed prior to the verification checks. Any findings of as-found conditions shall be documented in the comments field of the calibration form.

**Collocated comparison**

- Collocated the reference solar radiation sensor by either mounting the sensor on a tripod placed close to the existing site sensor or attaching the reference solar (or net) radiation sensor to the existing solar radiation support bracket. Connect the reference output to a portable datalogger and record several hours of values.
- Be sure the transfer standard is level and clean.
- Record measurements from both the collocated standard and the on-site sensor in the calibration form under "as-found" checks.

| AS FOUND | Solar Radiation | | |
| :---: | :---: | :---: | :---: |
| Hour | CTS (W/m$^2$) | DAS (W/m$^2$) | Difference |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| **MEAN ABS % DIFF** | | | |

- Inspect the site solar radiation sensor for proper level and cleanliness.  Make note of any obstructions.
- Note any additional findings in the comments field of the calibration form.

| | Standard Operating Procedure |
|---|---|
| Air Resource SPECIALISTS | **Verification and Maintenance of** |
| | **Solar Radiation Sensors** |

| **Version: 1** | *F_MET_MTCAL_SOL_F_1.0* | **Page 6 of 7** |
|---|---|---|

## 6.2    MAINTENANCE and EQUIPMENT EXCHANGE

Inspect all wiring for abrasions, damage or loose connections.    Inspect   all   connections   for possible corrosion and repair as necessary. Remove any dust or debris from the sensor and check the level of the sensor using the bubble level on the mounting bracket.

If  the  sensor  was  found to be operating outside of calibration acceptance criteria, document findings in the ARS Site Status Log (www.arssitestatuslog.com). If a spare sensor is available, install the spare sensor; on-site adjustments or calibrations are not recommended without project manager approval.

*Be sure to record the serial number(s) for each on-site sensor*

| AS FOUND | | |
|---|---|---|
| Manufacturer | | |
| Model | | |
| Serial Number | | |
| Translator | | |
| Logger Type | High Input (V) | |
| ESC | Low Input (V) | |
| | High Output | |
| | Low Output | |

| AS LEFT | | |
|---|---|---|
| Manufacturer | | |
| Model | | |
| Serial Number | | |
| Translator | | |
| Logger Type | High Input (V) | |
| ESC | Low Input (V) | |
| | High Output | |
| | Low Output | |

## 6.3    "AS-LEFT" or "POST-MAINTENANCE" VERIFICATION CHECKS

A  complete  verification  check  must  be  performed  following  any  maintenance  activity  or equipment exchange. Repeat the steps outlined in Section 6.1 and record the measurements in the "As-Left" field of the calibration form

| AS LEFT | Solar Radiation | | |
|---|---|---|---|
| Hour | CTS (W/m$^2$) | DAS (W/m$^2$) | Difference |
| 12:00 | 864 | 844 | -2.3% |
| 13:00 | 942 | 922 | -2.1% |
| 14:00 | 960 | 941 | -2.0% |
| 15:00 | 394 | 381 | -3.3% |
| 16:00 | 13.2 | 14 | 6.1% |
| **MEAN ABS % DIFF** | | **3.2%** | **PASS** |

- Return equipment to the meteorological field kit

## 7.0  REFERENCES

Environmental Protection Agency, 2008, Quality Assurance Handbook for Air Pollution Measurement Systems: Volume IV. Meteorological Measurements (Version 2.0), EPA-454/B-08-002 (March 2008).

Environmental Protection Agency, 2000, Meteorological Monitoring Guidance for Regulatory Modeling Applications, EPA-454/R-99-005 (February 2000).

## 8.0  DEFINITIONS AND ACRONYMS

| | |
|---|---|
| ARS | Air Resource Specialists, Inc. |
| EPA | U.S. Environmental Protection Agency |
| NIST | National Institute of Standards and Technology |
| QA | Quality Assurance |
| QAPP | Quality Assurance Project Plan |
| QC | Quality Control |
| SOP | Standard Operating Procedure |

**Verification**: establishes the quantitative relationship between the value of a known traceable standard and the instrument's response

**Calibration**: adjustment of the instrument or analyzer so that it operates within established acceptance criteria (defined in the network of project specific QAPP)

# Approvals

The purpose of this review and approval is to evaluate this Standard Operating Procedure (SOP) for adequacy prior to issuance. The signatories below are stating that the approach defined within this document is acceptable and that the affected company interests have been represented.


Author Signature:

Program:     QA Manager - Genevieve Lariviere


Approval Signature:

Program:     Field Operations Manager

| | Standard Operating Procedure |
| :---: | :---: |
| Air Resource SPECIALISTS | Verification and Maintenance of Wind Direction Sensors |

| **Version: 1** | *F_MET_MTCAL_WD_F_1.0* | **Page 2 of 9** |

# REVISION HISTORY

| Review date: | Changes made: | Changes made by: |
| :--- | :--- | :--- |
| 10/21/2016 | Initial Version 1.0 | E. Vanden Hoek |
| 11/17/2017 | No changes necessary | E. Vanden Hoek |
| 10/29/2019 | Removed date reference from file name | E. Vanden Hoek |
| 2/24/2020 | Minor text edits | E. Vanden Hoek |
| 10/6/2021 | No changes necessary | E. Vanden Hoek |
| 10/5/2022 | Updated personnel, minor text edits (sec 6.2) | E. Vanden Hoek |
| | | |

# ANNUAL REVIEW

The undersigned attests that this standard operating procedure has undergone annual review for adherence to current practices and the latest QA/QC protocols:

| Signature | Title | Date |
|---|---|---|
| | QA Manager | 10/29/2019 |
| Max Abrahamson | Field Specialist | 2/7/2020 |
| | Field Specialist | 10/6/2021 |
| Chad Cole | Field Specialist | 9/15/2022 |

| | **Standard Operating Procedure** |
| :---: | :---: |
| Air Resource SPECIALISTS | **Verification and Maintenance of** |
| | **Wind Direction Sensors** |

| Version: 1 | *F_MET_MTCAL_WD_F_1.0* | Page 4 of 9 |
| :--- | :---: | :---: |

### 1.0    PURPOSE

Instructions provided herein outline the steps for the proper verification and maintenance of wind direction sensors operated by Air Resource Specialists, Inc. (ARS).

Results from the verifications checks constitute required quality control checks, which are used to measure the performance of the instrument against acceptance criteria established in the network or site specific Quality Assurance Project Plan (QAPP).

### 2.0    SUMMARY OF METHOD

Wind direction (vane) measurements are verified using a compass or transit comparisons to known landmarks or manufacturer-provided alignment rods. The results from the on-site sensor and the transfer standard(s) are entered into the calibration form. Results shown in the form dictate any required corrective action.

### 3.0    SCOPE

Activities described in this document are performed by ARS field technicians or specialists during routinely scheduled or emergency visits to monitoring stations. ARS field staff have been appropriately trained in site operations and possess the required technical knowledge and abilities to perform the activities described below.

### 4.0    ROLES AND RESPONSIBILITIES

**Program or Project Manager**

- Establish project specific calibration and reporting schedule and requirements as documented in the network or site specific Quality Assurance Project Plan (QAPP)
- Review calibration results, identify inconsistencies and initiate corrective action

**Fields Operations Manager**
- Coordinate site visit schedules
- Conducts field technician/specialist training and assessments

**Field Technician or Specialist**
- Coordinate scheduled visit with client as directed by project manager or field supervisor
- Verify all transfer standards to be used are in current certification with appropriate documentation
- Perform as-found verification checks
- Perform any required instrument maintenance, repair and calibration
- Perform as-left verification checks
- Document all calibration results and maintenance procedures
- Summarize visit in written trip report within 30 days

| | Standard Operating Procedure |
| --- | --- |
| Air Resource SPECIALISTS | **Verification and Maintenance of** |
| | **Wind Direction Sensors** |

| Version: 1 | *F_MET_MTCAL_WD_F_1.0* | Page 5 of 9 |
| --- | --- | --- |

## 5.0    REQUIRED EQUIPMENT AND MATERIALS

- Meteorological field kit
- Transit or **non-ferrous** tripod-mounted compass, accurate to at least 1 degree
- Site location in latitude and longitude
- Program to calculate the sun's azimuth direction
- Linearity jig
- Torque disc
- Torque meter
- Calibration forms in Excel format with site and standards information completed
- Instrument manual for specific sensor(s) in use

## 6.0    PROCEDURES

### 6.1    "AS-FOUND" or "PRE-MAINTENANCE" VERIFICATION CHECKS

A complete verification check must be performed prior to any maintenance activity. No equipment maintenance or replacement should be performed prior to the verification checks. Any findings of as-found conditions shall be documented in the comments field of the calibration form.

**Sensor Alignment**

- Make notation in station logs and/or flag the wind direction channel in the on-site datalogger indicating maintenance
- Determine the magnetic declination of magnetic north from true north using one of the following methods (methods marked with * are preferred):
  - ARS Solar Azimuth Calculator*
  - Approved Solar Azimuth applications on your smart phone*
  - National Geomagnetism Program from the USGS web site (http://geomag.usgs.gov/models)
  - National Geographic Data Center web site (http://www.ngdc.noaa.gov/seg/geomag/magfield.shtml)
  - U.S. Navy Observatory web site (http://aa.Usno.navy.mil/data/docs/AltAz.html)
- Set up tripod and affix compass or transit at the same

| SENSOR ALIGNMENT | | | |
| --- | --- | --- | --- |
| N-S Reference | Degrees | DAS | Difference |
| From the North | 0 | 2.1 | 2.1 |
| From the South | 180 | 183.2 | 3.2 |
| From the East | 90 | 93.8 | 3.8 |
| From the West | 270 | 274.4 | 4.4 |
| Total Alignment MAX ABS Diff | | | 3.4    PASS |

**OR**

| SENSOR ALIGNMENT | | | |
| --- | --- | --- | --- |
| Landmark | Degrees | DAS | Difference |
| From the North | 0 | | |
| From the South | 180 | | |
| From the East | 90 | | |
| From the West | 270 | | |
| Total Alignment MAX ABS Diff | | | |

**OR**

| SENSOR ALIGNMENT | | | |
| --- | --- | --- | --- |
| X Reference | Degrees | DAS | Difference |
| | 1 | | |
| | 181 | | |
| | 91 | | |
| | 271 | | |
| Total Alignment MAX ABS Diff | | | |

| | Standard Operating Procedure |
| --- | --- |
| Air Resource SPECIALISTS | Verification and Maintenance of Wind Direction Sensors |

| Version: 1 | *F_MET_MTCAL_WD_F_1.0* | Page 6 of 9 |
| --- | --- | --- |

location where alignment checks were performed (care should be taken to ensure the location is free of nearby interferences such as buried wires or pipes, buildings, cell phones, belt buckles, or other ferrous materials)
- Position compass or transit to align the cross-hairs through the cross-arm or alignment rod of the wind direction sensor
- Enter alignment results in the calibration form

| Reference Alignment (degrees) | 0.0 | PASS |
| --- | --- | --- |

- Determine if the orientation of the alignment rod. If the alignment rod is intended to be North-South, use the "N-S reference" section of the form. For any other reference, use the "X reference" section of the form. For use of landmarks (usually associated with towers that require climbing), use the "Landmark" section of the form
- Be aware that a "dead zone" exists within the potentiometer. Most often found between 0° and 360°

**NOTE: Only one of these methods is required to be completed on the form**

### Sensor Linearity

- Use the appropriate linearity test assembly for the sensor under test
  - RM Young sensors generally use either RM Young Model 18112 or 18212.
  - Climatronics sensors use a 8-position Wilson Machining disc
- Cycle the test assembly through nine 45° increments.
- Enter results in calibration form

| SENSOR LINEARITY | | | |
| --- | --- | --- | --- |
| Point | DAS | Difference | |
| 1 | 353.2 | N/A | |
| 2 | 307.9 | 0 | PASS |
| 3 | 262.9 | 0 | PASS |
| 4 | 216.5 | -1 | PASS |
| 5 | 171.3 | 0 | PASS |
| 6 | 125.9 | 0 | PASS |
| 7 | 79.3 | -2 | PASS |
| 8 | 31.7 | -3 | PASS |
| 1 | 349.3 | 3 | PASS |
| MAX Difference | | 3 | |
| | | NO ACTION REQUIRED | |

### Starting Threshold Check

- Remove the sensor from the cross-arm
- Remove the vane, if necessary, and install the torque disc on the sensor shaft
- Hold the sensor in a:
  - Position such that the sensor shaft is parallel to the ground using an adaptor if necessary
  - Position such that the sensor vane body is parallel to the ground (RM Young)
- Note the weight size and distance from center when the shaft first turns (torque)

| | **Standard Operating Procedure** |
|---|---|
| | **Verification and Maintenance of** |
| | **Wind Direction Sensors** |

| **Version: 1** | *F_MET_MTCAL_WD_F_1.0* | **Page 7 of 9** |
|---|---|---|

- Enter value in calibration form. Sensors over the threshold limit require action. Sensors near the limit require consideration.

| Starting Threshold | TORQUE |
|---|---|
| Torque <=     9.0 g-cm | 8.0 |
| | NO ACTION REQUIRED |

- Note any additional findings in the comments field of the calibration form

## 6.2    MAINTENANCE and EQUIPMENT EXCHANGE

Inspect all wiring for abrasions, damage or loose connections. Inspect all connections for possible corrosion or damage and repair as necessary. If the sensor has a heater, verify correction operation of the heater if conditions allow. *If the site uses an ESC datalogger, the wind direction scaling may need to be updated.*

If the network or project schedule dictates a sensor exchange, replace the sensor and repeat the verification checks from Section 6.1 on the replacement sensor.  Potentionmeter or bearing replacements in the field should generally NOT be performed in the field.  Such maintenance requires project manager approval.

*Be sure to record the serial number(s) for each on-site sensor*

| AS FOUND | | AS LEFT | |
|---|---|---|---|
| **Manufacturer & Model** | | **Manufacturer & Model** | |
| **Sensor Serial #** | | **Sensor Serial #** | |
| **Vane Serial #** | | **Vane Serial #** | |

## 6.3    "AS-LEFT" or "POST-MAINTENANCE" VERIFICATION CHECKS

A complete verification check must be performed following any maintenance activity or equipment exchange. Repeat the steps outlined in Section 6.1 and record the measurements in the "As-Left" field of the calibration form

- Verify all data were recorded on calibration forms
- Remount the site sensor and vane, ensuring sufficient strain relief for signal wiring
- Make notation in station logs and/or unflag the wind speed and direction channels in the on-site datalogger indicating maintenance has been completed
- Return equipment to the meteorological field kit

### 6.4 SENSORS REMOVED FROM THE FIELD

All sensors removed from the field should be turned in to the ARS laboratory for routine maintenance and any necessary repairs. All sensors are required to have an Instrument Service Order Form completed and accompany the sensor to the ARS laboratory. See the project manager for additional information.

| | **Standard Operating Procedure** |
| --- | --- |
| | **Verification and Maintenance of** |
| | **Wind Direction Sensors** |

| Version: 1 | *F_MET_MTCAL_WD_F_1.0* | Page 9 of 9 |
| --- | --- | --- |

## 7.0    REFERENCES

Environmental Protection Agency, 2008, Quality Assurance Handbook for Air Pollution Measurement Systems: Volume IV. Meteorological Measurements (Version 2.0), EPA-454/B-08-002 (March 2008).

Environmental Protection Agency, 2000, Meteorological Monitoring Guidance for Regulatory Modeling Applications, EPA-454/R-99-005 (February 2000).

## 8.0    DEFINITIONS AND ACRONYMS

| | |
| --- | --- |
| ARS | Air Resource Specialists, Inc. |
| AQDB | Air Quality Database |
| CFR | Code of Federal Regulations |
| DAS | Data Acquisition System |
| EPA | U.S. Environmental Protection Agency |
| IMC | Information Management Center |
| NIST | National Institute of Standards and Technology |
| PDF | Portable Document Format |
| QA | Quality Assurance |
| QAPP | Quality Assurance Project Plan |
| QC | Quality Control |
| SLAMS | State and Local Air Monitoring Stations |
| SOP | Standard Operating Procedure |

**Verification**: establishes the quantitative relationship between the value of a known traceable standard and the instrument's response

**Calibration**: adjustment of the instrument or analyzer so it operates within established acceptance criteria (defined in the network of project specific QAPP)

# Approvals

The purpose of this review and approval is to evaluate this Standard Operating Procedure (SOP) for adequacy prior to issuance. The signatories below are stating that the approach defined within this document is acceptable and that the affected company interests have been represented.

Author Signature:

Program:                 QA Manager - Genevieve Lariviere

Approval Signature:

Program:                 Field Operations Manager

# REVISION HISTORY

| Review date: | Changes made: | Changes made by: |
|---|---|---|
| 10/21/2016 | Initial Version 1.0 | E. Vanden Hoek |
| 11/16/2017 | No changes necessary | E. Vanden Hoek |
| 10/29/2019 | Removed date reference from file name | E. Vanden Hoek |
| 2/24/2020 | Minor text edits | E. Vanden Hoek |
| 10/6/2021 | No changes necessary | E. Vanden Hoek |
| 10/5/2022 | Updated personnel | E. Vanden Hoek |
| | | |

# ANNUAL REVIEW

The undersigned attests that this standard operating procedure has undergone annual review for adherence to current practices and the latest QA/QC protocols:

| Signature | Title | Date |
|---|---|---|
| | QA Manager | 10/29/2019 |
| Max Abrahamson | Field Specialist | 2/7/2020 |
| | Field Specialist | 10/6/2021 |
| Chad Cole | Field Specialist | 9/15/2022 |

| | **Standard Operating Procedure** |
| :---: | :---: |
| Air Resource SPECIALISTS | **Verification and Maintenance of** |
| | **Wind Speed Sensors** |

| | | |
| :--- | :--- | ---: |
| **Version: 1** | *F_MET_MTCAL_WS_F_1.0* | **Page 4 of 7** |

## 1.0    PURPOSE

Instructions provided herein outline the steps for the proper verification and maintenance of wind speed sensors operated by Air Resource Specialists, Inc. (ARS).

Results from the verifications checks constitute required quality control checks, which are used to measure the performance of the instrument against acceptance criteria established in the network or site specific Quality Assurance Project Plan (QAPP).

## 2.0    SUMMARY OF METHOD

The operation of a propeller or cup anemometer wind speed sensor is verified by turning the on-site anemometer with a motor drive at known speeds and observing the output. The results from the on-site sensor and the transfer standard(s) are entered into the calibration form. Results shown in the form dictate any required corrective action.

## 3.0    SCOPE

Activities described in this document are performed by ARS field technicians or specialists during routinely scheduled or emergency visits to monitoring stations. ARS field staff have been appropriately trained in site operations and possess the required technical knowledge and abilities to perform the activities described below.

## 4.0    ROLES AND RESPONSIBILITIES

**Program or Project Manager**

- Establish project specific calibration and reporting schedule and requirements as documented in the network or site specific Quality Assurance Project Plan (QAPP)
- Review calibration results, identify inconsistencies and initiate corrective action

**Fields Operations Manager**
- Coordinate site visit schedules
- Conducts field technician/specialist training and assessments

**Field Technician or Specialist**
- Coordinate scheduled visit with client as directed by project manager or field supervisor
- Verify all transfer standards to be used are in current certification with appropriate documentation
- Perform as-found verification checks
- Perform any required instrument maintenance, repair and calibration
- Perform as-left verification checks following repair and/or replacement of sensor
- Document all calibration results and maintenance procedures
- Summarize visit in written trip report within 30 days

### 5.0    REQUIRED EQUIPMENT AND MATERIALS

- Meteorological field kit
- Anemometer drive
- Site location in latitude and longitude
- Torque disc
- Calibration forms in Excel format with site and standards information completed
- Instrument manual for specific sensor(s) in use

### 6.0    PROCEDURES

#### 6.1    "AS-FOUND" or "PRE-MAINTENANCE" VERIFICATION CHECKS

A complete verification check must be performed prior to any maintenance activity. No equipment maintenance or replacement should be performed prior to the verification checks. Any findings of as-found conditions shall be documented in the comments field of the calibration form.

- Make notation in station logs and/or flag the wind speed channel in the on-site datalogger indicating maintenance
- Select manufacturer and model of sensor and measured units on calibration form – this populates motor speed targets in form
- Remove the propeller or cups from the on-site sensor and attach the variable speed calibration motor to the sensor shaft input
- Set the certified anemometer drive for the slowest motor speed on the calibration form and allow to stabilize
- Record results in wind speed calibration form under "as-found"
- Repeat procedure for other motor speeds listed on form
- Note any additional findings in the comments field of the calibration form



| AS FOUND | | Wind Speed | | | |
|---|---|---|---|---|---|
| Motor Speed (rpm) | Target Speed | DAS | Difference | | |
| 0 | 0.000 | 0.230 | N/A | N/A | N/A |
| 300 | 7.274 | 7.311 | | 0.5% | PASS |
| 600 | 14.325 | 14.390 | | 0.5% | PASS |
| 900 | 21.375 | 21.500 | | 0.6% | PASS |
| 1200 | 28.426 | 28.580 | | 0.5% | PASS |
| 1800 | 42.527 | 42.730 | | 0.5% | PASS |
| | | | | PASS | |

**Starting Threshold Check**

- Remove the sensor from the cross-arm
- Install the torque disc on the sensor shaft (using an adaptor if necessary)
- Hold the sensor such that the shaft if parallel with the ground
- Note the weight size and distance from center when the shaft first turns (torque)
- Enter value in form
- Note any additional findings in the comments field of the calibration form

| Starting Threshold | TORQUE |
|---|---|
| Torque <= 2.9 g-cm | 2.0 |
| | NO ACTION REQUIRED |

## 6.2    MAINTENANCE and EQUIPMENT EXCHANGE

Inspect all wiring for abrasions, damage or loose connections. Inspect all connections for possible corrosion or damage and repair as necessary.  If the sensor has a heater, verify correction operation of the heater if conditions allow.

If the network or project schedule dictates a sensor exchange, replace the sensor and repeat the verification checks from Section 6.1 on the replacement sensor.  If the network or project schedule dictates field sensor maintenance (i.e. bearing replacement), perform the maintenance and repeat the verification checks from Section 6.1.

*Be sure to record the serial number(s) for each on-site sensor*

| AS FOUND | | AS LEFT | |
|---|---|---|---|
| Manufacturer and Model | | Manufacturer and Model | |
| Sensor Serial # | | Sensor Serial # | |
| Cups Serial # | | Cups Serial # | |

## 6.3    "AS-LEFT" or "POST-MAINTENANCE" VERIFICATION CHECKS

A complete verification check must be performed following any maintenance activity or equipment exchange. Repeat the steps outlined in Section 6.1 and record the measurements in the "As-Left" field of the calibration form.

- Verify all data were recorded on calibration forms
- Remount the site sensor and propeller or vane, ensuring sufficient strain relief for signal wiring
- Make notation in station logs and/or unflag the wind speed channels in the on-site datalogger indicating maintenance has been completed.
- Return equipment to the meteorological field kit

### 6.4 SENSORS REMOVED FROM THE FIELD

All sensors removed from the field should be turned in to the ARS laboratory for routine maintenance and any necessary repairs. All sensors are required to have an Instrument Service Order Form completed and accompany the sensor to the ARS laboratory. See the project manager for additional information.

## 7.0 REFERENCES

Environmental Protection Agency, 2008, Quality Assurance Handbook for Air Pollution Measurement Systems: Volume IV. Meteorological Measurements (Version 2.0), EPA-454/B-08-002 (March 2008).

Environmental Protection Agency, 2000, Meteorological Monitoring Guidance for Regulatory Modeling Applications, EPA-454/R-99-005 (February 2000).

## 8.0 DEFINITIONS AND ACRONYMS

| | |
|---|---|
| ARS | Air Resource Specialists, Inc. |
| AQDB | Air Quality Database |
| CFR | Code of Federal Regulations |
| DAS | Data Acquisition System |
| EPA | U.S. Environmental Protection Agency |
| IMC | Information Management Center |
| NIST | National Institute of Standards and Technology |
| PDF | Portable Document Format |
| QA | Quality Assurance |
| QAPP | Quality Assurance Project Plan |
| QC | Quality Control |
| SLAMS | State and Local Air Monitoring Stations |
| SOP | Standard Operating Procedure |

**Verification**: establishes the quantitative relationship between the value of a known traceable standard and the instrument's response

**Calibration**: adjustment of the instrument or analyzer so it operates within established acceptance criteria (defined in the network of project specific QAPP)

# Approvals

The purpose of this review and approval is to evaluate this Standard Operating Procedure (SOP) for adequacy prior to issuance.  The signatories below are stating that the approach defined within this document is acceptable and that the affected company interests have been represented.

Author Signature:

_____

Program:        QA Manager – Genevieve Lariviere

Approval Signature:

_____

Program:        Field Operations Manager – Mark Tigges

# REVISION HISTORY

| Review date: | Changes made: | Changes made by: |
| :--- | :--- | :--- |
| 10/17/2016 | Initial Version 1.0 | E. Vanden Hoek |
| 12/15/2017 | No changes necessary | E. Vanden Hoek |
| 10/29/2018 | Removed date reference from file name | E. Vanden Hoek |
| 10/23/2019 | Minor text edits | E. Vanden Hoek |
| 10/28/2020 | No changes necessary | E. Vanden Hoek |
| 10/5/2022 | Updated personnel | E. Vanden Hoek |
| | | |

# ANNUAL REVIEW

The undersigned attests that this standard operating procedure has undergone annual review for adherence to current practices and the latest QA/QC protocols:

| Signature | Title | Date |
|---|---|---|
| | QA Manager | 10/29/2018 |
| | QA Officer | 10/12/2019 |
| | QA Manager | 10/28/2020 |
| Jon Wenrick | Field Specialist | 9/9/2022 |

### 1.0    PURPOSE

This standard operating procedure (SOP) serves as a guide for transferring the certificate of authority from a verified ozone UV photometer (primary standard) or certified ozone transfer standard to a candidate ozone transfer standard. This SOP also serves as a guide to re-certify a previously certified ozone transfer standard. This procedure is for photometer-based ozone analyzers only, not stand-alone ozone generating sources.

Results from the verifications checks constitute required quality control checks, which are used to measure the performance of the instrument against acceptance criteria established in the network or site specific Quality Assurance Project Plan (QAPP).

### 2.0    SUMMARY OF METHOD

Because ozone ($O_3$) cannot be reliably stored, $O_3$ concentrations for analyzer calibration purposes must be generated and carefully assayed on-site. Transfer standards are used to assay generated $O_3$ concentrations used for calibrations. Certification of candidate ozone transfer standards requires a six-point calibration check performed on six different days (six-by-six calibration). The days need not be consecutive.  Success of the certification process is determined by statistical analysis of the calibration check results. Ozone transfer standard certifications are valid for 180 days and require re-certification semi-annually.

Re-certification involves one six-point calibration check. Data from the most recent six-point calibration checks are subjected to analysis to determine the success of the re-certification. A moving (rolling) average of results is calculated and maintained each quarter. Should an ozone transfer standard fail re-certification, or should its certification lapse, the entire certification process must be repeated, starting with a new six-by-six calibration check procedure

### 3.0    SCOPE

Activities described in this document are performed by ARS laboratory technicians or specialists. ARS field staff have been appropriately trained in site operations and possess the required technical knowledge and abilities to perform the activities described below.

### 4.0    ROLES AND RESPONSIBILITIES

**Quality Assurance Manager and Officer**

- Oversee and ensure certification is performed according to the required schedule.
- Review certification results.
- Review and approve any changes to certification procedures.
- Identify inconsistencies in certification results and initiate corrective action.

**Laboratory Specialist**
- Perform required certifications as described in this SOP and manufacturer's instrument manual.
- Document all certification results and procedures performed.

### 5.0 REQUIRED EQUIPMENT AND MATERIALS

- A UV photometer (primary standard) under current verification, or an ozone transfer standard under current certification
- Candidate ozone transfer standard
- Ozone Transfer Standard Certification Worksheet
- Instrument manual for specific equipment in use

### 6.0 PROCEDURES

#### 6.1 PREPARATION FOR OZONE TRANSFER STANDARD CERTIFICATION

Transfer standard certifications are critical, lengthy (six day) operations that require careful attention to detail and record keeping. Certification should be performed in a properly equipped laboratory where external variables can be kept to a minimum. Personnel performing the certifications need to be experienced technicians familiar with the operation of UV photometric-based ozone analyzers.

Preparation for transfer standard certification involves the following procedures:

| | |
|---|---|
| CONFIGURE STANDARDS | Configure the primary (or certified transfer) standard and candidate transfer standard(s) for operation. |
| CONFIGURE TEFLON TUBING | Configure clean Teflon tubing so the candidate transfer standard is assaying ozone concentrations generated from the primary (or certified transfer) standard. Be certain flows generated by the primary (or certified transfer) standard satisfy the demands of the photometers. |
| WARM UP INSTRUMENTS | Warm up the instruments for an adequate amount of time. |
| VERIFY DOCUMENTATION | Confirm that calibration documentation is current, complete, and available. |

#### 6.2 CERTIFICATION (SIX-BY-SIX) OF AN OZONE TRANSFER STANDARD

The following procedures detail the necessary steps to complete the six-by-six certification process. Re-certification procedures are identical to certification, but just one calibration check is required rather than six. The procedures assume that an ozone primary standard (UV photometer) is being used to transfer authority to a candidate transfer standard. The procedures are identical if a certified transfer standard is used in place of the ozone primary standard.

### 6.2.1 Introduce Known Ozone Concentrations and Record Instrument Responses

RECORD PARAMETERS

Check all instrument-specific operational parameters for operation and record parameter values on the Ozone Transfer Standard Certification Worksheet.

INTRODUCE ZERO AIR

Direct a flow of zero air into the candidate transfer standard(s) and allow the value to stabilize (as indicated by the DAS). Record the response on the calibration form. This point represents the zero response, the first of the six levels of known ozone concentration.

GENERATE OZONE

Consecutively generate the following concentrations of ozone from the primary standard and direct the flow into the candidate transfer standard. Allow sufficient time for each point to stabilize (as indicated by the DAS). Concentrations to be generated include:

| 0 | CERTIFYING STANDARD | 0.5 |
| | STANDARD TO BE CERTIFIED | -0.4 |

| 225 | CERTIFYING STANDARD | 225.0 |
| | STANDARD TO BE CERTIFIED | 215.0 |

| 180 | CERTIFYING STANDARD | 180.2 |
| | STANDARD TO BE CERTIFIED | 171.1 |

| 125 | CERTIFYING STANDARD | 125.0 |
| | STANDARD TO BE CERTIFIED | 119.8 |

| 90 | CERTIFYING STANDARD | 89.6 |
| | STANDARD TO BE CERTIFIED | 85.7 |

| 50 | CERTIFYING STANDARD | 50.9 |
| | STANDARD TO BE CERTIFIED | 48.5 |

RECORD VALUES

As each point stabilizes, note and average five consecutive updates of both the primary standard and candidate transfer standard(s). Record the primary standard value on the calibration form as the primary ozone concentration and the candidate transfer standard as the transfer response.

REPEAT

Repeat the above procedures once a day for a total of six days.

## 6.3 RE-CERTIFICATION OF AN OZONE TRANSFER STANDARD

Re-certification of an ozone transfer standard requires only a single (one day) six-point check semi-annually. All other re-certification procedures are identical to the certification procedures presented in Section 6.2.

Re-certification documentation procedures require using the most recent six calibration checks to determine certification success. Complete the Ozone Transfer Standard Certification Worksheet with the most recent calibration check first, followed by the five most recent calibration checks.

If the transfer standard does not pass the re-certification tests, the standard should be evaluated and serviced. At any time that a transfer standard fails the re-certification process, a new, complete six-by-six certification procedure must be initiated.

## 7.0 REFERENCES

Environmental Protection Agency, 2013, Quality Assurance Handbook for Air Pollution Measurement Systems, Volume II, Ambient Air Quality Monitoring Program, EPA-454/B-13-003 (May 2013).

Environmental Protection Agency (EPA), October 2013, Transfer Standards for the Calibration of Ambient Air Monitoring Analyzers for Ozone, Technical Assistance Document. (EPA-454/B-13-004).

## 8.0 DEFINITIONS AND ACRONYMS

| | |
|---|---|
| ARS | Air Resource Specialists, Inc. |
| AQDB | Air Quality Database |
| CFR | Code of Federal Regulations |
| DAS | Data Acquisition System |
| EPA | U.S. Environmental Protection Agency |
| IMC | Information Management Center |
| NIST | National Institute of Standards and Technology |
| PDF | Portable Document Format |
| QA | Quality Assurance |
| QAPP | Quality Assurance Project Plan |
| QC | Quality Control |
| SLAMS | State and Local Air Monitoring Stations |
| SOP | Standard Operating Procedure |

**Verification**: establishes the quantitative relationship between the value of a known traceable standard and the instrument's response

**Calibration**: adjustment of the instrument or analyzer so it operates within established acceptance criteria (defined in the network of project specific QAPP)

**Certification**: The procedure and methodology of transferring the authority of measurement from one device to another. In ozone monitoring, this procedure is commonly known as a "six-by-six" calibration referring to subjecting a candidate transfer standard to a six-point calibration check on six different days.

**Ozone Transfer Standard**: A device capable of accurately assaying concentrations of ozone. Ozone transfer standards are typically ozone analyzers that have been dedicated in their usage as transfer standards.

**Re-Certification**: A single six point verification check of a previously-certified ozone transfer standard.