Revision
Revision 1 (DRAFT 1D– Issue for Review)

Date
December 1, 2019

QUALITY ASSURANCE PROJECT PLAN

TORRANCE REFINERY RULE 1180 FENCELINE AIR MONITORING SYSTEM

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Revision History

A. PROJECT MANAGEMENT

A.1 Title and Approval Sheet

Document Title:	Quality Assurance Project Plan for Torrance Refinery Rule 1180 Fenceline Air Monitoring System
Revision/Date:	**Revision 1 (DRAFT 1D– Issue for Review)/December 1, 2019**
System Owner:	Name (print):____________________ Environmental Manager Torrance Refining Company *3700 W. 190th Street, Torrance, California 90504* __________________ / __________ Signature/Date
Program Quality Assurance Manager:	Name (print):____________________ Spectrum Environmental Solutions *2340 W Braker Lane Austin, Texas 78731* __________________ / __________ Signature/Date
System Manager/Operator:	Name (print):____________________ Spectrum Environmental Solutions *2340 Braker Lane, Suite A, Austin, TX 78758* __________________ / __________ Signature/Date
Rule 1180 Quality Assurance Manager:	Name (print):____________________ Rule 1180 Quality Assurance Manager South Coast Air Quality Management District *21865 Copley Drive, Diamond Bar, CA 91765* __________________ / __________ Signature/Date
	This approval sheet may be signed in counterparts for full approval.

Signatures of the approving officials above indicate both their approval of this Quality Assurance Project Plan and the commitment of their respective organizations to follow the procedures herein.

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A.2 Table of Contents

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REVISION HISTORY

Revision	Date	Prepared by	Approved by	Comment
0	July 27, 2018	Glenn England	Scott Weaver	Issue for review - South Coast AQMD
1	September 10, 2019	Glenn England	Valerie Tse	Issue for review – DRAFT for South Coast AQMD review
1 (D)	December 1, 2019	Glenn England	Valerie Tse	Issue for review – revised DRAFT for South Coast AQMD review and public comment

ACRONYMS AND ABBREVIATIONS

Acronym	Definition
%	percent
°	degrees
°C	degrees centigrade
$\mu g/m^3$	micrograms per cubic meter
cm	centimeter
cm^{-1}	inverse centimeters (wavelength)
CV	coefficient of variation
DC	direct current
DQI	data quality indicator
DQO	data quality objective
EPA	U.S. Environmental Protection Agency
FAQ	frequently-asked-questions
FTIR	Fourier transform infrared
GB	gigabytes
GHz	gigahertz
hPa	hectopascals
Hz	Hertz
K	Kelvins
km	kilometer
LAN	local area network
LED	light-emitting diode
m/s	meters per second
mm/hr	millimeters per hour
MQO	measurement quality objective
ng/m^3	nanograms per cubic meter
nm	nanometer
NO	nitric oxide
NO_2	nitrogen dioxide
NO_X	nitrogen oxides
O&M	operation and maintenance
OPA	open-path analyzer location
OPR	open-path retroreflector location
PC	personal computer
ppb	parts per million
ppm	parts per million
PMT	photomultiplier tube
QA	quality assurance
QAPP	quality assurance project plan
QC	quality control
South Coast AQMD	South Coast Air Quality Management District
SEP	supplemental environmental project
SOPs	standard operating procedures
TBD	to be determined
TORC	Torrance Refining Company, LLC
USB	universal serial bus
UV	ultraviolet

Acronym	Definition
UVDOAS	ultraviolet differential optical absorption spectroscopy
VAC	volts alternating current
VDC	volts direct current
VOCs	volatile organic compounds
W	watts

A.3 Distribution List

The distribution list (Table A-1) identifies all individuals that should receive a copy of this Quality Assurance Project Plan (QAPP), either in hard copy or electronic format, including any subsequent revisions. Additionally, all individuals listed in Section A.1 as well as all supervisory and line staff and contractors directly involved in any aspect of this monitoring project will receive a copy of the QAPP. Document storage and control is addressed in Section A.9 of this QAPP, while training of new staff and re-training of existing staff is addressed in Section A.8 of this QAPP.

Table A-1: Distribution list (Individual names and contact information may change over time. A distribution list with names and contact information will be attached separately at time of distribution)

Name and Role	Organization	Email	Phone Number
System Owner	Torrance Refining Company		
Rule 1180 Program Manager	Torrance Refining Company		
Andrea Polidori, Rule 1180 Program Manager	South Coast Air Quality Management District	apolidori@aqmd.gov	(909) 396-3283
Kevin Durkee, Rule 1180 Quality Assurance Manager	South Coast Air Quality Management District	kdurkee@aqmd.gov	(909) 396-3168
Program QA Manager	Spectrum Environmental Solutions		
System Manager/Operator	Spectrum Environmental Solutions		
Data/QC Manager	Spectrum Environmental Solutions		
Website/Data System Manager	Spectrum Environmental Solutions		
Technical Specialist/Site Operator	Spectrum Environmental Solutions		
Data Reviewer	Spectrum Environmental Solutions		
Data Reviewer	Spectrum Environmental Solutions		
Lead Internal Auditor	Spectrum Environmental Solutions		

A.4 Project Organization and Roles

This section identifies the roles and responsibilities of the key individuals involved in the operation of the fenceline air monitoring system (Table A-2) and lines of authority and communications between these individuals and authorities. The organizational chart (Figure A-1) provides lines of authority and communications for all organizations involved in operation and maintenance of the fenceline air monitoring system (including contractors and subcontractors) to accomplish the QA objectives specified in this QAPP.

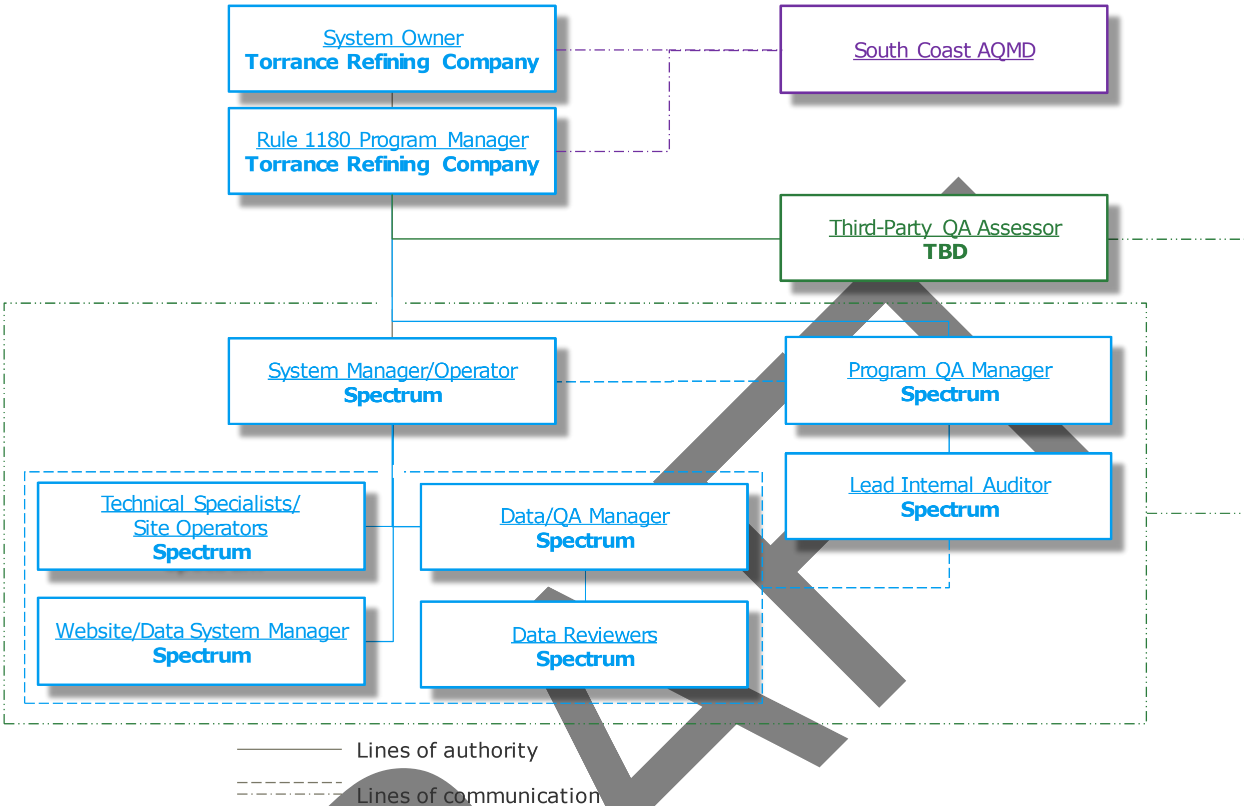

Figure A-1: QA organization chart

Table A-2: Key individuals and responsibilities

Organization	Roles	Responsibilities
Torrance Refining Company	System Owner	Overall system performance Financial resources to operate and maintain the System Appoint System Manager and Program QA Manager Review/approve QAPP
Torrance Refining Company	Rule 1180 Program Manager	Overall system operation, maintenance and data management Review/approve quarterly reports Procure Third-Party QA assessor
Spectrum Environmental Solutions	System Manager/Operator	System operation and maintenance Oversee technical specialists and instrument suppliers Coordinate staff resources

Table A-2: Key individuals and responsibilities

Organization	Roles	Responsibilities
Spectrum Environmental Solutions	Program Quality Assurance Manager	Prepare/revise/approve QAPP Conformance with QAPP QAPP updates & revisions Coordinate internal periodic QA checks and audits Review/approve quarterly reports
Spectrum Environmental Solutions	Data/Quality Control Manager	Oversee data collection & processing Oversee daily data anomaly checks & investigations Oversee data review & validation Review/approve quarterly reports
Spectrum Environmental Solutions	Website/Data System Manager	Website administration Upload reports Ensure timely response to feedback Issue notifications
Spectrum Environmental Solutions	Technical Specialists/Site Operators	Remote and on-site system operation Preventative maintenance Unscheduled maintenance (including minor repairs) System maintenance notifications Prepare first draft quarterly reports
Spectrum Environmental Solutions	Data Reviewers	Monitor real-time data collection & processing Perform daily data anomaly checks & investigations Perform manual data review & validation
Spectrum Environmental Solutions	Lead Internal Auditor	Internal auditing tasks Internal performance evaluations Internal periodic technical audits Internal reporting system audits
TBD	Third-Party Quality Assurance Assessor	Conduct third-party QA activities including: • Technical systems audits e.g., field, laboratory, data systems, data validation, data storage, reporting & recordkeeping, personnel, training; • Performance evaluation audits; • Data quality reviews.

Torrance Refining Company, LLC (Torrance Refinery) is the **System Owner** with overall responsibility for all aspects of fenceline air monitoring system. The System Owner provides the financial resources necessary to operate and maintain the fenceline air monitoring system in accordance with this QAPP. The System Owner appoint the organizations that will be responsible for system operation, maintenance, data management and reporting. The System Owner also review and approve the QAPP.

The system is managed by a **Rule 1180 Program Manager** appointed by Torrance Refinery. The Rule 1180 Program Manager acts as the central point of contact for Torrance Refinery, the South Coast Air Quality Management District (South Coast AQMD) and the Program Quality Assurance Manager. The Rule 1180 Program Manager is responsible for overseeing the system's operation, maintenance, reporting, and data management.

The system is operated by a **System Manager/Operator**, who has overall responsibility over the operation and maintenance of the fenceline air monitoring system. The System Manager/Operator oversees technical specialists, engineers, scientists, and technicians responsible for operation, maintenance, data collection, data quality, reporting, and website operations. The System Manager/Operator will coordinate staff coverage and serve as a technical resource for site measurements.

The **Program Quality Assurance Manager** is responsible for assuring the quality of data on behalf of the Rule 1180 Program Manager. The Program Quality Assurance Manager reports to the Rule 1180 Program Manager and may communicate directly with the System Owner, Rule 1180 Program Manager, and the Third-Party QA Assessor, independently of the System Manager/Operator, escalating as appropriate to assure that any issues identified by the Program Quality Assurance Manager are promptly addressed. The Program Quality Assurance Manager provides QA oversight for the system and oversees and reports on QA activities to the Rule 1180 Program Manager. The Program Quality Assurance Manager assures that daily data review and data management activities are performed in accordance with the QAPP, works with the Rule 1180 Program Manager to ensure that any data issues are promptly addressed, and that data provided to the public are of high quality. The Program Quality Assurance Manager is responsible for developing QAPP updates and revisions when necessary. The Program Quality Assurance Manager is responsible for assuring timely response to and closure of corrective action reports.

Technical Specialists/Site Operators conduct system operation checks and perform instrument maintenance. The technical specialists ensure that all measurements are collected in accordance with all applicable SOPs, standard methods, and regulations. Technical specialists perform the required quality checks on instruments and document all work in site logs. Technical specialists may conduct these activities on-site or remotely, as applicable to the specific activities. Technical Specialists/Site Operators may initiate and participate in responses to corrective action reports.

The **Instrument Suppliers** provide technical support for the instruments deployed in the field.

The **Data/Quality Control Manager** is responsible for ensuring that daily data reviews are conducted, oversees data collection and review of data anomalies (e.g., fail auto-screening), and ensures that data validation follows the schedule and procedures described in the QAPP. The Data/Quality Control Manager is responsible for preparing quarterly reports, providing message board updates for O&M activities and report availability and for delivering the validated data to the System Manager/Operator. The Data/Quality Control Manager may initiate and participate in responses to corrective action reports.

Daily data review and data validation are conducted by experienced air monitoring system analysts. The **Data Reviewers** communicate with the Data/Quality Control Manager when there are issues and may also interact with the Technical Specialists when they observe potential O&M issues that need to be addressed.

The **Website/Data System Manager** is responsible for properly displaying data on the website, managing inquiries from the public, and ensuring that validated quarterly reports are available for download on a quarterly basis. Automated alerts will notify the Website/Data System Manager when the real-time data are not available on the website. The Website/Data System Manager is responsible for assessing and fixing data communication and other information technology–related issues concerning the website and data system. The Website/Data System Manager may initiate and participate in responses to corrective action reports.

The **Lead Internal Auditor** is not involved in the management or routine operations of this measurements program, and functions independently from the fenceline air monitoring system operations & maintenance organizational structure. The Lead Internal Auditor is responsible for coordinating internal auditing tasks, performance evaluations, and periodic audits. This internal auditing function is intended to supplement and not replace this project's 3rd party auditing requirement. The Lead Internal Auditor reports to the Program QA Manager and may initiate and participate in responses to corrective action reports.

The **Third-Party QA Assessor** is responsible for assessing whether the fenceline air monitoring system is being operated and maintained in accordance with the *Torrance Refinery Rule 1180 Fenceline Air Monitoring Plan*[1] and this QAPP. The Third-Party QA Assessor coordinates and performs third-party QA activities independent from the operations and maintenance and internal quality assurance organizations. Activities include developing and performing periodic technical systems audits and performance evaluation audits. The Third-Party QA Assessor prepares audit reports for the Rule 1180 Program Manager and may initiate corrective action reports. The Third-Party QA Assessor reports to the Rule 1180 Program Manager and may communicate directly with all members of the operations and maintenance team, internal QA organization, Rule 1180 Program Manager and System Owner as appropriate to assure timely response and closure of corrective action reports.

A.5 Problem Definition/Background

This QAPP applies to a fenceline air monitoring system installed at the Torrance Refinery to comply with South Coast AQMD Rule 1180 *Refinery Fenceline and Community Air Monitoring*[2] (the "Rule"). This QAPP is intended to satisfy the requirements of Rule 1180 and its associated *Refinery Fenceline Air Monitoring Guidelines*.[3] As suggested in the South Coast AQMD Rule 1180 guidelines, this QAPP generally conforms with content requirements specified in EPA guidelines.[4]

Rule 1180 requires monitoring for target air compounds along the refinery fenceline using open-path optical and point measurement technologies and meteorological monitoring instruments. The Rule requires public access to the data in real time via a public website and notification system.

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[1] *Torrance Refinery Fenceline Air Monitoring Plan*, Revision 2, prepared by Ramboll US Corporation, Irvine, California (in preparation pending SCAQMD review as of November 21, 2019).

[2] *Rule 1180. Refinery Fenceline and Community Air Monitoring*, in Regulation XI Source Specific Standards, South Coast AQMD Rule Book, South Coast Air Quality Management District, Diamond Bar, California. Adopted December 1, 2017. See http://www.aqmd.gov/docs/default-source/rule-book/reg-xi/r1180.pdf?sfvrsn=9 (accessed August 2019).

[3] *Rule 1180 Refinery Fenceline Air Monitoring Plan Guidelines*, South Coast Air Quality Management District, Diamond Bar, California. December 2017. See http://www.aqmd.gov/docs/default-source/rule-book/support-documents/1180/rule-1180-guidelines.pdf (accessed August 2019).

[4] U.S.EPA, *Guidance for quality Assurance Project Plans*, QA-G5, 2002. EPA/240/R-02/009. See https://www.epa.gov/sites/production/files/2015-06/documents/g5-final.pdf (accessed August 2019)

This QAPP defines criteria and actions that the project team will take to ensure that the data collected meet all regulatory requirements and the data quality objectives (DQOs) defined in the QAPP.

A.6 System Description and Approach

The fenceline air monitoring system that is implemented to satisfy the requirements of Rule 1180 collects continuous monitoring data for the target pollutants utilizing open-path monitors and fixed-point monitors. This monitoring system, which is intended as a permanent installation with an estimated lifespan of at least twenty years, provides continuous real-time data for target air pollutants at or near the Torrance Refinery perimeter fenceline.

The system configuration includes six open-path analyzer locations (OPA), identified as OPA-1 through OPA-6 in Figure A-2 and listed in Table A-4. Each of these six locations has one monostatic open-path Fourier transform infrared (FTIR) analyzer and one monostatic open-path ultraviolet differential optical absorption (UVDOAS) analyzer. All locations serve two paths[5] on an alternating 5-minute basis by use of a computer-controlled motorized pan-and-tilt mount. For each of the six open-path analyzer locations there are two paths identified as "a" and "b", with open-path retroreflector (OPR) for each analyzer located at the path end opposite the analyzer (e.g., path from OPA-1 to OPR-1a, path OPA-1 to OPR-1b). Additionally, continuous fixed-point monitors for measuring black carbon and hydrogen sulfide are placed at six locations around the facility boundary (Figure A-2).

The fenceline air monitoring locations were selected by considering potential for community exposure, potential emission sources within the refinery, and prevalent wind directions. It is expected that the chosen monitoring locations will provide data representative of the overall air quality and meteorology of the area.

This QAPP also addresses meteorological monitoring as specified in the Rule 1180 Guidelines. Meteorological monitoring is necessary to characterize wind and weather patterns and estimate movement and dispersion of the measured pollutants. Rule 1180 Guidelines require monitoring for the following meteorological parameters: ambient temperature, horizontal wind speed, horizontal wind direction, barometric pressure, relative humidity, visibility, and precipitation. The parameters to be monitored including target pollutants and meteorological variables are listed in Table A-3. The major components and features of the fenceline air monitoring system are summarized in Table A-4. Additional equipment specifications can be found in Appendix I.

[5] See Figure A-2 in this QAPP and Section 5 of the *Torrance Refinery Rule 1180 Fenceline Air Monitoring Plan*[1] for path lengths.

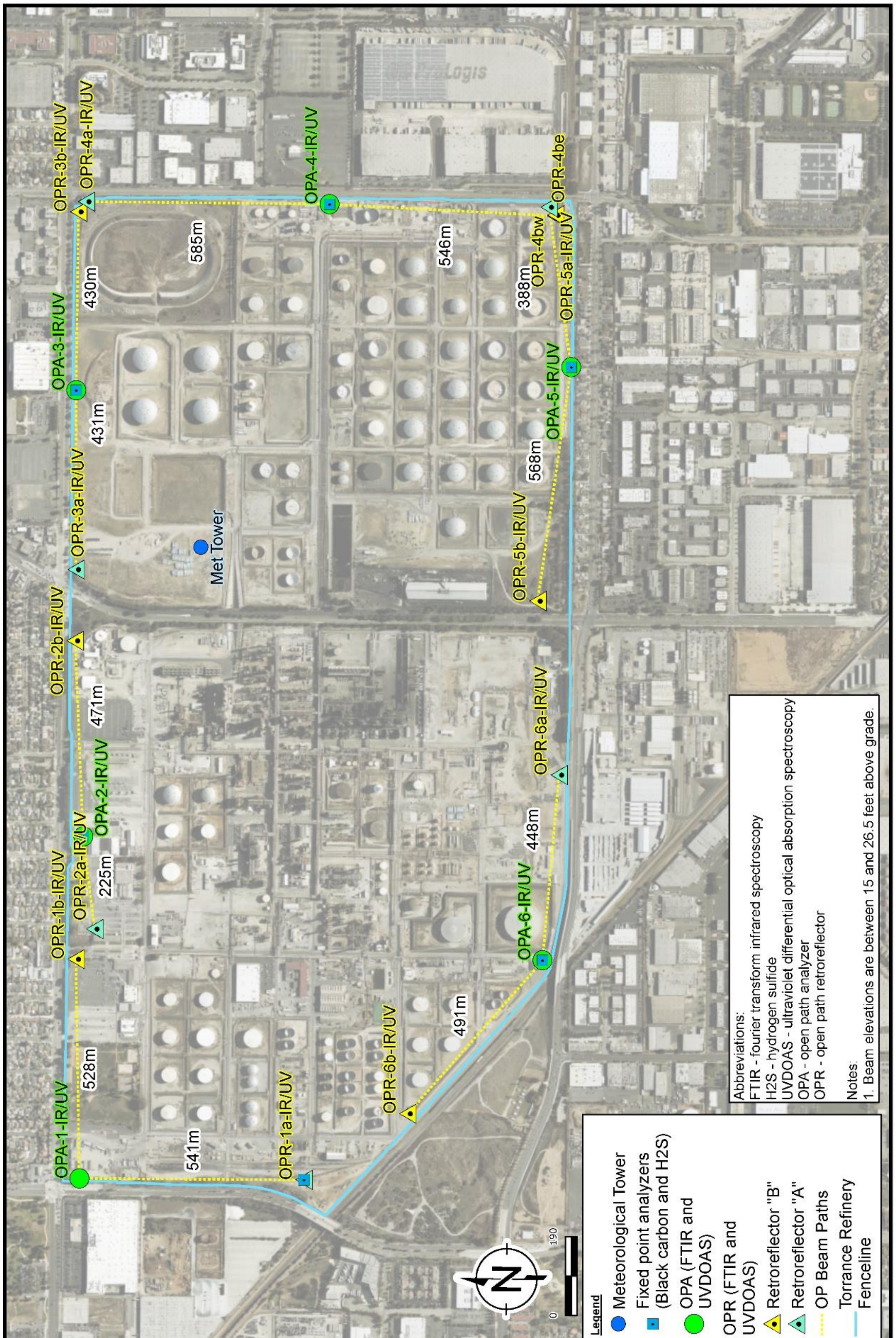

Figure A-2: Layout of open-path FTIR, open-path UVDOAS and fixed-point monitors

Table A-3: Target air pollutants and monitored meteorological parameters

Category	Parameters
Criteria air pollutants	Sulfur dioxide Nitrogen oxides
Volatile organic compounds (VOCs)	Total VOCs (non-methane hydrocarbons)[6] Formaldehyde Acetaldehyde Acrolein 1,3-Butadiene BTEX compounds (benzene, toluene, ethylbenzene, xylenes) Styrene[7]
Other compounds	Hydrogen cyanide Hydrogen sulfide Carbonyl sulfide Ammonia Black carbon Hydrogen fluoride
Meteorological parameters	Horizontal wind speed and direction Temperature Precipitation Barometric pressure Relative humidity Visibility

Table A-4: Rule 1180 fenceline air monitoring system equipment

Component	Make/Model	Quantity
OPA-1 (Tag #A50001)		
Monostatic open-path FTIR system	Spectrum WaveRunIR	1

[6] For purposes of Rule 1180 monitoring, South Coast AQMD staff has specified that "*non-methane hydrocarbons*" are defined for this program as total hydrocarbons measured by FTIR that absorb in the spectral region near 3000 cm^{-1}. This results in a measurement which approximately represents the sum of most alkanes and alkenes (with a carbon number of three and greater). Because all individual alkanes and alkenes cannot be reliably distinguished from one another by FTIR, Torrance Refinery expresses this measurement result as an equivalent concentration of propane. The concentrations measured using this method will include a group of hydrocarbons that is different from regulatory definitions for "*total gaseous non-methane hydrocarbons*" and "*volatile organic compounds*" and may include certain non-reactive compounds which are exempt under U.S. EPA and/or South Coast AQMD rules.

[7] Styrene data will be provided in quarterly reports only.

Table A-4: Rule 1180 fenceline air monitoring system equipment

Component	Make/Model	Quantity
Monostatic open-path UVDOAS system	Spectrum OP-UVDOAS	1
Auto positioner/Pan and Tilt - open-path FTIR	Moog MPT-90	1
Auto positioner/Pan and Tilt – UVDOAS	Moog MPT-90	1
OPA-2 (Tag #A50002)		
Monostatic open-path FTIR system	Spectrum WaveRunIR[8]	1
Monostatic open-path UVDOAS system	Spectrum OP-UVDOAS [8]	1
Auto positioner/Pan and Tilt - open-path FTIR	Moog MPT-90	1
Auto positioner/Pan and Tilt – open-path UVDOAS	Moog MPT-90	1
Black carbon monitor	Met One BC 1060	1
Hydrogen sulfide monitor	Teledyne API T101	1
OPA-3 (Tag #A55001)		
Monostatic open-path FTIR system	Spectrum WaveRunIR[8]	1
Monostatic open-path UVDOAS system	Spectrum OP-UVDOAS [8]	1
Auto positioner/Pan and Tilt - open-path FTIR	Moog MPT-90	1
Auto positioner/Pan and Tilt – open-path UVDOAS	Moog MPT-90	1
Black carbon monitor	Met One BC 1060	1
Hydrogen sulfide monitor	Teledyne API T101	1
OPA-4 (Tag #A72001)		
Monostatic open-path FTIR system	Spectrum WaveRunIR	1
Monostatic open-path UVDOAS system	Spectrum OP-UVDOAS	1
Auto positioner/Pan and Tilt - open-path FTIR	Moog MPT-90	1
Auto positioner/Pan and Tilt – open-path UVDOAS	Moog MPT-90	1
Black carbon monitor	Met One BC 1060	1
Hydrogen sulfide monitor	Teledyne API T101	1
OPA-5 (Tag #A55002)		
Monostatic open-path FTIR system	Spectrum WaveRunIR	1
Monostatic open-path UVDOAS system	Spectrum OP-UVDOAS	1

[8] To be installed and operated after the completion of South Coast AQMD's Supplemental Environmental Project (SEP) monitoring program, circa June 2021. See Section B.9 of this QAPP for additional information.

Table A-4: Rule 1180 fenceline air monitoring system equipment

Component	Make/Model	Quantity
Auto positioner/Pan and Tilt - open-path FTIR	Moog MPT-90	1
Auto positioner/Pan and Tilt – open-path UVDOAS	Moog MPT-90	1
Black carbon monitor	Met One BC 1060	1
Hydrogen sulfide monitor	Teledyne API T101	1
OPA-6 (Tag #A50003)		
Monostatic open-path FTIR system	Spectrum WaveRunIR	1
Monostatic open-path UVDOAS system	Spectrum OP-UVDOAS	1
Auto positioner/Pan and Tilt - open-path FTIR	Moog MPT-90	1
Auto positioner/Pan and Tilt – open-path UVDOAS	Moog MPT-90	1
Black carbon monitor	Met One BC 1060	1
Hydrogen sulfide monitor	Teledyne API T101	1
OPR-1a		
Open-path FTIR Retroreflector	Spectrum	1
Open-path UVDOAS retroreflector	Spectrum	1
Black carbon monitor	Met One BC 1060	1
Hydrogen sulfide monitor	Teledyne API T101	1
OPR-1b		
Open-path FTIR Retroreflector	Spectrum	1
Open-path UVDOAS retroreflector	Spectrum	1
OPR-2a		
Open-path FTIR Retroreflector	Spectrum[8]	1
Open-path UVDOAS retroreflector	Spectrum[8]	1
OPR-2b		
Open-path FTIR Retroreflector	Spectrum[8]	1
Open-path UVDOAS retroreflector	Spectrum[8]	1
OPR-3a		
Open-path FTIR Retroreflector	Spectrum[8]	1
Open-path UVDOAS retroreflector	Spectrum[8]	1
OPR-3b		

Table A-4: Rule 1180 fenceline air monitoring system equipment

Component	Make/Model	Quantity
Open-path FTIR Retroreflector	Spectrum[8]	1
Open-path UVDOAS retroreflector	Spectrum[8]	1
OPR-4a		
Open-path FTIR Retroreflector	Spectrum	1
Open-path UVDOAS retroreflector	Spectrum	1
OPR-4b		
Open-path FTIR Retroreflector	Spectrum	1
Open-path UVDOAS retroreflector	Spectrum	1
OPR-5a		
Open-path FTIR Retroreflector	Spectrum	1
Open-path UVDOAS retroreflector	Spectrum	1
OPR-5b		
Open-path FTIR Retroreflector	Spectrum	1
Open-path UVDOAS retroreflector	Spectrum	1
OPR-6a		
Open-path FTIR Retroreflector	Spectrum	1
Open-path UVDOAS retroreflector	Spectrum	1
OPR-6b		
Open-path FTIR Retroreflector	Spectrum	1
Open-path UVDOAS retroreflector	Spectrum	1
Meteorological Tower System		
10-meter tower assembly	Met One 970895	1
Wind speed	Met One 101C/2672	1
Wind direction	Met One 020C/10296	1
Relative humidity/temperature	Met One 085-35/5980	1
Precipitation	Met One 360-1	1
Barometric pressure	Met One 092	1
Visibility	Met One 6400	1

A.6.1 Open-Path Monitors

The fenceline air monitoring system uses a combination of open-path monitors and fixed-point monitors. The system includes both open-path FTIR analyzers and open-path UVDOAS analyzers. Open-path monitors operate by projecting a beam of ultraviolet or infrared light through open air to retroreflectors, which reflects the light back to the monitor where spectral absorption characteristics are measured. The unique spectral absorption characteristics of each gas are used to calculate and record the concentrations of each gas present in the beam. The measurement represents an average concentration over the length of the beam. The Torrance Refinery open-path monitors consist of twelve analyzers at six locations serving twenty-four paths (twelve parallel paths) on all sides of the refinery with path lengths between approximately 230 and 590 meters.

The light is transmitted to a retroreflector and back to a detector co-located with the transmitter. An auto-positioner (pan and tilt) rotates the analyzer to alternate between two different retroreflectors for two paths at five-minute intervals. The analyzer software provides five-minute (real-time) and 1-hour (rolling) spectrally-averaged concentration measurements for each path for each of the compounds listed in Table A-5. The analyzer software also provides 8-hour rolling average concentrations, calculated from the 1-hour spectrally-averaged data. Because each analyzer alternates between two paths for five minutes each, the data for each path are updated at 10-minute intervals.

The detection limit of open-path systems is a dynamic quantity that will change as atmospheric conditions change. Accordingly, an *effective detection limit* is calculated for each individual 5-minute average measurement on each open-path analyzer using a custom process developed by the analyzer supplier. The process for calculating the effective detection limit involves the calculation and evaluation of three separate values with the effective detection limit being the largest of these three values. The three values that go into the determination of the effective detection limit are:

- The standard deviation (i.e., TO-16) value;
- The classic least squares (CLS) value; and
- The report value.

A description of each of these three values is provided below.

The standard deviation value is calculated based on the detection limit calculation procedure described in US EPA Method TO-16, Section 9.6 *The Determination of the Detection Limit*[9]. In this procedure, the standard deviation value is calculated for a given target analyte using most recent fifteen five-minute spectra for which that target analyte is not present. This standard deviation value is then multiplied by a value of 3 which is the approximate Student's *t*-value for a single-tailed 99.5th percentile t statistic and a standard deviation estimate with 14 degrees of freedom. Whereas the detection limit methodology in TO-16 requires that the most recent fifteen spectra be contiguous (i.e., no time is allowed to elapse between them), the methodology used for this measurement program does not allow this. Therefore, fewer than fifteen spectra may need to be considered to evaluate detection limits over shorter, but more representative, time periods.

The CLS value also is referred to as a "goodness-of-fit" parameter since it assesses the agreement between the target analyte's reference spectrum and the shape of the current spectrum. After each measurement period, upon quantification of the absorbance spectrum, a primary concentration value for each analyte is calculated. Additionally, a residual (or CLS) spectrum is produced for each analyte.

[9] *Long-Path Open-Path Fourier Transform Infrared Monitoring of Atmospheric Gases*, Compendium Method TO-16, U.S. Environmental Protection Agency, Cincinnati, Ohio, 1999. See https://www3.epa.gov/ttn/amtic/files/ambient/airtox/to-16r.pdf (accessed July 19, 2018).

This residual spectrum produces a separate set of residual concentrations, one for each analyte. The residual spectrum can be thought of as a spectrum made by taking the root mean square of the difference between the absorbance spectrum and a synthetic spectrum created by using the concentration data and the spectral reference set that resides in the analysis method. Unlike the primary concentration values, the residual concentrations are always positive. The CLS value is equal to the residual concentration multiplied by a nominal value of 3. The CLS multiplication factor may vary depending upon the individual analyte and may be adjusted to balance between competing objectives of achieving low detection limits and minimizing the reporting of false positive values.

The last value, the report value, is a lower bound on the concentration for which a compound's presence is considered high enough to render the current spectrum inappropriate as a background for subsequent spectra. This value is designed to handle situations where a target analyte is commonly present above its standard deviation value and CLS value, but at concentrations that are still inconsequential with respect to a program's data quality objectives. This means that unless the report value has been the effective detection limit for two or more contiguous measurements, the effective detection limit will change with each measurement.

When calculating effective detection limits for other averaging periods (e.g., rolling 1-hour and 8-hour periods) the effective detection limit is simply calculated by arithmetic average of the 5-minute effective detection limits that make up that averaging period.

The open-path monitors include a reference gas cell that can be placed in the beam path during quality assurance activities. This enables periodic quality assurance checks using reference gas mixtures containing known concentrations of a reference gas (or gases). This procedure is referred to as an instrument challenge and is discussed in Section B.7.1 of this QAPP. Information on the frequency of QA checks on open-path instruments is also discussed there.

Additional equipment specifications are provided in Appendix I of this QAPP.

Table A-5: Approximate detection levels for open-path monitors

Parameter	Manufacturer	Model	Reporting units	Approximate lower detection level (ppb)	Approximate upper detection level[10] (ppm)
Hydrogen fluoride	Spectrum	WaveRunIR	ppb	4	10,000
Total VOCs				2	10,000
Nitrogen oxides				10	10,000
Formaldehyde				2	10,000
Acetaldehyde				10	10,000
Acrolein				4	10,000
1,3 Butadiene				8	10,000
Carbonyl sulfide				1.5	10,000
Ammonia				2	10,000

[10] Upper detection levels will be available after manual validation and reprocessing of raw data.

Table A-5: Approximate detection levels for open-path monitors

Parameter	Manufacturer	Model	Reporting units	Approximate lower detection level (ppb)	Approximate upper detection level[10] (ppm)
Hydrogen cyanide				3	10,000
Sulfur dioxide	Spectrum	OP-UVDOAS	ppb	4	100
Benzene				0.5	100
Toluene				2	100
Ethyl benzene				5	100
Xylenes (sum of m, o and p isomers)				5	100

A.6.2 Fixed-Point Monitors

Black carbon and hydrogen sulfide are monitored using fixed-point instruments, which analyze samples collected from a single location each. Met One BC 1060 black carbon monitors will measure black carbon concentrations at six locations around the fenceline. The BC 1060 analyzer is a two-wavelength aethalometer, which measures the amount of black carbon in ambient air via attenuation of light signals across a filter tape. Ambient air is drawn through a size-selective inlet and through a glass fiber tape onto which ambient particulate matter is deposited. The tape is then advanced to a light detector, which measures optical transmission of light at 880 nanometers (nm) and 370 nm wavelengths through the tape filter, thereby providing an average measurement of ambient black carbon for the selected sampling time.

The lower detection limit for aethalometers decreases with increasing sampling time. Thus, a single measurement collected over a one-hour period would have a lower detection level than a measurement collected over five minutes. The instruments are configured to collect and record data in five-minute averages. The data are used to calculate rolling averages for different time periods (i.e., 1-hour and 8-hour) updated every five minutes.

Hydrogen sulfide is monitored at six locations around the fenceline using Teledyne/Advanced Pollution Instrumentation (Teledyne/API) T101 hydrogen sulfide analyzers. In the T101 analyzer, sulfur dioxide is removed from the sample gas in a scrubber. Hydrogen sulfide in the sample gas then is converted into sulfur dioxide in a molybdenum converter operating at 315 °C, designed to minimize conversion of reduced sulfur species other than hydrogen sulfide. Sulfur dioxide is measured through excitation by ultraviolet (UV) light, where sulfur dioxide molecules absorb UV light and become excited at one wavelength, and decay to a lower energy state emitting UV light at a different wavelength. The emitted light is captured on a photomultiplier tube through a bandpass filter tuned to wavelengths emitted by excited sulfur dioxide molecules and is converted into a reading of hydrogen sulfide concentration.

The hydrogen sulfide analyzer collects and records data in five-minute averages. The data will be used to calculate 1-hour and 8-hour rolling averages, updated every five minutes.

Table A-6 lists approximate pollutant detection limits and ranges for fixed-point monitors. See Appendix I of the QAPP for fixed-point monitor equipment specifications.

Table A-6: Performance specifications for hydrogen sulfide and black carbon fixed-point monitors.

Parameter	Manufacturer	Model	Reporting Units	Lower detection level	Upper detection level
Black carbon	Met One	BC-1060	ng/m^3	200	100,000
Hydrogen sulfide	Teledyne/ Advanced Pollution Instrumentation	T101	ppb	0.4	10,000

A.6.3 Meteorological Monitoring

The meteorological monitoring tower uses high quality sensors to collect and record data continuously and in real time. The data are used to calculate 1-hour and 8-hour rolling averages updated every five minutes. These meteorological instruments meet EPA specifications[11] for accuracy, range and resolution (Table A-7).

Table A-7: Performance specifications for the meteorological tower components

Parameter	Sensor Make and model	Reporting units	Accuracy[12]	Range	Resolution
Horizontal wind speed	Met One 010C 3-cup anemometer	Meters per second (m/s)	± 0.1	0.4 - 55.9	0.1
Horizontal wind direction	Met One 020C airfoil vane	Degrees (°)	± 3	0 to 360	0.1
Ambient temperature	Met One 083E thermistor	Degrees Celsius (°C)	± 0.15	-30 to 50	0.1
Barometric Pressure	Met One 092 solid-state pressure transducer	Hectopascals (hPa)	± 0.35 (at 20 °C) ±1.0 over full range ±0.5 over any 200 hPa range	500 to 1,100	0.1
Relative humidity	Met One 083E thin film polymer capacitor	Percent (%)	± 2	0 to 100	0.1

[11] *Quality Assurance Handbook for Air Pollution Measurement Systems*, Volume IV: Meteorological Measurements, U.S. Environmental Protection Agency, Research Triangle Park, North Carolina, March 2008, EPA-454/B-08-002. See https://www3.epa.gov/ttn/amtic/files/ambient/met/Volume_IV_Meteorological_Measurements.pdf (accessed July 19, 2018)

[12] Accuracy, range and resolution values listed in this table are the manufacturer's published performance specifications.

Table A-7: Performance specifications for the meteorological tower components

Parameter	Sensor Make and model	Reporting units	Accuracy[12]	Range	Resolution
Precipitation	Met One 360 dual-chambered tipping bucket	Millimeter per hour (mm/hr)	± 1% of reading (0 to 30 mm/hr) ±5% of reading (30 to 120 mm/hr)	0 to 120	0.25
Visibility	Met One 6400 IR forward scattering	Kilometers (km)	± 10% of reading	0.006 to 80	--

A.6.4 Ancillary Equipment

Ancillary equipment includes sample inlets, sample transport lines, calibration and QA check equipment, computers, data loggers, communication devices, electricity supply and conditioning equipment, lighting, etc.

Equipment housed in each enclosure is listed in Table A-4.

A.7 Quality Objectives and Criteria

The primary objective of Rule 1180 refinery fenceline monitoring is to provide air quality information to the public about levels of eighteen air pollutants and groups of compounds (see Table A-3 of this QAPP), at or near the property boundaries of petroleum refineries in the South Coast Basin. DQOs for the Torrance Refinery fenceline air monitoring system are established to assure monitoring data can be reported with a known degree of confidence. The DQOs presented in this QAPP are established considering EPA guidelines[13,14] adapted as appropriate for the informational purposes of this Rule 1180 monitoring system.

A.7.1 Data Quality Objective Process

The DQO process consists of seven steps which establish the link between the specific end use of the data, the data collection process, and the data quality requirements. These steps are detailed below, along with the results of each step.

A.7.1.1 Problem Statement

The fenceline monitoring program established in the Plan and defined in this QAPP must satisfy the requirements of Rule 1180 and its associated *Refinery Fenceline Air Monitoring Guidelines*,[15] which requires monitoring for eighteen target air pollutants along the refinery fenceline and providing public access to the data in real time. See also Section A.5 of this QAPP.

[13] *Ambient Monitoring Guidelines for Prevention of Significant Deterioration (PSD)*, U.S. Environmental Protection Agency, May 1987. EPA-450/4-87-007. See https://www.epa.gov/sites/production/files/2015-07/documents/monguide.pdf (accessed August 2019).

[14] *U.S. EPA Guidance for the Data Quality Objectives Process*, U.S. Environmental Protection Agency, February 2006. EPA QA/G-4. See https://www.epa.gov/sites/production/files/2015-06/documents/g4-final.pdf (accessed November 2019).

[15] *Rule 1180 Refinery Fenceline Air Monitoring Plan Guidelines*, South Coast Air Quality Management District, Diamond Bar, California. December 2017. See http://www.aqmd.gov/docs/default-source/rule-book/support-documents/1180/rule-1180-guidelines.pdf (accessed August 2019).

A.7.1.2 Program Goals

Rule 1180 defines the program goals:

> *"The purpose of this rule is to require real-time fenceline air monitoring systems and to establish a fee schedule to fund refinery-related community air monitoring systems that provide air quality information to the public about levels of various criteria air pollutants, volatile organic compounds, metals, and other compounds, at or near the property boundaries of petroleum refineries and in nearby communities."*

The Torrance Refinery fenceline air monitoring system provides information to the public about concentrations of eighteen target air pollutants and groups of compounds (see Table A-3) specified in Rule 1180 along the refinery fenceline. Monitoring data are collected with instrumentation that provides continuous concentration measurements in real-time (five-minute averages) and averaged over longer time periods (e.g., 1-hour and 8-hour rolling averages). Real-time and averaged data, and supporting information to contextualize the measurement data, are published on a publicly-accessible website. Additionally, notifications are distributed via email to subscribers when pollutants exceed pre-determined thresholds. Finally, monitoring data that has undergone extensive quality assurance checks are published in quarterly reports on the website.

A.7.1.3 Information Inputs

Section A.6 of this QAPP describes the monitoring apparatus and techniques that are used to obtain ambient pollutant concentration data to address the goals of the monitoring program. Further, Section B.10 outlines the website, and community interface and, along with the public notification system which informs, that will be established to inform the public of the measurement data.

A.7.1.4 Project Boundaries

Section A.6 describes the spatial extent of the fenceline monitoring program, measurement temporal characteristics and the target pollutants and meteorological parameters to be measured.

A.7.1.5 Analytical Approach

Sections A.6 and B.4 of this QAPP describe the monitoring systems and the analytical approaches used for each measurement. The analytical approaches were specified by South Coast AQMD in the Guidelines and subsequent discussions with their staff during Monitoring Plan and QAPP development.

A.7.1.6 Performance Criteria

Performance or acceptance criteria specific to each monitoring system (i.e., open path, fixed point or meteorological system) are provided in the form of specific Data Quality Indicators (DQIs) and Monitoring Quality Objectives (MQOs) in Section A.7.2. below.

The MQOs for open-path and fixed-point monitors are established to provide pollutant measurement data that represent conditions at the fenceline with known confidence and allow measured data comparison with established action thresholds that trigger public notifications.

MQOs for meteorological systems are established to provide context for measured concentrations (i.e., whether the point of measurement is upwind or downwind of the refinery) and identify periods of adverse atmospheric conditions that may impede open-path measurements.

Additional project-level performance criteria include:

- Records of quality control and quality assurance procedures performed during data collection will be retained. Specific documents are listed in Section A.9 (Documents and Records);

- References gases shall be working standards certified by comparison to a National Institute of Science and Technology Gaseous Standard Reference Material[16], where these are commercially available;
- The minimum valid data completeness objective[17] is 75% per calendar quarter for all fenceline air quality monitoring data including the advanced technology open-path monitors, fixed-point monitors and meteorological monitors, as an indicator that there are sufficient data commensurate with the informational purposes of Rule 1180. The typical good performance expectation for completeness is 90%. If data completeness (as defined in Section B.5.1.4 of this QAPP) falls below 90%, the system is assessed for improvements towards achieving 90% completeness. Note, open-path monitor interferences and signal degradation from uncontrollable adverse atmospheric conditions such as fog, rain, ozone, particulate matter and visibility adversely affect data collection. Periods when data collection is impacted by adverse atmospheric conditions are properly flagged and accounted for in the determination of the data completeness as defined in Section B.5.1.4 of this QAPP.

It should be recognized that the DQOs for open-path measurement technologies used in permanent monitoring applications are not well-established because little information is available in the open literature on the long-term performance of this type of fenceline air monitoring system deployment. Torrance Refinery will continually re-evaluate DQOs and other related metrics as the program is implemented and new information is obtained about system performance.

A.7.1.7 Plan for Obtaining Data

Sections B.1 through B.8 of this QAPP outline the approach for generating concentration data that are consistent with the DQOs of this monitoring program and to meet the overall acceptance criteria specified above and in Section A.7.2 below.

A.7.2 Project Quality Objectives

Having established project DQOs, the quality of the data must be evaluated and controlled to ensure they are maintained within established acceptance criteria. Controlling and assessing data quality requires the development of project-specific Measurement Quality Objectives (MQOs). These project MQOs provide a framework for ensuring that data are of a known and documented quality. The MQOs are defined in terms of Data Quality Indicators (DQIs).

The DQIs which define the fenceline monitoring system data quality are based on definitions provided in US EPA Guidance for Quality Assurance Project Plans[18]:

- Precision – a measure of agreement among repeated measurements of the same property under identical or substantially similar conditions;
- Bias – the systematic or persistent distortion of a measurement process that causes errors in one direction;

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[16] NIST Traceable Reference Material Program for Gas Standards. See https://www.nist.gov/programs-projects/nist-traceable-reference-material-program-gas-standards (accessed November 2019)

[17] A minimum data completeness objective of 75% is consistent with that for the approved South Coast AQMD QAPP for federal criteria air pollutant monitoring, which employs conventional and proven measurement technologies that generally are not affected by atmospheric conditions.

[18] U.S.EPA, *Guidance for quality Assurance Project Plans*, QA-G5, 2002. EPA/240/R-02/009. See https://www.epa.gov/sites/production/files/2015-06/documents/g5-final.pdf (accessed August 2019)

- Accuracy – a measure of overall agreement of a measurement to a known value; it includes a combination of random error (precision) and systematic error (bias);
- Representativeness – a qualitative term that expresses the degree to which data accurately and precisely represent a characteristic of a population;
- Comparability – a qualitative term that expresses the measure of confidence that one data set has when compared to another;
- Sensitivity – a measure of a method or instrument's ability to discriminate between measurement responses representing different levels of the variable of interest; and
- Completeness – a measure of the amount of valid data obtained from a measurement system.

Details on how these DQIs are defined and assessed for the fenceline monitoring system are provided in Tables A-8 and A-9 below, and in Sections B.5 and B.7 of this QAPP.

Representativeness was addressed during the design of this air monitoring network and can be evaluated in terms of the spatial coverage and temporal resolution. For example, the system described in this plan includes measurement paths that will actively monitor pollutant concentrations along approximately 85% of the refinery perimeter fenceline. These measurement paths border residential, commercial, and industrial communities on all sides of the refinery and provide near-complete coverage on the predominantly downwind sides. With regard to temporal resolution, all of the measurement equipment utilized in this study sample continuously and generate high time resolution data (i.e., 5-minute discrete or average measurements). As such, the design will assure that the data generated by the fenceline air monitoring system will appropriately characterize pollutant concentrations along the refinery fenceline. An assessment of the representativeness of this project's monitoring data also will take place as a part of the processes described in Section D.3 of this QAPP, Reconciliation with Data Quality Objectives.

Comparability is assessed in multiple ways, including evaluating measured concentrations against VOC measurements that have been and will be performed by South Coast AQMD's Optical Remote Sensing van around the refinery. Additional information on this topic is included in Section D.1 of this QAPP, Data Review, Verification, and Validation.

The remaining DQIs are addressed in measurement quality objectives (MQOs) for open-path and fixed-point monitors (Table A-8) and meteorology monitors (Table A-9). Completeness is evaluated against the calendar quarter data set of hourly averages with a minimum 75% completeness of 5-minute data (periods during which adverse atmospheric conditions, acts of God, vandalism, terrorism, loss of station power or other events over which neither the refinery nor their monitoring contractor has control over are accounted for in data loss calculations as specified in Section B.5 of this QAPP). US EPA guidelines on quality assurance for meteorological measurements[1911] do not specify precision MQOs for meteorological measurements. Formulas for calculating DQIs are presented in Section B.5 of this QAPP.

[19] *Quality Assurance Handbook for Air Pollution Measurement Systems*, Volume IV: Meteorological Measurements, U.S. Environmental Protection Agency, Research Triangle Park, North Carolina, March 2008, EPA-454/B-08-002. See https://www3.epa.gov/ttn/amtic/files/ambient/met/Volume_IV_Meteorological_Measurements.pdf (accessed July 19, 2018)

Table A-8: DQIs and MQOs for refinery fenceline air monitoring systems

DQIs	MQOs for open-path systems	MQOs for fixed point systems	MQOs for meteorological systems
Completeness	Minimum 75%	Minimum 75%	Minimum 75%
Accuracy	See Tables B-6 – B-7	See Tables B-9 – B-10	See Table B-11
Precision	See Tables B-6 – B-7	See Tables B-9 – B-10	See Table B-11
Sensitivity (detection limits)	See Table A-5	See Table A-6	--

Table A-9: DQIs and MQOs for the meteorological tower system[20]

Measurement	Method	Reporting Units	Operating Range	System Accuracy	Sensitivity (resolution)	Completeness (minimum)
Ambient Temperature	Thermistor	°C	-30 to 50	± 0.15	0.1	75%
Relative Humidity	Psychrometer/ Hygrometer	%	0 to 100	± 2	0.1	75%
Barometric Pressure	Aneroid Barometer	hPa	500 to 1,100	±0.35 (at 20 °C) ±1.0 over full range ±0.5 over any 200 hPa range	0.01	75%
Wind Speed	Cup or sonic anemometer	m/s	0.4 to 50.0	± 0.1	0.003 (0.1 mph)	75%
Wind Direction	Vane or sonic anemometer	Degrees (°)	0 to 360	± 5, includes orientation error	0.1	75%
Precipitation	Tipping Bucket	mm/hr	0 to 50	±1% of reading (0 to 30 mm/hr) ±5% of reading (30 to 120 mm/hr)	0.25	75%
Visibility	Forward light scattering	meters	0.006 to 80	± 10% of reading	--	75%

[20] Accuracy, range and resolution values listed in this table are the manufacturer's published performance specifications of the corresponding sensors.

A.8 Training and Certifications

Adequate education and training are key components to any successful monitoring system that strives to produce data of known quality meeting DQOs. Activities conducted under this QAPP are performed by individuals with proper training and experience. All personnel assigned to operation, maintenance, quality assurance, and data handling will be sufficiently trained in the underlying technical and scientific principles behind the air monitoring equipment being used. Staff assigned to operate and maintain the system will be trained on operation and maintenance of the system prior to and during the start-up phase. The System Manager/Operator will determine specific training requirements, including periodic refresher training for existing staff and initial training of new staff, for operation and maintenance of the system. Training will be provided by the System Manager/Operator or designated representatives, and a record of training will be maintained by the System Manager/Operator.

Staff new to the refinery fenceline air monitoring program will undergo the above-mentioned training program before beginning work associated with the program. Additionally, periodic refresher training of all staff will be performed at least once every 2 years to ensure all staff maintain currency with procedures established in the Plan and QAPP, and are aware of changes to the monitoring system, Rule 1180 program or the QAPP.

A.9 Documents and Records

The System Manager/Operator is responsible for distributing the most recently-approved QAPP (and other documents used throughout the project operation) to all personnel identified in the QAPP distribution list via email. Controlled versions of all project documents, including the QAPP, are maintained in electronic format by the Program Quality Assurance Manager on a network server location accessible to the System Manager/Operator, Rule 1180 Program Manager, and Program Quality Assurance Manager staff. The QAPP and project documents should be reviewed, updated and re-approved as the fenceline air monitoring system requirements, design or equipment change. These documents can be made available to South Coast AQMD staff upon request.

The dataset created for this monitoring program will consist of the following components for open-path, point monitors and meteorological systems stored for at least five years in the project database and project files:

- For open-path monitors:
  - The 5-minute and 1-hour spectrally-averaged concentration measurements for each path;
  - Detection limits for the 5-minute and 1-hour spectrally-averaged concentration measurements generated for each path;
  - Calculated 8-hour rolling average concentrations and respective detection limits for each path;
  - Individual absorption spectra including raw and processed spectra; spectral references, light source spectra, instrumental noise spectra, and dark spectra from each path;
- 5-minute average wind speed, wind direction, ambient temperature, barometric pressure, visibility, relative humidity and visibility measurements at the meteorological tower, and the calculated hourly rolling average of the 5-minute meteorological data;
- 5-minute average concentration data generated from each hydrogen sulfide monitor and the calculated 1-hour and 8-hour rolling average concentrations; and

- 5-minute average concentration data generated from each black carbon monitor and the calculated 1-hour and 8-hour rolling average concentrations.

The following sources of information will support these data:

- Station log books and operator notes (in electronic form);
- Absorption spectra and raw data files from the open-path FTIR and UVDOAS monitors;
- Calibration records for all measurement systems, consisting of quality assurance checks with reference gases introduced into cells in the open-path monitor beams, fixed-point monitor calibrations and meteorological sensor calibrations;
- Maintenance records for all measurement systems;
- Data validation and editing instructions;
- Quarterly QA audits of field operations and system performance; and
- Third-party QA audit, inspection, assessment
- Standard operating procedures (SOPs)
- Corrective action reports

Quarterly data summary reports are prepared as a part of this air monitoring program. These reports will include a comparison of monitored target pollutant concentrations against their respective health thresholds, assessments of data completeness, a description of any significant instrument issues encountered, and a summary of quality control efforts. Additional detail on these quarterly reports are provided in Section B.10, Data Management and Section C.2, Reports to Management of this QAPP.

Documents and Records

B. DATA GENERATION AND ACQUISITION

B.1 Sampling Process Design

Fenceline air monitoring data are collected using open-path instruments to measure and record pollutant concentrations over a path interval of nominally 500 meters (corresponding to a folded optical path length of 1000 meters for the monostatic systems) along or near the Torrance Refinery fenceline. Additionally, continuous fixed-point monitors are used at six representative locations on or near the facility fenceline to monitor levels of black carbon and hydrogen sulfide. The selection of monitoring sites is discussed in the *Torrance Refinery Rule 1180 Fenceline Air Monitoring Plan*[1]. Additional information on the design of this monitoring network is provided in Section A.6 of this QAPP, and additional details on data management are provided in Section B.10.

B.2 Sampling Methods

This section describes the field work associated with this program, including the sampling methods and equipment that are used. All measurements are performed on a continuous basis; no physical samples are collected for offsite analysis. Standard operating procedures and methods for all of the measurement equipment used in this study can be found in the respective equipment operation manuals.

B.2.1 Open-Path Monitoring Systems

This QAPP will serve as the primary reference for the open-path FTIR and open-path UVDOAS monitoring systems for the Torrance Refinery. All pertinent O&M and QA/QC procedures are cited as references and summarized in this QAPP.

The open-path analyzers are described in Section A.6.1 of this QAPP. The open-path FTIR analyzer is a Spectrum WaveRunIR™, and the open-path UVDOAS analyzer is a Spectrum OP-UVDOAS analyzer. Both are mono-static multi-gas open-path analyzers. The analyzer systems operate by sending a beam of infrared or ultraviolet light through open air from a light source to a retroreflector cube array that redirects the light beam back to the analyzer.

The System Manager Operator team will remotely perform daily system checks, data validations, and will travel to the site as needed to perform both routine and emergency maintenance. The Technical Specialists/Site Operators will provide on-site checks and necessary routine maintenance (system alignment optimization, bulb replacement, etc.) or repairs. A cellular modem interface to the analyzer computer(s) and to the alarm system allows the System Manager/Operator team to remotely retrieve data and system logs, conduct system performance checks, and perform certain types of system recoveries and adjustments.

The open-path monitors will record concentrations along pathway segments along or near the perimeter fenceline. Each measurement is collected over a 5-minute period. All the monitors will cover two adjacent pathways via use of an auto-positioner (pan and tilt) that will rotate the instrument between the two paths at programmed 5-minute intervals.

Pollutant concentration data are collected using on-site computers which will parse the data and perform preliminary automated QC of the data. The data are then sent to a cloud server through a cellular connection every five minutes. Once delivered to the cloud server, validation calculations and distribution will occur. Concentration values are presented on a public website as five-minute measurement results, rolling 1-hour averages, and rolling 8-hour averages.

B.2.2 Fixed-Point Monitor Data

The fixed-point monitors for black carbon and hydrogen sulfide are described in Section A.6.2 of this QAPP. The continuous data from each monitor is collected in five-minute averages, updated every five minutes. The five-minute average data are used to calculate 1-hour rolling averages and 1-hour rolling averages are used to calculate 8-hour rolling averages.

B.2.3 Meteorological Data Collection

Meteorological instruments installed on a 10-meter tower at one location within the refinery are described in Section A.6.3 of this QAPP. The meteorological instruments are configured to collect and record data with high resolution (e.g., every five-minutes). The meteorological data may be used, for example, to establish pollutant trajectories or determine if the measured pollutant concentrations on a fenceline path originate upwind or downwind of Torrance Refinery operations.

B.2.4 Backup Monitoring

Rule 1180 requires alternate or temporary monitoring systems when the continuous monitoring systems are offline for extended periods (e.g., for maintenance or repair). The alternative monitoring systems will not be used to determine individual gaseous target compounds and/or surrogates when the open-path systems are down due to atmospheric conditions, but only in the event of extended periods for unscheduled maintenance or outages.

The backup monitoring plan is described in Section 6.6 of the *Torrance Refinery Rule 1180 Fenceline Air Monitoring Plan*[1]. The approach to backup monitoring may be adjusted over time, for example, as techniques and technologies evolve.

B.3 Monitoring Data Documentation, Custody and Control

The real-time open-path monitors and fixed-point monitors used to collect data for the fenceline air monitoring system do not involve physical sample shipping or custody transfer. However, the real-time monitoring data produced by the monitors are controlled using chain-of-custody information that verifies that monitoring data have not been changed or altered during data handling and transmission processes. Field operation records include site visit logs, continuous monitor calibration/validation documents, and maintenance logbooks. Many of these records are in electronic form, primarily as spreadsheets or text files. All field operation records are returned at least monthly to the Data/QA Manager for inclusion in the project files. The automatic data polling systems are password protected and only selected System Manager/Operator team members have access.

Monitoring data chain-of-custody records are maintained as specified in Section 2 of the Rule 1180 Guidelines.[21] The original monitoring data records (including the original spectral data from open-path monitors) are stored as read-only files. Changes are made only to duplicates of the original files. Changes to data records, when required, will generally occur during data validation activities. Each data record will include one or more fields for data qualifiers (Table B-1) entered during data review and validation. If a change is required, the original record is flagged appropriately. For example, if a data-point has to be invalidated it is marked as “invalid – correction applied” (or similarly marked) and will not be included in recalculation of time-averaged results. A duplicate record with corrected data is created for the same date and time and flagged “duplicate – validated” and included in recalculation of time-averaged results. The time and date of each change to a data record, if any, is noted along with the names of the persons making and approving each change.

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[21] *Rule 1180 Refinery Fenceline Air Monitoring Plan Guidelines*, South Coast Air Quality Management District, Diamond Bar, California. December 2017. See http://www.aqmd.gov/docs/default-source/rule-book/support-documents/1180/rule-1180-guidelines.pdf (accessed August 2019).

Table B-1: Data qualifiers for fenceline air monitoring data

Flag	Type	Explanation
BDL	Data Qualifier	Measurement results is below the minimum detection limit (MDL). The compound was not detected at a concentration that could be reliably quantitated. This may mean the compound is present but had interferences present, was below the detection capability of the instrument, or not present at all.
FEW	Data Qualifier	Averaging period has between 25% and 75% data completeness - not enough measurements available to create a representative average. There must be at least 75% data completeness in order for a valid, non-qualified average to be created.
J	Data Qualifier	Result below limit of quantitation, but above minimum detection level.
E	Data Qualifier	Estimated value - measurement above upper calibration or measurement range.
Q	Data Qualifier	Questionable data
V	Data Qualifier	Validated data. Data accepted by data validators. The validators have reviewed the data and determined that it is valid.
MNT	Null Data Qualifier	Indicates the instrument or monitoring site is undergoing maintenance and data collected is not valid data.
MAL	Null Data Qualifier	A (instrument) malfunction that voids the data has occurred. The operator has determined that the datum is not valid and should be ignored; or the instrument has generated an error code and is not producing valid measurement data.
QAQC	Null Data Qualifier	Instrument off-line for routine quality assurance/quality control activities (e.g., calibration checks, calibrations, audits, etc.)
INS	Null Data Qualifier	Insufficient Data (cannot calculate). Less than 25% data completeness for the averaging period

Table B-1: Data qualifiers for fenceline air monitoring data

Flag	Type	Explanation
NEG	Null Data Qualifier	The measurement exceeds a lower limit and has too negative a value. It is possible to get small negative values under routine conditions, but large negative numbers indicate a problem in the data collection system.
LIM	Null Data Qualifier	Data exceeds automatic criteria for rejection.
L	Null Data Qualifier	Low signal (open path analyzers).
ATM	Null Data Qualifier	Data invalid - interference due to atmospheric conditions.
NVAL	Null Data Qualifier	Invalid/Null Data. Datum rejected by data validators. The validators have reviewed the datum and determined that it is not valid.
M	Null Data Qualifier	Generic "Missing" for data, especially averages, for which the cause of the anomaly has yet to be assigned. Usually indicates that data was never collected. This may also be triggered by delays or breakdowns in data communications.
PWR	Null Data Qualifier	No power to site. No data collected.

B.4 Analytical Methods

The analytical methods for each monitor type are described briefly below. Refer to Sections A.7, B.5 and B.7 for details on instrument performance criteria and refer to Section C.1.4 which outlines corrective action reports and procedures.

B.4.1 Spectral Methods for Open-Path analyzers

The analytical methods employed for the open-path FTIR and open-path UVDOAS systems are based on applying a least squares regression analysis to compare calibrated reference spectra to measured absorption spectra as described in EPA Compendium Method TO-16[22]. Tables A-5 and A-6 of the QAPP present the target compounds and their respective detection limits. Table 7-2 of the *Torrance Refinery Rule 1180 Fenceline Air Monitoring Plan*[1] lists the selected health-based inhalation exposure thresholds for each compound.

B.4.2 Black Carbon Analyzer

Black carbon concentrations are calculated based on the relationship between measured optical attenuation through the filter tape as black carbon accumulates and ambient black carbon levels based

[22] *Long-Path Open-Path Fourier Transform Infrared Monitoring of Atmospheric Gases*, Compendium Method TO-16, U.S. Environmental Protection Agency, Cincinnati, Ohio, 1999. See https://www3.epa.gov/ttn/amtic/files/ambient/airtox/to-16r.pdf (accessed July 19, 2018).

on historical measurement data collected by thermo-optical methods. Based on laser light absorption onto quartz filters measured via the thermo-optical techniques, an empirical relationship is developed that describes the mass attenuation cross section "MACS" (in units of m^2g^{-1}) and its wavelength dependence. The relationship between the attenuation of laser light through quartz filters onto which ambient particulate samples containing soot had been collected and the concentration of "graphitic carbon" of the same samples has been established in previous literature, and this correlation has been found to be linear over a wide concentration range.[23,24]

The black carbon analyzer measures the ambient concentration of black carbon by detecting the change in optical transmission as black carbon-containing particulate matter accumulates onto a filter. Transmission of light coming from light emitting diodes is measured across filter tape onto which sampled aerosol containing black carbon is being accumulated. Reference transmission across a clean portion of the filter tape is simultaneously measured.[25] As black carbon accumulates onto the filter tape light transmission across the portion of the tape onto which black carbon is accumulating relative to the reference transmission will decrease. This transmission data are converted into black carbon concentration by normalizing by volumetric flow rate, time interval of measurement and cross-sectional area of the filter spot.

The Met One BC 1060 black carbon analyzer uses two industry-standard wavelengths, 880 nm and 370nm, to determine the concentration of black carbon and "UVPM" (UV light absorbing PM).

B.4.3 Hydrogen Sulfide Analyzer

UV fluorescence fixed-point monitors are used to monitor hydrogen sulfide. The Teledyne/Advanced Pollution Instrumentation T101 UV fluorescence hydrogen sulfide analyzer is selected to monitor hydrogen sulfide concentrations at six locations around the fenceline. Hydrogen sulfide is measured on the principle that hydrogen sulfide can be converted into sulfur dioxide. The hydrogen sulfide-to-sulfur dioxide converter receives sample gas from which the sulfur dioxide has been removed by a scrubber, which removes sulfur dioxide from the sample gas. The hydrogen sulfide converter contains a molybdenum catalyst and operates at 315 °C, which is designed to minimize conversion of reduced sulfur species other than hydrogen sulfide. Sulfur dioxide is measured through excitation by UV light from a low-pressure zinc-vapor lamp.

Sulfur dioxide molecules absorb UV light and become excited at a wavelength of approximately 214 nm, then decay to a lower energy state emitting UV light at wavelength of 330 nm. Excitation light is supplied by a low-pressure zinc-vapor lamp, and light from the lamp is focused using a UV source lens and passes through a bandpass filter configured to allow light with a wavelength of 214 nm, the excitation frequency of sulfur dioxide.

Light emitted from the decay of excited sulfur dioxide molecules is captured on a photomultiplier tube (PMT) through a bandpass filter tuned to a wavelength of 330 nm corresponding to light emitted by excited sulfur dioxide molecules. This filter trips away light outside of the fluorescence spectrum of decaying excited sulfur dioxide including reflected UV form the source lamp and other stray light. To further assure that the PMT only detects light given off by decaying sulfur dioxide the pathway of the excitation UV and field of view of the PMT are perpendicular to each other and the inside surfaces of the sample chamber are coated with a layer of black Teflon® that absorbs stray light.

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[23] Rosen, H., Hansen, A. D., Gundel, L., and Novakov, T., "Identification of the optically absorbing component in urban aerosols." *Appl. Opt.,* **17**:3859-3861, 1978.

[24] Gundel, L., Dod, R., Rosen, H., and Novakov, T., "The relationship between optical attenuation and black carbon concentration for ambient and source particles." *The Science of the Total Environment*, **36**:197-202, 1984.

[25] BC 1060 Black Carbon Monitor Operation Manual Section 9, BC 1060-9800, REV A, Met One Instruments.

B.5 Quality Control

This section describes QC calculations for the monitoring systems. A discussion of the various calibration checks and QC checks performed as a part of this program are provided in Section B.7 - Equipment Calibration. Section B.7 and B.8 of this QAPP describe the acceptable thresholds for the statistics presented here for each measurement system. Furthermore, Section C.1.4 outlines the procedures for corrective action should any of these parameters exceed their acceptable thresholds.

Data verification and validation is discussed in Section D.2 of this QAPP.

B.5.1 Statistics for the Assessment of QC Checks

Calculations of measurement uncertainty are carried out following procedures like those used for ambient air monitoring networks[26], provided in the following subsections.

B.5.1.1 Percent Difference

All measurement quality checks start with a comparison of an audit concentration or value (flow rate) to the concentration/value measured by the analyzer using the percent difference calculation shown in Equation 1. For each single point check the percent difference, d_i, is calculated as follows:

$$d_i = \frac{meas - audit}{audit} \times 100 \qquad \text{Equation 1}$$

Where, *meas* is the concentration indicated by the monitoring organization's instrument and *audit* is the audit concentration of the standard used in the QC check being measured.

B.5.1.2 Precision Estimate

The precision estimate is used to assess the one-point QC checks for each instrument. The precision estimator is the coefficient of variation (CV) and is calculated using equation 2:

$$CV,\% = \frac{\sigma_{meas}}{\overline{C_{meas}}} \times 100 \qquad \text{Equation 2}$$

Where $\overline{C_{meas}}$ is the average measured gas concentration and σ_{meas} is the standard deviation of the measurements, defined as:

$$\sigma_{meas} = \sqrt{\frac{\sum(C_{meas} - \overline{C_{meas}})^2}{n-1}} \qquad \text{Equation 3}$$

Where C_{meas} is a single measured concentration and *n* refers to the number of measurements conducted.

B.5.1.3 Accuracy Estimate

Accuracy, A, is defined as:

$$A,\% = \frac{|\overline{C_{audit}} - \overline{C_{meas}}|}{\overline{C_{audit}}} \times 100 \qquad \text{Equation 4}$$

Where C_{audit} refers to the average value of the reference gas and $\overline{C_{meas}}$ refers to the average value of all measurements.

B.5.1.4 Completeness

Completeness is a measure of the amount of valid data obtained from a measurement system. Completeness objectives are listed in Table A-8 for open-path and fixed-point monitors and Table A-9 for meteorological monitors.

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[26] Quality Assurance Requirements for Monitors used in Evaluations of National Ambient Air Quality Standards, Appendix A, Part 58, Title 41 *U.S. Code of Federal Regulations*.

Due to the nature of open-path measurement devices, adverse atmospheric conditions such as fog, high humidity, rain, high ozone, particulate matter, haze, and other conditions can affect a monitor's ability to provide reliable data. Since these conditions are uncontrollable, it is not possible to mitigate their effects.

Scheduled and unscheduled maintenance also results in loss of data. Scheduled or preventative maintenance is predictable and accounted for in setting data completeness objectives. Unscheduled maintenance is determined by the robustness of the monitoring equipment designs, component selections and preventative maintenance procedures. It should be noted that the reliability of the open-path monitors is not well known over long periods of continuous operation and this was considered in establishing data completeness objectives.

The data completeness criteria for all monitoring systems (fixed point, open-path and meteorological) is 75% for hourly, daily and quarterly data completeness. Data completeness is calculated for each target pollutant and path or fixed point. Hourly, daily and quarterly completeness for open-path systems are defined as follows:

$$\% \text{ complete}_{\text{hourly}} = 100 \text{ x } \frac{n_{\text{valid}}}{n_{hour} - n_{\text{excluded}}} \qquad \text{Equation 5}$$

Where n_{hour} refers to the number of five-minute measurements within each whole hour (n_{hour} is equal to 12 for fixed-point and meteorological monitors and is equal to 6 for each open-path monitor path), n_{valid} refers to the number of valid 5-minute measurements taken within each whole hour, and n_{excluded} refers to the number of 5-minute measurements invalidated due to adverse atmospheric conditions or scheduled maintenance.

$$\% \text{ complete}_{\text{daily}} = 100 \text{ x } \frac{h_{\text{valid}}}{24 - h_{\text{excluded}}} \qquad \text{Equation 6}$$

Where h_{valid} refers to the number of contiguous whole hours in a calendar day with complete or valid data (i.e., whole hours that have met or exceeded the target completeness percentage for fixed-point and meteorological monitors and whole hours with valid 1-hour spectrally-averaged measurements for open-path monitors) and h_{excluded} refers to the number of whole hours during which all data are invalidated due to adverse atmospheric conditions or scheduled maintenance.

$$\% \text{ complete}_{\text{quarterly}} = 100 \text{ x } \frac{d_{\text{valid}}}{d_{\text{quarter}} - d_{\text{excluded}}} \qquad \text{Equation 7}$$

Where d_{valid} refers to the number of whole days in a calendar quarter with complete data (i.e., whole days that have met or exceeded the target completeness percentage), d_{quarter} refers to the number of contiguous whole days in that calendar quarter and d_{excluded} refers to the number of whole days during which all data are invalidated due to adverse atmospheric conditions or scheduled maintenance.

B.6 Equipment Inspection, Testing, and Maintenance

The System Manager/Operator team performs equipment inspection, testing and routine maintenance to assure the monitoring data quality meets DQOs. This section cites procedures and summarizes recordkeeping requirements for all field analytical instrumentation and equipment. Instrument maintenance logs are maintained, and all instrumentation is checked prior to use. Detailed descriptions of how inspections and maintenance activities are performed can be found in the instrument operation manuals referenced in this section (see "Procedure Documents" listed in Tables B-1 through B-5). Additionally, information on how re-inspections should be performed and how to assess the effectiveness of corrective actions can also be found in the instrument manuals referenced in this section.

Field personnel will also be responsible for ensuring that critical spare parts are included with the field instruments to reduce potential downtime for repairs. The inventory will primarily contain parts that are subject to frequent failure, have limited useful lifetimes, and/or cannot be obtained in a timely manner.

B.6.1 Open-Path FTIR Monitor Inspection, Testing and Maintenance

Routine open-path FTIR monitor inspection, testing and maintenance are performed according to the manufacturer's recommendations (Table B-1). This table also lists the recommended frequency for each activity and cites the section numbers of the manufacturer's Operation and Maintenance Manual where these detailed standard operating procedures (SOPs) may be found. Signal strength should be evaluated following environmental events such as wildfires or dust storms to determine whether signal strength has degraded, and retroreflector array cleaning is required.

Table B-1: Inspection, testing and maintenance activities for open-path FTIR monitors

Activity	Frequency	Procedure Document
Cleaning the optical bearing	Every two years	*Open-Path FTIR Manual*, Spectrum Environmental Solutions, Section 3.1
Validation cell inspection	Annually	*Open-Path FTIR Manual*, Spectrum Environmental Solutions, Section 3.3
IR source inspection	Annually	*Open-Path FTIR Manual*, Spectrum Environmental Solutions, Section 3.4
HeNe laser voltage level inspection	Annually	*Open-Path FTIR Manual*, Spectrum Environmental Solutions, Section 3.5
IR detector inspection	Annually	*Open-Path FTIR Manual*, Spectrum Environmental Solutions, Section 3.8
Optimizing the Tracker Positioning	Quarterly	*Open-Path FTIR Manual*, Spectrum Environmental Solutions, Section 3.9
Retroreflector array cleaning	Every six months or as needed	*Open-Path FTIR Manual*, Spectrum Environmental Solutions, Section 3.10
Telescope turning flat cleaning	Every six months	*Open Path FTIR Manual*, Spectrum Environmental Solutions, Section 3.11
Telescope optics cleaning	Every two years	*Open-Path FTIR Manual*, Spectrum Environmental Solutions, Section 3.11

B.6.2 Open-Path UVDOAS Monitor Inspection, Testing and Maintenance

Routine open-path UVDOAS monitor inspection, testing and maintenance are performed according to the manufacturer's recommendations (Table B-2). This table also lists the recommended frequency for each activity and cites the section number of the manufacturer's Operation and Maintenance Manual SOPs where these detailed standard operating procedures (SOPs) for these maintenance activities may be found. Signal strength should be evaluated following environmental events such as wildfires or dust storms to determine whether signal strength has degraded, and retroreflector array cleaning is required.

Table B-2: Inspection, testing and maintenance activities for open-path UVDOAS monitors

Activity	Frequency	Procedure Document
Cleaning retroreflector array	Every six months	*Open-Path UV Manual*, Spectrum Environmental Solutions, Section 3.2
Validation cell inspection	Annually	*Open-Path UV Manual*, Spectrum Environmental Solutions, Section 3.3
UV lamp inspection	Quarterly or as needed	*Open-Path UV Manual*, Spectrum Environmental Solutions, Section 3.4

B.6.3 Black Carbon Monitor Inspection, Testing and Maintenance

Routine black carbon monitor inspection, testing and maintenance are performed according to the manufacturer's recommendations (Table B-3). This table lists the suggested frequency for each activity and cites the section number of the manufacturer's Operation and Maintenance Manual where the SOPs may be found. Maintenance that is recommended on an "as required" basis will be evaluated once the systems are commissioned at the facility.

Table B-3: Inspection, testing and maintenance activities for black carbon monitors

Activity	Minimum frequency	Procedure Document
Debris Filter Changes	Annually	BC 1060 Operation Manual[27], Met One Instruments, Section 6.6
Cyclone Trap Cleaning	Monthly	BC 1060 Operation Manual[27], Met One Instruments, Section 6.7
Cyclone Main Cavity Cleaning	Quarterly	BC 1060 Operation Manual[27], Met One Instruments, Section 6.7
TSP Inlet Inspection and Cleaning	Quarterly	BC 1060 Operation Manual[27], Met One Instruments, Section 6.7
Filter Tape Installation, Loading, and Filter Material Notes	As required (typically 2- to 12-month intervals depending on sampling duration between measurements)	BC 1060 Operation Manual[27], Met One Instruments, Section 3.7
Leak test	Monthly	BC 1060 Operation Manual[27], Met One Instruments, Section 6.5
Replace cyclone O-rings	As required	BC 1060 Operation Manual[27], Met One Instruments, Section 6.7

B.6.4 Inspection, Testing and Maintenance of Hydrogen Sulfide Monitors

Routine hydrogen sulfide monitor inspection, testing and maintenance are performed according to the manufacturer's recommendations (Table B-4). This table lists the suggested frequency for each activity and cites the section number of the manufacturer's Operation and Maintenance Manual where

[27] BC 1060 Black Carbon Monitor Operation Manual, BC 1060-9800, REV A, Met One Instruments.

the SOPs may be found. Maintenance recommended on an "as required" basis will be evaluated once the systems are commissioned at the facility.

Table B-4: Inspection, testing and maintenance activities for hydrogen sulfide monitors

Activity	Frequency	Procedure document
Change the sample particulate filter	Weekly	Teledyne API, User Manual Model T101 UV Fluorescence H_2S Manual[28], Section 7.3.1
Replace the sulfur dioxide scrubber reagent	Every six months	Teledyne API, User Manual Model T101 UV Fluorescence H_2S Manual[28], Section 7.3.3
Change the external zero air scrubber	Every six months	Teledyne API, User Manual Model T101 UV Fluorescence H_2S Manual[28], Section 7.3.4
Replace the hydrogen sulfide-to-sulfur dioxide converter catalyst	Annually or as required	Teledyne API, User Manual Model T101 UV Fluorescence H_2S Manual[28], Section 7.3.5
Change the critical flow orifice and sintered filters	Annually	Teledyne API, User Manual Model T101 UV Fluorescence H_2S Manual[28], Section 7.3.7
Perform flow check	Monthly	Teledyne API, User Manual Model T101 UV Fluorescence H_2S Manual[28], Section 8.5.2
Verify test functions	Weekly	Teledyne API, User Manual Model T101 UV Fluorescence H_2S Manual[28], Appendix C

B.6.5 Inspection, Testing and Maintenance of Meteorological Sensors

Routine meteorological sensor inspection, testing and maintenance are performed according to the manufacturer's recommendations (Table B-5). This table lists the suggested frequency for each activity and cites the section number of the manufacturer's Operation and Maintenance Manual where the SOPs may be found. Most of these sensors should operate for an extended period of time with a minimum of care or maintenance.

Table B-5: Inspection, testing and maintenance activities for meteorological sensors

Sensor	Activities	Frequency	Procedure Document
Met One 010C wind speed sensor	Inspect for proper operation	Every 6 months	Met One Model 010C Wind Speed Sensor Manual, Section 4.2[29]
	Inspect wind speed sensor bearings	Every 6 months	Met One Model 010C Wind Speed Sensor Manual, Section 4.5[29]

[28] *Model T101 UV Fluorescence H_2S Analyzer*, Document 07266C DCN7335, 10 August 2016. Teledyne API.

[29] Model 010C Wind Speed Sensor Operation Manual, 010C-9800, REV D, Met One Instruments.

Table B-5: Inspection, testing and maintenance activities for meteorological sensors

Sensor	Activities	Frequency	Procedure Document
Met One 020C wind direction sensor	Inspect for proper operation	Every 6 months	Met One Model 020C Wind Direction Sensor Manual, Section 7.6[30]
	Inspect wind direction sensor bearings	Every 6 months	Met One Model 020C Wind Direction Sensor Manual, Section 8.1[30]
Met One 083E relative humidity and temperature sensor	Inspect for proper operation	Every 6 months	Met One Model 083E/085 Relative Humidity / Temperature Sensor Manual, Section 4.0[31]
Met One 092 barometric pressure sensor	Clean the sintered filter	As required	Met One Model 092 Barometric Pressure Sensor Manual, Section 8.0[32]
Met One 360 precipitation gauge	Clean the funnel and buckets. Verify that the bucket moves freely.	Every 6 months	Met One Model 360 Precipitation Gauge Operation Manual, Section 4.0[33]
Met One 6400 visibility sensor	Inspect for proper operation. Clean optics.	Every 3 months	Belfort Instrument Visibility Sensor Manual Model 6400, Section 4.0[34]

B.6.6 Remote and Visual Inspection

Quality control activities will include:

- Periodic checks by a remote operator;
- Periodic and as-needed site visits; and
- Documentation of the condition of the various equipment in the site log book. Any equipment maintenance or repairs also is documented in the site log.

Data validation is performed in real time and at regular intervals to verify measurement anomalies and facilitate early detection of equipment malfunctions. Any discrepancies in the logs or inconsistencies with this QAPP are brought to the attention of the Rule 1180 Program Manager, Program Quality Assurance Manager, and the System Manager/Operator. Corrective actions are implemented by the System Manager/Operator as appropriate, verified by the Program Quality Assurance Manager and reported to the Rule 1180 Program Manager. Section D.1 of this QAPP provides additional details regarding data validation activities.

[30] Model 020C Wind Direction Sensor Operation Manual, 020C-9800, REV A, Met One Instruments.

[31] Model 085 Wind Direction Sensor Operation Manual, 085-9800, REV A, Met One Instruments

[32] Model 092 Barometric Pressure Sensor Operation Manual, 092-9800, REV G, Met One Instruments

[33] Model 360 Precipitation Gauge Operation Manual, 360-9800, REV B, Met One Instruments

[34] Belfort Instrument Visibility Sensor Manual Model 6400, 12VDC, REV B, Belfort Instrument Company

B.7 Equipment Calibration

This section summarizes procedures and frequencies for calibration checks and calibrations. For open-path systems, there are no field calibrations because the instruments are factory calibrated to spectral reference libraries. A reference gas cell and one reference gas of known concentration are used with the open-path monitors for quality assurance purposes. A summary of the instrument challenge procedure for open-path systems is provided in this section. Additionally, SOPs for the instrument challenge process are under development. Periodic calibration checks are performed for the fixed-point and meteorological monitors.

Calibrations and validations, flow rate checks, audits, and calculations are selectively reviewed by the Program Quality Assurance Manager to ensure that:

- Quality assurance procedures are being followed;
- The performance of all equipment is within the limits specified in this document;
- All calculations are being performed properly; and
- All data are reasonable and technically consistent.

If the Program Quality Assurance Manager finds systemic or ongoing issues that may significantly impact data quality or completeness during their review, a corrective action report is created to document the issue, action taken to correct it and resolution of the problem. See Section C.1.4 of this QAPP for further details on corrective action procedures.

B.7.1 Fenceline Air Monitoring System Validation for Open-Path Systems

Verify the instrument performance through various checks, many of which are described in EPA Method TO-16r[35] and in the *EPA Handbook for Optical Remote Sensing for Measurement and Monitoring of Emissions Flux and Particulate Matter*[36]. This document outlines general QA/QC procedures for a variety of sensing technologies, and its guidelines were used to inform this QAPP.

The frequency and acceptance criteria for each check is shown in Tables B-6 through B-8.

Table B-6: Quality assurance for FTIR monitors

Parameter	Frequency	Acceptance criteria	Procedure document
Reference gas QA checks	Quarterly for first two years; semi-annual checks will be considered if QA checks meet acceptance criteria in at least 80% of preceding eight quarterly checks. After major maintenance Initial commissioning	Accuracy: ≤ 30% of reference gas value, calculated using Equation 4 presented in Section B.5.2 Precision: ± 25%, calculated using Equation 2 presented in Section B.5.2	*Factory and Site Acceptance Test Plan, TORC Rule 1180 Project*, Spectrum Environmental Solutions, Section 2.1.5

[35] *Long-Path Open-Path Fourier Transform Infrared Monitoring of Atmospheric Gases*, Compendium Method TO-16, U.S. Environmental Protection Agency, Cincinnati, Ohio, 1999. See https://www3.epa.gov/ttn/amtic/files/ambient/airtox/to-16r.pdf (accessed July 19, 2018).

[36] *EPA Handbook: Optical and Remote Sensing for Measurement and Monitoring of Emissions Flux of Gases and Particulate Matter*, U.S. Environmental Protection Agency, September 1, 2018. See https://www.epa.gov/sites/production/files/2016-06/documents/gd-052.pdf (accessed May 2019).

Table B-6: Quality assurance for FTIR monitors

Parameter	Frequency	Acceptance criteria	Procedure document
Line shift	Continuous	0.5 cm^{-1} resolution	*Factory and Site Acceptance Test Plan, TORC Rule 1180 Project*, Spectrum Environmental Solutions, Section 2.1.2
Black body radiation (background)	Continuous	--	*Open-Path FTIR Manual*, Spectrum Environmental Solutions, Section 2.2.2 Basics of Data Collection Software algorithm executed every 5 minutes
Baseline noise determination	Once at commissioning	Instrument signal intensity divided by the sum of instrument noise and stray light must be > 5	*Factory and Site Acceptance Test Plan, TORC 1180 Project*, Spectrum Environmental Solutions, Section 2.1.3 Noise Equivalent Absorbance (NEA) Testing
Stray light check	Continuous	--	*Open-Path FTIR Manual*, Spectrum Environmental Solutions, Section 2.2.2 Basics of Data Collection; Software algorithm executed every 5 minutes
Detection level (sensitivity)	Quarterly for first two years; semi-annual checks will be considered if QA checks meet acceptance criteria in at least 80% of preceding eight quarterly checks. After major maintenance Initial Commissioning	Equal to or less than the approximate minimum detection levels specified in this QAPP for each target pollutant	*Factory and Site Acceptance Test Plan, TORC 1180 Project*, Spectrum Environmental Solutions, Section 2.1.4 Detection Limit Sensitivity
Instrument Resolution	Once at Commissioning	0.5 cm^{-1} resolution	*Factory and Site Acceptance Test Plan, TORC Rule 1180 Project*, Spectrum Environmental Solutions, Section 2.1.1 Instrument Resolution
Detector Linearity	Once at Commissioning	< 3.0% standard deviation	*Factory and Site Acceptance Test Plan, TORC Rule 1180 Project*, Spectrum Environmental Solutions, Section 2.1.6 Detector Linearity
Path Repeatability Tests	Once at Commissioning	< 3.0% standard deviation	*Factory and Site Acceptance Test Plan, TORC Rule 1180 Project*, Spectrum Environmental Solutions, Section 2.1.7 Path Repeatability Tests

Equipment Calibration

Table B-7: Quality assurance for open-path UVDOAS monitors

Parameter	Frequency	Acceptance criteria	Procedure document
Reference gas check	Quarterly for first two years; semi-annual checks will be considered if QA checks meet acceptance criteria in at least 80% of preceding eight quarterly checks. After major maintenance Initial Commissioning	Accuracy: ≤ 30% of reference gas value, calculated using Equation 4 presented in Section B.5.2 Precision: ± 25%, calculated using Equation 2 presented in Section B.5.2	*Factory and Site Acceptance Test Plan, TORC Rule 1180 Project*, Spectrum Environmental Solutions, Section 2.2.5
Detection level (sensitivity)	Annual	Equal to or less than the approximate minimum detection levels specified in this QAPP for each target pollutant	*Factory and Site Acceptance Test Plan, TORC 1180 Project*, Spectrum Environmental Solutions, Section 2.2.4 Detection Limit Sensitivity
Line shift	Continuous	0.5 cm^{-1} resolution	*Factory and Site Acceptance Test Plan, TORC 1180 Project*, Spectrum Environmental Solutions, Section 2.2.2 Line Shift Correction
Baseline noise equivalent absorbance (NEA) test	Once at commissioning	--	*Factory and Site Acceptance Test Plan, TORC 1180 Project*, Spectrum Environmental Solutions, Section 2.2.3 Noise Equivalent Absorbance (NEA) Testing
Path repeatability test	Once at commissioning	< 3.0% standard deviation	*Factory and Site Acceptance Test Plan, TORC 1180 Project*, Spectrum Environmental Solutions, Section 2.2.6

Note, because open-path instruments rely on accurate spectroscopy calibrated to standard reference spectra for each gas, surrogates are used in place of measuring DQOs for each parameter. All open-path instruments will have a reference gas or a QA cell. Reference gases with path adjusted concentrations[37] are used for checking DQOs.

B.7.1.1 Reference Gas Spectra

Each FTIR monitor response is compared against a known IR spectra curve (e.g., from the Pacific Northwest National Laboratory) for selected pollutants of concern. An instrument challenge test is conducted by taking a measurement of a known concentration in an enclosed cell placed into the normal measurement path, over a fixed path length and at a known temperature and pressure. This serves as a quality assurance check in the presence of all the spectral interferences present in the normal measurement path. That measurement is then compared to the reference spectra, and if

[37] To achieve the same ppb-m absorbance with the short reference gas cell as in the full monitor path, reference gas concentrations need to be much higher than in the ambient air (in proportion to the optical path length difference between the monitor path and reference cell).

values are within acceptable criteria, the calibration can be verified. Calibration generally requires one point, since absorption and response are linear.

A FTIR or UVDOAS challenge test with one measured gas verifies performance for all measured gases because it verifies the spectral measurements and analysis used for all gases.[3836] Instrument challenge tests are performed with ethyl benzene, selected because of its lesser toxicity compared with other target pollutants and satisfactory absorbance in both the infrared and ultraviolet bands making it suitable for both the FTIR and UVDOAS challenge tests.

Another type of QA check is known as an "atmospheric challenge." In this check, the atmospheric concentration of a gas measured by the open path system is compared against an expected or known concentration value. For the UVDOAS systems, the atmospheric check is conducted by comparing the measured ambient air ozone concentration against the ozone concentration measured by a nearby ambient ozone monitor operated by an independent organization (e.g., South Coast AQMD). For the FTIR systems, the atmospheric check is conducted by comparing the measured concentration of nitrous oxide (N_2O) against its global average concentration of approximately 330 ppb[39]. This check is possible with N_2O as it is a fixed atmospheric gas with a relatively uniform spatial and temporal distribution.

Table B-8 summarizes information for both of these challenges. Atmospheric challenges are evaluated on a daily basis. Instrument challenges are performed and evaluated on a quarterly basis. Instrument challenges should also be performed after initial commissioning, major repair or replacement; and spectral method changes. The results of all instrument challenges are noted in the operations log. Any significant difference between measured and expected concentrations is noted and investigated.

Table B-8: Reference gases to be used during commissioning and periodic QA checks for fenceline monitoring systems

Challenge Type	UVDOAS monitors	FTIR monitors
Instrument challenge	Ethyl benzene (or equivalent gas) approximately 120 ppb path equivalent (750 ppm/balance nitrogen)	Ethyl benzene (or equivalent gas) approximately 120 ppb path equivalent (750 ppm/balance nitrogen)
Atmospheric challenge	Measured atmospheric ozone is compared against nearby ozone monitoring site(s)	Measured atmospheric nitrous oxide is compared against the global average nitrous oxide concentration (approximately 330 ppb)

B.7.1.2 Baseline Determination and Spectral Line Drift

Instrument noise is the radiation seen by an instrument resulting from the operation of internal electronics and sensors. A spectral baseline reading is determined by measuring the instrument noise in a controlled environment. Each time a FTIR monitor is powered up or on a quarterly basis, the spectral baseline is determined, to account for this baseline when calculating concentrations.

Over time, the baseline reading can drift, especially as the instrument heats up during use. Therefore, the first hour of data collected after powering up an instrument is discarded, to allow the instrument to properly warm up and begin collecting valid data.

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[38] *EPA Handbook: Optical and Remote Sensing for Measurement and Monitoring of Emissions Flux of Gases and Particulate Matter*, U.S. Environmental Protection Agency, September 1, 2018. See https://www.epa.gov/sites/production/files/2016-06/documents/gd-052.pdf (accessed May 2019).

[39] See https://www.n2olevels.org/ (accessed September 9, 2019).

B.7.1.3 Stray Light Check

Prior to installation of open-path FTIR monitors, a stray light check is conducted to determine the percentage of light coming from background sources, when compared to the instrument readings. The intensity of the instrument signal shall be at least 5 times the combined intensity of background light and instrument noise.

B.7.2 Quality Assurance for Black Carbon Monitors (Aethalometers)

Table B-9 lists quality assurance criteria for the black carbon monitors.

Table B-9: Quality assurance for black carbon monitors (aethalometers)

Method	Frequency	Acceptance criteria	Procedure document
Flow Calibration Check	Monthly	≤ ± 5% (% difference)	BC1060 Black Carbon Monitor[40], Met One Instruments, Section 6.4.3
Flow Calibration	Quarterly		
Temperature Calibration Check	Monthly	≤ ± 1° C	BC1060 Black Carbon Monitor[40], Met One Instruments, Section 6.4.1
Temperature Calibration	Quarterly		
Barometric Pressure Calibration Check	Monthly	≤ ± 10 mbar	BC1060 Black Carbon Monitor[40], Met One Instruments, Section 6.4.2
Barometric Pressure Calibration	Quarterly		
Optical Span Test	Quarterly	≤ ± 5% of the values indicated on the label of the neutral density (ND) Filter	BC1060 Black Carbon Monitor[40], Met One Instruments, Section 6.4.6

B.7.3 Quality Assurance for Hydrogen Sulfide Monitors

Table B-10 lists calibration procedures and acceptance criteria for the hydrogen sulfide monitors. Reference gases with hydrogen sulfide concentrations of 100 ppb and 1,000 ppb are introduced during the span calibration.

Table B-10: Quality Assurance for hydrogen sulfide monitors

Parameter	Frequency	Acceptance Criteria	Procedure Document
Zero Calibration Check	Weekly	< ±3 ppb	Teledyne API, Model T101 UV Fluorescence H_2S Analyzer, User Manual[41], Section 6.3

[40] BC 1060 Black Carbon Monitor Operation Manual, BC 1060-9800, REV A, Met One Instruments.

[41] *Model T101 UV Fluorescence H_2S Analyzer*, Document 07266C DCN7335, 10 August 2016. Teledyne API.

Table B-10: Quality Assurance for hydrogen sulfide monitors

Parameter	Frequency	Acceptance Criteria	Procedure Document
Zero Calibration	Monthly		Teledyne API, Model T101 UV Fluorescence H_2S Analyzer, User Manual[41], Section 6.2
Span calibration Check	Monthly	± 10%	Teledyne API, Model T101 UV Fluorescence H_2S Analyzer, User Manual[41], Section 6.3
Span Calibration	Quarterly		Teledyne API, Model T101 UV Fluorescence H_2S Analyzer, User Manual[41], Section 6.2
Sulfur dioxide scrubber check	Quarterly	≤ 2%	Teledyne API, Model T101 UV Fluorescence H_2S Analyzer, User Manual[41], Section 7.3.3

B.7.4 Meteorological Equipment Calibrations

This section summarizes calibration information for the meteorological sensors at the meteorological tower system. The meteorological sensors are fully calibrated by the manufacturer at the time of purchase. Additional calibrations and system audits for all meteorological equipment are conducted on a bi-annual basis, with calibrations and audits alternating on a periodic basis. The frequency for calibration and accuracy checks was established on the basis that these measurements are for information purposes rather than for monitoring relative to established standards. Table B-11 summarizes the calibration and accuracy criteria for the meteorological equipment.

Table B-11: Meteorological sensor calibration and accuracy criteria

Measurement parameter	Measurement principle	Accuracy criteria	Frequency
Ambient temperature	Aspirated Thermistor Met One 076B, 060-A2	±1.0 ˚C	Every 12 months
Relative humidity	Thin film polymer capacitor, Met One 083E	±7% relative humidity	Every 12 months
Barometric pressure	Capacitor Met One 090D	±3 mb	Every 12 months
Wind speed	Anemometer/Pulse Frequency Counter Met One 010C	±0.2 m/s	Every 12 months
Wind direction	Vane Potentiometer Met One 020C	±5 degrees	Every 12 months
Precipitation	Dual-chambered tipping bucket Met One 360	±10%	Every 12 months
Visibility	IR forward scattering Met One 6400	±10%	Every 12 months

B.7.5 Fenceline Air Monitoring System Calibration and Verification Recordkeeping

All calibration data are recorded and documented following the processes described in Section A.9, Documents and Records, and B.10, Data Management.The Site Operators document the serial numbers of all equipment used in the calibration process and information for all gas standards (e.g., cylinder ID, certification date, expiration date, verified concentration, etc.) in the field log. The Site Operators have primary responsibly for analyzing the calibration data following the procedures and processes described and referenced in this section.

B.8 Inspection of Supplies and Consumables

Acceptance criteria for supplies and consumables vary with the operation being conducted and are generally described in the relevant SOPs. In general, the SOPs are checked to ensure the adequate criteria for supplies and consumables are met and appropriate for use for the operation. Reference gas labels are checked to ensure they are traceable to NIST standards and meet the required accuracy and concentration specifications. All parts received via shipment are opened and examined to ensure they are not damaged, the packing slips are archived, and an inspection log shall be maintained which records when the incoming shipments were received and inspected.

The spare parts and consumable items strategy is designed to achieve the data completeness criteria without an inventory of redundant complete analyzers. The System Manager/Operator orders and maintains spare parts inventory for the fenceline air monitoring systems, at the minimum quantities recommended by the respective suppliers and as necessary to achieve the data completeness objectives. The System Manager/Operator also maintains a consumable supplies inventory and update it as consumable items are used, or as new parts are ordered. The System Manager/Operator performs routine and emergency maintenance, including the replacement of spare parts, in an expedited manner.

B.9 Non-Direct Measurements

This section identifies types of data that are not directly generated or collected by this measurements program. As referenced in Table A-4 (air monitoring system equipment by location), the open path measurement systems (UVDOAS and FTIR) at OPA-2 and OPA-3 will not be operated by Torrance Refinery until the conclusion of a Supplementary Environmental Project (SEP) being administered by South Coast AQMD. The SEP is scheduled for completion by approximately June 2021. Until that time, the open path monitors at these two locations and related operation, maintenance, and data validation are supplied by a third party. The Torrance Refinery fenceline air monitoring system will download data produced by the SEP systems into its database and display them on the public website; however, Torrance Refinery is not responsible for validating the SEP data. See Section B.10.1, Website Management and Community Interface, for additional information.

B.10 Data Management

Pollutant concentration data are collected using on-site computers which parse the data and perform preliminary automated QC of the data. The data are then sent to a cloud server through a cellular connection every five minutes for further validation, archiving, and distribution. Once delivered to the cloud server, validation calculations and distribution will occur. Concentration values are presented on a public website as 5-minute measurements, 1-hour rolling averages, and 8-hour rolling averages. These values are updated for each path every ten minutes for the open-path systems and every five minutes for fixed-point monitors. Once a 5-minute measurement is collected, it is typically be posted to the public website within approximately one minute.

The pathway for raw and validated data is shown in Figure B-2 and described in detail in the following sections.

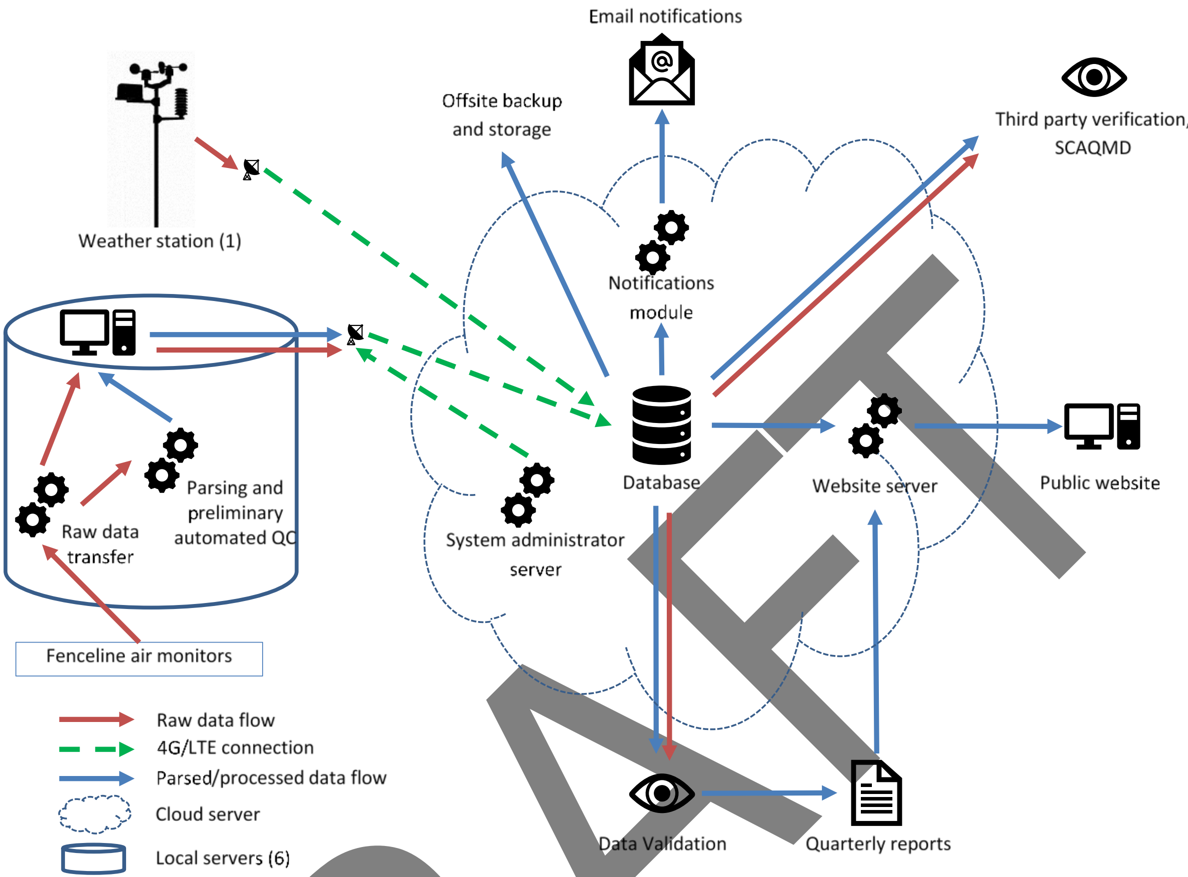

Figure B-2: Raw and validated data flow

B.10.1 Website Management and Community Interface

A publicly accessible website displays data in real time. A detailed description of the website layout, directions for interactions, and figures is provided in Section 7 of the *Torrance Refinery Rule 1180 Fenceline Air Monitoring Plan*[1], but a brief overview of its functionality is provided below.

The overall goals of the website are to: inform the public of pollutant concentrations at or near the refinery fenceline; inform the public of fenceline air monitoring system operations, outages, and events; and educate the public on the health-based concentration thresholds, monitoring techniques and procedures, and provide links to community emergency response planning resources.

A message board page shows a history of notifications in chronological order. This is primarily used to notify the public of pollutant concentrations that are greater than thresholds, instrument outages (planned or unplanned), and announce the availability of quarterly data reports. Users can subscribe to receive automated notifications from the website through an email service.

A data page shows real-time and averaged values for conditions at the facility in an interactive map. Users can view current concentrations at any of the monitors placed around the facility fenceline and view meteorological conditions in real time. Users also can view historical data for a given time period, monitor, and parameters of their choosing.

All quarterly data reports are made available on the website for download through the Reports page. Data are verified and validated according to the steps outlined in Section D before quarterly data reports are published on the website, to ensure that the data are accurate, valid, and representative of ambient conditions at the refinery fenceline. Any third-party data displayed on the website or contained in quarterly reports are clearly marked as such.

Finally, a Learning Center page provides some insight into monitoring operations, in the form of a FAQ page. This section also provides information on the monitors used, potentially emitted pollutants and their health effects, significant threshold levels, commonly used terms and definitions, etc. Links are provided to additional resources for users that want to learn even more.

B.10.2 Public Notification System

An email notification system, available to anyone, sends automated email alerts to announce a pollutant anomaly, planned or unplanned monitor outages, or the availability of quarterly data reports.

Automated public notifications are sent via email immediately after a 1-hour rolling average pollutant concentration is measured that is greater than its respective threshold. Pollutant concentration notification thresholds are presented in Section 7 of the *Torrance Refinery Rule 1180 Fenceline Air Monitoring Plan*.[1] Measurements invalidated via the automatic QA/QC system, such as during known instrument outages or when instruments are showing operational errors, do not generate automated public notifications. However, they are reviewed by the Data/Quality Control Manager and the Program Quality Assurance Manager.

C. ASSESSMENT AND OVERSIGHT

C.1 Audits and Response Actions

The project team includes a quality assurance specialist whose duties are solely in the area of independent assessment of the measurement effort. This individual is part of the same corporate organization as the project team but holds no duties or interests in the operation of any of the monitoring sites and networks that he/she audits. To promote objectivity and independence, the specialists maintains designated audit equipment in a separate location from the operations center and has access to the Program Quality Assurance Manager for assistance in promoting the quality objectives of the company. The Program Quality Assurance Manager is also available to assist in resolution of project issues related to quality. Assessments conducted for this project fall into two categories: Technical systems audits (TSA) and performance evaluation (PE) audits. Both provide vital information regarding the status of the project team operation and how well the measurement data adhere to the quality specifications of the QAPP.

All performance and technical systems audits are conducted following the guidance documents in the "EPA Quality Assurance Handbook" series, Volumes I,[42] II,[43] and IV. [44] Additional method specific quality guidance is provided by the applicable sections of the manufacturer operating manuals, in the absence of an EPA guidance document specific to the application of an equipment-specific measurement.

C.1.1 Technical Systems Audits

Technical systems audits for the field operation have several areas of focus. The primary goal of Technical system audits is to determine if operation and maintenance of the fenceline air monitoring system conforms with the procedures and criteria specified in this QAPP. The audit is conducted employing a checklist as a guide to the major topics to be assessed, and the auditor is free to allot greater amounts of time to any particular area as needed. The checklist is prepared in advance of the audit and is based on information presented in the QAPP and in general, the guidance of the EPA QA Handbook series.

The field technical system audit includes a review of overall equipment siting and exposure, site visit logs, continuous analyzer and meteorological operating procedures and documentation and any site maintenance activities. From this assessment, the auditor is able to determine the quality requirements for the monitoring effort from the QAPP, and then report on the level of adherence to the specifications. This review includes traceability documentation for gas standards and test equipment to conduct quality control checks on pollutant and meteorological monitors. Where the

[42] A Field Guide to .Environmental Quality Assurance, Volume I, in *Quality Assurance Handbook for Air Pollution Measurement Systems*, Office of Research and Development, U.S. Environmental Protection Agency, Washington, D.C., April 1994. EPA-600/R-94/038a. See https://www3.epa.gov/ttn/amtic/files/ambient/qaqc/r94-038a.pdf (accessed December 2019).

[43] Ambient Air Quality Monitoring Program, Volume II, in *Quality Assurance Handbook for Air Pollution Measurement Systems*, Air Quality Assessment Division, Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, North Carolina, January 2017. EPA-454/B-17-001 . See https://www3.epa.gov/ttn/amtic/files/ambient/pm25/qa/Final%20Handbook%20Document%201_17.pdf (accessed December, 2019)

[44] Meteorological Measurements, Volume IV (Version 2.0, Final), in *Quality Assurance Handbook for Air Pollution Measurement Systems*, Air Quality Assessment Division, Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, North Carolina, March 2008. EPA-454/B-08-002. See https://www3.epa.gov/ttn/amtic/files/ambient/met/Volume_IV_Meteorological_Measurements.pdf (accessed December 2019).

specification appears incomplete or inadequate, the auditor should be able to apply EPA guidance document information and personal experience.

Technical systems audits may cover the following instrumentation aspects:

- Compare actual O&M practices with SOPs;
- Inspect preventative and unscheduled maintenance logs;
- Inspect spare parts inventories;
- Inspect exterior and interior structures (clean, serviceable, etc.);
- Review of logs and determinations if past problems were addressed/resolved;
- Examine all open-path, fixed-point and meteorological monitor functions and components using the maintenance checklist to confirm that the equipment is operating with manufacturer specifications; and
- Analysis methods for of target compound(s) accuracy, precision and sensitivity per requirements listed in Table A-8 and A-9.

C.1.2 Performance Evaluation Audits

Performance evaluation audits are quantitative audits which are conducted periodically coincident with one of the programmed quarterly assurance checks. Performance evaluation audits consist of third-party reviews of open-path analyzer spectral analysis and blind challenges of the monitors with reference gases with concentrations known only to the third-party assessor. Performance evaluation audits are performed by the Third-Party QA Assessor.

C.1.3 Periodic Data Quality Assessments

Periodic Data Quality Assessments (DQAs) are conducted to determine whether the quality of data is adequate to support decisions based on the DQOs. DQAs involve statistical analysis of environmental data to estimate the quality of data being collected (i.e., calculating DQIs presented in Section A.7 of the QAPP). Further information on the DQAs is presented in Section D.3 of this QAPP.

C.1.4 Corrective Action Procedure

Corrective action reports (CARs) are issued when a TSA or PE audit reveals a quality assurance problem that impacts data quality, storage or reporting. CARs are issued by the Program QA Manager, based on internal QA audits or QA issues noted by them, raised by the lead internal auditor, technical specialists, or external 3rd party auditors. The CAR is sent via email to the personnel responsible for the system in question and/or responsible for mitigation actions (i.e., System Manager/Operator, Website/Data System Manager or Data/QA Manager). The System Manager/Operator is notified of all CARs issued.

The CAR contains the date of the finding, a summary of the finding, a recommendation on how to resolve the issue, suggestions for steps to minimize recurrence and a proposed date for completion. Follow-up meetings may be scheduled depending on the severity of the issue, though each manager is empowered to take corrective action without discussion should it be clear that immediate action is warranted. Resolution of the QA issue is then documented in the CAR which is signed by the appropriate responsible personnel and returned to the Program QA manager.

CARs are issued by the Program QA manager to the relevant responsible personnel within seven days of any internal QA audit, or within seven days of when a QA issue is raised. The responsible personnel shall respond within four days with an acceptance of the CAR, a revised date of completion, or decline the CAR and indicate the reason(s) for not pursuing action. The responsible personnel shall communicate to the Program QA manager should there be any delays to the completion date. The CAR shall be completed with a summary of the corrective action implemented, signed and dated, and returned to the Program QA manager within seven days of completion of work.

QA issues and CARs are documented in quarterly reports to management. They are reviewed together with the System Manager/Operator and Program QA manager to determine whether there any patterns in the findings that could be indicative of a systematic quality issue.

Corrective actions arising from equipment maintenance and validation activities are conducted according to the individual equipment manuals and SOPs referenced in Section B.6 and B.7. These actions, and their resolution, are noted in operator field logs.

C.2 Reports to Management

Reports for field performance and technical systems audits include a statement of the scope of the audit, summary presentation of results, and a listing of specific observations or findings related to the specifications under review. Also, the field data and traceability documents for each audit standard employed are included. The auditor should always provide the field technician and or the System Manager/Operator a list of preliminary findings and recommendations during a debriefing meeting held at the conclusion of the audits. If significant deficiencies are determined that impact the ability of the system to properly function, the System Manager/Operator is notified immediately. The System Manager/Operator notifies the Rule 1180 Program Manager of the situation and advises on the response actions being undertaken to restore the systems to full operational status. A formal report is provided to the project team within three weeks of completion of the audits. If there are no corrective action items, the auditor may close the audit. If further action is required, the audit is classified as open pending verification that the corrective action was completed, and the audit specification is met.

The System Manager/Operator team develops quarterly reports summarizing systems performance and containing the final validated monitoring results for that quarter. Quarterly reports are due by the end of the month following the month for which the data were collected. After the quarterly reports have been approved, they are posted on the Torrance Refinery website for public access.

D. DATA VALIDATION AND USABILITY

D.1 Data Review, Verification, and Validation

Data review, validation and verification procedures are presented in this section. Verification of data involves evaluating the completeness, correctness, and conformance/compliance of a specific data set against the predetermined specifications (i.e., DQIs specified in this QAPP). Data validation extends evaluation of data to determine the quality of data relative to its end use (in this case, providing air quality information to the public about pollutant levels at the refinery's fenceline).

Three types of data are collected for this project:

- Continuous data from the open-path systems;
- Continuous data from the fixed-point monitors; and
- Continuous data from the meteorology sensors.

Data are declared invalid whenever documented evidence exists demonstrating that a monitor was malfunctioning, or data were collected under non-representative conditions. It should be noted that the monitors are independent of one another for the purpose of documenting invalid data. For example, if the meteorological system is down, the data from an open-path or fixed-point monitor may still be acceptable and reported.

Data reviews and appropriate validations are performed for each monthly data set under the supervision of the project manager. The data management task leader verifies that the data from the individual monitors are complete for the month. The task leader then informs the System Manager/Operator when the complete data set is ready.

The activities involved in validation of the data in general include the following:

- Reviewing the site visit logs, calibration data (as appropriate), audit data, and project memoranda for indications of malfunctioning or instrument maintenance events; and
- Examining the monitor and meteorology data for spikes in the data, unusual persistence, unusually high rates of change, or measurement values that seem incongruous with normal measurement ranges and/or diurnal variations. Spectral analysis for selected large or anomalous measurements may be required; and
- Comparing measured concentrations against data from nearby air monitoring stations as well as overlapping open path monitor data for those pollutants that are measured by both the FTIR and UV-DOAS analyzers on the same path.

Data are never declared invalid solely because they are unlikely to occur in nature but may be flagged as suspect and subject to further review until the cause for an apparent anomaly is determined. The results from all quality control and quality assurance checks are evaluated to determine if the DQOs for each instrument are being met. Data qualifier codes (Table B-1 in Section B.3 of this QAPP) are assigned to monitoring results during data validation as appropriate to indicate data limitations or explanations for data anomalies.

Evidence of overwhelming measurement bias, external influences on the representativeness of the data, or lack of reproducibility of the measurement data may be cause for the data to be judged invalid.

D.1.1 Open-Path and Fixed-Point Monitors

The open-path and fixed-point monitor measurements and system performance data are transmitted to the cloud server continuously via modem. The data are reviewed at least daily to verify that the systems are collecting data and that there are no indications of equipment malfunctions. If a problem is detected in the daily reviews, the System Manager/Operator (or his designee) is immediately notified (text or email) so that he can direct the site operator's corrective actions. This contact is documented via email and distributed to the project team so that the situation may be accounted for in the monthly validation process and summary reports.

Open-path monitor spectral data are archived continuously. All other data are archived on System Manager/Operator network drives so that they are available to post-processing and reporting personnel. Manual spectral validations are performed on data above the action levels listed in Section 7 of the *Torrance Refinery Rule 1180 Fenceline Air Monitoring Plan*[1]. Additional data validations are performed as needed/required during reporting or times where operations of the open-path systems are suspect.

A conservative approach is taken with the open-path data in that it is accepted as is except under situations where QC indicators are met. The primary QC indicators are past alarms events that have been validated as false positives or any data deemed erroneous due to known system influences or failures.

D.1.2 Meteorology Sensors

The meteorology data are retrieved and subject to manual data review. Certain screening tests, such as those recommended by EPA,[45] are performed to aid in identifying data that require further investigation.

D.2 Verification and Validation Methods

US EPA guidance on remote sensing for monitoring of ambient pollutants[4636] recommends four levels of data validation: level 0, 1, 2 and 3. These levels are described below along with specific activities that are performed to ensure validity and usability of the fenceline data collected from the open-path and fixed-point monitors.

Level 0 verification includes review of raw calibration data and initial setup observation prior to collecting field data. It also includes field observation of the equipment setup and function.

Because monitoring results are displayed in real-time, the system software will incorporate a variety of automated data QC verification checks to reduce the likelihood that real-time results are affected by instrument malfunction or spurious data. The following general types of automated verification checks are performed on all measurements:

- Range checks will confirm the measurement is within pre-defined minimum and maximum values;
- Sticking value checks are used to flag data for further review;

[45] *On-Site Meteorological Program Guidance for Regulatory Modeling Applications*, U.S. Environmental Protection Agency, February 2000. EPA-454/R-99-5. See https://www3.epa.gov/scram001/guidance/met/mmgrma.pdf (accessed August 2019).

[46] *EPA Handbook: Optical and Remote Sensing for Measurement and Monitoring of Emissions Flux of Gases and Particulate Matter*, U.S. Environmental Protection Agency, September 1, 2018. See https://www.epa.gov/sites/production/files/2016-06/documents/gd-052.pdf (accessed May 2019).

- Rate of change checks will confirm that subsequent observations change by a reasonable extent and are used to identify potentially spurious data or instrument failure for further review;
- Sensor codes or alarms generated by the instruments, if available, are used to validate observation data; and
- The return beam intensity also is used to verify data for open path instruments.

Reference gas check results for the open-path analyzers and calibration data from the fixed-point monitors and meteorological system are reviewed after each verification check has been performed to ensure they satisfy requirements set forth in this QAPP, SOPs or operation manuals for the following criteria:

- Calibrations are performed on schedule;
- Calibrations are performed in the proper sequence;
- Reference gas and calibration standards reflect conditions expected during operational measurements or manufacturer's recommendations; and
- Linearity checks or other checks were performed to ensure the measurement system was stable during calibration.

Monthly visual field inspections also are performed to visually verify performance of monitors as follows:

- The equipment is operational and optical data was being collected and stored;
- The equipment is aimed correctly, and the collected data are different from zero or full saturation; and
- There are no anomalies in the time-series of data collected by the monitors or meteorological sensors.

These inspections are logged and kept on file for audit inspections or other review.

If anomalies are found, or if results exceed action thresholds for notifications, data are flagged, and an email notification is sent to the System Manager/Operator and Program Quality Assurance Manager for further verification and validation.

Level 1 validation involves downloading data from the measurement systems/instruments and reviewing variables calculated as part of the QC process. Specific aspects that are reviewed consist of the following:

- Whether the signal intensity from the equipment has drifted or diminished relative to the most recent maintenance activity;
- The frequency with which data exceed the allowable ranges or fail the sticking value check;
- Whether the measurement results contained any data qualifiers (defined in Table B-1 in Section B.3 of this QAPP) or other indication of anomalous data collection; and
- Whether the range and values of minimum detection limits reported by the instruments are within expected bounds.

- During the QA Manager review, data time series charts and other data visualizations are reviewed to identify potential outliers and special attention is given to unusually low or high outliers or deviations in the minimum measured value from day to day;
- Data completeness and representativeness DQOs are assessed; and
- Five-minute average data are reviewed to flag and evaluate rapid changes in value between successive data points.

Level 3 data validation represents the highest level of data review conducted and is performed by the independent Third-Party QA Assessor. This team will have a basic understanding of the instrument operation and will be familiar with typical results from similar measurement projects.

Level 3 data validation will determine which open-path measurement data should be invalidated if a serious response problem with the open-path technology is detected, or if calibration errors are identified. The reasons for changes to data quality resulting from the validation process, and details of corrective action taken, are documented. Data qualifier codes are reviewed to interpret combinations of multiple data qualifiers and contribute to decisions on whether data should be invalidated.

D.3 Reconciliation with Data Quality Objectives

Periodically, the Program Quality Assurance Manager and System Manager/Operator evaluate the monitoring system's progress toward meeting the goals and objectives given in Section A.7 of this QAPP . This evaluation occurs annually at a minimum and more frequently as needed. Two areas are reviewed: the performance of the project in respect to the quality goals and objectives specified in Section A.7 of this QAPP and the limitations (if any) on the measurement data for their intended use. Also, per the Rule 1180 Guidelines,[47] this annual evaluation also assesses the effectiveness of the monitoring plan covering experimental design, representativeness of the data, and peer review. The results of this annual evaluation are reported to the Rule 1180 Program Manager.

D.3.1 Assessment of Measurement Performance

As part of the annual review the performance of the monitoring network are assessed to determine to what extent the measurement data meet the requirements of the data user (client and/or regulatory agency). In Section A.7 on Quality Objectives and Criteria, a discussion of the DQIs is presented in relation to precision, accuracy, completeness, representativeness, and comparability goals for the monitoring effort. Specific quantitative measures of precision, accuracy and completeness are defined for use in estimating the quality of the data set. These metrics are calculated and compared with the project goals and objectives.

D.3.2 Data Quality Assessment

If any of the data quality measures indicate performance outside the desired objective (e.g., an audit result fails to meet the stated objective or quarterly data completeness is less than the goal) the data associated with that result are not considered useless. The burden is on the System Manager/Operator to determine the extent to which a quality issue affects the related data, and ultimately how the issue impacts the fitness for use of the data. Most often a single isolated incident in which the performance objective is not met does not automatically render the data useless, but rather slightly reduces the confidence that the measurement is reliable and indicates that increased quality control measures are needed. Any such data for which there are questions of confidence are appropriately flagged in the database. The DQOs are assessed periodically throughout the monitoring year, and a complete

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[47] *Rule 1180 Refinery Fenceline Air Monitoring Plan Guidelines*, South Coast Air Quality Management District, Diamond Bar, California. December 2017. See http://www.aqmd.gov/docs/default-source/rule-book/support-documents/1180/rule-1180-guidelines.pdf (accessed August 2019).

evaluation is conducted at the completion of each calendar quarter. A quarter in which the completeness statistic for a given monitor is below the objectives is cause for concern and corrective action, but if the other quarters within a four-quarter period are within the objective, the confidence in the data set remains high.

Any potential limitations of the validated data set are identified and communicated. The project team presents all known or potential data limitations with each data submittal and apply and annotate data qualifier codes as needed so that users may determine if the data should be used for a particular discussion or decision.

Table B-1 lists data qualifier codes that are used during data validation to qualify raw and processed data.

[End of Main Report]

APPENDIX I
FENCELINE AIR MONITORING SYSTEM SPECIFICATIONS

Table I-1: Open-path FTIR analyzer specifications

Parameter	Units	Specification	Comment
Analyzer type	None	FTIR	
Wave resolution	cm^{-1}	0.125 - 32	
Spectral range	cm^{-1}	550 – 7,800	Range is dependent on supplier
Scan frequency	scans/second	Varies – 0.5 to 2 at 0.5 cm^{-1}	Scan frequency increases as resolution decreases
Receiver configuration	None	monostatic	
Source type	None	Polaris™ long lifetime source	
Detector type	None	Mercury Cadmium Telluride (MCT)	
Detector cooling type	None	Stirling cyrocooler	
Detector temperature	K	77	
Beam splitter	None	ZnSe	
Interferometer type	None	90° dynamically aligned Michelson interferometer	
Signal to noise ratio	None	100,000:1	
Bench stabilization	None	Dynamic alignment	Algorithm reduces noise
QA gas cell type	None	Internal linear dual pass cell	Cell can be moved into beam path.
Cell Window	None	ZnSe	
Operating Temperature	°C	0 to 60 °C	
Time resolution (averaging time)	Minutes per reading	5 per path	
Power requirement	VAC	110 - 240	
Signal sampling	ADC	24-bit	Used for data acquisition
Output	None	USB	
Material of construction	None	Aluminum with stainless steel fasteners	Robust and ruggedness required

Table I-2: FTIR – ancillary equipment specifications

Parameter	Units	Specification	Comment
Alignment Mechanism/Rotating Pedestal/Auto-positioner			
Type	None	Moog MPT-90	
Mechanism	None	Pan and Tilt Unit	Required to remotely position analyzer
Load capacity	pounds	At least 100	
Pan movement range	°	435°	
Tilt movement range	°	180°	
Operating temperature	°F	5 to 131	Without heaters (heaters not required in southern California weather conditions)
Motor yype	None	Stepper	
Communications to pan & tilt		RS232 or LAN to PC	
Communications to sensors		RS232 Analog or LAN pass-through	
Material	None	Housing: 6061-T6 aluminum, stainless steel hardware permanently sealed radial ball bearings	
Retroreflectors			
Configuration	None	Open hollow cubes	Hollow cube retro reflectors have three flat sides that are attached in an orientation so that the reflected beam exits at nearly the same angle of incidence as the incoming beam.
Mounting	None	Rail mounted	
Material (substrate)	None	Polished glass	
Coating	None	Gold coating	
Surface quality	None	80-50 scratch dig	
Adhesion	None	Mil F-48616; Humidity MIL F-48616 or equivalent	
Operating temperature range	°C	-40 to 60	

Table I-2: FTIR – ancillary equipment specifications

Parameter	Units	Specification	Comment
Reflectivity	cm^{-1}	500 to 15,000	
Array configuration	None	85 to 104 cubes	Varies by path length
Enclosure	None	Customer supplied	
Heater	None	Optional	Can help reduce condensation
Heater power consumption	W	480 maximum	Required 120 VAC, 5 amp, 60 Hz

Table I-3: FTIR – computer and software specifications

Parameter	Specification	Comment
Computer	Windows 7 or above; Memory: 3 GB minimum; Dual Core 2.1 GHz processor; Min. 2 USB ports; Ethernet port; 802.11 b/g/n wireless LAN.	
Software		
Type	Real-time monitoring of pollutants	
Data display	Real-time display of results as well as instrument diagnostics.	
Alarms	User programmable to set alarms when concentrations are greater than thresholds	
Notifications	Ability to send notifications when pollutant concentrations greater than a specified threshold are measured	
Beam intensity	Ability to display beam intensity being measured	
Communication	Compatible with all computer systems and software for data processing	The equipment should be able to communicate alarms, operational parameters and results with a computer.
Remote control	Calibrations and augments done remotely	

Table I-3: FTIR – computer and software specifications

Parameter	Specification	Comment
Smart features	Analytical method customization; Background and interference compensation; Retroactive spectra analysis.	

Table I-4: Open-path UVDOAS analyzer specifications

Parameter	Units	Specification	Comment
Analyzer type	None	open-path UVDOAS	
Receiver configuration	None	monostatic	
Spectrometer resolution	nm	0.5	
UV source		150 W Xenon lamp	
UV source replacement	hours	Every 3000 hours	Minimum expected lifetime; can be longer as long as light intensity is is sufficient and spectral features are adequate
Operational wavelength	nm	210-340	
Beam operating temperature	°C	-20 to 50	
Indoor shelter temperature limits	°C	-15 to 35	
Bench stability	None	Thermally-stabilized	
Operating humidity	%	0 to 95%	
Detector type	None	2048 pixel spectrometer	
QA gas cell	None	8-cm flow-through cell	
Electrical requirements	VAC	110 or 240, single phase, 50-60 Hz, 5 amp maximum	
Time resolution (averaging time)	minutes	5 minutes per reading	
Data acquisition rate	Milliseconds/scan	10-1000	
Data output rate		10 sec – 5 min	User configurable
Output	None	USB	
Material of construction	None	Aluminum with stainless steel fasteners	Robust and ruggedness required

Table I-5: Open-path UVDOAS – ancillary equipment specifications

Parameter	Units	Specification	Comment
Alignment Mechanism / Rotating Pedestal / Auto-positioner			
Type	None	Moog MPT-90	
Mechanism	None	Pan and Tilt Unit	Required to remotely position analyzer
Load capacity	pounds	At least 100	
Pan movement range	°	435°	
Tilt movement range	°	180°	
Operating temperature	°F	5 to 131	Without heaters (heaters not required in southern California weather conditions)
Motor type	None	Stepper	
Communications to pan & tilt		RS232 or LAN to PC	
Communications to sensors		RS232 analog or LAN pass-through	
Material	None	Housing: 6061-T6 aluminum, stainless steel hardware permanently sealed radial ball bearings	
Retroreflectors			
Configuration	None	Open hollow cubes	Hollow cube retro reflectors have three flat sides that are attached in an orientation so that the reflected beam exits at nearly the same angle of incidence as the incoming beam.
Mounting	None	Rail mounted	
Material (substrate)	None	Polished glass	
Coating	None	Enhanced aluminum coating	
Surface quality	None	80-50 scratch dig	
Adhesion	None	Mil F-48616; Humidity MIL F-48616 or equivalent	

Table I-5: Open-path UVDOAS – ancillary equipment specifications

Parameter	Units	Specification	Comment
Operating temperature range	°C	-40 to 60	
Reflectivity	Nm	200-400	
Array configuration	None	27 to 37 cubes	Varies by path length
Enclosure	None	Customer supplied	
Heater	None	Optional	Can help reduce condensation
Heater power consumption	W	480 maximum	Required 120 VAC, 5 amp, 60 Hz.

Table I-6: Open-path UVDOAS – computer and software specifications

Parameter	Specification	Comment
Computer	Windows 7 or above; Memory: 3GB minimum; Dual Core 2.1 GHz processor; Min. 2 USB ports; Ethernet port; 802.11 b/g/n wireless LAN.	
Software		
Type	Real-time monitoring of pollutants	
Data display	Real-time display of results as well as instrument diagnostics.	
Alarms	User programmable to set alarms when concentrations are greater than thresholds	
Notifications	Ability to send notifications when pollutant concentrations greater than a specified threshold are measured	
Beam intensity	Ability to display beam intensity being measured	
Communication	Compatible with all computer systems and software for data processing	The equipment should be able to communicate alarms, operational parameters and results with a computer.
Remote control	Calibrations and augments done remotely	

Table I-6: Open-path UVDOAS – computer and software specifications

Parameter	Specification	Comment
Smart Features	Analytical method customization; Background and interference compensation; Retroactive spectra analysis.	

Table I-7: Aethalometer specifications

Parameter	Units	Specification	Comment
Cartridge filter bypass	None	Required	Filter used for clean air tests, should be replaced once a year.
Electronic data output	None	Single serial output through either RS-232, USB, or Ethernet port.	1200 to 115200 baud.
Calibration kit	None	Neutral density optical filter calibration kit or equivalent	Ability to calibrate the absorptive properties of the instrument
Filter tape material	None	Reinforced glass fiber	Reduce effects of relative humidity.
Flow rate options	Liters per minute	2	
Internal vacuum pump	None	Internal DC powered pump	
Light source	(nm)	LED light sources at different wavelengths	Different wavelengths measure the absorption of different types of carbon (including black carbon at 880 nm).
Power supply	Watts (W)	12 V DC. Universal 100-240 VAC 50/60 Hz input.	12 VDC 8.5 amp output supply included.
Pulse damper	None	Recommended	Decrease pump pulsations to minimize interferences with sensitive measurements.
Resolution	Microgram per cubic meter (μg/m^3)	0.001	
Sample inlet tubing	None	Static Dissipative tubing	Minimize amount of tubing required.
Time base of measurements	Seconds (s)	5-minute time base	

Table I-8: Black carbon analyzers - computer and software specifications

Parameter	Specification	Comment
Computer	Minimum 1 GB, Windows 7	
Software		
Alarms	Operational parameters and analyzer operation issues logged	
Communication	Compatible with all computer systems and software for data processing	
Remote control	Alarm identification and troubleshooting, calibration and flow checks, ability to view real time concentrations remotely	
Data display	Physical display on equipment and remote display of consolidated data	
Data processing	5-minute, 1-hour, 8-hour averaging capabilities, processing of alarms and QA check information	

Table I-9: Hydrogen sulfide UV fluorescence analyzer specifications

Parameter	Units	Specification	Comment
Manufacturer/model	--	Teledyne/API T-101	
Electronic data output	None	RS-232, Ethernet, or USB port capabilities; Capability to transmit analyzer information to software	
Flow rate options	Liters per minute	0.65 - 1	
Light source	(nm)	LED light sources in the range of sulfur dioxide absorption wavelengths	UV light in the range of wavelengths absorbed by sulfur dioxide (190 nm - 230 nm).
Power supply	Watts (W)	100-230VAC, 50/60Hz (auto-switching) – 200-300 W average	Standard US Connection.
Resolution	ppb	1	
Time base of measurements	Seconds (s)	5-minute time base	

Table I-9: Hydrogen sulfide UV fluorescence analyzer specifications

Parameter	Units	Specification	Comment
Operating Temperature	°C	20-30	
Lag time	seconds	25	