The Importance of Open Path Fenceline Monitoring for Sustaining Compliance with the New Refinery Rule

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Emission Reduction Efforts

**When** – detect leakage within minutes and hours rather than days or never – fast response time

**What** – detect and identify the leaking material with absolute certainty

**Where** – locate leakage source accurately

**How much** – quantifying how much gas was released
Optical Remote Sensing for Emission Characterization from Non-point Sources

1.0 Scope and Application

1.1 Introduction. This protocol provides the user with methodologies for characterizing gaseous emissions from non-point pollutant sources. These methodologies use an open-path, Path-Integrated Optical Remote Sensing (PI-ORS) system in multiple beam configurations to directly identify “hot spots” and measure emission fluxes. Basic knowledge of a PI-ORS system and the ability to obtain quality path-integrated concentration (PIC) data is assumed. The user must be capable of using commercial software to utilize the procedures and algorithms explained in this protocol. The methodologies in this protocol have been well developed, evaluated, demonstrated, validated, and peer-reviewed.

NOTE 1 — Any mention of a “PI-ORS system” in this protocol refers to the open-path PI-ORS instrument itself, as well as any associated components used, such as mirrors, scanners, and software.

This protocol does not discuss specific applications (e.g., hog farms, landfills), but provides general guidelines or procedures that can be applied. Detailed protocols for specific applications may be added at a future date.

1.1.1 Scope. This protocol currently describes three methodologies, each for a specific use. The Horizontal Radial Plume Mapping (HRPM) methodology was designed to map pollutant concentrations in a horizontal plane. The Vertical Radial Plume Mapping (VRPM) methodology was designed to measure mass flux of pollutants through a vertical plane, downstream from an emission source. The one-dimensional Radial Plume Mapping methodology (1D-RPM) was designed to profile pollutant concentrations along a line-of-sight (e.g., along an industrial site fence line). In future revisions to this protocol, additional PI-ORS emission monitoring methodologies (other than the methodologies described in this protocol) that address non-point sources can be added as validation data are generated.

1.1.2 Choice of Instrumentation. The choice of PI-ORS system to be used for the collection of measurement data (and subsequent calculation of PIC) is left to the discretion of the user, and should be dependent on the compounds of interest and the purpose of the study. The methodologies are independent of the particular PI-ORS system used to generate the PIC data. It is recommended for the HRPM, VRPM, and 1D-RPM methodologies that the typical expected concentration over the longer beams should be about 10 times the minimum detection limit of the instrument. When this is not the case, the user should replace nondetects with values of half the minimum detection limit (see Table A.3 in the Appendix A).
OTM-10 1-D RPM Configuration

Figure 3. Example of a 1D-RPM Configuration

Figure 5. An Example of a 1D-RPM Fenceline Monitoring Setup
The US EPA indicates 3 scales of measurements in 2006

A New EPA Method: Leak Detection Beyond LDAR

Extended Abstract #686

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Process Area/Fenceline Measurements—This scale of measurement includes the range from the size of a process area, say ten meters, to the fenceline of a facility. It is significantly larger and is not generally used to pinpoint leaking process components, though it can be useful for locating significant leaks. Measurements at this scale are particularly advantageous in identifying processes with significant emissions and in quantifying the emissions. Remote sensing approaches currently being applied on this scale include differential absorption light detection and ranging instrumentation (DIAL), path-integrated remote sensing coupled with dispersion modeling, and the RPM approach discussed in this paper which uses path-integrated remote sensing such as Fourier Transform infrared spectroscopy (FTIR), tunable diode lasers (TDL), and ultraviolet differential optical absorption spectroscopy (UV-DOAS).
Atmosfir’s Triangle for Fugitive Emissions Measurement and Monitoring

- **Annual Emission Rate**
- **Emission Reduction**
- **Fenceline Long Term & Real-Time Monitoring**
- **Plume characterization**
- **Short Term Flux Studies**

3.0 Measurements Applicable to Emissions Flux

Optical remote technologies have been applied to answer a variety of fugitive and area source emissions questions. The range of applications spans both short-term characterization and measurement of emission flux to long-term monitoring of trends in control strategy performance. ORS technologies have been used in mobile applications to screen pipelines or industrial sites for leaks or major sources and in stationary applications to measure flux from landfills, waste lagoons, and petrochemical plants.

The technologies described in Chapter 2 can be used alone or in combination to provide three major types of data: plume characterization, short-term flux measurements and long-term monitoring studies.
Annual Emission Rate

• Detailed short term emission flux studies at fenceline continuous monitoring sites
• Detailed composition profiling specific to a fenceline continuous monitoring site
• Data correlation between short term and continuous allows an accurate estimate of annual emission rate
Benzene VRPM to Beam Flux Regression

\[ y = 65x \]

\[ R^2 = 0.53 \]
South Coast AQMD Study

- 6-day short term detailed emission study by DIAL and SOF
- 4-week 24/7 D-fenceline installation
- Data correlation and total emissions for the 4-week period
- Repetitive SOF survey at six South Coast refineries
SE Wind Direction ~600 ppb 61 g/mol
South Wind Direction 180 ppb 73 g/mol
South Wind Direction 30 ppb 92 g/mol
Benzene | M5 | 03/18/2014, 22:12:35 | 14.12ppb | MQL: 0.87 | Path-Length: 147m
Benzene | M5 | 03/18/2014, 21:40:29 | 7.11 ppb | MQL: 0.85 | Path-Length: 147 m

`atmosfir`

![Graph with absorbance vs. wavenumber](image.png)
Benzene | M1 | 03/19/2014, 06:41:19 | 2.26 ppb | MQL: 0.97 | Path-Length: 208 m
Benzene | M4 | 03/18/2014, 21:26:31 | 1.59ppb | MQL: 0.83 | Path-Length: 147m

Absorbance [AU]

Wavenumber [cm⁻¹]
### Air Quality Alerts

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<tr>
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### Table

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<th>S3 [ppb]</th>
<th>S4 [ppb]</th>
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Pollutant roses
Relevance to Refinery Rule

• Time and spatial resolution for:
  – Root cause analysis
  – Emission reduction during the 2-week period
  – Large leaks of total alkane mixture

• Alternative fenceline monitoring
  – Target sensitivity of 0.3 ppb at 15-minute resolution
  – 2-week rolling average updated daily