

This Appendix provides a toolbox of information for learning more about open path technologies. The [overview](#) URL has a basic description of all the open path technologies and a searchable database of over 600 abstracts on various open path subjects. The [case studies](#) section provides a wide range of examples where open path technologies have been deployed and each citation is hyperlinked to its complete article or abstract for further information. The [Environmental Technology Verification Program](#) section contains links to EPA performance reports on various open path vendor equipment. The [guidance](#) section has both EPA and European documents on the use of open path equipment. Finally the [vendor](#) section lists the vendors, with contact information, who made presentations or had displays at the workshop.

## **OVERVIEW**

A layman's description of how DIAL works, some examples of its deployment, and references are found at <http://www.cluin.org/programs/21m2/openpath/lidar/>

## **CASE STUDIES**

An OP-FTIR fence-line monitoring system has been in operation at the TOSCO refinery in Rodeo, California, since 1997. The system consists of two monostatic OP-FTIR configurations deployed along the north and south fence lines of the plant. The one-way optical path of the north fence line is 930 m long and the south path of the south fence line is 955 m. The systems are set to monitor on a frequency of every five minutes and to sound an alarm if concentrations of some 26 target compounds exceed pre-set concentration levels (ppm/m level). Each month a report is developed that evaluates system performance and summarizes the chemicals detected, their concentrations, and the system detection limit for them. The system has a spectral library of over 300 chemicals. Because the collected monitoring spectra are preserved electronically, it is possible to re-examine a given time period to look for the presence of other than target chemicals. See the EPA webpage at <http://www.epa.gov/region09/features/tosco/monitoring.html>, or Contra Costa County Health Services at <http://www.cchealth.org/groups/hazmat/fenceline/>

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## **ENVIRONMENTAL TECHNOLOGY VERIFICATION PROGRAM**

The EPA ETV program has tested three OP-FTIR instruments, and the verification reports are available on the ETV website at: <http://www.epa.gov/etv>

Ail Systems Inc.--RAM 2000 Fourier Transform Infrared Open-Path Monitor  
Verification Statement (PDF, 42.2 K)  
[http://www.epa.gov/etv/pdfs/vrvs/01\\_vs\\_ail.pdf](http://www.epa.gov/etv/pdfs/vrvs/01_vs_ail.pdf)  
Verification Report (PDF, 541K) [http://www.epa.gov/etv/pdfs/vrvs/01\\_vr\\_ail.pdf](http://www.epa.gov/etv/pdfs/vrvs/01_vr_ail.pdf)

Bruker Daltonics, Inc.-- OPAG 22 Open-Path Gas Analyzer  
Verification Report. [http://www.epa.gov/etv/pdfs/vrvs/01\\_vr\\_bruker\\_opag.pdf](http://www.epa.gov/etv/pdfs/vrvs/01_vr_bruker_opag.pdf)

Spectrex, Inc.--SafEye 227 Infrared Open-Path Monitor  
Verification Statement: [http://www.epa.gov/etv/pdfs/vrvs/01\\_vs\\_safeyetwo.pdf](http://www.epa.gov/etv/pdfs/vrvs/01_vs_safeyetwo.pdf)  
Verification Report: [http://www.epa.gov/etv/pdfs/vrvs/01\\_vr\\_safeyetwo.pdf](http://www.epa.gov/etv/pdfs/vrvs/01_vr_safeyetwo.pdf)

The EPA ETV program has tested four TDL instruments.

Aerodyne Research, Inc.--QC-TILDAS. Open path tunable IR laser with quantum cascade test for Ammonia.  
Verification Statement: [http://www.epa.gov/etv/pubs/01\\_vs\\_aerodyne.pdf](http://www.epa.gov/etv/pubs/01_vs_aerodyne.pdf)  
Verification Report: [http://www.epa.gov/etv/pubs/01\\_vr\\_aerodyne.pdf](http://www.epa.gov/etv/pubs/01_vr_aerodyne.pdf)

Boreal Laser-- GasFinder 2.0 TDL Open-Path Monitor  
Verification Statement: [http://www.epa.gov/etv/pubs/01\\_vs\\_boreal.pdf](http://www.epa.gov/etv/pubs/01_vs_boreal.pdf)

Verification Report: [http://www.epa.gov/etv/pubs/01\\_vr\\_boreal.pdf](http://www.epa.gov/etv/pubs/01_vr_boreal.pdf)

OP SIS, AB--, LD500 Continuous Emission Monitor for Ammonia

Verification Statement: [http://www.epa.gov/etv/pdfs/vrvs/01\\_vs\\_opsis\\_ld500.pdf](http://www.epa.gov/etv/pdfs/vrvs/01_vs_opsis_ld500.pdf)

Verification Report: [http://www.epa.gov/etv/pdfs/vrvs/01\\_vr\\_opsis\\_ld500.pdf](http://www.epa.gov/etv/pdfs/vrvs/01_vr_opsis_ld500.pdf)

Siemens Laser Analytics, AB, LDS 3000 Continuous Emission Monitor for Ammonia

Verification Statement: [http://www.epa.gov/etv/pdfs/vrvs/01\\_vs\\_siemens.pdf](http://www.epa.gov/etv/pdfs/vrvs/01_vs_siemens.pdf)

Verification Report: [http://www.epa.gov/etv/pdfs/vrvs/01\\_vr\\_siemens.pdf](http://www.epa.gov/etv/pdfs/vrvs/01_vr_siemens.pdf)

UNISEARCH Associates, Inc.

LasIR Tunable Diode Laser Open-Path Monitor

Verification Statement: [http://www.epa.gov/etv/pubs/01\\_vs\\_unisearch.pdf](http://www.epa.gov/etv/pubs/01_vs_unisearch.pdf)

Verification Report: [http://www.epa.gov/etv/pubs/01\\_vr\\_unisearch.pdf](http://www.epa.gov/etv/pubs/01_vr_unisearch.pdf)

The EPA ETV program has tested three UV instruments, and the verification reports are available on the ETV website at: <http://www.epa.gov/etv>

Opsis, Inc.--AR-500 Ultraviolet Open-Path Monitor

Verification Statement: [http://www.epa.gov/etv/pubs/01\\_vs\\_opsis.pdf](http://www.epa.gov/etv/pubs/01_vs_opsis.pdf)

Verification Report: [http://www.epa.gov/etv/pubs/01\\_vr\\_opsis.pdf](http://www.epa.gov/etv/pubs/01_vr_opsis.pdf)

Spectrex, Inc.--SafEye 420 Ultraviolet Open-Path Monitor

Verification Statement: [http://www.epa.gov/etv/pubs/01\\_vs\\_safeyefour.pdf](http://www.epa.gov/etv/pubs/01_vs_safeyefour.pdf)

Verification Report: [http://www.epa.gov/etv/pubs/01\\_vr\\_safeyefour.pdf](http://www.epa.gov/etv/pubs/01_vr_safeyefour.pdf)

## **GUIDANCE AND REPORTS**

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Sira Ltd. 2004b. Recommendations for Performance Standards for Open-Path Instrumentation. Remote Optical Sensing Evaluation (ROSE) Consortium, 174 pp.

## **VENDORS MAKING PRESENTATIONS AT WORKSHOP**

ARCADIS--RPM and VRPM technology  
[ram.hashmonay@arcadis-us.com](mailto:ram.hashmonay@arcadis-us.com) or <http://www.arcadis-us.com/>

Boreal Laser, Inc.—Tunable Diode Laser manufacturer  
[hadam@boreal-laser.com](mailto:hadam@boreal-laser.com) or <http://www.boreal-laser.com>

Agenda Enviro AB—Environmental Consulting  
[lennart.frisch@telia.com](mailto:lennart.frisch@telia.com) or <http://www.agendaenviro.se/eng/>

Fluxsense, AB is a spin off company from research done at Chalmers University of Technology in Göteborg, Sweden. They have a number of reports and papers on the Solar Occultation Flux Method.  
[http://www.fluxsense.se/sof\\_reference\\_reports.htm](http://www.fluxsense.se/sof_reference_reports.htm)

IMACC Instruments—FTIR open path instrument manufacturer  
[rspellicy@imacc-instruments.com](mailto:rspellicy@imacc-instruments.com) or <http://www.ftir.bz/>

ITT Corporation-Space Systems Division—Aircraft borne DIAL for gas pipeline leaks  
[rspellicy@imacc-instruments.com](mailto:rspellicy@imacc-instruments.com) or <http://www.ssd.itt.com/angel/overview.shtml>

Spectrasyne, Ltd.—DIAL Lidar  
For more information on Spectrasyne see:  
[jan@spectrasyne.ltd.uk](mailto:jan@spectrasyne.ltd.uk) or [http://www.spectrasyne.ltd.uk/html/about\\_dial.html](http://www.spectrasyne.ltd.uk/html/about_dial.html)

The TGB Partnership—Environmental Consulting--control of air emissions, the development of standards and regulations, structure design  
[randy.kissell@tgbpartnership.com](mailto:randy.kissell@tgbpartnership.com) or <http://www.tgbpartnership.com/>

## **VENDORS HAVING DISPLAYS AT THE WORKSHOP BUT NOT MAKING PRESENTATIONS**

LaSen, Inc.—Airborne open path pipeline leak detection (ALPIS)  
[rrjennett@zianet.com](mailto:rrjennett@zianet.com) or [www.laseninc.com](http://www.laseninc.com)

MIDAC Corporation—FTIR instrument manufacturer  
[mpanek@midac.com](mailto:mpanek@midac.com) or <http://www.midac.com/>

MSI Air—Environmental Consulting—use of open path monitoring at remedial sites  
[trminnich@msiair.net](mailto:trminnich@msiair.net) or <http://www.msiair.net/>

Opgal, Inc.—IR camera manufacturer  
[wahnon@opgal.com](mailto:wahnon@opgal.com) or <http://www.opgal.com/>

Opsis, Inc.—DOAS system manufacturer  
[paulsf86@prodigy.net](mailto:paulsf86@prodigy.net) or <http://www.opsis.se/>

Terra Air Services—Environmental consulting—open path fenceline monitoring  
[mball@terraairservices.com](mailto:mball@terraairservices.com)