

Emerging Technology Optical Imaging Leak Detection



**Murphy Exploration and Production,
Gulf Coast Environmental Affairs Group,
American Petroleum Institute and
EPA's Natural Gas STAR Program**

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Optical Imaging Technology

- Optical Imaging Technology for DI&M
- IR BAGI Camera
- IMSS IR Camera
- Motion pictures of BAGI leak detections



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Optical Imaging Technology for DI&M

- Class of technologies that use principles of infrared light and optics to create an image of chemical emission plumes
- Offer more cost-effective use of resources (labor, equipment etc.)
 - ◆ Screen hundreds of components an hour
 - ◆ Quicker identification & repair of leaks



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Technologies for Methane Detection

- Two technologies currently in development
- Backscatter Absorption Gas Imaging (BAGI)
 - ◆ Viewing area illuminated with IR laser light
 - ◆ IR camera images reflected laser light
 - ◆ Gas cloud absorbs the IR light (negative image)
- Image Multi-Spectral Sensing (IMSS)
 - ◆ IR camera acquires image in full light spectrum
 - ◆ Optics separate and recombine selected spectrum emitted by chosen chemicals to create an image
 - ◆ Computer processes into a false-color image of emission plume superimposed on visible image



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IR BAGI Camera

- ❑ Developed by Sandia National Laboratory
- ❑ Real-time instantaneous detection
- ❑ No quantification of detected leaks yet
- ❑ Does not differentiate chemical species
 - ◆ Tuned to optimum wavelength absorbed by chemical species



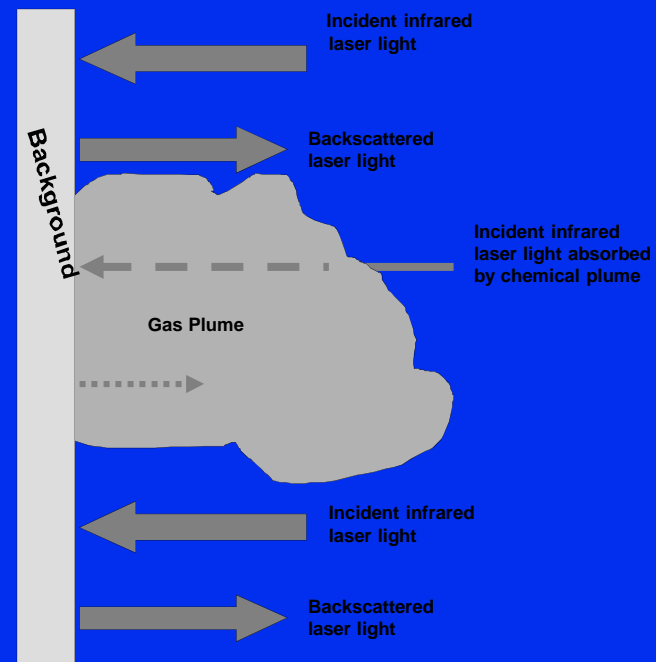
Shoulder-mounted camera

Backpack power/control



Backscatter Absorption Gas Imaging (BAGI) Process

- ❑ Incident IR laser light reflects off background & returns to camera
- ❑ IR camera creates black & white image of equipment
- ❑ Chemical plume absorbs IR light creating a negative image
- ❑ Leak plume appears as a black, smoky image in BAGI camera



Source: As Adapted from McRae, Tom, *GasVue: A Rapid Leak Location Technology for Large VOC Fugitive Emissions*. (Presentation at the CSI Petroleum Refining Sector Equipment Leaks Group, Washington, DC, Sept. 9, 1997).

Note: Although this Exhibit shows the gas in contact with the background material, it is not a requirement that the gas be in contact with the background. The gas plume need only be between the background and the infrared camera.



IR BAGI Camera, cont.

- Portable
 - ◆ Camera ~20 pounds
 - ◆ Shoulder- or tripod-mounted operation
 - ◆ Size of a shoulder-mounted TV camera
- DC or AC Power
 - ◆ Rechargeable battery back-pack ~12 pounds
- Camera viewer and tape recording toggle between IR and visible light



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BAGI Demonstrations

- Joint Government – Industry Test Initiative, 1999 - present
 - ◆ Laboratory Testing
 - ◆ Chemical Plants
 - ◆ Refineries
- EPA, DOE, Texas Environmental Agencies, API and petroleum companies



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Leak Detected w/BAGI Camera

Visible light view of leaking flange



Leaking flange

Infrared view of leaking flange



Flange

Hydrocarbon plume



IMSS IR Camera

- ❑ Developed by Pacific Advanced Technology (PAT)
- ❑ Based on principle of diffractive optics
- ❑ Consists of:
 - ◆ IR Camera
 - ◆ Patented IMSS Lens
 - ◆ Internal PC with algorithms to process images



PAT Sherlock Camera – Pre-production Model



IMSS IR Camera, cont.

- ❑ Does not quantify leaks yet
- ❑ Can differentiate chemical species
- ❑ Battery operated
- ❑ Portable
 - ◆ 12 lb (including battery)
 - ◆ 12" x 6" x 8"

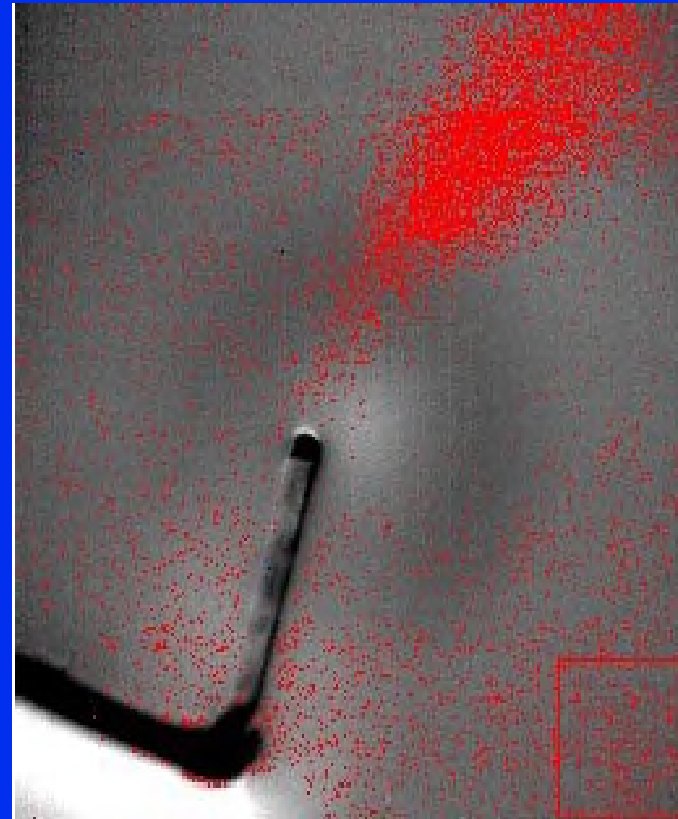


IMSS on Radiance 1 Infrared Camera in Oil Refinery (Precursor to PAT Sherlock Camera)



IMSS IR Camera, cont.

- Camera acquires image of component of interest
 - ◆ No background required
- Image processed in PC
- Results presented
 - ◆ Leak shown in false-color overlay
- Sherlock Camera with real-time image processing currently being tested



Methane Gas Leaking from Simulated Roof Vent.
Detected with IMSS and Radiance 1 Infrared
Camera



IMSS IR Demonstrations

- Demonstrations at:
 - ◆ Off shore oil platform
 - ◆ Refinery
 - ◆ Oil & gas processing plants
 - ◆ Airborne platform
- Laboratory performance testing



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Contact Information

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◆ Sandia National Laboratories

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□ IMSS IR Camera

◆ Pacific Advanced Technology

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□ Optics

◆ Laser Imaging Systems

- **Tom McRae**
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Contributions by Many

- **API Member Company Representatives**
 - ◆ Technical review and project planning
- **API Staff**
 - ◆ Funding of studies, coordination of regulatory activities
- **Department of Energy-Office of Fossil Fuels**
 - ◆ Funding fiber laser development at Sandia Labs
- **Department of Energy-Office of Industrial Technology**
 - ◆ Funding fiber laser development at Sandia Labs
- **EPA-National Enforcement and Investigation Center**
 - ◆ Looking for reliable alternative to Method 21
- **EPA-Office of Air Quality Planning and Standards**
 - ◆ Responsible for preparing regulatory change documentation



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Contributions by Many

- **National Advisory Committee on Environmental Policy and Technology**
 - ◆ EPA advisory group that funded early analyses
- **Laser Imaging Systems, Inc.**
 - ◆ Holds patent on scanner used in fiber laser
- **Sandia National Laboratory**
 - ◆ Development of fiber laser, has several patent applications, leading discussions with vendors for commercialization
- **ICF Consulting**
 - ◆ Protocols, data analysis, reporting, QA/QC, funded by EPA and API
- **URS Radian**
 - ◆ Performed bagging emissions quantification during field tests
- **Texas Council on Environmental Technologies**
 - ◆ Funding additional testing of alternative imaging technologies

