

Emerging Technology Optical Imaging Leak Detection



Gas STAR 10th Annual Implementation Workshop

Houston, Texas

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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



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



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



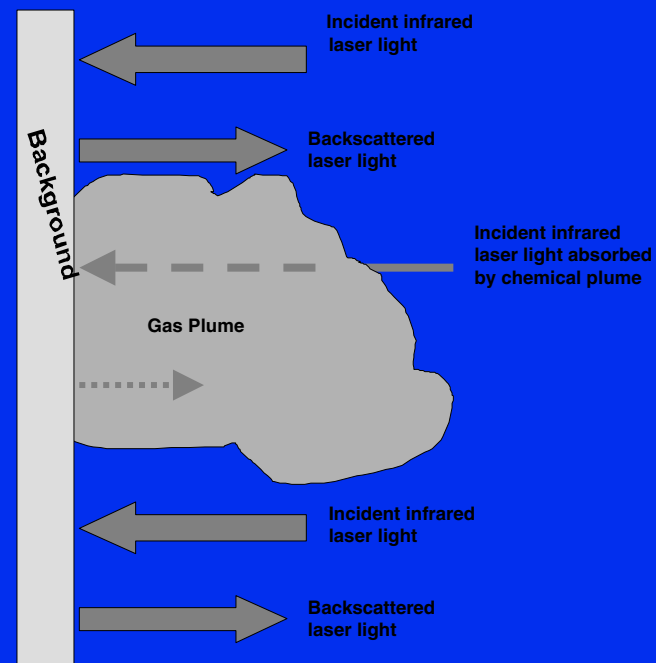
Shoulder-mounted camera

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



BAGI Demonstrations

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

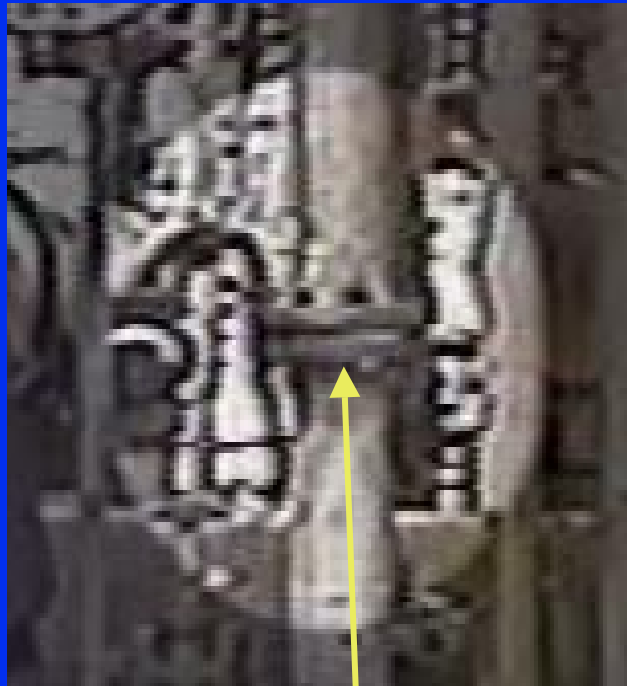


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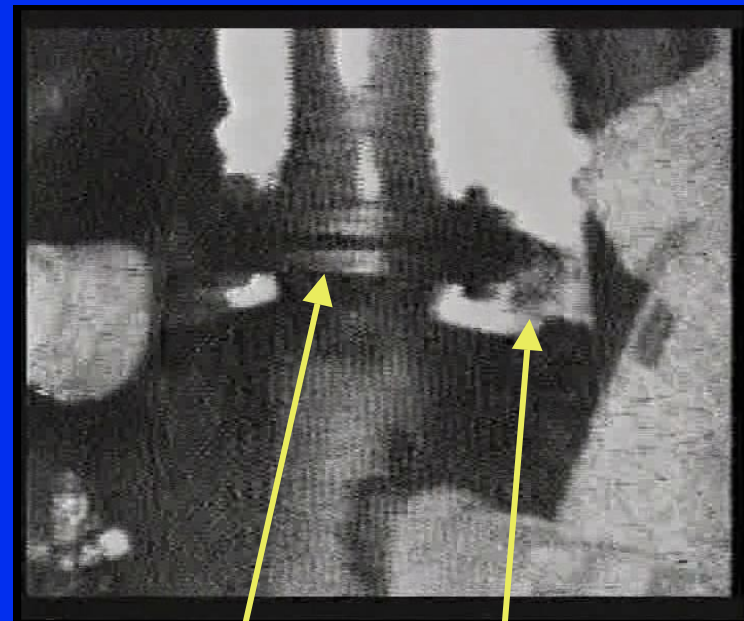
Leak Detected w/BAGI Camera

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"

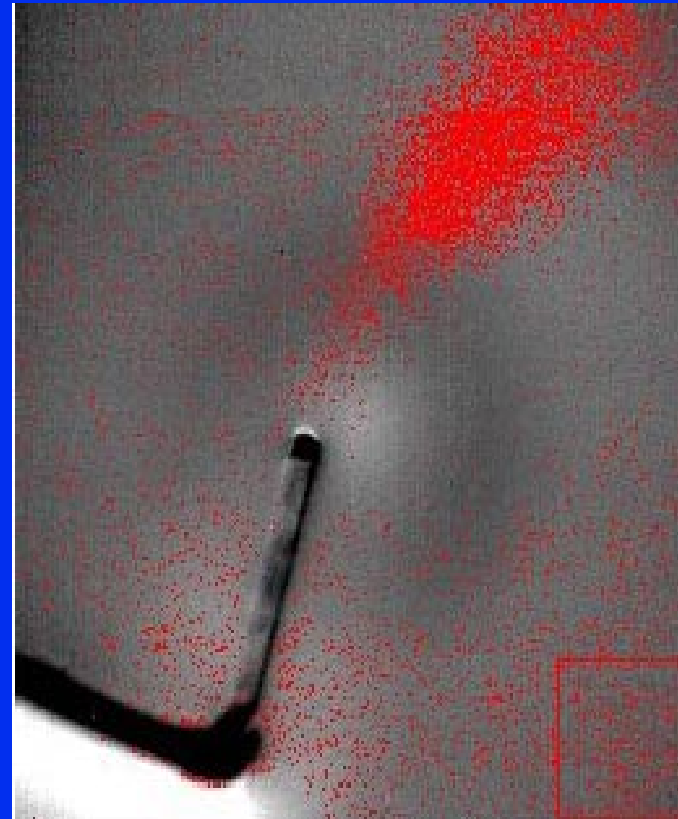


IMSS on Radiance 1 Infrared Camera in Oil Refinery (Precursor to PAT Sherlock Camera)



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



Contact Information

★ BAGE IR Camera

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★ IMSS IR Camera

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★ Optics

- ◆ Laser Imaging Systems
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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



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

