

CRAIG O'NEILL

DIRECTOR OF BUSINESS DEVELOPMENT  
OPTICAL GAS IMAGING

# OPTICAL GAS IMAGING AND US REGULATORY FRAMEWORK

APRIL 2024

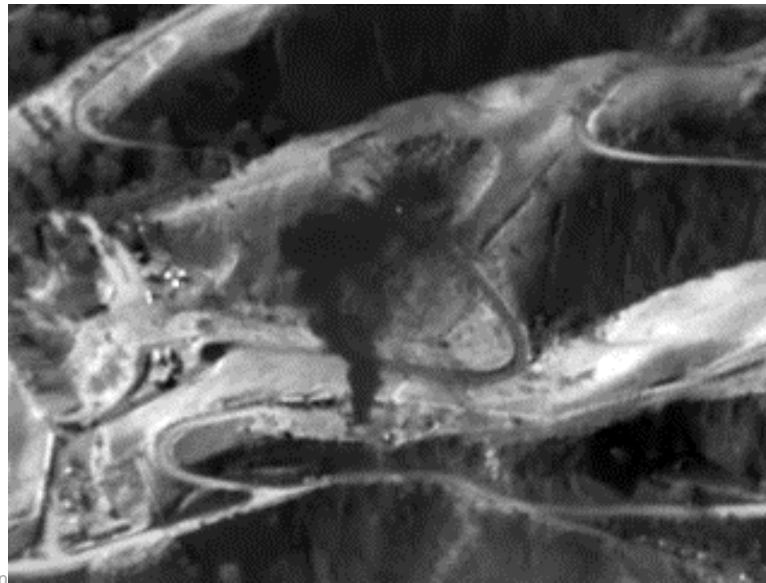


# OPTICAL GAS IMAGING (OGI)



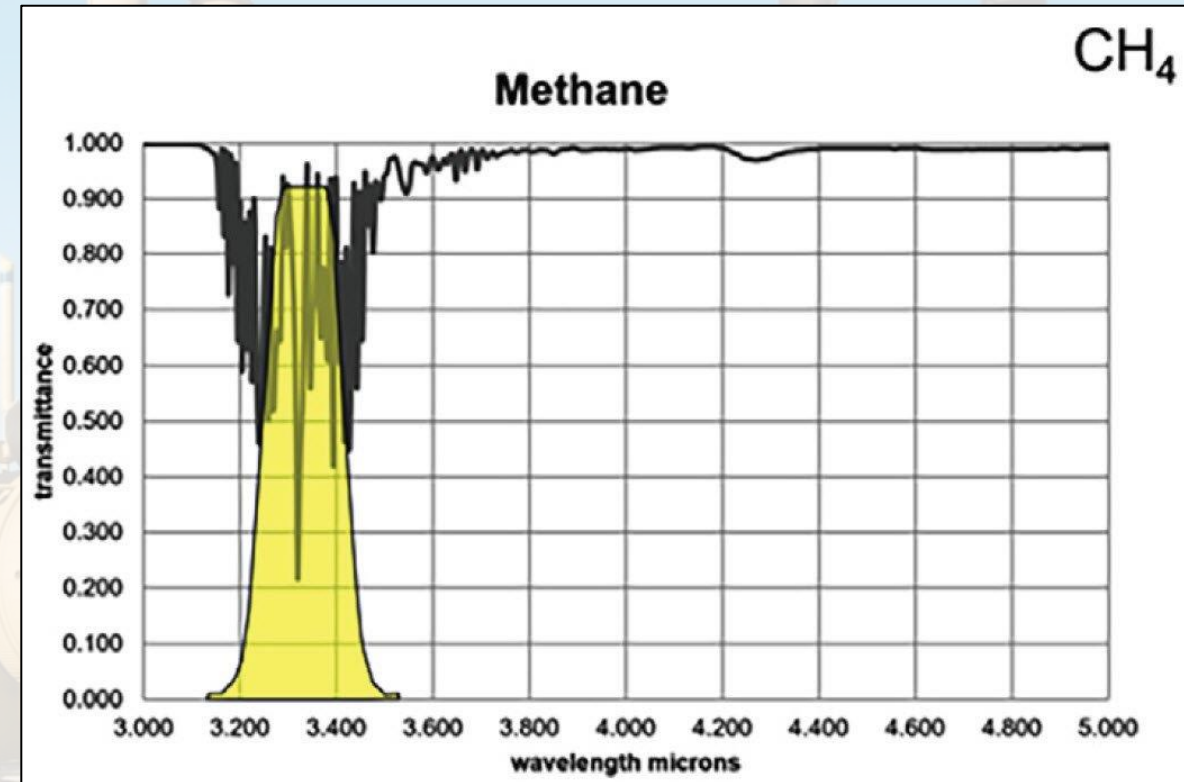
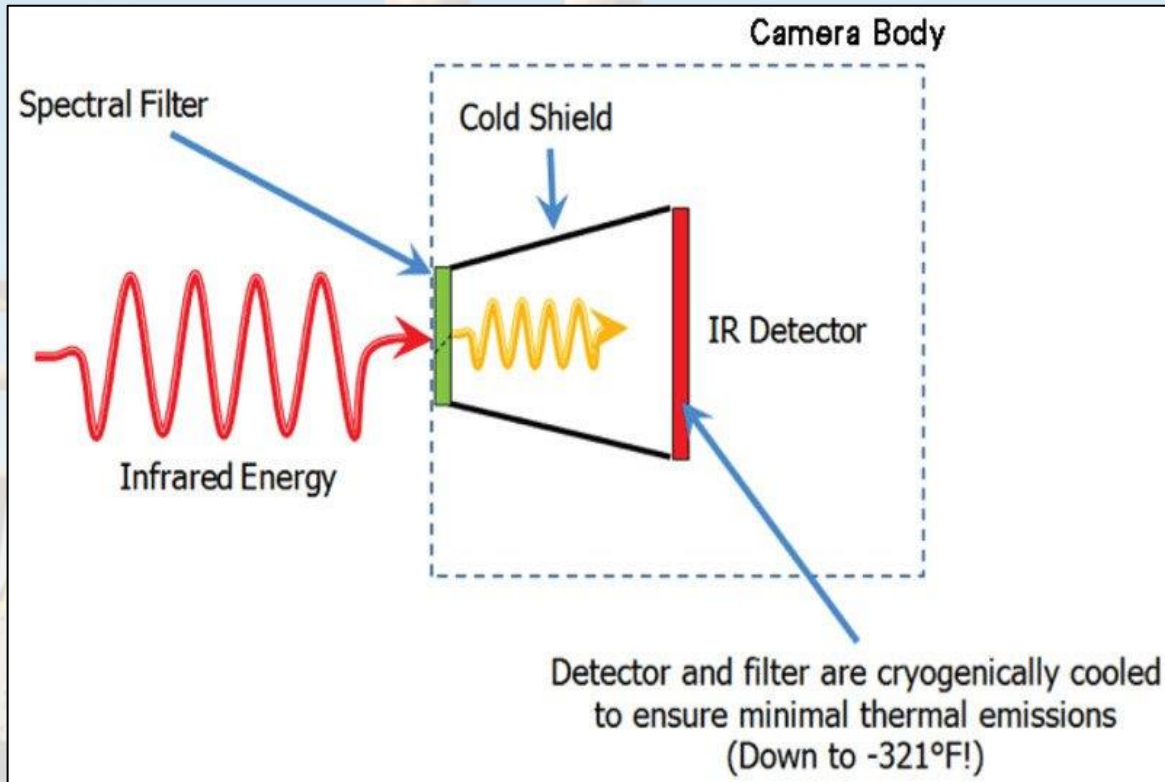
## Gas Leak Detection

- Improving safety and emission mitigation
- Enhancing productivity and ROI
- Lowering capital and operational costs
- Reducing business risk



# What is Optical Gas Imaging?

Optical Gas Imaging (OGI) Cameras are specialized Infrared cameras that use spectral filtering techniques focused on unique band passes where specific gases absorb energy. These cameras can visualize gas emissions by limiting the energy that reaches highly sensitive detectors making gas emissions appear as “smoke” in the image.



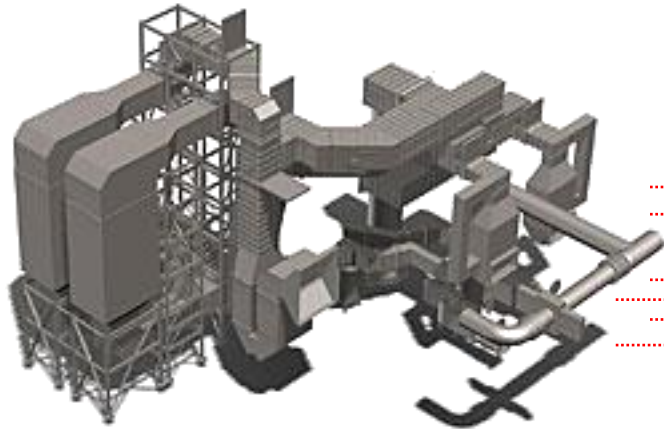
Infrared Absorption for Methane

The **yellow area** is the spectral filter for hydrocarbons

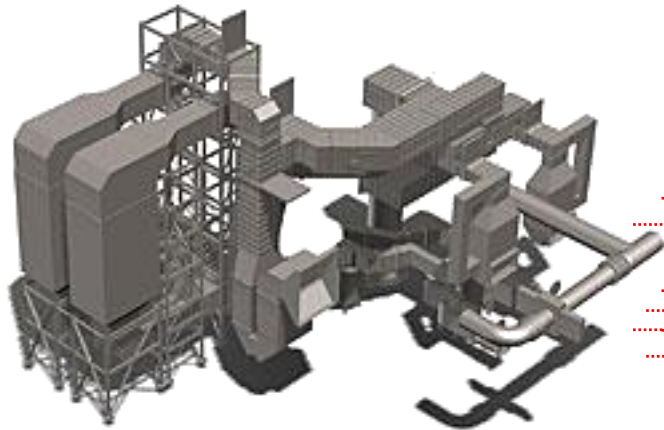
# How Does Optical Gas Imaging Work?



# How Does Optical Gas Imaging Work?



# How Does Optical Gas Imaging Work?



# Understanding Regulations tied to Optical Gas Imaging

- ▶ History of LDAR and Optical Gas Imaging
- ▶ Regulations of Today
- ▶ Current Proposed, New and Tomorrow's OGI Regulations
- ▶ How do OGI Cameras Help LDAR Operators Meet Regulations?

# Historical Perspective

## 1970 Environmental Activities in the U.S.

- July 1970: Title 40 of the Code of Federal Regulations, “Protection of the Environment” was signed into law
- December 1970: The EPA came into formal existence
- December 1970: The initial Clean Air Act was passed
  
- January 20, 1984: Proposed VOC and SO<sub>2</sub> regulations for new stationary sources
  
- 1990: EPA mandated that users of Volatile Organic Compounds (VOC) establish a Leak Detection and Repair (LDAR) program.



1960's Smog, Los Angeles



# US OGI Regulations: Key Dates



FLIR introduces the world's first commercial Optical Gas Imager, the GasFindIR

2005

May 2005

2023

# Historical Perspective



Optical Gas Imaging emerged in 2005 as an alternative to LDAR. Research had been ongoing for several years prior and EPA was carefully monitoring progress (EPA was quoted in the trade release of the 1<sup>st</sup> commercial OGI camera, the GasFindIR).



June 8, 2005

## FLIR Systems Introduces New Infrared Camera for Detection of Volatile Organic Compounds

### GasFindIR(TM) Helps Improve Safety at Petrochemical Refining, Transportation and Storage Facilities

PORTLAND, OR, Jun 08, 2005 (MARKET WIRE via COMTEX) -- FLIR Systems, Inc. (NASDAQ: FLIR), the global leader in infrared cameras, announced today the introduction of its new GasFindIR™ infrared (IR) camera. GasFindIR is the first commercially viable infrared camera capable of detecting volatile organic compound (VOC) gas emissions. Sources of VOCs include petrochemical facilities, natural gas pipelines, transfer stations, tankers, railway cars and even landfills emitting methane gas and other toxic chemicals into the environment.

Often referred to as "fugitive gas emissions," VOC gases are a major contributor to global warming. In addition, these emissions cost industry millions of dollars in lost product and in regulatory fines. They also pose safety risks to workers and civilians. A truly revolutionary product, GasFindIR makes what was once invisible, visible, in order that the leakage can be easily identified and stopped. A typical refinery can have up to 500,000 points that currently have to be checked manually with a "sniffer" placed directly on the leak, which is an expensive and time consuming process.

"We are in the process of writing new regulations to take advantage of this new infrared camera," said David Markwordt, of the Environmental Protection Agency's Emissions Standards Division while presenting at the recent annual Fugitive Emissions conference. "It's a remarkable new technology."

# US OGI Regulations: Key Dates



FLIR introduces the world's first commercial Optical Gas Imager, the GasFindIR

EPA Subpart W proposal with "OGI Enhancement Factor"

Subpart W final rule signed

EPA OOOOa final rule

2005      May 2005      Dec 2008      Nov 2010      Sept 2015      June 2016      Nov 2021      Aug 2023      Mar 2024      2024

EPA's Alternative Work Practice (AWP) for Method 21

EPA OOOOa Effective Date: September 18, 2015

EPA publishes OOOOa/b/c draft and amends Appendix K

EPA OOOOa/b/c final rule

# OGI as a Standard in Regulations

## Alternative Work Practice

EPA NSPS 40 CFR part 60, subpart OOOOa

While the AWP introduced OGI as an alternative method to Method 21, it had some “restrictions” addressed in petitions for reconsideration:

- Must perform Annual Method 21 Survey
- Removal of Minimum Detection Sensitivity Level
- Requirement to record entire survey and keep records
- Did not allow Difficult-to-Monitor (DTM) provisions

Final Subpart OOOOa Standards for Emission Sources with BSER (Best System for Emissions Reduction)			
Source	BSER	Monitoring Frequency	Alternative Method Allowed
Oil & Gas well sites	Optical Gas Imaging	Bi-annual	Method 21 with 500 ppm threshold
Compressor stations (Production gathering & boosting stations)	Optical Gas Imaging	Quarterly	Method 21 with 500 ppm threshold

OOOOa-b-c

## Controlling Air Pollution from the Oil and Natural Gas Industry

[CONTACT US](#)

[Oil and Natural Gas Air Standards Home](#)

[Basic Information](#)

[Actions and Notices](#)

[Implementation](#)

# EPA Issues Supplemental Proposal to Reduce Methane and Other Harmful Pollution from Oil and Natural Gas Operations

November 11, 2022 -- EPA is proposing to update, strengthen and expand its November 2021 proposal that would secure major climate and health benefits for all Americans by reducing emissions of methane and other harmful air pollution from both new and existing oil and gas operations. The Agency has issued a supplemental proposal that would achieve more comprehensive emissions reductions from oil and natural gas facilities by improving standards in the 2021 proposal and adding proposed requirements for sources not previously covered.

**Note: The comment period on the supplemental proposal closed February 13, 2023.**

### Regulatory Documents

- [Standards of Performance for New, Reconstructed, and Modified Sources and Emissions Guidelines for Existing Sources: Oil and Natural Gas Sector Climate Review](#)
- [Additional regulatory documents](#)
- [Regulatory Impact Analysis](#)
  - [Supplementary Material for the RIA: Draft Report on the Social Cost of Greenhouse Gases \(pdf\)](#) (6.69 MB)

# Summary of OOOOabc

## 2021 Proposed Regulations

- Undo previous Policy Rule"
- Revise OOOOa - This is referred to as "NSPS OOOOb"
  - Add types of sources covered
  - Add components non-covered in OOOOa
  - Increase monitoring frequency
  - **Add OGI to Natural Gas Plant monitoring**
- Address **Existing Sources with Emission Guidelines (EG) OOOOc**
- Expand Affected Sources for Gas Plants

## 2022 Draft Update

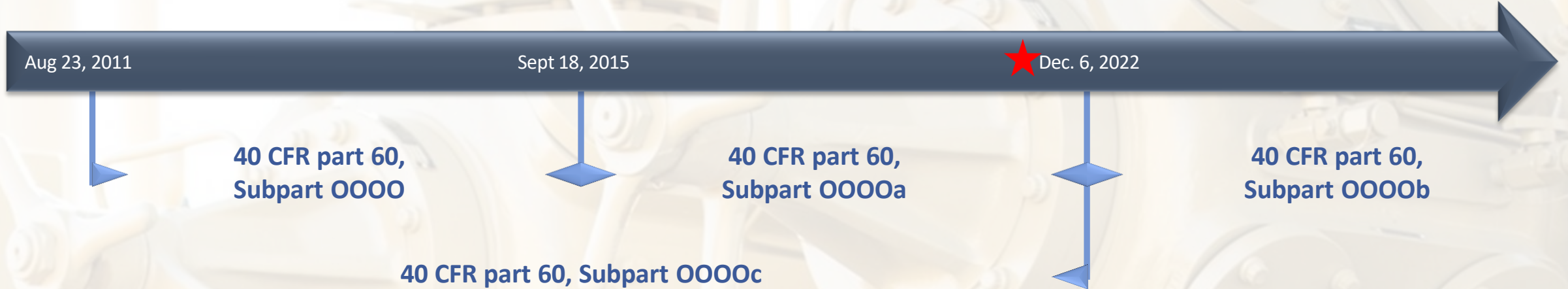
- Update, strengthen and/or **expand** standards previously presented in **2021 proposal**
- Establish **implementation requirements for states** to limit methane
- Focuses on "**new and developing technologies** (Advanced Methane Measurement Technologies)
- Adds a "**super-emitter response program**" (100 kg/hr of methane or greater)

## 2023 Final Rule

- New affected date is **December 6, 2022** (vs November 15, 2021)
- Advanced Technology Updates
  - Introduce **periodic vs continuous** methods
  - use multiple technologies in combination
  - pathway for **demonstrating new technologies** meet the performance requirements
- **Finalizing "Super Emitter Program"**
- Finalizing that process **controllers emission rate of zero**

# Key Dates for Regulatory Action

## NEW, MODIFIED, OR RECONSTRUCTED SOURCES



Subpart	Source Type	Applicable Dates
40 CFR part 60, subpart OOOO	New, modified, or reconstructed sources	After August 23, 2011, and on or before September 18, 2015
40 CFR part 60, subpart OOOOa	New, modified, or reconstructed sources	After September 18, 2015, and on or before December 6, 2022 ★
40 CFR part 60, subpart OOOOb	New, modified, or reconstructed sources	After December 6, 2022 ★
40 CFR part 60, subpart OOOOc	Existing sources	On or before December 6, 2022 ★

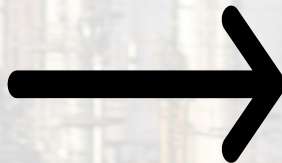
# NSPS 0000b vs EG 0000c

## NSPS 0000b - Standards of Performance for ... Facilities ... After December 6, 2022\*\*\*

- Regulates GHG, **VOC**, SO<sub>2</sub>
- Well site, compressor station BSER maintained as OGI (§60.5397b), additional AVO requirements
- Gas processing plants BSER updated from M21 to OGI – Appendix K

## EG 0000c – Emissions Guidelines for Greenhouse Gas Emissions ... <existing> on or Before December 6, 2022\*\*\*

- Control of **GHG only**... LDAR matches 0000b
- Expected timeline:
  - *States plan due to EPA*: 18 months following final EG
  - *Compliance deadline*: 36 months after state plan submittal deadline





# 0000b-c LDAR Comparison



SOURCE	Table 1-1 NSPS 0000b Emissions Sources, Baseline Requirements, and Requirements under the Final Rule		Table 1-2 EG 0000c Emissions Sources, Baseline Requirements, and Requirements under the Final Rule	
	Standards of Performance		Presumptive Standards of Performance	
	In the Baseline	Under the Final Rule	In the Baseline	Under the Final Rule
Fugitive Emissions/Equipment Leaks				
Well Sites				
Wellhead only, single well site	No requirement	Quarterly AVO monitoring	No requirement	Quarterly AVO monitoring
Wellhead only, multiple well site	No requirement	Quarterly AVO monitoring + Semiannual OGI	No requirement	Quarterly AVO monitoring + Semiannual OGI
Single well site with a single piece of major equipment and no tank battery	Semiannual OGI	Quarterly AVO monitoring	Pre-0000a: No requirement Post-0000a: Semiannual OGI	Quarterly AVO monitoring
Multiple well site with a single piece of major equipment, or any site with two or more pieces of major equipment or one piece of major equipment and a tank battery	Semiannual OGI	Bimonthly AVO monitoring + Quarterly OGI	Pre-0000a: No requirement Post-0000a: Semiannual OGI	Bimonthly AVO monitoring + Quarterly OGI
Gathering and Boosting Stations				
Transmission and Storage Compressor Stations	Quarterly OGI	Monthly AVO monitoring + Quarterly OGI	Pre-0000a: No requirement Post-0000a: Quarterly OGI	Monthly AVO monitoring + Quarterly OGI
Natural Gas Processing Plants	NSPS Subpart VVa	Bimonthly OGI via Appendix K	Pre-KKK: No requirement Post-KKK and Pre-0000: NSPS Subpart VV Post-0000: NSPS Subpart VVa	Bimonthly OGI via Appendix K

# Impact of 0000c



**Table 2-6 Projection of Incrementally Impacted Affected Facilities under the Final NSPS 0000b and EG 0000c, 2024 to 2038 (Production Sources)**

Year	Fugitive Emissions		Pneumatics		Associated Gas	Liquids Unloading	Storage Vessels		
	Well Sites	Flares	Well Sites	Controllers	Pumps	Well Sites	Events	Batteries	Tanks
2024	8,800	4,700	6,500	45,000	1,900	2,300	460	570	1,900
2025	18,000	9,800	14,000	95,000	4,000	4,700	980	1,200	4,000
2026	28,000	15,000	21,000	140,000	6,200	7,200	1,500	1,900	6,300
2027	38,000	20,000	28,000	190,000	8,300	9,700	2,100	2,500	8,300
2028	520,000	55,000	350,000	1,400,000	100,000	67,000	270,000	3,000	9,700
2029	510,000	57,000	350,000	1,400,000	100,000	67,000	260,000	3,400	11,000
2030	500,000	59,000	340,000	1,400,000	100,000	67,000	260,000	3,800	12,000
2031	490,000	62,000	340,000	1,400,000	99,000	68,000	250,000	4,200	12,000

# Advanced Methane Detection Technology



## Action Levels for **PERIODIC SCREENING** Table 1 & 2 to Subpart OOOOb of Part 60

Table 1: Facilities with Quarterly OGI

Minimum Screening Frequency	Minimum Detection Threshold of Screening Technology
Quarterly	≤1 kg/hr
Bimonthly	≤2 kg/hr
Monthly	≤5 kg/hr
Bimonthly + Annual OGI	≤10 kg/hr
Monthly + Annual OGI	≤15 kg/hr

Table 2: Single well, Multi-wellhead and Small well Sites

Minimum Screening Frequency	Minimum Detection Threshold of Screening Technology
Semiannual	≤1 kg/hr
Triannual	≤2 kg/hr
Quarterly	≤5 kg/hr
Triannual + Annual OGI	≤10 kg/hr
Quarterly + Annual OGI	≤15 kg/hr
Bimonthly	≤15 kg/hr

## Action Levels for **CONTINUOUS MONITORING**

Action Level	Wellhead only	other well sites and compressor stations
Long-term	1.2 kg/hr	1.6 kg/hr
Short-term	15 kg/hr	21 kg/hr

Long-term action level → 90-day rolling average  
Short-term action level → 7-day rolling average

- New detection thresholds of 0.40 kg/hr (CH<sub>4</sub>)
- Systems must transmit data every 24 hours

**Note:** Fixed OGI Monitoring expected to be PERIODIC



# Appendix K

## Determination of Volatile Organic Compound and Greenhouse Gas Leaks Using Optical Gas Imaging

### 1.0 Scope and Application

#### 1.1 Analytes.

Analytes	CAS No.
Volatile Organic Compounds (VOCs)	No CAS number assigned.
Methane	74-82-8
Ethane	74-84-0

1.1.1 This protocol is applicable to the detection of VOCs, including hazardous air pollutants (HAPs), and hydrocarbons, such as methane and ethane.

1.2 Scope. This protocol covers surveys of process equipment using Optical Gas Imaging (OGI) cameras in sectors where the majority of compounds (>75 percent by volume) in the emissions streams have a response factor of at least 0.25 when compared to the response factor of propane and can be imaged by the equipment specified in Section 6.0. The specific component focus for the surveys is determined by the referencing subpart, and can include, but is not limited to, valves, flanges, connectors, pumps, compressors, open-ended lines, pressure relief devices, and seal systems.

1.3 Applicability. This protocol is applicable to facilities when specified in a referencing subpart. This protocol is intended to help determine the presence and location of leaks and is not currently applicable for use in direct emission rate measurements from sources.

### 2.0 Summary

2.1 A field portable infrared (IR) camera capable of imaging the target gas species is employed to survey process equipment and locate fugitive or leaking gas emissions. By restricting the amount of incoming thermal radiation to a small bandwidth corresponding to a region of interaction for the gas species of interest, the camera provides an image of an invisible gas to the camera operator. The camera type and manufacturer are not specified in this protocol, but the camera used must meet the specifications and performance criteria presented in Section 6. The keys to becoming proficient and maintaining leak detection proficiency using OGI cameras are proper camera operator training with sufficient field experience and conducting OGI surveys frequently throughout the year.

### 3.0 Definitions

*Ambient air temperature* means the air temperature in the general location of the component being surveyed.

*Camera configuration* means different ways of setting up an OGI camera that affect its detection capability. Examples of camera configurations that can be changed include the operating mode (e.g., standard versus high sensitivity or enhanced), the lens, the portability (e.g., handheld versus tripod), and the viewer (e.g., OGI camera screen versus an external device like a tablet).

*Delta temperature (delta-T or  $\Delta T$ )* means the difference in temperature between the emitted process gas temperature and the surrounding background temperature. It is an acceptable practice in the field to assume that the emitted process gas temperature is equal to the ambient air temperature.

# Appendix K History

- Appendix K was **first mentioned in the Alternative Work Practice** of 2012 as a “Test Plan Study”
- The first released Appendix K Technical Support Document (TSD) draft (40 CFR Part 60, Appendix K) was in August 2015 **to support the OOOO and OOOOa** regulations
- The original “Appendix K” documents were **TSD only** with no formal release of an Appendix on “Determination of .... Leaks Using Optical Gas Imaging”

★ Appendix K was **released as part of the 2021 OOOOabc** proposal, revised in 2022 and finalized on December 2, 2023, with updates/changes

**ERG**

Test Plan for Laboratory Feasibility Study  
WA 2-09, Task 3  
“Optical Gas Imaging Protocol”

Prepared for:  
**U.S. Environmental Protection Agency**  
Mr. Jason DeWees  
U.S. Environmental Protection Agency  
OAQPS/MTG  
109 TW Alexander Drive  
Mail Code E143-02  
RTP, N.C. 27711

Prepared by:  
**Eastern Research Group, Inc.**  
601 Keystone Park Drive  
Suite 700  
Morrisville, NC 27560

November 19, 2012

EPA Contract No. EP-D-11-006  
Work Assignment 2-09

**DRAFT**  
Support Document  
Optical Gas Imaging Protocol  
(40 CFR Part 60, Appendix K)

Prepared by:  
Jason DeWees  
U.S. Environmental Protection Agency  
Air Quality Planning Standards  
Air Quality Assessment Division  
Optical Gas Imaging Technology Group (E141-03)  
Research Triangle Park, NC 27711

Prepared by:  
Tracey L. Footer  
**Eastern Research Group, Inc.**  
601 Keystone Park Drive, Suite 700  
Morrisville, NC 27560

Revision No. 5  
August 11, 2015

EPA Contract No. EP-D-11-006  
Work Assignment 3-09

# What is Appendix K?

## **Determination of Volatile Organic Compound and Greenhouse Gas Leaks Using Optical Gas Imaging**

- It is a “protocol” that:
  - is applicable to the detection of VOCs, (HAPs), and hydrocarbons, such as methane...
  - covers surveys of process equipment using Optical Gas Imaging (OGI) cameras ...
  - is applicable to facilities when specified in a referencing subpart...
- It is applied to:
  - a field portable infrared (IR) camera ...
  - survey process equipment and locate fugitive or leaking gas emissions
  - the camera used must meet the specifications and performance criteria presented in Section 6
  - Requires camera operator training with sufficient field experience ...

# Key Aspects of Appendix K

## Major topics in Appendix K:

- Performance of IR Cameras
  - Can detect compounds of interest (VOC and not just methane)
  - ★ Minimum Detectable Limits of 19 g/hr methane and 29 g/hr butane or 22 g/hr propane
  - Camera performs to a developed Operating Envelope (wind, distance and Delta T)
    - ★ Option to do daily field check in lieu of Operating Envelope
- Develop Monitoring Plans for the survey, operator and reporting
  - Breaks: 5 minutes every 30 minutes of “continuous” operation
  - Dwell time **per component** of 2 seconds via 2 angles
    - ★ Addition of “simple scene” option (10 components per less in scene)
- Training
  - Classroom, Field Surveys and Quarterly Reviews
  - Senior OGI Camera Operator: minimum of 1400 hours using OGI (at least 40 hours in the past 12 months)
- Record keeping for 5 years (including video or photo of leaking component)



# Appendix K vs §60.5397b

Appendix K only applies to “referenced subparts” of regulations. Optical Gas Imaging operations would be governed by §60.5397 in many previous regulations.

## Where Appendix K Applies

- Gas Processing Plants only
- 1.2 Scope: ...The specific component focus for the surveys is determined by the referencing subpart...
- The only current “referenced subpart” is Natural Gas Processing Plants (in OOOOb). All other parts of the oil and gas supply chain are covered by 40 CFR 60.5397b or OOOOa.

## Where §60.5397b Applies

- All other facilities except for closed vent systems including:
  - Wellsites
    - single wellhead only or small sites;
    - wellhead only well sites with two or more wellheads
  - Centralized Production Facilities
    - One or more storage vessels
    - One or more control devices
    - One or more pneumatics
    - Two or more other major processing equipment
  - Compressor stations

**NOTE:** If OGI is added to future applications (refineries, chemical plants, etc.), Appendix K will likely apply to those facilities



# Subpart W

## Greenhouse Gas Reporting Program (GHGRP)

[CONTACT US](#)[GHGRP Home](#)[Find and Use GHGRP Data](#)[National Data Highlights](#)[Sector Data Highlights](#)[Data Sets](#)[For GHG Reporters](#)[Learn About GHGRP](#)[Help Center](#)[Data Citation](#)

## Subpart W – Petroleum and Natural Gas Systems

Owners or operators of facilities that contain petroleum and natural gas systems and emit 25,000 metric tons or more of GHGs per year (expressed as carbon dioxide equivalents) report GHG data to EPA. Owners or operators collect GHG data; calculate GHG emissions; and follow the specified procedures for quality assurance, missing data, recordkeeping, and reporting. Subpart W consists of emission sources in ten segments of the petroleum and natural gas industry.

### General Information about Subpart W

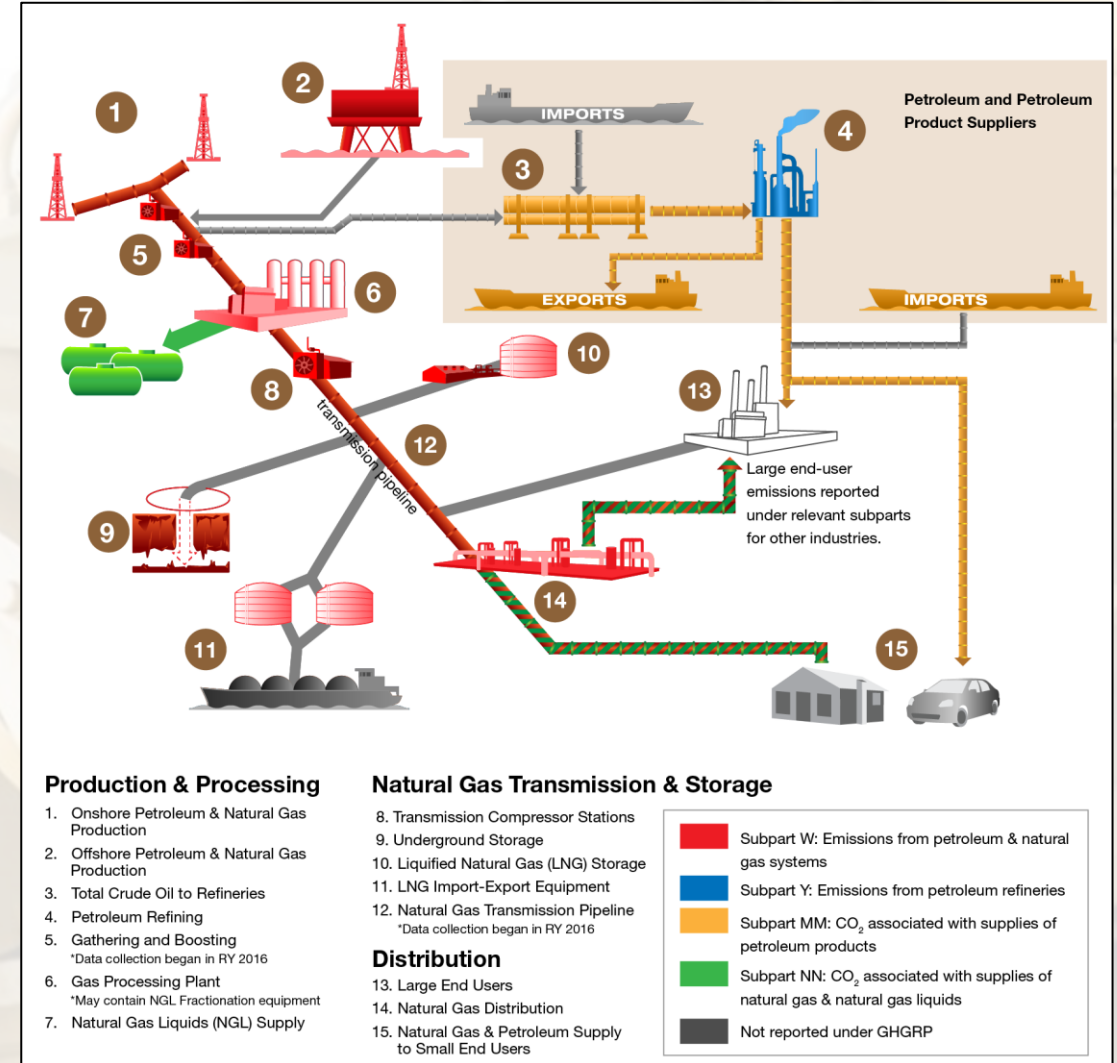
- [Basic Information](#) - Information about emissions from the oil and natural gas industry.
- [Subpart W Reported Data](#) - Subpart W data that has been reported.
- [Rulemaking Resources](#) - Links to Subpart W final rules and associated documents.
- [Help](#) - Informational materials for Subpart W reporters.
- [Archive](#)

[Read Current Rule](#) [Browse FAQs](#) [View Data Highlights](#)

# Proposed Subpart W Amendments

The proposed amendments consist of four parts:

1. revisions to address potential gaps in reporting of emissions data for specific sectors to ensure the reporting under subpart W reflects total methane emissions from the applicable facilities;
2. revisions to add new emissions calculation methodologies or improve existing emissions calculation methodologies to ensure the reporting under subpart W is based on empirical data;
3. revisions to reporting requirements to improve verification and transparency of the data collected;
4. and technical amendments, clarifications, and corrections.



# Parts of Subpart W for OGI

- Addressed in Section III (Proposed Amendments); P (Equipment Leak Surveys)
- Proposed addition of an “**OGI Enhancement Factor**”: the ratio (~1.63) between the OGI emission factors and the Method 21 emission factors for the upstream industry segments
- Addition of Method To Quantify Emissions Using **Direct Measurement**
- Add Option to Develop Site Specific Leaker Factor
- Removes additional Method 21 Requirement





§ 98.234(a)(7): 500 PPM Leak Definition (2016)

§ 98.234(a)(2)(ii): 500 PPM Leak Definition (2023)

§ 98.234(a)(1) through (6): 10,000 PPM Leak Definition (2016)

§ 98.234(a)(2)(i): 10,000 PPM Leak Definition (2023)

§ 98.234(a)(1), (3), or (5): OGI, Infrared Laser, and Acoustic

## Summary of U.S. EPA Subpart W (40 CFR Part 98, Subpart W - Greenhouse Gas Reporting Rule: Revisions and Confidentiality Determinations for Petroleum and Natural Gas Systems)

Current proposed regulation: <https://www.govinfo.gov/content/pkg/FR-2023-08-01/pdf/2023-14338.pdf>

Nov 30, 2016 regulation: <https://www.govinfo.gov/content/pkg/FR-2016-11-30/pdf/2016-27981.pdf>

Nov 30, 2010 regulation: <https://www.govinfo.gov/content/pkg/FR-2010-11-30/pdf/2010-28655.pdf>

**Table W-3A & W-4A (2016) vs Table W-4 (2023) to Subpart W of Part 98—DEFAULT **HYDROCARBON** LEAKER EMISSION FACTORS**

Equipment Components	Emission factor (scf/hour/component)				
	If you survey using Method 21 as specified in § 98.234(a)(7)	If you survey using Method 21 as specified in § 98.234(a)(2)(ii)	If you survey using any of the methods in § 98.234(a)(1) through (6)	If you survey using Method 21 as specified in § 98.234(a)(2)(i)	If you survey using any of the methods in § 98.234(a)(1), (3), or (5)
<b>Leaker Emission Factors—Onshore Natural Gas Processing, Onshore Natural Gas Transmission Compression — Compressor Components, &amp; Underground Natural Gas Storage; Storage Station, Gas Service</b>					
Valve	9.51	9.51	14.84	14.84	24.2
Connector	3.58	3.58	5.59	5.59	9.13
Open-Ended Line	11.07	11.07	17.27	17.27	28.2
Pressure Relief Valve	25.42	25.42	39.66	39.66	64.8
Meter	12.39	12.39	19.33	19.33	31.6
Other	2.63	2.63	4.1	4.1	6.7
<b>Leaker Emission Factors—Onshore Natural Gas Processing, Onshore Natural Gas Transmission Compression—Non-Compressor Components, Gas Service</b>					
Valve	3.2	4.12	4.5	6.42	10.5
Connector	0.7	3.66	1.2	5.71	9.3
Open-Ended Line	2	7.22	3.8	11.27	18.4
Pressure Relief Valve	1.7	1.29	2.5	2.01	3.28
Meter & Instrument	2.5	1.88	4.1	2.93	4.79
Other	2.5	2.63	4.1	4.1	6.7
<b>Leaker Emission Factors—Underground Natural Gas Storage—Storage Wellheads, Gas Service</b>					
Valve	3.2	3.2	4.5	4.5	7.35
Connector	0.7	0.7	1.2	1.2	1.96
Open-Ended Line	2	2	3.8	3.8	6.21
Pressure Relief Valve	1.7	1.7	2.5	2.5	4.08
Meter & Instrument	2.5	2.5	4.1	4.1	6.7
Other	2.5	2.5	4.1	4.1	6.7

# How OGI Cameras Help Meet Regulations



# Do OGI Cameras Meet Appendix K?

**Appendix K; Section 6.1.2:** The OGI camera must be capable of detecting ... methane emissions of 19 grams per hour (g/hr) and either n-butane emissions of 29 g/hr or propane emissions of 22 g/hr at a viewing distance of 2.0 meters and a delta-T of 5.0 °Celsius (C) ... around 1 meter per second (m/s) or less, ...

Cooled OGI Appendix K Test



Uncooled OGI Appendix K Test



# Appendix K Operating Envelope

## Gx320: Handheld operation using HSM mode

FOV 24 Lens

FOV 14 Lens

FOV 6 Lens

Low  $\Delta T (\leq 3^{\circ}\text{C})$

Distance ft (m)	Wind Speed (mph)			
	0 to 5	5 to 10	10 to 20	> 20
8 (2.4)	Green	Green	Green	Green
10 (3)	Green	Green	Green	Red
35 (10.7)	Green	Green	Red	Red
100 (30.5)	Green	Red	Red	Red

Low  $\Delta T (\leq 3^{\circ}\text{C})$

Distance ft (m)	Wind Speed (mph)			
	0 to 5	5 to 10	10 to 20	> 20
8.5 (2.6)	Green	Green	Green	Green
20 (6)	Green	Green	Green	Red
50 (15.2)	Green	Green	Red	Red
120 (36.6)	Green	Red	Red	Red

Low  $\Delta T (\leq 3^{\circ}\text{C})$

Distance ft (m)	Wind Speed (mph)			
	0 to 5	5 to 10	10 to 20	> 20
15 (4.6)	Green	Green	Green	Green
40 (12.2)	Green	Green	Green	Red
75 (22.9)	Green	Green	Red	Red
150 (45.7)	Green	Red	Red	Red

Intermediate  $\Delta T (3^{\circ}\text{C} \leq \Delta T \leq 7^{\circ}\text{C})$

Distance ft (m)	Wind Speed (mph)			
	0 to 5	5 to 10	10 to 20	> 20
8.5 (2.6)	Green	Green	Green	Green
10 (3)	Green	Green	Green	Red
70 (21.3)	Green	Green	Red	Red
100 (30.5)	Green	Red	Red	Red

Intermediate  $\Delta T (3^{\circ}\text{C} \leq \Delta T \leq 7^{\circ}\text{C})$

Distance ft (m)	Wind Speed (mph)			
	0 to 5	5 to 10	10 to 20	> 20
12 (3.7)	Green	Green	Green	Green
20 (6.1)	Green	Green	Green	Red
80 (24.4)	Green	Green	Red	Red
150 (45.7)	Green	Red	Red	Red

Intermediate  $\Delta T (3^{\circ}\text{C} \leq \Delta T \leq 7^{\circ}\text{C})$

Distance ft (m)	Wind Speed (mph)			
	0 to 5	5 to 10	10 to 20	> 20
15 (4.6)	Green	Green	Green	Green
40 (12.2)	Green	Green	Green	Red
100 (30.5)	Green	Green	Red	Red
150 (45.7)	Green	Red	Red	Red

High  $\Delta T (\geq 7^{\circ}\text{C})$

Distance ft (m)	Wind Speed (mph)			
	0 to 5	5 to 10	10 to 20	> 20
9 (2.7)	Green	Green	Green	Green
22.9 (7)	Green	Green	Green	Red
70 (21.3)	Green	Green	Red	Red
100 (30.5)	Green	Red	Red	Red

High  $\Delta T (\geq 7^{\circ}\text{C})$

Distance ft (m)	Wind Speed (mph)			
	0 to 5	5 to 10	10 to 20	> 20
12 (3.7)	Green	Green	Green	Green
40 (12.2)	Green	Green	Green	Red
100 (30.5)	Green	Green	Red	Red
150 (45.7)	Green	Red	Red	Red

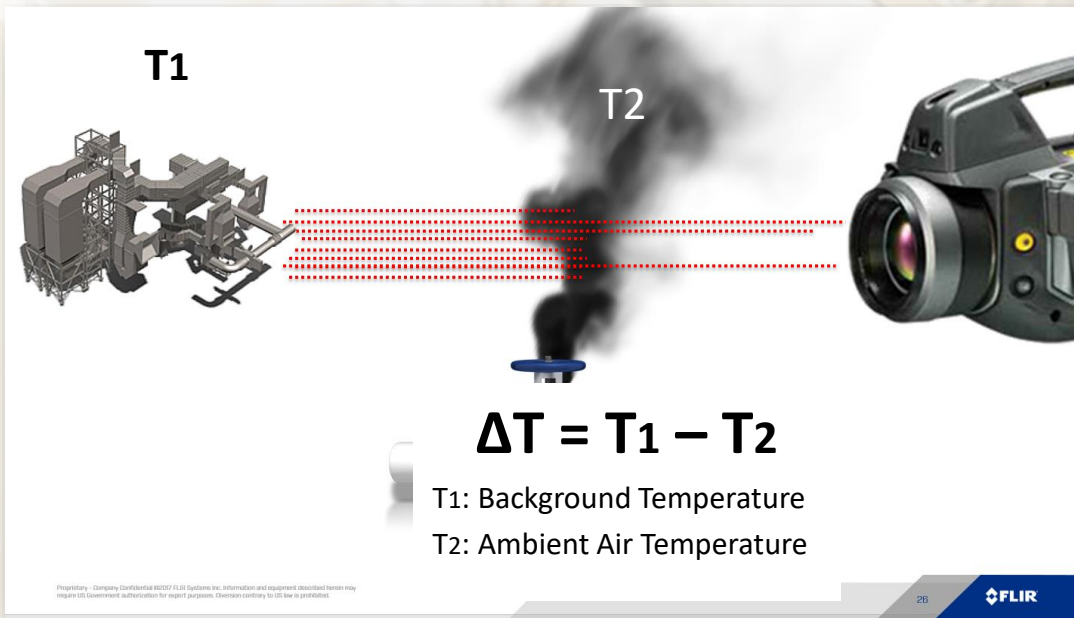
High  $\Delta T (\geq 7^{\circ}\text{C})$

Distance ft (m)	Wind Speed (mph)			
	0 to 5	5 to 10	10 to 20	> 20
15 (4.6)	Green	Green	Green	Green
85 (25.9)	Green	Green	Green	Red
100 (30.5)	Green	Green	Red	Red
150 (45.7)	Green	Red	Red	Red

# Delta-T and Appendix K

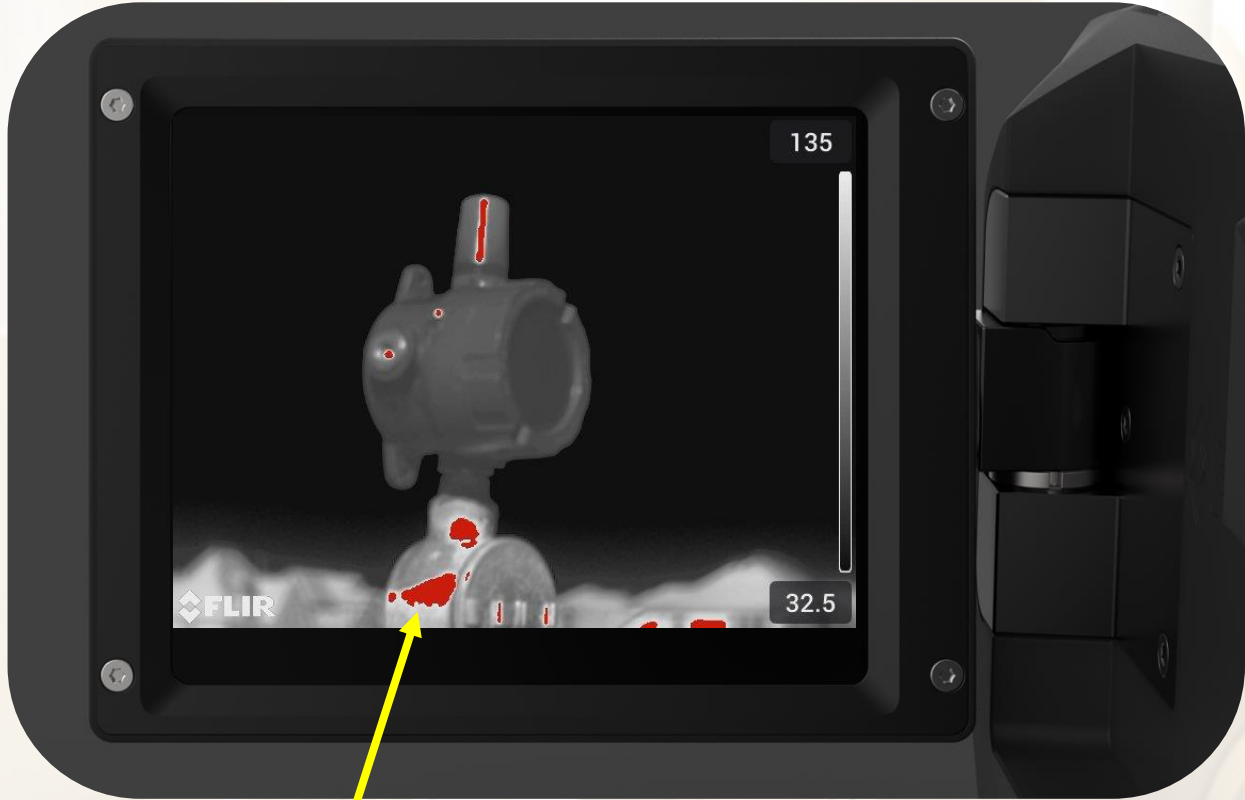
**Appendix K; Section 9.2.3:** Description of how the operator will ensure an adequate delta-T is present in order to view potential gaseous emissions, e.g., using a delta-T check function built into the features of the OGI camera ...

$\Delta T$ : The temperature differential between the gas emitted temp (assumed to be ambient air temp) and the background temp



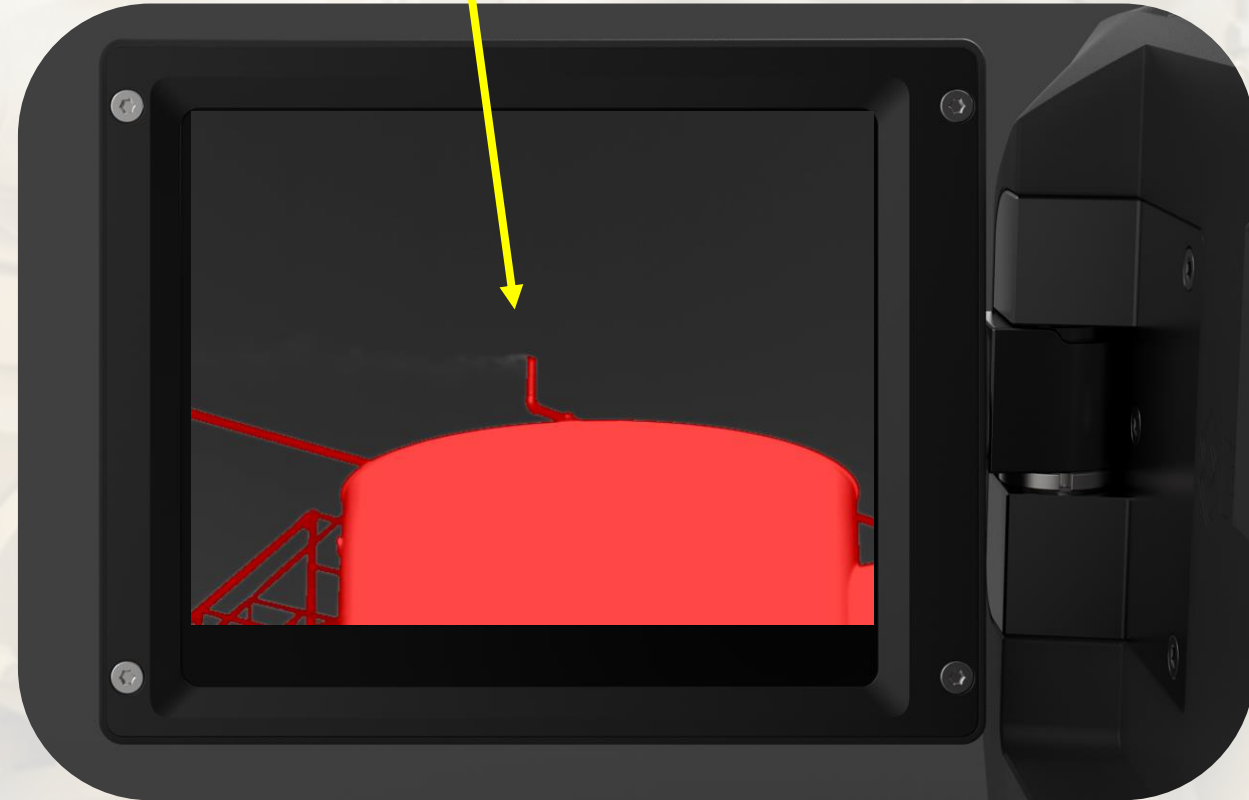


# OGI Camera Delta-T check Function



Built-in Delta T function to ensure proper inspection

Is Delta T for a full image or per pixel?  
*(What if this were a blow down valve?)*

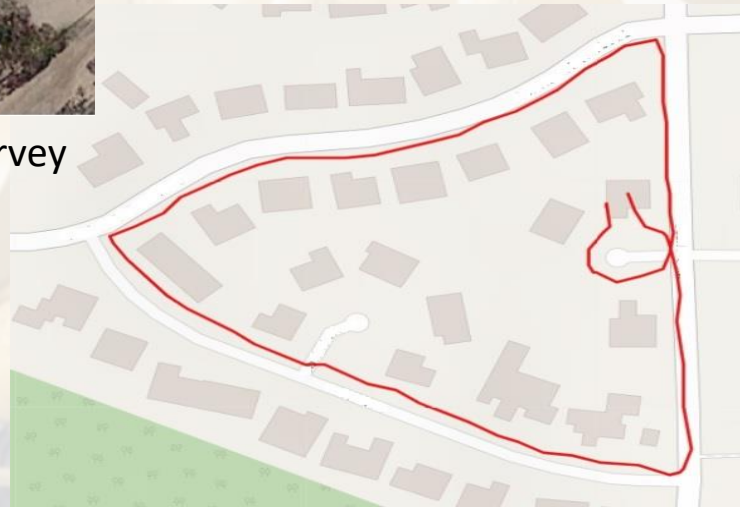


# Appendix K Observation/Survey Path

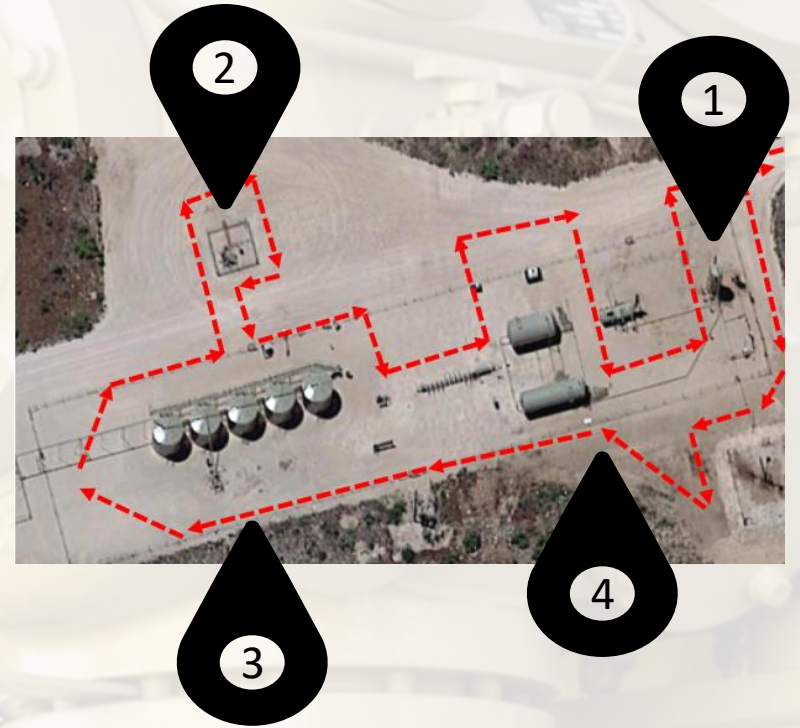
**Appendix K; Section 9.3.3:** Use of global positioning system (GPS) route tracing. The facility must document the path taken during the survey by **capturing GPS coordinates along the survey path**, along with date and time stamps ...



Observation Path Defined for the Survey



Path Followed with the OGI Camera

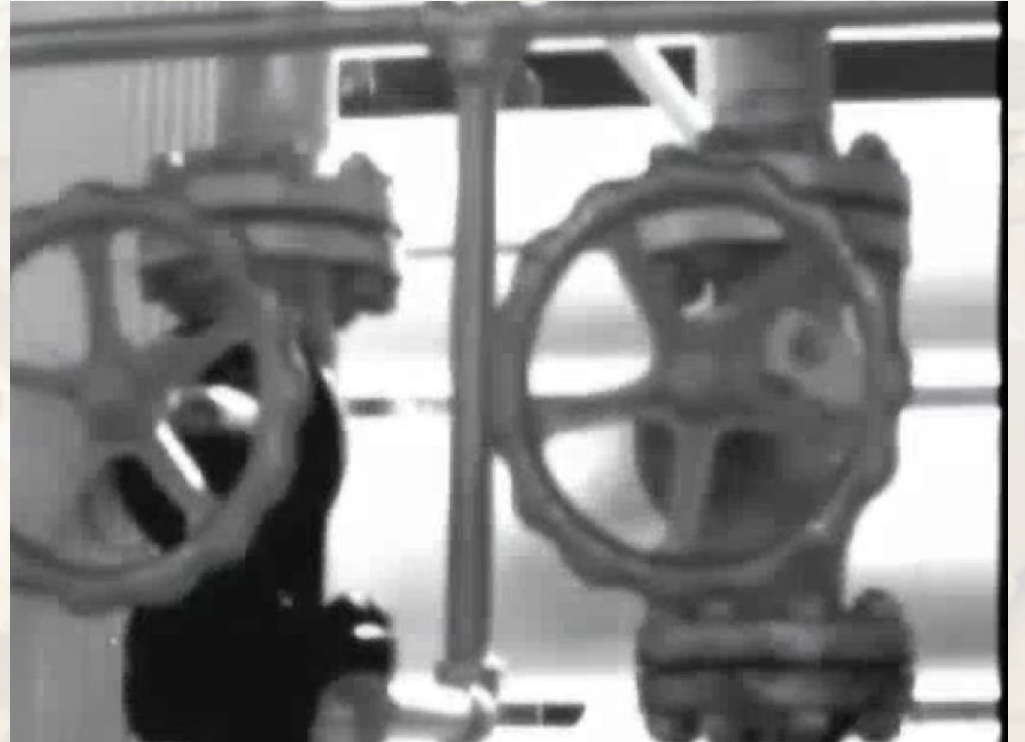
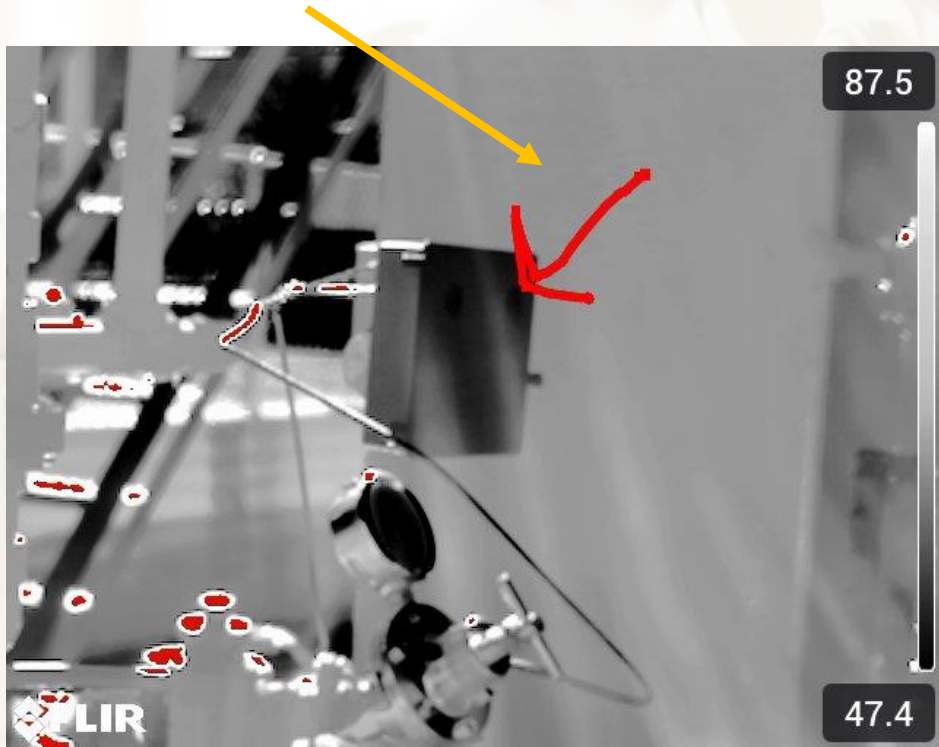


Plan inspection route in a camera

# Appendix K Leak Identification

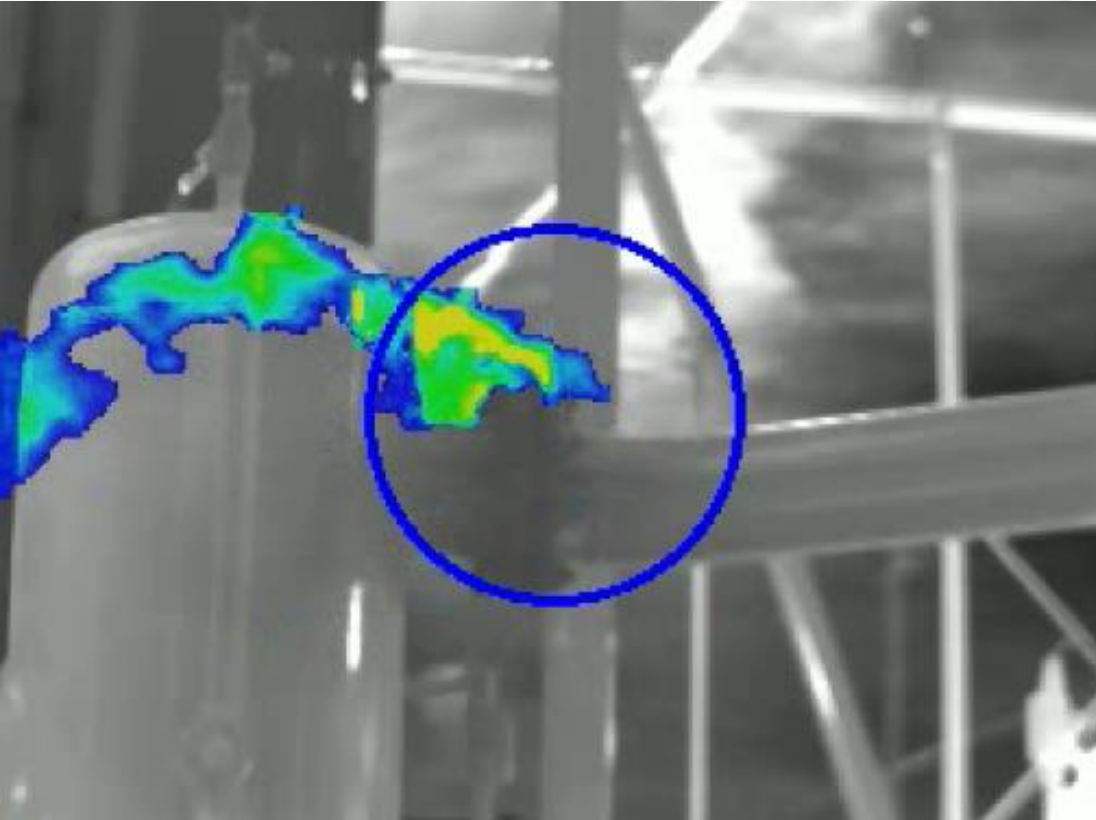
**Appendix K; Section 9.7.1:** If a leak is found, capture either a short video clip or photograph of the component associated with the leak ...

Sketch on IR image to show leaking component

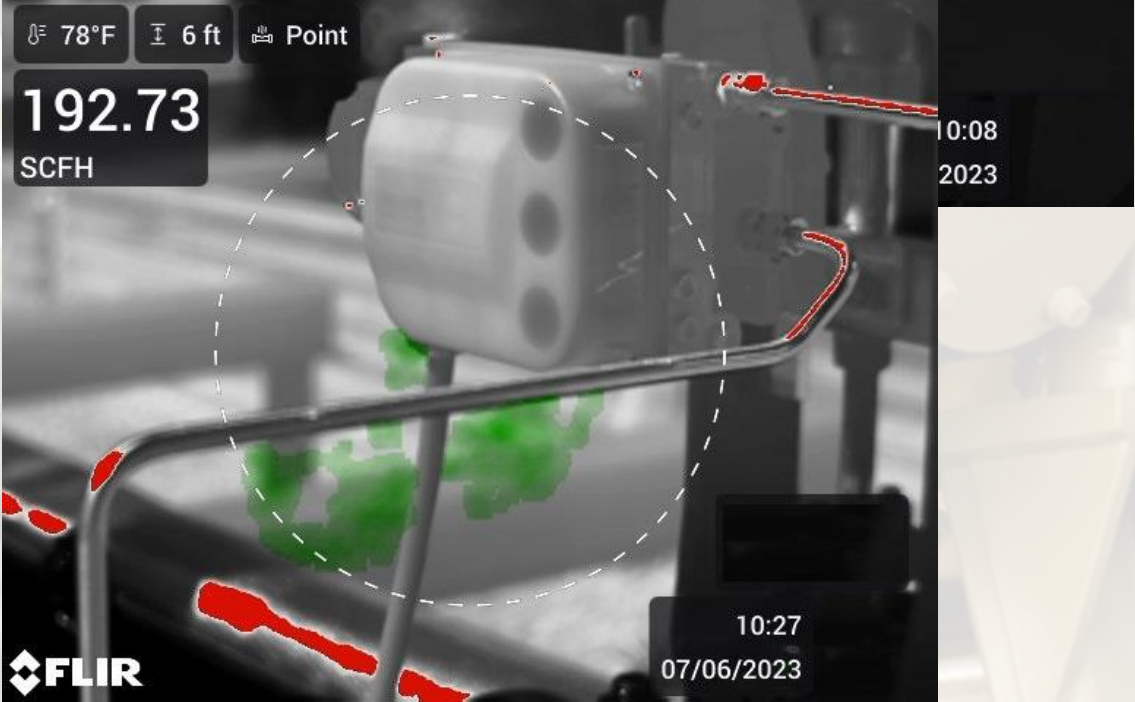
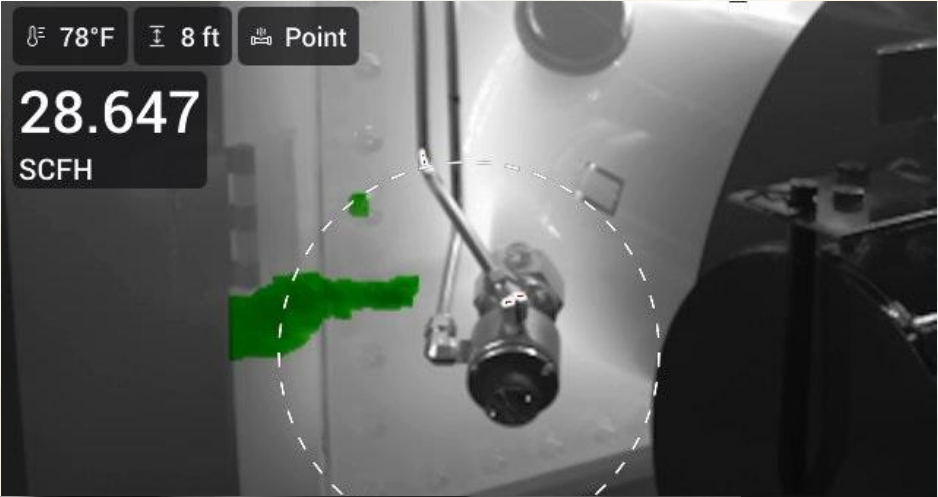


# Subpart W Quantification

Method To Quantify Emissions Using Direct Measurement



110 SCFH Flange Leak



# Summary

- Regulatory bodies, like the U.S. EPA, are focused on reducing emissions in the Oil and Gas sector
- Advanced technologies, like Optical Gas Imaging, play a key role in achieving this goal
- While 18 years old, OGI as a technology is still both handcuffed (AWP) and recommended (OOOOa)
- Efforts should be made to ensure that proven technology is embraced without being burdensome
- If the goal is to reduce emissions, advanced technologies should not be selectively targeted in regulation

