

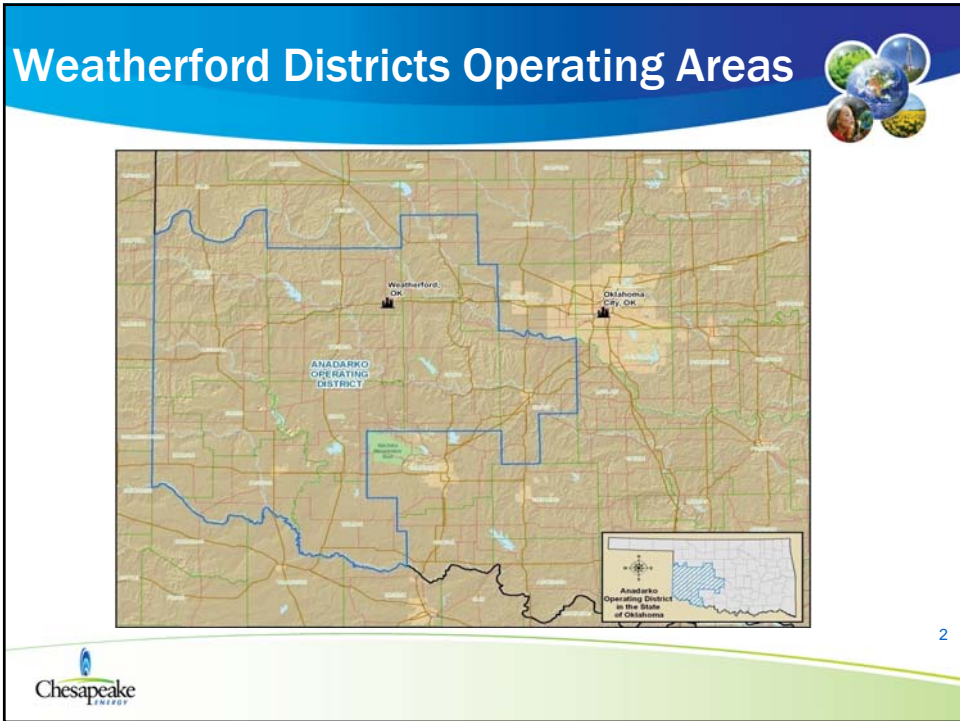


Thermal Imaging and Leak Detection  
**FLIR Camera Initiative**  
 Weatherford Office


NaturalGas  
 EPA POLLUTION PREVENTER

The slide features a blue header with a graphic of a globe and environmental icons. Below the header, the title "Thermal Imaging and Leak Detection FLIR Camera Initiative Weatherford Office" is displayed. To the left is an image of a FLIR thermal camera. To the right is the "NaturalGas EPA POLLUTION PREVENTER" logo. The main image is a photograph of a large, single-story industrial building with a sign that reads "CHESAPEAKE ENERGY". Several cars are parked in front of the building.



Weatherford Districts Operating Areas



ANADARKO OPERATING DISTRICT

Weatherford, OK

OKLAHOMA CITY, OK

Chesapeake Energy

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The slide features a blue header with the title "Weatherford Districts Operating Areas" and a graphic of a globe and environmental icons. Below the header is a topographic map of the Weatherford area in Oklahoma. The map shows the "ANADARKO OPERATING DISTRICT" outlined in blue. Key locations marked include "Weatherford, OK" and "OKLAHOMA CITY, OK". An inset map in the bottom right corner shows the "Anadarko Operating District in the State of Oklahoma". The Chesapeake Energy logo is in the bottom left corner, and the number "2" is in the bottom right corner.

## Weatherford District Office Aerial View



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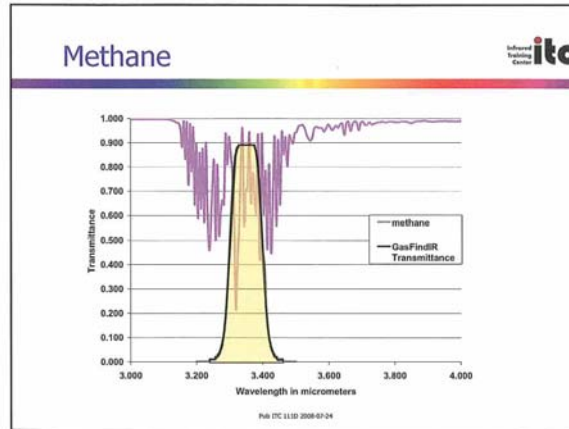
## FLIR Camera Highlights



- Real time detection
- Facilitates location & repair of leaks
- Ability to screen hundreds of components quickly from near or far (Zoom Lense)
- Ability to record/document leaks and repairs for record keeping
- Waveband range is 3 - 5 micrometers window
- Depends on object temperature, reflections, and medium (air) between camera and object.
- Methane content ranges from 80-98%
- Methane or leaking gas causes a temperature differential (enables the camera to isolate the difference in the ambient air)

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# Absorption Characteristics of Methane



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# Detection Capabilities of a FLIR Camera



- |               |             |
|---------------|-------------|
| Benzene       | Pentane     |
| Ethanol       | 1 - Pentene |
| Ethyl benzene | Toluene     |
| Heptane       | Zylene      |
| Hexane        | Butane      |
| Methanol      | Ethane      |
| MEK           | Methane     |
| MIBK          | Propane     |
| Octane        | Ethylene    |
|               | Propylene   |

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# FLIR Camera Basics....



- Get training
- Survey for leaks, emphasize high pressure - high volume areas.
- Measure leaks (bag test) if possible
- Document leaks. Tag or fix “on the spot”
- Maintain spreadsheet/database of leak inspection and repairs.
- Follow-up on requested repairs....
- Update STARtracker



# Tracking



## FLIR CAMERA INSPECTIONS

District:		Barnett - Cleburn	Barnett - Tarrant	W. Mid Cont	Anadarko	Arkoma	Arkansas
Inspector:		Glenn Stetson Dustin Durkee	Grant Macdonald Neal Poindexter	Greg Kochenower	Larry Ross	Travis Brown	Keith Wagner
Well/Facility/CDP Name	MidCon Unit #	Inspection Date	Leak Location	Component	Tagged? (Y/N)	Operator	Leak Rate (SCF/D)
Johns Mansville 3H	2198	11/17/08	Compressor	Blow-down Union	N	MidCon	793
Green Muddler 2H	3060	11/18/08	Compressor	Liq Lvl Controller	Y	MidCon	291
Williams 9H	1889	11/19/08	Compressor	Liq Lvl Controller	Y	MidCon	300
Falvel 11H	2577	11/21/08	Compressor	Liq Lvl Controller	Y	MidCon	300
North Lake 4H	2391	11/24/08	Compressor	Liq Lvl Controller	Y	MidCon	300
Parnell 9H	3087	11/25/08	Compressor Line	Hammer Union	Y	MidCon	807
Cleburne CS 1	1327	11/26/08	Comp Station	Fuel Line	Y	MidCon	1100
Cleburne CS 2	1327	11/26/08	Comp Station	Valve Cap	Y	MidCon	800
Cleburne CS 3	1347	11/26/08	Comp Station	Fuel Line	Y	MidCon	700
Cleburne CS 4	1347	11/26/08	Comp Station	Valve Plug	Y	MidCon	400
Hidden Creek 4H		10/22/08	Separator	Stainless Line to Safety Valve	N	COI	20
Crowley Minerals CS		10/27/08	Dehy	Glycol Line	Y	CEMI	5,760
Harbison-Fischer CS	116752-01	10/28/08	Exterran Compressor #1	Stainless Line Connector	Y	CEMI	540
Harbison-Fischer CS	104202-01	10/28/08	Exterran Compressor #2	Unknown Line Transfer Component	Y	CEMI	864
Gateway Park4H	1999	10/29/08	Well Compressor	Stainless Supply Line	Y	MidCon	86,400
Arc Park CS	2370	11/03/08	MidCon Compressor #1	Starter Line Connector	N	MidCon	1,296
Arc Park CS	215566	11/03/08	Exterran Compressor #3	Starter Line Connector	Y	CEMI	2,880
Riverbend B 1H	1844	11/06/08	MidCon Well Compressor	Starter Supply Line Connector	Y	MidCon	712
Mary Creek 2H	2350	11/07/08	Separator/Sales Line	Sales Line Differential Flange	Y	MidCon	1037
Lucky Horse 1-1		11/12/08	Heater	copper tbq connection	N	COI	1
Velvet Elvis 1-13		11/14/08	Tank	Tank Vent	N	COI	432
Crall 12-1		10/17/08	Compressor	Level Controller	N	COI	288
Crall 12-1		10/17/08	Compressor	Suct. Controller	N	COI	860

## FLIR Camera Limitations



- Distance Range past 100 feet
- Gas cloud differential needed
- Strong winds & small leaks – tough situation
- Rainy and misty days

## Video Examples

### Two-Inch Union Leak



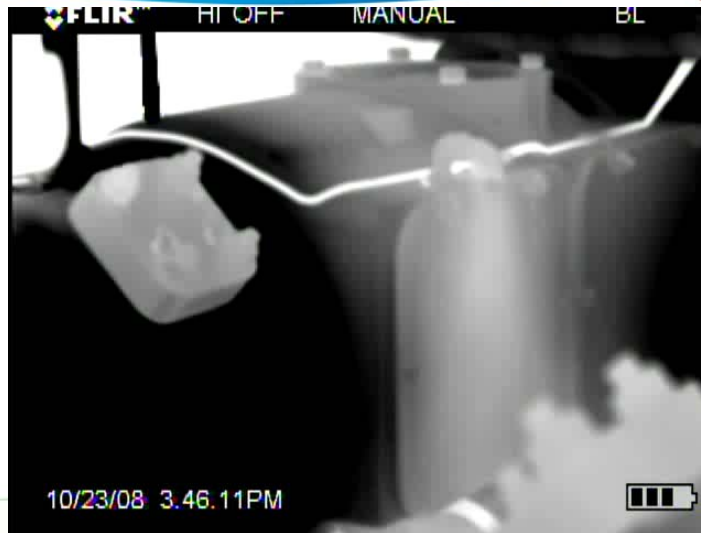


# Compressor Vent



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# Compressor Packing - Gas Loss Video



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## Compressor Suction Control Valve Gas Loss



## Fuel Gas Scrubber Union Leak



# Fuel Gas Regulator Valve



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# Video – Fuel Gas Regulator



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## Summary of Common Leaks



### PRODUCTION EQUIPMENT

- Pressure, relief, and control valves.
- Level and pressure controllers.
- Connections types: unions, threaded flanges, and piping
- Tank venting

### ENGINES and COMPRESSORS

- Compressor pressure packing.
- Controller types: fuel, pressure, and level.
- Regulator venting.
- Compressor valve caps and loading pockets.

### Generally Speaking

- Leaks that are not visible
- Leaks that are not heard
- Leaks that are not smelled

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## Summary of Weatherford Camera Experience



### District Inspection

- Less than 3% of area completed during pilot
- Estimate a full year to inspect this district properly
- Re-inspection of repairs: needs done

### Camera Justification

- Environment, Safety, Savings, and Economics
- Results + Potential justify a full time Camera Tech/DI& M program
- Due diligence inspection
- More cameras company wide?
- Purchase High Flow Sampler?
- New well (initial) inspections with camera – great idea
- New equipment installation – warrants inspection

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## Results - FLIR Camera DI&M:



- Simple Economics of “fixed on the spot”, Equipment repair, Replace equipment for demo period:
  - Approximate repair costs = \$15,000
  - Emissions Reductions = 160 MCFPD
- 160 MCFPD recovered @ \$3.50/MCF = \$204,400 annual savings
- Many leaks could be fixed on the spot with no extra costs by FLIR Technician.
- Majority (50% to 75%) of the leaks found with the FLIR camera would otherwise go undetected.
- It is sometimes difficult to quantify leak rates (with a calibrated bag). Owning a High Flow Sampler may be necessary.

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