



TEQUIPMENT &  
FLIR SYSTEMS WEBINAR

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# LEAK DETECTION & PREDICTIVE / PREVENTATIVE MAINTENANCE SOLUTIONS

MARCH 9<sup>TH</sup>, 2021

# AGENDA

Leak Detection Overview

Gas Detection (GF77)

Air Leaks & Partial Discharge (Si124)

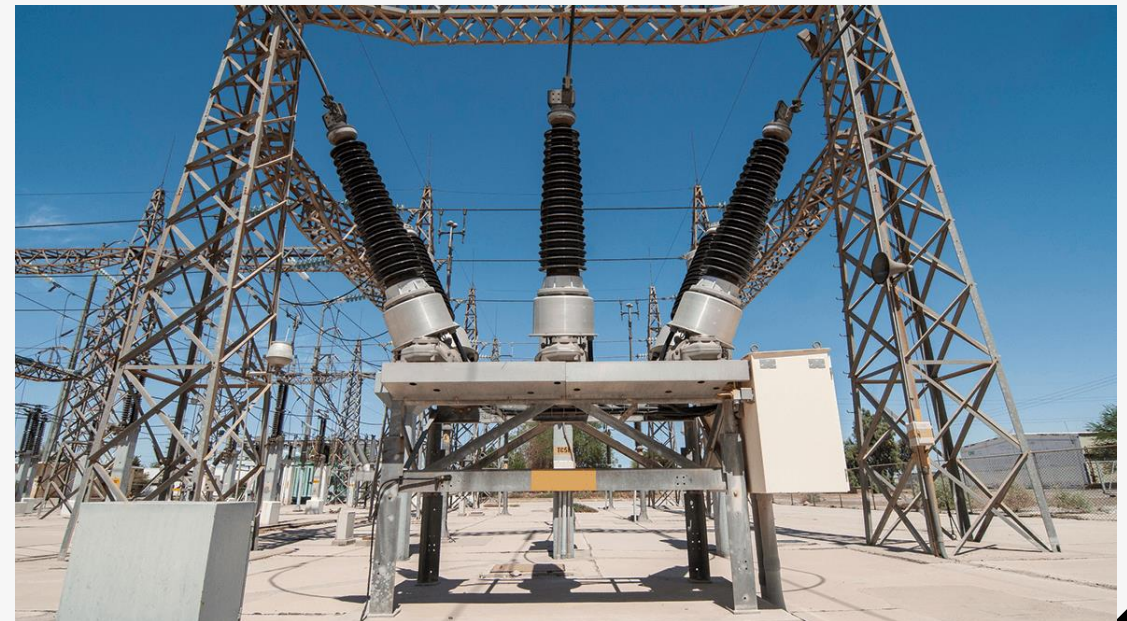
Q&A



FLIR Si124



FLIR GF77





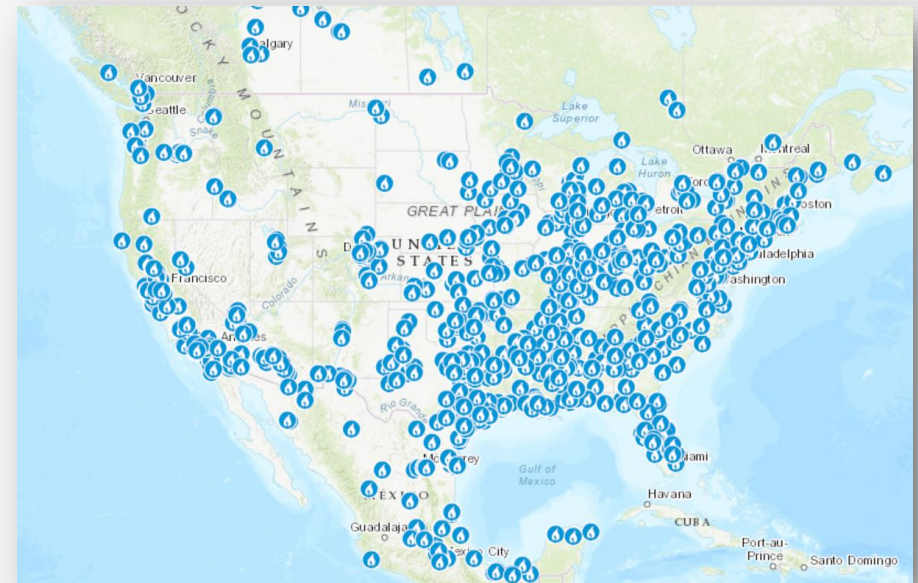
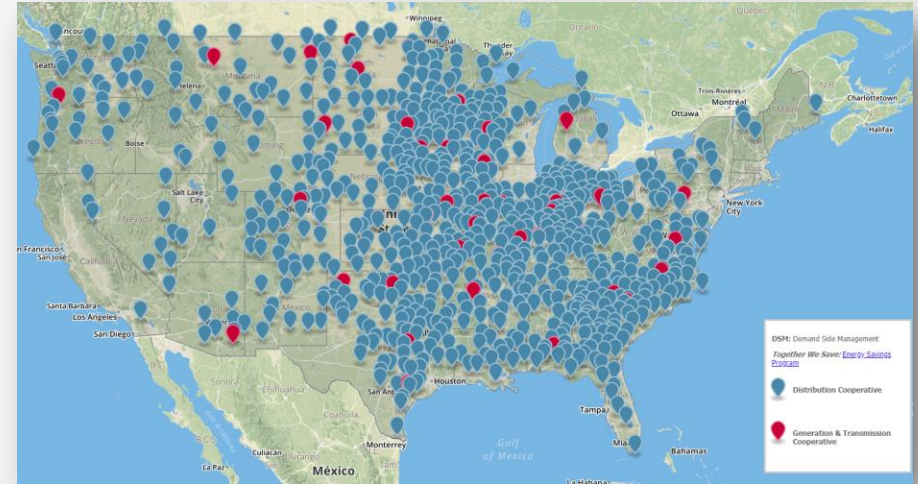
LEAK DETECTION & PREDICTIVE / PREVENTATIVE MAINTENANCE SOLUTIONS

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# LEAK DETECTION OVERVIEW

# TARGET USERS & APPLICATIONS

- One of 3,300 utilities that provide power transmission and distribution of electricity through out the US
- IOU, Co-op's, Municipalities
- Electric Generation using Nuclear, Natural Gas, Coal, Renewable energy



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# TARGET USERS & APPLICATIONS

- Do you have gas or air leaks that are hard to find?
- Do you have gas or air leaks that you think you have but aren't sure (because if you can't see it, it must not be there)?
- Do these potential leaks create a safety/environmental hazard at your plant?
- Do these leaks cost you money if left unattended?
- Do you want to find partial discharge failures?
- Do you want to improve the reliability of your operation?
- Do you wish every employee had access to a thermal camera for quick checks and safe working environments?
- Do you think thermal imaging cameras are expensive?

# HOW DO YOU FIND A GAS LEAK?

Gas is invisible to the naked eye



# COMMON CHALLENGES?

- Time Consuming
- Hard to pinpoint where the leak is coming from
- Especially around energized equipment
- Easy to miss leaks (leaks could happen right under your nose)
- Expensive – You paid for the gas why waste it
- Environmental Damage especially SF6 and Methane
- Safety – Can cause explosions and loss of life



# DO YOU/EMPLOYEES WEAR PPE/FR CLOTHING?

- PPE = seat belts, it's the last line of defense.
- Seat belts don't prevent the car crash and PPE doesn't prevent the Arc Flash.
- Do you drive at night without head lights?
  - Answer = No
- So why do we do electrical work in the dark?



Flame Resistant Clothing (FRC), FR ...  
unifirst.com





# THERE HAS TO BE A BETTER WAY

- What if you could scan large areas quickly and safely at a distance like an RMLD?
- What if you can pinpoint exactly where it was coming from like Snoop or a TVA(sniffer)?
- What if you could document in a picture or a video the exact location of the leak to make repairing faster?





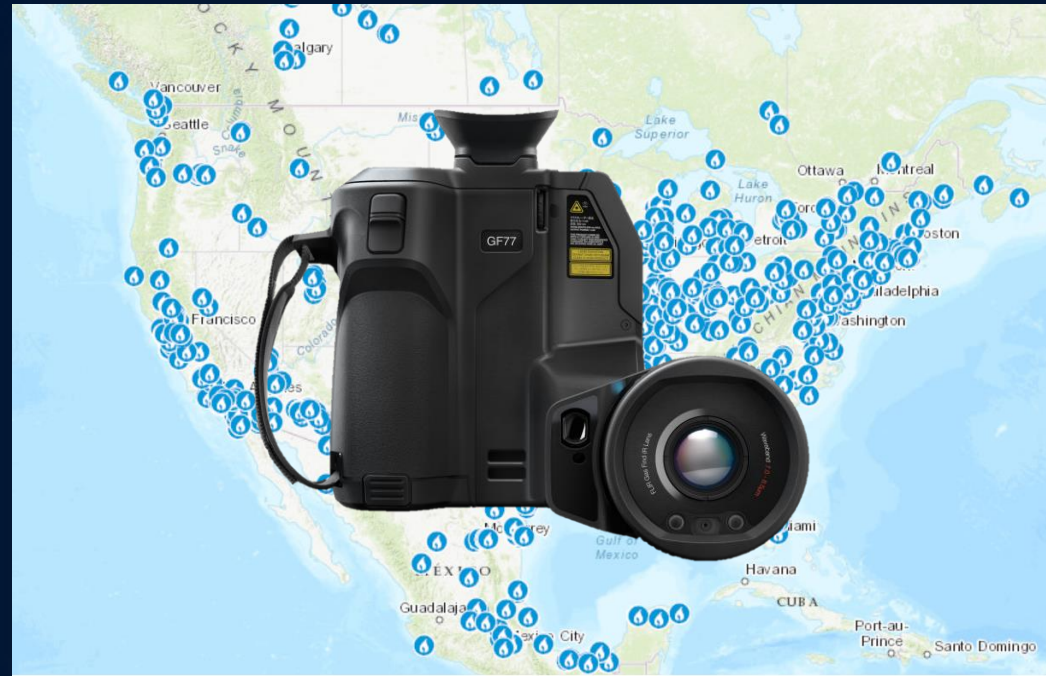
LEAK DETECTION & PREDICTIVE / PREVENTATIVE MAINTENANCE SOLUTIONS

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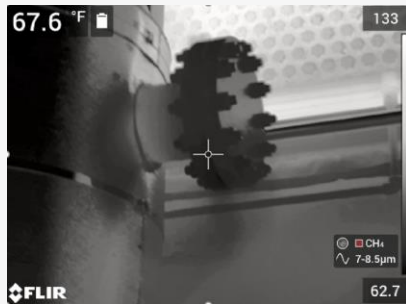
# FLIR GF77 – GAS DETECTION

# FLIR GF77

THE FIRST OPTICAL GAS IMAGING CAMERA  
VERSATILE ENOUGH TO ALSO SEE  
THERMAL (HOT SPOTS)



## METHANE DETECTION



## SF6 DETECTION



## AMMONIA DETECTION



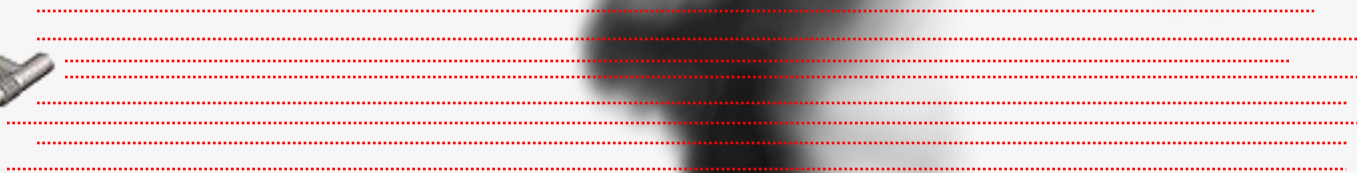
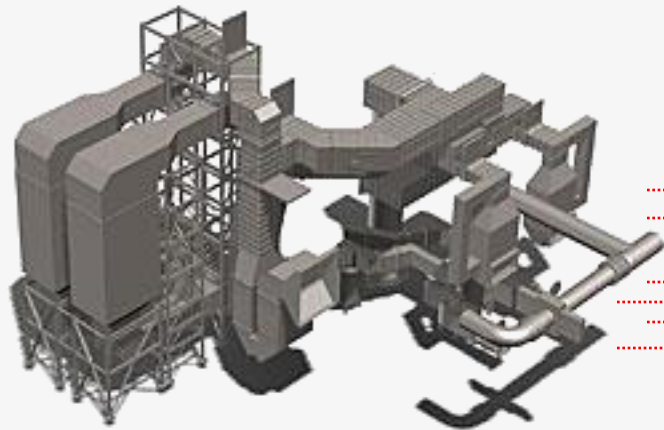
## HOT SPOTS



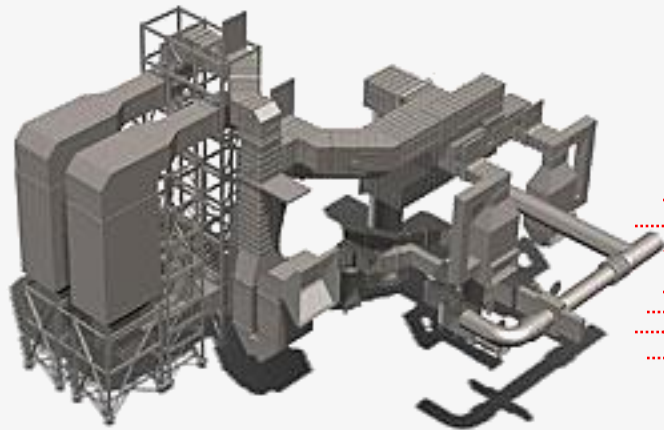
# HOW DOES OPTICAL GAS IMAGING WORK?



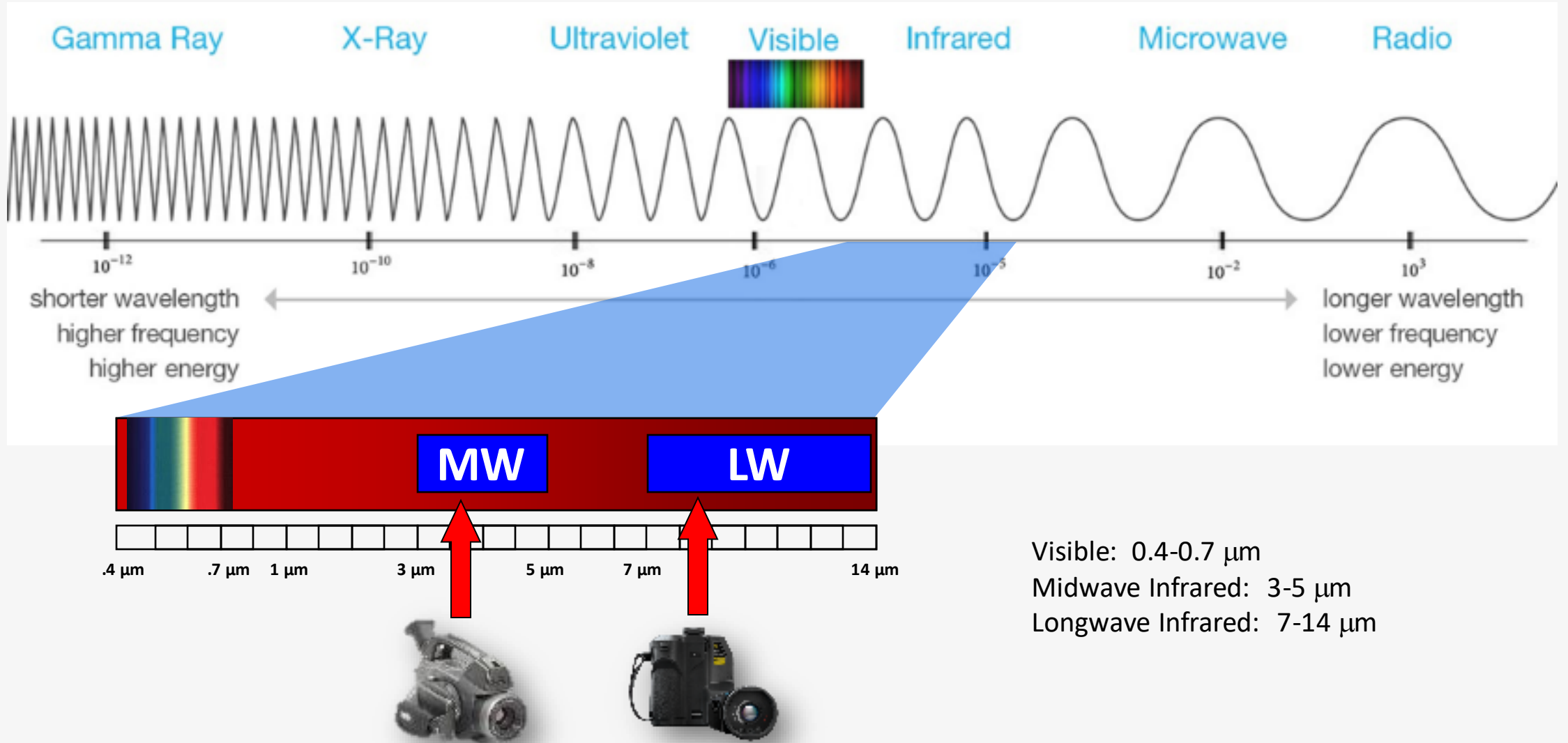
# HOW DOES OPTICAL GAS IMAGING WORK?



# HOW DOES OPTICAL GAS IMAGING WORK?



# ELECTROMAGNETIC SPECTRUM



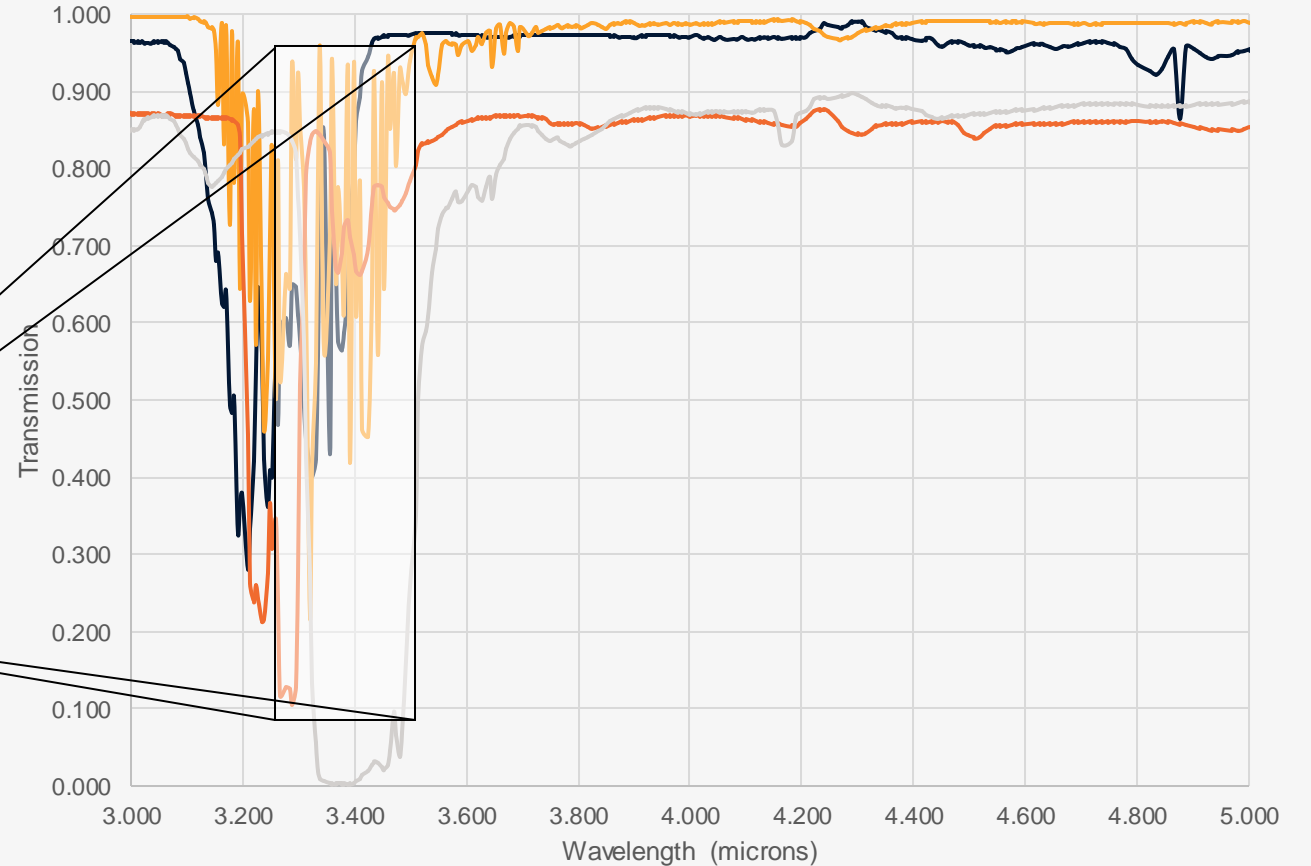
# THE SCIENCE BEHIND OGI

Cooled Midwave OGI Camera

We “match” the spectral response of the camera to the “peak” spectral absorption of the gas!



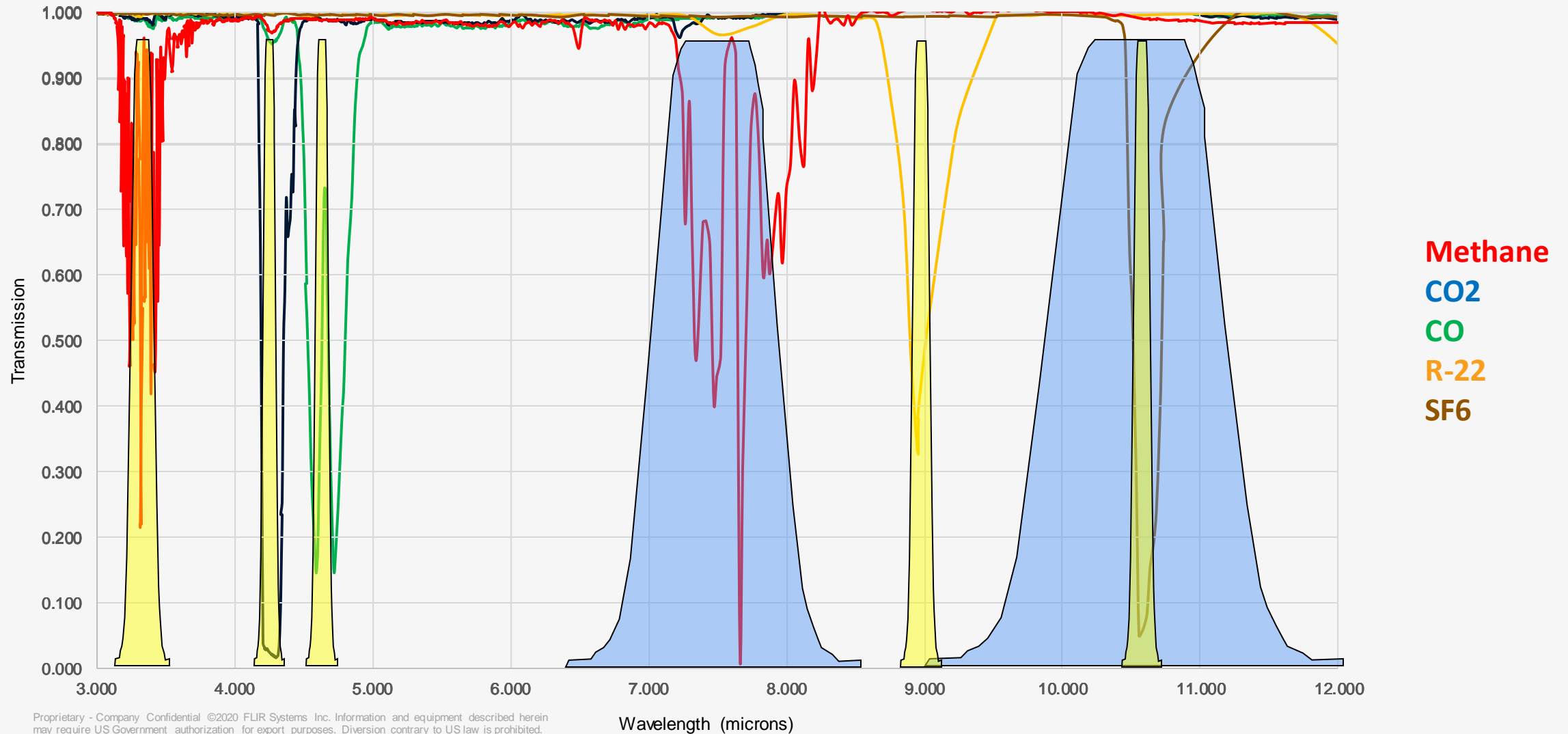
Propane, Benzene, Methane, Ethylene



— Ethylene — Methane — Benzene — Propane



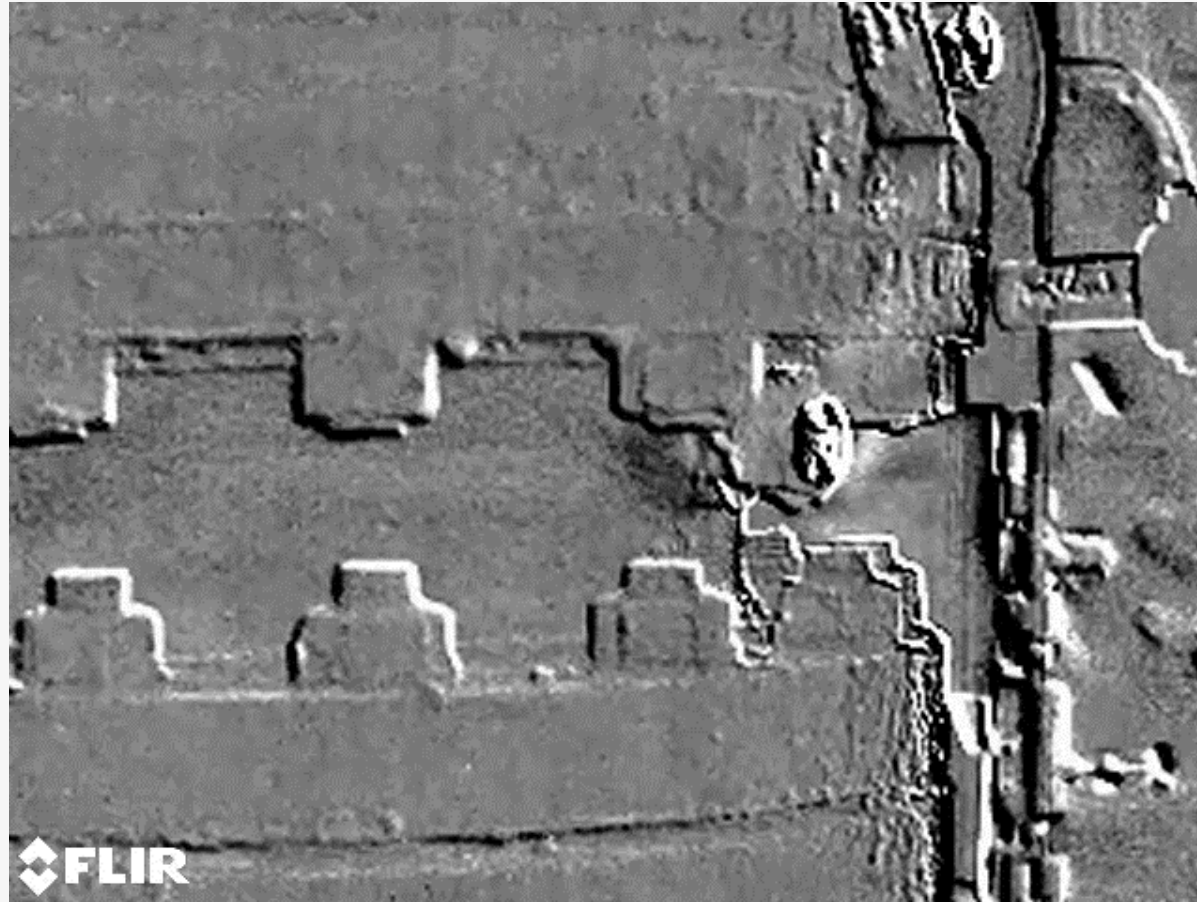
# INFRARED GAS SPECTRA OF COMMON GASES



Proprietary - Company Confidential ©2020 FLIR Systems Inc. Information and equipment described herein may require US Government authorization for export purposes. Diversion contrary to US law is prohibited.

\* Data intentionally skewed to protect proprietary filter location

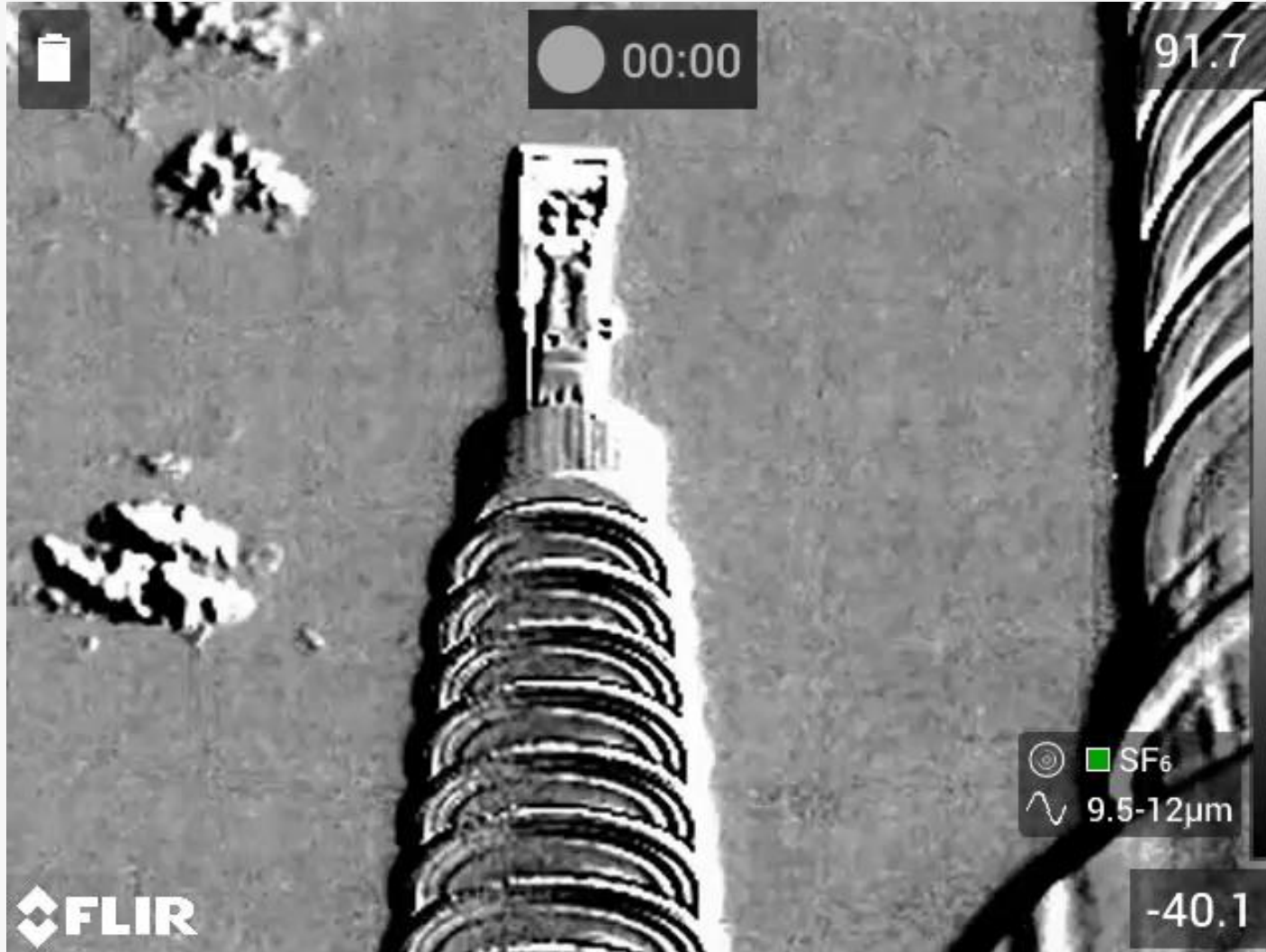
# FUEL GAS SKID (METHANE) – GF77



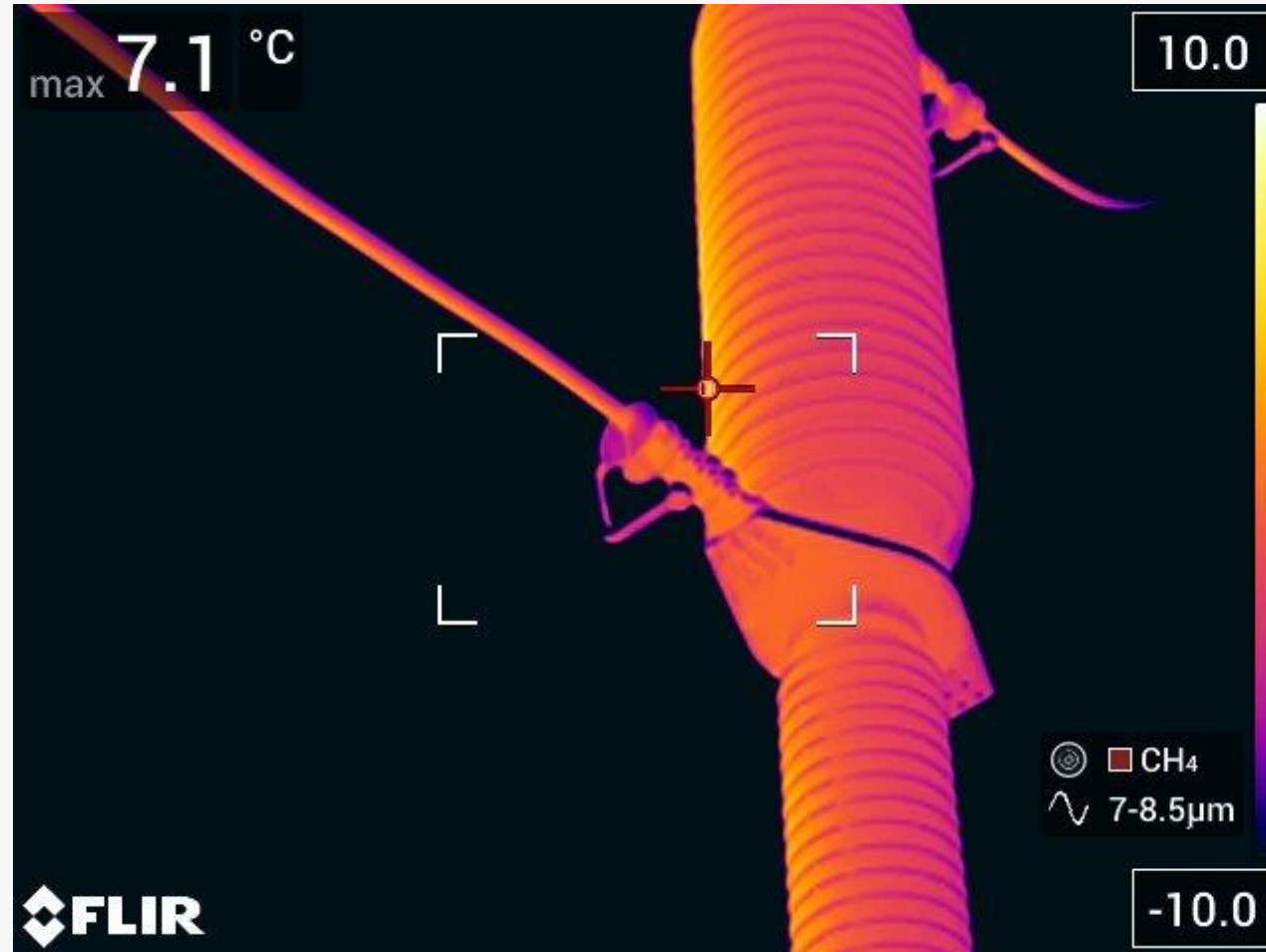
# FLANGE (METHANE) – GF77



# CIRCUIT BREAKER SF6 GF77



# GF77 PREDICTIVE MAINTENANCE





# FLIR GF77 PORTFOLIO

## GF77 CAMERA FEATURES

- Temperature ranges:
  - -20 – 80 °C
  - 0 – 250 °C
  - 0 – 500 °C
- On-board routing available
- Temperature accuracy of  $\pm 3^{\circ}\text{C}$

## GF77-HR LENS

- Spectral range: **9.5-12  $\mu\text{m}$**
- Primary Gas:  $\text{SF}_6$  (Sulfur Hexafluoride)
- Secondary Gases:  $\text{NH}_3$  (Ammonia),  $\text{C}_2\text{H}_4$  (Ethylene)
- Lenses
  - FOV 25
  - FOV 6

## NEW GF77-LR LENS

- Spectral range: **7- 8.5  $\mu\text{m}$**
- Primary Gas:  $\text{CH}_4$  (Methane)
- New Secondary Gases:  $\text{SO}_2$ , (Sulfur Dioxide),  $\text{N}_2\text{O}$  (Nitrous Oxide) R-134a, R-152a
- Lenses
  - FOV 25
  - FOV 6

# GF77 PRICING



- Camera bundles
  - Base model: GF77 25° LR OR 25° HR **MSRP: \$29,950**
  - Base model + extra 25° **MSRP: \$34,900**
  - Base model + extra 6° **MSRP: \$39,900**
  - Base model + extra 25° + 1 extra 6° **MSRP: \$44,850**
  - Base model + extra 25° + 2 extra 6° **MSRP: \$54,800**
- Aftermarket lens purchase
  - Extra 25° **MSRP: \$6,950**
  - Extra 6° **MSRP: \$12,950**



LEAK DETECTION & PREDICTIVE / PREVENTATIVE MAINTENANCE SOLUTIONS

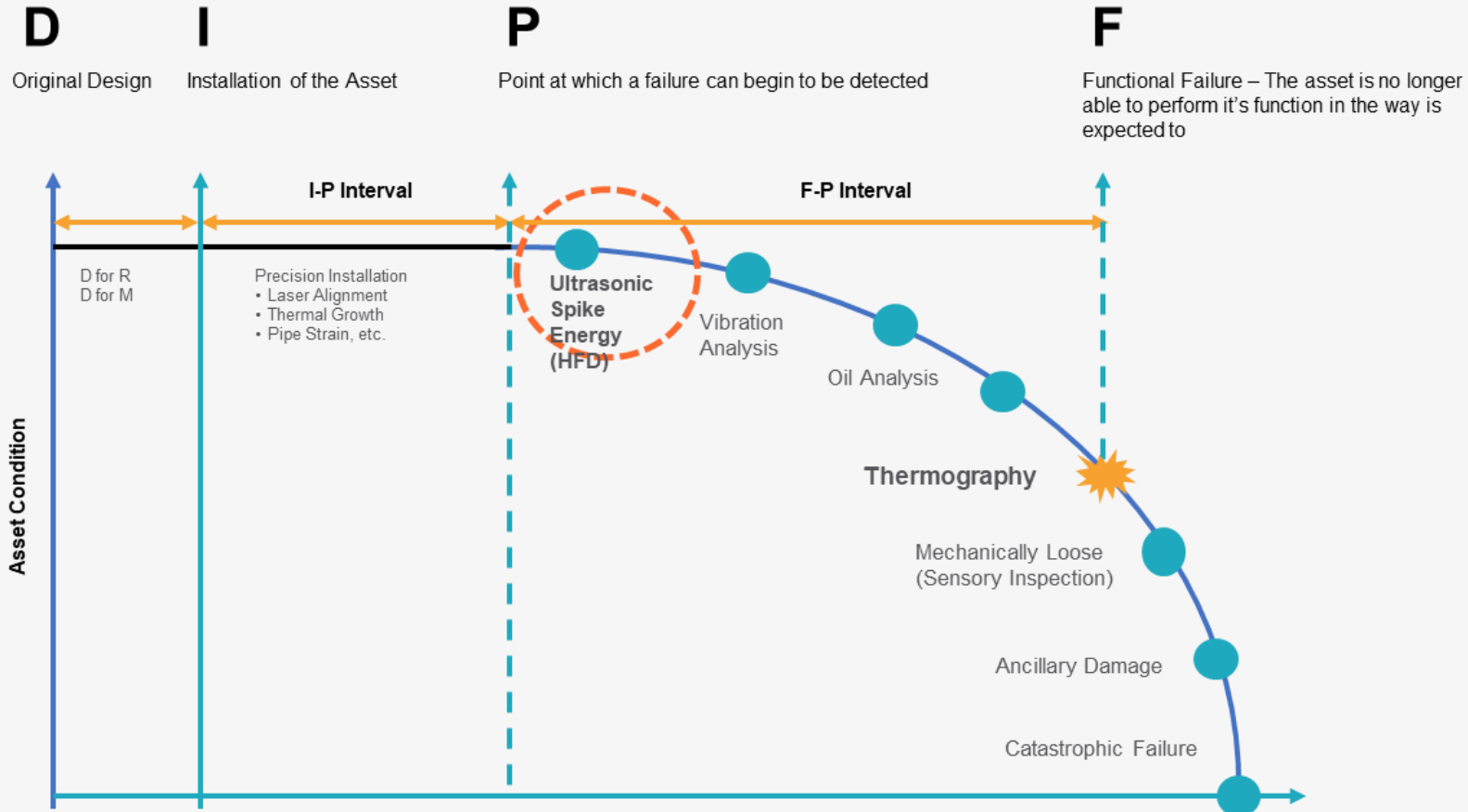
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# FLIR SI124 – ACOUSTIC IMAGING CAMERA



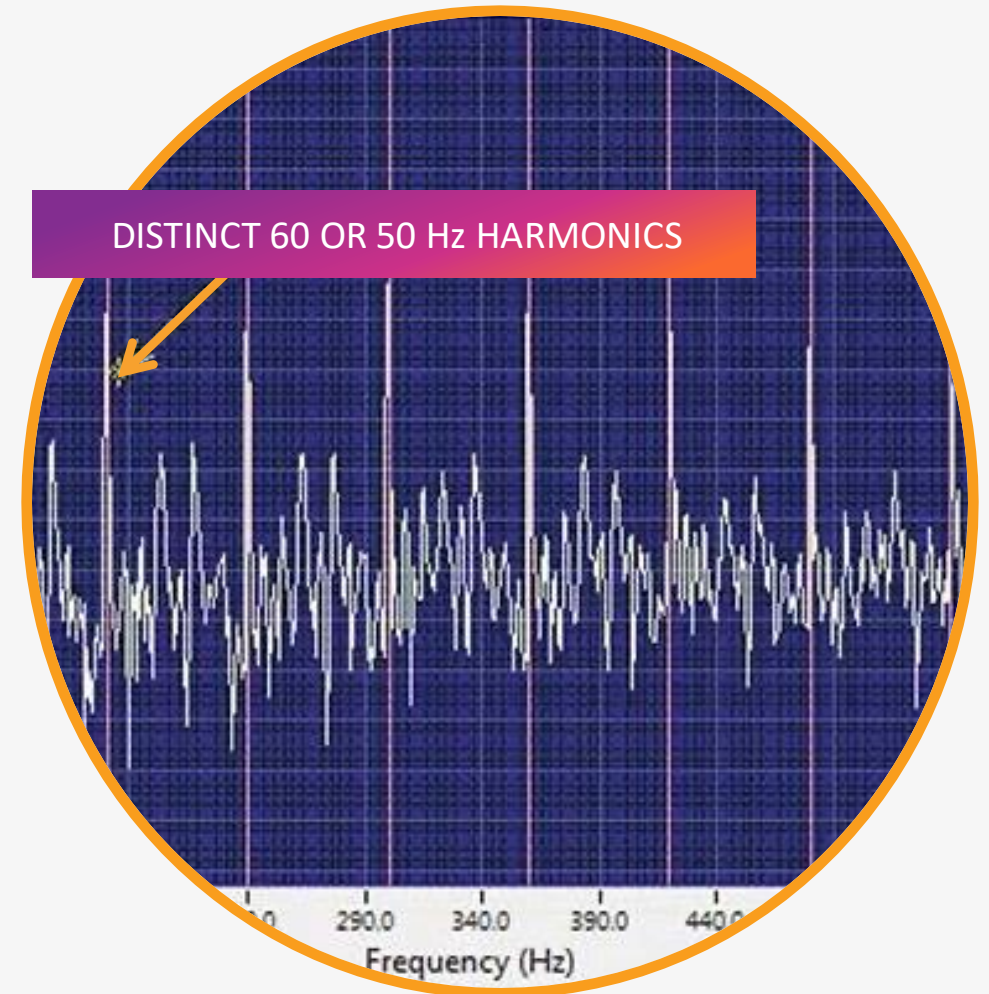
# COMMON CONDITION MONITORING TOOLS

## EARLY DETECTION OF POTENTIAL FAILURES



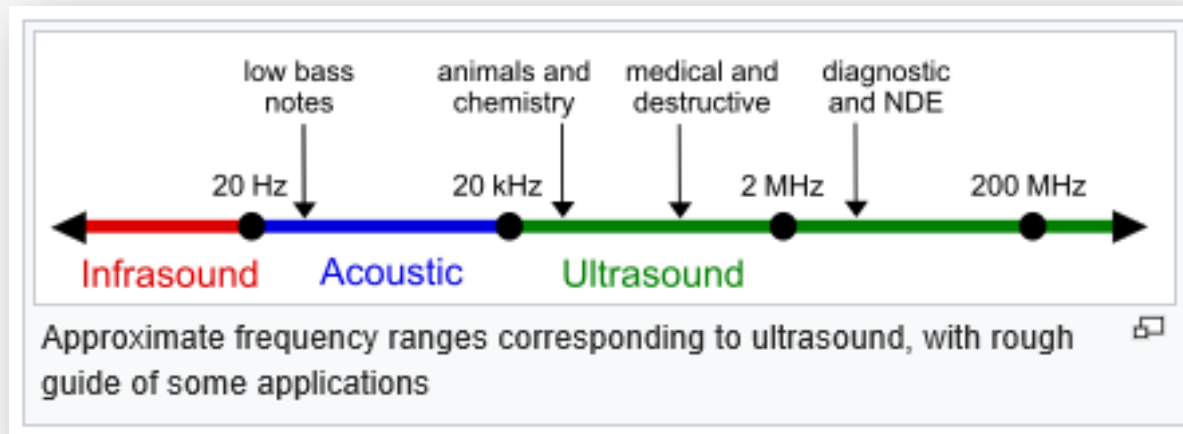
# WHAT IS ULTRASOUND?

- ✓ High frequency sound waves
- ✓ Beyond the range of human hearing
- ✓ Produced by operating equipment, electrical emissions and by leaks
- ✓ Highly Directional
- ✓ Highly localized sources
- ✓ Provides early warning of impending failure
- ✓ Part of a comprehensive asset management system



# WHY ULTRASOUND?

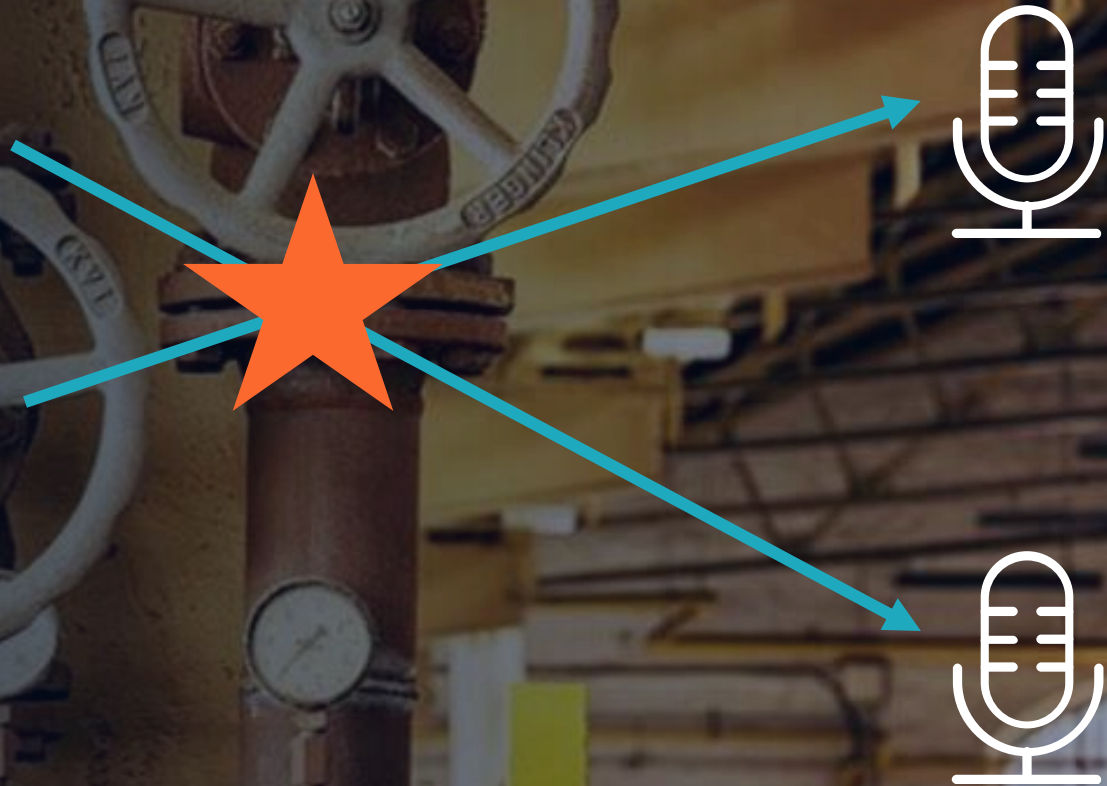
- A pressurized leak **will cause turbulence**, which can be located using **ultrasound**.
- When **air leaks into air**, finding it using any other method than ultrasound can be difficult. With an advanced ultrasonic system it can be easy.
- Background noise can very effectively be **filtered out**, which means that a good ultrasonic solution like the FLIR Si124 Camera also works in **noisy conditions**.



# WHY ULTRASONIC IMAGING?



Multiple microphones allow the camera to triangulate the source of the high frequency sound because the sound is directional



# WHY ULTRASONIC IMAGING?

- ✓ Combine an array of microphones with a camera and you can pinpoint the sound location on a picture
- ✓ Imaging technologies typically provide a 90% reduction in inspection time
- ✓ Imaging technologies are relatively easy to learn



# WHY SO MANY MICROPHONES?

- More microphones improve the ability of the camera to precisely locate the source of the sound
- Similar to pixels on your TV, the more pixels you have, the greater clarity and detail you'll receive



# ULTRASOUND APPLICATIONS

- **Electrical Partial Discharge**
- **Compressed Air System Leak detection**
- **Vacuum system leak detection**
- Compressed Gas leaks (any gas)
- Product Design
- Sound Localization and Analysis
- Mechanical troubleshooting
- Upset condition identification and alarming
- Scientific research
- Building acoustics planning
- Sound abatement



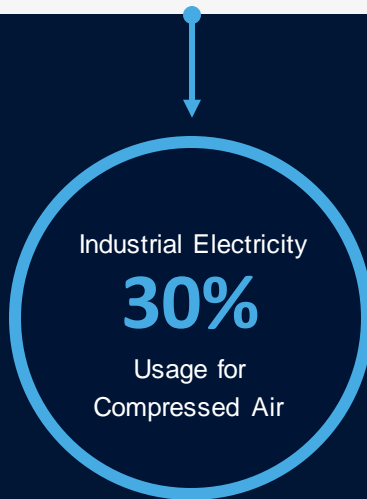
# AIR LEAKS





# COMPRESSED AIR SYSTEMS

US DOE Estimates up to 30% of a Manufacturing facility's electricity is consumed for compressed air.



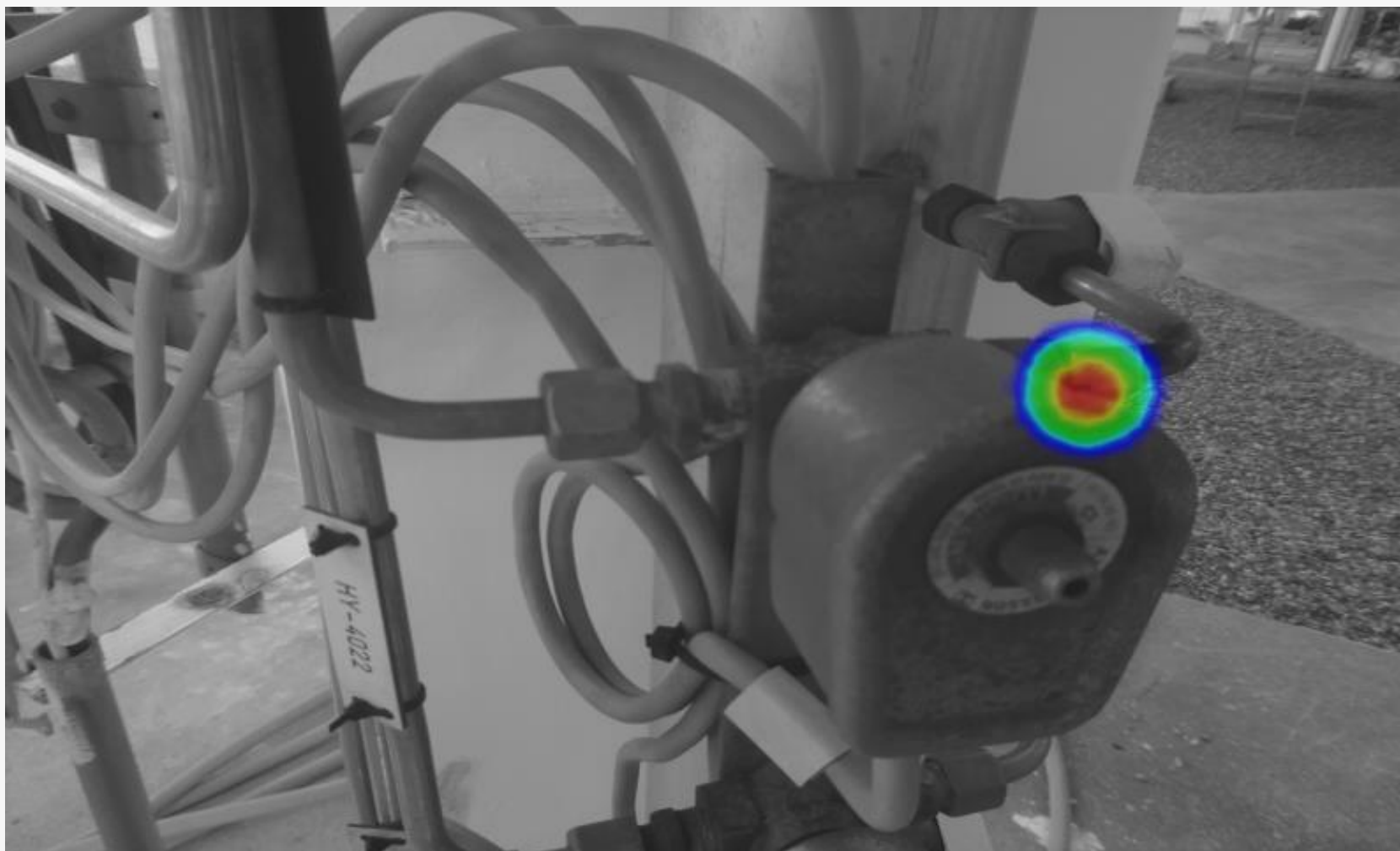
On average 1/3 of compressed air is wasted due to leaks, misuse, pressure drops and over pressurization.



Based on a typical manufacturing facility running a 200 Hp compressor, 6,800 hrs./yr and \$0.11/kw







# PARTIAL DISCHARGE

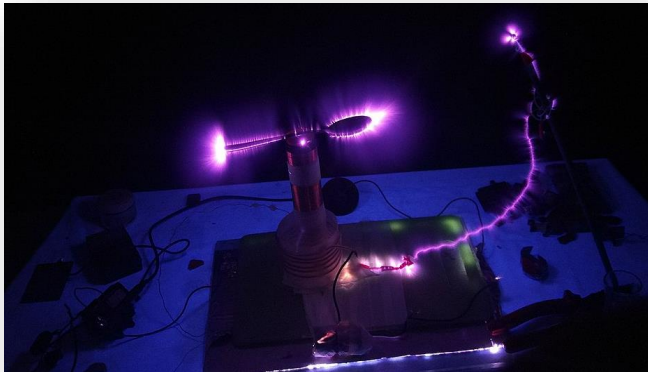


# CLASSIFICATION OF PARTIAL DISCHARGE

## CORONA

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Ionization of fluid or air surrounding a conductor



## TRACKING

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Surface tracking over contaminated insulation



## ARCING

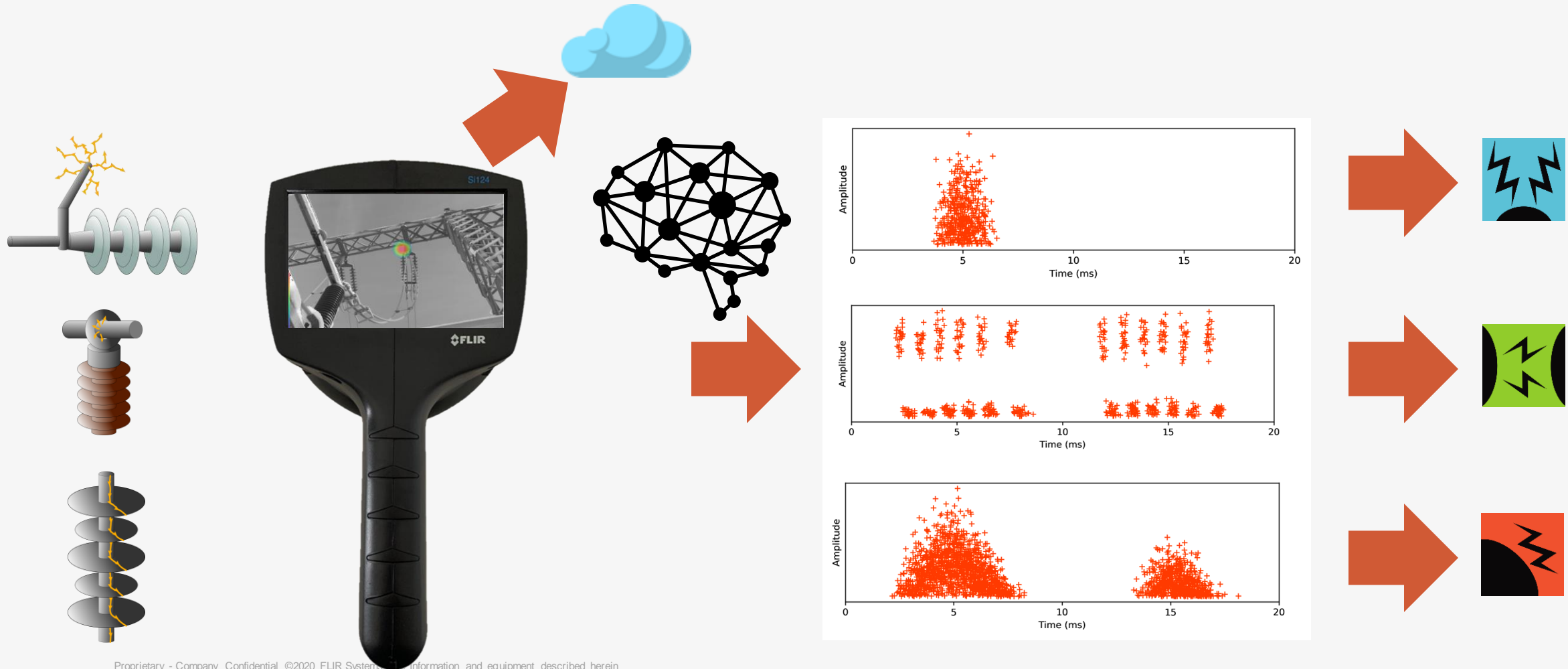
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Electrical breakdown of a gas producing a plasma discharge



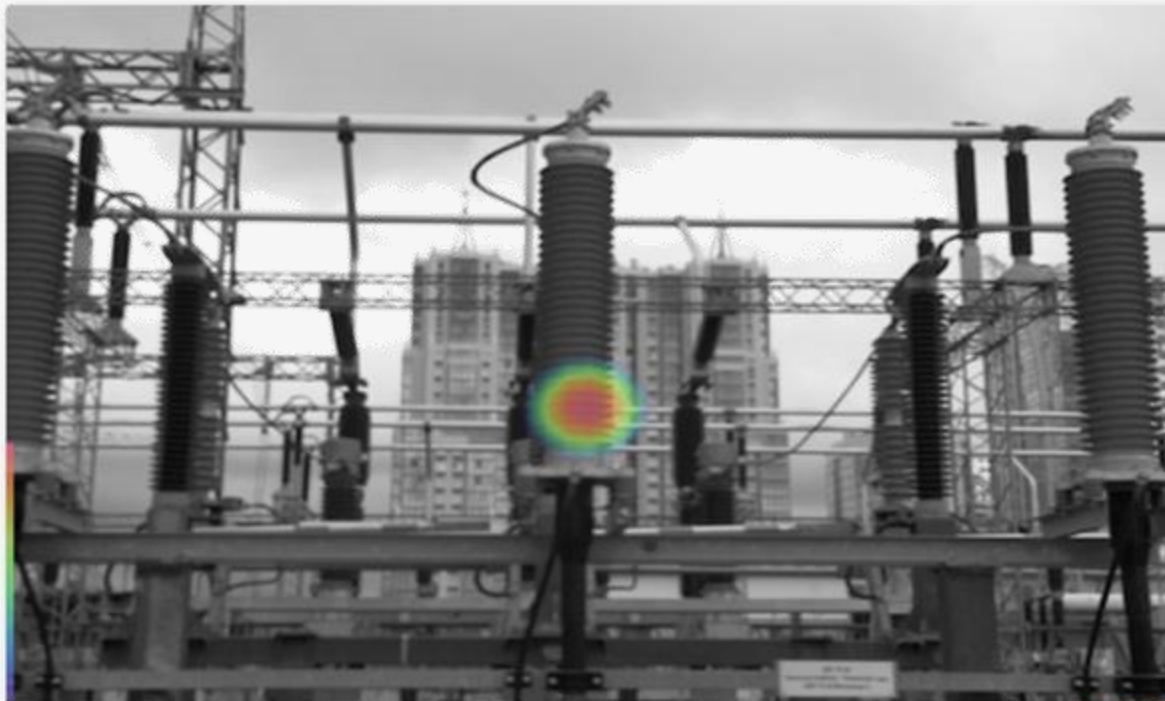
# PD DETECTION PROCESS / WORKFLOW

We combine advanced signal processing with AI to automatically detect and recognize PD's



# PARTIAL DISCHARGE

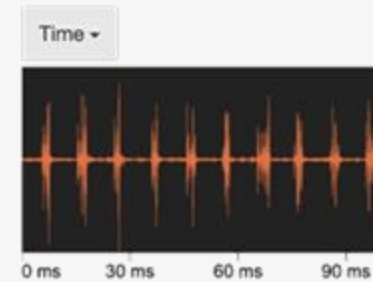
## Faulty Insulator



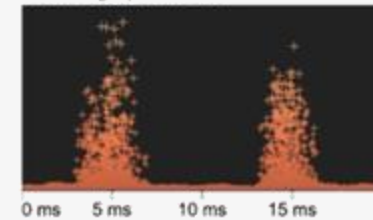
Range:

Measured dB(Z):  
23.7 dB

Signal last 100ms:



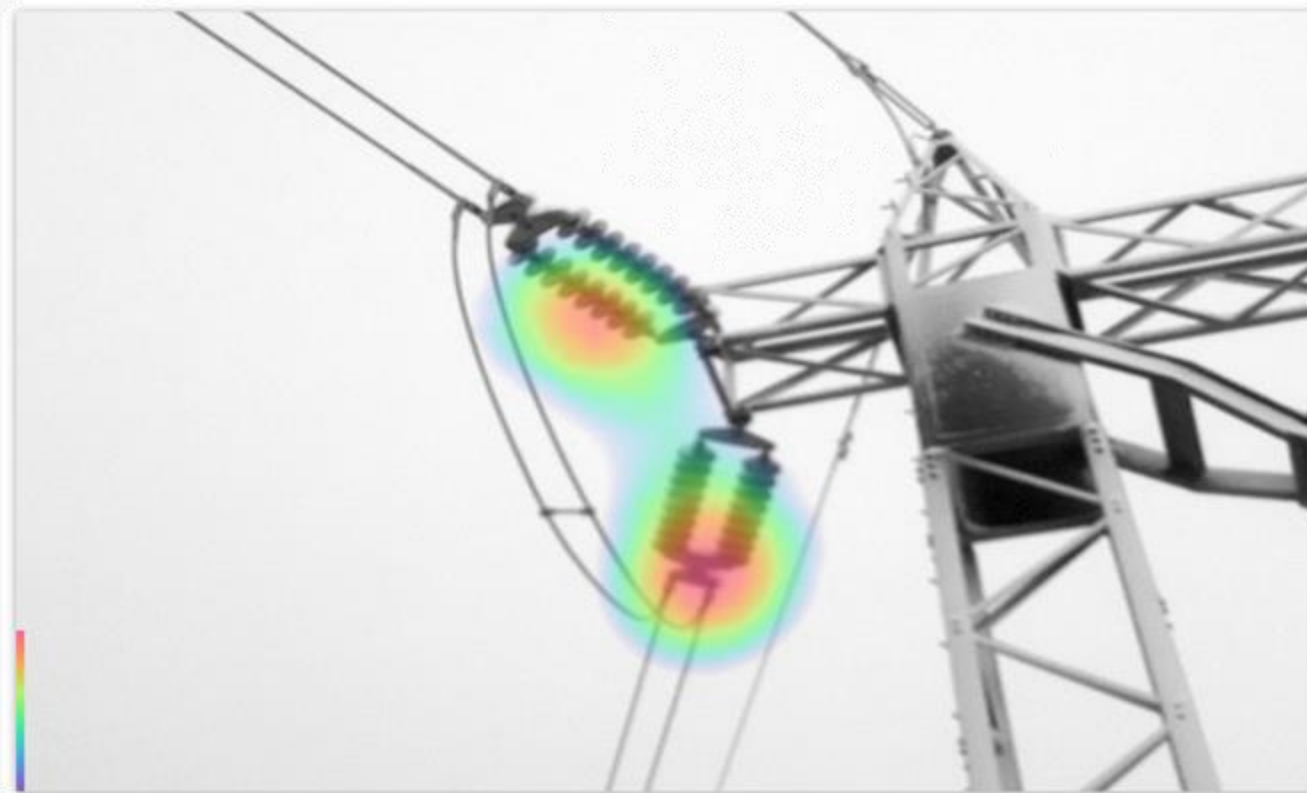
Discharge prediction:



Discharge on surface or inside component

# PARTIAL DISCHARGE

## Surface Discharge on Insulator

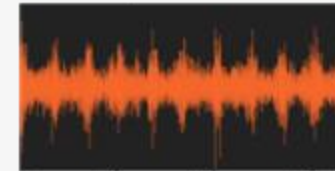


Measured dB(Z):

0.7 dB

Signal last 100ms:

Time ▾



0 ms 30 ms 60 ms 90 ms

$\Delta f$ : 12000Hz — 31250Hz

Discharge prediction:

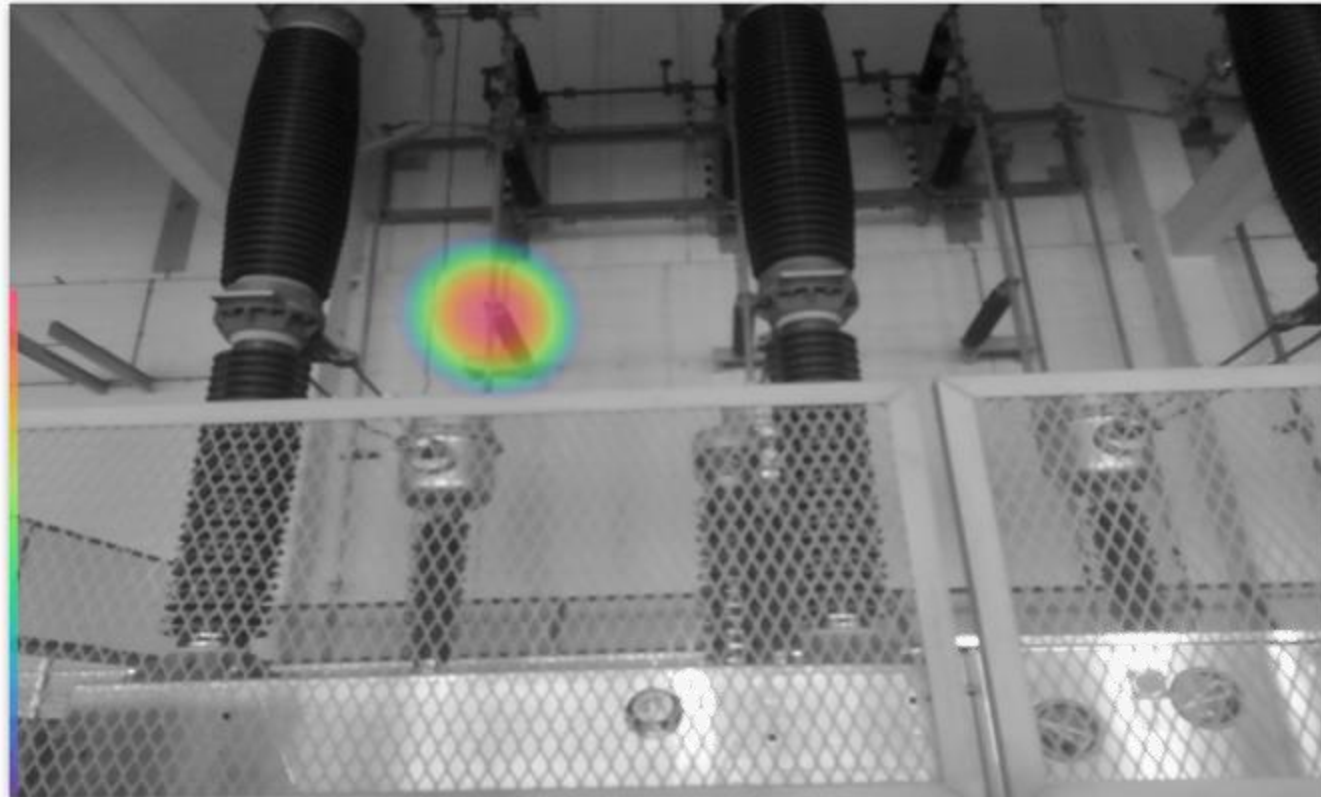


0 ms 5 ms 10 ms 15 ms

Discharge on surface or  
inside component



# FLOATING DISCHARGE

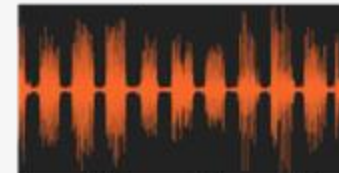


Measured dB(Z):

31.7 dB

Signal last 100ms:

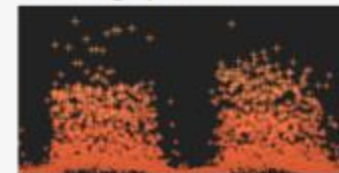
Time ▾



0 ms 30 ms 60 ms 90 ms

$\Delta f$ : 14000Hz — 31250Hz

Discharge prediction:



0 ms 5 ms 10 ms 15 ms

Discharge between  
components

# FEATURES – SI124



- Can do both air leaks and partial discharge
- Lightweight and portable (2.2 lbs / 980 g) - can be operated with one hand
- Operating range from close to mid distance 1.6' to 49' (0.5 to 15 M) all the way up to 328' (100 M)
- Both built-in + external replaceable battery allowing up to 8hrs of operating time
- Built in Wi-fi for connecting to cloud for further AI powered analysis
- Bright 5-inch color display
- Operation temperature +14 to +122°F (-10 to +50°C)
- Pricing - \$19,999



LEAK DETECTION & PREDICTIVE / PREVENTATIVE MAINTENANCE SOLUTIONS

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QUESTIONS?



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# APPENDIX

# IS THIS YOUR OPERATION?

1. Difficult to see outside on the LCD
2. Multiple points to inspect (taking too long to finish)
3. Not sure what is next on the list to inspect
4. Inexperienced user
5. Using pen and paper to document inspection
6. Targets are far away
7. Working safely is a challenge
8. Limited ability to share your data with colleagues quickly and effectively
9. Reporting is time-consuming
10. Lack of historical data for determining action plan on faults



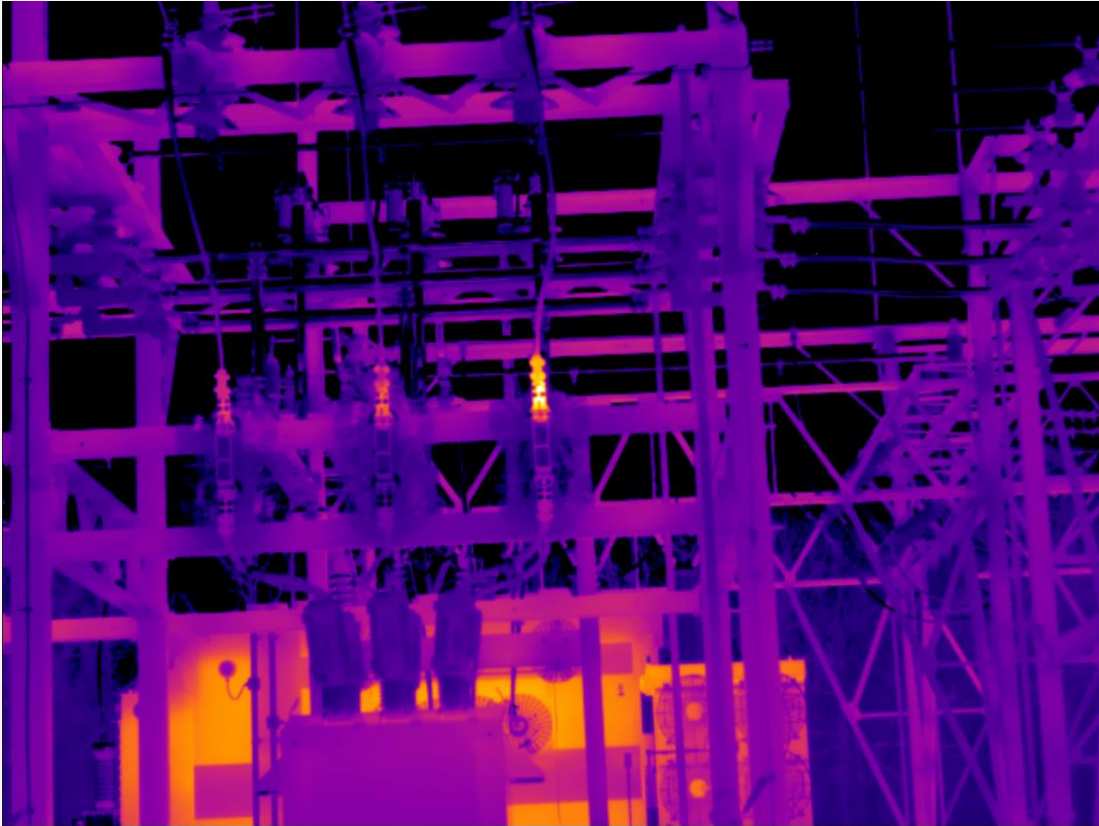
# FLIR T-SERIES – COMPLETE SOLUTION

- Resolution (Pixels) to meet any budget
  - From 76,800 pixels to 786,432
- Eyepiece to make outdoor work easy to see
- Split Design for comfortable work
- Also great for tight spots or look around objects
- New lens offerings for amazing picture and temperature details
- Newest camera - T560/640x480 under 20K
- New Routing Functionality
  - Load route into camera
  - Camera will tell operator what to scan next
  - Software stores all data on image for future reference
  - Allows for new users to easily scan large systems

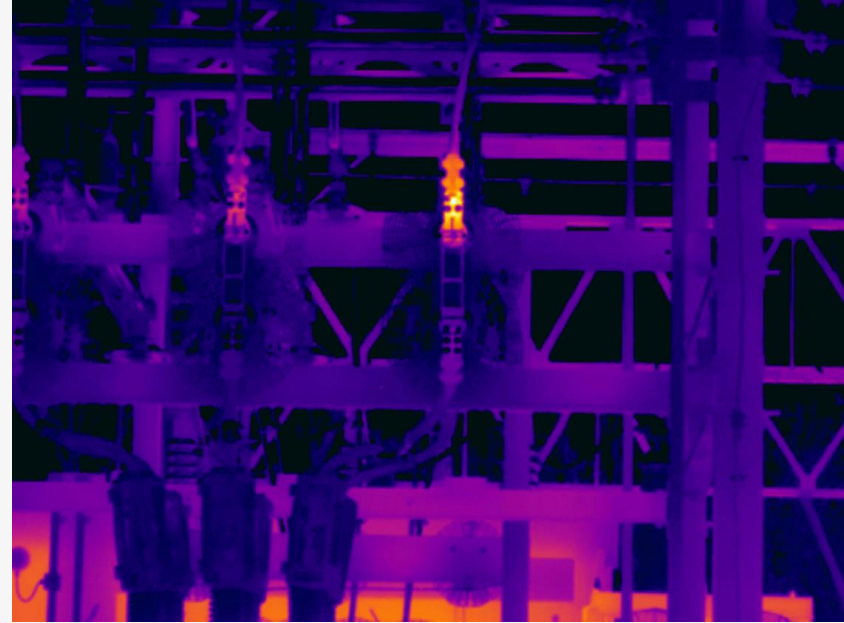


# IMAGES 640 X 480

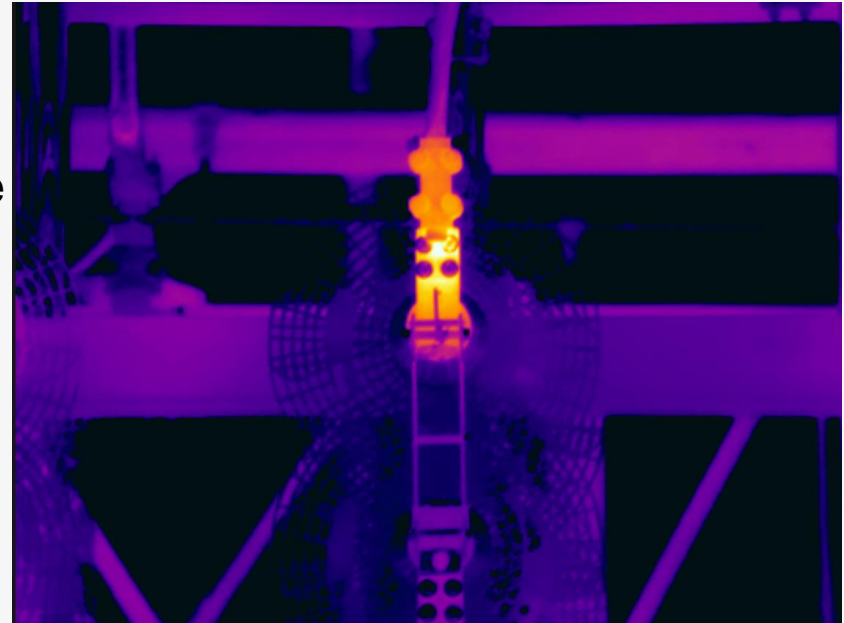
24 degree



14 degree



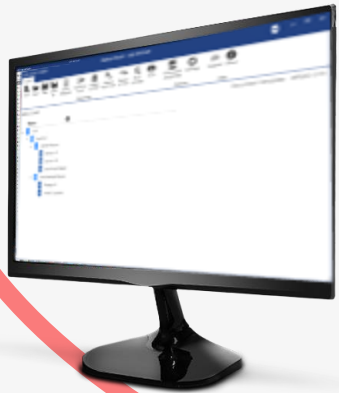
6 degree



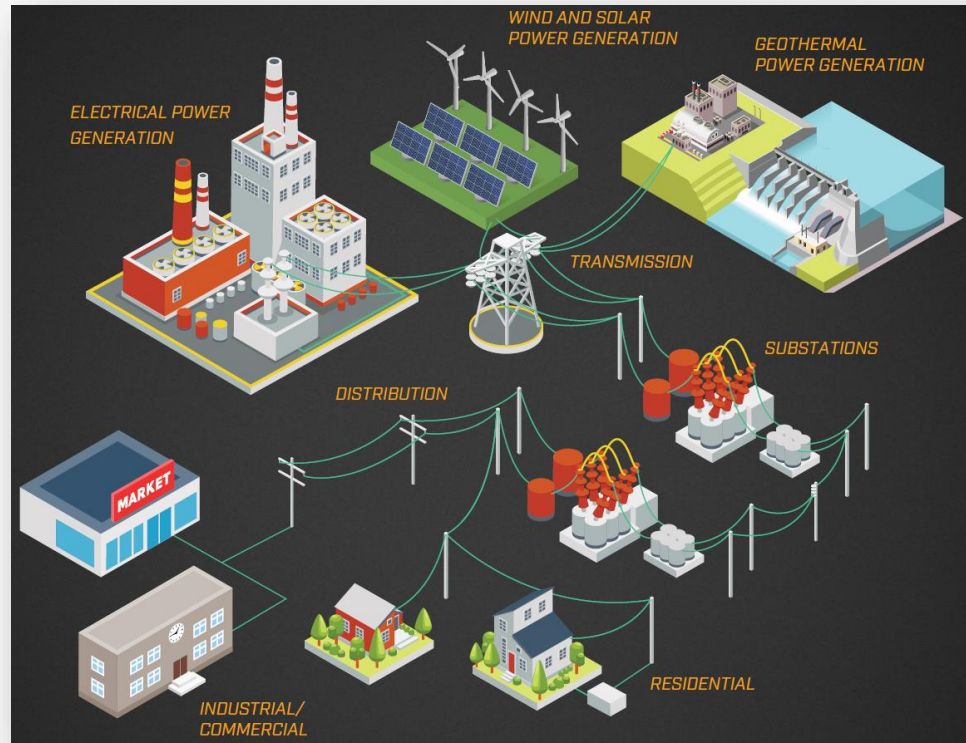
# COMPLETE RELIABILITY SOLUTION



FLIR Thermal Studio Pro



FLIR Inspection Route Creator



FLIR Thermal with Inspection Route Camera Software

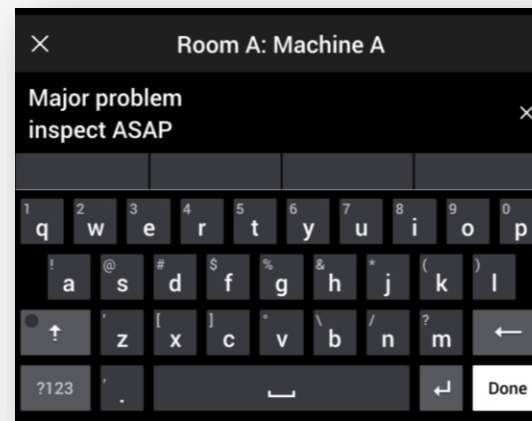
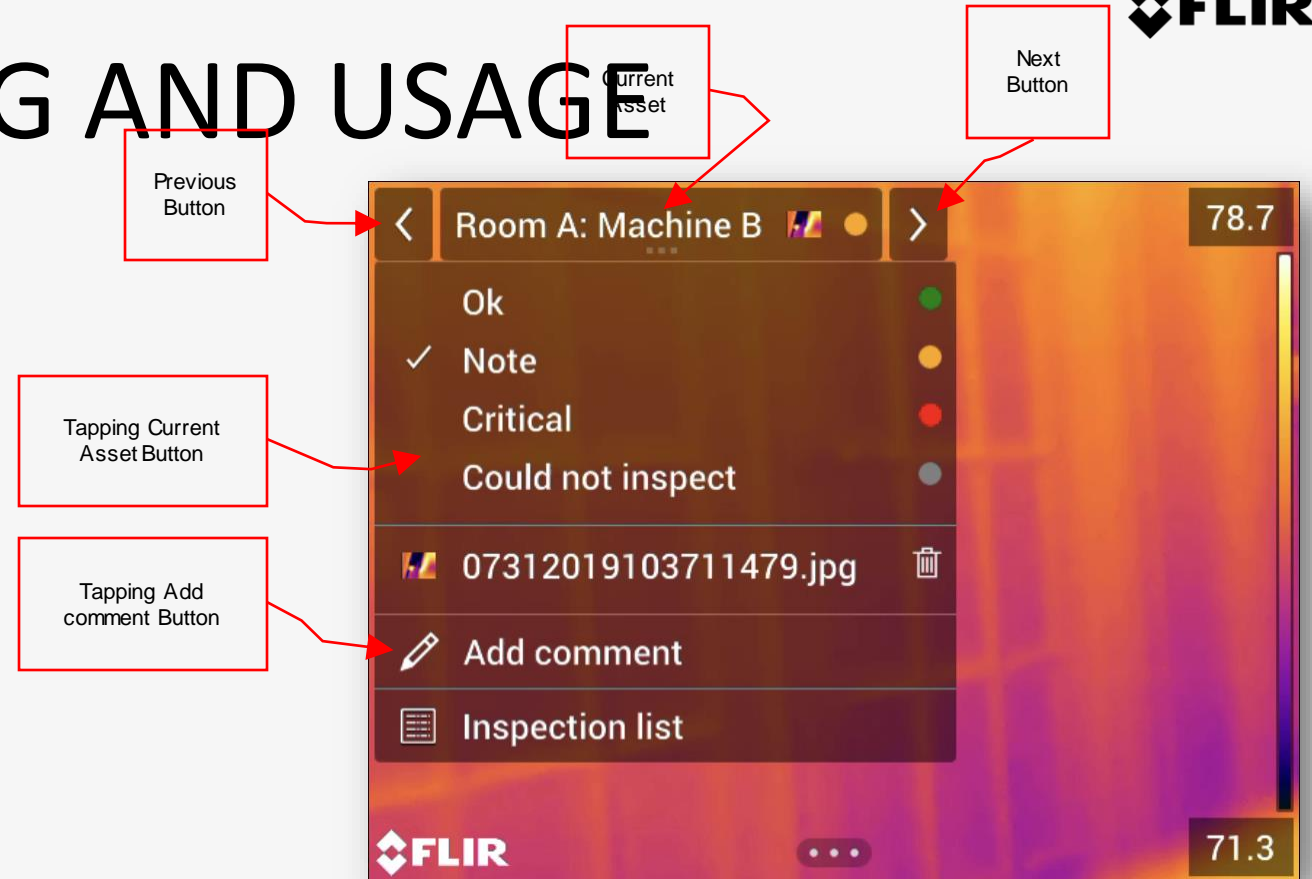


# EFFICIENT REPORTING AND USAGE

Configure an automated workflow, where the camera automatically sets the status and steps to the next inspection point when an image is saved

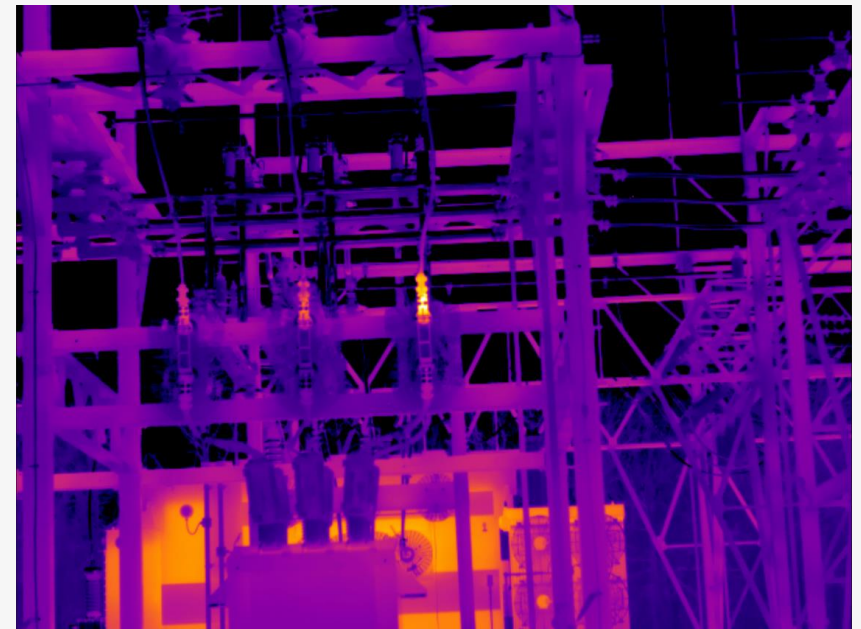
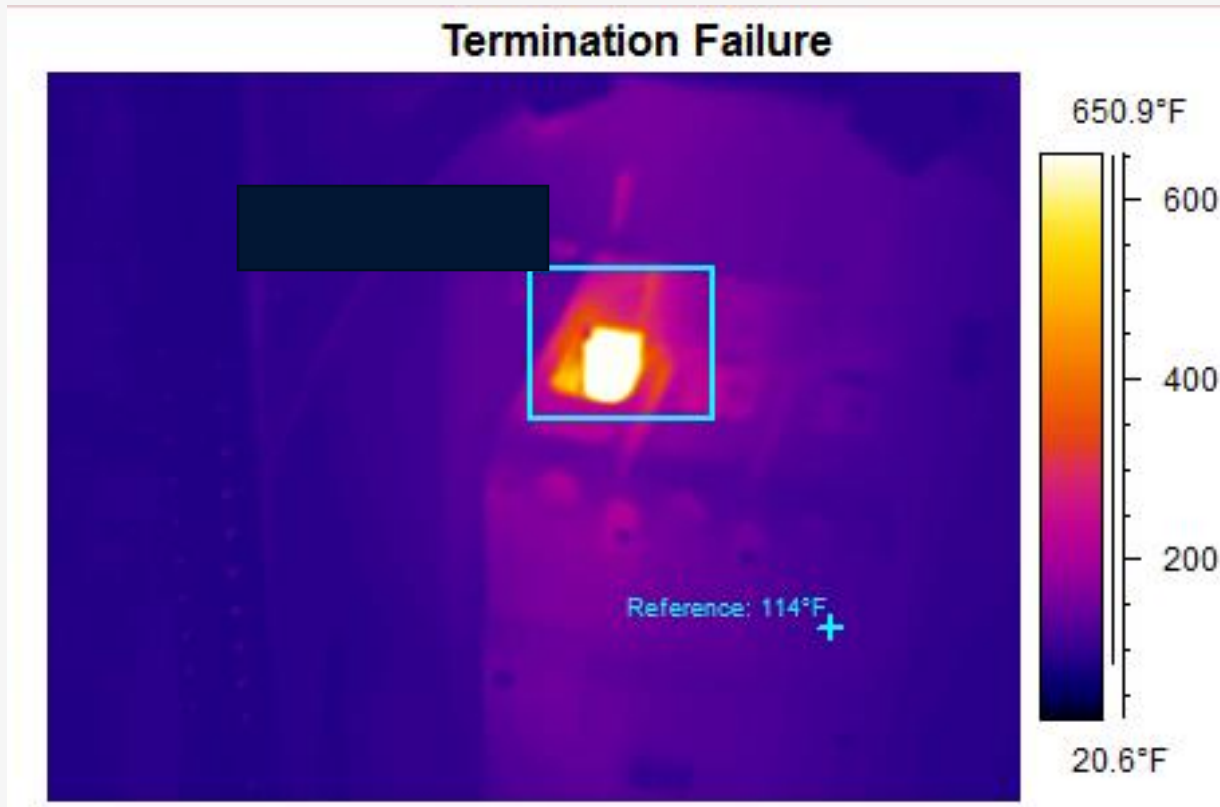
Even a new user could pick up the camera and complete the route without knowing where to go next.

The camera with Inspection Route Software will tell you where to go NEXT!



# HOW TO PREVENT ARC FLASH

What is the Melt Temperature of Aluminum?



# C5 – POCKET PORTABLE

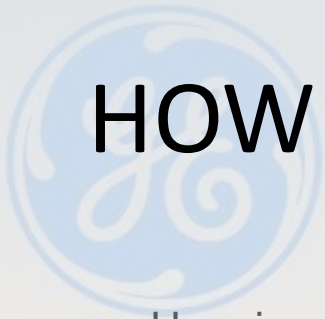
- Fits in your pocket
- Great resolution for the package size, 19600 pixels
- On board storage and measurement analysis
- WiFi for instant reporting and image sharing
- Affordable \$699.99 MSRP



# SUMMARY

- If you are looking for gas or air leaks, we have a unique solution for you
- If you are outdoors or in tight confined areas the T series provides tremendous payback for its key
- If you wanted to equip your entire team(to work safely) with a thermal camera you should look at its capability and affordability.
- Demonstrations are available/contact your local FLIR Representative

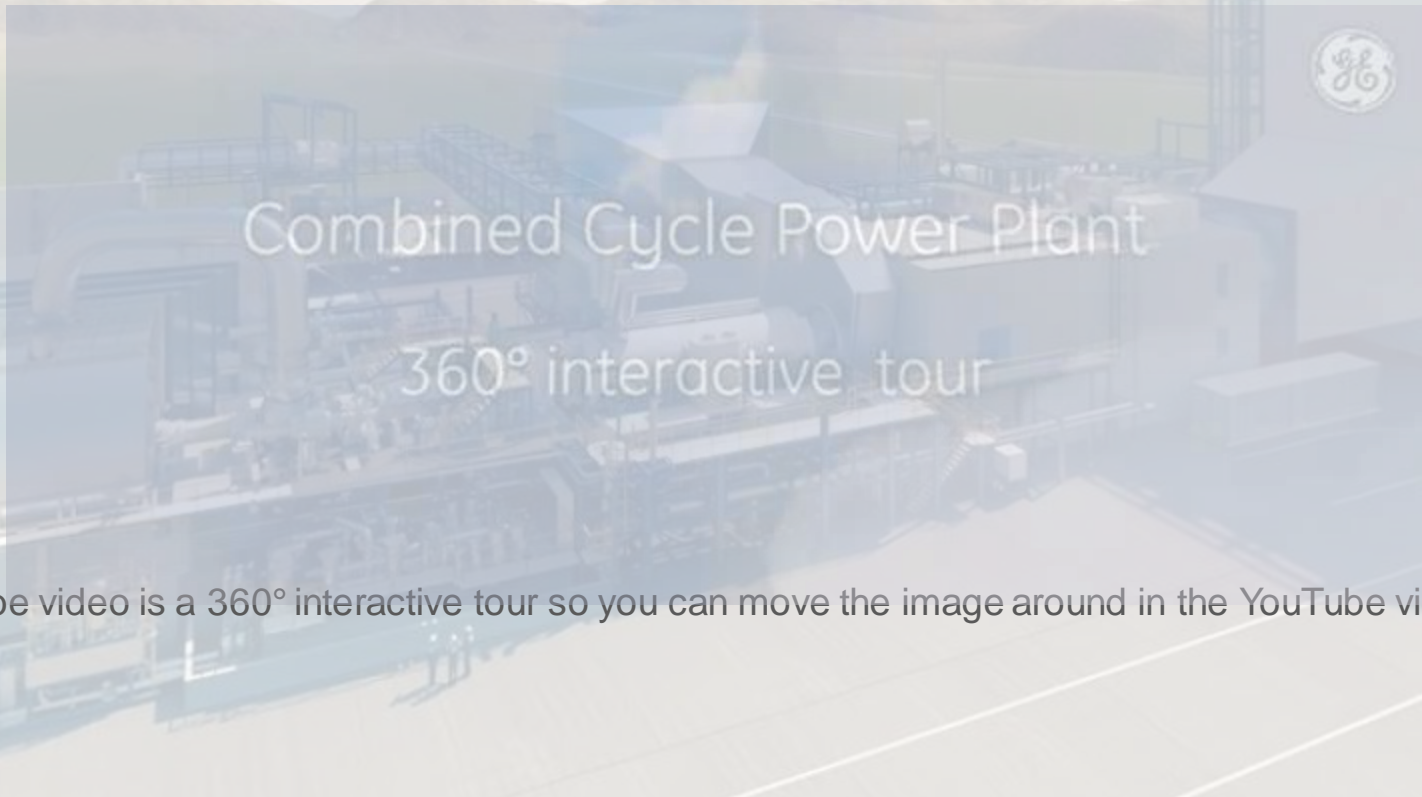




# HOW A COMBINED-CYCLE PLANT WORKS

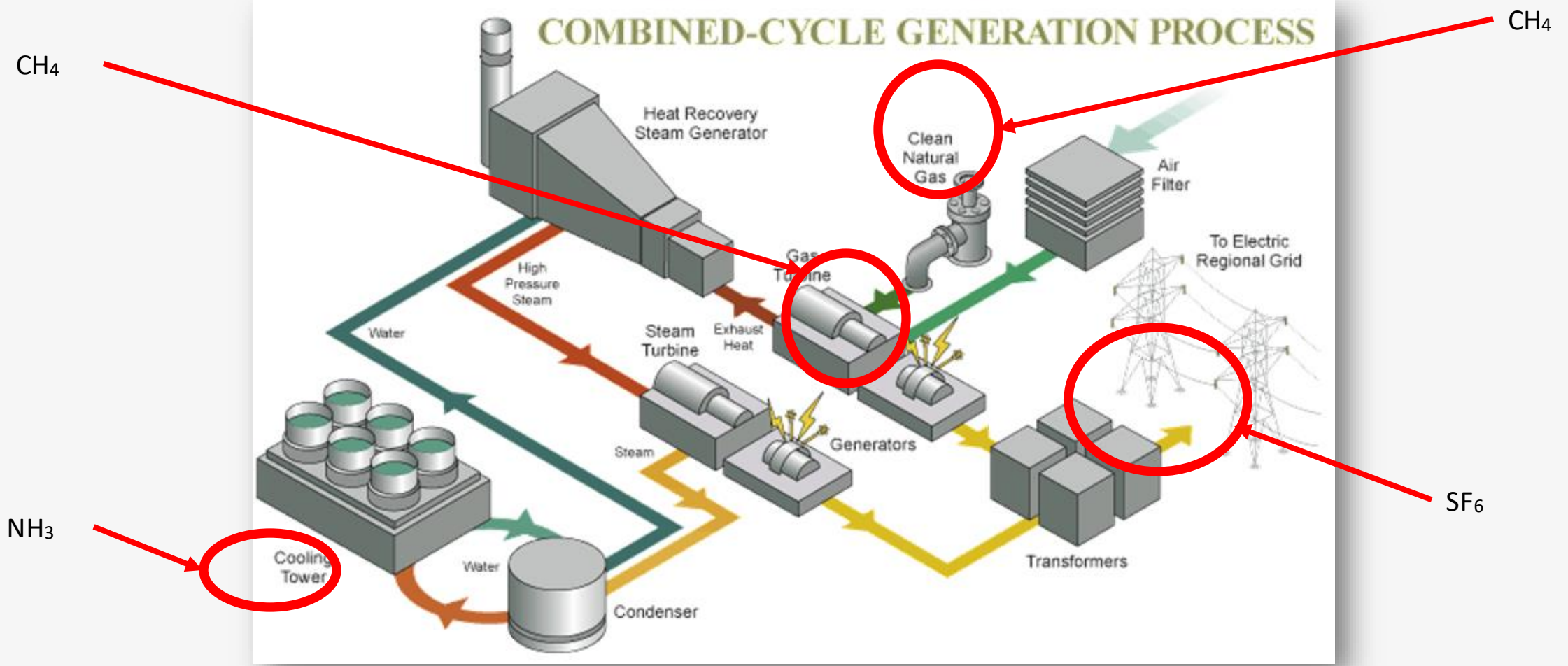
Here is a great interactive video from GE on how a Combined Cycle Power Plant works::

<https://www.youtube.com/watch?v=KVjtFXWe9Eo&feature=youtu.be&list=PLpSQBjC0ANgxIJ4YaFxiTCSfLQQPsKD5s>



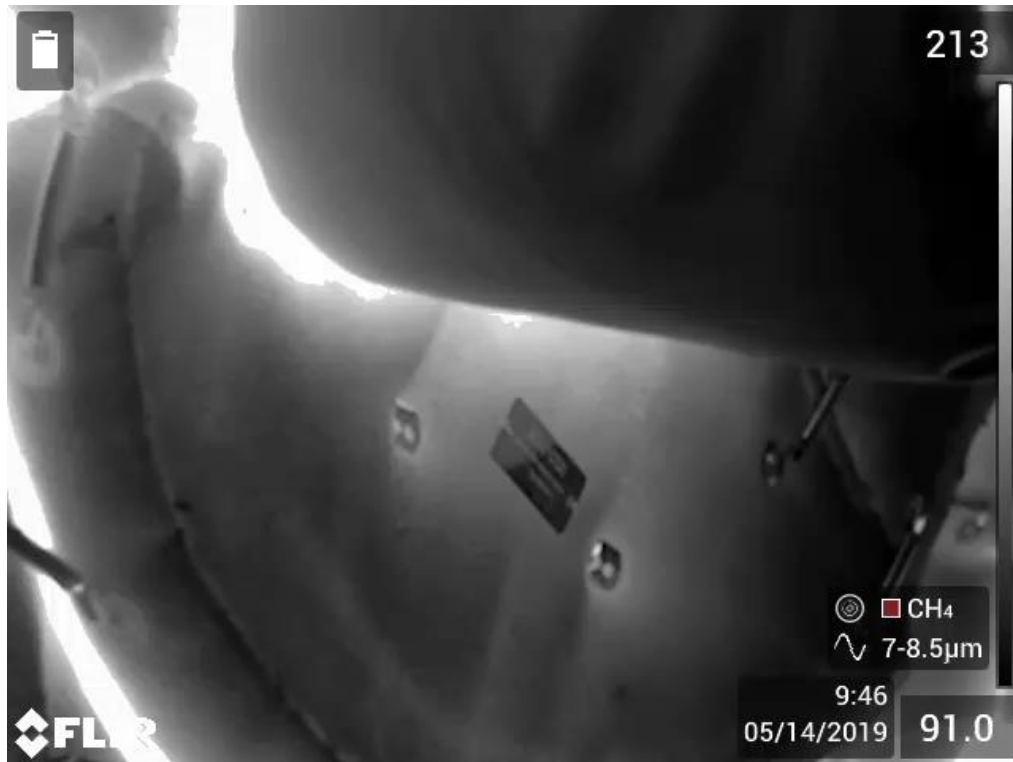
NOTE: This YouTube video is a 360° interactive tour so you can move the image around in the YouTube video

# WHERE IS OGI APPLICABLE?



# INSULATION LEAKS

## INSULATION LEAK IN CT ROOM (GF77)

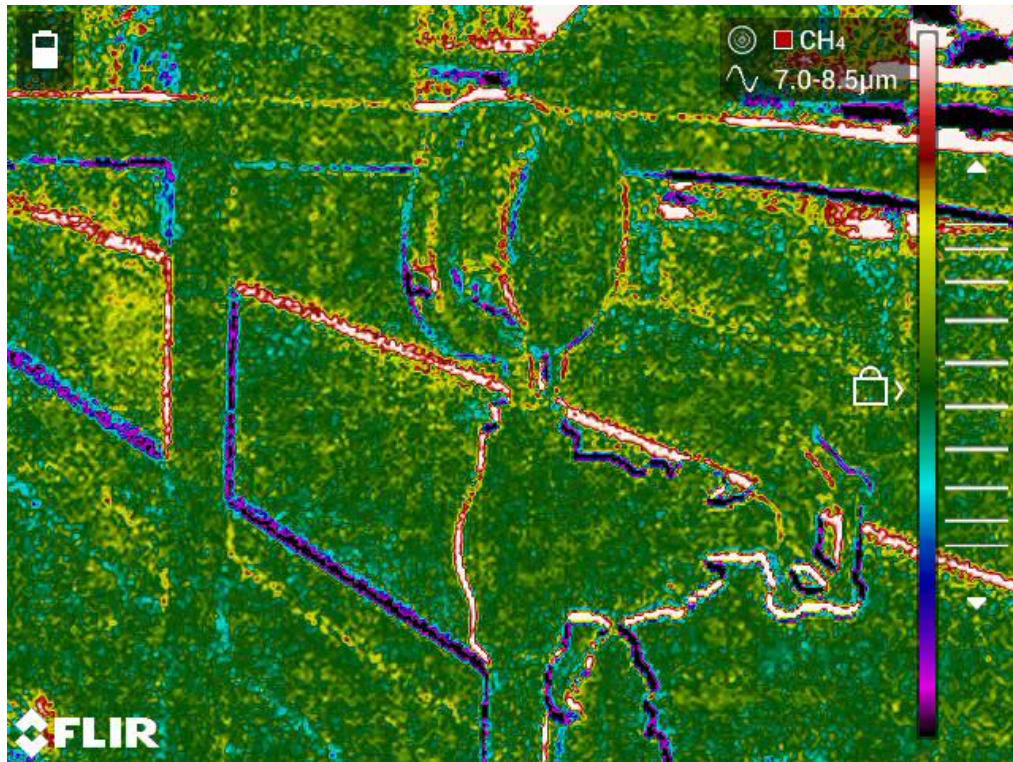


## OVERHEAD INSULATION LEAK (GF77)

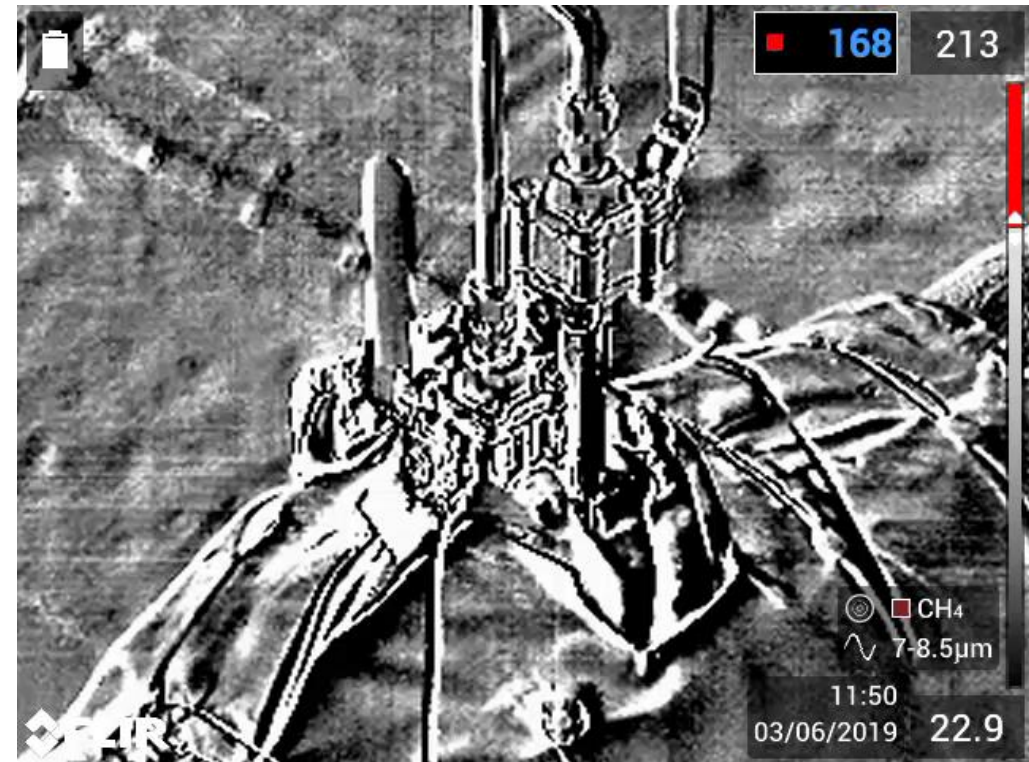


# GENERAL INSPECTION LEAKS IN A PLANT

## PRESSURE GAUGE LEAK (GF77)



## VALVE LEAK (GF77)

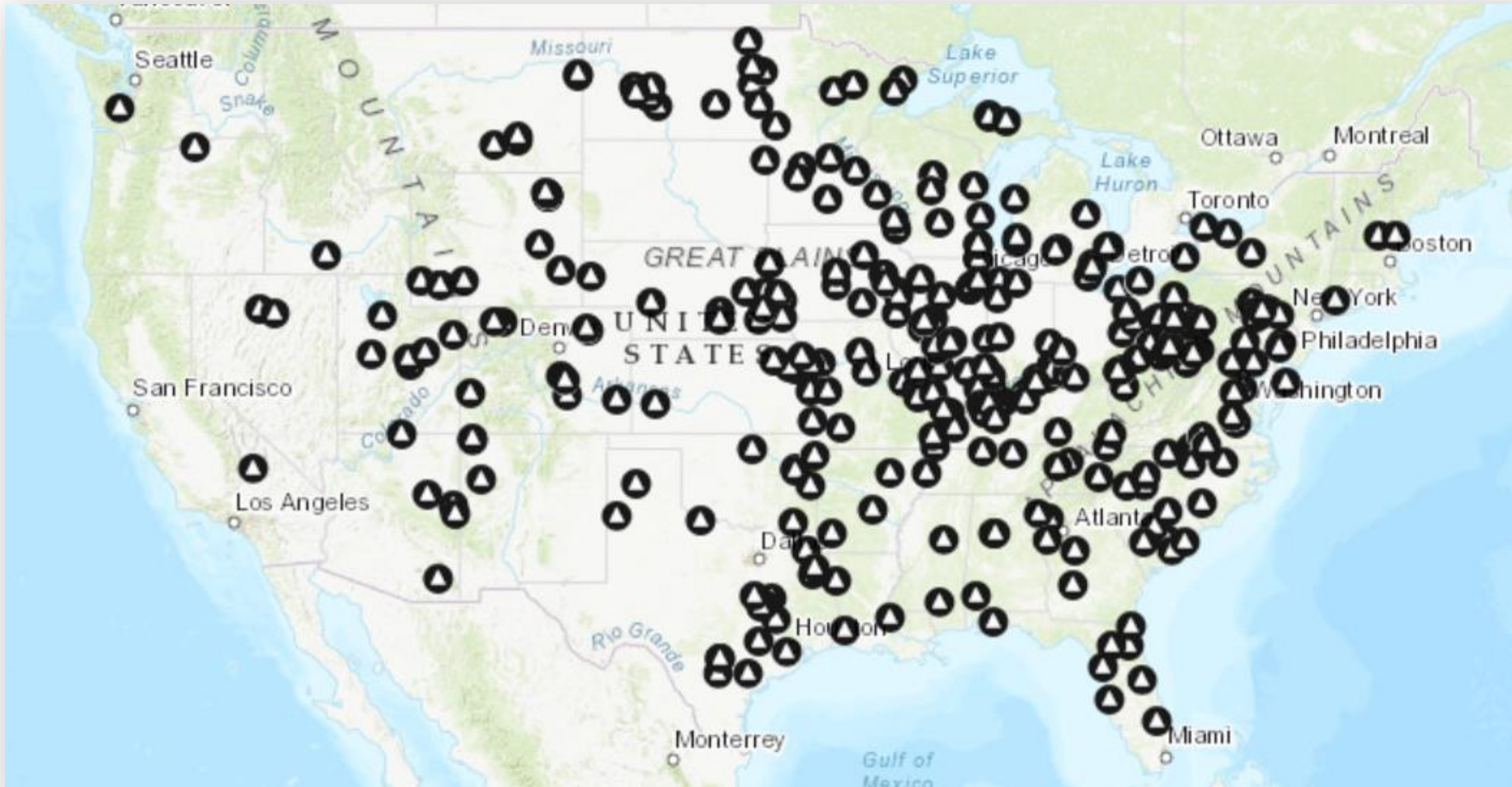






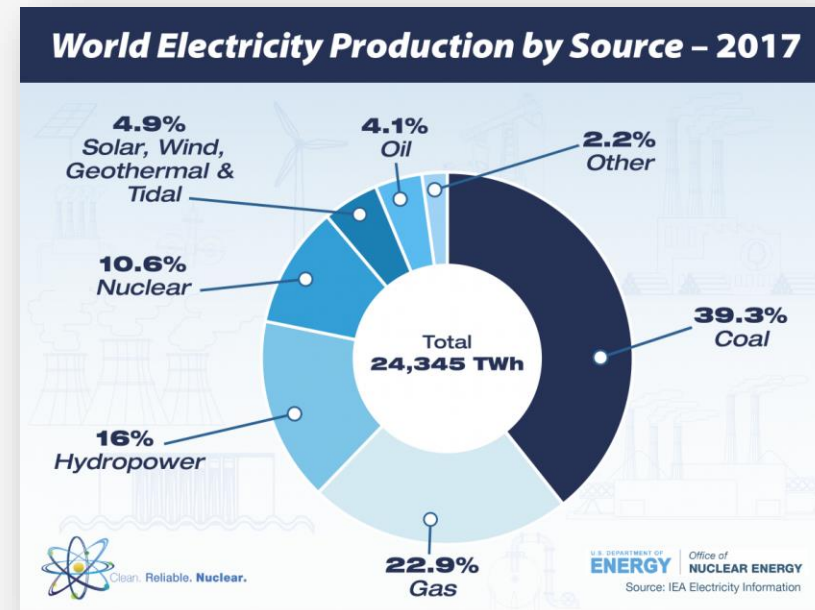
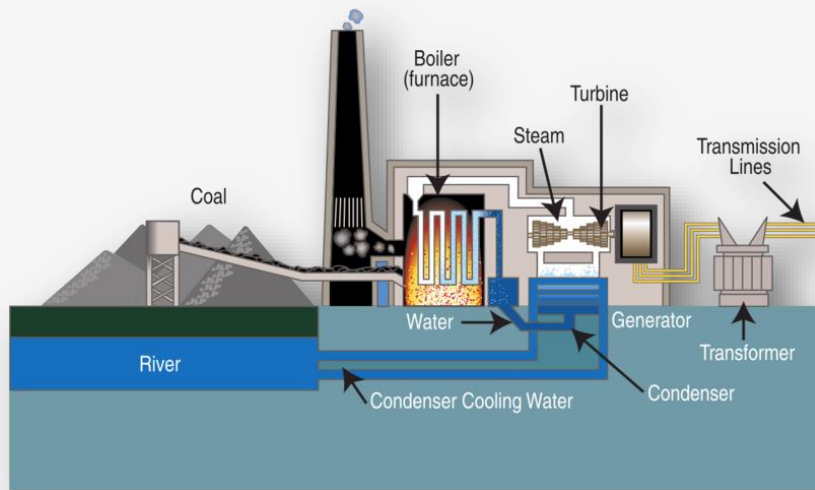
# FOSSIL FUEL POWER PLANTS

# COAL FIRED POWER PLANTS



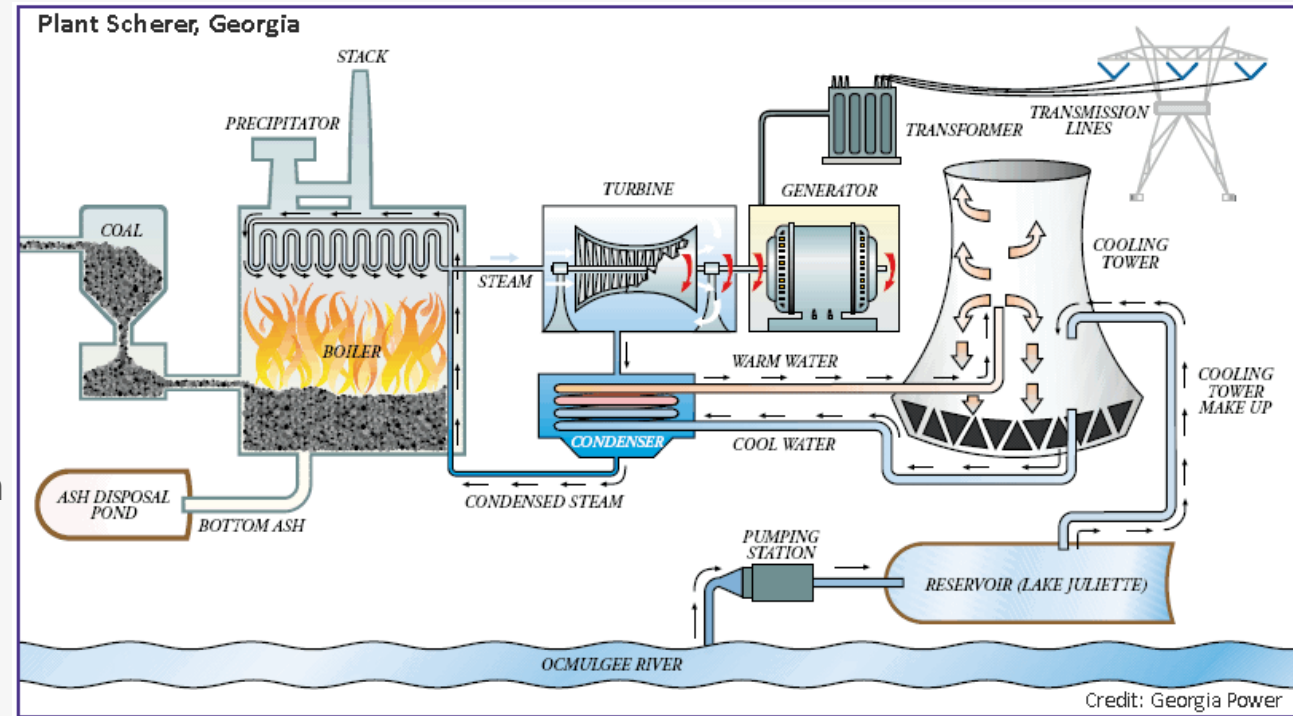
# WHAT ARE COAL FIRED POWER PLANTS?

- **Coal Fired Power Plants** provide more electricity globally than any other form of power generation. They work by burning crushed coal to produce steam that is used to spin a generator and produce electricity.
- **Coal Fired Power Plants** often use Natural Gas to ignite and keep the burners in the boiler running and Ammonia in the cooling process.

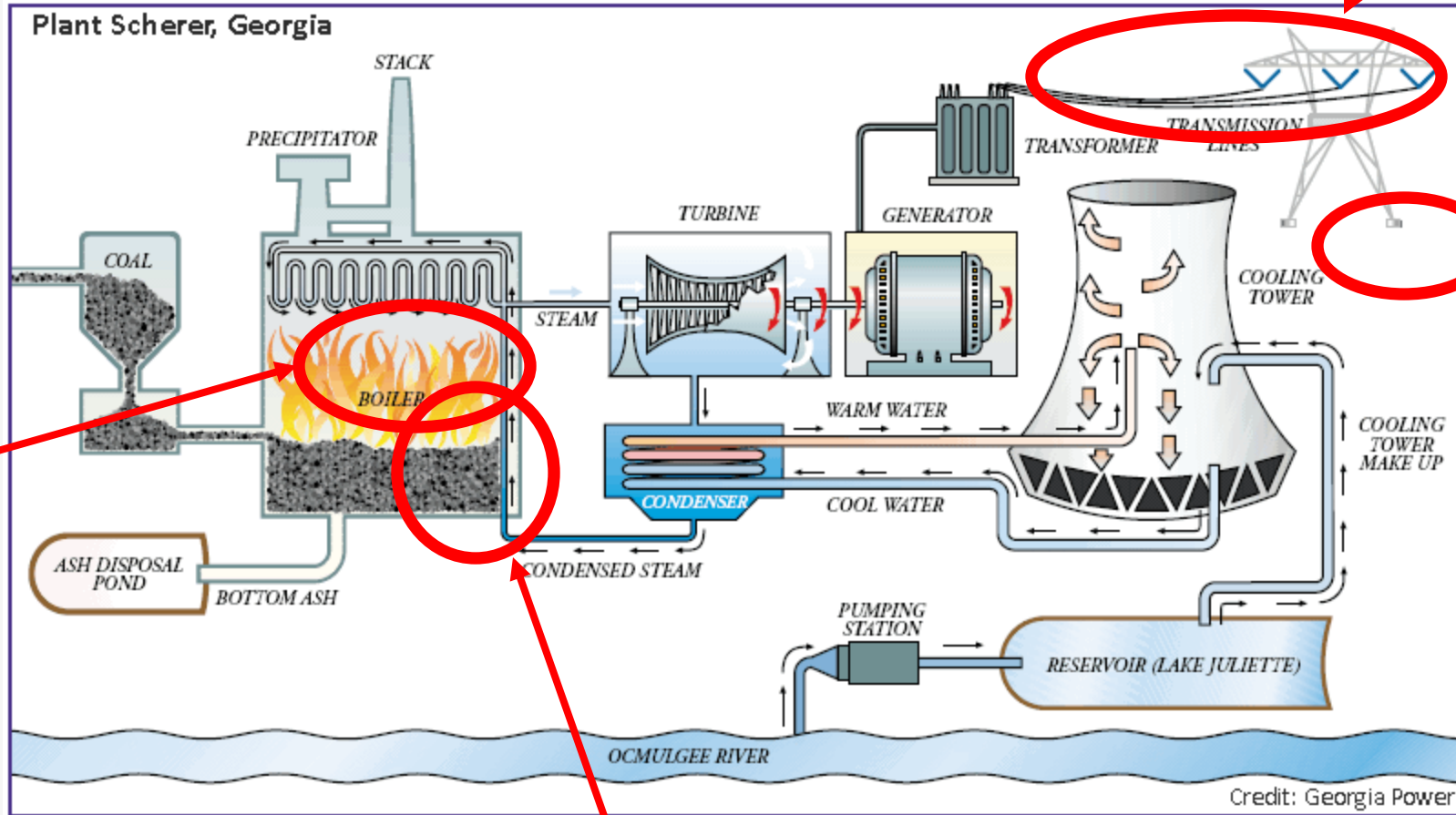


# HOW A COAL FIRED PLANT WORKS

- **Coal Fired Power Plants** work by burning pulverized coal to heat water and produce steam.
- The steam is sent to a turbine, under immense pressure, which spins a generator to produce electricity.
- The steam is then sent to a condenser to cool it, turn it into water and the process starts over.



# WHERE IS OGI APPLICABLE?



Not OGI but you can use a GF309 to inspect the slag in the boiler

CH<sub>4</sub> (in the burners for the Boiler)

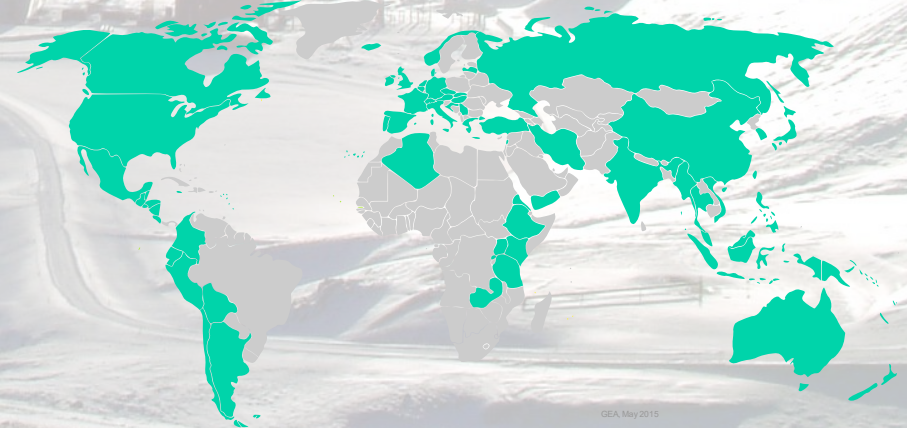


# GEOTHERMAL ENERGY INDUSTRY

Need more research. May not be a good CH4 Market

# WHAT IS GEOTHERMAL POWER?

- **Geothermal power** is power generated by geothermal energy. Geothermal power is considered to be a sustainable, renewable source of energy because the heat extraction is small compared with the Earth's heat content. Geothermal electricity generation is currently used in 24 countries, while geothermal heating is in use in 70 countries
- **Geothermal power stations** are similar to other steam turbine thermal power stations in that heat from a fuel source (i.e. the Earth's core) is used to heat water or another working fluid to generate steam and make electricity. The working fluid is then used to turn a turbine of a generator, thereby producing electricity. The fluid is then cooled and returned to the heat source.



# WHERE ARE THE OPPORTUNITIES?



Geothermal  
Power  
Plants in the  
US



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# HOW A GEOTHERMAL POWER PLANT WORKS

In a biogas plant the waste is transformed into bioenergy and high quality fertilizers. Biogas is a result of a naturally working process, where micro-organisms degrade the organic matter under anaerobic conditions. **Main functions of a biogas plant: waste management and decentralized production of renewable energy and fertilizers.** Biogas is primarily methane ( $\text{CH}_4$ ) which is fed to the natural gas pipelines or converted to electricity and supplied to the electricity grid and carbon dioxide ( $\text{CO}_2$ ) that can be captured, purified and sold to be used as fertilizer.

<https://archive.epa.gov/climatechange/kids/solutions/technologies/geothermal.html>

