Compressed Air Leak Detection: Techniques, Methods, Tips, and Tools

Ron Marshall
Marshall Compressed Air Consulting
Keynote Speaker

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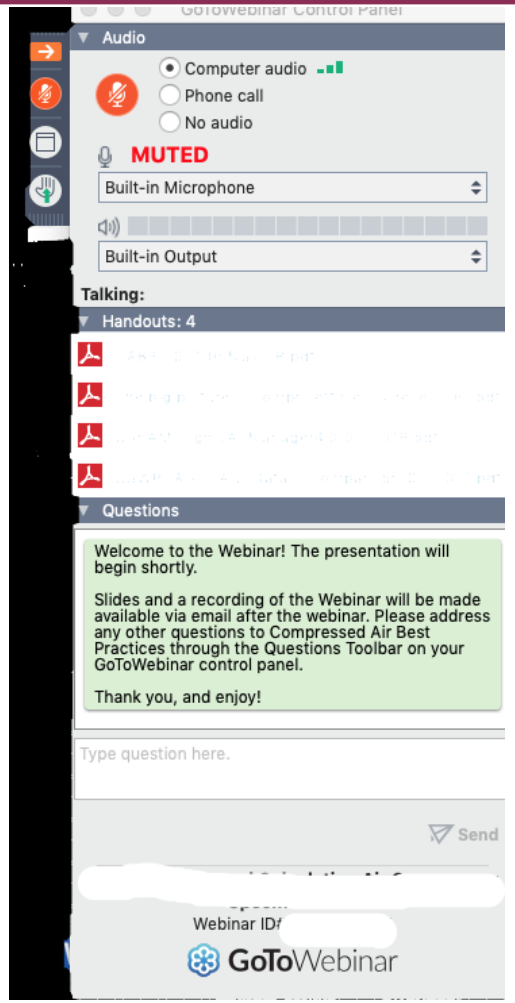
PDH Certificates will be e-mailed to attendees within 2 days

Q&A Format



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- Direct all questions to Compressed Air Best Practices® Magazine

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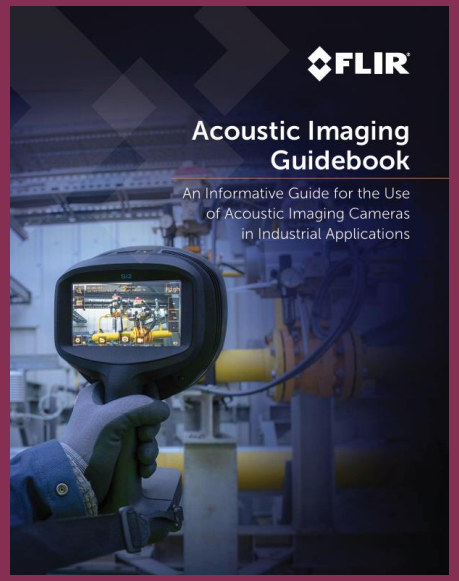
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An Informative Guide for the Use of Acoustic Imaging Cameras in Industrial Applications


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Disclaimer

All materials presented are educational. Each system is unique and must be evaluated on its own merits.

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Compressed Air Leak Detection: Techniques, Methods, Tips, and Tools

Introduction by

Compressed Air Best Practices® Magazine

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About the Speaker

Ron Marshall
Marshall Compressed Air Consulting

- Consultant MCAC
- 38 years with Power Utility
- 27 years Technical CA Support
- CAC Level 2 Instructor
- International Trainer UNIDO
- 900+ projects completed

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The Air Guy

Coming Up

- Why fix leaks – what's the benefit
- Why stop at air leaks – there's more!
- Is your system ready to save?
- Budget - Anticipate some costs
- Finding the waste - tools
- Quantifying the waste – what are costs
- Tracking and fixing waste – software
- Validating the benefits – did you save?
- Personal experience – my best/worst finds
- Summary

Why fix leaks – what's the benefit

- Sometimes wasting 20-30% of a compressors output

  In addition to being a source of wasted energy, leaks can also contribute to other operating losses.

  - Cause a drop in system pressure, which makes end uses function less efficiently, adversely affecting production
  - Shorten the life of supply system equipment
  - Or can increase the running time which leads to additional maintenance requirements and increased unscheduled downtime
  - Can lead to adding unnecessary compressor capacity and increased cost

Size	Air Flow	Cost per year
1/16"	6.49 scfm	$1,050
1/8"	26.0 scfm	$4,190
1/4"	104 scfm	$16,760

Costs calculated using electricity rate of $0.10 per kWh, assuming constant operation, 100 psig, and a typical compressor.

Note: These values assume a perfect orifice and 24/7 operation.

Why aren’t leaks fixed?

- It is easy to ignore leaks
  - Colorless, odorless and does not make a mess
  - People think air is free
  - There is really no negative effect on the average worker until compressed air capacity runs out
  - Corporate culture may not address air leakage

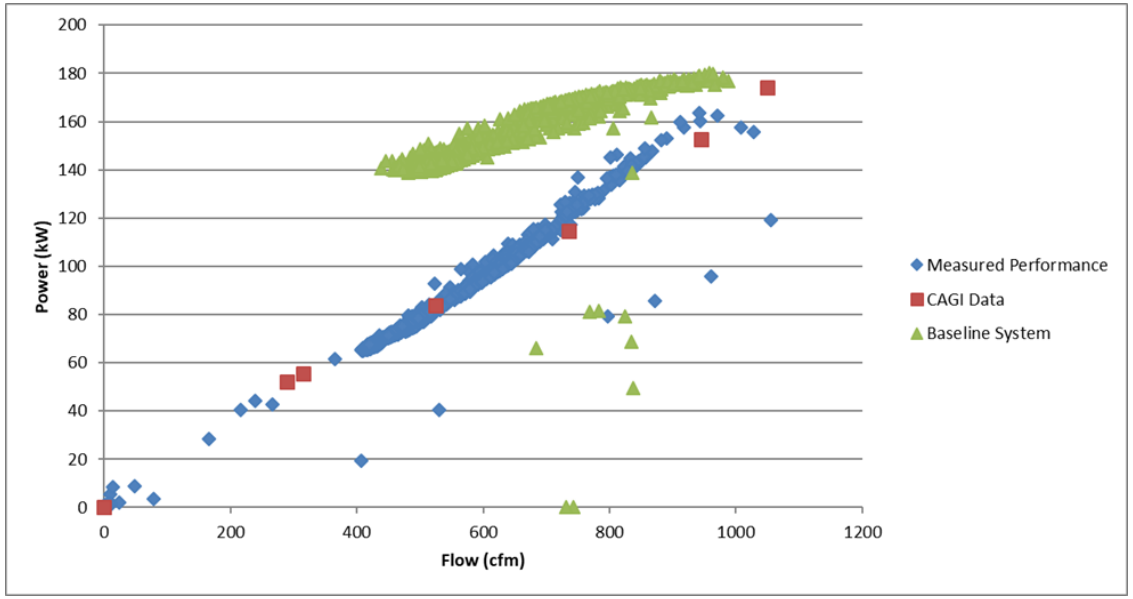
Which is leaking?

Why stop at air leaks – there's more!

- Compressed Air is not the only waste you will find when doing leak detection
- Other costly items
  - Inappropriate uses
  - Failed equipment (dryers)
  - Industrial Gas
  - Steam
  - Vacuum
  - Fire systems

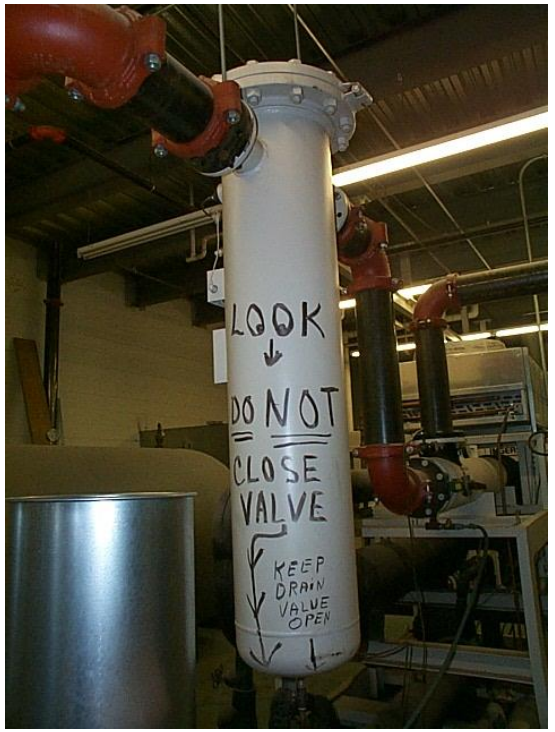
Is your system ready to save?

- To gain the predicted savings your compressed air system must be well controlled
- Power turn down is important to get a good result
- Poor systems have little power turndown with flow reduction
- Good systems have near 1:1 reduction



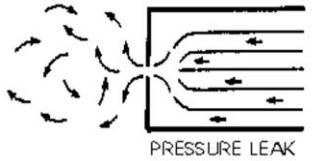
Budget - Anticipate some costs

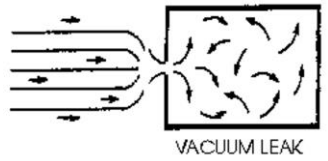
- Finding leaks is an inexpensive exercise that requires some equipment and time resources
- Fixing leaks is often expensive requiring
  - Time
  - Parts
  - Shutdowns
- Be sure to anticipate repair costs of about 2 to 3 times detection costs



Finding the waste - tools

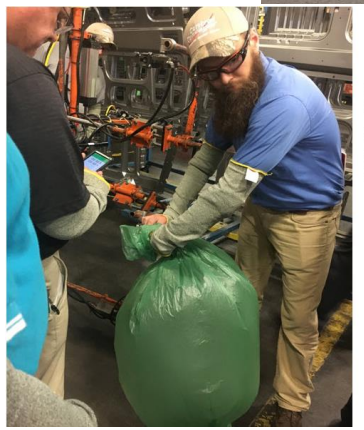
- Human ears
- Human eyes
- Ultrasonic guns
- Acoustical detectors
- Flow meters
- Calculation methods
- Soap bubble testing





Quantifying the waste – what are costs

- Estimation based on db reading and distance - manual
- Calculation based on instrument calibration - automatic
- Backup flow meter readings - backfeed
- Compressor Loading Test
- Compressor Display (VSD)
- Bleed Test
- Garbage bag method



gallon size	Time to fill (seconds)	scfm
50	10	40.10695187
50	60	6.684491979
50	120	3.342245989
30	2	120.3208556
50	15	26.73796791
		#DIV/0!

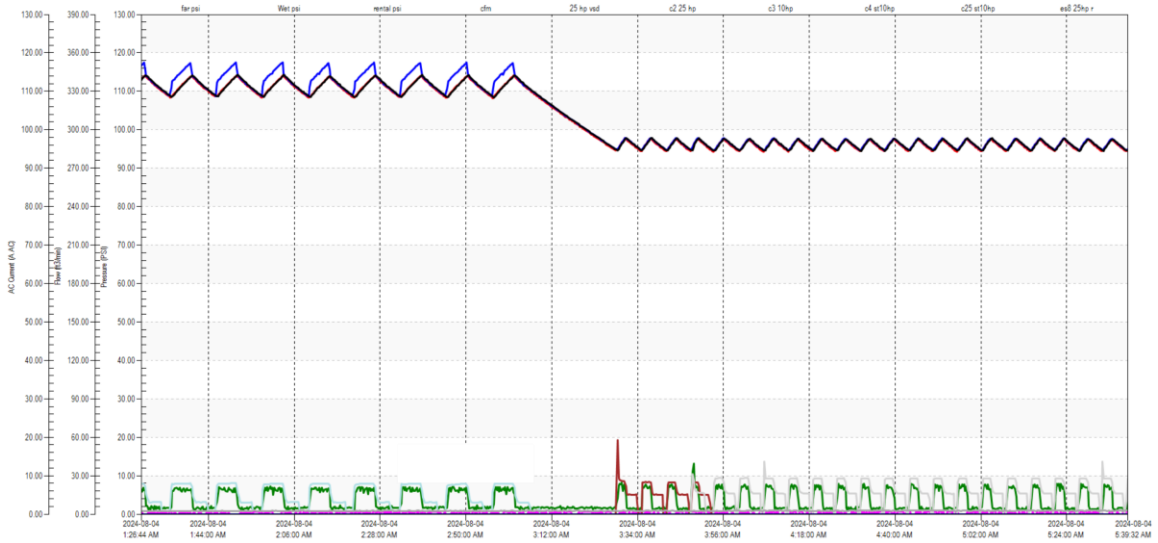
Quantifying the waste – Calculations and Tools

Load/Unload

$$\text{Leakage (\%)} = \left(\frac{T}{T+t}\right)\times 100$$

Where: T = total loaded time (seconds)

t = total unloaded time (seconds)

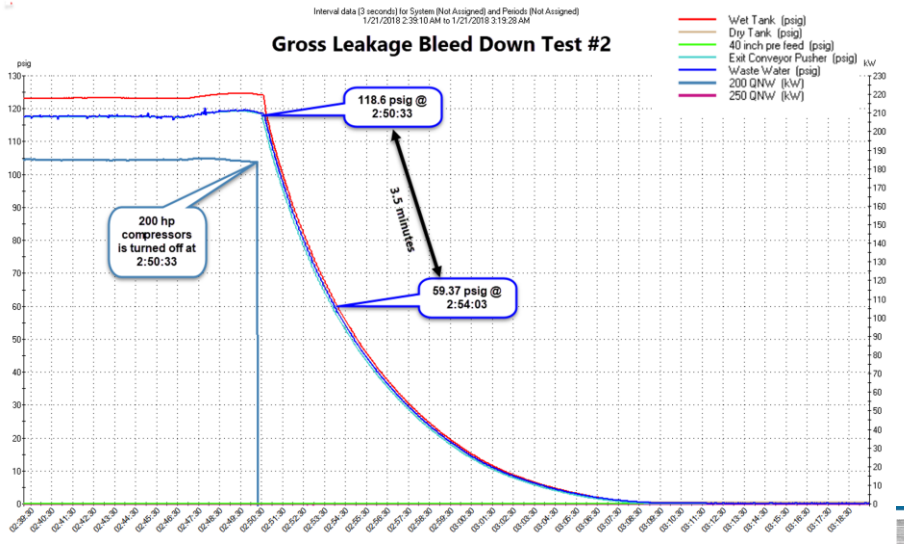


Modulate

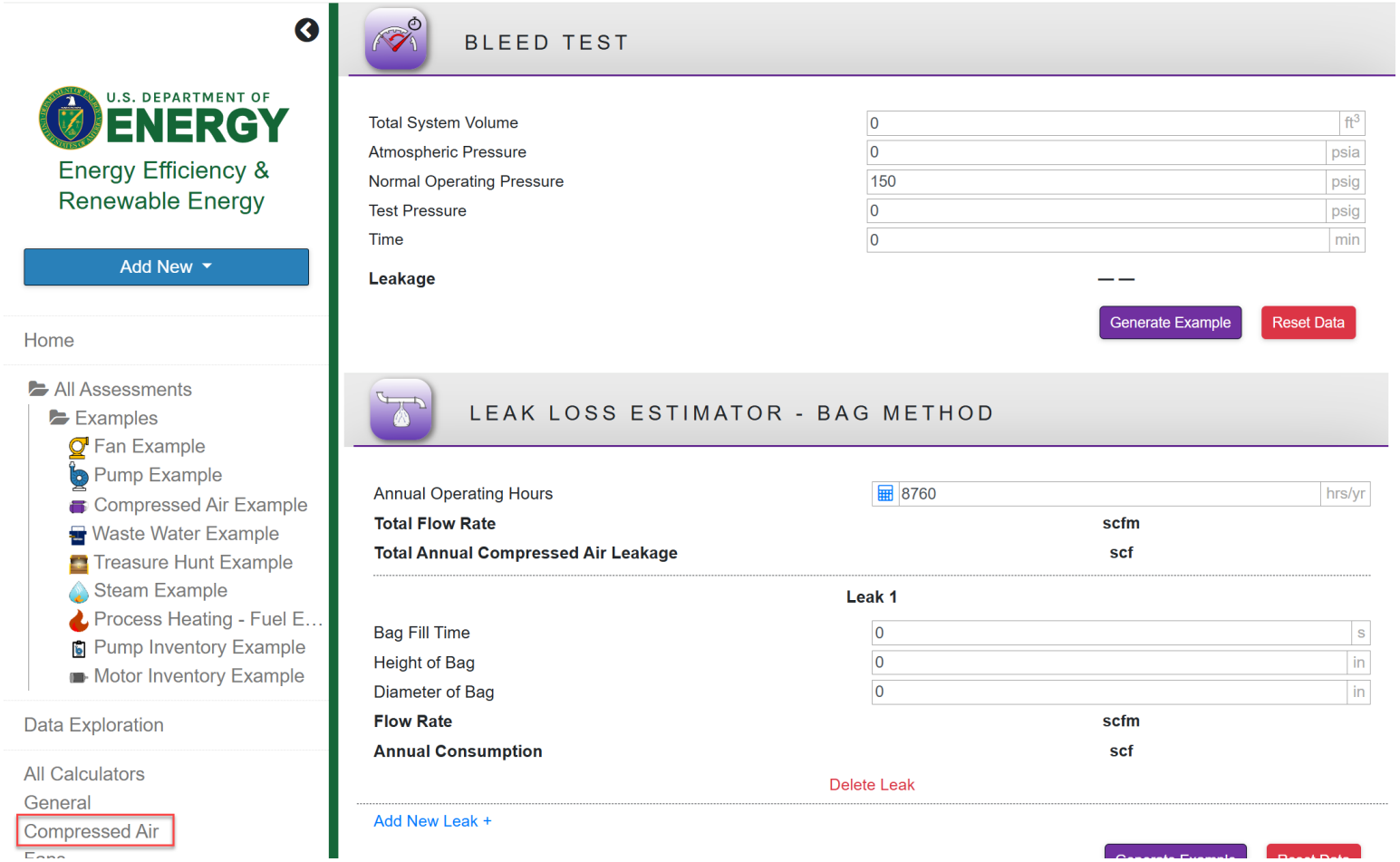
- Requires an estimate of total system piping volume
- Include all receivers
- Bring system to normal operating pressure
- Turn compressors off
- Measure time for system to drop to ½ of starting pressure
- The following calculation can be used with other controls.

$$\text{Leakage (cfm free air)} = \left[\frac{V\times(P_1-P_2)}{T\times P_a}\right]\times 1.25$$

The 1.25 multiplier corrects leakage to normal system pressure, allowing for reduced leakage with falling system pressure to 50% of the initial reading.

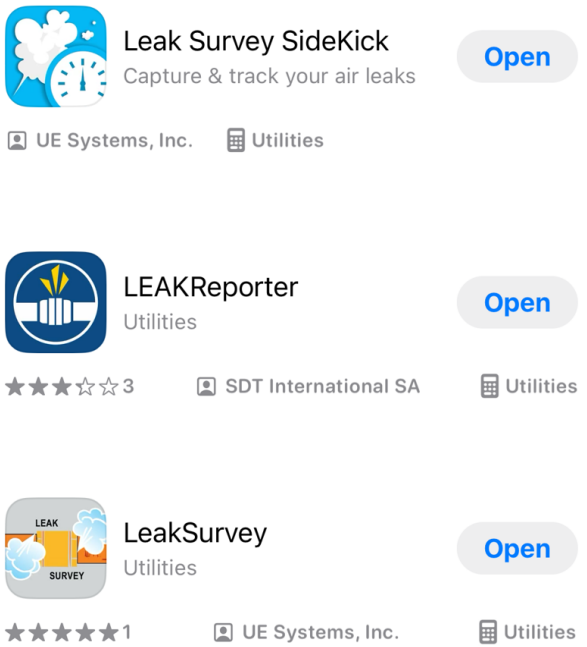


Quantifying the waste – MEASUR

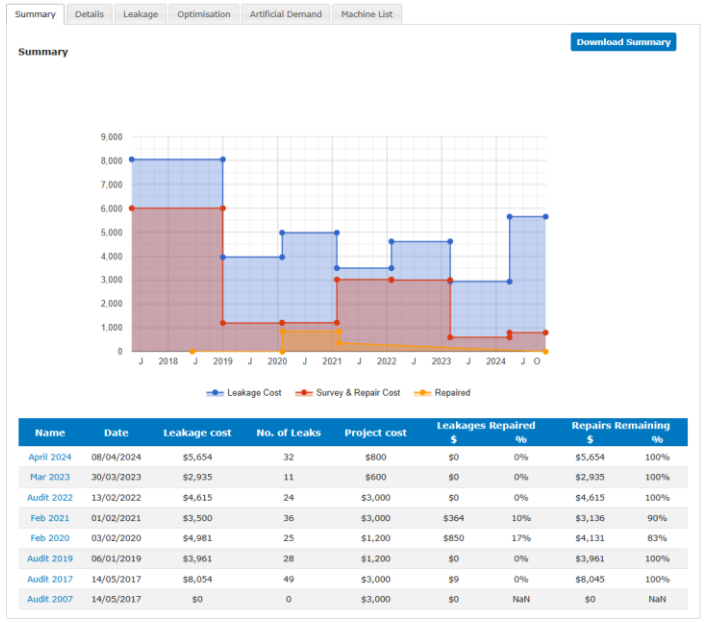


Tracking and fixing waste – software

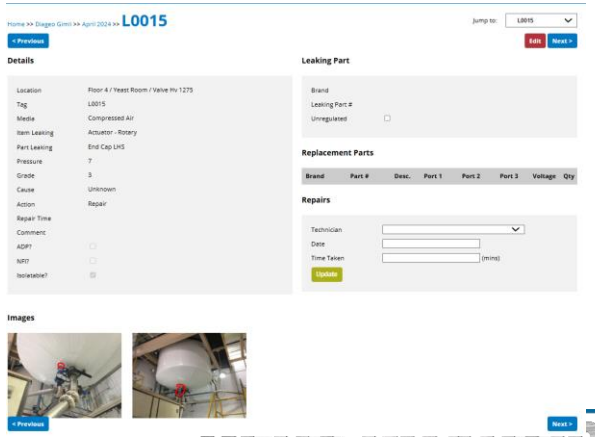
- Most leak detector companies have reporting program
- Often built into high end detectors
- Important to ensure backup visual data captured to find the leaks again
- Tracking and cost estimating functions valuable if this is a regular program



Tracking and fixing waste – software



Name	Date	Leakage cost	No. of Leaks	Project cost	Leakages Repaired $	Leakages Repaired %	Repairs Remaining $	Repairs Remaining %
April 2024	08/04/2024	$5,654	32	$800	$0	0%	$5,654	100%
Mar 2023	30/03/2023	$2,935	11	$600	$0	0%	$2,935	100%
Audit 2022	13/02/2022	$4,615	24	$3,000	$0	0%	$4,615	100%
Feb 2021	01/02/2021	$3,500	36	$3,000	$364	10%	$3,136	90%
Feb 2020	03/02/2020	$4,981	25	$1,200	$850	17%	$4,131	83%
Audit 2019	06/01/2019	$3,961	28	$1,200	$0	0%	$3,961	100%
Audit 2017	14/05/2017	$8,054	49	$3,000	$9	0%	$8,045	100%
Audit 2007	14/05/2017	$0	0	$3,000	$0	NaN	$0	NaN



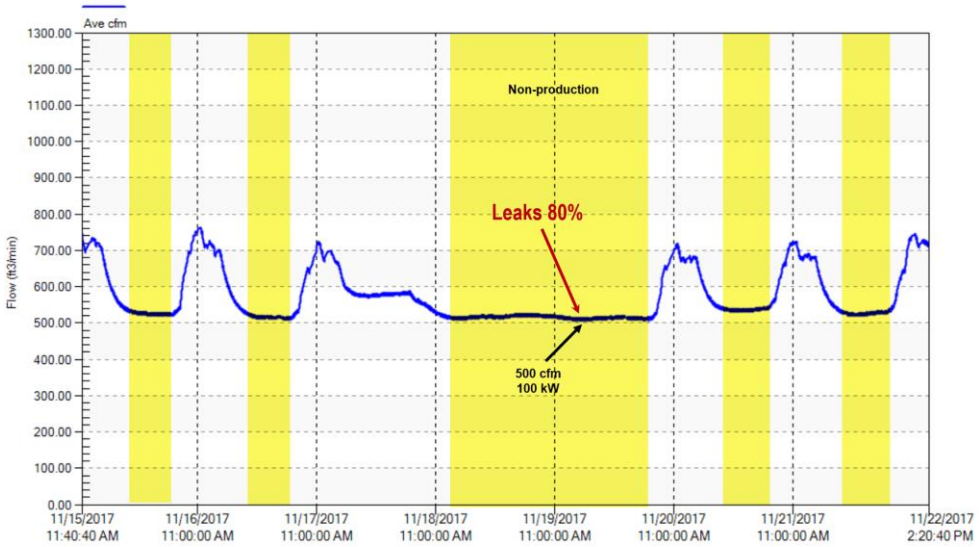
Source: Basil V.R. Greatrex Pty Ltd

Validating the benefits – did you save?

- Redo the leak audit to ensure success
- Check the change in the main flow meter
- Redo compressor leak load test
- Check compressed air system power/energy consumption
- Don’t have power meters? Get some!

Personal experience – My best/worst finds

- Highest waste levels usually occur in grossly oversized systems
- Biggest individual leak – 550 cfm
  - Dust collector manifold
- Highest leak level large system – 80%
  - Large oversized system
- Highest leak/waste level – 98%
  - System running 8,760 hours at 38 cfm
  - Actual demand 2,200 hours at 2 cfm



Summary

- Realize your leaks are likely costing you a fortune
- Leak detection finds other wastes
- To save your system needs to be well controlled
- You need an adequate budget to fix all the waste that is found
- Make sure to supply your workers with easy-to-use leak detection tools
- Quantify, track and validate your leak detection and repair efforts
- Make sure you take action on repairs – leaks are easy to ignore

About the Speaker

Ryan French
Rogers Machinery

- Air System Auditor at Rogers Machinery
- Joined Rogers Machinery Audits and Consulting Group in 2021
- Conducted plant-wide industrial energy assessments for 3 years at Oregon State University Industrial Assessment Center

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Air Leak Detection

Estimate · Quantify · Realize Energy Savings

Presented by Ryan French
Air System Auditor
Rogers Machinery Company

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Today's Topics

- Leak Load Estimation Methods
- Data logging for leak studies
- Effect of compressor control type on energy savings

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3-Step Process

Scope

Goals

Estimate leak load as a percent of compressor capacity

Estimate costs savings potential

Study

Goals

Quantify costs ($/CuFt)

Evaluate compressor controls

Detect & Tag Leaks

Quantify Savings

Save

Goals

Ongoing monitoring

Ongoing detection and identification

Ongoing repairs

Lower Operating Costs!

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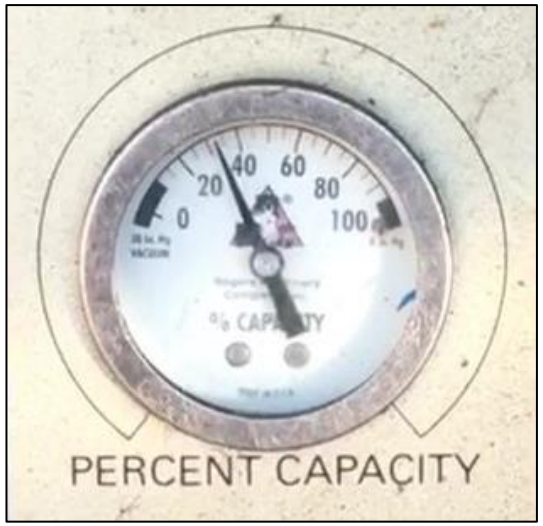
Estimate Leak Load

Leak Down Formula

$$CFM = \frac{V \times \Delta P}{T \times P_{atm}} \times 1.25$$

V = system volume (cu.ft.)
ΔP = pressure drop (psi)
T = time for pressure drop to occur (min)
P_{atm} = local atmospheric pressure (psia)

Compressor Capacity



Load-Unload: $\frac{T_{loaded}}{T_{running}} \times 100$

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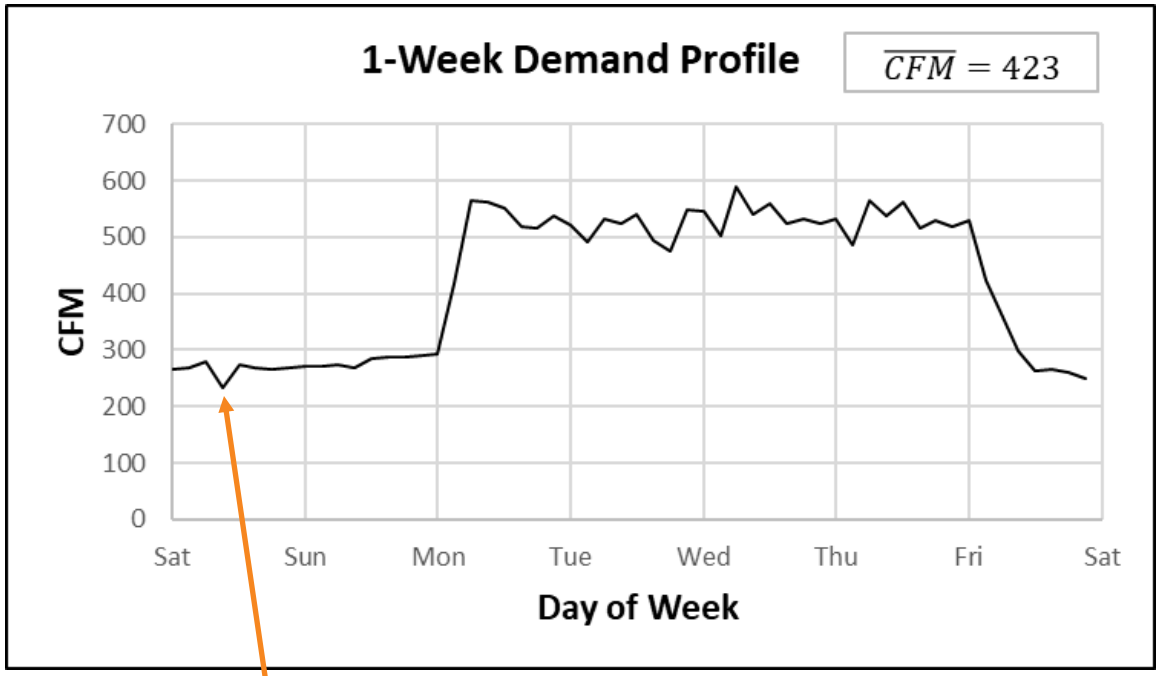
Data Logging Leak Load

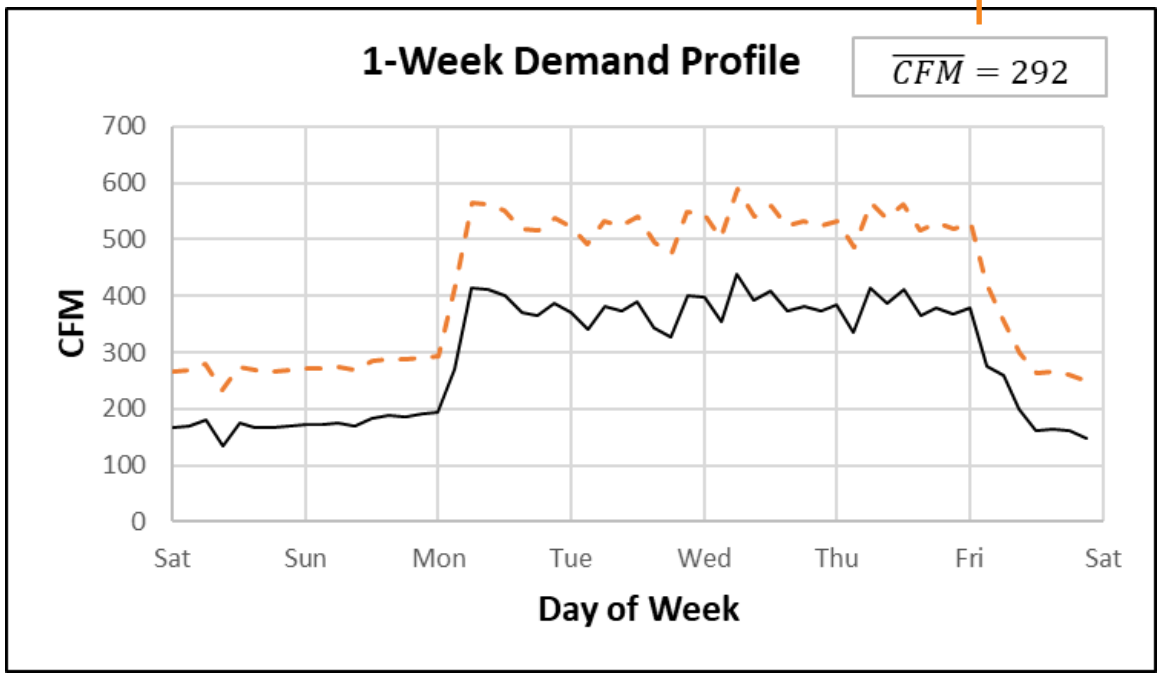
131 CFM Saved!

Before Leak Repair



200 CFM “Dead” Leak Load

After Leak Repair



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What Are The Cost Savings?

Annual Cost per CFM

$100 / CFM

$13,100 /yr

Data Logging Results			
	Before	After	Savings
Demand	423 CFM	292 CFM	131 CFM
Power	94 kW	87 kW	7 kW
Annual Cost	$41,172	$38,106	**$3,066**

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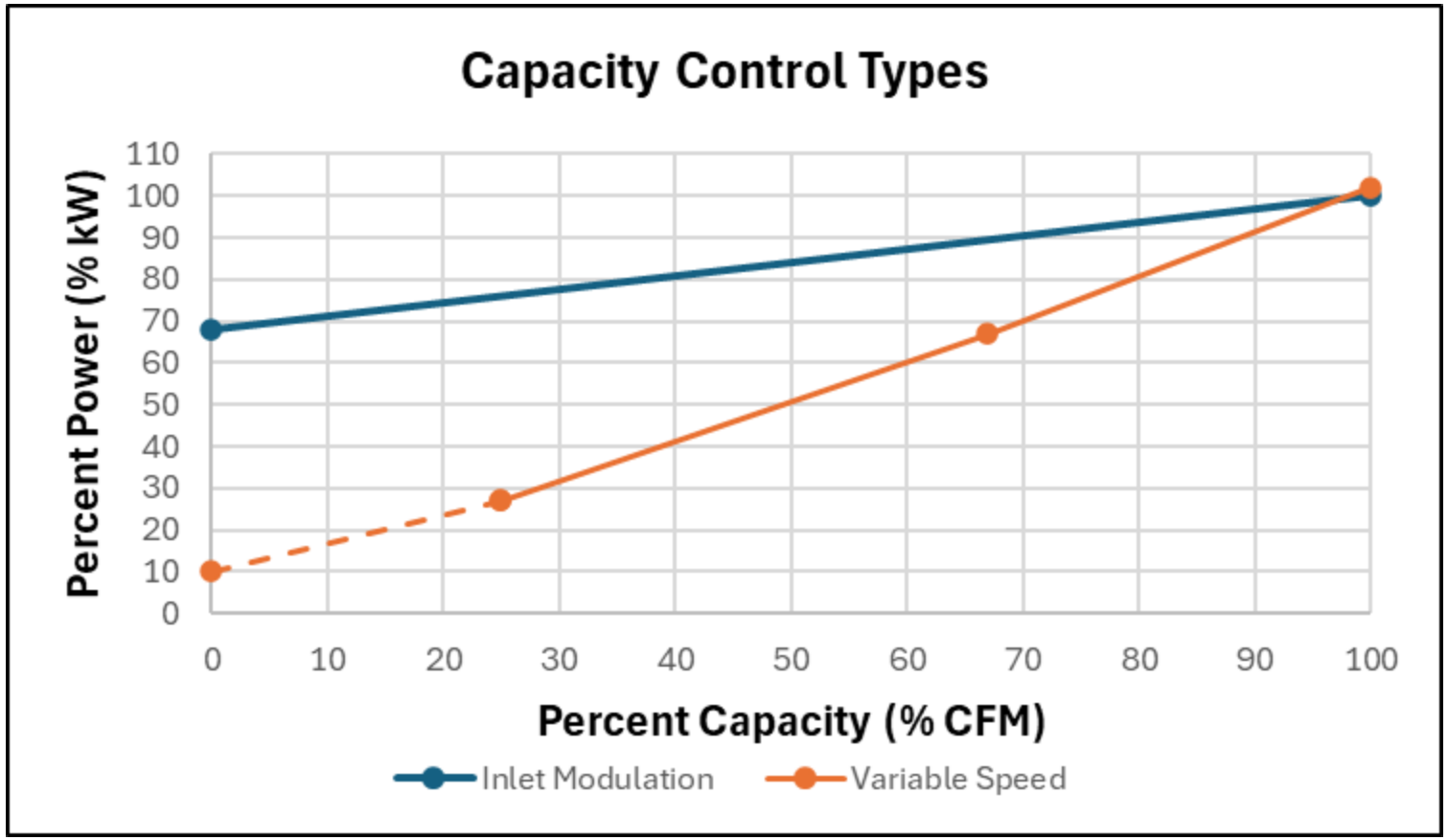
Effect of Capacity Controls



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What Are The Cost Savings?

Annual Cost per CFM

$75 / CFM

$9,825 /yr

Data Logging Results			
	Before	After	Savings
Demand	423 CFM	292 CFM	131 CFM
Power	73 kW	51 kW	22 kW
Annual Cost	$31,974	$22,338	**$9,636**

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In Summary

- Scope – Study – Save
- Know your system
  - Simple & sophisticated approaches available
- Invest in your system
  - Efficient controls
  - External audits as appropriate
- Air leaks require ongoing attention

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Questions?

Learn More About Air System Audits

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About the Speaker

John Gould
Teledyne FLIR

- Global Business Development – Condition Monitoring, Teledyne FLIR
- 24 years in facilities and operations management
- Developed IoT and sensor-based Condition-Based Maintenance Programs
- Certified Reliability Leader (CRL)

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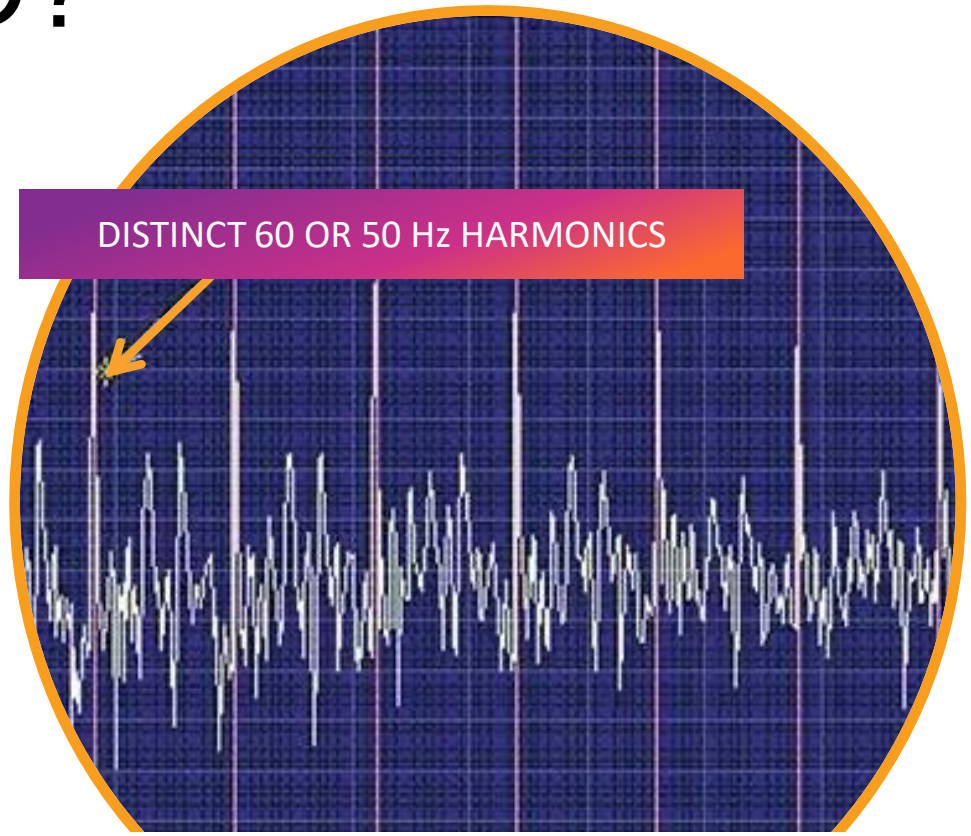
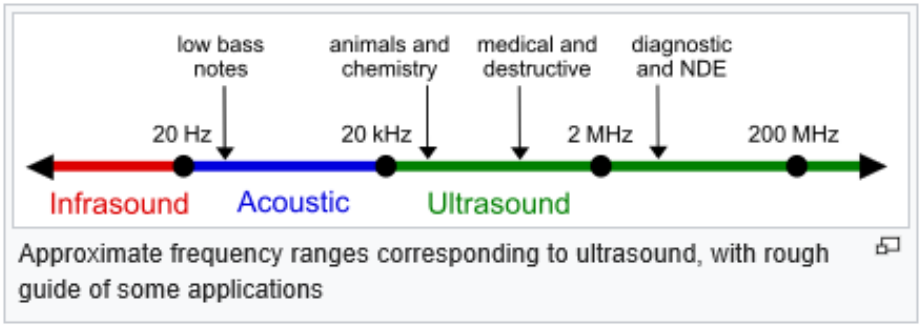
ACOUSTIC IMAGING - ***SEE*** YOUR LEAKS

VALUE OF ACOUSTIC IMAGING FOR AIR LEAK DETECTION

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





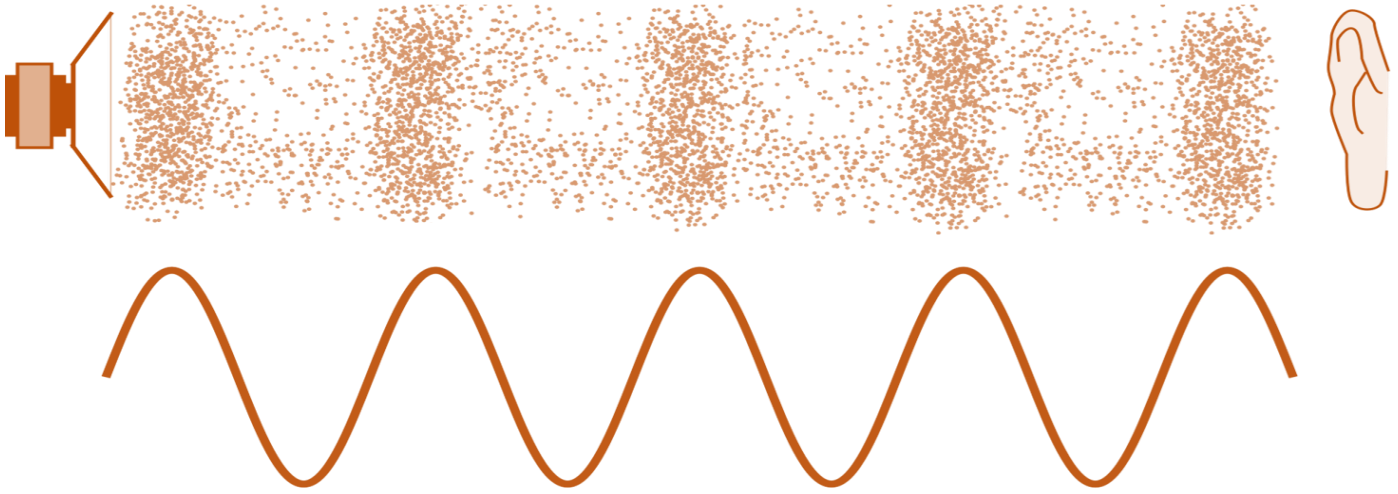
Approximate frequency ranges corresponding to ultrasound, with rough guide of some applications

ULTRASOUND APPLICATIONS

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

How Is Sound Created?

- Sound is produced when something vibrates, in our case, through the air
- The air expands and contracts
- **Essential sound properties: Amplitude, Wavelength & Frequency**



Amplitude

Relative **strength** of sound waves (transmitted vibrations), we perceive as loudness or volume. Consider this the ‘height’ of the waveform.

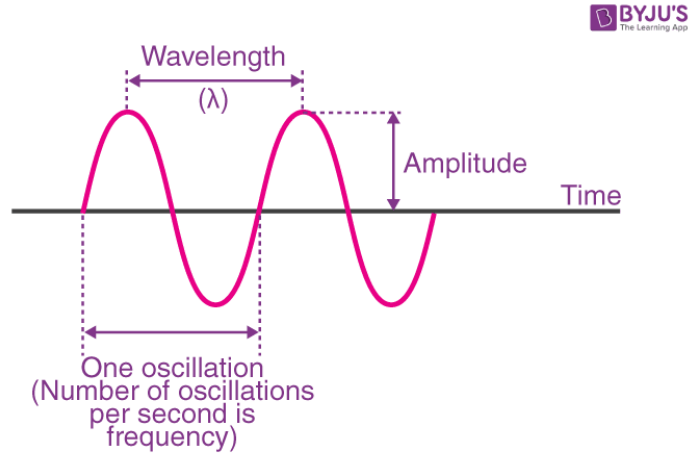
Amplitude is measured in decibels (**dB**),

which refers to the **Sound Pressure Level:**

SPL

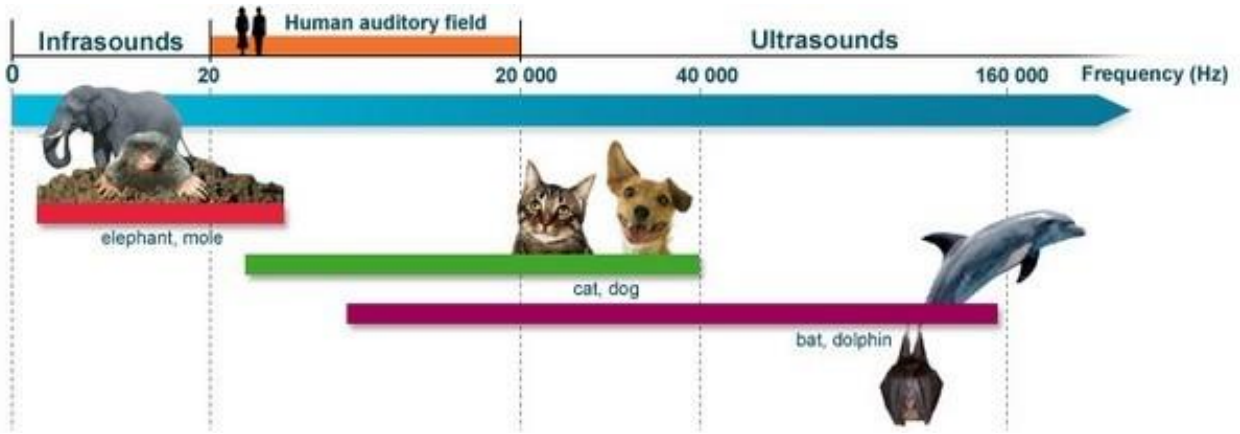
Wavelength

- The distance between two consecutive points on a wave with the same phase
- Wavelength is an important parameter of waves, and is related to frequency and sound speed:
- **Frequency**: The number of wave repetitions per second, often given in Hertz (Hz). Waves with a high frequency have a short wavelength, while waves with a low frequency have a longer wavelength.
- **Sound speed**: The speed the wave travels in meters per second.
- **Wavelength calculation**: The wavelength can be calculated using the equation wavelength = speed/frequency.



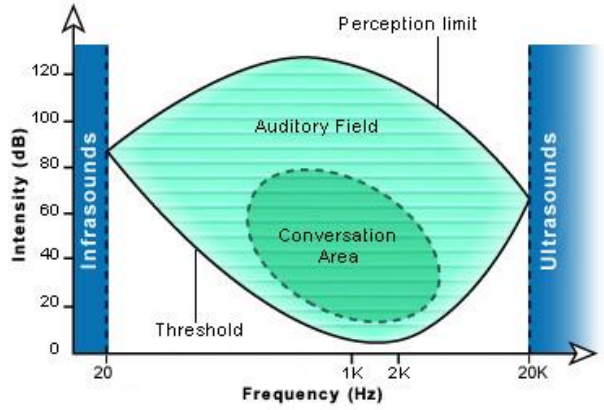
https://cdn1.byjus.com/wp-content/uploads/2021/04/Properties-of-Waves.png

Frequency



Number of times per second that a sound wave repeats itself.

- The lower the frequency, the fewer the oscillations.
- High frequencies produce more oscillations.
- The units of frequency are “hertz” (Hz) (1/sec)

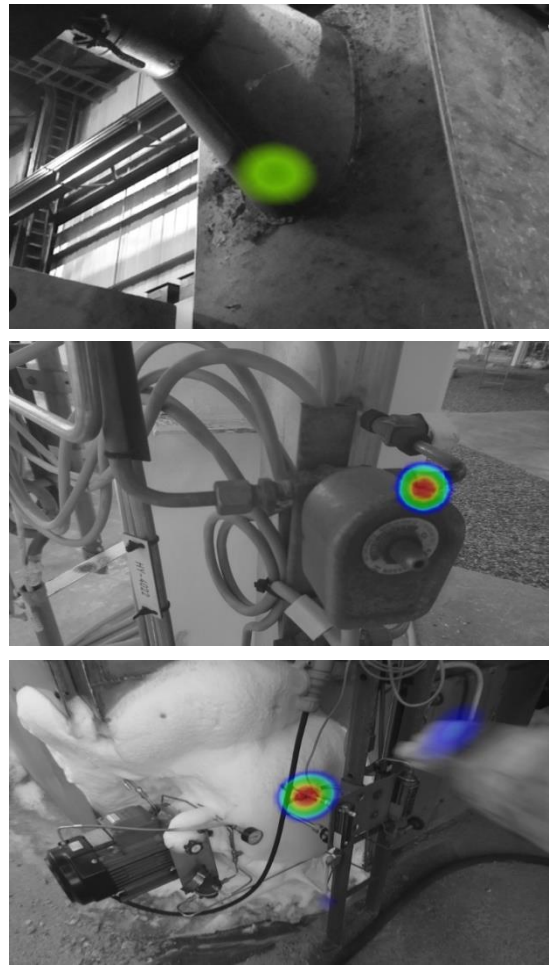


Humans with normal hearing can hear sounds between **20 Hz and 20,000 Hz.**

Frequencies **above 20,000 Hz** are known as **ultrasound**.

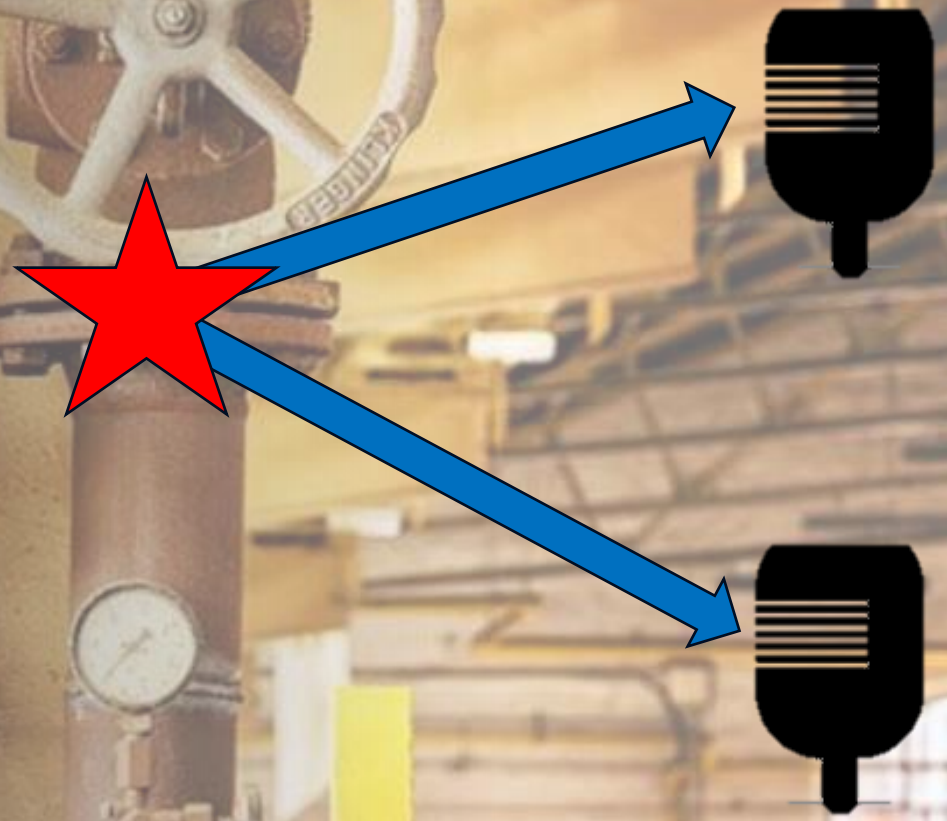
Application to Air Leak Detection

- Ultrasound is utilized for detecting friction and turbulence.
- As compressed air or gases escape through a leak, they create turbulence that can be measured.
- These sounds are often **high frequency beyond human hearing** and given the directionality of sound, can be pinpointed, even in loud environments.



WHY ULTRASONIC IMAGING?

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



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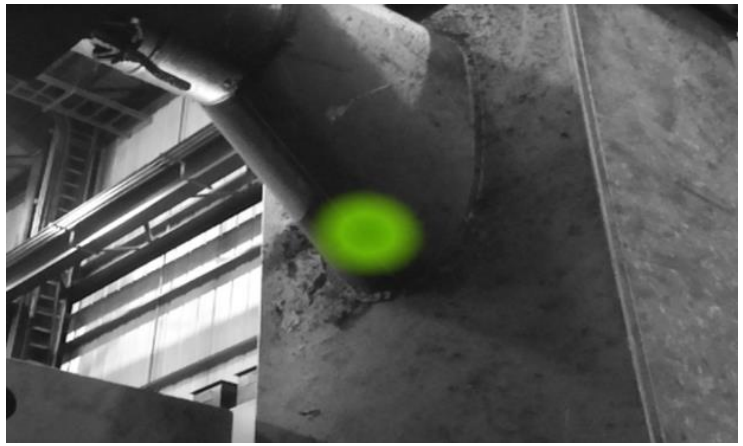
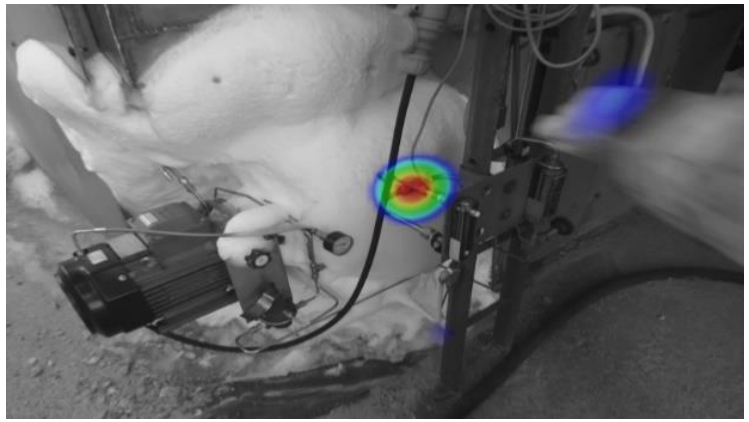
- Combine an array of microphones with a camera and you can pinpoint the sound location on a picture
- Imaging technologies provide up to 90% reduction in inspection time
- Imaging technologies are relatively easy to learn

LEAKS WASTE ENERGY AND MONEY





Industrial gas leaks are expensive, harmful to the environment, and a threat to worker safety and operational reliability.

Traditional leak detection methods are time-intensive and require an expert user to effectively analyze the sound. Sniffers and soap bubbles are inaccurate and very time-consuming. Reports are created manually and can be time consuming.

Acoustic Imaging cameras can locate and quantify industrial compressed gas leaks including compressed air, CO2, hydrogen, helium, argon, methane and ammonia. Having the right software can generate comprehensive reports with analysis in seconds.

COMPRESSED AIR LEAKS AT A PAPER MANUFACTURING FACILITY

During a 25-minutes quick inspection at a paper manufacturing factory, the acoustic camera was able to find a total of 12 compressed air leaks worth over $5,000 per year, in the production department alone.

The camera performed extremely well despite the noisy paper machines running and the high steam and humidity of the production facility.

COMPRESSED AIR LEAKS IN A FURNITURE PLANT

The yearly electricity expenses at a furniture manufacturing plant have been quadrupled after the energy price increase in Europe.

Considering the vast use of compressed air at the manufacturing facility, leaks have been estimated to amount to extra costs of about 2 million £.

Following a visit, we collaborated on a plan including bi-weekly inspections and a leak fixing protocol that will deliver significant savings.

The user-friendly plan includes a clear review of the team performance, and the money saved, using data about leaks detected and time-to-fix, as well as costs and the appearance rate of new leaks.

RAPID ROI IN A LARGE FACILITY

Large and often noisy industrial facilities present a challenge to the accuracy and efficiency of leak detection methods.

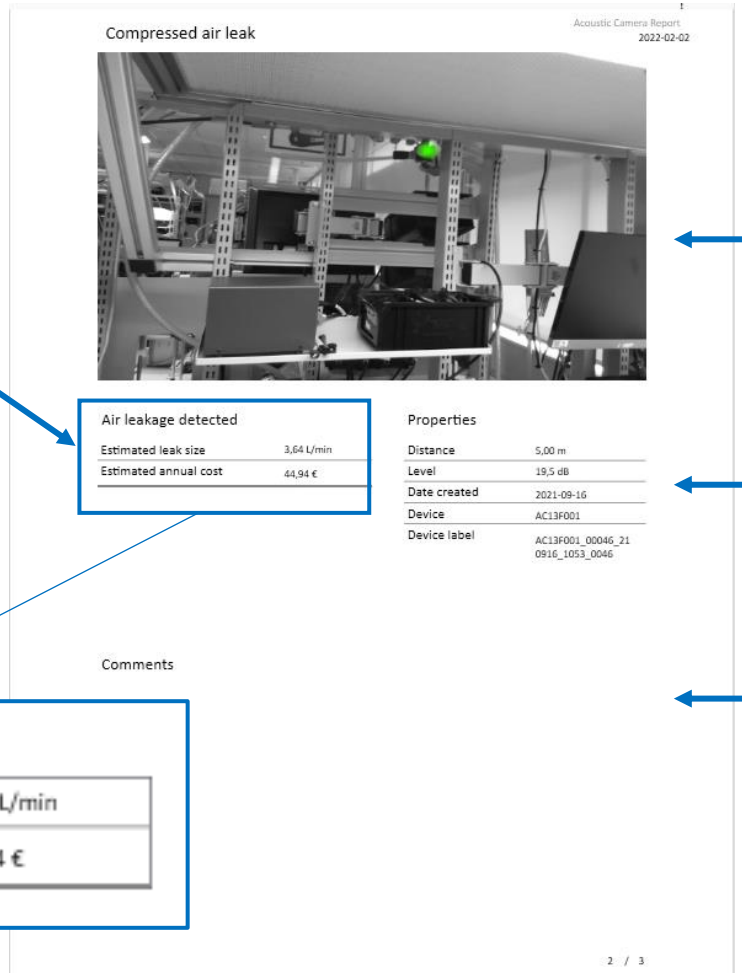
At a recent inspection, the FLIR acoustic camera was able to identify 155 leaks in just 6 hours at a vast 6,500 m² manufacturing site, equating to an ROI estimated within 2 inspection rounds in 4 to 6 months.

5-DIGIT SAVINGS IN 10 MINUTES

Specialty gasses, such as CO_2 and Argon, are a widely used but costly commodity in many industries.

During an inspection at a production facility, the FLIR acoustic camera was able to locate 5 specialty gas leaks within just 10 minutes, resulting in annual savings of approximately $15,000 and an estimated ROI within just 2 months.

COMPRESSED AIR LEAKAGE REPORT



Compressed air leak analysis

Air leakage detected

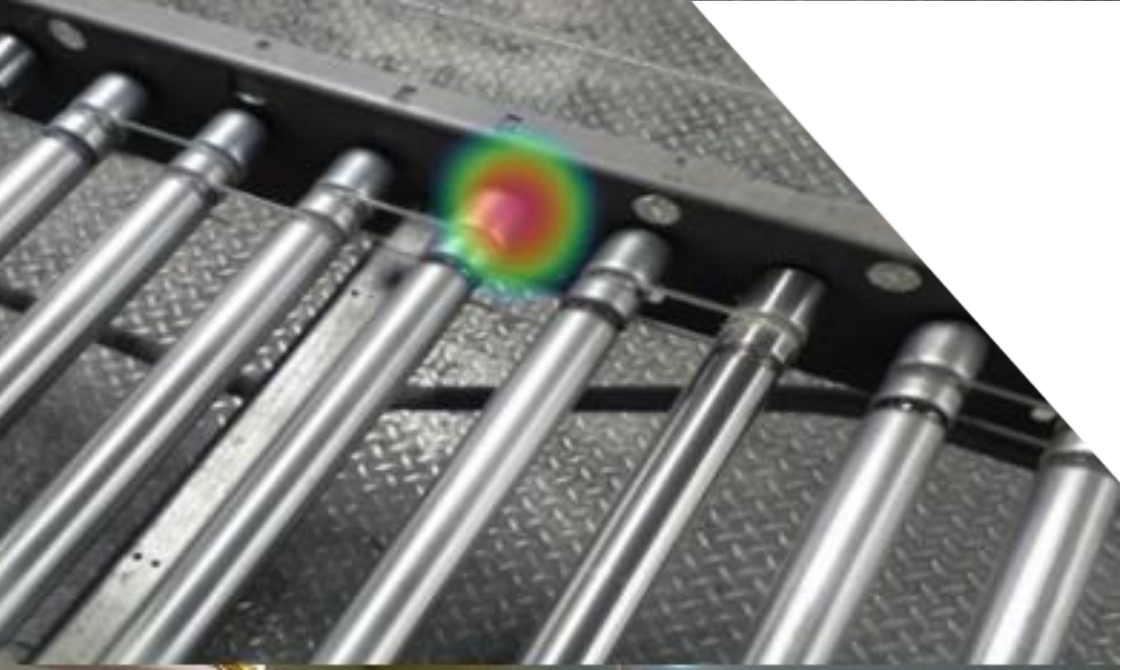
Estimated leak size	3,64 L/min
Estimated annual cost	44,94 €

Image shows leak location

Image properties

Comments field

Detailed reporting to document and manage your leak repairs



ACOUSTIC IMAGING RETURN ON INVESTMENT

WHY EVERY PLANT NEEDS AN ACOUSTIC CAMERA

- Payback from improved personal safety
- Payback from reduced unplanned outages
- Payback from getting time back from quicker inspections
- Payback from improved plant output quality
- Payback from repairing vs replacing damaged equipment
- Payback from reduced energy costs

Want to learn more?

https://www.flir.com

Scan Here:

Reach out directly:

John Gould

603-320-7814

john.gould@teledyne.com

Compressed Air Leak Detection: Techniques, Methods, Tips, and Tools

Q&A

Please submit any questions through the Question Window on your GoToWebinar interface, directing them to Compressed Air Best Practices Magazine. Our panelists will do their best to address your questions and will follow up with you on anything that goes unanswered during this session.

Thank you for attending!

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Tom Taranto
Data Power Services
Keynote Speaker

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