

Air Leakage Detection and Characterization in Facility Assessments

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Optimizing Compressed Air and Asset Reliability with Ultrasound

A roundtable webinar for the Industrial Food and Beverage Sector



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Outline

1. About NITAC

- Self introduction
- NITAC team
- Department of Energy's ITAC program
- Assessments, recommendations, tools, capabilities

2. Compressed air leakage detection

- Technology
- Quantification



1. About us - leadership

David Yuill

Director of NITAC

Ph.D. and P.E. in mechanical engineering

Associate Professor of Architectural Engineering

Research & teaching: thermodynamics, HVAC, energy efficiency, buildings



Bruce Dvorak

Assistant Director of NITAC

Ph.D. and P.E. in civil engineering

Professor of Civil and Environmental Engineering

Research & teaching: environmental eng., pollution prevention, sustainability



About us: Our Team



Industrial Training and Assessment Centers

Created by US Department of Commerce in 1976

Goals: help small & medium-sized manufacturers to...

Reduce energy costs; operating costs; waste

Energy usage *and* demand

Workforce development

“Train students and help the little guy”

Provide no-cost assessments to eligible facilities

Fully-developed protocol

Confidential



Manufacturer eligibility*

- Site utility costs between \$100k and \$3.5M annually
- SIC code between 2000 and 3999
- Annual gross sales less than \$250M
- Less than 500 employees at the plant site

* Some exceptions possible



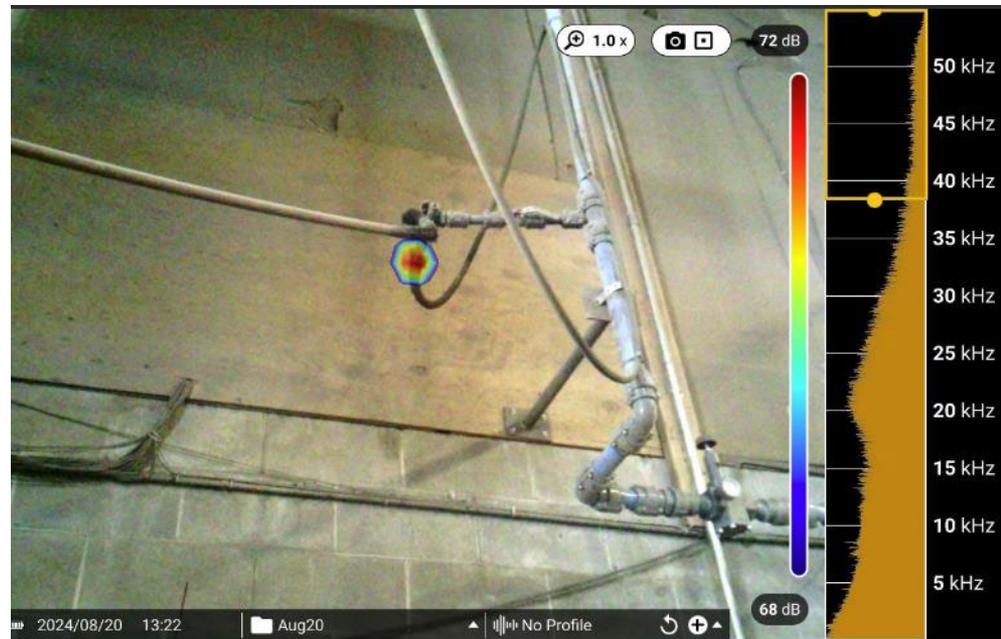
On-site Assessment Day

- Team of 6 students & staff
- Interact with plant staff
- Bring UNL PPE and follow plant safety protocols
- Make measurements (sometimes leave dataloggers)
- Preliminary calculations



On-site Assessment Day – Tools

- Thermal Imaging Camera
- Flue Gas Combustion Analyzer
- Laser Tachometer
- Illuminance Meter
- Anemometer
- Ultrasonic Air Leak Detector
- Air Leak Acoustic Imager
- Vibration Logger
- Temperature/Humidity Loggers
- Power Logger
- Dissolved Oxygen Meter



Analysis and Report

- Assessment Recommendations

- Have short payback periods & good certainty
- Estimates or vendor quotes for capital upgrades
- Calculation details included

- Other Measures

- Savings, but not sufficient payback
- Too uncertain/more data needed
- Non-monetary benefits

- Multiple levels of review

- Lead student
- Energy engineer
- Lead faculty
- ITAC headquarters

- Delivered to client in about 60 days

$$P_i = Load * hp * \frac{0.746 kW}{\eta_{pt}}$$

$$P_i = 0.75 * 40 * \frac{0.746 kW}{0.942} = 23.8 kW$$

Now that the input power of the replacement motor has been calculated for a partial load of 75%, the annual cost to operate the motor is calculated as follows:

$$E_{Motor} = 23.8 kW * \frac{6,000 hours}{year} = 142,548 kWh$$

$$C_{Motor} = 142,548 kWh * \frac{\$0.027}{kWh} + 23.8 kW * \frac{\$21.478}{kW * month} * 12 months = \frac{\$9,983}{year}$$

These equations are applicable to all motors in your facility. To avoid redundancy, Table 5.4-5 shows the resulting cost for all the motors being analyzed. Table 5.4-6 shows the estimated savings of downsizing these motors.

Table 5.4-5: Summary of Replacement Motors

Replacement Motor	Hours in Operation (hours/year)	Input Power/Demand (kW)	Energy Usage (kWh/year)	Annual Cost (\$/year)
40-hp Banbury Motor	6,000	23.8	142,548	\$9,983
25-hp Calender motor	6,000	14.9	89,282	\$6,251
30-hp Vacuum motor	6,000	18.3	109,706	\$7,679
Totals	-	57.0	341,536	\$23,913

Table 5.4-6: Estimated Savings of Downsizing Motors

Current Motor	Replacement Motor	Monthly Demand Savings (kW/month)	Energy Savings (kWh/year)	Annual Cost Savings
250-hp	40-hp	-	22,964	\$1,599
			18,773	\$1,306
			6,302	\$428
			48,040	\$3,333

Table 1-1: Overall Summary of Assessment Recommendations

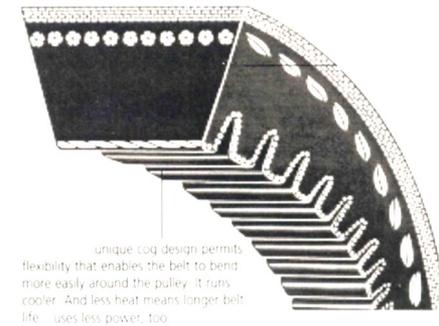
Assessment Recommendation (AR)	Annual Savings		Capital Investment	Simple Payback (Years)
	Resource (Unit/year)	Dollars (\$/year)		
AR No. 1: Replace Electric Resistance Humidifier with Ultrasonic Humidifier	66,496 kWh	\$5,384	\$20,000	3.7
	205.1 kW			
AR No. 2: Upgrade Exterior Lighting	55,101 kWh	\$3,816	\$3,372	0.9
	6.3 kW			
AR No. 3: Install HVLS Fan	-	\$3,717	\$5,000	1.3
AR No. 4: Upgrade Main Facility Lighting	25,219 kWh	\$3,153	\$3,266	1.0
	58.3 kW			
AR No. 5: Reconfigure the Facility's Process Flow	1,001 gallons of diesel	\$2,848	\$9,480	3.3
AR No. 6: Install Pre-Filters in HVAC System	-	\$495	\$44	0.1
AR No. 7: Upgrade Facility Exit Signs	7,666 kWh	\$425	\$2,064	4.9
	10.5 kW			
AR No. 8: Reduce Air Leaks in the Distribution System	20,265 kWh	\$288	\$1,600	5.6
AR No. 9: Install Cool Air Intake for Compressors	6,273 kWh	\$220	\$525	2.4
AR No. 10: Install Occupancy Sensors to Upgraded Lighting	2,801 kWh	\$98	\$298	3.0
Total Sum*		\$20,545	\$45,648	2.2

*The overall payback was calculated based on the total sum of all capital investments divided by the total sum of dollar savings from all the recommendations



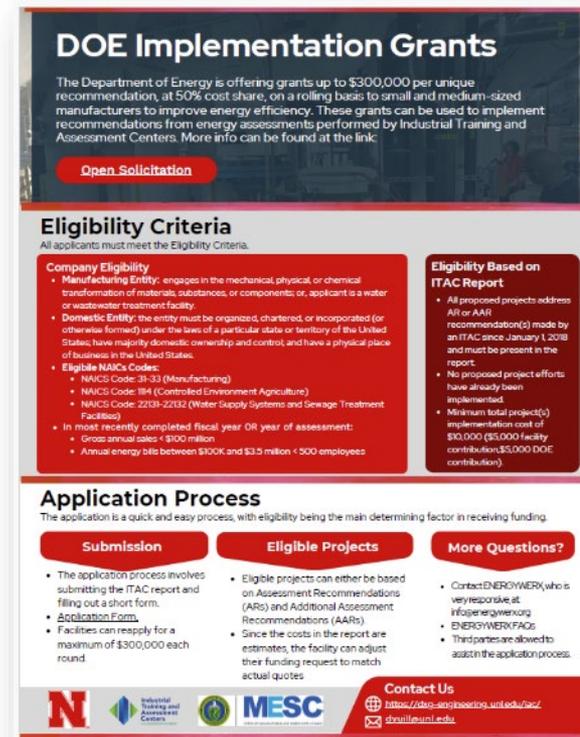
Common Assessment Recommendations

- Fluorescent to LED lighting
- Compressed air management (leaks; cold air intake; etc.)
- Cogged belts
- Steam trap repairs
- Variable frequency drives
- Air economizer
- Temperature reset
- Solid waste management
- Deduct meter
- Tax, incentives, and rebates



Big opportunity: Implementation Grant

- DOE program
- 1 to 1 cost match up to \$300k for anything NITAC recommends
- Multiple recommendations from a single NITAC visit possible
- Very high success rate
- \$350M still available
- Clients are pretty interested
- Currently on hold while they evaluate if it's "consistent with administration priorities"



DOE Implementation Grants

The Department of Energy is offering grants up to \$300,000 per unique recommendation, at 50% cost share, on a rolling basis to small and medium-sized manufacturers to improve energy efficiency. These grants can be used to implement recommendations from energy assessments performed by Industrial Training and Assessment Centers. More info can be found at the link:

[Open Solicitation](#)

Eligibility Criteria

All applicants must meet the Eligibility Criteria.

Company Eligibility

- **Manufacturing Entity:** engages in the mechanical, physical, or chemical transformation of materials, substances, or components; or, applicant is a water or wastewater treatment facility.
- **Domestic Entity:** the entity must be organized, chartered, or incorporated (or otherwise formed) under the laws of a particular state or territory of the United States; have majority domestic ownership and control; and have a physical place of business in the United States.
- **Eligible NAICS Codes:**
 - NAICS Code: 31-33 (Manufacturing)
 - NAICS Code: 184 (Controlled Environment Agriculture)
 - NAICS Code: 2203-22032 (Water Supply Systems and Sewage Treatment Facilities)
- In most recently completed fiscal year OR year of assessment:
 - Gross annual sales < \$100 million
 - Annual energy bills between \$100K and \$3.5 million < 500 employees

Eligibility Based on ITAC Report

- All proposed projects address AR or AAR recommendation(s) made by an ITAC since January 1, 2016 and must be present in the report.
- No proposed project efforts have already been implemented.
- Minimum total project(s) implementation cost of \$10,000 (\$5,000 facility contribution/\$5,000 DOE contribution).

Application Process

The application is a quick and easy process, with eligibility being the main determining factor in receiving funding.

Submission

- The application process involves submitting the ITAC report and filing out a short form.
- **Application Form.**
- Facilities can reapply for a maximum of \$300,000 each round.

Eligible Projects

- Eligible projects can either be based on Assessment Recommendations (ARs) and Additional Assessment Recommendations (AARs).
- Since the costs in the report are estimates, the facility can adjust their funding request to match actual quotes.

More Questions?

- Contact ENERGYWERK, who is very responsive at info@energywerk.com
- ENERGYWERK FAC.
- Their partners are always to assist in the application process.

Contact Us
<https://the-energyefficiency.utd.edu/ae/>
info@energywerk.com

Logos: N (North Texas), Industrial Training and Assessment Centers, MESC (Manufacturing Extension Partnership)



2. Compressed Air Leakage

- Unavoidable
- Up to 30% of C.A. energy is lost to leaks
 - DOE: \$8000/year savings
- Leakage reduction has great payback (0.4 years)
- Quarterly leak detection program (DOE)
 - Identification and tagging
 - Tracking
 - Repair
 - Verification
 - Employee involvement
- Target: 5-12% leakage, depending on facility type and size



Compressed Air Leakage - Detection

- Old-school methods
 - Listening/feeling leaks
 - Soapy water
 - Handheld directional ultrasonic detectors
- Each of these has challenges
 - Worker time!



- Recommendation – ultrasonic imager



Ultrasonic Imager

Pros

- Real-time visual representation of leaks
- Saves images and data for subsequent reporting & analysis
- Longer distance leak detection
- Quantifies leakage by frequency and amplitude
- Photos facilitate repair
- Easy to learn

Cons

- Cost (ours was \$25k)
- Rentals available
- Borrow from IA PP

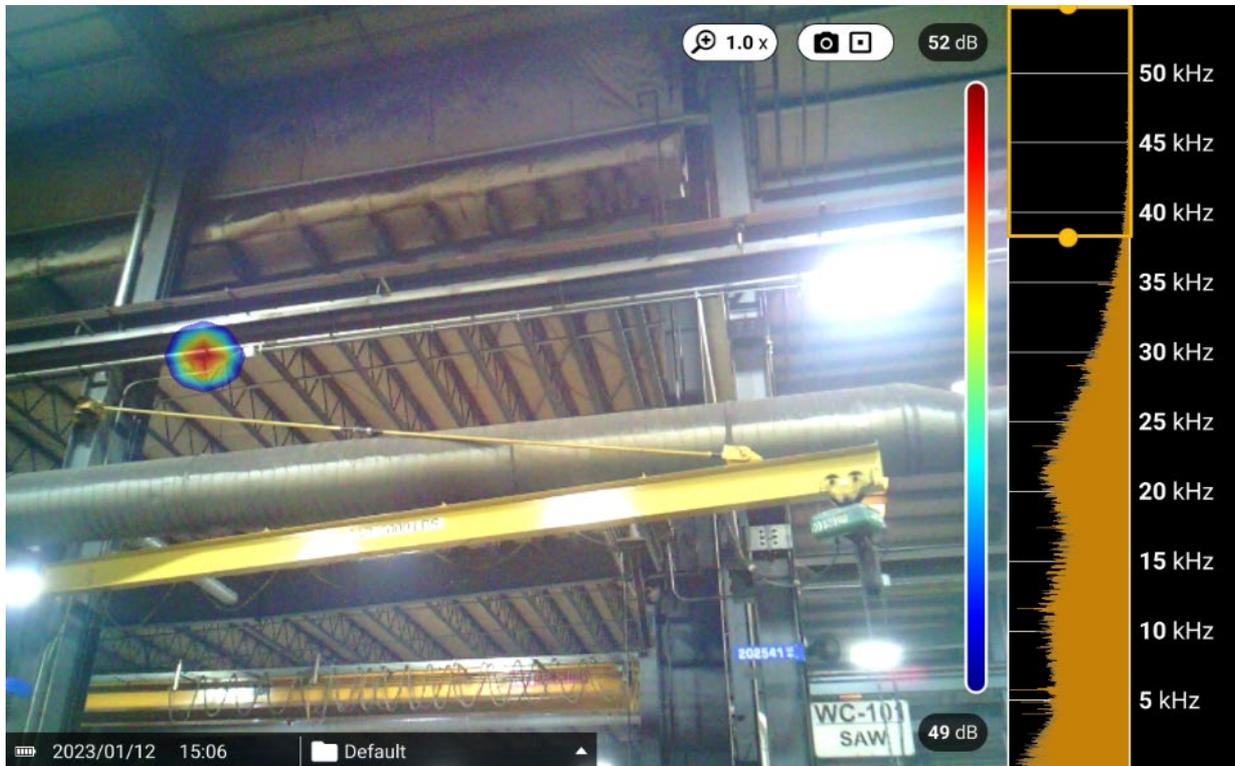
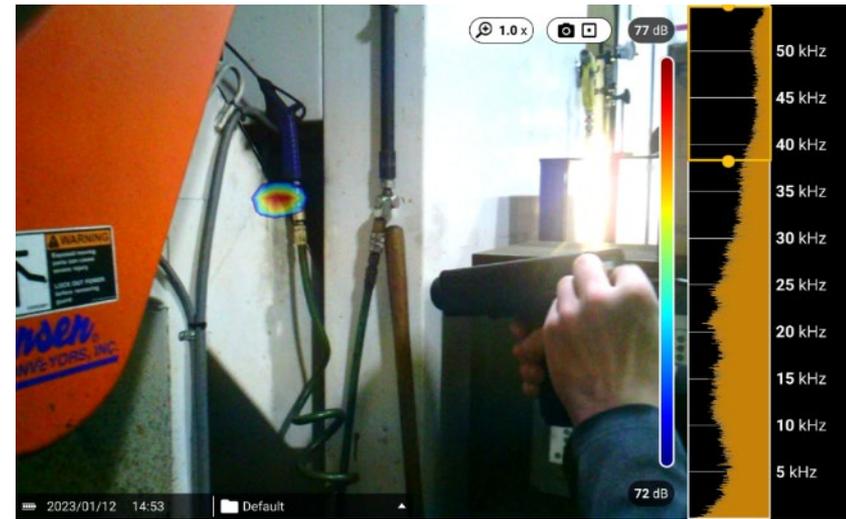
Compressor Building - Air Hose
Next to Valve (Start point)



Compressor Building - End point
of Air Hose



Ultrasonic Imager



Leak Detection – Effort and Savings

- Case study of 11 facilities we assessed
- Usually don't scan entire facility
- Savings a function of leak rates, utility costs, operating hours, compressor specs, loading factor

Plant #	% of Facility Scanned	Plant Size (1000 ft ²)	Leak Detection Effort (hours)	# of Leaks	Cost Savings (\$/yr)*
1	80%	1,700	10	240	\$ 230,000
2	25%	400	2	19	\$ 2,200
3	60%	134	2	42	\$ 12,000
4	20%	320	2	14	\$ 7,300
5	7%	500	2	8	\$ 10,000
6	25%	373	1.5	20	\$ 3,600
7	10%	994	1.5	24	\$ 18,000
8	100%	1,400	10	119	\$ 23,000
9	100%	353	10	77	\$ 19,000
10	100%	294	10	32	\$ 13,000
11	100%	138	10	24	\$ 10,000
Average	57%	601	6	56	\$ 31,645

*Cost savings extrapolated for plants that were not fully scanned



Thank you!

Contact us for more information

- DYUILL@UNL.EDU
- (402) 554-4176
- <https://engineering.unl.edu/iac/>
- Or use DOE's national ITAC portal at iac.university



IAC Highlights Resources Centers Database **APPLY NOW** Ask the IACs Login

Industrial Assessment Center

Industrial Assessment Centers

Sponsored by **MESC**

IMPLEMENTATION GRANT FUNDING OPPORTUNITY OPEN Learn More

IMPORTANT: The grant program operates on a rolling basis and applications may be submitted at any time, with quarterly reviews.

Saving Energy and Reducing Costs at Small and Medium-sized US Manufacturers

The USDOE Industrial Assessment Centers (IACs) can help small and medium-sized US manufacturers save energy, improve productivity, and reduce waste by providing no-cost technical assessments conducted by university-based teams of engineering students and faculty.

After the site visit, the IAC team provides a comprehensive report with specific details on all opportunities for improving competitiveness identified during the assessment, including applicable rebates and incentives.

APPLY NOW Ask the IACs a technical question

The IAC program has already conducted over 21,794 assessments with more than 162,224 associated recommendations. Average recommended yearly savings is \$142,175.

Industrial Assessment Centers 2022-2026

