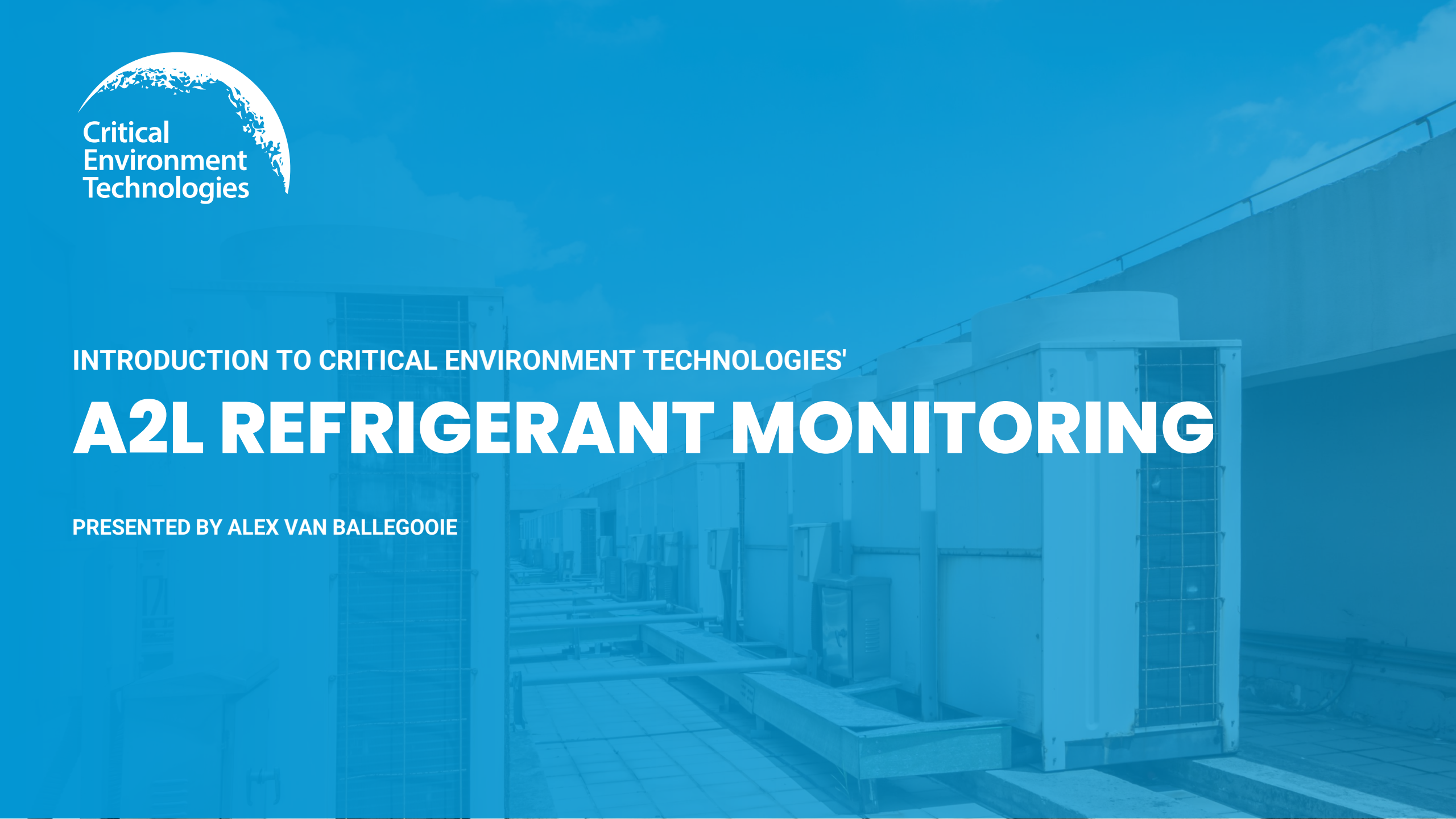
Critical Environment Technologies

INTRODUCTION TO CRITICAL ENVIRONMENT TECHNOLOGIES'

A2L REFRIGERANT MONITORING

PRESENTED BY ALEX VAN BALLEGOOIE



AGENDA

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01 WHY MONITOR REFRIGERANTS

02 TYPES OF REFRIGERANTS

03 REFRIGERANT SENSOR TECHNOLOGY

04 ASHRAE 15-2024 STANDARDS & APPLICATION EXAMPLES

05 RESOURCES FOR YOU

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WHY MONITOR REFRIGERANTS

SAFETY & ECONOMIC CONSIDERATIONS

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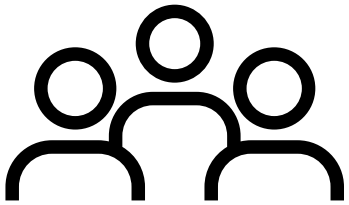
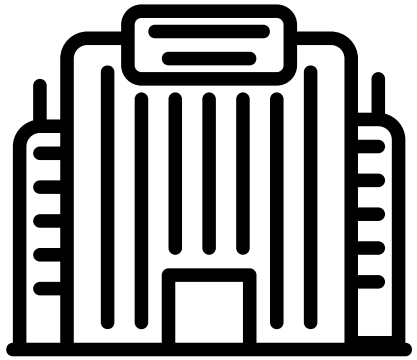
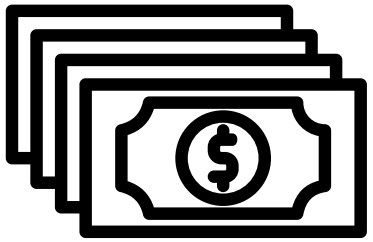


PROTECT LIVES



PROTECT PROPERTY

PROTECT THE ENVIRONMENT



SAVE MONEY

CONSIDERATIONS

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- Slow steady loss of refrigerant are barely detectable and can lead to harmful concentrations
- Compressors, condensers, evaporators, refrigerant feed lines are common leak sources
- Caused by pitting, corrosion, small fatigue cracks in the coils, valves and seals from repeated thermal cycling
- Smaller cubic volume areas will have a higher and quicker rise in gas concentration whereas a larger area result in a diluted concentration until it builds up
- Adequate coverage of the common leak points may require installation of multiple gas detectors

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TYPES OF REFRIGERANTS

REFRIGERANT TIMELINE

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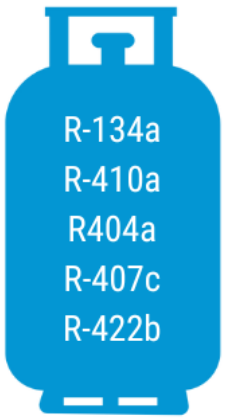
1930's
CFC's

1950's
HCFC's

1990's
HFC's

2025's
HFO's & HC's



High ODP
Highest GPW (10,900)

Lower ODP
High GPW (1,810)

No ODP
High GPW (2,088)

No ODP
Low GPW <700

A1 Classification

A2L Classification

REFRIGERANT SAFETY GROUPS

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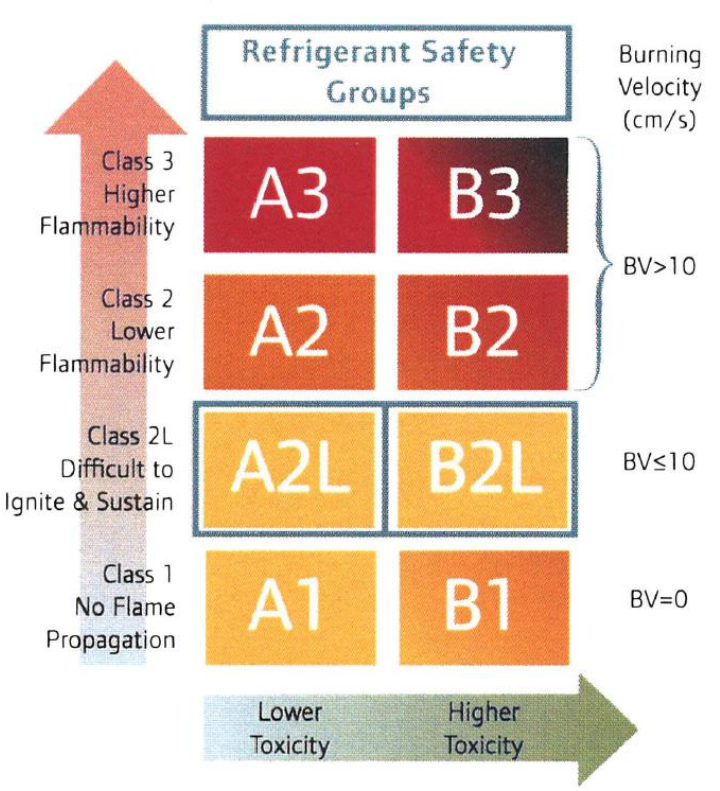

Refrigerant Safety Groups (examples)	Lower Toxicity OEL > 400ppm	Higher Toxicity OEL < 400ppm
Higher Flammability	**A3** all hydrocarbons	**B3**
Lower Flammability HCFs, non-fluorocarbons	**A2** R-152a	**B2**
Lower Flammability (Mildly Flammable) Low Burning Velocity HCFs, HFC/HFO Blends, HFOs	**A2L** R-32, R-452B, R-454B, R-455A, R-516A, R-1234yf, R-1234ze(E)	**B2L** ammonia (R-717)
No Flame Propagation HFFCs, HFC/HFO Blends, HFOs, HCFOs, HFO/chloro-olefin blends, non-fluorocarbons	**A1** R-134a, R410A, R-448A, R-449A, R-460B, R-513A, R-515A, R-1336mzz(Z), R-1233zd(E), CO_2 (R-744)	**B1** R-245fa, R-514A

REGULATORY AUTHORITIES

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OSHA®

National Institute for Occupational Safety and Health NIOSH

ASHRAE®

ACGIH®

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

TYPE OF REFRIGERANTS

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Gas detectors monitor the following refrigerants:

- R-22, R-32, R-123, R-134a, R-143a, R-227ea, R-402a, R-404a, R-407a, R-407c, R-407f, R-410a, R-417a, R-422a, R-422d, R-427a, R-434a, R-438a, R-442a, R-448a, R-449a, R-450a, R-452a, R-453a, R-454a, R-454b, R-455a, R-507, R-513a, R-514a
- HFO1234yf, HFO1234ze, HFO1233zd
- R-SF6 Sulphur Hexafluoride
- R-717 Ammonia (NH_3)
- R-744 Carbon Dioxide (CO_2)
- R-290 Propane (C_3H_8)

A2L REFRIGERANTS

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	Health Hazards	Safety Group	LEL (vol)	UEL (vol)	LFL	RCL	OEL	TWA (8 hrs)	STEL (15 min)	IDLH
R-32	Low toxicity, mildly flammable, asphyxiant, frostbite	A2L	13%	33%	144,000 ppm	36,000 ppm	1,000 ppm	1,000 ppm	n/a	n/a
R-1234ze	Low toxicity, mildly flammable, asphyxiant, frostbite	A2L	n/a	n/a	65,000 ppm	16,000 ppm	800 ppm	800 ppm	n/a	n/a
R-452b	Low toxicity, mildly flammable, asphyxiant, frostbite	A2L	12%	23.3%	119,000 ppm	30,000 ppm	870 ppm	1,000 ppm	n/a	n/a
R-454b	Low toxicity, mildly flammable, asphyxiant, frostbite	A2L	11.25%	22%	77,000 ppm	19,000 ppm	850 ppm	1,000 ppm	n/a	n/a

CET Alarm Setpoints:

LOW RANGE:
Low = 250 ppm / Mid = 500 ppm / High = 1,000 ppm

HIGH RANGE:
Single setpoint at 25%LEL

LEL = Lower Explosive Limit
UEL = Upper Explosive Limit

LFL = Lower Flammability Limit
RCL= Refrigerant Concentration Limit

OEL = Occupational Exposure Limit
TWA = Time Weighted Average

STEL = Short Term Exposure Limit
IDHL = Immediately Dangerous to Life or Health

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REFRIGERANT SENSOR TECHNOLOGY

REFRIGERANT SENSOR TYPES

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	Low Range Solid State (MOS) Refrigerant Sensor	Low Range Dual Beam Infrared Refrigerant Sensor	High Range Dual Beam Infrared Refrigerant Sensor
Range	0 – 2,000 ppm	0 – 2,000 ppm 0 – 500 ppm for R-123 0 – 5% vol for CO_2 R-744	0 – 100% LEL
Minimum Detection	25 ppm	1 ppm	1% LEL
Life Expectancy	5 – 7 years	10 years	10 years
Calibration Frequency	Annual testing	Annual testing	Annual testing
Response Time	<2 minutes @T_{90}	<2 minutes @T_{90}	<2 minutes @T_{90}

REFRIGERANT SENSOR TYPES

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	Solid State (MOS) Refrigerant Sensor	Infrared Refrigerant Sensor
Response to changes in RH and Temperature	Sensitive to changes in RH and Temperature	Short term response to changes in temperature, RH may affect response and promote corrosion
Operating Environment	Wet or dirty/dusty environments will shorten lifespan	Wet or dirty/dusty environments can impair the ability of the optics to function and reduce sensor response
Cross Sensitivities	Other refrigerants and gases, vapours, chemicals, solvents, paints, etc.	May show slight response to hydrocarbons in solvents, cleaning agents
Exposure to high concentrations of target gas	More likely to be poisoned	Immune to poisoning
Continuous exposure to gas	Reading will become unreliable	Does not affect operation
Power Consumption	High	High
Cost	Economical	Expensive

MOUNTING HEIGHTS

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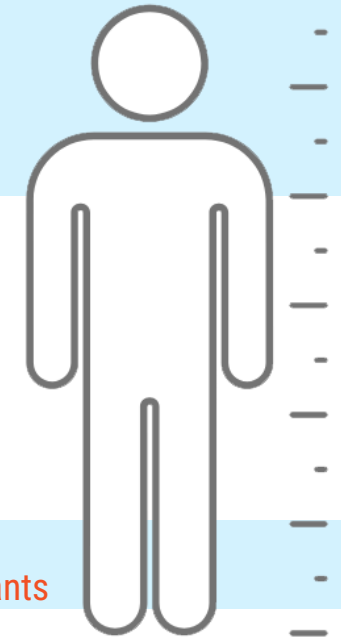
Fixed refrigerant gas detectors should be mounted as close as possible to the common leak points and downwind from the direction of the forced air ventilation.

CEILING: 6-12in (15-30cm) from ceiling

Lighter than air	Ammonia (NH_3), Hydrogen (H_2), Methane (CH_4)

BREATHING ZONE: 4-6ft (1.2-1.8m) from floor

Same as air	Carbon Dioxide (CO_2), Carbon, Monoxide (CO), Ethylene (C_2H_4), Formaldehyde (CH_2O), Oxygen (O_2), Nitrogen Dioxide (NO_2)



FLOOR: 6-12in (15-30cm) from floor

Heavier than air	Chlorine (Cl_2), Hydrogen Chloride (HCl), Ozone (O_3), Propane (C_3H_8), Sulphur Dioxide (SO_2), & most Refrigerants

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ASHRAE 15-2024 SAFETY STANDARDS & APPLICATION EXAMPLES

TIMELINE

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Compliance dates for stationary residential and light commercial AC and heat pumps are:

- Manufacture and import: Jan. 1, 2025
- Installation for all except VRF: Jan. 1, 2025
- Manufacture and import for VRF: Jan. 1, 2026
- Installation for VRF: Dec 31, 2026

SHAFT & PIPING REQUIREMENTS

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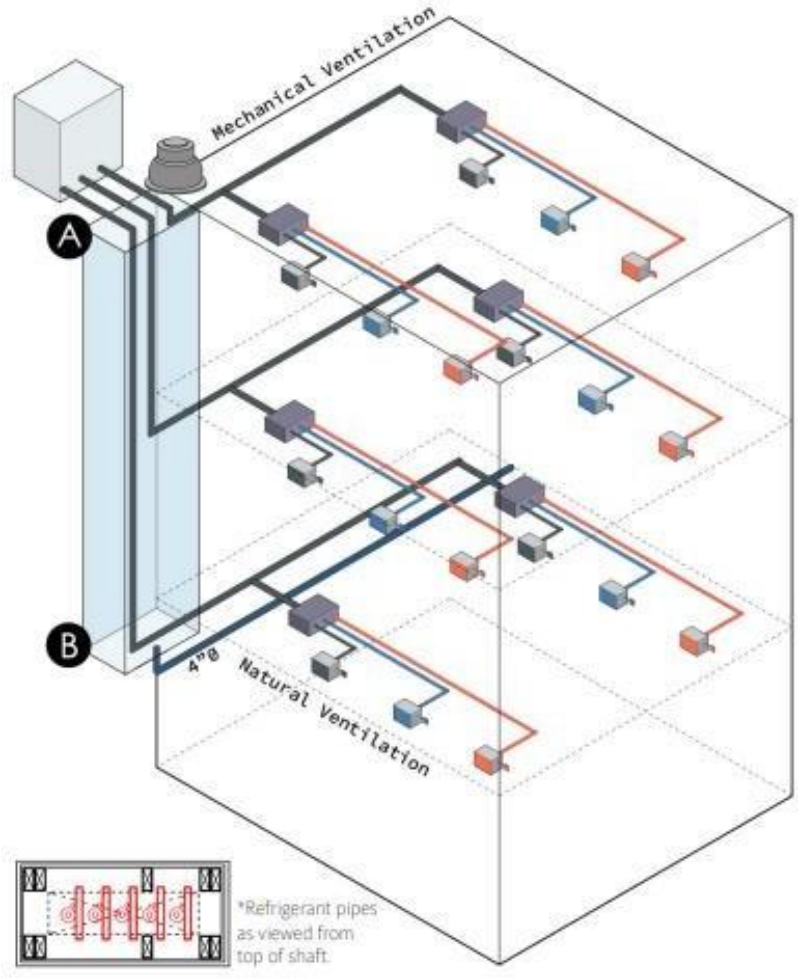

- **Groups A2, A3, B2, B3:** Continuous mechanical ventilation and refrigerant detector required.
- **Groups A2L, B2L:** Natural or mechanical ventilation required.
- **Pipe shafts with A2L or B2L:** Mechanical ventilation can be activated by a refrigerant detector.
- **Refrigerant detector:** Setpoint ≤ OEL, located where leaks concentrate.
- **Double-wall pipe:** No ventilation needed if interstitial space is vented outdoors per Section 9.7.8.2

SHAFT APPLICATION

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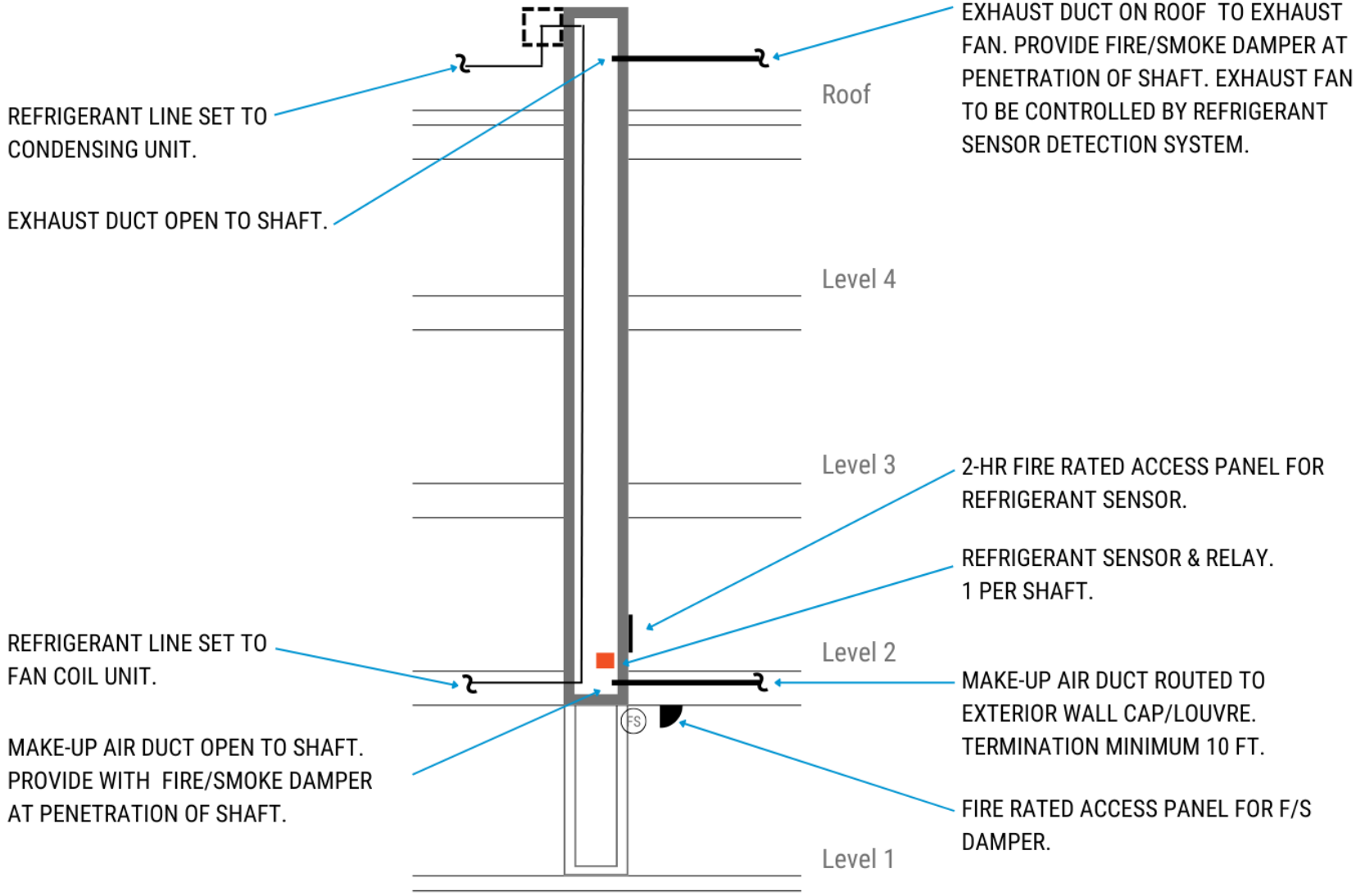


DUCTED HVAC AND INSTITUTIONAL SYSTEMS

Critical Environment Technologies

ASHRAE 15-2024, SECTION 7.6.2.3

The following manufacturer's refrigeration systems shall have an integral Refrigeration Detection System:

- Ducted HVAC systems with a releasable refrigerant charge (m_{rel}) more than 4.0 lbs (1.8 kg) and with any duct openings less than 5.9 ft (1.8 m) above the finished floor.
- Ducted HVAC systems where spaces connected to the same supply air duct are used as the dispersal floor area to calculate volume as per section 7.2
- Refrigeration systems installed where the occupancy classification is institutional occupancy

RELEASE MITIGATION CONTROLS

ASHRAE 15-2024, SECTION 7.3.4.4

Integral Refrigeration Detection System Requirements:

- **Mitigation Controls:** Activated by refrigerant detection system.
- **Detector Location:** In all refrigerant equipment or spaces served by the mitigation-controlled circuit.
- **Function:** Activates mitigation controls and isolates refrigerant leak paths.
- **Compliance:** Must comply with Section 7.6.2.4 and activate the mitigation requirements as per Section 7.6.2.5

REFRIGERATION DETECTION SYSTEM

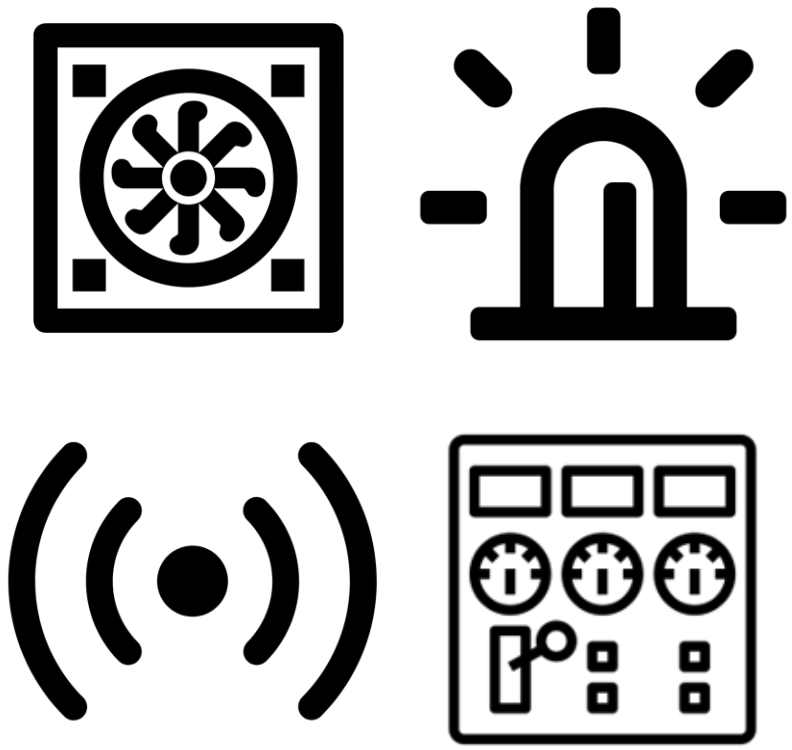
ASHRAE 15-2024, SECTION 7.6.2.4

Integral Refrigeration Detection System Requirements:

- Fixed, nonadjustable setpoint
- Generates output signal within 30 seconds when exposed to 25% LFL
- Access for replacement of detection system components
- The system cannot be recalibrated in the field.
- Must detect the specific refrigerant being used in the system
- Must perform self-checks

MITIGATION ACTIONS

ASHRAE 15-2024, SECTION 7.6.2.5



Requirements:

Shall be completed in not more than 15 seconds after the initiation of the signal output and be maintained for at least 5 minutes after the output signal has reset.

- Turn on air circulation fans
- Open or set air duct zone dampers to full airflow
- Activate shutoff valves to reduce releasable refrigerant charge
- Activate mechanical ventilation if required
- De-energize connected electric resistance heat installed in air ducts
- De-energize all potential ignition sources

AC IN COMMERCIAL BUILDINGS

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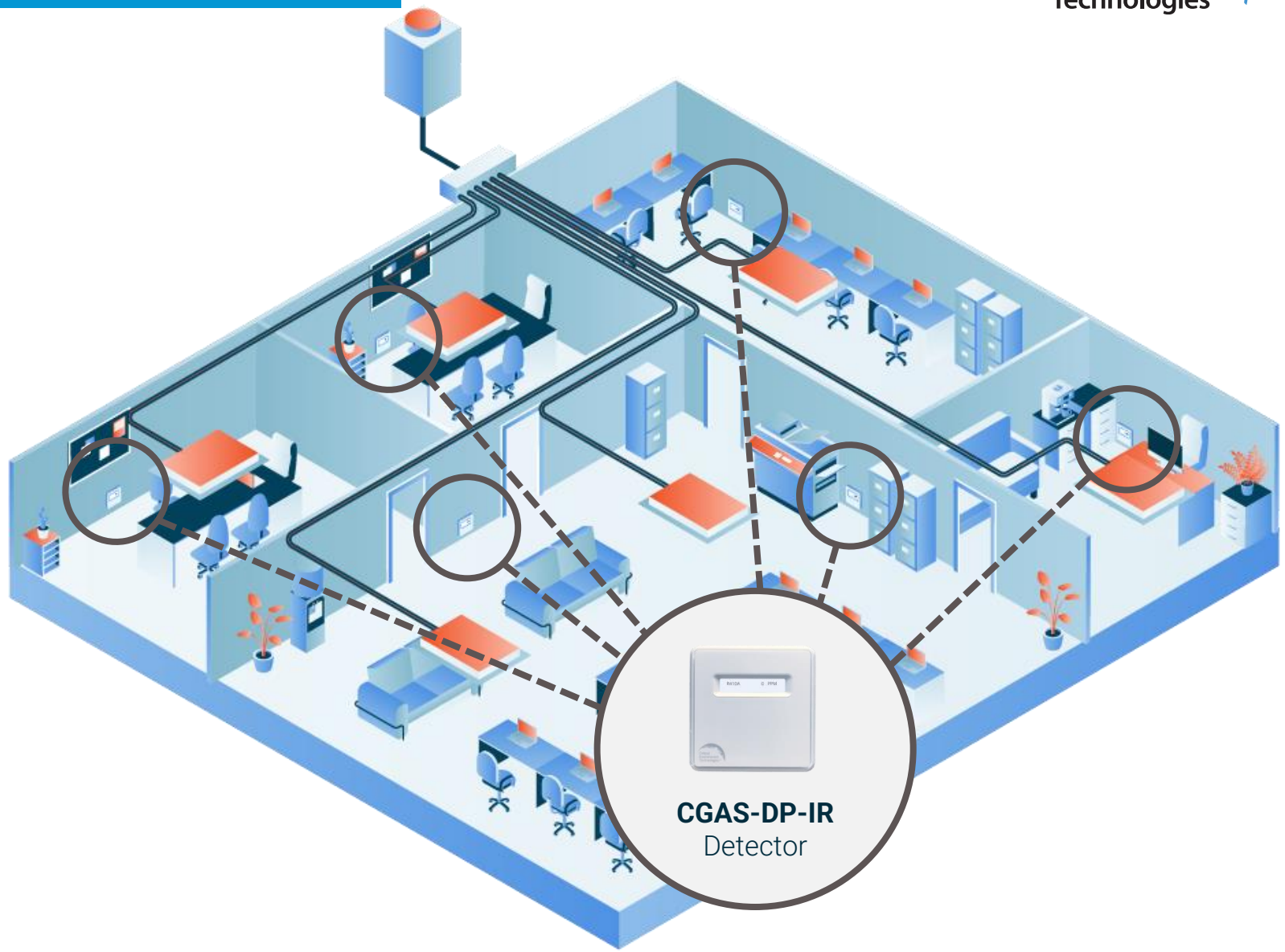
Continuous refrigerant monitoring: For leaks in the refrigerant piping running throughout the building from the outdoor refrigeration units typically located on the roof of the building. Ensures safety in buildings with HVAC systems.

Sensor Location: Depends on VRV system design and type of refrigerants being monitored. Both low range and high detectors may be required in different locations.



HOTELS

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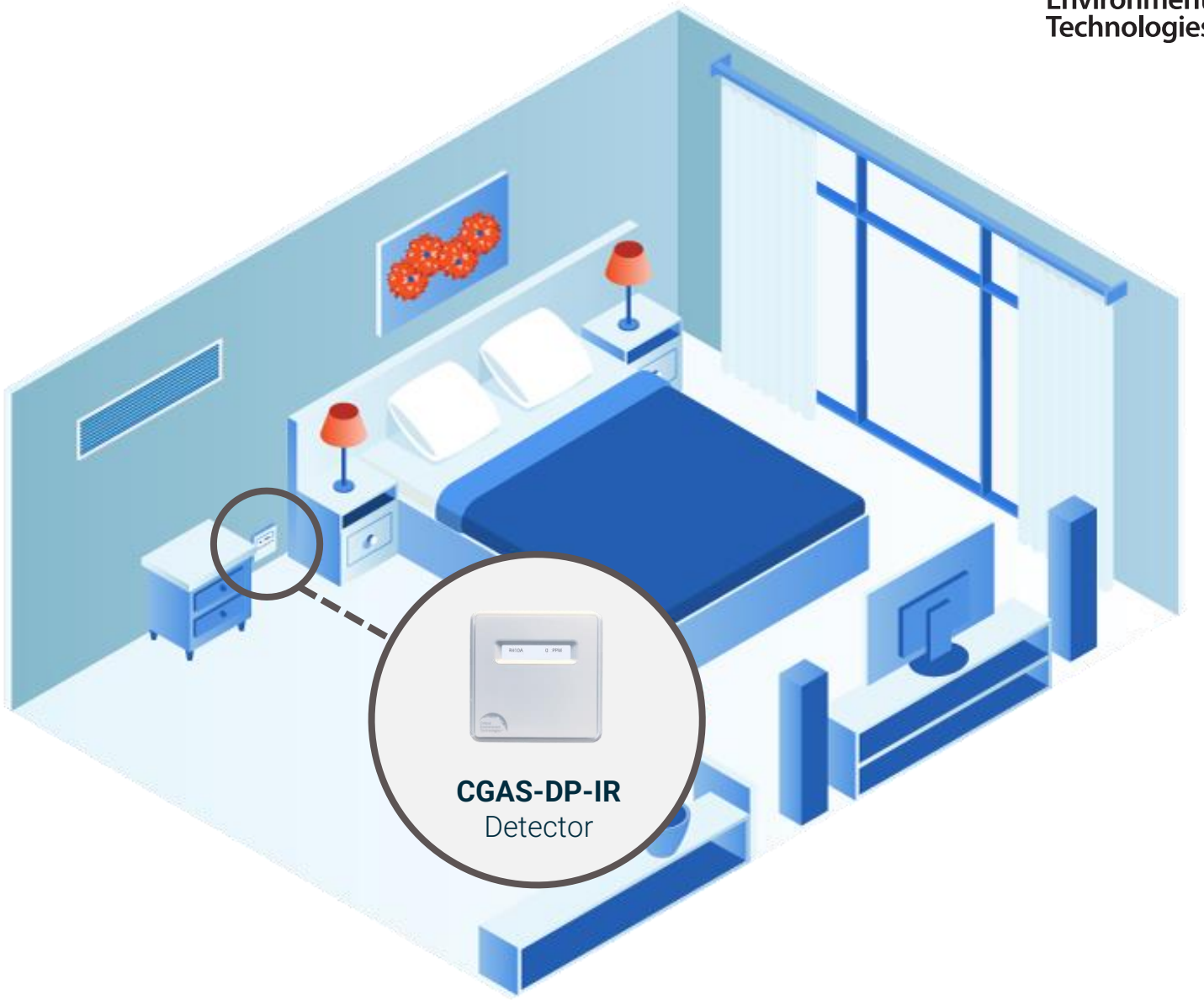
Refrigerant Monitoring: Continuous monitoring in hotel rooms that use high efficiency, high volume refrigerant cooling and heating systems.

Sensor Coverage: Depends on VRV system design and type of refrigerants being monitored. Both low range and high detectors may be required in different locations.



SCHOOLS

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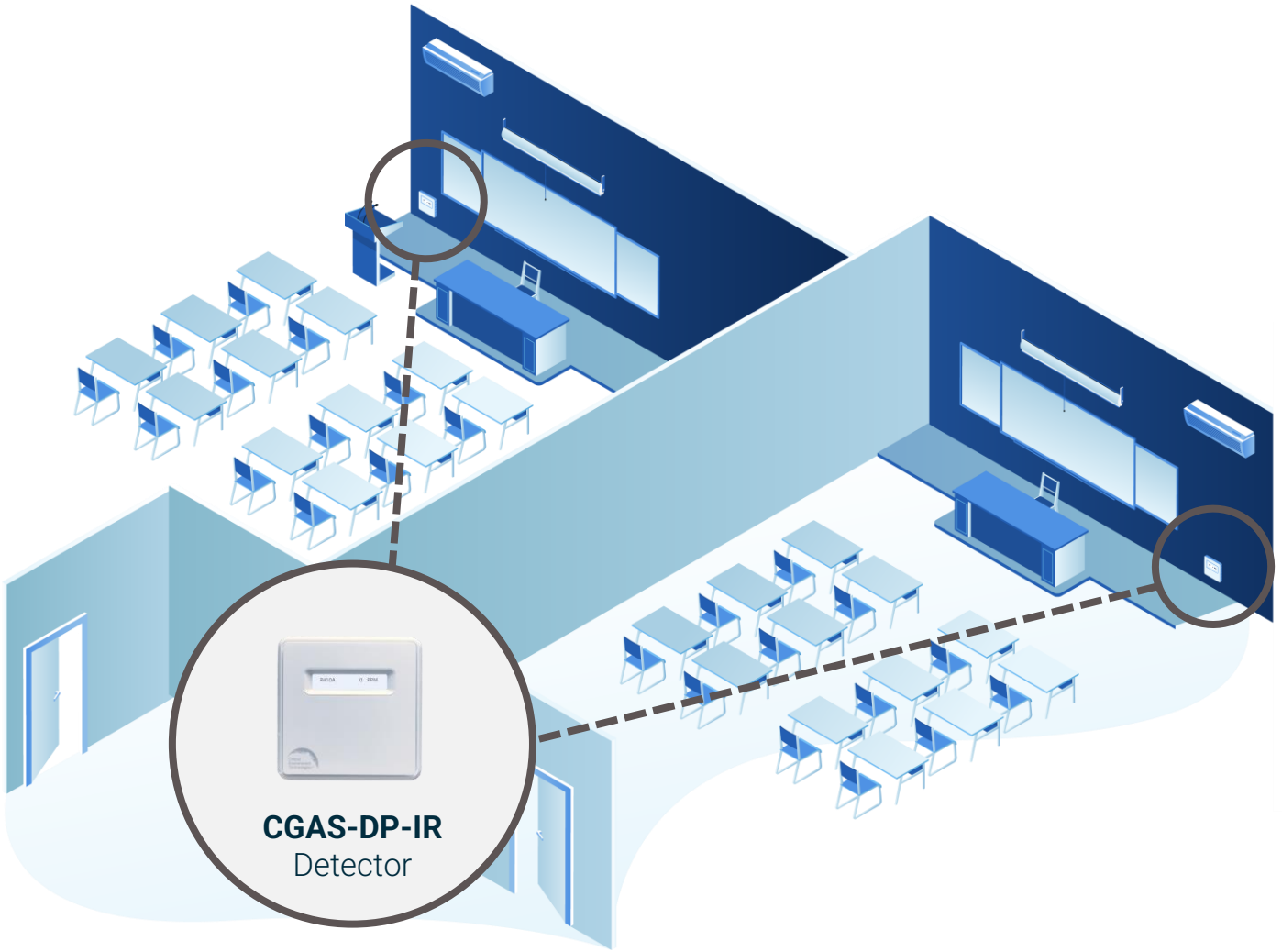
Refrigerant Monitoring: Continuous monitoring in occupied spaces in schools that use high efficiency, high volume refrigerant cooling and heating systems.

Sensor Coverage: Depends on VRV system design and type of refrigerants being monitored. Both low range and high detectors may be required in different locations.



MACHINERY ROOM GENERAL REQUIREMENTS

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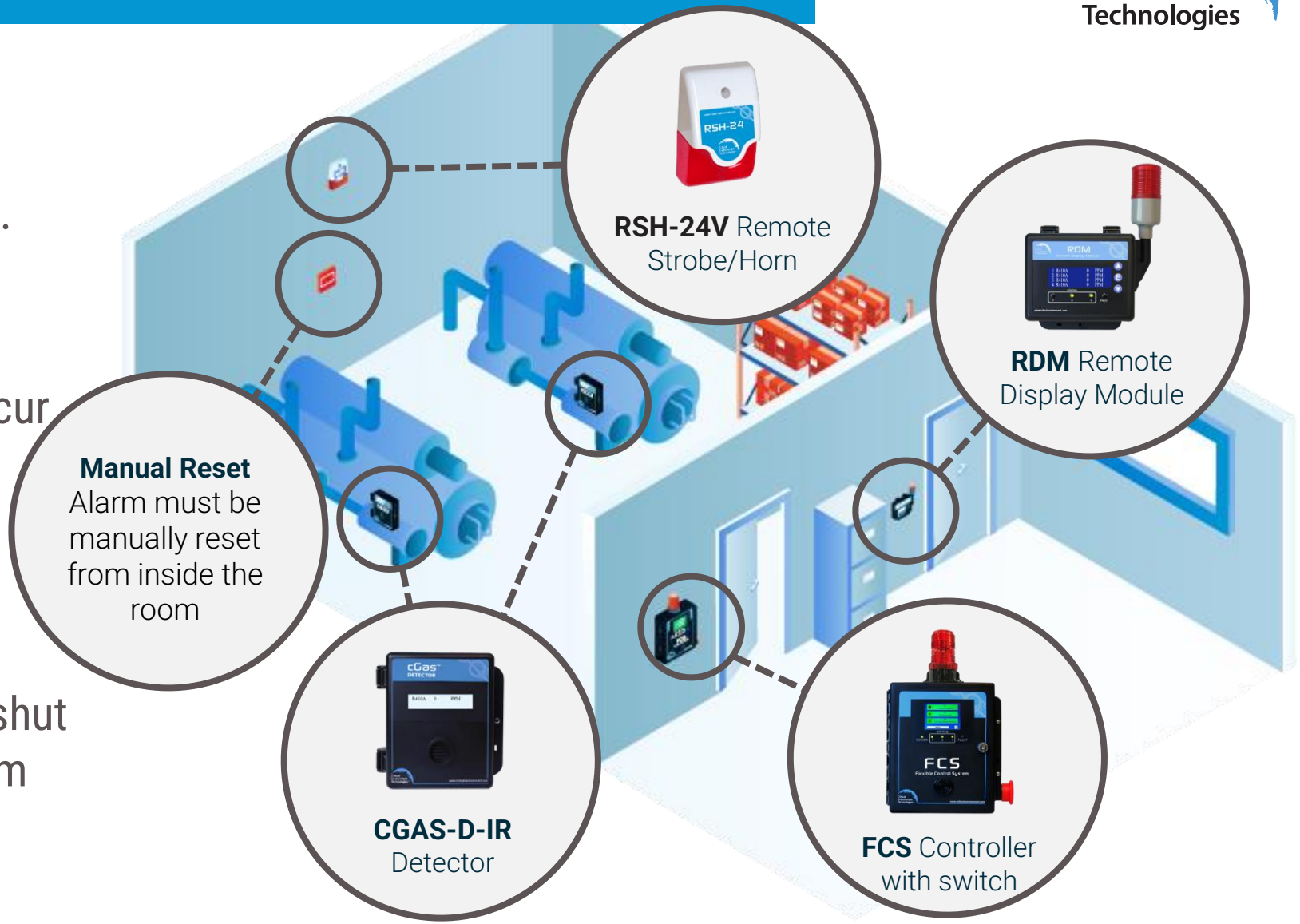
ASHRAE 15-2024, SECTION 8.9.5

Life Safety: Monitors for leaks, activates fans, shuts off chillers.

Sensor Location: Each chiller requires a dedicated sensor; mounted where leak likely to occur and 6in / 15cm from floor.

Requirements: Shut off switch outside room for immediate response to shut off equipment, internal relay to activate chiller shut off sequence, manual reset alarm inside room, Remote Display Module outside each entrance



MACHINERY ROOM SPECIAL REQUIREMENTS

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ASHRAE 15-2024, SECTION 8.10 & 8.11

- **Remote Control:** For immediate equipment shutdown, located outside the door.
- **Ventilation Fans:** Separate circuit, control switch outside the door.
- **Ventilation System:** Continuous or activated by the refrigerant detector(s); fire/smoke systems can override.
- **Ventilation Duration:** Continue at least 5 minutes after gas concentration drops below setpoint.
- **Gas Detection:** Refrigerant gas that exceeds 25% of the LFL or the upper detection limit of the detector, (whichever is lower) triggers automatic shutdown of compressors, pumps, valves, and ignition sources.
- **Multiport Devices:** Prohibited.

MACHINERY ROOM A2L DETECTOR REQUIREMENTS

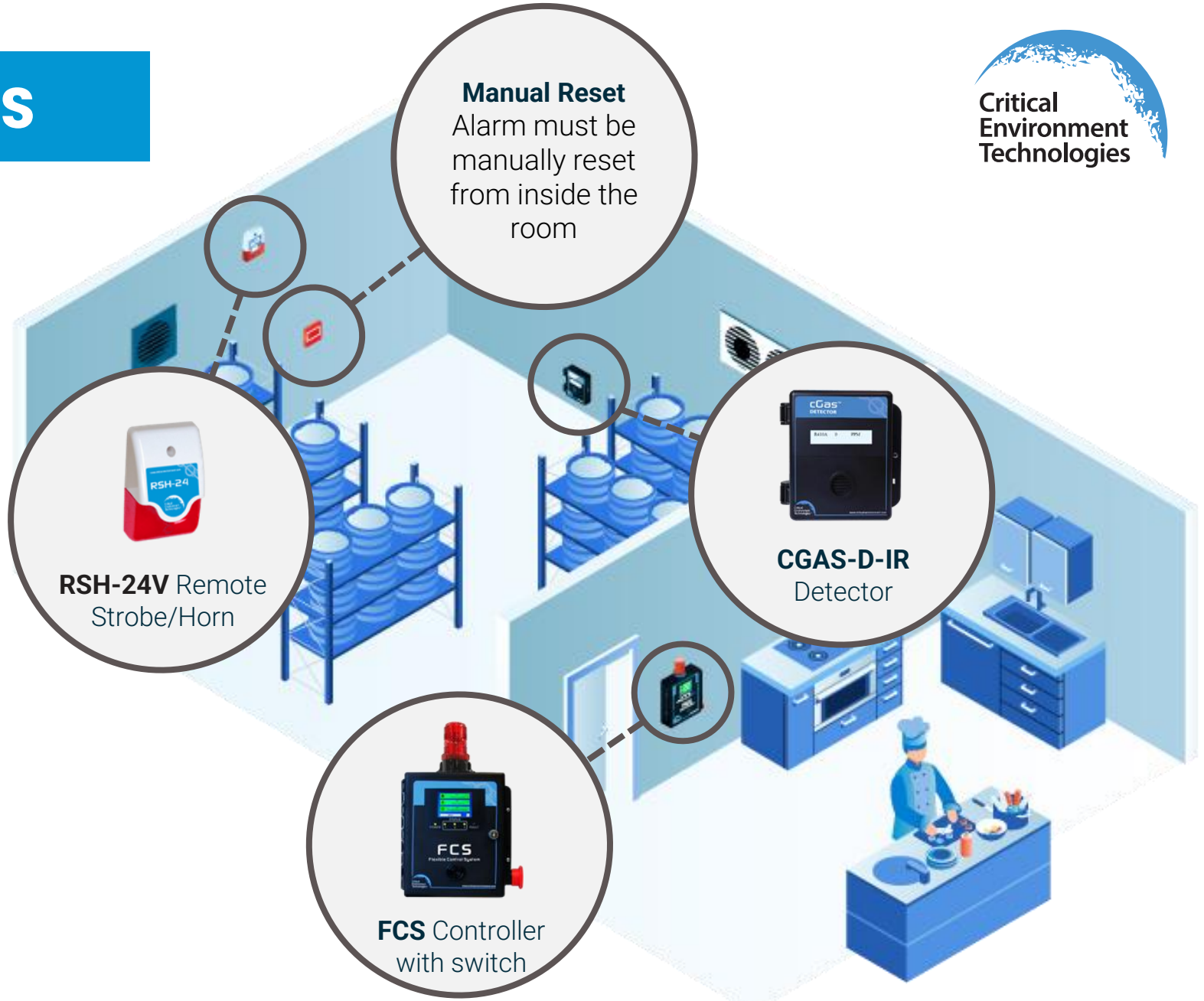
ASHRAE 15-2024, SECTION 8.10 & 8.11

- **Detection:** Capable of detecting each specific refrigerant in the room.
- **Alarm Setpoint:** ≤ applicable OEL (lowest value if multiple gases) and ≤ applicable RCL (lowest value if multiple gases).
- **Self-Testing:** Automatic; failure sends trouble signal to monitored location.
- **Annual Testing:** During installation and once every year to verify compliance with setpoints and response times.

COLD STORAGE ROOMS

Sensor Location:
Refrigerants/CO_2 mounted 6 in from floor inside refrigerated room.

Compliance: Refrigerant detectors shall be installed as required in refrigeration machinery rooms in accordance with Section 8.9.5



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ASHRAE 15-2024, SECTION 8.10 & 8.11

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Refrigerant Detector Setpoints, Response Times, Alarms and Ventilation Levels:

Setpoint	Response Time	Alarm Type	Alarm Reset Type	Ventilation Level	Ventilation Reset Type
≤OEL	≤300 seconds	Trouble	Automatic	Level 1	Automatic
≤RCL	≤15 seconds	Emergency	Manual	Level 2	Manual

- Visual and audible alarm inside machinery room and outside each entrance to the room
- Manual reset type alarms shall have the reset located inside the machinery room
- Other alarm levels and automatic reset alarms are permitted in addition to these requirements
- The meaning of each alarm must be marked by signage near each annunciator

SUMMARY

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- **Low-range detectors** monitor for leaks approaching toxicity levels in occupied spaces like walk-in coolers and freezers, ensuring refrigerant concentrations stay below 8-hour TWA OEL levels.
- **High-range detectors** monitor areas with large refrigerant volumes, quickly detecting high concentrations that pose fire and oxygen displacement risks.
- **OEMs integrated high-range A2L sensors** into refrigeration equipment, but low-range detectors are still needed for slow leaks

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RESOURCES FOR YOU

SPEC REVIEW SERVICE

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01 **Assist** in bringing engineering specifications up-to-date

02 **Help** identify outdated equipment and related concerns

03 **Recommend** the latest technology & best practices for spec adherence

04 **Highlight** any recommendations made for your review

05 **Assess** general or project-specific specs

06 **Support** Engineers in optimizing gas detection system designs for success

ENGINEERING PORTAL

- Installation & User Manuals
- Engineering Specifications
- Product Datasheets
- Wiring Drawings & Diagrams

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DRAWINGS & SUBMITTALS SUPPORT

- **Comprehensive Materials List**
- **Professional-Grade Drawings**
- **Detailed Wiring Diagrams**
- **Professional Datasheets**

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ABOUT US

WHO WE ARE

Critical Environment Technologies

- **Gas detection leader for almost 30 years,** across design, manufacturing and service
- **Gas detection is our only business** – we are specialized and laser-focused
- **Sold in all states and provinces**, and more than 20 countries globally
- +15 product lines, **supporting +50 gasses, for +25 different applications**
- **State-of-the-art** production, testing and R&D facilities

Our Mission:

SAFER AIR EVERYWHERE

WHAT MAKES US DIFFERENT

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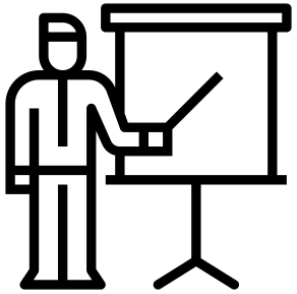
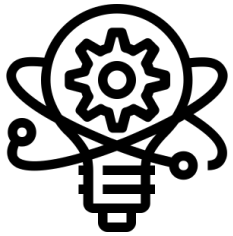
Best-in-Class Service



Comprehensive Training



Innovative Products

Dedicated After-Market Support

Competitive Pricing

WHERE WE CAN BE FOUND

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+100,000 UNITS SOLD

WHO WE WORK WITH

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TCF
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Johnson Controls

SIEMENS

Delta CONTROLS

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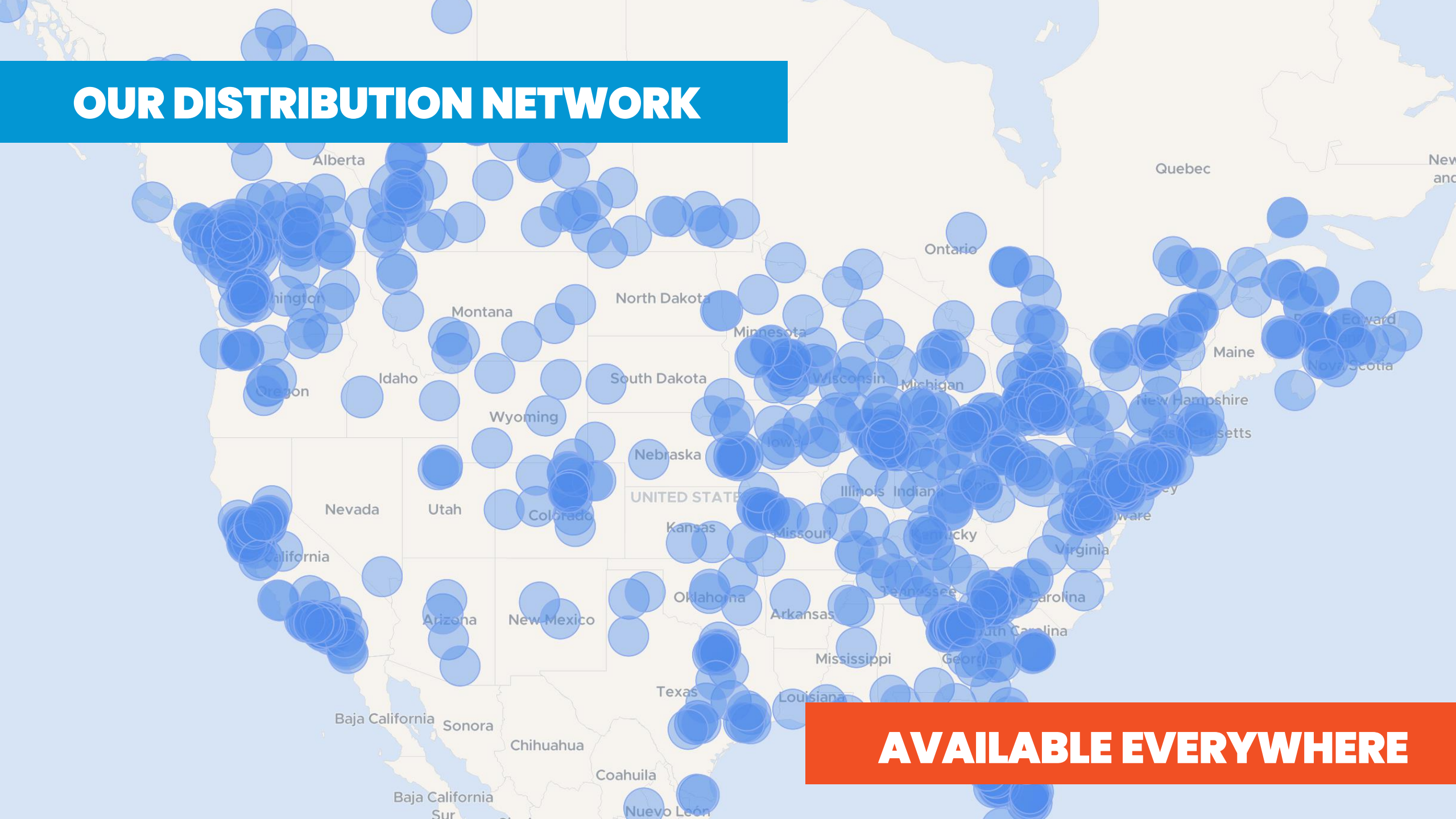

AVAILABLE EVERYWHERE

WE'RE HERE TO HELP

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THANK YOU