AN INSIDE LOOK ON
LOW-GWP REFRIGERANT REPLACEMENTS

Presented by: Sharon Haeg

Introductions

Sharon Haeg, PE, CEM, LEED AP BD+C

HVAC Systems Business Development Manager

Sharon.haeg@daikinapplied.com

- Joined Daikin in November 2024
- 17 years of experience
  - Energy efficiency and infrastructure renewal
  - HVAC equipment and systems
  - Building automation and controls

- Focus areas at Daikin include:
  - Refrigerants
  - Decarbonization
  - Energy efficiency

Disclaimer

- The content in these materials is copyrighted by Daikin Applied Americas Inc. (Daikin Applied) and cannot be used without the express written permission of Daikin Applied. This training, along with the related materials, is for educational purposes and is only for the persons attending the training. It is not intended to provide legal or technical advice and does not replace independent professional judgment. While all information in the training materials is provided in good faith, Daikin Applied makes no representation or warranty of any kind, express or implied, regarding the accuracy, adequacy, validity, reliability, availability, or completeness of any information in the training materials. Under no circumstance shall Daikin Applied have any liability to you or any other party for any loss or damage of any kind incurred as a result of the use of the training materials or reliance on any information provided in the training materials. Your use of the training materials and your reliance on any information in the training materials is solely at your own risk. The ultimate responsibility is on the engineer of record to ensure the design complies with all applicable codes and regulations.
- Always consult your state & local codes, which may take precedence over standards like ASHRAE Standards 15, 34, or other standards which vary in adoption, complete or partial, by state. Also note that a state may adopt a different year of the standard than the latest version.
- The local Authority Having Jurisdiction (AHJ) has the final authority in interpreting code requirements. When in doubt, contact the AHJ.

Agenda

Address common questions:

- How do refrigerants align with the goal of decarbonization
- Low GWP refrigerant alternatives
- Evaluating existing high GWP systems – Navigating potential speedbumps
  - Understanding the EPA SNAP Final Rule 23
  - UL 60335-2-40 listing requirements
  - Common challenges complying with ASHRAE Standard 15
  - Refrigerant pipe shaft requirements
  - Operations and maintenance considerations

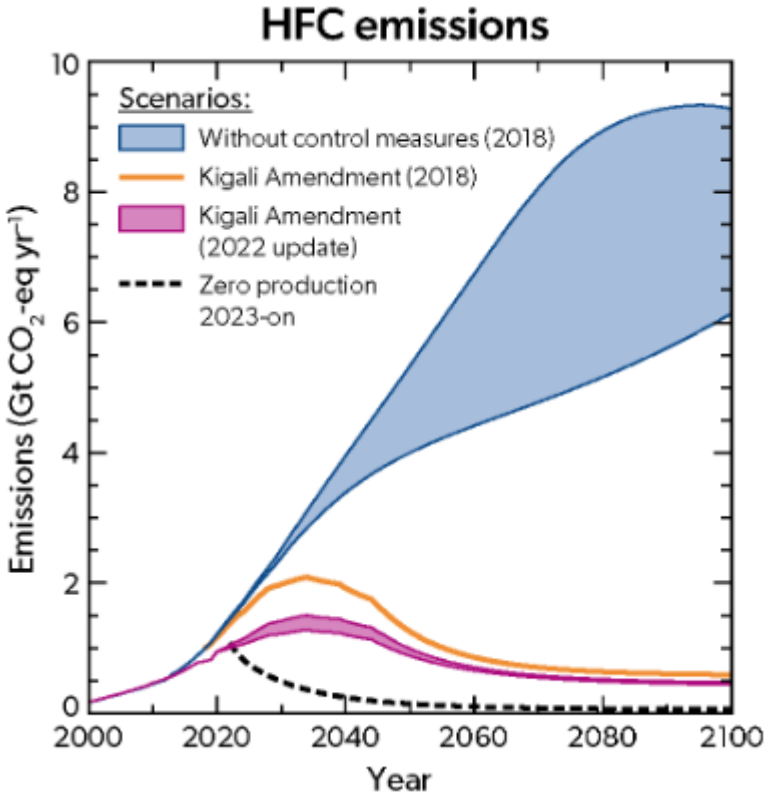
Agenda

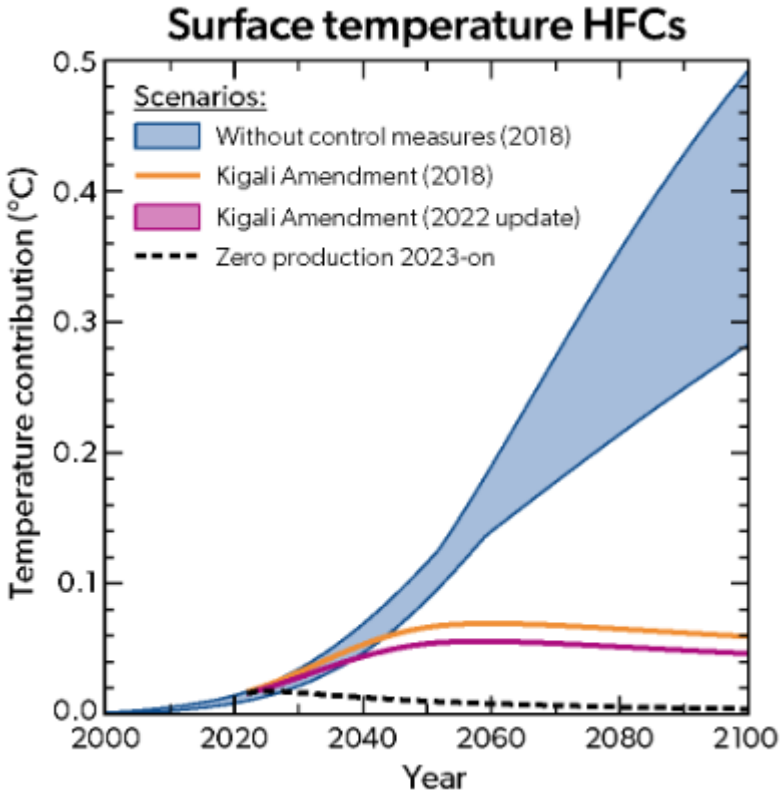
What are we really getting into today…

- Can I service my existing R-410A system?
- Can I replace my existing R-410A system with new R-410A?
- What other options do I have if I don’t want to replace my air handling system?
- What can I do if my refrigerant charge is too high?
- What refrigerant is the best choice for my project or building?

Why Are Refrigerants Important for Decarbonization?

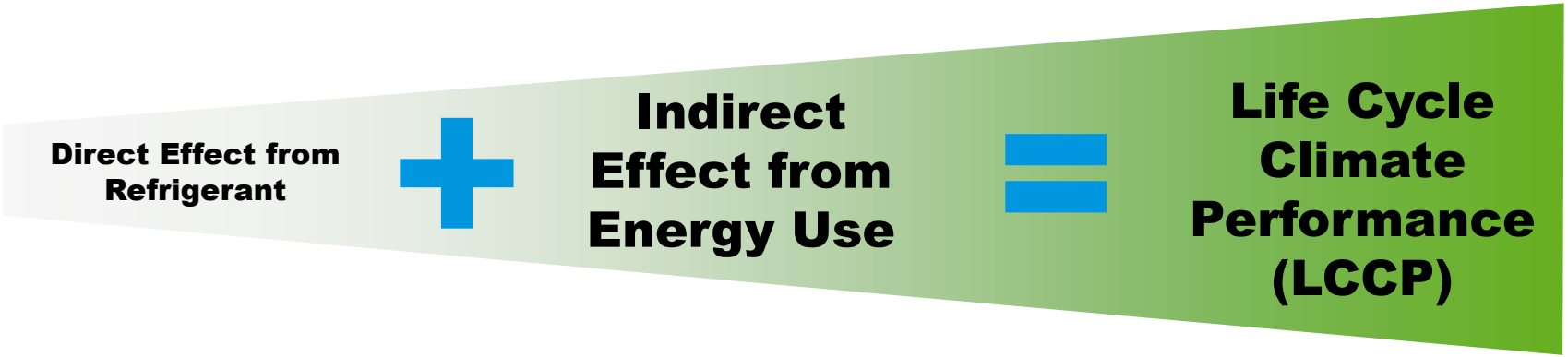
Kigali Amendment to Montreal Protocol





Scientific Assessment of Ozone Depletion: 2022, Executive Summary

GWP is Not the Full Measure of Emissions



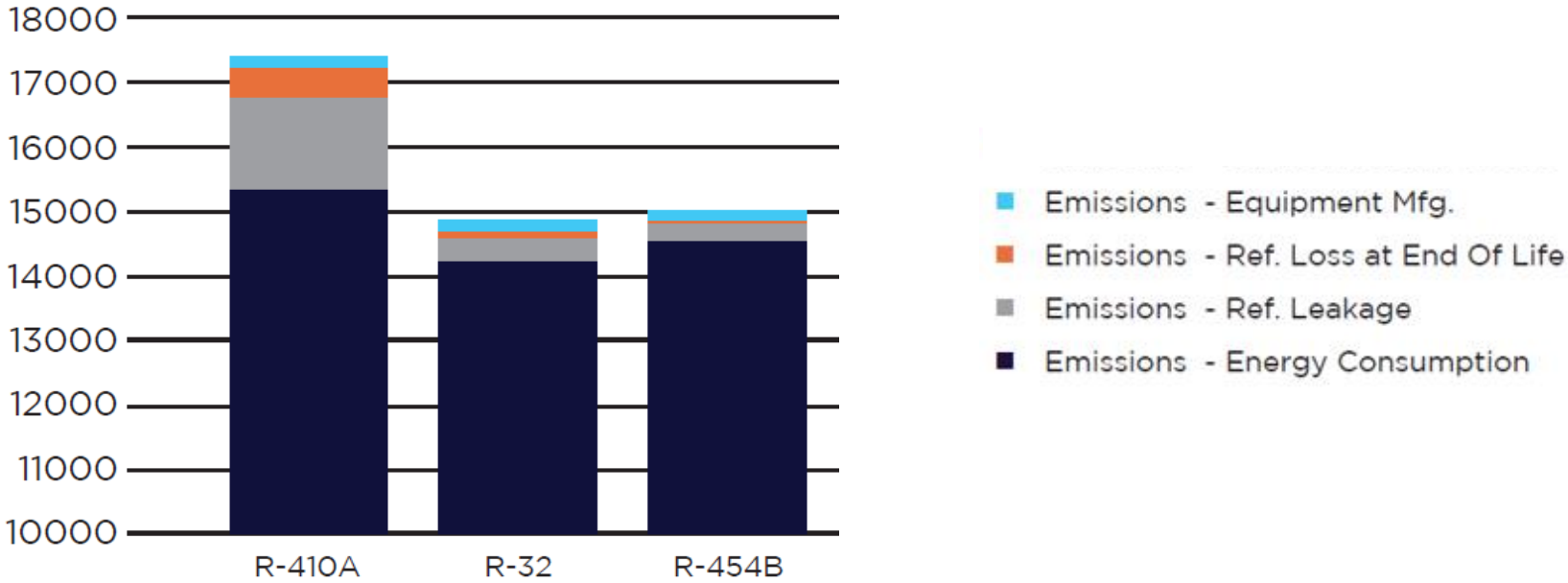
- Majority of climate impact from HVAC is electrical power generation over equipment lifetime
- A lower GWP refrigerant with lower efficiency could actually create more global warming!

Source: Zhang M., et al. 2011. “Life Cycle Climate Performance Model for Residential Heat Pump Systems.” AHRTI Report 09003-01

Lifetime Emissions

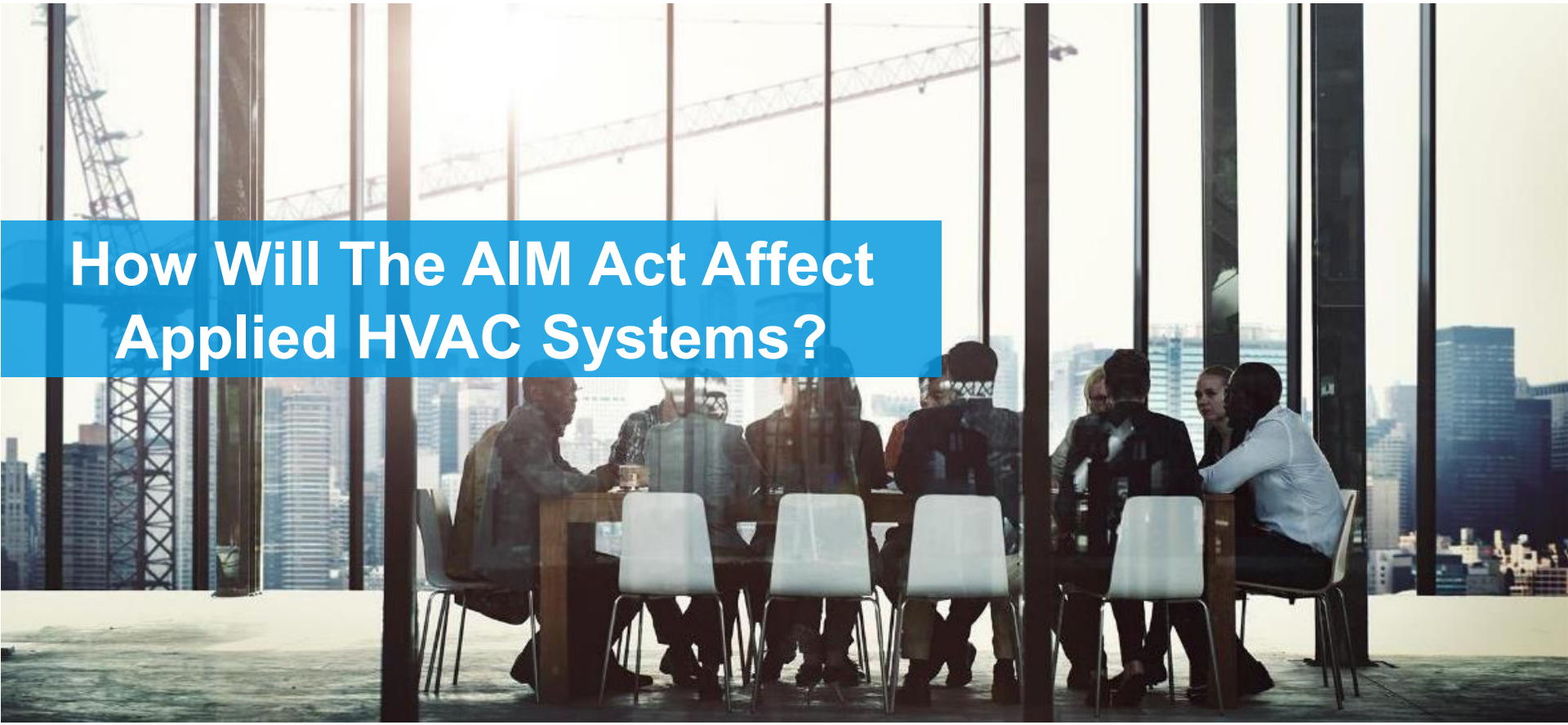
Lifetime Emissions from an HVAC System*

R-410A vs R-32 vs R-454B



*Comparison is made using the Life Cycle Climate Performance (LCCP) metric, measured in kg-CO2.eq. LCCP analysis was performed using a high efficiency HP (24+ SEER), using performance gains claimed by respective refrigerant manufacturer, for a residential sized (9000 Btu/h cooling capacity), installed in Houston, TX climate zone, with an assumed annual leakage rate of 4% and end of life refrigerant leakage of 15% with a 15 year lifetime. The heating COP and SEER were adjusted based on refrigerant characteristics and performance. The physical system size, trim charge requirements and capacity were kept consistent to ensure a like-to-like comparison.

How Will The AIM Act Affect Applied HVAC Systems?



AIM Act: Law Passed Dec. 2020 | EPA Rulemaking Status

EPA

The AIM Act gives authority to the EPA to phase down HFC refrigerants in the US

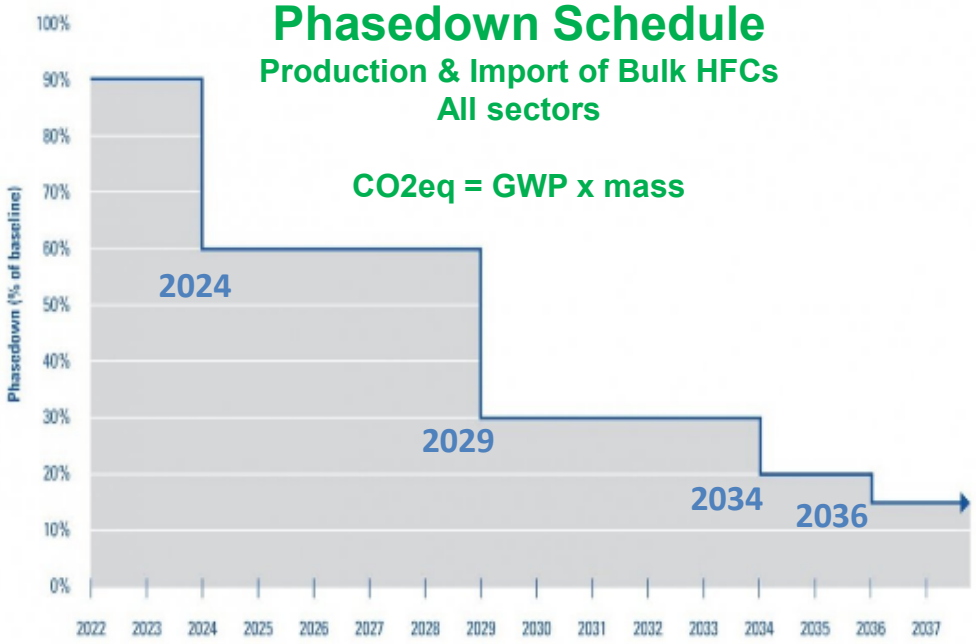
Old news: EPA must write rules to *phase down* production and consumption of bulk HFCs to 15% of baseline, maximize reclamation, minimize releases from equipment and facilitate transition through sector-based restrictions

PHASEDOWN
via CO2eq Allocations of Bulk HFCs
(Supply Side constraints)

TECHNOLOGY TRANSITIONS
Sector based controls
SNAP restrictions

REFRIGERANT MANAGEMENT
Minimizing leaks
Maximizing recovery & reclamation

AIM Act: EPA Phasedown and Allocations



CO2eq Phasedown

- Baseline over 300 million metric tonnes CO2 equivalency
- Phases down creating supply shortage of HFCs

Not refrigerant specific – not a phaseout

- All bulk virgin HFCs in all sectors
- Produced in USA and imported

Existing equipment may be serviced

- Installed base can be serviced
- Will need to transition to lower GWP refrigerants

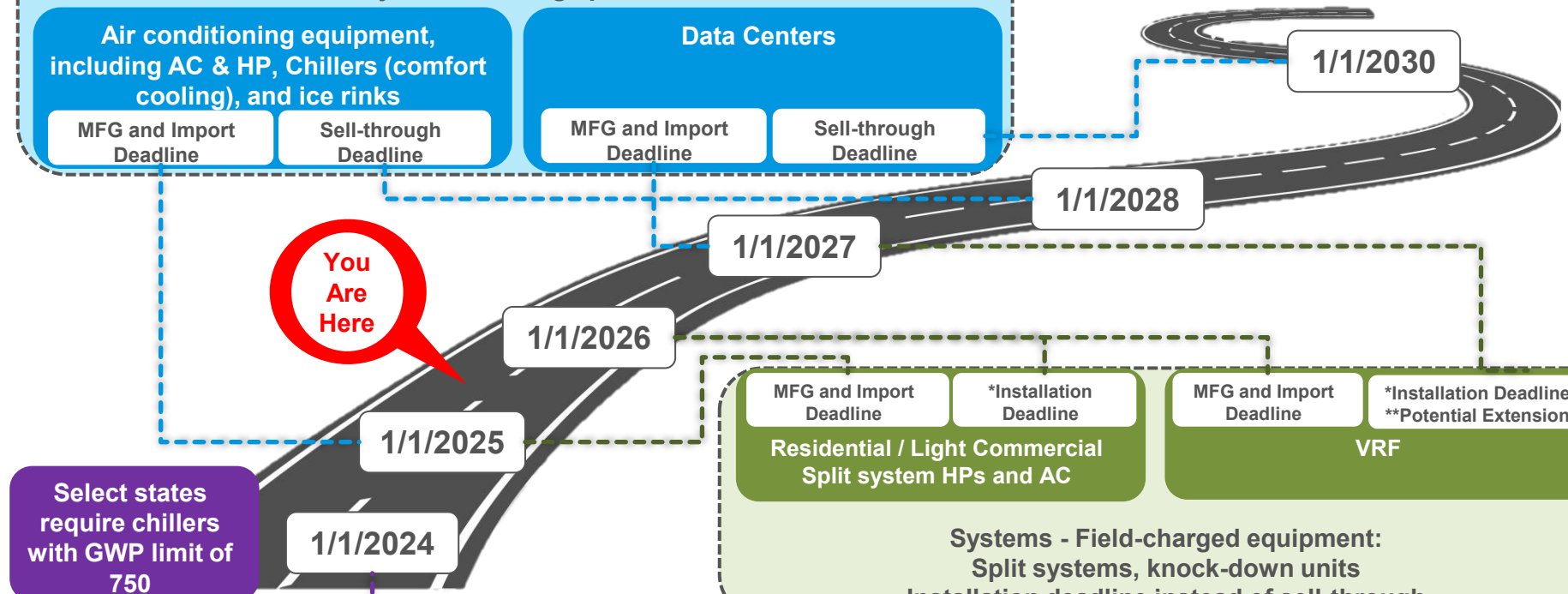
AIM Act: EPA Technology Transition

*Installation deadline means charging the refrigeration circuit to full charge

Products - Factory-Charged Equipment
Chillers, RTUs, WSHP, PTAC
3-year sell-through period

Air conditioning equipment, including AC & HP, Chillers (comfort cooling), and ice rinks
- MFG and Import Deadline
- Sell-through Deadline

Data Centers
- MFG and Import Deadline
- Sell-through Deadline



Select states require chillers with GWP limit of 750

Residential / Light Commercial Split system HPs and AC
- MFG and Import Deadline
- *Installation Deadline

VRF
- MFG and Import Deadline
- *Installation Deadline
- **Potential Extension

Systems - Field-charged equipment:
Split systems, knock-down units
Installation deadline instead of sell-through

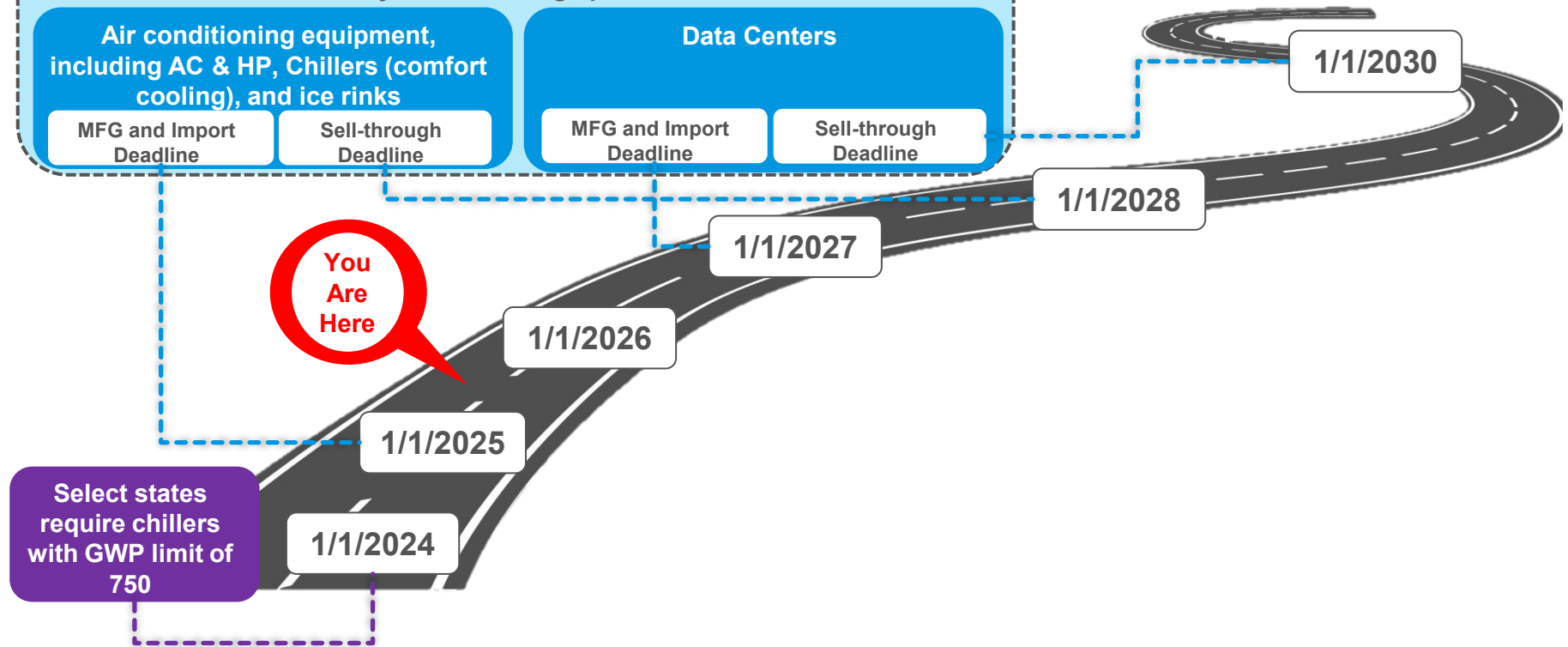
**For projects that were issued a building permit which approved the use of an HFC or blend containing an HFC in a VRF system prior to October 5, 2023, installation is allowed until January 1, 2028.

AIM Act: EPA Technology Transition

Products - Factory-Charged Equipment
Chillers, RTUs, WSHP, PTAC
3-year sell-through period

Air conditioning equipment, including AC & HP, Chillers (comfort cooling), and ice rinks		Data Centers	
MFG and Import Deadline	Sell-through Deadline	MFG and Import Deadline	Sell-through Deadline

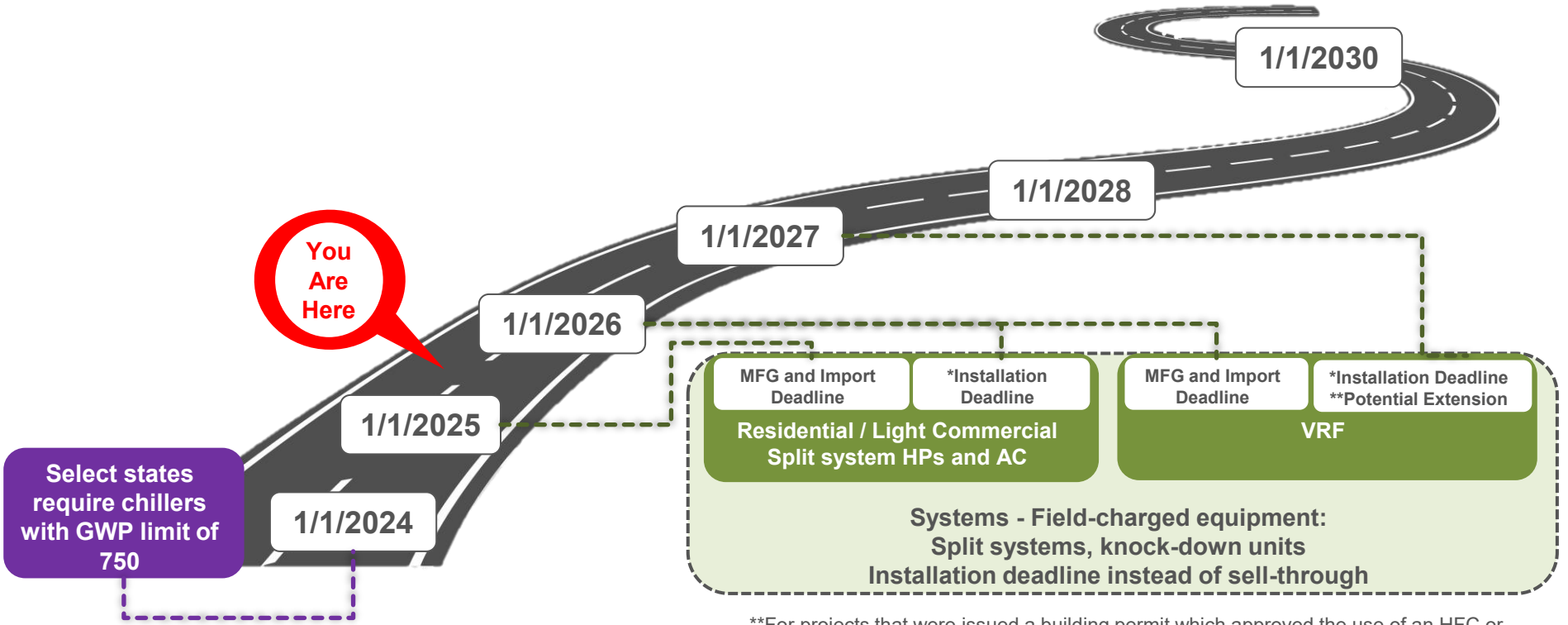
*Installation deadline means charging the refrigeration circuit to full charge



Select states require chillers with GWP limit of 750

AIM Act: EPA Technology Transition

*Installation deadline means charging the refrigeration circuit to full charge



**For projects that were issued a building permit which approved the use of an HFC or blend containing an HFC in a VRF system prior to October 5, 2023, installation is allowed until January 1, 2028.

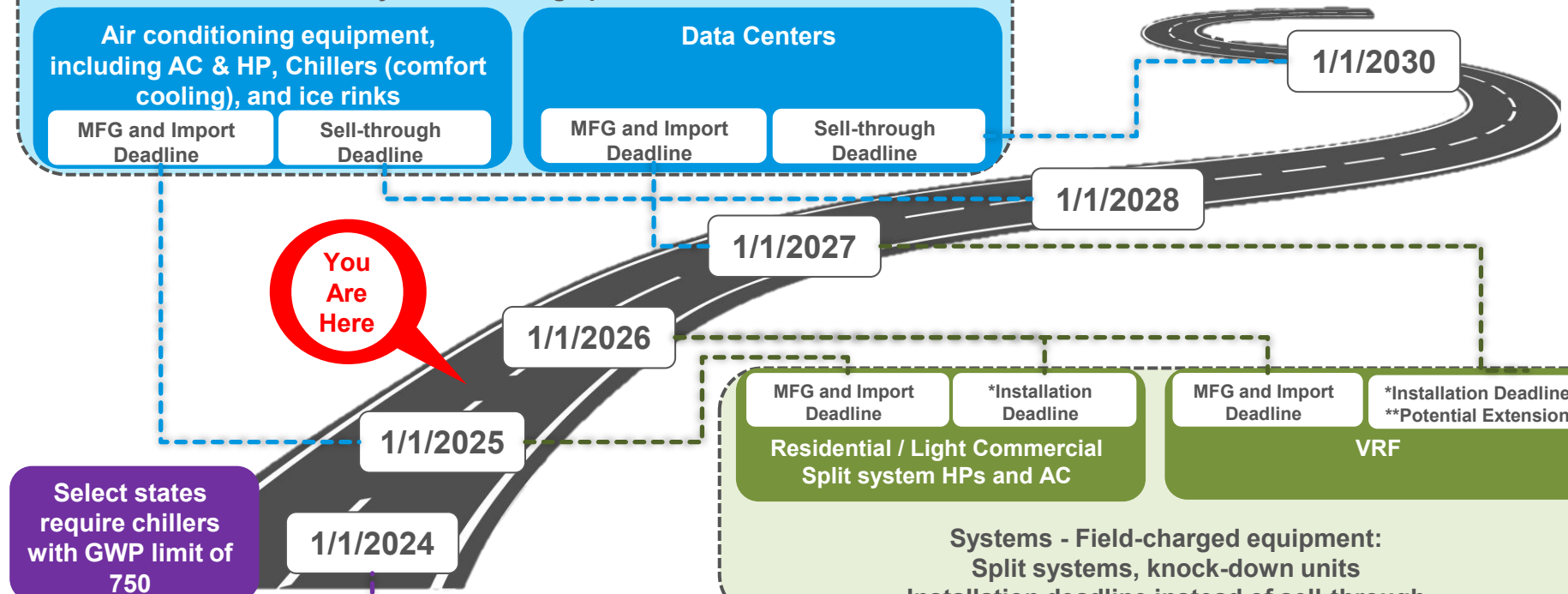
AIM Act: EPA Technology Transition

*Installation deadline means charging the refrigeration circuit to full charge

Products - Factory-Charged Equipment
Chillers, RTUs, WSHP, PTAC
3-year sell-through period

Air conditioning equipment, including AC & HP, Chillers (comfort cooling), and ice rinks
- MFG and Import Deadline
- Sell-through Deadline

Data Centers
- MFG and Import Deadline
- Sell-through Deadline



Select states require chillers with GWP limit of 750

Residential / Light Commercial Split system HPs and AC
- MFG and Import Deadline
- *Installation Deadline

VRF
- MFG and Import Deadline
- *Installation Deadline
- **Potential Extension

Systems - Field-charged equipment:
Split systems, knock-down units
Installation deadline instead of sell-through

**For projects that were issued a building permit which approved the use of an HFC or blend containing an HFC in a VRF system prior to October 5, 2023, installation is allowed until January 1, 2028.

What Will Replace R-410A?

What is Replacing R-410A?

Examples of announced products using R-32

DAIKIN Amana Heating & Air Conditioning Goodman

All products previously using R-410A

Carrier

Air-cooled scroll chillers

LENNOX

Mini-split products

SAMSUNG

Most products except ‘Hylex

LG

All split-system products

Examples of announced products using R-454B

Johnson Controls

Residential, light commercial and commercial ducted HVAC applications

Carrier

Ducted and ductless residential and light commercial applications

LENNOX

Residential HPs and AC; commercial rooftop units and ducted split systems

MITSUBISHI ELECTRIC TRANE

MITSUBISHI ELECTRIC TRANE HVAC US

Light commercial and residential heating and AC products

Why is R-32 the Right Choice to Replace R-410A?

PROVEN

- In over 280 million units installed around the world

EASY

- Top off and recharge R-32 in the field

EFFICIENT

- Up to 12% more efficient than comparable R-410A systems

AVAILABLE

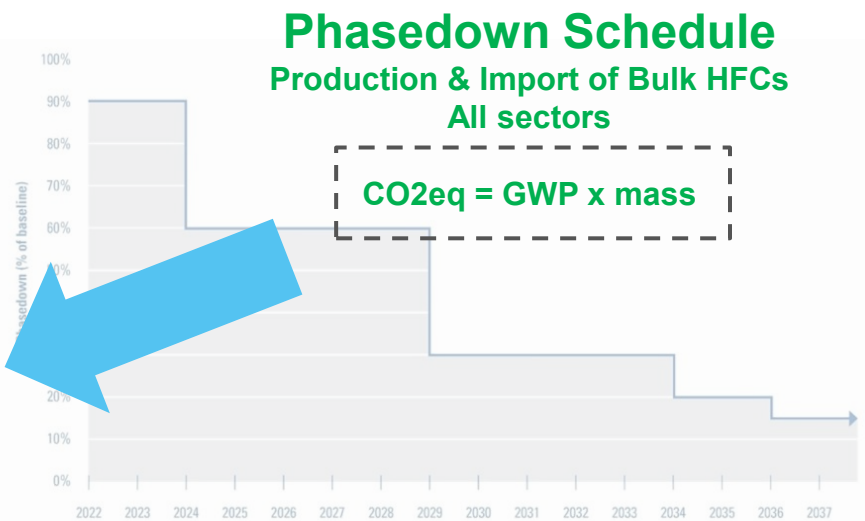
- A commodity with no active patents on the refrigerant

Is it as Simple as GWP?

Does the higher GWP of R-32 relative to R-454B mean R-32 is worse for the environment or will be phased down sooner?

- **R-32's GWP is higher than R-454B's GWP <u>but…</u>**
- Charge/ton is typically lower for R-32
- R-32 efficiency is superior
- Produced Mass * GWP is what matters
- Less mass of R-32 per ton of cooling is needed

Refrigerant	Safety Class	GWP100 (AR4)	Refrigerant charge level (R-410A baseline)	'Adjusted' GWP vs R-410A
R-410A	A1	2088	1	**2088**
R-32	A2L	675	~0.65	**~435**
R-454B	A2L	466	~0.9	**~419**

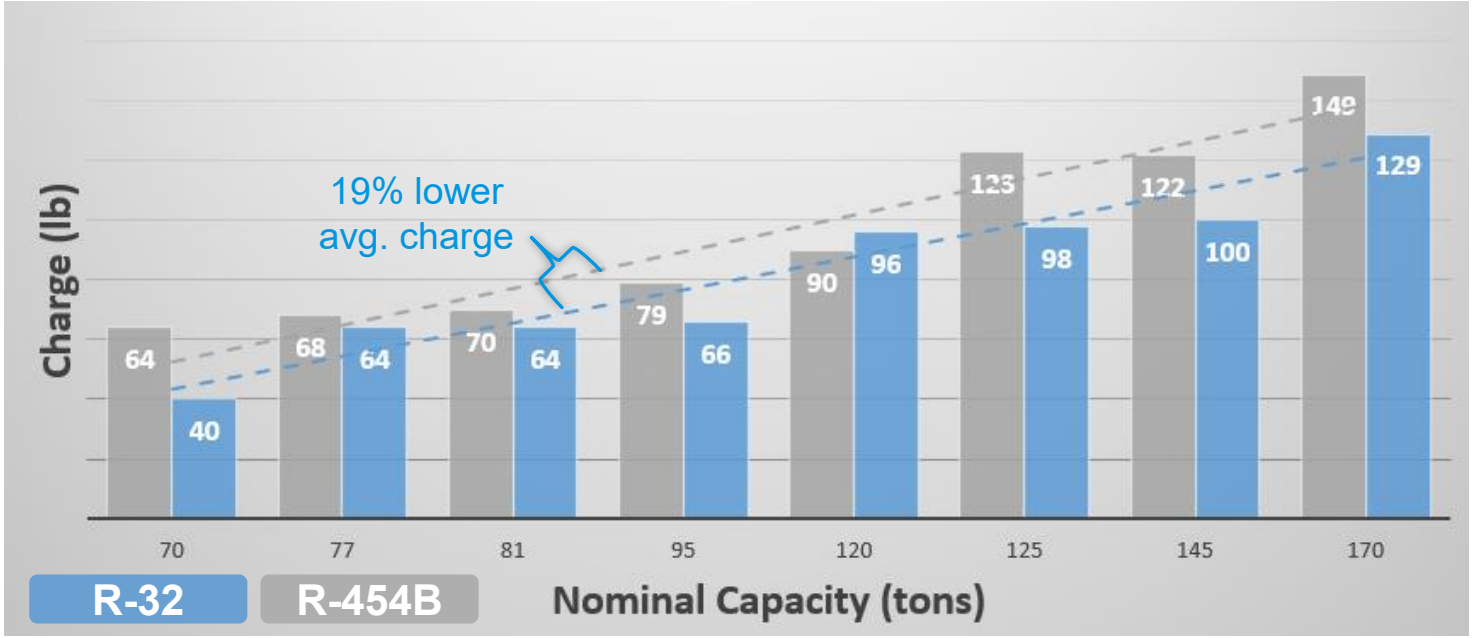


Source: US EPA

Efficiency and Refrigerant Charge

R-32 air-cooled scroll chiller vs. comparable R-454B scroll chiller

- Actual side-by-side comparisons will vary due to non-refrigerant design factors
- Tradeoff between efficiency and charge – maximizing efficiency would limit charge savings and vice-versa



R-32 Charge

19% Less

R-32 Efficiency

5% higher

Intellectual Property & Patents

R-32

- No active patents on the chemical itself
- Used in R-410A and R-454B
- Technology patents have been released to allow easier adoption

R-454B

- Proprietary and patented

R-32 TECHNOLOGY PATENT TIMELINE

2011
Patent owner offered free access to 93 technology patents for emerging countries

2015
Expanded free access worldwide

2019
Reinforced pledge to free access to technology patents filed since 2011

2021
Released 123 further technology patents

2022
Added 120 new technology patents, bringing the total to 419 to be used free of charge

The underlying concern is really cost, not patents, right…?

R-32: Common Misconceptions - Cost

Is R-32 more expensive than R-454B?

R-410A 25lb Cylinder

$6.93 / lb

R-32 20lb Cylinder

$13.47 / lb

R-454B 20lb Cylinder

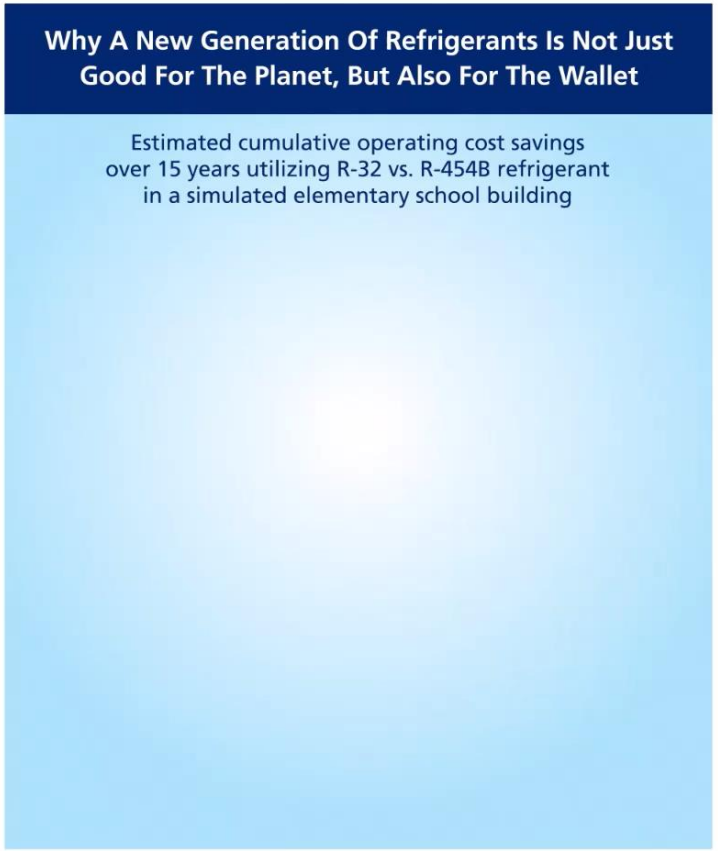
$34.60 / lb

* Price source: Daikin Parts (September 2025)

**Online retailer eRefrigerants lists R-32 for $429/20lbs and R-454B for $869 per 20lb cylinder

Efficiency Cost Savings

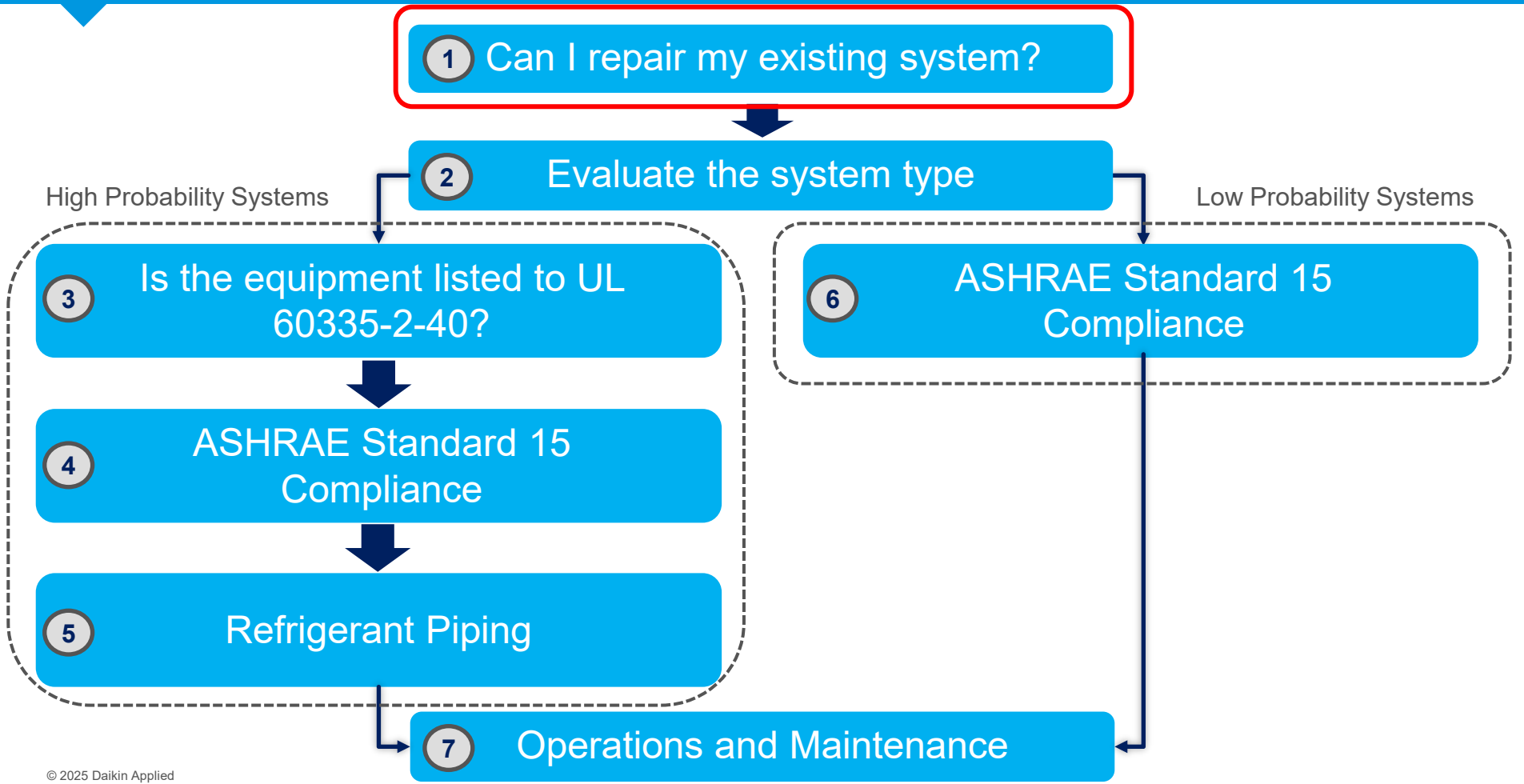
Cost saving *for an* ***R-32 air cooled chiller vs. R-454B air cooled chiller*** *range from* ***$41,000-$117,000*** *depending on the climate zone, making R-32 a highly cost-effective choice*



*The cumulative whole-building operating cost savings over a 15-year period for the Elementary School building model utilizing a commercially available R-32 air-cooled chiller compliant with ASHRAE Standard 90.1-2019, relative to a comparable R-454B chiller. A 2.67% annual utility cost escalation rate is assumed, derived from a 25-year U.S. national average reported by the U.S. Energy Information Administration (Source: US EIA).

Evaluating Existing Systems

Evaluating Existing Systems



Can I Repair My Existing System?

1

EPA Technology Transition provides regulation on what is considered service on an existing system vs a new installation subject to GWP restrictions

Components (condensing units, condensers, compressors, evaporator units, & evaporators) needed to repair existing RACHP equipment can be serviced as long as the repair doesn't consist of a new system installation and the service parts that are specified components are labeled appropriately.

To distinguish between routine maintenance and what qualifies as a new system installation, the EPA has issued specific criteria in its October 2023 Final Rule – Phasedown of Hydrofluorocarbons: Restrictions on the Use of Certain Hydrofluorocarbons under Subsection (i) of the American Innovation and Manufacturing Act of 2020 Facts Sheet.
"Specifically, the following actions, upon charging the system to full charge, are considered a new installation of a RACHP system and thus subject to the relevant HFC use restrictions:

- ***Assembling a system for the first time from used or new components;***
- ***Increasing the cooling capacity, in BTU per hour, of an existing system; or***
- ***Replacing 75 percent or more of evaporators (by number) and 100 percent of the compressor racks, condensers, and connected evaporator loads of an existing system."***

Any system modifications meeting these criteria are treated as new installations rather than maintenance and must comply with refrigerant GWP restrictions.

DAIKIN

Evaluating Existing High GWP Refrigerant DX Systems (Figure 1)

Simplifying assumptions:

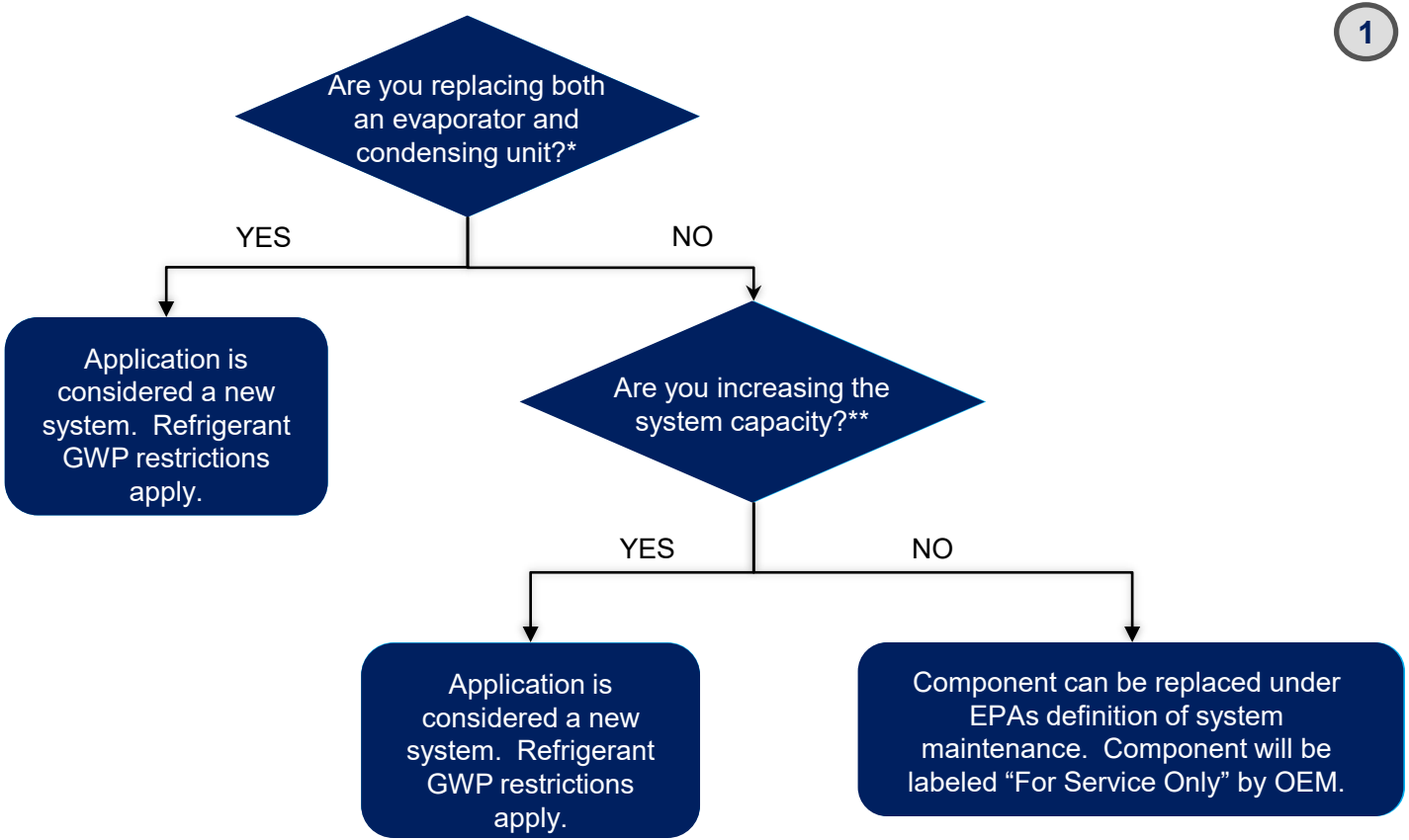
- Equipment is not a Variable Refrigerant Flow or commercial refrigerating system.
- The application is a high probability system

Figure 1: EPA defines the distinction between maintenance of a system and installation of a new system in the October 2023 Final Rule – Phasedown of Hydrofluorocarbons: Restrictions on the Use of Certain Hydrofluorocarbons under Subsection (i) of the American Innovation and Manufacturing Act of 2020 facts sheet. "Specifically, the following actions, upon charging the system to full charge, are considered a new installation of a RACHP system and thus subject to the relevant HFC use restrictions:

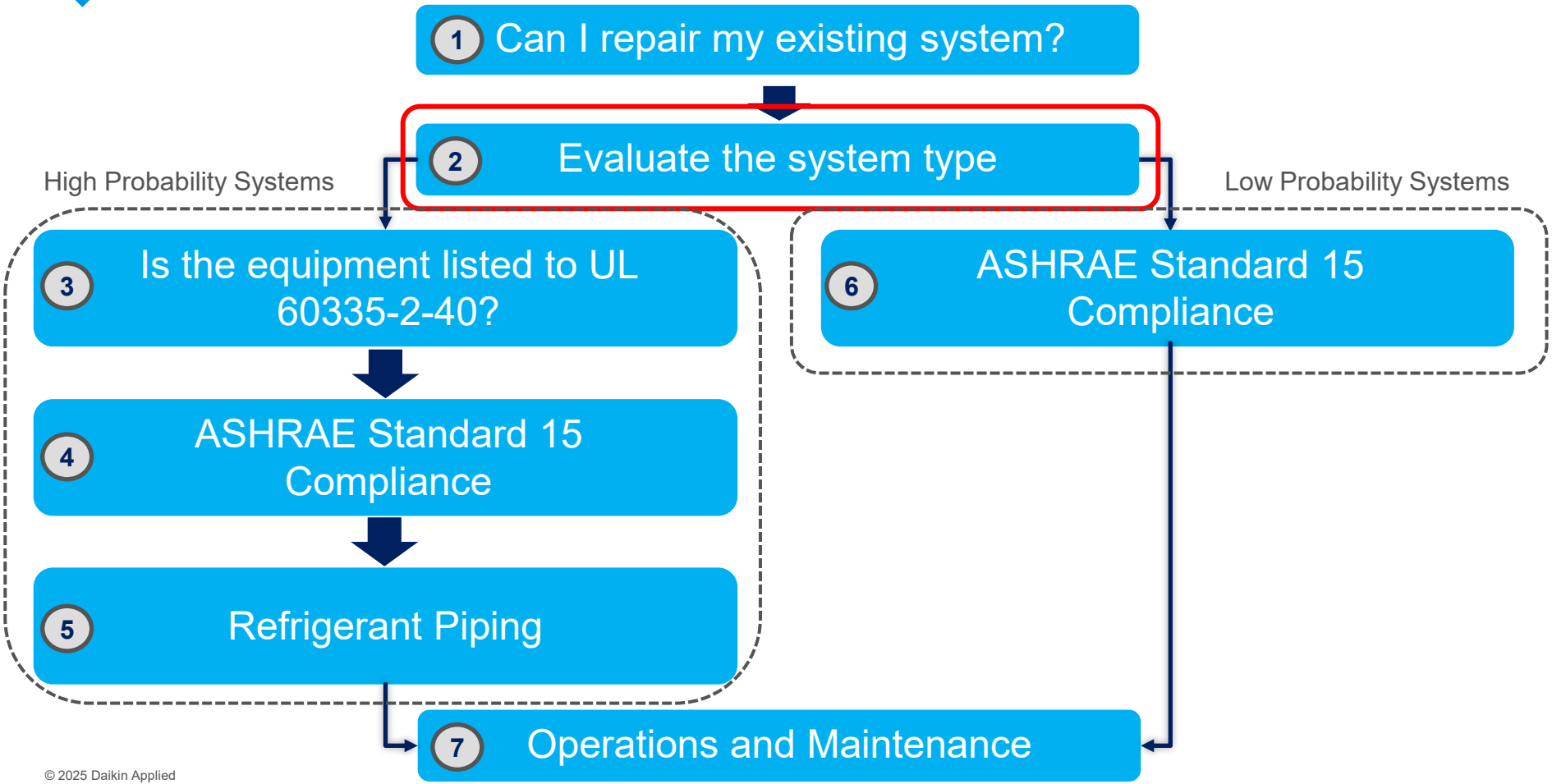
*Assembling a system for the first time from used or new components;

**Increasing the cooling capacity, in BTU per hour, of an existing system; or

Replacing 75 percent or more of evaporators (by number) and 100 percent of the compressor racks, condensers, and connected evaporator loads of an existing system."



Evaluating Existing Systems

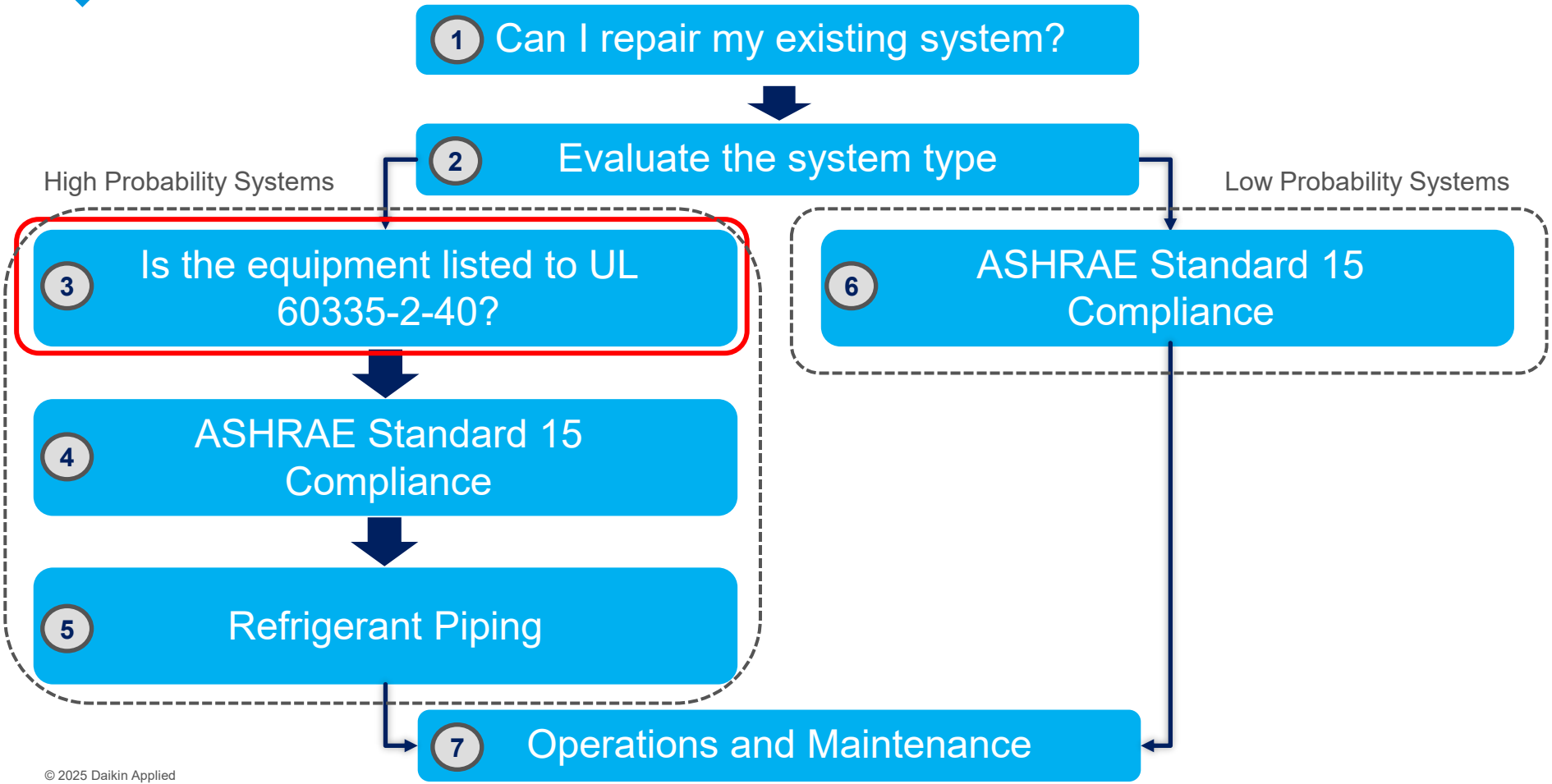


Evaluate the System Type

2

Classification	Definition	Examples
High Probability	Any system where leakage of refrigerant has **high probability to enter the occupied space**.	**Direct Systems** • Direct expansion (DX) split system • Packaged RTU • Water source heat pump • VRF • PTAC
Low Probability	Any system where leakage of refrigerant **cannot enter the occupied space**.	**Indirect closed systems** • Water-cooled chiller in machinery room • Air-cooled chiller outdoors • Water-to-water heat pump in machinery room

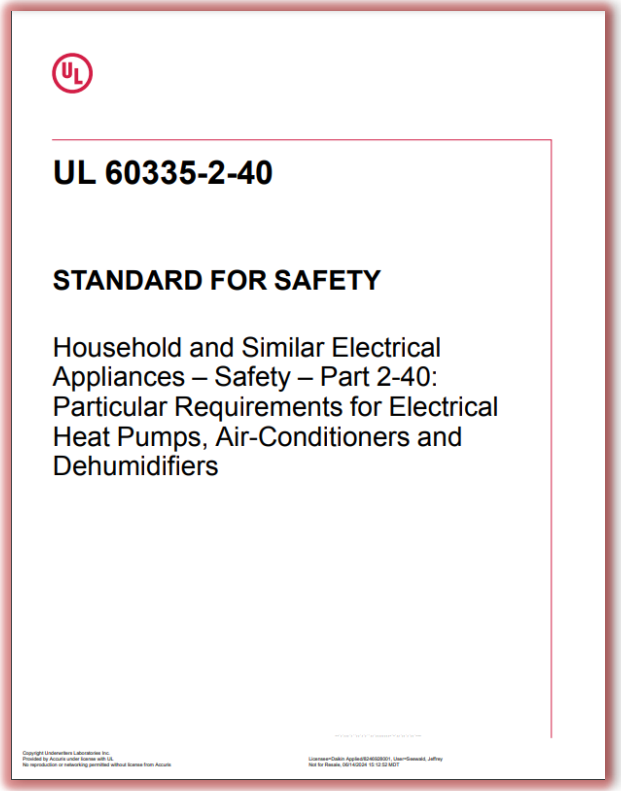
Evaluating Existing Systems



UL 60335-2-40

Product Safety Standard(s)

- Refrigeration systems **must be listed** in accordance with **UL 60335-2-40** for HVAC equipment with A2L refrigerants
- Sets safety requirements for equipment manufacturers
  - Leak testing
  - Ignition source restrictions
  - Equipment markings
- Requires certain information that **OEMs must include in IOMs**. For example:
  - Instructions for installation including refrigerant piping and SSOVs
  - Handling, installation, cleaning, servicing and disposal of refrigerant
- **Always refer to the manufacturer's IOM for specific installation requirements!**



Is the Equipment Listed to UL 60335-2-40?

Most retrofits are prohibited due to the requirement for a UL 60335-2-40 listing

The EPA prohibited retrofits in the SNAP Final Rule 23

"in new equipment designed specifically and clearly identified for the refrigerant; i.e., none of these substitutes are being listed for use as a conversion or "retrofit" refrigerant for existing equipment. "New" equipment to include a new compressor, evaporator, condenser and refrigerant tubing."

UL prohibits retrofitting equipment from A1 to A2L

Existing equipment has not been certified to UL 60335-2-40 containing the requirements for safety testing, charge sizes, ventilation requirements, identification, etc. when utilizing an A2L.

Alternatives to Retrofitting Existing Equipment with A2L Refrigerant

If a replacement isn't feasible for financial and/or technical reasons, what are alternatives?

Repair the existing system

- Existing high GWP systems can continue to operate throughout their useful life and can be serviced if following the guidelines of the EPA

Investigate a hydronic solution

- Is it technically feasible
  - Is there space in the AHU for a CHW coil
  - Is there routing in the building for CHW piping
  - Accounting for the additional static pressure drop
- Modular chiller plant or chiller
  - Is there physical space
  - Is there power available at the location
  - Is there any weight concerns (for roof installations)

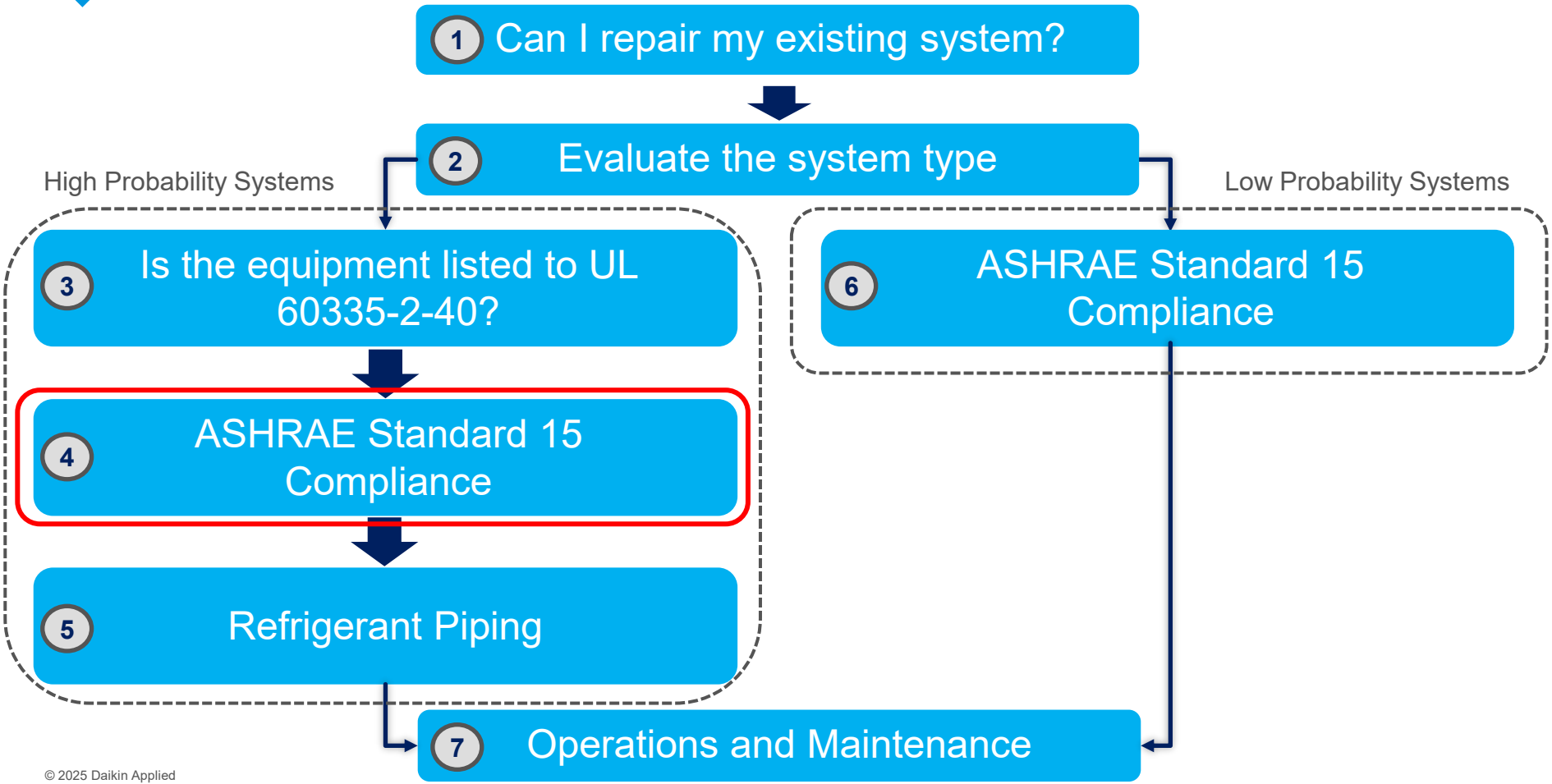
Evaluate a rooftop unit solution

- Solution for interior space restrictions
- Is there structural support for the unit

Talk to the Authority Having Jurisdictions

- Would the AHJ accept an alternative compliance path

Evaluating Existing Systems



ASHRAE Standard 15-2024

Safety Standard for Refrigeration Systems

ASHRAE Standard 15 specifies requirements for the safe design, construction, installation, and operation of refrigeration systems.

- Changes to **refrigerant use restrictions**, especially for A2Ls
- Refrigerant overpressure protection and **piping**
- Volume and **refrigerant charge limit** calculations
- **Refrigerant detector**/detection and mitigation actions
- Machinery room requirements

ASHRAE web site has errata sheet corrections and interpretations available for download.


STANDARD

ASHRAE

ANSI/ASHRAE Standard 15-2024
(Supersedes ANSI/ASHRAE Standard 15-2022)
Includes ANSI/ASHRAE addenda listed in Appendix G

Safety Standard for Refrigeration Systems

See Informative Appendix G for approval dates by ASHRAE and the American National Standards Institute.

This Standard is under continuous maintenance by a Standing Standard Project Committee (SSPC) for which the Standards Committee has established a documented program for regular publication of addenda or revisions, including procedures for timely, documented, consensus action on requests for change to any part of the Standard. Instructions for how to submit a change can be found on the ASHRAE® website (www.ashrae.org/continuous-maintenance).

The latest edition of an ASHRAE Standard may be purchased from the ASHRAE website (www.ashrae.org) or from ASHRAE Customer Service, 180 Technology Parkway, Peachtree Corners, GA 30092. E-mail: orders@ashrae.org. Fax: 678-539-2129. Telephone: 404-636-8400 (worldwide); or toll free 1-800-527-4723 (for orders in US and Canada). For reprint permission, go to www.ashrae.org/permissions.

© 2024 ASHRAE ISSN 1041-2336

PDF includes hyperlinks for convenient navigation. Click on a reference to a section, table, figure, or equation to jump to its location. Return to the previous page via the bookmark menu.

ANSI

ASHRAE Standard 15 Compliance - EDVC

- Check the **releasable refrigerant charge (M_{rel})** against the **Effective Dispersal Volume Charge (EDVC)**
  - The **smallest volume into which refrigerant disperses shall be used** when determining EDVC

$$M_{rel} \leq EDVC$$

If you don't comply initially, you can consider additional mitigation strategies

ASHRAE Standard 15 Compliance - EDVC

If you are over the EDVC, what are the alternatives?

Connected Spaces

- Natural ventilation openings may be used to increase the effective dispersal volume by connecting separate enclosed spaces with openings to allow refrigerant to disperse
- Ducted Air Distribution Systems may be used to increase the effective dispersal volume by connecting separate enclosed spaces

Mechanical Ventilation

- Can use mechanical ventilation to exhaust and dilute the refrigerant concentration in the space
- The CFM required is proportional for how far off you are from the EDVC – the higher your charge is above the EDVC the more ventilation you'll need to provide for the space

Safety Shut Off Valves (SSOV)

- Close when a leak is detected and limit the amount of refrigerant that can escape
- These controls are used to provide a smaller 'releasable refrigerant charge' to help comply with EDVC

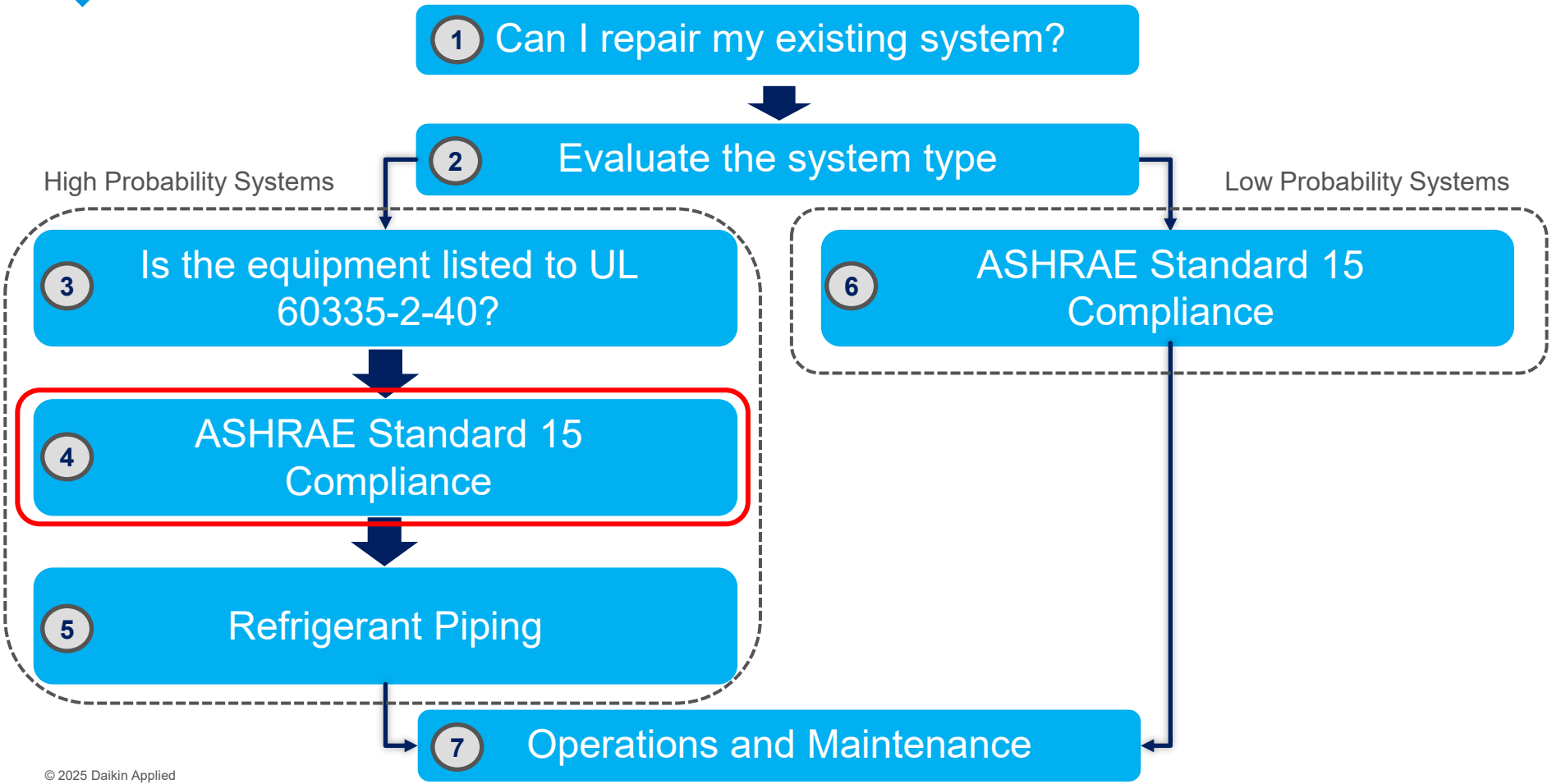
Rezone/Smaller Units

- Reduce the releasable charge by reducing the area served by the equipment

Hydronic Solution

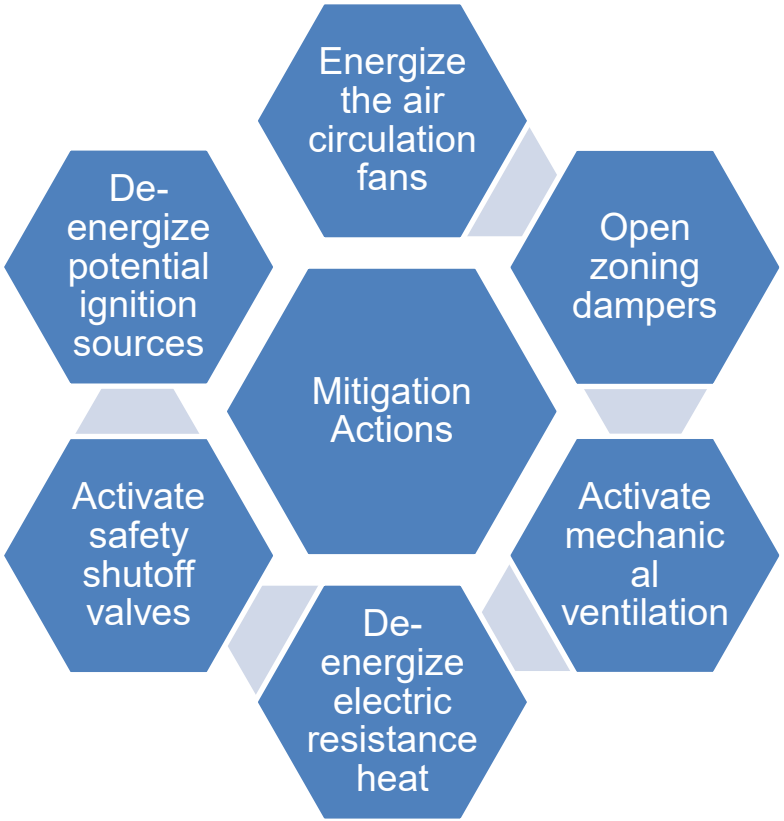
- Modular chiller plant or chiller
  - Is there physical space
  - Is there power available at the location
  - Is there any weight concerns (for roof installations
- Is it technically feasible
  - Is there space in the AHU for a CHW coil
  - Is there routing in the building for CHW piping
  - Accounting for the additional static pressure drop

Evaluating Existing Systems



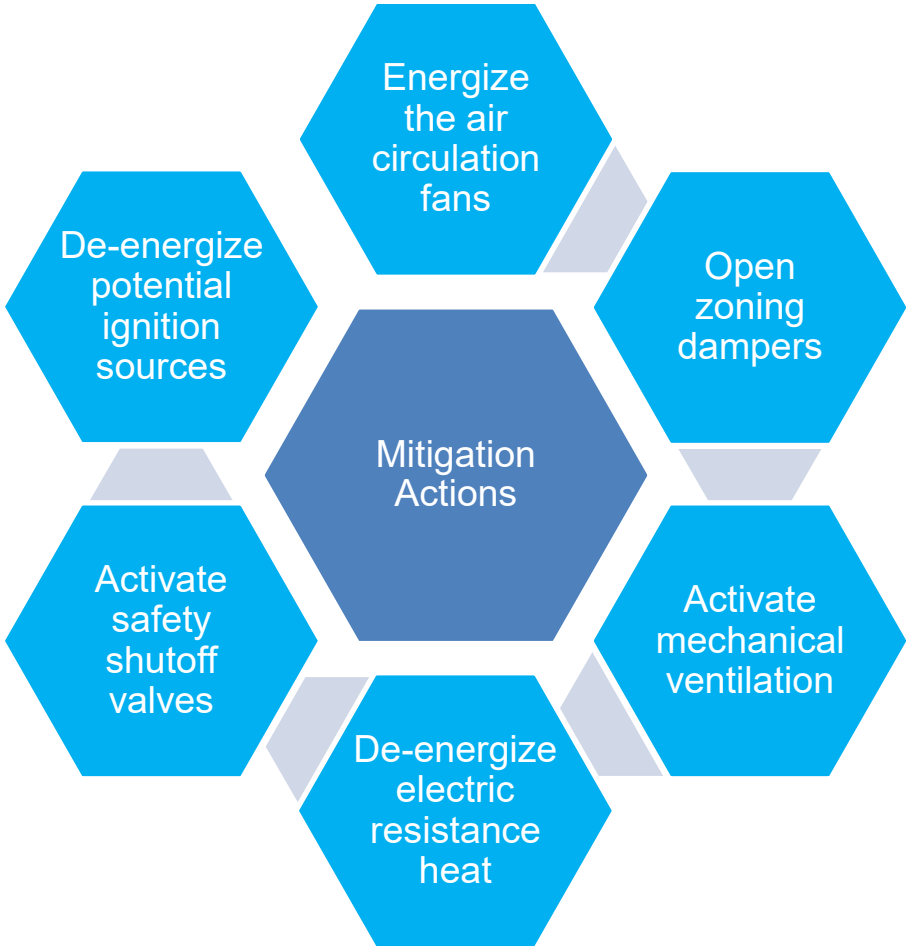
ASHRAE Standard 15 Compliance – Mitigation Actions

7.6.2.5* Mitigation Action Requirements. The following *mitigation actions shall* be completed in not more than 15 seconds after the initiation of the output signal of Section 7.6.2.4(h), and *shall* be maintained for at least five (5) minutes after the output signal has reset:



ASHRAE Standard 15 Compliance – Mitigation Actions

De-energizing ignition sources and electric resistance heat during a mitigation event requires additional controls programming



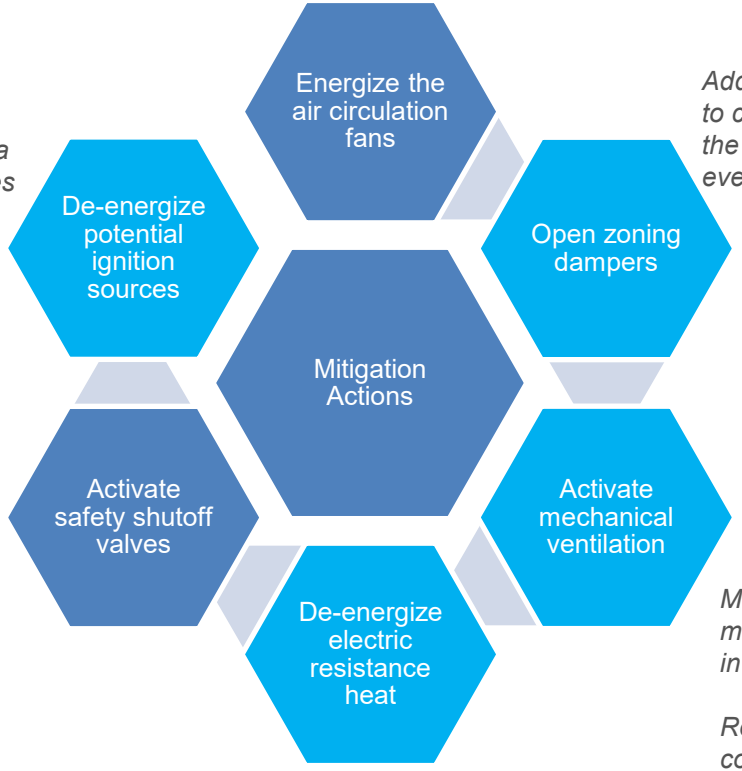
Additional controls required to control ancillary devices in the event of a mitigation event

Mechanical ventilation may not be easily installed in the building.

Requires additional controls programming

ASHRAE Standard 15 Compliance – Mitigation Actions

De-energizing ignition sources and electric resistance heat during a mitigation event requires additional controls programming



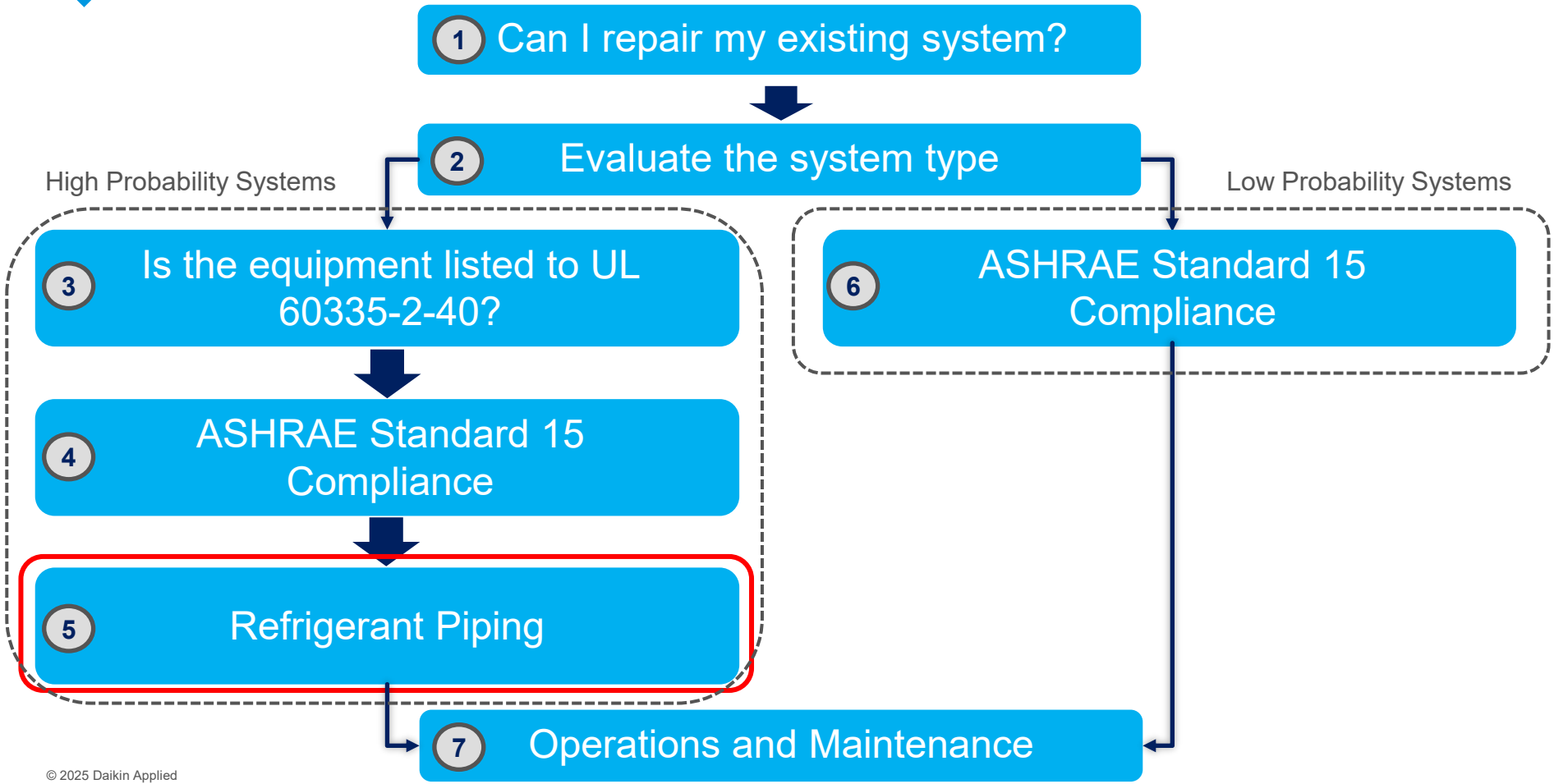
Additional controls required to control ancillary devices in the event of a mitigation event

Mechanical ventilation may not be easily installed in the building.

Requires additional controls programming

If performing mitigation actions is cost prohibitive, consider repairing the existing system or a hydronic solution

Evaluating Existing Systems

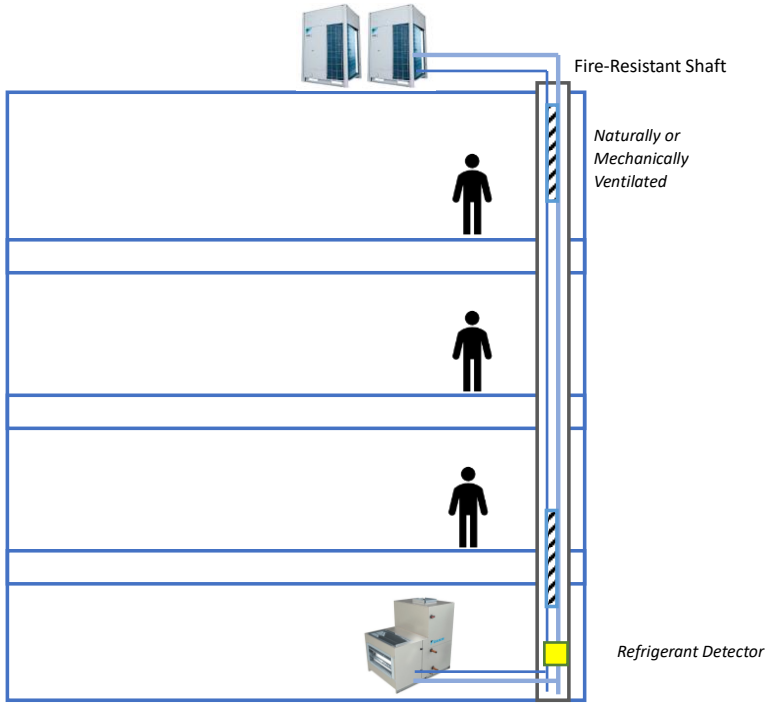


Refrigerant Piping

Are you penetrating two or more floor/ceiling assemblies?

Refrigerant piping requires special construction per ASHRAE Standard 15 Section 9.12. Some examples (there are more):

- Refrigerant piping **that penetrates two or more floor/ceiling assemblies shall be enclosed in a fire-resistance-rated shaft enclosure**.
- Refrigerant pipe shafts with systems **using only Group A2L or B2L refrigerants shall be naturally or mechanically ventilated**.



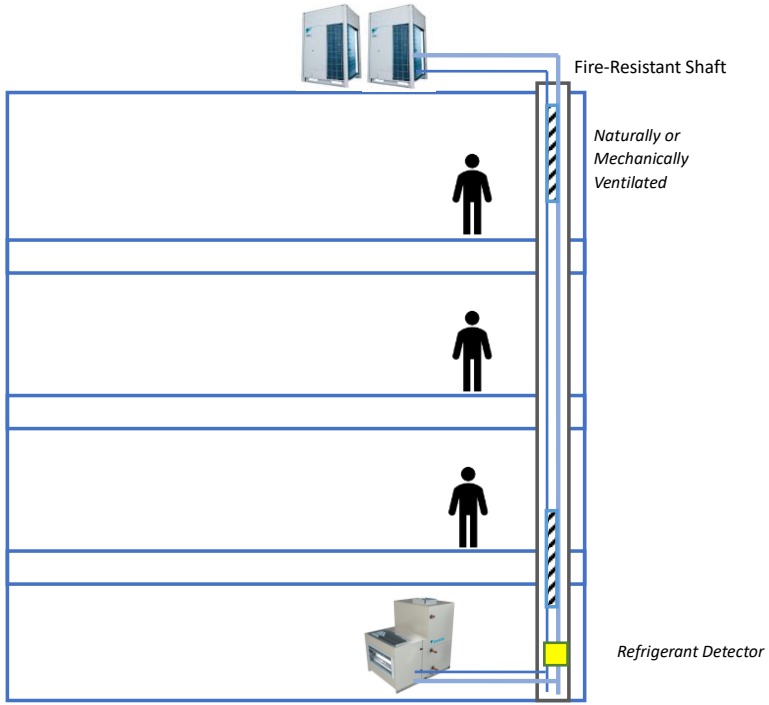
Refrigerant Piping

5

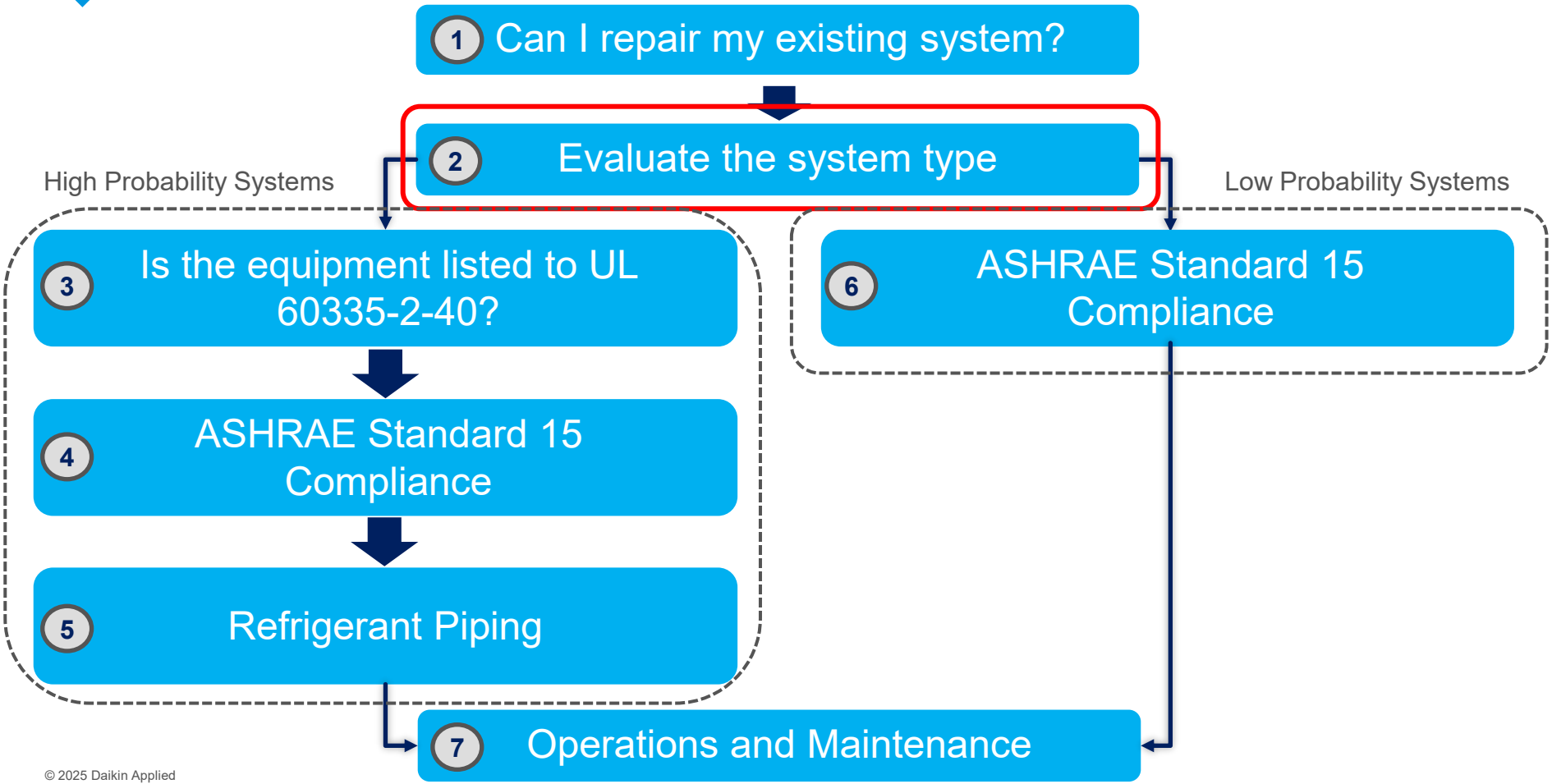
Are you penetrating two or more floor/ceiling assemblies?

What can be done if installing a ventilated shaft is not feasible?

- **Verify compliance with the shaft alternative 9.12.1.5**
  - *Four paths to comply with alternative*
    - *Utilizing water as refrigerant*
    - *Refrigerant concentration limits*
    - *Locate piping on the building exterior*
    - *Continuous piping (including joints and connections) tested in accordance with section 9.13*
- **Talk to the AHJ**
  - Use refrigerant pipe shaft analysis as support material
- **Investigate alternate pipe routing/locations**
  - Can the indoor and outdoor units be located to avoid refrigerant piping pass through 2 or more floor/ceiling assemblies
- **Investigate a hydronic solution**
  - Modular chiller plant or chiller
    - Is there physical space
    - Is there power available at the location
    - Is there any weight concerns (for roof installations
  - Is it technically feasible
    - Is there space in the equipment for a CHW coil
    - Is there routing in the building for CHW piping
    - Accounting for the additional static pressure drop



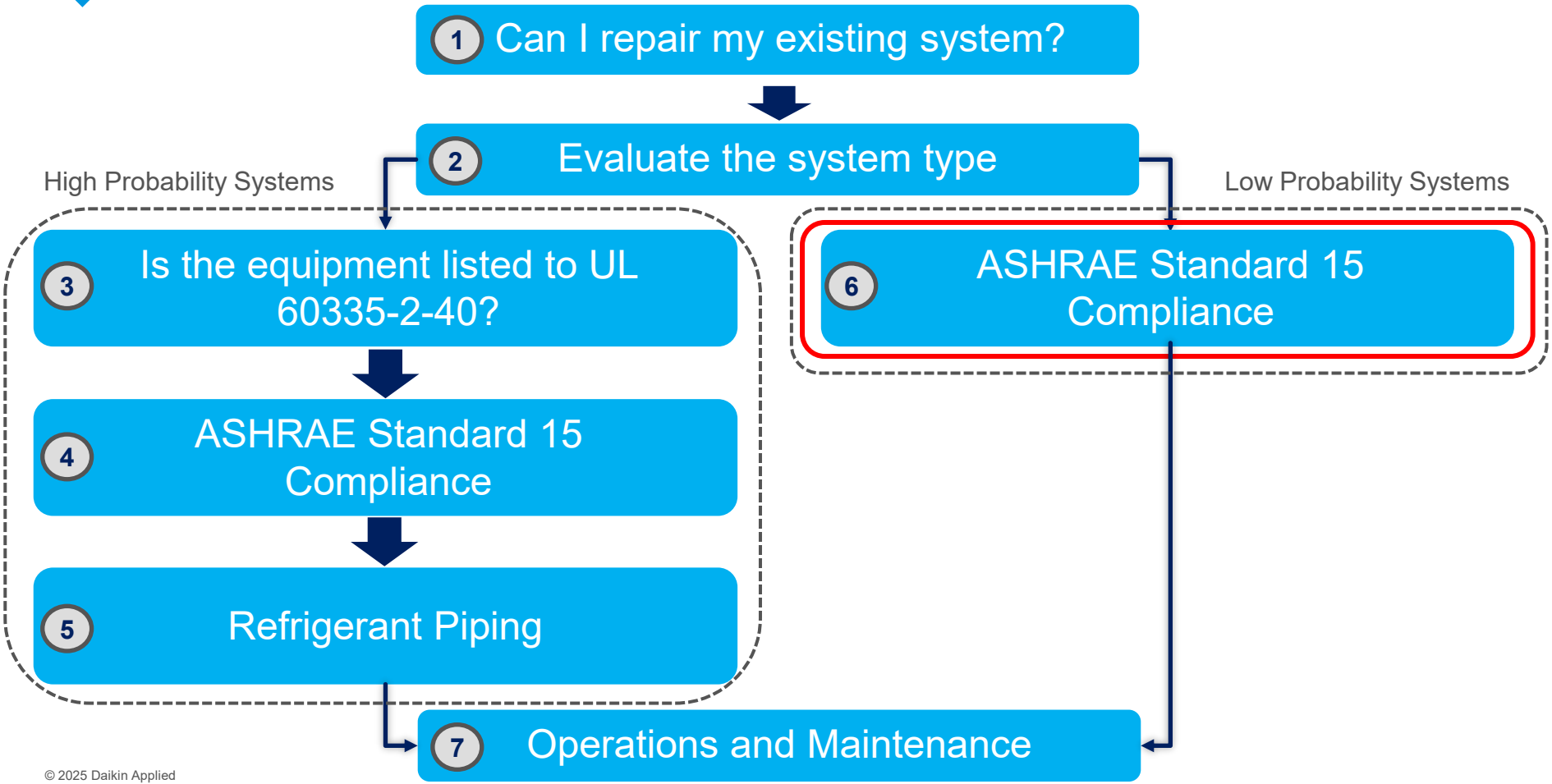
Evaluating Existing Systems



Evaluate the System Type

Classification	Definition	Examples
High Probability	Any system where leakage of refrigerant has **high probability to enter the occupied space**.	**Direct Systems** • Direct expansion (DX) split system • Packaged RTU • Water source heat pump • VRF • PTAC
Low Probability	Any system where leakage of refrigerant **cannot enter the occupied space**.	**Indirect closed systems** • Water-cooled chiller in machinery room • Air-cooled chiller outdoors • Water-to-water heat pump in machinery room

Evaluating Existing Systems



ASHRAE Standard 15 - Machinery Rooms

- **Some notable requirements:**
  - Tight fitting doors
  - Access restriction to authorized personnel
  - No airflow to or from an occupied space
  - Refrigerant detectors that can actuate an alarm and mechanical ventilation

- **8.11.1 to 8.11.7** define special requirements for A2L and B2L refrigerants.
- **Elimination or interlocks** of ignition sources
- Ventilation for 2 different alarm states
  - **Trouble** (set point ≤ OEL): respond within 300 seconds, automatic reset of alarm and ventilation is permissible
  - **Emergency** (set point ≤ RCL): respond within 15 seconds, manual reset required for alarm and ventilation, higher CFM requirements

Machinery Room Requirements

Machinery Room Requirement	A1, B1	A2, B2, A3, B3	A2L, B2L
Equipment clearances with clear head room	Required (Section 8.9.1)	Required (Section 8.9.1)	Required (Section 8.9.1)
Tight-fitting, self-closing doors	Required (Section 8.9.2)	Required (Sections 8.9.2, 8.10.b)	Required (Sections 8.9.2, 8.11.2)
Exterior doors must not open under a fire escape or stairway	Not Required	Required (Section8.10.d)	Required (Section 8.11.4)
No openings to building, tightly-sealed penetrations	Required (Section 8.9.2)	Required (Sections 8.9.2, 8.10.e)	Required (Sections 8.9.2, 8.11.5)
Gasketed ductwork/AHU panels and doors	Required (Section 8.9.3)	Required (Section 8.9.3)	Required (Section 8.9.3)
Restricted access, door signs	Required (Sections 8.9.4, 10.1.3)	Required (Sections 8.9.4, 10.1.3)	Required (Sections 8.9.4, 10.1.3)
Refrigerant detector	Required (Section 8.9.5)	Required (Section 8.9.5)	Required (Sections 8.11.8 - 8.11.10)
Mechanical ventilation to the outdoors	Required (Section 8.9.6 - 8.9.8)	Required (Sections 8.9.6- 8.9.8)	Requirement Varies (Sections 8.9.6 – 8.9.8 or 8.11.11)
No open flames or hot surfaces	Exceptions Allowed (Section 8.9.9)	No Exceptions (Section 8.10a)	Exceptions Allowed (Section 8.11.1)
Non-combustable construction (walls, floor, ceiling)	Not Required	Required (Section 8.10.c)	Required (Section 8.11.3)
Conform to NEC Class 1, Division 2	Not Required	Required (Section 8.10.f)	May Not Be Required (comply with Section 8.11.6)
Remote control for shutting down equipment	Not Required	Required (Section 8.10.g)	Required (Section 8.11.7)

ASHRAE Standard 15 - Machinery Rooms

Refrigerant Detector Set Points, Response Times, Alarms, and Ventilation Levels

Only for A2L and B2L refrigerants

Limit Value	Response Time (s)	Alarm Type	Alarm Reset Type	Ventilation Level	Ventilation Reset Type
Set point ≤ OEL	≤ 300	Trouble	Automatic	Level 1	Automatic
Set point ≤ RCL	≤ 15	Emergency	Manual	Level 2	Manual

ASHRAE Standard 15 - Machinery Rooms

Alternatives if providing required ventilation is not feasible

Smaller Equipment

- Is there space for additional equipment
- Additional compressors to maintain

Lower Pressure Refrigerant

- Is there space for a larger machine

A1 Chiller Solution

- There are A1 solutions for both screw and centrifugal machines

Modular Chiller Plant

- Is there space onsite
- Is the structure adequate for a roof installation
- Is there power and/or water available for installation location

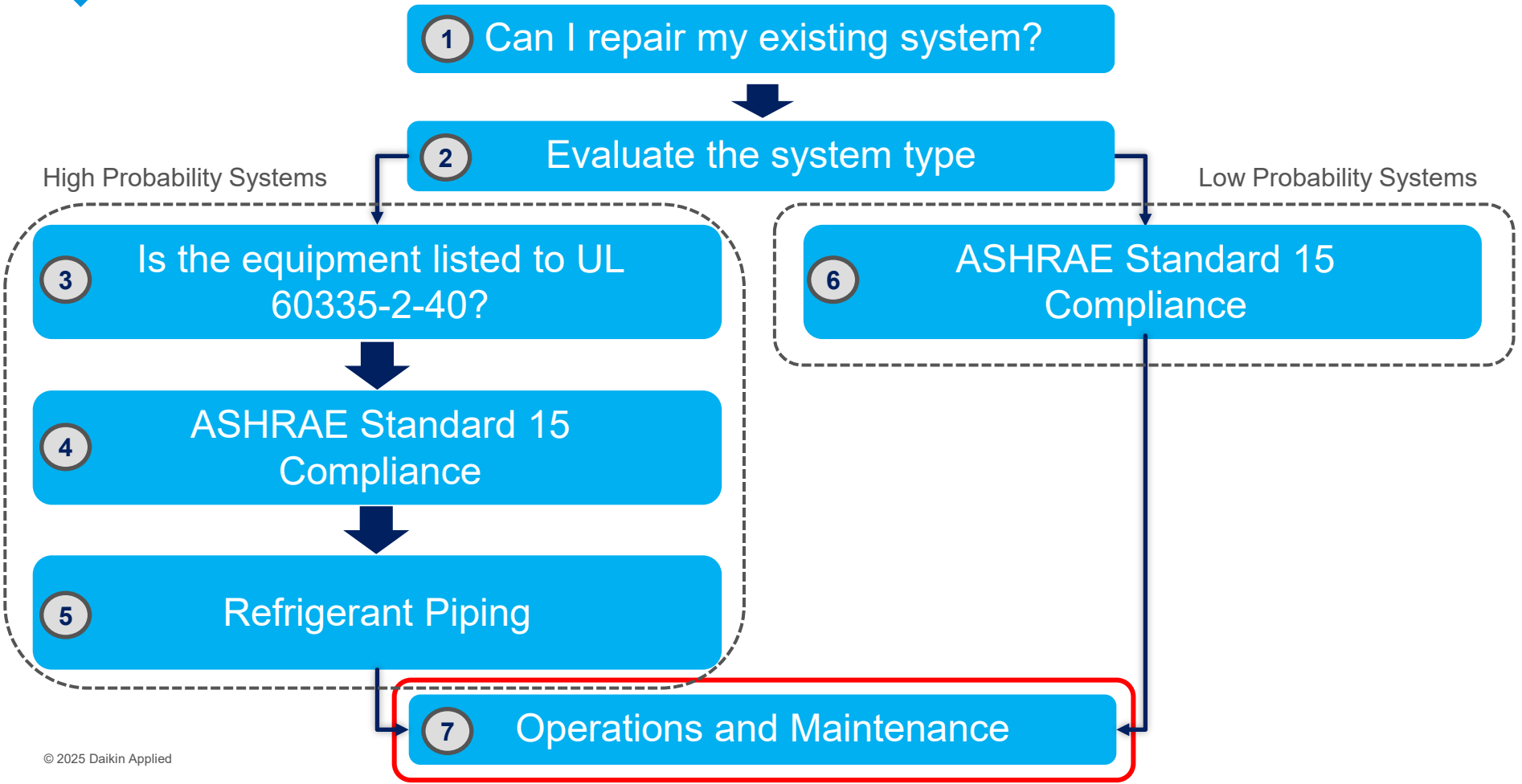
Air-Cooled Chiller

- Is there space onsite
- Is the structure adequate for a roof installation
- Is there sound level concerns
- Is there power available at installation location

Class 1 Div 2 Designation

- In accordance with NFPA 70
- Comply with ventilation requirements in section 8.9.6 and refrigerant detection requirements in section 8.11.6.2

Evaluating Existing Systems



What to consider when evaluating a potential refrigerant

Availability

- Will downtime be an issue
- Will impact maintenance costs

Serviceability

- Single component refrigerants can be charged in both the liquid and gas phases
- Will impact maintenance costs

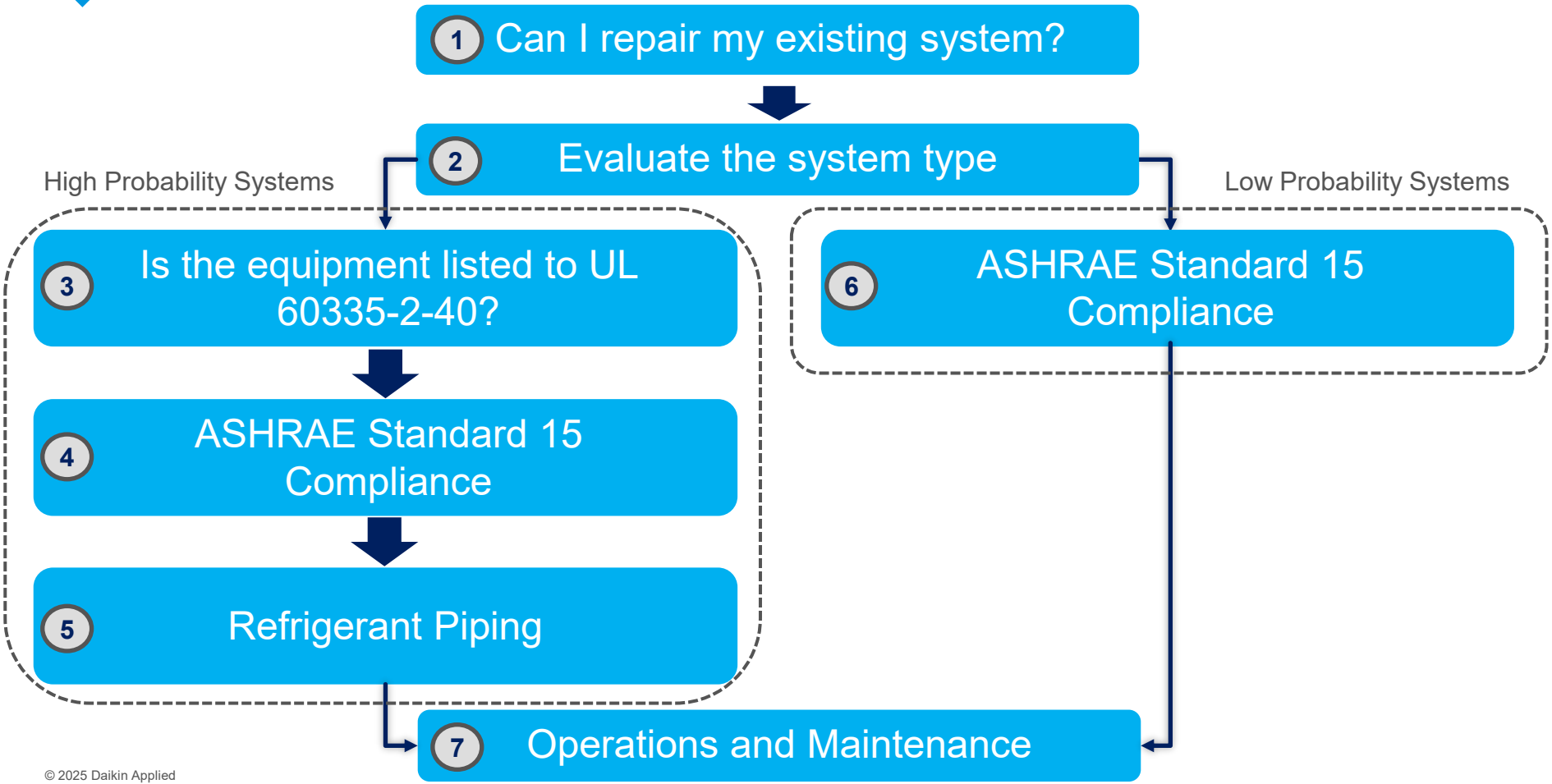
Refrigerant Cost

- Historic $/lb
- Charge needed for the equipment utilized
- Will impact up front and maintenance costs

Efficiency

- Utility savings can add up over the lifetime of the equipment

Evaluating Existing Systems



Summary

Transition is Underway	Evaluating Existing Systems
• New Low GWP refrigerants are here supporting the goal of decarbonization • Standards impacting the safe application of A2Ls • Low GWP alternatives, it isn't all about GWP	• EPAs definition of for service vs. a new system • Requirements for equipment to be listed to UL 60335-2-40 • Overcoming ASHRAE 15 speedbumps – EDVC, mitigation actions, and machinery room ventilation • Refrigerant piping shaft requirements and alternatives • Operation and maintenance considerations when evaluating refrigerants

Where Can I Learn More?

Where Can I Go for Information?

Applying A2L Refrigerants:

- A2L Refrigerant Engineering Guide
- Navigating Retrofits and Replacements for High GWP Refrigerants Engineering Guide
- Navigating Retrofits and Replacements for High GWP Refrigerants Video

Building Codes:

- ASHRAE Standards 15 and 34
- https://www.ashrae.org/technical-resources/bookstore/ashrae-refrigeration-resources
- https://www.ashrae.org/technical-resources/standards-and-guidelines/read-only-versions-of-ashrae-standards

General Guidance:

- Preparing Buildings for A2L Refrigerants
- https://www.daikinapplied.com/decarbonization/refrigerants

Where Can I Go for Information?

General Guidance:

- AHRI Webcast Series
  - An Introduction to A2L Refrigerants
  - A2L Refrigerants Webinar Series Part 2 - Updates to Standards and Model Codes
  - A2L Refrigerants Webinar Series Part 3: State and Local Codes and Available Resources
- https://www.iccsafe.org/products-and-services/i-codes/a2l-refrigerants-transition/
- https://www.ashrae.org/news/ashraejournal/ashrae-journal-podcast-episode-3
- https://www.ahrinet.org/saferefrigerant
- https://www.acca.org/education/a2l-refrigerants
- https://www.rses.org/training/
- https://www.achrnews.com/articles/153195-understanding-a2l-refrigerants
- https://www.esmagazine.com/articles/99996-a2l-refrigerants-safely-addressing-refrigerant-flammability-concerns

THANK YOU FOR YOUR TIME AND ATTENTION

For more information, contact:

Sharon Haeg
Sharon.Haeg@daikinapplied.com