2.5

Overview of AHRI Risk Assessment Studies for A2L Refrigerants

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Overview

- Introduction
- Equipment type
- Methodology
- Results
- Conclusions

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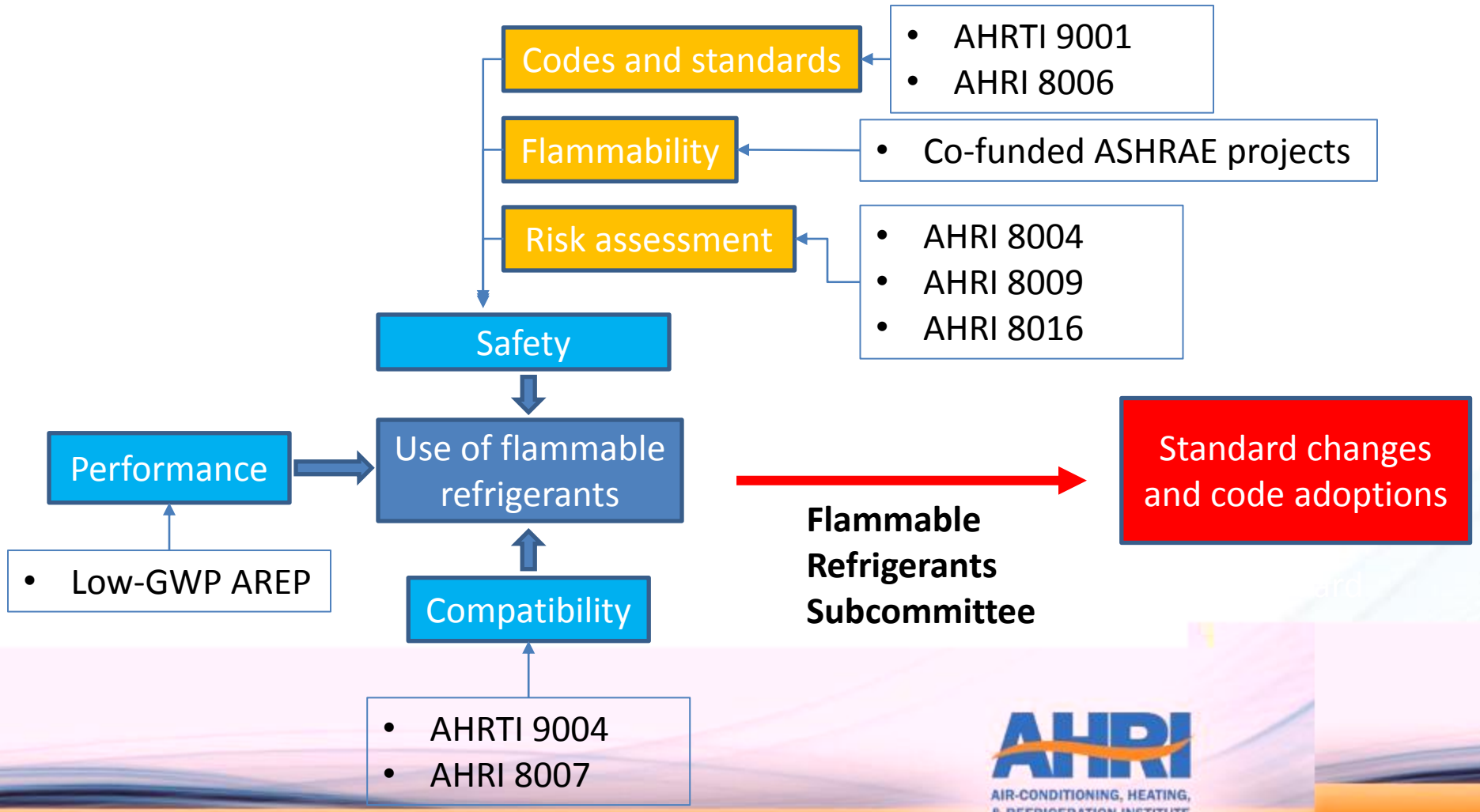
AHRI Research Activities on Flammable Refrigerants



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Introduction

- **Risk assessment completed/ongoing:**
  - Residential heat pumps
  - Commercial refrigeration products
  - Rooftop units
- **Refrigerants**
  - R-32
  - R-1234yf
  - R-1234ze

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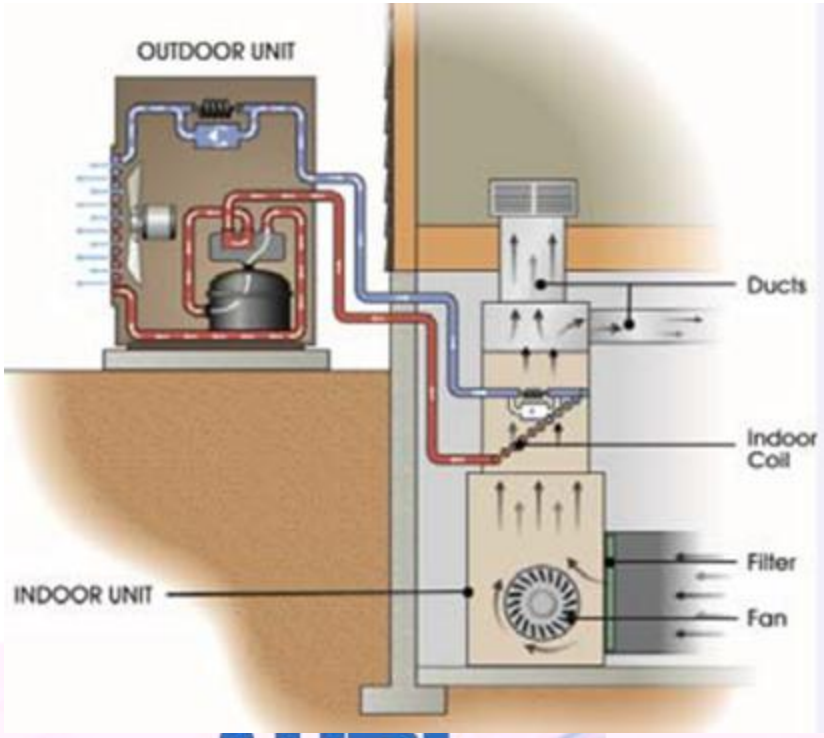
Equipment

- **Residential heat pumps**
  - ducted split heat pumps

Outdoor Unit	Indoor Unit (with blower on/off)
Outside	Basement
	Garage
	Attic
	Utility closet



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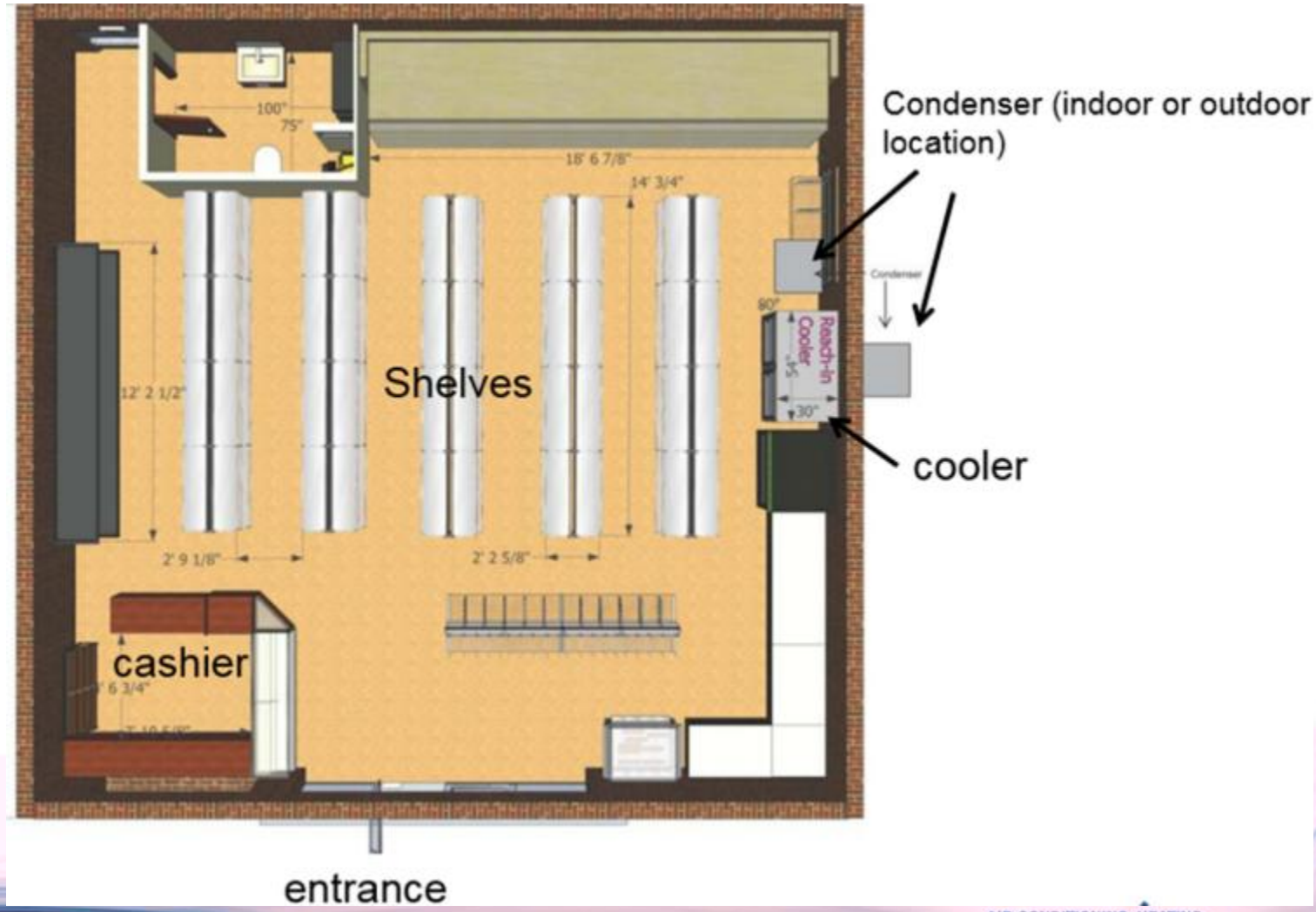
Equipment

➢ Commercial refrigeration product

Leak Type/Equipment	Location
Large (rupture) and small (corrosion-induced) leaks in a self-contained reach-in cooler located in:	A convenience store. A kitchen in a small restaurant. A lunch counter.
Large (rupture) and small (corrosion-induced) leaks in a self-contained walk-in cooler located in:	A convenience store. A kitchen in a small restaurant.
Large (rupture) and small (corrosion-induced) leaks in a single condensing unit located outdoors and connected to:	A walk-in cooler in a convenience store. A walk-in cooler associated with a kitchen in a small restaurant.

Convenience Store



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Small Restaurant/Lunch Counter

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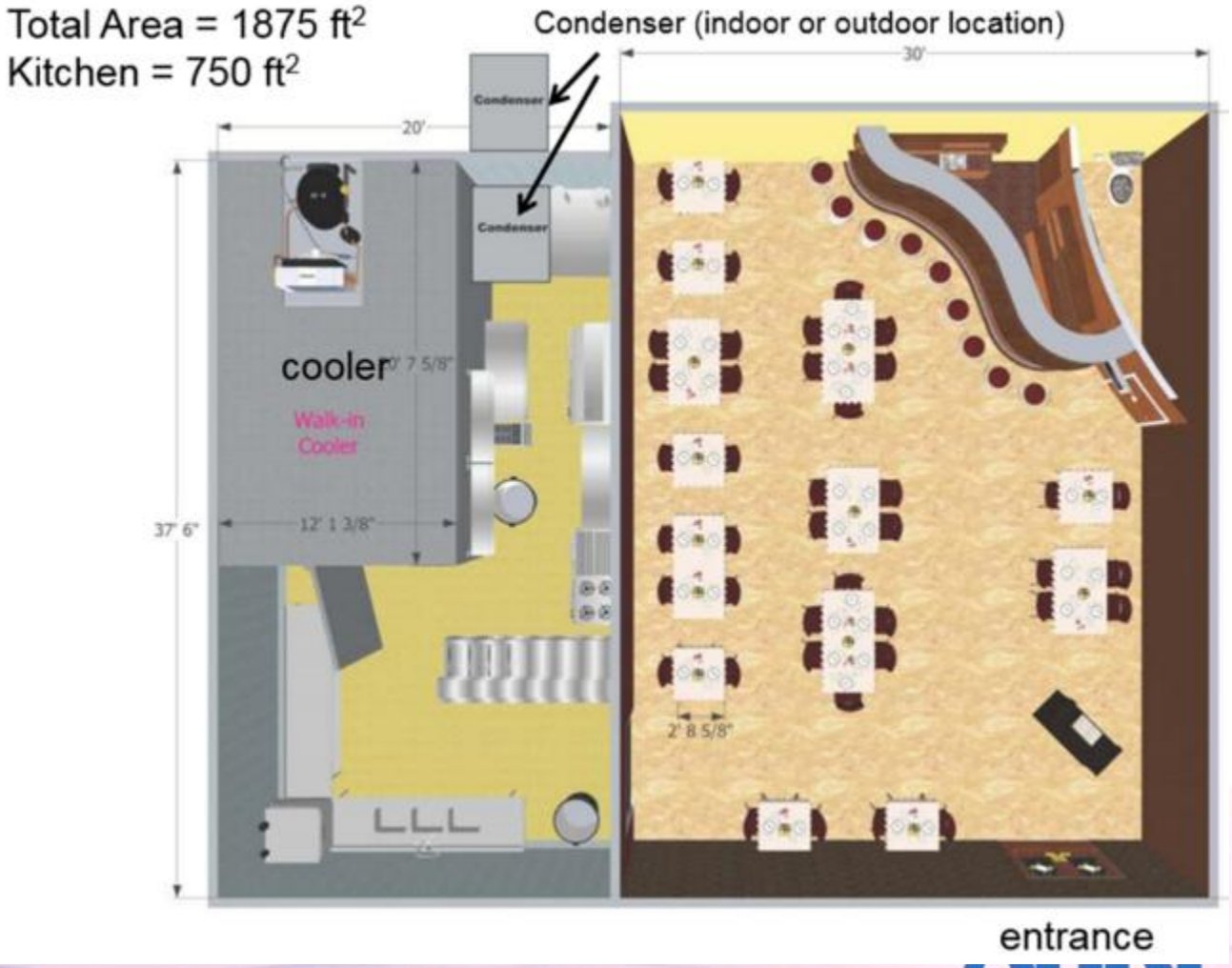
Commercial Kitchen



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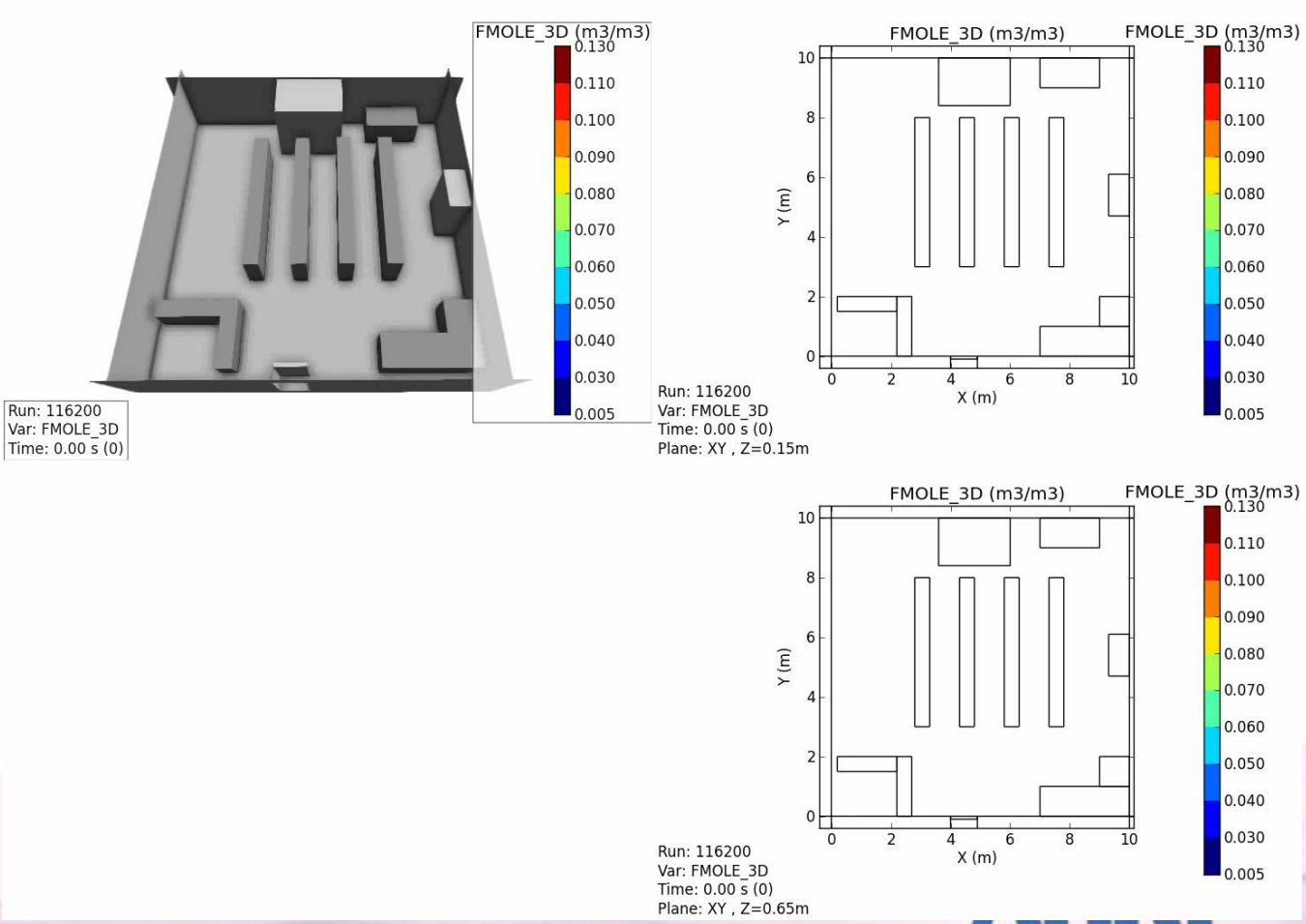
CFD Simulation



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CFD Results

Table 3.4 Summary of Results of CFD Modeling for R-32

Scenario (Leak Rate)	Time LFL Exceeded (s)	Maximum Conc. at Monitoring Points (%)	Time LFL Exceeded (s)	Comment
Basic Scenarios				
Restaurant Kitchen	0	3.32	0	Concentrations well below the LFL in all locations.
Lunch Counter	0	0.41	0	Concentrations well below the LFL in all locations.
Convenience Store	0	0.63	0	Concentrations well below the LFL in all locations.
Exploratory Scenarios				
Restaurant Kitchen (Walk-in Cooler Door Closed)	0	7.12	0	Concentrations well below the LFL in all locations.

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CFD Results

Table 3.5 Summary of Results of CFD Modeling for R-1234ze(E)

Scenario (Leak Rate)	Time LFL Exceeded (s)	Maximum Conc. at Monitoring Points (%)	Time LFL Exceeded (s)	Comment
Basic Scenarios				
Restaurant Kitchen	0	1.43	0	Concentrations well below the LFL in all locations.
Lunch Counter	0	0.31	0	Concentrations well below the LFL in all locations.
Convenience Store	0	0.30	0	Concentrations well below the LFL in all locations.
Exploratory Scenarios				
Restaurant Kitchen (Walk-in Cooler Door Closed)	0	3.38	0	Concentrations well below the LFL in all locations.

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Experimental Study/Concentration Measurements

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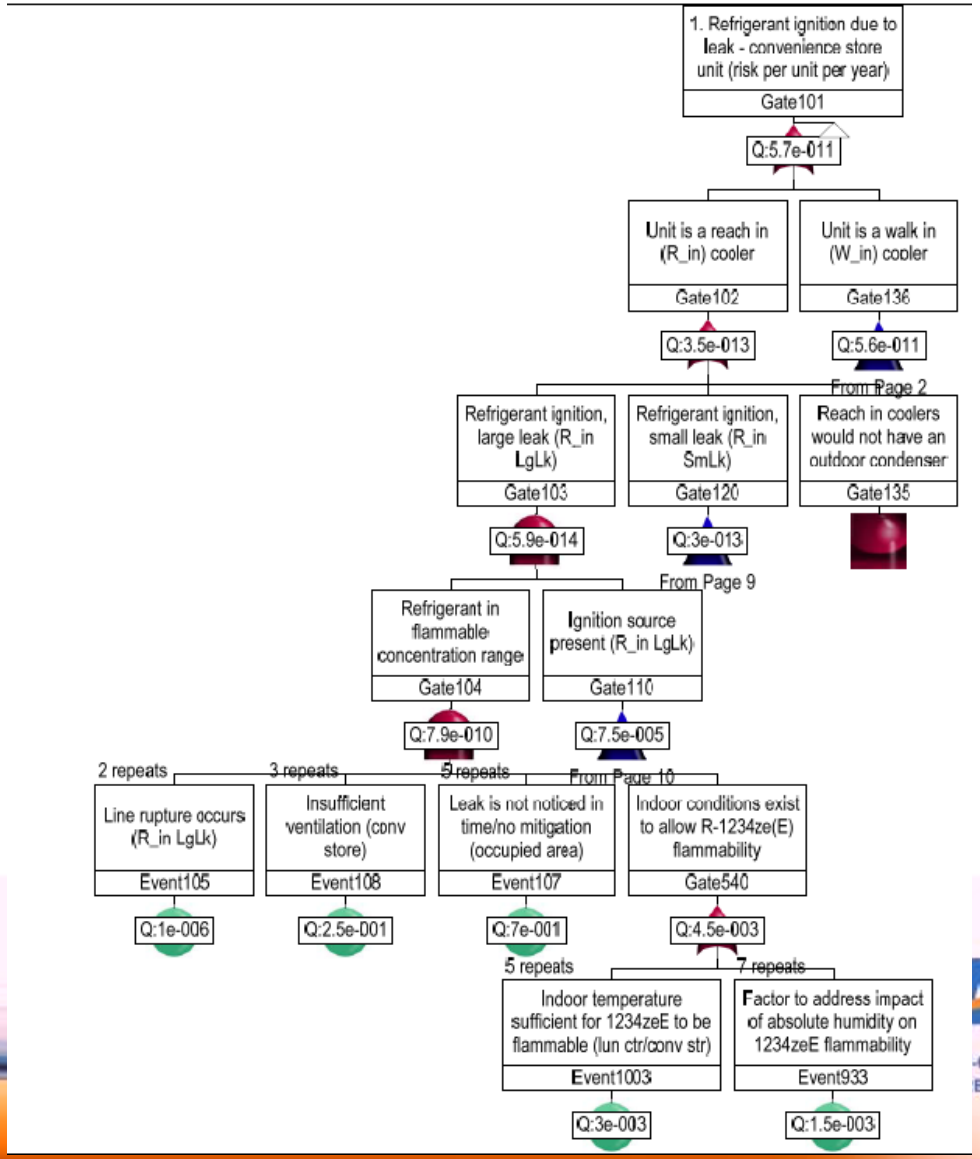
Fault Tree Analysis



FTA Results

Table 4.1 Results of FTA

Scenario	Fault Tree	Risk of Refrigerant Ignition (Events per Unit per Year)		
		R-32	R-1234ze(E)	R-1234yf
Convenience Store Scenario	1	1×10^{-9}	6×10^{-11}	2×10^{-10}
Inside event[1]				
Reach-in		8×10^{-11}	4×10^{-13}	8×10^{-11}
Walk-in		6×10^{-11}	3×10^{-13}	6×10^{-11}
Outside event[2]		1×10^{-9}	6×10^{-11}	6×10^{-11}
Lunch Counter Scenario[3]	2	2×10^{-10}	7×10^{-13}	2×10^{-10}
Restaurant Kitchen Scenario	3	3×10^{-9}	3×10^{-10}	2×10^{-9}
Inside event				
Reach-in		6×10^{-10}	2×10^{-10}	6×10^{-10}
Walk-in		9×10^{-10}	4×10^{-10}	9×10^{-10}
Outside event		1×10^{-9}	6×10^{-11}	6×10^{-11}
Repair Scenario	R	1×10^{-11}	2×10^{-13}	4×10^{-12}

Ongoing project

➢ Rooftop Unit

Equipment Types	Building Types	Conditions
25T Roof Mount	Office	The FTA will assess risk under the following three conditions: 1. Installation 2. Servicing 3. Operation
5T Ground Mount		
15T Roof Mount	Commercial Kitchen	

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Thank you for your attention!

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