
Technical Workshop on Hydrocarbon Refrigerants; Safety and Application

Part 2: Thermotar product development

8th and 9th February 2018

Barranquilla, Colombia

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Part 2: Thermotar product development

Overview of refrigerant choices

Rooftop



Ducted split



Model number	EPAC-036-	EPAC-048-	EPAC-060-	CV036-	CV048-	CV060-
Nominal capacity	10.5 kW	14 kW	17.5 kW	10.5 kW	14 kW	17.5 kW
R22 charge	1300 kg	1775 kg	2210 kg	1360 kg	1815 kg	2265 kg

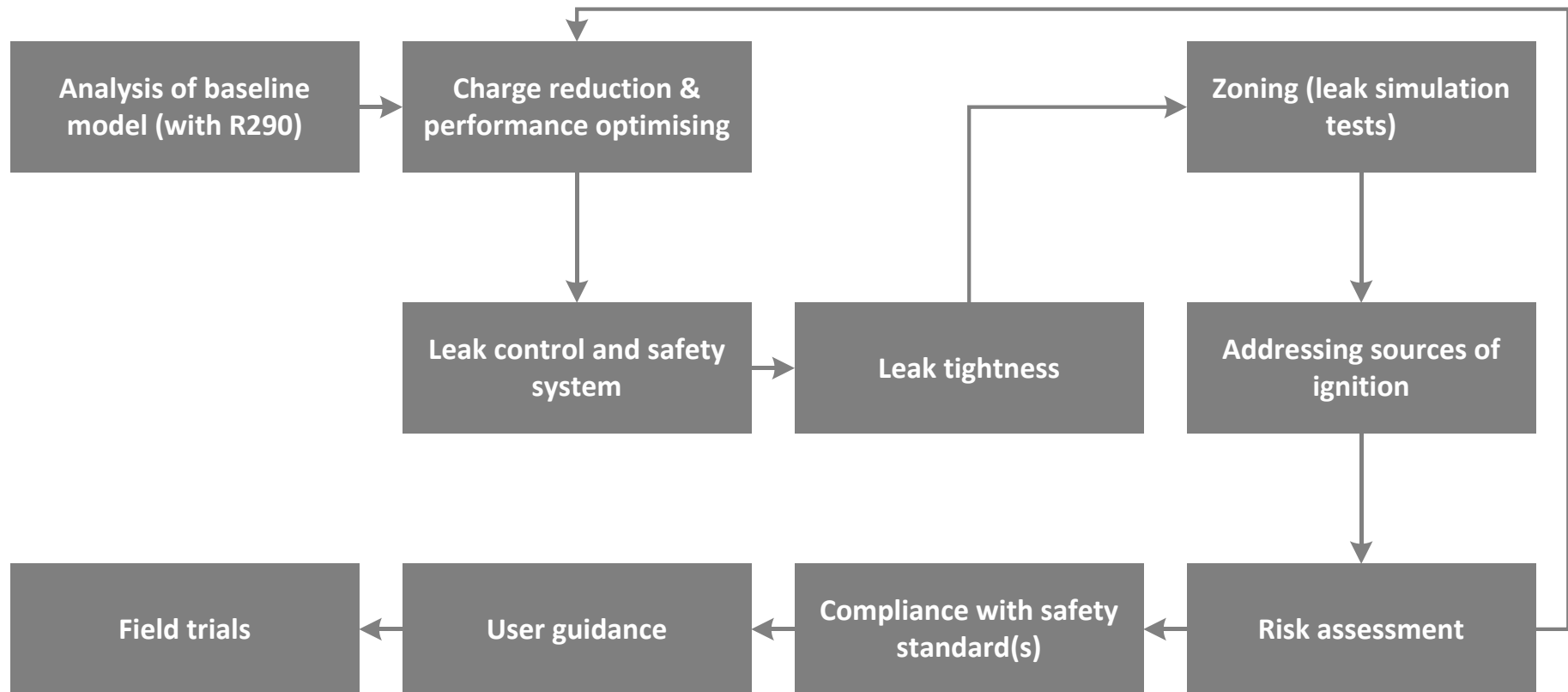
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Approach for safe product











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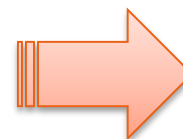
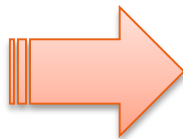
Development sequence



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Charge reduction

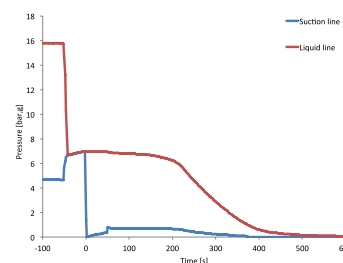
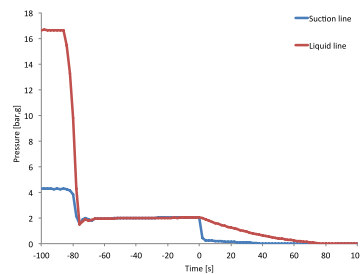
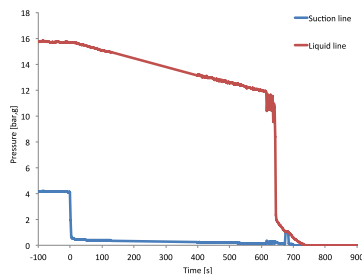
	Rooftop			Ducted split		
						
R22 charge	1300 g	1775 g	2210 g	1360 g	1815 g	2265 g
						
R290 charge	590 g	800 g	1000 g	610 g	820 g	1020 g



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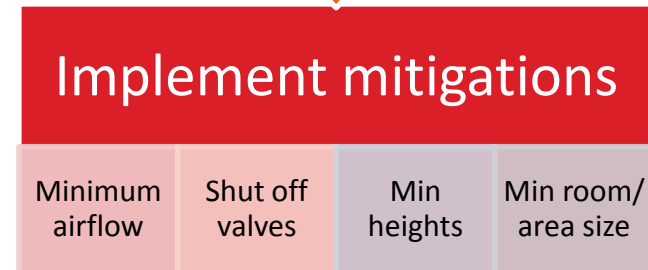
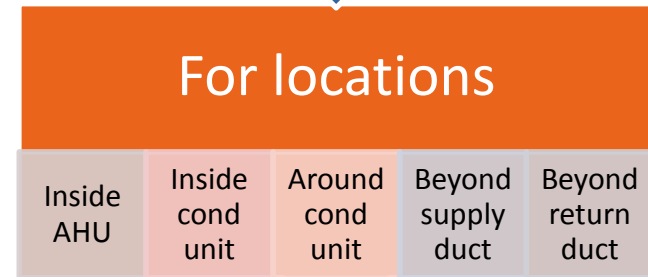
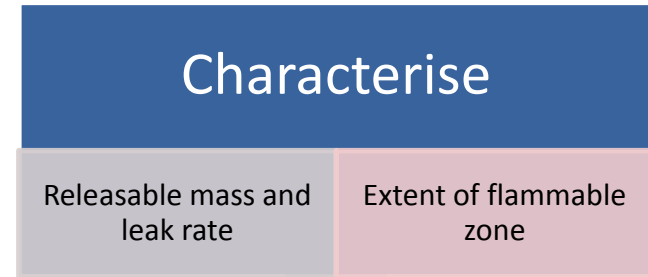
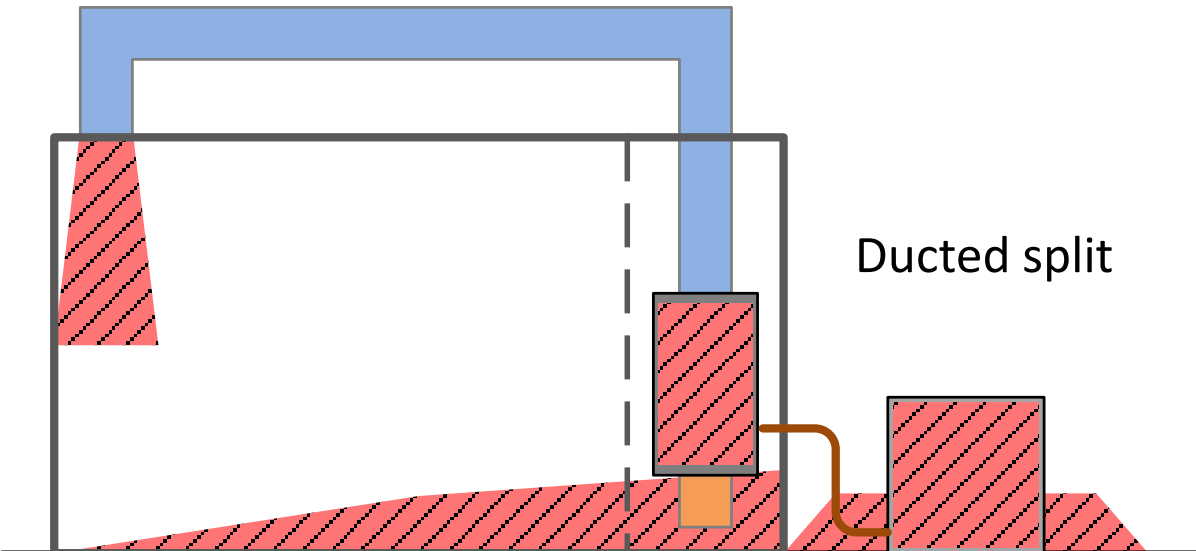
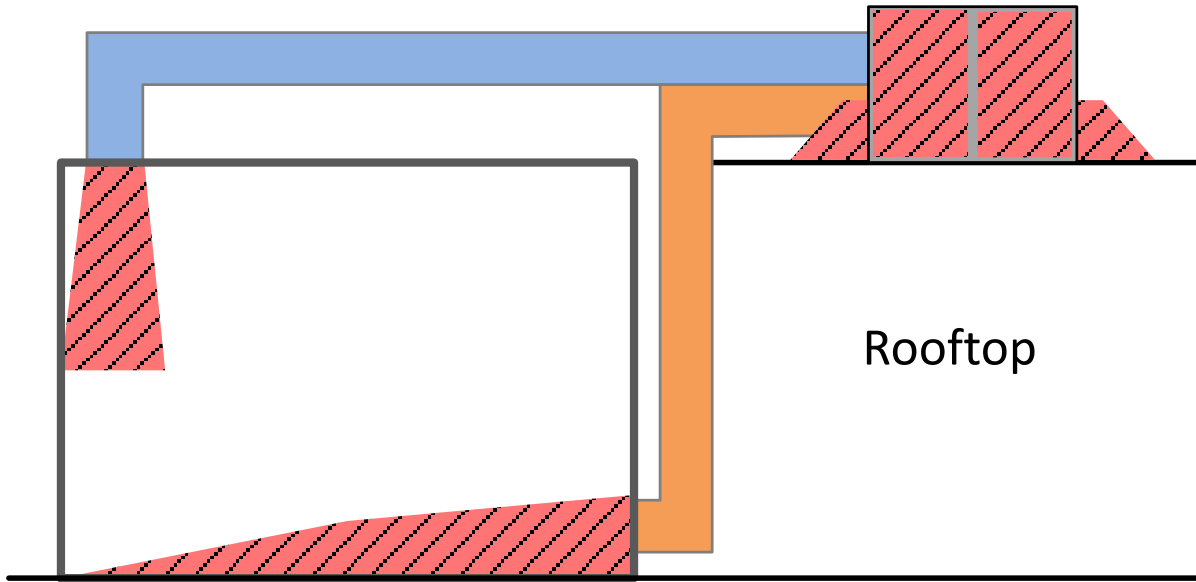
Evaluating leak amount and control

System operation			Condition	Released mass [g]		Mass flux [g/min/mm ²]	
				Low side	High side	Low side	High side
State on(i)	Compressor on	Leak initiated	Compr on, LP switch off	540	990	50	220
	T'stat cold		Compr on, LP switch off, LLSV closes	540	990	15	220
	SV closes		Compr off, LLSV closed, poor NRV	420	570	40	100
State off(i)	LP switches		Compr off, LLSV closed, tight NRV	330	660	45	100
	Compressor off	Leak initiated	Following pump-down	100	890	15	100
	T'stat warm		Compr off	990	990	40	100
State on(ii)	SV opens		Compr oil de-gassing	20	20	0.5	0.5
	Compressor on	Leak continuing					



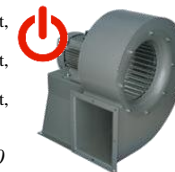
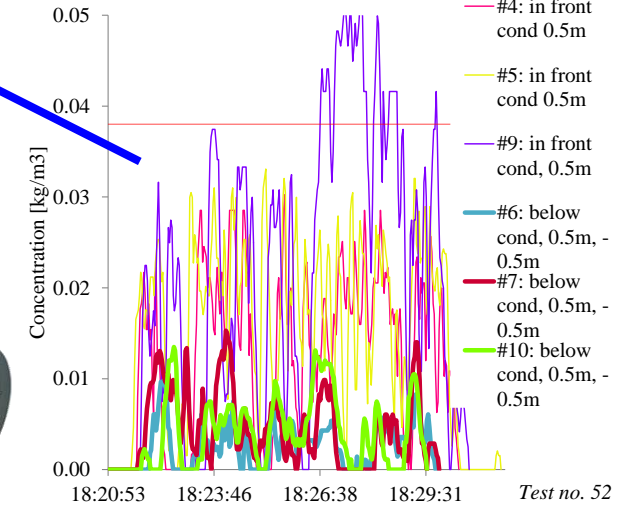
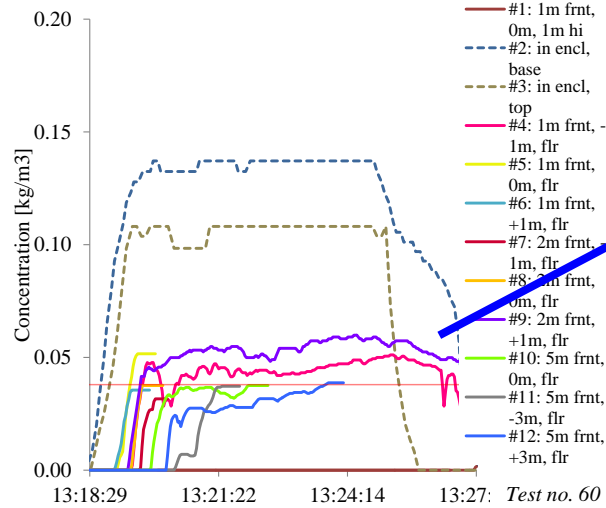
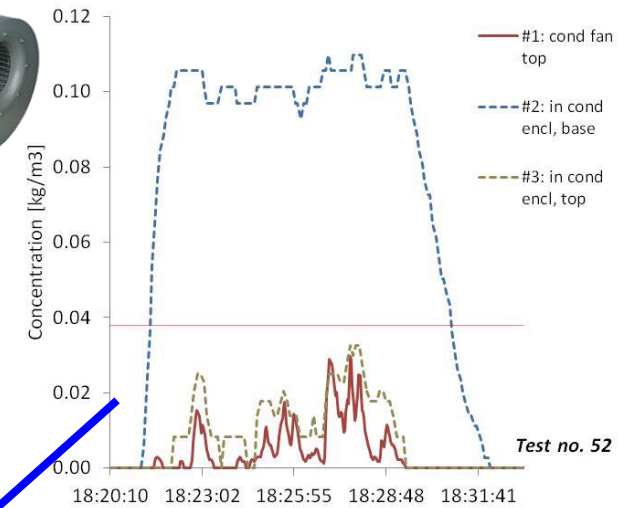
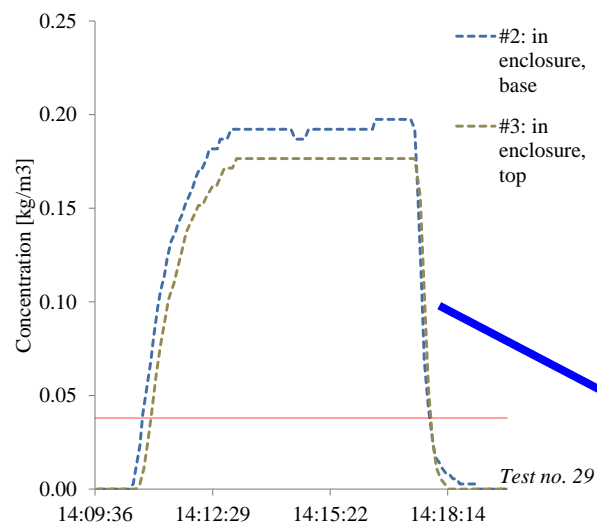
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Zoning



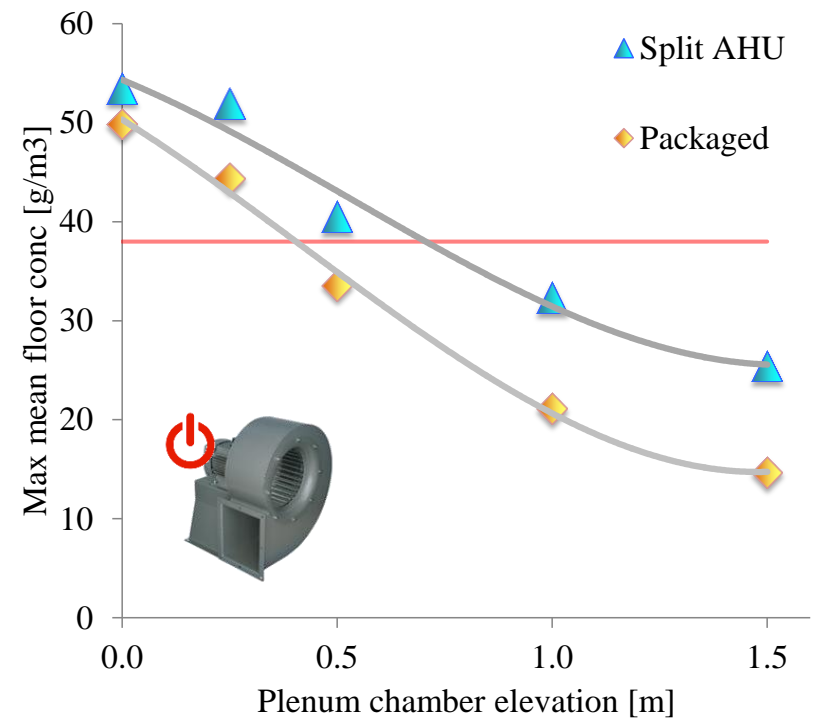
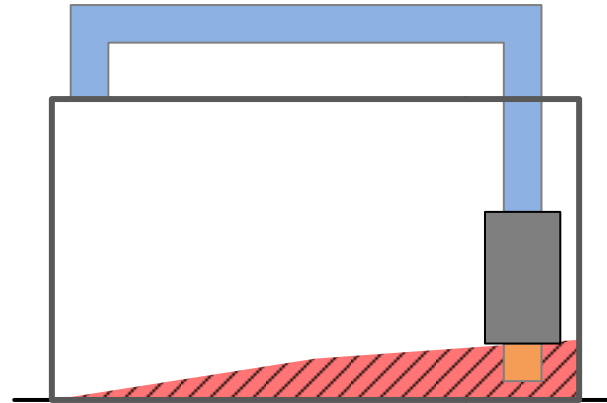
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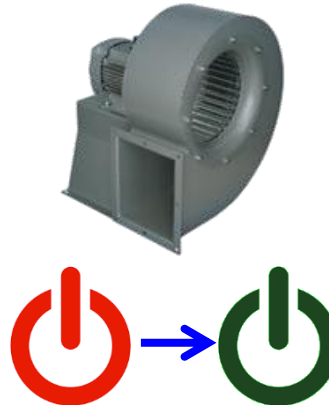


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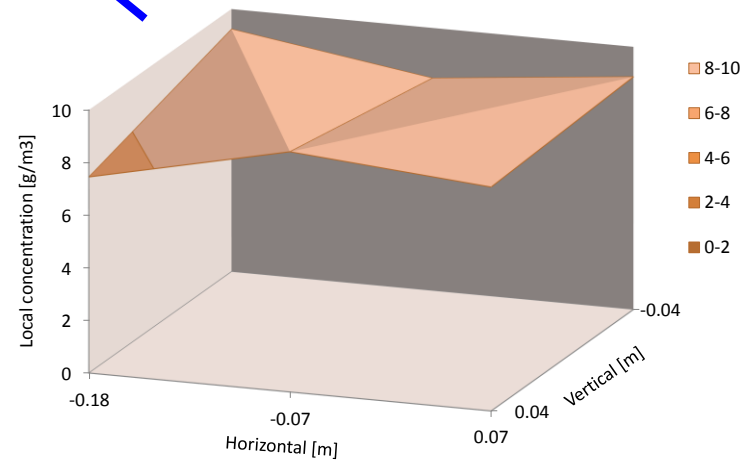
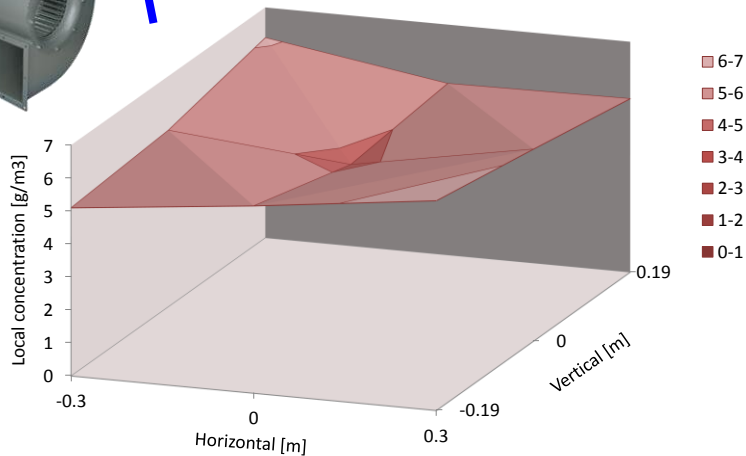
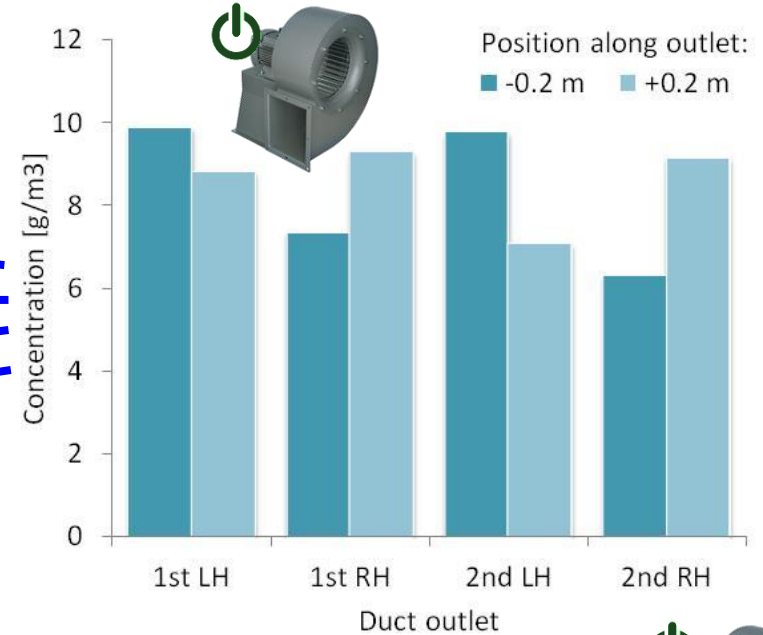
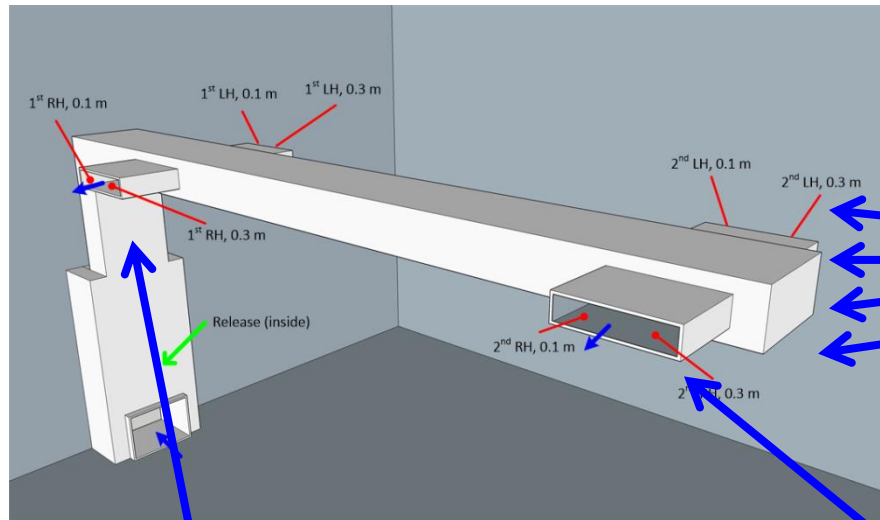


Zoning



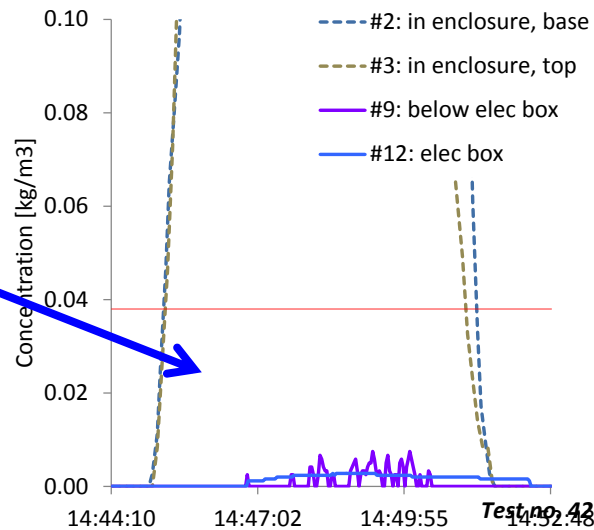
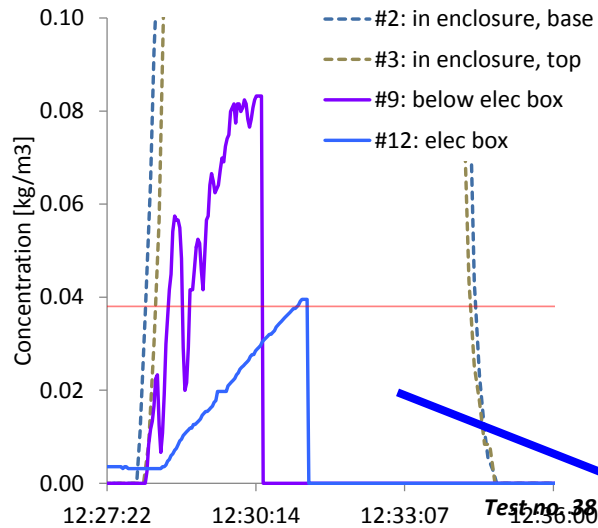
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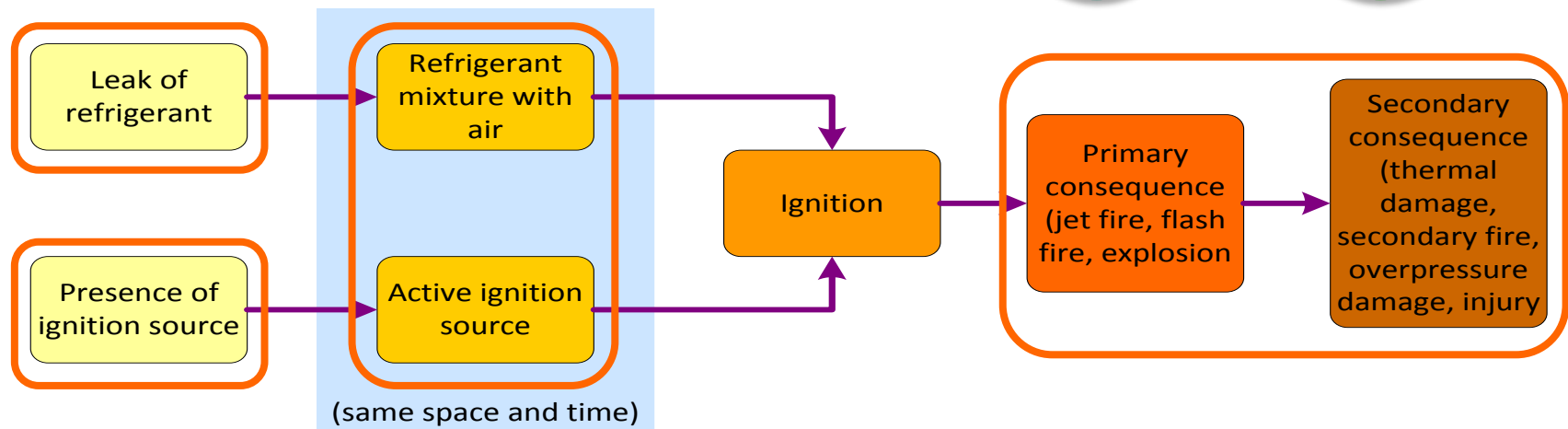
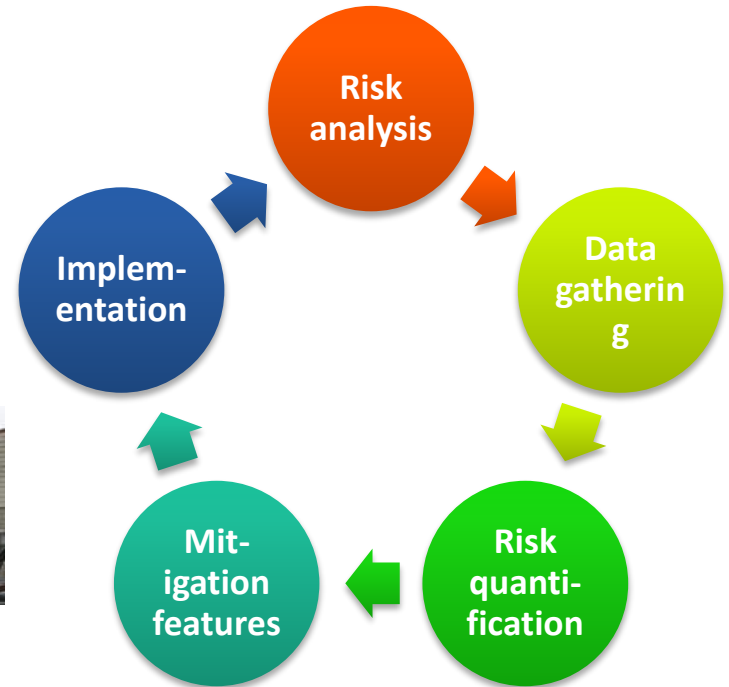
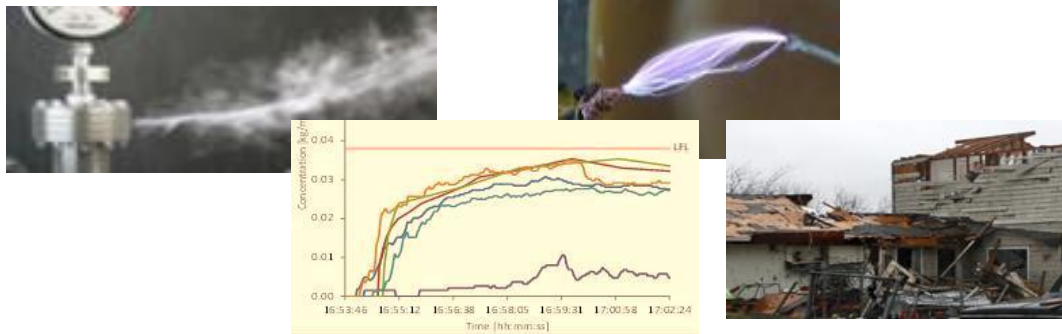
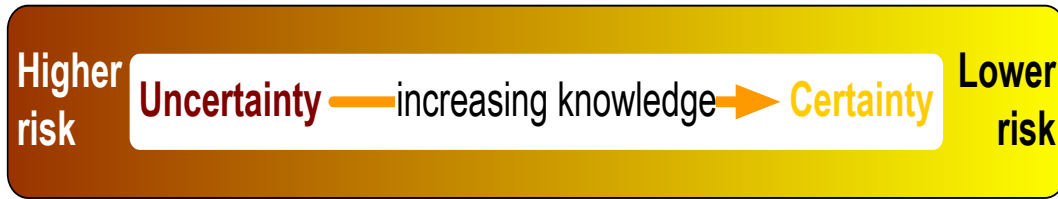
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Sources of ignition



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Risk assessment

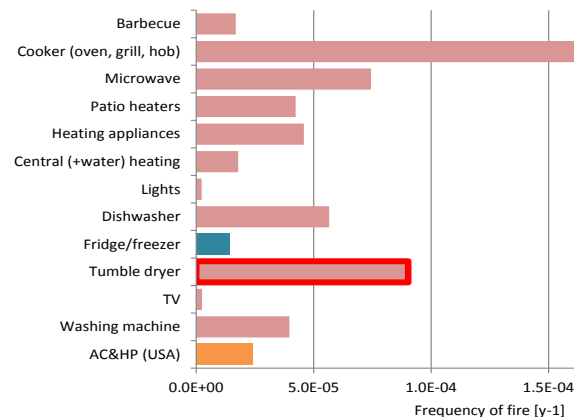


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Risk assessment

Ignition location	Ignition frequency (y ⁻¹)		Max consequences	
	Rooftop	Ducted split	TI (s(kW/m ²) ^{4/3})	OP (kPa)
Within/by condensing unit	1.1E-15	1.1E-15	30	1.1 (DS), 1.2 (RT)
Cond install area	5.8E-06	5.8E-06	60	n/a
Inside/by AHU	3.4E-16	3.4E-16	30	14.0 (DS), 17.8 (RT)
Occupied space (return duct)	1.5E-07	1.7E-07	200	4.1
Occupied space (supply duct)	1.5E-07	0.0E+00	10	0.4
Inside ducting	4.9E-11	0.0E+00	20	4.5

**PRELIMINARY
RESULTS**



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Compliance with safety standards

NTC 6228: Sistemas de refrigeración y bombas de calor.

Requerimientos de seguridad y medioambientales.

PROYECTO DE NORMA TÉCNICA COLOMBIANA	NTC 6228-1	DE 69616
CONTENIDO		
Página		
INTRODUCCIÓN	1	
ACERCA DE		
1. OBJETO Y CAMPO DE APLICACIÓN		
2. REFERENCIAS NORMATIVAS		
3. TÉRMINOS Y DEFINICIONES		
4. ACRONIMOS		
5. CLASIFICACIÓN		
5.1 CLASIFICACIÓN DE OCUPACIONES		
5.2 CLASIFICACIÓN DE SISTEMAS		
5.3 CLASIFICACIÓN DE LA LOCALIZACIÓN DE LOS SISTEMAS DE REFRIGERACIÓN		
5.4 CLASIFICACIÓN DEL REFRIGERANTE		
CANTIDAD DE REFRIGERANTE POR ESPACIO OCUPADO		
CÁLCULO DE VOLUMEN ESPACIO		
FLUIDO DE TRANSFERENCIA DE CALOR		
GENERALIDADES		
INGENIERÍA		



EN 378: Refrigerating systems and heat pumps. Safety and environmental requirements



Read manual or handbook



Part 2: Thermotar product development

Summarising remarks

- Followed conventional sequence of steps for addressing flammability hazard in safe design
- Extensive testing and evaluation
 - Releasable refrigerant quantity
 - Concentration development following a leak
 - Effectiveness of mitigation measures
- Appraised through flammability QRA
 - Utilised as much experimental and empirical/field data as possible
- Applied safety standards
- Products considered to be “safe”

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