

Technical Support for Heat Pump Systems with Low-GWP Refrigerants

Samuel F. Yana Motta, Distinguished R&D Staff

Enabling the Adoption of Flammable Refrigerants

- **Problem:** Most ultralow-GWP (global warming potential) refrigerants are flammable (A2L, A3), which limits their immediate application and deployment
- **Approach:** Work with members of installation (ASHRAE) and equipment standards to identify information needed to include flammable refrigerants.
- Impact in support of the decarbonization blueprint: Enable the safe use of flammable refrigerants (e.g., propane) in secondary loop and low-charge/selfcontained applications.
 - Reduce direct GHG emissions by up to 99% by using ultralow GWP refrigerants
 - Compliance with energy (decarbonization) and environmental targets (UNEP Kigali Amendment, 2016)

Current Activities

- Monitoring of safety standards
 - Refrigerants standards: **ASHRAE 34, ISO 817**
 - Equipment and installation





Flammable A3

Propane

	Event		Probability per vehicle per operating hour	Citation				
	Probability of being in a	police reported vehicle collision	4 x 10 ⁻⁵	NHTSA, 2013				
	Probability of automotiv	e vehicle fire (any cause)	1 x 10⁻ ⁶	Ahrens, 2013; FHA, 2009				
	Probability of vehicle co	Ilision due to vehicle brake failure	3 x 10-7	New York State DMV, 2008				
	Probability of dying in a nation	regularly scheduled plane trip in a developed	7 x 10⁻ ⁸	Barnett, 2011				
	Estimated probability experiencing HF expos an R-1234yf ignition eve	of vehicle occupant/former occupant ure above health based limits associated with ent	5 x 10 ⁻¹²	CRP1234, 2009				
	Estimated probability vehicle fire due to R- engine compartment)	of vehicle occupant being exposed to a 1234yf ignition (due to leak and ignition in	3 x 10 ⁻¹²	Current analysis				
	Estimated probability o flame due to R-1234yf cabin)	f vehicle occupant being exposed to an open ignition (primarily due to leak and ignition in	9 x 10 ⁻¹⁴	CRP1234, 2009				
	•Home appliances 10-8 •Critical items 10-8 NITE: Home appliances should meet a tolerance of 10-8 per million in the market							
ris	el of risk	Risk_Level = F(Conce	entration)					
IS	- Leve							

standards: ASHRAE 15, ISO 5149, UL 60335-2-40

- A3 refrigerants limited to very low charge (<114 g)
- Not enough coverage for secondary loop systems
- How to change standards
 - 1) Perform risk assessment searching for the minimum likelihood possible (single event considered)
 - 2) Establish acceptable risk level for all users (e.g., end users, technicians, manufacturers)
 - 3) Reach consensus by identifying the value (e.g., refrigerant concentration) for below the acceptable risk level (e.g. 10-8)
- Type of research suggested:
 - Fundamental: Hot surface ignition temperature determination for hydrocarbon **Benefit:** Enable the use of efficient heaters with A3 refrigerants (propane).

i	Very difficult	10 ⁻⁸						
Ľ	Extremely difficult	10 ⁻⁹		Acceptor				
	Near-zero	10 ⁻¹⁰		ab/e				
			0	I	Π	Ш	IV	
Possibility of incident		t	No damage	Minor damage (smoke from product)	Light damage (fire from product, light injury)	Major damage (fire, human injury)	Lethal damage (permanent injury, death, burn down of house)	
			→Severity					

- Risk assessment-based (likelihood): Self-contained equipment (window AC, portables, PTACS, and heat pump water heaters).
 - **Benefit**: Increase the charge allowance form current limit (114 g for R-290).
- Whole-room experiments (severity): Equipment exposed to external fires. **Benefit:** Adopt safer procedures and PPE for firefighters and first-aid workers.

Suggested Follow-up Activities



- Assist the industry in performing the research needed to enable ultra-low GWP flammable refrigerants in the most relevant applications (Self-contained, RAC, Light commercial AC)
- Collaborate in the preparation of specific proposals to update safety standards.





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