



A/C Refrigerant Information Panel

**Ward Atkinson – Former Chair, SAE ICC
Committee**

Peter Coll – Neutronics Refrigerant Analysis

Mary Koban – DuPont Fluoroproducts

Jeff Murphy – RTI Division, MAHLE Clevite, Inc.

Ward Atkinson – Sun Test Engineering

Former Chair, SAE Interior Climate Control Committee

- **Technical Advisor to MACS Worldwide**
- **Numerous Awards for Work with SAE ICC**
 - EPA “Stratospheric Ozone Protection Award” (1990/1997)
 - SAE “Outstanding Contribution Award” (2009)
 - Arch T. Colwell Cooperative Engineering Medal (1998)
- **GM/Chevrolet Engineering (Retired 1981)**

Peter Coll – Neutronics

VP – Neutronics Refrigerant Analysis

- **Board of Directors – MACS Worldwide**
- **SAE Interior Climate Control Committee**
- **Consultant to US Government Agencies, Foreign Government Agencies, and UNEP**
- **Working with Neutronics Since 1998**

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“How Did We Get Here?”



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1950's - R12-based Front-Mounted A/C Systems Introduced

Global Financial Crisis!

Daimler Announcement

1st SAE ICCE CRP Formed for R1234yf

1st R1234yf Vehicle Introductions

US Clean Air Act



1950's | 1996 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013

1990's R134a-based A/C Systems Introduced

J2788 Adopted

VDA Confirms Use Of R1234yf

EU Directive 2006/40/EC

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R1234yf



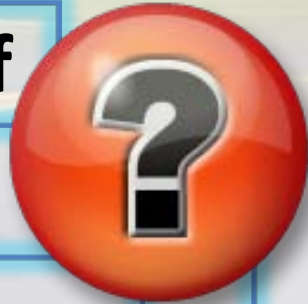
Reversal by Daimler

↪ Industry Impact?



Other Refrigerants?

R1234yf



CO₂



AC6



R134a

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Counterfeit Refrigerants

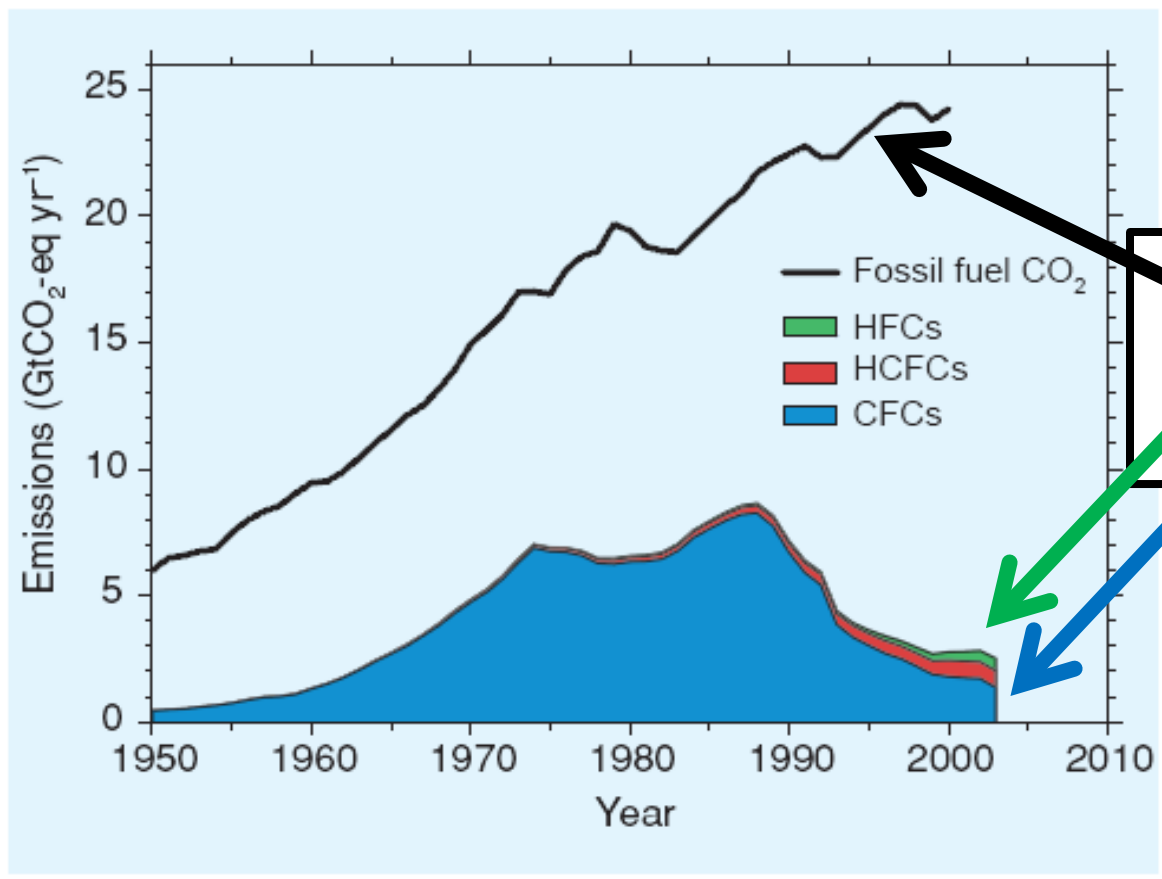
How Big Is The Problem?



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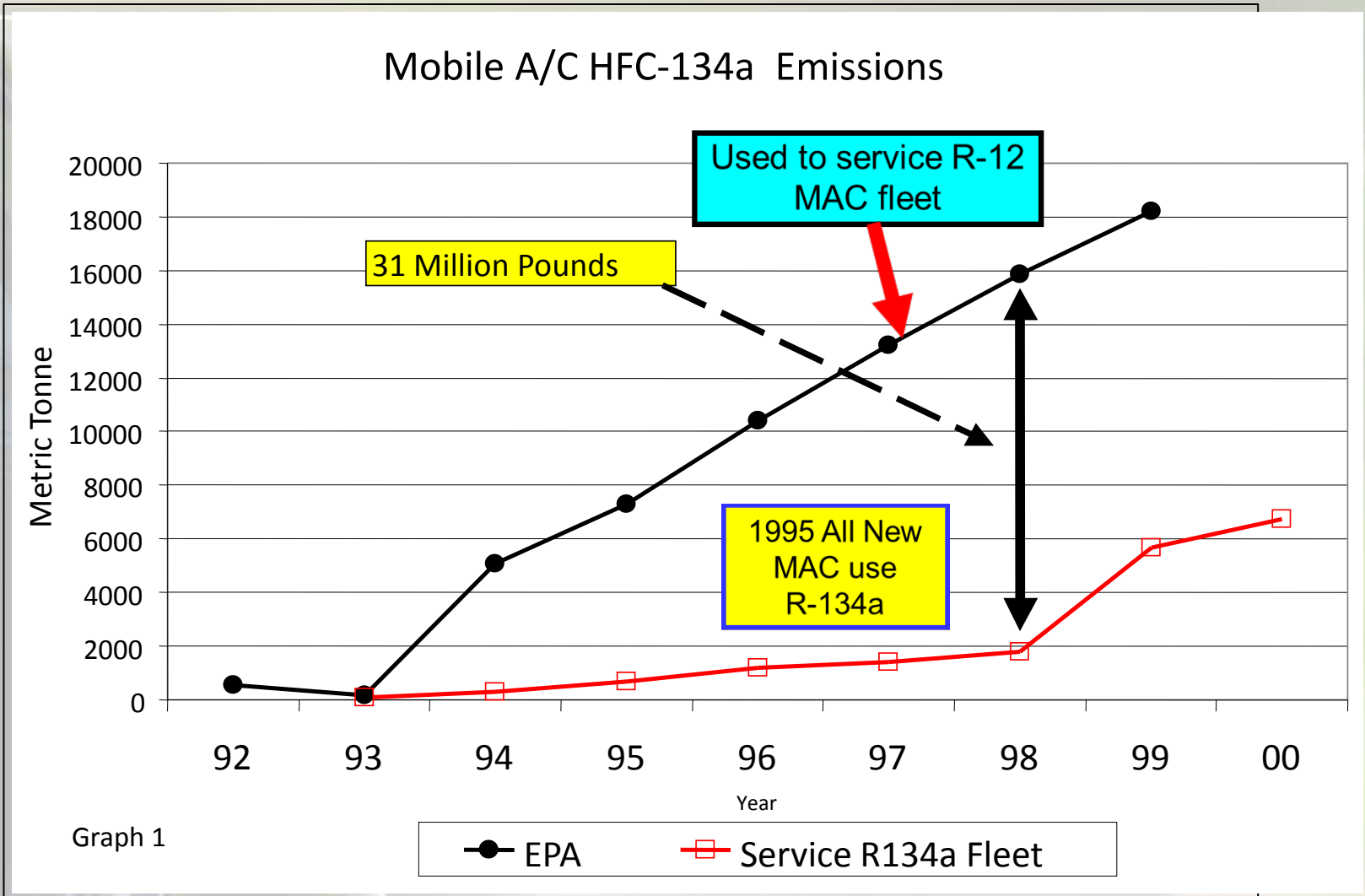


R-134a is the biggest HFC, but HFCs are a small part of the global warming problem



Fossil Fuel
HFC's
CFCs

U.S. NCCTI Report October 12, 2001



New Global Refrigerants Studied

- **R744 Carbon Dioxide**
- **HFC-152a [secondary loop]**
- **GAR Blends**
 - DuPont DP -1
 - Honeywell Fluid H
 - Ineos Fluor AC-1
 - Solvay
- **HFO-1234yf**
 - DuPont-Honeywell

Alternative Refrigerant Development Program(s)

- **Introduction of a replacement refrigerant**
 - **Very complex**
 - **Requires considerable time**
- **None are “Drop In” replacements**
- **Requires US EPA “SNAP” Listing**
 - **May require safety mitigation features**

What's Needed To Consider New Refrigerants

- **Toxicity**
- **Material Compatibility**
- **Component Refrigerant Permeation/leakage Evaluation**
- **Performance**
- **Energy Requirements**
- **Meet Regulatory Requirements**

New MAC System Refrigerant

**Mexichem Low GWP Blend
AC6**

MAC Service Issues using Blend Refrigerants

Testing Overview of Lower GWP Blend Refrigerants

Blend “AC6” Composition

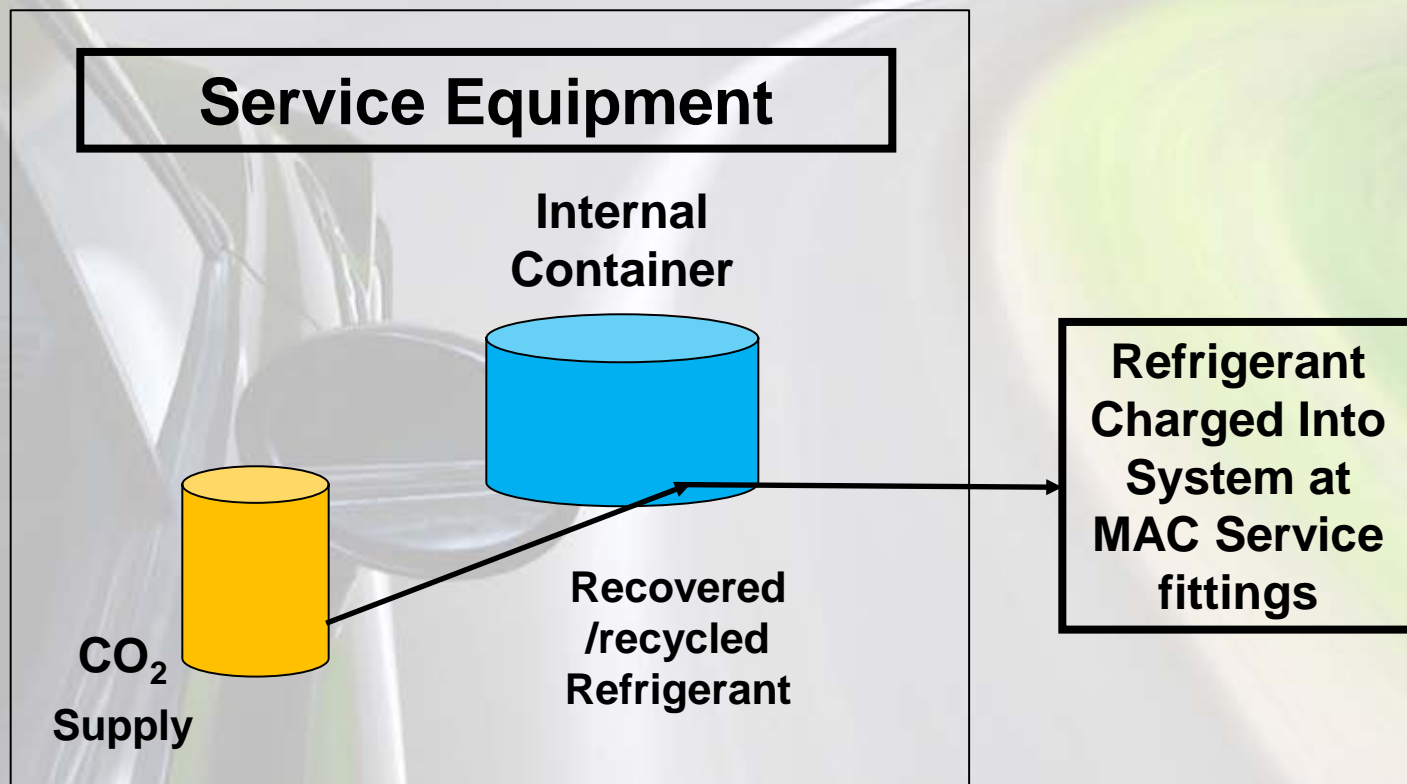
6% CO₂, 9% R134a, 85% R1234ze

Potential for composition shift of ternary blend composition whenever a vapor-liquid interface is created

Composition will vary as liquid level and temperature change

On-site Blend Recovery/refill

The AC6 blend recovery/refill process, including the use of a “Refrigerant Identifier” to establish the correct CO₂ composition for a production application, is currently under development



Where Does This Industry Need to Go?

- **Expand Service to Include Total Vehicle Environment Management That Interface With HVAC systems**
 - Include Hybrid and electric vehicles
- **Control Systems (Electronic)**
 - Comfort of occupants and inclement weather visibility
 - Battery/electronic devices
- **Recovery of waste heat (Engine Cooling Systems management)**
- **Heat pumps**
- **Secondary loop systems**
- **New Technologies Requires Extensive Training**