

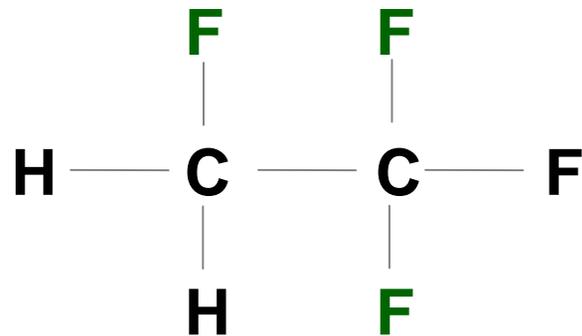
# **R-152a for Mobile Air Conditioning**

**James A. Baker**  
**Delphi Corporation**

## **Mobile Air Conditioning Summit 2005**

California Air Resources Board  
United States Environmental Protection Agency  
Sacramento, California  
March 15-16, 2005

# R-152a - Chemically Very Similar to R-134a, But, Environmentally Very Different

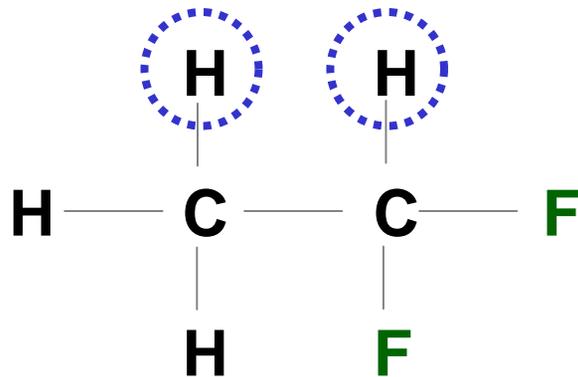


R-134a

Molecular Weight = 102

ASHRAE A1 – Non-Flammable

GWP = 1300



R-152a

Molecular Weight = 66

ASHRAE A2 – **Mildly Flammable**

Similar Materials Compatibility

GWP = 120

**Refrigerant Change Would Reduce Climate Impact by 94%**

(Combined effect of reduced GWP + reduced refrigerant charge)

**[94% Savings Does Not Include Possible Energy Savings]**

# Mobile A/C System Types

## ◆ Direct System (Primary Loop)

(Heat exchanger containing refrigerant in **passenger cabin**)

- Single Evaporator System – Automobiles
- Dual Evaporator System – SUV's, Vans, etc.

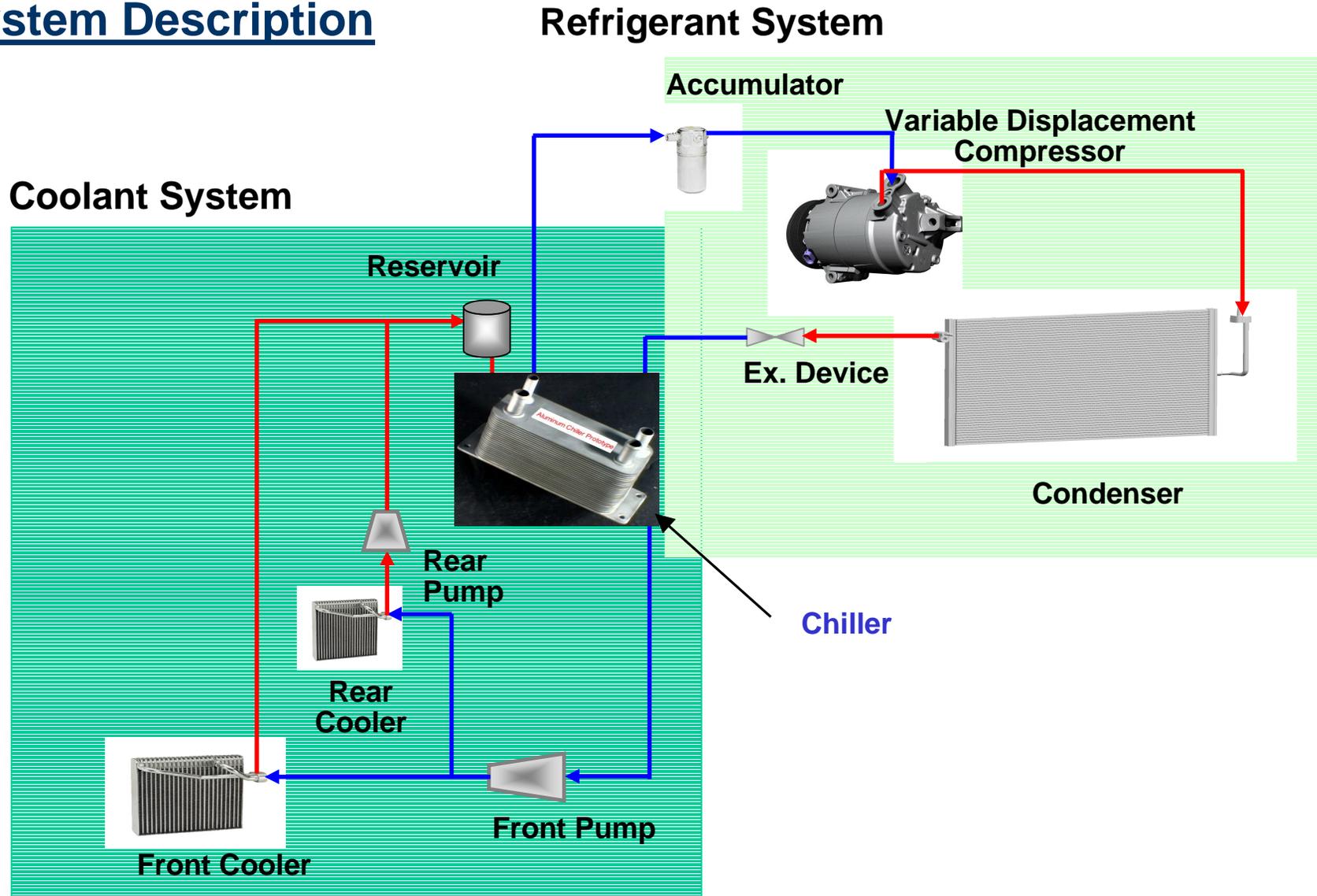
## ◆ Indirect System (Secondary Loop)

(Refrigerant contained within **engine compartment**)

- Single Cooler System – Automobiles
- Multiple Cooler Systems – All Passenger Vehicles

# Mobile A/C System Types

## System Description





## **R-152a Mobile A/C with Directed Relief Safety System**

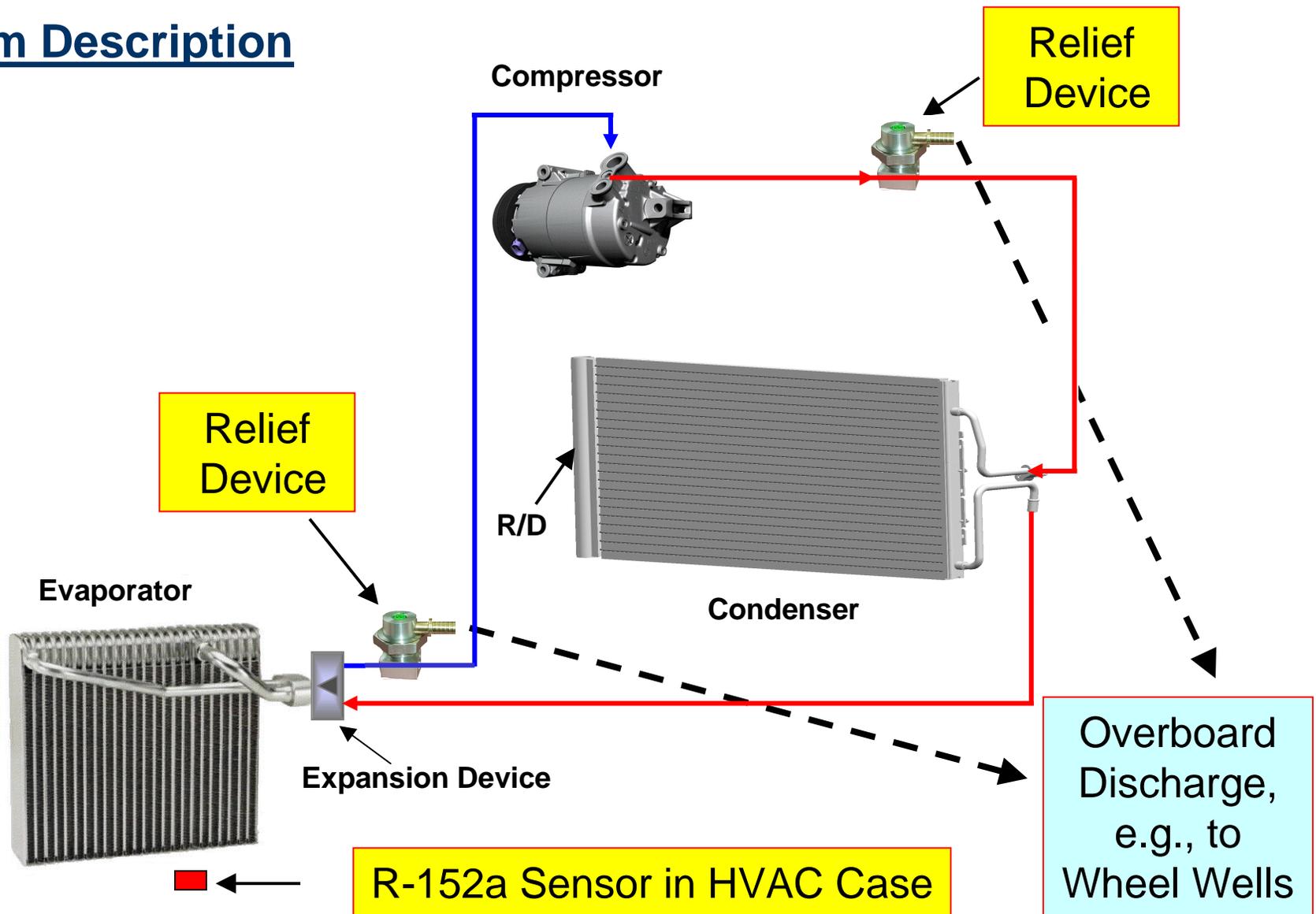
**Mahmoud Ghodbane, Ph.D.  
James A. Baker  
Delphi**

**Stephen O. Andersen, Ph.D.  
U. S. EPA**

*Summer 2003*

# Direct Expansion R-152a Mobile A/C System

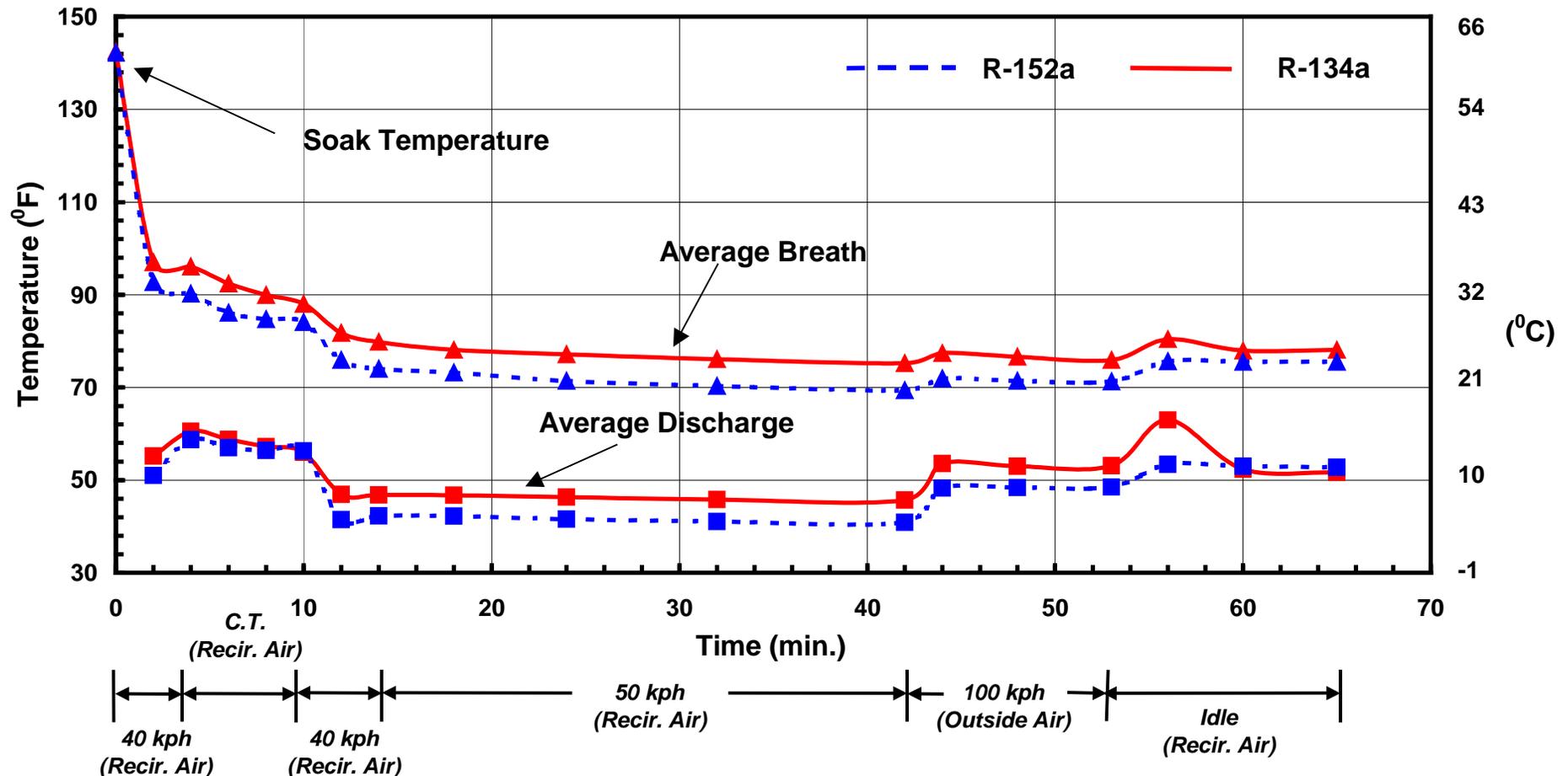
## System Description



# Direct Expansion R-152a Mobile A/C System

## Performance Comparison

Ion A/C Cool Down Performance Comparison  
@ 100 °F x 40% R.H. Ambient (38 °C x 40% R.H.)

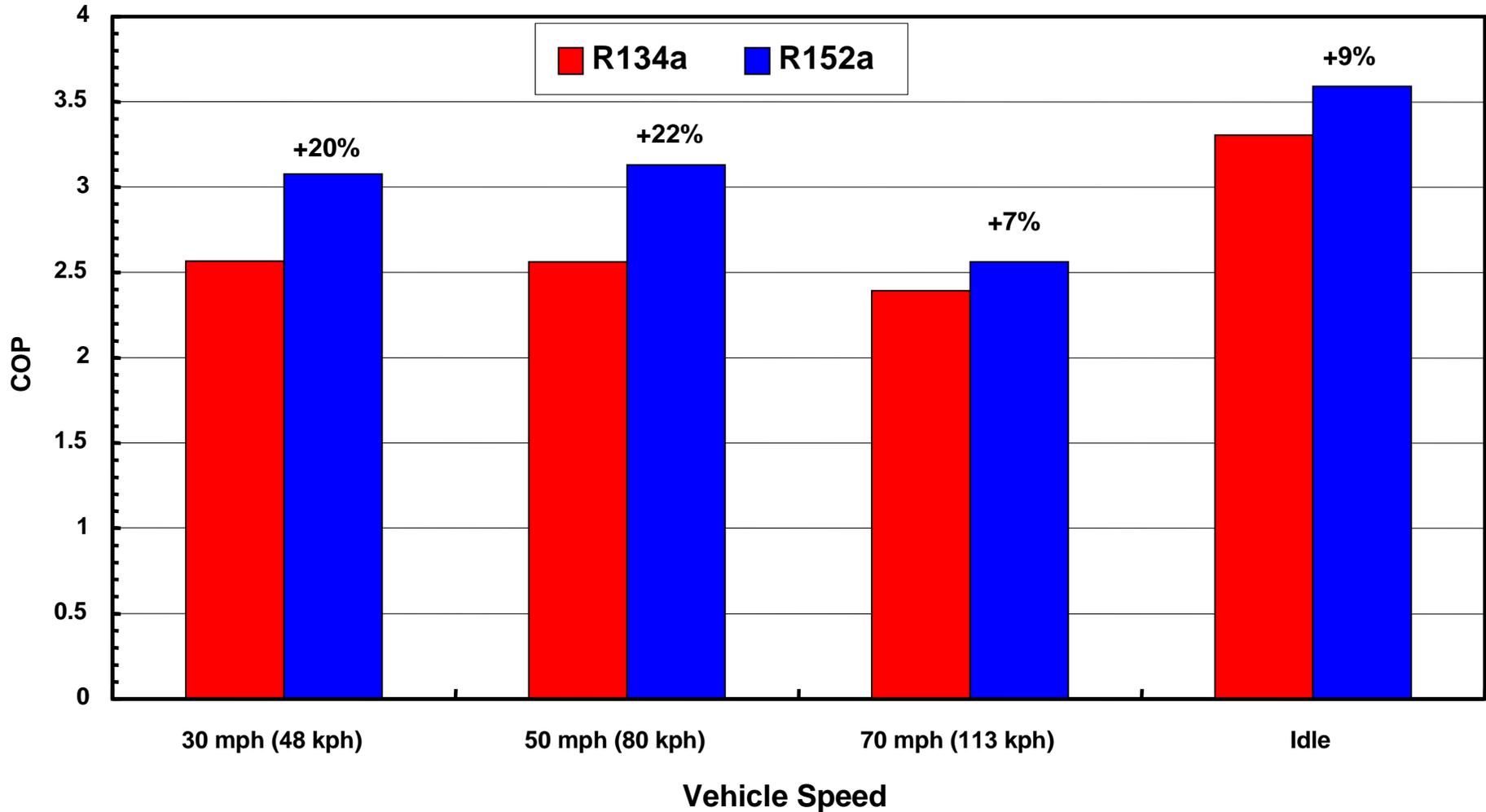


# Direct Expansion R-152a Mobile A/C System

## Efficiency

### Coefficient of Performance Comparison

100 °F x 40% R.H. (38 °C x 40% R.H.)



# Direct Expansion R-152a Mobile A/C System

## Conclusions

- ◆ **R-152a Offers**
  - Outstanding environmental advantages
  - Better cooling performance than R-134a
  - Better energy efficiency than R-134a
  - Relative ease of industry conversion

**R-152a Merits Consideration by Vehicle Makers for Future A/C Systems**

# Secondary Loop R-152a Mobile A/C System

**Mahmoud Ghodbane, Ph.D.**  
**Delphi**

**Hans Fernqvist**  
**Volvo**

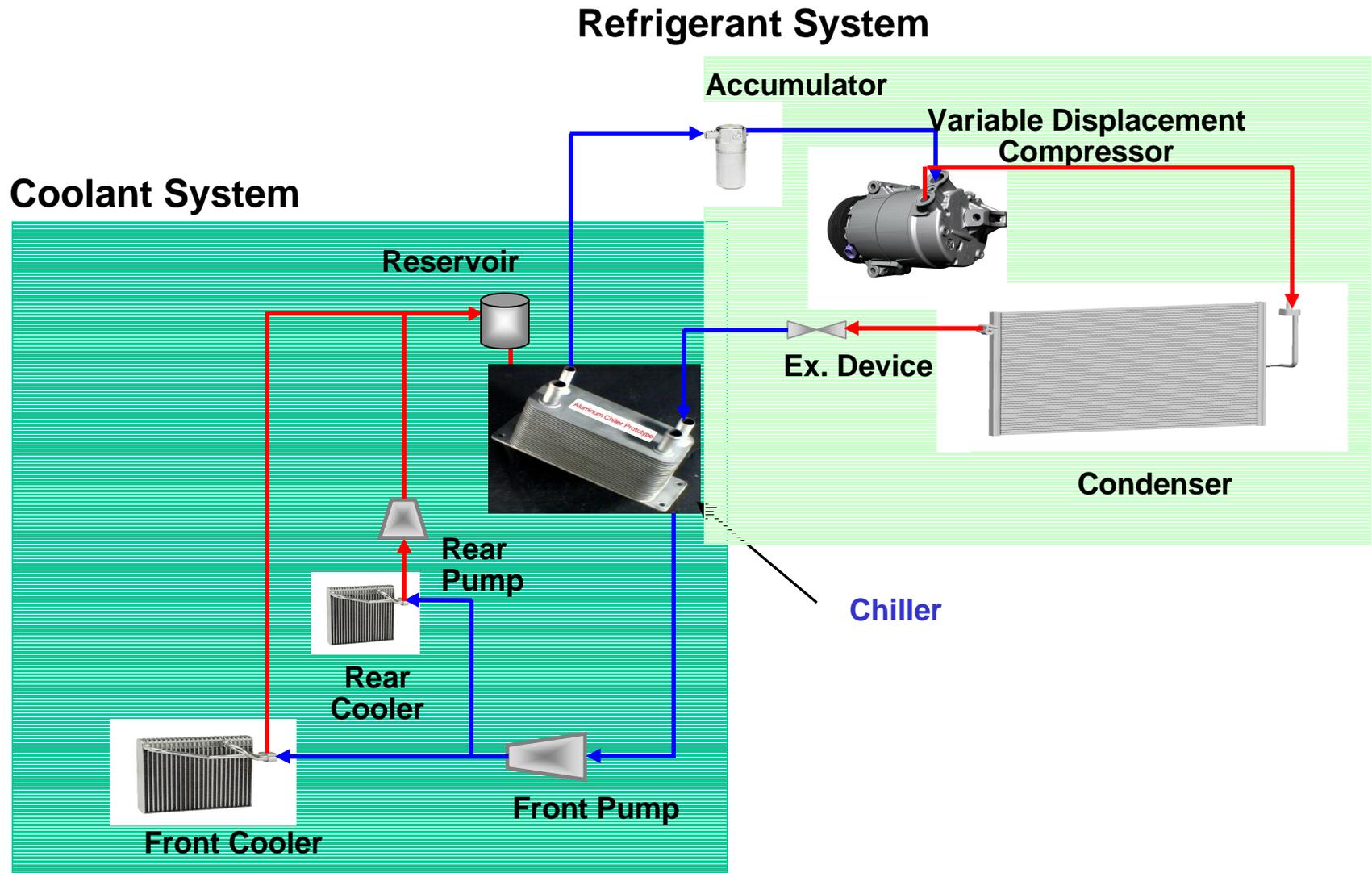
*Summer 2003*

# Secondary Loop R-152a Mobile A/C System

## Test Vehicle

- ◆ Sport utility vehicle (SUV) with front and rear A/C system
- ◆ Vehicle tested first with O.E. R-134a system, then equipped & tested with R-152a Secondary Loop System in the same tunnel
- ◆ Same condenser and evaporator air flows for both systems
- ◆ Refrigerant charge: **2.87 lb (1302 g)** for R-134a baseline system versus **1.30 lb (590 g)** for R-152a Secondary Loop system

# Secondary Loop R-152a Mobile A/C System

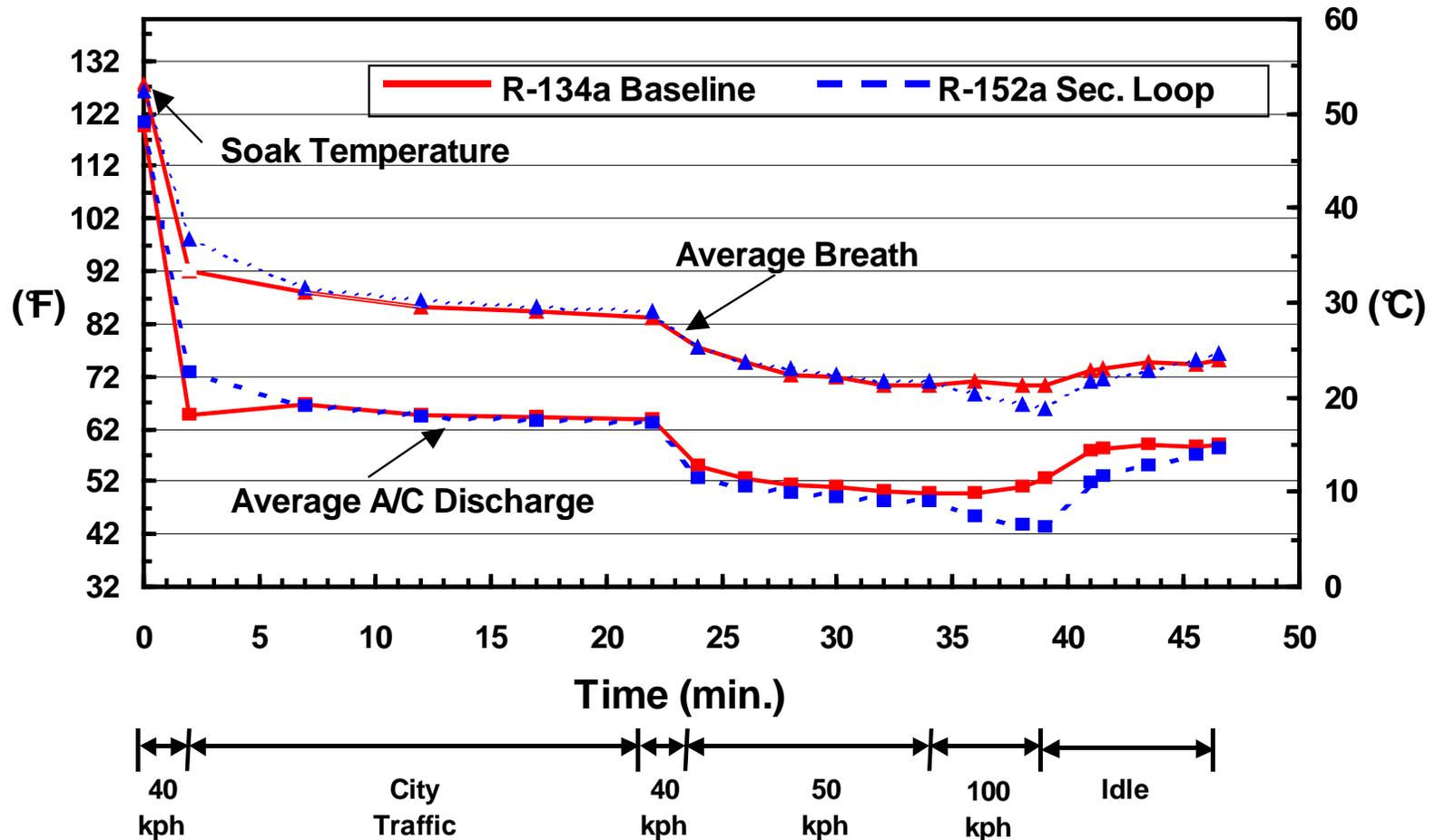


# Secondary Loop R-152a Mobile A/C System

## Performance Comparison

XC90 A/C Cool-Down Performance Comparison

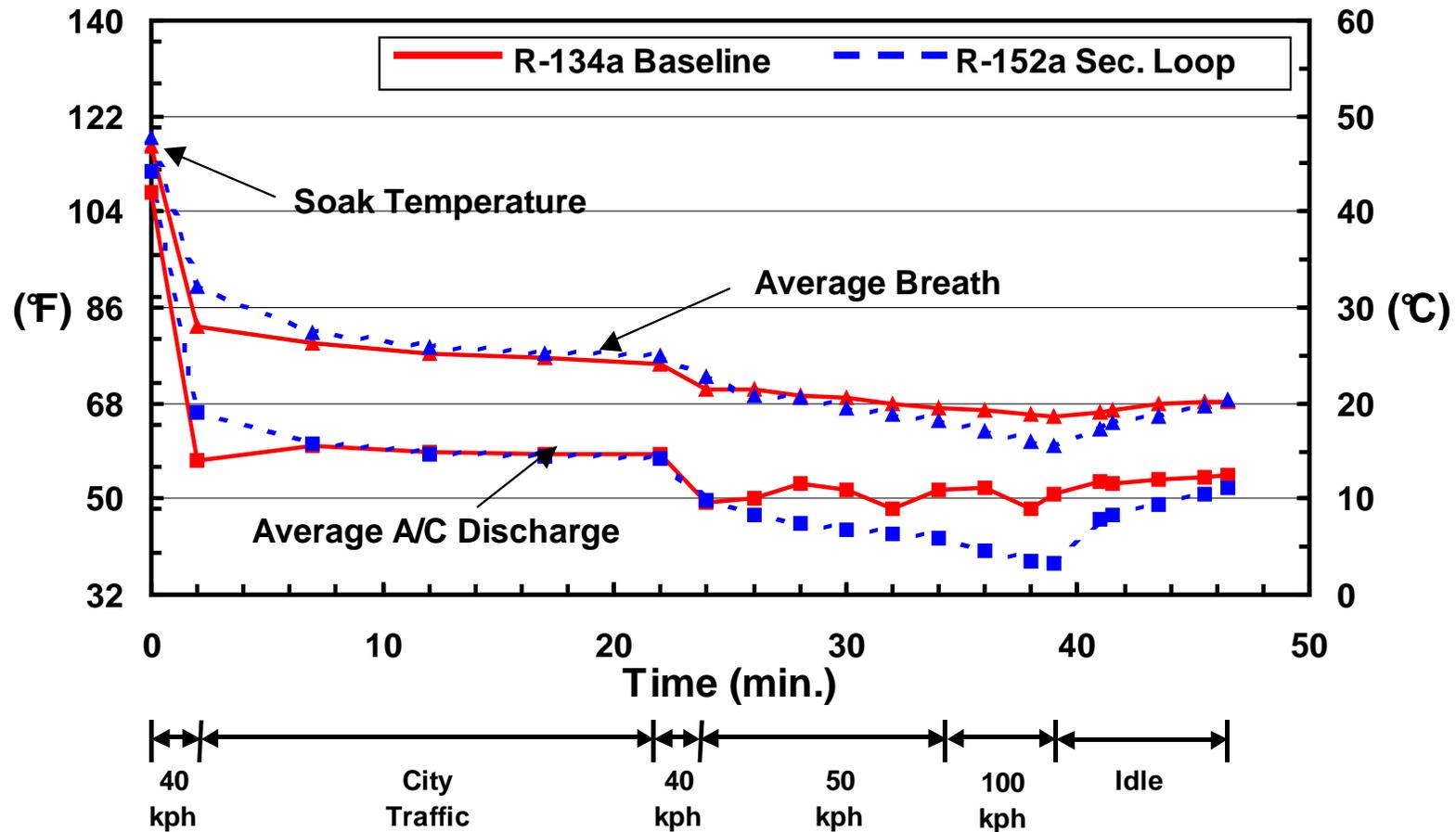
@ 100°F x 40% R.H. (38°C x 40% R.H.)



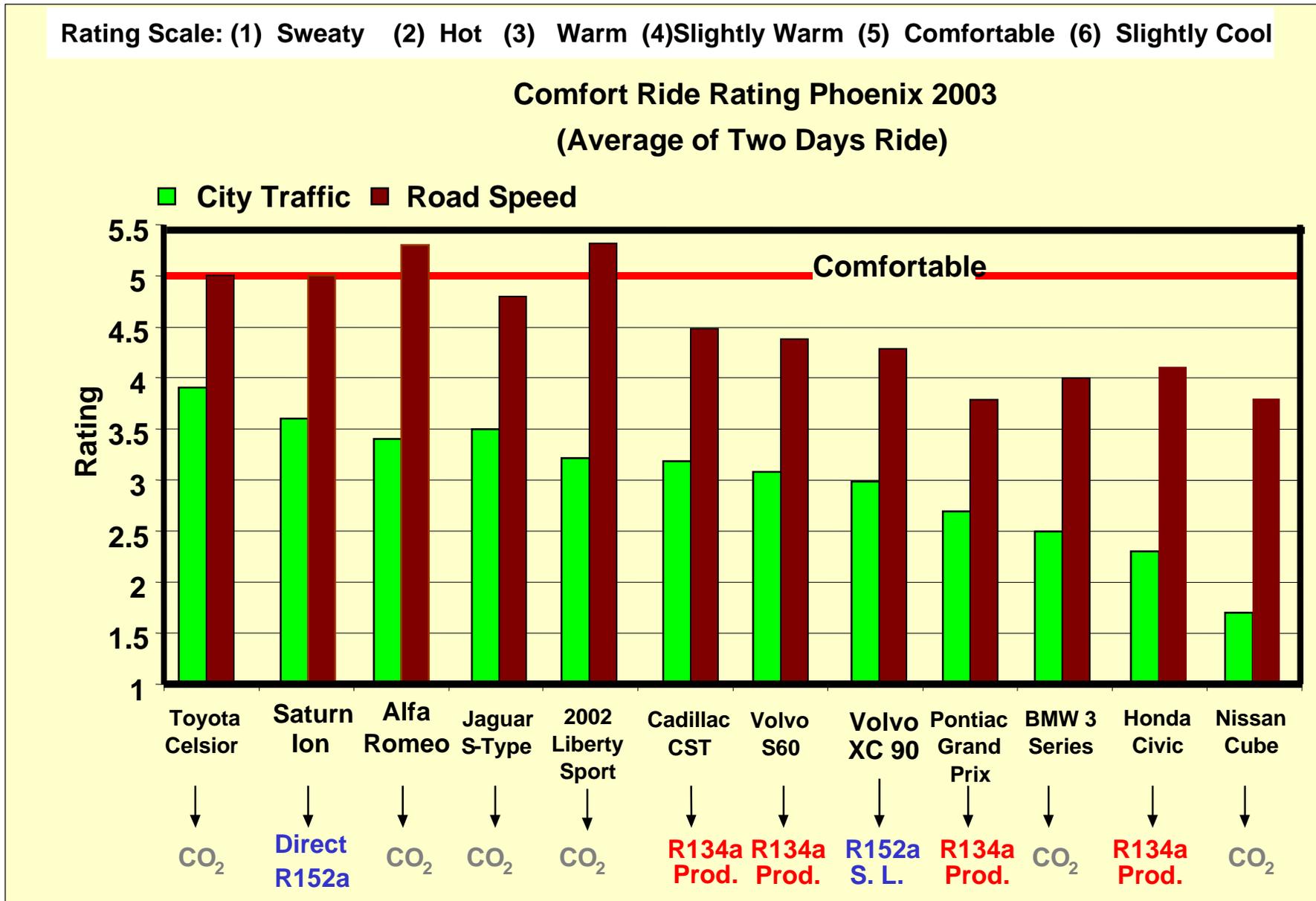
# Secondary Loop R-152a Mobile A/C System

## Performance Comparison

XC90 A/C Cool-Down Performance Comparison  
@ 86°F x 60% R.H. (30°C x 60% R.H.)



# Alternative Refrigerant Systems SAE Phoenix Forum Comfort Evaluation



WARNING: HFC-152a is a flammable refrigerant and should not be used in systems unless specifically designed for its use.

# Secondary Loop R-152a Mobile A/C System

## Summary of Secondary Loop versus Current R-134a System

### Front System

	Versus R-134a
Environmental	++
Performance	0 *
Energy	- (5 to 10%)
Mass	- -
Packaging	- -
Reliability	0
Cost	-

### Front & Rear System

	Versus R-134a
Environmental	++
Performance	0 *
Energy	- (5 to 10%)
Mass	-
Packaging	-
Reliability	++
Cost	0/+

**\* In city traffic and Idle, the advantage goes to Secondary Loop**

# Secondary Loop R-152a Mobile A/C System

## Conclusions

### **General Benefits**

- ◆ **Comparable Cooling Performance to Direct R-134a Systems**
- ◆ **Improves City Traffic & Idle Cooling Performance**
- ◆ **Reduces Refrigerant Charge & Leakage**
- ◆ **Enables Maintenance of Comfort with Compressor off (Idle-Stop)**  
*(Rail & Border Crossing, Compressor De-Stroking at WOT & Idle, Hybrid Vehicles at Stop, etc...)* **Potential for Energy Savings**
- ◆ **Potential for Targeted Cooling (e.g., Seats)**
- ◆ **Refrigerant System Noise Reduction - Front and Rear**
- ◆ **Eliminates refrigerant mal-distribution (Coolant exhibits more uniform temperature distribution than refrigerant)**

# Secondary Loop R-152a Mobile A/C System

## Conclusions

### *Vehicles with Rear HVAC Systems*

- Eliminates Entire Rear Refrigerant System
- Reduces Rear HVAC Case Size (Rear Single Heat Exchanger)
- **Cost Savings over Current System !**

## Challenges

- ◆ Chiller / Pump Packaging Underhood
- ◆ Small A/C Energy Penalty (5 to 10%)
- ◆ Small Mass Penalty (3-4 kg)

**Note: No technical barriers exist that would prevent the rapid commercialization of R-152a secondary loop systems**

# Conclusions

- ◆ **R-152a Offers**
  - **Outstanding environmental advantages**
  - **At least equal cooling performance to R-134a**
  - **Comparable energy efficiency to R-134a**
  - **Relative ease of industry conversion**

**R-152a Merits Consideration by Vehicle Makers for Future A/C Systems**

# The “Bottom Line”

## R-152a Secondary Loop Systems Offer

- **the best combination of environmental performance, lowest cost, and lowest technical & reliability risk of any alternative to R-134a proposed to date. Change would be transparent to consumers**
- **the ability to use current R-134a component technologies, allowing smoother, lower cost transition from R-134a**
- **the safest alternative to R-134a proposed to date**



**Intergovernmental Panel on  
Climate Change**



**IPCC/TEAP Special Report on Safeguarding the Ozone Layer and  
the Global Climate System: Issues Related to Hydrofluorocarbons  
And Perfluorocarbons**

**Summary for Policymakers (SPM)**

**January 11, 2005**

**“There is currently no significant difference  
between technically achievable LCCP of  
HFC-152a and CO<sub>2</sub> systems.”**

# What is Needed for R-152a Success (*Those Who Can Make It Happen*)

- **Regulatory Support**

- **European Union (Retain GWP 150)**
- **California Air Resources Board**
- **US EPA *SNAP* Program**

- **Vehicle Makers' Support**

- **Chemical Industry Support**

- **Supply of R-152a**

**“The Future is  
in the Hands of Those  
Who Can Make it Happen”**