SAE Improved Mobile Air Conditioning Cooperative Research Program

Improved HFC-134a Refrigerant Systems

Mobile Air Conditioning Summit, Sacramento CA

March 15-16, 2005

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Improved MAC (I-MAC)

- Announced April 22, 2004
- Financed by ≈ $3 million for 2005/06
- Demonstrate technologies to reduce direct and indirect HFC-134a refrigerant emissions

I-MAC CRP

- ≈ $3 million budget
  - Project duration - 2005 and 2006
  - Funded by industry and *government (TBD May 2005)*
- Current funding commitments

	Industry	In-Kind Industry
2005	$540,000	$900,000
2006	$500,000	$900,000

I-MAC CRP Objectives

- **Reduce direct and indirect HFC-134a refrigerant emissions from mobile A/C systems**
- **Demonstrate potential improvements in performance using existing technologies**
  - **Vehicle and A/C system design**
  - **Servicing of A/C systems**
- **Provide a direct comparative engineering evaluation**
- **Convert best practices and test procedures into SAE standards**

Program Goals

Team 3
Thermal Load
Reduction

Team 4
Reduction of Losses
During Service

Team 2
Efficiency
Improvement

Team 1
Leakage Reduction

Demonstration Vehicles
2005/2006

I-MAC CRP
Program Details

- Participants include
  - International automobile manufacturers
  - International A/C system manufacturers
  - Component suppliers
  - Service equipment suppliers
- Funding of SAE CRP reduces financial burden to the industry

Current Sponsors

- Arkema (Autofina)
- Behr
- DaimlerChrysler
- Delphi
- Denso
- DuPont
- Ford
- Fujikoki
- General Motors
- Goodyear
- Honeywell
- Ineous Fluor
- Japan Fluor Mfg Assoc
- Nissan
- Parker Hannifin
- Sanden
- Solvay
- TI Automotive
- Toyota
- Viking Plastics
- Visteon

Program Organization

CORE GROUP

Tier One	Tier Two	OEM	Industry

SAE

- *Overall Project Management*
- *Financial Oversight*
- *Funding strategy*
- *Educate management*

Leakage	Efficiency	Vehicle Load	Service
Members: •Tier 1 suppliers •Tier 2 suppliers •OEM's •MACS and Members •EPA •Refrigerant Suppliers •Other	**Members:** •OEM's •Tier 1 suppliers •EPA •Universities •Other	**Members:** •OEM's •Tier 1 suppliers •NREL •Universities •Other	**Members:** •OEM's •Tier 1 suppliers •EPA •MACS and Members •Other

- *Overall Technical Leadership*
- *LCA & Cost Benefit Analysis*
- *Sub-group Coordination*

OEM Advisors
- **GM**
- **Ford**
- **DCX**

To advise in case of proprietary technologies

I-MAC CRP Teams

	Team1	Team2	Team3	Team4
Team Name:	Refrigerant Leakage Reduction	A/C System Efficiency Improvement	Vehicle Thermal Load Reduction	Service Refrigerant Loss Reduction
Total Number of Team Members:	24	16	8	18
OEM's:	5	4	3	1
Tier1's:	13	8	1	6
Others:	6	4	4	11
Goals:	Reduction in Leakage	Improved COP	Load Reduction, Improved Comfort	Reduction in refrigerant losses at service

Team 1 - Refrigerant Leakage Reduction

- **Goal:**
  - **Reduce HFC-134a mobile air conditioning system refrigerant direct emissions by 50%**

Progress to Date
Team 1

- **Identified 4 current production vehicles to baseline for refrigerant leakage rate**
  - **Dodge Caravan (dual system)**
  - **Ford F150**
  - **Toyota Camry**
  - **GM W Car**

- **New low emissions technologies may be applied to the following components**
  - **Fittings**
  - **O-rings**
  - **Seals**
  - **Hoses**

Progress to Date
Team 1

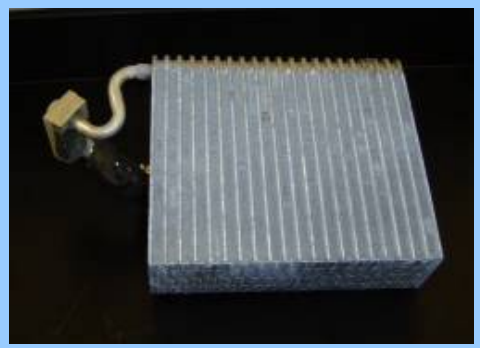
- Evaluated mini-shed test proposals
  - Procedure selected
  - Testing of baseline vehicles is on-going
- Evaluating procedures to identify high leakage systems during vehicle assembly
  - contamination
  - damage

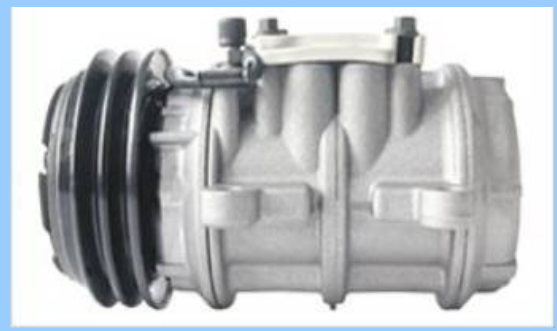
Deliverables - Team 1

- Develop SAE standard for
  - Component and system mini-shed test
  - Reclaim procedure to determine actual vehicle charge level
- Evaluate new low emissions technologies per standards

Team 2 - System Efficiency

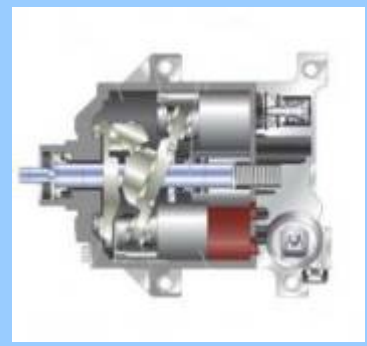
- **Goal:**
  - **Improve system COP by 30% over the ARCRP Enhanced HFC-134a system and demonstrate equivalent thermal performance in a vehicle**





Progress to Date Team 2

- Obtained vehicles
- Developed a list of potential improvements
  - Heat exchangers
  - Compressor
  - Oil separator
  - Airflow management
  - Improved system control
  - Expansion valve



- Currently selecting which improvements to test

Progress to Date
Team 2

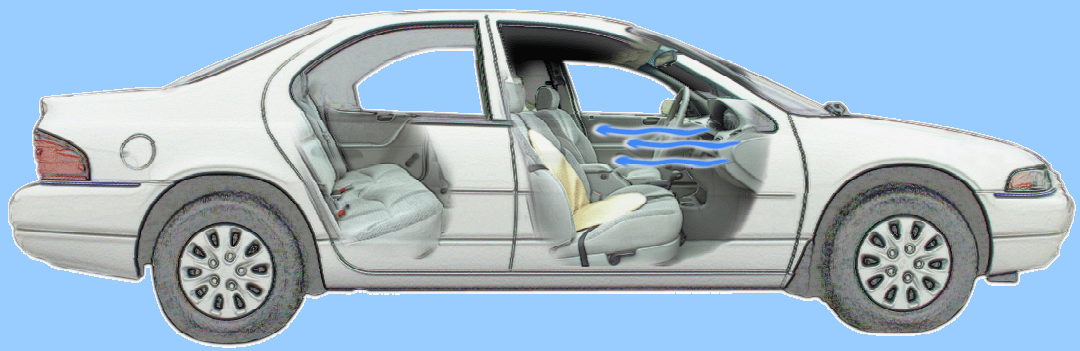
- Funds committed for initial testing
- Test components are currently being installed at the University of Illinois for initial evaluation

Deliverables-Team 2

- Improved system COP
- Evaluation of technologies with laboratory results
- Demonstration vehicles in 2005/06
- A/C test procedures & methods
  - SAE J-standards for measuring HFC-134a component and system performance
- Ranking of cost/benefits for various enabling technologies
- Communication and education materials

Team 3 - Vehicle Load Reduction

- **Goal:**
  - **Demonstrate vehicle level technologies that reduce the cooling load by 30%**



Points to Consider

- From Hyundai/Visteon joint effort (Sonata)
  - Focus on what is *feasible*, not what is *possible*
  - Reduced energy consumption is not sufficient motivation for US market
- Confounding technologies
  - A given technology may reduce thermal load while cruising, increase it while soaking
  - Impact on cold-weather climates
- Technologies are applicable for any refrigerant (HFC-134a, HFC-152a, R744)

Progress to Date Team 3

- Discussions with suppliers
  - Webasto; power ventilation devices
  - W.E.T; improved comfort seats
  - Exatec; polycarbonate solar reflective glazing
  - BASF & Ferro; solar reflective paint
  - PPG; solar reflective glazing
  - Aerogel; lightweight insulation

- Generated list of target technologies and approximated impact on comfort
- Developing (at NREL) model to estimate a technology's impact on time to comfort and power consumption

Deliverables-Team 3

- Procedure for evaluation of technology
- Evaluation of technologies in laboratory and field
- Demonstration vehicle in 2005 and 2006
- Ranking of approximate cost/benefits for various technologies
- Communication and education materials

Team 4 - Reduction in Refrigerant Loss During Servicing

- **Goal:**
  - **Reduce refrigerant losses at service and end of life by 50%**

Progress and Plans
Team 4

1. Leak detection tools & procedures
   - Identified facilities and parameters for testing
   - Determine status of current technology
2. Service equipment & procedures
   - Developed test procedures to determine how much of charge is being removed in service recovery
   - Evaluation of different equipment and manufacturers
   - Evaluation of techniques to improve recovery

Progress and Plans
Team 4

3. **Replacement of flexible coupled hose assemblies in the field**
   - **Identify and test a specific assembly for leakage**
   - **Develop a cost-effective means of field evaluation of assemblies**
4. **Determine best A/C system design practices to reduce cost/complexity and minimize emissions during service**

Progress and Plans
Team 4

5. **Investigate refrigerant mass imbalance**
   - **Amount sold ≠ Amount used**
6. **Vehicle end-of-life**
   - **Established contact with Automotive Recyclers Association and Institute of Scrap Recycling Industries**
   - **Researched regulations**
   - **Identified potential problem areas that need to be addressed**

Deliverables - Team 4

- **Evaluate and recommend improvements for service tools, equipment, and service procedures**
  - **new or revised standards**
- **Quantify and address losses from one-way refrigerant containers**
- **Produce educational materials and conduct outreach to reduce refrigerant emissions**

Reasons to be Involved in the I-MAC CRP

- Good for national energy security and the environment
- Participate in the development of:
  - New A/C system requirements for North American market
  - New A/C design standards for components and total system
  - New procedures and equipment for identification and containment of refrigerant during service
- Exposure of your component to the community
- Access to results of program


Demonstrate benefits of low emission MACs
Thank you