SAE Improved Mobile Air Conditioning Cooperative Research Program

Improved HFC-134a Refrigerant Systems
Mobile Air Conditioning Summit, Sacramento CA
March 15-16, 2005
John Rugh
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

<table>
<thead>
<tr>
<th></th>
<th>Industry</th>
<th>In-Kind Industry</th>
</tr>
</thead>
<tbody>
<tr>
<td>2005</td>
<td>$540,000</td>
<td>$900,000</td>
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<tr>
<td>2006</td>
<td>$500,000</td>
<td>$900,000</td>
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</tbody>
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March 15-16, 2005 I-MAC CRP
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 1

Leakage Reduction

Team 2

Efficiency Improvement

Team 3

Thermal Load Reduction

Team 4

Reduction of Losses During Service

Demonstration Vehicles

2005/2006
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**

- Leakages
- Efficiency
- Members:
  - Tier 1 suppliers
  - Tier 2 suppliers
  - OEM’s
  - MACS and Members
  - EPA
  - Refrigerant Suppliers
  - Other

**Tier Two**

- Vehicle Load
- Service
- Members:
  - OEM’s
  - Tier 1 suppliers
  - EPA
  - Universities
  - Other

**OEM**

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

**Industry**

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

**OEM Advisors**

- GM
- Ford
- DCX

To advise in case of proprietary technologies

March 15-16, 2005

I-MAC CRP
## I-MAC CRP Teams

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

March 15-16, 2005
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
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