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B-COOL

Low Cost and High Efficiency CO_2 Mobile Air Conditioning system for lower segment cars

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BCOOL Consortium

BCOOL - Low Cost and High Efficiency CO_2 Mobile Air Conditioning System for Lower Segment Cars -
is a project funded by the EU in the 6th framework

Consortium

In kind contribution: Schrader

Main Objectives

Development of a **low cost and high efficiency air-conditioning system based on CO_2** (R744) for A, B and similar vehicles (low C class or LCV)

Definition of **agreed methods** to assess:

- performance
- fuel annual consumption
- environmental impact

23 - 34 October 2006 - Paris
B-COOL

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B COOL Prototypes

CRF – Fiat Auto: Fiat Panda 1.2 l gasoline with automatic air conditioning system

FORD: Ford KA 1.3 l gasoline with manual air conditioning system

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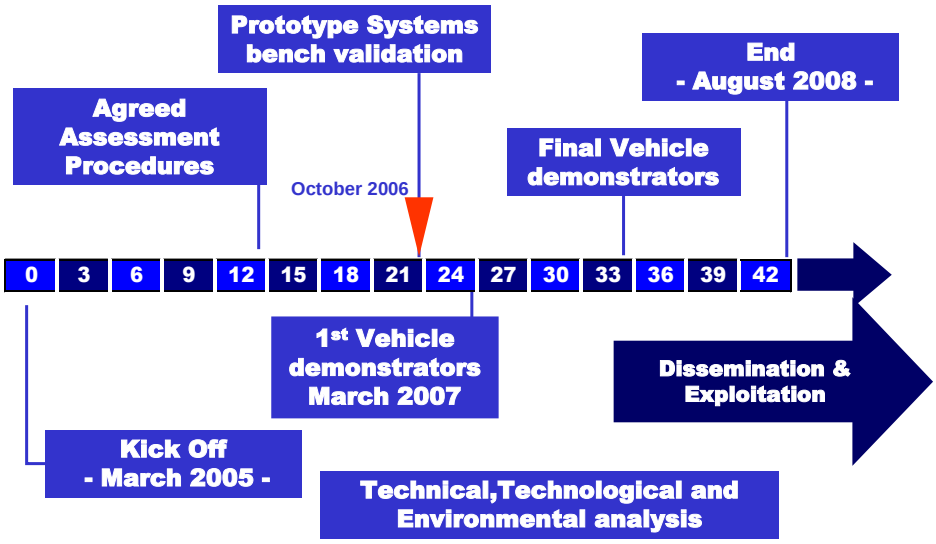
Project Scheduling



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Fuel consumption & comfort assessment

The procedure has been developed within the EU cluster **Highly efficient air conditioning systems with near zero green house gas emissions and elimination of hydro fluorocarbon (HFC)**

Two projects form the cluster:

- **BCOOL:** Low Cost and High Efficiency CO_2 Mobile Air Conditioning System for Lower Segment Cars
- **TopMacs:** Thermally OPerated Mobile Air Conditioning Systems

The procedure is conceived as a proposal for a common method to qualify the Mobile Air Conditioning System so to compare systems based on different approaches or technologies.

The procedure is under examination in the framework of the UNEP initiative named EcoMAC and of ACEA (EU Car Manufacturers Association)

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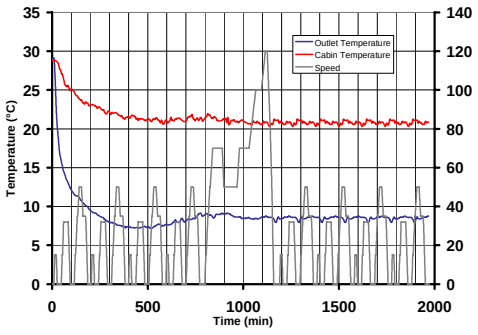
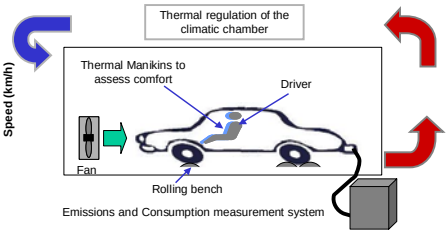
Fuel consumption & comfort assessment



Test Chamber with no irradiation lamps



A modified NEDC cycle is used

Cycles with and without A/C are performed

The fuel consumption is calculated as:

1st ECE consumption/2 + EUDC consumption + 2nd ECE consumption/2

All tests are carried out with the engine hot

Test Conditions

Mean European Summer Climate Conditions

28°C – 50% R.H Test => Cabin Set Point: 20°C

Severe Summer Conditions

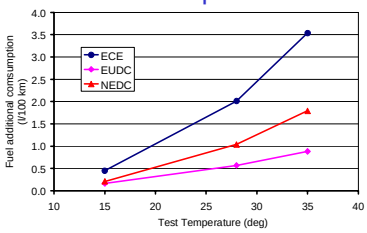
35°C – 60% R.H Test => Cabin Set Point: 23°C

Mid Season Conditions

15°C – 70% R.H Test => Cabin Set Point: 20°C

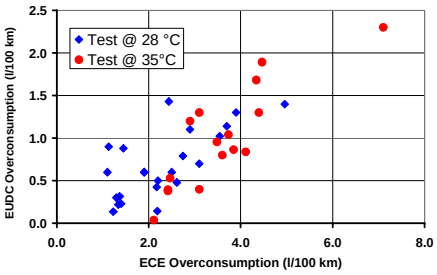
Fuel consumption & comfort assessment

Example of Fuel A/C consumption measurements

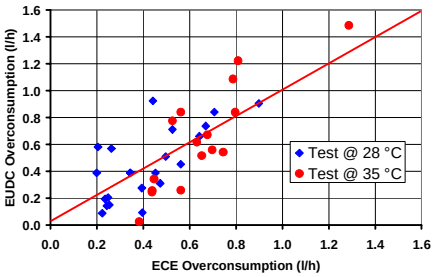


Consumption vs temperature

Fuel consumption per 100 km



Hourly Fuel consumption



Fuel consumption & comfort assessment

A **Figure of Merit**, based on the **Operative Temperature** measurements, has been introduced **to exclude systems with poor performance**.

Skin Elements

an SIXTAU
Integrated Systems for Automation and Testing

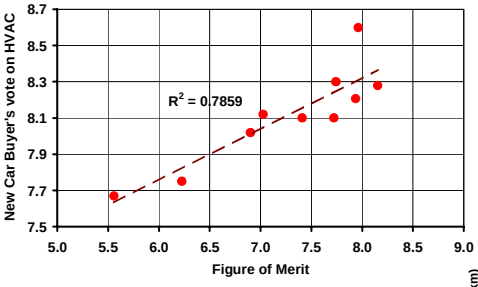
The **Operative Temperature** takes into account the effect of air flow, irradiation and air temperature on thermal exchange

The CRF manikin is based on the “skin elements” concept where each sensor measures the:

- Operative Temperature
- Air temperature
- Relative Humidity
- Local air speed

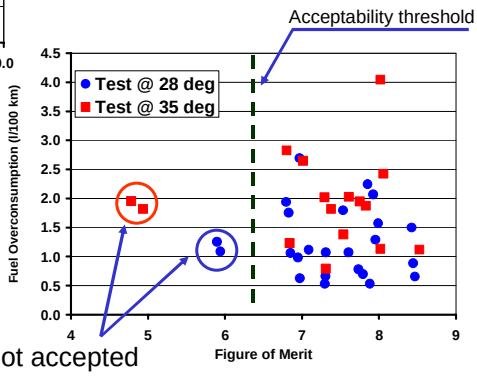
A specific model of the human thermoregulatory system allows the evaluation of different clothing and metabolism

Fuel consumption & comfort assessment



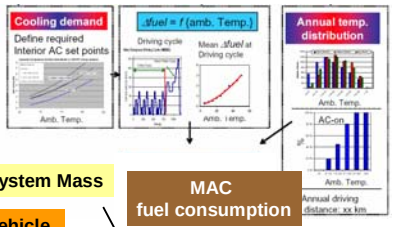
Correlation of the Figure of Merit with the New Car Buyers vote on HVAC

Application of the criteria to a panel of vehicles tested following the B-COOL procedure to assess the fuel consumption of a MAC system



Vehicles not accepted

LCCP (Life Cycle Climate Performance) assessment



A procedure to assess the LCCP has is under refinement to compare the environmental impact of MAC systems

Inputs:
- annual HFC leakage
- End of Life
- Lifetime services

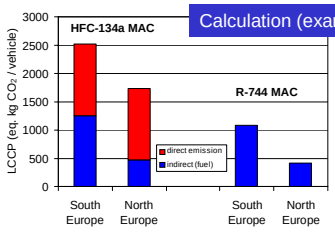
System Mass

Vehicle Mission

MAC fuel consumption

Direct GHG emissions
+
Fuel Consumption => CO_2 emissions → CO_2 emissions
=
LCCP

Calculation (example)



Inputs (example)

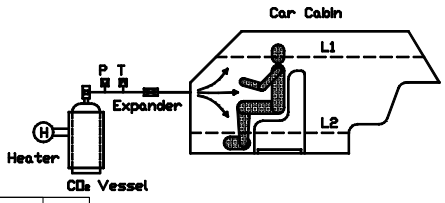
Direct emissions input:
- annual HFC leakage: 20 g/a
- End of Life: 20 %
- Lifetime services: 5

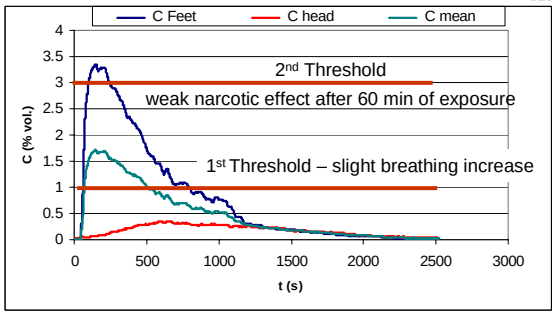
	at 35°C	at 28°C
HFC-134a	**2.2**	**1.0**
R-744	**2.3**	**0.8**

Safety Assessment

- A procedure to evaluate the safety issue has been proposed and it is under validation
- Preliminary results have been obtained measuring the concentration of CO_2 in the cabin of a Fiat Panda and of a Ford Ka

Scheme of cabin CO_2 concentration measurements



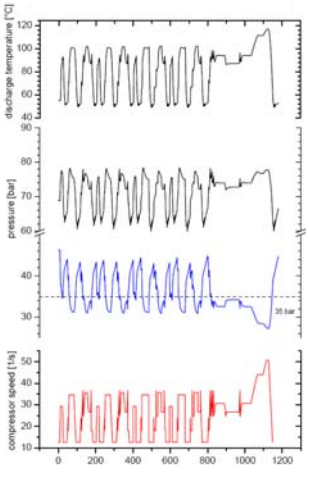


- Ventilation OFF
- Recirculation OFF
- 200 g CO_2 released
- 1 Passenger

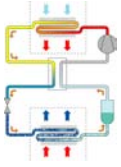
System Design

- A model of the system has been developed using the tool Modelica to identify the best architecture in terms of efficiency and cost
- The Fiat Panda System model has been completed, the Ford Ka model is under completion
- The first results show that the BCOOL system will have an average efficiency similar to the present R134a system

NEDC simulation



Simple scheme of a CO2 A/C system



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Demonstrator set up

- The integration on the vehicle is under completion: the vehicles will be equipped with the two different versions of the system before the end of 2006
- The first results on vehicles will be produced before March 2007 and will be confidential
- The first publishable results will be available after October 2007
- A second generation of demonstrators will be realised before March 2008

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Costs

No information can be disclosed at this stage of the activity

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Thank You!