QUANTIFICATIONAL ANALYSIS OF MAC FUEL CONSUMPTION ON EPA DRIVE CYCLE

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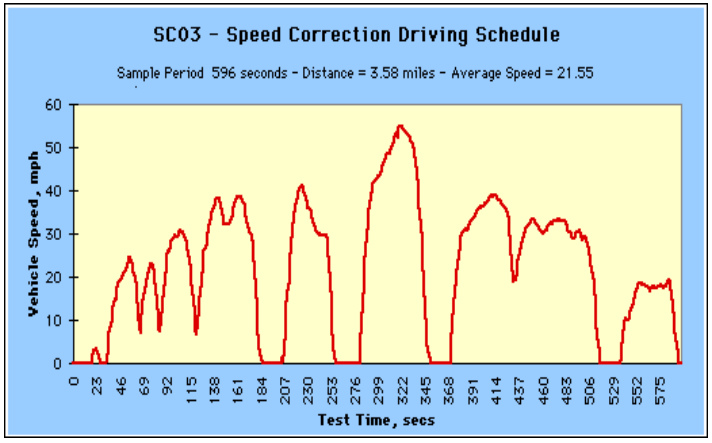


Agenda

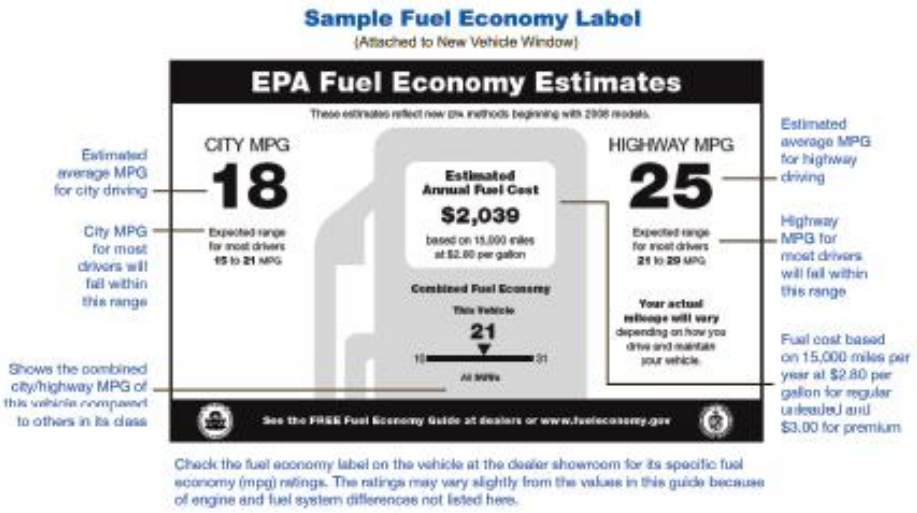
- The 5-Cycle Methodology
- EPA New Labeling Rule
- EPA Highlight Main Points
- NREL Information
- Vehicle Model Selection
- Dynamic Simulation
- Ambient Impact
- Cab Cooling Load Impact
- Condenser Impact
- Total Fuel Saving Potential

EPA New Labeling Rule EPA

New Estimates Effective This Year!

EPA has revised its methods for estimating MPG to better represent current real-world driving conditions. Beginning with 2008 model year vehicles, city and highway estimates will account for more aggressive driving (higher speeds and faster acceleration), air conditioner use, and cold temperature operation. Details about the new methodology are available at www.epa.gov/fueleconomy.

Vehicle Fuel Economy Labeling and the Effect of Cold Temperature, Air-Conditioning Usage and Aggressive Driving on Fuel Economy



Check the fuel economy label on the vehicle at the dealer showroom for its specific fuel economy (mpg) ratings. The ratings may vary slightly from the values in this guide because of engine and fuel system differences not listed here.

The 5-Cycle Methodology

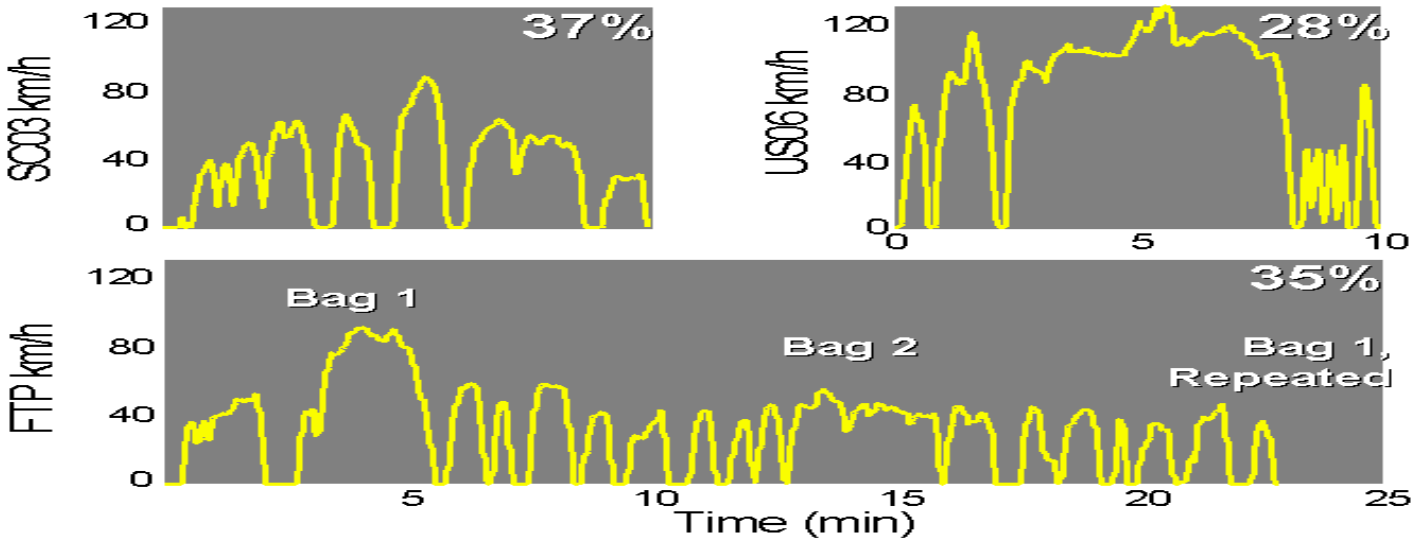
Table I-1.--Characteristics of the Fuel Economy and Emission Tests of the 5-Cycle Methodology

Test	Designed to represent	Avg speed (mph)	Max speed (mph)	Max accel (mph/sec)	Ambient conditions	Primary use
Federal Test Procedure (FTP).....	Urban stop-and-go driving from 1970's.	21	58	3.3	75 [deg]F.....	Emissions & fuel economy testing.
Highway Fuel Economy Test (HFET).....	Rural driving.....	48	60	3.3	75 [deg]F.....	Fuel economy testing.
US06.....	High speeds and aggressive driving.	48	80	8.5	75 [deg]F.....	Emissions testing.
SC03.....	Air conditioner operation.	22	55	5.1	95 [deg]F & 40% relative humidity.	Emissions testing.
Cold FTP.....	Cold temperature operation.	21	58	3.3	20 [deg]F.....	Emissions testing.

Fuel Economy Labeling of Motor Vehicles: Revisions To Improve Calculation of Fuel Economy Estimates

Federal Register: December 27, 2006 (Volume 71, Number 248)

NREL Information

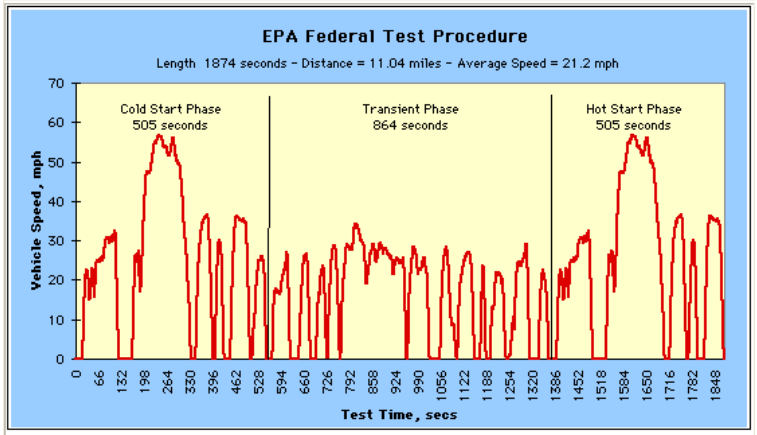


EPA indicates, ”Running electrical accessories (e.g., air conditioner) decreases fuel economy. **Operating the air conditioner on "Max" can reduce MPG by roughly 5-25% compared to not using it**”.

Drive Cycle w/o AC

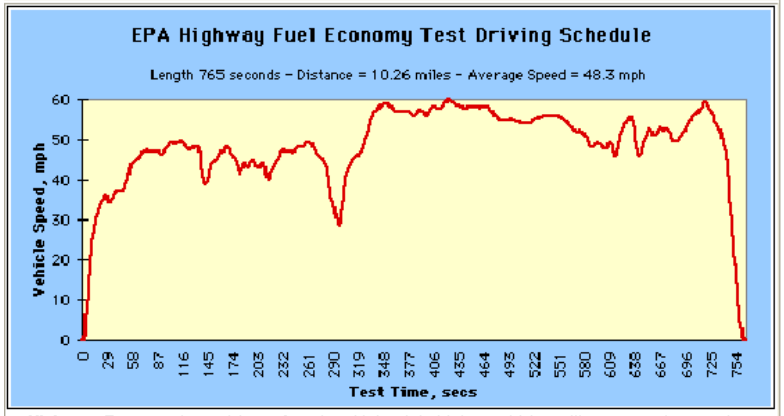
New Tests

City | Highway | High Speed | Air Conditioning | Cold Temperature | Detailed Comparison



City: Represents urban driving, in which a vehicle is started with the engine cold and driven in stop-and-go rush hour traffic.

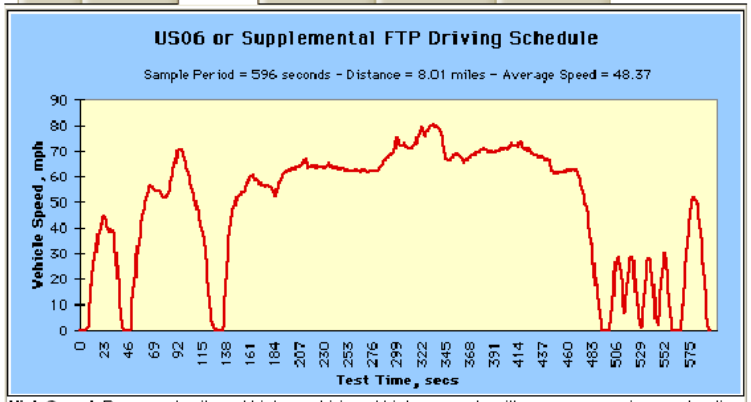
City | Highway | High Speed | Air Conditioning | Cold Temperature | Detailed Comparison



Highway: Represents a mixture of rural and Interstate highway driving with a warmed-up engine,

New Tests

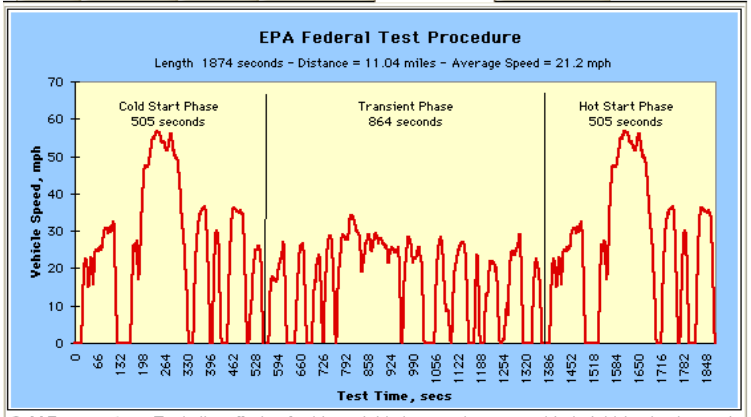
City | Highway | High Speed | Air Conditioning | Cold Temperature | Detailed Comparison



High Speed: Represents city and highway driving at higher speeds with more aggressive acceleration and braking.

New Tests

City | Highway | High Speed | Air Conditioning | Cold Temperature | Detailed Comparison



Cold Temperature: Tests the effects of colder outside temperatures on cold-start driving in stop-and-go traffic.

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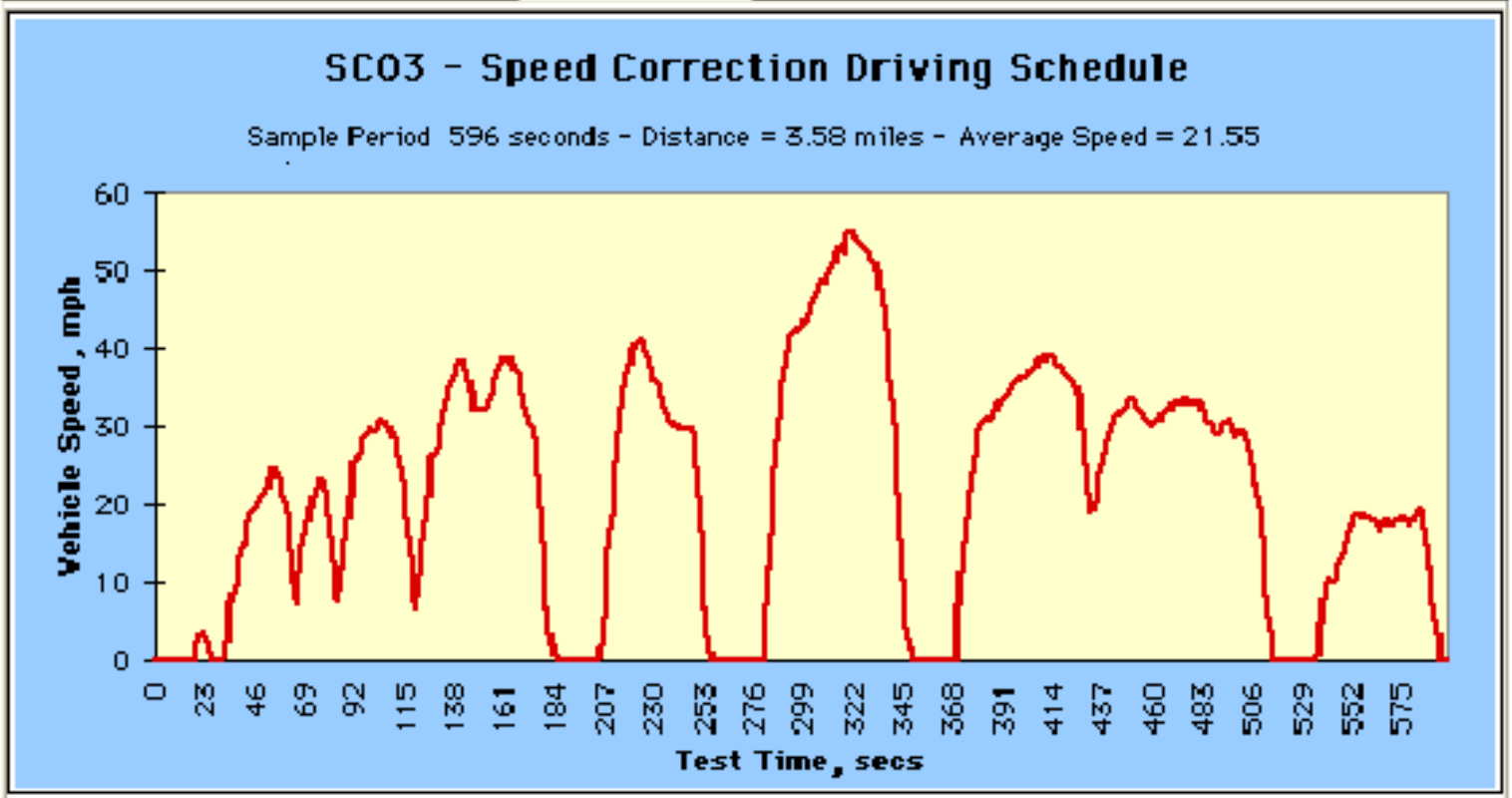
Drive Cycle SC03 W/ AC Schedule

City | Highway | High Speed | Air Conditioning | Cold Temperature | Detailed Comparison



Air Conditioning: Account for air conditioning use under hot outside conditions (95°F sun load).

http://www.fueleconomy.gov/feg/fe_test_schedules.shtml

5-Cycle Test Schedule Summary

City | Highway | High Speed | Air Conditioning | Cold Temperature | Detailed Comparison

Driving Schedule Attributes	Test Schedule				
	City	Highway	High Speed	AC	Cold Temp
Trip Type	Low speeds in stop-and-go urban traffic	Free-flow traffic at highway speeds	Higher speeds; harder acceleration & braking	AC use under hot ambient conditions	*City* test w/ colder outside temperature
Top Speed	56 mph	60 mph	**80 mph**	54.8 mph	56 mph
Average Speed	21.2 mph	48.3 mph	48.4 mph	21.2 mph	21.2 mph
Max. Acceleration	3.3 mph/sec	3.2 mph/sec	**8.46 mph/sec**	5.1 mph/sec	3.3 mph/sec
Simulated Distance	11 mi.	10.3 mi.	8 mi.	3.6 mi.	11 mi.
Time	31.2 min.	12.75 min.	9.9 min.	9.9 min.	31.2 min.
Stops	23	None	4	5	23
Idling time	18% of time	None	7% of time	19% of time	18% of time
Engine Startup*	**Cold**	Warm	Warm	Warm	**Cold**
Lab temperature	68-86°F			**95°F**	**20°F**
Vehicle air conditioning	Off	Off	Off	**On**	Off

* A vehicle's engine doesn't reach maximum fuel efficiency until it is warm.

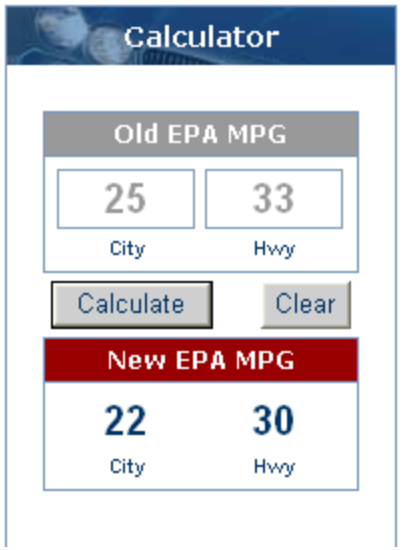
Difference of New/Old Sticker

New MPG	Old MPG
25	28
22 City / Combined / 29 Hwy	26 City / Combined / 32 Hwy

2006 Ford Focus
Automatic 4-spd
4 Cylinders
2 Liters
Regular Gasoline

New MPG	Old MPG
18	20
16 City / Combined / 23 Hwy	18 City / Combined / 25 Hwy

2007 Chrysler Pacifica 2WD
Automatic 4-spd
6 Cylinders
3.8 Liters
Regular Gasoline



So beginning with 2008 model-year cars, the EPA is including results from three additional test cycles in their calculations: One that includes more aggressive acceleration and highway speeds up to 80 miles-per-hour, another with the use of air conditioning, and finally a 20-degree cold start. Yolanda Vazquez ,MotorWeek

Impacts On the Major Automakers

Table II.-4.--Effect of New Methods on Fuel Economy Estimates for Major Manufacturers

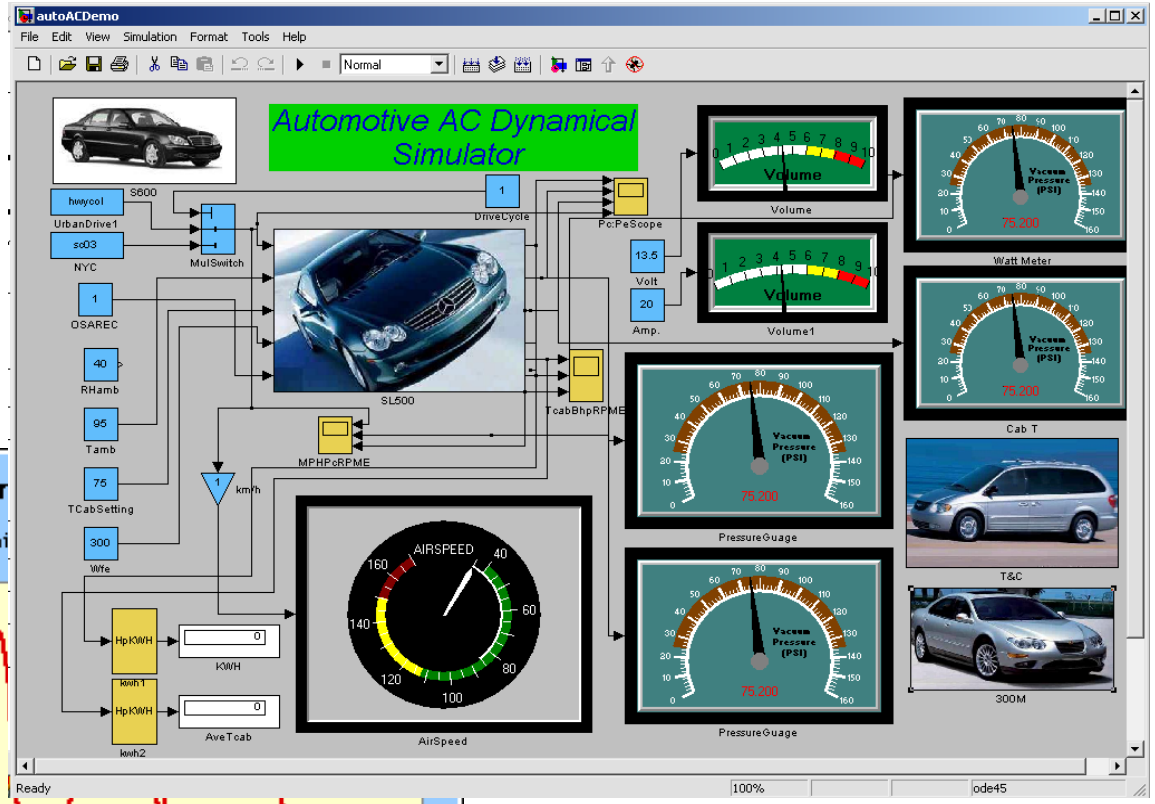
Manufacturer	2005 U.S. market share (percent)*	Average change in city fuel economy estimate (percent)	Average change in highway fuel economy estimate (percent)
General Motors	25.9	-10	-11
Ford Motor Co	17.9	-12	-10
DaimlerChrysler	14.9	-10	-11
Toyota	13.7	-11	-7
Honda	8.9	-13	-7
Nissan	6.1	-11	-7
Hyundai	2.9	-13	-8
Average	.....	-12	-8

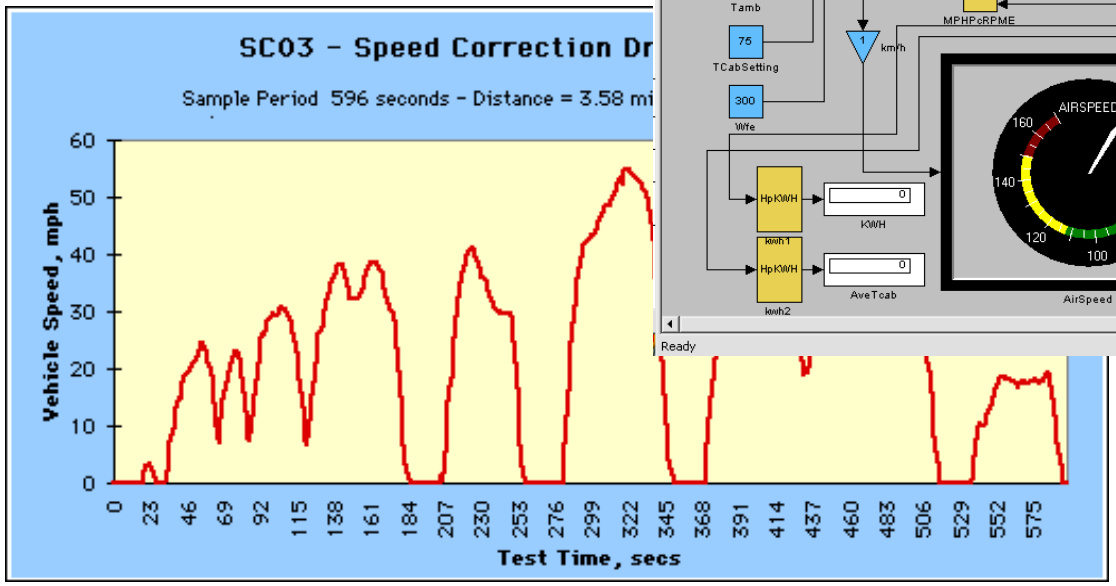
* Source: Autodata Corp., Woodcliff Lake, New Jersey.

Vehicle Model Selection

A. Typical compact car	B. Typical SUV
Weight = 2361 lb Vehicle CD = 0.312 Width = 66.9 in Height = 56.3 in Frontal face area = 2.06 (m^2) Engine displacement = 1.9 L SC03 29.1 MPG HWY 33.7 MPG	Generated by 2002 version of ADVISOR Weight* = 3997 lb Vehicle CD = 0.44 Frontal face area = 2.66 (m^2) Engine displacement = 3.0 L SC03 17.6 MPG HWY 19.2 MPH

Dynamic Simulation





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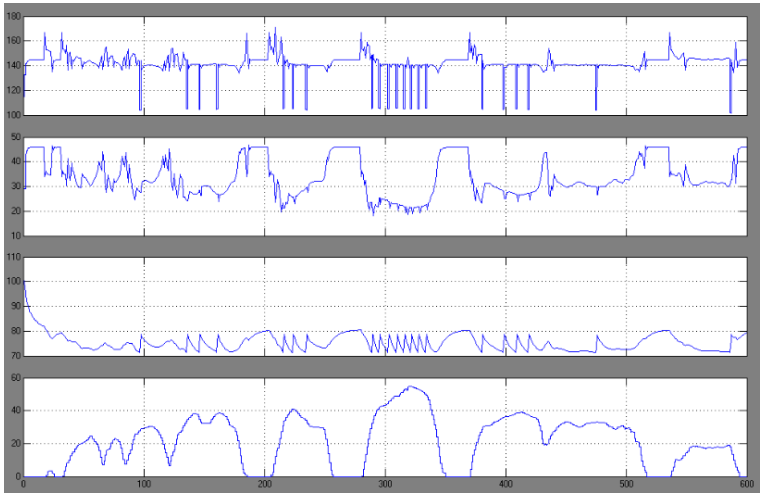
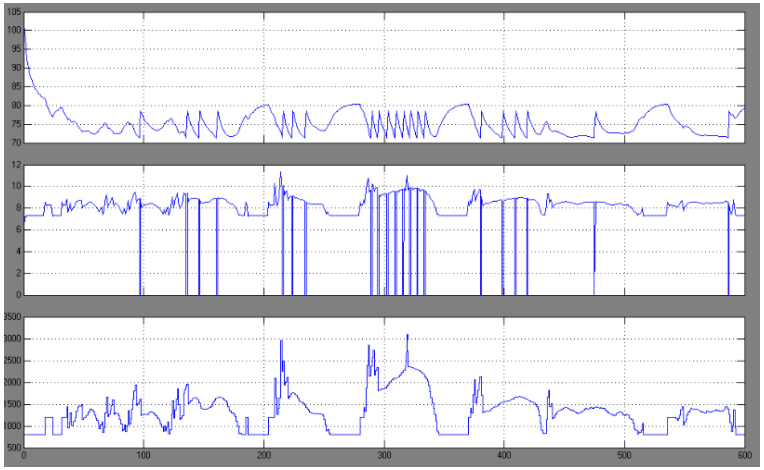
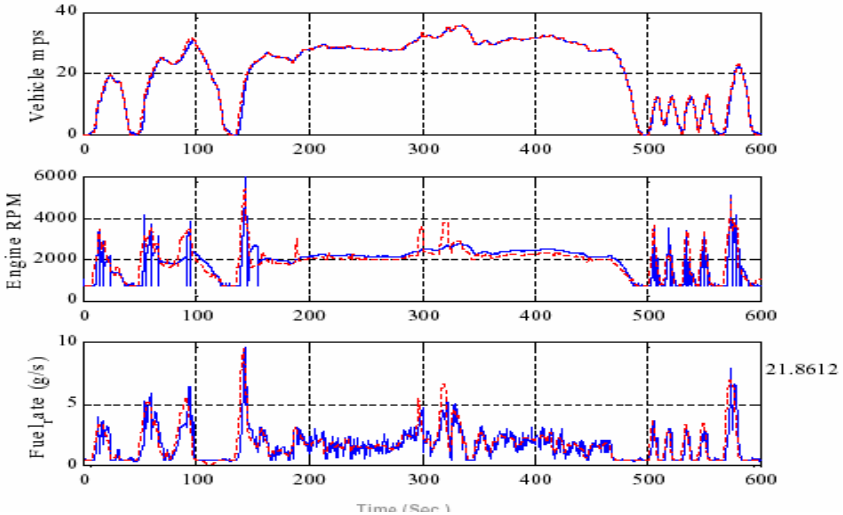
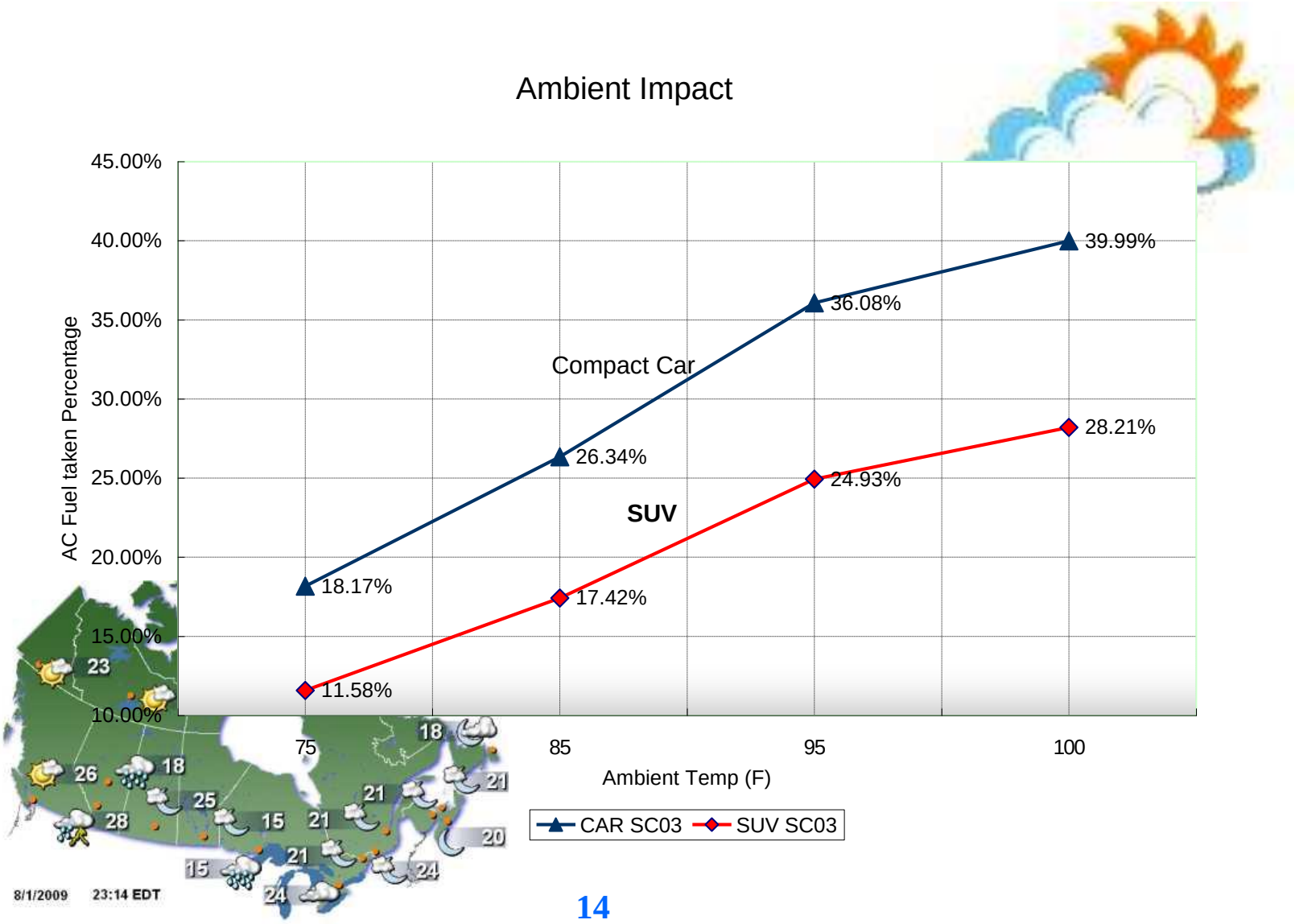
Simulation Process







Ambient Impact



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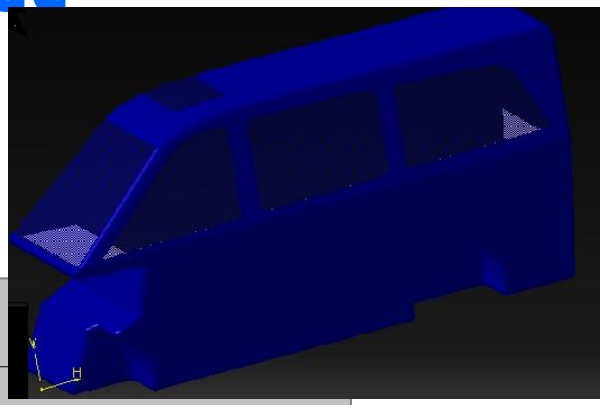
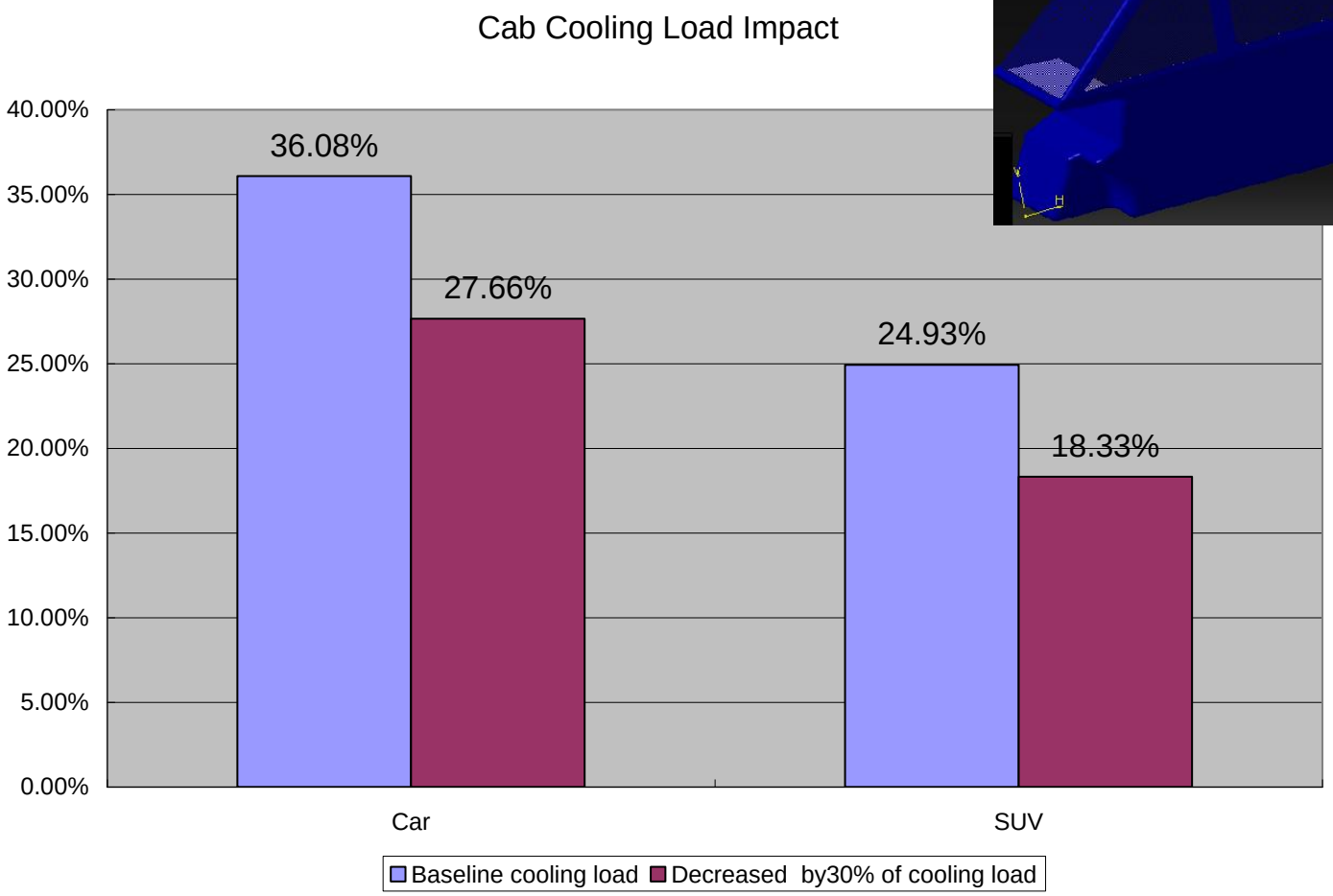
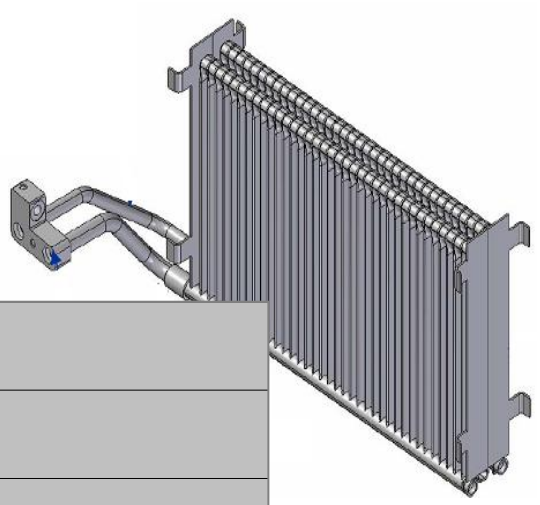
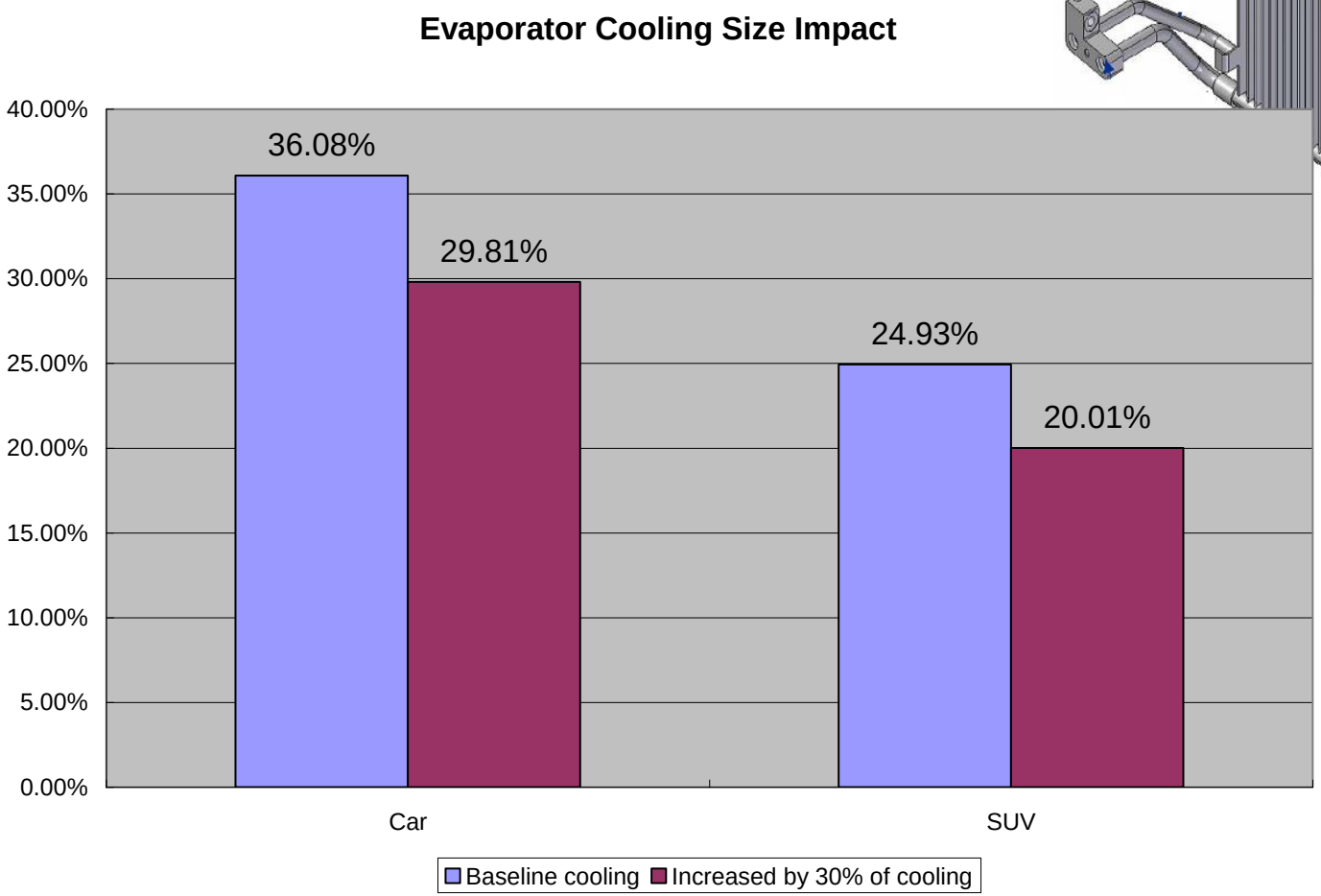
Cab Cooling Load Impact



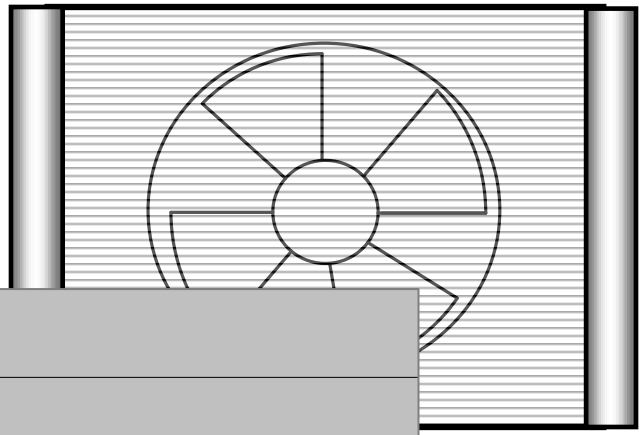


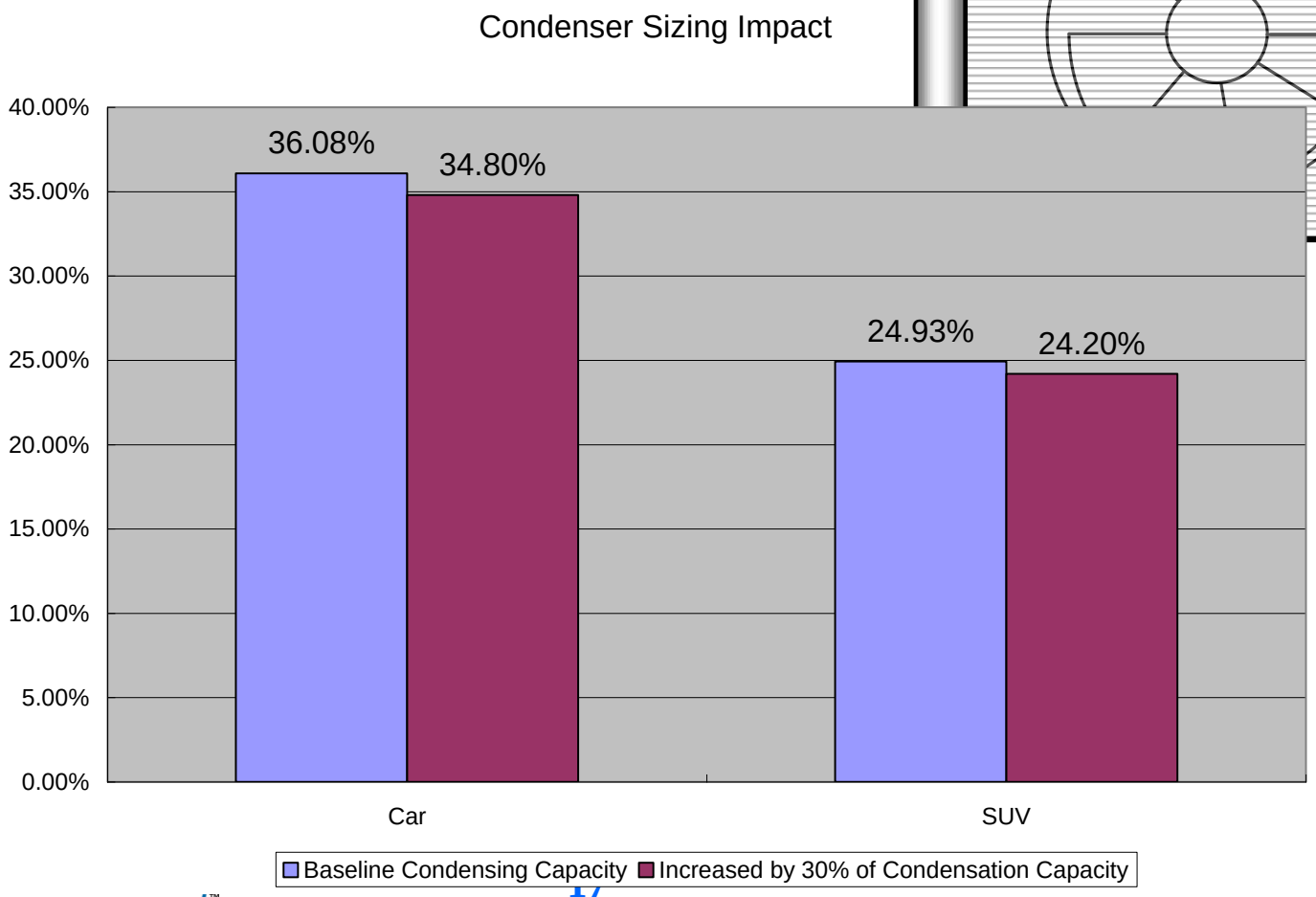
Evaporator Impact





Condenser Impact

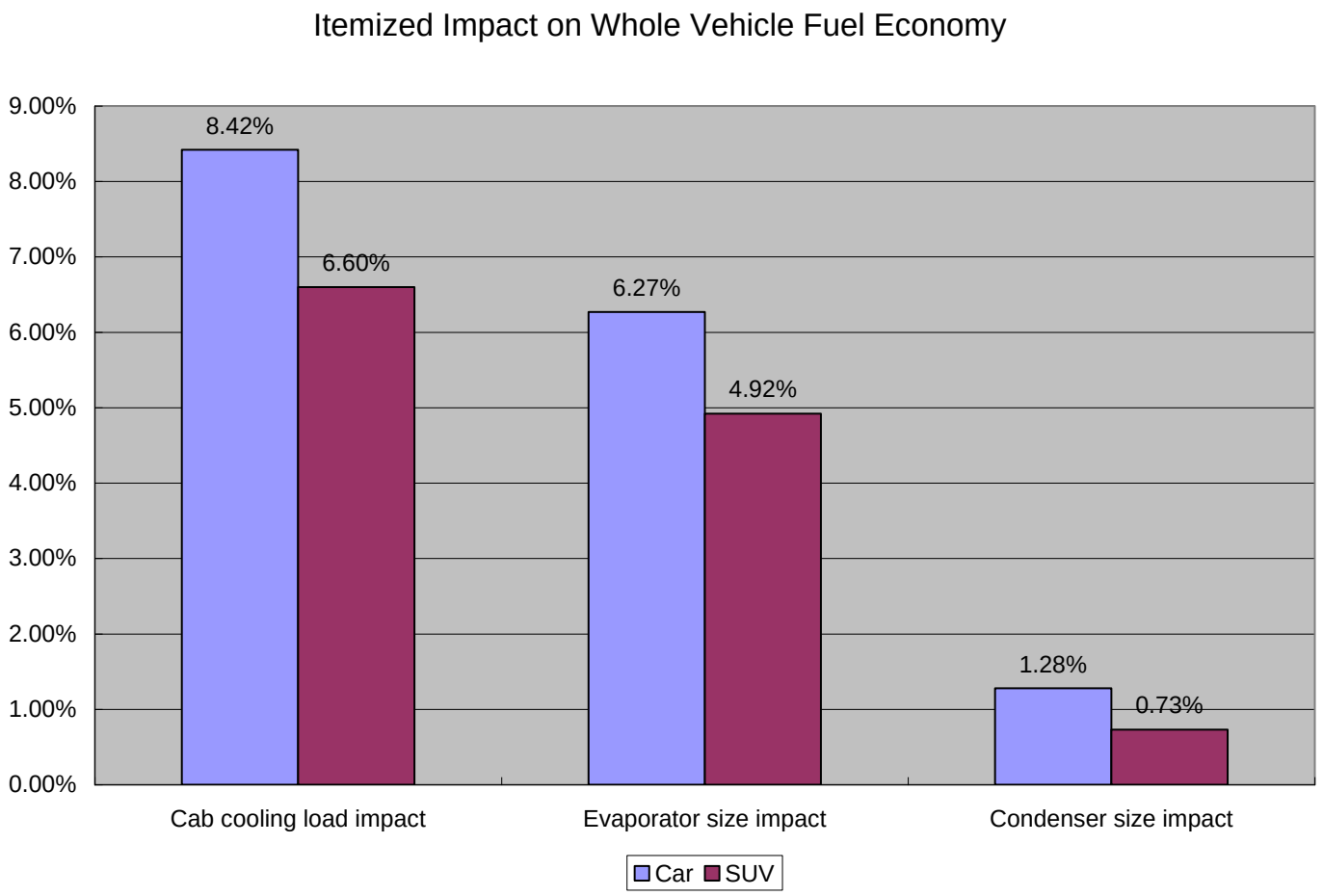




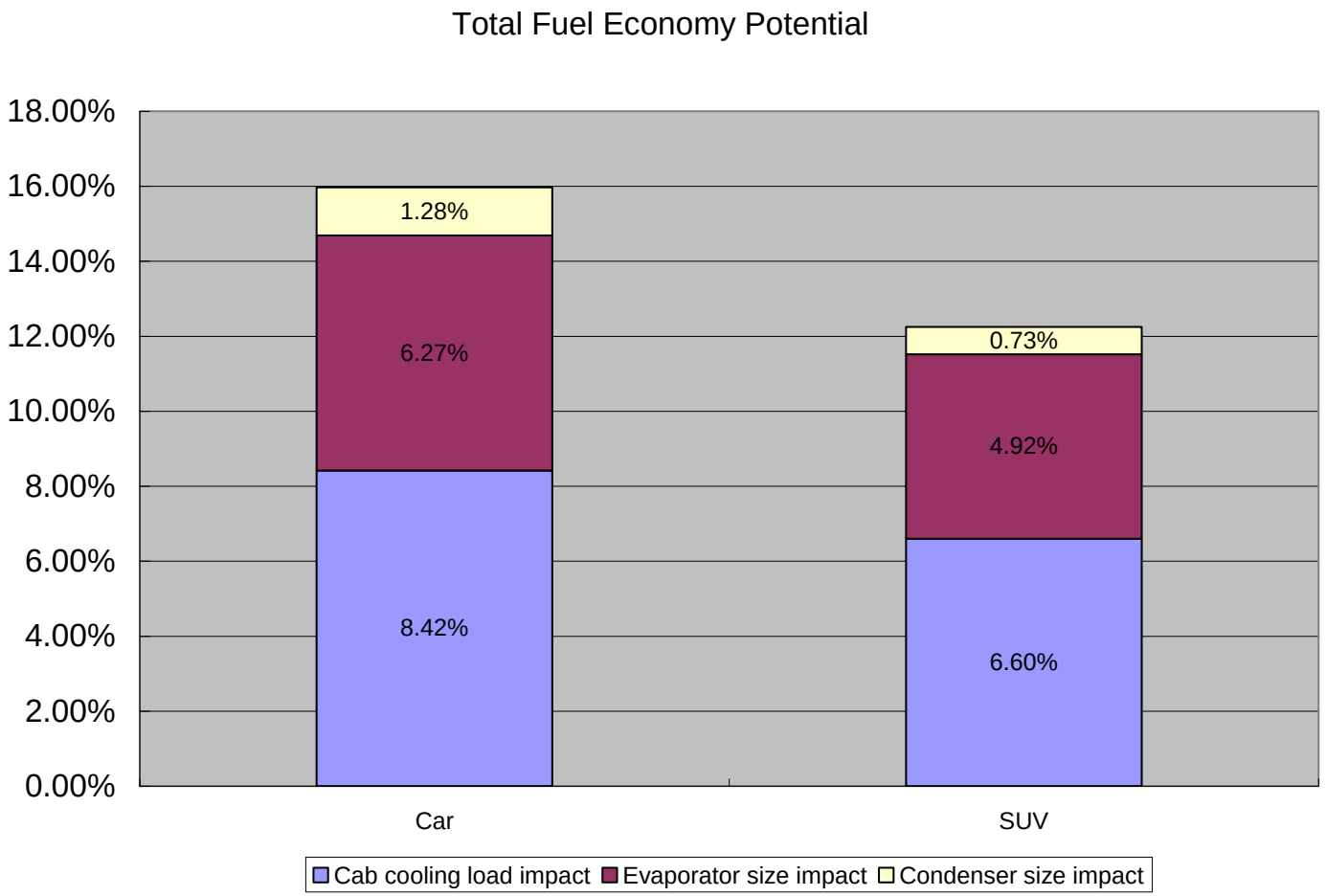
Total Impact Analysis

Impacting Items	Car	SUV
Cab Cooling Load Impact	Fuel Use percentage	
Baseline Cooling Load	36.08%	24.93%
Decreased By 30% Of Cooling Load	27.66%	18.33%
Improvement On Whole Vehicle Fuel Saving	8.42%	6.60%
Evaporator Sizing Impact	Fuel Use percentage	
Baseline Cooling	36.08%	24.93%
Increased By 30% Of Cooling	29.81%	20.01%
Improvement On Whole Vehicle Fuel Saving	6.27%	4.92%
Condenser Sizing Impact	Fuel Use percentage	
Baseline Condensing Capacity	36.08%	24.93%
Increased By 30% Of Condensation Capacity	34.80%	24.20%
Improvement On Whole Vehicle Fuel Saving	1.28%	0.73%
Total Potential Fuel Saving On Whole Vehicle	**15.97%**	**12.25%**

Itemized Impacts



Total Fuel Saving Potential



THANKS & QUESTIONS

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