CHRYSLER

April 29, 2013

Attn: Linc Wehrly

U.S. Environmental Protection Agency
Office of Transportation & Air Quality
Assessment and Standards Division
2000 Traverwood Drive
Ann Arbor, MI 48105

Re: Application for Alternative Methodology for Off-Cycle Technology Credits

As discussed in our meeting, January 9th, 2013, Chrysler Group LLC ("Chrysler") is applying for 2009-2013MY alternative methodology off-cycle technology credits for Passenger Cars and Light-Duty Trucks requiring Federal Register notice.

Off-cycle technologies were acknowledged by EPA as an important contributor for lowering greenhouse gases and reducing petroleum dependence in the 2012-2016MY and 2017-2025MY greenhouse gas and fuel economy rules.

The off-cycle technologies being considered in this application have met the required alternative (non 5-cycle) methodologies as described in 75 FR 25440. The technologies included in this application are thermal control and high efficiency exterior lights. Attached in the appendix are details of the alternative methodologies, the estimated credit levels, and sample calculations. The methodologies are supported by Society of Automotive Engineering (SAE), National Renewable Energy Lab (NREL) and internal Chrysler analyses.

Chrysler is a full line automotive manufacturer engaged in the design and production of light-duty vehicles ranging from compact passenger cars to full size pickup trucks. Chrysler is committed to implementing technologies that reduce greenhouse gases and fuel consumption.

Chrysler appreciates the opportunity to submit this application for off-cycle credits and looks forward to your timely review.

Sincerely,

Steven Mazure

Senior Manager - Vehicle Environmental Certification
Regulatory Affairs - Chrysler Group LLC

cc: Gary R Oshnock
Fuel Economy/GHG Programs, Regulatory Affairs, Chrysler Group LLC

APPENDIX

I. **Thermal Control Technologies**
   i. Solar Glass/Glazing
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APPENDIX I

Thermal Control Technologies

Thermal control technology off-cycle credits are calculated using average yearly duty-cycle under various climatic conditions.

i. Solar Glass/Glazing

Chrysler evaluates its glazing technologies using the SAE (2007-01-1194)[1] findings, which quantified the ability of solar thermal technologies that reduce air conditioning (A/C) fuel usage. The main goal of this SAE study was to demonstrate that advance thermal technologies can reduce cooling loads by 30% after a vehicle is parked in the sun.[1] The study further found that this 30% reduction in load equates to an average 26% reduction in fuel consumption.

The SAE data shown in Table 1.1[1] below, shows that the air breath temperature is reduced by 9.7°C when using solar glass with 33% total solar energy transmittance (42 Tts rating) . Using “Air Breath Temperature” to gauge occupant comfort levels is a standard industry practice.

Table 1.1

	Air-Foot	Air-Breath	Air	Dashboard	Roof Exterior	Front Driver Seat	Front Pass Seat	Windshield
Solar Reflective Glass-all locations, ventilation	5.6	12.0	8.8	16.8	9.8/6.0	10.3	11.9	20.4
Solar Reflective Glass-all locations	4.4	9.7	7.1	14.5	5.5	8.7	8.7	19.3

Using the data from the SAE study, one can interpolate that each 1°C reduction in the air breath temperature equates to 2.2% fuel usage reduction for the average vehicle. These calculations are shown in Table 1.2 below:

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[1] SAE [2007-01-1194] Reduction in Vehicle Temperature and Fuel Use from Cabin Ventilation, Solar-Reflective Paint, and a New Solar-Reflective Glazing

Table 1.2

Technology	Air Breath Temperature Reduction (°C)	Air Condition Load Reduction (%)	Air Condition Fuel Consumption Reduction (%)	A/C (%) Fuel Consumption Reduction per °C
Solar Glass + Ventilation	12.0	30	26	
Solar Glass	**9.7**	=30*(9.7/12) = 24.25	=26*(9.7/12) = **21**	= 21 / 9.7 = **2.2**

When the SAE study was conducted during the summer 2005 through 2006, industry was using solar light green glass with a Tts rating of 62 as its "baseline" glass. Therefore this delta in the air breath temperature reduction of 9.7°C on the 42 Tts glass in the modified vehicle was over a 62 Tts glass baseline vehicle. Chrysler is using solar glass with ratings better than 62 Tts on vehicles to reduce solar loads. The solar glass lowers the vehicle cabin air breath temperatures as detailed above and therefore Chrysler meets the off-cycle technology criteria. An example calculation for the off-cycle credit is shown below. The Air Breath Temperature Reduction vs Tts is shown in the table 1.3 and the relationship is plotted in Figure 1.1 below:

Table 1.3

Glass Technology	Glass Tts (%)	Air Breath Temperature Reduction (°C)
Baseline Glass	62	0
Glass Studied in SAE [2007-01-1194]	42	9.7

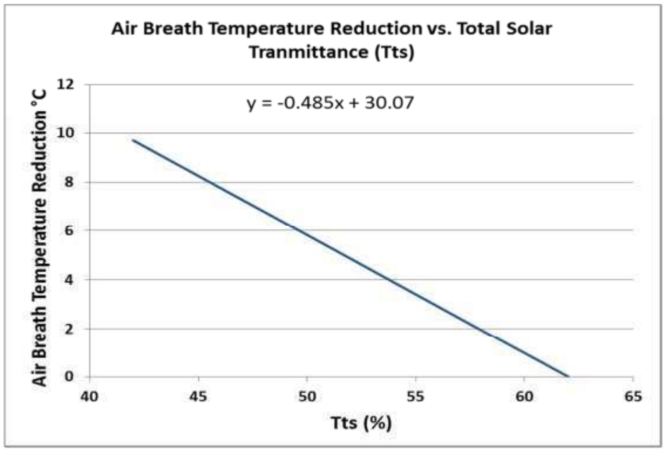

Figure 1.1 (Tts vs. Air Breath Temperature Reduction Plot)

Based on the above analysis, an example credit calculation is shown below for calculating off-cycle credits for 58 Tts solar glass.[2]

Example Off-Cycle Credit calculation for the solar glass:

Air Breath Temperature Reduction = (-0.485 * 58 + 30.07) = 1.94°C

A/C Fuel Consumption Reduction = 1.94°C * 2.2% / °C = 4.27%

Off-Cycle Credit:

Average Vehicle Off-Cycle Credit Car = 13.2 * 4.27/100 = **0.56** g/mile

Average Vehicle Off-Cycle Credit Truck = 15.2 * 4.27/100 = **0.65** g/mile

Where

- 13.2 g/mile is the average impact of A/C for car[3]
- 15.2 g/mile is the average impact of A/C for truck[3]
- 4.27 is the % A/C fuel consumption reduction with 58 Tts rated solar glass

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[2] Chrysler/Supplier testing on the base solar glass/glazing (ISO 13837)

[3] In the 2012-16MY rule, EPA estimated that the average impact of the A/C system load is 14.0 g CO_2/mile*. The Agency also estimated that the car/truck industry mix is 60/40. Utilizing this information, Chrysler calculates the A/C impact for the car and the truck based on the volume mix and normalized to Vehicle Miles Travelled (VMT) as shown in the table below.

Vehicle	VMT (Vehicle Miles Travelled)	A/C Impact (g/mile)
Fleet Average	207,504 = (0.6 *195264 + 0.4 * 225,865)	14.0
Car	195,264	13.2 = (14 *195264 / 207504)
Truck	225,865	15.2 = (14 * 225865 / 207504)

* 2017-25MY Joint Technical Support Document (on average impact of automotive air conditioning of 14.0 g/mile for the 2012 fleet).

Chrysler's solar glass is designed to provide benefit in lowering cabin air breath temperature while not interfering with the connectivity of cell phones, GPS, toll booth EZ pass, electronic tethers, etc.

ii. Solar Reflective Paint

John P. Rugh, Lawrence Chaney and Jason Lustbader of NREL[1] in this SAE study also determined that a 3M (CI-100T) solar reflective film with a total solar energy rejection (or TSER) of 59%[4], when installed on the roof lowered the average vehicle cabin air breath temperature by 1.2°C (refer figure 1.2). When coupled with the 2.2% fuel consumption reduction per °C from above, this equates to 2.64% (1.2°C x 2.2%/°C) less A/C fuel consumption.

The cool car study done by "California Energy Commission" [5] on low solar reflective (ρ = 0.05) black car and high solar reflectance (ρ = 0.58) silver car show that the temperature difference observed in the cabin air was about 5-6°C between the black and silver cars. The paper also states that each degree reduction reduces the compressor load by 2.3%.[5] This study show higher temperature reduction and benefits as compared to the NREL findings. Chrysler used NREL supporting studies to calculate off cycle credits for solar reflective paints.

TSER is a superior metric to near infra read (NIR) ratings for calculating the air breath temperature reduction since it covers the whole spectrum of light and therefore quantifies the total benefit of solar reflective paint more accurately. Chrysler has implemented solar reflective paint which qualifies for solar reflective paint off-cycle credits, on some vehicles.

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[4] Data tables attached from 3M product specification on CI-100T (used on the SAE study on solar reflective paint)

	Shading Coefficient	Visible Light Reflected	Transmitted	Emissivity	U Value	Heat Gain Reduction	Heat Loss	Glare	UV Block	Total Solar Energy Rejected
CI 100T	0.47	**8%**	71%	0.73	0.98	52%	6%	21%	99%	**59%**

[5] Cool Colored Cars to Reduce Air Conditioning Energy Use and Reduce CO2 Emission (Primary Author(s): Ronnen Levinson, Hashem Akbari, George Ban-Weiss, Heng Pan, Riccardo Paolini, Pablo Rosado, Michael Spears, Joyce Tam)

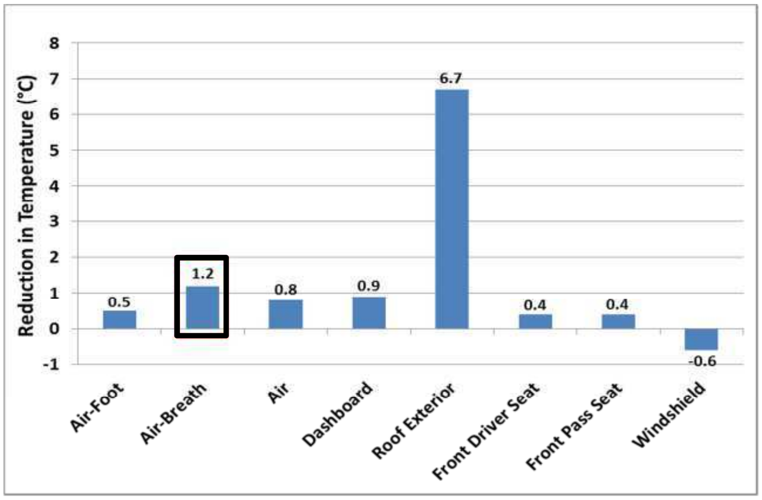

Figure 1.2[1]

Example Off-Cycle Credit calculation for the solar reflective paint:

A vehicle with solar reflective paint *total solar energy rejection* (TSER) rating of 59% (CI 100T 3M film tested by SAE)[4] qualifies for an off-cycle credit as follows:

Air Breath Temperature Reduction (SAE paper) [1] = 1.2°C
A/C Fuel Consumption Reduction = 1.2°C * 2.2% / °C = 2.64%

Off-Cycle Credit:

Average Vehicle Off-Cycle Credit Car = 13.2 * 2.64/100 = **0.35** g/mile
Average Vehicle Off-Cycle Credit Truck = 15.2 * 2.64/100 = **0.40** g/mile

Where

- 13.2 g/mile is the Average Impact of A/C for car[3]
- 15.2 g/mile is the Average Impact of A/C for truck[3]
- 2.64 is the % A/C fuel consumption reduction from solar paint (TSER $\geq$ 59)

Table 1.4 below shows the magnitude of off-cycle credits for paints based in TSER ratings. Chrysler believes that paints with TSER ratings of $\geq$ 59 should be awarded with full credit and the credit values should be scalable for paints with TSER ratings between 0 and 58.

Table 1.4

Paint	Paint 1	Paint 2	Paint 3	Paint 4	Paint 5

TSER Rating	≥ 59	57	42	30	20
Temp. Reduction °C	1.2	1.1	0.8	0.6	0.4
Off-Cycle Credit (g/mi) - Car	**0.4**	**0.3**	**0.2**	**0.1**	**0.1**
Off-Cycle Credit (g/mi) - Truck	**0.4**	**0.4**	**0.3**	**0.2**	**0.1**

iii. Ventilated Seats

SAE [2007-01-1194][1] study determines based on NREL's A/C fuel use model that 7.5% reduction in U.S. A/C fuel use could be achieved when adding ventilated seats without compromising driver comfort.

Example Off-Cycle Credit calculation for the ventilated seats::

A/C Fuel Consumption Reduction = 7.5%

Off-cycle credit:

Average Vehicle Off-Cycle Credit Car = 13.2 * 7.5/100 = **1.0** g/mile
Average Vehicle Off-Cycle Credit Truck = 15.2 * 7.5/100 = **1.1** g/mile

Where

- 13.2 g/mile is the Average Impact of A/C for car[3]
- 15.2 g/mile is the Average Impact of A/C for truck[3]
- 7.5 is the % A/C fuel consumption reduction from ventilated seats

APPENDIX II

Electrical load reduction:

i. High Efficiency Exterior Lights

LED lights require less electrical power and subsequently less fuel to operate. Since many of the lights are not activated during standard fuel economy tests, this technology would be considered an off-cycle technology. The power consumption of LED lights compared to conventional lights is well documented in a benchmark study performed by the University of Michigan Transportation Research Institute.[6]

Chrysler's current product portfolio does not include LED headlights (low beam or high beam). Additionally, LED stop/brake, back-up/reverse and CHMSL lights are not taken into consideration for

[6] "Schoettle, B., et al., "LEDS and Power Consumption of Exterior Automotive Lighting: Implications for Gasoline and Electric Vehicles," University of Michigan Transportation Research Institute, October, 2008"

power consumption reduction because the CO2 benefits from these lights are captured on the FTP emission cycles.

Below is the table 2.1 that defines power consumption of base and LED lights.

Table 2.1 (Power requirements of the traditional and LED-based exterior lighting systems) [6]

Light	Quantity	Base (watts)	LED (watts)	Power Reduction (watts)
Parking/position	2	14.8	3.3	11.5
Turn signal, front	2	53.6	13.8	39.8
Side marker, front	2	9.6	3.4	6.2
Tail	2	14.4	2.8	11.6
Turn signal, rear	2	53.6	13.8	39.8
Side marker, rear	2	9.6	3.4	6.2
License plate	2	9.6	1	8.6

Lighting is primarily used for night operation. Therefore, a VMT (vehicle miles traveled) usage fraction must be applied to determine the amount of power reduction for the real world driving. MOVES modeling data[7], applies a VMT discount of 28.2% for night lighting components. Turn signals also have a defined duty cycle. According to MOVES, turn signal light (day and night) usage is also discounted 95%. Table 2.2 below shows Chrysler's LED power reduction adjustments:

Table 2.2

Light	Reduction (watts)	VMT MOVES Usage	Total Reduction (watts)
Parking/position	11.5	28.2%	3.2
Turn signal, front	39.8	5.0%	2.0
Side marker, front	6.2	28.2%	1.7
Tail	11.6	28.2%	3.3
Turn signal, rear	39.8	5.0%	2.0
Side marker, rear	6.2	28.2%	1.7

[7] EPA MOVES model ver 2010a (http://www.epa.gov/otaq /models /moves/index.htm)

License plate	8.6	28.2%	2.4

To determine the amount of off-cycle credits, quantification of power reduction compared to tailpipe CO2 reduction is required. Utilizing simulation results, for every 100 watts of electrical energy saved, a reduction of 3.2g/mi CO2 can be utilized for off-cycle credits; i.e., 0.032 g/mi-watt.[8]

To calculate the off-cycle credit, the follow formula is utilized.

High Efficiency Exterior Lighting Credit =

(Reduction in watts) x VMT MOVES fraction x 0.032 g/mi-watt

The table 2.3 below is the tabulated off-cycle table credit for each LED light configuration.

Table 2.3

LED Light	Off-Cycle Credit (g/mi)
Parking/position	0.10
Turn signal, front	0.06
Side marker, front	0.06
Tail	0.10
Turn signal, rear	0.06
Side marker, rear	0.06
License plate	0.08

[8] "Project Report: Computer Simulation of Light-Duty Vehicle Technologies for Greenhouse Gas Emission Reduction in the 2020-2025 Timeframe", Contract No. EP-C-11-007, Work Assignment 0-12, Docket ID: EPA-HQ-OAR-2010-0799, Document ID: EPA-HQ-OAR-2010-0799-1144

<u>Example Off-Cycle Credit calculation for the high efficiency exterior lights</u>:

<u>Chrysler 300 LED (sample credit calculation):</u>

Parking/position	0.10
Side marker, front	0.06
Tail	0.10
Turn signal, rear	0.06
Side marker rear	0.06

Total lighting off-cycle credit = 0.38 g/mi

Glass Off-Cycle Description

- Per our Off-Cycle documentation:

- Example Off-Cycle Credit calculation for the solar glass:

  Air Breath Temperature Reduction = (-0.485 * 58 + 30.07) = 1.94°C

  A/C Fuel Consumption Reduction = 1.94°C * 2.2% / °C = 4.27%

  Off-Cycle Credit:

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  Average Vehicle Off-Cycle Credit Truck = 15.2 * 4.27/100 = 0.65 g/mile

  Where

  13.2 g/mile is the average impact of A/C for car

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Vehicle	VMT (Vehicle Miles Travelled)	A/C Impact (g/mile)
Fleet Average	207,504 = (0.6 *195264 + 0.4 * 225,865)	14.0
Car	195,264	13.2 = (14 *195264 / 207504)
Truck	225,865	15.2 = (14 * 225865 / 207504)

Calculation of Glass Off-Cycle Credit

Using Chrysler Group Glass Characteristics:

- First, calculate the glass size for windshield/rear/rear quarter (right+left)/Side front (right+left)/side rear(right+left).
- Obtain Tts for each individual window.
- We glass area weighted averaged the Tts rating for all glass on the vehicle line
  - = ∑(glass position*TTs) / Total Glass = Area Weighted Vehicle TTs (i.e. 50.4 for)
- Air Breath Temperature Reduction= (-0.485 * 50.4 + 30.07) = 5.6°C for
- A/C Fuel Consumption Reduction = 5.6°C * 2.2% / °C = 12.38% AC fuel consumption for
- Off-Cycle Credit = 15.2(Truck) * 12.38% /100 = 1.88 g/mile

On EPA Off Cycle Technologies GHG Reporting Template

- Total Credit = Off-Cycle Credit (g/mile) * VMT * Volume
- (i.e. 2009 – Row 30)
  - Off-Cycle Credit = 1.88 g/mile * 225,865 * 56,401 = 23,949Mg

Chrysler Group Glass Characteristics

Carline Name	Windshield (Sq Meter)	Rear (Sq Meter)	Rear Quarter Glass Rt & Lt (Sq Meter)	Side Front Doors (Sq Meter)	Side Rear Doors (Sq Meter)	Total Glass area (Sq Meter)
Ram 1500 Crew Cab	1.4	0.7	0.0	0.5	0.5	3.0
Fiat 500	1.0	0.4	0.2	0.5	0.0	2.2
Journey (5 passenger)	1.3	0.6	0.4	0.5	0.6	3.3
Journey (7 passenger)	1.3	0.6	0.4	0.5	0.6	3.3
Avenger/Sebring/200	1.2	0.8	0.0	0.7	0.6	3.2
Chrysler Sebring Convertible	1.2	0.7	0.0	0.7	0.6	3.2
Dodge Charger	1.2	1.1	0.0	0.4	0.3	3.1
Chrysler 300/SRT-8	1.2	0.8	0.0	0.8	0.6	3.5
Dodge Dart	1.3	0.9	0.0	0.4	0.4	3.0
Jeep Wrangler	0.6	0.6	0.5	0.5	0.5	2.7
Town & Country/Grand Caravan/Routon	1.6	0.7	0.7	0.5	0.9	4.5
Durango	1.3	0.6	0.5	0.4	0.6	3.3
Grand Cherokee	1.3	0.7	0.4	0.4	0.5	3.3
PT Cruiser	0.9	0.6	0.2	0.6	0.7	2.9
Dakota/Raider Extended Cab	1.0	0.5	0.1	0.3	0.0	2.0
Dodge Dakota Crew Cab	1.0	0.5	0.3	0.3	0.7	2.8
Dodge Caliber	1.1	0.5	0.2	0.7	0.5	3.0
Jeep Patriot 2WD	1.1	0.6	0.2	0.7	0.5	3.1
Jeep Patriot 4WD	1.1	0.6	0.2	0.7	0.5	3.1
Jeep Compass 2WD	1.1	0.6	0.2	0.7	0.5	3.1
Jeep Compass 4WD	1.1	0.6	0.2	0.7	0.5	3.1
Ram 1500 Regular Cab	1.4	0.7	0.0	0.5	0.0	2.5
Jeep Wrangler	0.6	0.6	0.8	0.4	0.0	2.5
Jeep Liberty/Dodge Nitro FWD	0.9	0.6	0.5	0.5	0.6	3.1
Jeep Liberty/Dodge Nitro AWD	0.9	0.6	0.5	0.5	0.6	3.1
Dodge Durango/Aspen	1.3	0.7	0.7	0.6	0.7	3.9
Jeep Commander	0.9	0.5	0.6	0.7	0.6	3.4
Ram 1500 Quad Cab	1.4	0.7	0	0.5	0.2	2.8
Ram Cargo Van (C/V)	1.6	0	0	0.5	0	2.1

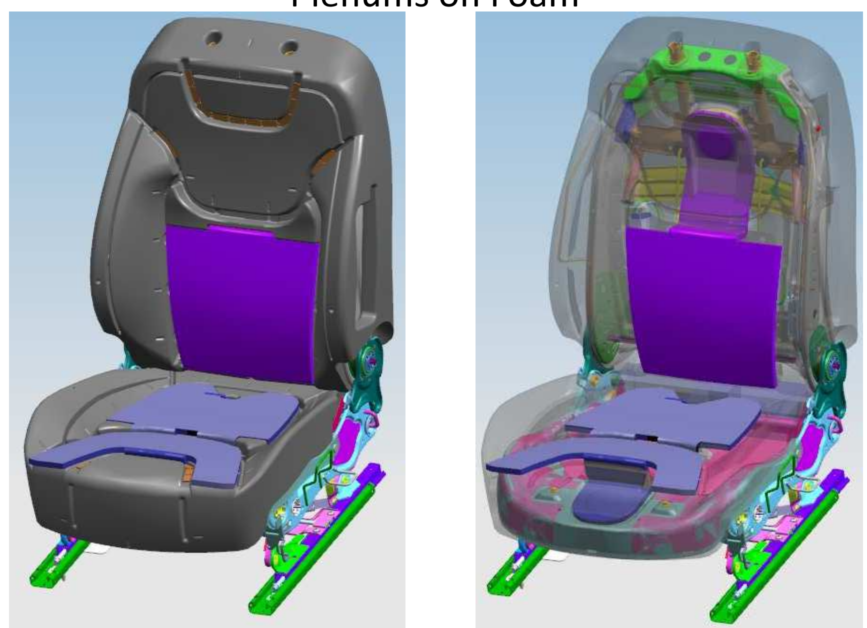
HVS Seat Overview

HVS key points:

- The fundamental seat vent system is draw type.
- There are 2 blowers in every seat – back and cushion, attached to frame.
- Blowers connect / seal to plenums. Plenums route air under occupant.
- Blowers receive PWR/GND from seat harness and PWM signal from CSWM module.
- The VP2/3/4 Radio has soft switches which sends request to CSWM to turn ON blowers.

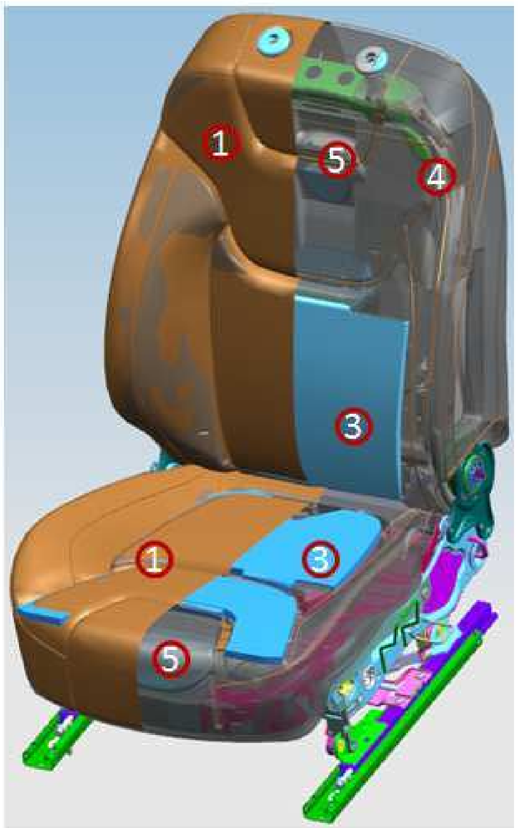
STO (Covers)

Plenums on Foam

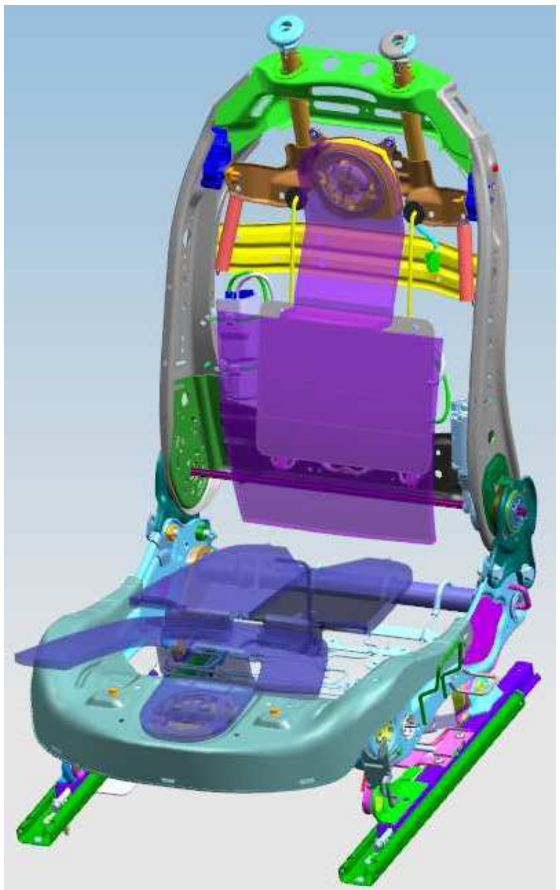


Seat Ventilation System Components (based on current KL foundation):

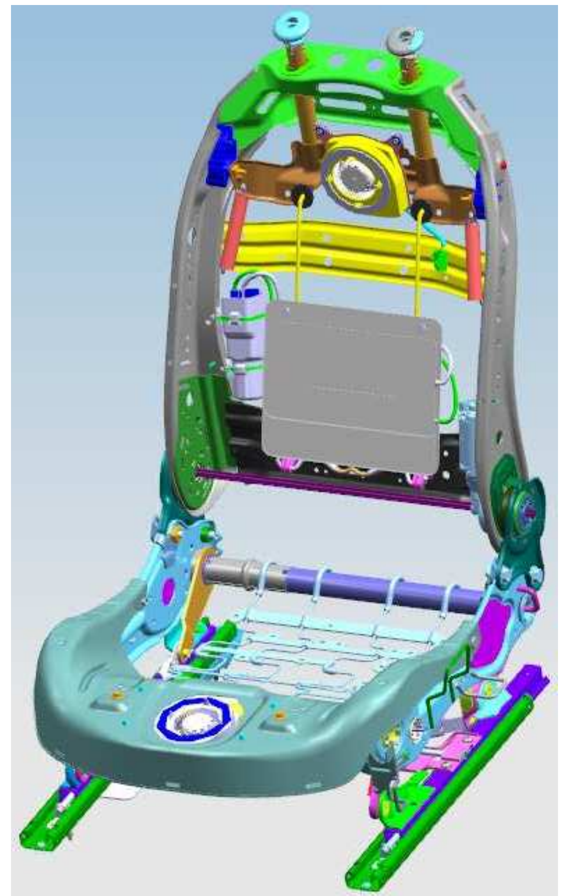
- Permeable seat layers (perforated leather or cloth (1), diffusion layer (2), vent plenum (3))
- Seat foams (4) built to accept ventilated system
- Seat cushion and back blowers (5) move air, connect to plenums
- Seat frame modified to mount seat blowers



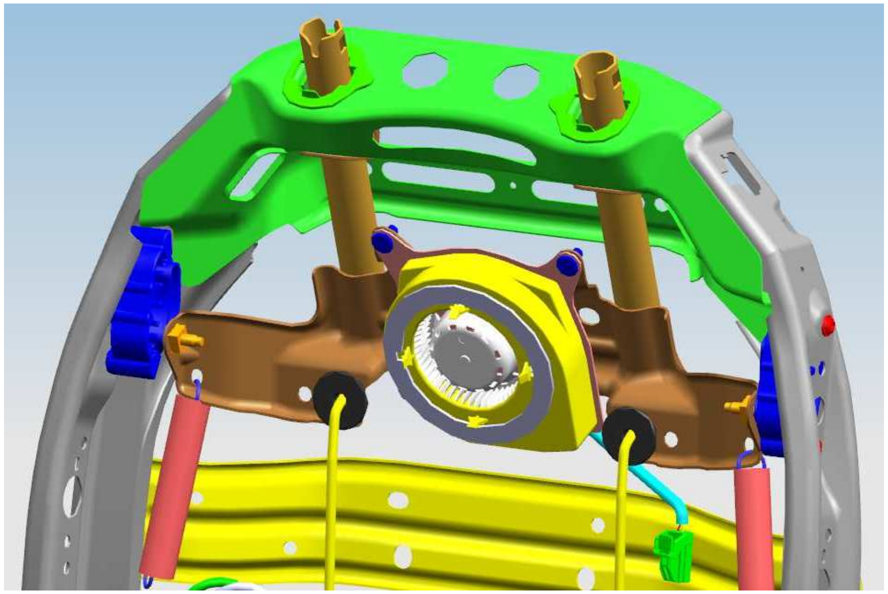
Seat Plenums In Position
Connected to Seat Blowers

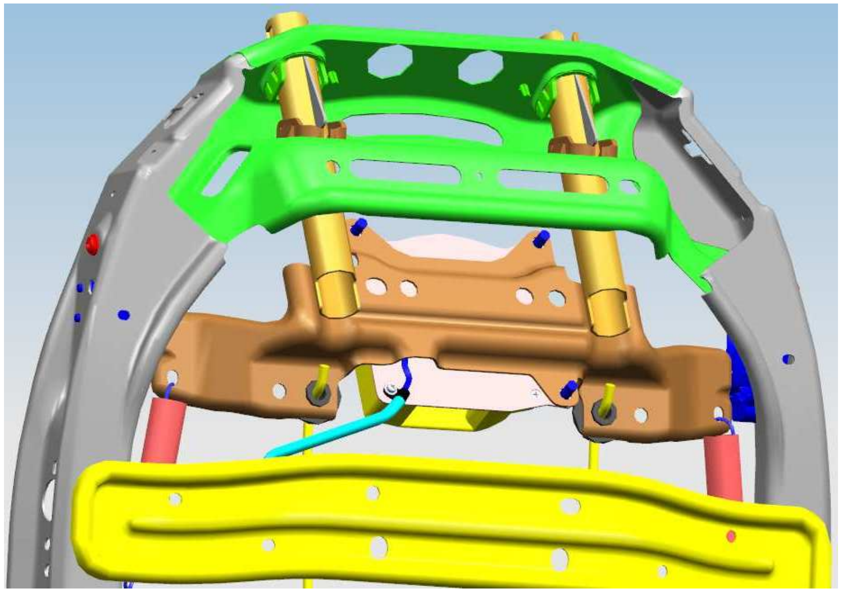


Seat Blowers In Position
Attached to Seat Frame

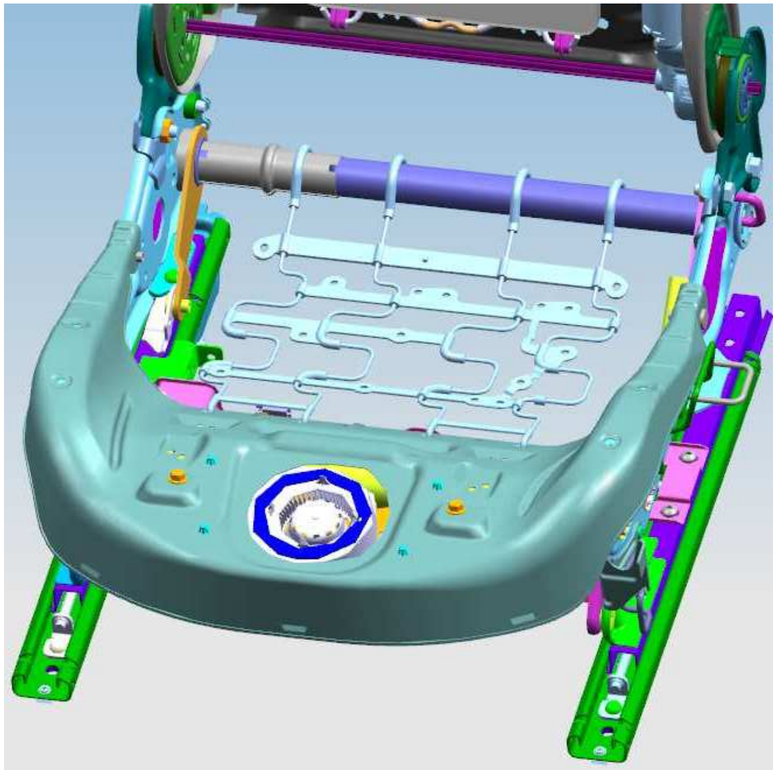


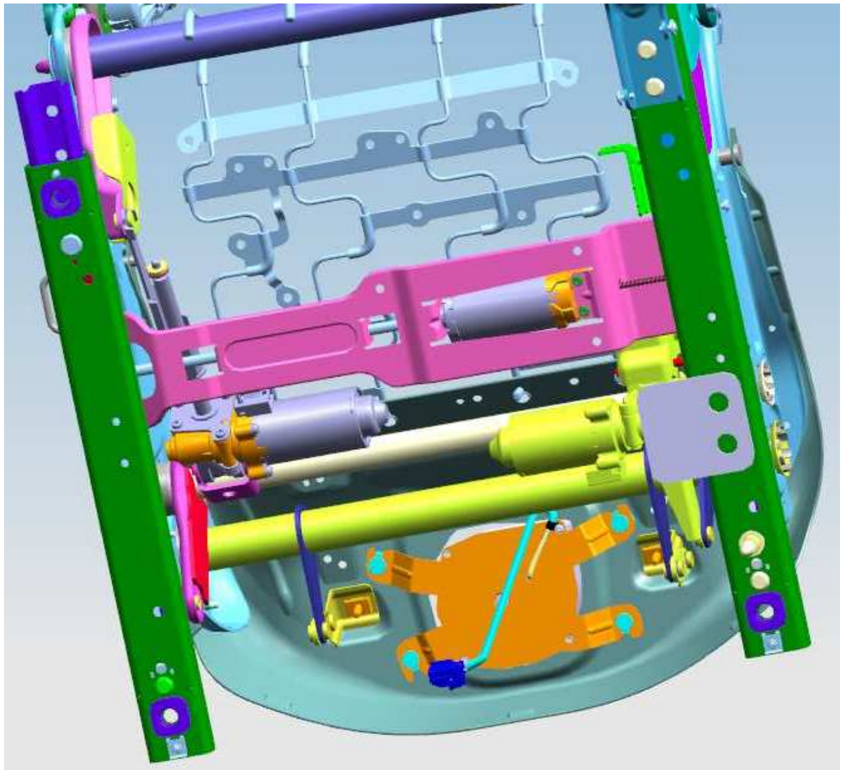
Seat Back Blower Attachment Method





Seat Cushion Blower Attachment Method





EPA Off Cycle Technologies GHG Reporting Template

Model Year	Carline Name	Area m2 front windshield, side windows and rear window	Average TTS	Glass Credit	VMT	Glass Volume	Total Glass Credit (Megagrams)	LED Credits: LED lights credits (g/mile)	LED Credits: Total LED lights Credit (Mega grams)	Vent seat Credits: Vent seat volume (Driver and Passenger)	Vent seat Credits: Ventalated Seat Credit per Vehicle (g/mile)	Vent seat Credits: Total Ventalated Seat Credit (Megagrams)	High TSR Paint Credit: High TSR Paint Vehicles	High TSR Paint Credit: High TSR Paint Credit per Vehicle (g/mile)	High TSR Paint Credit: Total High TSR Paint credit (Megagrams)	Total Credit by model
						2009 Totals	311413		0			4127			22547	338087
						2010 Totals	433667		0			6004			36835	476506

EPA Off Cycle Technologies GHG Reporting Template

								LED Credits		Vent seat Credits			High TSR Paint Credit			
Model Year	Carline Name	Area m2 front windshield, side windows and rear window	Average TTS	Glass Credit	VMT	Glass Volume	Total Glass Credit (Megagrams)	LED lights credits (g/mile)	Total LED lights Credit (Mega grams)	Vent seat volume (Driver and Passenger)	Ventalated Seat Credit per Vehicle (g/mile)	Total Ventalated Seat Credit (Megagrams)	High TSR Paint Vehicles	High TSR Paint Credit per Vehicle (g/mile)	Total High TSR Paint credit (Megagrams)	Total Credit by model
						2011 Totals	427960		0			24979			33582	486521
						2012 Totals	570192		33536			21637			45305	670670

EPA Off Cycle Technologies GHG Reporting Template

								LED Credits		Vent seat Credits			High TSR Paint Credit			
Model Year	Carline Name	Area m2 front windshield, side windows and rear window	Average TTS	Glass Credit	VMT	Glass Volume	Total Glass Credit (Megagrams)	LED lights credits (g/mile)	Total LED lights Credit (Mega grams)	Vent seat volume (Driver and Passenger)	Ventalated Seat Credit per Vehicle (g/mile)	Total Ventalated Seat Credit (Megagrams)	High TSR Paint Vehicles	High TSR Paint Credit per Vehicle (g/mile)	Total High TSR Paint credit (Megagrams)	Total Credit by model
						2013 Totals	502185		75059			22282			28613	628139
						2009 - 2013 Totals	2,245,417		108,595			79,029			166,882	2,599,923