VOLKSWAGEN

GROUP OF AMERICA

Mr. Linc Wehrly
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May 25, 2018 Date

Subject: Off-Cycle Greenhouse Gas (GHG) Technology Approval Request-2010 and 2011 Model Year

Dear Mr. Wehrly:

Volkswagen Group of America, Inc. ("Volkswagen")[1] herewith submits an application for off-cycle greenhouse gas (GHG) technology credit approval, in accordance with the provisions of 40 CFR 86.1869-12(d). Volkswagen has reviewed its 2010 and 2011 product offering and has concluded that many of the vehicles incorporate features that may qualify as off-cycle technologies eligible for GHG credit.

These features include:

- high-efficiency lighting,
- active aerodynamic improvements,
- engine warm-up,
- transmission warm-up,
- thermal control technologies;
    - including glazing,
    - paint,
    - and seat ventilation

Enclosed is the formal application requesting these technologies be approved for off-cycle credits. A brief explanation of the technologies and references to supporting technical material are provided. The credit values per technology are determined consistent with procedures described in the Technical Support Document (ref. Joint Technical Support Document: Final Rulemaking for 2017-2025 Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards; EPA-420-R-12-901, August 2012). The credit values are therefore consistent with the values for similar technologies described in 40 CFR 86.1869-12(b).

Upon completion of EPA's review and subsequent decision, Volkswagen will submit a complete list of applicable vehicles and volumes per approved technology in order to determine the overall off-cycle credit values per compliance fleet for model years 2010 and 2011.

[1] For purposes of this request, Volkswagen Group of America, Inc. represents Volkswagen, Audi, Bentley, Lamborghini, and Bugatti brand vehicles marketed in the United States.

Volkswagen appreciates EPA's consideration of this application. Should you have further questions, please contact Matt Kevnick of my staff at 248-754-4807

Best Regards,

Rob Sutschek

Rob Sutschek
Director, Engineeing and Environmental Office
Volkswagen Group of America

Enclosures

Technology descriptions

1.1 High Efficiency Exterior Lights

1.1.1 Definition

High efficiency exterior lighting means a lighting technology that, when installed on the vehicle, is expected to reduce the total electrical demand of the exterior lighting system when compared to conventional lighting systems.

1.1.2 VW Group Methodology to determine off-cycle credits

Exterior LED lights are eligible for credit without the requirement of additional power demand tests and can get a fixed credit value according to the table referenced from §86.1869-12 (1) (ii)

Lighting Component	Credit (grams/mile)
Low beam	0.38
High beam	0.05
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

Other lighting technologies (Not just LED) are eligible for credits (e.g., for high discharge lights) and are determined by comparing the wattage of new high efficiency exterior lights to the wattage of the baseline lighting technologies. (See table below column baseline, source Joint Technical Support Document page 5-71) that are replaced.

Table 5-21 Individual Credit Values for High Efficiency Exterior Lighting Components

Lighting Component	Baseline	High Eff	Night Use Only %	Day & Night Use %	g/mi CO2 Credit	Savings %
Low Beam*	112.4	***66***	91%	0%	0.38	52%
High Beam	127.8	68.8	9%	0%	0.05	46%
Parking/Position	14.8	3.3	100%	0%	0.10	78%
Turn Signal, front	53.6	13.8	0%	5%	0.06	74%
Side Marker, Front	9.6	3.4	100%	0%	0.06	65%
Tail	14.4	2.8	100%	0%	0.10	81%
Turn signal, rear	53.6	13.8	0%	5%	0.06	74%
Side Marker, rear	9.6	3.4	100%	0%	0.06	65%
License Plate	9.6	1	100%	0%	0.08	90%
Base electrical load redux	100	watts				
Fuel savings per 100W	3.2	g/mi	Nighttime VMT (MOVES Data):		28.2%	
Total Available Credit	1.0	g/mi				
**Value for high efficiency wattage changed based on comments and supporting data*						

The power demand of the related control units is excluded for the determination of the power demand of the lighting component, as the power demand of the baseline lighting components was established without incorporating the control units.

Formula for determination of power demand per lighting component/system:

Power[P] = mean forward voltage per lamp [V] * electric current [A] *eq. 0-1*

The power demand established for lighting components in the baseline and the high-efficiency lighting were determined with two light technologies. (i.e., combined power demand of both the right and left headlights, rather than just one headlight).

If several functions are integrated into one component then the according pre-set values will be combined as well, as illustrated in the figure below:

Component	Power demand JTSD	Power demand own component	Eligible
Tail	2.8		
Turn rear	13.8 / 2 (50% flashing frequency)		
Side rear	3.4		
Sum	13.1	12	Yes

Q Model rear bumper lighting: Tail and turn signal rear and sidemarker

Figure: Illustration of combined lighting components

The credits VW Group are requesting for lighting technologies other than LED lighting components are calculated by using the formula from the Joint Technical Support Document which is based on our power demand determination for high efficient lighting (PHEL) and thereby comparing to the baseline power demand stated in table 5-71 of the JTSD:

$$Credit_{HEL}\left(\frac{g}{mil}\right) = \frac{(P_{BL} - P_{HEL}) \cdot UR \cdot x_{VMT} \cdot 3{,}2\left[\frac{g_{CO_2}}{mil}\right]}{100[W]} \qquad \textit{eq. 0-2}$$

P_{EL} = baseline lighting wattage
P_{HEL} = high efficiency lighting wattage
UR = usage rate = see table above
x_{VMT} = vehicle miles traveled fraction = 0.282

The fleet credit will be calculated based on credit for each type of vehicle incorporating various high efficiency lights, vehicle lifetime miles and U.S. sales volume for applicable 2010 & 2011 model year products.

1.2 Active-Aerodynamic Improvements

1.2.1 Definition

Active-aerodynamic improvements means technologies that are automatically activated under certain conditions to improve aerodynamic efficiency (e.g., lowering of the coefficient of drag, or CD), while preserving other vehicle attributes or functions.

1.2.2 VW Group Methodology to determine off-cycle credits

The credit for active aerodynamic improvements for passenger automobiles shall be calculated using the following equation, and rounded to the nearest 0.1 grams/mile:

Where:

A) For Passenger Cars:

$$Credit\left(\frac{g}{mi}\right) = 19{,}36\ x\ CD_{Reduced} \qquad \textit{eq. 0-3}$$

B) For Light Trucks:

$$Credit\left(\frac{g}{mi}\right) = 33{,}16\ x\ CD_{Reduced} \qquad \textit{eq. 0-4}$$

$CD_{reduced}$ is the percent reduction in the coefficient of drag (cd), shown as a value from 0 to 1. The coefficient of drag shall be determined using good engineering judgment consistent with standard industry test methods and practices.

$CD_{reduced}$ is calculated via the following equation:

$$CD_{Reduced} = \frac{Basis\ CD\ Value - CD\ Value\ with\ Active\ Aero\ Activated}{Basis\ CD\ Value}$$

VW Group determined CD reduced with the following assumptions:

- For a given vehicle, the provided "basis CD value" is the highest CD value (or as high as possible) of all of the vehicle's offered equipment variants (i.e., tire/rim combination with worst CD) with all of the vehicle's Active-Aerodynamic Technologies deactivated
- For a given vehicle, the provided "CD value with Active-Aero Activated" is the highest CD value of all of the vehicle's offered equipment variants (i.e., tire/rim combination with worst CD) with the vehicle's Active-Aerodynamic Technologies activated

This methodology allows to apply for the worst case percentage of CD reduction for a given model line and without separating the sales volumes for each different tire & rim combinations.

The measurement of VW Group CD values are usually done:

- At on-site VW Group wind tunnel facilities in Germany, fixed speed (standard 140km/h; CD not depending on speed)
- Hardware state of the art, without aspiration for ground simulation, controlled by ring comparison of different EU wind tunnels

Active Spoiler:

- $CD_{reduced}$ by comparing spoiler in vs. spoiler out condition

- The cd values of each brand and carline can be found in the credit calculation tables
- The spoiler operation strategies of each brand and carline can be found in the brand annexes

Vehicle ride height:

- $CD_{reduced}$ by comparing vehicle ride height level "normal" vs. "lowered" condition
- The cd values of each brand and carline can be found in the credit calculation tables
- The ride height operation strategies of each brand and carline can be found in the brand annexes

Grill shutter:

- $CD_{reduced}$ by comparing grill shutter open vs. closed condition
- The cd values of each brand and carline can be found in the credit calculation tables
- The grill shutter operation strategies of each brand and carline can be found in the brand annexes

The fleet credit will be calculated based on credit for each type of vehicle, vehicle lifetime miles and U.S. sales volume for applicable 2010 & 2011 model year products.

1.3 Active Transmission Warm-up Technologies

1.3.1 Definition

Active transmission warm-up means a system that uses waste heat from the vehicle to quickly warm the transmission fluid to an operating temperature range using a heat exchanger, increasing the overall transmission efficiency by reducing parasitic losses associated with the transmission fluid, such as losses related to friction and fluid viscosity.

1.3.2 VW Group Methodology to determine off-cycle credits

Using the methodology as described in the Joint Technical Support Document regarding off-cycle credit determination, we intend to apply the pre-defined credit listed for each active transmission warm-up technologies for passenger cars and light-duty trucks.

Active Transmission Warm Up –Credits: (40 CFR §86.1869-12 (b) (vi).

(A) The passenger automobile credit is 1.5 grams/mile.
(B) The light truck credit is 3.2 grams/mile.

In the case where vehicles are equipped with both transmission and engine warm-up technologies and contain second loop then VW Group will apply for both technology credits.

The fleet credit will be calculated based on credit for each type of vehicle, vehicle lifetime miles and U.S. sales volume for applicable 2010 & 2011 model year products.

1.4 Active engine warm-up technologies

1.4.1 Definition

Active engine warm-up means a system using waste heat from the vehicle to warm up targeted parts of the engine. This reduces engine friction losses and enables the closed-loop fuel control more quickly allowing for a faster transition from cold operation to warm operation, thereby decreasing CO_2 emissions, and increasing fuel economy.

1.4.2 VW Group Methodology to determine off-cycle credits

Using the methodology as described in the Joint Technical Support Document regarding off-cycle credit determination, we intend to apply the pre- defined credit listed for each active engine warm-up technologies for passenger cars and light-duty trucks. Active Engine Warm Up –Credits: (40 CFR §86.1869-12 (b) (vii).)

(A) The passenger automobile credit is 1.5 grams/mile.
(B) The light truck credit is 3.2 grams/mile.

In the case where vehicles are equipped with both transmission and engine warm-up technologies and contain second loop then VW Group will apply for both technology credits.

The fleet credit will be calculated based on credit for each type of vehicle, vehicle lifetime miles and U.S. sales volume for applicable 2010 & 2011 model year products.

1.5 Thermal Control Technologies - Thermal Glass/Glazing

1.5.1 Definition

Glass Glazing Technologies which can reduce the amount of solar heat gain in the cabin by reflecting or absorbing some of the infrared solar energy. One measure of solar load-reducing potential for glazing is Total Solar Transmittance or Tts which expresses the percentage of solar energy which passes through the glazing. (p. 5-101 of EPA's Joint Technical Support Document: Final Rulemaking for 2017-2025 Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards.)

1.5.2 VW Group Methodology to determine off-cycle credits

The credits VW Group is requesting are calculated by using EPA's formula from the Federal Regulation 40 CFR §86.1869-12 (b) (viii) (A) and rounded to the nearest 0.1 grams/mile:

$$Credit = \left[Z \, x \sum_{i=1}^{n} \frac{T_i x G_i}{G} \right] \qquad \textit{eq. 0-5}$$

Where:
Credit = the total glass or glazing credits, in grams per mile rounded to the nearest 0.1 grams/mile. The credit may not exceed 2.9 g/mi for passenger automobiles or 3.9 g/mi for light trucks;

Z = 0.3 for passenger automobiles and 0.4 for light trucks;
G_i = the measured glass area of window i, in square meters and rounded to the nearest tenth;
G = the total glass area of the vehicle, in square meters and rounded to the nearest tenth;
T_i = the estimated temperature reduction for the glass area of window i, determined using the following formula:

$$T_i = 0{,}3987 \cdot (Tts_{base} - Tts_{new}) \qquad \textit{eq. 0-6}$$

Where:

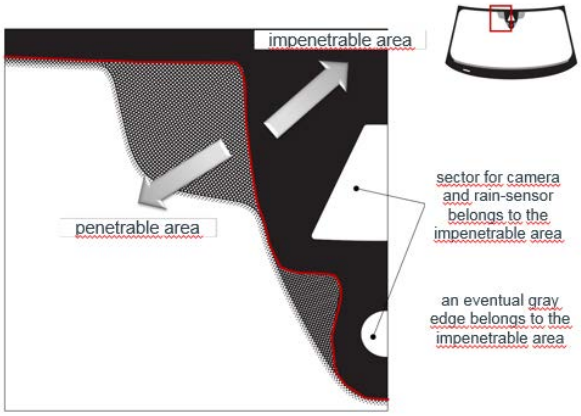
Tts_{new} = the total solar transmittance of the glass, measured according to ISO 13837, "Safety glazing materials—Method for determination of solar transmittance" (incorporated by reference in §86.1).
Tts_{base} = 62 for the windshield, side-front, side-rear, rear-quarter and backlight locations, and 40 for roof lite locations.

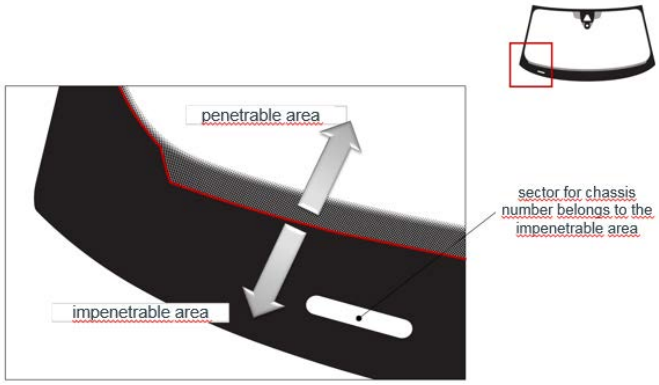
Following further assumption to ISO 13837 were set at VW Group:
v1= approximately 4 m/s for vehicles at rest as this represents the worst case
Convention B (air mass 1, 0)
Documentation as nominal value and tolerance at 3 sigma

Based on the requirements of S3 FMVSS No 104 NHTSA Daylight Opening Standard the glass area (Gi/ for the credit eligible windows was determined. Following assumptions regarding the visible surface area have been made:

- **<u>Windshield, rear window, fixed side windows and roof systems:</u>**
  The dot matrix (fade area) is part of the transparent surface, the black print area must be subtracted from the visible surface area.

Thereby the area for telepass-instruments is neglected and counted to the transparent area. The VIN and camera/sensor windows are counted as blacked area because measurement instruments are behind the screen and prohibit the solar transmittance.

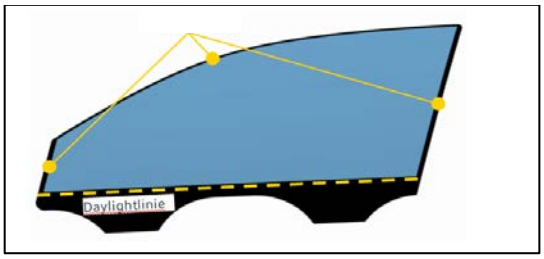




- **Roof area**
  The transparent area is the glass roof area without blackened part. The faded area is determined as transparent area.

- **Retractable windows:**

  The visible surface area of door and retractable glass is the area above the daylight line, the seals are subtracted. For the seals an average value of 10% of transparent area is deducted.



Antenna prints, visible heating conductors, antenna conductors or glass stamps are not taken into account and are defined as transparent surfaces.

The fleet credit will be calculated based on credit for each type of vehicle, vehicle lifetime miles and U.S. sales volume for applicable 2010 & 2011 model year products.

1.6 Thermal Control Technologies - Solar Reflective Paints

1.6.1 Definition

Solar reflective surface coating means a vehicle paint or other surface coating which reflects at least 65 per cent of the impinging infrared solar energy, as determined using ASTM standards E903, E1918-06 or C1549-09 (incorporated by reference in § 86.1). The coating must be applied at a minimum to all of the approximately horizontal surfaces of the vehicle that border the passenger and luggage compartments of the vehicle (e.g. the rear deck lid, the cabin roof).

1.6.2 VW Group Methodology to determine off-cycle credits

VW Group intends to apply the methodology of the Joint Technical Support Document and fixed credit values according to 40 CFR §86.1869-12 (b) (viii) (C) and EPA-420-R-14-025; September 2014.

The determination of the TSR (Total Solar Reflectance) values for all available paint colors for the model years in question was done with the following assumptions:

In cases where

- there were more than one paint supplier for a given color
- the paint supplier or other factors (e.g. under coatings, coating application process,…) changed over the course of a model year,

The lowest TSR value, rounded down, was used as the absolute value. All TSR values were measured by suppliers based upon the approved methodologies defined in the ASTM standards above.

The fleet credit will be calculated based on credit for each model type of vehicle, vehicle lifetime miles and U.S. sales volume for the model years in question.

Solar Reflective Surface Coating – (40 CFR §86.1869-12 (b) (viii) (C)):

(A) The passenger automobile credit is 0.4 grams/mile
(B) The light truck credit is 0.5 grams/mile

Regarding EPA's approval (EPA-420-R-14-025; September 2014) of FCA's request based on SAE 2007-01-1194 ("Reduction in Vehicle Temperature and Fuel Use from Cabin Ventilation, Solar-Reflective Paint and a New Solar-Reflective Glazing"), VW Group is requesting credits for solar reflective surface coating with TSR values below 65 per cent corresponding to the following table:

	GHG-Regulation	Additional approach with regard to EPA-420-R-14-025 Sep. 2014		
TSR Rating	**≥ 65**	**≥ 59**	**≥57**	**≥42**
Temp. Reduction °C		**1.2**	**1.1**	**0.8**
Off-Cycle Credit (g/mi) – Passenger Car	**0.4**	**0.35**	**0.3**	**0.2**
Off-Cycle Credit (g/mi) – Light Duty Truck	**0.5**	**0.4**	**0.4**	**0.3**

The fleet credit will be calculated based on credit for each type of vehicle, vehicle lifetime miles and U.S. sales volume for applicable 2010 & 2011 model year products.

1.7 Thermal control technologies – Active Seat Ventilation

1.7.1 Definition

Active Seat Ventilation is a device which draws air and forces air or transfers heat from the seating surface which is in contact with the occupant and exhausts it to a location away from the seat. At a minimum, the front driver and passenger seats must utilize this technology for a vehicle to be eligible for credit. If the vehicle only has two seats, then these seats must have active seat ventilation for a vehicle to be eligible for credit.

1.7.2 VW Group Methodology to determine off-cycle credits

Using the methodology as described in the Joint Technical Support Document regarding off-cycle credit determination, we intend to apply the pre-defined credit listed for each thermal control technology for passenger cars and light-duty trucks.

Active Seat Ventilation – (40 CFR §86.1869-12 (b) (viii) (B))

(C) The passenger automobile credit is 1.0 grams/mile
(D) The light truck credit is 1.3 grams/mile

The fleet credit will be calculated based on credit for each type of vehicle, vehicle lifetime miles and U.S. sales volume for applicable 2010 & 2011 model year products.