

BMW Group

October 9, 2020

The Honorable James C. Owens
Deputy Administrator
National Highway Traffic Safety Administration
1200 New Jersey Ave., S.E.
Washington, DC 20590

**Re: 49 CFR 556 – Petition for Inconsequential Non-Compliance
FMVSS 104 (Windshield wiper and washing systems)
20V-555**

- **Model Year 2019-2021 BMW 3 Series, 8 Series Coupe/Convertible, X5 SAV, X7 SAV, Z4**
- **Model Year 2020-2021 BMW 2 Series Gran Coupe, 8 Series Gran Coupe, X6 SAC, Z4**
- **Model Year 2021 BMW X5 xDrive45e, 330e, 4 Series Coupe/Convertible**
- **Model Year 2020-2021 Toyota Supra**

Dear Deputy Administrator Owens:

BMW of North America, LLC, a subsidiary of BMW AG, Munich, Germany, is submitting this 49 CFR 556 Petition for Inconsequential Non-Compliance.

On September 11, 2020, BMW submitted a 49 CFR 573 report pertaining to windshield wiper frequency involving approximately 244,433 Model Year 2019-2021 BMW and Model Year 2020-2021 Toyota vehicles (the “affected vehicles”). The windshield wiper frequency decreases when the vehicle is at rest, e.g., at a stop light, and in the brief interval when accelerating from rest (0mph) to approximately 2.5mph. Depending upon the specific vehicle model, the noncompliance involves FMVSS 104 Section 4.1.1.2, or involves Sections 4.1.1.2 and 4.1.1.3, and only in the limited conditions noted.

A copy of BMW’s September 11, 2020 Part 573 report is included as Attachment 1.

We believe that this issue is inconsequential to motor vehicle safety for the reasons set forth below. A summary is provided, and is followed by detailed information supporting the specific points.

- The wiper system is compliant in the vast majority of driving situations / modes, especially when wipers are needed most, i.e., while driving when the wipers are selected by the driver to be in either the “High” or “Low” setting/mode. Any potential non-compliance only occurs when the vehicle is at rest, or in the very brief time period when accelerating from 0mph to 2.5mph.
- The BMW wiper system contains an Auto (Rain Sensor) setting/mode where the frequencies contained in FMVSS 104 Sections 4.1.1.2 and 4.1.1.3 are met under the conditions (i.e., rain volumes) that necessitate those levels of wiper speeds.
- When wiper frequency setting/mode High is selected, then at vehicle rest or when accelerating from 0mph to 2.5mph, although the momentary decreased wiper frequency is slightly less than the required 45 cycles/min, it is significantly larger than the FMVSS 104 absolute minimum frequency of 20 cycles/min.
- When wiper frequency setting/mode Low is selected, then at vehicle rest or when accelerating from 0mph to 2.5mph, the momentary decreased wiper frequency is

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marginally less than the required 20 cycles/min for only two vehicle models. In this condition, it is unlikely that there is any perceptible difference in visibility to the driver, and consequently no affect upon (no decrease in) vehicle safety.

- For a given rainfall velocity, driver visibility while the vehicle is at rest with this slight or marginal non-compliance is greater than driver visibility while the vehicle is moving with a compliant system, especially when the vehicle is moving at city and highway speeds.
- SAE J903 (1999) contains a requirement for minimum wiper frequency of 10 cycles/min. Given the SAE Standards process as briefly outlined further in the petition, it would appear that even a wiper frequency of only 10 cycles/min is safe.
- In the brief interval during vehicle acceleration from 0mph to 2.5mph, an average vehicle moves only a small amount, approximately 1 ft.
- The wiper frequency does not decrease when the vehicle is decelerating to 0mph.
- Affected vehicles comply to all other applicable provisions of FMVSS 104.
- BMW is not aware of any customer complaints, accidents, or injuries related to this issue. Toyota is not aware of any accidents, or injuries, and has no field reports or claims relating to this issue in Supra vehicles.
- Vehicle production has been corrected.

* * *

FMVSS 104 Section 4.1.1.2

FMVSS 104 Section 4.1.1.2 states:

One frequency or speed shall be at least 45 cycles per minute regardless of engine load and engine speed.

FMVSS 104 Section 4.1.1.3

FMVSS 104 Section 4.1.1.3 states:

Regardless of engine speed and engine load, the highest and one lower frequency or speed shall differ by at least 15 cycles per minute. Such lower frequency or speed shall be at least 20 cycles per minute regardless of engine speed and engine load.

Wiper System Design / Functionality

Affected vehicles are equipped with a wiper system that contains a driver-selectable setting/mode Low, a driver-selectable setting/mode High, a driver-selectable setting/mode Auto (Rain Sensor), and a non-selectable pre-programed setting/mode that we will refer to as Standstill Mode (“Standstill”). System function is described below.

Driver Selects Low Mode

If a driver selects the wiper frequency mode Low, then wiper frequency while driving is larger than 40 cycles/min, and is model dependent as noted further in the petition. When the vehicle comes to rest, e.g., at a stop light, then the frequency decreases. The decreased frequency is also present in the brief period of time when the vehicle accelerates from 0mph to 2.5mph. This decreased frequency is the frequency of the Standstill mode and is due to a pre-programmed comfort function described further below. The wiper frequency quickly and automatically returns to its selected mode, in this case Low, as soon as the vehicle reaches 2.5mph.

Driver Selects High Mode

If a driver selects wiper frequency High mode, then wiper frequency while driving is larger than 56 cycles/min, and is model dependent as noted further in the petition. When the vehicle comes to rest, e.g., at a stop light, then the frequency decreases. The decreased frequency is also present in the brief period of time when the vehicle accelerates from 0mph to 2.5mph. The decreased frequency is the frequency of the Low setting/mode, and is due to the pre-programmed comfort function described further below. The wiper frequency quickly and automatically returns to its selected mode, in this case High, as soon as the vehicle reaches 2.5mph.

Auto (Rain Sensor) Mode

If the driver selects Auto (Rain Sensor) mode, then wiper frequency while driving is a function of the amount of rain detected on the windshield by the rain sensor. Depending upon the amount of rain, the system will provide an appropriate wiper frequency up to the maximum wiper system frequency which is larger than the FMVSS 104 Section 4.1.1.2 requirement of 45 cycles/min.

Comfort Function

The decrease in wiper frequency when the vehicle is at rest is a “comfort function” and was introduced because at vehicle rest, the amount of water on the windshield compared to the amount of water on the windshield on a moving vehicle is significantly less. The comfort function was introduced to allow the driver to focus on the driving task and surroundings, and not be distracted (or annoyed) by a wiper system in which the higher frequency (when the vehicle was moving) is not needed when the vehicle is at rest. At vehicle rest (and during acceleration from 0mph to 2.5mph), the frequency is decreased briefly from either High to Low, or from Low to Standstill, and then quickly and automatically increases again to the prior driver-selected frequency when the vehicle reaches 2.5mph.

Driver Can Increase Wiper Frequency While Vehicle is at Rest

The driver can also, while the vehicle is at rest, increase the wiper frequency.

If the driver had selected wiper frequency mode Low, then when the vehicle comes to rest, the frequency will decrease to Standstill. In this case, if the driver perceives a need to increase the frequency while the vehicle is momentarily at rest, the driver can quickly and easily increase the frequency by moving the wiper arm/control upward. The wiper frequency will increase from Standstill to High. When the vehicle accelerates, the frequency will remain at High. If desired, the driver can then decrease the frequency to Low again.

If the driver had selected wiper frequency mode High, then when the vehicle comes to rest, the frequency will decrease to Low. In this case, if the driver perceives a need to increase the frequency while the vehicle is momentarily at rest, the driver can quickly and easily increase the frequency by moving the wiper arm/control first downward and then upward. The wiper frequency will increase from Low to High. When the vehicle accelerates, the frequency will remain at High.

The Non-Compliance

Wiper Frequency Change – High-to-Low

In this case, the driver selected wiper frequency mode High, but due to the comfort function, at vehicle rest, and when accelerating from 0mph to 2.5mph, the wiper frequency has decreased to mode Low. While the wiper frequency is at least 41 cycles/min, it is slightly less than the FMVSS 104 Section 4.1.1.2 requirement of 45 cycles/min.

Wiper Frequency Change – Low-to-Standstill

In this case, the driver selected wiper frequency mode Low, but due to the comfort function, at vehicle rest, and when accelerating from 0mph to 2.5mph, the wiper frequency has decreased to mode Standstill. For only two vehicle models, the frequency is 19.8 cycles/min and therefore marginally less than the FMVSS 104 Section 4.1.1.3 requirement of 20 cycles/min.

Test Results

Vehicles were tested and pertinent test results are contained in Table 1.

Model	Wiper Setting (High) Frequency (cycles/min)	High @ 0=< v <=2.5 v (mph) “Standstill” Frequency (cycles/min)	Wiper Setting (Low) Frequency (cycles/min)	Low @ 0=<v<=2.5 v (mph) “Standstill” Frequency (cycles/min)
2 Series Gran Coupe	70.8	47.3	47.7	21.3
3 Series	75.7	48.3	48.7	21.2
4 Series Coupe	83.5	51.5	51.7	21.3
8 Series Gran Coupe	58.7	42.0	42.2	21.2
X5 SAV	57.0	41.0	41.0	20.5
X6 SAC	56.8	41.2	41.2	20.5
Z4	56.5	41.0	41.0	19.8
Supra	56.8	41.2	41.2	19.8

Table 1.

In this petition, although there are more than five vehicle models potentially affected, 5 wiper systems account for the systems installed across all vehicle models. Table 1 contains test results involving several vehicle models and accounts for these systems. In some cases, only one vehicle model was tested for a given wiper system such as the 8 Series Gran Coupe, whereas in some cases, more than one vehicle model was tested for a given wiper system, such as the X5 SAV and X6 SAC, and also the Z4 and Supra.

Entries in the table for the 2 Series, 3 Series, and 4 Series suggest that these vehicles comply with FMVSS 104 Sections 4.1.1.2 and 4.1.1.3. However, due to wiper system tolerances, a slight or marginal non-complying condition could occur.

The wiper frequencies (cycles/min) in Table 1 are based upon actual measurements of wiper movement on the subject vehicles during a three-minute time period, and then adjusted for a one-minute time period to denote wiper frequency in units of cycles/min. To assess the accuracy of the 3-minute count (and the cycles/minute equivalency), a control was used in

which a time period was measured for a wiper frequency consisting of 10 wipe cycles. Using this control, wiper frequency in cycles/min was calculated and then assessed against the actual measured 3-minute count (adjusted to the equivalent frequency for a 1-minute time period) as a check.

As noted earlier, if the driver selected wiper frequency High, then due to the comfort function, at vehicle rest (and between 0mph and 2.5mph), wiper frequency changes to Low. The “High @...” column indicates that some models have a reduced wiper frequency of either 41 cycles/min or 42 cycles/min.

Similarly, if the driver selected wiper frequency Low, then due to the comfort function, at vehicle rest (and between 0mph and 2.5mph), wiper frequency changes to Standstill. The “Low @...” column indicates that the Z4 and Supra have a reduced wiper frequency of 19.8 cycles/min.

Wiper Frequency Comparisons

Wiper Frequency High

FMVSS 104 Section 4.1.1.2 requires a minimum wiper frequency of 45 cycles/min. In some vehicle models, the frequency is 41 cycles/min. A wiper frequency of 45 cycles/min equates to a single wipe cycle of approximately 1.33 seconds. A wiper frequency of 41 cycles/min equates to a single wipe cycle of 1.46 seconds. The difference is approximately 0.13 seconds and is unlikely to affect driver visibility as explained further below in the section comparing a stationary vehicle with a moving vehicle regarding the amount of water on the windshield.

Wiper Frequency Low

FMVSS 104 Section 4.1.1.3 requires a minimum wiper frequency of 20 cycles/min. In some vehicle models, the frequency is 19.8 cycles/min. A wiper frequency of 20 cycles/min equates to a single wipe cycle of approximately 3.00 seconds. A wiper frequency of 19.8 cycles/min equates to a single wipe cycle of 3.03 seconds. The difference is approximately 0.03 seconds and is extremely unlikely to affect driver visibility as explained further below in the section comparing a stationary vehicle with a moving vehicle regarding the amount of water on the windshield.

Vehicle Travels Very Small Distance When Accelerating from 0mph to 2.5mph

In the brief interval during vehicle acceleration from 0mph to 2.5mph, an average vehicle travels only a small amount, approximately 1 ft. and, at that point (distance), the driver-selected wiper frequency, i.e., either Low or High, is quickly and automatically re-established. Please refer to the calculation below.

Covered distance when accelerating to 2.5 mph (4 km/h)

When starting, the reduced wipe frequency due to the stationary downshift is automatically been switched up to the former operated frequency when reaching a speed of 2.5 mph ($v = 1.11 \text{ m/s} \approx 4 \text{ km/h}$).

The distance covered here is on average 1 foot (0.31 m).

Calculation basis:

The maximum acceleration of a medium-sized vehicle is $3.4 - 7 \text{ m/s}^2$.

It is assumed that the vehicle normally starts with a slower acceleration.

The acceleration value used in the calculation is $a = 2 \text{ m/s}^2$ which is around $1/3$ to $1/2$ of the maximum acceleration of a passenger car, and can also be reached by bike (roughly $1 - 2 \text{ m/s}^2$).

Calculation formula: $s = \frac{1}{2} \times a \times t^2$ with $t = v / a$

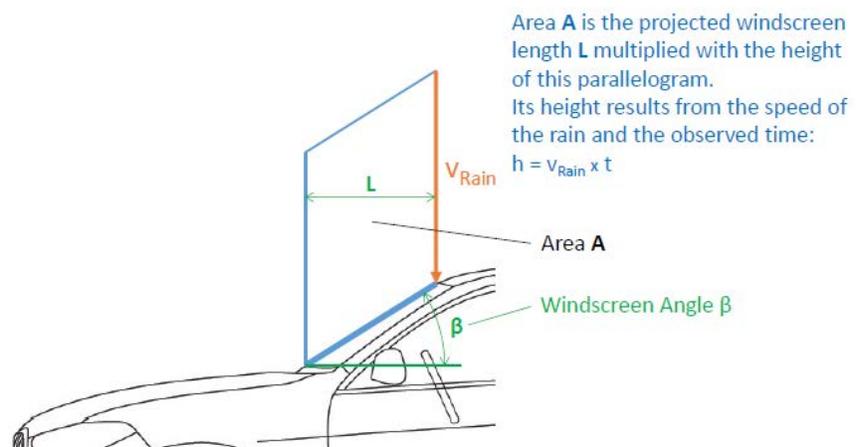
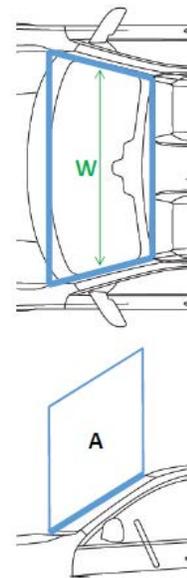
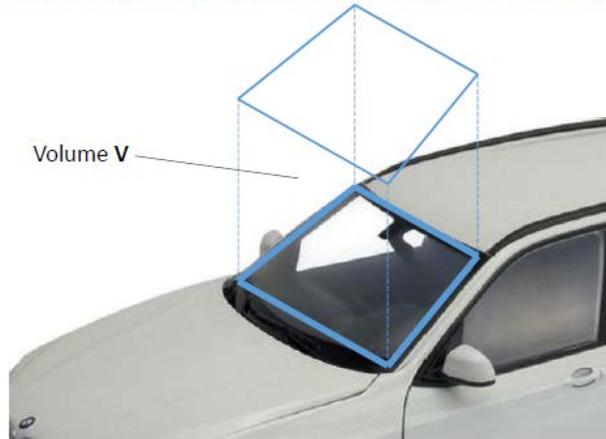
Rain Volume Comparison Between a Vehicle at Rest and a Moving Vehicle

In a given period of time, the volume of water on the windshield while the vehicle is at rest is significantly less than the volume of water on the windshield while the vehicle is moving, for example at city or highway speeds. For example, and as shown in the calculations below, the amount of water on the windshield while the vehicle is at rest is approximately 50% less than the amount of water on the windshield when driving at approximately 25mph. Therefore, if wiper frequencies of 20 cycles/min and 45 cycles/min are deemed to be sufficient when driving then, when the vehicle is at rest, wiper frequencies of 19.8 cycles/min and 41 cycles/min are sufficient for an overview of the traffic and roadway conditions. As noted earlier, there is only a 0.13 second difference in time for a single wipe cycle between the required 45 cycles/min and the 41 cycles/min condition, and only a 0.03 second difference in time for a single wipe cycle between the required 20 cycles/min and the 19.8 cycles/min condition.

For a given rainfall velocity, driver visibility while the vehicle is at rest with this slight or marginal non-compliance is greater than driver visibility while the vehicle is moving with a compliant system, especially when the vehicle is moving at city and highway speeds. Please refer to the calculations below.

Windscreen wetting in dependence of vehicle speed

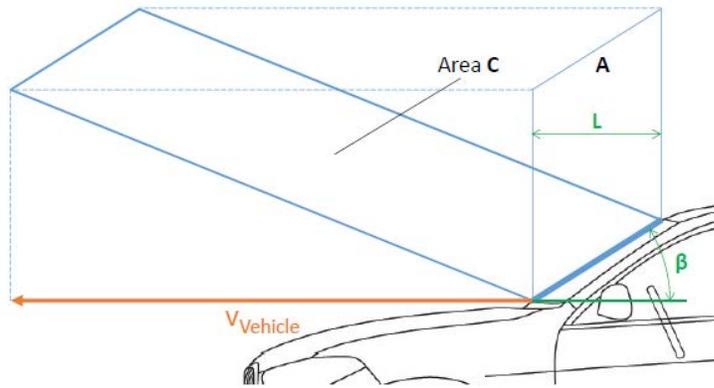
For a stationary vehicle, only the precipitation vertically above hits the windscreen. Its amount (volume **V**) is the average screen width **W** multiplied with Area **A**.



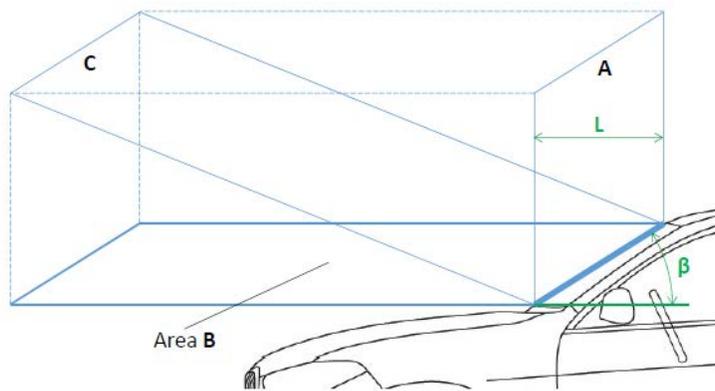
So the volume of air and precipitation containing the raindrops which hit the windscreen in a certain time is:

$$V = W \times L \times v_{\text{Rain}} \times t$$

with rigid values for windscreen width **W** and projected length **L**.



Due to the relative movement between precipitation and vehicle, the rain in the area diagonally in front of it hits the windshield of a moving car. Its volume is calculated from the constant windshield width W multiplied with Area C.



Geometrically, Area C is the sum of Area A and B. That means, the vehicle movement adds the volume V_B resulting from Area B to the amount of rain hitting the windshield of a stationary car, and this volume is increasing linearly with the vehicle speed.

Comparison of a vehicle in city traffic to a statutory one

The amount of precipitation at city speeds is about **twice as high** as if the vehicle stops at the traffic light under identical environmental conditions.

Calculation basis:

The average drop falling speed of a normal rainfall is: $v_{\text{Rain}} = 7 \text{ m/s} \approx 23 \text{ ft/s} \approx 16 \text{ mph}$

The average windscreen angle for sedan and SUV is: $\beta = 31^\circ$

The volume of air and precipitation containing the hitting raindrops within a time of one second ($t = 1 \text{ s}$), calculated for a simplified windscreen width of one meter ($W = 1 \text{ m}$) and a projected standardized screen length of one meter ($L = 1 \text{ m}$) is:

For a statutory vehicle, speed = 0 mph

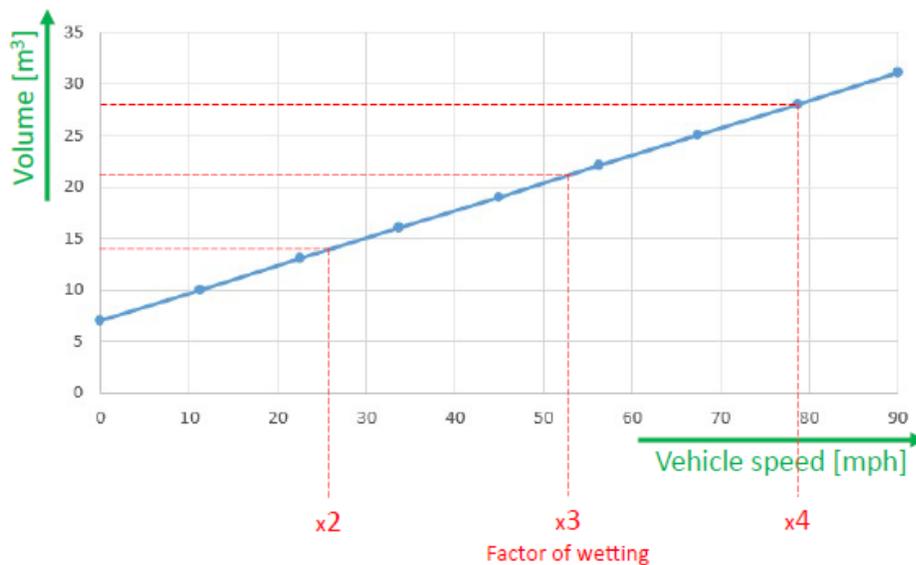
$$V_{\text{stat}} = W \times L \times v_{\text{Rain}} \times t = 1 \times 1 \times 7 \times 1 \text{ [m} \times \text{m} \times \text{m/s} \times \text{s}] = 7 \text{ m}^3$$

For a moving vehicle at a speed of $v_{\text{Vehicle}} = 13 \text{ m/s} \approx 29 \text{ mph}$

$$V_{\text{B}} = W \times L \times \tan \beta \times v_{\text{Vehicle}} \times t = 1 \times 1 \times \tan 31^\circ \times 13 \times 1 \text{ [m} \times \text{m} \times \text{m/s} \times \text{s}] = 7.8 \text{ m}^3$$

$$V_{\text{mov}} = V_{\text{stat}} + V_{\text{B}} = 14.8 \text{ m}^3$$

Graphics



Another perspective involves determining an equivalent condition between a vehicle at rest containing this slight non-compliance and a moving vehicle that is compliant. A vehicle at rest with this slight non-compliance, i.e., with a wiper frequency of 41 cycles/min (instead of 45 cycles/min) has a reduced wiper frequency and, therefore, it is slightly less efficient in removing the rain from the windshield. Using the calculations outlined above, an equivalent condition would result in a vehicle velocity of approximately 2.3mph. Therefore, a vehicle containing this slight non-compliance at rest can be considered to be equivalent to a compliant vehicle at 2.3mph. Moreover, this pertains to the High wiper frequency mode. If the Low wiper frequency mode is selected, the equivalent vehicle velocity is 0.2mph.

Driver visibility while the vehicle is at rest with this slight or marginal non-compliance is greater than driver visibility while the vehicle is moving with a compliant system, especially when the vehicle is moving at city and highway speeds.

The Wiper System Does Not Decrease During Vehicle Deceleration

The wiper system functionality on the vehicles that are the subject of this petition is such that wiper frequency does not decrease during vehicle deceleration. Therefore, the slight or marginal non-compliance does not exist during vehicle deceleration, including the small period of time when the vehicle is coming to rest, e.g., approaching a stop light. In those circumstances, there could be a vehicle already at the stop light or a pedestrian in the crosswalk. In these instances, the vehicles that are the subject of this petition are fully compliant.

SAE J903 (Passenger Car Windshield Wiper Systems)

SAE J903 (1999) – Passenger Car Windshield Wiper Systems was most recently updated and published in May 1999. Section 4.1.2.1 pertains to wiper frequencies and sub-section 4.1.2.1(b) states that, “One of not less than 10 and not more than 55 cycles/min.” In other words, the minimum performance outlined for a vehicle wiper frequency is 10 cycles/min. [Emphasis added.]

Section 1 (Scope) states that, J903 “...establishes for passenger cars, light trucks, and multipurpose vehicles...a) minimum performance standards for windshield wiper systems.” It also states that “[T]he test procedures and minimum performance standards...are based on currently available engineering data. It is the intent that all portions of the document will be periodically reviewed and revised as additional data regarding windshield wiping system performance are developed.” [Emphasis added.]

From a review of the most recent release of SAE J903, it would appear that, based upon a review of “currently available engineering data” by the technical expert group responsible for ongoing releases of SAE J903, that the currently-accepted minimum performance requirement is 10 cycles/min. As noted in our petition, under certain limited circumstances our wiper system frequencies (cycles/min) are at approximately 41 or 42 instead of 45, or at 19.8 instead of 20 and, in all of these conditions, all frequencies are well-above a wiper frequency rate of 10 cycles/min. Therefore, it would appear, according to the current version of SAE J903 that these wiper frequency rates are also safe.

Field Experience

BMW has not received any complaints from vehicle owners, and is not aware of any accidents or injuries that have occurred as a result of this issue. Toyota is not aware of any accidents or injuries, and has no field reports or claims relating to this issue in Supra vehicles.

Vehicle Production

Vehicle production has been corrected to conform to FMVSS 104 Sections 4.1.1.2 and 4.1.1.3.

Additional Testing

Additional testing is being considered with the intent to supplement this petition within the next several weeks.

* * *

For the reasons set forth above, we believe that this issue is inconsequential to motor vehicle safety. Accordingly, BMW requests relief from the 49 CFR 573 notification and remedy requirements.

Sincerely,

BMW of North America, LLC



Samuel Campbell, III
Department Head
Safety Engineering and Intelligent Transportation Systems

Attachments

- Attachment 1 – BMW 49 CFR 573 Report (11 Sep 2020)

Cc: J. Giuseppe, Associate Administrator for Enforcement
O. Matheke, Director, Office of Vehicle Safety Compliance (OVSC)
V. Williams, Acting Chief, OVSC (Crash Avoidance Division)



BMW of North America, LLC

Vehicle Report

Transaction ID: 20-0010039-25035-10 (Original Report)

Required fields indicated with *

Your report has been submitted. Your Transaction No. is 20-0010039-25035-10.

Manufacturer: BMW of North America, LLC

P.O. Box 1227
Westwood NJ 07675-1227[Martin Rapaport](#)
201-571-5208,This is a Noncompliance Report. Filing a petition pursuant to [49 CFR 556](#)

Vehicle Information

Toyota Supra 2020 - 2021

* **Model Yr. Start:** 2020 * **Model Yr. End:** 2021
 * **Make:** Toyota
 * **Model:** Supra

Type: LIGHT VEHICLES
Body Style: 2-DOOR
Powertrain: GAS

Production Dates Begin: 02/06/2019
 End: 07/24/2020

Descriptive Information:

Approximately 9,108 vehicles may not fully conform to FMVSS 104 Sections 4.1.1.2 and 4.1.1.3. Basis for recall population determination: Vehicle assembly information was used to determine the start and end date of potentially affected vehicles. Recall component difference to non-recall component: Recall vehicles have wiper control software that may not fully conform to FMVSS 104 Sections 4.1.1.2 and 4.1.1.3.

VIN Range(s): Begin: End:

BMW 2 Series Gran Coupe (228i, 228i xDrive, M235i xDrive) 2020 - 2021

* **Model Yr. Start:** 2020 * **Model Yr. End:** 2021
 * **Make:** BMW
 * **Model:** 2 Series Gran Coupe (228i, 228i xDrive, M235i xDrive)

Type: LIGHT VEHICLES
Body Style: 2-DOOR
Powertrain: GAS

Production Dates Begin: 03/12/2019
 End: 08/04/2020

Descriptive Information:

Approximately 7,177 vehicles may not fully conform to FMVSS 104 Sections 4.1.1.2 and 4.1.1.3. Basis for recall population determination: Vehicle assembly information was used to determine the start and end date of potentially affected vehicles. Recall component difference to non-recall component: Recall vehicles have wiper control software that may not fully conform to FMVSS 104 Sections 4.1.1.2 and 4.1.1.3.

VIN Range(s): Begin: End:

BMW 8 Series Convertible (840i, 840i xDrive, M850i xDrive, M8) 2019 - 2021

* **Model Yr. Start:** 2019 * **Model Yr. End:** 2021
 * **Make:** BMW
 * **Model:** 8 Series Convertible (840i, 840i xDrive, M850i xDrive, M8)

Type: LIGHT VEHICLES
Body Style: 2-DOOR
Powertrain: GAS

Production Dates Begin: 03/15/2018
 End: 07/31/2020

Descriptive Information:

Approximately 4,250 vehicles may not fully conform to FMVSS 104 Sections 4.1.1.2 and 4.1.1.3. Basis for recall population determination: Vehicle assembly information was used to determine the start and end date of potentially affected vehicles. Recall component difference to non-recall component: Recall vehicles have wiper control software that may not fully conform to FMVSS 104 Sections 4.1.1.2 and 4.1.1.3.

VIN Range(s): Begin: End:

BMW 8 Series Coupe (840i, 840i xDrive, M850i xDrive, M8) 2019 - 2021

End: 08/04/2020

Approximately 4,834 vehicles may not fully conform to FMVSS 104 Sections 4.1.1.2 and 4.1.1.3. Basis for recall population determination: Vehicle assembly information was used to determine the start and end date of potentially affected vehicles. Recall component difference to non-recall component: Recall vehicles have wiper control software that may not fully conform to FMVSS 104 Sections 4.1.1.2 and 4.1.1.3.

VIN Range(s): Begin: End:

BMW X7 xDrive40i, X7 xDrive50i, X7 M50i 2019 - 2021

* **Model Yr. Start:** 2019 * **Model Yr. End:** 2021
 * **Make:** BMW
 * **Model:** X7 xDrive40i, X7 xDrive50i, X7 M50i

Type: LIGHT VEHICLES
Body Style: SUV
Powertrain: GAS

Production Dates Begin: 07/10/2018
 End: 08/04/2020

Descriptive Information:

Approximately 33,673 vehicles may not fully conform to FMVSS 104 Sections 4.1.1.2 and 4.1.1.3. Basis for recall population determination: Vehicle assembly information was used to determine the start and end date of potentially affected vehicles. Recall component difference to non-recall component: Recall vehicles have wiper control software that may not fully conform to FMVSS 104 Sections 4.1.1.2 and 4.1.1.3.

VIN Range(s): Begin: End:

BMW 330i, 330i xDrive, M340i, M340i 2019 - 2021

* **Model Yr. Start:** 2019 * **Model Yr. End:** 2021
 * **Make:** BMW
 * **Model:** 330i, 330i xDrive, M340i, M340i

Type: LIGHT VEHICLES
Body Style: 4-DOOR
Powertrain: GAS

Production Dates Begin: 05/14/2018
 End: 08/03/2020

Descriptive Information:

Approximately 78,257 vehicles may not fully conform to FMVSS 104 Sections 4.1.1.2 and 4.1.1.3. Basis for recall population determination: Vehicle assembly information was used to determine the start and end date of potentially affected vehicles. Recall component difference to non-recall component: Recall vehicles have wiper control software that may not fully conform to FMVSS 104 Sections 4.1.1.2 and 4.1.1.3.

VIN Range(s): Begin: End:

BMW 330e, 330e xDrive 2021

* **Model Yr. Start:** 2021 * **Model Yr. End:** 2021
 * **Make:** BMW
 * **Model:** 330e, 330e xDrive

Type: LIGHT VEHICLES
Body Style: 4-DOOR
Powertrain: HYBRID ELECTRIC

Production Dates Begin: 03/02/2020
 End: 07/10/2020

Descriptive Information:

Approximately 342 vehicles may not fully conform to FMVSS 104 Sections 4.1.1.2 and 4.1.1.3. Basis for recall population determination: Vehicle assembly information was used to determine the start and end date of potentially affected vehicles. Recall component difference to non-recall component: Recall vehicles have wiper control software that may not fully conform to FMVSS 104 Sections 4.1.1.2 and 4.1.1.3.

VIN Range(s): Begin: End:

BMW 4 Series Coupe (430i, 430i xDrive, M440i xDrive) 2021

* **Model Yr. Start:** 2021 * **Model Yr. End:** 2021
 * **Make:** BMW
 * **Model:** 4 Series Coupe (430i, 430i xDrive, M440i xDrive)

Type: LIGHT VEHICLES
Body Style: 2-DOOR
Powertrain: GAS

Production Dates Begin: 06/09/2020
 End: 07/30/2020

Descriptive Information:

Approximately 144 vehicles may not fully conform to FMVSS 104 Sections 4.1.1.2 and 4.1.1.3. Basis for recall population determination: Vehicle assembly information was used to determine the start and end date of potentially affected vehicles. Recall component difference to non-recall component: Recall vehicles have wiper control software that may not fully conform to FMVSS 104 Sections 4.1.1.2 and 4.1.1.3.

If the defect or noncompliance involves a specific component(s), identify that component(s) below.

Component Name: Windshield Wiper System
Component Description: Windshield Wiper System
Component Part Number: N/A - Part 556 Petition to be Submitted

Chronology of Defect / Noncompliance Determination

Provide the chronology of events leading up to the defect decision or test data for the noncompliance decision.:

On July 7, 2020, during a quality review, it was noticed that if the vehicle speed was 0km/h, the windshield wiper frequency decreased. Between July and August, an engineering analysis was conducted. Engineering release information, software programming / coding parameters, and databases were reviewed. Wiper control system software and coding parameters were checked. The review indicated that, due to certain coding parameters, this would cause the wiper frequency to change under certain conditions. Specifically, if the vehicle speed was zero, or between 0 km/h and 4 km/h (when accelerating from a stop), wiper frequency would decrease. The reduction in wiper frequency when the vehicle speed was close to 0 km/h was intended as a quality / comfort function for the wiper system / driver respectively. On September 9th and 11th, 2020, it was determined that the affected BMW and Toyota vehicles, respectively, may not fully conform to FMVSS 104 Sections 4.1.1.2 and 4.1.1.3. BMW has not received any reports, nor is BMW otherwise aware, of any accidents or injuries related to this issue.

Identify the Remedy

Describe the defect/noncompliance remedy program, including the manufacturer's plan for reimbursement.

BMW believes that this matter is inconsequential to motor vehicle safety and therefore will be filing a Petition for Decision of Inconsequential Noncompliance in accordance with the provisions of Part 556.

Describe what distinguishes the remedy component from the recalled component.

N/A BMW believes that this matter is inconsequential to motor vehicle safety and therefore will be filing a Petition for Decision of Inconsequential Noncompliance in accordance with the provisions of Part 556.

Identify and describe how and when the recall condition was corrected in production.

Identify the Recall Schedule

Describe the recall schedule for notifications.:

BMW believes that this matter is inconsequential to motor vehicle safety and therefore will be filing a Petition for Decision of Inconsequential Noncompliance in accordance with the provisions of Part 556.

Planned Dealer Notification Begin Date:

Planned Dealer Notification End Date:

Planned Owner Notification Begin Date:

Planned Owner Notification End Date:

Manufacturer's identification code for this recall (if applicable):

Please be reminded that owner notification letters must be mailed no more than 60 days from submission of this report.

Manufacturer Comments to NHTSA Staff

BMW believes that this matter is inconsequential to motor vehicle safety and therefore will be filing a Petition for Decision of Inconsequential Noncompliance in accordance with the provisions of Part 556.

Document Upload

There are 0 documents associated with this report.

BMW Group

February 22, 2021

The Honorable Steven Cliff
Deputy Administrator
National Highway Traffic Safety Administration
1200 New Jersey Ave., S.E.
Washington, DC 20590

**Re: 49 CFR 556 – Petition for Inconsequential Non-Compliance
FMVSS 104 (Windshield wiper and washing systems)
20V-555
Supplemental Information (Human Factors Study – Test Results)**

Dear Deputy Administrator Cliff:

BMW of North America, LLC, a subsidiary of BMW AG, Munich, Germany, is submitting the enclosed information (human-factors study and test results) to supplement our October 9, 2020 49 CFR 556 Petition for Inconsequential Non-Compliance. The supplemental information pertains to a study created and conducted by BMW's Human-Factor's group in conjunction with the technical development group responsible for wiper systems.

Our October 9, 2020 petition pertained to BMW's September 11, 2020 49 CFR 573 report regarding FMVSS 104 windshield wiper frequency involving approximately 244,433 Model Year 2019-2021 BMW and Model Year 2020-2021 Toyota vehicles (the "affected vehicles"). A copy of BMW's Part 556 Petition and Part 573 Report are also enclosed for reference, and to aid the agency in its review of the supplemental information.

We would appreciate NHTSA's review of the supplemental information being provided. If the agency has any questions regarding BMW's human-factors testing and results, we would be willing to discuss the information with the agency at their request.

Company
BMW of North America, LLC

BMW Group Company

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Sincerely,

BMW of North America, LLC



Samuel Campbell, III
Department Head
Safety Engineering and Intelligent Transportation Systems

Enclosures

- Attachments 1 & 2 – BMW Human-Factors Study & Test Results – (February 2021)
- Attachment 3 – BMW Part 573 Report (20V-555) – (11 Sep 2020)
- Attachment 4 – BMW Part 556 Petition – (9 Oct 2020)

Cc: J. Giuseppe, Associate Administrator for Enforcement
O. Matheke, Director, Office of Vehicle Safety Compliance (OVSC)
M. Hicks, Chief, OVSC (Crash Avoidance Division)
C. Hatipoglu, Associate Administrator for Research

**Part 556 Petition for Inconsequential Non-Compliance
FMVSS 104 (Windshield Wiping and Washing Systems)
Supplemental Information
BMW Human Factors Study
February 2021**

ABSTRACT

The objective of this study was to evaluate two different wiping speeds (41 rpm and 45 rpm) in two identical vehicles and their influence on the recognizability and legibility of traffic signs using an experimental setup. During the standardized test, a rain simulation was used to create comparable visibility conditions. The participants had to read out different traffic signs to an experimenter and evaluate their recognizability while sitting in the vehicle with the wipers on. Steady rain conditions were simulated by applying water to the windshield. There was no statistically significant difference in the self-reported difficulty of reading the traffic signs, and there was no difference in the recognition rate of the signs (i.e., speed limits and additional texts). There was also no difference in the satisfaction with the wiping performance.

METHOD

Sample

In total, $N = 50$ participants (25 female, 25 male) took part in the study. All participants held a valid driver's license. The mean age was 38.3 years ($SD = 13.2$) with a range from 19 to 60 years. 11 of the 50 participants drive more than 20.000 km per year. The majority ($n = 23$) drive between 10.000 and 20.000 km and 16 participants between 5.000 and 10.000 km per year. 11 of the participants own a BMW.

Wiping systems

Two identical BMW X5 with different wiping speeds were used in the study. One vehicle had been prepared to have a front wiper system speed of approximately 41 min^{-1} . The other vehicle provided a front wiper system speed of 45 min^{-1} . The variation in the wiping speeds were evaluated to test the reliability of the technical setup following FMVSS test procedure TP104-08 (chapter 13.1). The vehicle engine was running at its idle speed and water was applied to the windshield with an external spray device. The wipe cycles have been evaluated before the first and after the last test person, and three times in-between. The white BMW X5 had a wiping speed with 41 ± 0.2 rpm and the black BMW X5 45 ± 0.2 rpm, proving the reliability of the technical setup.

Technical set-up

In addition to the wiper system, other parameters were adjusted and measured according to the requirements of FMVSS test procedure TP104-08 (chapter 13.1):

- Ambient temperature:
 - Requirement: 50...100°F (10...38°C). /
 - Measured: 21°C [2020-12-11 / 6:30 p.m.]
- Water temperature:
 - Requirement: max. 100°F (38°C)
 - Measured: 19°C [2020-12-11 / 6:30 p.m.]
- Water Nozzles:
 - Requirement: 2 nozzles, water flow min. 50 in³ (820 cm³) per minute.
 - Provided: 2 nozzles, water flow 1,200 cm³

**Part 556 Petition for Inconsequential Non-Compliance
FMVSS 104 (Windshield Wiping and Washing Systems)
Supplemental Information
BMW Human Factors Study
February 2021**

- Water Hardness:
 - Requirement: max. 12 grains/gal (0.2 kg/m³).
 - Provided: demineralized water

The two vehicles were positioned at a defined distance to the traffic signs (see Figure 1). They were each placed with a distance of 4.4 m. Two speed limit signs (30 km/h, 80 km/h) were used in this test, each with an additional text sign. One additional sign was "Roadworks exit" and the other "Dirty roadway" (see Figure 1). The traffic signs were arranged in such a way that they corresponded to a realistic environment. The height of the signs was also adjusted to a realistic level.



Figure 1 Technical set-up

Study design

In this experiment, two different wiping speeds (41 rpm vs. 45 rpm) were evaluated. The wiping speed conditions were created using two experimental vehicles. The task of the participants was to identify different traffic signs (speed limits and additional texts) and rate how easy or difficult it is to read them on a 7-point rating scale (so-called Likert scale) ranging from very difficult to very easy. The user satisfaction with the two wiping speeds and the satisfaction with the respective perceived wiping performance were also measured using 7-point Likert scales ranging from very unsatisfied to very satisfied. All participants completed all experimental conditions (i.e., they gave ratings on both wiper speeds and both traffic signs). To prevent order effects, the order of the two wiper speeds and the traffic signs were balanced within the sample (see Figure 2). Thus, half of the sample started with one of the two vehicles and switched then to the other one. The two traffic signs were also balanced between the two experimental groups (i.e., half of the participant started with one sign, the other half with the other).

**Part 556 Petition for Inconsequential Non-Compliance
FMVSS 104 (Windshield Wiping and Washing Systems)
Supplemental Information
BMW Human Factors Study
February 2021**

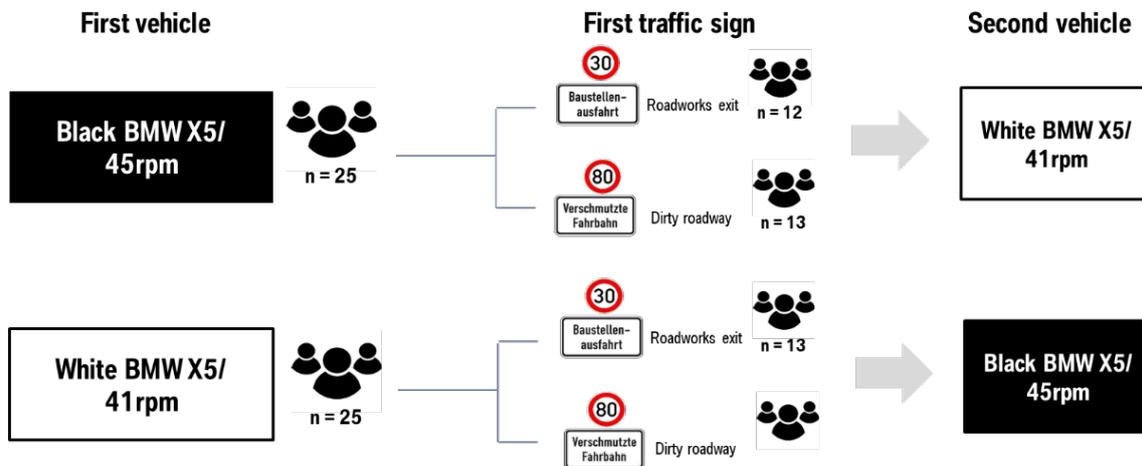


Figure 2 Overview of the experimental set-up

Study procedure

In December 2020, the user study was conducted in a standardized test setting according to FMVSS 104. One experimenter conducted the study over the course of two weeks. Each test trial lasted approximately 30 minutes per participant. Participants were welcomed and informed about the purpose of the study. After having provided informed consent, a pre-interview was conducted outside the vehicle. Afterwards, the participants were asked to get into the first vehicle and adjust the seat and the steering wheel. The rain device was started and the participants were asked to observe the traffic signs. Then, the participants were asked about the visibility of the traffic sign with an open-ended question (i.e., they had to read the sign out loud) and to provide ratings about the reading difficulty (“How easy or difficult do you find it to recognize the traffic sign?”). In addition, they rated their satisfaction (“How satisfied are you with the speed of the wipers?”) with the wiping system and the wiping performance (“How satisfied are you with the wiping performance?”). In addition to the target questions, we also included some distractor questions to avoid that the participants would answer in a socially desirable way (i.e., that they would answer the questions according to the assumed goal of the study). Then the same evaluation took place in the second vehicle. The traffic signs were only revealed after the participants had entered the vehicles (one after another).

RESULTS

Visibility of the traffic signs

The first question was about the recognizability of the traffic signs (“How easy or difficult do you find it to recognize the traffic sign?”). An overview of the ratings is shown in Figure 3. At the wiper speed of 41 rpm, 38 participants indicated to recognize the traffic sign very easy. Only one participant found it rather difficult to see the sign. On average, the participants rated the visibility of the traffic signs with the speed of 41 rpm as $M=2.68$ ($SD=0.7$). 34 participants indicated to recognize the traffic sign very easy at a wiper speed of 45 rpm. Only one participant found it rather difficult to see the sign. On average, the participants rated the visibility of the traffic signs with the speed of 45 rpm as $M=2.48$ ($SD=0.9$). A paired t-test revealed no significant differences between the two different wiping speeds as far as the recognizability of the traffic sign is concerned ($p=.096$). All participants were able to see the speed limits as well as to read the additional text correctly in both conditions.

**Part 556 Petition for Inconsequential Non-Compliance
FMVSS 104 (Windshield Wiping and Washing Systems)
Supplemental Information
BMW Human Factors Study
February 2021**

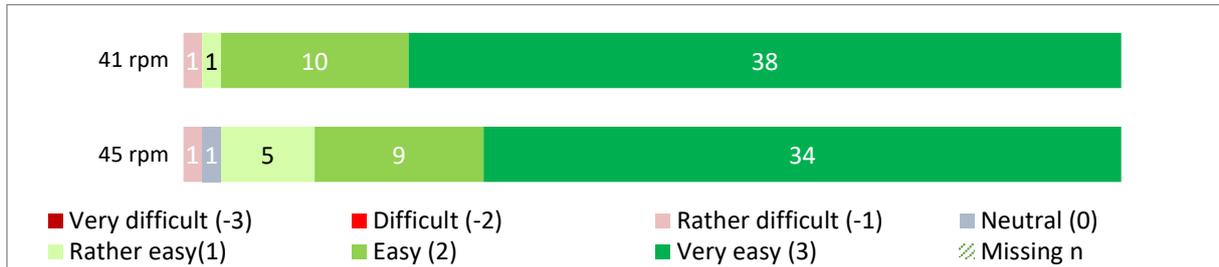


Figure 3 Rating of the visibility of the traffic signs

Satisfaction with wiping performance

In response to the question how satisfied the participants are with the wiping performance (“How satisfied are you with the wiping performance?”), 34 indicated that they were very satisfied with the speed of 41 rpm. 9 of the 50 participants were satisfied and 7 rather satisfied with the wiping performance. On average, the participants rated the wiping performance as $M= 2.54$ ($SD= 0.7$). At the wiping speed of 45 rpm, 33 participants found it very satisfied, 15 were satisfied, one rather satisfied and one were rather unsatisfied. On average, the participants rated the wiping performance as $M= 2.58$ ($SD= 0.7$). An overview of the results of the satisfaction is shown in Figure 4. A paired t-test revealed no significant differences between the perceived wiping performance of the two wiping speeds ($p= .770$).

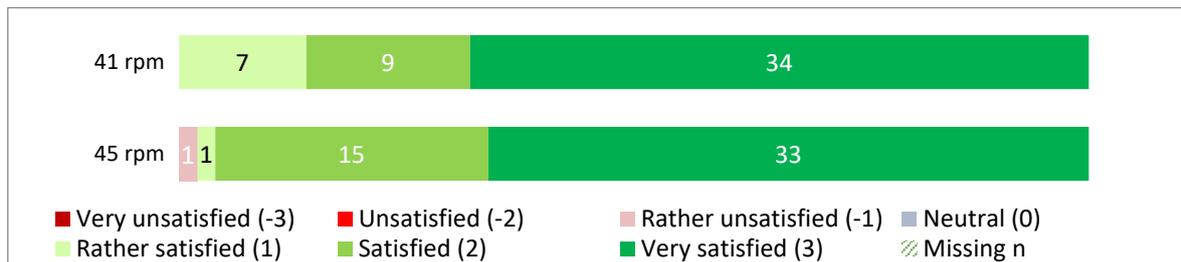


Figure 4 Rating of the satisfaction of the wiping performance

Satisfaction with wiping speed

In addition, the participants were asked how satisfied they are with the speed of the wipers (“How satisfied are you with the speed of the wipers?”). 28 participants indicated to be very satisfied with the wiping speed of 41 rpm and only 17 with the wiping speed of 45 rpm. An overview of the ratings is shown in Figure 5. On average, the participants rated their satisfaction with the 41 rpm wiping speed as $M= 2.24$ ($SD= 1.1$) and the wiping speed of 45 rpm as $M= 1.78$ ($SD= 1.2$). Thus, they indicated a lower satisfaction with the faster wiping speed. A paired t-test revealed that this difference between the perceived wiping performance was statistically significant ($p= .016$). The participants justified the rating of the wiping speed 41 rpm by stating that this is slightly too fast ($n= 9$) or slightly too slow ($n= 11$). 21 participants found the wiping speed 45 rpm slightly too fast and 6 slightly too slow. In conclusion, the slower wiping speed leads to significantly higher satisfaction among the participants. The higher wiping frequency is often perceived as somewhat too fast or hectic.

**Part 556 Petition for Inconsequential Non-Compliance
FMVSS 104 (Windshield Wiping and Washing Systems)
Supplemental Information
BMW Human Factors Study
February 2021**

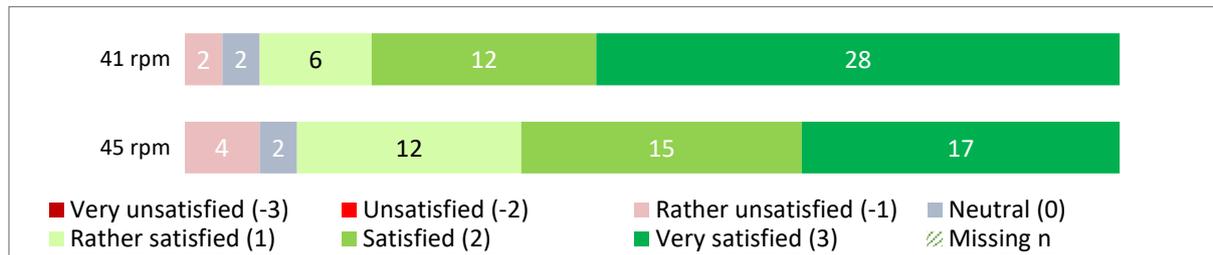


Figure 5 Satisfaction with the two wiping speeds

Satisfaction with distractors

The participants were also asked to rate their satisfaction with different distractors, such as the cleanliness of the wiped surface, noise level and the length of the wiper blades. A paired t-test showed no significant differences between the two wipers and the surveyed distractors (see Table 1).

Table 1: Satisfaction with distractors

Distractors	<i>M</i>	<i>SD</i>	<i>p</i>
Noise level	$M_{41rpm} = 1.96$ $M_{45rpm} = 1.86$	$SD_{41rpm} = 1.0$ $SD_{45rpm} = 1.1$.47
Cleanliness of the wiped surface	$M_{41rpm} = 2.66$ $M_{45rpm} = 2.70$	$SD_{41rpm} = 0.6$ $SD_{45rpm} = 0.8$.76
Wiper blades length	$M_{41rpm} = 2.84$ $M_{45rpm} = 2.64$	$SD_{41rpm} = 0.5$ $SD_{45rpm} = 0.8$.096

Conclusion

The objective of this study was to evaluate two different wiping speeds and their influence on the recognizability of traffic signs in an experimental setup with 50 test participants. In addition, the user satisfaction with the two wiping speeds and the satisfaction with the respective perceived wiping performance were measured.

The most important result of the study was that there is no statistically significant difference between the two different wiping speeds as far as the recognizability of the traffic sign is concerned. This holds true both for the identification of the traffic signs as well as the self-reported difficulty of reading the traffic signs in the standardized rain setting. In line with this, there is no statistically significant difference in the self-reported wiping performance of the two wiping speeds. Thus, the fast and the slow wiping speed perform equally well in cleaning the windshield from the rain from the participants' point of view.

RESULTS WIPER-STUDY.

USER STUDY.

Sample: Car drivers



**BMW
GROUP**

THE NEXT
100 YEARS





01

STUDY DESIGN

RESEARCH QUESTIONS.

FOCUS: COMPARISON OF TWO WIPING SPEEDS.



WIPING SPEEDS:

- Does the speed of the windshield wipers have an influence on the recognizability and legibility of the traffic signs?
- How does the subjective satisfaction of the users differ with the speed of the two windshield wipers and their wiping performance?
- Which wipers are preferred and for what reasons?

METHODS.

Study procedure

- The study was carried out with 50 participants in standardized test setting according to FMVSS 104
- The participants completed two trials that varied in the wiper speed (41 rmp vs. 45 rpm)
- The wiper speed conditions were created using two experimental vehicles
- They had to identify different traffic signs (speed limits and additional texts) and rate how easy or difficult it is to read them
- Additional ratings were collected while sitting in the vehicle and also after the test run
- To prevent order effects, the two wiper speeds and the traffic signs were balanced

TEST PROCEDURE

COMPARISON OF TWO WIPING SPEEDS.



30 MINUTES

PRE-INTERVIEW

🕒 5 min.

P

INTRODUCTION

- Information about regulations and questions about Covid-19
- Introduction

FIRST VEHICLE – WIPING SPEED I

🕒 10 min.

P

WIPING SYSTEM I

- Description of the wiping behavior
- Visibility of the traffic sign (open-ended + difficulty rating)
- Satisfaction with wiping speed and wiping performance
- Satisfaction with distractors (cleanliness, wiping area, noise level, length of wiper blades)

SECOND VEHICLE – WIPING SPEED II

🕒 10 min.

P

WIPING SYSTEM II

- Description of the wiping behavior
- Visibility of the traffic sign (open-ended + difficulty rating)
- Satisfaction with wiping speed and wiping performance
- Satisfaction with distractors (cleanliness, wiping area, noise level, length of wiper blades)

COMPARISON

🕒 5 min.

P

COMPARISON

- Notable differences
- Differences in wiping performance
- Differences regarding the recognizability of the traffic sign
- Preference

SPECIAL FEATURES



- The order of the vehicles was rotated.
- The order of the traffic signs was rotated.
- After half of the interviews, the position of the two vehicles was switched.

SET-UP. KEY DATA.



📍 WIPER STUDY

- Location: Light channel in building 70
- Implementation: Two BMW X5 (identical in construction) with different wiping speeds
- Wiping speed: White BMW X5: 41 ±0.2 rpm
Black BMW X5: 45 ±0.2 rpm

🔍 STUDY DESIGN

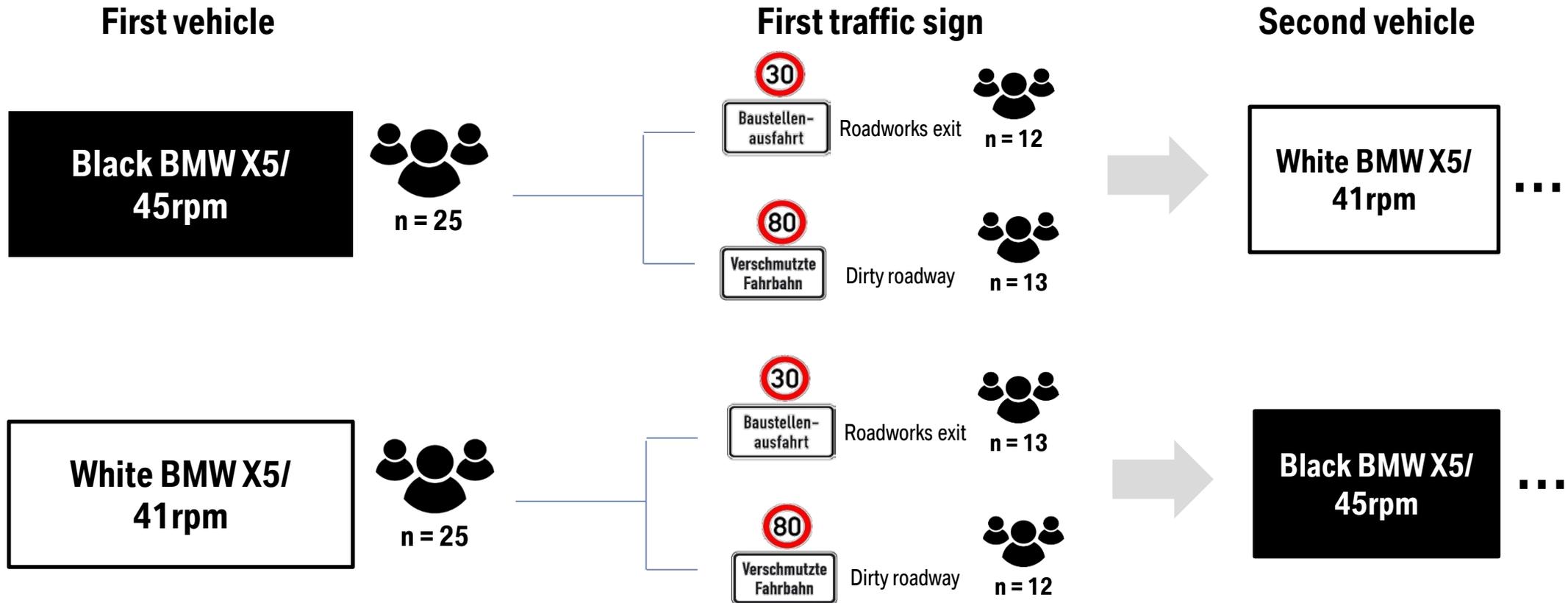
- Sample: N=50 car drivers

📅 TIME PERIOD

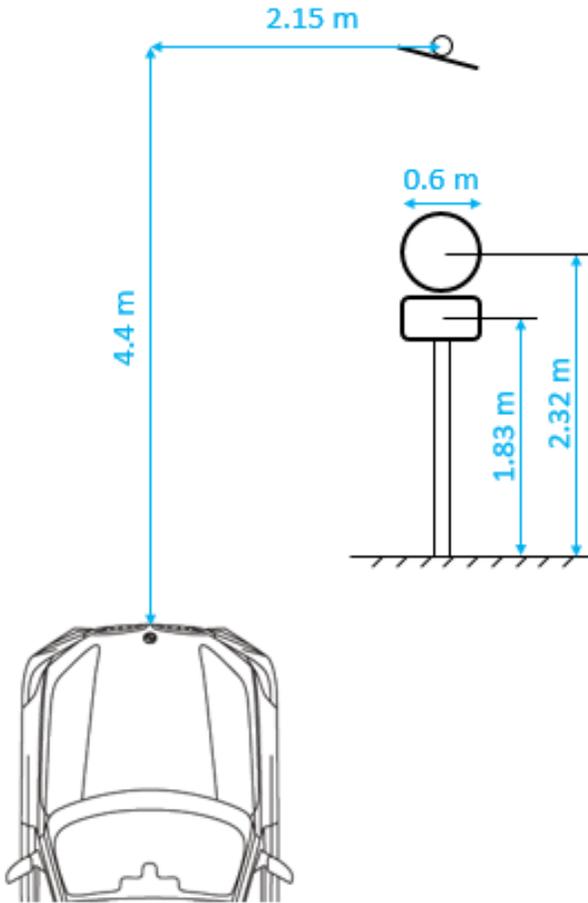
- Field phase: 09:00 am-06:30 pm per day
December 7th 2020 until December 18th 2020
- Duration: Approx. 30 minutes per slot
- Organization: 1 interviewer, max. 7 slots/day

SET-UP. ROTATION PLAN.

- All 50 study participants evaluated two different wiping speeds in two vehicles. To prevent order effect, half of the sample started with one of the two vehicles and switched then to the other one. The two traffic signs were also balanced between the two experimental groups.



SET-UP. TECHNICAL DETAILS.



WIPING SPEED

- According FMVSS 104, one [wipe] frequency or speed shall be at least 45 cycles per minute.
- The vehicles have been prepared to have one with a front wiper system speed of approximately 41 min⁻¹, a frequency which has been detected on several involved models for LOW wiper speed below 45 min⁻¹. The other vehicle provides a front wiper system speed of 45 min⁻¹ according legal requirement for the HIGH wiper speed.
- Both vehicles are identical models (BMW X5) with similar wiper systems, the wiper speed adjustment has been possible since an electronic wiper motor is in use of those systems, providing largely independent of voltage and load the requested frequency.
- Using the test setup as already described and following the frequency test description according FMVSS test procedure TP104-08, chapter 13.1, with the vehicle engine running at its idle speed and applying water by the external spray device, the wipe cycles have been evaluated before the first and after the last test person, and three times in-between, with an expected stable result due to the electronic wiper motor, leading to not evaluable variations.
- Results: White BMW X5: 41 ±0.2 rpm; Black BMW X5: 45 ±0.2 rpm

OTHER PARAMETERS (according to SAE chapter 4)

- 4.1.2 (a) Ambient temperature: Requirement: 50...100°F (10...38°C). // Measured: 21°C [2020-12-11 / 6:30 p.m.]
- 4.1.2 (b) Water temperature: Requirement: max. 100°F (38°C). // Measured: 19°C [2020-12-11 / 6:30 p.m.]
- 4.1.2 (c) Water Nozzles: Requirement: 2 nozzles, water flow min. 50 in³ (820 cm³) per minute. // Provided: 2 nozzles, water flow 1,200 cm³
- 4.1.2 (d) Water Hardness: Requirement: max. 12 grains/gal (0.2 kg/m³). // Provided: demineralized water

SAMPLE.

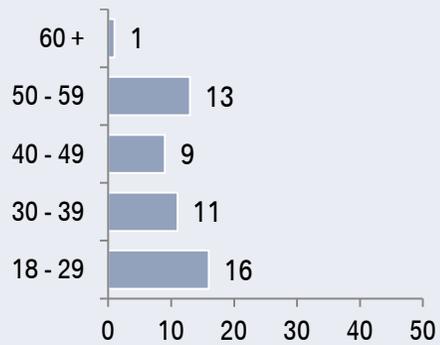
TARGET GROUP: CAR DRIVERS

DEMOGRAPHY

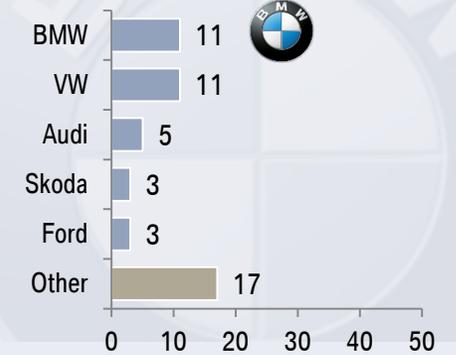
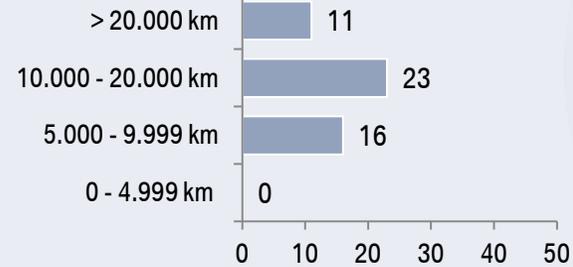
N = 50 car drivers



19 years ← \bar{x} 38.3 (SD=13.2) → 60 years



Vehicle usage | N=50





02

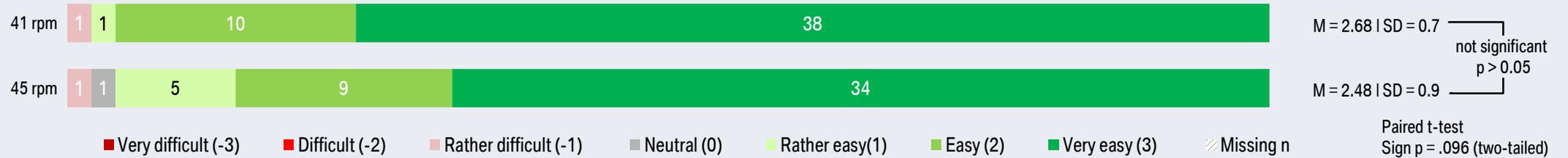
RESULTS

COMPARISON. VISIBILITY OF THE TRAFFIC SIGNS.

How easy or difficult do you find it to recognize the traffic sign?

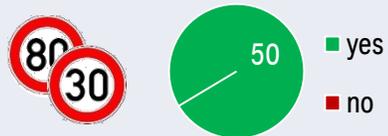
N = 50

DIFFICULTY



WIPING SPEED 41rpm

Were able to see ...
Speed limit



Were able to read ...
Additional text



WIPING SPEED 45 rpm

Were able to see ...
Speed limit



Were able to read ...
Additional text



CONCLUSION

There is no significant difference between the two different wiper speeds as far as the recognizability of the traffic sign is concerned.

COMPARISON. SATISFACTION WITH WIPING PERFORMANCE.

How satisfied are you with the wiping performance?

N = 50

SATISFACTION



WIPING SPEED 41 rpm



- Wipe very neat, wipers are also new. (f, 25)
- Does not draw streaks, I see everything, everything is wiped. (f, 24)



- Traffic sign is partially visible only blurred. (m, 34)
- Could be faster. (f, 23)

WIPING SPEED 45 rpm



- Nice and clean without streaks. (f, 53)
- The wiping speed is perfect. (f, 55)



- Noise is too loud. (m, 29)
- I have the wipers permanently in view, speed should be slower. (f, 25)



CONCLUSION

There is no significant difference between the perceived wiping performance of the two wiping speeds.

COMPARISON. SATISFACTION WITH WIPING SPEED.

How satisfied are you with the speed of the wipers?

N = 50

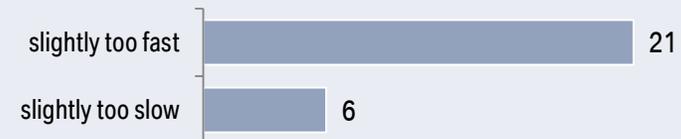
SATISFACTION



WIPING SPEED 41 rpm – open answers



WIPING SPEED 45 rpm – open answers



CONCLUSION

The slower wiping speed leads to significantly higher satisfaction among the participants. The higher wiping frequency is often perceived as somewhat too fast or hectic (for the amount of rain).

COMPARISON.

Key results

- There is no statistically significant difference between the two different wiping speeds as far as the recognizability of the traffic sign is concerned. This holds true both for the identification of the traffic signs as well as the self-reported difficulty of reading the traffic signs in the standardized rain setting.
- In line with this, there is no statistically significant difference in the self-reported wiping performance of the two wiping speeds. Thus, the fast and the slow wiping speed perform equally well in cleaning the windshield from the rain.
- Regarding the satisfaction with the wiper system, we found a difference between the two experimental conditions. The slower wiping speed leads to significantly higher satisfaction among the participants. The higher wiping frequency is often perceived as somewhat too fast or hectic (for the amount of rain).

SUMMARY.

Study design

- In December 2020, a user study was conducted with 50 car drivers.
- The objective was to evaluate **two different wiping speeds** (in two identical vehicles and also otherwise identical design) and their influence on the **recognizability and legibility of traffic signs**.
- In addition, the **user satisfaction** with the **two wiping speeds** and the satisfaction with the respective perceived wiping performance were measured using Likert scales.

Key results

- There is **no significant difference** between the two wiping speeds with regard to the recognizability / legibility of the traffic signs.
- However, the participants were slightly **more satisfied** with the **slower wiping speed** (significantly). This is often explained by the fact that the faster wiping speed is perceived as somewhat too fast/hectic for the amount of rain.



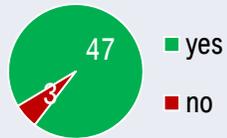
03

APPENDIX

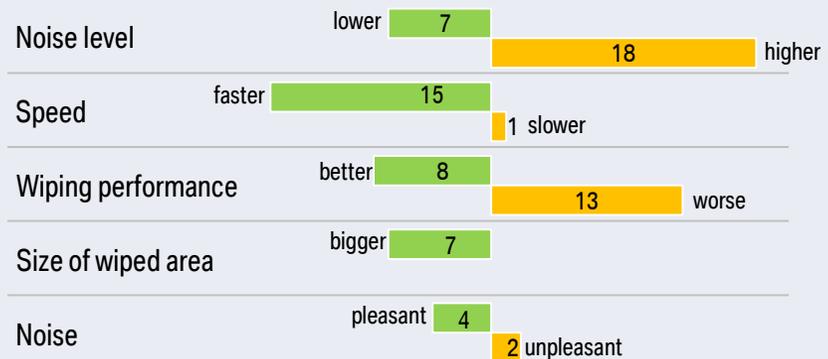
FINAL COMPARISON. DIFFERENCES.

— Perceived differences in general — ...regarding wiping performance — ...regarding visibility of traffic sign N = 50 —

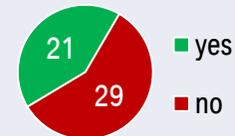
DIFFERENCES



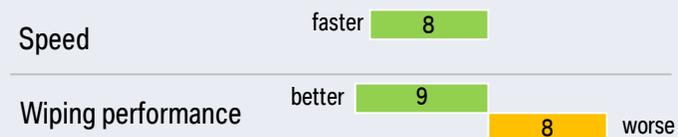
WIPING SPEED 45rpm vs. 41rpm



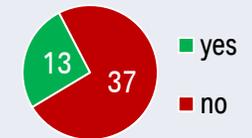
DIFFERENCES



WIPING SPEED 45rpm vs. 41rpm



DIFFERENCES



WIPING SPEED 45rpm vs. 41rpm



CONCLUSION

The higher wiping speed is also often recognized as faster, but this does not seem to have a significant positive effect on the perceived wiping performance. In the final assessment of the recognizability of the traffic sign, there is no clear tendency in favor of one of the two wipers.

COMPARISON. DISTRACTORS I.

How satisfied are you with the [...]?

N = 50

SATISFACTION WITH NOISE LEVEL



SATISFACTION WITH CLEANLINESS OF THE WIPED SURFACE



CONCLUSION

The surveyed distractors show no significant differences between the two wipers.

COMPARISON. DISTRACTORS II.

How satisfied are you with the [...]?

N = 50

SATISFACTION WITH WIPER BLADES LENGTH



CONCLUSION

The surveyed distractors show no significant differences between the two wipers.



BMW of North America, LLC

Vehicle Report

Transaction ID: 20-0010039-25035-10 (Original Report)

Required fields indicated with *

Your report has been submitted. Your Transaction No. is 20-0010039-25035-10.

Manufacturer: BMW of North America, LLC

P.O. Box 1227
Westwood NJ 07675-1227This is a Noncompliance Report. Filing a petition pursuant to [49 CFR 556](#)

Vehicle Information

Toyota Supra 2020 - 2021

* **Model Yr. Start:** 2020 * **Model Yr. End:** 2021
 * **Make:** Toyota
 * **Model:** Supra

Type: LIGHT VEHICLES
Body Style: 2-DOOR
Powertrain: GAS

Production Dates Begin: 02/06/2019
 End: 07/24/2020

Descriptive Information:

Approximately 9,108 vehicles may not fully conform to FMVSS 104 Sections 4.1.1.2 and 4.1.1.3. Basis for recall population determination: Vehicle assembly information was used to determine the start and end date of potentially affected vehicles. Recall component difference to non-recall component: Recall vehicles have wiper control software that may not fully conform to FMVSS 104 Sections 4.1.1.2 and 4.1.1.3.

VIN Range(s): Begin: End:

BMW 2 Series Gran Coupe (228i, 228i xDrive, M235i xDrive) 2020 - 2021

* **Model Yr. Start:** 2020 * **Model Yr. End:** 2021
 * **Make:** BMW
 * **Model:** 2 Series Gran Coupe (228i, 228i xDrive, M235i xDrive)

Type: LIGHT VEHICLES
Body Style: 2-DOOR
Powertrain: GAS

Production Dates Begin: 03/12/2019
 End: 08/04/2020

Descriptive Information:

Approximately 7,177 vehicles may not fully conform to FMVSS 104 Sections 4.1.1.2 and 4.1.1.3. Basis for recall population determination: Vehicle assembly information was used to determine the start and end date of potentially affected vehicles. Recall component difference to non-recall component: Recall vehicles have wiper control software that may not fully conform to FMVSS 104 Sections 4.1.1.2 and 4.1.1.3.

VIN Range(s): Begin: End:

BMW 8 Series Convertible (840i, 840i xDrive, M850i xDrive, M8) 2019 - 2021

* **Model Yr. Start:** 2019 * **Model Yr. End:** 2021
 * **Make:** BMW
 * **Model:** 8 Series Convertible (840i, 840i xDrive, M850i xDrive, M8)

Type: LIGHT VEHICLES
Body Style: 2-DOOR
Powertrain: GAS

Production Dates Begin: 03/15/2018
 End: 07/31/2020

Descriptive Information:

Approximately 4,250 vehicles may not fully conform to FMVSS 104 Sections 4.1.1.2 and 4.1.1.3. Basis for recall population determination: Vehicle assembly information was used to determine the start and end date of potentially affected vehicles. Recall component difference to non-recall component: Recall vehicles have wiper control software that may not fully conform to FMVSS 104 Sections 4.1.1.2 and 4.1.1.3.

VIN Range(s): Begin: End:

BMW 8 Series Coupe (840i, 840i xDrive, M850i xDrive, M8) 2019 - 2021

End: 08/04/2020

Approximately 4,834 vehicles may not fully conform to FMVSS 104 Sections 4.1.1.2 and 4.1.1.3. Basis for recall population determination: Vehicle assembly information was used to determine the start and end date of potentially affected vehicles. Recall component difference to non-recall component: Recall vehicles have wiper control software that may not fully conform to FMVSS 104 Sections 4.1.1.2 and 4.1.1.3.

VIN Range(s): Begin: End:

BMW X7 xDrive40i, X7 xDrive50i, X7 M50i 2019 - 2021

* **Model Yr. Start:** 2019 * **Model Yr. End:** 2021
 * **Make:** BMW
 * **Model:** X7 xDrive40i, X7 xDrive50i, X7 M50i

Type: LIGHT VEHICLES
Body Style: SUV
Powertrain: GAS

Production Dates Begin: 07/10/2018
 End: 08/04/2020

Descriptive Information:

Approximately 33,673 vehicles may not fully conform to FMVSS 104 Sections 4.1.1.2 and 4.1.1.3. Basis for recall population determination: Vehicle assembly information was used to determine the start and end date of potentially affected vehicles. Recall component difference to non-recall component: Recall vehicles have wiper control software that may not fully conform to FMVSS 104 Sections 4.1.1.2 and 4.1.1.3.

VIN Range(s): Begin: End:

BMW 330i, 330i xDrive, M340i, M340i 2019 - 2021

* **Model Yr. Start:** 2019 * **Model Yr. End:** 2021
 * **Make:** BMW
 * **Model:** 330i, 330i xDrive, M340i, M340i

Type: LIGHT VEHICLES
Body Style: 4-DOOR
Powertrain: GAS

Production Dates Begin: 05/14/2018
 End: 08/03/2020

Descriptive Information:

Approximately 78,257 vehicles may not fully conform to FMVSS 104 Sections 4.1.1.2 and 4.1.1.3. Basis for recall population determination: Vehicle assembly information was used to determine the start and end date of potentially affected vehicles. Recall component difference to non-recall component: Recall vehicles have wiper control software that may not fully conform to FMVSS 104 Sections 4.1.1.2 and 4.1.1.3.

VIN Range(s): Begin: End:

BMW 330e, 330e xDrive 2021

* **Model Yr. Start:** 2021 * **Model Yr. End:** 2021
 * **Make:** BMW
 * **Model:** 330e, 330e xDrive

Type: LIGHT VEHICLES
Body Style: 4-DOOR
Powertrain: HYBRID ELECTRIC

Production Dates Begin: 03/02/2020
 End: 07/10/2020

Descriptive Information:

Approximately 342 vehicles may not fully conform to FMVSS 104 Sections 4.1.1.2 and 4.1.1.3. Basis for recall population determination: Vehicle assembly information was used to determine the start and end date of potentially affected vehicles. Recall component difference to non-recall component: Recall vehicles have wiper control software that may not fully conform to FMVSS 104 Sections 4.1.1.2 and 4.1.1.3.

VIN Range(s): Begin: End:

BMW 4 Series Coupe (430i, 430i xDrive, M440i xDrive) 2021

* **Model Yr. Start:** 2021 * **Model Yr. End:** 2021
 * **Make:** BMW
 * **Model:** 4 Series Coupe (430i, 430i xDrive, M440i xDrive)

Type: LIGHT VEHICLES
Body Style: 2-DOOR
Powertrain: GAS

Production Dates Begin: 06/09/2020
 End: 07/30/2020

Descriptive Information:

Approximately 144 vehicles may not fully conform to FMVSS 104 Sections 4.1.1.2 and 4.1.1.3. Basis for recall population determination: Vehicle assembly information was used to determine the start and end date of potentially affected vehicles. Recall component difference to non-recall component: Recall vehicles have wiper control software that may not fully conform to FMVSS 104 Sections 4.1.1.2 and 4.1.1.3.

VIN Range(s): Begin: End:

BMW 4 Series Convertible (430i, M440i) 2021

* **Model Yr. Start:** 2021 * **Model Yr. End:** 2021
 * **Make:** BMW
 * **Model:** 4 Series Convertible (430i, M440i)

Type: LIGHT VEHICLES
Body Style: 2-DOOR
Powertrain: GAS

Production Dates Begin: 06/24/2020
 End: 06/30/2020

Descriptive Information:
 Approximately 5 vehicles may not fully conform to FMVSS 104 Sections 4.1.1.2 and 4.1.1.3. Basis for recall population determination: Vehicle assembly information was used to determine the start and end date of potentially affected vehicles. Recall component difference to non-recall component: Recall vehicles have wiper control software that may not fully conform to FMVSS 104 Sections 4.1.1.2 and 4.1.1.3.

VIN Range(s): Begin: End:

BMW Z4 sDrive30i, Z4M40i 2019 - 2021

* **Model Yr. Start:** 2019 * **Model Yr. End:** 2021
 * **Make:** BMW
 * **Model:** Z4 sDrive30i, Z4M40i

Type: LIGHT VEHICLES
Body Style: 2-DOOR
Powertrain: GAS

Production Dates Begin: 11/05/2018
 End: 07/30/2020

Descriptive Information:
 Approximately 5,419 vehicles may not fully conform to FMVSS 104 Sections 4.1.1.2 and 4.1.1.3. Basis for recall population determination: Vehicle assembly information was used to determine the start and end date of potentially affected vehicles. Recall component difference to non-recall component: Recall vehicles have wiper control software that may not fully conform to FMVSS 104 Sections 4.1.1.2 and 4.1.1.3.

VIN Range(s): Begin: End:

Number potentially involved: 244433 **Estimated percentage of involved with defect:** 100%

Defect / Noncompliance Description

For this Defect/Noncompliance:

*** Describe the defect or noncompliance:**
 This non-compliance recall involves the windshield wiper frequency. Due to a coding parameter issue, the vehicles may not fully conform to FMVSS 104 Sections 4.1.1.2 and 4.1.1.3. Specifically, when the vehicle speed is 0 km/h, or when accelerating after a stop up to a vehicle speed of 4 km/h (approximately 2.5mph), the wiper frequency is below the FMVSS 104 Sections 4.1.1.2 and 4.1.1.3 frequencies.

*** Describe the safety risk:**
 BMW believes that this matter is inconsequential to motor vehicle safety and therefore will be filing a Petition for Decision of Inconsequential Noncompliance in accordance with the provisions of Part 556.

Identify any warning which can precede or occur:

If a noncompliance, provide the applicable FMVSS:
 104 - Windshield wiping and washing systems

If applicable, provide any further FMVSS affected:

Describe the cause:

This Recall affects all vehicles.

If applicable, identify the manufacturer of the defective or noncompliant component. If the manufacturer of the component is unknown, provide the information for the company that supplied the subject component.

Component manufacturer

Company Information

Company Contact Information

Company Name: BMW AG

First Name:

Country:

Last Name:

Address 1:

Position:

Address 2:

Email:

City:

Phone:

State:

Zip/Postal Code:

Involved Components

If the defect or noncompliance involves a specific component(s), identify that component(s) below.

Component Name: Windshield Wiper System
Component Description: Windshield Wiper System
Component Part Number: N/A - Part 556 Petition to be Submitted

Chronology of Defect / Noncompliance Determination

Provide the chronology of events leading up to the defect decision or test data for the noncompliance decision.:

On July 7, 2020, during a quality review, it was noticed that if the vehicle speed was 0km/h, the windshield wiper frequency decreased. Between July and August, an engineering analysis was conducted. Engineering release information, software programming / coding parameters, and databases were reviewed. Wiper control system software and coding parameters were checked. The review indicated that, due to certain coding parameters, this would cause the wiper frequency to change under certain conditions. Specifically, if the vehicle speed was zero, or between 0 km/h and 4 km/h (when accelerating from a stop), wiper frequency would decrease. The reduction in wiper frequency when the vehicle speed was close to 0 km/h was intended as a quality / comfort function for the wiper system / driver respectively. On September 9th and 11th, 2020, it was determined that the affected BMW and Toyota vehicles, respectively, may not fully conform to FMVSS 104 Sections 4.1.1.2 and 4.1.1.3. BMW has not received any reports, nor is BMW otherwise aware, of any accidents or injuries related to this issue.

Identify the Remedy

Describe the defect/noncompliance remedy program, including the manufacturer's plan for reimbursement.

BMW believes that this matter is inconsequential to motor vehicle safety and therefore will be filing a Petition for Decision of Inconsequential Noncompliance in accordance with the provisions of Part 556.

Describe what distinguishes the remedy component from the recalled component.

N/A BMW believes that this matter is inconsequential to motor vehicle safety and therefore will be filing a Petition for Decision of Inconsequential Noncompliance in accordance with the provisions of Part 556.

Identify and describe how and when the recall condition was corrected in production.

Identify the Recall Schedule

Describe the recall schedule for notifications.:

BMW believes that this matter is inconsequential to motor vehicle safety and therefore will be filing a Petition for Decision of Inconsequential Noncompliance in accordance with the provisions of Part 556.

Planned Dealer Notification Begin Date:

Planned Dealer Notification End Date:

Planned Owner Notification Begin Date:

Planned Owner Notification End Date:

Manufacturer's identification code for this recall (if applicable):

Please be reminded that owner notification letters must be mailed no more than 60 days from submission of this report.

Manufacturer Comments to NHTSA Staff

[REDACTED]

Document Upload

There are 0 documents associated with this report.

BMW Group

October 9, 2020

The Honorable James C. Owens
Deputy Administrator
National Highway Traffic Safety Administration
1200 New Jersey Ave., S.E.
Washington, DC 20590

**Re: 49 CFR 556 – Petition for Inconsequential Non-Compliance
FMVSS 104 (Windshield wiper and washing systems)
20V-555**

- **Model Year 2019-2021 BMW 3 Series, 8 Series Coupe/Convertible, X5 SAV, X7 SAV, Z4**
- **Model Year 2020-2021 BMW 2 Series Gran Coupe, 8 Series Gran Coupe, X6 SAC, Z4**
- **Model Year 2021 BMW X5 xDrive45e, 330e, 4 Series Coupe/Convertible**
- **Model Year 2020-2021 Toyota Supra**

Dear Deputy Administrator Owens:

BMW of North America, LLC, a subsidiary of BMW AG, Munich, Germany, is submitting this 49 CFR 556 Petition for Inconsequential Non-Compliance.

On September 11, 2020, BMW submitted a 49 CFR 573 report pertaining to windshield wiper frequency involving approximately 244,433 Model Year 2019-2021 BMW and Model Year 2020-2021 Toyota vehicles (the “affected vehicles”). The windshield wiper frequency decreases when the vehicle is at rest, e.g., at a stop light, and in the brief interval when accelerating from rest (0mph) to approximately 2.5mph. Depending upon the specific vehicle model, the noncompliance involves FMVSS 104 Section 4.1.1.2, or involves Sections 4.1.1.2 and 4.1.1.3, and only in the limited conditions noted.

A copy of BMW’s September 11, 2020 Part 573 report is included as Attachment 1.

We believe that this issue is inconsequential to motor vehicle safety for the reasons set forth below. A summary is provided, and is followed by detailed information supporting the specific points.

- The wiper system is compliant in the vast majority of driving situations / modes, especially when wipers are needed most, i.e., while driving when the wipers are selected by the driver to be in either the “High” or “Low” setting/mode. Any potential non-compliance only occurs when the vehicle is at rest, or in the very brief time period when accelerating from 0mph to 2.5mph.
- The BMW wiper system contains an Auto (Rain Sensor) setting/mode where the frequencies contained in FMVSS 104 Sections 4.1.1.2 and 4.1.1.3 are met under the conditions (i.e., rain volumes) that necessitate those levels of wiper speeds.
- When wiper frequency setting/mode High is selected, then at vehicle rest or when accelerating from 0mph to 2.5mph, although the momentary decreased wiper frequency is slightly less than the required 45 cycles/min, it is significantly larger than the FMVSS 104 absolute minimum frequency of 20 cycles/min.
- When wiper frequency setting/mode Low is selected, then at vehicle rest or when accelerating from 0mph to 2.5mph, the momentary decreased wiper frequency is

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marginally less than the required 20 cycles/min for only two vehicle models. In this condition, it is unlikely that there is any perceptible difference in visibility to the driver, and consequently no affect upon (no decrease in) vehicle safety.

- For a given rainfall velocity, driver visibility while the vehicle is at rest with this slight or marginal non-compliance is greater than driver visibility while the vehicle is moving with a compliant system, especially when the vehicle is moving at city and highway speeds.
- SAE J903 (1999) contains a requirement for minimum wiper frequency of 10 cycles/min. Given the SAE Standards process as briefly outlined further in the petition, it would appear that even a wiper frequency of only 10 cycles/min is safe.
- In the brief interval during vehicle acceleration from 0mph to 2.5mph, an average vehicle moves only a small amount, approximately 1 ft.
- The wiper frequency does not decrease when the vehicle is decelerating to 0mph.
- Affected vehicles comply to all other applicable provisions of FMVSS 104.
- BMW is not aware of any customer complaints, accidents, or injuries related to this issue. Toyota is not aware of any accidents, or injuries, and has no field reports or claims relating to this issue in Supra vehicles.
- Vehicle production has been corrected.

* * *

FMVSS 104 Section 4.1.1.2

FMVSS 104 Section 4.1.1.2 states:

One frequency or speed shall be at least 45 cycles per minute regardless of engine load and engine speed.

FMVSS 104 Section 4.1.1.3

FMVSS 104 Section 4.1.1.3 states:

Regardless of engine speed and engine load, the highest and one lower frequency or speed shall differ by at least 15 cycles per minute. Such lower frequency or speed shall be at least 20 cycles per minute regardless of engine speed and engine load.

Wiper System Design / Functionality

Affected vehicles are equipped with a wiper system that contains a driver-selectable setting/mode Low, a driver-selectable setting/mode High, a driver-selectable setting/mode Auto (Rain Sensor), and a non-selectable pre-programed setting/mode that we will refer to as Standstill Mode (“Standstill”). System function is described below.

Driver Selects Low Mode

If a driver selects the wiper frequency mode Low, then wiper frequency while driving is larger than 40 cycles/min, and is model dependent as noted further in the petition. When the vehicle comes to rest, e.g., at a stop light, then the frequency decreases. The decreased frequency is also present in the brief period of time when the vehicle accelerates from 0mph to 2.5mph. This decreased frequency is the frequency of the Standstill mode and is due to a pre-programmed comfort function described further below. The wiper frequency quickly and automatically returns to its selected mode, in this case Low, as soon as the vehicle reaches 2.5mph.

Driver Selects High Mode

If a driver selects wiper frequency High mode, then wiper frequency while driving is larger than 56 cycles/min, and is model dependent as noted further in the petition. When the vehicle comes to rest, e.g., at a stop light, then the frequency decreases. The decreased frequency is also present in the brief period of time when the vehicle accelerates from 0mph to 2.5mph. The decreased frequency is the frequency of the Low setting/mode, and is due to the pre-programmed comfort function described further below. The wiper frequency quickly and automatically returns to its selected mode, in this case High, as soon as the vehicle reaches 2.5mph.

Auto (Rain Sensor) Mode

If the driver selects Auto (Rain Sensor) mode, then wiper frequency while driving is a function of the amount of rain detected on the windshield by the rain sensor. Depending upon the amount of rain, the system will provide an appropriate wiper frequency up to the maximum wiper system frequency which is larger than the FMVSS 104 Section 4.1.1.2 requirement of 45 cycles/min.

Comfort Function

The decrease in wiper frequency when the vehicle is at rest is a “comfort function” and was introduced because at vehicle rest, the amount of water on the windshield compared to the amount of water on the windshield on a moving vehicle is significantly less. The comfort function was introduced to allow the driver to focus on the driving task and surroundings, and not be distracted (or annoyed) by a wiper system in which the higher frequency (when the vehicle was moving) is not needed when the vehicle is at rest. At vehicle rest (and during acceleration from 0mph to 2.5mph), the frequency is decreased briefly from either High to Low, or from Low to Standstill, and then quickly and automatically increases again to the prior driver-selected frequency when the vehicle reaches 2.5mph.

Driver Can Increase Wiper Frequency While Vehicle is at Rest

The driver can also, while the vehicle is at rest, increase the wiper frequency.

If the driver had selected wiper frequency mode Low, then when the vehicle comes to rest, the frequency will decrease to Standstill. In this case, if the driver perceives a need to increase the frequency while the vehicle is momentarily at rest, the driver can quickly and easily increase the frequency by moving the wiper arm/control upward. The wiper frequency will increase from Standstill to High. When the vehicle accelerates, the frequency will remain at High. If desired, the driver can then decrease the frequency to Low again.

If the driver had selected wiper frequency mode High, then when the vehicle comes to rest, the frequency will decrease to Low. In this case, if the driver perceives a need to increase the frequency while the vehicle is momentarily at rest, the driver can quickly and easily increase the frequency by moving the wiper arm/control first downward and then upward. The wiper frequency will increase from Low to High. When the vehicle accelerates, the frequency will remain at High.

The Non-Compliance

Wiper Frequency Change – High-to-Low

In this case, the driver selected wiper frequency mode High, but due to the comfort function, at vehicle rest, and when accelerating from 0mph to 2.5mph, the wiper frequency has decreased to mode Low. While the wiper frequency is at least 41 cycles/min, it is slightly less than the FMVSS 104 Section 4.1.1.2 requirement of 45 cycles/min.

Wiper Frequency Change – Low-to-Standstill

In this case, the driver selected wiper frequency mode Low, but due to the comfort function, at vehicle rest, and when accelerating from 0mph to 2.5mph, the wiper frequency has decreased to mode Standstill. For only two vehicle models, the frequency is 19.8 cycles/min and therefore marginally less than the FMVSS 104 Section 4.1.1.3 requirement of 20 cycles/min.

Test Results

Vehicles were tested and pertinent test results are contained in Table 1.

Model	Wiper Setting (High) Frequency (cycles/min)	High @ 0=<v <=2.5 v (mph) “Standstill” Frequency (cycles/min)	Wiper Setting (Low) Frequency (cycles/min)	Low @ 0=<v <=2.5 v (mph) “Standstill” Frequency (cycles/min)
2 Series Gran Coupe	70.8	47.3	47.7	21.3
3 Series	75.7	48.3	48.7	21.2
4 Series Coupe	83.5	51.5	51.7	21.3
8 Series Gran Coupe	58.7	42.0	42.2	21.2
X5 SAV	57.0	41.0	41.0	20.5
X6 SAC	56.8	41.2	41.2	20.5
Z4	56.5	41.0	41.0	19.8
Supra	56.8	41.2	41.2	19.8

Table 1.

In this petition, although there are more than five vehicle models potentially affected, 5 wiper systems account for the systems installed across all vehicle models. Table 1 contains test results involving several vehicle models and accounts for these systems. In some cases, only one vehicle model was tested for a given wiper system such as the 8 Series Gran Coupe, whereas in some cases, more than one vehicle model was tested for a given wiper system, such as the X5 SAV and X6 SAC, and also the Z4 and Supra.

Entries in the table for the 2 Series, 3 Series, and 4 Series suggest that these vehicles comply with FMVSS 104 Sections 4.1.1.2 and 4.1.1.3. However, due to wiper system tolerances, a slight or marginal non-complying condition could occur.

The wiper frequencies (cycles/min) in Table 1 are based upon actual measurements of wiper movement on the subject vehicles during a three-minute time period, and then adjusted for a one-minute time period to denote wiper frequency in units of cycles/min. To assess the accuracy of the 3-minute count (and the cycles/minute equivalency), a control was used in

which a time period was measured for a wiper frequency consisting of 10 wipe cycles. Using this control, wiper frequency in cycles/min was calculated and then assessed against the actual measured 3-minute count (adjusted to the equivalent frequency for a 1-minute time period) as a check.

As noted earlier, if the driver selected wiper frequency High, then due to the comfort function, at vehicle rest (and between 0mph and 2.5mph), wiper frequency changes to Low. The “High @...” column indicates that some models have a reduced wiper frequency of either 41 cycles/min or 42 cycles/min.

Similarly, if the driver selected wiper frequency Low, then due to the comfort function, at vehicle rest (and between 0mph and 2.5mph), wiper frequency changes to Standstill. The “Low @...” column indicates that the Z4 and Supra have a reduced wiper frequency of 19.8 cycles/min.

Wiper Frequency Comparisons

Wiper Frequency High

FMVSS 104 Section 4.1.1.2 requires a minimum wiper frequency of 45 cycles/min. In some vehicle models, the frequency is 41 cycles/min. A wiper frequency of 45 cycles/min equates to a single wipe cycle of approximately 1.33 seconds. A wiper frequency of 41 cycles/min equates to a single wipe cycle of 1.46 seconds. The difference is approximately 0.13 seconds and is unlikely to affect driver visibility as explained further below in the section comparing a stationary vehicle with a moving vehicle regarding the amount of water on the windshield.

Wiper Frequency Low

FMVSS 104 Section 4.1.1.3 requires a minimum wiper frequency of 20 cycles/min. In some vehicle models, the frequency is 19.8 cycles/min. A wiper frequency of 20 cycles/min equates to a single wipe cycle of approximately 3.00 seconds. A wiper frequency of 19.8 cycles/min equates to a single wipe cycle of 3.03 seconds. The difference is approximately 0.03 seconds and is extremely unlikely to affect driver visibility as explained further below in the section comparing a stationary vehicle with a moving vehicle regarding the amount of water on the windshield.

Vehicle Travels Very Small Distance When Accelerating from 0mph to 2.5mph

In the brief interval during vehicle acceleration from 0mph to 2.5mph, an average vehicle travels only a small amount, approximately 1 ft. and, at that point (distance), the driver-selected wiper frequency, i.e., either Low or High, is quickly and automatically re-established. Please refer to the calculation below.

Covered distance when accelerating to 2.5 mph (4 km/h)

When starting, the reduced wipe frequency due to the stationary downshift is automatically been switched up to the former operated frequency when reaching a speed of 2.5 mph ($v = 1.11 \text{ m/s} \approx 4 \text{ km/h}$).

The distance covered here is on average 1 foot (0.31 m).

Calculation basis:

The maximum acceleration of a medium-sized vehicle is $3.4 - 7 \text{ m/s}^2$.

It is assumed that the vehicle normally starts with a slower acceleration.

The acceleration value used in the calculation is $a = 2 \text{ m/s}^2$ which is around $1/3$ to $1/2$ of the maximum acceleration of a passenger car, and can also be reached by bike (roughly $1 - 2 \text{ m/s}^2$).

Calculation formula: $s = \frac{1}{2} \times a \times t^2$ with $t = v / a$

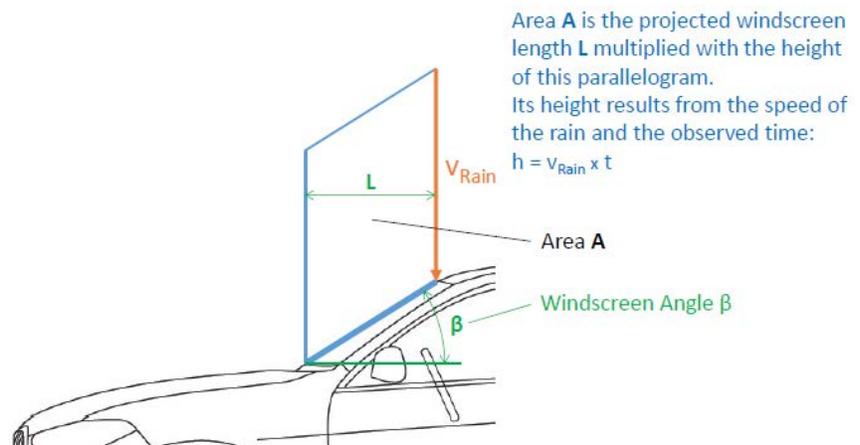
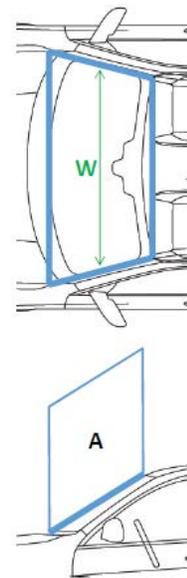
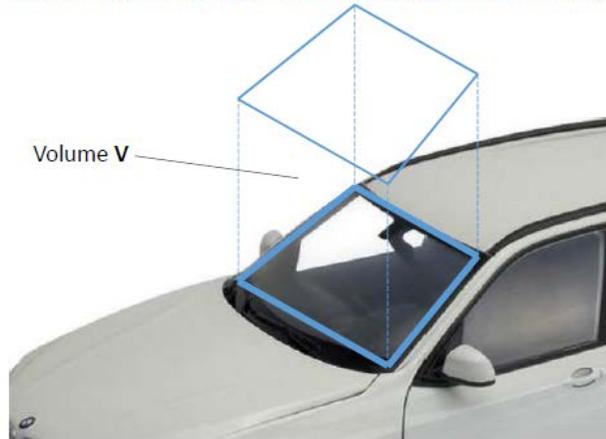
Rain Volume Comparison Between a Vehicle at Rest and a Moving Vehicle

In a given period of time, the volume of water on the windshield while the vehicle is at rest is significantly less than the volume of water on the windshield while the vehicle is moving, for example at city or highway speeds. For example, and as shown in the calculations below, the amount of water on the windshield while the vehicle is at rest is approximately 50% less than the amount of water on the windshield when driving at approximately 25mph. Therefore, if wiper frequencies of 20 cycles/min and 45 cycles/min are deemed to be sufficient when driving then, when the vehicle is at rest, wiper frequencies of 19.8 cycles/min and 41 cycles/min are sufficient for an overview of the traffic and roadway conditions. As noted earlier, there is only a 0.13 second difference in time for a single wipe cycle between the required 45 cycles/min and the 41 cycles/min condition, and only a 0.03 second difference in time for a single wipe cycle between the required 20 cycles/min and the 19.8 cycles/min condition.

For a given rainfall velocity, driver visibility while the vehicle is at rest with this slight or marginal non-compliance is greater than driver visibility while the vehicle is moving with a compliant system, especially when the vehicle is moving at city and highway speeds. Please refer to the calculations below.

Windscreen wetting in dependence of vehicle speed

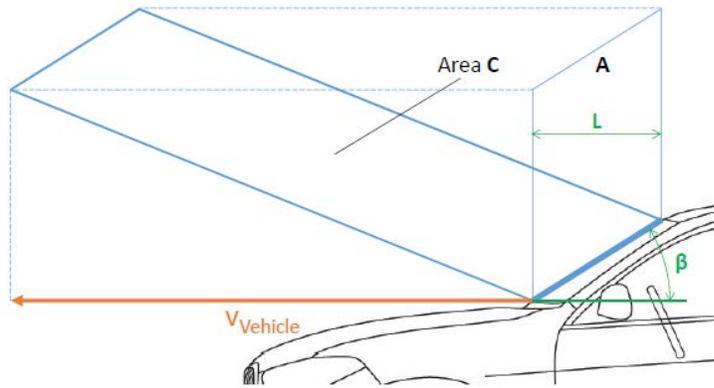
For a stationary vehicle, only the precipitation vertically above hits the windscreen. Its amount (volume **V**) is the average screen width **W** multiplied with Area **A**.



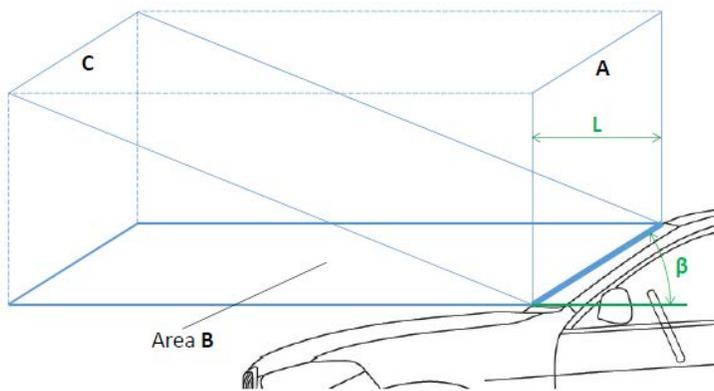
So the volume of air and precipitation containing the raindrops which hit the windscreen in a certain time is:

$$V = W \times L \times v_{\text{Rain}} \times t$$

with rigid values for windscreen width **W** and projected length **L**.



Due to the relative movement between precipitation and vehicle, the rain in the area diagonally in front of it hits the windshield of a moving car. Its volume is calculated from the constant windshield width W multiplied with Area C.



Geometrically, Area C is the sum of Area A and B. That means, the vehicle movement adds the volume V_B resulting from Area B to the amount of rain hitting the windshield of a stationary car, and this volume is increasing linearly with the vehicle speed.

Comparison of a vehicle in city traffic to a statutory one

The amount of precipitation at city speeds is about **twice as high** as if the vehicle stops at the traffic light under identical environmental conditions.

Calculation basis:

The average drop falling speed of a normal rainfall is: $v_{\text{Rain}} = 7 \text{ m/s} \approx 23 \text{ ft/s} \approx 16 \text{ mph}$

The average windscreen angle for sedan and SUV is: $\beta = 31^\circ$

The volume of air and precipitation containing the hitting raindrops within a time of one second ($t = 1 \text{ s}$), calculated for a simplified windscreen width of one meter ($W = 1 \text{ m}$) and a projected standardized screen length of one meter ($L = 1 \text{ m}$) is:

For a statutory vehicle, speed = 0 mph

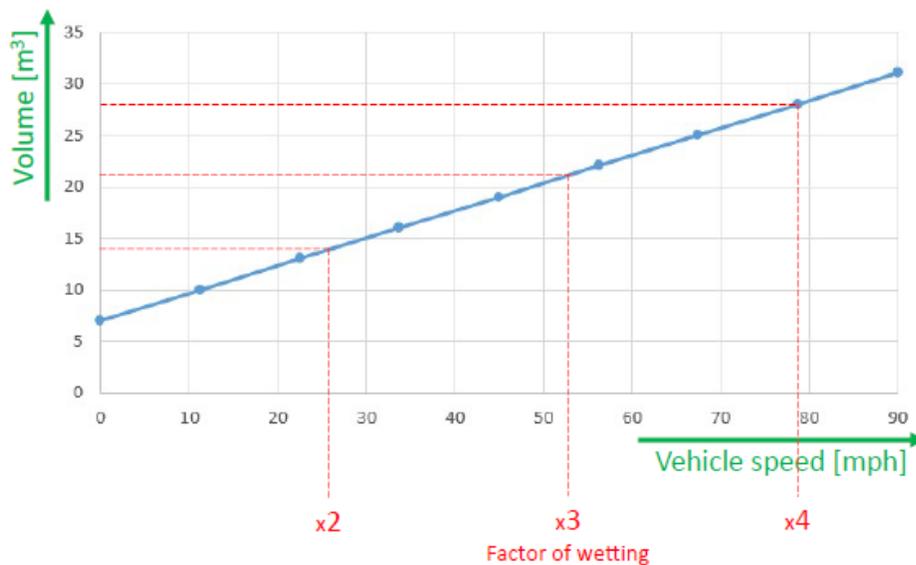
$$V_{\text{stat}} = W \times L \times v_{\text{Rain}} \times t = 1 \times 1 \times 7 \times 1 \text{ [m} \times \text{m} \times \text{m/s} \times \text{s}] = 7 \text{ m}^3$$

For a moving vehicle at a speed of $v_{\text{Vehicle}} = 13 \text{ m/s} \approx 29 \text{ mph}$

$$V_{\text{B}} = W \times L \times \tan \beta \times v_{\text{Vehicle}} \times t = 1 \times 1 \times \tan 31^\circ \times 13 \times 1 \text{ [m} \times \text{m} \times \text{m/s} \times \text{s}] = 7.8 \text{ m}^3$$

$$V_{\text{mov}} = V_{\text{stat}} + V_{\text{B}} = 14.8 \text{ m}^3$$

Graphics



Another perspective involves determining an equivalent condition between a vehicle at rest containing this slight non-compliance and a moving vehicle that is compliant. A vehicle at rest with this slight non-compliance, i.e., with a wiper frequency of 41 cycles/min (instead of 45 cycles/min) has a reduced wiper frequency and, therefore, it is slightly less efficient in removing the rain from the windshield. Using the calculations outlined above, an equivalent condition would result in a vehicle velocity of approximately 2.3mph. Therefore, a vehicle containing this slight non-compliance at rest can be considered to be equivalent to a compliant vehicle at 2.3mph. Moreover, this pertains to the High wiper frequency mode. If the Low wiper frequency mode is selected, the equivalent vehicle velocity is 0.2mph.

Driver visibility while the vehicle is at rest with this slight or marginal non-compliance is greater than driver visibility while the vehicle is moving with a compliant system, especially when the vehicle is moving at city and highway speeds.

The Wiper System Does Not Decrease During Vehicle Deceleration

The wiper system functionality on the vehicles that are the subject of this petition is such that wiper frequency does not decrease during vehicle deceleration. Therefore, the slight or marginal non-compliance does not exist during vehicle deceleration, including the small period of time when the vehicle is coming to rest, e.g., approaching a stop light. In those circumstances, there could be a vehicle already at the stop light or a pedestrian in the crosswalk. In these instances, the vehicles that are the subject of this petition are fully compliant.

SAE J903 (Passenger Car Windshield Wiper Systems)

SAE J903 (1999) – Passenger Car Windshield Wiper Systems was most recently updated and published in May 1999. Section 4.1.2.1 pertains to wiper frequencies and sub-section 4.1.2.1(b) states that, “One of not less than 10 and not more than 55 cycles/min.” In other words, the minimum performance outlined for a vehicle wiper frequency is 10 cycles/min. [Emphasis added.]

Section 1 (Scope) states that, J903 “...establishes for passenger cars, light trucks, and multipurpose vehicles...a) minimum performance standards for windshield wiper systems.” It also states that “[T]he test procedures and minimum performance standards...are based on currently available engineering data. It is the intent that all portions of the document will be periodically reviewed and revised as additional data regarding windshield wiping system performance are developed.” [Emphasis added.]

From a review of the most recent release of SAE J903, it would appear that, based upon a review of “currently available engineering data” by the technical expert group responsible for ongoing releases of SAE J903, that the currently-accepted minimum performance requirement is 10 cycles/min. As noted in our petition, under certain limited circumstances our wiper system frequencies (cycles/min) are at approximately 41 or 42 instead of 45, or at 19.8 instead of 20 and, in all of these conditions, all frequencies are well-above a wiper frequency rate of 10 cycles/min. Therefore, it would appear, according to the current version of SAE J903 that these wiper frequency rates are also safe.

Field Experience

BMW has not received any complaints from vehicle owners, and is not aware of any accidents or injuries that have occurred as a result of this issue. Toyota is not aware of any accidents or injuries, and has no field reports or claims relating to this issue in Supra vehicles.

Vehicle Production

Vehicle production has been corrected to conform to FMVSS 104 Sections 4.1.1.2 and 4.1.1.3.

Additional Testing

Additional testing is being considered with the intent to supplement this petition within the next several weeks.

* * *

For the reasons set forth above, we believe that this issue is inconsequential to motor vehicle safety. Accordingly, BMW requests relief from the 49 CFR 573 notification and remedy requirements.

Sincerely,

BMW of North America, LLC



Samuel Campbell, III
Department Head
Safety Engineering and Intelligent Transportation Systems

Attachments

- Attachment 1 – BMW 49 CFR 573 Report (11 Sep 2020)

Cc: J. Giuseppe, Associate Administrator for Enforcement
O. Matheke, Director, Office of Vehicle Safety Compliance (OVSC)
V. Williams, Acting Chief, OVSC (Crash Avoidance Division)

Part 573 Safety Recall Report

20V-555

Manufacturer Name : BMW of North America, LLC

Submission Date : SEP 11, 2020

NHTSA Recall No. : 20V-555

Manufacturer Recall No. : NR



Manufacturer Information :

Manufacturer Name : BMW of North America, LLC

Address : P.O. Box 1227

Westwood NJ 07675-1227

Company phone : 18005257417

Population :

Number of potentially involved : 244,433

Estimated percentage with defect : 100 %

Vehicle Information :

Vehicle 1 : 2020-2021 Toyota Supra

Vehicle Type : LIGHT VEHICLES

Body Style : 2-DOOR

Power Train : GAS

Descriptive Information : Approximately 9,108 vehicles may not fully conform to FMVSS 104 Sections 4.1.1.2 and 4.1.1.3.

Basis for recall population determination: Vehicle assembly information was used to determine the start and end date of potentially affected vehicles.

Recall component difference to non-recall component:
Recall vehicles have wiper control software that may not fully conform to FMVSS 104 Sections 4.1.1.2 and 4.1.1.3.

Production Dates : FEB 06, 2019 - JUL 24, 2020

VIN Range 1 : Begin :

NR

End : NR

Not sequential

Vehicle 2 : 2020-2021 BMW 2 Series Gran Coupe (228i, 228i xDrive, M235i xDrive)

Vehicle Type : LIGHT VEHICLES

Body Style : 2-DOOR

Power Train : GAS

Descriptive Information : Approximately 7,177 vehicles may not fully conform to FMVSS 104 Sections 4.1.1.2 and 4.1.1.3.

Basis for recall population determination: Vehicle assembly information was used to determine the start and end date of potentially affected vehicles.

Recall component difference to non-recall component:

Recall vehicles have wiper control software that may not fully conform to FMVSS 104 Sections 4.1.1.2 and 4.1.1.3.

Production Dates : MAR 12, 2019 - AUG 04, 2020

VIN Range 1 : Begin :

NR

End : NR

Not sequential

Vehicle 3 : 2019-2021 BMW 8 Series Convertible (840i, 840i xDrive, M850i xDrive, M8)

Vehicle Type : LIGHT VEHICLES

Body Style : 2-DOOR

Power Train : GAS

Descriptive Information : Approximately 4,250 vehicles may not fully conform to FMVSS 104 Sections 4.1.1.2 and 4.1.1.3.

Basis for recall population determination: Vehicle assembly information was used to determine the start and end date of potentially affected vehicles.

Recall component difference to non-recall component:

Recall vehicles have wiper control software that may not fully conform to FMVSS 104 Sections 4.1.1.2 and 4.1.1.3.

Production Dates : MAR 15, 2018 - JUL 31, 2020

VIN Range 1 : Begin :

NR

End : NR

Not sequential

Vehicle 4 : 2019-2021 BMW 8 Series Coupe (840i, 840i xDrive, M850i xDrive, M8)

Vehicle Type : LIGHT VEHICLES

Body Style : 2-DOOR

Power Train : GAS

Descriptive Information : Approximately 4,034 vehicles may not fully conform to FMVSS 104 Sections 4.1.1.2 and 4.1.1.3.

Basis for recall population determination: Vehicle assembly information was used to determine the start and end date of potentially affected vehicles.

Recall component difference to non-recall component:

Recall vehicles have wiper control software that may not fully conform to FMVSS 104 Sections 4.1.1.2 and 4.1.1.3.

Production Dates : FEB 09, 2018 - JUL 30, 2020

VIN Range 1 : Begin :

NR

End : NR

Not sequential

Vehicle 5 : 2020-2021 BMW 8 Series Gran Coupe (840i, 840i xDrive, M850i xDrive, M8)

Vehicle Type : LIGHT VEHICLES

Body Style : 4-DOOR

Power Train : GAS

Descriptive Information : Approximately 3,739 vehicles may not fully conform to FMVSS 104 Sections 4.1.1.2 and 4.1.1.3.

Basis for recall population determination: Vehicle assembly information was used to determine the start and end date of potentially affected vehicles.

Recall component difference to non-recall component:

Recall vehicles have wiper control software that may not fully conform to FMVSS 104 Sections 4.1.1.2 and 4.1.1.3.

Production Dates : FEB 18, 2019 - JUL 31, 2020

VIN Range 1 : Begin :

NR

End : NR

Not sequential

Vehicle 6 : 2019-2021 BMW X5 sDrive40i, X5 xDrivex40i, X5 xDrive50i, X5 M50i, X5M
Vehicle Type : LIGHT VEHICLES
Body Style : SUV
Power Train : GAS

Descriptive Information : Approximately 92,452 vehicles may not fully conform to FMVSS 104 Sections 4.1.1.2 and 4.1.1.3.

Basis for recall population determination: Vehicle assembly information was used to determine the start and end date of potentially affected vehicles.

Recall component difference to non-recall component:
Recall vehicles have wiper control software that may not fully conform to FMVSS 104 Sections 4.1.1.2 and 4.1.1.3.

Production Dates : JUN 04, 2018 - AUG 04, 2020

VIN Range 1 : Begin :

NR

End : NR

Not sequential

Vehicle 7 : 2021-2021 BMW X5 xDrive45e
Vehicle Type : LIGHT VEHICLES
Body Style : SUV
Power Train : HYBRID ELECTRIC

Descriptive Information : Approximately 999 vehicles may not fully conform to FMVSS 104 Sections 4.1.1.2 and 4.1.1.3.

Basis for recall population determination: Vehicle assembly information was used to determine the start and end date of potentially affected vehicles.

Recall component difference to non-recall component:
Recall vehicles have wiper control software that may not fully conform to FMVSS 104 Sections 4.1.1.2 and 4.1.1.3.

Production Dates : JUN 04, 2020 - AUG 04, 2020

VIN Range 1 : Begin :

NR

End : NR

Not sequential

Vehicle 8 : 2020-2021 BMW X6 sDrive40i, X6 xDrivex40i, X6 M50i, X6M

Vehicle Type : LIGHT VEHICLES

Body Style : SUV

Power Train : GAS

Descriptive Information : Approximately 4,834 vehicles may not fully conform to FMVSS 104 Sections 4.1.1.2 and 4.1.1.3.

Basis for recall population determination: Vehicle assembly information was used to determine the start and end date of potentially affected vehicles.

Recall component difference to non-recall component:

Recall vehicles have wiper control software that may not fully conform to FMVSS 104 Sections 4.1.1.2 and 4.1.1.3.

Production Dates : JUL 15, 2019 - AUG 04, 2020

VIN Range 1 : Begin :

NR

End : NR

Not sequential

Vehicle 9 : 2019-2021 BMW X7 xDrive40i, X7 xDrive50i, X7 M50i

Vehicle Type : LIGHT VEHICLES

Body Style : SUV

Power Train : GAS

Descriptive Information : Approximately 33,673 vehicles may not fully conform to FMVSS 104 Sections 4.1.1.2 and 4.1.1.3.

Basis for recall population determination: Vehicle assembly information was used to determine the start and end date of potentially affected vehicles.

Recall component difference to non-recall component:

Recall vehicles have wiper control software that may not fully conform to FMVSS 104 Sections 4.1.1.2 and 4.1.1.3.

Production Dates : JUL 10, 2018 - AUG 04, 2020

VIN Range 1 : Begin :

NR

End : NR

Not sequential

Vehicle 10 : 2019-2021 BMW 330i, 330i xDrive, M340i, M340i
Vehicle Type : LIGHT VEHICLES
Body Style : 4-DOOR
Power Train : GAS

Descriptive Information : Approximately 78,257 vehicles may not fully conform to FMVSS 104 Sections 4.1.1.2 and 4.1.1.3.

Basis for recall population determination: Vehicle assembly information was used to determine the start and end date of potentially affected vehicles.

Recall component difference to non-recall component:
Recall vehicles have wiper control software that may not fully conform to FMVSS 104 Sections 4.1.1.2 and 4.1.1.3.

Production Dates : MAY 14, 2018 - AUG 03, 2020

VIN Range 1 : Begin : NR End : NR Not sequential

Vehicle 11 : 2021-2021 BMW 330e, 330e xDrive
Vehicle Type : LIGHT VEHICLES
Body Style : 4-DOOR
Power Train : HYBRID ELECTRIC

Descriptive Information : Approximately 342 vehicles may not fully conform to FMVSS 104 Sections 4.1.1.2 and 4.1.1.3.

Basis for recall population determination: Vehicle assembly information was used to determine the start and end date of potentially affected vehicles.

Recall component difference to non-recall component:
Recall vehicles have wiper control software that may not fully conform to FMVSS 104 Sections 4.1.1.2 and 4.1.1.3.

Production Dates : MAR 02, 2020 - JUL 10, 2020

VIN Range 1 : Begin : NR End : NR Not sequential

Vehicle 12 : 2021-2021 BMW 4 Series Coupe (430i, 430i xDrive, M440i xDrive)

Vehicle Type : LIGHT VEHICLES

Body Style : 2-DOOR

Power Train : GAS

Descriptive Information : Approximately 144 vehicles may not fully conform to FMVSS 104 Sections 4.1.1.2 and 4.1.1.3.

Basis for recall population determination: Vehicle assembly information was used to determine the start and end date of potentially affected vehicles.

Recall component difference to non-recall component:

Recall vehicles have wiper control software that may not fully conform to FMVSS 104 Sections 4.1.1.2 and 4.1.1.3.

Production Dates : JUN 09, 2020 - JUL 30, 2020

VIN Range 1 : Begin :

NR

End : NR

Not sequential

Vehicle 13 : 2021-2021 BMW 4 Series Convertible (430i, M440i)

Vehicle Type : LIGHT VEHICLES

Body Style : 2-DOOR

Power Train : GAS

Descriptive Information : Approximately 5 vehicles may not fully conform to FMVSS 104 Sections 4.1.1.2 and 4.1.1.3.

Basis for recall population determination: Vehicle assembly information was used to determine the start and end date of potentially affected vehicles.

Recall component difference to non-recall component:

Recall vehicles have wiper control software that may not fully conform to FMVSS 104 Sections 4.1.1.2 and 4.1.1.3.

Production Dates : JUN 24, 2020 - JUN 30, 2020

VIN Range 1 : Begin :

NR

End : NR

Not sequential

Vehicle 14 : 2019-2021 BMW Z4 sDrive30i, Z4M40i
Vehicle Type : LIGHT VEHICLES
Body Style : 2-DOOR
Power Train : GAS

Descriptive Information : Approximately 5,419 vehicles may not fully conform to FMVSS 104 Sections 4.1.1.2 and 4.1.1.3.

Basis for recall population determination: Vehicle assembly information was used to determine the start and end date of potentially affected vehicles.

Recall component difference to non-recall component:
Recall vehicles have wiper control software that may not fully conform to FMVSS 104 Sections 4.1.1.2 and 4.1.1.3.

Production Dates : NOV 05, 2018 - JUL 30, 2020

VIN Range 1 : Begin :

NR

End : NR

Not sequential

Description of Noncompliance :

Description of the Noncompliance : This non-compliance recall involves the windshield wiper frequency. Due to a coding parameter issue, the vehicles may not fully conform to FMVSS 104 Sections 4.1.1.2 and 4.1.1.3. Specifically, when the vehicle speed is 0 km/h, or when accelerating after a stop up to a vehicle speed of 4 km/h (approximately 2.5mph), the wiper frequency is below the FMVSS 104 Sections 4.1.1.2 and 4.1.1.3 frequencies.

FMVSS 1 : 104 - Windshield wiping and washing systems

FMVSS 2 : NR

Description of the Safety Risk : BMW believes that this matter is inconsequential to motor vehicle safety and therefore will be filing a Petition for Decision of Inconsequential Noncompliance in accordance with the provisions of Part 556.

Description of the Cause : NR

Identification of Any Warning that can Occur : NR

Involved Components :

Component Name 1 : Windshield Wiper System

Component Description : Windshield Wiper System

Component Part Number : N/A - Part 556 Petition to be Submitted

Supplier Identification :

Component Manufacturer

Name : BMW AG
Address : NR
NR
Country : NR

Chronology :

On July 7, 2020, during a quality review, it was noticed that if the vehicle speed was 0km/h, the windshield wiper frequency decreased.

Between July and August, an engineering analysis was conducted. Engineering release information, software programming / coding parameters, and databases were reviewed.

Wiper control system software and coding parameters were checked. The review indicated that, due to certain coding parameters, this would cause the wiper frequency to change under certain conditions. Specifically, if the vehicle speed was zero, or between 0 km/h and 4 km/h (when accelerating from a stop), wiper frequency would decrease. The reduction in wiper frequency when the vehicle speed was close to 0 km/h was intended as a quality / comfort function for the wiper system / driver respectively.

On September 9th and 11th, 2020, it was determined that the affected BMW and Toyota vehicles, respectively, may not fully conform to FMVSS 104 Sections 4.1.1.2 and 4.1.1.3.

BMW has not received any reports, nor is BMW otherwise aware, of any accidents or injuries related to this issue.

Description of Remedy :

Description of Remedy Program : BMW believes that this matter is inconsequential to motor vehicle safety and therefore will be filing a Petition for Decision of Inconsequential Noncompliance in accordance with the provisions of Part 556.

How Remedy Component Differs from Recalled Component :

N/A
BMW believes that this matter is inconsequential to motor vehicle safety and therefore will be filing a Petition for Decision of Inconsequential Noncompliance in accordance with the provisions of Part 556.

Identify How/When Recall Condition was Corrected in Production : NR

Recall Schedule :

Description of Recall Schedule : BMW believes that this matter is inconsequential to motor vehicle safety and therefore will be filing a Petition for Decision of Inconsequential Noncompliance in accordance with the provisions of Part 556.

Planned Dealer Notification Date : NR - NR

Planned Owner Notification Date : NR - NR

* NR - Not Reported