SURFACE VEHICLE RECOMMENDED PRACTICE

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Windshield Defrosting Systems Test Procedure and Performance Requirements - Trucks, Buses, and Multipurpose Vehicles

RATIONALE

Users inquired on how to use the photographic method. Revised to include additional example images of the test procedure.

1. SCOPE

This SAE Recommended Practice establishes uniform test procedures and performance requirements for the defrosting system of enclosed cab trucks, buses, and multipurpose vehicles. It is limited to a test that can be conducted on uniform test equipment in commercially available laboratory facilities. For laboratory evaluation of defroster systems, current engineering practice prescribes that an ice coating of known thickness be applied to the windshield and left- and right-hand side windows to provide more uniform and repeatable test results, even though - under actual conditions - such a coating would necessarily be scraped off before driving.

The test condition, therefore, represents a more severe condition than the actual condition, where the defroster system must merely be capable of maintaining a cleared viewing area. Because of the special nature of the operation of most of these vehicles (where vehicles are generally kept in a garage or warmed up before driving), and since defrosting under steady-state over-the-road operations is the main concern, test conditions have been adopted that assume that the engine is warm before the vehicle is driven.

There are two options for producing hot coolant in this recommended practice. Testing using these two approaches on the same vehicle will not necessarily provide identical results. Many vehicle models are offered with optional engines, and each engine has varying coolant temperatures and flow rates. If the test is being conducted to compare the performance of one defroster design to another defroster design, then the external coolant source approach (Test A) will yield the most comparable results. If the test is being conducted to validate the defroster installation on a specific vehicle model with a specific engine, then using the engine to heat the coolant (Test B) will be more appropriate.

This document will be reviewed and revised as technological progress in vehicle defroster test procedure requires.

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For more information on this standard, visit
https://www.sae.org/standards/content/J381_202502/

2. REFERENCES

2.1 Applicable Documents

The following publications form a part of this specification to the extent specified herein. Unless otherwise indicated, the latest issue of SAE publications shall apply.

2.1.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), www.sae.org.

SAE J198 Windshield Wiper Systems - Trucks, Buses, and Multipurpose Vehicles

2.1.2 NHTSA Publications

Available from National Highway Traffic Safety Administration, 1200 New Jersey Avenue, SE, Washington, DC 20590, Tel: 1-888-327-4236, https://www.nhtsa.gov/.

FMVSS 111 Rear Visibility

3. DEFINITIONS

3.1 COOLANT

Liquid used for heat transfer composed of 50% ethylene glycol/50% water or other liquids specified by the vehicle manufacturer for use in the heat transfer system.

3.2 DAYLIGHT OPENING (DLO)

The maximum opening of any glass aperture which is unobstructed by moldings, masking, frits, or framing.

3.3 DEFROST

To remove ice or frost from the surface of automotive glass surfaces.

3.4 DEFROSTED AREA

That area of the glass surface that is free of frozen ice or frost.

3.5 EV DRIVE UNIT TYPE

An electric vehicle type is referred to as an EV; a hybrid vehicle running in pure electric propulsion mode throughout the test is also called an EV.

3.6 HD DRIVE UNIT TYPE

A hybrid (internal combustion engine with electric propulsion mode) vehicle type is referred as an HD, unless running in pure electric propulsion mode throughout the test.

3.7 HIGH IDLE

A feature provided by the vehicle OEM to run the engine above the normal idling speed, typically used to provide additional power during operation of power takeoff equipment or for warming up the engine.

3.8 IC DRIVE UNIT TYPE

An internal combustion engine vehicle type is referred as an IC.

3.9 TARGET WINDSHIELD VIEWING AREA

The area of the windshield through which the driver should be able to see to safely operate the vehicle.

3.10 WINDSHIELD DEFROSTER SYSTEM

A heating device designed to defrost the windshield and specified portions of the front right and front left side windows.

4. TEST EQUIPMENT

4.1 Environmental chamber sufficiently large to contain the basic vehicle or basic vehicle body or partial body with provision for circulating air.

4.2 Means for recording the boundaries of the windshield areas defrosted (markers or photographic equipment).

4.3 Engine tachometer with an accuracy of 2% of observed values.

4.4 Stopwatch or other timing device.

4.5 Thermometers, thermocouples, or other temperature measuring devices with an accuracy of ±0.5 °C.

4.6 Throttle control device (if desired).

4.7 Spray gun for applying distilled water to the windshield and side windows with the following characteristics:

- Fluid: water.
- Liquid nozzle size diameter: 1.7 mm (0.070 inch).
- Operating gun gauge pressure: 345 kPa (50 psig).
- Airflow rate: 0.34 m^3/min ± 0.03 m^3/min (12 ft^3/min ± 1 ft^3/min).
- Pattern at 200 mm (8 inches) from surface: 250 mm ± 50 mm (10 inches ± 2 inches) wide.

4.8 Device for measuring the quantity of water applied to the windshield and side windows.

4.9 Auxiliary power supply for powering the defroster blower motor.

4.10 Anemometer to measure air velocity with a measuring accuracy of ±1.6 km/h (1 mph).

4.11 Independent coolant supply to provide coolant flow to the heater-defroster system under test.

4.12 Instrument for measuring voltage and amperage.

5. TEST CONDITIONS

5.1 Coolant Source

TEST A: Independent coolant supply.

TEST B: Engine running at 1500 rpm ± 50 rpm in neutral gear or the high idle rpm set by the vehicle OEM, whichever is higher. An auxiliary means for preheating the engine is permissible to provide easier engine starting. Engine speed shall be maintained with no load (normal engine parasitic loads only) throughout the test.

5.2 Heater Defroster System Coolant Flow

TEST A: 11.4 kg/min ± 2.3 kg/min (25 lb/min ± 5 lb/min) for IC or HD only.

TEST B: (With engine) The flow resulting from engine operation as prescribed in 5.1.

5.3 Heater Defroster System Coolant Temperatures

TEST A: To be maintained at 65 °C + 3 °C/-0 °C (150 °F + 5 °F/-0 °F) for the entire test period.

TEST B: To be at 65 °C ± 3 °C (150 °F ± 5 °F) at the start of the test or the maximum temperature that the engine can produce at the test conditions if it cannot reach this value. Coolant temperature after the start of the test is to be a function of the engine temperature control characteristics at the test conditions.

TEST C: For EV, the vehicle shall be set as recommended by the manufacturer for vehicle warming up in cold weather. The vehicle shall be either:

- On a chassis dynamometer the load shall not exceed speed and equivalent load at 40 km/h in manufacturer's recommended gear (specific to SAE/FMVSS).
- Turned on for cold weather warm-up.

5.4 Environmental Chamber Temperature

-18 °C ± 2 °C (0 °F ± 4 °F).

5.5 Environmental Chamber Air Velocity

The maximum wind speed measured 915 mm (36 inches) in front of the windshield shall not exceed 8 km/h (5 mph).

5.6 Environmental Chamber Air Temperature

The ambient air temperature shall be measured at a point that is located at the midpoint of the windshield 915 mm (3 feet) ahead of the windshield surface. As the test proceeds, this temperature shall not exceed -12 °C (+10 °F).

5.7 Vehicle Occupants during the Test

There shall be no more than two occupants inside the vehicle during the test.

5.8 Windshield Wipers

Wiper blades and arms are to be off the windshield glazing surface during the ice application. Windshield wipers are allowed to be used during the test. If windshield wipers are used, the number of wiper cycles and times are to be listed in the report.

5.9 Defroster and Heater System Settings

- Defroster blower fan(s): Maximum speed.
- Selection mode: Defrost.
- Inlet air mode: Outside air.
- Temperature control: Maximum heat.

5.10 Test Voltage

Not to exceed 15% over the nominal system rating at the blower motor (for example, 13.8 V on 12-V system) or the supply end of motor dropping resistor.

NOTE: Blower motor voltage and current are to be measured as close to the motor as possible and the distance documented.

The starting battery (12 V or 48 V) and high-voltage battery (where equipped) should be fully charged prior to soaking. The battery may remain on charge during the soak. The passenger cabin shall not be preconditioned.

5.11 Test Components

All engine, heater, and defroster units shall be standard production parts or equivalent, adjusted to the manufacturer's specified limits.

5.12 Cab Configuration

Engine hood, doors, windows, and controllable vents shall be closed. Operation of the side windows is not permitted during the test. Use of the bunk curtain should be consistent, whether closed or open, throughout the test series. Bunk blower off, if applicable.

5.13 Auxiliary Heaters

If an auxiliary heater (or heaters) is part of the standard heater and defroster system, it may be operated.

5.14 Electrically Conductive Heating

For systems using an electrically conductive heating medium integral with glazing material, and if a coolant heater defroster means is not used, the references to coolant control does not apply.

For systems that include an electrically conductive heating medium integral with the glazing material, set the control to its maximum setting.

6. TEST INSTRUMENTATION

6.1 Coolant Temperature

The temperature of the engine coolant or the independent supply coolant shall be measured as near to the inlet line of the heater unit as possible, but not farther than 152 mm (6 inches) from the heater inlet and outlet tubes. For those systems using more than one heater, it shall be measured at the inlet line of the heater unit getting the first coolant flow.

6.2 Coolant Flow

The coolant flow may be measured at any convenient point in the independent coolant supply system.

6.3 Glass Temperature

The windshield's interior surface temperature(s) shall be measured at a point located on the vertical and horizontal centerline of each section of windshield glass.

6.4 Defrost Pattern Marking

Marker method: Use dry-erase-type marker or wax pencil to mark the lines on the glass as the test proceeds.

Photographic method: Mount the cameras so that they are positioned perpendicular to the surface of the glass. Use a sufficient number of cameras so that each section of glass (windshield and side windows) can be photographed without distortion.

The line of the receding ice is determined by identifying the edge where the ice ends (if the windshield wipers are running) or the transition between the wet ice and the gray ice; see Figure 1.

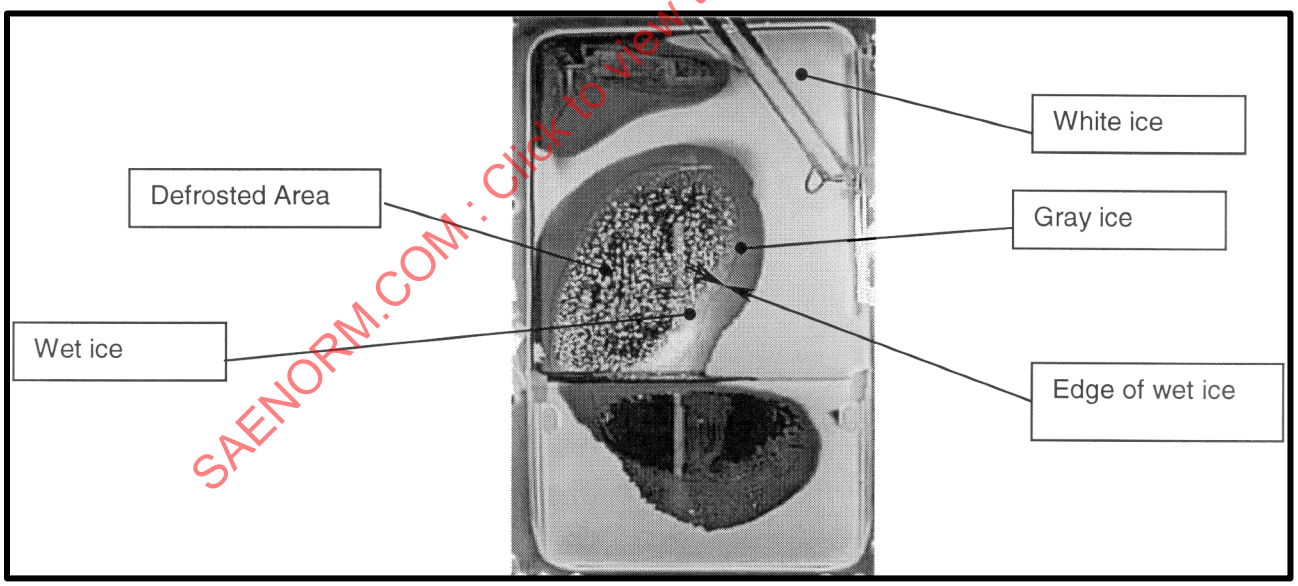


Figure 1 - Digital picture of defrosting window

7. TEST PROCEDURE

7.1 Glass Cleaning

Before the test, the outer and inner glazed surfaces of the windshield shall be thoroughly degreased using methylated spirit or another appropriate degreasing agent. When dry, apply a solution of ammonia in water with a volume fraction of 3 to 10%, allow to dry, and finally wipe with a dry, clean cotton cloth or paper towel.

7.2 Glass Marking

Transfer the target windshield viewing areas and the target side window viewing areas onto the interior surfaces of the glass using dry-erase markers or grease pencils.

7.3 Vehicle Cold Soak - Pre-Icing

Soak time in the environmental chamber prior to ice application shall be a minimum of 4 hours, unless instrumentation is available to assure that the windshield, cab, and HVAC system with ductwork are stabilized at the test temperature.

7.4 Ice Application

Following the vehicle cold soak period, a coating of ice shall be formed on the windshield(s) as follows:

The windshield(s) and front door windows on each side shall be sprayed with 0.05 mL of water per square centimeter of glass area (0.05 mL/cm^2 = 0.01 oz/in^2) applied by means of a spray gun with 345 kPa ± 35 kPa (50 psi ± 5 psi) air pressure at the device, measured while spraying to form an even coating of ice over the entire glass surface.

The spray nozzle (adjusted to full fan pattern and maximum flow) is held perpendicular to and 200 to 250 mm (8 to 10 inches) from the glass and stroked back and forth evenly in horizontal overlapping layers until the specified quantity of liquid is applied.

7.5 Vehicle Cold Soak - Post-Icing

Upon completion of the icing process, an additional soak period of not less than 30 minutes and not more than 40 minutes shall have elapsed before start of the test.

Figure 2 - Digital picture of defrosting window

7.6 Temperature Control

Prior to the start of the test period, while the engine or independent coolant supply is being warmed up:

- The temperature of the windshield glass surface measured as prescribed in the test shall not exceed -12 °C (+10 °F).
- The temperature of the coolant in the heater core (if used for defroster air heating) shall not exceed -12 °C (+10 °F).
- The temperature of the test chamber measured as prescribed in the test shall not exceed -18 °C ± 2 °C (0 °F ± 4 °F).

For electric vehicles (EVs), the vehicle shall be set as recommended by the manufacturer for a vehicle warming up in cold weather.

There shall be no solar load.

7.7 Start Test

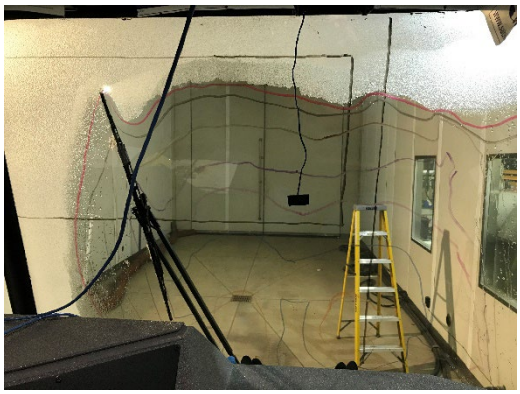
Two observers may enter the vehicle (when required to mark the pattern).

The test period may begin when the test conditions are met.

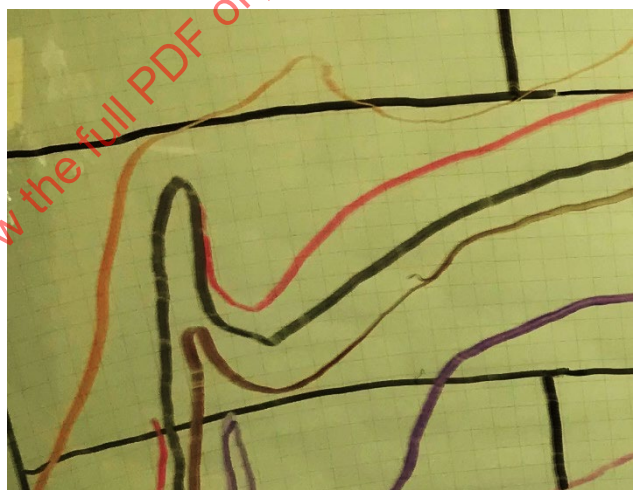
Turn on the blower(s) and begin timing to start the test.

7.8 Record Data

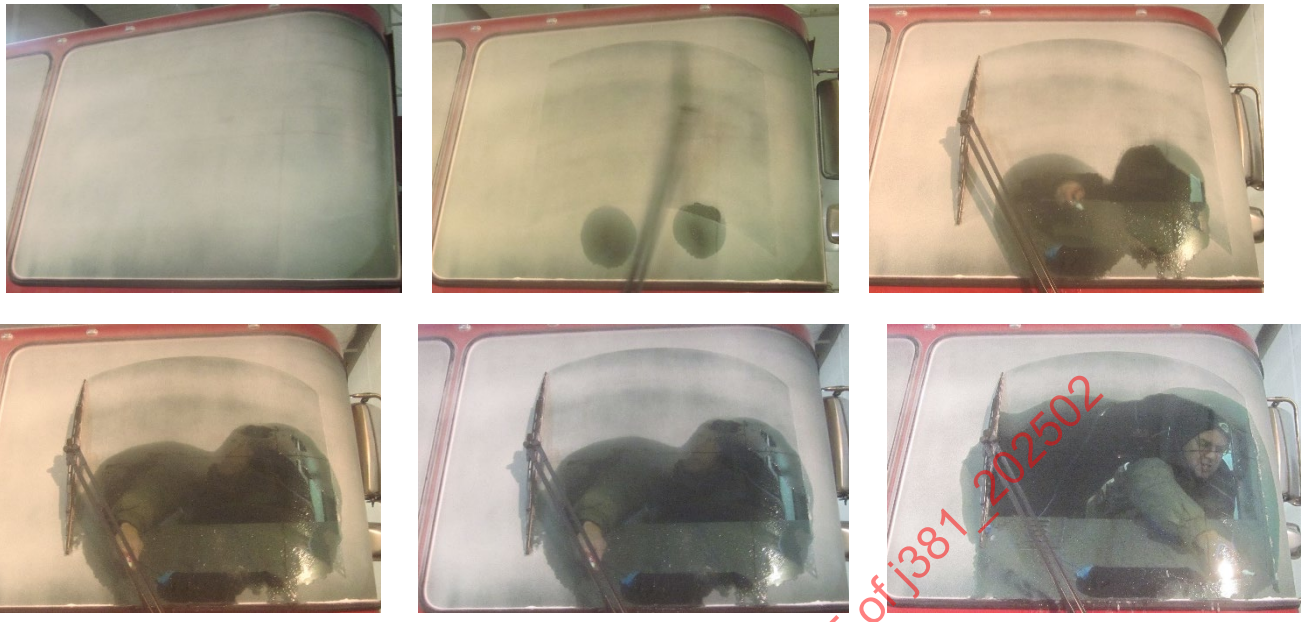
Marker method: Trace the boundary of the receding ice pattern with dry-erase markers or grease pencils at the end of each 5-minute period. The use of different colors for each trace may enhance the test results.



After the test is complete, tape a white paper with grid markings on the outside of the windshield. Count the squares or portions of each square within the melted portion of each zone for each time period.



Photographic method: Take photographs to document the receding ice pattern at the end of each 5-minute period.



After the test is complete, digitally superimpose a grid pattern and the ABC zones onto each image. Count the squares or portions of each square within the melted portion of each zone for each time period.

Other methods: Other methods are permissible so long as they allow accurate measurement of the defrosted area within each zone.

Record all data indicated in Figure 4 at the end of each 5-minute period.

Record results every 5 minutes for a total of at least 30 minutes.

8. DOCUMENTATION

Document the defrosted trace patterns at the completion of the test, making note of the trace line result at the end of the 30-minute period.

If using the marking method, capture the results by taking photographs of the markings or transfer the pattern to a transparent material by tracing. Be sure to indicate which images go with which areas (driver's side windshield, passenger side windshield, left- and right-side windows).

If using the photographic method, process the images in a way that they can be used to measure the area that is defrosted at each interval. Label each photograph with the time interval of the test.

Record the position of the bunk curtain, if applicable.

9. DEFROSTER PERFORMANCE CRITERIA

9.1 Target Windshield Viewing Area

The target windshield viewing area shall be determined using the criteria and methods found in SAE J198.