

|                                                                                                                        |                                                         |                   |                     |
|------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------|-------------------|---------------------|
|                                        | <b>SURFACE<br/>VEHICLE<br/>RECOMMENDED<br/>PRACTICE</b> | <b>SAE</b>        | <b>J381 JAN2009</b> |
|                                                                                                                        |                                                         | Issued<br>Revised | 1968-02<br>2009-01  |
|                                                                                                                        |                                                         | Superseding       | J381 SEP2000        |
| (R) Windshield Defrosting Systems Test Procedure and Performance Requirements—Trucks, Buses, and Multipurpose Vehicles |                                                         |                   |                     |

## RATIONALE

The current SAE J381 test procedure provides two separate means of heating the coolant during testing, but these two approaches can provide very different results. If the engine is used to heat the coolant, the engine rpm and engine load criteria are neither clear nor consistent.

There are two distinct reasons to test a defrost system:

- To compare two or more alternative defroster systems during the design process.
- To compare the defroster performance of a specific vehicle and engine configuration to an established standard.

This revision recognizes these differences in the reasons for testing, and provides specific test conditions depending on the test intent. Variations of the test between gasoline and diesel engines are eliminated with the rationale that how well the window clears should not be a function of the engine fuel source.

Diesel and gasoline engines in the past ran at very different rpms, but today most truck gasoline engines run high idle rpms at similar speeds when compared to their diesel counterparts.

The chamber wind condition was increased to up to 5 mph because this is easier for all chambers to meet and this should not significantly affect the results

Updated the test report template to match the procedure

References to the type of cameras that could be used were removed because such specific recommendations do not keep pace with advancements in technology.

## 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. Current engineering practice prescribes that for laboratory evaluation of defroster systems, 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.

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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 which 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.

## 2. REFERENCES

### 2.1 Applicable Publications

The following publications form a part of the specification to the extent specified herein. Unless otherwise indicated, the latest revision 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 724-776-4970 (outside USA), [www.sae.org](http://www.sae.org).

SAE J941 Motor Vehicle Drivers' Eye Locations

## 3. DEFINITIONS

### 3.1 Defrost

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

### 3.2 Windshield Defroster System

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

### 3.3 Defrosted Area

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

### 3.4 Coolant

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

### 3.5 Daylight Opening (DLO)

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

### 3.6 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 take-off equipment or for warming up the engine.

#### 4. DEFROSTING TEST

##### 4.1 General Purpose Requirements

The windshield area to be defrosted was developed to be compatible with vision requirements necessary to operate trucks, buses, and multipurpose vehicles. The area is based on SAE J941 with certain modifications to accommodate the wide variety of conditions encountered in these vehicles. For the purpose of this document, the head turn consideration in SAE J941 will not be used.

##### 4.2 Test Equipment

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

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

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

4.2.4 Stopwatch or other timing device.

4.2.5 Thermometers, thermocouples, or other temperature measuring devices with an accuracy of  $\pm 0.5$  °C.

4.2.6 Throttle control device (if desired).

4.2.7 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 in)

Operating gun gauge pressure—345 kPa (50 psig)

Airflow rate— $0.34 \text{ m}^3/\text{min} \pm 0.03 \text{ m}^3/\text{min}$  ( $12 \text{ ft}^3/\text{min} \pm 1 \text{ ft}^3/\text{min}$ )

Pattern at 200 mm (8 in) from surface—250 mm  $\pm$  50 mm (10 in  $\pm$  2 in) wide

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

4.2.9 Auxiliary power supply for powering the defroster blower motor.

4.2.10 Anemometer to measure air velocity with a measuring accuracy of  $\pm 1.6 \text{ km/h}$  (1 mph).

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

4.2.12 Instrument for measuring voltage and amperage.

##### 4.3 Test Conditions

###### 4.3.1 Coolant Source

**TEST A:** Independent coolant supply.

**TEST B:** Engine running at 1500 rpm  $\pm$  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.

###### 4.3.2 Heater Defroster System Coolant Flow

**TEST A:** 11.4 kg/min  $\pm$  2.3 kg/min (25 lb/min  $\pm$  5 lb/min)

**TEST B:** With engine—That flow resulting from engine operation as prescribed in 4.3.2.

#### 4.3.3 Heater Defroster System Coolant Temperatures

**TEST A:** To be maintained at  $65^{\circ}\text{C} + 3^{\circ}\text{C}/-0^{\circ}\text{C}$  ( $150^{\circ}\text{F} + 5^{\circ}\text{F}/-0^{\circ}\text{F}$ ) for the entire test period

**TEST B:** To be at  $65^{\circ}\text{C} \pm 3^{\circ}\text{C}$  ( $150^{\circ}\text{F} \pm 5^{\circ}\text{F}$ ) 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.

#### 4.3.4 Environmental Chamber Temperature

$-18^{\circ}\text{C} \pm 2^{\circ}\text{C}$  ( $0^{\circ}\text{F} \pm 4^{\circ}\text{F}$ ).

#### 4.3.5 Environmental Chamber Air Velocity

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

#### 4.3.6 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 ft) ahead of the windshield surface. As the test proceeds, this temperature shall not exceed  $-12^{\circ}\text{C}$  ( $+10^{\circ}\text{F}$ ).

#### 4.3.7 Number of Vehicle Occupants During the Test

Two maximum.

#### 4.3.8 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.

#### 4.3.9 Defroster and Heater System Settings

|                          |           |
|--------------------------|-----------|
| Defroster Blower Fan(s): | Max Speed |
| Selection Mode:          | Defrost   |
| Recirc Mode:             | Fresh Air |
| Temp Control:            | Max Heat  |

#### 4.3.10 Test Voltage

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.

#### 4.3.11 Test Components

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

#### 4.3.12 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.

#### 4.3.13 Auxiliary Heaters

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

4.3.14 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.

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

### 4.4 Test Instrumentation

#### 4.4.1 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 in) 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.

#### 4.4.2 Coolant Flow

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

#### 4.4.3 Glass Temperature

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

#### 4.4.4 Defrost Pattern Marking

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.

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

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 grey ice, see Figure 1.

### 4.5 Test Procedure

#### 4.5.1 Vehicle Soak Period

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.

#### 4.5.2 Ice Application

Following the vehicle soak period, a coating of ice shall be formed on the windshield(s) as follows: The windshield(s) shall be sprayed with 0.05 mL of water per square centimeter of glass area ( $0.05 \text{ mL/cm}^2 = 0.01 \text{ oz/in}^2$ ) applied by means of a spray gun with  $345 \text{ kPa} \pm 35 \text{ kPa}$  ( $50 \text{ psi} \pm 5 \text{ psi}$ ) 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 in) from the glass, and stroked back and forth evenly in horizontal overlapping layers until the specified quantity of liquid is applied. Upon completion of the icing process, an additional soak period of not less than 30 min and not more than 40 min shall have elapsed before start of the test.

#### 4.5.3 Coolant Temperature Control

Prior to the start of the test period, while the engine or independent coolant supply is being warmed up, the temperature at locations specified in 4.4.2 and 4.4.3 shall not exceed  $-12^{\circ}\text{C}$  ( $+10^{\circ}\text{F}$ ).

#### 4.5.4 Start Test

The test period begins when the conditions are met as specified in 4.3.3.

Turn on the blower(s) and begin timing.

#### 4.5.5 Record Data

Record results every 5 min for a total of 30 min:

All in-cab temperatures per Table in Figure 2.  
The boundary of receding ice pattern.

Figure 2 illustrates a typical form for recording test data.

#### 4.5.6 Documentation

At the completion of the test:

Document the defrosted pattern.

Record the position of the bunk curtain.

If using the marking method, transfer the pattern to a transparent material by tracing. This record shall be marked to identify the driver's side of the windshield and the 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.

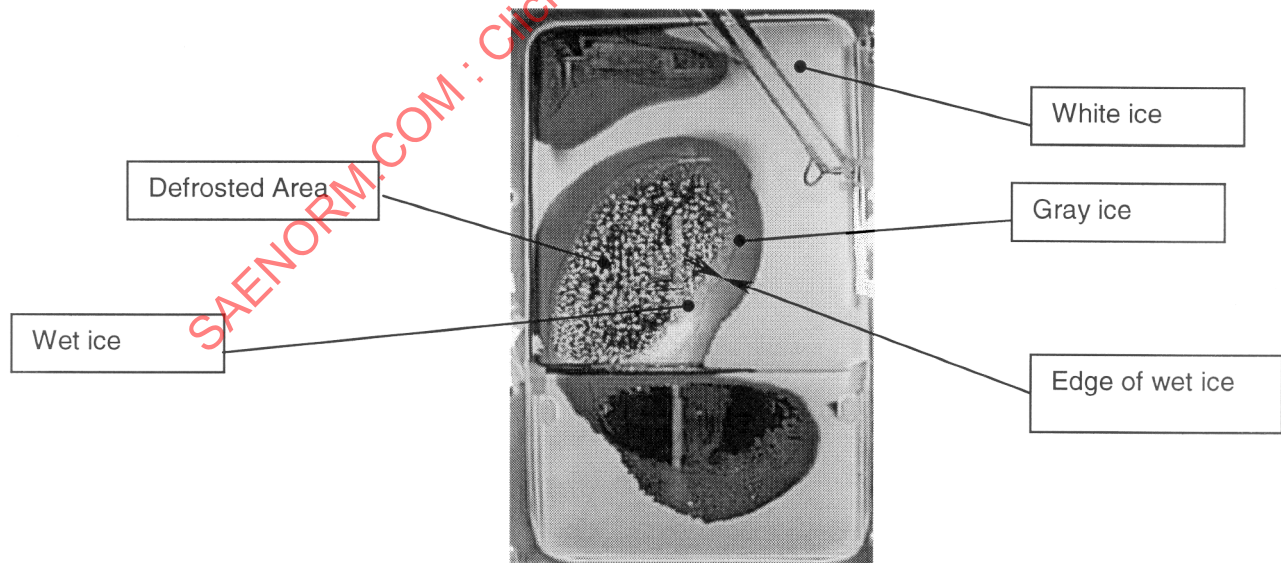


FIGURE 1 - DIGITAL PICTURE OF DEFROSTING WINDOW

## 4.6 Defroster Performance Criteria

The windshield area that shall be defrosted is described by the use of Area A and C in Table 1. Each area has been established using the angles of Table 2 applied as shown in Figure 3.

TABLE 1 - MINIMUM PERCENT OF WINDSHIELD TO BE DEFROSTED

|            | Area A | Area C |
|------------|--------|--------|
| One Piece  | 80     | 99     |
| Multipiece | 65     | 84     |

Vehicle Model \_\_\_\_\_ Description of Heater-Defroster \_\_\_\_\_  
 Vehicle Type \_\_\_\_\_ Vehicle No. \_\_\_\_\_  
 Test Date \_\_\_\_\_ Test No. \_\_\_\_\_  
 Location \_\_\_\_\_  
 Observers \_\_\_\_\_  
 Windshield Area \_\_\_\_\_ cm<sup>2</sup> \_\_\_\_\_ in<sup>2</sup>

Ice Application  
 Water Spray Gun Type \_\_\_\_\_ Spray Gun Pressure \_\_\_\_\_ kPa \_\_\_\_\_ psi  
 Nozzle Type \_\_\_\_\_ Water Used: 0.05 mL/cm<sup>2</sup> (0.01 oz/in<sup>2</sup>) of windshield area \_\_\_\_\_  
 Soak Period \_\_\_\_\_ H at \_\_\_\_\_ °C \_\_\_\_\_ °F

Engine speed 1500 rpm ± 50 rpm in neutral gear  
 or

The high idle rpm set by the vehicle OEM \_\_\_\_\_

Coolant flow-independent supply (when applicable) ☐

Wind velocity at windshield \_\_\_\_\_ km/h (mph)

Voltage to heater motor or resistor \_\_\_\_\_ V (115% of nominal)

Control position: Max. Temp ☐ Full Defrost ☐

Auxiliary heater operating (when applicable) ☐

No. of people in vehicle \_\_\_\_\_ doors and windows closed tightly ☐

Engine thermostat nominal control temperature \_\_\_\_\_ °C \_\_\_\_\_ °F

Test Data

Remarks \_\_\_\_\_

| Time<br>From<br>Start<br>—<br>Min | Temperature, °C (°F) |                       | Interior Temperature |       |        |      |       |      | Defrosted Area, % |   |        |    |
|-----------------------------------|----------------------|-----------------------|----------------------|-------|--------|------|-------|------|-------------------|---|--------|----|
|                                   | Room                 | Heater<br>Water<br>In | Defroster Air        |       | Breath |      | Floor |      | Windshield        |   | Window |    |
|                                   |                      |                       | Left                 | Right | Dr.    | Pass | Dr.   | Pass | A                 | C | LH     | RH |
|                                   |                      |                       |                      |       |        |      |       |      |                   |   |        |    |
| 0                                 |                      |                       |                      |       |        |      |       |      |                   |   |        |    |
| 5                                 |                      |                       |                      |       |        |      |       |      |                   |   |        |    |
| 10                                |                      |                       |                      |       |        |      |       |      |                   |   |        |    |
| 15                                |                      |                       |                      |       |        |      |       |      |                   |   |        |    |
| 20                                |                      |                       |                      |       |        |      |       |      |                   |   |        |    |
| 25                                |                      |                       |                      |       |        |      |       |      |                   |   |        |    |
| 30                                |                      |                       |                      |       |        |      |       |      |                   |   |        |    |
| 35                                |                      |                       |                      |       |        |      |       |      |                   |   |        |    |
| 40                                |                      |                       |                      |       |        |      |       |      |                   |   |        |    |

FIGURE 2 - FORM FOR RECORDING TEST DATA

TABLE 2 - WIPED AREA VIEWING REQUIREMENT

| Classification                                        | F Dimension<br>mm | F Dimension<br>in | Area | Center Angle<br>Up, deg | Center Angle<br>Down, deg | Center Angle<br>Left, deg | Center Angle<br>Right, deg |
|-------------------------------------------------------|-------------------|-------------------|------|-------------------------|---------------------------|---------------------------|----------------------------|
| Truck, CBE<br>and CAE <sup>(1)</sup>                  | 0-1020            | 0-40              | A    | 10                      | 5                         | 18                        | 56                         |
|                                                       |                   |                   | C    | 5                       | 1                         | 10                        | 15                         |
|                                                       | 1020-1270         | 40-50             | A    | 8                       | 7                         | 18                        | 56                         |
|                                                       |                   |                   | C    | 3                       | 3                         | 10                        | 15                         |
|                                                       | 1270-Up           | 50-Up             | A    | 6                       | 9                         | 18                        | 56                         |
|                                                       |                   |                   | C    | 1                       | 5                         | 10                        | 15                         |
| Buses, CBE<br>School and<br>Commercial <sup>(2)</sup> | 1270-1520         | 50-60             | A    | 7.5                     | 22                        | 22                        | 62                         |
|                                                       |                   |                   | C    | 1                       | 16                        | 22                        | 15                         |
| Buses, Forward<br>Control School<br>and Commercial    | 1270-1520         | 50-60             | A    | 7                       | 14                        | 18                        | 65                         |
|                                                       |                   |                   | C    | 1                       | 11                        | 18                        | 25                         |
| Forward Control<br>or Multipurpose                    | All               | All               | A    | 9                       | 7                         | 18                        | 56                         |
|                                                       |                   |                   | C    | 2                       | 2                         | 18                        | 15                         |
| Light-Duty Utility<br>Vehicle <sup>(1)</sup>          | All               | All               | A    | 7                       | 5                         | 16                        | 49                         |
|                                                       |                   |                   | C    | 4                       | 2                         | 8                         | 13                         |
| Van, Multistop <sup>(1)</sup>                         | Open              | Open              | A    | 7                       | 12                        | 18                        | 58                         |
|                                                       |                   |                   | C    | 1                       | 6                         | 10                        | 15                         |
| Trucks, COE                                           | 1020-Up           | 40-Up             | A    | 6                       | 9                         | 18                        | 56                         |
|                                                       |                   |                   | C    | 1                       | 5                         | 10                        | 15                         |

1. Specifications also cover passenger carrying derivatives.

2. Geometric center of eyellipse located 457 mm (18 in) from centerline of vehicle.

a. Side View—The upper and lower boundary of the area is established by the intersection of two planes, which are seen as lines in the side view tangent to the upper and lower edges of the eyellipse, with the windshield glazing surface. The planes are fixed by angles above and below the XX line.

b. Plan View—The left and right boundary of the area is established by the intersection of two vertical planes tangent to the left and right edges of the eyellipse with the windshield glazing surface. The planes are fixed by angles to the left and right of the XX line.

The areas used in determining the percentage of defrosted area are those areas on the exterior glazing surface which are not within 25 mm (1 in) of the edge of the daylight opening (pillars, division bar, header, etc.) The percentage is the ratio of defrosted area within the defined area to the defined area.

The left- and right-hand side window area that shall be defrosted is defined as 70% of that glass surface forward of line Y-Y. The defined 70% area must permit full visibility of the minimum size rear vision device specified by FMVSS 111.

Figure 4 illustrates all of the areas on a typical windshield.