APPENDIX B: School Bus Body and Chassis Specifications

WRITING COMMITTEE EDITS IN RED INK BY SECTION LOCATION:

BUS BODY HEATING SYSTEM TEST

APPENDIX B:
SCHOOL BUS BODY AND CHASSIS SPECIFICATIONS

NATIONAL SCHOOL BUS YELLOW STANDARD

The color known as “National School Bus Yellow (NSBY)” is specified below.

School Bus Manufacturer’s Technical Council (SBMTC)

National School Bus Yellow Color Standard SBMTC-008 (Source Document)

S1: SCOPE

This standard defines the color for a newly manufactured school bus having “National School Bus Yellow” by fundamental colorimetric data.

S2: PURPOSE

This standard is intended for use by manufacturers of school bus type vehicle body and chassis for purposes of procurement, and inspection.

S3: APPLICATION

This standard applies to school buses.

S4: COLOR DEFINITION

The color “National School Bus Yellow” is defined as:

> “The color resulting from the colorimetric tri-stimulus data shown below.”

COLORIMETRIC (CIE) DATA, C/10°

DESCRIPTION	REFLECTANCE	CHROMATICITY	
	Y	x	y
Centroid	40.2%	.4882	.4205
Light Limit	41.8%	.4882	.4198
Dark Limit	38.5%	.4902	.4206
Green Limit	40.6%	.4844	.4217
Red Limit	40.3%	.4907	.4174
Yellow Limit	40.6%	.4901	.4225
Blue Limit	40.2%	.4828	.4162

S5: REQUIREMENTS

The color “National School Bus Yellow” shall conform to the tolerance limits set in S4.

S6: COLOR MATCHING

The colorimetric data should be used for acceptance testing purposes. However, accurate comparison can be made only if values are obtained on the same instrument standardized under the same conditions.

Because this standard is not intended to be a performance standard for the paint and/or materials used in the manufacture of the school buses, color matching procedures provided in this standard cannot be used to determine conformity with this standard of school bus type vehicles in use.

BUS BODY HEATING SYSTEM TEST

Scope

This procedure, limited to liquid coolant systems, establishes uniform cold weather bus vehicle heating system test procedures for all vehicles designed to transport ten (10) or more passengers. Required test equipment, facilities and definitions are included. Defrosting and defogging procedures and requirements are established by SAE J381, *Windshield Defrosting Systems Test Procedure and Performance Requirements—Trucks, Buses, and Multipurpose Vehicles,* which document herein is included by reference.

Purpose - This procedure is designed to provide bus manufacturers with a cost-effective, standardized test method to provide relative approximations of cold weather interior temperatures.

Definitions

1. **Heat Exchanger System** - Means will exist for providing heating and windshield defrosting and defogging capability in a bus. The system shall consist of an integral assembly or assemblies, having a core assembly or assemblies, blower(s), fan(s) and necessary duct systems and controls to provide heating, defrosting and defogging functions. If the bus body structure makes up some portion of the duct system, this structure or a simulation of this structure must be included as part of the system.

2. **Heat Exchanger Core Assembly** - The core shall consist of a liquid-to-air heat transfer surface(s), liquid inlet and discharge tubes or pipes.

3. **Heat Exchanger-Defroster Blower -** An air moving device(s) compatible with energies available on the bus body.

4. **Coolant** - A 50-50 solution of commercially available glycol antifreeze and commercial purity water. Commercial purity water is defined as “that water obtained from a municipal water supply system.”

5. **Heat Exchanger-Defroster Duct System** - Passages that conduct inlet and discharge air throughout the heater system. The discharge outlet louvers shall be included as part of the system.

6. **Heater Test Vehicle** - The completed bus as designed by the manufacturer with or without a chassis, engine and driver train, including the defined heat exchanger system. If the vehicle is without a chassis, it shall be placed on the test site in such a way that the finished floor of the body is at a height, from

the test site floor, equal to its installed height when on a chassis, and all holes and other openings normally filled when installed on a chassis will be plugged.

7. **Heat Transfer** - The transfer of heat from liquid to air is directly proportional to the difference between the temperatures of the liquid and air entering the transfer system, for a given rate of liquid and air flow measured in pounds per minute, and that heat removed from liquid is equal to heat given to air.

Equipment

1. **Test Site** - A suitable location capable of maintaining an average ambient temperature not to exceed 25°F (-3.9°C) for the duration of the test period. The maximum air velocity across the vehicle shall be 5 mph (8 kph).

2. **Coolant Supply** - A closed loop system, independent of any engine/drive train system, capable of delivering a 50-50 (by volume) solution of antifreeze-water, as defined in 2.4, at 150°±5° (65.5°±1.7°C) above the test site ambient temperature, and 50 lbs (22.7 kg) per minute flow. The coolant supply device shall be equipped with an outlet diverter valve to circulate coolant within the device during its warm-up period. The valve will then permit switching the coolant supply to the bus heat exchanger system at the start of the test.

3. **Power Equipment Supply** - A source capable of providing the required test voltage and current for the heater system.

4. **Heat Exchange Units** - The heat exchangers used shall be labeled as specified by the School Bus Manufacturers Technical Council Standard No. 001, *Procedure for Testing and Rating Automotive Bus Hot Water and Heating and Ventilating Equipment* (Revised 4/94). The test rating of each unit, and quantity used, shall be recorded.

Instrumentation

1. **Air Temperature**

   a. **Interior** - Recommended air temperature measuring instrumentation are thermocouples or resistance temperature detectors (RTDs). Thermometers are not recommended because of their slow response to rapid temperature changes. Measuring instrumentation shall be placed on alternate seat rows beginning 39±5 inches (99±13 cm) from the rear of the body, at 36±2 inches (91±5 cm) from the finished floor of the body, and on the longitudinal centerline of the body.

   b. **Ambient** - A set of four electrically averaged temperature measuring devices shall be placed 18±5 inches (46±13 cm) from the nearest body surface, 96±5 inches (243±13 cm) above the floor of test site. One measuring device shall be placed at each of the following locations:

I Midline of body forward of windshield;

II Midline of body aft of the rear surface; and

III Midway between the axles on the right and left sides of the body.

c. **Driver** - Measuring devices shall be placed at appropriate locations to measure ankle, knee, and breath level temperatures with the driver's seat in rearmost, lowest and body center-most position.

I Ankle Level - Place a minimum of four electrically averaged temperature measuring devices at the corners of a 10 x 10 inches (25x25cm) square area, the rearmost edge of which begins 8 inches (20 cm) forward of the front edge of, and centered on, the seat cushion. The devices shall be located 3±0.5 inches (7.5±1.3 cm) above floor surface.

II Knee Level - Place a minimum of one measuring device at the height of the front top edge of the seat cushion and on the centerline of the seat. This measurement shall be 4±1 inches (10±2.5 cm) forward of the extreme front edge of the seat cushion and parallel to the floor.

III Breath Level - Place a minimum of one measuring device 42±2 inches (107±5 cm) above the floor and 10±2 inches (25±5 cm) forward of the seat back. The forward dimension shall be measured from the upper edge of the seat back and parallel to the floor.

d. **(Optional) Heat Exchanger Inlet and Outlet Temperature** - A minimum of four electrically averaged temperature measuring devices shall be used to measure the inlet air temperature of each heat exchange unit. Additionally, a minimum of four electronically averaged temperature measuring devices shall be used to measure the outlet air temperature of each heat exchange unit. These sensors shall be placed no closer than 2.0 inches (5.1 cm) from the face of any heater core, to prevent any incidence of radiant heat transfer. Outlet sensors shall be distributed throughout the outlet air stream(s) 1.0±0.25 inches (2.5±0.6 cm) from the outlet aperture(s) of the unit heater.

e. **(Optional) Defrost Air Temperature** - The temperature of the defrost air shall be measured at a point in the defroster outlet(s) that is in the main air flow and which is at least 1.0 inch (2.54 cm) below (upstream of) the plane of the defroster outlet opening. At least one temperature measurement shall be made in each outlet unit. The interior surface temperature(s) of the windshield shall be measured at a point located on the vertical and horizontal centerline(s) of the windshield.

f. **(Optional) Entrance Area Temperature** - The temperature of the vehicle entrance area shall be measured by two sets of three each electrically averaged temperature measuring devices. One set of three devices shall be placed 1.0 inch (2.54 cm) above the lowest tread of the entrance step, equally spaced on the longitudinal centerline of the tread. The second set of devices shall be placed on the next horizontal surface above the lowest entrance step, 4.0 inches (10.2 cm) from the outboard edge of that surface, spaced identically to the first set of sensors, and placed parallel with the outboard edge of the surface being measured.

2. **Coolant Temperature** - The temperature entering and leaving the heat exchanger/defroster system shall be measured as close to the entrance and exit points of the bus body as possible with an immersion thermocouple or RTD device which can be read within ±0.5°F (±0.3°C).

3. **Coolant Flow** - The quantity of coolant flowing shall be measured by means of a calibrated flow meter or weighing tank to an accuracy of at least 2% of setpoint.

4. **Coolant Pressure -** The coolant differential pressure shall be measured by suitable connection as close as possible to the inlet and outlet of the heat exchanger/defrosting system. Pressure may be read as inlet and outlet pressure and the differential calculated or read directly as PSID. Pressure readings shall be made with the use of gauges, manometers or transducers capable of reading within ±0.1 psi (689.5 Pa), accurate to ±0.5% of full scale.

5. **Additional Instrumentation** - Additional instrumentation required for vehicle heat exchanger system testing is a voltmeter and a shunt-type ammeter to read the voltage and current of the complete system. The ammeter and voltmeter shall be capable of an accuracy of ±1% of the reading.

Test Procedures

1. Install the heater test vehicle on the test site. Testing shall be conducted in such a way as to prevent the effects of solar heating. At an outdoor test site, testing shall commence, and data shall be recorded, during the hours following sunset and prior to sunrise, regardless of cloud cover or facility roof. Instrumentation is required to obtain the following readings:

    a. Vehicle interior (4.1.1);

    b. Inlet coolant temperature, at entrance to the bus body (4.2);

    c. Discharge coolant temperature, at exit from the bus body (4.2);

    d. Voltage and current at main bus bar connection of driver's control panel;

    e. Ambient temperature (4.1.2);

    f. Rate of coolant flow (4.3);

    g. Coolant flow pressure (4.4);

    h. Elapsed time (stopwatch);

    i. Driver's station temperatures (4.1.3);

    j. (Optional) Heat Exchanger Inlet and Outlet Temperatures (4.1.4);

    k. (Optional) Defrost Air Temperature (4.1.5); and

    l. (Optional) Entrance Area Temperature (4.1.6).

2. Soak the test vehicle, with doors open, for the length of time necessary to stabilize the interior temperature for a 30-minute period as recorded by the vehicle interior temperature measuring devices, and the coolant temperature as measured by the inlet and outlet coolant temperature measuring devices, at the test site temperature, ±5°F (±2.5°C), not to exceed 25°F (-3.9°C). Warm up the coolant device to the test temperature immediately prior to the start of the test. Use the coolant supply outlet diverter valve to prevent heated coolant from entering the bus heating system prior to the start of the test.

3. At this time, set the heater controls and all fan controls at maximum, and close all doors. A maximum of two windows may be left open a total of 1.0 inch (2.5 cm) each. A maximum of two occupants may be in the body during the test period. Record all instrumentation readings at five-minute intervals

for a period of 1 hour. Recording time shall begin with the initial introduction of heated coolant from the independent coolant supply. The electrical system shall be operated at a maximum of 115% of nominal system voltage ±0.2 volts, for example: 13.8 VDC ±0.2 volts for a 12- volt (DC) system, and the heat exchanger system shall be wired with the normal vehicle wiring.

4. *Optional*: Additional flow rates and/or coolant temperatures may also be used to generate supplementary data. Procedure shall be repeated (see 5. Test Procedure) for each additional flow rate and/or coolant temperature.

Computations

1. **Chart and Computations** - Customary Units - Data shall be recorded on Chart 6.1, or equivalent. Temperature data shall be recorded at the actual temperatures occurring at the time of testing. Air temperature data shall then be adjusted to a 0°F base prior to the construction of graphs. This data reduction shall be directly proportional to the difference between the actual ambient temperature, at the time of test, and 0°F (i.e., actual ambient of 18°F shall result in a reduction of all air temperatures by 18°F and actual ambient temperature of -8°F shall result in an increase of all air temperatures by 8°F). Temperature data shall be presented in graph form as well as tabular form. One graph shall be constructed for the body interior air temperatures (4.1.1) wherein the recording intervals shall be the X-axis and the °F the Y-axis. A separate graph shall be constructed for the driver's temperatures (4.1.3) using the same units for the axes. Optional temperature data (4.1.4, 4.1.5, 4.1.6) may be similarly graphed separate from the interior data.

a. Optional Computations BTU/Hr. Coolant

Heat Transfer: Q_w = CpWw(Tin - $_{Tout)}$ x 60 where:

I W_w = Flow of Coolant (lb/min) — *measured to ± 2 percent*

II Tin = Temperature of Coolant into System (°F) — *measured quantity*

III Tout = Temperature of Coolant out of System (°F) — *measured quantity*

IV Q_w = Heat removed from Coolant (Btu/hr) — *calculated quantity*

V Cp = Specific Heat of Coolant = 0.8515 (BTU/lb/°F) — *given quantity*

2. **Chart and Computations** - Metric Units - Data shall be recorded on Chart 6.2, or equivalent. Temperature data shall be recorded at the actual temperatures occurring at the time of testing. Air temperature data shall then be adjusted to a - 18°C base prior to the construction of graphs. This data reduction shall be directly proportional to the difference between the actual ambient temperature, at the time of test, and -18°C (i.e., actual ambient of -7.8°C shall result in a reduction of all air temperatures by 10.2°C and actual ambient temperature of -22.2°C shall result in an increase of all air temperatures by 4.2°C). Temperature data shall be presented in graph form as well as tabular form. One graph shall be constructed for the body interior air temperatures (4.1.1) wherein the recording intervals shall be the X-axis and °C the Y-axis. A separate graph shall be constructed for the driver's temperatures (4.1.3) using the same units for the axes. Optional temperature data (4.1.4, 4.1.5, 4.1.6) may be similarly graphed separate from the interior data.

a. Optional Computations BTU/Hr – Coolant

Heat Transfer: Q_w = CpWw(Tin - $_{Tout)}$ x 60 where:

I W_w = Flow of Coolant (kg/min) — *measured to ± 2 percent*

II Tin = Temperature of Coolant into System (°C) — *measured quantity*

III Tout = Temperature of Coolant out of System (°C) — *measured quantity*

IV Q_w = Heat removed from Coolant (Joules/hr) — *calculated quantity*

V C_p = Specific Heat of Coolant = 3559 (joule/kg/ºC) — *given quantity*

Chart 6.1

Description of Unit: ____

Purpose of Test: ____

Date: **Location:** **Observers:**

Readings/Calculations Water	**0**	**5**	**10**	**15**	**20**	**25**	**30**	**35**	**40**	**45**	**50**	**55**	**60**
Flow - lb/min													
Flow Pressure - PSID													
T-in °F													
T-out °F													
Air Temperature													
T1 rear - °F													
T2 - °F													
T3 - °F													
T4 - °F													
T5 - °F													
T6 front - °F													
T7 ambient - °F													
T8 Driver Ankle - °F													
T9 Driver Knee - °F													
T10 Driver Breath - °F													
Electrical System													
Volts													

Chart 6.1 Optional Measurements

Date: **Location:** **Observers:**

Readings/Calculations	**0**	**5**	**10**	**15**	**20**	**25**	**30**	**35**	**40**	**45**	**50**	**55**	**60**
T11 Windshield CL Left °F													
T12 Windshield CL Right °F													
T13 Defrost Outlet Left °F													
T14 Defrost Outlet Right °F													
T15 Heater-Inlet °F													
T15 Heater-Outlet °F													
T16 Heater-Inlet °F													
T16 Heater-Outlet °F													
T17 Heater-Inlet °F													
T17 Heater-Outlet °F													
T18 Heater-Inlet °F													
T18 Heater-Outlet °F													
T19 - 1st Entrance Step													
T20 - 2nd Entrance Step													
Heat Transfer - BTU/Hr-coolant													

Chart 6.2

Description of Unit: ____

Purpose of Test: ____

Date: **Location:** **Observers:**

Readings/Calculations Water	**0**	**5**	**10**	**15**	**20**	**25**	**30**	**35**	**40**	**45**	**50**	**55**	**60**
Flow - kg/min													
Flow Pressure - PaD													
T-in °C													
T-out °C													
Air Temperature													
T1 rear - °C													
T2 - °C													
T3 - °C													
T4 - °C													
T5 - °C													
T6 front - °C													
T7 ambient - °C													
T8 Driver Ankle - °C													
T9 Driver Knee - °C													
T10 Driver Breath - °C													
Electrical System													
Volts													

COMPUTATIONAL CHART 6.2 (Celsius)

Chart 6.2 Optional Measurements

Date: **Location:** **Observers:**

Readings/Calculations	0	5	10	15	20	25	30	35	40	45	50	55	60
T11 Windshield CL Left °C													
T12 Windshield CL Right °C													
T13 Defrost Outlet Left °C													
T14 Defrost Outlet Right °C													
T15 Heater-Inlet °C													
T15 Heater-Outlet °C													
T16 Heater-Inlet °C													
T16 Heater-Outlet °C													
T17 Heater-Inlet °C													
T17 Heater-Outlet °C													
T18 Heater-Inlet °C													
T18 Heater-Outlet °C													
T19 - 1st Entrance Step													
T20 - 2nd Entrance Step													
Heat Transfer - J/Hr-coolant													

RETROREFLECTIVE SHEETING DAYTIME COLOR SPECIFICATION

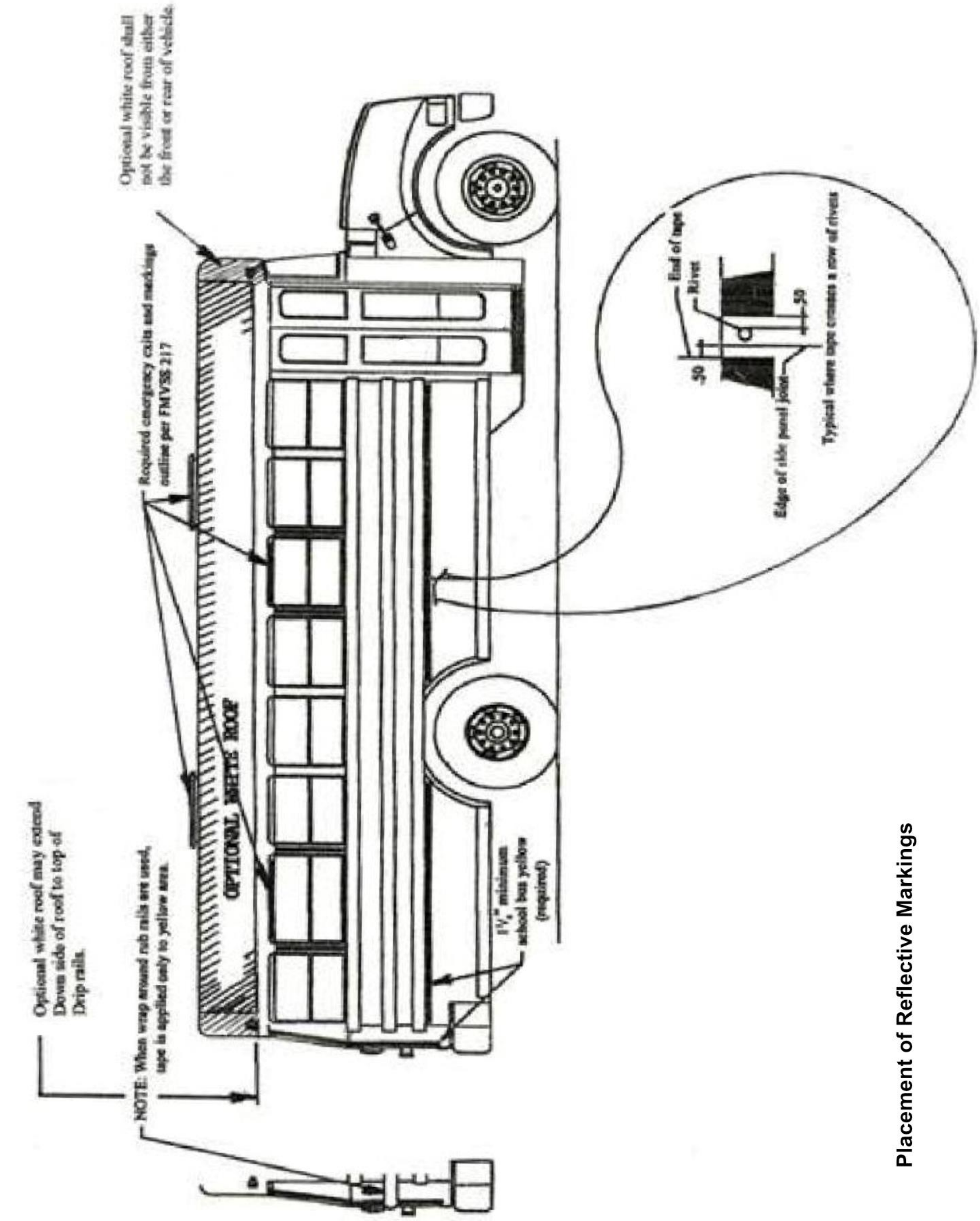
The daytime color of the RETROREFLECTIVE sheeting used to enhance school bus safety requires different color tolerances in order to assure optimum safety benefit, as well as to be consistent with the color of the school bus. The color of the RETROREFLECTIVE sheeting shall conform to the table below when samples applied to aluminum test panels are measured as specified in ASTM E1164. For colorimetric measurements, material is illuminated by Standard Illuminant D65 at an angle of 45 degrees with the normal to the surface the observations are made in the direction of the normal (45/0 degree geometry). The inverse (0/45 degree geometry) with the illuminant at the normal to the surface and the observations at 45 degrees with the normal to the surface may also be used. For materials which are directionally sensitive (e.g., prismatic sheeting), the colorimetric measurements are made using circumferential illumination and viewing and the various measurements are averaged. Calculations shall be done in accordance with ASTM E308 using the CIE 1931 (2 degree) Standard Observer.

Retroreflective Sheeting Daytime Color Chromaticity Coordinates
of Corner Points Determining the Permitted Color Area

	1	2	3	4
Yellow X	0.484	0.513	0.517	0.544
Y	0.455	0.426	0.482	0.455

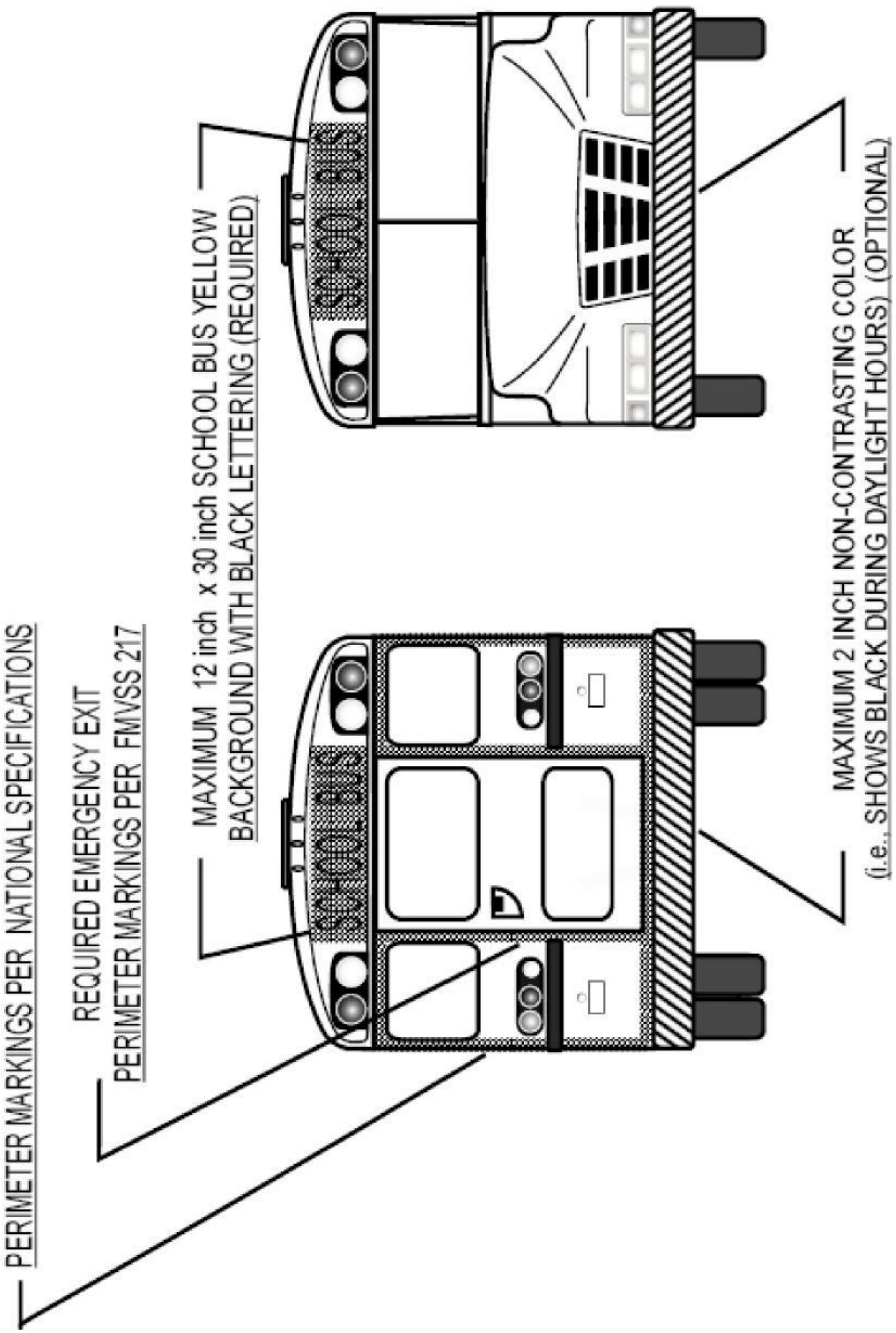
Luminance Factor (Y%)	Minimum	10.0
	Maximum	36.0

PLACEMENT OF REFLECTIVE MARKINGS AND WHITE ROOF



Placement of Reflective Markings

PLACEMENT OF RETROREFLECTIVE MARKINGS



NOISE TEST PROCEDURE

A. The vehicle is located so that no other vehicle or signboard, building, hill or other large reflecting surface is within 15.2 m (50 feet) of the occupant's seating position.

B. All vehicle doors, windows and ventilators are closed.

C. All power-operated accessories are turned off.

D. The driver is in the normal seated driving position and the person conducting the test is the only other person in the vehicle.

E. A sound level meter is used that is set at the "A-weighting fast" meter response and meets the requirements of:

1. The American National Standards Institute, Standard ANSI S1.4-1971: *Specifications for Sound Level Meters,* for Type 1 Meters; or

2. The International Electrotechnical Commission (IEC), Publication No. 179 (1973): *Precision Sound Level Meters*.

F. The microphone is located so that it points vertically upward six inches to the right and directly in line with, and on the same plane as, the occupant's ear, adjacent to the primary noise source.

G. If the motor vehicle's engine radiator fan drive is equipped with a clutch or similar device that automatically either reduces the rotational speed of the fan or completely disengages the fan from its power source in response to reduced engine cooling loads, the vehicle may be parked before testing with its engine running at high idle or any other speed the operator chooses for sufficient time, but not more than 10 minutes, to permit the engine radiator fan to automatically disengage.

H. With the vehicle's transmission in neutral gear, the engine is accelerated to:

1. Its maximum governed speed, if it is equipped with an engine governor; or

2. Its speed at its maximum rated horsepower, if it is not equipped with an engine governor, and the engine is stabilized at that speed.

I. The A-weighted sound level reading on the sound level meter for the stabilized engine speed condition referred to in H.1. or H.2., above, is observed and, if it has not been influenced by extraneous noise sources, is recorded.

J. The vehicle's engine speed is returned to idle and the procedures set out in paragraphs H. and I. are repeated until two maximum sound levels within two dBA of each other are recorded. The two maximum sound level readings are then averaged; and

K. The average obtained in accordance with paragraph J., with a value of two dBA subtracted there from to allow for variations in the test conditions and in the capabilities of meters, is the vehicle's interior sound level at the driver's seating position for the purposes of determining compliance with the requirements of this test procedure.

SCHOOL BUS SEAT UPHOLSTERY FIRE BLOCK TEST

A. **Test Chamber**

Cross Section

The suggested test chamber is the same cross section as the bus body in which seats are used with the rear section on each end. If a bus section is not used, the cross section is to be 91±1 inch in width x 75 inches ±3 inches in height. There shall be a door, which does not provide ventilation, in the center of each end of the test chamber. The doors shall be 38±3 inches in width and 53±3 inches in height and include a latch to keep the doors closed during the test. (See Figure 1.)

Length

The length of the test chamber shall allow three rows of seats at the minimum spacing recommended by the installer. (See Figure 1, Detail A.)

In order that different types of seats may be tested in the same chamber, a length tolerance of plus 45 inches is allowed.

Ventilation

One ventilation opening shall be in each end of the test chamber and shall be 325 square inches ±25 square inches. The bottom of the opening shall be 30 inches ±3 inches above the chamber floor. Ventilation openings shall be on the same side of the test chamber. (See Figure 1.)

There shall be no ventilation openings along the length of the test chamber. A forced-air ventilation system may not be used.

Baffles shall be used to prevent wind from blowing directly into the ventilation openings.

Camera View Area

An opening covered with glass shall be provided at the midpoint of the test chamber length for camera viewing. The opening shall allow the camera to view the seat parallel to the seat width. (See Figure 1.)

B. **Test Sample**

The sample shall be a fully-assembled seat.

Record the weight of all padding and upholstery prior to assembly. Record the weight of the fully-assembled seat.

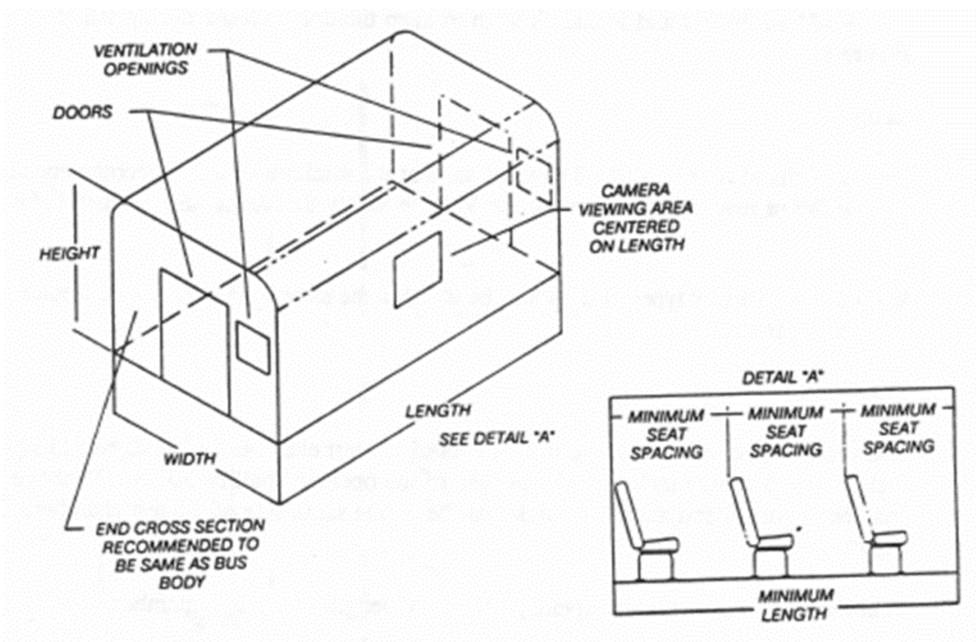
C. **Ignition Source**

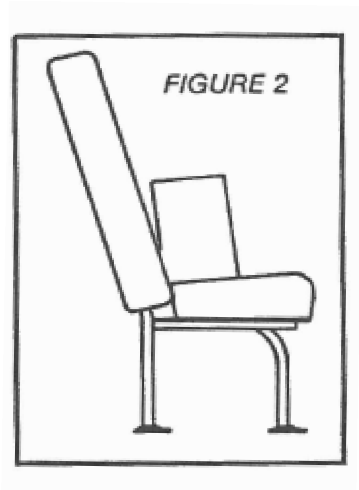
A paper grocery bag with dimensions of approximately 7x11x18 inches is used to contain double sheets of newsprint (black print only, approximately 22x28inches). The total combined weight of bag and newspaper shall be seven ounces ±0.5 ounces. After the newspaper is added to the paper bag, the two corners of the bag opening at each end of the 7” dimension may be stapled together using a single staple for newspaper retention if desired.

D. **Test Procedure**

1. Install three seats in the test chamber at minimum spacing, per installer recommendation. Seats shall be perpendicular to the dimension indicated as “length” in Figure 1. Install so that seat frames will not fall during the test. Seat width shall be determined so that maximum passenger capacity per row (two seats) for the seat style shall be tested.

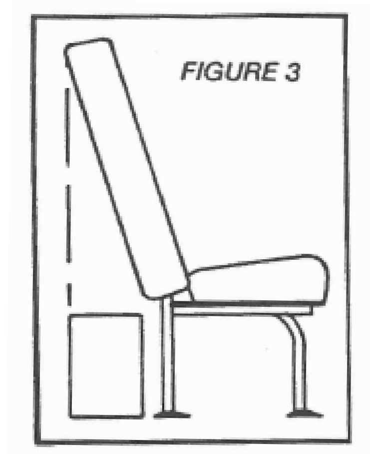
2. For each test, position the ignition source in the following positions outlined. Figure 1





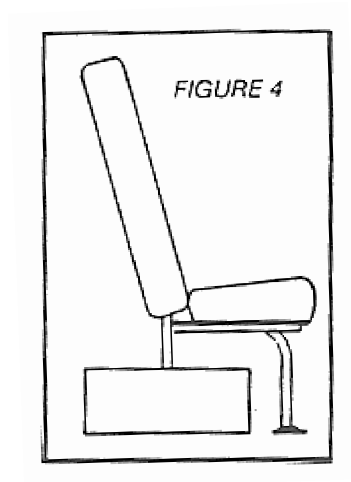
Position A

Position ignition source with 18-inch dimension in contact with the seat cushion and touching the seat back, the 11-inch dimension extending vertically from the surface of the cushion and the 7-inch dimension horizontal. Center the bag on top of the cushion. (See Figure 2.)



Position B.

Position the ignition source on the floor behind the seat with 18-inch side resting on the floor and parallel to seat width, centered on width so that the rear of bag does not extend beyond the rear seat back. (See Figure 3.)



Position C.

Position the ignition source on the floor on the aisle side of the seat with 18-inch dimension on the floor and perpendicular to the seat width touching the seat leg, with centerline of the bag at the center of the seat back. (See Figure 4.)

3. A wooden match shall be used to light the ignition source. Time the test, beginning when the ignition source is on fire and ending when all flames are out.

4. After each ignition source position test, weigh seat assembly, including loose material which has fallen off the seat onto the floor.

E. **Performance Criteria**

For each ignition source position test, the seat tested must meet all of the following criteria. A new seat specimen may be used for each ignition source position test.

1. Maximum time from ignition to flameout shall be 8 minutes.

2. Flame shall not spread to any other seat with the ignition source in Position A and Position C.

3. Weight loss may not exceed 10% of the pretest weight of padding and upholstery. Padding and upholstery may be combined in the form of integrally bonded seat foam