SURFACE VEHICLE STANDARD

J1503™	SEP2021

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Superseding J1503 SEP2004

Performance Test for Air-Conditioned, Heated, and Ventilated Off-Road, Self-Propelled Work Machines

RATIONALE

SAE J1503 has been reaffirmed to comply with the SAE Five-Year Review policy.

Foreword

This SAE Standard outlines a test procedure for off-road, self-propelled work machines providing a uniform measurement of the operator environmental temperature provided by a complete air-handling system operating in a specified ambient environment; and establishes minimum performance levels for the operator enclosure's heating, ventilating, and air-conditioning system

1. Scope

This SAE Standard applies to off-road, self-propelled work machines used in earth moving, agriculture, and forestry as defined in SAE J1116, and establishes the following minimum performance levels in the operator's environment for the seated position:

1.1 Minimum operator enclosure pressurization and ventilating levels in the operator's environment for the seated position.

1.2 Maximum operator environment temperature under air conditioning operation.

1.3 Minimum operator environment temperature under heating operation.

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.

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For more information on this standard, visit
https://www.sae.org/standards/content/J1503_202109

2.1.1 SAE PUBLICATIONS

Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

SAE J1012—Operator Station Pressurization System Test Procedure
SAE J1091—Earthmoving Machinery—Operators Field of View
SAE J1116—Categories of Off-Road Self-Propelled Work Machines
SAE J1163—Determining Seat Index Point
SAE J1349—Engine Power Test Code
SAE J1533—Operator Enclosure Air Filter Element Test Procedure
SAE J1559—Measurement of Solar Heating Effect

2.1.2 ISO PUBLICATIONS

Available from ANSI, 25 West 43rd Street, New York, NY 10036-8002.

ISO 5006-1—Earth-moving machinery—Operator's field of view
ISO 5353—Earth-moving machinery, and tractors and machinery for agriculture and forestry—Seat index point
ISO 5721—Tractors for agriculture—Operator's field of vision
ISO 9249—Earth-moving machinery—Engine test code—Net power

2.2 Related Publications

The following publications are provided for information purposes only and are not a required part of this document.

2.2.1 ASHRAE PUBLICATIONS

Available from 17191 Tullie Circle NE, Atlanta, GA 30329-2305.

ASHRAE Temperature Measurement 4166
ASHRAE Handbook of Fundamentals, 1981

2.2.2 ASME PUBLICATIONS

Available from ASME, 345 East 47th Street, New York, NY 10017-2330.

ASME Power Test Code, Pressure Measurement, PTC 19.21972
ASME Power Test Code, Electrical Measurement, PTC 19.61955

2.2.3 ISO PUBLICATIONS

Available from ISO, 25 West 43rd Street, New York, NY 10036-8002.

ISO 10263-4—Earth moving machinery—Operator enclosure environment—Part 4: Operator enclosure ventilating, heating and/or air-conditioning test method
ISO 14269-2—Tractors and self propelled machines for agriculture and forestry—Operator enclosure environment.

3. Definitions

3.1 Air-Handling System

Any system that moves air within the operator enclosure. The air source and system components may be within and/or outside the operator enclosure and may contain the air in some manner as part of their function.

3.2 Operator Environment

The space surrounding the operator as defined by the temperature measurement locations described in Figure 1.

3.3 Air-Conditioning System

Any system which lowers the effective temperature of the air within the operator environment.

3.4 Heating System

Any system which raises the effective temperature of the air within the operator's environment.

3.5 Ventilating System

Any system which provides outside air to, and maintains air circulation within, the operator's environment.

3.6 Operator Enclosure

The part of the machine which forms a boundary between the space surrounding the operator and the outside environment. This boundary shall comprise of components such as the glass, roof, and floor which completely surround the operator. This boundary effectively eliminates free passage of air, dust, or other substances into the area around the operator.

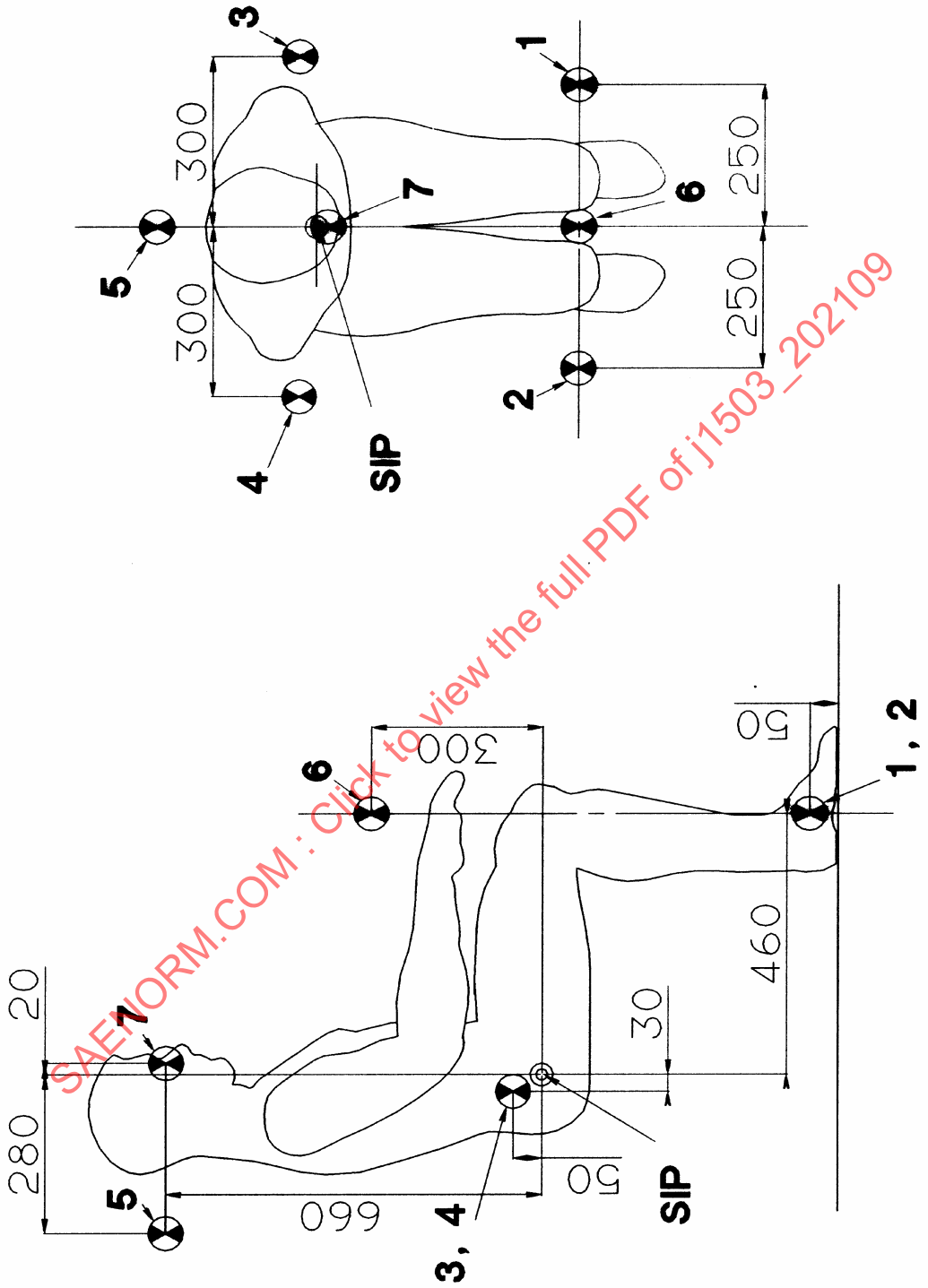

FIGURE 1—TEMPERATURE AND VELOCITY LOCATIONS (DIMENSIONS IN mm)

4. Test Equipment and Instrumentation

4.1 A test enclosure sufficiently large to contain the base machine with provisions to circulate conditioned air and to load the machine's engine and transmission if required.

4.1.1 Field test conditions may be used.

4.1.2 If it is not practical to test the base machine due to physical size limitations, the operator enclosure may be bench tested with the loads imposed by the base machine on the enclosure simulated. When bench testing is conducted in conjunction with solar loading, shading of the cab similar to that which is encountered on the vehicle in field conditions is permitted. If this procedure is used, correlation with field data shall be established.

4.2 Devices to Measure Dry Bulb Temperature

Measuring accuracy within ±0.5 °C of observed values.

4.3 Devices to Obtain Wet Bulb Temperature

Measuring accuracy within ±0.5 °C of observed values.

4.4 Devices to Measure Operator Enclosure Pressurization

Measuring accuracy within 5% of observed values.

4.5 Devices to Measure RPM

Measuring accuracy within 2% of observed values.

4.6 Devices to Measure Air Velocity

Measuring accuracy within 0.5 m/s.

4.7 Stopwatch of Other Timing Device

5. Measurement Locations

See Figure 1. The locations of the temperature and velocity measurement points are based on the seat index point, described in SAE J1163.

5.1 The ambient air temperature shall be measured at a location where the ambient air is not affected by the machine and at a height equivalent to the air intake height on the operator enclosure.

5.2 The operator enclosure pressurization shall be measured according to SAE J1012.

5.3 Dry bulb temperatures shall be measured as close as practical to positions 1 through 6 in Figure 1.

NOTE—If an alternative operator station position is available (for example, a reversible operator station), the alternate positions should also be tested with a comparable array of temperature measurement positions.

5.4 It is recommended that the air velocity be measured at the eye point (per SAE J1091) as shown in position 7 in Figure 1.

NOTE—If an alternative operator station position is available (for example, a reversible operator station), the alternate positions should also be tested with a comparable eye point position.

6. Performance Levels Common to Air-Conditioning, Heating, and/or Ventilating Systems

6.1 The operator enclosure should be capable of maintaining a minimum pressurization of 50 Pa throughout the test, as outlined in SAE J1012. Maximum pressurization should not exceed 200 Pa.

6.2 Under all conditions of air conditioning, heating, or ventilating, a minimum of 43 m^3/h of filtered outside air should be provided.

6.3 At the conclusion of the heating, ventilating or air-conditioning tests, the temperatures measured (locations 1-6, see Figure 1) in the operator's environment shall not vary more than 5 °C.

6.4 Filtered outside air should be passed through a filter that is a minimum of 96% efficient using fine test dust and test method specified in SAE J1533.

6.5 It is recommended that a means be provided to limit the maximum air velocity at position 7 in Figure 1 to 0.3 m/s. Adjustable diffusers may be used to redirect air.

6.6 Test conditions shall be maintained throughout the duration of the test.

6.7 Maximum air velocity passing the machine from front to rear: 5 m/s.

7. Common Test Procedures

7.1 The test conditions specified in 8.1, 9.1, and 10.1 shall be maintained throughout the duration of the respective test.

7.2 Record enclosure pressures, in pascals.

7.2.1 The pressure measuring device shall be positioned to avoid velocity head by keeping its reference and measuring points away from air streams.

7.3 Record the temperatures as described in 5.3 at intervals not greater than 5 min.

7.4 The operator enclosure dry bulb temperatures from locations 1-6 shall be averaged for each reading interval.

7.5 The test shall be considered terminated when either of the following conditions are fulfilled.

7.5.1 The minimum temperature recorded in 7.3 does not vary more than 0.5 °C in 15 min.

7.5.2 The test has run for 1 h.

7.6 An operator may be in the enclosure throughout the duration of the test.

8. Air-Conditioning Performance Test

8.1 Test Conditions

8.1.1 The air-conditioning system shall be tested in the intended production configuration, adjusted within the manufacturer's specifications.

8.1.2 The ambient conditions for moderate temperature and high humidity shall be:

8.1.2.1 Minimum dry bulb temperature, 38 °C.

8.1.2.2 Minimum moisture content of 0.018 kg H_2O per kg of dry air.

8.1.3 MACHINE LOAD AND SPEED

When the environment within the operator enclosure is influenced by engine or component temperatures (such as transmission), the machine shall be operated at rated engine speed in a mode which will provide at least 50% of the maximum rated net engine power determined in accordance with SAE J1349 or these conditions shall be simulated as referenced in 4.1.2. Loading of engine through the transmission is recommended.

8.1.4 Prior to conducting tests on the air-conditioning system, the machine shall be operated as specified in 8.1.3 for at least 1 h with the air-conditioning system not in use, to provide a stabilizing heat soak period. Stabilization is defined by a temperature change of less than 0.5 °C for 10 minutes in the engine and transmission oil sumps. During this period, ambient temperature shall be as specified in 8.1.2.

8.1.5 The air-conditioning system controls shall be set according to the manufacturer's specifications or to provide maximum cooling performance. The requirements specified in Section 6 shall be maintained throughout the test.

8.1.6 It is recommended that solar loading be applied in accordance with SAE J1559. The loading shall be applied in one of the following time periods:

a. If the machine or operator enclosure is heat soaked using the engine as defined in 8.1.4, the solar loading is to start at the beginning of the air conditioning tests. (Solar loading before the air-conditioning tests is allowable.)
b. If the machine or operator enclosure is not heat soaked as defined in 8.1.4, the solar loading is to begin a minimum of 1 h prior to conducting the air conditioning tests. Doors and windows shall be closed. During this period, ambient temperature shall be as specified in 8.1.2.

8.2 Minimum Air-Conditioning Performance

The air-conditioning system shall be capable of reducing the operator environment temperature to 25 °C dry bulb or lower.

9. Heater Performance Test

9.1 Test Conditions

9.1.1 The heating system shall be tested in the intended production configuration, adjusted within the manufacturer's specifications.

9.1.2 The maximum ambient temperature for the heating system test shall be –15 °C.

9.1.3 Before carrying out the tests, the machine shall be cold soaked for a minimum of 10 h at the temperature specified in 9.1.2. No external oil or coolant heating source shall be used during the cold soak.

9.1.4 The machine shall be operated in accordance with manufacturer's recommended warm-up procedure, then rated speed under a maximum load of no more than 20% of the maximum rated net engine power, net engine power shall be determined in accordance with SAE J1349 or these conditions shall be simulated as referenced in 4.1.2.

9.1.5 The heating system controls shall be set in accordance with the manufacturer's instructions or be adjusted to provide maximum operator enclosure pressurization.

9.2 Minimum Heater Performance

The heating system shall be capable of increasing the operator environment temperature to 25 °C dry bulb or greater.

10. Ventilating Test

10.1 Test Conditions

10.1.1 The ventilating system shall be tested in the intended production configuration, adjusted within the manufacturer's specifications.

10.1.2 The ambient conditions for the ventilating test shall be a minimum outside dry bulb temperature of 27 °C.

10.1.3 The machine shall be operated in accordance with the manufacturer’s recommended warm-up procedure, and then runat the rated speed under a maximum load of no more than 20% of the maximum rated net engine power, as determined in accordance with SAE J1349 or these conditions shall be simulated as referenced in 4.1.2.

10.1.4 The ventilating system controls shall be adjusted to the maximum position with maximum operator enclosure pressurization.

10.2 Minimum Ventilating Performance

The minimum ventilating performance requirements shall be as indicated in Section 6.1.

11. Test Report

The test report shall include the following information:

a. model and serial number of machine tested;
b. ambient conditions outside the operator enclosure (i.e., dry bulb temperature, moisture content (kg H_2O per kg dry air), and air velocity);
c. operator enclosure pressurization (Pa);
d. average dry bulb temperature in the operator enclosure at the end of the test (°C);
e. operator environment temperature uniformity;
f. volume of outside filtered air provided;
g. solar radiant energy levels as measured in accordance with SAE J1559.

In addition, the optional test conditions shall be recorded when they are used.

An example of a suitable test report form is given in Appendix A.

12. Notes

12.1 Marginal Indicia

The change bar (I) located in the left margin is for the convenience of the user in locating areas where technical revision shave been made to the previous issue of the report. An (R) symbol to the left of the document title indicates a complete revision of the report.

PREPARED BY THE SAE HUMAN FACTORS TECHNICAL COMMITTEE SC6—OPERATOR ACCOMMODATION OF THE SAE HUMAN FACTORS TECHNICAL COMMITTEE

APPENDIX A
EXAMPLE OF TEST REPORT FORM FOR OPERATOR ENCLOSURE HEATING, VENTILATING AND AIR-CONDITIONING SYSTEMS

Test machine

Type: ……Model: ……Serial No.:……

Air-conditioning system test (SAE 1503, part 8)

Ambient temperatures

dry bulb: ..... °C

moisture content: ..... kg H_2O per kg dry air

Air velocity passing machine (6.7): ..... m/s

Operator environment temperature at end of test

dry bulb (average): ..... °C

Operator environment temperature uniformity (6.3): ..... Δ°C

Minimum performance achieved (8.2): ..... yes/no

Enclosure pressure: ..... Pa

Setting of adjustable controls: .....

Solar heating: natural ☐ simulated ☐ none ☐

Solar radiant energy: ..... W/m^2

Method of engine loading (if applicable): .....

Duration of test: ..... min

Heating system test (SAE 1503, part 9)

Ambient dry bulb temperature: ..... °C

Air velocity passing machine (6.7): ..... m/s

Operator environment temperature at end of test

dry bulb (average): ..... °C

Operator environment temperature uniformity (6.3): ..... Δ°C

Minimum performance achieved (9.2): ..... yes/no

Enclosure pressure: ..... Pa

Setting of adjustable controls: .....

Method of engine loading (if applicable): .....

Duration of test: ..... min