

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

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 heater, ventilation, and air-conditioning system

1. **Scope**—This SAE Standard applies to off-road, self-propelled work machines used in construction, general-purpose industrial, agricultural, forestry, and specialized mining machinery as defined in SAE J1116 JUN86, and establishes the following minimum performance levels in the operator's environment for the seated position:

- 1.1 Minimum operator enclosure pressurization and ventilation levels in the operator's environment for the seated position.
- 1.2 Maximum temperature differential under air conditioning operation.
- 1.3 Minimum temperature differential under heater 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.

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

- SAE J1012 JUN93—Agricultural Equipment Enclosure Pressurization System Test Procedure
- SAE J1091—Operator's Field of Vision—Test Method
- SAE J1116 JUN86—Categories of Off-Road Self-Propelled Work Machines
- SAE J1163 JUN91—Determining Seat Index Point
- SAE J1349 JUN90—Engine Power Test Code
- SAE J1533 JUN93—Operator Enclosure Air Filter Element Test Procedure
- SAE J1559 JUL95—Measurement of Solar Heating Effect

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2.1.2 ISO PUBLICATIONS—Available from ANSI, 11 West 42nd Street, New York, NY 10036-8002.

ISO 5006-1:1991—Earth-moving machinery—Operator's field of view

ISO 5353:1978—Earth-moving machinery, tractors and machinery for agriculture and forestry—Seat Index Point

ISO 5721:1989—Tractors for agriculture—Operator's Field of Vision

ISO 9249:1989—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, 11 West 42nd Street, New York, NY 10036-8002.

ISO 10263-4:1994—Earth Moving Machinery—Operator enclosure environment—Part 4: Operator enclosure ventilation, 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 which lowers or raises the effective temperature of the air within the operator enclosure by the use of air-conditioning, heating, or ventilating systems.

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's environment by means of a refrigerant.

3.4 Heating System—Any system which raises the effective temperature of the air within the operator's environment.

3.5 Ventilation System—Any system which provides fresh 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.

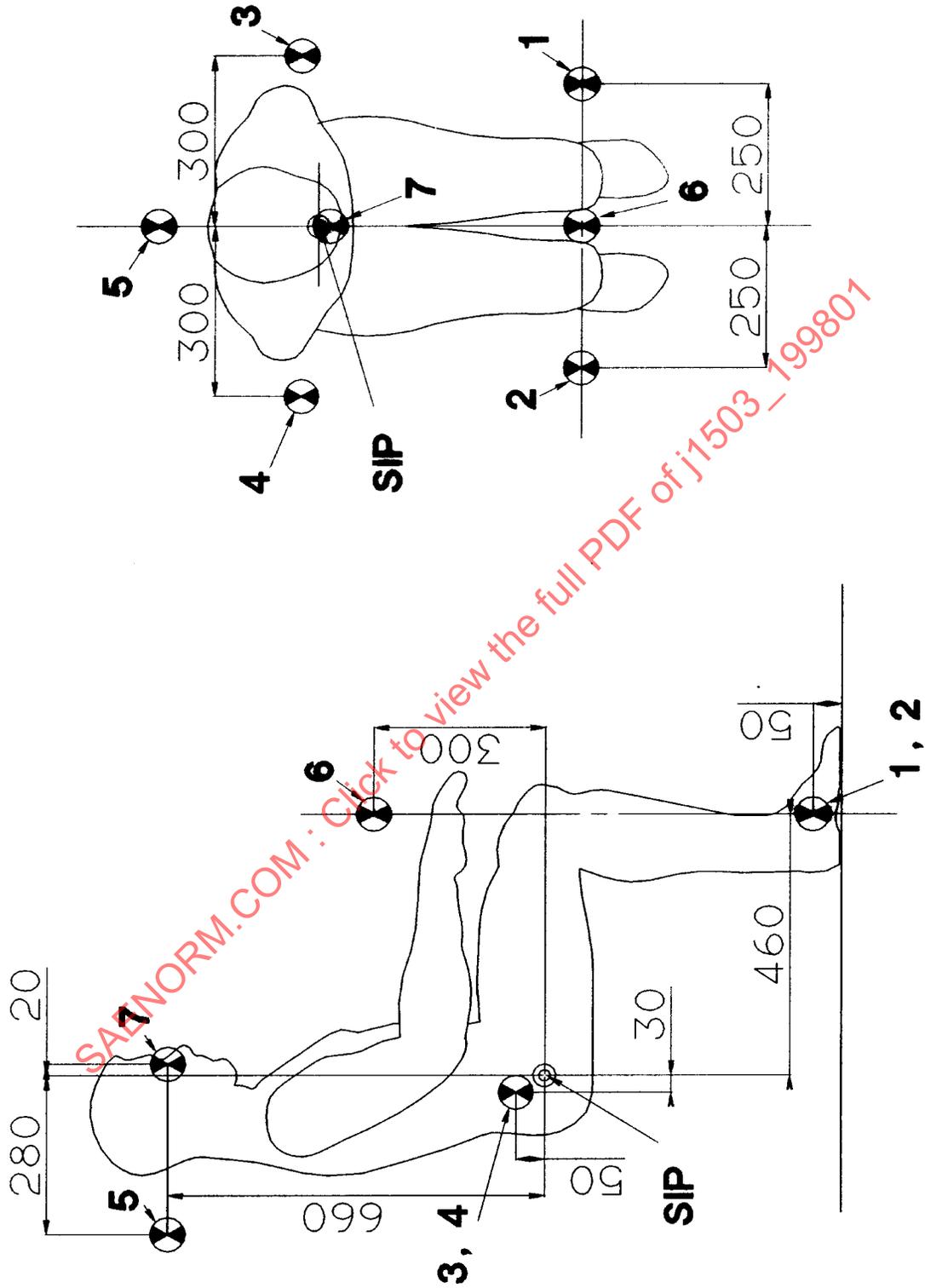


FIGURE 1—TEMPERATURE AND VELOCITY LOCATIONS

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 necessary.

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's 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 a ± 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 10% 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 10% of observed values.

5. Measurement Locations

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 to 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.

6. Minimum 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 ventilation, a minimum of 43 m³/h of filtered fresh air should be provided.

6.3 At the conclusion of the test, the temperatures measured in the operator's environment should be uniform within 5 °C.

6.4 Filtered fresh air should be passed through a filter that is a minimum of 96% efficient using fine test dust and test procedure as defined in SAE J1533.

6.5 It is recommended that a means be provided to limit the maximum velocity in front of the operator's eyes to 0.3 m/s. Adjustable diffusers may be used to redirect air.

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

7.3 The operator enclosure dry bulb temperatures from all six locations shall be averaged to obtain operator enclosure dry bulb temperature for each reading interval.

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

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

7.4.2 One hour of test operation.

7.5 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 H₂O per kg of dry air at or above 38 °C.

8.1.2.3 Maximum air velocity passing the machine from front to rear, 5 m/s.

8.1.3 **MACHINE LOAD AND SPEED**—When the engine or component temperatures (such as transmission) influence the environment within the operator enclosure, 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. Net engine power shall be determined in accordance with SAE J1349. 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 1 h with the air-conditioning system not in use, to provide a preliminary, stabilizing heat soak period. Doors and windows shall be closed. 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 to provide maximum cooling performance. Requirements of 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 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 ambient conditions for heating tests shall be:

9.1.2.1 Maximum dry bulb temperature, -15 °C.

9.1.2.2 Maximum air velocity passing the machine front to rear, 5 m/s.

9.1.3 Test machine shall be cold soaked at the conditions outlined in 9.1.2 for a minimum of 10 h prior to start of the test.

9.1.4 **MACHINE LOAD AND SPEED**—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.

9.1.5 The heater system controls shall be set according to the manufacturer's specifications for maximum heating capacity. Requirements of Section 6 shall be maintained throughout the test.

9.1.6 If the machine is field tested, no solar heating is allowed on the operator enclosure.

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. Ventilation Test

10.1 Test Conditions

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

10.1.2 The ambient conditions for the ventilation test shall be:

10.1.2.1 Minimum dry bulb temperature, 27 °C.

10.1.2.2 Maximum air velocity passing the machine from front to rear, 5 m/s.

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10.1.3 **MACHINE LOAD AND SPEED**—When the engine or component temperatures (such as transmission) influence the environment within the operator enclosure, 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. Net engine power shall be determined in accordance with SAE J1349. Loading of engine through the transmission is recommended.

10.1.4 The ventilation system controls shall be set according to the manufacturer's specifications for maximum ventilation.

10.2 Minimum ventilation performance requirements are outlined in Section 6.

11. Notes

11.1 Marginal Indicia—The change bar (I) located in the left margin is for the convenience of the user in locating areas where technical revision have 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.

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