



SURFACE VEHICLE RECOMMENDED PRACTICE

J3078™/3

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(R) Off-Road Self-Propelled Work Machines Operator Enclosure
Environment Part 3: Operator Enclosure Pressurization System and Ventilation
System Test Procedures

RATIONALE

Methods for measuring ventilation system total airflow and outside airflow have been added to this document. SAE J3078/4 specifies a minimum outside airflow requirement, and this document provides a procedure to obtain an outside airflow value.

1. SCOPE

SAE J3078/3 establishes a uniform test procedure for evaluating performance of operator enclosure pressurization and ventilation systems. This standard is applicable to off-road, self-propelled work machines, as defined in SAE J1116, and includes tractors and machinery for agriculture and forestry as defined in ASABE standard ANSI/ASAE S390.

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 J1116 Categories of Off-Road Self-Propelled Work Machines

SAE J3078/1 Off-Road Self-Propelled Work Machines Operator Enclosure Environment, Part 1: Terms and Definitions

2.1.2 ASABE Publications

Available from ASABE, 2950 Niles Road, St. Joseph, MI 49085, Tel: 269-429-0300, www.asabe.org.

ANSI/ASAE S390 Tractors and Machinery for Agriculture and Forestry - Basic Types – Vocabulary

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https://www.sae.org/standards/content/J3078/3_202410/

2.1.3 EN Publications

Available from European Standards online at <https://www.en-standard.eu/>.

EN15695 Agricultural tractors and self-propelled sprayers

2.2 Related Publications

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

2.2.1 ISO Publications

Copies of these documents are available online at <https://webstore.ansi.org/>.

ISO 10263-3 Earth-Moving Machinery - Operator Enclosure Environment - Part 3: Pressurization Test Method

ISO 14269-5 Agricultural Tractors and Self-Propelled Machines - Test Method for Enclosure Pressurization Systems

3. DEFINITIONS

3.1 BLEND DOOR

A method of controlling the airflow path through the heat exchangers in an HVAC module, where the airflow can either be diverted completely around one coil or partially as selected by the temperature control.

3.2 HVAC BLOWER

Blower in the HVAC system that provides airflow for the evaporator and heater. This may provide the only means to pressurize the operator enclosure. The blower will always provide the majority of air to the evaporator and heater, even if used in conjunction with a dedicated pressurizer.

3.3 MODE CONTROL

A part of the ventilation system that controls ventilation to areas selected by the operator (for example, defrost mode, panel mode, or floor mode). These modes can also be a combination of two modes. The mode control may be integrated within the HVAC module or be a part of the ventilation ducts.

3.4 OUTSIDE AIR

Air taken from outside the operator enclosure and frequently abbreviated OSA (outside air or outside airflow). Outside air has also been referred to as fresh air.

3.5 OUTSIDE AIRFLOW CONTROL

A part of the ventilation system that controls the amount of outside airflow into the operator enclosure. It can be used to reduce the outside airflow to the pressurization system, thereby reducing the heat load on the evaporator.

3.6 PRESSURIZATION

The pressure differential between the static positive pressure inside the operator enclosure and the atmospheric pressure outside of the operator enclosure.

3.7 PRESSURIZATION SYSTEM

Means used to pressurize the operator enclosure, including any components that will influence the performance of the system. Blowers, filters, ductwork, heat exchangers, etc., will be included if the pressurizer is used to provide airflow to these components.

3.8 PRESSURIZER

Blower or fan that is dedicated to providing outside airflow to the operator enclosure and thereby pressurizing the operator enclosure. In some instances, the pressurizer will have an integrated feature that is capable of removing particles of debris from the outside air (pre-cleaner). In either instance, the pressurizer is used in conjunction with the HVAC blower. The pressurizer can be installed such that it operates regardless of whether or not the HVAC blower is operating.

3.9 PRESSURIZER - STAND-ALONE

Blower or fan that is dedicated to providing outside airflow to the operator enclosure and thereby pressurizing the operator enclosure. This application is not used in conjunction with the HVAC blower.

4. TEST EQUIPMENT

- 4.1 A manometer or device to measure the differential static pressure between the air inside and outside the operator enclosure. Its maximum error shall not exceed 5% of observed value.
- 4.2 A voltmeter to monitor voltage in the pressurizer HVAC electrical system during the test. Its maximum error shall not exceed 2% of the observed value.
- 4.3 A thermometer or other temperature measuring device. Its maximum error shall not exceed ± 0.5 °C.
- 4.4 Device to measure barometric pressure. Its maximum error shall not exceed 2% of the observed value.
- 4.5 Anemometer to measure wind speed, louver air velocity, and air velocity from the auxiliary blower. Its maximum error shall not exceed 0.5 m/s.

NOTE 1: Anemometers with a larger-diameter vane - over 50 mm (2 inches) - will typically provide greater accuracy when measuring air velocity. When using with an adapter for measuring airflow, follow the manufacturer's recommendations with regard to minimum straight length for the design of the adapter.

NOTE 2: Hot wire anemometers are permissible to use. Care needs to be taken when using to ensure accurate results. Refer to EN15695 for proper usage.

- 4.6 Auxiliary blower with DC motor to provide airflow to operator enclosure for pressurization. Ducting to adapt auxiliary blower outlet to connect with operator enclosure and provide a location to install the anemometer in-line.
- 4.7 Portable AC to DC power supply for the auxiliary blower. Power supply shall have the capability to vary the supply voltage to the auxiliary blower.
- 4.8 Airflow meter to measure volumetric flow rate from the louvers, outside airflow, and the auxiliary blower. Its maximum error shall not exceed 2% of the observed value.
- 4.9 Device to measure humidity or moisture content in the air. Its maximum error shall not exceed 5% of the observed value.



Figure 1 - Vane anemometer with airflow adapters



Figure 2 - Airflow meter with adapter

5. TEST CONDITIONS FOR CAB PRESSURIZATION AND AIRFLOW

- 5.1 The pressurization system shall be completely powered by the standard equipment on the test machine, with the engine operating at rated speed (if so powered). The voltage at the blower and pressurizer (if so equipped) terminals shall be no more than 15% above the nominal rating of the system. (For example, 13.8 V for a 12-V system or 27.6 V for a 24-V system.) Although not required, it is good practice to measure the operator enclosure pressure with the machine at low idle as well. The data gathered at both points can point to machine voltage issues and operator enclosure pressurization being affected by the fan for the engine cooling package. For those instances where only the operator enclosure is being tested (not assembled to the machine), the power being supplied to the operator enclosure shall be no more than 15% above the nominal rating of the system or, if known, set to the expected machine system voltage. Later verification of the data on a complete machine is required.
- 5.2 All machine accessories pertinent to operation of the operator enclosure, enclosure components, outside air and recirculation air filters, and blowers shall be standard production parts or equivalent, adjusted within the manufacturer's specification limits. The cab sealing/leakage shall be representative of production intent. Clean outside air and recirculation air filters are recommended since the amount of dirt on the filter can affect pressurization.
- 5.3 It is recommended that the test be conducted in a controlled inside environment to minimize the influence of wind on the operator enclosure pressurization.
- 5.4 If the machine is tested in an outside environment, the machine shall be orientated such that the normal operating direction of the machine is facing into the wind, and the wind direction is not more than 30 degrees off the machine centerline. If field data is being taken in a high wind application, the machine shall be tested at 8 points relative to the direction of the wind to determine the worst-case scenario for the test.
- 5.5 Operator(s) are permitted to be inside the operator enclosure during the test.
- 5.6 Maximum wind speed passing the machine: 5 m/s.
- 5.7 For those machines equipped with mode control, blend door, and/or outside airflow control, cab pressurization will be taken for each mode with the outside air set to minimum and then repeated for each mode with the outside air set to maximum in both full cold and full hot blend door positions. For test repeatability, disable both the cooling and heating during this portion of the testing.
- 5.8 Preferred ambient conditions: 23 °C $\pm$ 5 °C and <80% relative humidity. For field testing, if the ambient conditions exceed the preferred, it shall be noted in the test report.
- 5.9 For all testing, the doors and windows to the operator enclosure shall remain closed.
- 5.10 For all testing, the pressure measuring device shall be positioned to avoid pressure variance by keeping both the reference and the measuring points away from airstreams.

6. TEST PROCEDURES

6.1 Cab Pressurization

- 6.1.1 The operator enclosure shall be equipped with all applicable equipment that affects cab pressurization (see 3.7). The pressurizer system shall be in operation for a minimum of 15 minutes prior to obtaining data. This is done to ensure the HVAC blower is getting a stable voltage on a running machine as the batteries could potentially be down on voltage when the machine is first started. Any automatic pressurization controls shall not be locked out.
- 6.1.2 The pressurization system shall be tested at minimum and maximum outside airflow conditions.
- 6.1.3 The blower voltage, ambient temperature, barometric pressure, wind velocity, and wind direction in relation to the machine centerline shall be recorded for reference only.
- 6.1.4 Record operator enclosure pressurization.

6.2 Airflow

- 6.2.1 There are three methods that may be used to measure the outside airflow. Each method provides accurate results. The different methods are being described to offer a valid test method based on the available equipment. Two of these methods may be used to measure the airflow coming out of the louvers/vents within the cab.

NOTE: Having total airflow along with outside airflow will provide your ratio of recirculation airflow to outside airflow.

- 6.2.2 The blower voltage, ambient temperature, barometric pressure, wind velocity, and wind direction in relation to the machine centerline shall be recorded for reference only.

- 6.2.3 To obtain an airflow value when using a vane anemometer, it is a simple conversion of the open area of the vane multiplied by the velocity measured. For a hot wire anemometer, refer to EN15695.

NOTE: When using an airflow meter or vane anemometer, all of the airflow needs to pass through the measurement device for accurate airflow measurements.

6.3 Method 1

- 6.3.1 For this method, the machine shall be running at low idle. When the cab is not mounted on the machine, power up the operator enclosure with the portable power supply. Set the voltage to the known voltage value of a machine running at low idle. If the value is not known at the time of the test, use the values stated in 5.1.

- 6.3.2 Use an airflow meter (properly sized for the anticipated airflow) and adapter attached to the outside air inlet on the operator enclosure. The devices shall be configured per Figure 3. Measure and record the airflow values for all blower speeds.

- 6.3.3 This method can also be used to measure the airflow coming out of each individual louver/vent. Adding the values for all the louvers/vents will provide the total airflow of the system.

6.4 Method 2

- 6.4.1 For this method, the machine shall be running at low idle. For a cab-only test, power up the operator enclosure with the portable power supply. Set the voltage to the known value of a machine running at low idle. If the value is not known at the time of the test, use the values stated in 5.1.

- 6.4.2 Use an anemometer, adapter(s), portable power supply, auxiliary blower, and manometer attached to the outside air inlet on the operator enclosure. The devices shall be configured per Figure 4. Using the portable power supply, adjust the voltage to the auxiliary blower so that the manometer reads 0 Pa. Measure the velocity and convert to airflow for all blower speeds.

NOTE: Voltage will need to be adjusted for the auxiliary blower such that the manometer reads 0 Pa on each blower speed.

- 6.4.3 This method can also be used to measure the airflow coming out of each individual louver/vent. To do this, however, the devices will need to be plumbed differently (see Figure 5).

6.5 Method 3

- 6.5.1 For this method, the machine shall not be running. We will use the cab pressurization measurements from 6.1. It is known that a specific amount of outside airflow will equal a specific cab pressurization. For this method, the operator enclosure is required to pressurize. If there is no pressurization, you will need to use another method to measure outside airflow.

- 6.5.2 Use an anemometer, adapter(s), portable power supply, auxiliary blower, and manometer attached to the outside air inlet (remove the outside air filter). The devices shall be plumbed per Figure 4. Using the portable power supply, adjust the voltage to the auxiliary blower so that it equals one of the cab pressurization measurement points, and record the air velocity. Repeat this for all cab pressurization measurements. Convert the velocity to airflow and record.

- 6.5.3 Optional: Airflow measurements can be taken at additional cab pressurization points to develop a curve. A minimum of 4 points is needed to develop a curve. This curve is often referred to as a cab sealing curve or cab pressurization curve. The information is useful because it indicates how well the operator enclosure seals, and the curve can be used to calculate outside airflow for other situations. For example, if the system air filters are dirty or if there is an outside air door that is used to reduce the amount of outside airflow to improve the HVAC system performance. See Figure 7, which has multiple curves as the cab sealing was improved during the testing.
- 6.5.4 This test method **cannot** be used to measure the airflow coming out of each individual louver/vent.

Method 1

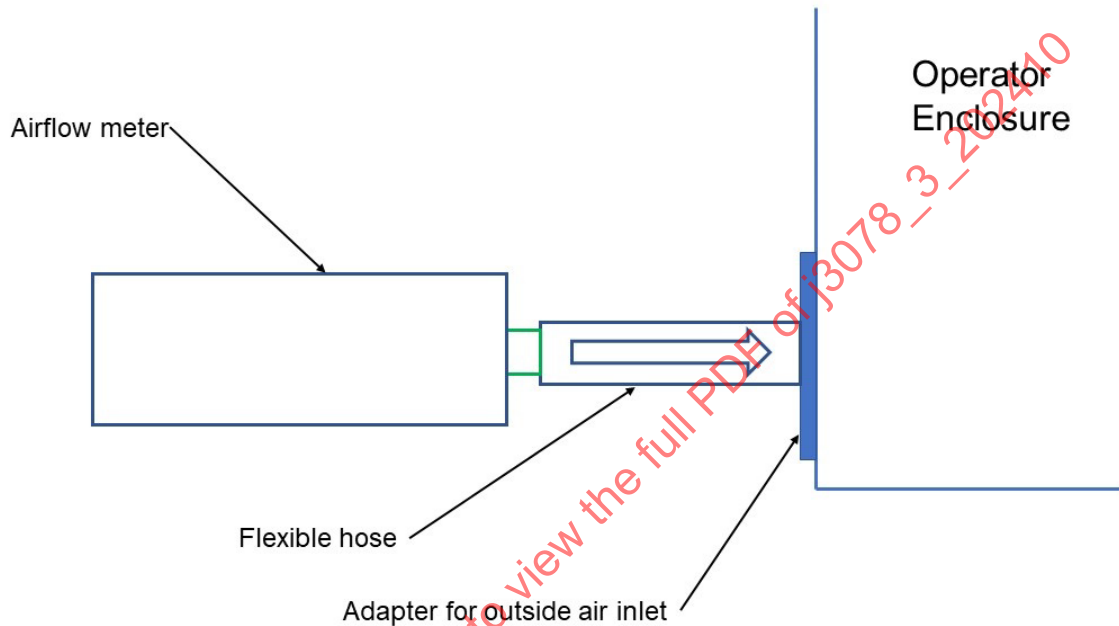


Figure 3 - Method 1 airflow measurement

Method 2 – outside airflow measurement

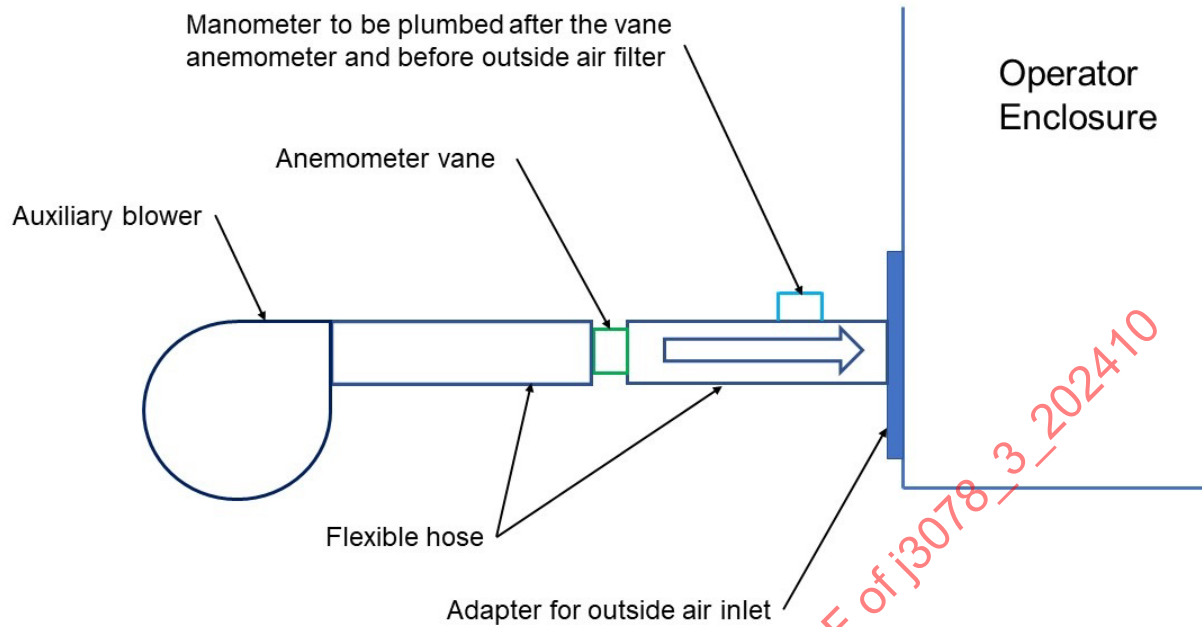


Figure 4 - Method 2 airflow measurement (outside airflow)

Method 2 – louver/vent airflow measurement

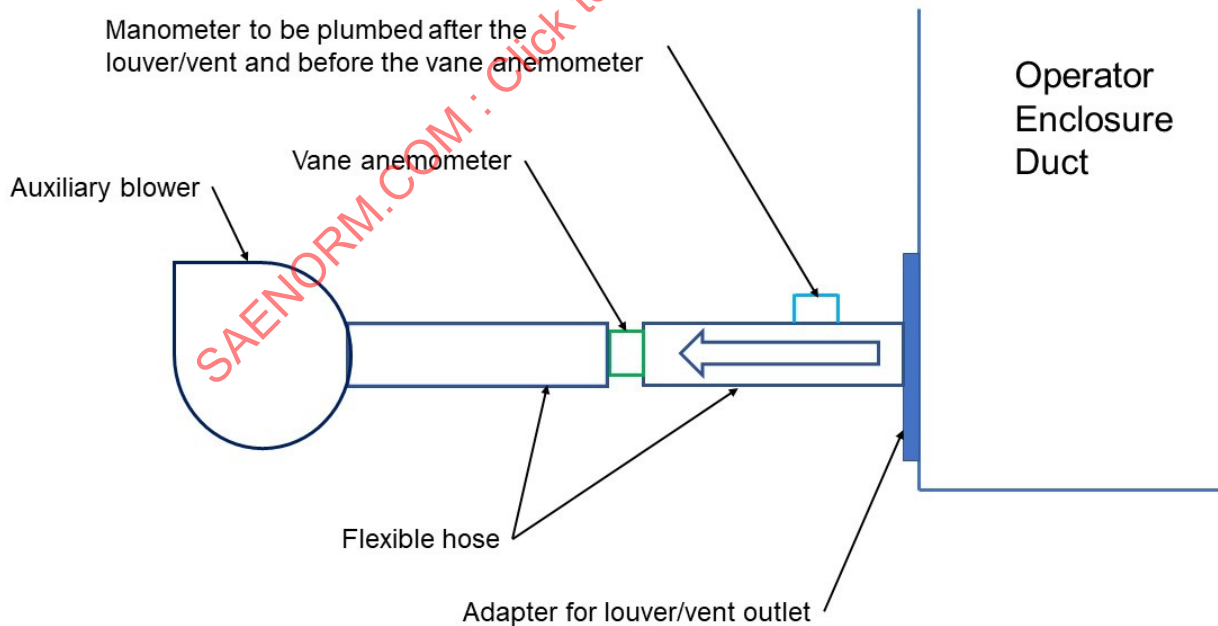


Figure 5 - Method 2 airflow measurement (louver/vent airflow)