BRITISH STANDARD

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ISO 789-8: 1991

Performance assessment of agricultural tractors —

Part 8: Method of testing engine air cleaners

UDC 631.372-73:620.1

Committees responsible for this British Standard

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Agricultural and Allied Workers National Trade Group
Agricultural Engineers Association
British Agricultural and Garden Machinery Association Ltd.
County Surveyors' Society
Department of Transport
Forestry Commission
Health and Safety Executive
Local Authority Organizations
Ministry of Agriculture, Fisheries and Food
National Farmers' Union
Silsoe Research Institute
United Kingdom Softwood Sawmillers Association
Coopted member

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Contents

National foreword

This Part of BS 6347 has been prepared under the direction of the Agricultural Machinery and Implements Standards Policy Committee. It is identical with ISO 789-8:1991 *Agricultural tractors — Test procedures — Part 8: Engine air cleaner* published by the International Organization for Standardization (ISO).

ISO 789-8 was prepared by Subcommittee SC2, Common tests, of ISO Technical Committee 23, Tractors and machinery for agriculture and forestry.

Cross-references

International Standard	Corresponding British Standard
ISO 5011:1988	BS 7226:1989 *Methods of test for performance equipment of inlet air cleaning equipment for internal combustion engines and compressors* (Identical)

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Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 6, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

1 Scope

This part of ISO 789 specifies test procedures for engine air cleaners fitted to agricultural tractors which are additional to those specified in ISO 5011. Additional tests are necessary because of the special conditions under which engine air cleaners fitted to agricultural tractors must operate.

2 Normative reference

The following standard contains provisions which, through reference in this text, constitute provisions of this part of ISO 789. At the time of publication, the edition indicated was valid. All standards are subject to revision, and parties to agreements based on this part of ISO 789 are encouraged to investigate the possibility of applying the most recent edition of the standard indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 5011:1988, *Inlet air cleaning equipment for internal combustion engines and compressors — Performance testing.*

3 Definitions and units

For the purposes of this part of ISO 789, the definitions and units contained in ISO 5011:1988, Annex A apply with the following addition.

3.1
safety element

air cleaner element fitted downstream of a primary, barrier-type element for the purpose of providing the engine with protection against dust in the event of either any type of primary element failure, or dust being present during the removal of the primary element for servicing

4 Measurement accuracy

4.1 Measurements shall be made, where they are given, to the accuracy specified in ISO 5011:1988, clause **4**.

4.2 Measure vibration acceleration within 2 %, amplitude within 3 % and frequency within 5 %.

4.3 Measure angles within 1°.

5 Test materials and test conditions

Test materials and test conditions shall be as specified in ISO 5011:1988, clause **5**, unless otherwise stated.

6 Resistance to vibration

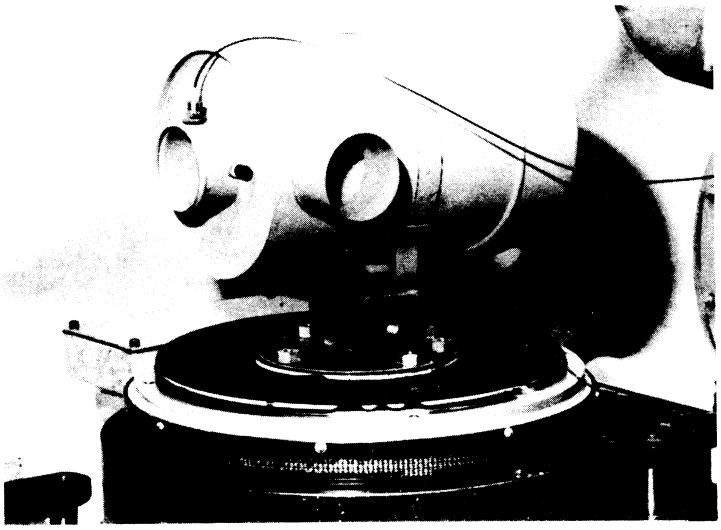
6.1 Introduction

6.1.1 This part of ISO 789 specifies a method of testing the constructional integrity of air cleaner assemblies to withstand engine or installation vibration.

6.1.2 The test values stated are intended as a guide and may be varied at the discretion of the air cleaner supplier and tractor manufacturer, particularly if actual tractor vibration data is available.

6.2 Operational characteristics to be tested

The following tests establish the ability of the air cleaner assembly to withstand vibration, in three mutually perpendicular planes, for a predetermined number of cycles (see Figure 1).



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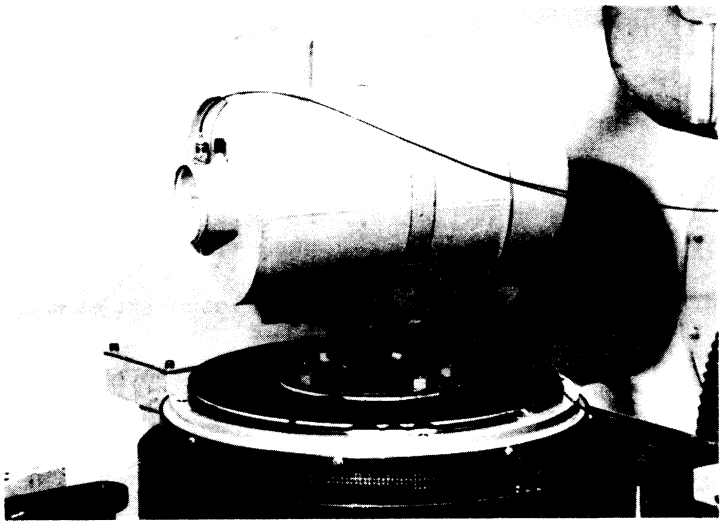
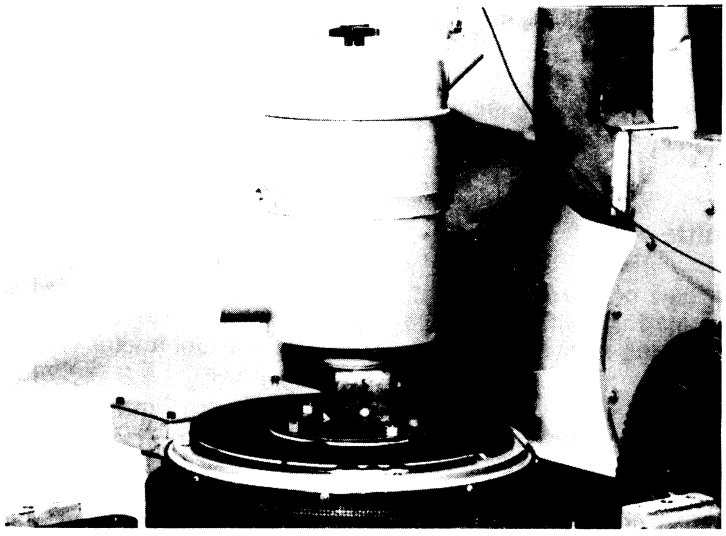


b)



c)

Figure 1 — Attachments and mounting for vibration test (see **6.4.1** to **6.4.3**)

6.3 Test rig

6.3.1 Electro-mechanical vibrator, together with sinusoidal oscillator and frequency controller, amplifier and display unit to indicate displacement, velocity and acceleration.

6.3.2 A minimum of **two accelerometers**, featuring linear calibration over a range of – 100 m/s^2 to + 100 m/s^2.

6.3.3 Air cleaner assembly to be tested, together with inlet pipe and cap (or precleaner if fitted and mounting straps or brackets, if available). The mass of a dust-laden element shall be included.

6.3.4 Rigid adaptor plate and brackets to enable air cleaner assembly to be mounted on the vibrator in triaxial planes.

6.4 Preparation and test procedure

6.4.1 Mount the air cleaner assembly onto either the rigid adaptor plate or one of the brackets (**6.3.4**).

6.4.2 Rigidly mount the adaptor plate/bracket on the vibrator (**6.3.1**), ensuring that the axis of excitation is at right angles to one of the air cleaner assembly triaxial planes.

6.4.3 Attach one accelerometer (**6.3.2**) to the rigid adaptor plate/bracket (to record input signal) and a second accelerometer to the air cleaner body diametrically opposite the adaptor plate/bracket (to record output signal). Additional accelerometers may be attached to any other part of the assembly which is observed to be resonating during the following tests. Attention should be paid to the precleaner/rain cap and to the internal parts of the cleaner insofar as they can be observed by sight or sound.

6.4.4 Conduct a resonance search up to a frequency of 200 Hz in the following stages:

a) up to 13 Hz at an amplitude of ± 0,6 mm;

b) from 13 Hz to 94 Hz at a velocity of 50 mm/s;

c) from 94 Hz to 200 Hz at an acceleration determined from the formula

$$a = 30 + 0{,}3\,(f - 100)$$

where

a is the acceleration, in metres per second squared;

f is the frequency, in hertz.

If resonance occurs at one frequency, carry out the test at that frequency and at the amplitude, velocity or acceleration, as appropriate, as specified above for the resonance search. If resonance occurs at more than one frequency, carry out the test, as above, at the frequency which exhibits the maximum amplitude.

If resonance does not occur at a frequency below 200 Hz, carry out the test at a frequency of 60 Hz and an acceleration of 25 m/s^2.

6.4.5 Test the assembly to a total of 10^7 cycles unless prior failure occurs. Commence testing at the frequency and acceleration values as determined in **6.4.4**.

As the resonant frequency of the assembly under test may vary throughout the test, the acceleration should be adjusted to the values determined in **6.4.4** after each $2{,}5 \times 10^6$ cycles.

6.4.6 If 10^7 cycles are completed without apparent failure, remove the air cleaner assembly and inspect for any visual signs of external damage.

6.4.7 Repeat **6.4.1** to **6.4.6** with the air cleaner assembly mounted in the other two planes. In each test, the accelerometer polar axes are to be in line with the axis of excitation.

6.4.8 Without disturbing the assembly, remove it from the vibrator and carry out a full life efficiency and capacity test as specified in ISO 5011:1988, clause **7.5** or **8.5** as appropriate.

With the agreement of the air cleaner supplier and the tractor manufacturer, the vibration test and the performance test may be carried out simultaneously.

6.5 Results to be recorded

The test report (see clause **13**) shall indicate at least the following:

a) the amplitude and frequency of vibration;

b) the mode of failure and its location (if any);

c) torques applied to fixing initially and at the end of the test;

d) the number of cycles to failure or the number of cycles completed;

e) the result of the full life efficiency and capacity test.

7 Effect of servicing of dry air cleaners

7.1 Purpose

This clause specifies a method of determining whether the air cleaner element can withstand the manufacturer's approved method of servicing, for the recommended number of times, without its performance dropping below an acceptable level.

7.2 Test procedure

Carry out a full life efficiency and capacity test as specified in ISO 5011:1988, clause **7.5**. Service the air cleaner according to the manufacturer's instructions. Repeat the tests and continue this procedure until the air cleaner has been serviced for the maximum number of times recommended by the manufacturer before replacement. Record the results of each test separately to indicate any progressive deterioration of performance.

8 Resistance to fibrous material

8.1 Purpose

The purpose of this test is to determine the effect of fibrous material on the air cleaner, e.g. clogging of precleaner vanes, screens or other small apertures. It may be carried out on dry or oil-bath air cleaners.

8.2 Fibrous material

Two fibrous materials shall be used:

a) dry, well ripened, cat pods, hand-stripped from the stalk (also known as Bull Rush seeds, *Typha angustifolia*);

b) dry cotton lint, ranging in fibre length from 3 mm to 30 mm, dried to less than 10 % moisture. The cotton lint collected from the inlet of the engine radiator of a cotton picker or cotton stripper will be suitable. Other materials such as leaf particles and dust will be included in cotton lint collected in this manner, but such inclusion is not objectionable in this test material.

8.3 Fibrous material preparation

Before using the fibrous material, a quantity sufficient to cover the test requirements shall be teased out and allowed to stabilize at a temperature of (23 ± 5) °C and (55 ± 15) % relative humidity for 2 h.

8.4 Test procedure

8.4.1 The test consists of the determination of the pressure drop/capacity characteristic.

8.4.2 Weigh out a quantity of fibrous material agreed between the user and manufacturer.

8.4.3 Start the air flow through the stand and stabilize it at the test air flow. Record the pressure drop.

8.4.4 Feed 10 g ± 15 % of the fibrous material per cubic metre of air flow.

8.4.5 Terminate the fibrous material feed when the specified pressure drop agreed between the user and manufacturer has been reached or the test quantity has been fed into the air cleaner.

8.4.6 Weigh the remaining fibrous material (if any) and hence determine the quantity fed into the air flow.

8.4.7 After completion of the test, examine the unit to determine whether the fibrous material has collected at a point upstream of the element and, if so, report its location.

9 Resistance to moisture of dry air cleaner elements

9.1 Purpose

The purpose of this test is to determine the effect, if any, of moisture on the functioning of the air filter.

9.2 Test method

9.2.1 *Test procedure*

9.2.1.1 Measure the pressure drop/restriction of the element/air cleaner assembly at the test flow as specified in ISO 5011:1988, clause **6.3**.

9.2.1.2 Remove the element to be tested and weigh it.

9.2.1.3 Immerse the element completely in clean water at the same temperature as the surroundings for approximately 12 h.

9.2.1.4 Allow the element to drain for 15 min; then gently shake to remove any loose droplets of water and reweigh it.

9.2.1.5 Re-assemble the filter unit/test rig. Increase the air flow through the element until the pressure drop/restriction reaches 100 mbar or the rated flow is achieved. Remove and inspect the element. Record any damage which has occurred to any of the component parts of the element or to its integrity.

9.2.1.6 Re-assemble the filter unit/test rig and run air through the filter at the rated flow until either the pressure drop or its mass return to those determined in **9.2.1.1** or **9.2.1.2**. If this does not occur then run the system until the mass of the element has stabilized.

9.2.1.7 Weigh the element.

9.2.1.8 Perform a dust holding capacity and overall efficiency test as specified in ISO 5011:1988, clause **7.5**.

9.2.2 *Results to be recorded*

The test report shall indicate the following:

a) the initial mass;

b) the wet mass;

c) the mass of retained moisture;

d) the mass after drying.

10 Safety element

10.1 Introduction

The requirement of a safety element is that it should block rapidly in the event of a leak occurring in the primary element, passing a minimum of dust in the process. To evaluate this, a specific penetration test shall be performed. During normal and correct operation of the air cleaning system, it is desirable that the safety element should not block during the lives of one or more primary elements. To evaluate this, a safety element blocking test shall be performed. This may be carried out as part of the full life efficiency and capacity test as specified in ISO 5011:1988, clause **7.5**.

10.2 Specific penetration test

10.2.1 *Preparation*

Using the housing normally employed to retain the safety elements, prepare a "dummy" primary element, i.e. a complete element skeleton lacking only the media, but including any swirl vane present. Fit the safety element and the dummy primary element into the housing.

10.2.2 *Test procedure*

The test shall be conducted in accordance with ISO 5011:1988, clause **7.5**, full life efficiency and capacity test, but with the following specifications.

10.2.2.1 The terminating condition for dust feeding shall be a pressure drop across the housing of 100 mbar.

10.2.2.2 The dust used shall be fine grade. Where a precleaner is provided, an additional test shall be carried out using coarse dust.

10.2.2.3 The air flow shall be the full rated air flow as agreed between the customer and supplier.

10.2.2.4 The dust concentration used shall be 1 g/m^3, unless this results in the test duration being less than 0,5 h, in which case the test shall be carried out with a dust concentration of 0,1 g/m^3.

10.2.2.5 Where applicable, the requirements of ISO 5011:1988, clauses **7.8.1** and **7.8.1.1** (precleaner dust removal) shall be met.

The precleaning efficiency will be slightly below normal during this test. However, should a large reduction be noted, the reasons for this should be checked and any observations recorded.

10.2.2.6 At the end of the test, prior to measuring efficiency, the flow rate shall be increased to produce a pressure drop across the housing of 125 mbar. The safety element shall not rupture under these conditions.

10.2.3 *Calculation and requirement*

To evaluate the results, the specific dust penetration SDP, in grams per cubic metre per minute, shall be calculated as follows:

$$\text{SDP} = \frac{m}{q_V}$$

where

m is the mass of dust passing the system, in grams;

q_V is the air flow, in cubic metres per minute.

This value shall not exceed 0,7 g/(m^3/min).

10.3 Safety element blocking test

10.3.1 *Preparation*

Use a clean primary element and safety element in the housing normally employed. The mass of the safety element after conditioning for 24 h in the test environment shall be determined.

10.3.2 *Test procedure*

10.3.2.1 Set up the air cleaner as in ISO 5011:1988, clause **6.3**. Measure and record the restriction/pressure drop of the unit at the rated flow only. Replace the primary element and retain the original for later reference.

10.3.2.2 Conduct a full life efficiency and capacity test as specified in ISO 5011:1988, clause **7.5**.

10.3.2.3 Replace the primary element with the reference one used at the start of the test. Repeat the restriction and pressure drop test in **10.3.2.1**. Note the result.

10.3.2.4 Remove the safety element and reweigh as in **10.3.1**.

10.3.3 *Presentation of results*

The increase in restriction/pressure drop of the unit shall be calculated from **10.3.2.1** and **10.3.2.3**, together with the increase in mass of the safety element.

11 Angle of operation of oil-bath air cleaners

Carry out the appropriate tests as specified in ISO 5011:1988, clause **8.4.7** with the air cleaner positioned at the attitude which it would adopt if the vehicle to which it is fitted were at an angle of pitch of ± 25° and an angle of roll of ± 17°.

12 Automatic dust unloading valves

The satisfactory operation of automatic dust unloading valves cannot be assessed other then on the engine to which the air cleaner is to be fitted, including additional precleaners or rain caps in a realistic dust environment.

13 Reports

Present the results of the tests in the form of the specimen test report shown in Annex A of this part of ISO 789 and in ISO 5011:1988, Annexes E, F and G, stating clearly the conditions under which the tests were carried out.

Annex A (normative)
Test report

The specimen test report shown in ISO 5011:1988, Annex E shall be used with the following additions, as appropriate.

Resistance to vibration

Amplitude of vibration: ..... mm
Frequency of vibration: ..... Hz
Location of failure: .....
Mode of failure (if any): .....

Torques applied to fixing –
  initially: ..... N·m
  at end of test: ..... N·m
Number of cycles to failure/completed .....

Resistance to moisture of dry air cleaner element

Initial mass: ..... g
Wet mass: ..... g
Mass of retained moisture: ..... g
Mass after drying: ..... g

List of references

See national foreword.

BS 6347-8: 1993
ISO 789-8: 1991

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