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Agricultural and forestry machines — Inspection of sprayers in use —

Part 5: Aerial spray systems

Matériel agricole et forestier — Contrôle des pulvérisateurs en service —

Partie 5: Systèmes aériens de pulvérisation

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 23, *Tractors and machinery for agriculture and forestry*, Subcommittee SC 6, *Equipment for crop protection*.

A list of all parts in the ISO 16122 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

Significant areas are sprayed globally by fixed wing and rotary aircraft in order to overcome serious pest threats to agriculture and forestry. Aerial application is used where difficult terrain or crop (forests) dictate as well as for timely application to large areas in order to maximize efficient use of crop protection products and minimize environmental impact. This document specifies requirements and methods for their inspection in use of such spray systems. Industry stakeholders such as the USA National Agricultural Aviation Association (NAAA) and their partner National Agricultural Aviation Research and Education Fund have provided input to the development.

Agricultural and forestry machines — Inspection of sprayers in use —

Part 5: Aerial spray systems

1 Scope

This document specifies the requirements, test methods and verification of the inspection of aerial fixed wing and rotary aircraft spray systems for agriculture, forestry, turf, and vegetation control in transport access ways (such as gas and electric lines), with regard to minimizing the potential risk of environmental contamination during use.

This document applies only to manned aerial aircraft. It does not cover aircraft safety and design criteria for air worthiness, aircraft registration, pilot or operator requirements, all of which are specified separately by countries or regions.

This document relates mainly to the condition of the equipment with respect to its potential risk for the environment and its performance to achieve good applications.

The general requirements of ISO 16122-1 apply where appropriate, including for the protection of inspectors during an inspection.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 5681, *Equipment for crop protection — Vocabulary*

ISO 5682-1:2017, *Equipment for crop protection — Spraying equipment — Part 1: Test methods for sprayer nozzles*

ISO 5682-2:2017, *Equipment for crop protection — Spraying equipment — Part 2: Test methods to assess the horizontal transverse distribution for hydraulic sprayers*

ISO 16122-1:2015, *Agricultural and forestry machinery — Inspection of sprayers in use — Part 1: General*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 5681 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1
fixed wing aircraft
aircraft with fixed wings approved by local or national authority and equipped for the application of plant protection products and fertilizers, on crops, including forestry and grasslands

3.2
rotary aircraft
helicopter (rotary propelled) aircraft approved by local or national authority, and equipped for the application of plant protection products and fertilizers, on crops, including forestry and grasslands

3.3
global navigation satellite system
GNSS
generic term for satellite navigation systems that provide autonomous geospatial positioning with global coverage

[SOURCE: ISO/TS 11356:2011, 3.2]

4 Requirements

4.1 General requirements

The spray system shall be cleaned and free from any damage that could cause spray liquid to leak from the tank, its lid (which shall be in good condition), its fittings, the pump, pipework and nozzles.

Compliance shall be checked by visual inspection.

4.1.1 Static leak test

A test for static leaks shall be performed with the tank filled to its nominal capacity with the aircraft parked on a level horizontal surface and the pump not running.

Compliance shall be checked by visual inspection.

4.1.2 Dynamic leak test

There shall be no visible leakage from pipes or hoses including their couplings when tested up to the maximum obtainable pressure from the system. If the following testing requires disassembly this test shall be repeated after completing reassembly.

Compliance shall be checked by visual inspection and function test.

4.2 Sprayer tanks

4.2.1 General

The tank surface shall be free from external and internal cuts or abrasion that may compromise wall integrity. There should be no loose parts in the spray tank.

Compliance shall be checked by visual inspection.

4.2.2 Tank opening(s)

Any tank opening greater than 400 mm in diameter shall be provided with a secured bar or coarse grating which can only be removed by the use of tools. The openings in the grating shall not exceed the 400 mm in order to prevent operator exposure.

Any opening lid shall be tightly sealed to avoid spillage.

Compliance shall be checked by measurement and visual inspection.

4.2.3 Strainers

Strainers with 20 mesh openings are recommended prior to transfer into the tank and strainers should be per recommendations of system manufactures and shall be free from damage or blockage.

Compliance shall be checked by visual inspection.

4.2.4 Emptying

No puddling of liquid shall be visible in bottom of spray tank after draining or cleaning procedure.

Compliance shall be checked by visual inspection and function test.

4.2.5 Tank emptying device

It shall be possible to use an emptying device while aircraft is parked such that emptying of the residual is achieved.

It shall be possible to collect the liquid at an outlet without contaminating the environment and without potential risk of exposure of the operator.

Compliance shall be checked by visual inspection.

4.2.6 Tank contents indicator(s)

The indication of contents shall be clearly readable from the pilot or operators position and from where the tank is filled. Turning of the head and the upper body is acceptable.

Compliance shall be checked by visual inspection.

4.2.7 Tank agitation

Spray tanks shall include operational recirculation/agitation systems that maintain an obviously disturbed surface with the tank filled to at least half its nominal volume. If the mix tank is located on operational site, testing shall be at nominal maximum batch volume and normal pump flowrate.

Compliance shall be checked by visual inspection.

4.3 Hoses and lines

4.3.1 General

All pressurized hoses shall be clearly marked with the maximum working pressure. Also, hoses and their connecting devices shall be protected by imperforate screens, so that leakage within the cockpit cannot come into contact with the pilot or operator.

Pressurized spray lines shall be equipped with quick-acting shut-off valve that allow suction back return to the spray tank for rapid de-pressurization of the spray boom unless liquid flow is controlled by starting and stopping the pump. All such controls shall be operable by the pilot or operator when in their normal operating position during spraying.

Compliance shall be checked by visual inspection and function test.

4.3.2 Bending/abrasion

Hoses shall not show excessive bending or abrasion through contact with surrounding surfaces. They shall be free from defects such as excessive surface wear, cuts or cracks. Hoses shall not have any deformation which can disturb the liquid flow.

Compliance shall be checked by visual inspection.

4.4 Spray boom

4.4.1 Spraying section

Spray boom shall not be warped or twisted, so that orientation of all the nozzles are within 5° of desired nominal angle to the application in forward flight.

Compliance shall be checked by measurement per ISO 5682-2:2017, 6.4.2 and visual inspection.

4.4.2 Nozzle orientation

Nozzles shall be positioned to avoid wing tip or rotor vortices for agricultural applications. Deep canopy spraying, such as forestry spraying, may require nozzles and boom be positioned to utilize wake turbulence to achieve penetration and deposition on interior surfaces. Nozzle orientation shall match nozzle manufacture's published guidelines.

Compliance shall be checked by visual inspection.

4.5 Pressure drop

The pressure drop between the point on the spray system where the indicated spray pressure is measured during working and the outermost end of each boom section (at least each side) shall not exceed 10 %.

A calibrated test pressure indicator (see Clause 5) shall be fitted at the same position as a nozzle at the outermost end of each boom section.

The test shall be carried out with the highest flow rate nozzle provided on the spray system and at a pressure within the working pressure range given by the nozzle manufacturer.

Measurements shall be made at least at two pressures, one high and one low, at the pressure indicator of the spray system using the calibrated test pressure indicator.

The values indicated by the pressure indicator of the spray system shall be compared with values measured by the calibrated test pressure indicator.

For each section, the pressure drop, (PD), between the inlet and the indicated spray pressure and the outermost end shall be calculated using the following Formula (1):

$$PD = 100\ \% \times (P0 - P1) / P0 \quad (1)$$

where

P0 is the reading of the pressure indicator of the spray system;

P1 is the outermost end pressure of the same section.

This test may be conducted with the spray boom dismounted from the aircraft, an external pump and recirculation system may be used to supply flow rate provided that appropriate conditions are achieved.

Compliance shall be checked by visual inspection and function test.

4.6 Filters

There shall be at least one filter on the discharge side of the pump and, in the case of positive displacement pumps, one filter on the suction side. Nozzle filters are not considered as discharge side filters and are generally not recommended.

Filters shall be accessible and filter insets shall be removable and/or flushable in accordance with manufactures instructions.

It shall be possible, with the tank filled to its nominal volume, to clean central filters without any spray liquid leaking out except for that which may be present in the filter casing and any connected lines.

Screens shall be free of damage such as distortion or blockage. The filter(s) shall be in good condition and mesh size shall correspond to sprayer system manufacture's recommendations.

Compliance shall be checked by visual inspection and function test.

4.7 Nozzles

4.7.1 Mounting

It shall be possible to fix nozzles in predetermined positions. Each nozzle shall be equipped with a fast closing anti-drip device (e.g. a check-valve). It shall be possible to shut off the flow from each nozzle immediately, in flight.

The orientation of all nozzles [per ISO 5682-2:2017, 6.2 and 6.4.2, except that vertical orientation is replaced with horizontal and angle notation is 0 degrees for straight back (with airflow, vertical straight down as 90° and forward as 91° to 180°)] should be the same for the same spray quality category required and appropriate for the type and configuration of nozzles used.

For rotary atomizers check that they can rotate freely and for any damage or wear.

Compliance shall be checked by visual inspection, measurement and function test.

4.7.2 Flow rate and spray quality

The flow rate of each individual nozzle, measured according to ISO 5682-1:2017, 6.1 to 6.3 when demounted from the aircraft, shall not deviate by more than ± 10 % from the data of the manufacturers published flow rate tables. Where nozzles shall be tested off the spray system a test bench consisting of pump supplying water at needed pressure, a pressure regulator, pressure indicator (analogue or digital, meeting 5.2 and 5.3 requirements) to monitor actual pressure, and flow meter to measure actual flow shall be used.

Nozzles of unknown orifice size (flowrate) shall be replaced.

Nozzle spray quality (drop size) category shall be available to the operator for nominal operational conditions.

NOTE This information can be obtained from the nozzle manufacturer's published material or other publications (see Annex A).

Compliance shall be checked by visual inspection of records and function test.

4.8 Measuring systems

4.8.1 General

All devices for measuring and/or adjusting the pressure and/or flow rate and valves for switch on or off spray shall function. Switching on and off all nozzles shall be possible simultaneously.

The controls to be operated during spraying shall be operable from the operator`s position and the instrument displays shall be readable from this position.

NOTE Turning of the head and the upper body is acceptable to achieve these requirements.

Compliance shall be checked by visual inspection and function test.

4.8.2 Control

All devices for measuring, indicating and/or adjusting the pressure and/or flow rate shall function with a tolerance of ± 10 % at constant setting and shall return within 10 s to the original working pressure ± 10 % after the spray system has been switched off and on again.

Control of the working pressure, atomizer RPM (if appropriate), the volume application rate (l/ha), where relevant, and the adjustment controls shall be operable from the pilot's or operator's position. Turning of the head and upper body is acceptable.

Aircraft GNNS swath displays shall be located within pilot's line of sight.

Spray systems shall be fitted with a spray boom pressure indicator.

Compliance shall be checked by visual inspection and function test.

4.8.3 Pressure indicator (s)

The pressure indicator will be readable from the pilot's or operator's position and operational for the working pressures required.

The pressure indication shall be stable.

4.8.3.1 Scale and size of analogue pressure indicators

The scale of the pressure indicator shall be marked:

— every 0,2 bar for working pressures less than 5 bar;

— every 1,0 bar for working pressures between 5 bar (included) and 20 bar (included);

— every 2,0 bar for working pressures more than 20 bar.

The minimum diameter shall be 63 mm.

Compliance shall be checked by visual inspection and measurement.

4.8.3.2 Accuracy of pressure indicator

The accuracy of the pressure indicator shall be:

— ± 0,2 bar for working pressures at 2 bar and below,

— ± 10 % of the real value for pressures at 2 bar and above.

This requirement shall be achieved within the working pressure range suitable for the nozzles mounted on the sprayer under test.

Compliance shall be checked by measurement according to ISO 16122-2:2015, 5.3.

4.8.4 Flow rate and other instruments

Measuring devices other than pressure indicators, especially flow meters used for controlling the volume/hectare rate, shall measure within a maximum error of ± 5 % of the value read on the reference instrument within the range of the measuring device.

Flow rate meters shall have flow rate verified per the applicable methodology of ISO 16122-2:2015, 5.4.

Compliance shall be checked by measurement and function test.

4.8.5 Pressure adjusting devices

All devices for adjusting pressure shall maintain a constant pressure with a tolerance of ± 10 % at constant setting and shall return within 10 s to the original working pressure ± 10 % after the sprayer has been switched off and on again.

Compliance shall be checked by function test and measurement according to ISO 16122-2:2015, 5.10.

4.9 Volume rate per area

Any automated flow control and/or application rate controller shall be shown to be within less than 10 % of application rate aim points.

To measure the amount discharged over a measured time, the time interval shall be sufficient to permit accurate measurement of liquid discharged and to minimize errors due to turning the system on and off. Run the spray system for at least 30 s ± 0,5 s. Measure the amount of liquid used by either refilling the tank to the initial level or by measuring the amount remaining in the tank and subtracting from the initial amount. Measurement precision shall be ± 2 % of the amount discharged in the test. If the spray system can be operated with the aircraft stationary the test can be accomplished without flying the aircraft. This test may be conducted with the spray boom dismounted from the aircraft, an external pump and recirculation system may be used to supply flow rate.

Aircraft spray systems shall be calibrated on a regular basis.

NOTE Local or regional requirements can prevail.

Compliance shall be checked by measurement and functional test.

4.10 Safety/Exposure

4.10.1 General

Cockpit seals shall be functional and secure, and free from visual defects.

If present emergency dump valve shall have unique look and feel and two actions to prevent unintended operation.

Compliance shall be by visual inspection and function test.

4.10.2 Inspector safety

Test inspector safety guidelines in ISO 16122-1 shall be followed where applicable.

Compliance shall be checked by visual inspection.

4.11 Flow control

Aircraft GNSS system, if present, shall provide the location time stamped report, and the flow control system, if present, shall be capable of providing an application rate output report, and match the flow rate in 4.9.

Compliance shall be checked by visual inspection.

5 Test facility and methods

5.1 General

The inspection shall be made at a location where the risk of pollution and water contamination is avoided. Influences by external conditions on the reproducibility on the results of the inspection shall be minimized.

NOTE National or regional regulation can also apply regarding pollution and water contamination.

All equipment necessary for the inspection and used by the inspector, for testing the sprayer (e.g. flow meters, pressure indicators, forward speed sensors, tachometer), shall be checked at regular intervals, normally at least once a year with certified equipment.

5.2 Validation pressure indicator(s)

Analogue pressure indicators used for verification shall have a minimum diameter of 100 mm. Other minimum requirements on pressure indicators used for verification are given in Table 1.

Table 1 — Characteristics of pressure indicators used for verification

(Values in accordance with EN 837-1)

Pressure to measure Δp bar	Scale unit max. bar	Accuracy bar	Class required	Scale end value bar
$0 < \Delta P \leq 6$	0,1	0,1	1,6 1,0 0,6	6 10 16
$6 < \Delta P \leq 16$	0,2	0,25	1,6 1,0	16 25
$\Delta P > 16$	1,0	1,0	2,5 1,6 1,0	40 60 100
1 bar = 0,1 MPa = 0,1 N/mm2 = 105 N/m2 = 14,5 psi.				

5.3 Verification method of the sprayer pressure indicator

The pressure indicator(s) of the spray system shall be tested by comparison with a calibrated test pressure indicator mounted on the aircraft spray system or on a test bench.

Measurements shall be carried out with both increasing and decreasing pressure. In each case, the accuracy of the pressure indicator of the spray system shall be checked at a minimum of four equally spaced points within the relevant working pressure range. The pressure shall be stable during measurement, e.g. no influence from pump rotation or pulsations.

6 Inspection report

Inspection report shall record besides applicable items in ISO 5682-2:

— aircraft registration number for the inspected spray system;

— owner identity;

— inspection results, discuss any negative results and note the measurement or function test results;

— the type(s) of application(s).

