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SPISE

Standardized Procedure for the Inspection of Sprayers in Europe

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Advice for functional inspection of special spraying trains and other vehicles for chemical weed control on railways and public roads

Advice for functional inspection of special spraying trains and other vehicles for chemical weed control on railways and public roads

This document has been compiled by the SPISE Technical Working Group 6.

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1 Introduction

The European Directive 128/2009 provides that sprayers used for the weeding of the railways (Fig. 1) and station areas are subject to a mandatory functional inspection because they have strong impact on the environment, due to the high consumption of herbicides (e.g. in Italy 1.83% of total amount of Plant Protection Products yearly used – Fontana, 2012).

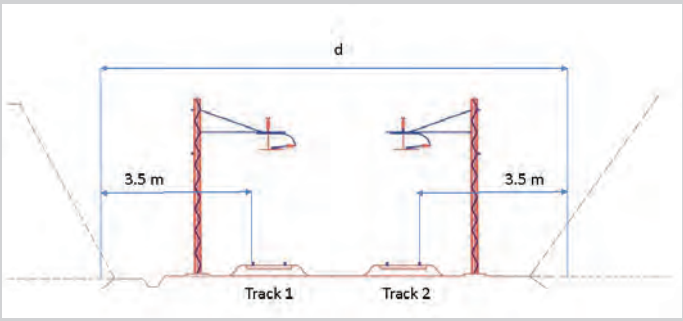

Fig. 1 – Example of the width (d) of the railway where it is necessary to ensure, according to the most common contracts, the elimination of 90% of the weeds (Italian situation).

A recent Spise survey in Europe (Kole, 2014) showed that the situation in relation to the different types of equipment used is very heterogeneous. Next to special trains designed and built specifically for weed control on the railways (generally equipped with PPP direct injection system) (Fig. 2 and Fig. 3) also exists traditional equipment (boom sprayers, air-blast sprayers, spray lances) adapted to be transported and used on a train or other vehicle able to travel on the railways (Fig. 4). For functional inspection of these last sprayers it shall be adopted the EN ISO 16122 Standard parts 1, 2, 3, 4).

Fig. 2 – Example of special trains designed and built specifically for weed control on the railways used in Italy (Technical Services S.r.l., 00013 Fonte Nuova (RM)).

Fig. 3 – Example of injection unit (Photo: Photo: A. Godyń).

Fig. 4 – Examples of traditional equipment adapted to be transported and used on a train. (Photo: A. Godyń) and http://fotoforum.gazeta.pl/zdjecie/1334309,5,121,17979,WM10.html.

A proper use of special trains designed and built specifically for weed control on the tracks are more challenging than e.g. crop sprayers, because of limited space of nozzle arrangement due to obstacles close to the train like poles (signals, electricity and others) and the need of high forward speed (20-60 km/h) due to high train frequency and limited available time for the treatment. Normally a range of up to 4 m is sprayed from the center of the track to the both sides. However when spraying station areas in some occasions horizontal booms may be used. An optimum positioning of nozzles and use of large drops are needed in order to obtain a proper distribution and low risk of drift combined with the high forward speed used.

Also concerning weed control on public roads, next to special trucks designed and built specifically for weed control on the roads and highways (Fig. 5) generally equipped with dosing system, can exist traditional equipment (boom sprayers, spray lances or similar); for their functional inspection it shall be adopted the EN ISO 16122 Standard parts 1, 2, 3, 4. These special trucks can be considered similar to special trains for weed control.

Fig. 5 – Example of special truck equipped with weed control system (Photo Sid Ambiente srl).

At present any EN or ISO Standards for functional inspection of special spraying trains and other vehicles for chemical weed control on railways and public roads are available.

This document provides some advices on how to operate functional inspection of special spraying trains and other vehicles for chemical weed control on railways and public roads at the workshop and about the type of instruments needed with their minimum technical requirements.

2 Requirements and method of verification

2.1 General requirements (before inspection)

2.1.1 General

The operator of the sprayer shall be present at the inspection. Visible and other know faults should be repaired before the inspection start.

All necessary inspection equipment shall be checked at regular intervals (according to National Action Plan) with certified equipment. Proof of adjustment shall be available.

2.1.2 Place for inspection

The inspection shall be made in a location avoiding any risk of pollution of environment, this means that at least the sprayed/leaked liquid shall be collected and transferred back into the sprayer tank at the end of the test.

To allow the required reproducibility of the test, the influence of external conditions (wind, rain, etc.) shall be minimized.

NOTE: National or local regulations may also apply regarding pollution and water contamination.

2.1.3 Pre-inspection

2.1.3.1 General

A preliminary inspection shall be carried out by the inspector to avoid:

- incidents that could result in either injury or damage to the health of the inspector;
- wasting time by making measurements on sprayers with very obvious serious faults.

2.1.3.2 Cleaning

The sprayer and the wagon where it is contained shall be clean.

Cleaning shall include internal parts, filters, filter inserts and external surfaces giving special consideration to areas of contamination to which the inspector could be exposed during the inspection.

Method of verification: visual check.

2.1.3.3 Moving parts

All guards provided for protection of the operator shall be present and functioning correctly.

Where possible or when not required for the sprayer function, all access to other moving parts shall be prevented by specific safety devices to prevent any risk to the inspector.

Method of verification: visual check.

2.1.3.4 Pipes and hoses for hydraulic transmission

There shall be no visible leakage from the hydraulic system.

Hydraulic hoses shall not show excessive bending and abrasion through contact with surrounding surfaces. They shall be free from defects such as excessive surface wear, cuts or cracks.

Hydraulic pipes shall be retained in position and be free of significant corrosion or damage.

Method of verification: visual check.

2.1.3.5 Structural parts and framework

All structural parts and the framework shall be in good condition, without permanent deformations, significant corrosion or other defects which could affect the rigidity or the strength of the sprayer.

Method of verification: visual check.

2.1.3.6 Lockable foldable parts

Locking of foldable parts of the sprayer shall secure these parts in their intended positions
Method of verification: visual check.

2.2 Requirements

2.2.1 Leaks

2.2.1.1 Static leaks

The sprayer should be filled to its nominal capacity.

With the pump not running and the sprayer positioned on a horizontal surface, a visual inspection to determine any leakage from all part of the machine (tank, pump and associated pipes…) shall be carried out.

Method of verification: visual check.

2.2.1.2 Pump leakage

There shall be no leakages (e.g. dripping) from any parts of the pump.

Method of verification: visual check.

2.2.1.3 Lines leakage

There shall be no visible leakage from pipes or hoses including their coupling when tested up to the maximum obtainable pressure for the system.

Method of verification: visual check and function test

2.2.2 Water Pump(s)

2.2.2.1 Capacity

The pump capacity shall be suited to the needs of the equipment. Method of verification: visual check

2.2.2.2 Pulsations

The pulsations shall not exceed 5 % of the working pressure.
Method of verification: visual check, measurement and function test.

2.2.2.3 Air chamber

If an air chamber is present, the air pressure shall be the pressure recommended by the sprayer manufacturer or from 30 % to 70 % of the working pressure.
The membrane shall not be damaged (no liquid shall appear when testing the air valve).
Method of verification: function test and measurement.

2.2.3 Spray mix agitation (only for sprayers without injection system)

2.2.3.1 Hydraulic

A clearly visible agitation shall be maintained:

- when spraying at the maximum working pressure as recommended by the sprayer or nozzle manufacturer (whichever is the lower);
- when the largest nozzles and all the nozzles mounted on the sprayer are in use;
- with pump rotation speed as recommended by the sprayer manufacturer;
- with the tank filled to half its nominal capacity.

Method of verification: visual check.

2.2.3.2 Mechanical

A clearly visible agitation shall be maintained when the agitation system is working as recommended by the sprayer manufacturer, with the tank filled to half its nominal capacity.
Method of verification: visual check.

2.2.4 Spray liquid tank

The tank shall be provided with a lid that shall be well adapted and in good condition.
This lid shall be tightly sealed to avoid unexpected opening and lose.
Method of verification: visual check.

2.2.5 Cleaning

2.2.5.1 Cleaning device for plant protection product container

If provided, the cleaning device for plant protection product container shall work properly.
Method of verification: function test.

2.2.5.2 Cleaning equipment

Tank cleaning device, device for external cleaning and device for cleaning of induction hopper, and devices for internal cleaning of complete sprayer, if provided, shall work properly.
Method of verification: visual check and function test.

2.2.6 Measuring systems, controls and regulation systems

2.2.6.1 General

All devices for measuring and/or adjusting the pressure and/or flow rate shall operate properly. The valves for switching on or off the spray shall operate properly.
Method of verification: visual check and function test.

2.2.6.2 Controls

The sprayer controls shall be operated from the operator`s position during spraying, and the instrument displays shall also be readable from this position.
NOTE Turning off the head and the upper body is acceptable.
Switching on and off of all nozzles shall be possible simultaneously.
Method of verification: visual check.

2.2.6.3 Scale of pressure indicator

Digital or analogue pressure indicator shall be clearly readable from the operator's position and suitable for the working pressure range used.
NOTE For analogue pressure indicators the minimum diameter is generally 63 mm.

Method of verification: visual check.

The scale of **analogue pressure indicators** shall provide graduations:

- at least every 0,2 bar for working pressures less than 5 bar;
- at least every 1,0 bar for working pressures between 5 bar and 20 bar;
- at least every 2,0 bar for working pressures more than 20 bar.

Method of verification: visual check.

2.2.6.4 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.

Method of verification: according to 3.3.

2.2.6.3 Pressure adjusting devices

All devices for adjusting pressure shall maintain a constant pressure with a tolerance of 10 % at constant setting and shall return to the original working pressure ±10 % after the equipment has been switched off and on again.
Method of verification: function test and measurement according to 3.3.3.

2.2.7 Lines (pipes and hoses)

2.2.7.1 Bending/abrasion

Hoses shall not show excessive bending and abrasion through contact with surrounding surfaces. They shall be free from defects such as excessive surface wear, cuts or cracks.
Method of verification: visual check.

2.2.8 Filtering

2.2.8.1 Filters presence

There shall be at least one filter on the discharge side of the pump and, in case of positive displacement pumps, one filter on the suction side.
NOTE Nozzle filters are not considered as discharge side filters.
The filter(s) shall be in good condition and the mesh size shall correspond to the nozzles fitted according to the instructions of nozzle manufacturers.
Method of verification: examination of specification and visual check.

2.2.8.2 Isolating device

It shall be possible, with the tank filled at its nominal volume, to clean filters without any spray liquid leaking out except for that which may be present in the filter casing and the suction lines.
Method of verification: function test.

2.2.8.3 Filters inserts changeability

Filter inserts shall be changeable in accordance with the sprayer manufacturers' instructions.
Method of verification: visual check and function test.

2.2.9 Application units

2.2.9.1 Stability

Vertical and horizontal booms, if present, shall be stable in all directions, i.e. no excessive movement and not be bent.
Method of verification: visual check and measurement.

2.2.9.2 Automatic resetting

When provided, the automatic resetting of booms shall operate to move backwards and forwards, in case of contact with obstacles.
Method of verification: visual check and function test.

2.2.9.3 Nozzle spacing/orientation

Any nozzle body configuration shall correspond to its configuration by design (e.g. border spraying).
It shall not be possible to modify unintentionally the position of the nozzles in working conditions. If equipped with remote controlled nozzles (e.g. to operate on different terrains with curves and slopes) this has to work properly.
Method of verification: visual check.

2.2.10 Nozzles

2.2.10.1 Dripping

After being switched off there shall be no continuous dripping 5 s after the spray jet has collapsed.
Method of verification: visual check.

2.2.10.2 Flow rate

Nominal nozzle flow rate known
The deviation of the flow rate of each nozzle shall not exceed 10 % of the nominal flow rate at the working pressure
Method of verification: measurement according to 3.4.
Nominal nozzle flow rate unknown
The flow rate of a single nozzle shall not exceed ±5% of the average flow rate of the nozzles of the same type mounted on the sprayer
In case of only two nozzles of a same type and size, the average value is not considered but the deviation between the two nozzle
Method of verification: measurement according to 3.4.

2.2.11 Chemical dosing system (if provided)

Dosing systems shall:

- not leak;
- have no backflow leakage though the chemical pathway or water inlet of the dosing unit;
- have a mixing chamber on the outlet side.

The injection rate of the chemical shall not deviate from what is set on the dosing device by more than 10%.
Method of verification: inspection, function test and measurement according to 3.5

2.2.12 Distribution control (optional)

The distribution system shall be manually or automatic controlled during the application in order to guarantee to address the spray only when and where it is necessary (Fig. 6).

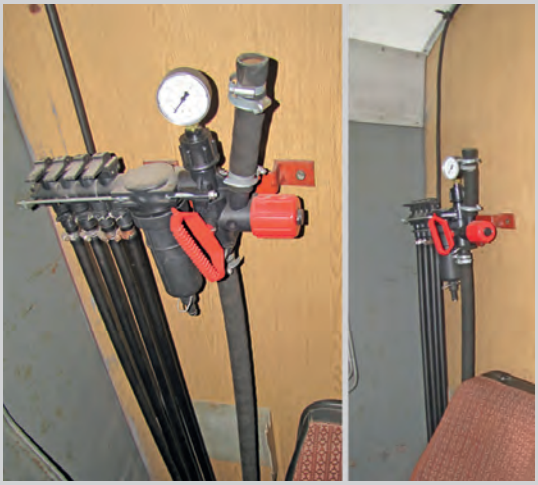

Fig. 6 – **Example** of manually control of distribution system (photo: A. Godyń).

2.2.12.1 Static

The distribution shall have a rectangular pattern with a distinct cut-off at the edge.
Method of verification: measurement according to 3.6.1.

2.2.12.2 Dynamic

The distribution pattern shall be distinct cut-off at the desired swath width especially at the outer edge .
Method of verification: visual check by the use of water sensitive paper according to 3.6.2.

2.2.13 Weed detecting system

When provided, shall work properly.
Method of verification: visual check by the use of artificial target according to ? 3.7

2.2.14 Other electronic devices

When provided, shall work properly.
Method of verification: visual check and function test.
NOTE: proper functionality of very complex devices shall be guaranteed by manufacturer.

2.2.15 Additional requirements for lances

2.2.15.1 Trigger

The trigger shall function. It shall be lockable in the closed position and not lockable in the open position.
The opening and closing system installed on the gun shall have a quick stop and opening.
There shall be no continuous dripping when the trigger is « off » (closed position). There shall be no leakage.
Method of verification: visual check and function test.

2.2.15.2 Adjustment of flow rate and angle

If the flow rate and/or spray angle of the spray gun is adjustable, the adjustment device shall function.
Method of verification: visual check and function test.

3 Test methods

3.1 Water Pump capacity test (optional)

3.1.1 Test method

The pump capacity shall be measured using the following procedure:

a) On sprayers not fitted with a test adapter, when pump capacity is not given by sprayer manufacturer for the pump mounted on the sprayer or for pumps for which the maximum working pressure is not known calibrated pressure indicator shall be placed at an end nozzle and the maximum working pressure recommended by the sprayer manufacturer or the nozzle manufacturer during test shall be established and used.

b) The tank shall be filled with clean water to half its nominal volume. A correct and clean filter shall be placed on suction side of the pump in accordance with the sprayer manufacturer's instructions.

All connections shall work properly without leakage at maximum operating pressure and without air inlet.

Connect the measuring device as close as possible to the pump outlet or at a position provided by the sprayer manufacturer.

In case of multiple pumps with separate outlets, one for agitation and one for nozzles, the measuring device shall be connected according to the sprayer manufacturer's instructions, either on each outlet separately or to both outlets connected together.

Water discharged from the measuring device shall be fed back into the sprayer's main tank.

The pump shall be operated at the nominal rotation speed given by the pump manufacturer.

Pumps with variable flow, driven by sprayer wheels, shall be operated according to the instructions given by the sprayer manufacturer.

The flow shall be measured at free outlet at one pressure between 8 (± 0.2) bar and 10 (± 0.2) bar, or if lower at the highest permitted working pressure for the pump.

3.1.2 Test equipment

The error of the flow meter shall not exceed 2 % of the measured value when the capacity of the pump is >100 l min^{-1} and 2 l min^{-1} when the capacity of the pump is < 100 l min^{-1}.

The flow measuring device shall have a transparent part to identify air leakages on the pumps suction side.

3.2 Pump pulsations

Pulsations shall be checked:

- with nominal rotation speed of the pump;
- at the location of the sprayer's pressure indicator (with the calibrated test pressure indicator).

3.3 Verification of the sprayers pressure indicators

3.3.1 Specifications of pressure indicators used for verification

Analogue pressure indicators used for testing shall have a minimum diameter of 100 mm and shall be damped. Other minimum requirements on pressure indicators used for testing are given in Tab. 1.

Tab. 1 – Characterization of pressure gauge used for testing in accordance with EN 837-1.

Pressure to measure Δp (bar)	Scale unit max. (bar)	Accuracy (bar)	Class required	Scale end value (bar)
0<Δp≤6	0,1	0,1	1,6 1,0 0,6	6 10 16
6<Δp≤16	0,2	0,25	1,6 1,0	16 25
Δ>16	1	1	2,5 1,6 1,0	40 60 100

1 bar = 0.1 MPa = 0.1 N/mm^2 = 10^5 N/m^2

Source: EN ISO 16122-2:2015

3.3.2 Verification method of the sprayer pressure indicator

The sprayers' pressure indicator shall be tested mounted on the sprayer or on a test bench.

Measurements shall be carried out with both increasing and decreasing pressures in each case as a minimum at 4 equally spaced points within the relevant working pressure range.

The measurements require a stable pressure (no pump pulsations).

3.3.3 Measurement of the pressure variation when the spray is switched off

Pressure variation shall be checked at the location of the sprayer's pressure indicator (with a calibrated test pressure indicator).

The variation of the value indicated by the calibrated test pressure indicator is observed and recorded when the spray is switched off.

The pressure shall be observed 10 s after spray is shut off.

3.4 Measurement of the flow rate of the spray nozzles

3.4.1 General

This test may be performed with nozzles mounted on the equipment or removed from the equipment. It shall be ensured that the spray jets are correctly formed when nozzles are mounted on the boom and before dismounting.

The error in the measured flow shall not exceed 2.5 % of the measured value.

The test shall be carried out at working pressure.

3.4.2 Measurement with nozzles fitted on the equipment

A) Agricultural nozzle:

The flow rate of each nozzle shall be measured according to ISO 5682-2:1997, 8.1, except 8.1.1.

B) Special nozzles (flow rate > 10 l min^{-1})

Method to be defined.

3.4.3 Measurement with nozzles removed from the equipment

A) Agricultural nozzle:

The measurement of the flow rate of each nozzle shall be carried out on a test bench.

The test bench consists of a pump by which water with a certain pressure can be pumped through the nozzle, a pressure regulator, a pressure indicator (analogue or digital) by which the actual pressure can be monitored and a flow meter by which the actual flow rate can be measured.

The pressure indicator shall meet the requirements in 3.3.1.

The liquid system, adapters, etc. shall not have an influence on the flow rate.

B) Special nozzles (flow rate > 10 l min^{-1})

Method to be defined.

3.5 Measurement of the accuracy of the chemical dosing systems

Set the chemical dosing system on the most used setting indicated by the owner/user. Use clean water in the direct injection system during measurement of the flow rate (Fig. 7).

Calculate the dosing rate as a percentage from using the following formula:

$$(A/B\text{-}A) \times 100$$

A = Chemical dosing system flow rate, using clean water.

B = Total discharge in l/min of the complete system (pump flow rate + dosing system flow rate) after the mixing device.

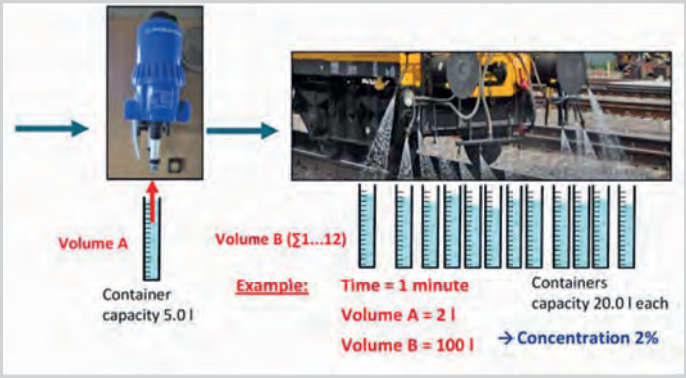

Fig. 7 - Accuracy of the injection system (source: A. Godyń).

3.6 Distribution control (optional)

3.6.1 Static

A patternator is laid out from centre to the outer side of the swath (Fig. 8).

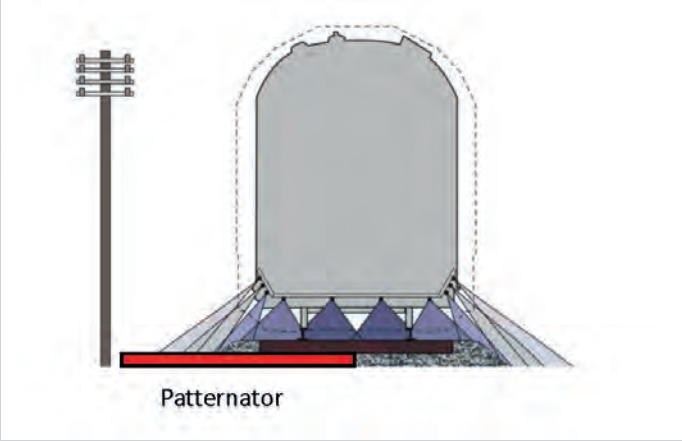

Fig. 8 – Determination of stationary distribution pattern (Source: G&G Company - Hungary)

3.6.2 Dynamic

The test will be made in some place with railway without regular traffic.

Water sensitive paper is laid perpendicular and parallel in correspondence of each spraying section to the track out to both sides. The train is passing with the normal application speed (Fig. 9).

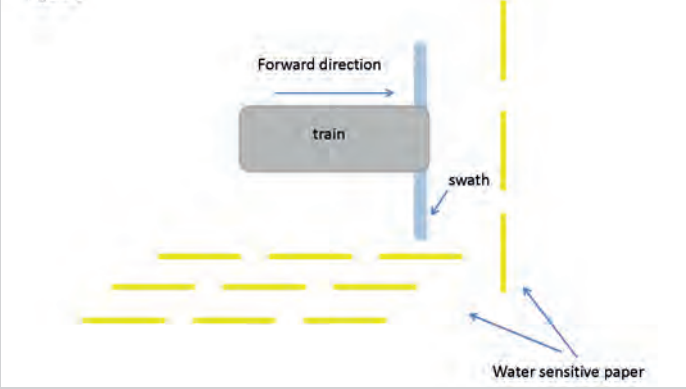

Fig. 9 – Determination of dynamic distribution pattern.

3.7 Accuracy of the weed detecting system

The measurement of the performance of the weed detecting system shall be carried out under dynamic circumstances. Therefore, ten targets per spraying sector in operation are laid out (e.g. artificial turf, 5 X 5 cm of size) with a minimum distance of 5 m in between the targets in forward direction. To control the spraying results water sensitive paper is laid out besides the targets (Fig. 10) as well as 2.5 m before and behind the target in order to control if the system is switching on/off. The train should be operated with normal working speed under different light conditions (at dawn, at noon, at dusk and at night). Overall, 90% of the artificial targets should be detected and sprayed. Results are controlled visually. For further information about methodological issues see Wegener et *al*. (2015) and Pályi et *al*. (2016).

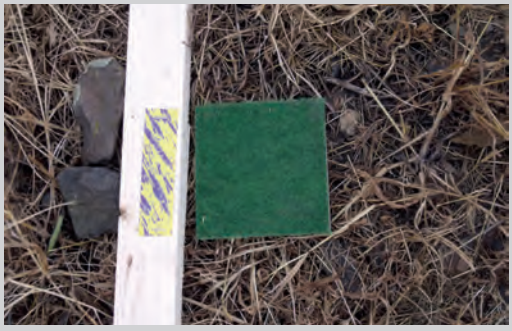

Fig. 10 - Determination of the working accuracy of the weed detecting system (Photo: B. Pályi)

4 Test report

A test report shall include the results of the pre-inspection and the sprayer specific part and shall be given to the owner.

The test report shall give at least the following information:

- Test station;
- Name and contact details of the inspector and, where different, the testing organization and signature;
- Date of inspection;
- Owner's identity;
- Owner's address;
- Sprayer type (special train/special truck);
- Serial number or other identification;
- Year of construction/production;
- Any malfunction of the sprayer. If the malfunction is a result of sprayer design this should be noted;
- Any information on malfunctions of the sprayer useful to identify the corrective work required;
- Results of measurements.

NOTE National or local regulations may give additional requirements for reporting of inspections.

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SPISE – Standardized Procedure for the Inspection of Sprayers in Europe
Established in 2004 by founding members from Belgium, France, Germany, Italy and the Netherlands, the SPISE Working Group aims to further the harmonisation and mutual acceptance of equipment inspections. In regular meetings, several Technical Working Groups (TWG) prepare advice about the items taken into account by the EU Directive 128/2009/EC but still not considered in the actual ISO/CEN Standards. The present document is intended to provide technical instructions and describes a procedure which is not mandatory but can be voluntary adopted in the course of inspection or calibration.

Further information can be found at **http://spise.julius-kuehn.de**

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