# Session 4: Regular calibration and technical checks of pesticide application equipment (according article 8/5)

## Introduction paper

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### Introduction

According to the Framework Directive on Sustainable use of Pesticides, 2009/128/EG (FWD) article 8:5: "Professional users shall conduct regular calibrations and technical checks of the pesticide application equipment according to the appropriate training received as provided for in Article 5". The purpose is to keep the equipment in good condition between inspections and to ensure correct dosage and distribution of the plant protection product. Furthermore the operators will have higher knowledge of the equipment and its use as well as higher awareness of failing equipments influence on environment.

From a legal point of view there is a clear demand on the user to conduct the calibration and technical checks. The training that member states are obliged to offer is not mandatory for the user of plant protection products to participate in. However, if the training is not mandatory in a Member State, it can be assumed that at least agricultural users will participate in the training, as the demands in FWD are subject of Cross Compliance. Other users may participate in training if it will be demanded in national regulations or by demands from market.

Due to the fact that the calibration and technical checks are mandatory there is a need to provide the users with reasonable, simplified methods and protocols yet assuring a high level of protection of environment and good effect of the treatments with plant protection products. Also it has to be considered that the methods shall be part of training and that the protocols are subject for control and therefore also must be possible to understand for control staff. At best, harmonised methods are developed for calibration and technical checks of the equipment as well as their part in training are agreed on. The legal aspects of the time when the different parts of FWD are put into force and how the situation can be solved before all users have had the possibility to attend training and methods are available for inspection has to be considered.

### Calibration

The essence of calibration is to know the output per area unit or treated mass. Mainly this is expressed as e.g. l/ha for sprayers or kg/ha for granule sprayers. Methods for calibration exist for all kinds of equipment. They can be found in operator manuals and are generally a part of training courses. Also technical aids for calibration are available e.g. tables, Calibration Disc or Calibration Slides. For sprayers: to get the output as l/ha it is necessary to know the flow, measured at the outlet or nozzle as l/min and the travelling speed as km/h. Formulas or technical aids can then be used to determine the output per ha. The users need guidance for calibration for different types of equipment. A checklist or protocol used for calibration can also be used for audits and controls. An example of protocol for calibration and examples of calibration methods are given in Annex A. Calibration of sprayers is further developed by Andersen and Jörgensen (2010).

### Technical checks

Regular technical check should be carried out by the operator of the equipment as simple visual checks and functional tests without technical aids. The technical checks should consider relevant parameters in order to make them understood, accepted and useful for the user and guarantee a high level of safety to the society. The level of checks should be on a realistic level for the user and make it possible to control that the checks have been performed. The regular technical checks should be linked to the content in the inspection of the equipment in use reflecting the demands in FWD Annex 2. For the user of the equipment it is also essential that the check consider demands in quality assurance systems like Integrated Pest Management, IPM, and GLOBALGAP. As it can be assumed that it will take

considerable time to develop the methods for inspection of all kinds of equipment in professional use, also methods for technical checks may be basic in the beginning and later on further developed as methods and training are developed. It has to be considered that the methods for technical check also must be suitable for regular training courses. Basic demands for all kinds of equipment are that there shall be no leakage from the equipment, all the different parts shall be suitable for the appropriate application, in good condition and work reliably. A good basis for regular technical checks can be found in GLOBALGAP control points and compliance criteria, Guideline for visual inspection and functional tests of application equipment. These parameters are based on the requirements in the inspection of sprayers in use according to EN 13790:

1. There shall be no leakages from the pump, spray liquid tank (when the cover is closed), pipes, hoses and filters.
2. All devises for measuring, switching on and off, adjusting pressure and/or flow rate shall work reliably and there shall be no leakages.
3. The nozzle equipment shall be suitable for appropriate application of the plant protection products. All nozzles shall be identical (type, size, material and origin), form a uniform spray jet (e.g. uniform shape, homogenous spray) and there shall be no dripping after switching of the nozzles.
4. All the different parts of the equipment (sprayer), e.g. nozzle holder/carrier, filters, blower, etc shall be in good condition and work reliably.

Proposal for parts of sprayer to be checked on boom-sprayer, mist blower, band-sprayer, handheld sprayer with engine and other sprayers working with same principles:

| **Part** | **Check method and demand** |
|---|---|
| Power transmission parts: | Visual check that there are no damages and that guards are in place and working properly. |
| Pump flow and agitation | Check with tank half full with clean water. Spray with the biggest nozzle on the highest used pressure. Visual check of the agitation in the tank.<br>No leakages from the pump. |
| Tank | Visual check for leakages<br>No leakages.<br>Lid in place. |
| Armature | Check by operating that on-/off adjustments and measuring device work reliably.<br>Manometer shows pressure stable.<br>No leakage. |
| Pipes and hoses | Visual check.<br>No leakages.<br>Not disturbing spray pattern. |
| Filters | Filters not blocked.<br>Good condition and works reliably. |
| Boom | Visual check.<br>Boom is straight.<br>No damages. |
| Boom-height adjustment and boom-end return works reliably. | Boom-height adjustment and boom-end return works reliably |
| Nozzles | Nozzles shall be suitable for the task.<br>Identical.<br>Good condition and work reliably.<br>Spray pattern Visual inspection.<br>No Spray pulsation.<br>No dripping after shut off. |
| Fan | Visual check.<br>Good condition.<br>Guards are safe.<br>Gear works (if applicable).<br>No vibrations. |
| Chassis, wheels | Visual check of chassis, draw-bar, three-point connection, wheel axles and wheels including bearings.<br>Good condition. |

Parts to be checked on portable and handheld sprayers:

| Part | Check method and demand |
|---|---|
| Pump | In good condition, works reliably. |
| | No leakage. |
| Tank | No leakage |
| Hose | No leakage |
| Handle | In good condition, works reliably. |
| | Even spray pattern. |
| | Even flow. |
| | No dripping. |

The control points mentioned above are all possible to check without technical means. As they also are part of the inspection of sprayers in use, the check will ensure that the sprayer is well maintained and works reliably also between inspections and is should result in less remarks during inspections. Check of chassis, wheels etc are proposed to be a part of regular checks as it is relevant to prevent accident that may result in large-scale leakages of spray-liquid causing major contamination of environment and also human injuries.

A simple protocol with checkpoints is needed for the checks and for the controlling authority. The protocol should be realistic for the user to use and for the authority to audit. Examples of protocols with control points and check-methods are given in annex B.

## Training

Training courses already exist in Member States with various levels of content. In most cases calibration and technical checks are already included in courses, so far at a level of best management practise and also reflecting recommendations given by manufacturers. As examples Denmark has a basic course to receive a “Spraying Certificate” on 74 hrs. The courses give a general certificate for use in agriculture, horticulture and forestry. Knowledge on sprayer’s construction, functions and adjustments is a part of the course. From 2009, a 1-day refresher course is demanded every 4 year, without exams. Another example, Sweden has a basic course on four days of which 4 hours are practical in calibration of knap sack sprayers and boom sprayers. Calibration and dosage calculations are important parts of the courses. A one-day refresher course is demanded every 5 years. Written exams are demanded on the courses. The participants need to give correct answers on calibration- and calculation questions to receive the certificate. The course gives a certificate for professional use of all plant protection products except seed-treatment that has a special course.

The FWD will cause Member States revision of the courses and development of new training courses. Concerning application equipment there will be obligations to deal with proper use of equipment subject to exemption from inspection as well as calibration and technical checks on equipment in a way that the performed measures can be recorded and controlled.

## References

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EN 13790 Agricultural machinery – Sprayers – Inspection of sprayers in use – Part 1: Field crop sprayers

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## Annex A

**Example of Report for calibration**

Equipment identity.

Type ……..

Owner ……

Date ……  Calibration performed by: ……..

Signature: ……

**Speed**

| **Time for 100 m** | **Speed** | **Optional: gear, rpm, wheel size** | **Optional: Shown on display** | **Notes** |
|---|---|---|---|---|
| | | | | |
| | | | | |
| | | | | |
| | | | | |

**Output**

| **Nozzle type/output type and size** | **Number of nozzles** | **Measured l/min** | **speed** | **l/ha** |
|---|---|---|---|---|
| | | | | |
| | | | | |
| | | | | |
| | | | | |

**Examples on calibration methods**

For the user of the equipment it is necessary to measure output per nozzle and travel speed. Knowing this, the liquid-rate per hectare can be calculated.

For boom sprayers, knappsack and handheld sprayers, the wanted output per nozzle is calculated with the formula:

$$\text{L/min} = \frac{\text{liquide rate (l/ha) x speed (km/h) x nozzle distance (m)}}{600}$$

The driving- or walking speed can easily be calculated by measuring the time for driving 100 m. This is also useful for checking the functioning of sprayer computers:

$$\text{Speed (km/h)} = \frac{360}{\text{Time to drive 100 m /sec)}}$$

Knowing the output per nozzle and speed the liquid-rate can be calculated.

The flowrate should be measured representative for sprayer sections and for all present nozzle types or sizes.

$$\text{Liquid rate (l/ha)} = \frac{\text{nozzle flow (l/min) x 600}}{\text{Speed (km/h) x nozzle distance (m) (working width)}}$$

Hand-operated sprayer (lance)

$$\text{Nozzle flow (l/min)} = \frac{\text{Sprayed area (m2) x liquide rate (l/1000 m2)}}{\text{Time (sec) x 16,7}}$$

## Mistblowers

Mistblowers for orchards, winery etc can be calibrated and checked by calculating the needed total flow for all nozzle and thereafter the wanted nozzle flow (l/min). It should be considered that different nozzle sizes can be used at the same time. Measurement of single nozzle flow should be made for each size on both sides of the sprayer.

Liquid flow for all nozzles

$$\text{Sum flow (l/min)} = \frac{\text{Liquid rate (l/ha) x speed (km/h) x row distance}}{600}$$

Single nozzle flow

$$\text{Nozzle flow (l/min)} = \frac{\text{Nozzle flow for all nozzles (l/min)}}{\text{Number of nozzles}}$$

Granule spreaders

Turn driving wheel 100 turns. Collect and measure the output amount from one or more outlets.

Calculate the output per hectar by

A = row distance

B = weight of collected output from 1 output after 100 turns

C = diameter of driving wheel

D = number of turns on driving wheel

E = number of spreaders/outputs

$$\text{Output rate (kg/ha)} = \frac{10 \times B}{A \times C \times D \times E \times 3{,}14}$$

## Annex B

**Example of report, Self certification Scheme Regular technical check of sprayer (boom-sprayer, mistblower, band-sprayer, handheld sprayer with engine….)**

Date: ……..

Sprayer identity: Brand, type: Owner:

……. …….. …….

Check performed by: Signature:

…….. ……..

| Checkpoint | | Demands, check method | OK | To be repaired | Note |
|---|---|---|---|---|---|
| 1 | PTO-shaft | No damages | | | |
| 2-3 | Pump-flow/agitation | Tank half-full with water.<br>Spray with biggest nozzle on highest pressure.<br>Visual check of agitation in tank.<br>No leakage from pump. | | | |
| 4 | Tank | No leakage<br>Lid in place | | | |
| 5 | Armature | On/off- adjustments and measuring works reliably.<br>Manometer shows pressure stabile.<br>No leakage | | | |
| 6 | Pipes and hoses | No leakage.<br>Not disturbing spray pattern. | | | |
| 7 | Filters | Not blocked.<br>Good condition, works reliably. | | | |
| 8 | Boom | Straight.<br>No damages.<br>Boom-height adjustment and boom-end return works. | | | |
| 9 | Nozzles | Nozzles shall be suitable for task.<br>Identical.<br>Note nozzles.<br>Good condition, work reliably.<br>Spray pattern: visual inspection.<br>No pulsation.<br>No dripping after shut off | | | |
| 10 | Fan | Good condition, work reliably.<br>Guards are safe.<br>Gear works (if applicable).<br>No vibrations. | | | |
| 11 | Chassis, wheels | Good condition<br>No damages<br>Visual check of chassis, draw-bar, three-point connection, wheel axles and wheels including bearings. | | | |

**Example of report: Self certification scheme regular technical check of sprayer (portable and handheld sprayers; knappsack sprayers, handheld sprayers….)**

Date: ……..

Sprayer identity: Brand, type: Owner:

……. …….. …….

Check performed by: Signature:

…….. ……..

| Checkpoint | | Demands, check method. | OK | To be repaired | Note |
|---|---|---|---|---|---|
| 1 | Pump | Good condition, work reliably.<br>No leakage. | | | |
| 2 | Tank | No leakage. | | | |
| 3 | Hose | No leakage. | | | |
| 4 | Handle | Good condition, work reliably.<br>No leakage. | | | |
| 5 | Nozzle | Good condition, work reliably.<br>Even spray pattern.<br>Even flow.<br>No dripping. | | | |