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**Equipment for crop protection —  
Closed transfer systems (CTS) —  
Performance specification**

*Matériel de protection des cultures — Systèmes de transfert fermés  
(STF) — Spécification des performances*

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## Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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](http://www.iso.org/directives)).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see [www.iso.org/patents](http://www.iso.org/patents)).

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For an explanation of 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 [www.iso.org/iso/foreword.html](http://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*.

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](http://www.iso.org/members.html).

# Equipment for crop protection — Closed transfer systems (CTS) — Performance specification

## 1 Scope

This document specifies operator and environment-related safety requirements and the means of their verification for the design and construction of closed transfer systems (CTS) for liquid formulations of plant protection products (PPP) in 1 l to 20 l containers.

In addition, it specifies the type of information on safe working practices including information about residual risks to be provided by the CTS manufacturer and specifies the maximum potential contamination during any single transfer operation.

## 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 3600, *Tractors, machinery for agriculture and forestry, powered lawn and garden equipment — Operator's manuals — Content and format*

ISO 3767-1, *Tractors, machinery for agriculture and forestry, powered lawn and garden equipment — Symbols for operator controls and other displays — Part 1: Common symbols*

ISO 3767-2, *Tractors, machinery for agriculture and forestry, powered lawn and garden equipment — Symbols for operator controls and other displays — Part 2: Symbols for agricultural tractors and machinery*

ISO 5681, *Equipment for crop protection — Vocabulary*

ISO 21278-1:2008, *Equipment for crop protection — Induction hoppers — Part 1: Test methods*

ISO 21278-2, *Equipment for crop protection — Induction hoppers — Part 2: General requirements and performance limits*

## 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

#### application equipment

device or assembly of components to mix and apply plant protection products and other compatible chemicals to the target

[SOURCE: ISO 5681:2020, 3.1.16]

**3.2**  
**closed transfer system**  
**CTS**

device or assembly of components, including the container to *application equipment* (3.1) interface, intended to wholly and partially transfer plant protection products or other compatible liquids from their original containers into application or mixing equipment by direct coupling or other engineering means of enclosure that reduces the exposure of the operator and environment

[SOURCE: ISO 5681:2020, 3.2.9.6]

**3.3**  
**single transfer operation**

actions required to be completed starting from connection of the container to the CTS, completion of the product transfer procedure, measurement of partial transfers where applicable, rinsing of the container and the transfer device, and removal of the container ready for storage or disposal

**4 General requirements**

**4.1** CTS shall include:

- a) a means of interfacing with containers (see [Annex A](#) as an example) and application equipment;
- b) a means of controlling or measuring part or all of the product from the container;
- c) a means to rinse the container in to the application equipment, if appropriate (for example if CTS is designed for containers as shown in [Annex A](#));
- d) a means of flushing the CTS as well as the interface.

Compliance shall be checked by inspection and the function tests specified in this document.

**4.2** A manual shall be provided by the CTS manufacturer that meets the requirements in [Clause 6](#).

**4.3** All operations of a CTS shall be possible while using appropriate personal protective equipment, including gloves as recommended in the operator's manual and on the container label.

Compliance shall be checked by a function test.

**4.4** CTS's shall be designed so that no part of the equipment is subjected to pressures greater than the manufacturer's stated maximum for the system. To minimize potential contamination in the event of a failure, no part of the CTS shall operate with the concentrated product formulation at a pressure greater than 100 kPa unless:

- a) the component parts of the CTS have been pressure tested with a pressure of two times the maximum for the system, or
- b) a secondary containment system is used.

The CTS shall not modify the pressure in the container by more than negative 4 kPa from the ambient atmospheric pressure.

Compliance shall be checked by measurement a) and inspection b).

**4.5** The CTS shall empty the content of the container while:

- a) maintaining the shape, dimensions and leak tightness of the container; no leakage shall occur in accordance with [5.1](#);
- b) allowing drainage of the contents, in accordance with [5.2](#);

- c) allowing effective rinsing of the container and any interfaces when required (after partial transfer, product measurement or no rinsing if the container is refillable), in accordance with [5.2](#).

**4.6** The CTS when operated according to the operator's manual and attached to the application equipment shall not:

- a) cause leakage at the device it is connected to;  
 b) influence the circulation system of the application equipment it is connected to;  
 c) allow the introduction of air that promotes foaming or reduces pump performance.

Compliance shall be checked by a function test.

**4.7** All controls on CTS's shall be clearly labelled using symbols conforming to ISO 3767-1 and ISO 3767-2 where appropriate.

Compliance shall be checked by a function test.

**4.8** CTS shall be designed to prevent any return of liquid to clean water supply.

Compliance shall be checked by a function test.

**4.9** In case the container opening is covered by a foil, the foil shall be kept attached to the container and be rinsed.

Compliance shall be checked by a function test.

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## 5 Performance requirements ISO 21191:2021

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### 5.1 Leakage

#### 5.1.1 General

When operating CTS equipment, in accordance with the manufacturers operating instructions, there shall be no observable leaks from the container, CTS, the interface between them including any associated connections, measuring or control devices when tested according to [5.1.4](#). One sample of each adaptor/interface available from the CTS manufacturer shall be supplied with the CTS tested.

#### 5.1.2 Principle

This test is conducted while the CTS is being used to connect, open, empty, measure (where measurement devices are present) and rinse the container and CTS. The test uses a 0,1 % solution of a surfactant in water with the addition of a fluorescent dye to disclose any leaks at the relevant stages of operation.

#### 5.1.3 Apparatus

**5.1.3.1 System leakage test formulation**, specified in [Annex C](#). A similar dye that fluoresces under the ultraviolet light specified in [5.1.3.6](#) can be substituted.

**5.1.3.2 Test container**, the maximum size container with which the system is designed to operate and specified in the CTS manufacturer's manual.

**5.1.3.3** The CTS to be tested shall be prepared to operate as determined by the manufacturers' operator instructions for installation and use.

**5.1.3.4** The **pipe/hose supplying** the rinsing water to the CTS shall be fitted with a pressure indicator and any pump or other means of assisted dispense shall be fitted with a crop sprayer pressure gauge.

Sprayers shall be fitted with a pressure indicator, the accuracy of which shall be

- $\pm 0,2$  bar for working pressures between 1 bar (included) and 8 bar (included),
- $\pm 0,5$  bar for working pressures between 8 bar and 20 bar (included), and
- $\pm 1$  bar for working pressures more than 20 bar.

The pressure indicator shall be clearly readable. The pressure indication shall be stable. The scale of the pressure indicator shall be marked as follows:

- 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.

**5.1.3.5 Ultraviolet disclosing goggles or filter with yellow lenses**, to protect the eyes of the test operator and to enhance visibility of UV fluorescence.

**5.1.3.6** An **ultraviolet light source: High output LED flashlight**, with a wavelength of 385 nm to 400 nm and a minimum UV-A intensity of 10 000  $\mu\text{W}/\text{cm}^2$ .

**5.1.3.7 Potable water and disposable wipes** for dye removal.

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**5.1.3.8** An **absorbent sheet** able to collect all splashes and leakages placed on ground under the CTS to be tested. The dimension should be able to collect splashes and leakage from the CTS and connection to the application equipment.

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## 5.1.4 Procedure

**5.1.4.1** Load the test formulation to the nominal volume of the container (5.1.3.2). Thoroughly clean all external surfaces of the product container and CTS using the ultraviolet dye removal materials specified in 5.1.3.7. Scan all surfaces of the product container and CTS with the UV light source and remove any disclosed areas using the dye removal materials to ensure no dye is visible.

**5.1.4.2** The operator shall ensure to use a coverall and gloves that are not contaminated with the test formulation. These can be tested using the UV light source in a dark room before and after the test. Connect the filled container prepared as specified in 5.1.4.1 to the CTS. Transfer the test formulation into the CTS to be tested in accordance with the CTS manufacturer's instructions including the measuring device if fitted.

**5.1.4.3** Immediately upon completion of the actions in 5.1.4.2 and with the connections to the container and CTS fully engaged and connected, blackout all windows and turn off all other light sources to the point that no visible light enters the room then use the UV light source to inspect all external surfaces of the container, CTS and associated connections. Using the appropriate yellow tinted spectacles/filter, observe the surfaces for evidence of leakage. Record any leakage in a test report (see example in Annex D).

**5.1.4.4** Operate the container rinsing device of the CTS as detailed in the manufacturers' operator manual to achieve the internal rinsing of the container and internal rinsing of the CTS as specified in 5.2. Use the UV light source to inspect all external surfaces of the product container, CTS and associated connections.



**5.1.4.5** Use the same procedure to identify any fluorescence of residues on the operator's coverall and gloves as this also indicates system leakage.

**5.1.4.6** Use the same procedure to identify any fluorescence of residues on the absorbent sheet on the ground as it indicates leakages to the environment.

**5.1.4.7** Complete this procedure a minimum of 5 times. Record results in a test report (see example in [D.2](#)).

## 5.2 Container and system interface rinsing

### 5.2.1 General

After rinsing the container, the maximum residue remaining in the test container and on systems interfaces shall not exceed 0,01 % of the test containers ([5.1.3.2](#)) nominal volume at each point.

### 5.2.2 Principle

This test uses a test liquid formulation containing a blue dye, of which small quantities can be traced and quantified using direct chemical analysis or spectrophotometric (colorimetric/fluorimetric) analysis techniques after extraction. The CTS equipment and each interface shall be cleaned and dry before each test.

### 5.2.3 Apparatus

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**5.2.3.1** The CTS to be tested shall be installed and operated according to the manufacturer's instructions. If the CTS is designed to function with a foil seal on the container closure, the test shall be completed with a foil seal on the test container.

**5.2.3.2** The **pipe/hose supplying** the rinsing water to the CTS shall be fitted with a pressure indicator and any pump or other means of assisted dispense shall be fitted with a crop sprayer pressure gauge.

Pressure indicator performance is as defined in 5.1.4.3.

**5.2.3.3** A **sticky reference product** test liquid as defined in [Table B.1](#).

**5.2.3.4** Clean **containers** with which the system is designed to operate as specified in the CTS manufacturers' manual ([5.1.3.2](#)).

**5.2.3.5** An **open top circular mixing container** with a nominal capacity suitable to prepare the total volume of test liquid required in one or more batches.

**5.2.3.6** A **two speed** (0 r/min to 1 100 r/min and 0 r/min to 3 000 r/min) **electric drill** fitted with a paint/plaster mixing attachment.

**5.2.3.7** **Clean absorbent swabs** (soft tissue paper) that can be moulded to the shape of a finger end to be used to collect any residues that are visible and accessible on the surfaces of the CTS, container and any of the CTS interfaces.

### 5.2.4 Procedures

The following procedures can be combined to reduce the complexity and time required.

#### 5.2.4.1 Container rinsing procedure

This test is detailed below and is similar to ISO 21278-1:2008, 6.8.1.

The CTS manufacturers' operating instructions shall be followed, and the tests conducted with an ambient temperature between 15 °C and 30 °C.

**5.2.4.1.1** The tests shall be carried out with a clean and dry container as specified in [5.1.3.2](#) and the test liquid in [Annex B](#).

**5.2.4.1.2** If the CTS being tested requires a sealing foil to be part of the container and packaging, this should be specified and the conditions for opening and rinsing the container shall be followed.

**5.2.4.1.3** Connect the container to the device to be tested. Empty the container, filled with the test liquid specified in [Annex B](#), until no evident dripping is present for at least 20 s and conduct the test directly.

**5.2.4.1.4** Clean the container and CTS using the procedure detailed in the manufacturer's instruction manual.

**5.2.4.1.5** Fill the container with a volume of water equivalent to 10 % of its nominal volume. Close the container with a lid, rinse the container by intense shaking and take a sample of that liquid. Determine the concentration of original test liquid formulation by using an appropriate spectrophotometric (colorimetric/fluorimetric) analysis technique to an accuracy of  $\pm 5,0 \mu\text{l/l}$ . Calculate the residue collected from the CTS using [Formula \(1\)](#):

$$R = c V \quad (1)$$

where

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$R$  is the residue collected from the CTS;

$V$  is the volume of water;

$c$  is the concentration of original test liquid.

Calculate the percentage of the residue of the container nominal volume,  $V_n$ , using [Formula \(2\)](#):

$$p = \frac{R}{V_n} 100\% \quad (2)$$

where

$p$  is the percentage of the residue of the container;

$V_n$  is the nominal volume.

#### 5.2.4.2 Interface residue procedure

On disconnection from the rinsed PPP container, the aggregate maximum residue on the interface of the CTS and the PPP container and any other interfaces, used to connect the system that are accessible to the operator, shall not exceed an amount equivalent to 0,25 ml of the [Annex B](#) test liquid.

**5.2.4.2.1** Before each test, the interfaces shall be cleaned and dried.

**5.2.4.2.2** Prepare the swabs by forming them into a shape similar in size and area to the end of a forefinger and label each swab (the top of an 'S' class gloved finger or a 12 mm dowel with a hemispherical head or test probe from ISO 5395-3 can be used to achieve this).

**5.2.4.2.3** Collect all accessible residues after having completed the transfer of a test liquid formulation (as specified in [Annex B](#)) and rinsing procedure when using the container specified by the manufacturer's instruction manual ([5.1.3.2](#)).

**5.2.4.2.4** Separate the interface and/or any other connections that should be disconnected according to the manufacturer's instruction manual.

**5.2.4.2.5** Use the swabs as prepared in [5.2.4.2.2](#) to recover any visible residues on the interface surfaces, that an operator could access, and touch during system operation. Use a separate swab for each part of each interface and record where they are used. Place the used swabs in a sealable container to prevent drying.

**5.2.4.2.6** Determine the concentration  $c$  of original test liquid formulation by immersing the swabs in a known volume,  $V$ , of water and then use an appropriate spectrophotometric (colorimetric/fluorimetric) analysis technique to an accuracy of  $\pm 5,0 \mu\text{l/l}$ . Calculate the residue collected from the CTS using [Formula \(1\)](#).

### 5.2.4.3 Simultaneous tests

Follow the CTS manufacturer's instruction manual procedures to complete a minimum of 5 container rinse and interface residue tests.

Record the details of the CTS being tested, the container used, pressure and volume of the rinse water used and any differential pressure generated in the model of table in [D.3](#), for the removal of the container residues, and in the model of table in [D.4](#) for the interface residues.

## 5.3 Transfer system residues

### 5.3.1 General

After dispensing the container, rinse test liquid as detailed in [Annex B](#) and rinsing/flushing the CTS according to the manufacturer's specified procedure the total maximum residue inside the CTS, including any associated measuring or control devices, shall be less than 1 ml of the container rinsing test liquid formulation. The manufacturer of the CTS shall determine the position where the flow path of liquid from CTS equipment ends and the application equipment it is connected to begin.

### 5.3.2 Principle

This test uses the container rinsing test liquid formulation detailed in [Annex B](#) of which small quantities can be traced and quantified using direct chemical analysis or spectrophotometric (colorimetric/fluorimetric) analysis techniques after extraction. This formulation is thick and sticky to represent the behaviour of a sticky product likely to resist rinsing.

### 5.3.3 Apparatus

**5.3.3.1** The CTS to be tested shall be, installed and operated according to the manufacturer's instructions.

**5.3.3.2** Container rinsing test liquid formulation, as specified in [Annex B](#).