# INTERNATIONAL STANDARD

**ISO 7749-2**

First edition
1990-10-15

# Irrigation equipment — Rotating sprinklers —

# Part 2: Uniformity of distribution and test methods



*Matériel d'irrigation — Asperseurs rotatifs —*
*Partie 2: Uniformité de la distribution et méthodes d'essai*



Reference number
ISO 7749-2 : 1990 (E)

## Foreword

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Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.



International Standard ISO 7749-2 was prepared by Technical Committee ISO/TC 23, *Tractors and machinery for agriculture and forestry.*



ISO 7749 consists of the following parts, under the general title *Irrigation equipment — Rotating sprinklers*:

— *Part 1: Design and operational requirements*

— *Part 2: Uniformity of distribution and test methods*

Annex A forms an integral part of this part of ISO 7749.



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Case postale 56 • CH-1211 Genève 20 • Switzerland
Printed in Switzerland

# Irrigation equipment — Rotating sprinklers —

# Part 2:
# Uniformity of distribution and test methods

## 1 Scope

This part of ISO 7749 specifies the conditions and methods used for testing the uniformity of distribution of rotating sprinklers, expressed as a function of the coefficient of distribution uniformity (CDU). It applies only to stationary rotating sprinklers intended for irrigation and for operation at the pressures recommended by the manufacturer.

## 2 Normative reference

The following standard contains provisions which, through reference in this text, constitute provisions of this part of ISO 7749. 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 7749 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 7749-1 : 1986, *Irrigation equipment — Rotating sprinklers — Part 1: Design and operational requirements*.

## 3 Definitions

For the purposes of this part of ISO 7749, the definitions given in ISO 7749-1 and the following definitions apply.

**3.1 water application rate**: Mean depth of water applied to an area irrigated in a unit of time (for example, millimetres per hour).

**3.2 collector**: Receptacle used for collecting the water discharged by the sprinkler during the test of distribution uniformity.

## 4 Test of distribution uniformity

### 4.1 General test conditions

#### 4.1.1 Test area layout

The test area where the collectors are positioned shall be levelled evenly in a horizontal plane (a maximum slope of 1 % for the test area is acceptable). It shall be free from obstacles that could block the free distribution of water.

There shall be no trees or obstructions in the vicinity, as these could cause varying air flow over the test area. The test area may be within a sheltered, enclosed structure or out in the open.

#### 4.1.2 Design of collectors

Collectors used for collecting the water discharged by the sprinkler shall be cylindrical for at least the top third of their height, of uniform shape and size, and their open edges shall be sharp and free from deformities. The collectors shall be so constructed that none of the water collected splashes out. The height of the collectors shall be at least twice the average depth of the water collected during the test, but not less than 15 cm.

The diameter of the collector opening shall be half to one times its height, but not less than 8,5 cm.

Collectors intended for collecting water for transfer to a measuring fixture shall have a sharp-edged round opening of at least 8,5 cm diameter. The collectors shall be cylindrical or conical (wide base on top), with side walls inclined at at least 45° from the horizontal.

Other types of collectors may be used, provided that their measuring accuracy is not less than the accuracy of the collectors described above.

The openings of all the collectors shall be in a plane parallel to the ground, with a tolerance of ± 5°, and the difference in height between any two adjacent collectors shall not exceed 2 cm.

#### 4.1.3 Installation of sprinkler for testing

New sprinklers shall be run-in before the test for a continuous one-hour period at the test operating pressure.

Mount the sprinkler on a riser with a diameter compatible with the connecting thread on the sprinkler. Ensure that the riser is fixed vertically, and that it does not bend or deviate from the vertical during the test. The maximum allowable deviation from the vertical during the test shall not exceed 1°.

The height of the principal sprinkler nozzle above the openings of the collectors shall be at least 10 times the nominal diameter of the sprinkler connection, but not less than 50 cm.

A sprinkler for which the manufacturer recommends a different height, e.g. a pop-up sprinkler, shall be tested with the height of the principal sprinkler nozzle above the openings of the collectors specified by the manufacturer as the height recommended for proper operation.

A strainer shall be installed in the supply line upstream of the pressure measuring tap. The strainer shall be fitted with a mesh that passes particles no greater than 30 % of the minor axis of the smallest clear passageway in the sprinkler.

#### 4.1.4 Measurement of atmospheric conditions

Before performance of the distribution test, and during the test at intervals not exceeding 15 min, the wind velocity and direction shall be measured in an open field. The wind velocity during the test shall be as specified in ISO 7749-1 : 1986, table 3. Change in wind direction shall be less than 20°, when wind velocity exceeds 0,4 m/s.

Wind measurements shall be carried out at a distance not greater than 50 m from a side of the test area, and at a height of about 90 % of the maximum trajectory height, but not less than 2 m. Wind velocities shall be indicated in the test certificate.

The relative humidity and ambient temperature shall be measured during the course of the test.

#### 4.1.5 Measuring devices and test conditions

The test pressure shall be measured at the height of the main nozzle of the test sprinkler (see figure 1). The point at which the pressure is measured shall be located at least 20 cm upstream of the sprinkler, so that the pressure measured is not affected by any local variation.

No fitting or device which may possibly cause a drop in pressure shall be installed between the point of pressure measurement and the sprinkler.

Dimensions in centimetres

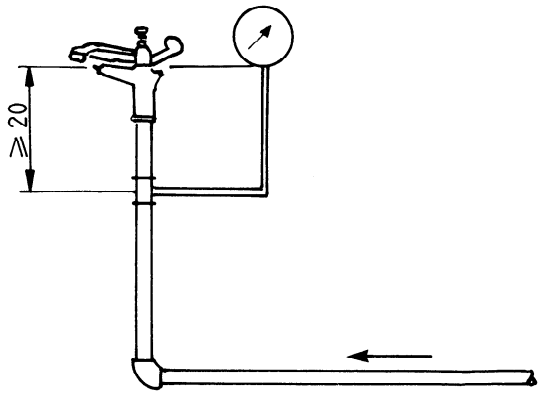



**Figure 1 — Measurement of sprinkler pressure**

The pressure shall not vary by more than ± 4 % during the test. The permissible deviation of the measuring devices from the actual value shall be as shown in table 1.

**Table 1 — Accuracy of measurement**

| Measured quantity | Allowable error |
|---|---|
| Flowrate | ±2 % |
| Pressure | ±2 % |

Wind velocity and direction shall be measured with a cup-fitted totalizing anemometer fitted with a vane or other direction-sensitive device, or with any other device.

Relative humidity and ambient temperature shall be measured with the standard devices used in meteorological field stations for measuring these parameters.

#### 4.1.6 Duration of test

The minimum test duration shall be 1 h.

#### 4.1.7 Calculation of application rate

The water application rate is calculated from the formula:

$$p_r = \frac{q \times 1\,000}{S_l \times S_m}$$

where

$p_r$ is the water application rate, in millimetres per hour;

$q$ is the flowrate of the sprinkler in cubic metres per hour;

$S_l$ is the spacing of sprinkler laterals, in metres;

$S_m$ is the spacing of sprinklers along the lateral, in metres.

### 4.2 Full field method

**4.2.1** Position the riser with the sprinkler at the centre of the test field, at the intersection of the diagonals drawn from the corners of the test field (see figure 2).

**4.2.2** The spacing of the collectors shall be as specified in figure 2. Permissible deviations in the spacings of collectors shall not exceed 5 cm in any direction. The area on which the collectors are placed shall be large enough to ensure complete coverage of the wetted area and shall have an additional suitable safety margin.

**4.2.3** The method of calculation of the coefficient of distribution uniformity (CDU) is given in annex A.

### 4.3 Radial method

This method shall only be performed in no-wind conditions.

Install the collectors along a straight line drawn from the test sprinkler at the centre. The maximum spacings of the collectors along the line shall be as shown in table 2.

**Table 2 — Collector spacing**

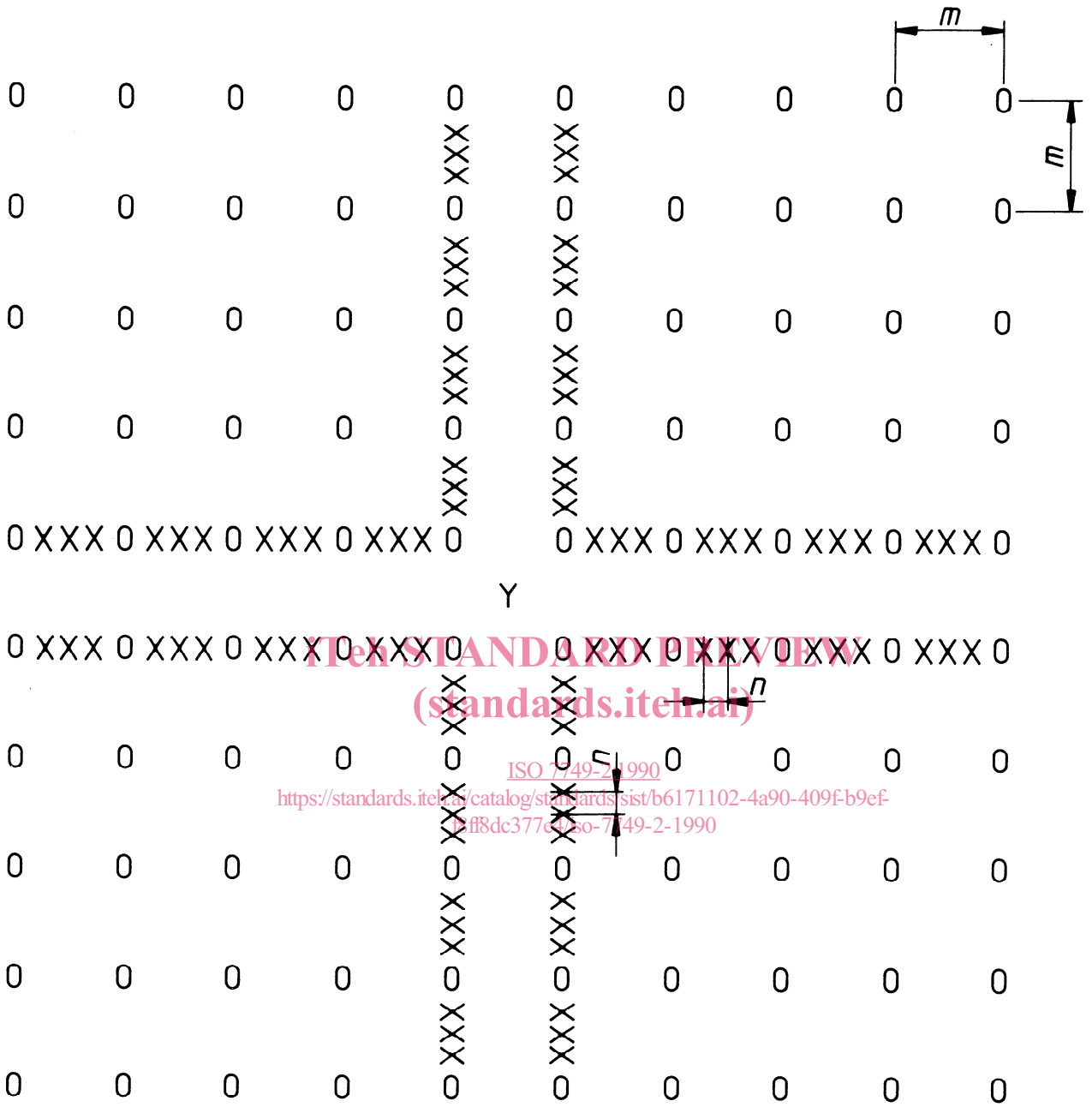
Dimensions in metres

| Collector spacing max. | Diameter of coverage |
|---|---|
| 1 | ⩽ 20 |
| 2 | > 20 |

The number of collectors along the line shall be such as to cover the entire radius of coverage of the sprinkler and shall have an additional safety margin.

During the test, the riser supporting the sprinkler shall be manually rotated a quarter of a revolution (90°) about its axis three times, at equal intervals of time. This rotation is performed during the periods when the water jet of the sprinkler is not above the collectors.

Calculation of the coefficient of distribution uniformity (CDU) is given in annex A.






**Key**

$m$ = 2 m for sprinklers of diameter of coverage greater than 10 m

$m$ = 1 m for sprinklers of diameter of coverage of 10 m and less

$n$ = 0,5 m

Y is the sprinkler;

O is the collector for measuring distribution;

X is the collector for establishing diameter of coverage (see ISO 7749-1).

NOTE — The method of testing the diameter of coverage is specified in ISO 7749-1.

**Figure 2 — Collector placement pattern for testing of sprinkler distribution and diameter of coverage by full field method**

# Annex A
(normative)

# Uniformity of water application

**A.1** The objective of sprinkler irrigation is to achieve uniform application over a given land area. Every sprinkler has a water distribution characteristic that is dependent on water pressure and size of the nozzle. Different sprinklers have different distribution characteristics. The distribution uniformity is affected by the distribution characteristics and the spacing pattern of the sprinklers. There is, therefore, a need to compare the distribution uniformity of different sprinklers under varying operating conditions.

**A.2** J.E. Christiansen[1] developed the following formula for calculating the coefficient of distribution uniformity (CDU):

$$CDU = 100 \left(1 - \frac{\Sigma |h_m - h_i|}{n \times h_m}\right)$$

where

CDU is the coefficient of distribution uniformity;

$n$ is the number of readings;

$h_m$ is the arithmetic average of the readings;

$h_i$ is the individual reading at each collector;

$\Sigma |h_m - h_i|$ is the sum of the absolute values of the individual deviations from the average.

**A.3** The coefficient of distribution uniformity is computed from the results of the sprinkler distribution tests in the field. Collectors of equal size and shape are spread at equal and fixed spacings over the test field. The quantity of water in each collector serves as a basis for computing the coefficient.

For overlapping individual sprinkler patterns for simulation of field conditions, the water distribution pattern for different sprinkler spacings — on the basis of the distribution pattern obtained from a single sprinkler tested by the full field method (see figure 2) — and the CDU for different spacings, are obtained as follows:

a) The collectors are set out as shown in figure 2.

b) The sprinkler is operated according to the conditions given in this part of ISO 7749 and the quantities of water in the collectors are measured.

c) The quantities of water collected are recorded.

d) The cumulative quantities of water that would accumulate in the collectors — if these were placed between four sprinklers identical to the tested sprinkler at the simulated sprinkler spacing for which the CDU is to be computed — are overlapped. The CDU is then computed according to the Christiansen formula.

**A.4** A distribution coefficient of 100 % denotes perfectly uniform distribution over the entire field. Lower percentage values of CDU indicate poorer levels of uniformity in the distribution of water.



**A.5** Testing of sprinklers by the radial method and calculation of the CDU are carried out as follows:

a) The collectors are set out at equal distances along the radial with their point of origin at the point where the sprinkler is mounted.

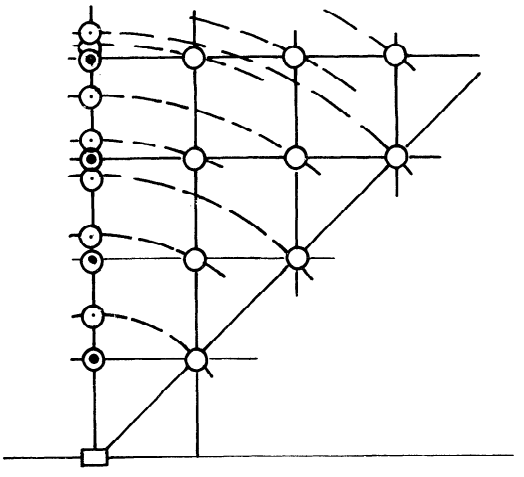
b) The sprinkler is operated according to the conditions specified in this part of ISO 7749 and the quantities of water in the collectors are measured.

c) The quantities of water collected in the simulated collectors, whose location along the radial represents their location (i.e. their distance from the tested sprinkler), if they had been set out according to the full field method (see figure A.1), are calculated.

The above-mentioned quantities of water represent the quantities that would have collected in the respective collectors, if they had been set out according to the full field method, and also show the distribution pattern of the tested sprinkler.

d) By simulating the sprinkler spacing, according to the spacing for which the CDU is to be calculated, the cumulative quantities of water that would have accumulated in the collectors, if these had been placed between four sprinklers identical to the tested sprinkler, are calculated. The CDU is then determined according to the Christiansen formula.

1) J.E. Christiansen, *Irrigation by Sprinkling*, Bulletin 670, University of California, Berkeley, 1942.



**Key**

- ◉ Location of collectors along the radius tested
- ⊙ Simulated location of collectors representing placement of collectors according to the full field method. The quantity of water in the simulated collectors is calculated by interpolation according to their radial distance from the tested sprinkler
- ○ Location of collectors according to the full field method for calculating distribution uniformity after overlapping
- ▭ Location of sprinkler



NOTE — Only 1/8 of the circle is shown.



**Figure A.1 — Collector placement pattern for determining sprinkler diameter of coverage and for calculating sprinkler distribution uniformity as a result of overlapping**

**UDC 631.347.4**

**Descriptors**: irrigation, agricultural equipment, agricultural sprayers, tests, determination, water distribution.

Price based on 6 pages