

INTERNATIONAL
STANDARD

ISO
7749-1

Second edition
1995-04-15

**Agricultural irrigation equipment —
Rotating sprinklers —**

Part 1:
Design and operational requirements

*Matériel agricole d'irrigation — Asperseurs rotatifs —
Partie 1: Exigences de conception et de fonctionnement*



Reference number
ISO 7749-1:1995(E)

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.

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 7749-1 was prepared by Technical Committee ISO/TC 23, *Tractors and machinery for agriculture and forestry*, Subcommittee SC 18, *Irrigation and drainage equipment and systems*.

This second edition cancels and replaces the first edition (ISO 7749-1:1986), of which it constitutes a technical revision.

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

- *Part 1: Design and operational requirements*
- *Part 2: Uniformity of distribution and test methods*

NOTE — Future parts will also cover part-circle sprinklers and pop-up sprinklers.

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

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International Organization for Standardization
Case Postale 56 • CH-1211 Genève 20 • Switzerland

Printed in Switzerland

Agricultural irrigation equipment — Rotating sprinklers —

Part 1: Design and operational requirements

1 Scope

This part of ISO 7749 specifies the design and operational requirements of rotating sprinklers and sprinkler nozzles for agricultural irrigation equipment and their test methods. It applies to sprinklers intended for assembly in pipeline networks for irrigation and operation at the pressures recommended by the manufacturer.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this part of ISO 7749. At the time of publication, the editions indicated were 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 editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 7-1:1994, *Pipe threads where pressure-tight joints are made on the threads — Part 1: Dimensions, tolerances and designation.*

ISO 2859-1:1989, *Sampling procedures for inspection by attributes — Part 1: Sampling plans indexed by acceptable quality level (AQL) for lot-by-lot inspection.*

ISO 3951:1989, *Sampling procedures and charts for inspection by variables for percent nonconforming.*

ISO 7749-2:1990, *Irrigation equipment — Rotating sprinklers — Part 2: Uniformity of distribution and test methods.*

3 Definitions

For the purposes of this part of ISO 7749, the following definitions apply.

3.1 rotating sprinkler: Device which by its rotating motion around its vertical axis distributes water over a circular area or part of a circular area.

3.2 nozzle: Aperture or adjutage of the sprinkler through which the water is discharged.

NOTE 1 A sprinkler may contain one or several cylindrical nozzles, or nozzles of other shapes. It may refer to either a single nozzle, or to a combination of nozzles in a multi-nozzled sprinkler.

3.3 equivalent nozzle diameter: Theoretical nozzle outlet diameter, calculated on the basis of nozzle pressure and flowrate.

NOTE 2 The calculation is described in annex A.

3.4 minimum effective pressure, p_{\min} : Lowest working pressure declared by the manufacturer, measured near the base of the sprinkler, at a point situated about 0,2 m below the main nozzle of the sprinkler, but with the pressure gauge situated in the same plane as the main nozzle. (See figure 1.)

3.5 maximum effective pressure p_{\max} : Highest working pressure declared by the manufacturer, measured near the base of the sprinkler, at a point

situated about 0,2 m below the main nozzle of the sprinkler, but with the pressure gauge situated in the same plane as the main nozzle. (See figure 1.)

3.6 range of effective pressure: Pressure range between the minimum effective pressure, p_{\min} , and the maximum effective pressure, p_{\max} , declared by the manufacturer as the pressure range in which the sprinklers operate effectively. (See figure 2.)

3.7 test pressure: Water pressure within the range of the effective pressure (3.6) used for testing the sprinkler.

3.8 nominal flowrate: Quantity of water per unit of time discharged by a sprinkler with a specific nozzle at ambient temperature at the test pressure declared by the manufacturer in the manufacturer's data sheets.

3.9 radius of throw: Farthest distance measured, while the sprinkler is rotating normally, from the sprinkler centreline to the point at which the sprinkler deposits water at the minimum rate of 0,25 mm/h for a sprinkler whose discharge exceeds 75 l/h, and 0,13 mm/h for a sprinkler whose discharge is equal to or less than 75 l/h, typically measured at any arc of coverage except at the arc extremes for part-circle sprinklers.

NOTE 3 The respective values relate only to sprinklers in continuous operation.

3.10 effective diameter of coverage: Twice the radius of throw (3.9).

3.11 trajectory height: Maximum height of the trajectory of the water stream above the sprinkler nozzle when operating at the test pressure.

3.12 trajectory angle: Angle of the water stream above a horizontal plane, as discharged from the sprinkler nozzle operating at the test pressure.

3.13 normal trajectory angle: Trajectory angle of 20° and greater.

3.14 low trajectory angle: Trajectory angle smaller than 20°.

3.15 sprinkler spacings: Distance between sprinklers along the irrigation laterals and distance between laterals.

3.16 coefficient of distribution uniformity, CDU: Uniformity of water application rate, depth or amount, at a given pressure and at a particular spacing, expressed as a percentage.

NOTE 4 The CDU is determined by the Christiansen method described in ISO 7749-2.

3.17 wind speed: Average wind speed at the test site during the test of distribution uniformity of the sprinkler.

NOTE 5 The calculation is described in ISO 7749-2.

3.18 irrigation lateral: Branch supply line on which water distribution devices (sprinklers, emitters, drippers) are mounted directly or by means of fittings, risers or tubes.

3.19 water distribution curve: Curve of application rates of the water accumulated in collectors laid out along a wetted radius, as a function of the distances of the collectors from the sprinkler.

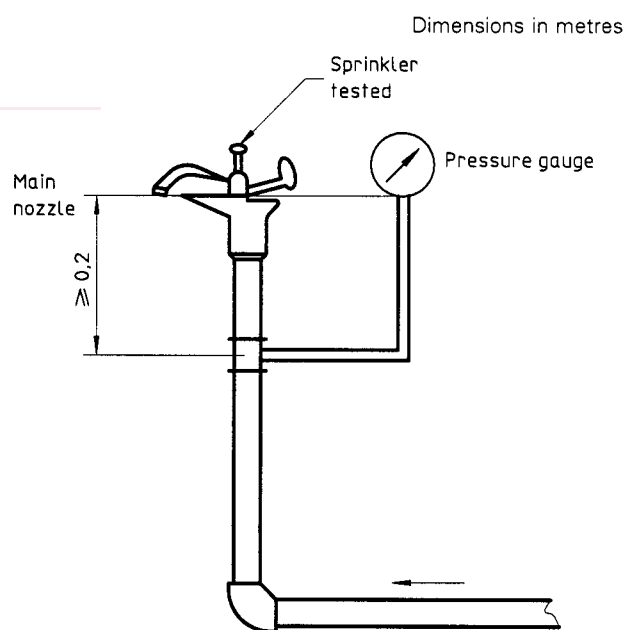


Figure 1 — Location of pressure gauge for measurement of sprinkler pressure

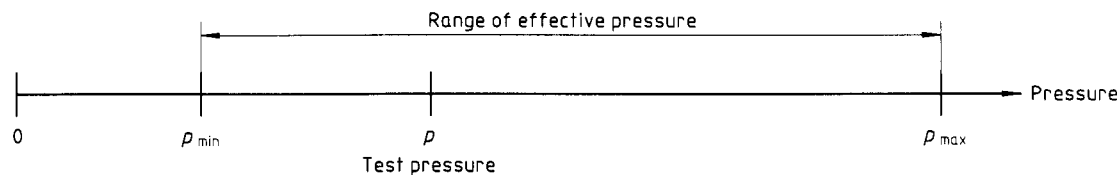


Figure 2 — Range of effective pressure

3.20 part-circle sprinkler: Rotating sprinkler designed to irrigate a sector of a circular area, either with or without an attachment which enables it to be adjusted to irrigate the entire circular area.

3.21 pop-up sprinkler: Irrigation sprinkler which is designed for installation so that the nozzle is below ground level when not operating.

NOTE 6 When the sprinkler is pressurized, the part containing the nozzle is raised so that the nozzle is above ground level for irrigation. When the pressure is shut off, the part containing the nozzle returns to its original position.

3.22 collector: Receptacle into which the water discharged by the sprinkler is deposited during the test for radius of throw.

3.23 ambient temperature: Temperature of the surroundings in the range of 15 °C to 30 °C.

4 General requirements

4.1 Materials

Sprinklers shall be made of metals or plastics. Metal sprinklers shall be made from a copper alloy or of other metals whose mechanical properties and resistance to corrosion when used with irrigation water are not less suitable than those of copper alloys.

Plastics parts of the sprinklers which conduct water and which are exposed to sunlight shall be opaque. Plastics parts of sprinklers exposed to ultraviolet (UV) radiation shall contain an additive resistant to UV radiation.

On request, the manufacturer shall provide information as to the resistance of the sprinkler to chemicals used in agriculture.

4.2 Construction and workmanship

4.2.1 Sprinkler parts, including nozzles, of the same type and manufacture shall be interchangeable.

If the construction of the sprinkler permits replace-

ment of parts, it shall be possible to replace the parts with standard tools; if special tools are required, the manufacturer shall be able to supply these tools.

4.2.2 The sprinkler shall be connected to the riser by means of threads or other means that ensure proper strength of the connection.

Sprinklers intended for threaded connection (see 4.3) to the pipeline or to risers shall be equipped with spanner flats or some other configuration, suitable for gripping with a standard open or adjustable wrench. Sprinklers having a plastics part for connection to risers may have other configurations (projections, slots, etc.) to facilitate manual assembly and removal.

4.2.3 Replaceable nozzles shall be attached to the sprinkler by threading, push-in or any other method that permits rapid and effective replacement under service conditions.

4.3 Threaded connections

In the case of sprinklers intended for threaded connection to a pipeline or to a riser, the threads shall comply with ISO 7-1. Alternatively, other threads may be allowed provided that a suitable adaptor shall be supplied with each threaded connection, making it comply with ISO 7-1.

4.4 Performance requirements

The following performance requirements apply to sprinklers having one or more nozzles.

4.4.1 Effective pressures

The sprinkler shall rotate continuously and regularly in its designed direction within its entire range of effective pressure from the minimum effective pressure, p_{min} , up to the maximum effective pressure, p_{max} .

4.4.2 Actuating mechanism

The actuating mechanism of the sprinkler shall operate in accordance with 7.6 at any inclination of the riser up to 10° from the vertical.

5 General test conditions

5.1 Sampling and acceptance tests

5.1.1 Type test

The test specimens shall be taken at random by the test laboratory representative from a quantity of at least 20 sprinklers. The number of test specimens required for each test shall be as specified in table 1.

If the number of defective specimens in the sample does not exceed the acceptance number specified in table 1, the sample shall be considered as complying with the requirements of this part of ISO 7749. If the number of defective specimens in the sample is greater than the acceptance number, the sample shall be considered as not complying with the requirements of this part of ISO 7749.

5.1.2 Acceptance tests

When acceptance of manufacturing lots or of shipments is required, conduct the sampling in accordance with ISO 2859-1:1989, based on acceptable quality level (AQL) 2,5 and special inspection level S-4.

Test all the test specimens in the sample, selected at random as provided for in table II-A of ISO 2859-1:1989, as specified in 6.3.

The shipment or manufacturing lot complies with this part of ISO 7749 if the number of defective specimens found in the test does not exceed the acceptance number specified in ISO 2859-1.

For the other tests, select the test specimen at random to conform with the number specified in table 1. The shipment or manufacturing lot is considered to comply with this part of ISO 7749 if the number of defective specimens found in the other tests does not exceed the acceptance number specified in table 1.

Table 1 — Required number of test specimens and acceptance number

Clause number	Subject of test	No. of test specimens	Acceptance No.
4	General requirements		
4.1	Materials	3	0
4.2	Construction and workmanship	3	0
4.3	Threaded connections	3	0
4.4	Performance requirements	3	0
6	Strength tests		
6.1	Construction and parts	3	0
6.2	Resistance of threaded connections	3	0
6.3	Resistance to hydrostatic pressure	3	0
6.4	Resistance to hydrostatic pressure at high temperature	3	0
6.5	Watertightness	3	0
7	Operating tests		
7.1	Uniformity of rotation speed	3	0
7.2	Uniformity of flowrate	1)	1)
7.3	Distribution characteristics	2	0
7.4	Effective diameter of coverage	2	0
7.5	Trajectory height	2	0
7.6	Range of effective pressure	2	0
8	Durability	2	0

1) Number of test specimens and acceptance conditions in accordance with ISO 3951.

It is not necessary to perform the tests in 7.3 and clause 8 within the framework of the acceptance tests if a type test has been carried out for the same sprinkler model and provided that the manufacturer has not introduced structural changes in the sprinkler since the type test.

The manufacturer shall give proof that no changes have been made in the product to obviate the need to perform type tests.

5.2 Accuracy of measuring devices

The allowable deviation of the measuring devices from their true values shall be as follows:

pressure: $\pm 2\%$

flowrate: $\pm 1\%$

Measure the rotation velocity with a stopwatch, graduated in divisions of 0,1 s.

5.3 Test pressure

Determine the test pressure of the sprinkler as the typical operating pressure declared by the manufacturer. If the operating pressure is given as a range of pressures, or in the absence of such declaration, the test pressure shall be determined in accordance with table 2.

5.4 Test liquid

Conduct the tests using water that has passed through a filter with a mesh as recommended by the manufacturer for normal field conditions; in the absence of such a recommendation, the water used shall first be passed through a filter with apertures of 0,4 mm.

Unless otherwise noted, perform the tests with water at ambient temperature.

Table 2 — Test pressure

Equivalent nozzle diameter ¹⁾ , <i>d</i> mm	Test pressure kPa
$d < 2$	200
$2 \leq d \leq 7$	300
$7 < d \leq 20$	400
$d > 20$	500

1) The equivalent nozzle diameter is calculated in accordance with annex A.

6 Strength tests

6.1 Test of construction and parts

Dismantle the sprinkler and check its parts visually. The parts shall show no manufacturing defects, such as bubbles, cracks or projections.

6.2 Test of resistance of threaded connections

6.2.1 Threaded connections to riser

For sprinklers made of metal, the threaded connection shall withstand a torque of 50 N·m for threads up to 25 mm as specified in ISO 7-1 without showing signs of damage and a torque of 100 N·m for threads greater than 25 mm without showing signs of damage.

6.2.2 Nozzle threads intended for threaded connection

The nozzle threads shall withstand a torque of 5 N·m without showing any signs of damage to the nozzle or sprinkler.

6.3 Test of resistance to hydrostatic pressure at ambient temperature

6.3.1 Connect the sprinkler to the test rig according to the recommendations of the manufacturer for field assembly and plug the nozzles such that no leakage occurs at the connection during the test.

Check that no air remains in the system, then gradually increase the water pressure, beginning with one-quarter of the test pressure in stages of 100 kPa, holding the system pressure for 5 s at each pressure stage.

For metal sprinklers, increase the water pressure to twice the maximum effective pressure, p_{max} , and maintain it at that level for 10 min at ambient temperature.

For plastics sprinklers, increase the water pressure to twice the maximum effective pressure, p_{max} , and maintain it at that level for 1 h at ambient temperature.

6.3.2 No defects in the sprinkler body shall appear during the test and no leakage shall occur through the sprinkler body or its gaskets.

NOTE 7 This does not include the rotary bearing covered in 6.5.

6.4 Test of resistance to hydrostatic pressure at high temperature

6.4.1 Connect the sprinkler to the test rig in accordance with the recommendations of the manufacturer for field assembly and plug the nozzles. Ensure that all connections are tight so that no leakage occurs during the test.

While the sprinkler is immersed in water at 60 °C, allow it to fill with water and check that no air remains in the system.

Connect the test assembly to a hydraulic pressure source and increase the pressure from zero up to the maximum effective pressure, p_{max} , within a period of about 15 s.

Maintain the maximum effective pressure for a period of

1 h for sprinklers made of metal;

24 h for sprinklers made of plastics.

Remove the sprinkler from the hot water bath and apply a pressure at the inlet equal to the test pressure. When technically possible, manually rotate the sprinkler two full rotations within 1 min and inspect for leakage through the sprinkler body and its connections.

6.4.2 The sprinkler and its parts shall withstand the test pressure without being damaged, no leakage shall occur through the sprinkler body or its connections, and the sprinkler shall not separate from the assembly.

6.5 Test of watertightness

6.5.1 Watertightness of sprinkler

6.5.1.1 Perform this test with nozzles whose size is in the mid-range of the range of nozzles made available by the manufacturer for the specific sprinkler.

Connect the sprinkler with its nozzles to the test rig in accordance with the recommendations of the manufacturer for field assembly.

Perform this watertightness test after 24 h of sprinkler operation at the test pressure $\pm 10\%$.

Increase the water pressure at the sprinkler inlet from p_{min} to p_{max} in steps of 100 kPa and maintain the pressure at each step for 1 min.

Throughout the test, collect leakage through the rotating bearing of the sprinkler by suitable means.

6.5.1.2 Watertightness shall meet the following requirements:

- a) for sprinklers with a nominal flowrate > 250 l/h, the leakage rate through the rotary journal bearing shall not exceed 2 % of sprinkler flowrate at the test pressure;
- b) for sprinklers with a nominal flowrate ≤ 250 l/h, the leakage rate shall not exceed 5 l/h.

There shall be no leakage through the threaded connection to the supply line.

6.5.2 Watertightness of nozzle connection

6.5.2.1 Plug the sprinkler nozzle or nozzles in the test assembly and install the sprinkler in the test assembly. Tighten threaded nozzles to the torque which, expressed in N·m, is numerically equal to the equivalent nozzle diameter, in millimetres. Connect the nozzle or nozzles intended for connection to the sprinkler by other means in accordance with the manufacturer's instructions. Do not use additional sealing materials unless specified by the manufacturer for normal installation.

Check that no air remains in the system, then increase the water pressure gradually from the minimum effective pressure, p_{min} , to the maximum effective pressure, p_{max} . Maintain this pressure for 10 min at ambient temperature.

6.5.2.2 Leakage through the connection of the nozzle to the sprinkler shall not exceed 0,25 % of the sprinkler nominal flowrate.

7 Operating tests

Perform separate tests for each sprinkler nozzle or combination of nozzles.

The pressure shall not vary by more than $\pm 4\%$ during the operating test.

7.1 Test of uniformity of rotation speed

7.1.1 This test applies to sprinklers with rotation speeds slower than one rotation per 20 s.

7.1.2 With the sprinkler mounted on a vertical riser, operate the sprinkler at its test pressure and measure the time required for each quarter revolution separately. Repeat the measurements over five revolutions.

Calculate the average time required for a quarter revolution and the greatest deviations, expressed as a percentage, from the average.

7.1.3 The extreme deviations from the average shall not exceed $\pm 12\%$.

7.2 Test of uniformity of flowrate

7.2.1 Test the sprinklers of one test sample for uniformity of flowrate at the test pressure, while mounted on risers, or on connecting devices recommended by the manufacturer. Mount each sprinkler on the test installation and measure its flowrate with the test pressure given in 5.3.

7.2.2 The sample shall comply with the requirements of ISO 3951, shall have an acceptable quality level (AQL) of 2,5 % and shall have upper and lower specification limits as follows:

- a) 7 % for sprinklers with nominal flowrates up to 250 l/h;
- b) 5 % for sprinklers with nominal flowrates exceeding 250 l/h.

7.3 Test of distribution characteristics

Perform the test of distribution characteristics as specified in ISO 7749-2.

Operate the sprinkler for a minimum of 1 h while maintaining the test pressure at the inlet to the sprinkler.

Measure the quantity of water collected in each of the collectors.

Calculate the water application rate, h , in millimetres per hour, from the equation:

$$h = \frac{V \times 10}{A} \times \frac{1}{t}$$

where

V is the volume, in cubic centimetres, collected in each collector;

A is the area, in square centimetres, of the collector opening;

t is the test duration, in hours.

Plot the curves for all the collectors which were measured as a function of the distance of each collector from the sprinkler along the radius.

7.3.1 All sprinklers

7.3.1.1 Perform the test along one radius and at no wind (see ISO 7749-2). Draw the distribution curve of three sprinklers and calculate the average distribution curves (see figure 3).

7.3.1.2 The sprinklers shall meet the following requirements.

- a) No point on the distribution curve of the tested sprinklers shall deviate by more than the greater of $\pm 0,25$ mm/h or $\pm 10\%$ from the corresponding point on the average distribution curve.
- b) No point on the average distribution curve shall deviate by more than the greater of $\pm 0,25$ mm/h or $\pm 10\%$ from the corresponding point on the distribution curve supplied by the manufacturer.

7.3.2 Sprinklers with flowrates greater than 250 l/h

Test the distribution uniformity of sprinklers by the full field method or by the radius method (see ISO 7749-2).

Perform the tests and the calculations of uniformity of distribution according to the conditions specified in table 3.

Calculate the coefficient of distribution uniformity (CDU) of the sprinkler by the Christiansen method (see ISO 7749-2:1990, annex A).

7.4 Test of effective diameter of coverage

7.4.1 Measure the effective diameter of coverage at the test pressure declared by the manufacturer. The test may be performed, as specified in 7.3, either by the full field method or by the radius method.

When testing by the full field method, calculate the effective diameter of coverage from the average of the measurements along four directions, at 90° angles to each other, at which the collectors were placed (two rows in each direction).

When testing by the radius method, calculate the effective diameter of coverage as the average of four measurements made when the sprinkler base is rotated a quarter-revolution (90°) about its axis for each measurement, or by placing the collectors along four radii at a 90° angle to each other; alternatively, a single radius may be used when tested indoors under no wind conditions.

Measure the effective diameter of coverage (see 3.9 and 3.10).

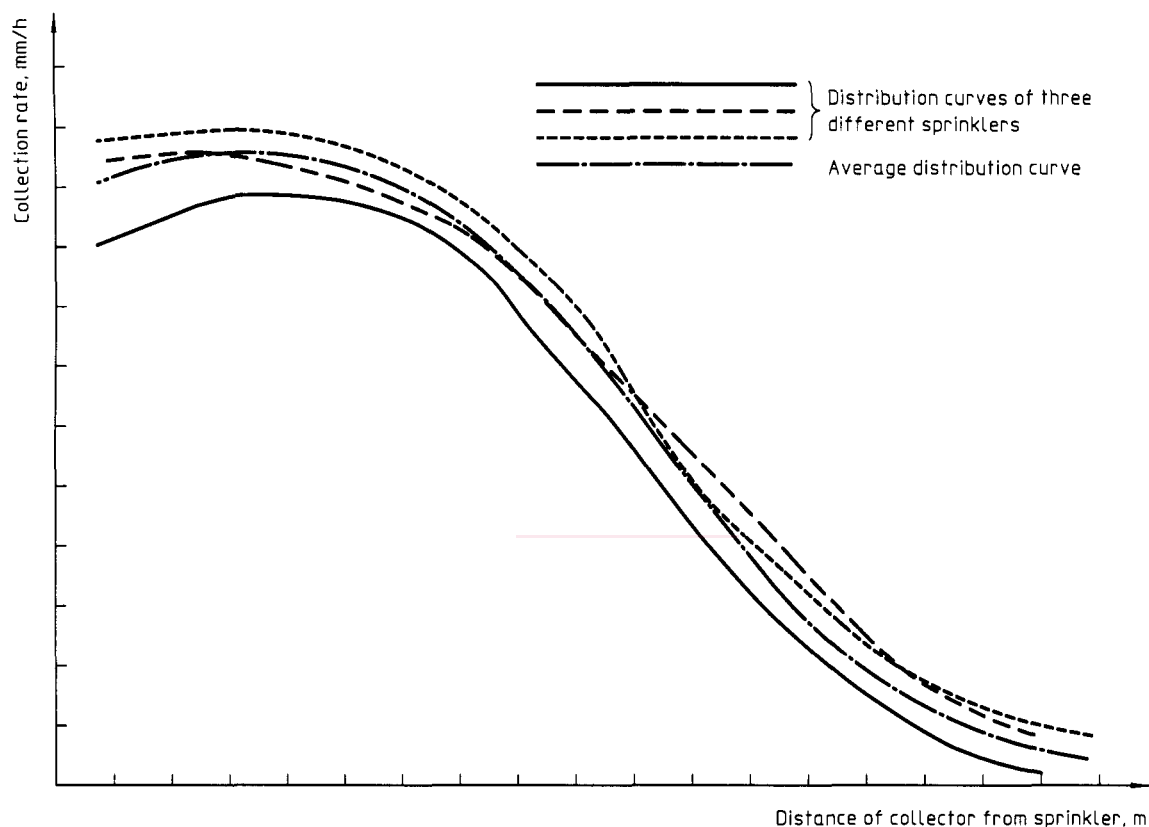


Figure 3 — Distribution curve

Table 3 — Uniformity of distribution

Wind velocity	Pressure	Sprinkler spacings
0,9 m/s max. ¹⁾	Three different pressures in multiples of 50 kPa, at the beginning, middle and end of the range of the effective pressure declared by the manufacturer	Three consecutive sprinkler spacings by agreement with the manufacturer
¹⁾ Sprinklers with normal trajectory angle may be tested by the full field method at a wind velocity of 2 m/s max. (but the manufacturer shall specify in his catalogue the wind velocity at which the test was conducted).		