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Agricultural irrigation equipment — Sprinklers —

Part 3: Characterization of distribution and test methods

Matériel agricole d'irrigation — Asperseurs —
Partie 3: Caractérisation de la distribution et méthodes d'essai

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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. 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.

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.

ISO 15886-3 was prepared by Technical Committee ISO/TC 23, *Tractors and machinery for agriculture and forestry*, Subcommittee SC 18, *Irrigation and drainage equipment and systems*.

ISO 15886 consists of the following parts, under the general title *Agricultural irrigation equipment — Sprinklers*:

— *Part 1: Definition of terms and classification*

— *Part 3: Characterization of distribution and test methods*

Design and operational requirements and test methods for durability are to form the subjects of future parts 2 and 4.

Agricultural irrigation equipment — Sprinklers —

Part 3:
Characterization of distribution and test methods

IMPORTANT — For any given sprinkler, a wide range of nozzle configurations, operating conditions and adjustments generates at least a theoretical need for a correspondingly large number of tests. Testing agencies and manufacturers may use interpolation techniques to reduce the number of actual test runs, provided accuracy standards are met.

1 Scope

This part of ISO 15886 specifies the conditions and methods used for testing and characterizing the water distribution patterns of sprinklers intended for agricultural irrigation. It deals both with indoor and outdoor, radial and full grid tests and is organized to deal first with conditions common to all the tests and then with those unique to indoor and outdoor testing, respectively.

The term *sprinkler* is used here in a broad, generic sense, as defined in ISO 15886-1, with the intent of covering the wide variety of products classified in ISO 15886-1. The specific performance measurements addressed in this part of ISO 15886 include distribution uniformity, wetted radius and water jet trajectory height: it is applicable to all irrigation sprinkler classifications for which uniformity of application, wetted radius and water jet trajectory height evaluation are required for the design objectives, as defined by the manufacturer. It does not address the specific performance testing required for sprinklers intended for frost protection use under freezing conditions, nor does it address the topic of drop spectrum measurement and characterization and the related questions of soil compaction, spray drift, evaporative losses, etc. It is not applicable to moving systems or sprinklers with a radius of throw of less than 1,0 m.

In order to use this part of ISO 15886 to evaluate irrigation coverage, all sprinklers must be identical and arranged in a fixed repeating geometric pattern.

2 Normative references

The following referenced documents are indispensable for the application 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 15886-1, *Agricultural irrigation equipment — Sprinklers — Part 1: Definition of terms and classification*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 15886-1 and the following apply.

3.1
ambient temperature
temperature of the air surrounding a sprinkler test site

3.2
area of coverage
wetted area from a sprinkler operated as specified in the manufacturer's literature where water is deposited at rates greater than or equal to the effective application rates

3.3
Christiansen's coefficient of uniformity
UCC
method of characterizing the uniformity of water application of sprinklers from full grid data that utilizes arithmetic deviations

NOTE The concept was introduced in 1942 and has been widely accepted as a measure of how well designs relate, with 80 % considered as the minimum acceptable uniformity coefficient. The coefficient lacks physical significance, however. Full grid data can be developed by actual field testing or computer simulated from distribution curves. See A.2.2.

3.4
clean water
water processed so as to contain suspended particles no larger than 200 mesh equivalent (74 microns) and to contain no dissolved chemicals known to have short-term effects on the sprinkler materials

3.5
collector
receptacle used for collecting irrigation water discharged by a sprinkler during a water distribution test

3.6
contour graphs
method of representing the area of coverage that shows a set of contour curves, each connecting locations in a horizontal plane receiving water at the same application rate

NOTE The number of contour lines plotted needs to be large enough to convey a visual impression of the physical significance of the data. The concept is useful in constructing area of coverage diagrams.

3.7
densogram
method of representing the area of coverage that utilizes the density of dot shading as directly proportional to the relative application rates in the area of coverage

3.8
distribution curve
graph of application rate (ordinate) versus distance (abscissa), measured along a particular section (leg) or line of the area of coverage

3.9
distribution uniformity
DU
method of characterizing the uniformity of water application of sprinklers from full grid data by a coefficient that utilizes an arbitrary definition of the lower 25 % as the critical area

NOTE The concept has had some acceptance in agricultural crops, but continues to suffer from the arbitrary nature of the definition. See A.2.4.

3.10
effective application rate
application rate greater than or equal to 0,26 mm/h for sprinklers with flow rates exceeding 75 L/h and 0,13 mm/h for sprinklers with flow rates equal to or less than 75 L/h

3.11
flow rate
volume of water flowing through an irrigation component per unit of time

3.12
full grid collector arrays
number of collectors located at the intersection of a two-axis geometric grid pattern determined to give a desired statistical result and represent the area of coverage

3.13
inlet connection
nominal pipe size designation for commercial purposes with no specific relationship to actual dimensions except as may be defined by reference to a recognized standard

3.14
irrigation lateral
branch supply line in an irrigation system on which water distribution devices such as sprayers, sprinklers and emitters are mounted directly or by means of fittings, risers, or tubes

3.15
maximum working pressure
P_{max}
maximum pressure at which a device will properly function hydraulically and operate mechanically

3.16
minimum working pressure
P_{min}
minimum pressure at which a device will properly function hydraulically and operate mechanically

3.17
nozzle
aperture or adjutage of the sprinkler through which the water is discharged

NOTE A sprinkler can contain one or several cylindrical nozzles, or nozzles of other shapes. The term can refer to either a single nozzle or to a combination of nozzles in the case of a multi-nozzle sprinkler.

3.18
nozzle pressure
pressure as measured immediately upstream of the nozzle or as inferred by a pitot tube measurement at the nozzle orifice *vena contracta*

3.19
nozzle size
nominal size designation for commercial purposes with no specific relationship to hydraulic properties

NOTE Nozzles are more accurately defined by their hydraulic properties.

3.20
part-circle sprinkler
sprinkler with an adjustable feature that enables it to irrigate any sector of a circular area or the entire circular area

3.21
pop-up sprinkler
irrigation sprinkler designed for installation so that the sprinkler nozzle is below ground level when it is not pressurized and above ground level when it is pressurized

3.22
pressure tap
precisely fabricated connection for communicating internal conduit pressures to an external pressure-measuring device

NOTE Tap construction is shown, for example, in ISO 9644.

3.23
radial collector arrays method
number of collectors located only on the radial axis projected from the sprinkler centreline, used to characterize the distribution curves

3.24
radius of throw
wetted radius
distance measured from a continuously operating sprinkler or sprayer centreline to the most remote point at which the sprinkler or sprayer deposits water at a minimum rate of 0,26 mm/h, for a sprinkler or sprayer with a discharge exceeding 75 L/h, or 0,13 mm/h, for a sprinkler or sprayer with a discharge equal to or less than 75 L/h, measured at any arc of coverage, except near the arc extremes for part-circle sprinklers or sprayers

3.25
range of working pressure
all pressures between P_{min} and P_{max}

3.26
scheduling coefficient
SC
method of characterizing the uniformity of water application of sprinklers from full grid data by a single coefficient that utilizes a definition of critical dry area

NOTE The concept, especially well suited to lawn and turf management, gives a run-time multiplier based on critical dry area turf quality management. See A.2.6.

3.27
sprinkler spacing
distance between the sprinklers along an irrigation lateral and between consecutive irrigation laterals

3.28
statistical uniformity coefficient
UCS
method of characterizing the uniformity of water application of sprinklers from full grid data by one coefficient that utilizes standard deviation as a measure of dispersion in statistical theory

NOTE Although introduced in 1947, this coefficient fails to enjoy any wide base of acceptance. The method presupposes that the distribution data is normally (Gaussian) distributed. See A.2.3.

3.29
test pressure
pressure at the inlet of a sprinkler declared by the manufacturer as the pressure to be used for test purposes

3.30
trajectory height
maximum height above a sprinkler or sprayer of the trajectory of the water stream discharged from the sprinkler nozzle or sprayer operating at test pressure

3.31
water application rate
mean depth of water applied per unit time

3.32
wetted diameter
sum of the radii of throw on the same diameter

3.33
wind speed
speed of the wind at a test site averaged over the time required for a test of the distribution uniformity of a sprinkler or sprayer

3.34
working pressure
pressure shown in the manufacturer's catalogue literature at which the sprinkler is known to function mechanically as designed

NOTE Working pressure bears no relationship to hydraulic properties except as may be defined by the manufacturer.

4 Collectors

4.1 Design

All collectors used for any single test shall be identical. Each shall be designed to minimize water splashes in or out.

The height of each collector shall be at least twice the maximum depth of the water collected during the test, but not less than 150 mm. It shall have a circular opening with sharp edges free from deformities. The diameter shall be from half the height to the same as the height, but shall not be less than 85 mm.

Alternative collector designs may be used, provided that their measuring accuracy is not less than for those specified.

The catchment from a collector shall be quantified from a direct reading of mass, depth or volumetric determination, provided that the required accuracy standard is met.

4.2 Collector ring orientation

The openings of all collector rings shall be in a common horizontal plane, with a slope not exceeding 2 % in any direction. The difference in height between any two adjacent collector rings shall not exceed 20 mm.

For indoor testing, collector ring height is not critical. For outdoor testing, the collector ring height shall be sufficient to ensure that vegetation does not interfere with jet access to the collectors.

5 Installation of sprinklers under test

The sprinkler selected for testing shall be representative of general production capabilities — particularly as relates to speed of rotation. New sprinklers shall be operated before the test for a period sufficient to demonstrate that the time per revolution has stabilized to ± 5 %.

Mount the sprinkler on a riser with nominal size designation the same as the sprinkler inlet connection. Ensure that the riser is fixed rigidly vertically, and that it does not vibrate sufficiently to cause a visual effect on the sprinkler operation, bend or deviate from the vertical during the test. The maximum allowable deviation from the vertical during the test shall not exceed 2°.

A steel pipe riser should be used to provide the required mechanical strength and facilitate the installation of a standard pressure tap.

Sprinkler nozzle height above the collectors should simulate the conditions under which the sprinkler is normally used. For example, for turf sprinklers, the top of the sprinkler body should coincide with the top of the collectors.

For agricultural sprinklers used under a variety of field conditions, the height of the principal sprinkler nozzle above the openings of the collectors shall be 10 times the nominal diameter of the sprinkler connection, but not less than 300 mm or at a height as specified by the manufacturer.

If the manufacturer specifies any special test-related conditions (e.g. testing at a minimum riser height or with straightening vanes), these shall be observed if the items concerned are provided as standard equipment with the sprinkler.

For a sprinkler not riser-mounted as described above, the test mounting shall be as specified by the manufacturer.

For single-leg distribution patterns, a shelter may be used around the sprinkler to baffle jet action, provided

a) the shelter is large enough and so constructed as to trap the jet and not let it interfere with the sprinkler's operation,

b) the shelter is designed to allow air circulation to develop around the jets,

c) the shelter provides a minimum sector for unrestricted jet operation of 45° centred on the collector radius, and

d) no jet deflection or splash is directed into the collectors.

If the testing agency uses an angle of less than 45° in relation to c), it shall demonstrate that the integrity of the results are not compromised.

6 Measurement

6.1 Accuracy

The accuracy required for all measurements not specifically addressed in this part of ISO 15886 shall be ± 3,0 %.

Application depths within collectors shall be measured with an accuracy of ± 3,0 %.

The pressure shall be measured with an accuracy of ± 1,0 %.

The flow rate through the sprinkler shall be measured with an accuracy of ± 2,0 %.

The temperature shall be measured with an accuracy of ± 0,5 °C.

Time shall be measured with stop watches accurate to ± 0,1 s.

6.2 Pressure measurement

The test pressure shall be measured at the height of the main nozzle. The location of the pressure tap shall be at least 200 mm upstream of the sprinkler base. (See ISO 9644 for information on pressure tap construction.) There shall be no flow obstructions between the pressure tap and the sprinkler base.

6.3 Atmospheric measurements

Relative humidity and ambient temperature shall be measured at the start, midpoint and end of the test. For indoor testing, changes in temperature and humidity during the test shall not exceed ± 5,0 % pre-test ambient.

7 Test methods — Collector arrangement, spacing and number

7.1 Full-grid collector arrays

This method refers to the use of a square grid of collectors with a sprinkler located inside the grid. It is especially useful in characterizing the impact of wind on sprinkler performance and characterizing sprinklers that do not produce symmetrical areas of coverage.

The same collector spacing shall be used for both axes of the grid. Additional collectors may be located on the downwind edge of the collector array if required to cover the anticipated wetted area. A minimum of 80 collectors shall be located within the area of coverage.

The sprinkler shall be located midway between four adjacent collectors.

Alternatively, the sprinkler may be located at the intersection of the grid axis.

7.2 Radial collector arrays

This method refers to the use of collectors located along a radius or several radii (usually 4, spaced at 90°) for purposes of characterizing the sprinkler's water application rate as a function of radial distance from the sprinkler. It is especially useful for sprinklers with a symmetrical pattern and under no-wind conditions.

The objective of the test is to develop an accurate relationship between water application rate and radius. If the sprinkler is known to have discontinuities between combinations of nozzles, for example, sufficient collectors shall be used to adequately characterize these features. In all cases, a minimum of 10 collectors shall be used on each radius.

Maximum spacing of collectors along the radius shall be in accordance with Table 1.

Table 1 — Maximum spacing of collectors — Radial collector arrays method

Dimensions in metres

Sprinkler radius of throw	Maximum collector spacing (centre to centre)
1,0 to 3,0	0,30
3,0 to 6,0	0,60
6,0 to 12,0	0,75
Over 12,0	1,00

The sprinkler shall be located one collector spacing from the first collector and on the same radius.

For multiple-array tests, the wetted radius/diameter shall be the average of all of the arrays used.

8 Additional tests

8.1 Time of rotation

The sprinkler time of rotation shall be measured only while the sprinkler is rotating from its own drive mechanism. It shall be measured at the beginning, midpoint and end of the test. In addition, at the midpoint in the test, the time shall be measured through each quadrant. The quadrant locations shall be indexed to the collector grid. The time shall be measured by an instrument capable of giving accuracy in accordance with 6.1.