SPREADMARK®

BOOKLET THREE

Spreadmark Code of Practice:

Technical Specifications for the Testing and Certification of Liquid Nutrient from Nozzles and for Nutrient Spread as a Slurry

www.fertqual.co.nz

Introduction

This booklet is one of four booklets containing information that supports the Spreadmark Code of Practice for the Application of Nutrients in New Zealand.

The Spreadmark Code of Practice can be found here.

This booklet forms part of the Code and all information related to copyright, document control, acknowledgments and glossary contained in the main Code apply equally to the information in this booklet.

Other booklets containing support information for the Spreadmark Code of Practice are:

- **Booklet 1:** Spreadmark Procedures, Protocols and Policies.
- **Booklet 2:** Technical Specifications for the Testing and Certification of Solid Nutrient Application Units.
- **Booklet 4:** Spread Pattern Testing and Certification for Fixed Wing Aerial Application of Solid Nutrients.

These booklets are supported by two technical documents listed below and found here: https://fertqual.co.nz/spreadmark/

- Nutrient Application Specifications; and
- Nutrient Physical Properties - General Information.

Index

This Booklet is in two parts: Part One deals with liquid nutrient spread using Conventional Boom Sprayers while Part Two deals with liquid nutrient spread using boomless nozzles and nutrient spread as a slurry.

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PRINCIPLES

Scope

In order to ensure that products are spread according to the requirements of the Spreadmark programme the following principles shall be followed with regard to the testing of nutrient applicator units.

1.1 Principles

a. The spreader test procedure allows each spreader to be characterised so it can be set to accommodate variable product characteristics. The test procedure has been linked to international methods and practice, adapted to New Zealand conditions.

b. Both indoor and outdoor testing is permitted for ground spreading units. For outdoor testing, requirements for wind speed and direction, angle of slope and nature of surface shall be set. Outdoor testing shall be carried out in a way that does not cause environmental contamination by overloading the test site. For indoor testing the test facility shall be of such a size as to not interfere with the test result.

c. The evenness of product spreading shall be expressed as a Coefficient of Variation. The evenness of spread both across and along the direction of spreader travel is important. Application rate at the time of test and application rate calibration settings shall be recorded.

d. To be Spreadmark Registered, application units must satisfy the performance standard for transverse CV% of 15% for nitrogenous nutrients and 25% for all other products.

e. The spreadability of product depends on its physical characteristics, usually described by their bulk density (BD); uniformity index (UI); and size guide number (SGN). Spreading units shall be tested on a sufficiently wide range of products to provide a guide to the maximum safe bout width for the range of products the spreader distributes.

f. Spreader certification testing shall be done at frequencies described in the Spreadmark Code of Practice Section 3.4 Approved Spreading Unit Testers.

g. Spreader operators should use simple field tools (sieve box and bulk density measure) to estimate these parameters in the field and adjust the spreading units accordingly.

h. Every certified spreader shall have, a unique identification number. For Groundspread vehicles spreader certification lapses if the boom changes to another vehicle.

1.2 Testing

a. There are two primary factors that determine whether nutrient is applied evenly and at the correct rate: the performance of the spreading unit; and the nutrient flow rate to that spreading unit.

b. The performance of the spreading unit is determined by measuring the evenness of transverse and longitudinal distribution.

c. The nutrient flow rate has two components; the average flow, which determines the application rate, and the momentary flow, which determines the longitudinal variation. The average flow rate is measured either directly when calibrating the spreader computer or can be determined by experience – the amount of product spread per unit area. Variations in momentary flow can be measured directly or indirectly by measuring the evenness of the longitudinal distribution.

d. The interaction of these factors is complex and momentary changes in flow may affect transverse as well as longitudinal distribution.

e. These two primary factors also interact with the operational conditions under which they are measured. It is necessary therefore to define the conditions under which they are measured. These are defined in the facilities section.

PART 1: CONVENTIONAL BOOM SPRAYERS

1. BACKGROUND

a. Conventional boom sprayers apply liquids through manufactured hydraulic nozzles usually at 0.5m spacing. Bout width is predetermined by this spacing and the number of nozzles. So for example, 24 nozzles at 0.5m spacing will cover a 12m width. For boom sprayers attached to vehicles the distance between the nozzles and the target (soil) is significantly less with a conventional boom at 0.4 to 0.8m as compared booms attached to aircraft and UAVs, and to spinning discs applying granule nutrient where the distance will be much greater especially when applied by helicopters or UAVs. As a result, conventional boom applications of liquid nutrient from vehicles achieve relatively discrete and accurate application rates.

b. There are two primary factors that determine whether liquid nutrient is applied evenly and at the correct rate; the flow rate of the liquid nutrient and the quality and performance of the nozzles.

2.1 Flow rate

a. For conventional boom sprayers the liquid nutrient flow rate determines the application rate which is a function of the spray pressure. The average flow rate is measured either directly when calibrating the sprayer controller or can be determined by experience1 based on the amount of product applied per unit area. For computer controlled liquid nutrient applications, system pressure is increased or decreased in relation to forward speed to maintain target application rate. For these tests it is assumed the flow and speed inputs to the sprayer controller are accurate and the operator is continually comparing volumes applied with area covered. Flow and speed measurement devices may have also been checked by a 3rd party sprayer calibrator.

2.2 Nozzles

a. At least two types of nozzle may be used. Specialist nozzles for liquid nutrient application or standard (flat fan type) spray nozzles designed for application of herbicides, insecticides and fungicides.

2.3 Nutrient Nozzles (Groundspread Only)

a. Specialist nozzles apply liquid nutrient as a stream. These are preferred to standard nozzles which can cause leaf burn. Specialist nutrient nozzles produce streams of liquid

[1] This certification procedure assumes a controller is always used to automatically adjust flow in relation to forward speed.

at intervals of 0.1m or less along the width of a conventional spray boom. Common liquid nutrient nozzle options are shown in Figure 1.

b. This certification procedure assumes a controller is always used to automatically adjust flow in relation to forward speed.

Figure 1 Common Liquid nutrient nozzle types

c. Reports of evenness of spread for nutrient nozzles are less common than for standard nozzles. One report shows a CV of 3.4% for a Lechlar FD 04 nozzle (Figure 2).

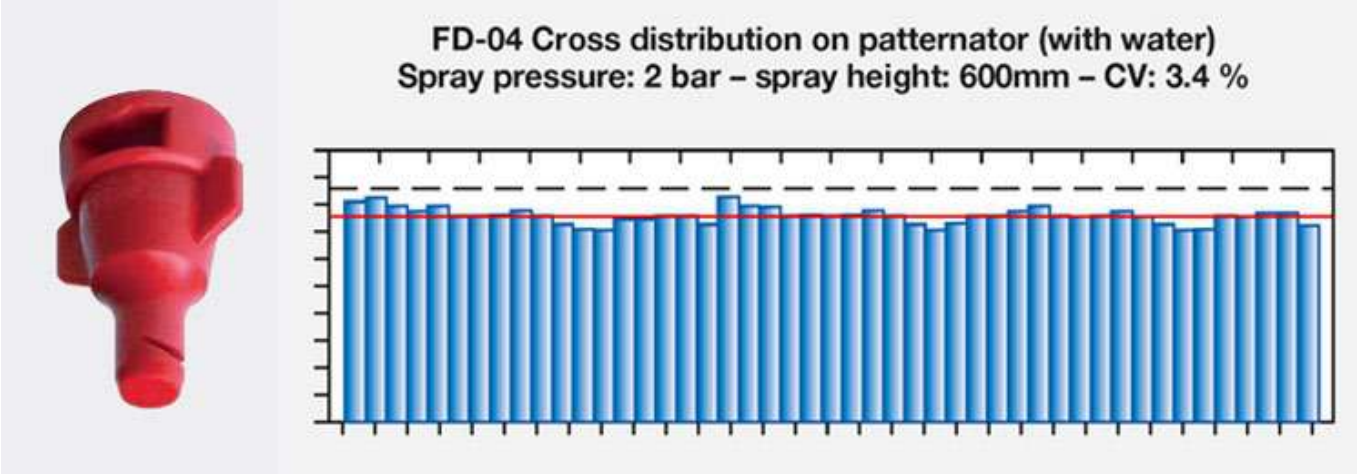

Figure 2 Evenness of spread for a Liquid nutrient nozzle

2.4 Standard Spray nozzles (flat fans)

a. Standard nozzles used for applying agrichemicals may also be used to apply nutrient in some situations. These precisely manufactured hydraulic nozzles are usually at 0.5m spacing along the spray boom and are manufactured in ISO certified facilities. For groundspread they are designed to achieve a coefficient of variation (CV) of about 6% for evenness of application transverse to the forward movement of the vehicle. This low level of CV requires that all nozzles on the boom are of the same size, produce the same pattern, are arranged correctly on the boom and the boom is operating at an appropriate height above the target.

2. GENERAL

3.1 Manufacturers specifications list pressure and flow expectations by nozzle. For example a typical nozzle might be a Teejet StreamJet SJ7-06—VP. Flow charts show expected flow is 2.01 litres/minute at 2.0 bar. Convention / good practice would be to replace nozzles when flow is 10% higher than design specifications due to wear which affects the flow and pattern emitted.

3.2 Given that nutrient and standard nozzles are fitted at relatively close intervals, are precisely manufactured and meter product at a relatively close distance to the target, pattern testing or testing of individual nozzle flows is unlikely to add significant value to any testing aimed at certifying evenness of spread.[2] Certification testing should focus on boom section pressures and comparison of test flow with expected performance.

3.3 Note that longitudinal distribution will be determined by the consistency of the liquid nutrient used and homogeneity of mixing processes.[3] Measurement conditions are defined below.

[2] Determining if nozzle flow is within 10% of specifications requires flow tests on individual nozzles. CV for nutrient nozzles operating in NZ should be carried out during the development of this specification unless this data is available from manufacturers.

[3] Longitudinal distribution for solid product is discussed in Booklet Two, but no testing procedure or standards are given.

3. FACILITIES

For ground spreaders certification tests may be conducted either indoors or outdoors providing all the following specifications are met. Outdoor specifications apply to UAVs and helicopters as well.

	INDOOR	OUTDOOR
Size	Width sufficient to unfold the spray boom	Width sufficient to unfold the spray boom
Slope	Flat	< 5^0
Wind	Nil	< 15km/hr
Surface	Flat and hard	Firm and smooth
Anti-bounce	Water for boom section and nozzle flow tests	Water for boom section and nozzle flow tests
Site usage	Not to exceed local drainage capacity	Not to exceed local drainage capacity

4. TEST PRODUCTS

a. It is proposed that water is used as the test product in lieu of actual product. Suggested tests are for a stationary sprayer. Safe disposal of liquid nutrients from a stationary sprayer could pose an environmental risk for stationary tests so water is preferred.

b. Likely application products include nitrogen as the dominant nutrient subject to liquid nutrient application. By default, any nutrients applied as a liquid are dissolved,[4] dissolved Urea[5] being the most common.

	%N[6]	PRODUCT EXAMPLE
1	18	Flow Fert N
2	19	Nrich Liquid Urea
3	?	Dissolved Urea
4	?	Other?

[4] There may be a need to define a liquid as compared with a slurry of fine (ground) particles in water as compared with a sludge. For the former the nutrient dissolves in water whereas for the latter the product remains solid but is in suspension. The concentration or specific gravity of the material in a tank may also indicate liquid versus slurry although some agrichemicals are suspended concentrates but are termed liquid rather than slurry. Viscosity describes the sheer resistance of a fluid.

[5] Common dissolved Urea products contain up to 19% N along with other macro-nutrients such as sulphur and micro-nutrients such as copper.

[6] The proportion of nitrogen on a weight-to-weight basis.

5. TEST CONDITIONS

Two stationary tests are required, boom section pressures and combined nozzle flow test. The following conditions must be met for measuring transverse distribution.

Conventional spray boom	Application units shall be clean and in sound working condition. The spray systems must have a display of pressure that can be observed by the operator while applying liquid nutrient. Operators should also be confident their flow meter is accurate and in sound working condition so that target application rates are being achieved. This should be continually tracked by keeping a running tally of volume used and hectares covered. Evidence of the use of an auditable GPS tracking device is mandatory for sprayers that are to have Spreadmark Test Certificates. It is expected that the positioning accuracy of the GPS is to within one metre. The tracking system must be able to verify that the placement of nutrient (mapping) is within the target area and in accordance with the Spreadmark test protocols so that nutrient is not spread into environmentally sensitive areas.
Tank fill	Sufficient to carry out boom sections tests and combined nozzle flow test with water (usually half full).
Application rate	Application rates used during test shall be the typical rates for that product used by the operator[7]
Wheel speed sensor (groundspread only)	At least 50m distance, preferably 100m distance, average of two runs
Airspeed sensor	Airspeed indicator and means of displaying ground speed

[7] Otherwise, the default nominated test rates shall be:
- 150 L/ha
- 25 kgN/ha

6. MEASUREMENT Techniques

Two tests are proposed to be performed on a stationary conventional boom sprayer.

7.1 Boom section test

Aim: Ensure each boom section is operating at the same pressure.

a. Application units shall have at least three boom sections and may have up to seven. Unfold the boom and with the nutrient nozzles turned on, run the stationary sprayer at required operating pressure for the selected forward speed and target volume application rate (e.g. 15 km/hr, 150 l/ha).

b. Once the operator is happy that the system is running at target rate, fit a pressure gauge to each boom section in sequence (suggest work left to right looking forward). Figure 3 shows potential methods for measurement of spray boom pressure. The cap and nozzle are removed, a gauge is fitted and the nozzle is fitted to the base of the gauge.

c. Record the pressure for each boom section. Boom pressures should be within 10% of each other e.g. range of 0.2 bar for an average pressure of 2 bar.

Figure 3 Possible methods set up for boom pressure measurement

Commercially available option (Spot On®, electronic)

AAMS Salvarini (courtesy of M. Keane)

Bottom entry ¼" Isometric 63 mm Gauge fitted on a ¼" Tee with Quick TeeJet cap*

Bottom entry standard mechanical 100mm pressure guage (Silvan NZ)

d. The test pressure gauge should be calibrated to ensure it is reading true pressure in the target range which is likely to be between 1 and 4 bar. A range on the gauge of 0 to 6 bar would be suitable. Check the test gauge after testing six boom sprayers or more often if necessary and at least annually.
e. Pressure gauge calibration – Several methods can be used to check the test gauge.
   - On a test rig fit a calibration[6] gauge and your test gauge with a tee junction. They should read the same pressure at 250 kPa (2.5 bar) within+/- 10 kPa
   - Purchase 5 gauges, compare them on a test rig, choose the most consistent two, one as test gauge and one as a calibration gauge. These two gauges should read within 10 kPa of each other.
   - WIKA brand pressure gauges can be sent to WIKA Instruments Ltd in Auckland for bench testing. A calibration report can be provided. Custom Pressure Systems NZ Ltd also provide a testing service with offices in Auckland, New Plymouth and Christchurch.
   - Other fittings may be needed for systems supplied by other manufacturers eg HARDI, ARAG, BFS.

7.2 Combined nozzle flow test

Aim: Ensure the nozzles are operating within 10% of their specification.

a. Even application across the width of the boom will be achieved as long as each nozzle is performing as designed and nozzles are at least 0.5 m above the target. The flow meter used by the sprayer controller can be used for combined nozzle flow test for the boom.

7.3 For Stream type and standard nozzles

a. Check that all nozzles are the same along the length of the boom. Identify the specified flow rate for 2 bar pressure from the manufacturers flow chart e.g. 2.01 litres /minute. Calculate the expected total boom flow per minute (flow per nozzle x number of nozzles) e.g. 48 nozzles x 2.01 litres/ minute = 96.48 litres/minute.
b. With the boom unfolded, fit a pressure gauge to boom section as for 7.1 (boom section test). Run the sprayer and adjust pressure and flow so that boom pressure is 2 bar. Turn the boom sections off, set the total flow on the controller to zero or record the total flow to date or maybe current tank volume (depends on the controller set up). This is the start volume.

[6] The calibration gauge is likely to be physically larger than a gauge found on a sprayer and should be compared with another calibration gauge annually or biannually. Note 1 bar = 100kPa = 14.5 psi

c. Turn on the whole boom for exactly 2 minutes. Record the volume sprayed from the controller. Compare this with expected flow per minute x 2. Where the flow is more than 5% different than expected e.g. actual total flow less than 183 litres or more than 202 litres, the flow from some individual nozzles is likely more than 10% different from expected. At this point individual nozzle flow should be checked to identify and replace (or clean) any such nozzles.

7.4 For Dribble bar type nozzles

a. Dribble or Stream bar type nozzles have manually adjustable flow systems to change orifice size. These systems are not manufactured with the same precision as stream type or standard nozzles so it is not practical to compare actual with expected flows. Also they can be subject to variation in positioning with manual adjustment.

b. Unfold the boom and check that all dribble bars have the same orifice setting. Run the stationary sprayer at required operating pressure for the selected forward speed and target volume application rate (e.g. 15 km/hr, 150 l/ha).

c. Once the operator is happy that the system is running at target rate, collect the flow from every second dribble bar for with Spreadmark trays or bucket for one minute.[7] The volume of water collected can be measured with a 5 litre calibrated measuring jug or weighed and used to calculate a CV for evenness of spread across the boom.

[7] Suggest use a 5-litre jug and collect for sufficient time to fill jug with more than 2.5 litres of water.

7. MEASUREMENT

Standards

The following measurements shall be made and recorded for each certification test.

FACTOR	MEASUREMENT	STANDARD
Boom section pressure	Bar or kPa	Test gauge +/-10kPa of calibration gauge
Distribution of boom pressure	Coefficient of Variation	<5%
Combined nozzle flow (stream or standard nozzles type)	Litres/minute at 2 bar nozzle pressure	+/- 5% of manufacturers specification[8]
Individual nozzle flow (dribble type)	Litres/minute at nominated boom pressure	Measuring jug, 5 litre, calibrated OR scales[9] accurate to +/- 10 gm
Distribution of nozzle flow (dribble type)	Coefficient of Variation	< 15%

[8] Manufacturers flow chart per nozzle multiplied by the number of nozzles.

[9] 1 millilitre (ml) of water = 1 gram.

8. SCHEDULE of Tests

The following tests shall be conducted:
For conventional spray boom with standard nozzles:

- Boom section test
- Combined nozzle flow test

For conventional spray boom with dribble bar type nozzles:

- Individual nozzle flow test

All tests to be carried out with water with stationary sprayer.

9. FIELD REPORT

The following records shall be kept for each test:

Identification	Date:				
	Operator:				
	Spreading Unit Unique Identifier:				
	Technician:				
	Location:				
Sprayer detail	Spray Controller:				
	Number of nozzles and spacing:				
	Number of boom sections:				
	Application Volume rate (L/ha)				
	Forward Speed (km/hr)				
	Operating pressure (bar)				
Test Nozzles	Nozzle	Expected flow at 2 bar			
Test Conditions	Spreader condition:				
	Tank size				
	Flow meter calibration value:(pulse per litre)				
	Wheel or air speed sensor calibration value: (pulse per metre, if fitted)				
Certification	Nozzle	Bout width	Application Volume (litres/ha)	Speed (km/hr)	Pressure (bar)

10. CERTIFIED Bout Widths

11.1 The tester will generate a CV for boom section pressures. The Certified Bout Width of a sprayer will be set by the number of nozzles and nozzle spacing where the test result for boom section pressures is 5% or less.

11.2 The tester shall also generate a comparison of measured combined nozzle flow with expected combined nozzle flow for Stream type and standard nozzles at 2 bar boom pressure. The Certified Bout Width of a sprayer will be set by the number of nozzles and nozzle spacing where the combined nozzle flow test shows the nozzles are within 5% of flow expected by manufacturers.

11.3 The tester shall generate a CV for dribble bars. The Certified Bout Width of a sprayer will be set by the number of nozzles and nozzle spacing where the test result is 15% or less for water.

11. REPORTING

12.1 Approved Spreading (Spraying) Unit Testers will, at the conclusion of the test, produce a Spreadmark Sprayer Performance Certificate.The Spreadmark Sprayer Performance Certificate must show, at least:

a. The spraying company name, a vehicle or spreading unit unique identification number, sprayer and tank size.

b. The boom section pressures.

c. Comparison of combined nozzle flow with manufacturers expected combined flow.

d. The Certified Bout Width for each nozzle tested.

e. The date of the test and the expiry date of the certificate. The expiry date shall be two years after the date of the test.

f. The certified application rate for each nozzle.

12.2 On completion the Sprayer Performance Certificate will be sent to the company with a copy to the Auditor.

PART 2: BOOMLESS NOZZLE SPRAYERS AND NUTRIENT SPREAD AS A SLURRY

Technical specification for the testing and certification of liquid nutrient application from boomless nozzles and for nutrient spread as a slurry

1. INTRODUCTION

Equipment applying liquid nutrients with boomless nozzles are capable of applying a wide range of material (liquids and slurries[1]) through relatively large volume (20+ L/min), low pressure (1.4 bar or 20psi), boomless nozzles with relatively large orifices (5 to 10mm)[2]. Example materials or products vary from urea, sulphate of ammonia, muriate of potash, lime slurry, through to fish fertiliser, compost tea, reactive phosphate rock and dairy farm effluent. Application of nitrogenous products having more than 3% N content are required to achieve a coefficient of variation of spread of 15% or less for a specified bout or track width to be consistent with Spreadmark certification.

Typically the equipment utilises a centrifugal pump producing a low pressure, high volume flow. Product is applied through one or more boomless nozzles to distribute liquid nutrient across a width wider than the machine. The distance between the nozzles and the target (soil) is significantly more with a boomless nozzle at 4 to 6m as compared with a conventional boom at 0.4 to 0.8m. As a result, applications of liquid nutrient through boomless nozzles are less uniform as compared with a conventional spray boom.

This situation is similar for machines set up to spread nutrient as a slurry. Slurry nutrient may also be known as a suspension nutrient.

Liquid Nutrient

There are two primary factors that determine whether liquid nutrient is applied evenly and at the correct rate; the spray pattern of the liquid nutrient, nozzle spacing and flow rate.

Spray Pattern – The spray or spread pattern of the boomless nozzle is created by a flow of liquid that hits an anvil (Figure 1). The anvil breaks the liquid into streams and droplets as the water hits it and disperses the liquid. Liquid pressure and the angle of the anvil (yaw and pitch) to the direction of forward travel impacts on the spread pattern achieved. Nozzle spacing and design is critical to the spray or spread pattern and eveness of application.

Flow rate – Liquid pressure, the size of the nozzle orifice and the flow characteristics of the material or product being applied determine the flow rate (litres/min). Flow rate and with forward speed determine the application rate (litres/ha) for a given bout width (track

[1] The terms liquid and slurry are used here without specificity except that slurries would be expected to be more concentrated and more viscous than liquids. For example a slurry would be expected for an application of ground and fluidised OAP while dissolved urea is more like a liquid or conventional spray mixture.

[2] Tow and Fert' machines are a common example equipment which uses boomless nozzles to apply liquids and slurries including nitrogenous product, mainly dissolved Urea.

spacing). For these tests it is assumed the flow and speed inputs are accurate, the operator is continually comparing volumes applied with area covered and GPS guidance is used for accurate track spacing. In some cases a spray controller may be used for liquid nutrient applications whereby system pressure is increased or decreased in relation to forward speed to maintain target application rate. Flow and speed measurement devices may have also been checked by a 3rd party.

Figure 1: A boomless nozzle and typical spread pattern are shown in Figure 1.

Boomless nozzle

Typical machine spray pattern

Given that boomless nozzles are fitted at relatively wide spacing eg 9m, certification testing should focus on transverse spread pattern achieved on the ground with machine operating at normal forward speed.

Nutrient applied as a slurry

Spreading of nutrient as a slurry or "fluidised" product is less common than liquid nutrient. Example equipment include NHance Technology and Fine Particle Application (FPA) NZ (Figure 2). The onboard NHance system mixes and grinds granular product with water to produce a fluidised product. Fine Paricle Application utilises a separate system to grind granular product into a fine particle compound for a suspension which is loaded into a spreader for application by two spinners each with four tubes at 5 to 6m centres.

Figure 2: Example Slurry Nutrient spreaders

NHance on-truck blending techology

Fine Particle Application NZ – equipment

Nutrient slurries have a lower water content than lliquid Nutrient. For example 25% water (60 kg/ha granular product plus 20 L/ha water) and the product is not fully dissolved unlike liquid nutrient which maybe 90% water (20 kg/ha Urea plus 180 L/ha water).

Note that longitudinal distribution will be determined by the consistency of the liquid or slurry product used and homogeneity of mixing processes[3].

Measurement conditions are defined below.

[3] Longitudinal distribution is discussed in the existing Spreadmark COP for dry product but no testing procedure or standards are apparent

2. FACILITIES

Certification tests may be conducted either indoors or outdoors providing all the following specifications are met:

	INDOOR	OUTDOOR
Size	Width sufficient to allow the swath to reach the collectors without hindrance and length sufficient to allow the speed and flow of the machine to stabilise prior to passing the collectors	Width sufficient to allow the swath to reach the collectors without hindrance and length sufficient to allow the speed and flow of the machine to stabilise prior to passing the collectors
Wind	Nil	< about 15 km/hr
Temperature Conditions	< 22°C (Liquid Fertililser only)	Less than 4°C difference between tray surface and ambient temperature[1]
Surface	Flat and hard	< 5o (the plane of the collectors must be the same as the spreader)
Site usage	Unlimited	Not to exceed local environmental requirements

It should also be noted that because of the vagaries of wind speed and direction, outdoor testing can only define the performance achieved under those specific conditions and, that performance may be less than the optimum performance the machine is capable of under ideal conditions. In winds speeds between 10 and 15 km/hr, both the test entrant and the Tester have the right to call a halt to testing if either considers the machine will be unduly advantaged or disadvantaged by the conditions.

Note

[1] For liquid nutrient use a surface thermometer to measure tray surface temperature to +/- 1 °C (eg Economy Non-Contact Thermometer)

3. TEST PRODUCTS

Likely application products for certification include nitrogen as the dominant nutrient subject to nutrient application. To obtain a meaningful measure of a nutrient spreader's performance, certification requires testing of at least one nitrogen product, most commonly dissolved urea for liquid and ground DAP for slurry.

	%N[1]	PRODUCT EXAMPLE
1	45	Urea[2]
2	20.5	Sulphate of Ammonia (SOA)
3	17.6	Diamonium Phosphate (DAP)
4	30	Ammo 30 N
5	31	Ammo 31 Pro

Notes

[1]The proportion of nitrogen on a weight to weight basis.

[2]Common application rates for liquid nutrient range from 20-40kgN/ha in 150 to 300 litres/ha (7 to 27% applied N). For slurriies application rates may range from 35 to 200 kg/ha

4. TEST CONDITIONS

The following conditions must be met for measuring transverse and longitudinal distribution.

Spreader equipment	Machines are to be clean and in sound working condition. System pressure must be displayed in a position that can be observed by the operator while spreading. Evidence of the use of an auditable GPS tracking device is mandatory for spreaders that are to have Spreadmark Test Certificates. It is expected that the positioning accuracy of the GPS is to within one meter. The tracking system is to be able to verify that the placement of product (mapping) is within the target area and in accordance with the Spreadmark test protocols so that nutrient is not spread into environmentally sensitive areas.
Tank loading	Sufficient to maintain system pressure throughout the duration of the test.
Application rate	Application rates used during test are to be the typical rates for that product by the operator[1]
Speed over the collectors	As near as possible to the typical operating speed as is consistent with safety considerations
Distance prior to passing the collectors	20 metres minimum[2]
Number of passes over collectors	One

Notes

[1] Otherwise, the default nominated test rates are to be:
- Liquid product - Dissolved Urea in 200 litres/ha applying at least 6kgN/ha
- Slurry product – Ground DAP applying at least 100 kg/ha

[2] Mechanically driven metering units require significantly less than 20m to achieve normal flow. For machines with computer controlled metering, the run-up distance may depend on the sensitivity of the software controlling the flow rate. All spreaders should be able to achieve stabilised flow within 20 metres of travel if they are to give acceptable performance in the field.

[3] The number of passes of the spreader over the trays will be between one and three. Where the nominal application rate is above 80 kg/ha a single pass will be used. Where more than one run is made, the runs will be in the same direction and with no alteration to the settings of the machine, there will be one weight for the three runs and the number of runs will be recorded on the test sheet.

5.COLLECTORS AND COLLECTOR LAYOUT

Use collectors (trays) and collector layout as described in Section 5 of Booklet Two: Technical Specifications for the Testing and Certification of Solid Nutrient Application Units eg arrange sufficient Spreadmark trays on the ground at 1.0 metre intervals to ensure the significant single pass pattern is measured.

Liquid nutrient

Product will be collected on paper towels as collection medium. Anti-ricochet inserts are not necessary. Minimise evaporative losses during testing by collecting papers as quickly as possible and avoiding hot, sunny and windy conditions. Paper towels, their placement and handling will comply with the following specifications:

- Weigh 10 paper towels[4] from the roll you intend to use. Enter weights into the Spreadmark report. Only use a roll of paper towels that meets the variability test in the Spreadmark report. It is best to use the paper towels from one supplier for a series of tests.
- Place four paper towels in the trays to cover the base. Place a small wire frame[5] (round or square) on top of the paper towels to keep them in place. Alternatively the modified anti ricochet inserts (use for interlacing inserts only).
- Place four paper towels in a spare tray by the weigh station in the same orientation as the field trays (tray on the ground but not under spreader).
- As soon as the machine has passed over the trays, quickly collect papers into stackable containers such as 500ml plastic disposable cups. Start collection from the tray furthest from the weigh station. Lift the wire frame or anti-ricochet insert and tap on the side of tray to displace any droplets adhering onto the paper towels. Gather up paper towels, bunch them lightly and place in the bottom of the first cup, place the second cup on top and proceed to the next tray and repeat. You may need two stacks of cups to gather all the papers from all the trays. Take these to the weigh station and place out of the sun and wind.
- Weigh the four unused papers from the spare tray. Use this weight as your "tare" so that subsequent weights can be directly entered into the Spreadmark report.
- Remove paper towels from the cups and weigh each noting which cup each set of four paper towels came from.

[4] Standard disposable paper kitchen towels approximately 22cm x 27cm, 2 or 3 ply from the supermarket. Brand names include Handee, Tuffy and Titan

[5] For example a small wire frame approximately 27cm x 27cm square made from 3.2 mm wire (No 8 fencing wire).

Slurry product

For slurry product, use the same procedure as above until collection of paper towels. For slurry;

- After the machine has passed over the trays, collect papers into stackable 900ml plastic containers. Start collection from the tray furthest from the weigh station. Lift the wire frame or anti-richocet insert and tap on the side of tray to displace any adhering product onto the paper towels. Gather up paper towels by folding and taking care to retain any loose granules within the paper towels. Place in the bottom of the first container, place the second container on top and proceed to the next tray and repeat. You may need two stacks of containers to gather all the papers from all the trays. Take these to the weigh station and place out of the sun and wind.

- During collection of slurries there may be a build up of material on trays between runs. This is acceptable and detailed cleaning[6] of all product from trays is not necessary unless significant changes were made to the spreader setting and design. Trays must be clean at the beginning or testing but subsequent detailed cleaning of trays can be at the discretion of test operator and operator of the spreading machine.

The liquid or slurry product caught in each collector will be weighed and used to produce a Spreader Performance Certificate. (See item 10, Reporting, below).

When measuring transverse distribution patterns there is a need to remove collectors to allow the spreader to pass. The weight of product collected in these places will be deemed to be the interpolated weight from the boxes on either side of the gaps.

The centre trays will be three boxes parallel to the direction of vehicle travel. The weight entered into the testing software to be the average of the weights collected in the three trays.

[6] Detailed cleaning refers to brushing and wiping out trays to and anti-ricochet inserts to remove product

6. MEASUREMENT STANDARDS

The following measurements will be made and recorded for each certification test.

FACTOR	MEASUREMENT	STANDARD
Weight of product	gm/collector	Scales accurate to +/- 0.1 gm
Application rate[1]	kg/ha	generally within 30% of set rate
Transverse distribution	Coefficient of Variation	< 15% for N products and 25% for all others
Longitudinal distribution	Coefficient of Variation	To be advised in future when limits are applied
Border spreading	Distance from spreader to pattern edge and shape of pattern	N/A

Note

[1] Where the measured application rate varies from the set application rate varies from the set application rate by more than 30% then the collected information should be reassessed.

7. SCHEDULE OF TESTS

The following tests will be conducted:

- Transverse distribution tests - all products certified
- Collection medium consistency – the weight of 10 paper towels will be measured for calculation of variability.

Note that the first run may have a lower recovery rate than subsequent runs as some residual moisture may remain on measuring equipment after paper collection. Subsequent runs will start with this residual moisture so net weights captured may be higher than for the first run. Despite the lower recovery the first run is likely to yield a useful result.

8. FIELD REPORT

The following records will be kept for each test:

IDENTIFICATION	DATE			
	Operator:			
	Machine:			
	Technician:			
	Location:			
	Size of venue:			
	Slope:			
	Wind speed:			
	Direction in relation to wind:			
	Ambient temperature/cloud cover			
	Tray surface temperature			
Sprayer detail (Liquid)	Number of nozzles and spacing:			
	Nozzle type/number:			
	Operating pressure (bar)			
Spreader detail (slurry)	Spinner speed			
	Distance between spinners			
	Water rate (L/ha)			
Test Products		**Rate**		**Rate**
	Product 1		Product 2	
	Product 3		Product 4	
Test Conditions	Speed over collectors:			
	Machine condition:			
	Tank / bin size/loading:			
	Distance/time of run-up:			
Collectors	Number per pass:			
	Distribution:			
Certification	Certified Bout Width Product 1 = Product 2 = Product 3 = Product 4= Product 5= Shape of CV v Bout Width graph=			

9. CERTIFIED BOUT WIDTHS

The tester will generate a CV versus bout width graph from the test information obtained for each liquid nutrient tested and will determine the Certified Bout Widths from these graphs.

The Certified Bout Width of a spreader will be the bout width where the test result is 15% or less for nitrogenous products and 25% or less for non-nitrogenous products. Refer to the Glossary of Terms (Section 4) in this Code for a definition of nitrogenous product.

Spreaders will have both their 'Round and Round' and their 'To and Fro' bout widths determined for each product tested.

If the CV versus bout width graph is 'S shaped' and intersects the appropriate CV limit at more than one bout width then this is to be recorded as, for example, "Up to 16 m and 22 to 29 meters".

For border spread certification the certified border width will be the tray beyond the one where the last drop of liquid nutrient was collected. In addition, in order to ensure that the spread pattern is not overly compromised when the spreader is set to 'border spread', the distance where the spreader returns to 80% of the average application rate should be recorded. In this way the machine can be compared with others of the same border spread capability.

10. REPORTING

Approved Spreading (Spraying) Equipment Testers will, at the conclusion of the test, produce a Spreadmark Sprayer Performance Certificate.

The Spreadmark Sprayer Performance Certificate must show, at least:

The spraying company name, a vehicle identification number, sprayer and tank size.
System pressure and nozzle type
The Certified Bout Width for each product tested (see item 9, for details).
The date of the test and the expiry date of the certificate. The expiry date will be two years after the date of the test.
The certified application rate for each nozzle and product.
Approved Spreading Equipment Testers will, at the conclusion of the test, produce a Spreadmark Spreader Performance Certificate.

On completion the Spreader Performance Certificate will be sent to the company with a copy to the Auditor.

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