PART B THE AERIAL SPREADMARK CODE

1. INTRODUCTION

This part of the Aerial Spreadmark Code sets out the performance standards for the aerial application of fertiliser

1.1 SCOPE

This Code describes good practice standards for aerial application of fertiliser. Good practice is sustainable, from the aerial applicators viewpoint, the farmer client's and the regulator's viewpoint. In simple terms, good practice for aerial application is often determined by whether the fertiliser was evenly applied and was at the required application rate. Coefficient of Variation (CV%) is used as the measure of evenness of application. The current minimum acceptable Spreadmark CV% for application equipment testing is a transverse CV% of 15 for fertiliser containing nitrogen and 25 for all other products.

1.2 SUSTAINABILITY

The principles of sustainability can be applied in a general sense to any operation, including application of fertiliser. In this Code they are applied to the aerial application industry as a whole, which means that they apply to each aerial applicator.

The five sustainability principles, and the outcomes for each are:

- *Production:* the practice achieves the desired (production) goal
- *Security:* the risk that the production goal will not be achieved is managed
- *Economic:* the practice is economically viable
- *Environmental:* any adverse effects on soil, water, air or other resources as a result of the practice are satisfactorily managed
- *Social*: the practice is socially acceptable, ie any potential adverse effects on people have been satisfactorily managed

If aerial application of fertiliser does not satisfy each of five broad principles, then it is not sustainable, and changes need to be made. These principles are applicable to the aerial applicator but can also be applied to the regulator or the farmer client.

Some of the principles are more business related, for example the productivity goals set and the financial performance targets, the strategic planning to cope with mechanical failures that lead to the production goal not being achieved, and the fees charged for service provided. Other principles are more quality related, for example the evenness and accuracy of fertiliser placement, minimisation of fertiliser applied directly to water, and the reduction of noise and dust.

This Code deals with the quality related issues, but all five principles are part of sustainability.

1.3 INFORMATION NEEDED

This Code deals only with the issues that the aerial operator can influence or has control over. In order to take the required actions, the operator needs specific information for each property where aerial application of fertiliser is being considered. There are four parts to the specification required by the operator in order that good practice may be achieved. They are

- What nutrients are needed?
- What application rate (of fertiliser) is required?
- Where is the fertiliser required (what area and what site)?
- When is the fertiliser required (date and or time of day)?

This information, which would normally come from the client or their agent, is an essential input to good practice for aerial application of fertiliser by air.

1.4 VERIFICATION AND COMPLIANCE

Practices that are mandatory for compliance with this Code are indicated by the use of the word "shall". Recommended practices are indicated by the use of the word "should".

In order to comply with this Code the operator shall comply with all the actions listed for the various risks. A series of Appendices is also included to provide assistance in managing these risks.

Verification of compliance requires objective evidence to be available.

1.5 PRODUCTS COVERED

The Code applies to all fertilisers as defined in the Code of Practice for Fertiliser Use. This includes physical forms ranging from solids, suspensions and liquid, whether applied separately or in combination.

2. RISK MANAGEMENT

2.1 SCOPE

This Code is about good practice for the aerial application of fertiliser.

The approach used is to consider what risk exists, and then the person most able to manage those risks must be identified. That individual will need certain information and may need to take some actions to meet their responsibilities. The information needed and the actions taken will depend on the nature of the risk. Inevitably some record of what happened will be needed, so documentation is important. Finally the individual responsible must be competent to discharge their responsibility satisfactorily.

In summary the approach is:

- Risk
- Responsibility
- Information
- Action
- Documentation
- Competency

The following sections explain the risk management approach in more detail.

2.2 RISKS

The main objective with aerial fertiliser application is to apply the specified fertiliser at the specified rate in the required place (and nowhere else), at the required time. The risks associated with not achieving each one of these objectives may differ in different situations with different fertiliser, and the consequences of not achieving the objective will also vary. Good practice requires that a process to manage these risks is active. An active risk management programme means that the risk of not achieving application of fertiliser by air in a sustainable way will have been identified, and strategies developed to manage those risks.

Under the Resource Management Act 1991 (RMA) there is a duty to avoid, remedy or mitigate adverse effects on the environment associated with the discharge of contaminants, which includes fertilisers. Appendix A summarises the relevant parts of the RMA and other rules and legislation that govern the application of fertiliser.

2.3 RESPONSIBILITY

A clear indication of who has the responsibility to manage the various risks is needed. This may include people other than the aerial operator (see section 3).

Note that the individual who has the responsibility to manage the risk may elect to delegate that responsibility to another individual. In such cases it shall be clear who has the delegated responsibility and there shall be evidence of that delegation.

2.4 INFORMATION AND ACTION

In order to manage risk, information is needed and actions may need to be taken. For example the risk of fertiliser not being applied accurately may be because the fertiliser has poor flow properties. That can be predicted from flow testing and the actions taken can range from not applying the fertiliser to improving the fertiliser flow properties.

All the information needed to ensure that the risks identified in relation to the application of fertiliser by air shall be available to the aerial operator so that any risks are managed satisfactorily, and any actions required as a result of that information are taken. Note that not all the identified actions may need to be taken – it depends on the risk.

2.5 DOCUMENTATION

The most practical way of demonstrating that good practice is being used is to provide objective evidence. Objective evidence can be verified. The most common objective evidence is documentation, which could include files or printouts from global positioning systems (GPS) showing tracks flown while the aircraft was applying fertiliser, or it may be a print-out of the spread pattern obtained with the fertiliser and application equipment being used.

Some aspects of fertiliser application will need to be documented and those records held for specified periods of time. The level of objective evidence varies according to the risk. Where risks are low, that is where the consequences of failure are low, then objective evidence of practices used to manage that risk are also likely to be low. The higher the risk, the greater is the need for objective evidence.

Documentation is objective evidence that risks have been managed. Evidence that these risks have been managed shall be available on request

2.6 COMPETENCY

When an individual has the responsibility to manage risk, that individual shall be competent to do so.

The pilot of any aircraft shall hold a current agricultural and chemical rating to apply fertiliser by air. Also, each person who has a responsibility to manage or carry out any part of an operation to apply fertiliser shall be competent do so and evidence of appropriate qualifications or other in-house training shall be available.

Note
CAA Advisory Circular AC 61 – 1.15 provides information on the training syllabus content that is acceptable to the Director for meeting the Civil Aviation Rule requirements for the issue of an Agricultural Rating. This Advisory Circular relates specifically to Civil Aviation Rule Part 61 Subpart O – Agricultural ratings.

3 TRANSPORT, STORAGE AND DISPOSAL

3.1 SCOPE

The transport, storage and disposal of fertiliser are not normally under the immediate control of the aerial applicator. However these activities can directly affect the aerial application operation, and if good practice is not followed for these activities the operator may have to deal with the consequences of that.

Appendix B summarises the CAA Safety Guideline *Farm Airstrips and Associated Fertiliser Cartage, Storage and Application*[2]*,* which describes some of the risks (hazards) associated with the aerial application of fertiliser. The three main risks to be managed are described next.

a) Fertiliser is not free flowing

Risk

- Failure to jettison because of total blockage in the hopper outlet
- Poor spreading because of uneven flow from the aircraft hopper

Responsibility

- Pilot in command (note that responsibility can be delegated but a system that records that delegation shall be maintained)

Information

- Mean particle size and size range (see Appendix C Fertiliser physical properties and aerial application)
- Moisture content of the fertiliser
- Hopper outlet mechanism functioning correctly

Actions

- Cease operations, where the fertiliser to be applied has flow properties that are unacceptable[3]
- Notify the manufacturer in relation to any product issues that may have contributed to unacceptable fertiliser flow properties. Note that verification of this is to be filed with NZAAA (See Appendix B)
- Notify the farmer/airstrip owner in relation to any fertiliser moisture issues from inadequate storage that may have contributed to unacceptable fertiliser flow properties

Documentation

- Incident report to the farmer/airstrip owner or the manufacturer detailing the nature of the problem
- Complete and sign the *Access, Storage and Strip checklist* (see Appendix B). This checklist shall be counter signed by the farmer or airstrip owner

[2] Available from the Civil Aviation Association
[3] Procedures to test flow properties in the field are currently being developed

Competency

- The pilot shall hold a current pilot agricultural and chemical rating.
- The pilot or whoever has the delegated responsibility shall be trained in procedures to test for fertiliser flow properties

b) Airstrip or operating site unsafe for use

Risk

- Damage to the aircraft
- Injury to the pilot
- Loss of productivity

Responsibility

- Pilot in command

Information

- Length of airstrip or other design limitations (including helipads)
- Airstrip width and surface, including the loading area
- Hazards other than the airstrip or helipad – eg wires

(Note – refer to Appendix B Airstrips and Operating Sites)

Actions

- Reduce the load carried until the farmer/airstrip owner has remedied the design limitations or carried out the required maintenance
- Cease operations until the farmer/airstrip owner has remedied the design limitations or carried out the required maintenance
- Cease operations until the hazard identification process for wires and other hazards has been reviewed
- Move operations to another operating site (eg helipad) where operating conditions are safe
- Communicate with the farmer/airstrip owner to ensure the requirements needed to make the operating site safe are understood.

Documentation

- Complete and sign the *Access, Storage and Strip checklist* (see Appendix B). This checklist shall be counter-signed by the farmer or airstrip owner
- Document the presence of wires and any other hazards for the operating site
- File an incident report where any damage to the aircraft has occurred
- File an accident report to OSH where any injury has occurred

Competency

- The pilot shall hold a current pilot agricultural and chemical rating.
- The pilot or whoever has the delegated responsibility shall be trained in the requirements for a safe operating site.
- The pilot or aerial operator shall ensure that all other parties (eg farmer/airstrip owner) have the required information and understand what needs to be done to make the operating site safe

c) Disposal of bags and containers

Risk

- Contamination of waterways from empty liquid fertiliser containers
- Aircraft damage from propeller/rotor strike due to unsecured empty bags

Responsibility

- The operator, who may advise the client of any requirements

Information

- Disposal options for the disposal of empty plastic containers or bags that have contained fertiliser

Action

- Triple rinse any empty plastic containers that have held liquid fertiliser and apply the rinsate to the target area or dispose of safely
- Secure any loose empty fertiliser bags for return to the manufacturer or confirm other safe disposal options

Documentation

- Record in daily flight records the number of bags/containers used and the disposal procedures followed. Where appropriate, provide information to the client confirming that any liquid containers have been triple rinsed.
- For any substances that are require tracking under the HSNO legislation a record of the where and when the disposal of the empty container took place shall be maintained

Competency

- The pilot shall hold a current pilot agricultural and chemical rating.
- The pilot or whoever has the delegated responsibility shall be trained in the requirements for a safe disposal of any fertiliser containers.
- The pilot or aerial operator shall ensure that all other parties (eg farmer/airstrip owner) have the required information and understand what needs to be done with any empty containers

4. APPLICATION

4.1 SCOPE

This section covers the application of fertiliser and the practices that shall be followed to ensure that both the regulatory and the client requirements are met. These practices are based on information required by the operator. Figure 1 summarises the information needed by the operator to enable the appropriate actions required to apply fertiliser by aircraft to be taken.

Information is required in four areas –

- What fertiliser is to be applied
- What application rate is required
- What is the application site
- When is the application required

Most often the information will come from the farmer, but it may come directly or indirectly from their agent or consultant.

4.2 REGULATORY REQUIREMENTS

Regulatory requirements include legislative, such as the Resource Management Act and the requirements found in the relevant Regional Resource Plan (Regional Council), or as part of an industry quality assurance programme. The requirements commonly deal with precision of fertiliser application in relation to specified areas, including waterways. These are off-property effects. In some instances however, regulatory requirements may extend to on-property activities including maximum permissible application rates and specified application times.

4.3 CLIENT REQUIREMENTS

Client requirements normally refer only to on – farm effects, where specifications for application of fertiliser by air are more to do with achieving the specified application rate for the fertiliser(s) to be applied over the required area. When an application rate is specified, an evenness of application specification is also implied, because an uneven application means a significant variation in actual application rate.

It shall be the responsibility of the client to verify that the regulatory requirements relating to the application of fertiliser in the relevant Regional Plan have been identified and taken into account in the application specification provided to operator.

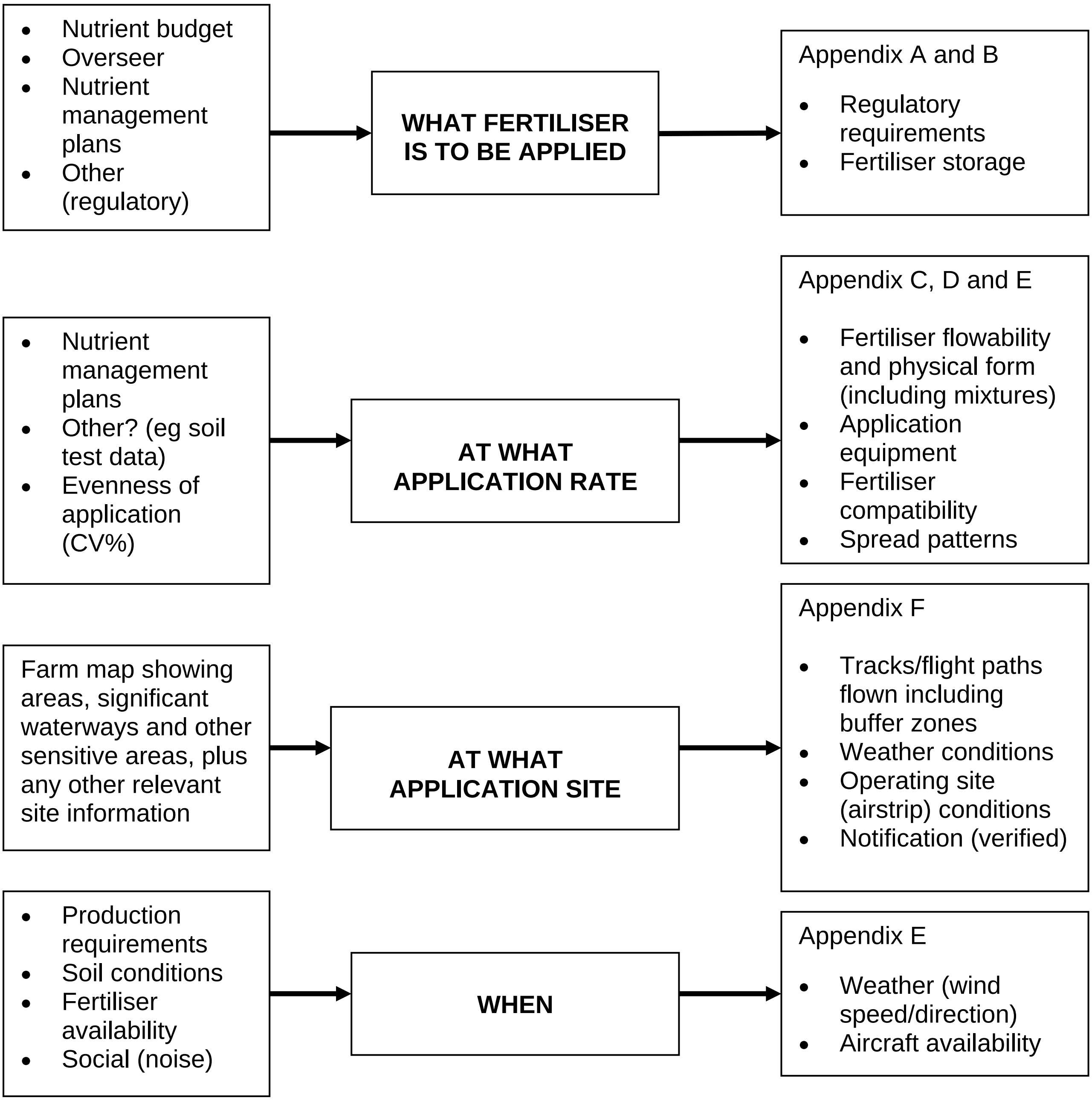
4.4 OPERATOR REQUIREMENTS

It shall be the responsibility of the aerial operator to verify that the regulatory requirements relating to aerial application of fertiliser in the relevant Regional Plan have been identified and taken into account in the application practices followed. The operator shall document the application rate and evenness of application required in the application specification provided to them.

The application specification is made up from information provided by the client or their agent. Figure 1 summarises these information requirements and identifies the Appendices where more detail is provided on why the information is important, how the operator can use the information and what actions might be needed.

Information is needed on each of the four areas shown in the centre column. The boxes on the left indicate the nature of the information required and where it may come from. The boxes on the right provide more detail on what information an operator may need to obtain or verify in order to meet the application specification.

Figure 1: Information requirements for an application of fertiliser by air



In the following section, the risk management approach (Section 2) is applied to each of the four areas identified. The operator shall manage the identified risks by taking the actions identified. In each case the risks given represent the possible consequences of not achieving the objective, which is to apply the specified fertiliser at the correct rate, only on the specified site at the required time. The risks listed refer only to those factors an operator can reasonably be expected to manage or control.

a) Application of the specified fertiliser, including mixtures

Risk

- Client dissatisfaction and complaint
- Breach of regulatory requirements
- Corrosion of components
- Costs of client compensation (lost production)

Responsibility

- Pilot (note that responsibility can be delegated but a system that records that delegation shall be maintained)

Information required

- Specifications of what nutrients (fertilisers) are to be applied, including mixtures. Where appropriate, this shall include a Safety Data Sheet
- Recommended storage life or any special requirements

Action

- Before commencing, confirm with the client the fertiliser application specification, any safety issues (eg corrosion) and the application rate and evenness of application requirements

Documentation

- Fertiliser applied (daily flight record and statistical return to CAA)

Competency

- The pilot shall hold a current agricultural rating and a current chemical rating

b) Application at the specified rate

Risk

- Client dissatisfaction and complaint (lost production, uneven spreading)
- Cost overrun (client compensation) from incorrect or unspecified CV% target
- Incompatible fertiliser leading to segregation or adverse reaction of mixtures either in the aircraft hopper or before loading

Responsibility

- Pilot

Information required

- Spread pattern data for the application equipment to be used

- Specification of the application rate (kg per ha or litres per ha) for the fertiliser to be applied
- Specification of the evenness of application (CV%) required[3]
- Confirmation of flowability/consistency of the fertiliser to be applied (solid fertiliser). For suspension fertiliser confirm the specific gravity (weight per volume)[4]

Action

- Check the condition of fertiliser to be applied, (moisture content, flowability, incompatibility for mixtures) and if necessary measure mean particle size (SGN) and size range (Uniformity index, UI)
- Confirm that a spread pattern is available for the application equipment used, and where required, obtain spread pattern data for any new fertiliser to be applied
- Select appropriate spreading system/device
- Check/verify that the aircraft application system has been calibrated (eg hopper flow rate, track spacing)

Documentation

- Spread pattern data for the fertiliser being applied shall be available on request
- Application rate recorded (daily flight record)
- Application equipment or method used including spreader type, suspension system, nozzles (liquid)

Competency

- The pilot shall hold a current agricultural rating and a current chemical rating

c) Correct application site

Risk

- Fertiliser applied on the wrong site
- Fertiliser applied in a sensitive area (off site)
- Incorrect/no buffer zone set around sensitive areas (sensitive areas not identified) - a likely regulatory requirement which requires information on particle size of the fertiliser so that set buffer zones can be achieved
- Cost overrun (client compensation) from application to the wrong site
- Noise, dust or other third parties hazards (eg power line corrosion)

Responsibility

- Pilot

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[3] The Spreadmark standard for evenness of application is expressed by CV% for application equipment, where a CV% of 15 or less is required for N based fertiliser and 25 or less for any other fertiliser.

[4] Poor flowability can affect application rate and evenness. In extreme cases poor flowability or high specific gravity is a safety risk for the operator. Information on the factors such as SGN, UI should provide a reason for the poor flowability and indicate what needs to change in order to improve it.

Information required

- Verification of application site – hard copy map or GIS data of the application site and any non-target areas where no fertiliser is to be applied[5]
- Verification that notification of neighbours/third parties has been carried out where required[6] (see Appendix F)
- Particle size (% less than 500 microns diameter)[7]

Action

- Where necessary, set appropriate buffer zones around non-target areas
- Log target areas onto GPS system or otherwise verify the location of the target site
- Confirm that the operating site (airstrip/helipad) available and suitable
- Establish/confirm any operational hazards (eg wires, livestock in or near the target area)

Documentation

- Buffer zones set (where required)
- GPS plots for the application site
- The type of fertiliser applied and the rate of application

Competency

- The pilot shall hold a current agricultural rating and a current chemical rating

d) Required application date

Risk

- No aircraft available
- No pilots available
- No ground crew available
- No spreader available (if required)
- Unsuitable weather
- Operating site unsuitable or not available
- Application site unsuitable (soil moisture)
- Noise problems (for the date or the time of application)

Responsibility

- The operator (note that responsibility can be delegated but a system that records that delegation shall be maintained)

Information required

- The required or preferred application date
- Weather – particularly wind direction and wind speed
- Aircraft availability
- Equipment availability (including loaders)

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[5] There will be situations where a hard copy map of the application site is not available before the fertiliser application. In these cases the operator shall assess the risk of proceeding without that information

[6] Note that the operator is not required to carry out any such notification, only to confirm that it has been done where required

[7] Important where the movement of fertiliser as dust off the application site presents a risk to an identified non-target area

- Staff availability (pilots, ground crew)
- Capacity (number of aircraft) to use or time needed to apply the amount of fertiliser specified

Action

- Communicate with client to confirm arrangements (notification)
- Have evidence available, if required on request, that notification has been done and appropriate actions taken to mitigate any adverse effects.

Documentation

- Date of application noted (daily flight record)
- Adverse events, if any, including jettison or off target application and strip report
- Equipment used
- Amount applied – statistical returns to CAA
- Weather conditions (wind speed and direction)
- Tracks flown (GPS data)

Competency

- The pilot shall hold a current agricultural rating and a current chemical rating

5. PRODUCT DATA

The physical form of fertiliser coupled with the required application rate affects the spread that can be achieved – both the swath width and the spread pattern. It also affects the ability to precisely control where the fertiliser goes in relation to the edge of the target area and the need to avoid placing any fertiliser in specified sensitive areas, including water. In some cases, poor flow properties may also directly contribute to incidents and accidents as a result of the failure to jettison when the situation requires it

5.1 RESPONSIBILITIES

Operators shall be familiar with the product names used by fertiliser manufacturers so that the specification provided by clients for the fertiliser to be applied can be identified.

a) *The operator*
It is the operators responsibility to ensure that the application system fitted to the aircraft is fit for purpose and that any fertiliser that is placed in an aircraft hopper, including slung spreader buckets, is also fit for purpose. That means:

- The hopper design and outlet mechanisms are such that no adverse effects on flow rate are caused
- The physical properties of the fertiliser are such that the fertiliser can be discharged at the required rate, and if necessary, be jettisoned should the situation require it.

b) *The fertiliser manufacturer*
It is the fertiliser manufacturer's responsibility to ensure that the fertiliser supplied for transport complies with the required specification for physical properties

c) *The farmer (client)*
It is the farmer's responsibility to ensure that the fertiliser delivered has not deteriorated below specification for physical properties at the time it is to be applied.

5.2 PRODUCT INFORMATION REQUIRED

All fertilisers applied should be Fertmark registered. Information that should be provided, or available on request includes

a) Solid fertilisers[8]
- Size guide number, SGN (the mean particle size)
- Uniformity index UI (the particle size range)
- Bulk Density BD (weight per volume)

b) Blends and mixtures
- Physical compatibility of blend components (SGN, UI)
- Chemical compatibility[9]

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[8] This information can be obtained on site by the use of a sieve box
[9] If no information exists on the chemical compatibility of a new mixture, a sample of the mixture should be tested before it is put in the aircraft hopper

c) Suspension and liquid fertiliser

- Specific gravity

Appendix A: Legislation and the Application of Fertiliser

1. INTRODUCTION

Various regulatory and other industry or quality assurance requirements affect the application of fertiliser. The main legislative requirements are the Resource Management Act 1991 (RMA), the Agricultural Compounds and Veterinary Medicines Act 1997 (ACVM) and the Hazardous Substances and New Organisms Act 1996 (HSNO). Each of these pieces of legislation is about risk management – to the environment (RMA), to trade and primary produce (ACVM) and to the environment, people or animals (HSNO). The Health and Safety in Employment Act 1992 (HSE) is also relevant in relation to safe workplace requirements.

2. LEGISLATION

2.1 The RMA

The principle item of legislation that affects the application of fertiliser is the Resource Management Act 1991 (RMA). Under the RMA:

No person may discharge any contaminant

- into water
- onto or into land if it may result in entering water
- into the air or onto the land

in a manner that contravenes the Regional Plan.

Regional Councils, including unitary authorities prepare resource management policies and plans under the RMA. The plans usually include rules that govern various activities, including the discharge of contaminants. In this context fertilisers are considered contaminants.

Under these rules, which may appear in a water plan, or an air quality plan, fertiliser application may be considered a discretionary activity in which case it will require a resource consent, and there will be conditions attached to that consent. More commonly fertiliser application will be a permitted activity. There will normally still be conditions attached to that status, meaning that the application of fertiliser can be carried out without the need for resource consent provided that the conditions are met.

For all aerial application of fertiliser, operators shall be familiar with the requirements of the relevant resource management plan for the area concerned.

2.2 The Agricultural Compounds and Veterinary Medicines Act 1997 (ACVM)

This legislation covers the requirements for the fertiliser group of agricultural compounds. Fertilisers are broadly defined as substances or products that are used to encourage plant growth but are further classed as either:

- Fertilisers - used to provide nutrients to encourage plant health and growth
- Fertiliser additives – used to adjust the chemical or biological characteristics of soil to facilitate uptake and use of nutrients

- Soil conditioners – used to adjust the physical characteristics of soil

All products that are either fertilisers or fertiliser additives are exempt from registration under the ACVM Regulation 9 as long as the requirements of the ACVM Regulations that cover the import manufacture and trade in fertilisers and fertiliser additives are met. That means the fertiliser must be fit for the purpose specified in the directions for use and be provided with information at the point of sale that including the trade name, nutrient content and modifying pH, details of any precautions to be taken to prevent or manage risk and directions for use. Normally this information will be in the form of a dispatch docket or consignment note.

2.3 The Hazardous Substances and New Organisms Act 1996 (HSNO)

The Minimum Degrees of Hazard Regulations 2001 and Hazardous Substances (Classification) Regulations 2001 determine and describe the hazardous properties of substances. Some fertilisers may be hazardous substances under these regulations, in which case any controls applied under the HSNO regulations must be complied with. The controls may relate to any stage of the life cycle of the substance including manufacture, transport, storage, use or disposal

2.4 Health and Safety in Employment Act 1992 (HSE)

Identifying hazards then eliminating, isolating or minimizing the hazard is a centerpiece of the HSE legislation along with providing a safe workplace. The consequences of poor flow properties of fertiliser leading to the inability to jettison a load from an aircraft in an emergency is one example where this legislation may affect the application of fertiliser.

3. RELATED CODES OF PRACTICE

Other programmes may influence fertiliser application.

3.1 Fertmark

Fertmark is an independently assessed fertiliser quality assurance programme. It provides quality assurance on claimed nutrient content to farmers purchasing fertiliser. Currently 68 products from 13 fertiliser companies operating on 18 sites are now Fertmark registered.

Independent audits are made on the quality assurance standards of Fertmark brand fertiliser. Regular follow-ups are made to ensure this quality control is maintained.

Currently almost all Fertmark-registered fertilisers are manufactured products, and do not yet include blends or mixtures. As the scheme develops, it will be extended to a greater range of products. Fertmark registered manufacturers, importers and suppliers also have an advertising code of conduct, so they should be able to verify the claims they make about the quality of the products they sell. The bright green Fertmark tick stands for fertiliser quality assurance.

The Code of Practice for the Sale of Fertiliser in New Zealand (the Fertmark Code) is an approved Code under the ACVM Act 1997

3.2 Fertiliser Users Code of Practice

The Code of Practice for Fertiliser Use is designed to enable individuals to undertake farm nutrient management that is specific to their unique situation within an effective decision making framework.

The Code enables a participatory, non-prescriptive approach that is consistent with the requirements of the Resource Management Act (RMA) which focuses on the effects of the activity rather than the activity itself.

To achieve this the Code uses an internationally recognised, agriculturally based process known as FESLM, Framework for Evaluating Sustainable Land Management. The system allows for the selection of a range of options for fertiliser use, which promotes sustainability and enables users to avoid, remedy or mitigate any adverse environmental effects as required under the RMA.

Options for fertiliser use are based on the following five guiding principles:

- to maintain or enhance production
- to reduce the level of production risk
- to protect natural resources and prevent degradation of soil and water quality
- to be economically viable
- to be socially acceptable

The Code is designed to address two main audiences - regulatory authorities (regional councils) and fertiliser users. Regulatory authorities require a document that is robust and has the legal status to be referred to in Regional Plans, and also provides a high degree of certainty with regard to outcomes. Farmers on the other hand need a practical document that provides them with the guidance and direction required to deal with issues specific to their situation.

To accommodate these requirements the Code has been developed in three sections:

- Fertiliser Practice
- User Guides
- Fact Sheets

Appendix B: Airstrips and Operating Sites

1. INTRODUCTION

Many of the accidents and deaths that have occurred in the aerial application of fertiliser are preventable. While many factors contribute to accidents, they can occur because of the poor condition and siting of topdressing airstrips or because of poor flow of fertiliser from the aircraft hopper. This can be due to the inclusion of foreign matter or objects, excessive moisture, compaction due to fineness of milling or problems with hopper outlet mechanisms.

CAA and OSH have produced a Safety Guideline[10] that covers:

- Manufacturers of Fertiliser.
- Transport Operators and Drivers.
- Airstrip owners.
- Farmers (as purchasers of fertiliser)
- Aircraft Operators, Loader drivers and Pilots

The section covering operators, loader drivers and pilots is included next.

2. HAZARD IDENTIFICATION – THE OPERATOR, LOADER DRIVERS AND PILOTS

The following text is from the CAA/OSH Safety Guideline

The Hazard:	**Lack of Training, information, supervision, and communication.**
Controlled by:	**Employers of staff, Employees**

2.1 Employer: Loader Driver and Pilot (and self-employed People)

Employers of pilots and loader drivers have a duty to ensure that the work assigned can be performed safely and that employees are not harmed. To this end, employers have a duty to provide supervision, training and information relevant to the tasks involved in work being performed.

Management of fundamental issues such as ensuring that the pilot is current on type, correctly trained, is medically fit and has knowledge of hazards and how to avoid them needs to be demonstrable. The same applies to loader drivers. Training and information with regard to specific hazards of the tasks involved is crucial.

Supervision, training and information, includes the following (S12 and S13 of the HSE Act):

[10] This guideline is called ''Farm Airstrips and Associated Fertiliser Cartage, Storage and Application”

- Ensuring that the pilot and the loader driver are conversant with the flow property requirements of the load, and how to test for that
- Ensuring that the pilot and the loader driver are conversant with the procedure to communicate the result of a flow test to both the farmer, and their own employer, if required.
- Ensuring the pilot is properly licensed and current on aircraft type, has the requisite certificates and is appropriately trained for the task.
- Ensuring that the pilot has the experience and knowledge necessary for the task or is properly supervised commensurate with training and experience.
- Communicating information relevant to hazards such as overhead wires and other hazards, obtained from the farmer.
- Ensuring that the loader/driver is properly licensed and trained to safely carry the necessary functions.

Employers must be aware that they have a duty to take all practicable steps to provide a safe place of work. Self-employed people have a duty to take all practicable steps to keep themselves from harm.

Both operators and pilots must be aware of the requirement under Civil Aviation Rule Part 137 Subpart C – Special Flight Rules, particularly 137.103 (a) (2) which relates to the aircraft jettison capability. This rule is printed below:

"137.103 Maximum take-off weight

(a) Notwithstanding Part 91 and subject to paragraph (b), a pilot performing, or being trained to perform, an agricultural aircraft operation in an aeroplane must not take-off at a weight greater than the MCTOW prescribed in the aeroplane's flight manual unless

(1) the pilot complies with the procedures listed in Appendix B[1]; and

(2) the aeroplane is equipped with a jettison system that, in accordance with D.5, is capable of discharging not less than 80 percent of the aeroplane's maximum hopper load within five seconds of the pilot initiating the jettison action.

(b) Where there is a third party risk as defined in Appendix A[1], the pilot must determine the maximum take-off weight in accordance with 137.107 and 137.109."

Note: Appendix A of Part 137 defines third party risk and Appendix B refers to overload weight determination.

It is a crucial that fertiliser being sown has an inherent capability such that the criterion for jettison is achievable. A material that is not free flowing may inevitably be implicated in hopper discharge problems; therefore, operators and pilots must take all practicable steps to ensure that:

- The jettison system is capable of discharging the agricultural material used within the criteria specified and
- The fertiliser material will remain free flowing after placement into the aircraft hopper

The employer (operator) must also abide by the conditions of CAA aviation safety reporting requirements under CAA Rules Part 12 and the Serious Harm reporting requirements of S25 of the HSE Act.

2.2 Loader driver

The HSE Act requires employees take all practicable steps to ensure their own safety while at work and to ensure no person in their workplace is harmed as a result of their actions or inaction.

Poor storage of fertiliser can affect the condition of the aircraft loads and the ability to spread the load in a safe manner. Loader drivers can therefore contribute significantly to the safety of the operation by ensuring that fertiliser is free flowing prior to loading it into an aircraft.

Loader drivers are in a good position to make early assessment of the fertiliser for free flowing characteristics and its suitability for spreading, and practicable steps include:

- Checking the flow characteristics of the load and communicating test results to the pilot.
- Checking and agreeing with the pilot as to the suitability of the fertiliser load to be spread.
- Communicating to their employer and to the farmer, any inadequacies of the storage facility that were noted.

The loader driver is responsible for the appropriate use of the loader and load weight/mass measurement mechanisms.

2.3 Pilots

The HSE Act requires self-employed persons (under section 17) and employees (under section 19) to take all practicable steps to ensure their own safety while at work and to ensure that no person is harmed as a result of their actions or inaction while at work. For employees there is a specific duty to use any protective clothing or equipment that is provided for their use.

For pilots these duties mean, for example, abiding by the conditions of the CAA Operating Certificate and Rules governing the role and operation of the aircraft and wearing appropriate safety gear. Other practicable steps may include the following:

- Operating in accordance with the employing company’s documented policies and procedures or Standard Operating Procedures (SOPs).
- Assessment of the safety/condition of the runway strip, operating areas and approaches with respect to the aircraft type to be used.
- Assessment of the environmental conditions.
- Checking and agreeing with the loader driver as to the suitability of the condition of the fertiliser to be spread.

- Give an informed positive or negative statement to his employer (if appropriate) and the farmer with regard to carrying out the work, based on the above.

The pilots must report incidents and accidents in accordance with CAA Rules Pt 12 and Serious Harm under the HSE Act 1992.

2.3 Pilot checks prior to commencing a topdressing contract

Agricultural pilots shall demonstrate that the risks of using a particular runway with the aircraft type have been considered in relation to the contract requirements. A checklist is one way of achieving this. The checklist should also be used to note that a briefing has been received from the owner or contractor on the known hazards, particularly with respect to wires, and of both the runway and the topdressing task itself, and that they have checked on the condition of the fertiliser and that it is suitable for the task.

Such a checklist should be incorporated with the job documentation and retained for future reference. Should an area be noted as unsatisfactory, the form could be used to bring the problem to the attention of the farmer for rectification.

Airstrip Risk Checks

Date:	Airfield Owner/ Occupier Name:	
Pilot Name:	Loader Name:	
Aircraft Type:		Aircraft Reg: **ZK-**
Airstrip Position:		Job Number

Checks

Item Checked	**OK**	**Not OK**	**Comments**
Airstrip Checks			
Runway approach/takeoff paths safe			
Runway length/slope satisfactory			
Runway width satisfactory			
Runway surface satisfactory			
Braking action satisfactory			
Wind Indicator satisfactory			
Fencing/obstacle/wire clearance satisfactory			
Weather satisfactory for the contract job			
Load Checks			
Aircraft load – adjusted for conditions			
Material flow checks satisfactory			
Job Hazard Briefs			
Runway hazard brief from owner received			
Job hazard brief received from Principal			

Pilot Signature………………………………………. Date/Time …………………..

Hand to loader/driver for retention and filing on return to home base.

Note: In the event of some items not being OK, a copy of this form shall be filed with the Executive Officer NZAAA, c/- Box 2096, Wellington.

Appendix C: Fertiliser Physical Properties and Aerial Application

1. INTRODUCTION

This appendix describes fertiliser physical properties and how these properties can affect flowability of fertiliser from the aircraft hopper. Information on physical properties should be available for any fertiliser applied. Normal practice would be to obtain this information at the time that spread pattern testing is done so that the spread pattern can be related to the fertiliser used

2. FERTILISER PHYSICAL PROPERTIES

2.1 Solid fertilisers

The most important solid fertiliser physical characteristics are:

- Size Guide Number (SGN) – the mean particle size
- Uniformity Index (UI) – the ratio of small to large particle sizes
- Bulk Density (BD) – affects ballistic properties and can affect the performance of spinning disc spreaders

Ballistic properties of fertiliser are most affected by the particle size and the particle density. Where a spinning disc spreading device is used, bigger, heavier particles can be thrown further and will be less affected by wind. Where no spreader is used, the range of particle sizes is important because of the need to get an even spread pattern, which means an even mass of fertiliser across the swath.

SGN, UI and BD data for any fertiliser should be obtained when spread pattern tests are carried out (see Appendix E). These data are obtained by sieve testing, using a stack of sieves and a sieve shaker, but for convenience and ease of use a sieve box is recommended. A sieve box also allows tests to be done after fertiliser has been delivered and before application. Representative sampling of the bulk fertiliser is vital.

Fertiliser	SGN	BD (t/m^3)	UI
Superphosphate	245 – 300	1.03 – 1.28	11
Potash Super	135 – 286		23
Urea	290 – 340	0.7 – 0.8	60
DAP	265 – 335	0.90 – 1.0	55
AS Std	90 – 160	1.02 – 1.10	20
AS granular	265 – 280	1.02 – 1.10	60
Lime	20 - 50	1.2 – 1.4	2

Table C 1 – Typical physical properties for a number of NZ fertilisers

2.2 Changes in the physical properties

The physical properties identified, including SGN, UI, BD, MC% and fertiliser flow properties may change as a result of handling (particle degradation) or exposure to weather. The extent to which these changes might occur can also be measured, for example hygroscopicity (the rate at which MC% changes when exposed to higher humidity). However the biggest factor is sampling error. The sample taken for testing must accurately represent the bulk material if the data are to be reliable and useful.

In the worst case, flowability may decrease to the point that blockages in the aircraft hopper can occur.

The best way to deal with such changes is through constant testing. This may begin with a sample prior to purchase, then at arrival, dispatch from the store and prior to spreading. The test methods therefore need to be simple and easy to use.

2.3 SUSPENSION FERTILISER

Solid fertiliser can be ground into fine particle sizes and mixed with water to form a suspension. The fineness of grinding affects the ability to produce and maintain a stable suspension, and the amount of water required to achieve that. A typical suspension would consist of 30% water by weight.

The ability to form suspensions in this way has a number of advantages. However two points to note in relation to the use of suspensions are:

a) It offers the opportunity to mix constituents that may be chemically incompatible, and which may produce reactions in the aircraft hopper. Unless a suspension has been shown to be safe, a sample mixture of the proposed suspension shall be prepared and tested for compatibility and stability before it is used in an aircraft

b) The specific gravity of a suspension may be up to 1.5 or higher. Because the amount placed in an aircraft hopper is often judged by volume, the increased specific gravity means that the aircraft may be grossly overloaded even though the hopper is not full.

Although a suspension behaves like a liquid, specialised equipment is needed to dispense the suspension in flight and achieve reliable starting and stopping of discharge

3. FLOW RATE

The rate at which fertiliser leaves the hopper on an aircraft depends on the application rate, the aircraft travel speed and the swath width (and hence the track spacing). The actual flow rate required may vary from 300 kg per minute to over 2000 kg per minute.

Good fertiliser "flowability" means the fertiliser will continue to flow at the required discharge rate from the time the hopper is full until it is empty. It also means that flow will recommence immediately the hopper outlet is opened, regardless of the length of time the outlet has been closed and regardless of whether the hopper is full or near empty.

Measuring "flowability" of fertiliser from an aircraft hopper is a complex problem because it involves a number of factors, many of which interact. The factors involved include physical properties of the fertiliser. The main properties are:

- Particle size
- Particle shape
- Range of particle sizes
- Particle hardness

- Moisture content

The way in which these factors interact with different aircraft hopper shapes and wall angles, different outlet designs, the effect of turbulent air at the outlet, and compression of particles at the bottom of the hopper from the weight of particles makes the flow properties difficult to predict. However the following guide can be used

	Flowability	
Property	**Good**	**Poor**
Particle size (SGN)[1]	High (> 200)	Low (< 50)
Particle size range (UI)[1]	High (> 20)	Low (<10)
Particle shape	Smooth, spherical	Rough, irregular
Particle hardness[2]	Hard	Soft
Moisture content[3]	Low (< 5%)	High (>5%)

Table C2 – Guide to flowability based on fertiliser physical properties

Note: This table is a guide only, providing a general indication of the likely effect on flowability for the various properties.

[1] = see section C2
[2] = particle hardness also includes cases where fertiliser is not mature
[3] = the effects of moisture content can vary considerably. Moisture content alone may not be a reliable indicator of flow

4. SPREAD PATTERNS

Appendix E describes the information that is collected when a spread pattern is measured. In practice, differences in spread pattern obtained in the field will be dominated by the weather conditions at the time of application (see Appendix D).

As a general rule, fertiliser with good flowability properties will tend to give a consistent spread pattern. If fertiliser with a high SGN and UI is used, the spread pattern in the field will not differ significantly from that obtained under test conditions. Spread patterns for fertiliser with poor flow properties, particularly where the UI is low, will vary according the wind conditions at the time of application.

Appendix D: Fertiliser Application Specifications

1. INTRODUCTION

In practice, fertiliser application will seldom if ever be uniform, and there will be departures from the specified application rate. This is especially so for aerial application because of the greater potential impact of weather conditions.

The significance of departures from uniformity in fertiliser application depends on the production system and objectives. The specifications for fertiliser application must be site specific, and may be modified or affected by production, environmental, financial or social factors. The fertiliser application specification may be derived using a range of different methods. These factors are outside the control of the operator and must be considered by the farmer or client; most likely as part of a nutrient management plan.

To be Spreadmark Accredited, application equipment must satisfy the performance standard for transverse CV% of 15% for nitrogenous fertilisers and 25% for all other products.

In simple terms the pilot will manage the actual application rate applied in two ways

- Within a specified accuracy for the required application rate, as described by the CV%.
- At an application rate of zero for areas where no fertiliser is to be applied. Such areas may include water bodies, wetlands or other designated non-target areas.

In each case information must be available to the pilot on the application site and the application rate and evenness required. Methods available to the operator to satisfy these two objectives may include firstly the setting of a specified track spacing and control over departures from that specified track and secondly, control over the discharge of fertiliser, both in terms of flow rate along the flight path and the spread pattern.

To satisfy the requirements of this Code, the operator shall document specifications for

a) Application rate (kg/ha) and
b) Evenness of application (CV% or departures above and below the mean application rate)

2. EVENNESS OF APPLICATION AND CV%

The Coefficient of Variation, or CV is a relative measure of evenness of application. To calculate CV%, divide the standard deviation (of the spread pattern achieved) by the mean application rate and express the result as a percentage. The approximate relationship between CV and departures from the mean application rate is shown in Table D1. The relationship is approximate because it depends on the general shape of the spread pattern. Also, because CV uses the standard deviation it describes the average of the departures around the mean rate. Those departures can be made up of either a small number of large departures or a large number of small departures to get the same CV value.

For example, at a CV of 25%, the rate of application is within 25% of the mean rate over 66% of the target and within 50% of the mean rate over 95% of the area

CV%	**Maximum departure from the mean application rate over different % of target area**		
	66%	95%	99%
5	5	10	12
10	10	20	25
15	15	30	40
20	20	40	50
25	25	50	65
30	30	60	80

Table D1 CV and variation from the mean application rate[11]

3. VARIATION IN ACTUAL APPLICATION RATE

The actual application rate achieved in the field depends on several factors, which may either increase the variation in actual rate or compensate for errors and reduce the variation.

The factors are:

- Spread pattern
- Track spacing
- Ground speed of the aircraft
- Discharge rate of fertiliser
- Cross wind and application altitude

Some of these factors can be controlled or at least influenced by the pilot, for example track spacing, ground speed, discharge rate and application height. The pilot may also be able to change the spread pattern by using a spreader. The one factor the pilot has no control over is the crosswind. However the effects of a cross wind in relation to the fertiliser being applied are known or can be established, and the wind conditions at the application site can be measured.

Where necessary, operators shall be able to provide evidence to verify the wind conditions at the application site and of the application systems and practices that were followed so that the actual evenness application can be established.

3.1 SWATH PATTERNS

A transverse spread pattern shall be available for all aircraft types and spreader combinations. Each spread pattern shall be recorded at a typical or average application rate for the fertiliser to be applied.

The spread or swath pattern from either a fixed wing aircraft or a helicopter, with or without a spreading device will be dominated by:

- Fertiliser particle size
- Crosswind speeds
- Application height

[11] Effects of uneven fertiliser spreading – a literature review. Dilz, K; van Brakel G D Fertiliser Society 1985

a) No spreader

With higher aircraft ground speeds and rates of application above about 150kg per ha, spreaders are not normally used because the high mass flow rates that must be put through makes the spreader less effective.

Where no spreader device is used on a fixed wing aircraft, and in calm conditions, fertiliser particle size does not influence the distribution pattern. The pattern will tend to be narrow and sharply peaked with an effective width of about 10 to 12 metres and the same pattern will occur almost irrespective of fertiliser type.

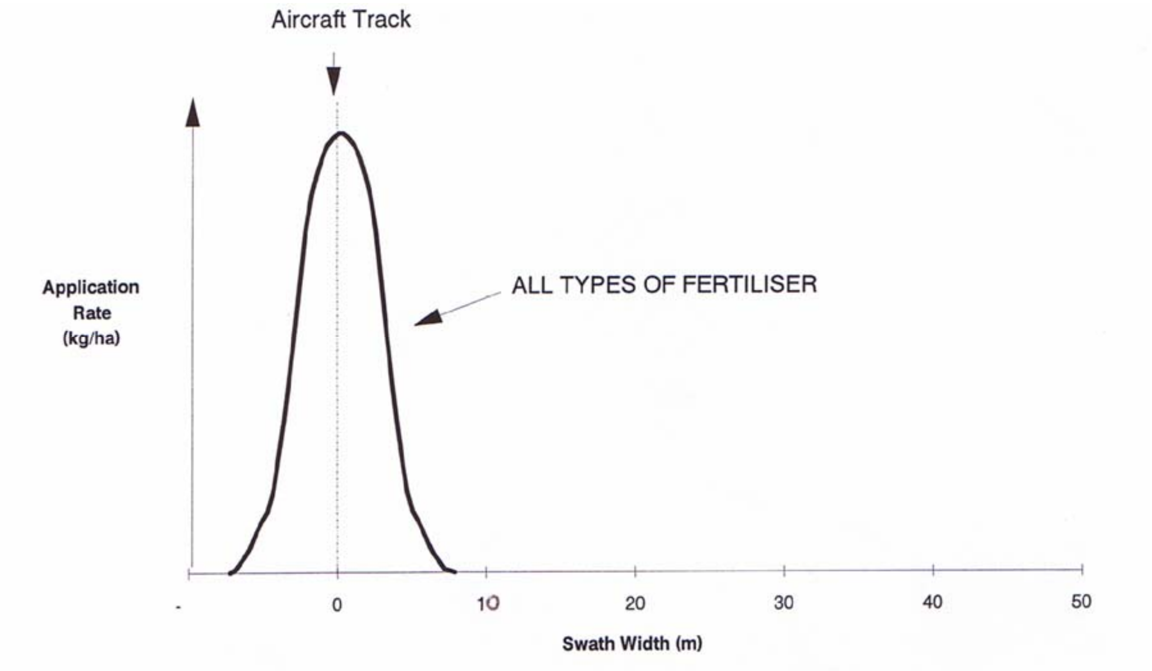

Figure D1 Typical swath pattern under calm conditions – all fertilisers

Where there is a crosswind, small particles will be moved downwind more than large particles. If the fertiliser contains a range of particle sizes, the spread pattern will become skewed. Where all the particles are large the shape of the spread pattern will not change much but the whole swath will move downwind.

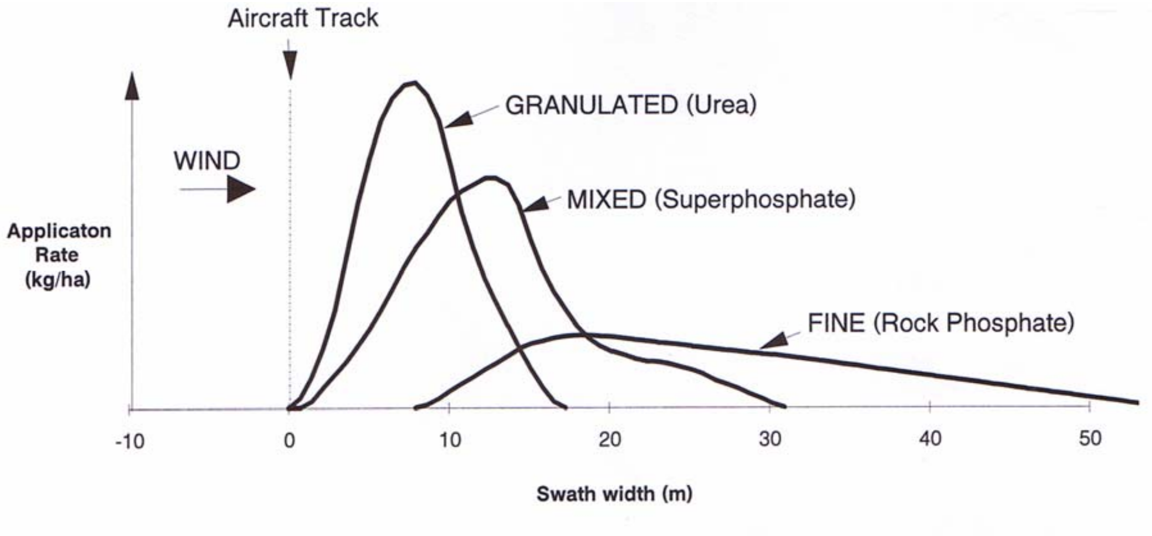

Figure D2 The effect of wind on swath patterns for different fertilisers

b) Spreaders

Spreaders will either be mechanical (eg spinning disc) or aerodynamic (eg ram air). In either case, they impart energy into the fertiliser particles to propel them transversely in relation to the travel direction. The larger the fertiliser particle the more energy can be imparted and the greater the distance the particle can be moved.

Spreaders will have little effect on particles of less than about 0.5mm diameter.

If particles are all the same size they will have roughly the same energy imparted and will therefore travel a similar distance laterally. Depending on the spreader design this can result in an “M” shaped spread pattern

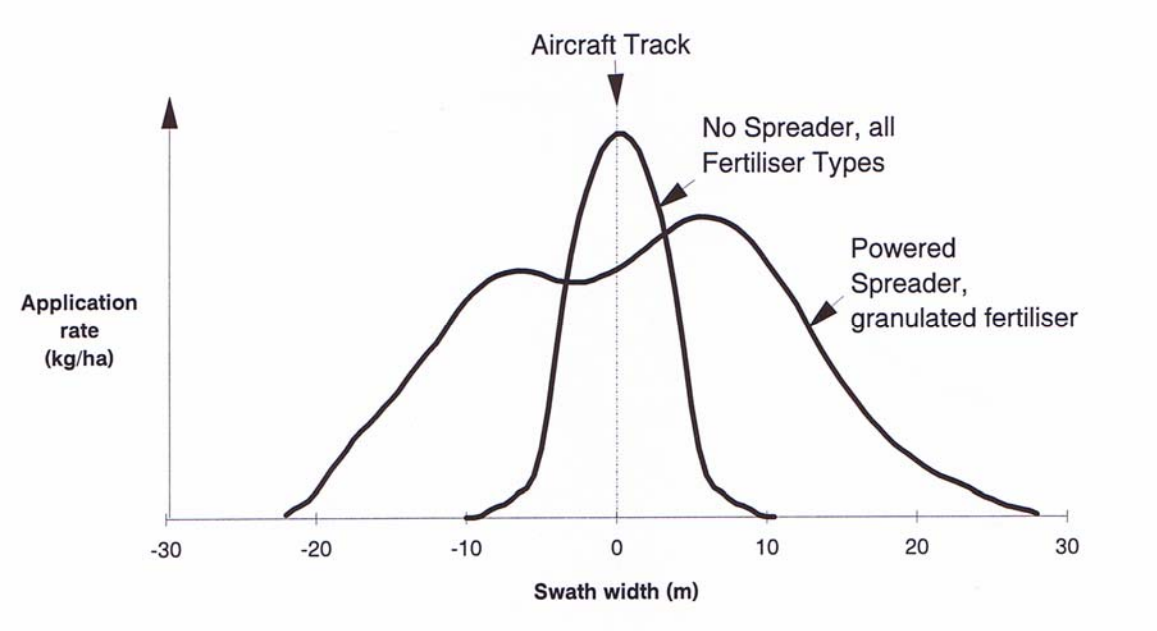

Figure D3 Typical swath patterns from a spreader

For any aerial application, achieving the required evenness of application depends on a number of factors including the spread and an even flow rate from the hopper. Spreaders influence the spread pattern achieved by changing the trajectory of fertiliser particles as they leave the aircraft.

Spread pattern testing is described in Appendix E, where the information that is collected when a spread pattern is measured is set out. Spread pattern tests are normally done under controlled conditions – a flat site, and constant application height with light or low wind speed. In practice the application height will vary because of the terrain, which means the winds that would typically be encountered at the application site will have a significant effect on the actual spread pattern achieved.

Within limits, the effect of any wind at the application site will be to improve the overall evenness of application. However in higher wind speeds it will also be more difficult to confine the fertiliser to the specified application site, and the risk of applying fertiliser in a sensitive area will increase.

In practice, differences in spread patterns obtained in the field, and hence variations in actual application rate, will be dominated by the wind conditions at the time of application. If fertiliser with a high SGN and UI is used the spread pattern in the field will not differ significantly from that obtained under test conditions. As a guide only, fertiliser with good flowability properties will tend to give a consistent spread pattern. See Appendix C. Spread patterns for fertiliser with poor flow properties, particularly where the UI is low, will vary according the wind conditions

3.2 Track spacing

Track spacing is the distance between successive passes of the aircraft. The application rate achieved and the variation in application rate, expressed by CV%, is obtained when the spread pattern is overlapped. Table D1 shows the typical track spacing to achieve a CV% of 25 for a range of fertiliser types and no cross wind. If all the conditions described in section 2 are constant apart from track spacing for an actual fertiliser application in the field, the affect on the evenness of application is indicated as follows;

Fertiliser type	**Track spacing (m)**		
	Fixed Wing (FW)	FW with powered spreader	Helicopter bucket with spinning disc
Superphosphate	12 (18)	23	34
Granulated (eg DAP)	11 (18)	26	35
RPR	12 (40)	12 (40)	13 (40)

Table D2 Track spacing to achieve a CV% of 25
Note

1. The application height is 30m
2. The figures in brackets are the tracks needed to achieve a CV% of 25 when the wind is greater than 8 km/hr

3.3 Ground speed of the aircraft

Variations in ground speed translate directly into variations in application rate. If the speed increases by 10% the application rate achieved decreases by 10% unless compensation is made by increasing the discharge rate for fertiliser at higher speeds, and decreasing it for lower speeds. Higher application speeds reduce the time available to make such changes.

3.4 Discharge rate of the fertiliser

An increase in discharge rate will tend to decrease the spread width obtained, whether a spreader is used or not. Discharge rate can also be affected by poor flow properties of the fertiliser so that the actual amount discharged will vary along the flight path. These two effects of longitudinal variation and the effect on the transverse spread pattern may compensate or they may be cumulative, but the important point is that poor fertiliser flow properties produce unpredictable results.

3.5 Cross wind and application altitude

A crosswind during fertiliser application has little effect on fertiliser that has a high SGN and UI (see Fig D2). However the effect can be significant for fertilisers with low SGN and UI and noticeable for fertiliser with high SGN and low UI.

Application altitude is important only to the extent that higher altitudes mean a longer time for the fertiliser to reach the ground and hence more time to be moved by any cross wind that does exist.

4. SITUATIONS WHERE APPLICATION RATE OF ZERO IS REQUIRED

4.1 Areas where zero application rate is required

For various reasons e.g. environmental or social, there may be areas where no fertiliser should be applied. A territorial authority (Regional Council) may designate such areas in a resource management plan. For example the plan might designate significant water bodies where no direct application of fertiliser is permitted. Other areas may be designated for different reasons eg organic farmed areas.

Identification of any areas where no fertiliser is to be applied is a basic requirement. As part of the requirement to identify the application site, the farmer/client has the responsibility to establish what areas within or adjacent to that site have been designated as areas where no direct application of fertiliser should be made.

The operator shall be aware of any such designated areas when confirming that application site with the client and adopt practices to ensure that no fertiliser is applied in those areas.

4.2 Strategies for achieving zero application rates

Three operational factors are relevant:

a) Fertiliser ballistic properties (ie particle size and density)
b) Orientation of the flight path in relation to the designated zero application rate area (ie directly towards, at an angle, or parallel)
c) Local weather (wind speed and direction)

Fertiliser ballistic properties are largely determined by particle size and density. When a fertiliser particle is released from an aircraft, it is traveling at the same speed as the aircraft but following release the particle rapidly slows because of air resistance and drag. Smaller particles stop more quickly and their fall speed to the ground is also slower. The behaviour of a single particle will be entrained by the mass of other particles around it when released from an aircraft, with the result that the downwind travel distance is likely to increase. The aircraft height is also relevant in terms of the opportunity presented for fertiliser released to travel downwind from the release point.

Table D3 distances (m) traveled by particles, released at various heights and travel speeds before reaching the ground

50 km/h

Particle size (mm)	Release height (m)		
	15	30	60
0.5	7	8	10
1.0	10	12	15
2.0	13	17	22
3.0	15	20	26
4.0	17	22	29
5.0	18	23	31

100 km/h

Particle size (mm)	Release height (m)		
	15	30	60
0.5	8	10	11
1.0	13	15	18
2.0	18	23	27
3.0	22	28	34
4.0	25	31	40
5.0	27	34	44

150 km/h

Particle size (mm)	Release height (m)		
	15	30	60
0.5	9	11	12
1.0	14	17	20
2.0	21	26	31
3.0	26	32	39
4.0	30	37	46
5.0	34	42	52

200 km/h

Particle size (mm)	Release height (m) 15	30	60
0.5	10	11	13
1.0	16	18	21
2.0	24	28	33
3.0	30	36	43
4.0	35	42	51
5.0	38	47	57

Notes:
1. These are rounded computed values for single particles. The assumptions include

Air density = 1.229 kg/m^3
Gravity = 10 m/sec^2
Particle density = 2000 kg/m^3

2. Where spinning disc spreaders are used, the travel speed must be added to the speed with which the particles leave the spinning disc. As a guide, if the particle velocity from a spinning disc is 35m/sec, which is typical, then a 4 mm particle would travel somewhere between 15 and 20 metres[12]. With the aircraft traveling at 100km/hr a 4 mm particle released at 60 m would travel 40m before hitting the ground. Adding this to say 20 metres gives an estimated 60 metre total distance.

3. The distances fertiliser travels in the field will differ mainly because of the effect of a mass of particles moving together on the drag coefficient

Where the flight path is directly towards a sensitive area the flow of fertiliser must be stopped in time so that no fertiliser reaches the sensitive area. The minimum dimension or size of a designated area where a zero application rate can be achieved is a largely a function of the travel speed of the aircraft, and the fertiliser ballistic properties. If the designated area is identified on a GIS database and the aircraft GPS system is operating from that GIS database, that can enable the fertiliser flow to be shut off in time to prevent any fertiliser entering that area. This method may allow smaller margins. Where the pilot does this fertiliser shut off, using visual assessment and judgement, the results will be less reliable with greater margins needed.

4.3 Buffer zones

In practice buffer zones can be set which provide a margin for error in ensuring that no fertiliser enters water directly. Buffer zone distances up to 100 metres may be set, depending on the circumstances. The width of a buffer zone will be a function of the aircraft type used for the application, the spreading mechanism used (if any), the physical properties of the fertiliser and the wind conditions at the site.

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[12] Dutzi, 2002 : Measurement of Physical Characteristics of Fertilisers and their Influence on Handling and Application. Int. Fert. Soc. Proc. #489

Appendix E: Spread Pattern Testing and Interpretation for Aerial Application

1. INTRODUCTION

New Zealand has a quality assurance programme for ground based fertiliser application called Spreadmark, which places limits on the variability of evenness of application that are deemed acceptable. The coefficient of variation or (CV%) is obtained from sample trays used in a single transverse test of the spread pattern. The CV is calculated by taking the standard deviation of the overlapped distribution and dividing by the respective mean and expressing as a percentage. A low CV% means more even spreading. The evenness of distribution is affected by the shape of the individual spread pattern and by the accuracy with which the required bout width or track spacing can be maintained

Although an aircraft may be in the correct position, there are a number of environmental factors affecting where the fertiliser lands. Wind clearly has an effect, as does the aircraft air disturbance as it travels at speeds up to 200km per hr (fixed wing). The physical characteristics of the material being spread also have a major bearing on ballistic behaviour of particles and hence the final spread pattern.

To be Spreadmark Accredited, application equipment must satisfy the performance standard for transverse CV% of 15% for nitrogenous fertilisers and 25% for all other products as indicated by an Approved Aerial Pattern Test Certificate

2. INFORMATION REQUIRED

2.1 Solid Fertiliser

The principle piece of information is the spread pattern achieved. A spread pattern shall be available for every material classed as Fine, Medium or Coarse (Table E1) for every spreader type used. The spread pattern shall be established at one application rate that is typical or average for that used for the fertiliser. Where the same spreader type is fitted to a different aircraft (fixed wing) type then additional spread pattern tests are required.

For helicopters the spread pattern achieved from a given spreader bucket is not normally affected by being used with a different helicopter so no additional pattern testing is required. One exception may be where the ground speeds are significantly higher and hence the required flow rate from the bucket is higher for a given application rate.

The spread pattern shall be displayed showing the centerline and the application rate and evenness of application (CV%) achieved for the selected track spacing.

2.2 Liquids

Again the most important information is the shape of the spread or swath pattern. A swath pattern shall be available for every boom/nozzle configuration used, at an application rate that is typical for the product (fertiliser) being applied. Where the same configuration is used with a different aircraft (fixed wing or helicopter) then additional swath pattern tests are required

3. COLLECTOR SPECIFICATIONS

Collectors used for spread pattern testing of solids shall comply with the Spreadmark specifications, which are:

- Collector size no less than 500mm x 500mm x 150 mm deep
- Collectors to have suitable anti ricochet systems

Collectors shall be set out in a single line for transverse distribution measurement, at right angles to the flight path. For Approved Aerial Pattern Test Certification, collector spacing shall be 1 metre centre to centre, and the number of collectors used shall be sufficient to ensure that the collectors at each end of the line remain empty.

4. APPLICATION EQUIPMENT TYPE (SOLIDS)

4.1 No spreader

Where no spreading attachment is used the dimensions of the hopper outlet when at the setting used for application shall be recorded and the type of outlet shut-off mechanism used (eg Easton box, louvre doors) noted. As well the use of hopper outlet fairings in front of or around the hopper outlet should be noted.

4.2 Ram air spreaders

This includes all spreader types where the fertiliser is introduced to the front of the spreader and the entrained air/fertiliser mixture is spread laterally by spreading vanes. The make/model of spreader used shall be recorded (eg Transland slimline) along with the following information:

- Dimensions of the front opening
- Dimensions of the rear opening
- Number of vanes

4.3 Powered spreaders

These typically are spinning disc spreaders. Information to be recorded includes:

- Spinning disc diameter
- Disc width (ie vertical dimension)
- Number of vanes and vane shape (eg straight radial, backwards sloping curved)
- Disc shrouded or open
- Disc speed
- Feed point onto the disc
- The flow rate metering device used (eg orifice disc, clamshell)

5. APPLICATION EQUIPMENT TYPE (LIQUIDS)

Information to be recorded includes:

- Nozzle type (eg flood jet, fan) and position on the boom of each nozzle (in many aircraft configurations the nozzle spacing is not constant)
- Total number of nozzles used.
- The orientation of each nozzle (180^0 = straight back and 90^0 = straight down)
- Boom pressure
- Boom width

6. AERIAL SPREAD PATTERN TESTING

6.1 Data collected

The information collected for any pattern test of an aircraft distribution system, whether for liquids or solids shall include:

- Wind speed at the test site
- Wind direction (relative to the flight path or the line of collectors)
- Fertiliser physical properties, including SGN, UI (for liquids this may be expressed as VMD or ($D_{v0.1}$ $D_{v0.5}$ and $D_{v0.9}$ which will depend on the nozzle type and pressure) and BD. See 2.1 below
- Application rate[13] (intended and achieved, kg per ha)
- Flight path (centerline collector)
- Application height (estimated + or – 5m)
- Ground speed (km/hr)
- Collector specification (size, spacing, number)
- Weight of fertiliser per collector[14] (gm)
- Application equipment type – see later

a) Solid fertiliser properties

SGN = Size guide number = the mean particle size
UI = Uniformity Index = the relationship of the small particles to large particles in the fertiliser mix. A low UI (eg 3) means the fertiliser has a wide range of particle sizes; a large number (eg 50) means the particles are very similar in size.
BD = Bulk Density

SGN	UI	Class
<150	<20	Fine
150 – 350	20 – 60	Medium
>350	>50	Coarse

Table E1 SGN and UI classes (solid fertilisers)

b) Liquid fertilisers

For liquids, the important physical properties include:

$D_{v0.1}$ = the diameter of droplets that make up 10% by volume of the spray mix
$D_{v0.5}$ = the diameter of droplets that make up 50% by volume of the spray mix
$D_{v0.9}$ = the diameter of droplets that make up 90% by volume of the spray mix
VMD = volume mean diameter = $D_{v0.5}$

These properties depend on the nozzle type and operating pressure (or rotation speed for rotary nozzles). All this information should be available from the spray nozzle manufacturer.

[13] Certification is valid only where the achieved application rate is within 30% of that intended
[14] Scales to be accurate to +/- 0.1 gm

7. TYPE TESTING OF SPREADING EQUIPMENT

Aerial application equipment may be type tested, which means that subject to meeting the requirements described below, subsequent items of spreading equipment built to that same specification will not need to be tested for spread patterns.

Applications for equipment type approval should be sent to:

The Secretary
Fertiliser Quality Council
C/- Box 414
Ashburton

7.1 Principles

a) Aerial application systems that meet the following general criteria can become Spreadmark Type Approved. Spreadmark Type Approved spreaders will:

- be able to consistently achieve satisfactory spreading performance over the range of the fertiliser types (particles sizes) specified by the applicant
- perform satisfactorily over the normal range of application rates for the fertiliser types specified by the applicant
- have longitudinal distribution patterns that are satisfactory over a representative range of fertiliser types and application rates.
- have substantially the same performance characteristics between different units of the same model.
- be provided with suitable operating guidelines to enable the operator to achieve satisfactory spreading with the fertilisers and application rates defined above.

Satisfactory spreading performance means the equipment meets the Spreadmark evenness standards at the range of bout widths for which the spreader is operated at the required application rates for a given fertiliser specification.

b) Type Approval will be subject to a re-approval process.

c) Aerial Spreadmark Approved Equipment Testers who carry out Aerial Spreadmark Type Approval Testing shall not be an employee of the spreader manufacturer or importer.

7.2 Type approval assessment criteria

The criteria used to assess whether a particular fertiliser spreader model used in aerial application should be Spreadmark Type Approved are described below. Data from other pattern testing may be accepted as sufficient evidence for type approval.

a) Spreading performance envelope of the type

The aim is to ensure that satisfactory spreader performance can be achieved over an appropriate range of fertilisers and application rates and that spreaders have reasonably stable operating characteristics over small variations in fertiliser characteristics. In order to do this one spreader unit will be tested as follows:

- The evenness of distribution will be tested with fine, medium and coarse fertiliser types, representing the particle size ranges (SGN and UI) that the spreader may need to spread (see Table E1)
- The effect of application rate on the evenness of distribution will be tested by transverse distribution measurements at the minimum, typical and maximum application rate for each product.
- Longitudinal variation may be measured with fine medium and coarse products at their mean application rates.

It may not be necessary to test all fertiliser products at all rates. Products may be grouped and one product used as a representative product once it has been established that their spreading performance is the same. If however, differences appear between similar products, more intensive testing will be done to define the extent of the difference and where it occurs. The actual amount of testing will be determined by the need to have enough information to decide whether the spreader performance is satisfactory over the appropriate range of fertilisers and application rates and whether or not the spreader has reasonably stable operating characteristics over small (normal) variations in fertiliser characteristics.

Testing for type approval for aerial application systems will also take into account the fact that the effect of wind on the spread pattern achieved may dominate particularly where fertilisers of low SGN and/or low UI are applied.

The manufacturer/importer may self-impose limits to the testing of the spreader model. Examples of this could be where upper limits to the application rate (flow rate) are set. Any such limits will be recorded and reported on the type test certificate and on the published list of Approved Aerial Spreading Equipment.

All tests will be carried out in accordance with the procedures set out in Appendix E and the data collection and reporting procedures of this Code

b) Reproducibility of the type

A number of units of the same model may be tested to identify whether different units of the same model of spreader have substantially the same performance characteristics. These tests will be carried out at critical points identified during the testing of the type performance envelope (eg at low application rates with difficult to spread products).

At least two units will need to be evaluated to check reproducibility between machines and the number of transverse distribution measurements made will normally be six per unit. Spreadmark or other pattern test data may also be used as reproducibility evidence. In order to be type approved the shape of the swath pattern under the same test parameters, will need to be substantially the same.

Reproducibility testing may be carried out at different times and places to the type performance envelope testing described in a) above. Reasonable care will be taken to use fertiliser products with the same or very similar SGN and UI values to those used for spreader performance envelope testing. It may be necessary to retain product between type tests or reconstitute product by particle size to ensure that products of the same SGN and UI are used for type testing.

c) Documentation

In order to be Spreadmark Type Approved, spreading equipment will be provided with a suitable manual describing performance characteristics and adjustments. The information in the operator's manual must be consistent with the information found from the spreader performance testing.

d) Standard design

Manufacturers or importers wishing to apply for type approval shall define the spreader model that is being type approved, and make a commitment to advise of changes to the spreader design.

The design shall be defined on a set of drawings showing the critical dimensions of the spreading equipment. These drawings may be used to check that the design of the approved models remains the same.

8. REPORTING

Approved Aerial Spreading Equipment Testers will, at the conclusion of the test, produce an Approved Aerial Pattern Test Certificate

The Certificate must show the data collected (see Section 5.2.3 Part a]), and include:

- The operators name and aircraft identification
- A description of the spreading equipment used (see Appendix E5)
- The Certified Bout Width for each fertiliser tested –see Note below
- A description of the physical characteristics of that fertiliser. The description to include: product name, bulk density (BD), uniformity index (UI), size guide number (SGN) and a graph of the particle size distribution. (see Table E1)
- 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.

Note: The Spreadmark Certified Bout Width is the maximum bout width where the CV is 15% or less for nitrogenous fertilisers and 25% or less for non-nitrogenous fertilisers

Appendix F: Site mapping and application verification

1. INTRODUCTION

Identification of the fertiliser application site is important for two main reasons:

- To ensure that the client contract is satisfied
- To enable any sensitive areas or other hazards to be identified and any risk management strategies to be developed and applied

There are both planning (before the task) and verification (after the task) aspects to consider. The particular circumstances for each application task may influence what is required. Relevant information includes

- The fertiliser to be applied (eg N, P)
- The nutrient status of the pasture/crop
- Local site conditions and the existence/proximity of sensitive areas
- Client demand (industry QA or production related)

This Appendix describes methods of site mapping and application verification that can be used and what factors are important with respect to buffer zone distances.

2. THE APPLICATION SITE

Fertiliser shall be applied only to the nominated site at the required evenness and application rate (kg/ha). The application site shall be appropriately identified. Options include (in order of acceptability as objective evidence):

- Verbal description from the client
- Hand drawn farm map, with site confirmed with the client by the operator
- Aerial photograph / overlay of application site
- Application site logged using GPS at or before the application date, with the site boundaries confirmed
- GIS coordinates (digital map) of application site available before application, with data entered into GPS

The method used to identify the application site may depend on the sensitivity of the situation and may include:

- Fertiliser types to be applied (N,P)
- Nutrient status of the application site
- Crop yield response (eg pasture and grazed animal; intensive cropping)
- Sensitivity of the receiving environment eg proximity of sensitive areas and waterways

Identification of the application site means that the areas where no fertiliser is to be applied are also identified.

Where such zero application areas are identified within 300 metres of an application site, the method used to identify the application site shall be verifiable (auditable).

3. APPLICATION VERIFICATION

Verification of the fertiliser application task carried out may be required. Information required may include:

- Location of the application site
- Date of application
- Fertiliser applied (eg, N, P K S) including trace elements and other additives
- Application rate (kg/ha)

Methods to verify application include:

- Verbal, with documentation where appropriate (eg diary note)
- Written daily flight logs
- GPS records

Where the application has been carried out within a distance of 300m from an identified sensitive area, then verifiable or auditable information of the application shall be available on request. The information shall include tracks flown and weather conditions (wind speed and direction) at the application site.