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PROJECT: **HURUNUI DISTRICT
Proposed Frost Fan Noise Rules**

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1. INTRODUCTION

Marshall Day Acoustics prepared a report in 2006 (06014C/1, dated 26 January 2006) discussing the form of proposed rules regarding noise from frost fans. This current report is a revision to our earlier report, with additional discussion based on information gathered since that time.

This report reviews rules for frost fans used by five other District Councils in New Zealand, and two Authorities in Australia, and considers a number of noise measurements undertaken by Marshall Day Acoustics. Recommended noise rules for the Hurunui District are then presented.

1.1. Background

In our experience, all current frost fans in New Zealand are relatively noisy items of equipment and are designed in such a way that noise control is difficult. Furthermore, all frost fans we have heard have "special audible characteristics" such as "blade slap" which makes the noise subjectively more annoying. Therefore, noise emissions to neighbouring properties can be significant.

However, frost fans do perform a vital role for many farmers and they operate only on a relatively low number of nights each year. Therefore, there is an argument that frost fans should be allowed to produce slightly higher noise levels than other equipment which operates more regularly. Clearly, there is a balance to be struck, and the purpose of this report is to consider where that balance might lie.

2. OTHER NOISE RULES

We have reviewed noise rules relating to frost fans from the following five New Zealand District Plans:

- Western Bay of Plenty District Council
- Hastings District Council
- Marlborough Sounds District Council
- Wairarapa Combined District Council
- Central Otago District Council

In addition, our Australian staff have provided rules from two authorities in Australia:

- South Australia Environment Protection Authority
- Griffith City / Leeston Shire Councils, NSW (Murrumbidgee Irrigation Area)

Rules relating to frost fans from each of these seven authorities are discussed below. In all cases we have abbreviated and paraphrased the noise rules to identify the points that we consider most

important to this review. There are subtleties to the actual wording used in the original documents, and we recommend reading the full texts in conjunction with this report.

Issues such as climatic conditions mean that rules from one district should not automatically be applied to another. We therefore recommend that the following analysis is read as a general guide to the current approach being taken to deal with what is relatively new technology. These rules may not represent best practice.

2.1. Western Bay of Plenty District Council

The noise rules in this District Plan are probably the most complicated of those reviewed. The Plan essentially sets three noise limits for frost fans:

Permitted activity	40 dBA L_{10} (noise rule for rural zone)
Controlled activity	55 dBA L_{10}
Restricted discretionary activity	60 dBA L_{10}

Maximum noise levels are also specified, but we consider that for frost fans the L_{10} measurement is most appropriate. However, frost fan noise levels vary as they rotate to change direction, and therefore the L_{10} must be determined over a time period encompassing several rotations.

The approach used in the Western Bay of Plenty District Plan is good in that by setting different thresholds, some non-contentious frost fans might avoid unnecessary bureaucracy applying for Resource Consent. Furthermore, there are details within the text about written neighbour approvals which removes the need for notification. However, most other rules reviewed below provide far more lenient noise limits for fans to operate as permitted activities anyway.

The Western Bay of Plenty rules are lacking in any controls on the frequency of use of frost fans. Also, the cumulative effect of more than one frost fan is not considered.

2.2. Hastings District Council

This District Plan is slightly ambiguous. The plan requires that both general and specific noise rules are achieved. In the specific noise rules for frost fans the requirements relate only to residential zones where the fans must either be:

- 300 m from a residential zone, or
- Up to 100 m from a residential zone, providing the noise is less than 65 dBA L_{10}

Other than a rule about best practicable option there are no specific rules for frost fans in zones other than residential. Therefore, it could be taken that the general rules apply, which would be 40 dBA L_{10} at the notional boundary of houses in the rural zone. It is unlikely that this was intended and it is more likely that no noise limit was intended for rural areas.

The Hastings Plan has no controls on frequency of fan operation and makes no comment on cumulative effects of more than one fan.

2.3. Marlborough Sounds District Council

The Marlborough Sounds Plan sets a noise limit of 60 dBA L_{10} at 300 m from a frost fan. In addition the rules require that the frost fan is no closer than 100 m to a dwelling or 500 m to an Urban Residential Zone.

By implication, these rules allow a noise level of up to approximately 70 dBA L_{10} outside a rural dwelling or approximately 55 dBA L_{10} at an urban residential zone.

The rules do include a clause that restricts the use of frost fans to nights when the local air temperature is below 2°C.

Again, there is no consideration of multiple frost fans on the same site.

2.4. Wairarapa Combined District Council

There are no rules explicitly related to noise in the Wairarapa Plan. The rules appear to be designed primarily to limit the operation of the fans. There is a threshold of 1°C above which frost fans should not be used.

Generally, with no noise limits and no minimum separation distances, the Wairarapa Plan is severely deficient with respect to noise control. However, there are two useful clauses worth noting for this review:

- Maintenance running is restricted to daytime hours only
- A log must be kept of frost fan operation

2.5. Central Otago District Council

The Central Otago Plan has rules which are very similar to Marlborough Sounds. Otago sets a slightly higher noise limit of 65 dBA L_{10} at 300 m from a frost fan. As in Marlborough, the rules also require that frost fans are no closer than 100 m to any dwelling. Other rules worth noting are;

- Fans are permitted in a Rural Resource Area, but not within 300 m of any Residential or Rural Settlement Resource Area
- Fans are only allowed to operate during the "...frost danger period until the leaves of the plant are dry and the air temperature has reached 1°C...". We take this to mean that the fans are not permitted operate until the temperature drops to 1°C
- The speed of fans must be restricted such that the rotor does not exceed the speed of sound
- Any new activity moving into any area with established frost fans must be designed to achieve an indoor sound level of 45 dBA L_{max} within any habitable room.

The setback distances specified in this plan mean that the allowable noise level in a residential or rural settlement area is 65 dBA, whilst 70 dBA is possible in a rural resource area because houses are allowed 100 metres from the fans rather than 300 metres in the other zones.

2.6. South Australia Environment Protection Authority

We understand that a particularly contentious case led the South Australia EPA to conduct a detailed study of frost fan noise. That study has been used to produce noise rules for frost fans that are in the current EPA noise policy document (available from www.epa.sa.gov.au). The noise limits are designed to prevent sleep disturbance but allow frost fans to be louder than other sources.

As an aside to the noise rules, the South Australia EPA has a succinct definition of frost fan which may be useful: *"frost fan" means a device designed or adapted to combat frost by fanning warmer air over the frost-affected surfaces*

The noise rules use two criteria: a relative "background + 5 dB" limit and absolute limits. Given the values of the absolute limits, we do not consider that the "background + 5 dB" criteria is relevant. We understand that this approach may be left-over from other rules in the noise policy.

The noise limits are 45 dBA L_{eq} outside buildings in residential, rural or rural living zones and 55 dBA L_{eq} outside buildings in light industry or intensive primary production zones. There are also corresponding internal noise limits of 25 dBA L_{eq} and 35 dBA L_{eq} .

The noise rules include several important provisions:

- The rules apply to multiple fans operating simultaneously.
- Maintenance running is restricted to daytime hours only
- The fans only operate "during a period when frost occurs or is reasonably likely to occur"

The last of these points is designed to limit usage of frost fans, which is an important issue. An alternative would be to impose a definite temperature threshold. Whilst this may be more robust, there are difficulties with this method because of the range of crops which can be protected using frost fans.

The noise rules in the South Australia EPA are more comprehensive than any of the New Zealand examples reviewed. However, it should be noted that the limits appear to be generally more stringent. Please note that the Australian rules are in terms of the L_{eq} rather than L_{10} used in the New Zealand District Plans. For frost fans, the L_{eq} and L_{10} are numerically similar.

2.7. Griffith City / Leeston Shire Councils

The frost fan noise rules for Griffith City and Leeston Shire Councils in New South Wales appear to be taken from the South Australia EPA rules discussed above. However, the Griffith City/Leeston Shire rules are more detailed and include several important points discussed below.

The noise rules state that if a fan is further than 1 km from any dwellings then a noise assessment is not required. This is a sensible measure which should prevent excessive regulation.

The rules require a detailed justification for new frost fans including details of crops, temperatures and predicted number of frosts.

The noise limits for the frost fans are the same as South Australia, but are categorised slightly differently as shown below. The key point about these categorisations is that rural zones are considered non-noise sensitive so the higher limits apply.

Noise sensitive zone	45 dBA L_{eq} (outside)	25 dBA L_{eq} (inside)
Non-noise sensitive zone	55 dBA L_{eq} (outside)	35 dBA L_{eq} (inside)

It is required that compliance monitoring is for 15 minute periods and internal measurements are with windows closed. The limits apply to the total noise from all frost fans on a site.

In addition to the noise limits the rules require that:

- The driving engine is in a noise enclosure.
- The driving engine has a muffler system and exhaust pipes set into pits in the ground.

We do not consider that this guidance should be necessary as the noise limits for frost fans would apply to all of the equipment including the engine. If the engine were to be noisier than the fan blades then this may actually reduce the special audible character, which could be beneficial.

In common with the other Plans discussed above there is a rule to restrict use of frost fans. The following wording used is:

"The frost control fan must have a thermostatic control that is set at all times to a temperature appropriate to the crop being protected"

3. CRITERIA

3.1. Subjective Impressions

The main purpose of this report is to consider appropriate noise limits. The above rules have given a wide range of different noise limits. To our knowledge, none of these rules are based on reliable subjective testing of human response to occasional frost fan noise. We have searched several academic journals but have not found any papers relating to frost fans.

As there is a lack of available information, it is also worth noting our own subjective impressions from two recent projects:

- For the frost fan at the Pepperhag Estate in the Hurunui District we noted that 50 dBA L_{10} was an "OK" level but 58-60 dBA L_{10} was unacceptable.
- For a project near Masterton we judged a frost fan noise level of 55 dBA L_{10} to be just acceptable.

3.2. New Zealand Standard 6802

The vast majority of New Zealand District Plans, including Hurunui and those reviewed above, have a reference to NZS 6802:1991 as a method for assessing noise. This standard recommends that where a noise source has "special audible characteristics" a 5 dB penalty should be applied. As noted above, we consider that all current frost fans have special audible characteristics and believe it is unlikely that these could be avoided. However, none of the frost fan noise limits in the New Zealand District Plans reviewed explicitly state whether the 5 dB penalty should be applied. Our interpretation is that the penalty is appropriate and should be applied.

A more robust way of dealing with this could be to accept that special audible character is present in frost fans, and reduce the noise limits by 5 dB to reflect this. It would then be necessary to explicitly state that a further penalty should not be made.

Since our initial report was prepared, the 2008 versions of the two New Zealand environmental noise standards (NZS 6801, and NZS 6802) have been released. We believe it would be appropriate to reference these standards in any new noise rules. This will require a change to use the L_{eq} parameter rather than the previously used L_{10} .

3.3. Noise Limits

The following summarises the various noise limits discussed above. Noise limits from New Zealand District Plans have been reduced by 5 dB to account for the special audible character of frost fans.

Western Bay of Plenty	35 dBA L_{10}	Permitted (rural zone)
	50 dBA L_{10}	Controlled
	55 dBA L_{10}	Restricted discretionary
Hastings	60 dBA L_{10}	Residential zone
Marlborough Sounds	50 dBA L_{10}	Urban residential zone
	65 dBA L_{10}	Rural zone
Central Otago	60 dBA L_{10}	Residential or Rural Settlement zones
	65 dBA L_{10}	Rural Resource Area
South Australia	45 dBA L_{eq}	Residential, rural
	55 dBA L_{eq}	Light Industry, intensive primary production
Griffith City / Leeston Shire	45 dBA L_{eq}	Noise sensitive
	55 dBA L_{eq}	Non-noise sensitive

All existing New Zealand noise rules use the L_{10} parameter. However, for frost fans, L_{10} and L_{eq} are numerically very similar. Note that the 2008 version of the acoustic standards adopt ISO terminology, such that "dBA L_{eq} " now becomes "dB L_{Aeq} ". In addition, a specified measurement period "t" can be included in the nomenclature, by using "dB $L_{Aeq, t}$ ".

Based on these noise limits and our experience of frost fans, we consider that a noise limit of 55 dBA L_{eq} would be appropriate as a permitted activity in areas where frost fans are anticipated. Based on our discussions with Council, we suggest that it may be appropriate for this limit to apply only to the Waipara Wine Growing Area as defined in the District Plan, as this is a long recognised

area of intensive grape growing. In all other areas, we consider a limit of 45 dBA L_{eq} to be appropriate. This suggested noise limit includes an allowance for the special audible character of frost fans so no further penalty should be applied to measured levels.

The suggested noise limits are higher than permitted noise levels for other activities within the District Plan, and are only appropriate on the basis that frost fans operate for a limited number of nights each year. Any Plan rules must therefore be accompanied by restrictions on use of frost fans as found in some of the other rules reviewed.

Virtually all of the rules reviewed use similar assessment positions. For residential zones the assessment position is at any point within the zone and for rural zones it is the notional boundary of any dwellings. Generally, any dwellings on the application site are excluded, and we consider this to be a sensible measure.

3.4. Current Frost Fans

We do not recommend using distance as the sole criterion for noise control as this does not either encourage development of quieter fans, or provide certainty that an intended level of amenity will be achieved. However, distances do provide a simple measurable means of allowing fans in remote areas to be established without a detailed acoustic assessment.

Marshall Day Acoustics has been employed by two different frost fan suppliers/manufacturers in New Zealand to measure the sound power levels of their equipment. Whilst we cannot release details of these measurements without approval from our clients, we have used the data to assess the implications of both the 55 dBA L_{eq} and the 45 dBA L_{eq} noise limit. Generally, existing frost fans would require a separation of at least 300 metres (and up to 400 metres) from any house to achieve a 55 dBA L_{eq} limit. To achieve 45 dBA, a separation distance of at least 950 metres would be required.

We understand that there is some research currently being undertaken in New Zealand to develop quieter frost fans. If successful, significantly smaller separation distances would be required.

4. HURUNUI DISTRICT PLAN

4.1. Existing Frost Fans

At the time we issued our 2006 report, there were only a very small number of consented frost fans in Hurunui District. Whilst we are aware of noise issues relating to one of these installations (Pepperhag Estate), the number of affected residents was very small, and specific noise rules were arguably not warranted.

Since that time, rapid growth of the viticulture industry has resulted in increasing numbers of frost fans, including one property which has 53 fans.

To date, frost fans have been installed without any specific acoustic analysis by virtue of an argument that they are part of normal agricultural practices. The District Plan noise rules specifically exempt *"Normal agricultural practices undertaken for a limited duration, such as harvesting"*.

It is clear from recent experience in the Hurunui District, and from similar experiences in the Marlborough District, that noise from frost fans have the potential to result in significant adverse effects, and as such, we believe that it is appropriate to develop rules which ensure that a detailed acoustic assessment is undertaken for any installations "close" to residential dwellings. Such assessments would have to be undertaken by way of a resource consent application for proposed frost fans.

There are also a small number of frost fans being used within the Hurunui District to protect Olive groves, and it is possible that other crops may be protected in the same way in years to come. We therefore consider it essential that any frost fan rules are robust enough to deal with a wide range of uses. In particular, temperature thresholds and the time of year during which protection is required, may vary between crops. To this end, the recommended rules and definition have been written to apply to a range of frost sensitive crops, not just grapes.

4.2. Cumulative Effects

One of the common concerns regarding noise is that of cumulative effects. What happens when more than one wine grower, for example, installs frost fans near the same dwelling?

We have considered this issue in two ways:

- We have proposed a setback distance within the Waipara Wine Growing region that ensures noise levels will generally be less than the recommended noise limit. This allows for more than one permitted group of frost fans near one dwelling without exceeding the noise limit.
- Frost fans within this setback distance will be a restricted discretionary activity, whereby Council can specifically consider cumulative effects as part of the consent application process.

For areas other than the Waipara Wine Growing Area, Frost Fans will be a discretionary activity, and cumulative effects will be considered as part of the consent process.

4.3. Proposed Noise Rules

In line with the above discussions, we recommend that rules be added to the Hurunui District Plan to control the noise of frost fans, along the lines of the following general comments.

1. Add a definition of "frost fan":

"frost fan" means a device designed or adapted to combat frost by fanning warmer air over the frost-affected surfaces

2. Close the loop hole in the plan rules, by noting that normal agricultural practices do not include the use of frost fans.

3. Add a new section allowing the use of frost fans subject to compliance with specific noise rules:

- We suggest making frost fans a permitted activity if they are located no closer than 1 km from any dwelling within the Waipara Wine Growing Area. Frost fans could be a restricted discretionary activity within this separation distance, with Council's discretion restricted to noise, including cumulative effects.
- It would also be appropriate to allow fans within the Waipara Wine Growing Area to be located as close as 500 metres to a dwelling, provided the rules ensured that there could be no more than 5 fans within this distance of any dwelling.
- Add a rule such as *"...Noise of frost fans shall not exceed 55 dB $L_{Aeq, 10min}$ when assessed at the notional boundary of any dwelling on any other site within the Waipara Wine Growing Area, nor shall it exceed 45 dB $L_{Aeq, 10min}$ at the notional boundary of any dwelling within any other area. The noise limit applies to the total noise from all frost fans on the premises operating simultaneously. The noise limit includes a correction for the special audible characteristics of frost fans and no further penalty shall be applied to measured or calculated noise levels..."*
- We consider 55 dB to be the upper limit of acceptability for frost fan noise, even when they operate on a limited number of occasions per year. As such, we recommend that an activity should be non-complying if it cannot comply with this limit. This should apply to all areas.

4. Restrict the number of nights fans are operated. Because fans need to run when a frost occurs, we do not consider it practical to impose a numerical limit on the number of operational nights. Instead, we recommend restrictions on the temperature at which fans may run, to ensure that they only operate infrequently. However, our recent experience on the large installation in Waipara (Waiata Estate) has shown that if fans remote from residents come on first, the fans closer to residents do not have to run anywhere near as often. We therefore suggest that a simple "1°C" control such as in Central Otago, is not ideal, and that any rule should allow for, and even encourage, variable temperature regimes where appropriate. We have also considered the mandatory use of thermostatic controls on all frost fans to enforce temperature limits. However, we understand this is already standard practice in the wine growing industry, and provided there is a specified cut-in temperature, we consider such a requirement to be unnecessary.

The height at which the temperature should be assessed will vary with age of the plants, and the type of crop being protected. This should also be provided for in the rules.

As a starting point, we suggest the following, although we acknowledge that the final wording of this is very likely to change as a result of the submission process;

"...Frost fans shall only operate when the local air temperature falls below 2°C, at a height above ground relevant to the bud height of the plants being protected..."

"...Other than express provisions for maintenance, frost fans shall only operate for the purposes of avoiding frost damage. Other uses, such as drying of plants, shall comply with the general noise rules in this Plan..."

5. Running for maintenance should be restricted to daytime hours: *"...Operation of frost fans for maintenance purposes shall be restricted to periods of less than 30 minutes between the hours of 08.00 hrs and 18.00 hrs weekdays..."*
6. Require that a log of use be kept, clearly recording the date and length of time each frost fan is used. The log should include the air temperature at which each frost fan started operation, and include running for maintenance purposes. We suggest requiring that a copy of the log be made available to Council upon request.
7. We suggest that future reverse sensitivity effects should be addressed by requiring that *"...Any new dwelling locating within 1 km of any frost fan within the Waipara Wine Growing Area, or within 2 km in any other area, shall be designed to ensure that the noise level inside any bedroom of the dwelling does not exceed 30 dBA (L_{eq})..."*