Project: CHRISTCHURCH AIRPORT DISTRICT PLAN REVIEW

Prepared for: Christchurch International Airport
PO Box 14001
Christchurch Airport
Christchurch 8544

Attention: Rhys Boswell

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1.0 INTRODUCTION

Marshall Day Acoustics (MDA) has been requested by CIAL to provide recommendations as to appropriate on-wing engine testing noise control and land use planning provisions in the forthcoming Christchurch City Council (CCC) District Plan Review (DPR).

Because of the timing of the review, and the original CCC desire to incorporate noise contours in the Council mapping software as soon as possible for notification, we provided indicative engine testing noise control boundaries (ETNCB) and proposed draft rules relating to the management of engine testing noise, in conjunction with proposed land use planning provisions to the CCC.

It was envisaged that these provisions would form the basis of the notified City Plan provisions that relate to engine testing noise management. However, because of the City Plan Review timetable it was also recognised that further iterations were likely to be required.

Therefore prior to the Hearings process, it is intended to provide a supplementary report detailing further refinements, methods of mitigation and noise management, following consultation with both the CCC and airline operators. This report details how the initial recommendations were formulated. This includes the methodology used to prepare the ETNCB, the rationale and justification of proposed rules and other details relating to the process.

This report only deals with on wing engine testing noise emissions, as all tests carried out when the engine is not on the wing are conducted in the specially designed facility located on-site. This has been designed to allow engine testing events to be able to comply with the normal District Plan night-time noise limits.

A Glossary of Terminology is included in Appendix A.

2.0 NOISE PERFORMANCE STANDARDS

The aviation industry has very strict procedure regarding the need to run an engine after maintenance before it can be used in flights. Routine or unplanned work on an engine will often require a period of idling or a short full power run of the engine. Therefore, the testing of aircraft engines is another noise generating activity that is vital to the operational viability of a commercial airport with scheduled flights.

The City Plan contains land use controls relating to engine testing noise in the Rural Zone (refer section 2.1), but does not contain controls for the management of engine testing noise emissions. However, night testing (i.e. between the hours of 2300 and 0600) can only be performed on aircraft that are required to operate scheduled services in the morning. This particular type of aircraft engine testing is managed under the Christchurch International Airport By-Laws. These are discussed in more detail below:

2.1 Operative District Plan

Engine testing noise at Christchurch Airport is partially controlled at present through provisions in the Operative Christchurch City Plan, specifically;

13.2.9 Aircraft noise testing area (updated 30 April 2011)

A rule applies in the rural zones controlling dwellings within 800m of the aircraft noise testing area, identified at the western end of the airport cross runway within the Special Purpose (Airport) Zone (Map 23B). This location, while not ideal, offers the least potential disturbance to persons living near the airport, although some disturbance may still occur from time to time. In order to ensure that adverse noise from engine testing is at least minimised, the majority of engine testing activities will take place within 200m of the "cross" identifying the Aircraft Engine Testing Area shown on Planning Map 23B.

This rule effectively recognises engine testing is a noisy activity, by preventing inappropriate development establishing near a location used for engine testing. Although this rule does not in itself
2.2 City Plan Review

CCC are at present undertaking a review of its District Plan, as required by the Resource Management Act. CCC has indicated throughout the development of the City Plan Review that it is seeking an update to the way engine testing noise is managed. On this basis, it has sought advice and technical input from CIALand MDA on engine testing noise matters. In the very early stages of the Review, engine testing noise contours were sought for inclusion in the notified city plan documents. These were provided to CCC in early 2015, and the contours and their development are discussed further in section 3 and 4 of this report.

2.3 Engine Testing Bylaw

On wing engine testing of CIA has historically been managed by the Christchurch International Airport By Laws: Section 52. Stationary Engine Testing as shown below:

52. Stationary Engine Testing

1) No person shall start up or run an aircraft engine in a hangar

2) Subject to subclause (3) of this by-law, no person shall start up or run an aircraft engine for the purposes of stationary testing in an open space at the airport unless-

a) The total duration of engine testing in respect of any aircraft does not exceed 5 minutes, or

b) The engine testing is carried out in a special facility approved in writing by the airport manager, or

c) The engine testing is carried out at the threshold of Runway 11 or, when Runway 11 is in use, in the holding bay on the main taxiway and under the direction of Air Traffic Control, or

d) The testing is carried out at such other place and in such other manner as shall be approved by the airport manager before the test commences.

3) Nothing in subclause (2) of this by-law authorises the testing of an aircraft engine testing between 2300 hours and 0600 hours unless –

a) The testing is necessary to provide an urgent scheduled flight, or

b) the person responsible for the testing delivers to the airport manager within 24 hours after the testing a report which sets out-

i) The date, time and duration of the test; and

ii) The reason for the test

iii) The date and time for the scheduled flight for which the test was necessary

2.4 National and International New Zealand Standards

New Zealand Standard NZS 6802:2008 “Acoustics - Environmental Noise” is the general noise emission assessment standard that applies to most forms of environmental noise assessment in New Zealand and is referenced in most District Plans for control of general noise levels. However, it is the opinion of MDA that just as aircraft noise cannot be appropriately controlled by the standard District Plan noise rules, it is also considered that engine testing requires its own specific noise rules.

There are no New Zealand Standards that are specifically intended to control aircraft engine testing noise emissions. We are also unaware of any specific international standards for the assessment of
engine testing noise emissions. Therefore bespoke rules are required. In broad concept, engine testing noise is similar to aircraft operational noise, in that it involves short duration moderate level noise events. Thus typical engine testing noise rules use the Day/Night ($L_{dn}$) as used for airport operations.

2.5 Engine Testing Rules of other New Zealand Airports

It is noted that most airports in New Zealand do not have a permanent engine maintenance facility or ability to undertake regular planned engine testing. However, there are often specific engine testing noise rules that apply, for example at Whangarei, New Plymouth, Napier, Gisborne. These allow higher noise levels during the daytime, with an average noise level criterion applying (typically $L_{Aeq (15\, \text{hour})}$). This allows periods of relatively high noise levels for short periods, followed by periods where no engine testing activity is occurring. This approach recognises that engine testing is inherently noisy, but also that in most cases it occurs over a relatively short timeframe, with significant periods of respite between events.

There is often a requirement to avoid night-time testing entirely, or with an allowance of a number of unplanned night-time testing events to occur in a year, at lower noise levels.

There are four airports in NZ with aircraft maintenance facilities where regular engine testing occurs. These are Auckland International Airport, Nelson Airport, Hamilton Airport and Christchurch International Airport.

Auckland International Airport has a specific engine testing rule, developed because of its requirements to undertake regular engine testing activity. The rule is reproduced in Appendix B. The noise rule applicable to Auckland is based on the $L_{dn (7\, \text{day})}$ metric. This is also an average noise level metric, with a 10 decibel penalty applied to night-time events, in recognition of increased sensitivity to night-time noise. As with the $L_{Aeq (15\, \text{hour})}$ metric, this allows periods of relatively high noise levels for short periods, followed by periods where no activity is occurring. Because engine testing is relatively frequent at Auckland, the $L_{dn (7\, \text{day})}$ metric also allows busy testing days to occur, with days either side having a much lesser number of tests, or none at all.

The $L_{dn}$ metric is the same as that used for general aircraft operations, but does have a different averaging period of 7 days to account for the variations in engine testing events that typically occur on a weekly basis, as opposed to a seasonal basis (general aircraft flight movements).

Because of the similarity between Auckland Airport’s and Christchurch Airport’s engine testing regimes, the Auckland rule is considered an appropriate rule to adopt in this case.

To protect from very short duration high noise level events occurring a $L_{A_{\text{max}}}$ rule could also be introduced. This would be for the purposes of protecting residents from sleep disturbance impacts. An appropriate rule would be 80 dB $L_{A_{\text{max}}}$ at the residential boundary. Although this would allow current engine testing noise levels to continue to occur, it would provide added protection of ensuring engine testing events that are very loud could not occur. The $L_{dn}$ control would continue to limit the total noise exposure at any given location.

There is also a duty under the provisions of the Resource Management Act to adopt the best practicable option to ensure that the noise from any activity does not exceed a reasonable level. This also applies to engine testing noise emissions.

2.6 Summary

The nature of aircraft engine testing often means that assessment of engine testing noise emissions requires special consideration. The methods of controlling engine testing noise throughout New Zealand vary from airport to airport, depending on the particular circumstances. For airports with no regular planned engine testing, control is often achieved with the use of either the standard District Plan noise controls or with a typical engine testing noise control rule.
For airports with a maintenance facility special consideration is required. At Auckland International Airport a specific noise control of 55 dB $L_{dn}$ (7 day) is used.

For Christchurch Airport, historically engine testing noise impacts have been managed by land use planning controls and a By-Law. Because the CCC is going through a plan review process, it is deemed opportune to update engine testing noise controls at Christchurch.

An approach in line with Auckland International Airport is proposed. In our opinion such an approach would ensure reasonable levels of noise in the community and allow adequate levels of engine testing to occur.

3.0 ENGINE TESTING NOISE CONTOUR DEVELOPMENT METHODOLOGY

In order for appropriate engine testing noise controls to be proposed at Christchurch, it was recognised at an early stage that current noise emissions would need to be quantified. Because engine testing involves multiple locations and variations in time, a spatial and temporal understanding of noise emissions was also necessary.

This led to the development of the Engine Testing Noise Monitoring Software (ETMS), that could calculate noise emissions at multiple receiver locations, based on actual records of engine testing that had occurred. Receiver locations used in the software are shown in Figure 1, Appendix F.

In addition to this the software and database records were used to model the worst case engine testing noise contours for various scenarios.

Several sources of input data were required to develop the ETMS, as discussed below.

3.1 Engine Testing Activity Data

In order to be able to quantify community engine testing noise levels, in terms of what is occurring on a day to day basis and what has occurred in the past, it is necessary to know what engine testing activity has previously occurred.

Records of night-time testing have been formally collated since late 2010, and these specific details were incorporated into the ETMS to enable accurate noise calculations to be undertaken.

Maintenance staff record a detailed set of information including of the type of engine testing activity, aircraft model, date and time, wind direction, and speed, duration of each engine ‘on’ time, power setting and aircraft orientation, as well as the location of the test. This data is then sent to CIAL for their records and automatically entered into the ETMS by MDA. These records are then used to calculate community noise exposure for different locations using the ETMS.

It is noted that until 2015 only tests carried out by Air New Zealand engineers were recorded, and that daytime tests were not being regularly recorded. This means that in some cases engine testing events, particularly the daytime Antarctic ground run events were not input automatically into the database. Daytime records are now being collected. The implications of the Antarctic testing is discussed further in Section 4.

A summary of all engine testing events that have been recorded in the ETMS is shown in Appendix C. The locations of engine testing are also shown in Figure 2, Appendix F.

3.2 Noise Source Data

An essential component of the ETMS calculation procedure is a detailed knowledge of the noise level emission levels of each aircraft type. This information includes noise level and directivity patterns and a variety of engine settings for each aircraft. This data has been collected via noise measurements at Christchurch and elsewhere, in conjunction with noise emission data sourced from aircraft manufacturers.
3.2.1 Manufacturers Noise Emission Data

For each type of aircraft on which engine testing occurs at Christchurch, noise level emissions data has been sourced through a literature review and discussions with the manufacturers, the main exceptions being the B757 and P3 Orion.

Data for these two aircraft types were not available at the time of the ETMS development. Because of the limited number of tests that occur for these aircraft types noise emissions from these are not expected to significantly affect the overall community noise levels. Detailed data for the C130 Hercules has been added in the last year.

Noise emission data comprises noise level measurements in polar plot form, for various engine types and under various thrust settings. This enables a fully comprehensive set of noise emissions data to be used. All manufacturer noise emission data is based on-site noise measurements of aircraft, with measurements occurring under reference meteorological conditions and at reference microphone positions.

3.2.2 Noise Measurements

MDA has undertaken a number of noise measurements in close proximity to various aircraft engine test events at Christchurch and these have been complimented by measurements at locations in the community. These noise level measurements have been used to ensure that the manufacturers data is accurate, and represents actual engine testing noise levels in practice. The noise measurements ensure that noise emissions data used in the calculations is accurate.

3.2.3 Computer Noise Modelling

Computer noise modelling was then employed to calculate community noise exposure levels for a number of different scenarios. The noise levels calculated at the initial stage was sound pressure levels at the 16 receiver locations.

The verified noise emissions data was used in noise modelling software to calculate noise levels for each possible engine testing scenarios at each receiver location. The purpose of this is develop a database of noise levels received at each location for each scenario so that differing noise exposure levels in the community can then be calculated.

Each scenario is based on a specific:

- Aircraft type
- Power setting
- Orientation
- Location

Based on these parameters there are more than 300 operating scenarios which have been calculated.

Computer noise modelling was carried out using SoundPLAN, an internationally recognised computer noise modelling software package.

In summary, a digital topographical model of the area of interest was entered into SoundPLAN together with locations of the noise sources (noise levels have been predicted in accordance with the algorithm detailed in ISO9613-2: 1996- Acoustics – Attenuation of sound during propagation outdoors – Part 2: General method of calculation (ISO9613) as implemented in SoundPLAN.

ISO9613 considers a range of frequency dependent attenuation factors, including spherical divergence, atmospheric absorption, ground effect, acoustic screening and directivity effects. It assumes meteorological conditions favourable to propagation from sources (downwind at wind speeds 1 -5 m/s in all directions), and as such, calculates slightly conservative sound levels.
The directivity effects that have been included are taken from the manufacturers’ noise emission data, with the exception of the C130, which has been developed using directivity data from INM ground run up calculations.

### 3.3 Engine Testing Noise Monitoring Software (ETMS)

The calculated sound pressure levels for each one of the above operating scenarios are then compiled into a database in the ETMS. It is the ETMS that is then used to calculate community noise exposure based on this noise level database and the historic records of time/duration of each operation activity.

Engine Testing Monitoring Software (ETMS) has been developed by Marshall Day Acoustics for CIAL. It is similar in concept to the software used to show compliance with the general aircraft noise emissions (INM) in that it is based on the records of the actual engine testing that has been carried out.

As discussed in section 3.1, aircraft maintenance staff record a detailed set of test information (including of the type of engine testing activity, aircraft model, date and time, wind direction, and speed) into the software so that the noise exposure levels can be calculated in the nearby community. It is intended that the ETMS will be used as the basis for on-going monitoring and reporting of compliance with the City Plan rules, following them being made operative.

In summary the ETMS was used to calculate community noise exposure using the following methodology:

- MDA reviewed all engine testing activity at CIA between January 2011 and December 2014, which included the various aircraft locations and orientations
- 16 representative receiver locations around the airport were used, to ensure noise levels were assessed with an appropriate spatial representation
- At each receiver location the worst case week (from all weeks January 2011 - December 2014) of noise levels was calculated. The worst case week was in some cases different for each receiver, depending on the location of engine testing activity relative to that receiver.

An example of the noise level calculations used in the above methodology and an example of the ETMS interface is shown in D2, Appendix D.

### 4.0 ENGINE TESTING NOISE CONTOURS

The ETMS was used to calculate worst case historic noise emissions between 2010 and 2014 so that the extent of community noise impact could be determined, and appropriate noise controls developed.

A summary of quarterly worst case predicted $L_{dn(7day)}$ noise levels from the ETMS for each receiver locations is shown in Appendix D.

Using this data, the worst case noise levels at each location were reviewed to ascertain what engine testing activity was responsible. This activity was then entered into SoundPLAN noise modelling software to calculate a set of worst case noise contours for each location.

This set of worst case noise contours was then overlaid on a map and the outer extent of each contour was drawn, creating one overall worst case Christchurch Airport noise contour.

In addition to this, to account for expected growth over time of engine testing activity, an allowance of 60% growth was included. This is consistent with the expected growth of the general airport operations. This future growth is consistent with that allowed for under the expert panel general airport contours that were the subject of the Regional Policy Statement Plan Change 1.

These noise contours became known as the Engine Testing Noise Control Boundaries (ETNCB)
4.1 Subsequent Review

Following the analysis of the worst case noise level predictions, it was determined that daytime records had not been provided to MDA prior to 2015. An extensive review enabled collation of daytime records previously missed. There were no daytime tests undertaken in the worst case weeks described above, so the ETNCB remain valid. We note also that daytime tests are 10 times less significant than night-time tests because of the nature of the $L_{dn}$ metric.

Following concern from the Project team over the potential for daytime noise exposure to have been missed in the calculations, further analysis was also undertaken specifically for Antarctic Operations. All Antarctic tests occur during daytime, but it was recognised that these occur for significant durations on each occasion, and are often concentrated in a particular week. Specific calculations of daytime worst case Antarctic operations show that noise exposure in the community was approximately 7 decibels lower than the ETNCB. This is primarily due to the daytime nature of these tests, and that for the majority of the time the tests are conducted at idle power (lower noise levels). It is considered therefore that the ETNCB remain valid as a representation of the worst case engine testing noise exposure at Christchurch.

The ETNCB can be seen in the attached Figure 2. In summary, these boundaries represent the worst case engine testing noise emissions that have occurred at the airport over the last 5 years, with an allowance for operational growth of testing activity at the airport.

These contours, in our opinion, provide a reasonable basis to move forward with both land use planning and noise control rules and provide a similar level of ‘fat’ to the aircraft operational methodology.

We note because of the highly variable nature of engine testing that if a significant amount of engine test activity occurs that was unplanned for (for example a large number of aircraft breakdowns, a CAA Directive, or a volcanic Ash Cloud event), then the noise contours would not accommodate that.

A draft noise control rule is shown in Appendix E which could be implemented to ensure that community noise exposure does not exceed acceptable levels.

Land use planning provisions associated with the ETNCB can be used to ensure reverse sensitivity issues do not arise in the future. We recommend these are consistent with those applicable inside the general airport noise contours. This would mean new noise sensitive activity or additions or alterations to existing noise sensitive activity should be prohibited inside 65 dB $L_{dn}$ sound insulation should be required inside 55 dB $L_{dn}$ and noise sensitive activities would be discouraged inside 50 dB $L_{dn}$ primarily by using rural zoning rules.

5.0 ASSESSMENT OF NOISE EFFECTS

The effects of the proposed engine testing noise control boundaries on the surrounding community have been assessed by considering the predicted level of annoyance in the community, in comparison to that likely to be experienced as a result of general aircraft operations.

5.1 Existing Noise Environment

Noise level measurements of the existing noise environment without aircraft engine testing or general flight movements in the vicinity of the engine testing locations, have been reviewed using data collected from automated noise data logging equipment installed at the airport as part of general airport noise compliance monitoring.

This data shows that measured noise levels in the vicinity are typical of an urban environment. At night the area is reasonably quiet (35 to 40 dB $L_{A90}$) with minimal local noise sources, mainly comprising of natural sounds in the vicinity but with some contributions from the nearby roading network and distant industry.
During the day, when aircraft are not operating at the airport, background noise levels are typically 40 to 50 dB $L_{A90}$. Adverse weather conditions result in elevated background and ambient noise levels. This suggests the area would otherwise be typical of a general urban fringe environment. However it is already affected to a moderate to significant extent by aircraft operations.

5.2 Annoyance Effects

Individual responses to a certain level of noise vary greatly. A large number of studies have been carried out overseas in an attempt to determine the overall relationship of response to noise of a residential community as a whole.

A dose response relationship specific to aircraft noise has been developed by Miedema and Ouldshoorn\(^1\), as shown in Figure 5.1 below. This relationship is similar to other relationships developed by Bradley\(^2\) and another study by Miedema and Vos\(^3\). This relationship is specific to aircraft noise emissions and other relationships exist for different transportation sources such as rail and road traffic. There has been no significant international studies into community response to engine testing noise, so therefore the aircraft dose response curves shown in Figure 5-1 are considered the most appropriate to use.

**Figure 5.1: Miedema & Ouldshoorn Dose-Response Relationship**

The above dose response relationship indicates that for aircraft noise environments of 65 dB $L_{dn}$ 28% of the population are likely to be highly annoyed. For aircraft noise environments of 55 dB $L_{dn}$ 11% of the population are likely to be highly annoyed by the noise.

As can be seen, annoyance effects are not confined to aircraft noise levels in excess of 55 dB $L_{dn}$, there may be some annoyance effects for a small percentage of people in areas exposed to much lower noise levels. This is because aircraft movements would still be audible. This is just one of the reasons why the Outer Control Boundary for Christchurch Airport has been set by decision makers at

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the 50 dB $L_{dn}$ contour relating to general airport operations for the purposes of implementing planning controls through zoning and rules. Figure 5.1 also shows that despite the presence of noise control boundaries, which delineate the onset of moderate to significant noise effects, there may still be lesser noise effects outside of these boundaries.

Taking the above into consideration, an analysis has been carried out to predict the number of people likely to be highly annoyed by both engine testing noise and by general aircraft noise inside the area affected by the proposed engine testing noise control boundaries.

To maintain a consistent population sample for this study, all dwellings located within the predicted engine testing 50 dB $L_{dn}$ contour have been considered.

Results are summarised in Table 5-1 below.

**Table 5-1: People Highly Annoyed (Miedema & Ouldshoorn)**

<table>
<thead>
<tr>
<th>Activity Scenario</th>
<th>Number of houses per 5 dB $L_{dn}$ band for each scenario $^{1,2}$</th>
<th>Number of People Highly Annoyed (% of population sample)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>45-50</td>
<td>50-55</td>
</tr>
<tr>
<td>Engine Testing</td>
<td>-</td>
<td>1550</td>
</tr>
<tr>
<td>General Airport Operations</td>
<td>1402</td>
<td>325</td>
</tr>
</tbody>
</table>

$^{1}$The 5 dB band used in this assessment are based on all the houses contained within the 50 dB $L_{dn}$ contour (population sample area) for the engine testing noise control boundaries, shown in Appendix F

$^{2}$ The total sample size is 1846 houses with a total of 4615 people

Engine testing noise occurring inside the sample area would result in 430 people potentially being highly annoyed. This represents a total percentage of the population of 9.3%. This is broadly in line with the annoyance levels experienced by the general population exposed to aircraft noise levels of 55 dB $L_{dn}$ (refer Figure 5-1), the noise level generally used for aircraft noise management in accordance with NZS 6805. However, in the same sample area the number of people also highly annoyed by general airport operations would be 225.

The total number of people likely to be highly annoyed by general airport operations (i.e. those inside the general airport noise contours elsewhere) would also be higher, because the population sample under investigation is focused on the Bishopdale/Harewood area, and excluded analysis of Rolleston, Kaiapoi and other populated areas.

However it is also noted that a third of the people likely to be annoyed by engine testing noise, 147 (out of 430 people, or 34%) actually live inside the general airport noise control boundaries.

Nevertheless, the analysis shows that the areas of overall community noise exposure to engine testing noise also experience a similar level of noise exposure to general airport operations.

The above analysis also supports the rationale for recommending the use of land use planning mechanisms restricting noise sensitive development inside the engine testing noise control boundaries to reduce future noise exposure and hence annoyance.

In summary, it is considered that overall annoyance effects would not be significantly different to those effectively already allowed for with the general airport noise contours.

As can be seen in D1, Appendix D, engine testing noise levels at the worst case receivers are generally below 65 dB $L_{dn}$ at all locations and are typically on the range of 50 – 65 dB $L_{dn}$ 7day. The exception to this is 87 Jessons which has experienced a noise level of 67 dB $L_{dn}$ 7day from engine testing noise. We
note that this occurred for one week in October 2011 and typically the noise level at this dwelling is 55-60 dB $L_{dn \ 7\text{day}}$, and occasionally 60-65 dB $L_{dn \ 7\text{day}}$. However, this location is also exposed to high levels of aircraft noise at present and is inside the general airport operational 65 dB $L_{dn}$ contour.

As discussed below, this highlights that although engine testing noise levels can be elevated at times; there are significant periods of time with respite or considerably lower noise exposure.

In addition, the variable nature of engine testing noise means there are numerous occasions when respite occurs for all other sensitive locations and over an extended time frame. This is because historically engine testing occurs;

- at a number of locations around the airport;
- the orientation of the aircraft is variable (dependent on metrological factors), and;
- the testing programme itself is variable.

The data shows that for all receivers the worst case 7 day noise level is considerably higher than the typical 7 day noise exposure (approximately 5 – 10 dB greater). Also, the worst case situation occurs infrequently with periods of extended respite in between, typically in the order of a number of weeks. An example of this can be seen in the image from the ETMS software shown in D2, Appendix D.

Overall, considering the locations of the most affected receivers and their proximity to a significant International Airport, and the subsequent high levels of operational noise that is anticipated by the District Plan already from general aircraft operations, engine testing noise exposure is considered by MDA to be acceptable.

In addition, there is also an obligation to ensure noise levels do not exceed a reasonable level. Because of this, methods to manage and mitigate engine testing noise exposure should also be investigated. It is envisaged that structural mitigation options and noise management regimes should be investigated, in consultation with the airline operators. This may enable lower engine testing noise exposure in the community.

5.3 Health Effects - World Health Organisation $L_{night}$

$L_{night}$ is a ‘health’ noise indicator developed by the World Health Organisation (WHO) as part of the Night Noise Guidelines for Europe. It is the A-weighted long-term average sound level outside at the most exposed façade, determined over all the night periods in a year in which the night period is eight hours.

Based on exposure-effects relationships presented in the Night Noise Guidelines for Europe, the WHO recommends 40 dB $L_{night}$ is desirable for the protection of public health from night noise with an interim target of 55 dB $L_{night}$.

Such a noise descriptor would enable all engine testing events to be averaged on an annual basis and would likely mean the airport could readily comply with the interim target at all locations, and the recommended criterion at most locations.

Nevertheless, in the opinion of MDA, it is considered that a one year average (as used for $L_{night}$) is an inappropriate criterion and that the NNG of 40 dB $L_{night}$ is not a realistic criterion for the management of adverse health effects in relation to noise effects from night-time engine testing activity where such activity may vary in frequency on different nights.

6.0 CONCLUSION

Marshall Day Acoustics has undertaken a quantitative review of community noise exposure to engine testing at Christchurch Airport, for the purposes of preparing appropriate engine testing noise contours for inclusion in the Christchurch City Plan.
Engine Testing Monitoring Software (ETMS) has been developed. It is intended that the ETMS will be used as the basis for on-going monitoring and reporting of compliance with the City Plan rules, following them being made operative.

The ETMS was used to calculate worst case historic noise emissions between 2010 and 2014 so that the extent of community noise impact could be determined, and appropriate noise controls developed. A set of noise contours were prepared based on this data. With an additional allowance for future growth, Engine Testing Noise Control Boundaries (ETNCB) were then developed.

The proposed engine testing noise control boundaries would result in a number of people being highly annoyed by engine testing noise. However, for the same population sample there would also be a number of people being highly annoyed by general airport noise.

In summary, it is considered that overall annoyance effects would not be significantly different to those effectively already allowed for with the general airport noise contours.

Appropriate land use planning and noise control rules have been developed, and these have been submitted by CIAL on the proposed Christchurch City Plan.
APPENDIX A: GLOSSARY OF TERMINOLOGY

**Noise**
A sound that is unwanted by, or distracting to, the receiver.

**Ambient**
The ambient noise level is the noise level measured in the absence of the intrusive noise or the noise requiring control. Ambient noise levels are frequently measured to determine the situation prior to the addition of a new noise source.

**dB**
Decibel
The unit of sound level.
Expressed as a logarithmic ratio of sound pressure \( P \) relative to a reference pressure of \( P_r = 20 \mu Pa \) i.e. \( dB = 20 \times \log(P/P_r) \)

**A-weighting**
The process by which noise levels are corrected to account for the non-linear frequency response of the human ear.

\( L_{A_{eq}}(t) \)
The equivalent continuous (time-averaged) A-weighted sound level. This is commonly referred to as the average noise level.
The suffix "t" represents the time period to which the noise level relates, e.g. (8 h) would represent a period of 8 hours, (15 min) would represent a period of 15 minutes and (2200-0700) would represent a measurement time between 10 pm and 7 am.

\( L_{A_{max}} \)
The A-weighted maximum noise level. The highest noise level which occurs during the measurement period.

\( L_{dn} \)
The day night noise level which is calculated from the 24 hour \( L_{A_{eq}} \) with a 10 dB penalty applied to the night-time (2200-0700 hours) \( L_{A_{eq}} \).

\( L_{den} \)
The day evening night noise level which is calculated from the 24 hour \( L_{A_{eq}} \) with a 5 decibel penalty applied to the evening (1800-2200 hours) \( L_{A_{eq}} \) and a 10 decibel penalty applied to the night-time (2200-0700 hours) \( L_{A_{eq}} \).

**SEL or \( L_{AE} \)**
Sound Exposure Level
The sound level of one second duration which has the same amount of energy as the actual noise event measured.
Usually used to measure the sound energy of a particular event, such as a train pass-by or an aircraft flyover.

**NZS 6801:2008**

**NZS 6802:2008**

**NZS 6805:1992**
APPENDIX B: ENGINE TESTING RULES AT AUCKLAND

Auckland International Airport Engine Testing Noise Rule

Engine Testing on Aircraft

(a) The testing of engines which are in situ on an aircraft (“in situ aircraft engines”) shall not exceed the following noise limits within the Main Residential Zone or within the notional boundary of any dwelling outside the designated area and outside the HANA, MANA and ANNA in the Mangere Puhinui Rural or Mangere Puhinui Heritage zones:

- 7 day rolling average: 55 dB $L_{dn}$
- 10pm to 7am: 75 dB $L_{AFmax}$

For the purpose of this control, testing of in situ aircraft engines shall be measured in accordance with NZS 6801:2008 Acoustics: Measurement of Environmental Sound.

(b) AIAL shall monitor and record all testing of in situ aircraft engines and provide a summary report of the tests undertaken and the calculated noise levels whenever requested in writing by the ANCCG.

(c) The testing of in situ aircraft engines is excluded from the calculation of the 7 day rolling average in clause (a) above where such testing is associated with work necessary to satisfy an airworthiness directive or other like safety requirement issued by the Minister of Transport, the Director of Civil Aviation or the Civil Aviation Authority, which requires within 7 days of the directive or requirement being issued, the ground running of the engines on:

- all aircraft with a specific engine type, or
- aircraft of a specific make or model.

Prior to any testing excluded by this clause commencing, AIAL shall give written notice to the ANCCG and the Council explaining:

- the nature of and the reason for the testing;
- its expected duration and noise effects; and
- details of the directive or requirement received.

13A. Cumulative Engine Testing Noise

Where any Existing Building is located outside the designated area but within the $L_{dn}$ 57 dBA Area shown on Figure 5 ($L_{dn}$ 57 dBA Area) of this designation, AIAL shall make an offer to the owner(s) to install the treatment measures described in Condition 10(e) on the basis set out in clauses (e), (q), (qq) and (r) of Condition 10. This offer shall be made within 18 months of this designation becoming operative.

Explanatory Note to Condition 13A

This rule recognises that there are some houses in the MANA and ANNA which may be potentially subject to noise from the testing of in situ aircraft engines that would put their cumulative total noise level (Aircraft Operations plus noise from engine testing) over $L_{dn}$ 60 dBA before they are offered sound insulation. It would be appropriate to mitigate this noise by offering sound insulation at the outset. The trigger level is $L_{dn}$ 57 dBA because $L_{dn}$ 57 dBA from engine testing and $L_{dn}$ 57 dBA from Aircraft Operations, add to give $L_{dn}$ 60 dBA cumulative.

This rule avoids the difficulty of mathematically adding Aircraft Operation noise contours with engine testing noise contours, because insulation will only be offered to existing property.
owners as the $L_{an}$ 60 contour reaches those properties. The engine testing contours are a hypothetical worst case combination of testing options that AIAL can operate and still comply with Condition 13. Condition 13A avoids the difficulty of monitoring and offering insulation when noise reaches a certain level.
APPENDIX C: ENGINE TESTING SUMMARY DATA

Tests by Location

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<tr>
<th>Location</th>
<th>Test Count</th>
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<td>A13</td>
<td>20</td>
</tr>
<tr>
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<td>RW11</td>
<td>400</td>
</tr>
<tr>
<td>A2</td>
<td>1000</td>
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<tr>
<td>Runup Pad</td>
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Tests by Aircraft Type on Runup Pad

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<th>Aircraft Type</th>
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<tr>
<td>B757</td>
<td>300</td>
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<tr>
<td>C130</td>
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<tr>
<td>B733</td>
<td>500</td>
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<tr>
<td>B737</td>
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<td>A320</td>
<td>700</td>
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<tr>
<td>ATR72</td>
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</table>

Engine Tests by Time of Day

- 12 a.m.: 0 tests
- 1 a.m.: 10 tests
- 2 a.m.: 20 tests
- 3 a.m.: 30 tests
- 4 a.m.: 40 tests
- 5 a.m.: 50 tests
- 6 a.m.: 60 tests
- 7 a.m.: 70 tests
- 8 a.m.: 80 tests
- 9 a.m.: 90 tests
- 10 a.m.: 100 tests
- 11 a.m.: 110 tests
- 12 p.m.: 120 tests
- 1 p.m.: 130 tests
- 2 p.m.: 140 tests
- 3 p.m.: 150 tests
- 4 p.m.: 160 tests
- 5 p.m.: 170 tests
- 6 p.m.: 180 tests
- 7 p.m.: 190 tests
- 8 p.m.: 200 tests
- 9 p.m.: 210 tests
- 10 p.m.: 220 tests
- 11 p.m.: 230 tests
Appendix D: Engine Testing Noise Contour Input Data

D1 – Worst case quarterly predicted noise levels

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<th>2013</th>
<th>2014</th>
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<td>Q2</td>
<td>Q3</td>
<td>Q4</td>
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</tbody>
</table>

Note: 655 Russley Road, 609 Avonhead Road, 565 Avonhead Road, 148 Grays Road, 50 Saviles Road and 559 Memorial Avenue are all owned by CIAL. These receivers were originally selected based on their spatial location around the airport, to enable the engine testing noise contours to be accurately calculated for all directions around the airport. The results have not been reported here as they are not used in the Assessment of Noise Effects (section 5) of this report.
D2 - Typical Engine Testing Monitoring Software Output
APPENDIX E: PROPOSED ENGINE TESTING RULE

The Proposed Engine Testing rule below contained in the CIAL submission on Engine Testing noise:

Christchurch International Airport Ltd (CIAL) shall manage the Christchurch International Airport so that noise from:

b) the testing of engines which are on the wing of an aircraft shall not exceed 65 \( \text{dB } L_{dn} \) at the engine testing compliance monitoring positions (ETCMP) shown on the Planning Maps and a nominated physical monitoring station suitable for monitoring compliance

i. Compliance or otherwise with b). shall be demonstrated using the CIAL engine testing monitoring software (ETMS). The calculations shall be based on measured engine testing noise emissions and actual log records of engine testing events.

ii. The noise level shall be calculated as a 7 day rolling average at the five ETCMP shown on the Planning Maps and a nominated physical monitoring station suitable for monitoring compliance

iii. The testing of aircraft engines on the wing of an aircraft is excluded from the calculation in clause (b) above where such testing is associated with work necessary to satisfy an airworthiness directive or other like safety requirement issued by the Minister of Transport, the Director of Civil Aviation or the Civil Aviation Authority, which requires within 7 days of the directive or requirement being issued, the ground running of the engines on:

a) all aircraft with a specific engine type, or;

b) aircraft of a specific make or model

iv. CIAL shall annually provide the Council’s Unit Manager Inspections and Enforcement with the results of noise calculations carried out in accordance with clause (i-iii) above. The results are to be included in the annual CIAL Noise Monitoring Report.
APPENDIX F: FIGURES

Figure 1: Locations of Engine Testing Activity
Notified Engine Testing Noise Control Boundaries (with compliance positions)
The noise contours in this Figure were obtained by computer interpolation between calculated grid points. There is an interpolation accuracy of approximately ±1.5 dB. For precise noise levels at specific locations, refer to point receiver calculations.

Map Legend
- Cadastral
- Building
- Engine Testing Compliance Monitoring Position (ETCMP)
- Selwyn/Waimakirri District Plan Boundaries (Expert Panel Contours)

Engine Testing Noise Level (dB L_{dn 7day})
- 50 dB L_{dn}
- 55 dB L_{dn}
- 60 dB L_{dn}
- 65 dB L_{dn}

Figure 4 R01 - Engine Testing Noise Control Boundaries and Engine Testing Compliance Monitoring Positions and ETMS Receiver Locations

Client: CIAL
Path: J:JOBS\2012\2012503A\06 Drawings
Filename: 1048 Figure 4 R01 ETMS SG.png Result File: Sc3-9 - 10lg7 +2dB
Prepared by: sjp Date: 10/06/2015

Scale 1:27500