REPORT

Tonkin+Taylor

Whenuapai Airbase - Engine Testing Noise Contours

Plan Change 5

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1 Executive Summary

Whenuapai Airbase has existed more or less in its present form since the 1940s and has been continuously occupied and used by the Royal New Zealand Air Force since that time. While there have been changes in the number, size and type of aircraft located at the base over this time, noise from aircraft operations and engine testing forms part of the local noise environment and has done for at least the past 50 years.

Engine testing is a regular activity at Whenuapai Airbase and is required for maintenance, testing and training purposes. Engine testing and the frequency and duration of engine testing varies between different aircraft and the tasks being undertaken. It does not follow a regular schedule but is dependent on aircraft requirements and can vary greatly in noise level and duration. Night-time engine testing may be required in some circumstances, although this is avoided if possible.

Engine testing is authorised under Designation 4310 in the Auckland Unitary Plan Operative in part (AUP) and the designation includes aircraft noise contours for Whenuapai Airbase. These contours were prepared to include the noise generated by aircraft when taking off and landing, but not the noise contribution from engine testing. Accordingly, despite engine testing being within the scope of the designation it is unable to comply with the noise limits in the conditions of the designation which reference the contours. However, engine testing currently undertaken at Whenuapai Airbase does not breach the Resource Management Act 1991 (RMA) due to a certificate issued under section 4(2) of the RMA relating specifically to this activity.

Auckland Council notified proposed Plan Change 5: Whenuapai (PC5) in 2017. As part of the plan change process a series of engine testing contours were produced to inform future land use planning controls in accordance with New Zealand Standard NZS 6805:1992 '*Airport Noise Management and Land Use Planning*' (NZS 6805). A finalised set of engine testing contours have now been produced taking into account a projection of future engine testing operations at Whenuapai Airbase, which is in accordance with NZS 6805. The time spent engine testing has been increased by a factor of 20% from the existing situation to account for future changes.

Two contours have been produced:

- 65 dB Ldn engine testing Inner Control Boundary - within which the amount of engine testing noise exposure is sufficiently high to require appropriate land use controls or other measures to avoid, remedy or mitigate any adverse effects on the environment, including effects on community health and amenity values. These controls typically prevent new noise sensitive development occurring.
- 57 dB Ldn engine testing Outer Control Boundary - within which there should be sound insulation performance requirements for new or altered buildings to ensure a reasonable level of indoor noise amenity with windows and doors closed.

The intent is that the new engine testing noise contours will inform PC5 and form the basis of future land use planning controls to provide protection against adverse levels of engine testing noise as anticipated by NZS 6805. The contours are included at Appendix D to this report.

2 Introduction

2.1 Background

The Royal New Zealand Airforce Base Auckland (Whenuapai Airbase) is located at Whenuapai and was first established in 1937. There has been an operational airfield at Whenuapai since 1928. Whenuapai Airbase has existed more or less in its present form since the 1940s and has been continuously occupied and used by the Royal New Zealand Air Force (RNZAF) since that time. Whenuapai was also Auckland's civil international airport from 1945 to 1965.

Whenuapai Airbase has two main runways plus extensive aircraft parking with associated taxiways and infrastructure. There are three flying squadrons located at the airbase as follows:

- No. 5 Squadron – Maritime Surveillance, using Lockheed P-3 Orion aircraft operating out of Whenuapai since 1968;
- No. 6 Squadron – Naval Aviation, using Kaman SH-2G Super Seasprite helicopters operating out of Whenuapai since 2005; and
- No. 40 Squadron – Tactical and Strategic Transport, using Lockheed C-130H Hercules operating out of Whenuapai since 1965 and Boeing 757 aircraft operating out of Whenuapai since 2002.

A location plan is shown in Figure 2.1 showing the boundary of the base and main runways.

Engine testing[1] of Whenuapai-based aircraft is required for maintenance, testing and training purposes. Engine testing is a regular activity at Whenuapai Airbase and the frequency and duration of engine testing varies between different aircraft and the tasks being undertaken. Unlike when aircraft take-off, land and taxi, engine tests can be prolonged depending upon the engineering and training requirements. Although there are some predictable elements of routine maintenance, engine testing does not follow a regular schedule but is dependent on aircraft and operational requirements and can vary greatly in noise level and duration. Night-time[2] engine testing may be required in some circumstances, although this is avoided if possible, and is conducted only with specific approval from the Base Commander[3].

While there have been changes in the size and type of aircraft being tested over the years, engine testing has always been undertaken. In this respect noise from engine testing undertaken by the RNZAF forms part of the local noise environment and has done for at least the past 80 years. Engine testing is a necessary requirement to allow flight operations at the Base to occur.

2.2 Purpose of report

Previous assessment work undertaken by New Zealand Defence Force (NZDF) for Auckland Council's Plan Change 5 (PC5) included the production of engine testing noise contours[4]. The purpose of this report is to update these engine testing noise contours to more accurately reflect day to day operations and to allow for future changes in engine testing requirements at Whenuapai Airbase by increasing the duration of current engine testing by 20% (see Section 6.3). The intent is that these new contours will inform PC5 and form the basis of future land use planning controls to provide protection against adverse levels of engine testing noise.

[1] In this report, engine testing is the preferred terminology to describe when aircraft are stationary and engines are operating for maintenance, testing and training. Other reports may use a variety of descriptors such as engine ground running, ground engine running, engine running, ground run-up, or on-wing engine runs, which are all variants of engine testing.
[2] Night-time has two meanings in this report see Section 5.2.
[3] See Section 4.2 - NZDF Base Standing Orders
[4] AECOM, Whenuapai Plan Change 5, Base Auckland – Engine Running Noise Assessment, November 2018.

A glossary of terms is included at the end of this report.

Figure 2.1: Location of Whenuapai Airbase, Whenuapai (Copyright TTMapViewer 2019)

3 Designation 4310

Designation 4310 in the AUP applies to Whenuapai Airbase and provides for the operation of the airbase for defence purposes as defined by section 5 of the Defence Act 1990. Engine testing is authorised by the designation. Condition 1 of the designation relates to aircraft noise and is reproduced below:

> *Aircraft Noise*
>
> 1. *Aircraft operations on the RNZAF Airbase shall not exceed a day/night (Ldn) level of:*
>   a. *65dBA outside the Airnoise Boundary (Ldn 65 dBA Contour) shown on the Airbase Noise map;*
>   b. *55dBA outside the Outer Control Boundary (Ldn 55 dBA Contour) shown on the Airbase Noise map.*
>
> *For the purpose of this control noise will be measured in accordance with the NZS 6805:1992 and calculated, as stated in NZS 6805:1992, using FAA Integrated Noise Model (INM) and records of actual aircraft operations and calculated as a 90 day rolling logarithmic average.*
>
> *Exceptions to noise limits:*
>
> a. *The aircraft is landing in an emergency;*
> b. *The aircraft is landing at the Airbase as an alternative in adverse weather conditions; or*
> c. *The aircraft is using the airfield as part of a search and rescue operation or civil emergency.*

The Airbase Noise map referred to in condition 1 is included in the Designation (reference Drawing 9A-2) and is attached at Appendix A. The Airbase Noise map is reproduced in the AUP as the Aircraft Noise Overlay for Whenuapai Airbase, see Appendix B. The contours represent the extent of aircraft noise from aircraft either in flight or when on the ground during taking off or landing. Noise is only present along the runways and flight tracks. The contours were not prepared to include the noise contribution from any other source of aircraft noise (including additional noise around taxiways, aprons, and engine testing locations). However, pursuant to a recent (2019) decision of the Environment Court, engine testing noise was required to comply with the noise limits in the conditions of the designation which reference the contours. Because NZDF could not comply with those limits, engine testing has been exempted from compliance with these limits pursuant to a certificate issued under section 4(2) of the RMA.

Three types of aircraft operations at Whenuapai Airbase are expressly excluded from compliance with the airnoise boundary of condition 1. These operations relate to unplanned or unforeseen events such as emergencies (emergency landings or diversions due to adverse weather) or where aircraft are used for search and rescue or civil events such as those declared under the Civil Emergency Management Act 2002.

4 Land use planning – aircraft noise

4.1 NZS 6805:1992

New Zealand Standard NZS 6805:1992 'Airport Noise Management and Land Use Planning' is used to assess and rate aircraft noise in the vicinity of airports (including aerodromes / airfields). This standard does not specifically exclude nor include engine testing noise when assessing the overall level of airport noise. Rather it is focused on the noise generated by aircraft from 'start of roll', when inflight and when an aircraft lands and departs the runway. NZS 6805:1992 is relevant to this assessment since it provides guidance on the use of the day / night sound level (Ldn) and the averaging of aircraft activity.

The Ldn parameter is the day / night average energy level and it has a 10 dB weighting for any aircraft noise events which occur during the period 2200-0700 hrs. Ldn is widely used to assess environmental noise from other sources as well as aircraft noise and has been used to establish reasonable noise thresholds for determining community response to noise from aircraft operations (take-off and landing movements) and other sources of environmental noise. The Ldn 10 dB weighting recognises that night-time noise can be more disturbing than noise that occurs during the day, and that noise at night can result in adverse health effects due to loss of sleep. The Ldn weighting means that, for example, a 5-minute night-time engine test would be equivalent to 10 similar tests conducted during the day.

To account for the variation in activity that may occur at an airport, NZS 6805 recommends that a busy three-month (90 day) period is used to determine the typical level of aircraft movements that may occur over a busy 24-hour day. This averaging period reflects the normal convention that at commercial airports, the busy summer period (December, January, and February) is when aircraft movements are at their greatest. If the same averaging duration were applied to engine testing then the consequence would be a significant underestimation of the true noise effects as engine testing is more sporadic / infrequent. For engine testing, a busy 7-day period is typically preferred and has been used elsewhere in New Zealand, for example at Christchurch International Airport. This is based on a rolling period of 7 days and reflects that engine testing can vary from day to day and can occur on weekends. In contrast to operational flying, if a longer period were to be used, it would tend to average out short term 'peaks' in engine testing activity. This 7-day period is then used to calculate a representative 24-hour period.

Unlike a commercial operator, NZDF aircraft requirements will vary from week to week and there will be periods of low activity in contrast to periods of higher activity, especially if there are deployments, preparation for military training, search and rescue or humanitarian requirements (see graphs in Section 6.2). This variation can result in a significant difference in the aircraft noise environment from day to day and from week to week. While this variation may not affect the aircraft noise contours based on a 90-day assessment period, a 7-day assessment period for engine testing noise can result in multiple scenarios being developed as the frequency of engine testing can vary much more than flight movements. When developing engine testing contours for land use planning purposes this 7-day period must therefore allow for a worst case, or at least a busy scenario in a similar manner to that required by NZS 6805 for airnoise (i.e. busy 24-hour day average).

4.2 Airnoise boundary

NZS 6805 uses the Airnoise Boundary concept to enable councils to establish appropriate land use planning controls for the management of aircraft noise at airports to protect the health and amenity of neighbouring communities without unduly restricting the operation of airports. The Standard provides the minimum requirement to protect people from adverse effects by establishing a maximum level of aircraft noise exposure (Airnoise Boundary) and a separate Outer Control Boundary for the protection of amenity values.

Figure 4.1 shows Whenuapai Airbase's Airnoise Boundary (the darker blue shaded area) and Outer Control Boundary (the lighter blue shaded area) of Condition 1 (Designation drawing 9A-2, refer Appendix A). These airnoise boundaries are included in the AUP via the Aircraft Noise Overlay (as shown in Appendix B) which provides for land use controls consistent with NZS 6805.

Figure 4.1: Whenuapai Airbase Airnoise Boundaries

Noise from "aircraft operations" is not to exceed either the 65 dBA Airnoise Boundary (i.e. the outer edge of the dark blue shaded area) or the 55 dBA Outer Control Boundary (i.e. the outer edge of the light blue shaded area). NZS 6805 defines the Airnoise Boundary as:

> *'an area around an airport within which the current or future daily amount of aircraft noise exposure will be sufficiently high to require appropriate land use controls or other measures to avoid, remedy or mitigate any adverse effects on the environment, including effects on community health and amenity values whilst recognizing the need to operate an airport efficiently.'*

Unlike the Airnoise Boundary, which precludes new noise sensitive development, NZS 6805 defines the Outer Control Boundary as:

> *"an area within which there shall be no new incompatible land uses, unless a district plan permits such uses subject to requirements to incorporate appropriate acoustic insulation".*

The noise boundaries can represent either the existing level of aircraft noise or a future forecast of aircraft noise. However NZS 6805 recommends that a projection should be made of future operations and that a minimum period of 10 years should be used as the basis of the projected contours. Typically, commercial airports will forward forecast to a point 20-30 years into the future to reflect a projection of anticipated growth in airport capacity.

Unlike a commercial airport with planned growth in passenger and freight traffic and hence greater numbers of aircraft movements (and/or larger capacity aircraft), there is not the same anticipated level of growth for NZDF operations due to the NZDF's role remaining relatively unchanged, i.e. similar activities are anticipated in the future as currently occur. However, future global uncertainty may require enhanced military capability or increased humanitarian support following the effects of natural disasters and climate change. This uncertainty should be allowed for when defining land use planning control noise boundaries in terms of the numbers of future aircraft movements and probable changes in the future Whenuapai Airbase home aircraft fleet. It should also be noted that the noise signature of new aircraft may be higher if they have jet engines.

4.3 Whenuapai Airbase noise boundaries

As discussed above, the Whenuapai Airbase aircraft noise modelling (and the associated airnoise contours) did not include the noise from aircraft taxiing or from engine testing.

The noise from taxiing operations is negligible in comparison to the noise from either aircraft movements on the runway or from engine testing at Whenuapai Airbase due to the relatively low numbers of taxiing operations, the relatively low noise emissions and that the main taxiways are located close to the main runway (see Figure 5.1).

It is common practice both nationally and internationally to assess the effects of noise from aircraft in flight and from engine testing separately[5]. For aerodromes with occasional engine testing, the noise contribution from engine testing may be included in the airnoise contours. However for aerodromes which have significant engine testing due to the presence of maintenance, repair, and overhaul (MRO) facilities, which is the case at Whenuapai Airbase, separate contours will be produced and the effects of the two aircraft noise sources will be treated separately. Local communities near aerodromes with MRO engine testing activity will hear both aircraft in flight, and engine testing. In these situations, appropriate land use controls are adopted by defining separate noise boundaries for each activity.

When assessing the effects of airnoise, thresholds of Ldn 65 dB and 55 dB are used for airport noise management and for setting land use planning controls (including the AUP Aircraft Noise Overlay as shown in Appendix B). These thresholds are derived from community noise studies. An overview of community response to aircraft noise is included at Appendix C together with the dose response thresholds that form the recommended land use control thresholds of NZS 6805. These dose responses are used to assess the degree of community noise annoyance to various modes of transportation, including aircraft.

Unlike airnoise, there are no community noise significance thresholds used to rate the annoyance from engine testing noise. For PC5, engine testing noise thresholds of Ldn 65 dB and 57 dB[6] were adopted which are based on the airnoise thresholds. The upper level of 65 dB being the threshold at which 20% of the exposed population would be highly annoyed by airnoise and 57 dB is roughly at the onset of significant community annoyance from airnoise (i.e. similar to the airnoise threshold of Ldn 55 dB). Below 57 dB there will be a proportion of the population who will be annoyed by airnoise, however, this proportion is considered statistically small.

[5] Aircraft in flight (take off, landings and circuit work) can be short in duration with many events during the day and lesser numbers at night. Whereas engine testing can be prolonged and comprise irregular activity during the day and at night. Hence the two assessment approaches.

[6] 57 dB Ldn was adopted on the basis that narrowly open windows have been shown to achieve a reduction of approximately 17 dB. This would result in an internal Ldn of 40 dB which is an appropriate indoor sound level and is consistent with extant Rule D24.6.1 (for North Shore Airport, Kaipara Flats and Whenuapai). It is also consistent with the onset of significant community response to aircraft noise with a minor adjustment of 2 dB to reflect the intermittent nature of engine testing compared to flight operations.

5 Engine testing at Whenuapai Airbase

The airfield has two main paved runways plus extensive aircraft parking. Figure 5.1 shows a plan of Whenuapai Airbase as extracted from the New Zealand Aeronautical Information Publication (NZ AIP[7]). The plan shows the two main runways (RWY), main taxiways (TWY) and the airfield's aprons. There are four possible runway directions RWY 08/26 and RWY 03/21. The main runway is 03/21.

The locations marked as TWY F (Foxtrot) and TWY J (Juliet) are where high-power engine testing can be undertaken (see Section 5). TWY D (Delta) is no longer available for engine testing as discussed at Section 5.2. Lower-power testing occurs on the apron outside the squadron hangars.

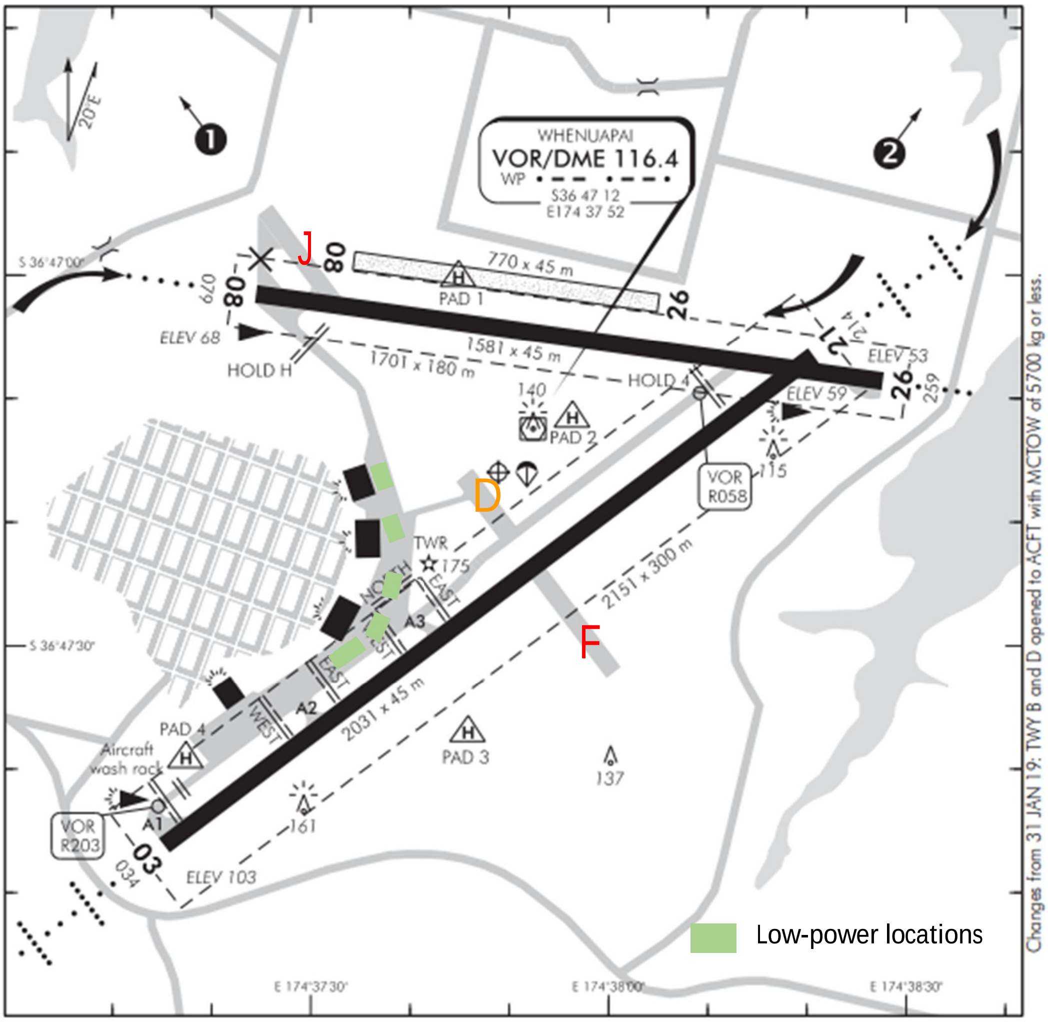

Figure 5.1: Airfield layout showing high-power engine testing locations marked (F & J currently used and D has been decommissioned) and low-power locations (source NZ AIP)

As set out in Section 1, there are three flying squadrons operating out of Whenuapai Airbase:

- No. 5 Squadron – Maritime Surveillance, using Lockheed P-3K2 Orion aircraft (large four engine turboprop).
- No. 6 Squadron – Naval Aviation, using Kaman SH-2G Super Seasprite helicopters.

[7] NZWP AD 2 - 51.1 (http://www.aip.net.nz/pdf/NZWP_51.1_51.2.pdf)

- No. 40 Squadron – Tactical and Strategic Transport, using Lockheed C-130H Hercules (large four engine turboprop military transport aircraft) and Boeing 757 aircraft (large twin engine jet airliner).

The P-3K2 Orion (P-3), which performs a search and rescue role, is being decommissioned and is being replaced by the P-8A Poseidon (P-8A) aircraft which will be based at RNZAF Base Ohakea. The P-3 will no longer operate from Whenuapai Airbase from around 2023. The P-8A will not provide full operational cover for the P-3 and additional aircraft resources may be required, which could be provided by either a new aircraft or increased use of the existing fleet (i.e. either additional aircraft or increased utilisation).

The following sections discuss the engine testing requirements of the different home aircraft, including what should be allowed for to account for future engine testing.

5.1 Engine testing requirements

Engine testing is required for scheduled maintenance or rectification maintenance. Scheduled maintenance is based on operating time or flying hours and is planned as part of the aircraft fleet management plan. Scheduled maintenance, and the individual tasks within the maintenance schedule, are set by the manufacturer and ensures aircraft are technically air worthy, i.e. fit and safe for flight operations. Rectification maintenance is completed when something fails or does not operate as expected, or when an inspection discovers a component or system not functioning correctly. This is responsive in its nature and cannot be planned for. This rectification maintenance may have to be undertaken at short notice to prepare aircraft for immediate deployment or for other operational reasons. Work may have to take place at night to ensure aircraft are available the following day or immediately following the maintenance.

Engine testing is generally classed into the following categories (this is not an exhaustive list).

<u>Low-power:</u>

- Leak checks.
- Operational and functional checks.
- Scheduled maintenance.
- Fault investigation.
- Pressurisation runs.
- Personnel training (tied into runs in the previous categories where possible).

<u>High-power:</u>

- Operational and functional checks.
- Fault investigation.
- Scheduled maintenance.
- Propeller balancing.
- Personnel training (as above).

Additionally, the P-3 is required to have approximately 15 minutes of high-power engine testing at the thresholds of the main runway (THR RWY 03 and THR RWY 21) prior to in-flight evaluation checks. These checks do not take place every flight and occur approximately every fortnight for each aircraft depending upon aircraft usage.

5.2 NZDF Base Standing Orders

The following 'self-imposed' restrictions are in place under current NZDF Base Standing Orders.

Currently authorised locations for high-power engine runs for C–130H and P–3K2 are:

- TWY Foxtrot (F).
- THR RWY 08.
- TWY Juliet (J).

The authorised location for high-power engine tests for B757 is THR RWY 08. No other locations can be used due to either the unsuitability of the surface for jet engine testing or jet blast safety considerations.

Low-power engine tests (nil throttle movement) lasting less than 20 minutes may be conducted on the aprons outside each squadron's hangar. High-power engine tests during day-time hours (0700-2200) can only occur after obtaining clearance from Operations. High-power tests are prohibited on TWY F overlay when prevailing wind direction is 225–255° due to propeller wash and fume hazards to neighbouring properties. Out of normal working hours, i.e. 2200-0700 hrs, high-power engine runs require prior authorisation by the Base Commander and can only take place on TWY J. During daylight savings this time is extended to 2300 hrs, which is different to the NZS 6805 definition of night-time, i.e. 2200-0700 hrs.

Historically TWY D was used for engine testing, however, due to the poor surface condition of TWY D, it can no longer be used. TWY D was decommissioned in early 2018 and is noted in the NZ AIP as only being suitable for aircraft taxiing (no engine testing) with a maximum certificated take-off weight (MCTOW) of less than 5,700 kg. None of the home aircraft at Whenuapai Airbase are less than MCTOW 5,700 kg. For night-time high-power testing, TWY F is now used instead of TWY D (together with continued use of TWY J).

Base Standing Orders do not explicitly impose any restrictions on engine testing with respect to noise, apart from the seeking the necessary approvals to perform engine testing at night. However, restrictions on wind direction when aircraft are using TWY F does have noise benefits for the closest dwellings on Rata Road and Kauri Road, due to the orientation of the aircraft and hence its noise signature. The Base is mindful of other noise management measures and these are discussed at Section 8.4.

5.3 Other practical requirements for engine testing

In addition to these Aviation Orders, there are additional practicalities that dictate when and where engine testing can and cannot occur. Some of these requirements are Whenuapai Airbase specific, whereas others are accepted practice for engine testing.

- Engine testing must not interfere with the operations that are taking place that day, by blocking a taxiway or interfering with the safe operation of the active runway. Runways must always remain open, especially for any emergencies which may require diverted aircraft to land. Runway clearance requirements must be met (depicted by the dashed outline around each runway as shown in Figure 5.1). This clearance ensures that aircraft do not penetrate the inner transitional side surface of the runway.
- Operational tasks such as search and rescue or humanitarian assistance / disaster relief response may mean that unscheduled engine testing has to be done in the evening or during the night. NZDF is required to have a P-3 or C-130H on standby and ready to be airborne within two hours at all times.

- When conducting high-power engine testing, aircraft are positioned into the wind to increase cooling and to minimise any in-flow air turbulence. Low-power engine runs do not require the aircraft to be positioned into wind.
- Due to the effects of jet blast and prop wash, engine testing can only occur within certain areas of the Base such that the effects of running engines do not pose a hazard for people, buildings, or other aircraft due to the potential to generate flying debris (FOD – foreign object damage).
- Noise effects on Base personnel (inside and outside offices/workshops and living quarters) are also a consideration.
- Low-power tests can occur anywhere on the apron and do not require the aircraft to be taxied to a specific area.
- During engine testing, engine settings may be increased from idle to a high-power setting to simulate what would happen in flight. Not all engine testing requires high-power settings.
- The frequency of engine testing fluctuates according to operational requirements. There can be days when no testing occurs and depending upon operational requirements, there can be busy periods prior to aircraft deployments or exercises.

There are also limitations on the use of high-power testing:

- Engines do not run at maximum power continuously during a high-power engine test, rather the engines are turned up and down throughout the entire power range. Generally, an engine will not run continuously at high-power for more than five minutes at a time due to the stress imposed on the aircraft.
- For aircraft with more than two engines, only one engine is run at maximum power at a time.

Meetings[8] have been held at Whenuapai Airbase with engineering personnel from No. 5 Squadron (P-3) and No. 40 Squadron (C-130H and B757) and other Base personnel. The most recent meeting was held in November 2019 and clarified several matters regarding the use of pulling power and high-power tests. From the two meetings the following additional information was obtained.

- It was confirmed that the Air Traffic Control (ATC) engine testing records record any movement of the throttle from ground idle (low-power) as a high-power engine run, even if maximum take-off power is not used.
- For a high-power engine test recorded by ATC, Base personnel considered that typically 50 % of the time is spent at low-power, i.e. ground idle and 50 % at a high-power setting. As noted above, a high-power setting is whenever the throttle is moved and does not necessarily mean maximum power and hence maximum noise.
- Base personnel indicated that the engine testing records were recorded on the sheets by ATC prior to the aircraft having completed its maintenance check. An engine test recorded as being 20 minutes in duration could, if an issue arose during the test, last either longer or shorter than that noted on the record sheet. In some situations, there may be a delay in the time of the planned test, and conversely a test may occur earlier than planned. Without going through each individual aircraft's maintenance log the ATC records are the best source of available information. Base personnel considered that the ATC records when aggregated across each aircraft type were representative of the tests being performed on Base (duration and time of occurrence).
- Analysis of the ATC engine testing records show that tests vary in duration from 20 to 120 minutes, with 60 minutes being the most common duration. From discussion with engineering

8 Meetings held in October 2018 and November 2019.

staff, an engine test may involve multiple start / stops of engine(s). Hence there may not be continuous operation of the engines during a prolonged engine test.

Initial noise modelling for PC5 assumed that any movement of the throttle resulted in use of maximum take-off power. This assumption therefore resulted in depicting a greater noise impact than in practice. Following input from Base personnel at the last meeting, three power settings were established – ground idle, pulling power and high (maximum take-off) power. An example situation was provided that for a high-power test of a P-3, a 20-minute test could have approximately 10 % of the test being at 'pulling power', with only 1 minute of the test at high-power (i.e. 17 minutes of ground idle, 2 minutes at pulling power and 1 minute at high-power). In comparison to the PC5 assumption, this example results in an approximate 2-4 dB reduction. Base personnel provided a range of operating situations for which maximum power would be used. It was noted that not every test required use of maximum take-off power, which includes high duration testing of the Hercules. This information was also verified by a period of noise monitoring which is discussed later in this report (Section 6.6).

TWY D was decommissioned in early 2018. Base personnel confirmed that using the historic records it would be realistic to substitute a combination of TWY F and TWY J in place of engine testing that occurred on TWY D. For night-time testing, the total engine testing on TWY D and TWY F should be summed, with 90 % of the total moved to TWY F and 10 % to THR TWY 08 / TWY J. For daytime running a 50 / 50 split should be assumed between TWY F and TWY J. There are no current plans to recommission TWY D.

The P-3 is required to have a 15-minute engine test at the threshold of the main runway (THR RWY 03 or THR RWY 21[9]) prior to in-flight evaluation checks. This generally only happens about once every fortnight for each of the aircraft. The pre-flight test involves approximately ten minutes of low-power running and five minutes of high-power testing (maximum power rather than pulling power).

During the November 2019 meeting it was determined with Base personnel that a combination of unattended noise monitoring and further engine testing data would assist in establishing a representative breakdown of how long tests last and the variation in engine setting and hence noise level. This data collection is detailed in Section 6.5 and forms the basis of the assumptions regarding the future engine testing regime (Section 6.3).

[9] RWY 03 is used for 60 % of the time and RWY 21 is used for 40 % of the time.

6 Engine testing noise

6.1 Overview

Sound levels will vary around an aircraft during engine testing due to the directivity pattern of the engines and the noise generated from the propellers of turboprop aircraft. Sound level differences of 20 dB can be experienced around the aircraft with the highest sound levels generally being towards the rear and approximately 120° and 240° from the nose of the aircraft. At the lower power settings there can be a marked difference between the directivity pattern compared to a high-power test. As aircraft are positioned into wind for high-power testing the prevailing wind direction will influence the extent of the noise experienced around Whenuapai. For low-power tests on the apron the aircraft are assumed to be positioned in their normal parked position, which is typically with the nose of the aircraft towards the hangars.

The frequency content of the noise will also vary around the aircraft. For example, jet aircraft will generate higher frequency sound levels to the front of the aircraft due to compressor fan noise, whereas behind the aircraft jet mixing noise will result in a greater proportion of low frequency noise. The blade passing frequency of the turbo-prop aircraft will generate a noticeable peak in the frequency content of the C-130H and P-3 aircraft especially on axis to the propellers. As sound level propagation is dependent upon the frequency content of the sound it is important to characterise the frequency content of the aircraft noise source (higher frequencies are attenuated more quickly than low frequencies).

The overall level of engine testing noise is therefore dependent on:

- Aircraft type.
- Engine power setting.
- Duration at each power setting.
- Location of the aircraft.
- Orientation of the aircraft.
- Time of day (whether night-time penalty applies).

6.2 Engine records

Whenuapai Airbase has been recording engine testing records via ATC since 2017. These records record the planned date and time of the test, the aircraft type, duration of the test for low-power and high-power, the location and the prevailing wind direction. All aircraft requiring an engine test are required to communicate with ATC, especially when manoeuvring aircraft from the apron to the high-power testing locations. All manoeuvring is done by tractor and not under the aircraft's own power. The ATC is not staffed 24 hours a day and for afterhours running, testing is recorded separately by the individual squadrons. Engine testing normally takes place between Monday and Friday with occasional testing on the weekend.

For PC5 modelling, the ATC records covered a period of 124 days during which there was 61 days with recorded high-power tests and 101 days with low-power tests. During this period, high-power testing occurred on 15 nights.

T+T was provided with the original hand-written records which were prepared by ATC when any engine testing occurred[10]. These same records were used in 2018 to derive the contours that were included in the notified PC5.

The ATC records span from August 2017 to 19 January 2018, being 157 days in total. However, there was a large gap in recording data over the whole of December 2017 (hence the 124 days of valid data). During the period, there were periods of no engine testing which demonstrates the variability of engine testing, i.e. unlike a commercial airport with scheduled flights there is a variability at Whenuapai Airbase on a week-to-week basis. This variability must be considered when developing a future engine testing scenario for noise modelling.

Figure 6.1 provides a breakdown for the entire recording period of the number of engine tests performed by each aircraft type split into day (0700-2200) and night (2200-0700).

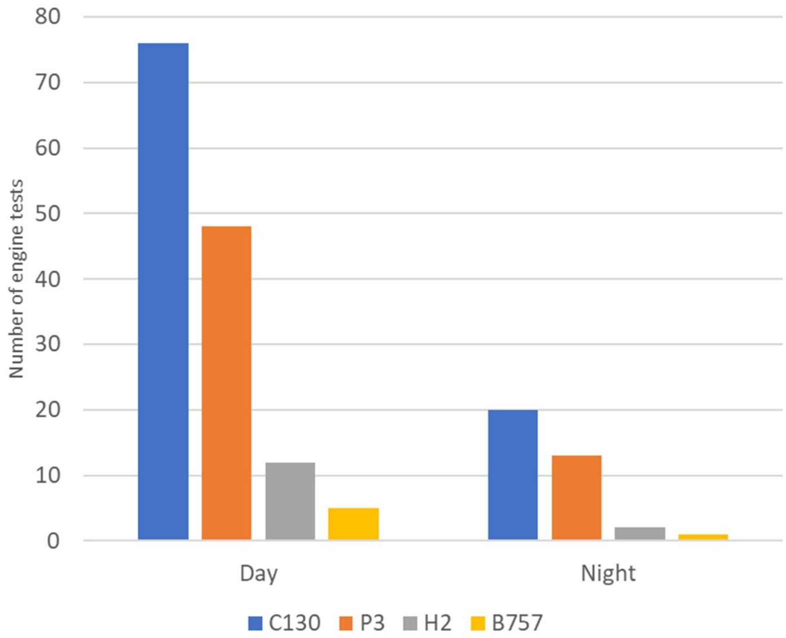

Figure 6.1: Breakdown of engine testing by aircraft type over 124 days

The time of day breakdown is provided in Figure 6.2, and Figure 6.3 provides the duration of engine testing (both low and high-power combined) as recorded by ATC.

Most of the engine testing takes place during daytime hours. Night-time testing occurs more frequently during the period 2200 to 0000 hrs.

[10] The records provided include a separate log of out of hours records when the ATC was closed. These additional records were recorded by engineering personnel and provided additional information on engine testing. All subsequent references to ATC logs include these out of hour records.

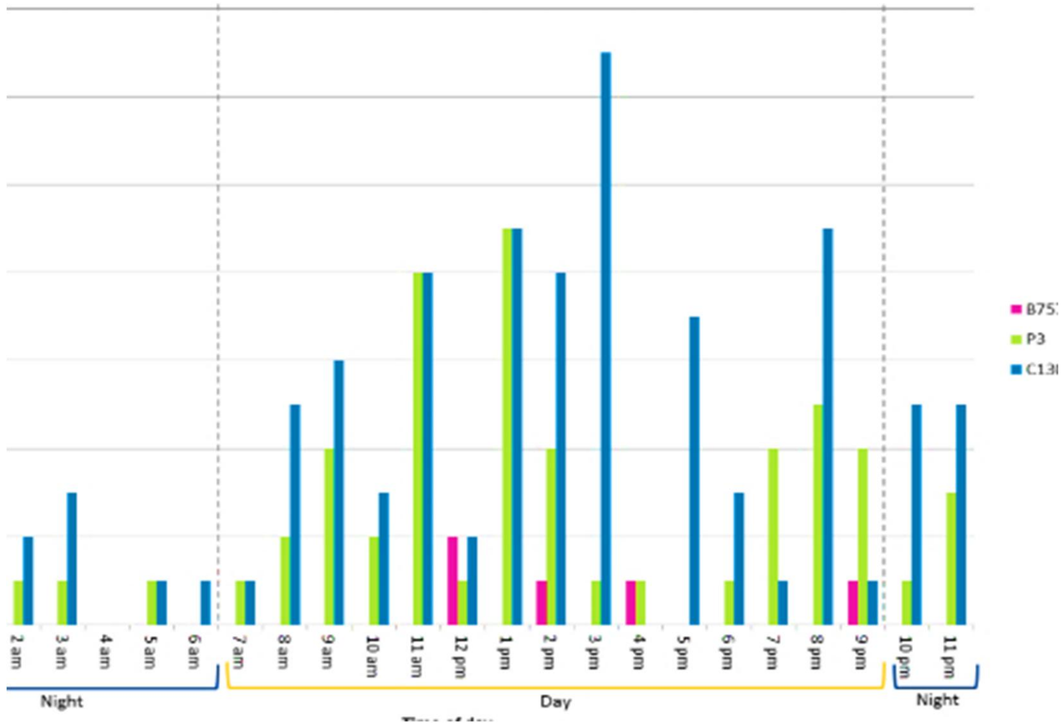

Figure 6.2: Count of engine runs by aircraft type and time of day over 124 days

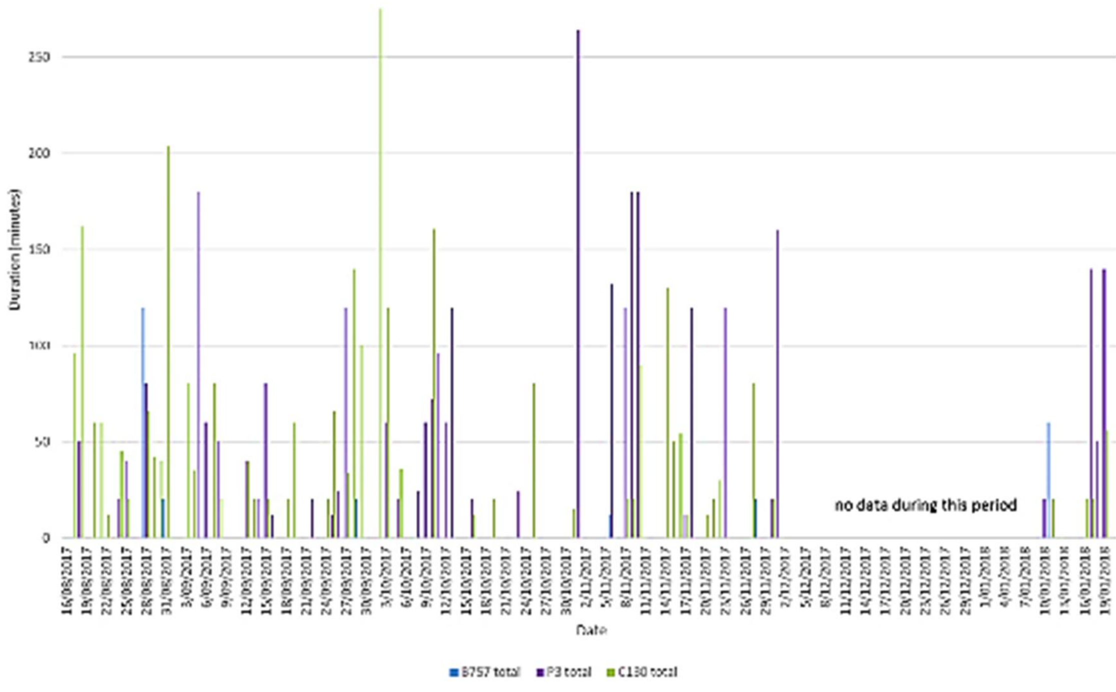

Figure 6.3: Total duration of engine testing per day over period August 2017 to January 2018

Figure 6.3 highlights the variability of engine testing and that for some weeks there is minimal engine testing. This is further emphasised by the breakdown in the ATC records for low-power (Figure 6.4) and high-power (Figure 6.5) testing. There are significant periods of no high-power runs during the assessment period. In some cases a week or more can go by between high-power testing. Therefore a long term appraisal of engine testing is required to establish a representative level of testing rather than simply relying on a two to four week 'snapshot'.

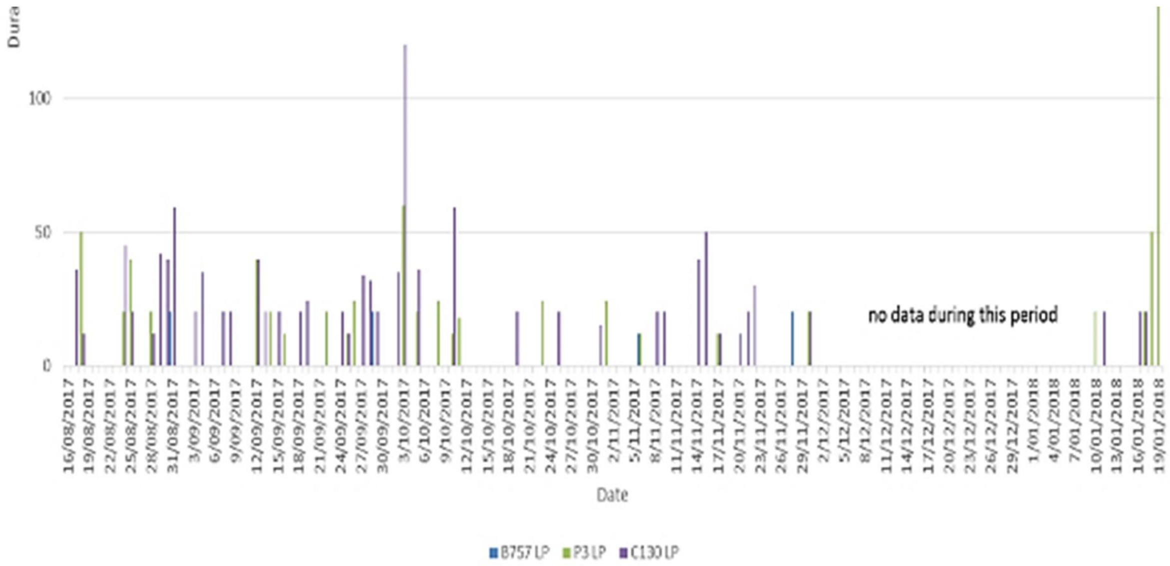

Figure 6.4: Total duration of low-power engine testing per day over period August 2017 to January 2018

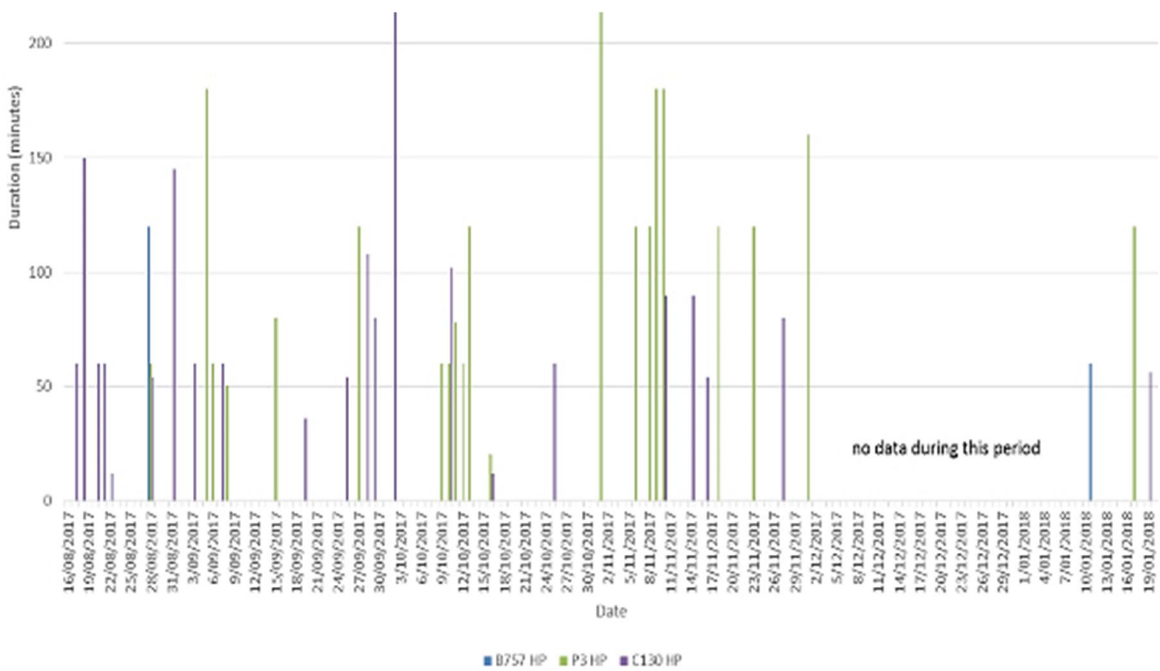

Figure 6.5: Total duration of high-power engine testing per day over period August 2017 to January 2018

The total duration over a rolling 7-day period was calculated, and two 7-day periods were established from the engine testing records which represented a busy period and a noisy period. The busiest week is based on duration only, with no weighting for night-time duration. The noisiest week included the 10 dB night-time penalty and reflects the greatest level of noise.

The busiest 7-day week commenced 27 September 2017 and had three hours of C-130H night-time running logged on 3 October 2017, as well as over 11 hours of C-130H daytime running over the course of the week. In addition, there was some running of B757 and P3 aircraft. The noisiest 7-day week commenced 9 October 2017 and included five hours of P3 running at night over the 7 days.

The noisiest week has been used as the basis for calculating the engine testing contours as this reflects the noisiest period during the 124 days. The resulting contours represent the ‘base case’, or existing environment based on the worst case (noisiest week) for the purposes of establishing land use controls.

6.3 Future engine testing regime

The C-130H is by far the most common aircraft which performs engine testing. At Whenuapai Airbase there are five C-130H aircraft and in June 2020 the Government announced the replacement of the aging 'H' variant with five C-130J Super Hercules in 2024/2025. The C-130J has updated engines and propellers, as well as being able to carry heavier payloads. The overall noise signature when engine testing is similar to the H-version, albeit that the blade passing frequency increases to 102 Hz[11] compared to 68 Hz for the C-130H[12]. This change results in a different noise character for the replacement Hercules. Due to changing circumstances the role of the future Hercules fleet may change resulting from a greater need to support future operations and this should be allowed for when developing noise contours for engine testing that will control the noise that can be generated by the activity in the future.

Similarly, the two B757s are likely to be replaced in the future due to increasing maintenance requirements to keep these aircraft operational. These two aircraft currently provide freight and passenger services. Although the replacement aircraft hasn't been identified, it may be larger in size with different noise characteristics. The maintenance requirements of these replacement aircraft are unknown; however it is reasonable to assume that future aircraft will perform engine testing in a similar manner to the B757 fleet.

As the P-3 will be replaced by the P-8A in 2023, which will be based at Base Ohakea, there will be no further P-3 engine testing once the P-8A has commenced full service. As mentioned previously, additional aircraft, which are not currently within the NZDF fleet, will be needed to supplement the role of the P-8A. This aircraft fleet could be based at Whenuapai Airbase. As the aircraft type and numbers are currently unknown, the noise signature and engine testing records of the P-3 have been incorporated into the future engine testing scenario as a place holder. This includes an element of engine testing at the thresholds of the main runway during daytime hours to potentially accommodate this activity prior to inflight evaluation tests. NZDF has confirmed that inclusion of the P-3 is appropriate given the unknown future situation regarding the additional aircraft.

The H-2 helicopter entry in the data is rotary wing engine testing of the SH-2G. Noise levels from this aircraft will be significantly lower than from other aircraft and will not materially affect overall predicted levels of engine testing noise. Any engine testing of the helicopter is performed on the apron and only low-power is used. This aircraft type has therefore been disregarded in this assessment.

In summary, engine testing noise from C-130H, P-3 and B757 aircraft was assessed for the noisiest period of operations.

To account for future operations and aircraft types, the noisy week engine testing durations have been increased by 20%. This factor equates to an approximate 1 dB increase in engine testing noise levels compared to the existing environment contours, a level of average noise increase which is not discernible. NZDF has confirmed that within this allowance, there is sufficient scope to allow for an

[11] George, E.J. (2001). C-130J Human and equipment vibration environment investigation (AFFTCPRR-01-01). Edwards Air Force Base, CA: Air Force Flight Test Centre.
[12] Cook, R., & Jarvis, G. (2002). Vibration & acoustic assessment of the C-130J-30 and C-130H transport aircraft (NAL Consulting Commissioned Report No. 303). Chatswood, Australia: National Acoustic Laboratories.

increase in future operations. In addition, within this 20%[13], any modelling uncertainty associated with the engine testing records is allowed for, as discussed in Section 6.6.

6.4 Aircraft locations

All aircraft are generally positioned outside the relevant squadron hangars and aprons on the airfield as shown in Figure 5.1. It is only when performing certain types of engine tests that the aircraft will be moved, as noted in the Base Standing Orders. The high-power locations are shown in Figure 5.1.

6.5 Measured sound levels

Measured sound level data has been used for each of the three aircraft in the assessment: the B757, C-130H and P-3. Data for each aircraft type included both octave data (or finer resolution 1/3rd octave data) and polar data. Several engine power scenarios were measured for each aircraft, for example low-power, and different running options for high-power.

6.6 Noise monitoring

Noise monitoring was conducted at Whenuapai Airbase between Wednesday 13 November 2019 and 29 November 2019. Two Ngara noise monitors were installed at the locations shown in Figure 6.6. Location 1 was positioned near to TWY F to record noise from engine testing on the taxiway and Location 2 near to the RWY THR 08 and TWY J for engine testing of B757 aircraft. The equipment was setup to continuously record one second data. The principal aim of the survey was to record the variation of engine testing noise levels. Engine testing records were provided by Whenuapai Airbase as to which aircraft was being tested and the type of test being performed during the survey. The overall noise levels from each monitor also provided information that could be used to validate/calibrate the engine testing noise model.

[13] The Airports Council International indicates a growth rate of 2% per annum for aircraft movements at commercial airports i.e. 40% forecasted growth over a 20-year period (https://aci.aero/data-centre/annual-traffic-data/). While not directly relevant, the 20% adopted for Whenuapai Airbase is considerably lower than this.

Figure 6.6: Noise survey locations (source Google Earth imagery 2019)

Weekly measured noise level data is provided in Figure 6.7 and Figure 6.8. The data shows the normal diurnal variation of the noise environment at each location due to on-Base and off-Base noise (aircraft and general environmental noise sources such as road traffic).

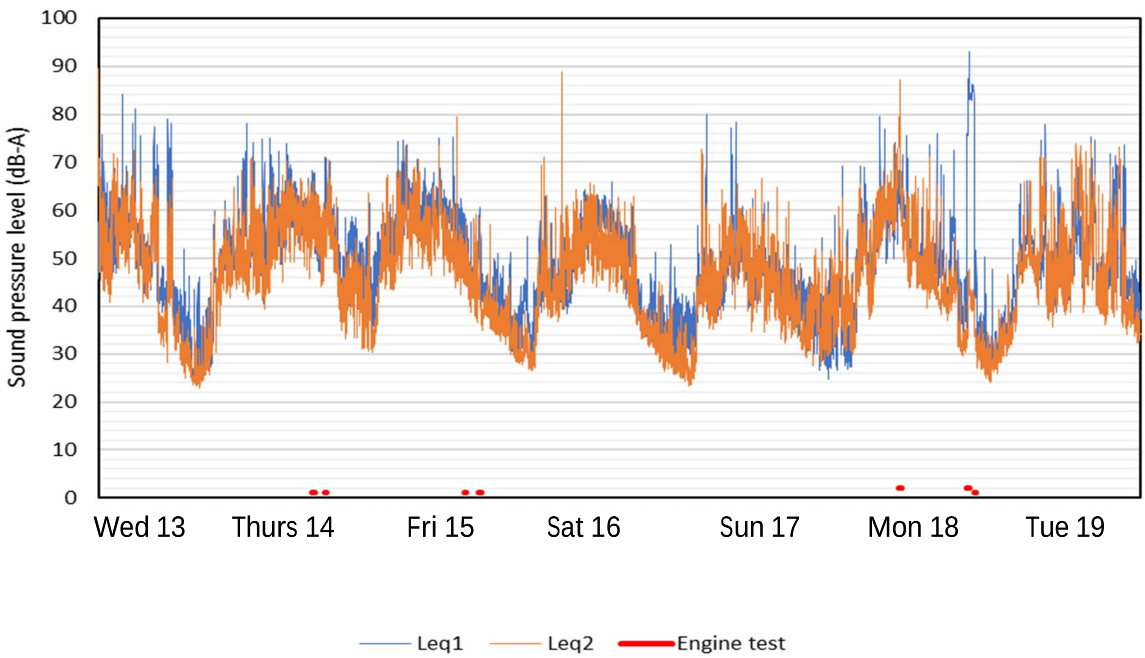

Figure 6.7: Week 1 time history data

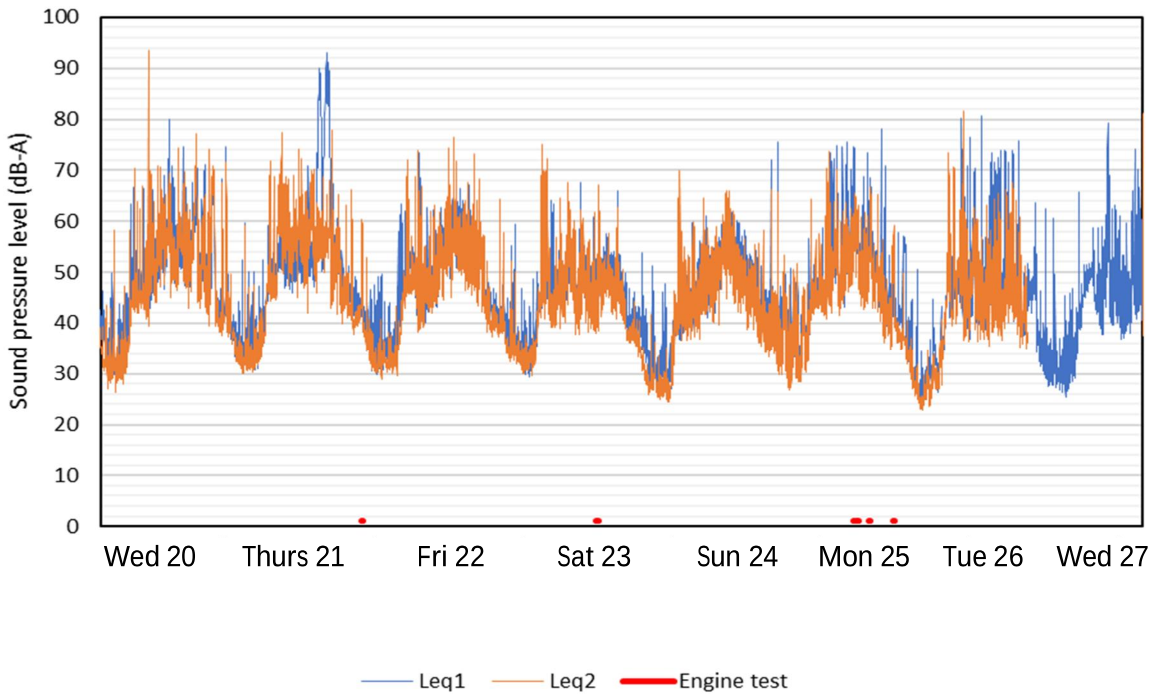

Figure 6.8: Week 2 time history data

Figure 6.9 shows an example of a two hour C-130H test involving running each engine at high-power. The aircraft was positioned on TWY F. A more detailed engine test breakdown is shown in Figure 6.10. In the ATC records high-power engine testing of a C-130H on TWY F was scheduled to be completed in 20 minutes and prior to 2200 hrs. The test shows the engine testing running until approximately 2300 hrs. This example highlights a limitation in the ATC records. While the 7-day period during which the test was conducted was not busy, as the test extended into the night time period the resulting noise impact would have been much greater than if the ATC records alone were relied on. This therefore justifies the addition of a headroom factor which should be applied to the noisy engine testing period to reflect situations such as this example.

Considering the potential for a future change in the engine testing regime (Section 6.3) and any limitation in the ATC records, it is considered that the 20% adjustment discussed previously would allow for any uncertainties in the engine testing contours both now and in the future, i.e. in at least 10 years' time.

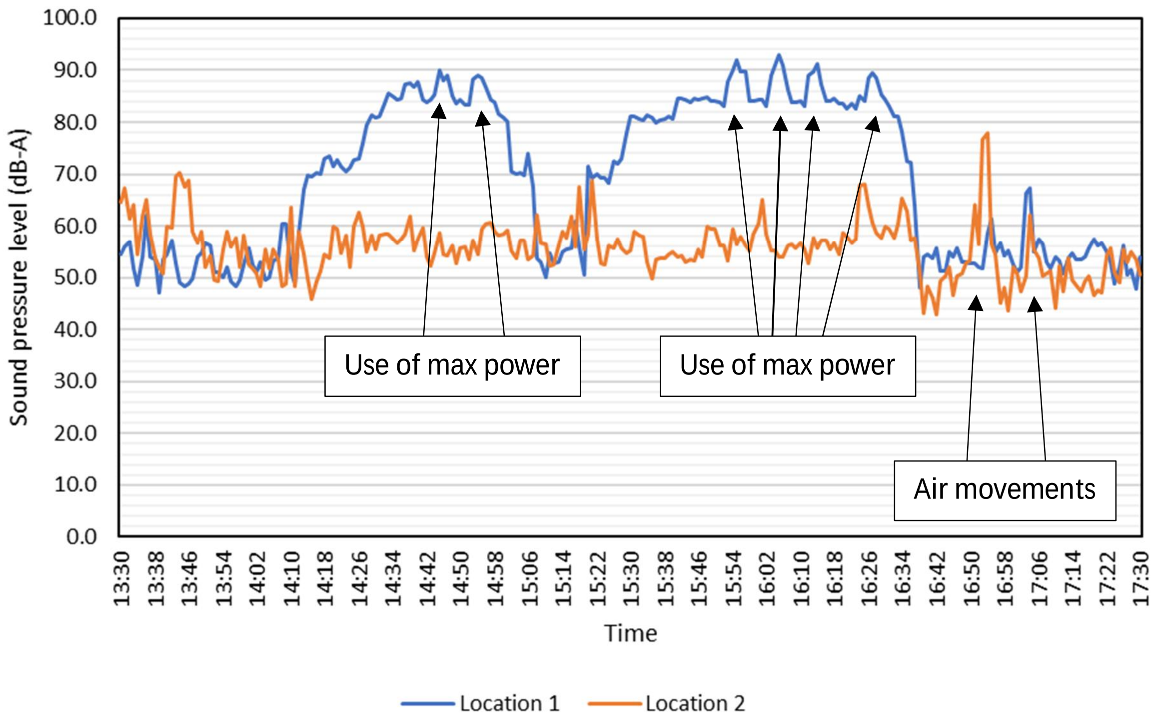

Figure 6.9: Thursday 21 November 2019 C-130H engine test showing a pause during the testing

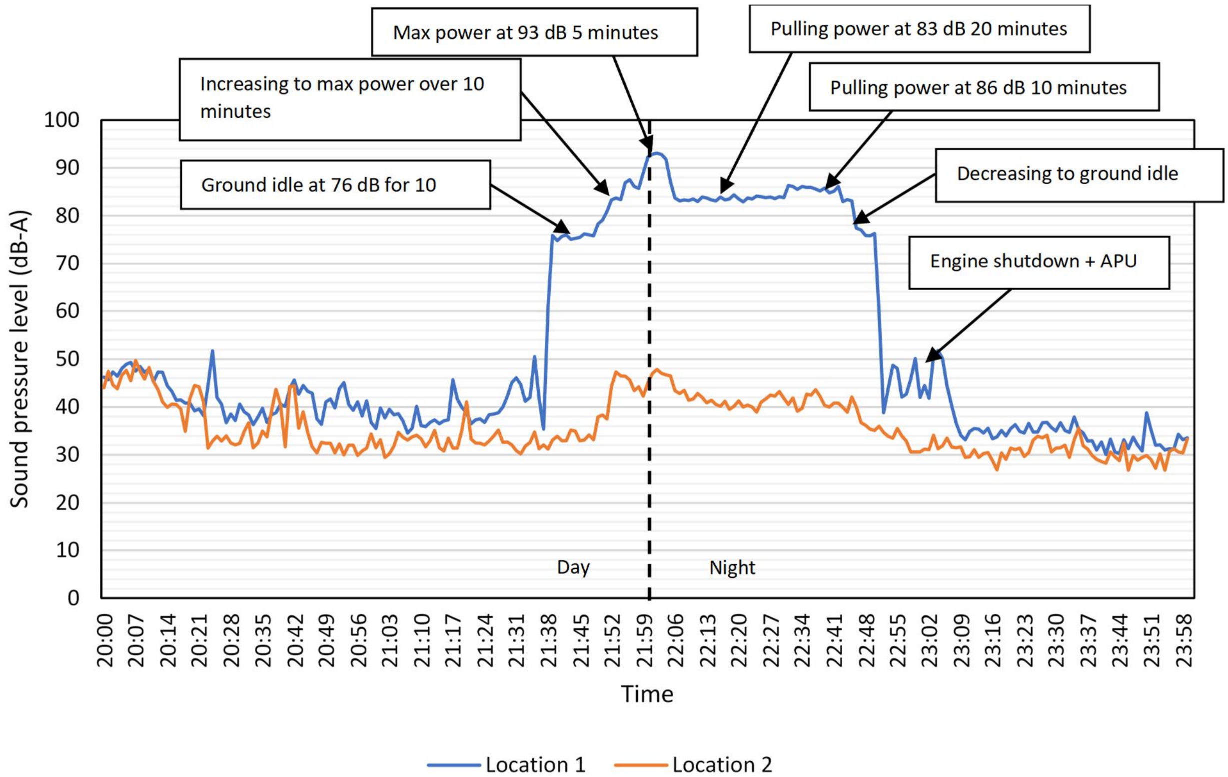

Figure 6.10: C-130H engine test on Monday November 18 2019

6.7 Aircraft orientation

Wind data for Auckland Airport was obtained and the long-term wind rose for the area is shown in Figure 6.11. A much shorter duration dataset for the local area around Whenuapai Airbase was cross referenced to the long-term data and found to be comparable. As the wind direction influences the orientation of the aircraft at Whenuapai Airbase for high-power engine testing, this information will influence the pattern of noise received around the airfield and may result in higher sound levels at locations that are downwind of aircraft more often.

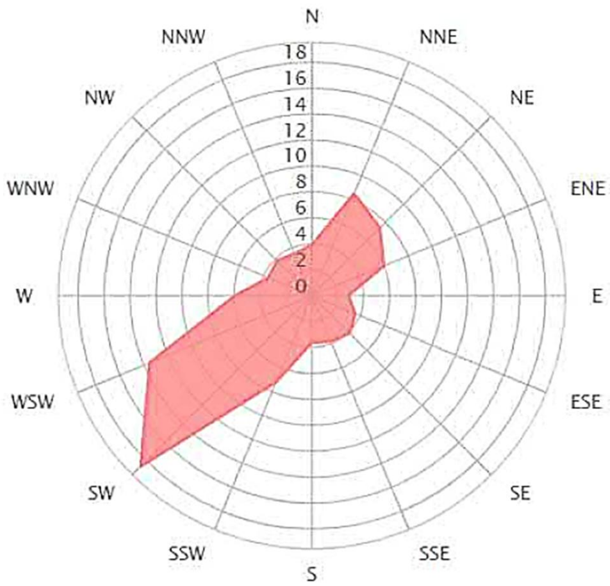

Figure 6.11: Long term wind rose for Auckland Airport (% distribution)

As noted in Section 5.2, the current Aviation Orders prohibit engine testing for certain wind vectors. The wind rose above and the individual aircraft polar plots were combined to create a long-term average directivity pattern for each aircraft type. The source directivities were weighted proportionally according to the wind rose as per the following simplified example. If the wind rose is taken as 75 % from the SW and 25 % from the NE then the directivity for the aircraft would be rotated to 225° (SW) and weighted as 75 %, then rotated to face 45° (NE) and weighted for 25 % of the time. These two weighted directivities would be summed for each direction.

7 SoundPlan noise model

SoundPlan 8.2 software was used to produce the engine testing noise contours using the sound propagation calculations of ISO 9613. ISO 9613:1996 predicts sound levels under moderate downwind conditions and is independent of the source directivity corrections performed in this assessment.

Land Information New Zealand (LINZ) ground contours with a resolution of 1 metre were processed to form a digital elevation model. This terrain data provides a degree of shielding when there is no line of sight between the source of the noise and receiver location. Building footprints were also obtained from LINZ. These were set to have a uniform height of 6 m, with no reflectivity, whereas hangars were set to a height of 12 m.

Ground absorption was set to 1, i.e. soft ground across the site. A penalty of 10 dB was applied to all night-time running. A receiver calculation grid of 4 metres above local ground height was used for the calculations.

7.1 Sound level data

Sound power levels were calculated assuming hemispherical radiation. Each aircraft is treated as a point source which is appropriate given the calculation distance. Directivity was applied to each point source as per the aircraft orientation described in Section 6.7.

Table 7.1: Aircraft source data

Aircraft Type	Sound Power Level L_{WA} / dB		
	Low-power	Intermediate or "pulling" power	High-power
P-3	139	142	147
C-130H	127	136	140
B757	130	142	150

The low-power and high-power data has been taken from the 2018 dataset, and the pulling power taken from an analysis of the noise monitoring and from additional sources of engine performance data[14].

The aircraft noise sources were modelled at the following heights; representative of the mid-point of the engines, following consultation with Whenuapai Airbase personnel:

- B757 at 2.3 m.
- C-130H at 4.1 m.
- P3 at 2.9 m.

7.2 Duration

The following rolling average 7-day durations were used (data represents the time for one single 24-hour period). This data was taken from the noisy week beginning 9 October 2017.

[14] Taken from a number of sources including BADA (Base of Aircraft Data) and technical reports from the USAF and UK RAF.

Table 7.2: Noisy scenario – base case modelled data

Aircraft	Power setting	Location	Daytime duration (min)	Night time duration (min)
B757	Low	15	3	
C130	High	TWY F	15	
	low	Area 11		2
P3	Low	Area 3	2	2
	Low	Area 7	2	
	Low	TWY F		3
	High	TWY F	9	23
	High	TWY J		22
	Low	THR 03	12	
	Low	THR 21	8	
	High	THR 03	6	
	High	THR 21	4	

For high-power testing, the time spent at "pulling power", i.e. between 70-85 % of full power, maximum power was taken as 90 % pulling power and the remainder as maximum take-off power. This breakdown has been derived from discussions with NZDF personnel and November 2019 noise monitoring.

8 Engine testing noise levels

8.1 Engine testing contours

The modelled engine testing noise contours that NZDF are seeking Auckland Council to include in PC5 are presented at Appendix D.

The SoundPlan modelling output has been smoothed to remove any modelling 'irregularities'. Contour smoothing is the preferred method of presenting aircraft noise contours, especially for engine testing which is strongly influenced by terrain and building shielding.

8.2 Absolute sound levels

Table 8.1 provides sound level data for the three aircraft types tested at Whenuapai Airbase, together with estimated sound levels at different distances for each power setting. This distance data is based on the maximum level of noise from the aircraft, i.e. towards the rear of the aircraft. Unlike the engine testing contours, which are based on a 7-day Ldn average, this table provides an indication what the sound level could be during a specific engine test.

Table 8.1: Aircraft sound levels

Aircraft Type	Power setting	Sound power L_{WA} dB	Sound Pressure Level at distance – dB(A)					
			100 m	200 m	300 m	400 m	500 m	600 m
P-3K2	Low	139	90	82	78	75	73	71
P-3K2	High	147	98	90	86	83	81	79
C-130H	Low	127	78	70	66	63	61	59
C-130H	High	140	91	83	79	76	74	72
B757	Low	130	81	73	69	66	64	62
B757	High	150	101	93	89	86	84	82

8.3 Noise effects

Individuals living around Whenuapai Airbase currently hear aircraft. After a period of time based on their experiences, it is likely that they will be able to discern the difference between an aircraft taking off and landing compared to an aircraft performing an engine test[15]. Unlike a commercial airport which has reasonably well defined periods of aircraft activity, the noise generated by NZDF aircraft is more variable. For engine testing, this variability will mean that there are periods (couple of days or more) of no activity to periods of high activity (including night time engine testing) as aircraft are prepared for operations. The future engine testing scenario has used the actual worst case period of engine testing records and applied a 20% allowance to allow for a future situation.

The worst case period used to derive the engine testing contours occurred in a continuous 7-day period from a total of 124 days of recorded engine tests. Although the duration of engine testing during this worst case period has been increased by 20%, engine testing in the future may mean that there is more frequent testing. This may mean 'more of the same' (greater frequency of testing), or that different and potentially noisier aircraft will be introduced in the next 10-20 years. Whichever situation arises, the inclusion of engine testing noise contours in the AUP via PC5 will assist in managing the noise effects of engine testing by introducing land use planning controls.

[15] Unlike the noise generated by air movements on the runway (taking off and landing), engine testing noise can be prolonged – this is demonstrated by the sound level data shown in Figure 6.9.

As engine testing at Whenuapai Airbase is only conducted at specific locations, noise effects are localised around the airfield. As is often the case, the engine testing noise contours extend further from the airnoise contours in the areas between runway ends (see Appendix A). This is due to noise from aircraft taking-off or landing having less overall sound energy (in terms of duration) compared to engine testing noise. Within these areas, noise sensitive land uses can expect engine testing noise to be clearly audible in comparison to ambient noise levels. The noise experienced varies in magnitude and character depending upon the location of the listener. The highest noise levels occur towards the rear of the aircraft and have a more pronounced low frequency component compared to noise generated to the front.

As the engine testing contours (Appendix D) are an average of a 7-day period, event specific sound levels (see Table 8.1) can exceed 70 dB when experienced during a high-power engine test anywhere within the 57 dB Ldn contour. Within the 65 dB Ldn contour sound levels can exceed 75 dB during high power engine tests. As residents experience noise inside and outside their dwellings, an indication of the potential noise effects is provided in Table 8.2.

Table 8.2: Subjective response to environmental noise levels

External sound level (LAeq)	Potential daytime effects outdoors	Corresponding internal sound level (LAeq)	Potential daytime effects indoors[1]
Up to 65 dB	Conversation becomes strained, particularly over longer distances.	Up to 45 dB	Noise levels would be noticeable but unlikely to interfere with residential activities.
65 to 70 dB	People would not want to spend any length of time outside	45 to 50 dB	Concentration would start to be affected. TV and telephone conversations would begin to be affected.
70 to 75 dB	Outdoor users would experience considerable disruption.	50 to 55 dB	Phone conversations would become difficult. Personal conversations would need slightly raised voices. For residential activity, TV and radio sound levels would need to be raised.
75 to 80 dB	Some people may choose hearing protection for long periods of exposure. Conversation would be very difficult, even with raised voices.	55 to 60 dB	People would actively seek respite when exposed for a long duration.
80 to 90 dB	Hearing protection would be required for prolonged exposure (8 hours at 85 dB) to prevent hearing loss.	60 to 70 dB	Untenable for residential environments. Unlikely to be tolerated for any extent of time.

1 - Note: The adjustment factor between the external noise level and the internal noise level is based on a 20-dB reduction as allowed for in NZS 6803:1999 'Acoustics – Construction noise'. 20 dB is considered to be the typical sound reduction achieved in New Zealand buildings with doors and windows closed.

Historically engine testing of aircraft has been undertaken at Whenuapai Airbase for a considerable period of time. For example, the C-130H aircraft of No. 40 Squadron were procured in the mid to late 1960s and the noise generated by C-130H engine testing has been a feature of the local noise environment for over 50 years. Although the frequency of engine testing may have changed over time, which would affect the Ldn, the absolute levels of noise will not have changed.

For some of the closest existing dwellings outside the designation boundary on Rata Road and Kauri Road (approximately 370 m from an engine test), high-power noise levels of approximately 75-80 dBA can be expected for short periods. When outdoors, conversation will be difficult even with raised voices. Noise levels will be similar to being next to a busy road with large trucks driving by. When indoors, TV and radio sound levels would need to be increased and personal conversation would need raised voices even with windows and doors closed. At lower power settings, conversation outdoors would start to be affected if people are standing more than 5 metres apart and noise levels indoors would be noticeable but unlikely to interfere with residential activities.

8.4 Engine testing noise management

There are existing procedures in place at Whenuapai Airbase to manage engine testing noise (see Section 5.3). For example, Base Standing Orders require that any night-time engine testing must have prior approval from the Base Commander and there are certain limitations on when high-power engine testing can be performed on TWY F due to its proximity to dwellings on Rata Road and Kauri Road. From discussions with Base personnel, the Base is also cognisant of the noise effects on the Base community which also includes the noise experienced by Base personnel within offices/workshops and living quarters.

From discussions with Base personnel and having reviewed the existing controls, Whenuapai Airbase manages engine testing noise in a similar manner to other airports according to three considerations:

1. Location – can the engine testing be conducted at a location which minimises the noise experienced at noise sensitive locations? If distance alone does result in a positive outcome, then the number of people affected needs to be considered by limiting the number of people exposed to high levels of noise. Another consideration is that the location of engine testing must maintain safe operation of the taxiways and runway(s), therefore engine testing locations are usually near the outer edges of the airfield away from the runways and active taxiways.
2. Time of day – can the engine testing be carried out in the non-sensitive periods of the day, i.e. 0900-1500 hrs for example. If testing must be carried out in the evening and night, can it be completed as early as practicable?
3. Orientation – For high-power testing aircraft have to be positioned into wind, however can engine testing wait until favourable conditions occur such that the highest noise levels are not in the direction of noise sensitive locations?

All of these considerations indicate that, wherever practicable, Whenuapai Airbase manages engine testing noise to minimise adverse noise effects and that the extents of the engine testing contours are constrained by these noise management and mitigation measures.

9 Conclusions

Engine testing noise contours for Whenuapai Airbase have been developed to be included in Auckland Council's PC5.

The noise from engine testing has been modelled using computer software using data from a 7-day period of considerable low-power and high-power aircraft engine testing. To allow for future changes which could occur, the time spent at each power setting has been increased by a factor of 20%.

Two noise contours have been produced:

- 65 dB Ldn engine testing Inner Control Boundary - within which the amount of aircraft noise exposure is sufficiently high to require appropriate land use controls or other measures to avoid, remedy or mitigate any adverse effects on the environment, including effects on community health and amenity values. These controls typically prevent new noise sensitive development being constructed.
- 57 dB Ldn engine testing Outer Control Boundary – within which there should be sound insulation performance requirements for new or altered buildings to ensure a reasonable level of indoor noise amenity with windows and doors closed.

The extents of the engine testing contours are constrained by noise management and mitigation measures that are implemented at Whenuapai Airbase. The engine testing noise contours are therefore localised around the Base and reflect the locations where engine testing takes place.

It is recommended that the engine testing noise contours included at Appendix D are reflected in PC5.

10 Applicability

This report has been prepared for the exclusive use of our client the New Zealand Defence Force, with respect to the particular brief given to us and it may not be relied upon in other contexts or for any other purpose, or by any person other than our client, without our prior written agreement.

We understand and agree that this report will be used by Auckland Council in undertaking its regulatory functions in connection with PC5.

Tonkin & Taylor Ltd

Report prepared by:	Authorised for Tonkin & Taylor Ltd by:
....	....
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Senior Acoustics Specialist	Project Director

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11 Glossary of Terms

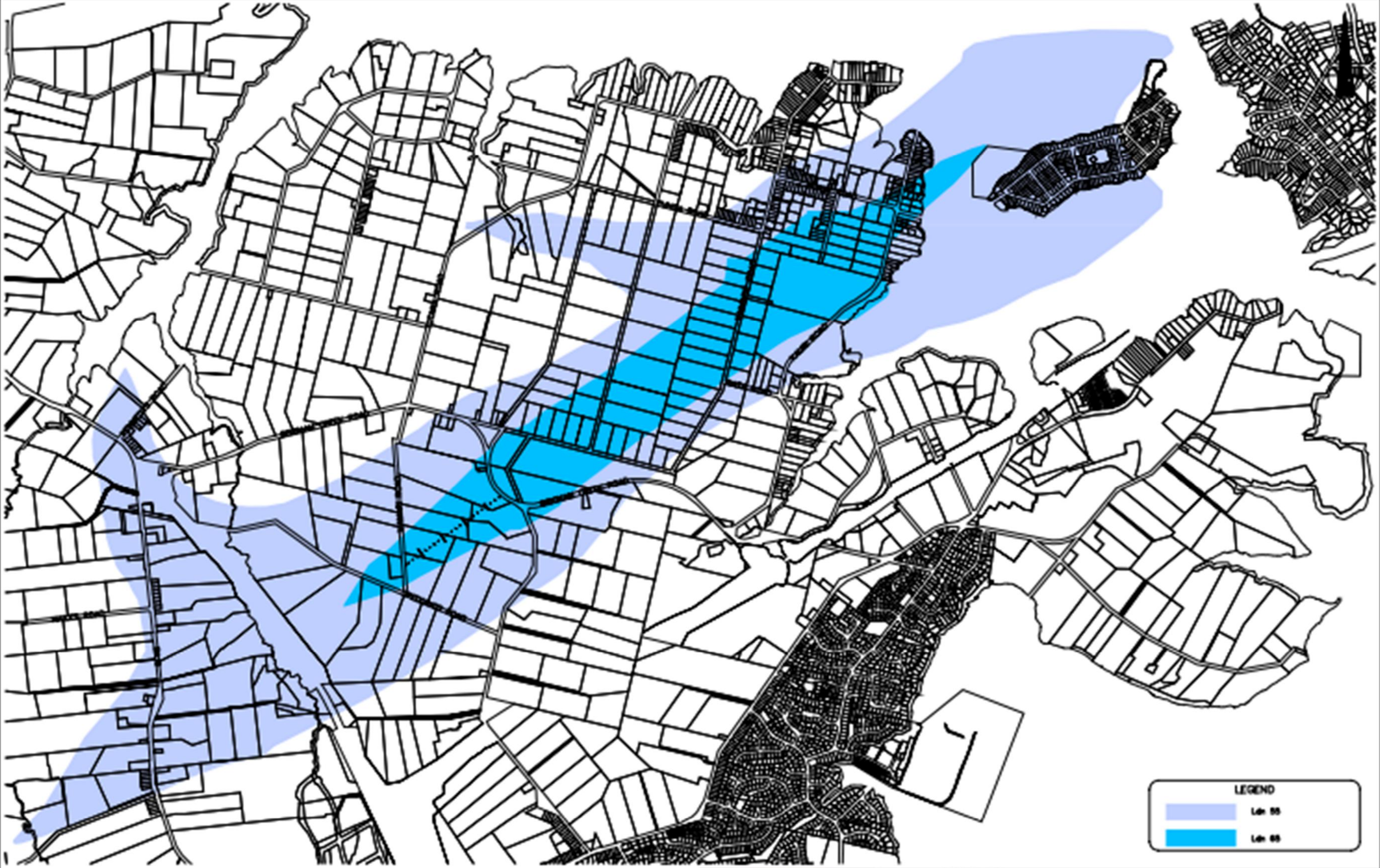
Term	Definition
AIP	Aeronautical information publication - http://www.aip.net.nz/
Airnoise	The noise from aircraft in flight while departing from and arriving at an aerodrome. That includes the noise of the take-off ground roll and use of reverse thrust after landing. It excludes the noise of taxiing and from all other aircraft and non-aircraft sources within the aerodrome boundaries - which together are referred to as ground noise.
Airnoise boundary	Area around an airport within which the current or future daily amount of aircraft noise exposure will be sufficiently high as to require appropriate land use controls or other measures to avoid, remedy or mitigate any adverse effect on the environment, including effects on community health and amenity values whilst recognising the need to operate an airport efficiently.
APU	Auxiliary power unit
ATC	Air traffic control
AUP	Auckland Unitary Plan
CoS	Chief of Staff
Decibel (dB)	A unit of measurement on a logarithmic scale which describes the magnitude of sound pressure with respect to a reference value (20 µPa).
Ground-noise	Sound or noise emanating from an aerodrome from sources other than aircraft taking off and landing. These include aircraft taxiing, maintenance activities, auxiliary power units, surface vehicles and any other sources within the aerodrome boundaries. It excludes the noise from aircraft on the runways and in flight while departing from and arriving at the aerodrome which is referred to as air noise.
Hertz (Hz)	Unit of frequency – the number cycles per second of a wave form.
$L_{Aeq(t)}$	The A-weighted time-average sound level over a period of time (t), measured in units of decibels (dB).
L_{Amax}	The maximum A-weighted sound pressure level over a period of time or of a particular noise event, measured in units of decibels (dB).
Ldn	The A-weighted time weighted average sound level over a period of 24 hours after the addition of 10 decibels to sound levels measured during the night (2200-0700).
$L_{Aeq,t}$	The A-weighted time weighted average sound level over a period of time, t.
L_w / SWL	Sound power level of a source, measured in decibels (dB).
MRO	Maintenance repair and overall.
RWY	Runway
SEL / L_{Ae}	Sound exposure level – the A-weighted sound pressure level which is maintained constant for a period of one second would contain the same sound energy of a given noise event.
THR	Threshold of runway
TWY	Taxiway
Noise	Unwanted sound
Noise contour	A line of constant value of cumulative aircraft noise level or index around an airport.
Outer control boundary	An area outside the airnoise boundary within which there shall be no new incompatible land uses

Every 10 dB increase in sound level doubles the perceived noise level. A sound of 70 dB is twice as loud as a sound level of 60 dB and a sound level of 80 dB is four times louder than a sound level of 60 dB. An increase or decrease in sound level of 3 dB or more is perceptible. A change in sound level of less than 3 dB is not usually discernible, with a 1 dB change not being perceptible.

As sound levels are measured on a logarithmic scale, the following chart provides examples of typical sources of noise.

Decibel (dB)	Example
0	Hearing threshold
20	Still night-time
30	Library
40	Typical office room with no talking
50	Heat pump running in living room
60	Conversational speech
70	10 m from edge of busy urban road
80	10 m from large diesel truck
90	Lawn mower - petrol
100	Riding a motorcycle at 80 kph
110	Rock band at a concert
120	Emergency vehicle siren
140	Threshold of permanent hearing damage

Appendix A: Condition 1 of Designation 4130 – noise contours



SCALE 1:20,000
0 200 400 600 800 1000(m)

ORIGINAL IN COLOUR

Property boundaries sourced from Land Information New Zealand data as at 7-Feb-2012 (Crown Copyright Reserved).

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NEW ZEALAND DEFENCE FORCE
NOISE CONTROL AREA
NZDF WHENUAPAI
Site Plan

Figure 9A-2

0

Appendix B: AUP aircraft noise overlay Whenuapai Airbase

Source - https://unitaryplanmaps.aucklandcouncil.govt.nz/upviewer/

Appendix C: Community response to aircraft noise

C1 Factors in community response to noise

Community response to noise is affected by a wide range of factors, both physical and psychological. The physical factors are easier to quantify and include (for aircraft noise) the number of flights, the duration, and the frequency of events. The measurable noise level will affect the response, as well as the time of day or night that flights occur. The difference in noise level between the event and the general level of background noise is also important.

Psychological factors are a lot more subjective, and therefore much harder to quantify. These include people's perception of the noise source, and whether they think it is reasonable, as well as their general sensitivity to noise. This may depend on tasks being undertaken and time of day amongst other factors.

C2 Types of response to noise

Psychological or behavioural responses to noise start with disturbance: distraction from tasks, sleep disturbance and speech interference. At a higher level of noise this will lead to annoyance, and action such as making complaints.

Physical or physiological responses to noise range from health effects such as stress to noise induced hearing loss.

C3 Community response to noise

A community's response to noise will vary widely with different people's sensitivities and perceptions. There is no simple indicator of how a certain level of noise will be perceived by a community.

Schultz (1978) compared the percentage of survey respondents who were 'highly annoyed' with the day-night noise level for different modes of transport noise, including aircraft noise, and produced a dose-response curve, commonly known as the Schultz curve (shown below). This demonstrates that community annoyance levels can be correlated with the long-term noise exposure of that community. For aircraft noise the dose-response relationship occurs at lower sound levels, i.e. people are generally more annoyed by aircraft than other sources of environmental noise.

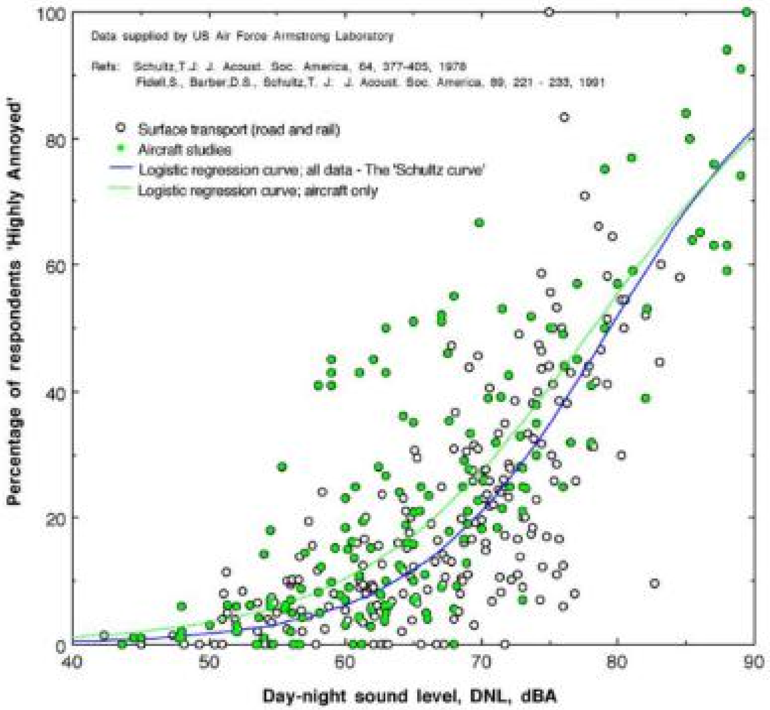
An extensive survey was undertaken by the CAA in 1980 of people living in close proximity to airports around the UK (CAA, 1985). The results of the Aircraft Noise Index Study (ANIS) were subsequently compared to the Schultz curve and showed the same general trends.

An Ldn of 65 dB corresponds to 20% of the community being highly annoyed from the Schultz curve, and this value is taken as the threshold of significant noise exposure, above which noise levels are not acceptable for residential activity. At approximately Ldn 55-57 dB adverse annoyance begins for the community as a whole.

Since Schultz there have been other studies – Kryter (1982 & 1983); Fidell et al. (1991); Miedema and Vos (1998); Miedema and Oudshoorn (2001), which have undertaken further work and reported meta-analyses of community noise studies.

The Miedema and Oudshoorn (2001) study analysed the dose response data from multiple studies and established a polynomial approximation between Ldn and annoyance for aircraft:

%HA : $-1.395\text{x}10^{-4}\,(\text{Ldn}-42)^3 + 4.081\text{X}10^{-2}\,(\text{Ldn}-42)^2 + 0.342(\text{Ldn}-42)$



CAA (1985), DR Report 8402 - United Kingdom Aircraft Noise Index Study: Main Report

Fidell, S., Barber, D. S., and Schultz, Th. J (1991). Updating as dosage-effect relationship for the prevalence of annoyance due to general transportation noise, J. Acoust.Soc.Am. 90, pp 221-233.

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Appendix D: Engine testing noise contours

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C:\Users\cobe\Documents\whenuapai\Whenuapai\Whenuapai.aprx   Layout: T+T A3 Landscape Map Template4   2021-Jan-29 16:14   Drawn by COBE

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REV	DESCRIPTION	GIS	CHK	DATE
0	First version	COBE	DAHU	4/03/21

LOCATION PLAN

PROJECT No.	1009485	
DESIGNED	COBE	MAR.21
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CHECKED		
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CLIENT NEW ZEALAND DEFENCE FORCE

PROJECT NZAF WHENUAPAI ENGINE TESTING CONTOURS

TITLE NZDF WHENUAPAI AIRBASE - ENGINE TESTING CONTOURS - PC5

SCALE (A3) 1:25,000   FIG No. FIGURE D.   REV 0

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REV	DESCRIPTION	GIS	CHK	DATE
0	First version	COBE	DAHU	29/01/21

LOCATION PLAN

PROJECT No.	1009465	
DESIGNED	COBE	JAN.21
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CHECKED		
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CLIENT NEW ZEALAND DEFENCE FORCE
PROJECT NZAF WHENUAPAI ENGINE TESTING CONTOURS
TITLE NZDF WHENUAPAI AIRBASE - ENGINE TESTING CONTOURS - PC5
SCALE (A3) 1:24,711   FIG No. FIGURE 1.   REV 0