# Exuma International Airport, Commonwealth of the Bahamas

# Noise Management Study - Final Report



**Prepared For:**

Stantec

Stantec Consulting International Ltd.
Winnipeg, Canada

**Prepared By:**

Aviotec International Inc.
Toronto, Canada

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# Noise Management Study – Exuma International Airport (MYEF), The Bahamas

**DRAFT REPORT**

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Prepared For:

Stantec

Stantec Consulting International Ltd.
500 - 311 Portage Avenue
Winnipeg, Manitoba, Canada
R3B 2B9

Prepared By:

Aviotec

Aviotec International Inc.
5925 Airport Road, Suite 200
Mississauga, Ontario, Canada
L4V 1W1

# Document History

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# 1 Introduction and Context

## 1.1 Report Objective

The purpose of this report is to document the findings and conclusions of a Noise Management Study for Exuma International Airport (MYEF), which included the modelling of the current and future predicted exposure of surrounding land uses to noise generated from aircraft operations, and the preparation of corresponding noise exposure maps.

As well, this report serves to recommend a noise modelling methodology, a set of land use guidelines for use at and surrounding public use aerodromes, and management and control strategies for mitigating noise exposure and their impacts, which the Commonwealth of the Bahamas should adopt.

This component report forms a part of the overall Master Plan for MYEF which is being prepared by Stantec Consulting International Ltd. (herein referred to as Stantec).

## 1.2 Instructions

Aviotec International Inc. (herein referred to as Aviotec) has been commissionned by and taken instructions from Stantec to conduct the Noise Management Study for MYEF and to prepare the accompanying report.

## 1.3 Statement of Assumptions and Limiting Conditions

This report is subject to the following assumptions and limiting conditions:

- The content, analyses, and opinions set forth in this report are the sole product of Aviotec.
- Stantec is the party who have engaged Aviotec in the specific assignment. Any other party receiving a copy of this report from any source does not, as a consequence, become a party to the consultant-client relationship.
- The analysis, opinions, and conclusions are limited only by the report assumptions and the limiting conditions contained herein, and are the unbiased professional analyses, opinions and conclusions of Aviotec.
- Aviotec has relied upon the accuracy and completeness of the documentation and information supplied by Stantec and the Bahamas Civil Aviation Department, as well as the airport site visit of February 18-19, 2015.
- The condition of the aerodrome and the surrounding land uses are deemed to be that which existed at the time of the site visit.
- The extent of analysis and recommendations were limited by the lack of suitable air traffic movement data for MYEF, and the lack of land use and property plans for the airport and surrounding communities.

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# 2 Background and Context

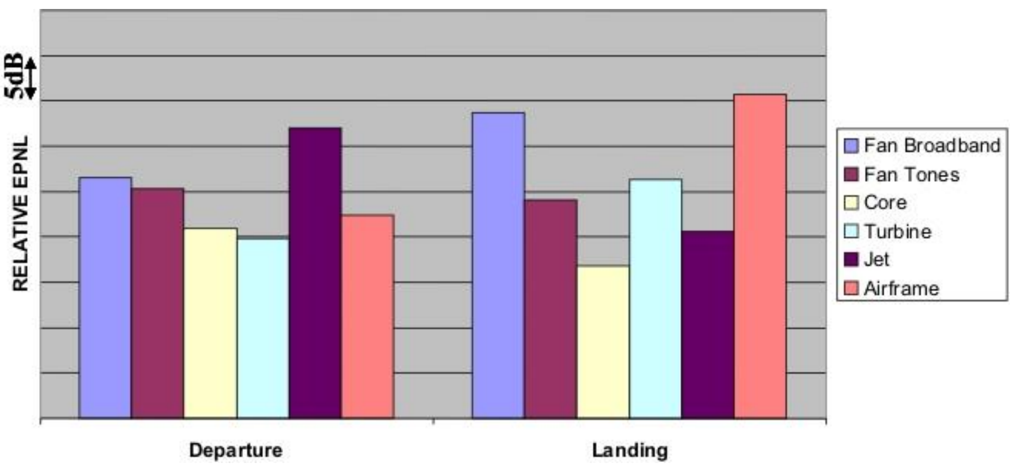
## 2.1 Noise Basics

### 2.1.1 Noise Definition

Noise is defined by the World Health Organization (WHO) as unwanted sound. In other words, noise is sound that disturbs routine activities or quiet, and/or causes feelings of annoyance. Whether sound is interpreted as pleasant (e.g., music), or unpleasant (e.g., jackhammer) depends largely on the listener's current activity, past experience, and attitude toward the source.

In the context of aircraft, noise is generated from the operation of aircraft during various phases of flight. Exhibit 2-1 presents the relative weighting of engine and airframe component sound levels generated during the take-off and landing phases.

Exhibit 2-1 – Sound Levels for Aircraft Component Noise Sources




Source: Aviotec International Inc. adapted from Airbus - Getting to Grips with Aircraft Noise (2003).

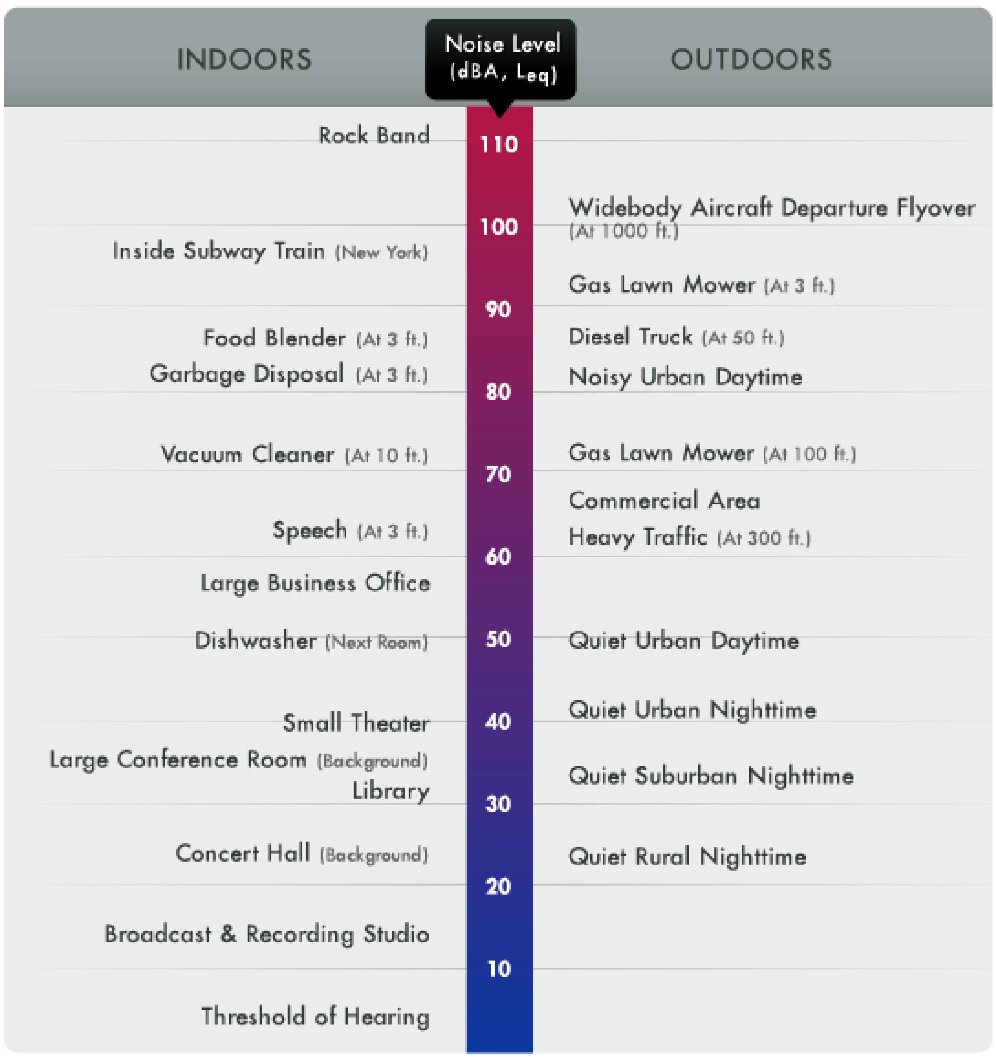
### 2.1.2 Perceiving Noise

Sound is transmitted by alternating compression and decompression in air pressure. These relatively small changes in atmospheric pressure are called sound waves. The measurement and human perception of sound involves two physical characteristics—intensity and frequency. Intensity is a measure of the strength or magnitude of the sound vibrations, and is expressed in terms of the Sound Pressure Level (SPL). The higher the SPL, the more intense is the perception of that sound. The other characteristic is sound frequency or "pitch"—the speed of vibration. Frequencies are expressed in terms of cycles per second or hertz (Hz). Low frequency sounds might be characterized as a rumble or roar, while high frequency sounds are typified by sirens or screeches. Noise analysis accounts for both of these characteristics in the units used to measure sound.

### 2.1.3 Decibel Metric

The human ear is sensitive to an extremely wide range of sound intensity, which covers a relative scale of 1 to 100,000,000. Representation of sound intensity using a linear index becomes difficult because of this wide range. As a result, the decibel metric - a logarithmic measure of the magnitude of sound - is typically used. Sound intensity is measured in terms of sound levels ranging from 0 dB, which is approximately the threshold of hearing, to 140 dB, which is the threshold of pain. Exhibit 2-2 illustrates the sound pressure levels of typical events or activities.

Exhibit 2-2 – Typical Sound Level Events in Decibels

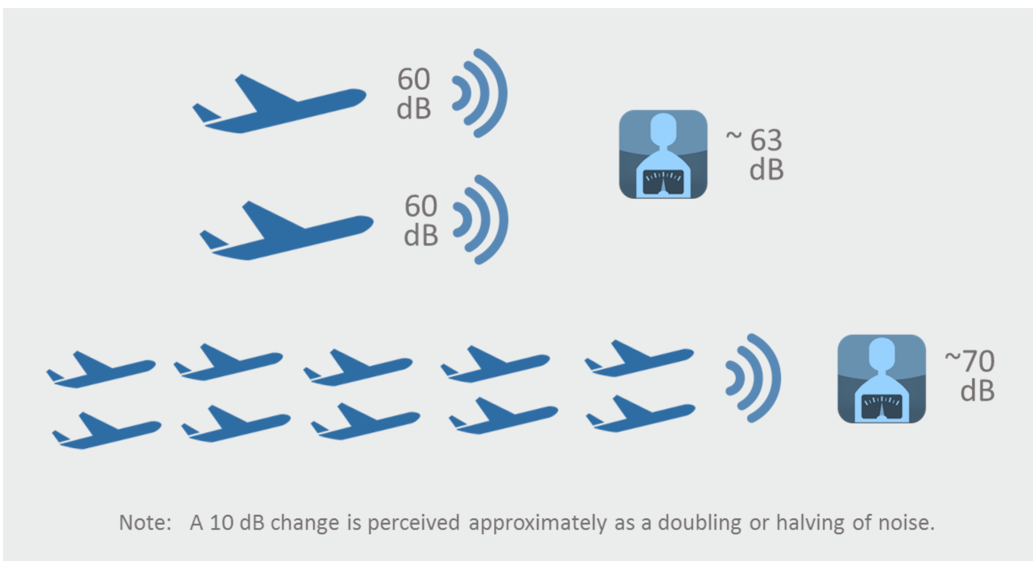



Source: Aviotec International Inc.

Because of the logarithmic unit of measurement, decibels cannot be added or subtracted linearly as graphically illustrated in Exhibit 2-3. The following examples describe how changes in sound levels are perceived by the typical person.

- If two sounds of the same level are added, the sound level increases by approximately 3 dB. For example: 60 dB + 60 dB = 63 dB.
- The sum of two sounds of a different level is only slightly higher than the louder level. For example: 60 dB + 70 dB = 70.4 dB.
- Sound from a "point source," such as an aircraft, decreases approximately 6 dB for each doubling of distance.
- Although the human ear can detect a sound as faint as 1 dB, the typical person does not perceive changes of less than approximately 3 dB.
- A 10 dB change in sound level is perceived by the average person as a doubling, or halving, of the sound's loudness.

Exhibit 2-3 – Additive Nature of Noise Decibels

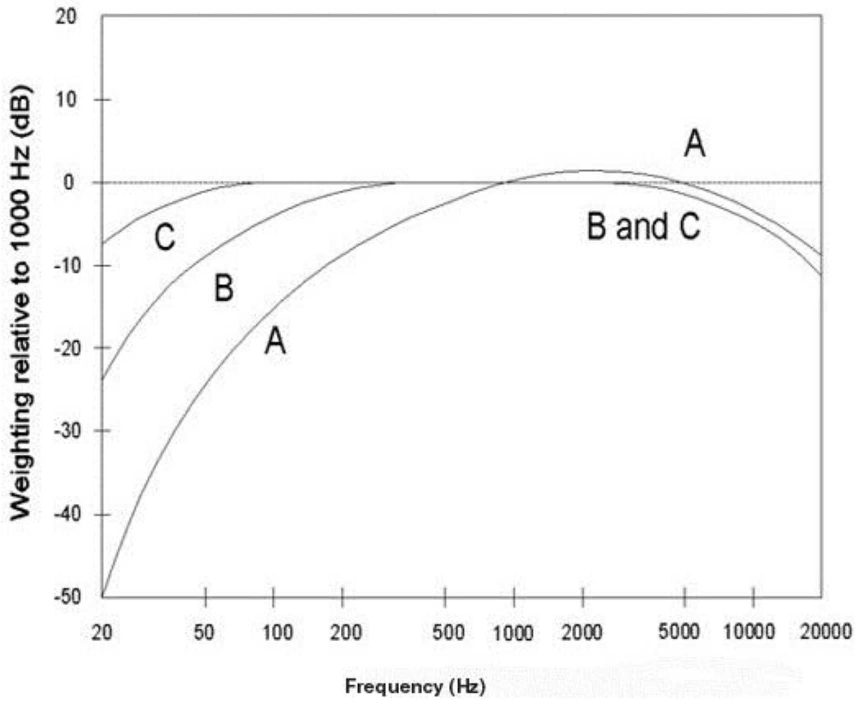



Source: Aviotec International Inc.

### 2.1.4 A-Weighted Metric

Humans are most sensitive to frequencies near the normal range of speech communications. "A-weighting" reflects this sensitivity by emphasizing midrange frequencies and deemphasizing high and low frequencies (refer to Exhibit 2-4 om the following page). Since the A-weighted decibel (dBA) provides a better prediction of human reaction to environmental noise than the unweighted decibel, it is the metric most frequently used in noise compatibility planning.

Exhibit 2-4 – Comparison of A-Weighted & C-Weighted Decibel Metric




Source: U.S. National Air and Space Administration (NASA).

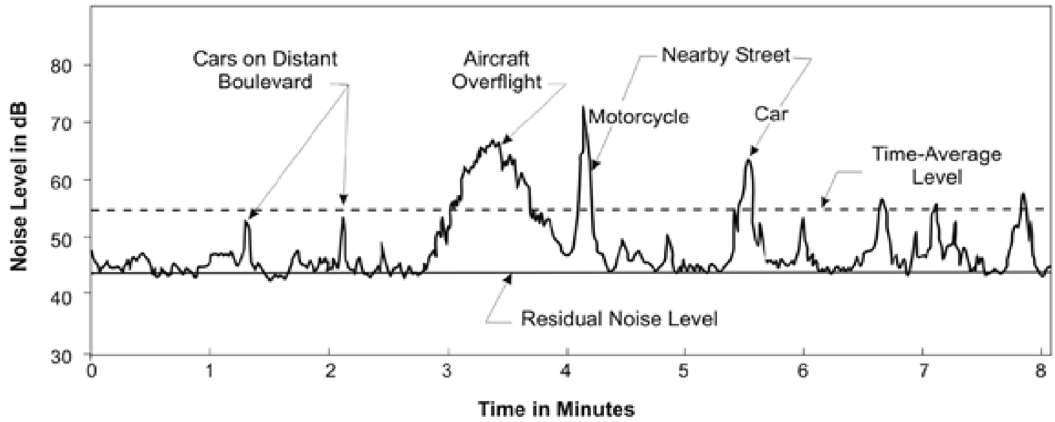
### 2.1.5 C-Weighted Metric

Another metric that is sometimes used in the assessment of aircraft noise is the C-weighted decibel. As illustrated in Exhibit 2-4, the C-weighting is nearly flat throughout the audible frequency range with limited de-emphasis of the low frequency components of the total noise event. C-weighting may occasionally be preferable in evaluating sounds whose lower frequency components are responsible for secondary effects such as rattling windows or perceptible vibration. For aircraft activity, the C-weighted metric has been used to assess the effects of low frequency noise generated during take-off or when reverse thrust is applied during landing.

### 2.1.6 Sound Exposure Level (SEL)

The measurement of sound is not a simple task. Consider typical sounds in a suburban neighbourhood on a normal or "quiet" afternoon. If a short time in the history of those sounds is plotted on a graph, it would look very much like Exhibit 2-5 (on the following page). The background, or residual sound level in the absence of any identifiable noise sources, is approximately 43 dB. About three-quarters of the time, the sound level is 55 dB or less. The highest sound level, caused by a nearby motorcycle, is approximately 72 dB, while an overflying aircraft generates a maximum sound level of about 68 dB.

Exhibit 2-5 – Sound Levels for Aircraft Component Noise Sources




Source: Sacramento County Airport System - "Noise 101" (http://www.sacramento.aero/scas/environment/noise/noise_101).

The aircraft in this example is not as loud as the motorcycle, but the aircraft sound lasts longer. For most people, the aircraft would be more annoying than the motorcycle event. Thus, the maximum sound level alone is not sufficient to predict human reaction to environmental noise.

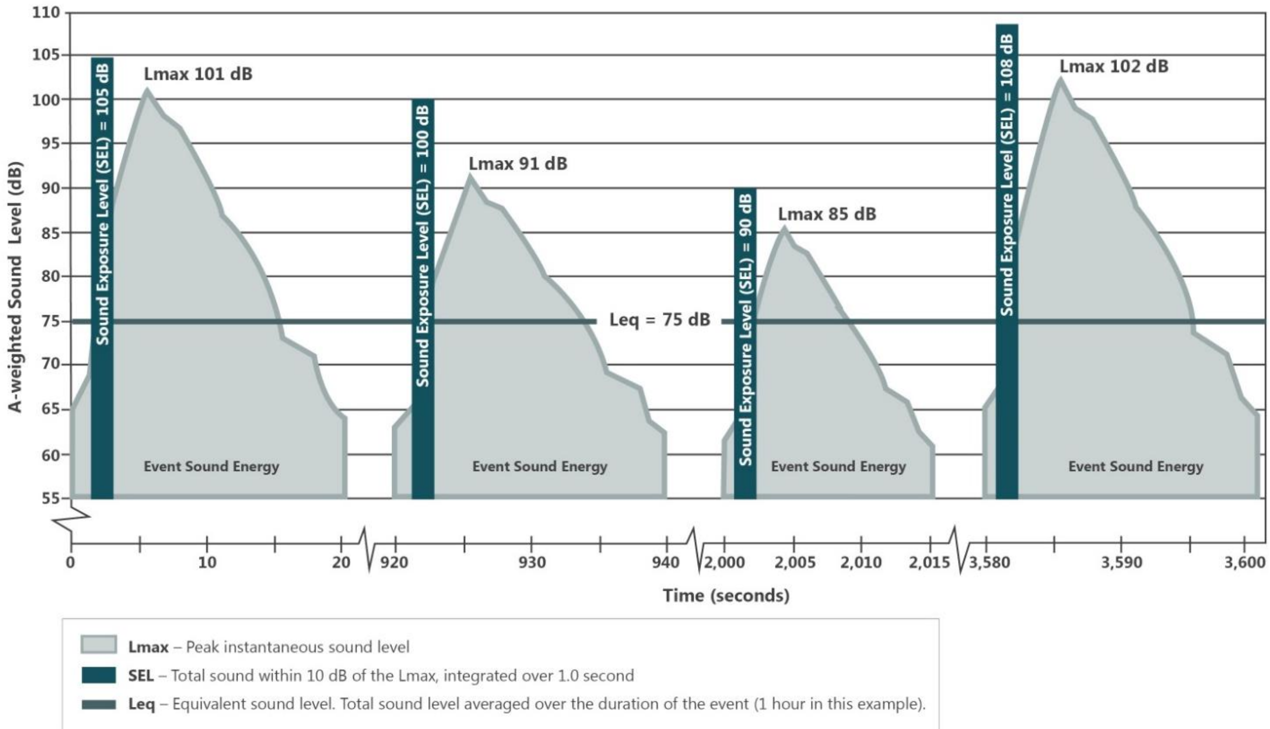
Clearly, the longer a noise lasts the more it disrupts activity and the more annoying it is likely to be. Laboratory tests show that the acceptability of noise decreases at a rate of roughly 3 dB per doubling of duration. In other words, two sounds would be judged equally acceptable if one had an intensity of 3 dB more than the other, but half the duration of the other. Accordingly, a second manner of describing noise is to measure the Sound Exposure Level (SEL), which is the total sound energy of a single sound event. By accounting for both intensity and duration, the SEL allows us to compare the "annoyance" of different events.

One way to understand SEL is to think of it as the sound level you would experience if all of the sound energy of a sound event occurred in one second. This normalization to a duration of one second allows the direct comparison of sounds of different duration. In the example in Exhibit 2-6 (on the following page), if four aircraft overflights occurred during an hour period, the total sound energy of the individual events (SEL) might range from 90 dB to 108 dB.

### 2.1.7 Equivalent Sound Level

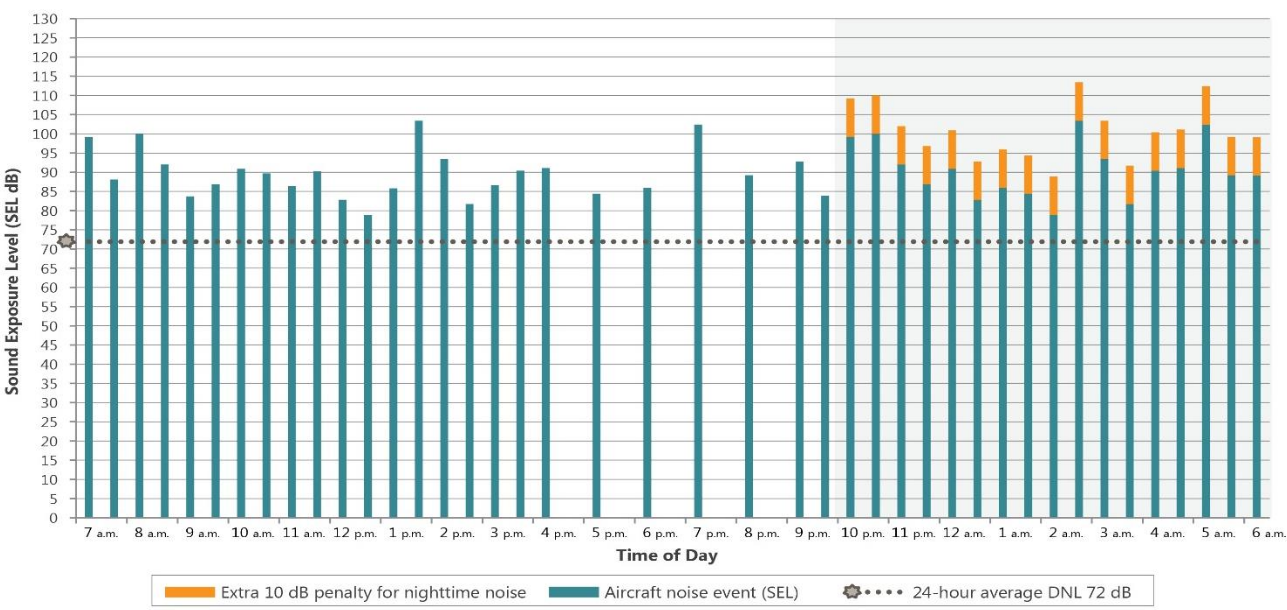
The maximum sound level and SEL are used to measure individual events. But the number of events can also be an important consideration in estimating the effect of noise. One way to describe this factor might be to count the number of events exceeding SEL 95 dBA, plus the number that exceed SEL 85 dBA, plus the number that exceed SEL 80 dBA, etc. A more efficient way to describe both the number of such events, and the sound exposure level of each is the time-average of the total sound energy over a specified period, referred to as the Equivalent Sound Level ($L_{eq}$). Research has substantiated that community reaction to noise corresponds well to the total acoustic energy that is represented by the $L_{eq}$. In the example shown on Exhibit 2-6, the cumulative sound level during the hour or $L_{eq}$ is roughly 75 dBA.

Exhibit 2-6 – Sound Exposure Level (SEL) Noise Descriptor




Source: Shreveport Regional Airport.

Exhibit 2-7 – Day-Night Average Sound Level




Source: Shreveport Regional Airport.

### 2.1.8 Day-Night Average Sound Level

One additional factor, which is important in measuring a sound/sound events, is the occurrence of sounds during nighttime hours. People are normally more sensitive to intrusive sound events at night, and the background sound levels are normally lower at night because of decreased human activity. Therefore, noise events during the nighttime hours are likely to be more annoying than noise events at other times. For this reason, a penalty is typically applied to nighttime aircraft operations in recognition of the increased annoyance that is generally associated with noise during the late night and early morning.

For example, Transport Canada's methodology for producing NEF's in Canada requires that a 12.2 dB penalty (the highest in common use) be applied to all nighttime aircraft/helicopter operations which equates to a factoring of nighttime movements by 16.7 times. In the U.S., the FAA require that a 10 dB nighttime penalty be applied. This 10 dB penalty means that one nighttime sound event is equivalent to 10 daytime events of the same level.

In the example in Exhibit 2-7 (on the previous page), 42 aircraft noise events occur during the 24 hour period – 25 in daytime and 17 in nighttime hours. The noise levels of the events range from 78 dB to 103 dB. An extra 10 dB penalty is applied to the nighttime events to reflect the increased sensitivity that people have to nighttime noise. This results in total noise levels as high as 113 dB.

### 2.1.9 Natural Factors Affecting Noise

Noise is essentially a sound wave propagating through the air and distributed in equal directions away from the source. As it travels away from the source, sound energy is dispersed but is also absorbed.

Sound levels decrease primarily as a function of:

- Distance from source;
- Atmospheric absorption; and
- Ground attenuation.

Generally, noise levels decrease as the distance increases between the source and the receiver. However, the direction in which the sound waves travel can be altered by natural factors, which may result in varying noise levels at the same location at different times.

Overall, atmospheric conditions play a significant role in affecting sound levels and how these sounds are perceived by the public. The atmosphere can absorb sound depending on the temperature of the air and humidity levels. Less sound will be absorbed by the atmosphere on days with high humidity and high temperatures.

For example, during thunderstorms, cloud cover tends to bend or reflect sound waves downward toward the ground and that can increase the sound heard by a receiver. Inversions, which occur when the air temperature increases as altitude increases, have the same effect on noise as does cloud cover. These types of weather conditions slow the atmospheric absorption of sound waves and may cause aircraft noise to sound louder.

Wind is another factor that generally causes sound waves to bend in the direction it flows. In the

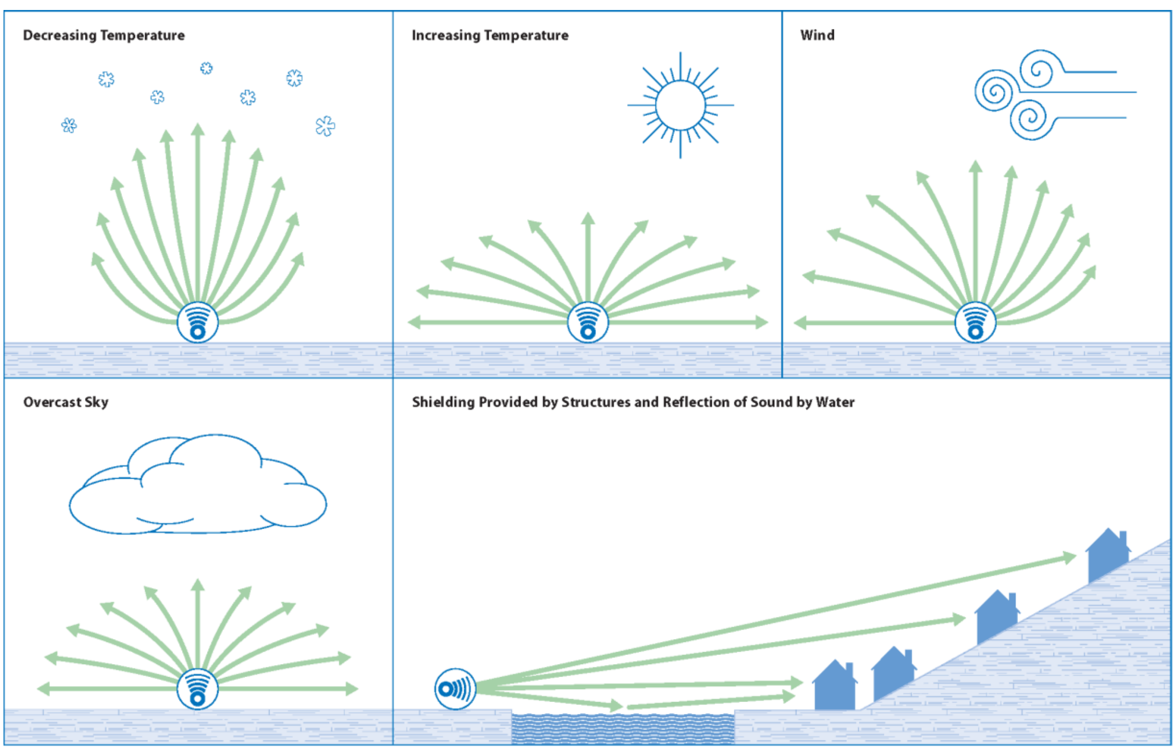
Family Islands, winds are generally from the northeast or southwest and planes takeoff and land into the direction of the wind. When this occurs, residents on either side of the flight path may hear changes in noise levels.

Ground absorption is also an important factor in the study of noise exposure. The closer the source of the noise is to the ground, the more the sound will be attenuated by the ground. Soft surfaces, such as vegetation, absorb more sound than hard surfaces like water or pavement.

In the Family Islands, the effect of sound travelling across a water surface is an important consideration, and is affected by two factors: refraction and reflection. Refraction causes sound waves to bend when they strike a material in which it would normally travel slower. Since water temperatures are usually cooler than air temperatures, the air just above the water level is cooled by the water. The temperature varies according to the distance from the surface of the water. This gradient of speeds results in a lens effect due to refraction of sound, which tends to focus and thus increase its apparent loudness. In addition, water acts as a hard acoustical surface that enhances the reflection of the sound resulting in increased annoyance compared to a situation where sound would be absorbed by a soft ground surface such as a grass. If the water is smooth or calm, the sound waves skim the surface of the water and are reflected toward the observer, adding to the amplification. However, if the water is choppy, the sound is randomly reflected and makes no contribution to the amplitude of the sound.

Exhibit 2-8 graphically illustrates the effect of various natural forces on sound levels.

Exhibit 2-8 – Natural Factors Affecting Sound




Source: Oakland International Airport Master Plan Update (March 2006).

## 2.2 Quantifying Noise Exposure and Their Impacts

It has been well established that noise has a significant effect on the quality of a person's life. An individual's reaction to a particular noise depends on many factors such as the source of the noise, its loudness relative to the background noise level, and the time of day. The reaction to noise can also be highly subjective; the perceived effect of a particular noise can vary widely among individuals in a community. Although the reaction to noise may vary, it is clear that noise is a significant component of the environment, and excessively noisy conditions can affect an individual's health and well-being.

The effects of noise are often only transitory, but adverse effects can be cumulative with prolonged or repeated exposure. The effects of noise on a community can be organized into six broad categories: noise-induced hearing loss; interference with communication; effects on sleep; effects on performance and behavior; extra-auditory health effects; and annoyance.

The degree of annoyance that people experience from the exposure to aircraft noise varies, depending on the specific location and their activities at any given time. People are usually less disturbed by aircraft noise when they are shopping, working, or driving than when they are at home. Interestingly, transient hotel customers near an airport seldom express as much concern with aircraft noise as do permanent residents of the same area. Therefore, it is no easy task to quantify noise exposure and their impacts.

Noise exposure can be quantified by using field measurements or by modeling in order to understand how individuals perceive noise in different locations, under different conditions and during different times of the day.

Field measurement of sound levels are helpful in accurately tell us:

- The sound levels at a specific location for the time period that the measurements were made;
- Historical record of the sound levels at a specific location; and
- Historical trends.

However, field measurements will not be able to predict future noise levels.

Discrete modeling of sound exposure can accurately:

- Quantify sound levels over broad geographic areas, as well as, at specific locations for a specific time period;
- Produce a historical record; and
- Provide future trends by using predictive means.

## 2.3 Noise Exposure Methodologies

Since the 1950's, studies have been conducted on communities exposed to the noise produced both by air traffic and by aircraft ground operations, in order to effectively describe the human perception and impact caused by different noise characteristics. These studies principally consideration both sleep disturbance and annoyance and led to the development of a number of different noise metrics.

The following subsections discuss the various noise exposure metrics and methodologies currently in common use in other countries.

### 2.3.1 Day-Night Level (DNL)

$L_{dn}$, also known as the Day-Night Level (DNL), is a 24-hour $L_{eq}$ measure with a 10 dB penalty for any aircraft noise events which occur during nighttime hours (typically, from 2200 to 0700 hours). There is no penalty applied to day and evening periods. DNL is presently used in the United States, Belgium and New Zealand.

### 2.3.2 Day-Evening-Night Level (DENL)

$L_{den}$, also known as the Day-Evening-Night Level (DENL), is similar to $L_{dn}$, except that it adds an extra 5 dB penalty to aircraft noise events occurring during evening hours, defined as 1900 to 2300 hours. The DENL metric is presently used in France, Denmark and Finland, and it is also the metric specified for use in producing noise maps produced under the European Noise Directive (Directive 2002/49/EC). The default day/evening/nighttime periods in the EU Directive are 0700 to 1900, 1900 to 2300 and 2300 to 0700, however, Member States are permitted to shorten the evening period by up to two hours and accordingly adjust the day and/or nighttime periods.

### 2.3.3 Noise Exposure Forecast (NEF)

The Noise Exposure Forecast (NEF) methodology was original developed in the United States in the 1960's for use in expressing perceived noise levels at commercial airports. The associated NEF metric combines the sound level expressed as EPNL with the number of events, as well as a 12.2 dB penalty (or 16.7 factor) for nighttime operations (defined as 2200 to 0700). The metric only accounts for events above a threshold EPNL level. The NEF methodology is presently used in Canada, Hong Kong, Singapore, Spain and Greece as the principal metric in airport land use planning and controls.

The NEF metric is defined as follows and is summed over all aircraft types and all flight paths:

$$NEF = \langle EPNL \rangle + 10 \bullet \log_{10} (N_d + 16.7 \bullet N_n) - 88 \text{ (dB)}$$

where $\langle EPNL \rangle$ is the mean Effective Perceived Noise Level of aircraft fly-overs, and $N_d$ and $N_n$ are the numbers of day-time and nighttime operations, respectively.

### 2.3.4 Australian Noise Exposure Forecast (ANEF)

Australia uses a modified version of the NEF, called the Australian Noise Exposure Forecast (ANEF), which incorporates a penalty for the time period 1900 to 0700 hours. The Australian national guideline sets the acceptable level for residential construction at the 10% level ("seriously affected") for the noise dose/response relationship which was established in 1980 as part of an extensive socio-acoustic survey study.

### 2.3.5 Weighted Equivalent Continuous Perceived Noise Level (WECPNL)

WECPNL may be considered a hybrid of EPNL, since it incorporates EPNL, which is tone and duration corrected, but also includes a time-of-day energy average, and a seasonal correction based on temperature. WECPNL is in use in Japan, China and Korea, but it is being gradually replaced with other general purpose metrics, such as $L_{den}$.

### 2.3.6 Störindex 'Q'

Störindex 'Q' is a German metric used for aircraft traffic, similar to $L_{dn}$, however it uses a lesser night-time penalty (5 dB penalty only) and takes into account the duration of the noise event and the day period. The indicator was discontinued and replaced with the German regulation Air Traffic Noise Act 2007, where noise levels are evaluated using the sixteen hours LAeq,16h. Luxembourg has also adopted this noise metric.

### 2.3.7 Higher Equivalent Aircraft Noise (FBN)

Higher Equivalent Aircraft Noise (FBN) is the Swedish equivalent of the $L_{eq}$ metric but includes a nine-hour nighttime (2200- 0700) penalty of 10 dB and a three-hour evening (1900-2200) penalty of 4.78 dB. Using 4.78 dB gives a numerical weighting on the number of flights of exactly 3, whereas the 5 dB weighting in $L_{den}$ effectively makes one evening flight count as 3.162 day flights.

### 2.3.8 Community Noise Exposure Level (CNEL)

The CNEL metric was developed in the 1970's and it was recommended in the California technical law for airport noise impact (California Department of Aeronautics, 1971). The indicator takes into account the duration and number of flights and the frequency response of the human ear. It is expressed in dBA to avoid the complex calculation of other indicators like EPNL, and it does not contain any pure tonal corrections. It uses the same parameters as FBN, with a twelve-hour day, nine-hour night period, and three-hour evening period. The evening period also has a weighting of 4.78 dB.

### 2.3.9 Equivalent Aircraft Noise (EFN)

Equivalent Aircraft Noise (EFN) is Norway's $L_{eq}$ based metric. It is a composite index based on the equivalent continuous A-weighted sound level comparable to $L_{den}$ but including a continuous time weighting factor. The metric applies the commonly used nighttime penalty of 10 dB but avoids discontinuities at the beginning and end of the nighttime period. In addition, the metric applies a Sunday day-time penalty.

### 2.3.10 LVA

The LVA metric is used in Italy, as an Equivalent Continuous Sound Level. A 10 dB penalty is applied to nighttime movements. The metric is an energy mean of the representative aircraft noise emission over a year period using measurements taken in three equal periods of the year.

### 2.3.11 Hourly $L_{eq}$

In Switzerland, airports use the 16-hour $L_{eq}$ value to represent day-time (0600-2200) operations plus three one-hour $L_{eq}$ values for nighttime (2200-2300, 2300-2400 and 0500-0600) operations. The one-hour nighttime $L_{eq}$'s are intended to serve two purposes: they impose a limitation on the maximum allowable single noise event to minimize sleep disturbance, as well as address the sensitivity to the number of aircraft movements.

### 2.3.12 Number of Events Above ($N_A$)

In order to provide more meaningful information on the levels of aircraft noise exposure to the public, the 'Number of Noise Events Above' ($N_A$) metric was devised. The metric combines information on single event noise levels with aircraft movement numbers, for all aircraft events louder than a set threshold represented in dBA. Typically, the $N_{70}$ (70 dBA) metric is used for daytime assessments and $N_{60}$ (60 dBA) metric for nighttime assessments. The $N_A$ metric is useful for presenting complex noise impacts to the general public since it is purely an arithmetic indicator. All other things being equal, if the number of aircraft movements over an area doubles, the $N_A$ doubles, which is a different result to logarithmic indicators, such as NEF, which are relatively insensitive to change. However, if the extra movements were of a quieter aircraft type, not exceeding 70 dBA at the location, then the $N_{70}$ would remain unchanged.

The $N_A$ is a useful metric as it permits measured noise levels to be conveniently summarized and presented for any given period. This type of presentation can be very useful as a supplement to a $L_{eq}$ type metric and as a communication tool to the public. However, a significant weakness of this metric is that it treats a noise event at 70 dBA the same as one at 90 dBA. Some experts argue that this issue is not important since the $N_A$ is based on the concept that once a certain threshold is reached the event becomes intrusive and the actual level of the noise is not necessarily important. Nevertheless, the metric can also be expressed at other threshold levels (such as 90 dBA).

# 3 Regulations and Standards

This section of the report documents the applicable international and national regulations, standards and recommended practices relating to aircraft and airport noise, and their implications to surrounding land uses and social considerations.

## 3.1 ICAO Standards and Recommended Practices

The International Civil Aviation Organisation (ICAO) has set progressively stricter certification standards for noise emissions from civil aircraft, known as chapters. The chapters set maximum acceptable noise levels for different aircraft during the take-off and landing phases of flight.

ICAO adopted a set of aircraft noise standards that are embedded into Annex 16 (Vol.1) of the Convention on International Civil Aviation (the "Chicago Convention"). Aircraft are classified in 13 Chapters according to their year of design, type and weight. For each type and for each corresponding weight, a maximum noise emission level is set (expressed in units of Effective Perceived Noise in Decibels [EPNdb]). These noise emission levels are calculated on the basis of the following criteria: level, frequency, distribution and variation over time of aircraft noise. Basically, for the same category of aircraft, the more recent and light it is, generally the quieter the aircraft will be.

ICAO adopted its first aircraft noise standard in 1972 for subsonic jet aeroplanes with type certificate submitted before 6 October 1977 and it was included in Chapter 2 of Annex 16 (Vol. 1) of the Chicago Convention. The Boeing 727 and the Douglas DC-9 are examples of aircraft covered by Chapter 2. Chapter 3 was adopted in 1977 with more stringent noise standards for subsonic jet and propeller-driven aeroplanes with type certificates submitted on or after 6 October 1977 and before 1 January 2006. Chapter 2 aircraft were then phased-out in the beginning of 1995 with an objective of being completed by the end of 2002. Today, with the exception of smaller jets, Chapter 2 aircraft are only permitted in certain developing countries.

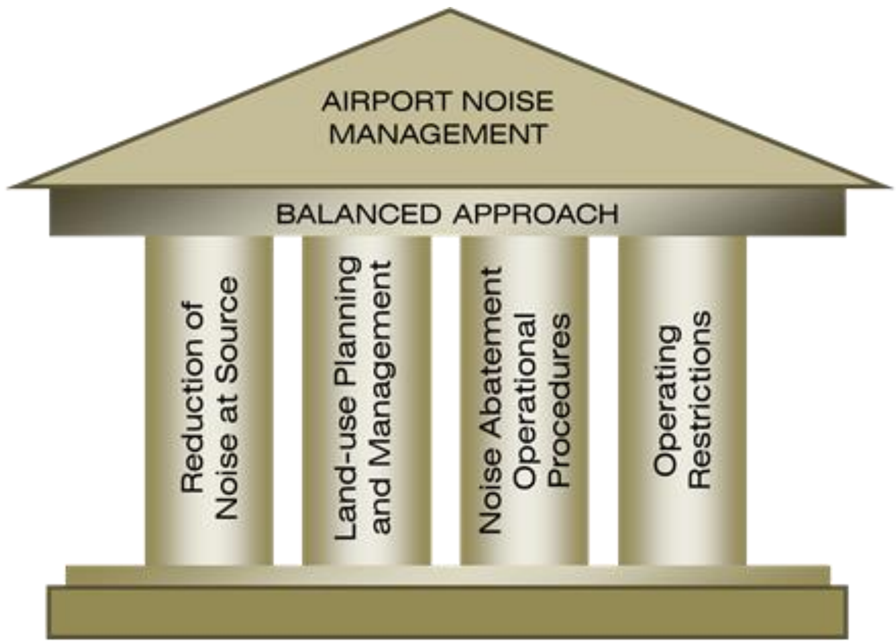
In 2001, a new Chapter 4 was adopted under the auspices of ICAO, with more stringent noise standards for aircraft with type certificates submitted on or after 1 January 2006. The newest aircraft, including the Airbus A380, the Boeing 787 and future Bombardier C-Series, are all about 15 decibels (cumulative) better than ICAO's Chapter 4 standard. Also, starting 1 January 2006, recertification to Chapter 4 was requested for all Chapter 3 aircraft.

On 7 February 2013, at the Ninth Meeting of ICAO's Committee on Aviation Environmental Protection (CAEP), new even more stringent standards were agreed upon, which are set to become the new Chapter 14 of Annex 16 (Vol. 1) of the Chicago Convention. This standard will require that starting in 2017, new large civil aircraft must be at least 7 EPNdB quieter than the current Chapter 4 standard. It will apply to smaller aircraft types of less than 55 tonnes from 2020.

Although significant progress had been made since 1990 in the reduction of aircraft noise at source through technological advances, the proliferation of different noise standards worldwide led to a variety of national laws and regulations which turned out to be barriers to airport capacity expansion and economic growth. Consequently, ICAO was keen in developing a holistic approach which provided a more common, global framework and solution to local airport noise issues, and encouraged the involvement of a broader range of aviation partners.

In 2001, the ICAO Assembly endorsed the concept of a "Balanced Approach" to aircraft noise management, with a view to assisting all airports in developing noise reduction measures, while at the same time minimizing the negative impacts on traffic and on airline fleets. The approach rests on four main pillars, as illustrated in Exhibit 3-1, intended to be used in the most cost-effective and proportionate manner. The Assembly in 2007, reaffirmed the "Balanced Approach" principle and called upon Member States to recognize ICAO's role in dealing with the problems of aircraft noise.

Exhibit 3-1 – ICAO Noise Management Balanced Approach




Source: Aviotec International Inc. based on ICAO Document No. 9829.

The approach consists of identifying the noise problem at an airport and then analyzing the various measures available to reduce noise through the exploration of four principal elements, namely reduction at source (quieter aircraft), land-use planning and management, noise abatement operational procedures and operating restrictions, with the goal of addressing the noise problem in the most cost-effective manner. ICAO has developed recommended policies and practices for each of these elements, as well as on noise charges, which are contained in ICAO Document No. 9829 – "Guidance on the balanced approach to aircraft noise management". This reference document has now become the de facto guidance material for aircraft noise management around airports worldwide.

It is important to note that airport operators are reliant on their partners to implement the measures of the Balanced Approach. In terms of reduction of noise at source, the adoption of a new noise standard is a decision made by ICAO Member States, while fleet replacement strategies are the responsibility of specific airlines. For land use planning, measures are taken by local authorities and for noise abatement procedures, these are the result of cooperation between airlines, air traffic management and airport operators. Operating restrictions are determined by local or national authorities.

### 3.1.1 Reduction of Noise at Source

The reduction of noise at source has proven to be one of the most effective means to limit aircraft noise. Measures in this category are typically technology-driven, the result of extensive research and development in the fields of aircraft and engine design, and thus are not initiated by or within the control of individual airports. Instead, they are undertaken through the adoption and implementation of noise certification standards as defined in ICAO's Annex 16 (Volume I). Measures involve the introduction of newer, quieter aircraft types, as well as, the reduction of acoustic output of existing aircraft types by physical modification. Currently, Chapter 4 aircraft are considered state-of-the-art while Chapter 2 aircraft have already been banned from most international airports.

### 3.1.2 Land-use Planning and Management

Land-use planning and management measures aim to achieve compatibility between airport activities (i.e. aircraft and helicopter operations) and on- and off-airport land uses in order to minimize the impact on surrounding communities. These measures include:

- Land-use planning (e.g. zoning by-laws, easements);
- Mitigation measures (e.g. building codes, building insulation programs, real estate disclosure); and
- Financial instruments (e.g. tax incentives, noise charges).

### 3.1.3 Operating Procedures

Operating procedures to mitigate aircraft noise, also referred to as noise abatement procedures, are the result of cooperation between airlines, air traffic management services and airport operators, and generally fall into the following categories:

- The use of preferential runways (in order to direct aircraft flight paths away from noise-sensitive areas or to provide periods of respite for certain areas at certain times of the day);
- The use of specific take-off or approach procedures (such as steeper landing trajectories in order to optimize the distribution of noise on the ground); and
- The use of preferential routes or turns during take-off or approach (in order to assist aircraft in avoiding noise-sensitive areas).

### 3.1.4 Operating Restrictions

There are a number of operating restrictions which may be employed by airports, ranging from aircraft operational caps during peak periods to an outright ban of noisier aircraft types. Noise related operating restrictions are more commonly applied to night flights because of the effect that they have on the overall noise annoyance metric at an airport. Operating restrictions principally affect airlines by limiting or reducing aircraft access to airports.

Another measure which is used by airports to limit the use of noisier aircraft is the levying of noise charges to aircraft operators, for instance, per take-off based on the aircraft's noise profile per departing passenger (e.g. FRA, BRU, CDG), or per landing (e.g. VIE).

## 3.2 Airports Council International (ACI)

Airports Council International (ACI) is a non-profit global trade organisation that represents the world's airports. ACI represents airports interests with governments and international organizations such as ICAO, develops standards, policies and recommended practices for airports, and provides information and training opportunities to raise standards around the world.

Section 6.1 of ACI's Policy and Recommended Practices Handbook (6th Edition, Dec. 2008) outlines a number of policies relating to airport noise and outlines global noise management best practices consistent with the implementation of each policy.

The key relevant ACI policies relating to noise management are as follows:

- Minimise or mitigate the adverse effects of aircraft noise on people;
- ACI supports the implementation of ICAO's Balanced Approach (BA);
- Reduction of noise at source is the most effective and lasting way to curtail aircraft noise on a permanent and global scale;
- Land use planning is an effective tool in minimising the impact of aircraft noise;
- Sound insulation is part of the solution for residences, classrooms and other noise sensitive buildings affected by aircraft noise;
- Noise abatement procedures can be used to help reduce aircraft noise levels;
- Restricting operations can reduce noise disturbance at sensitive times, usually at night;
- Noise monitoring at airports is an important process in understanding and dealing with aircraft noise impacts;
- Interaction with communities affected by noise is an important tool in community/airport cohesion;
- Noise metrics provide a valuable tool for communicating with communities;
- Noise-related user charges can be a strong incentive for airlines to operate quieter fleet; and
- Ground-based noise sources must also be considered for mitigation measures.

When the Chapter 4 standard was adopted by ICAO, ACI concluded that the standard was insufficient to manage noise impacts and created the ACI Aircraft Noise Rating Index as a tool to better define the wide ranging noise performance of aircraft within the Chapter 3 and Chapter 4 categories. Based on measured noise levels in comparison to Chapter 3 noise certification limits, the aircraft are placed into one of six categories of noise performance. These range from "A" (quietest) to "F" (noisiest).

## 3.3 International Air Transport Association (IATA)

The International Air Transport Association (IATA) is the trade association for the world's airlines, representing some 260 airlines or 83% of total air traffic. They support many areas of aviation activity and help formulate industry policy, guidelines and standards for key aviation issues and initiatives.

IATA generally agree with and endorse ICAO's Balanced Approach to Noise Management. However, considering the impact operating restrictions may have on airlines, passengers and local economies, IATA believes that operating restrictions should not be used as a first resort but only after a full assessment of all available measures to address demonstrated noise problems at an airport. Further, nighttime operating restrictions (in the form of curfews) have a particularly negative impact on air cargo and express operators that support many industries' global supply chains, as well as, the ability of airlines to schedule flights in an optimal manner and to facilitate connectivity for travellers.

IATA recommends that operating restrictions should only be introduced based on the ICAO Balanced Approach and relevant ICAO guidance.

When the introduction of operating restrictions is considered, IATA strongly urges competent authorities to follow the principles endorsed by ICAO in Assembly Resolution A37-18 including, in particular, the following rules:

- Operating restrictions should only be introduced at airports with a demonstrated noise problem.
- Operating restrictions should not be introduced as a first resort but only after a full assessment of available measures and of the benefits to be gained from other elements of the balanced approach.
- Operating restrictions should only be introduced if they address the noise problem in the most cost-effective manner.
- All relevant stakeholders, including airlines, should be consulted before a decision is made to introduce operating restrictions.
- Operating restrictions should be based on the certified noise levels of aircraft and not on other criteria such as the type of operations.
- Airlines must be given a sufficient period of advance notice and operating restrictions should be introduced gradually over time where possible.
- Operating restrictions should not aim at the withdrawal of aircraft that comply with the noise standards in Volume I, Chapters 4 and/or 14 of Annex 16.

## 3.4 Bahamian Laws and Regulations

At present, there are no Bahamian laws, regulations or policy statements which specifically address aircraft and/or airport noise and the mitigation of their community impacts.

The only exception to this are Schedule 5.060, Schedule 10.051 and Schedule 17.100 of the Bahamas Civil Aviation Safety Regulations (BASR), which address noise certification of all Bahamas registered aircraft involved in international operations, as well as Advisory Circular AC-05-006 – Validation of Aircraft Noise Certificate.

The consultant is not aware of any regional/island or local zoning by-laws under the Local Government Act (1996) which control incompatible development in the vicinity of airports and specifically limit residential development in areas that may be significantly impacted by noise resulting from aircraft take-offs and landings at a nearby aerodrome.

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# 4 Noise Modelling

## 4.1 Aircraft Noise Modeling Methodology

Noise compatibility planning emphasises the identification of community annoyance and incompatible land use. The established industry method of predicting the degree of community annoyance from aircraft (and airport) noise is by modelling various acoustical and operational data, and producing noise exposure mapping of the airport and surrounding communities showing contours that join points of equal noise exposure.

At this time, the Commonwealth of the Bahamas has not yet established standards or guidelines regarding the methodology for quantifying and expressing the degree of community annoyance related to aircraft noise at and near aerodromes. For this reason, the consultant is recommending that the Bahamas Civil Aviation Department (BCAD) adopt the Noise Exposure Forecast (NEF) metric (as described in Section 2.3.3) and the methodology for modelling and preparing aircraft noise exposure maps, similar to that in use in Canada and Hong Kong. It is the consultant's opinion that the NEF metric is an appropriate basis for controlling incompatible land uses in the vicinity of aerodromes in the Bahamas. Also, studies have shown that the NEF metric correlates well with other popular noise metrics such as DNL and DENL.

As a result, the analysis of noise exposure at and near MYEF and the expression as noise contours in this study were prepared using Transport Canada's (TC) in-house developed software program (NEFCALC Version 2.0.6.1) to model aircraft noise and produce noise exposure mapping.

Inputs to the noise model include the runway definition, number of aircraft operations during the period evaluated, the types of aircraft flown, how frequently each runway is used for arriving and departing aircraft, and the routes of flight used to and from the runways. The NEF program uses a database of aircraft noise characteristics for a selected list of commonly used aircraft types. The noise model calculates noise exposure for the area at and around the Airport and outputs contours of equal noise exposure. The primary use of noise modelling is to produce estimates of annual average noise conditions in the airport environs. For this study, equal noise exposure forecast (NEF) contours for the levels NEF 25, 30 and 35 were calculated.

## 4.2 Limitations of Noise Modelling

The validity and accuracy of noise modeling depend on the basic information used in the calculations. For future airport activities, the reliability of calculations is affected by a number of uncertainties, such as the following.

- Aviation activity levels—e.g., the number of aircraft operations, the types of aircraft serving the airport, the times of operation (daytime, evening, and nighttime), and aircraft flight tracks—continually change over time.
- Aircraft acoustical and performance characteristics are estimates. When new aircraft designs are involved, aircraft noise data and flight characteristics must be estimated.
- The NEF and related metrics represent typical human response to aircraft noise. Because people

vary in their responses to noise, the NEF scale can show only an average response to aircraft noise that might be expected from a community, but cannot predict an individual's reaction.

- Single flight tracks are used, as required, in computer modeling to represent a wider band of actual flight tracks. The model program then assumes a certain rate of aircraft dispersion from the set flight paths to estimate the variation experienced in actual aircraft flight.

## 4.3 Noise Model Input Data

This section describes the input data used for the noise analysis model. Input data include:

- Airfield configuration;
- Departure and arrival flight tracks;
- Origin and destination stage length;
- Aircraft noise characteristics and climb/descent profiles;
- Aircraft operations by aircraft type and time-of-day; and
- Average runway use.

### 4.3.1 Airfield Configurations

Latitude and longitude coordinates for all runway ends/thresholds were specified for model input. The MYEF airfield has a single runway, Runway 12-30, which has a take-off and landing length of 7,000 feet. Runway 12-30 has no existing threshold displacements. The runway model parameters are attached as Appendix A.

### 4.3.2 Flight Path Definitions

The location of aircraft flight paths (flight corridors) is an important factor in determining the geographic distribution of noise contours on the ground.

Typically when modelling aircraft noise, a historical set of aircraft approach and departure flight tracks, as recorded by area air traffic radar, are analyzed in order to define the most representative set of flight paths. Since radar data of actual flight tracks were not available from the Bahamas Air Traffic Services, representative aircraft flight paths were developed using the runway approach and departure procedures published in the current *Aeronautical Information Publication* (AIP) for MYEF, as well as from observations during the airport site visit.

*Departure Paths*

To define a departure path in the NEF program, the user can assign a straight out path or can define a turn. In the case of Runway 12-30, turns were assumed to start upon reaching a height of 3,000 feet above ground level (AGL). Since the start point of the turns is based on altitude, the NEF model accounts for the differing climb profiles for each aircraft type and the turn is assumed to be executed at different distances from the airport dependent on the aircraft type.

For all Runway 30 departures, aircraft were assumed to make a 61 degree left hand turn. For all

Runway 12 departures, aircraft were assumed to make a 91 degree right hand turn.

*Arrival Paths*

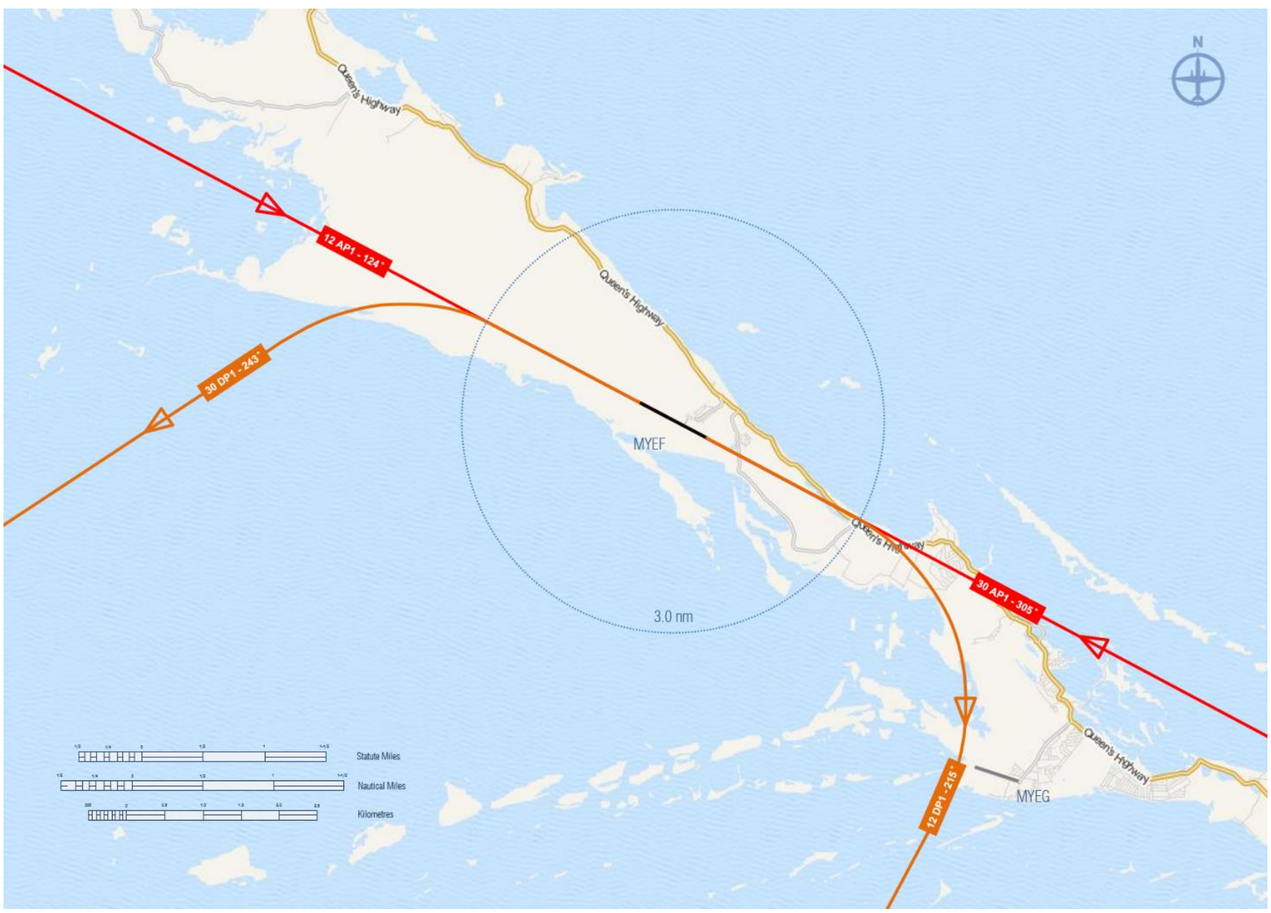
The NEF model will only allow the user to define straight-in approaches to the runway. Although in reality most aircraft will turn onto the final approach path, the turn is typically performed sufficiently distant from the airport (greater than 5,000 feet from the threshold) that it would have no appreciable effect on the noise contours.

Therefore, the flight paths for Runway 12-30 were modeled as straight-in approaches with a glide slope of 3 degrees regardless of aircraft type.

*Aircraft Dispersion*

Since aircraft do not precisely follow a defined track during flight, the NEF model assumes that the actual pattern of approaching and departing aircraft is dispersed about the flight path's main track. The degree of dispersion is normally a function of the distance travelled by an aircraft along the route after take-off or prior to the touchdown point and also on the form of route.

Exhibit 4-1 – Representative Aircraft Flight Paths - MYEF




Source: Aviotec International Inc.

The effect of dispersion on the noise contours is to slightly widen but shorten the contours where aircraft noise dominates. It is commonly found that the spread of aircraft tracks approximates to a "normal distribution" pattern, the shape or spread of which will vary with distance along the approach or departure path. The NEF model assumes that there are five "dispersed" tracks associated with each defined approach and departure path.

*Defined Flight Paths*

The definitions for the various approach and departure paths used in the NEF model for MYEF are described in Appendix A.

Exhibit 4-1 (on the previous page) illustrates the approximate aircraft approach and departure flight paths for MYEF which were input into the model.

### 4.3.3 Aircraft Stage Length

Aircraft noise characteristics vary depending on the departure profiles (or takeoff climb rates) of aircraft. Aircraft takeoff weight directly affects the departure profiles. Because of the difficulty of obtaining data on aircraft takeoff weight, stage length is often used as a surrogate. Stage length refers to the average distance an aircraft travels non-stop.

Departure operations in the NEF model are divided into seven (7) stage lengths, which correspond to approximate non-stop flight distances in increments of 500 nautical miles (nm). Each stage length associates the aircraft operation with a takeoff weight that represents a typical passenger load factor and fuel requirement. Heavier aircraft usually take longer to reach takeoff velocity, thereby using more runway length and climbing at a slower rate than a lighter aircraft, particularly on hot days. Therefore, more land area will be exposed to higher levels of aircraft noise by departures of heavier aircraft than departures of the same aircraft with lighter loads.

For MYEF, the predominant non-stop flight activity is to Nassau and Florida (U.S.A.). Therefore, a single stage length of 0 to 500 nm (Range “1”) was used in the NEF model for most all aircraft types. The only exceptions were regional jets (Canadair CL-601), large business jets (Gulfstream IV, Falcon 50/7X) and some commercial narrow-body jets (Airbus A319, Embraer 190/195) which were assumed to travel to/from destinations with a stage length of between 750 nm and 1250 nm (e.g. ATL, YYZ), or a range of “2”. For most general aviation aircraft with a range of “1”, the NEF model automatically defaults to their maximum takeoff weight.

### 4.3.4 NEF Database

The NEF aircraft database includes information for commercial, general aviation, and military aircraft powered by turbojet, turbofan, or propeller-driven engines. For each aircraft in the database, the following information is provided: (1) a set of departure profiles for each applicable trip length, (2) a set of approach parameters, and (3) noise versus distance curves.

Transport Canada’s NEF model software includes 383 aircraft types in its database. The user must assign a surrogate/substitute for all aircraft not in the database which have a similar performance and noise profile. Alternatively, the user may define an aircraft type by supplying take-off, sideline, and approach noise levels for those aircraft that do not have a direct NEF equivalent. Substitute aircraft are also used to simplify noise modelling by grouping aircraft with similar performance and noise profiles.

Table 4-1 summarizes the aircraft substitutions that were made for the various aircraft types which typically operate into and out of MYEF.

Table 4-1 – Aircraft Substitutions for MYEF Noise Modelling

| Aircraft Type | Substitution Aircraft | NEFCAL Code | Aircraft Represented by Substitute Aircraft |
|---|---|---|---|
| Single-Engine Piston | GA Fixed Pitch | GASEPF | Cessna 140/150/152/170/172, Piper PA-28 Cherokee Archer, Piper PA-11/12 Cub, North American, Beechcraft A23A Musketeer, Pilatus PC-12, Socata TBM 850/900, PA-46-500TP Malibu Meridian, Commander 114. |
| | GA Variable Pitch | GASEPV | Cessna 177/180/182/185/205/206/210; Piper PA-28R Cherokee Arrow, Piper PA-32-300 Cherokee Six, Cirrus SR20/22, Diamond DA40 Star, Beech 36/A36 Bonanza. |
| Twin-Engine Piston | Beech Baron 58 | BEC58P | Beech 50/55/58, Piper PA-23/30/34/44, Cessna 300 & 400 Series, Diamond DA42 Twin Star, Partenavia P.68. |
| Twin-Engine Turboprop | Cessna 441 Conquest II | CNA441 | King Air C90/100/200, Piper PA-31 Navajo/PA-42 Cheyenne, Swearingen II/III, Cessna C406/C425, Rockwell Turbo Commander, Britten-Norman Islander 2A/2T, Beech 99, Mitsubishi MU-2. |
| | DeHavilland Dash 6 | DHC6 | Super King Air 300/350, Beech 1900D, DC-3, Embraer 110 Bandeirante, Swearingen SA-227. |
| | Saab SF-340 | SF340 | BAe Jetstream 41 |
| | DeHavilland Dash 8-300 | DHC830 | Dash 8-200/400 (Q400), BAe Jetstream 31/32, ATR 42/72. |
| Twin-Engine Regional / Business Jet | Mitsubishi MU-300 Diamond | MU3001 | Beechjet 400, Cessna C551/560/56X Citation. |
| | Canadair CL-601 | CL601 | Dornier 328J, Hawker 800/4000, Falcon 900/2000, Challenger 300, Canadair RJ, Embraer 135/145, Cessna C680, Gulfstream G200, Bombardier Global Express. |
| | Learjet 35 | LEAR35 | Learjet 31/40/45/55/60, BAe 125-400, Falcon 10. |
| | Gulfstream IV | GIV | Gulfstream G450, Falcon 50/7X. |
| Twin-Engine Commercial Jet | Airbus A319 | A319 | Embraer 170/175/190/195. |
| | Boeing 717 | 717 | No substitutions. |
| | Boeing 737-500 | 737500 | No substitutions. |
| Four-Engine Commercial Jet | BAE 146 | BAE146 | RJ70/85. |

Source: Aviotec International Inc.

### 4.3.5 Other Noise Model Assumptions

In addition to the aforementioned noise model inputs, the following conditions were assumed in developing the MYEF noise exposure mapping:

- Approach and departure profiles were those typical of each aircraft type given the indicated stage length.
- Overflying aircraft were not taken into account in the noise model, since there are no published air routes that pass over or near the airport.
- Aircraft are assumed to initiate the takeoff roll from the runway end and not from intermediate runway intersection points.
- Noise, thrust, and altitude data for each specific aircraft type is as specified in the current version of the noise model (NEFCALC Version 2.0.6.1) aircraft database.
- Ground topography is assumed to be flat and for lateral attenuation purposes, the ground is assumed by the model to be acoustically soft ground.

## 4.4 Aircraft Operations

### 4.4.1 Runway End Use

For the purposes of noise modelling, the forecast level of traffic must be allocated according to runway end use. This determines which flight paths will be used by the model. Typically, the allocation of traffic by runway end is based on an analysis of historical aircraft movement data organized by runway end used for take-off and landing.

However, in the case of MYEF, the available air traffic tower log data does not include notations regarding the arrival and/or departure runway information. As a result, the runway end usage was estimated based on an analysis of historical meteorological data (to determine prevailing winds and permissible cross-wind limits), consultations with relevant airport stakeholders, and site observations of operations.

Table 4-2 presents the estimated distribution of aircraft movements by runway end. It has been assumed that the distribution will remain unchanged during the planning period.

Table 4-2 – Distribution of Aircraft Movements by Runway End

| Runway Designation | Type of Operation | Percentage of Aircraft Movements |
|---|---|---|
| 12 | Approach | 37.5% |
| | Departure | 37.5% |
| 30 | Approach | 12.5% |
| | Departure | 12.5% |

Source: Aviotec International Inc.

Based on stakeholder consultations, there is little to no local airport circuit activity (which would be typified by flight training operations).

### 4.4.2 Daytime/Nighttime Operations

The NEF noise modelling methodology assumes that a 12.2 dB penalty be applied to all nighttime aircraft/helicopter operations which equates to a factoring of nighttime movements by 16.7 times. (This approach, which is used by Transport Canada and other jurisdictions, is considered to be more conservative than that used by the U.S. Federal Aviation Administration which applies a 10 dB penalty for nighttime operations.) Nighttime operations are deemed to occur between 2200 and 0659 local time, and thus the penalty is applied through this time period.

Based on the MYEF flight activity logs for January 2015, significantly less than 0.2% of flight operations occurred during the nighttime period. Therefore, for the purposes of the modelling, no nighttime operations were assumed.

### 4.4.3 Aircraft Movements

As noted in Section 2, the NEF metric is based on the cumulative average noise energy for the peak planning day, which represents a near to worst case 24-hour period. The peak planning day is commonly represented as the 95th percentile day determined through an analysis of at least one year's worth of movement data for an airport.

*Current Movements*

BCAD Air Traffic Services personnel at MYEF provided the consultant with handwritten daily logs of aircraft movements for January 2015. (No other movement data was made available to the consultant.) Each movement entry included the aircraft registration number, aircraft type, and arrival and/or departure times and in some cases the origin and destination airport.

Since complete air traffic control tower log data was not available for MYEF, the 95$^{th}$ percentile daily number of movements was determined for January 2015 only, which anecdotally is the second busiest month after March. Therefore, the total number of aircraft movements for the peak planning day was calculated to be 70.35. This figure was then used to prorate all traffic movement data by aircraft type and by time of day into a daily distribution.

Table 4-3 (on the following page) presents the 2015 peak planning day arrival/departure movements by aircraft type, runway end use, and time of day. Where aircraft types were found to be infrequent or the noise parameters were similar to other aircraft types, surrogate aircraft were selected. In this case, 15 different surrogate aircraft types were selected for the modelling (refer to Table 4-1).

*Forecast Movements*

In March 2014, DKMA Inc. prepared the air traffic forecasts for MYEF which included an analysis of historical aircraft movements and projections to the Year 2033. Subsequently in May 2015, DKMA determined the current and future busy day and peak hour aircraft movements. The DKMA analysis utilized available commercial and general aviation aircraft movement statistics for the Year 2013. The studies projected that over the next 20-year period (2015-2035) total MYEF aircraft movements would increase by 1.5% annually and that the busy day movements would increase by 1.97% annually.

Table 4-3 – Existing Distribution of Aircraft Movements for MYEF by Runway

| Aircraft / Engine Type | NEFCAL Code | Itinerant Movements | | | | | | | | Totals |
|---|---|---|---|---|---|---|---|---|---|---|
| | | *Runway 12* | | | | *Runway 30* | | | | |
| | | Day | | Night | | Day | | Night | | |
| | | Arr | Dep | Arr | Dep | Arr | Dep | Arr | Dep | |
| Single-Engine, Piston | GASEPF | 4.449 | 4.449 | 0.000 | 0.000 | 1.483 | 1.483 | 0.000 | 0.000 | 11.865 |
| Single-Engine, Piston | GASEPV | 0.674 | 0.674 | 0.000 | 0.000 | 0.225 | 0.225 | 0.000 | 0.000 | 1.798 |
| Twin-Engine, Piston | BEC58P | 7.820 | 7.820 | 0.000 | 0.000 | 2.607 | 2.607 | 0.000 | 0.000 | 20.853 |
| Twin-Engine, Turboprop | CNA441 | 0.899 | 0.899 | 0.000 | 0.000 | 0.300 | 0.300 | 0.000 | 0.000 | 2.397 |
| Twin-Engine, Turboprop | DHC6 | 0.629 | 0.629 | 0.000 | 0.000 | 0.210 | 0.210 | 0.000 | 0.000 | 1.678 |
| Twin-Engine, Turboprop | SF340 | 3.056 | 3.056 | 0.000 | 0.000 | 1.019 | 1.019 | 0.000 | 0.000 | 8.150 |
| Twin-Engine, Turboprop | DHC830 | 2.472 | 2.472 | 0.000 | 0.000 | 0.824 | 0.824 | 0.000 | 0.000 | 6.592 |
| Four-Engine, Regional Jet | BAE146 | 0.090 | 0.090 | 0.000 | 0.000 | 0.030 | 0.030 | 0.000 | 0.000 | 0.240 |
| Twin-Engine, Business Jet | MU3001 | 1.079 | 1.079 | 0.000 | 0.000 | 0.360 | 0.360 | 0.000 | 0.000 | 2.876 |
| Twin-Engine, Regional Jet | CL601 | 3.550 | 3.550 | 0.000 | 0.000 | 1.183 | 1.183 | 0.000 | 0.000 | 9.468 |
| Twin-Engine, Business Jet | LEAR35 | 0.404 | 0.404 | 0.000 | 0.000 | 0.135 | 0.135 | 0.000 | 0.000 | 1.079 |
| Twin-Engine, Business Jet | GIV | 0.360 | 0.360 | 0.000 | 0.000 | 0.120 | 0.120 | 0.000 | 0.000 | 0.959 |
| Twin-Engine, Business Jet | CIT3 | 0.270 | 0.270 | 0.000 | 0.000 | 0.090 | 0.090 | 0.000 | 0.000 | 0.719 |
| Twin-Engine, Medium Jet | 717 | 0.090 | 0.090 | 0.000 | 0.000 | 0.030 | 0.030 | 0.000 | 0.000 | 0.240 |
| Twin-Engine, Medium Jet | A319 | 0.449 | 0.449 | 0.000 | 0.000 | 0.150 | 0.150 | 0.000 | 0.000 | 1.198 |
| Twin-Engine, Medium Jet | 737500 | 0.090 | 0.090 | 0.000 | 0.000 | 0.030 | 0.030 | 0.000 | 0.000 | 0.240 |
| **Total Movements - All Aircraft** | | **26.381** | **26.381** | **0.000** | **0.000** | **8.794** | **8.794** | **0.000** | **0.000** | **70.350** |
| **Percentage Breakdown** | | **37.50%** | **37.50%** | **0.00%** | **0.00%** | **12.50%** | **12.50%** | **0.00%** | **0.00%** | **100.00%** |

Source: Aviotec International Inc. based on analysis of BCAD Air Traffic Services' tower log data for January 2015.
Note 1: Assumed marginal (less than 0.2%) local, helicopter and nighttime operations. Runway end use is estimated.

No guidance was provided in the DKMA studies, as to how movements would grow for specific aircraft types. Therefore, for the purposes of noise modelling, the same aircraft movement growth rate was assumed for all aircraft types equally.

Table 4-4 (on the following page) presents the peak planning day arrival/departure movements projected for 2035 by aircraft type, runway end use, and time of day (daytime, nighttime).

At this time, there are very few nighttime aircraft operations at MYEF (between 2200 and 0700). Those that do occur are related to air ambulance flights and aircraft emergencies. It has been suggested that the airspace and airport operations at MYEF may be modified in the future to permit a greater level of nighttime aircraft activity. Therefore, the consultant has created a variation to the projected 2035 movements which allocates 5% of the movements to the nighttime period, as presented in Table 4-5 (on the following page). This operational variation allowed the consultant to test the sensitivity of nighttime operations on the noise exposure mapping.

Table 4-4 – Projected 2035 Distribution of Aircraft Movements for MYEF by Runway

| Aircraft / Engine Type | NEFCAL Code | Itinerant Movements | | | | | | | | Totals |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Runway 12 | | | | Runway 30 | | | | |
| | | Day | | Night | | Day | | Night | | |
| | | Arr | Dep | Arr | Dep | Arr | Dep | Arr | Dep | |
| Single-Engine, Piston | GASEPF | 6.580 | 6.580 | 0.000 | 0.000 | 2.190 | 2.190 | 0.000 | 0.000 | 17.540 |
| Single-Engine, Piston | GASEPV | 1.000 | 1.000 | 0.000 | 0.000 | 0.330 | 0.330 | 0.000 | 0.000 | 2.660 |
| Twin-Engine, Piston | BEC58P | 11.570 | 11.570 | 0.000 | 0.000 | 3.860 | 3.860 | 0.000 | 0.000 | 30.860 |
| Twin-Engine, Turboprop | CNA441 | 1.330 | 1.330 | 0.000 | 0.000 | 0.440 | 0.440 | 0.000 | 0.000 | 3.540 |
| Twin-Engine, Turboprop | DHC6 | 0.930 | 0.930 | 0.000 | 0.000 | 0.310 | 0.310 | 0.000 | 0.000 | 2.480 |
| Twin-Engine, Turboprop | SF340 | 4.520 | 4.520 | 0.000 | 0.000 | 1.510 | 1.510 | 0.000 | 0.000 | 12.060 |
| Twin-Engine, Turboprop | DHC830 | 3.660 | 3.660 | 0.000 | 0.000 | 1.220 | 1.220 | 0.000 | 0.000 | 9.760 |
| Four-Engine, Regional Jet | BAE146 | 0.130 | 0.130 | 0.000 | 0.000 | 0.040 | 0.040 | 0.000 | 0.000 | 0.340 |
| Twin-Engine, Business Jet | MU3001 | 1.600 | 1.600 | 0.000 | 0.000 | 0.530 | 0.530 | 0.000 | 0.000 | 4.260 |
| Twin-Engine, Regional Jet | CL601 | 5.250 | 5.250 | 0.000 | 0.000 | 1.750 | 1.750 | 0.000 | 0.000 | 14.000 |
| Twin-Engine, Business Jet | LEAR35 | 0.600 | 0.600 | 0.000 | 0.000 | 0.200 | 0.200 | 0.000 | 0.000 | 1.600 |
| Twin-Engine, Business Jet | GIV | 0.530 | 0.530 | 0.000 | 0.000 | 0.180 | 0.180 | 0.000 | 0.000 | 1.420 |
| Twin-Engine, Business Jet | CIT3 | 0.400 | 0.400 | 0.000 | 0.000 | 0.130 | 0.130 | 0.000 | 0.000 | 1.060 |
| Twin-Engine, Medium Jet | 717 | 0.130 | 0.130 | 0.000 | 0.000 | 0.040 | 0.040 | 0.000 | 0.000 | 0.340 |
| Twin-Engine, Medium Jet | A319 | 0.660 | 0.660 | 0.000 | 0.000 | 0.220 | 0.220 | 0.000 | 0.000 | 1.760 |
| Twin-Engine, Medium Jet | 737500 | 0.130 | 0.130 | 0.000 | 0.000 | 0.040 | 0.040 | 0.000 | 0.000 | 0.340 |
| **Total Movements - All Aircraft** | | **39.020** | **39.020** | **0.000** | **0.000** | **12.990** | **12.990** | **0.000** | **0.000** | **104.020** |
| **Percentage Breakdown** | | **37.51%** | **37.51%** | **0.00%** | **0.00%** | **12.49%** | **12.49%** | **0.00%** | **0.00%** | **100.00%** |

Source: Aviotec International Inc. based on analysis of BCAD Air Traffic Services' tower log data for January 2015.

Table 4-5 – Project 2035 Distribution of Aircraft Movements with 5% Nighttime

| Aircraft / Engine Type | NEFCAL Code | Itinerant Movements | | | | | | | | Totals |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Runway 12 | | | | Runway 30 | | | | |
| | | Day | | Night | | Day | | Night | | |
| | | Arr | Dep | Arr | Dep | Arr | Dep | Arr | Dep | |
| Single-Engine, Piston | GASEPF | 6.251 | 6.251 | 0.329 | 0.329 | 2.081 | 2.081 | 0.110 | 0.110 | 17.540 |
| Single-Engine, Piston | GASEPV | 0.950 | 0.950 | 0.050 | 0.050 | 0.314 | 0.314 | 0.017 | 0.017 | 2.660 |
| Twin-Engine, Piston | BEC58P | 10.991 | 10.991 | 0.578 | 0.578 | 3.667 | 3.667 | 0.193 | 0.193 | 30.860 |
| Twin-Engine, Turboprop | CNA441 | 1.264 | 1.264 | 0.067 | 0.067 | 0.418 | 0.418 | 0.022 | 0.022 | 3.540 |
| Twin-Engine, Turboprop | DHC6 | 0.884 | 0.884 | 0.047 | 0.047 | 0.295 | 0.295 | 0.016 | 0.016 | 2.480 |
| Twin-Engine, Turboprop | SF340 | 4.294 | 4.294 | 0.226 | 0.226 | 1.434 | 1.434 | 0.075 | 0.075 | 12.060 |
| Twin-Engine, Turboprop | DHC830 | 3.477 | 3.477 | 0.183 | 0.183 | 1.159 | 1.159 | 0.061 | 0.061 | 9.760 |
| Four-Engine, Regional Jet | BAE146 | 0.123 | 0.123 | 0.006 | 0.006 | 0.038 | 0.038 | 0.002 | 0.002 | 0.340 |
| Twin-Engine, Business Jet | MU3001 | 1.520 | 1.520 | 0.080 | 0.080 | 0.503 | 0.503 | 0.026 | 0.026 | 4.260 |
| Twin-Engine, Regional Jet | CL601 | 4.988 | 4.988 | 0.263 | 0.263 | 1.663 | 1.663 | 0.088 | 0.088 | 14.000 |
| Twin-Engine, Business Jet | LEAR35 | 0.570 | 0.570 | 0.030 | 0.030 | 0.190 | 0.190 | 0.010 | 0.010 | 1.600 |
| Twin-Engine, Business Jet | GIV | 0.503 | 0.503 | 0.026 | 0.026 | 0.171 | 0.171 | 0.009 | 0.009 | 1.420 |
| Twin-Engine, Business Jet | CIT3 | 0.380 | 0.380 | 0.020 | 0.020 | 0.123 | 0.123 | 0.006 | 0.006 | 1.060 |
| Twin-Engine, Medium Jet | 717 | 0.123 | 0.123 | 0.006 | 0.006 | 0.038 | 0.038 | 0.002 | 0.002 | 0.340 |
| Twin-Engine, Medium Jet | A319 | 0.627 | 0.627 | 0.033 | 0.033 | 0.209 | 0.209 | 0.011 | 0.011 | 1.760 |
| Twin-Engine, Medium Jet | 737500 | 0.123 | 0.123 | 0.006 | 0.006 | 0.038 | 0.038 | 0.002 | 0.002 | 0.340 |
| **Total Movements - All Aircraft** | | **37.069** | **37.069** | **1.951** | **1.951** | **12.340** | **12.340** | **0.649** | **0.649** | **104.020** |
| **Percentage Breakdown** | | **35.64%** | **35.64%** | **1.88%** | **1.88%** | **11.86%** | **11.86%** | **0.62%** | **0.62%** | **100.00%** |

Source: Aviotec International Inc. based on analysis of BCAD Air Traffic Services' tower log data for January 2015.

## 4.5 Noise Modeling Results

### 4.5.1 Noise Exposure Maps

When preparing noise exposure contours or maps, it is common to model the existing airport condition, as well as under some future time horizons - most commonly 20 years out. Forecasting noise exposure for future periods allows the airport planner to anticipate future trends and take into account predicted future aircraft types, traffic growth, flight patterns and any changes to runway configurations that are expected to occur during the planning period.

The prediction of future aircraft noise exposure and its potential impact on the airport and surrounding land uses assists local and regional governments in making informed planning decisions by identifying where future incompatible development might occur as a result of exposure to expected future levels of aircraft activity. The need to avoid incompatible land use development will exist for as long as an airport exists. Once development occurs near an airport, it is virtually impossible - or, at the very least, costly and time consuming - to change the land uses to ones that are more compatible with airport activities.

For MYEF, noise exposure mapping was prepared using the NEF noise model for the Year 2015 assuming the existing land use, aircraft operations and fleet mix, airfield layout, and other noise modeling considerations described earlier in this section. The mapping is presented in Exhibit B-1 attached as Appendix B.

The noise model was also run for the projected 2035 aircraft operations, as well as two (2) additional scenarios:

- Scenario A – Projected 2035 aircraft operations with no appreciable change to airfield configuration or aircraft types;
- Scenario B - Projected 2035 aircraft operations with 5% of total movements allocated to the nighttime period (between 2200 and 0700); and
- Scenario C - Projected 2035 aircraft operations with a 1000 ft (305 metre) extension to Runway 30.

The noise exposure maps for the above scenarios are presented in Exhibits B-2, B-3 and B-4 respectively, attached as Appendix B.

### 4.5.2 Impacts on Surrounding Land Uses

No accurate land use mapping of the area surrounding the airport was made available to the consultant. In addition, the consultant has been advised by BCAD that no formal legal boundary has been established for the MYEF airport lands. As a result, the noise exposure contour outputs generated from the model were superimposed on an aerial image of the airport and the surrounding areas. (Note that the imagery used was sourced from Google Earth and therefore is not orthorectified to provide a true planar image. As a result, the locational accuracy of specific land uses cannot be verified.)

Table 4-6 summarizes the total land area (in acres) that encompasses the key noise contours under the various noise model scenarios. These areas are helpful in quantifying the increased impact to surrounding land areas under various future airport scenarios.

Table 4-6 – Total Land Area Encompassed by Key Noise Contours

| Scenario Description | Total Encompassed Land Area (in acres) | | |
|---|---|---|---|
| | NEF 25 | NEF 30 | NEF 35 |
| Existing Year 2015 Aircraft Operations | 170.5 | 67.5 | 48.7 |
| Scenario A – Projected Year 2035 Aircraft Operations | 231.0 | 94.4 | 64.2 |
| Scenario B – Projected Year 2035 Aircraft Operations with 5% Allocated to Nighttime Operations | 373.1 | 148.5 | 100.6 |
| Scenario C – Projected Year 2035 Aircraft Operations with 1000 foot Extension to Runway 30 | 376.6 | 155.9 | 103.8 |

Source: Aviotec International Inc.

As is discussed in Section 5, the NEF 30 contour has been recommended as the critical limitation for incompatible land uses, above which noise mitigation or elimination strategies should be undertaken by the airport.

Based on a site visit by the consultant, interpretation of the aerial imagery and the NEF noise contour mapping, there do not appear to be any current incompatible land uses, such as residential or public/community uses, that fall within the > NEF 30 zone either now or through the planning horizon (to 2035).

Nevertheless, the consultant offers the following recommendations:

- Recommendation #1 – BCAD and local Exuma government adminstrators should limit or control any new development within the > NEF 25 zone which are deemed to be incompatible in accordance with the guidelines in Table 5-2.
- Recommendation #2 – BCAD should formalize a legal boundary for the airport lands, which encompasses sufficient land base to allow the effective control of critical lands from an aviation safety, airport operations, noise exposure and future expansion perspective.
- Recommendation #3 - Under Scenarios B and C, BCAD should monitor the impacts of aircraft noise on the existing residential properties situated about 3,100 feet southeast of Runway 30, which may in the future fall within the > NEF 25 zone.

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# 5 Recommended Land Use Guidelines

## 5.1 The Evolution of Airport and Surrounding Land Uses

Aircraft noise is often cited as the concern voiced by communities and is often the primary reason for opposing airport development and improvements to air traffic management. However, individual and community responses to aircraft noise are subjective with some residents responding with annoyance or irritation, while others have little to no response. Prospective residents of areas exposed to airborne and ground based aircraft noise should make an informed decision by understanding their tolerance to aircraft noise and act accordingly.

Flight paths and procedures are designed to ICAO standards, and in many cases changes cannot easily be accommodated to minimize noise and overflights of populated areas without impacting the safety of the aviation system. Ad hoc solutions often offered by residents such as “have the aircraft only fly over the water” or “have the aircraft fly higher” are over-simplified solutions to a very technical, safety-driven and complex issue.

Aviation noise is a community and social impact that the aviation industry and airport operators assign significant resources to mitigate; however, the efforts of residents to educate themselves and understand the challenges associated with the many issues is a significant stride in managing the impacts of noise from aircraft operations.

A major concern related to the creation and expansion of airports is incompatible land use, in and around noise-sensitive (such as hospitals and educational institutions) and residential communities. For instance, past studies have shown that residential populations tend to move towards airports, which ultimately lead to complaints by community members and a negative public perception of the airport (Kelly, 1997).

Despite this negative community reaction, the aviation industry continues to develop new services to meet the demands of our dynamic economy. Airports create employment opportunities, thereby making areas around airports major industrial compounds that increase the local rate of employment. Businesses that rely upon the aviation industry are established in the vicinity of airports to reduce the cost of transporting goods and supplies. A study by McMillan (2004) suggests that better employment opportunities also attract people toward airports. A large number of people want to live as close as possible to their place of employment, thus minimizing their time commuting to work. This leads to more residents near the airport and, in turn, the construction of schools, hospitals, shopping centers, churches, and other community facilities. Often there is prime land located near an airport, thus attracting developers, and in turn resulting in higher development of those areas, which results in increased air traffic. Therefore, it becomes absolutely essential to ensure the compatibility of land uses around airports.

## 5.2 Community Response to Aircraft Noise

In the 1990’s, Transport Canada undertook a study of noise complaints at twenty-one (21) Canadian airports. The noise complaint data was analyzed as to severity, frequency of complaint, and distribution around the airports to establish a relationship with known noise values. It was found that the community response results from the study correlated well with the specific noise exposure mapping then in use at the specific airports. Based on the Transport Canada study and predecessor studies undertaken in the United States, Table 5-1 presents the predicted community response at various Noise Exposure Forecast (NEF) contour levels.

Table 5-1 – Predicted Community Response to Aircraft Noise

| Response Levels | Community Response Prediction |
|---|---|
| 1 (over 40 NEF) | Repeated and vigorous individual complaints are likely. Concerted group and legal action might be expected |
| 2 (35-40 NEF) | Individual complaints may be vigorous. Possible group action and appeals to authorities. |
| 3 (30-35 NEF) | Sporadic to repeated individual complaints. Group action is possible. |
| 4 (below 30 NEF) | Sporadic complaints may occur. Noise may interfere occasionally with certain activities of the residents. |

Source: Land Use In The Vicinity of Aerodromes, Doc. No. TP1247E, Transport Canada, 2013-2014.

The noise exposure forecast mapping for MYEF which was presented in Section 4 can be an effective tool in identifying incompatible land uses. Suitable land use compatibility guidelines can be used to screen for problems with existing or proposed land uses.

Table 5-2 below presents a recommended set of land use compatibility guidelines which have been adapted from guidelines developed by Transport Canada. These and other similar guidelines have been based on a compilation of results from past scientific research into noise-related activity interference and attitudinal response. However, the usefulness of guidelines can be limited by the highly subjective nature of an individual's response to noise, and the fact that special circumstances can affect individual tolerances. For example, a high, non-aircraft background noise level can reduce the significance of aircraft noise, such as in areas constantly exposed to relatively high levels of vehicular or marine traffic noise. Alternatively, residents of areas with unusually low background noise levels may find relatively low levels of aircraft noise annoying.

Table 5-2 – Recommended Land Use Compatibility Guidelines

| Noise Exposure Forecast Values | > 40 | 40-35 | 35-30 | < 30 |
|---|---|---|---|---|
| Response Areas | 1 | 2 | 3 | 4 |
| I. RESIDENTIAL | | | | |
| Detached, Semi-Detached Homes | NO | NO | NO | 1 |
| Town Houses, Garden Homes | NO | NO | NO | 1 |
| Apartments, Condominiums | NO | NO | NO | 1 |

1 Annoyance caused by aircraft noise may begin as low as NEF 25. It is recommended that developers be made aware of this fact and that they undertake to so inform all prospective tenants or purchasers of residential units. In addition, it is suggested that development should not proceed until the responsible authority is satisfied that acoustic insulation features, if required, have been considered.

| Noise Exposure Forecast Values | > 40 | 40-35 | 35-30 | < 30 |
|---|---|---|---|---|
| Response Areas | 1 | 2 | 3 | 4 |
| II. RECREATIONAL – OUTDOOR USES | | | | |
| Athletic Fields | NO | 2 | 3 | YES |
| Stadiums | NO | NO | 3 | YES |
| Theatres - Outdoor | NO | NO | NO | 4 |
| Racetracks - Horses | NO | 3 | 3 | YES |
| Racetracks - Autos | YES | YES | YES | YES |
| Fairgrounds | 3 | 3 | YES | YES |
| Golf Courses | YES | YES | YES | YES |
| Beaches and Pools | YES | YES | YES | YES |
| Tennis Courts | NO | 3 | YES | YES |
| Playgrounds | 3 | 3 | YES | YES |
| Marinas | YES | YES | YES | YES |
| Camping Grounds | NO | NO | NO | NO |
| Park and Picnic Areas | NO | 3 | YES | YES |

2 Undesirable if there is spectator involvement.
3 It is recommended that serious consideration be given to an analysis of peak noise levels and the effects of these levels on the specific land use under consideration.
4 Facilities of this nature should not be located close to the NEF 30 contour unless a detailed noise analysis has been conducted.

| | | | | |
|---|---|---|---|---|
| III. COMMERCIAL USES | | | | |
| Offices | 5 | 6 | 7 | YES |
| Retail Sales | 5 | 7 | YES | YES |
| Restaurants | 5 | 7 | 7 | YES |
| Indoor Theatres | NO | 8 | 7 | YES |
| Hotels and Motels | NO | 5 | 8 | YES |
| Parking Lots | YES | YES | YES | YES |
| Gasoline Stations | YES | YES | YES | YES |
| Warehouses | YES | YES | YES | YES |
| Outdoor Sales | 7 | YES | YES | YES |

5 Use should only be permitted if related directly to aviation-oriented activities or services. Conventional construction will generally be inadequate and therefore noise insulation features may be required in the building design.
6 Use should only be considered if a detailed noise analysis is conducted to ensure a reasonable indoor environment suited to office functions.
7 Use should only be approved upon completion of a detailed noise analysis and the required noise reduction features considered in the facility development & design.
8 Generally, these facilities should not be permitted in this zone. However, where it can be demonstrated that such a land use is highly desirable, construction may be permitted provided that a detailed noise analysis is conducted and the required noise insulation features are included in the building design.

| Noise Exposure Forecast Values | > 40 | 40-35 | 35-30 | < 30 |
|---|---|---|---|---|
| Response Areas | 1 | 2 | 3 | 4 |
| **IV. PUBLIC USES** | | | | |
| Schools | NO | NO | 9 | YES |
| Churches | NO | NO | 9 | YES |
| Hospitals | NO | NO | NO | 9 |
| Nursing Homes | NO | NO | NO | 9 |
| Auditoriums | NO | NO | 9 | YES |
| Libraries | NO | NO | 9 | YES |
| Community Centres | NO | NO | 9 | YES |
| Cemeteries | YES | YES | YES | YES |
| 9 Use should only be approved upon completion of a detailed noise analysis and the required noise insulation features considered in the building design. | | | | |
| **V. MUNICIPAL UTILITIES** | | | | |
| Electric Generating Plants | YES | YES | YES | YES |
| Gas & Oil Storage | YES | YES | YES | YES |
| Garbage Disposal | YES | YES | YES | YES |
| Sewage Treatment | YES | YES | YES | YES |
| Water Treatment | YES | YES | YES | YES |
| Water Storage | YES | YES | YES | YES |
| **VI. INDUSTRIAL** | | | | |
| Factories | 10 | 10 | YES | YES |
| Machine Shops | 10 | 10 | YES | YES |
| Ship or Rail Yards | YES | YES | YES | YES |
| Cement Plants | 10 | 10 | YES | YES |
| Quarries | YES | YES | YES | YES |
| Refineries | 10 | 10 | YES | YES |
| Laboratories | NO | 11 | YES | YES |
| Lumber Yards | YES | YES | YES | YES |
| Saw Mills | 10 | 10 | YES | YES |
| 10 Use is typically acceptable in all NEF zones; however, consideration should be given to internally generated noise levels, and acceptable noise levels in working areas. | | | | |
| 11 Use should only be approved upon completion of a detailed noise analysis and the required noise insulation features considered in the building design. | | | | |
| **VII. TRANSPORTATION** | | | | |
| Highways | YES | YES | YES | YES |
| Railroads | YES | YES | YES | YES |
| Shipping Terminals | YES | YES | YES | YES |
| Passenger Terminals | 12 | YES | YES | YES |

| Noise Exposure Forecast Values | > 40 | 40-35 | 35-30 | < 30 |
|---|---|---|---|---|
| Response Areas | 1 | 2 | 3 | 4 |
| 12 Use should only be approved upon completion of a detailed noise analysis and the required noise insulation features considered in the building design. | | | | |
| VIII. AGRICULTURE | | | | |
| Crop Farms | YES | YES | YES | YES |
| Market Gardens | YES | YES | YES | YES |
| Plant Nurseries | YES | YES | YES | YES |
| Tree Farms | YES | YES | YES | YES |
| Livestock Pastures | 13 | YES | YES | YES |
| Poultry Farms | 14 | 14 | YES | YES |
| Stockyards | 13 | YES | YES | YES |
| Dairy Farms and Feed Lots | 13 | YES | YES | YES |
| 13 Research has shown that animals condition themselves to high noise levels; however, it is recommended that peak noise levels be assessed before this use is permitted. | | | | |
| 14 The construction of covered enclosures should be undertaken if this use is to be newly introduced to the noise environment and refer to Note 13. | | | | |

Source: Aviotec International Inc. adapted from "Land Use In The Vicinity of Aerodromes", Doc. No. TP1247E, Transport Canada, 2013-2014.

In Table 5-2 where reference is made to a detailed on-site noise analysis, or to peak noise levels, the notes are intended to apply specifically to existing aerodromes, where a field assessment is possible. For planning with respect to new aerodromes, such zones should be considered cautionary. Before reaching a final decision with respect to permitting a particular land use, the particular responsible authority may wish to consider local topographic effects and ambient noise levels, in conjunction with generalized peak noise level "footprints" for the predominant aircraft types intended to use the new aerodrome.

The analysis of the effect of aircraft noise on various working and living environments is a complex matter. For each case where there is a note in the Land Use Guidelines (Table 5-2), it is desirable that a noise climate analysis or a noise reduction requirement analysis be undertaken, since each note indicates a particular specialised problem.

## 5.3 Application of Land Use Guidelines

The purpose of the Land Use Compatibility Guidelines in Table 5-2 are to provide guidance and identify a process for assessing land use compatibility relative to areas exposed to aircraft noise. However, these guidelines are generalised for a typical airport and surrounding community environment, and thus should not be strictly applied to an airport, such as MYEF.

The responsible authority, which is typically the governing District Council under the authority bestowed unto it by the Bahamas' Local Government Act (1996), should adapt the guidelines to the island community's specific activities and environment. As well, for key land uses, such as residential developments and public gathering spaces, the District Council should incorporate reasonable land use control measures within their local zoning by-laws in order to ensure the long-term compatibility of the community with aircraft operations. These controls could be directly tied to and limited by specific NEF contour lines.

Where an aerodrome is already surrounded by residential or other noise sensitive land uses, the intent of land use planning guidelines is to prevent any increases in incompatible land use. As urbanisation increases, any new aerodrome would, by necessity, be planned for and built in non-urban areas. Therefore, where a new aerodrome is planned on land designated as an airport site, an opportunity exists to establish appropriate land use planning guidelines that recognize the unique noise environment of a non-urban area and preserve the balance between the integrity of the future aerodrome and the quality of life of the community that it will serve. The encroachment of incompatible, sensitive land uses is clearly a vital factor in planning and establishing appropriate protection criteria for new aerodromes. The best and often only opportunity to establish a sufficient buffer zone to control noise sensitive development around a new aerodrome is in the initial planning stage of that new aerodrome. This opportunity diminishes quickly as the aerodrome develops and community land use patterns become established. In addition to the traditional approach of defining land use planning guidelines, pertinent factors should be considered when establishing land use guidelines for new aerodromes including not only individual activity interference (speech and sleep) criteria, but also habituation to noise, the type of environment (non-urban versus urban environment), community attitudes toward the noise source, the extent of prior exposure to the noise source, and the type of flight operations causing the noise.

For new aerodromes, we recommend that no new noise sensitive land uses be permitted above the 25 NEF level. Noise sensitive land uses include residential, schools, day care centres, nursing homes and hospitals. Using such a noise limitation ensures ease of implementation and administration since below a 25 NEF, all land uses are permissible without restriction. Also, such a limitation protects against the long-term uncertainties inherent in planning for a new aerodrome.

For existing aerodromes, the guidelines in Table 5-2 should be followed. Specifically, we recommend that residential development be limited to areas that have an NEF of 30 or lower. However, in areas with an NEF of between 30 and 25, residential development should not proceed until the responsible authority is satisfied that home acoustic insulation features, as may be required under local building code requirements, are adequate for the purpose of limiting annoyance from aircraft noise.

It is recommended that noise exposure mapping should be revised every 5 to 10 years, or whenever a critical change occurs to aircraft operations and/or the airport's physical configuration or capabilities.

# 6 Noise Management Strategies

## 6.1 Requirement for Noise Management

Based on the results of the aircraft noise modelling for MYEF undertaken as part of this study, there are no immediate concerns with regard to noise exposure or impacts on surrounding land uses which would necessitate aircraft noise mitigation or elimination measures at this time.

Nevertheless, it is incumbent on BCAD and local Exuma government administrators to be aware of the range of noise management strategies which are available to them in the event that conditions at the airport change dramatically (such as rapid growth in aircraft movements or the introduction of nighttime operations). The remainder of this section provides guidance in the establishment of an Airport Noise Management Plan and specific measures, regulations and policies which could be utilised at MYEF to mitigate or eliminate noise exposure impacts.

## 6.2 Establishing a Noise Management Plan

The development of an effective Noise Management Plan (NMP) begins with an evaluation of all reasonable and feasible strategies that could be employed to reduce or control potential land use non-compatibilities which have been identified through the noise exposure mapping process, or to prevent the formation of additional incompatible land uses within critical areas.

NMP land use strategies generally fall into three (3) principal categories

- Operational Measures – these measures are applied at the airfield or to aircraft operations and include changes in runway use or changes in flight path locations;
- Preventative Measures – these are control measures intended to prevent the introduction of new noise-sensitive land uses within existing and future airport noise contours at sensitive levels; such measures include compatible land use zoning or noise overlay zoning within off-airport noise exposure areas; and
- Remedial (Corrective) Measures – these are mitigation measures applied to existing incompatible land uses; such measures include property acquisition or sound insulation of homes.

### 6.2.1 Operational Measures

Operational measures are those that seek to alter or restrict aircraft operations or implement facility development which will reduce the exposure or impact of aircraft noise. These are measures that generally must be implemented by the airport. Examples include the following.

- Flight Track Changes: Evaluate potential changes to existing published approach and departure tracks to reduce noise in specific community areas, or the implementation of a Continuous Descent Arrivals (CDA) procedure which allows an aircraft to perform a continuous descent at idle power from a high altitude to glide slope intercept on the final approach to the runway.

- Flight Management: Develop the use of advanced navigation procedures that have the potential to more accurately define arrival and departure procedures at an airport, thus narrowing flight corridors and reducing noise exposure by avoiding the more densely populated residential areas.; for example the establishment of Area Navigation (RNAV) Overlay Procedures, Required Navigation Performance (RNP), or the National Business Aviation Association's (NBAA) recommended Noise Abatement Procedures (e.g. close-in departure procedures).
- Preferential Runway Use: When meteorological (wind) conditions permit, encourage the use of specific runway ends for landing or take-off to minimise flight over populated areas.
- Flight Constraints or Restrictions: Implement operating curfews and fines or aircraft type restrictions, particularly to limit activity during nighttime hours.
- Reverse Thrust Reduction and Monitoring: Pilots use reverse thrust after landing to improve safety margins by providing a retardation largely independent of runway surface conditions. Because of the safety considerations, it is not possible to altogether ban the use of this technique, however, the airport can encourage the use of balanced braking techniques.
- De-rated Thrust Departure Procedure: A take-off procedure used in jet aircraft (usually narrow and wide-body) that employs less than maximum thrust to complete a safe take-off roll and climb-out. This procedure can be used safely when an aircraft is at less than the maximum takeoff weight.
- Implement Noise Attenuating Structures: Consists of the construction of physical structures that are designed to reflect or absorb noise, such as noise berms/walls or ground run-up barriers.
- Establish Noise Attenuating Standards: Encourage or require the design of airport facilities and buildings to reflect/absorb aircraft ground noise; this could also extend to the physical siting of buildings to improve sound attenuation.

### 6.2.2 Preventative Measures

Preventative land use management techniques seek to prevent the introduction of additional noise-sensitive land uses within existing and future airport noise contours. Preventative measures include two categories – regulatory and policy.

*Regulatory:*

- Compatible Use Zoning: commercial, industrial, or farmland zoning.
- Zoning Changes, Residential Density: large-lot zoning, planned development or multi-family zoning with the intent of controlling residential densities in order to reduce the number of residents impacted by aircraft noise.
- Noise Overlay Zoning: special regulations within high-noise areas.
- Transfer of Development Rights: zoning framework to authorize the private sale of development rights to encourage sparse development in high-noise areas
- Environmental Zoning: environmental protection zoning to support airport land use

compatibility.

- Subdivision Regulation Changes: require dedication of noise and avigation easements, plat notes
- Building Code Changes: establish codes to ensure measures to reduce interior noise level; require soundproofing in new construction.
- Dedicated Noise and Avigation Easements: gives the right to fly over a particular property including its associated impacts (e.g. noise).
- Fair Disclosure Regulations: require property seller to notify property buyer of aircraft noise impacts; official notification should be attached to the property.
- Preventative Property Acquisition: voluntary sale of properties to avoid residential development and rezoned by local authorities as undeveloped, open space or farm field.

*Policy:*

- Comprehensive Planning: policies supporting land use compatibility. Can involve specific land use plans and policies to guide rezoning, variances, conditional uses, public projects.
- Capital Improvement Programming: public investments which support airport land use compatibility.

### 6.2.3 Remedial Land Use Management Techniques

Remedial land use management techniques seek to remedy existing and projected future unavoidable noise impacts in existing areas of incompatible land use.

Remedial land use management techniques can be classified under two general categories: modifying use and maintaining use. Examples measures include the following.

*Modifying Existing Use:*

- Guaranteed Purchase (Fee Simple): outright purchase of property with the intent of removing incompatible use by demolition of structure.
- Development Rights Purchase: purchase of rights to develop property.
- Land Banking: acquisition of vacant land for long-term airport facility needs.
- Redevelopment: acquisition and redevelopment of property.

*Maintaining Existing Use:*

- Purchase Assurance: airport sponsor acts as buyer of last resort, sound insulates house, sells property, retains easement.
- Sales Assistance: airport sponsor sound insulates house; guarantees that the property owner will receive the appraised value, or some increment thereof, regardless of final sales value that is negotiated with a buyer; retains easement.

- Sound Attenuation: sound insulation of houses; noise-sensitive public facilities; retains easement.
- Noise and Avigation Easement Purchase: purchase of easement only.

### 6.2.4 Community and Stakeholder Outreach

A successful noise management program also requires the use of active and passive media techniques to effectively communicate noise management information to all airport and community stakeholders. Although the benefits of a media communication campaign are mainly indirect; the true benefit is improved credibility and trust between the airport and all stakeholders. BCAD and the MYEF staff should continuously communicate noise exposure information to all stakeholders that both responds to and manages public expectations, using easy to understand metrics and terminology.

For specific airport users and airlines, MYEF should establish a noise advisory committee that periodically meets to discuss specific noise issues and mitigation measures.

## 6.3 Role of Local Government and Authorities

Local governments play an important role in minimising the size of the population affected by aircraft noise by introducing more restrictive land-use zoning around airports. As previously noted, many of the recommended land use control measures and strategies cannot be implemented solely by the airport operator, but must be initiated by local government or other authorities having jurisdiction. Nevertheless, it is incumbent on the airport operator to identify and assess the control measures which can best serve to mitigate or eliminate the impacts of aircraft noise, and encourage their implementation by the local authority having jurisdiction. Otherwise, the airport operator may feel the downstream implications of public dissatisfaction in the form of regular noise complaints, nuisance lawsuits, or public opposition to future proposals for airport expansion.

The airport operator should therefore plan to meet with local authorities having jurisdiction on a periodic basis to discuss changes in airport or aircraft use, proposed airport developments, etc. to ensure that land use compatibility measures being considered or currently in place are still validate and effective.

# APPENDIX A – NEF Noise Model Parameters and Inputs

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# Nef-Calc
## MYEF - Runway

| **Runway** | 12 | | |
|---|---|---|---|
| **Start X** | 0.00 kFt | **End X** | 6.19 kFt |
| **Start Y** | 0.00 kFt | **End Y** | -3.27 kFt |

**Notes**

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| **Runway** | 30 | | |
|---|---|---|---|
| **Start X** | 6.19 kFt | **End X** | 0.00 kFt |
| **Start Y** | -3.27 kFt | **End Y** | 0.00 kFt |

**Notes**

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# Nef-Calc
## MYEF - Runway Extension

| | | | |
|---|---|---|---|
| **Runway** | 12 | | |
| **Start X** | 0.00 kFt | **End X** | 7.06 kFt |
| **Start Y** | 0.00 kFt | **End Y** | -3.75 kFt |

**Notes**

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| | | | |
|---|---|---|---|
| **Runway** | 30 | | |
| **Start X** | 7.06 kFt | **End X** | 0.00 kFt |
| **Start Y** | -3.75 kFt | **End Y** | 0.00 kFt |

**Notes**

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# Nef-Calc

## MYEF - Flightpaths

**FLIGHTPATH** 12AP1

**Runway** 12

**Type** Approach

**Glide Slope 1 (GS1)** 3.00 degs.
**Altitude that GS1 starts** 3.00 kFt
**Glide Slope 2 (GS2)** 3.00 degs.
**Distance from runway wher** 11.00 kFt

**Notes**

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**FLIGHTPATH** 30AP1

**Runway** 30

**Type** Approach

**Glide Slope 1 (GS1)** 3.00 degs.
**Altitude that GS1 starts** 3.00 kFt
**Glide Slope 2 (GS2)** 3.00 degs.
**Distance from runway wher** 11.00 kFt

**Notes**

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**FLIGHTPATH** 12DP1

**Runway** 12

**Type** One Turn Departure

**1st Turn Direction** Right
**Angle of Turn** 91.00 degs.
**Criteria for Turn Start** Height 3.00 kFt
**Turn Criteria** Rate 1.00 3 degs/Sec

**Notes**

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# Nef-Calc

## MYEF - Flightpaths

| | |
|---|---|
| **FLIGHTPATH** | 30DP1 |
| **Runway** | 30 |
| **Type** | One Turn Departure |

| | | | |
|---|---|---|---|
| **1st Turn Direction** | Right | | |
| **Angle of Turn** | 62.00 | degs. | |
| **Criteria for Turn Start** | Height | 3.00 | kFt |
| **Turn Criteria** | Rate | 1.00 | 3 degs/Sec |

**Notes**

| ACODE | FLIGHTPATH | Range | DayTimeEvents | NightTimeEvents |
|---|---|---|---|---|
| **717** | | | | |
| 717 | 12AP1 | 0 | 0.09 | 0.00 |
| 717 | 30AP1 | 0 | 0.03 | 0.00 |
| 717 | 12DP1 | 2 | 0.09 | 0.00 |
| 717 | 30DP1 | 2 | 0.03 | 0.00 |
| **717** | | | **0.24** | **0.00** |
| **737500** | | | | |
| 737500 | 12AP1 | 0 | 0.09 | 0.00 |
| 737500 | 30AP1 | 0 | 0.03 | 0.00 |
| 737500 | 12DP1 | 1 | 0.09 | 0.00 |
| 737500 | 30DP1 | 1 | 0.03 | 0.00 |
| **737500** | | | **0.24** | **0.00** |
| **A319** | | | | |
| A319 | 12AP1 | 0 | 0.45 | 0.00 |
| A319 | 30AP1 | 0 | 0.15 | 0.00 |
| A319 | 12DP1 | 2 | 0.45 | 0.00 |
| A319 | 30DP1 | 2 | 0.15 | 0.00 |
| **A319** | | | **1.20** | **0.00** |
| **BAE146** | | | | |
| BAE146 | 12AP1 | 0 | 0.09 | 0.00 |
| BAE146 | 30AP1 | 0 | 0.03 | 0.00 |
| BAE146 | 12DP1 | 1 | 0.09 | 0.00 |
| BAE146 | 30DP1 | 1 | 0.03 | 0.00 |
| **BAE146** | | | **0.24** | **0.00** |
| **BEC58P** | | | | |
| BEC58P | 12AP1 | 0 | 7.82 | 0.00 |
| BEC58P | 30AP1 | 0 | 2.61 | 0.00 |
| BEC58P | 12DP1 | 1 | 7.82 | 0.00 |
| BEC58P | 30DP1 | 1 | 2.61 | 0.00 |
| **BEC58P** | | | **20.85** | **0.00** |
| **CIT3** | | | | |
| CIT3 | 12AP1 | 0 | 0.27 | 0.00 |
| CIT3 | 30AP1 | 0 | 0.09 | 0.00 |
| CIT3 | 12DP1 | 1 | 0.27 | 0.00 |
| CIT3 | 30DP1 | 1 | 0.09 | 0.00 |
| **CIT3** | | | **0.72** | **0.00** |
| **CL601** | | | | |
| CL601 | 12AP1 | 0 | 3.55 | 0.00 |
| CL601 | 30AP1 | 0 | 1.18 | 0.00 |
| CL601 | 12DP1 | 2 | 3.55 | 0.00 |
| CL601 | 30DP1 | 2 | 1.18 | 0.00 |
| **CL601** | | | **9.47** | **0.00** |

| ACODE | FLIGHTPATH | Range | DayTimeEvents | NightTimeEvents |
|---|---|---|---|---|
| **CNA441** | | | | |
| CNA441 | 12AP1 | 0 | 0.90 | 0.00 |
| CNA441 | 30AP1 | 0 | 0.30 | 0.00 |
| CNA441 | 12DP1 | 1 | 0.90 | 0.00 |
| CNA441 | 30DP1 | 1 | 0.30 | 0.00 |
| **CNA441** | | | **2.40** | **0.00** |
| **DHC6** | | | | |
| DHC6 | 12AP1 | 0 | 0.63 | 0.00 |
| DHC6 | 30AP1 | 0 | 0.21 | 0.00 |
| DHC6 | 12DP1 | 1 | 0.63 | 0.00 |
| DHC6 | 30DP1 | 1 | 0.21 | 0.00 |
| **DHC6** | | | **1.68** | **0.00** |
| **DHC830** | | | | |
| DHC830 | 12AP1 | 0 | 2.47 | 0.00 |
| DHC830 | 30AP1 | 0 | 0.82 | 0.00 |
| DHC830 | 12DP1 | 1 | 2.47 | 0.00 |
| DHC830 | 30DP1 | 1 | 0.82 | 0.00 |
| **DHC830** | | | **6.59** | **0.00** |
| **GASEPF** | | | | |
| GASEPF | 12AP1 | 0 | 4.45 | 0.00 |
| GASEPF | 30AP1 | 0 | 1.48 | 0.00 |
| GASEPF | 12DP1 | 1 | 4.45 | 0.00 |
| GASEPF | 30DP1 | 1 | 1.48 | 0.00 |
| **GASEPF** | | | **11.86** | **0.00** |
| **GASEPV** | | | | |
| GASEPV | 12AP1 | 0 | 0.67 | 0.00 |
| GASEPV | 30AP1 | 0 | 0.22 | 0.00 |
| GASEPV | 12DP1 | 1 | 0.67 | 0.00 |
| GASEPV | 30DP1 | 1 | 0.22 | 0.00 |
| **GASEPV** | | | **1.80** | **0.00** |
| **GIV** | | | | |
| GIV | 12AP1 | 0 | 0.36 | 0.00 |
| GIV | 30AP1 | 0 | 0.12 | 0.00 |
| GIV | 12DP1 | 2 | 0.36 | 0.00 |
| GIV | 30DP1 | 2 | 0.12 | 0.00 |
| **GIV** | | | **0.96** | **0.00** |
| **LEAR35** | | | | |
| LEAR35 | 12AP1 | 0 | 0.40 | 0.00 |
| LEAR35 | 30AP1 | 0 | 0.13 | 0.00 |
| LEAR35 | 12DP1 | 1 | 0.40 | 0.00 |
| LEAR35 | 30DP1 | 1 | 0.13 | 0.00 |
| **LEAR35** | | | **1.08** | **0.00** |

| ACODE | FLIGHTPATH | Range | DayTimeEvents | NightTimeEvents |
|---|---|---|---|---|
| **MU3001** | | | | |
| MU3001 | 12AP1 | 0 | 1.08 | 0.00 |
| MU3001 | 30AP1 | 0 | 0.36 | 0.00 |
| MU3001 | 12DP1 | 1 | 1.08 | 0.00 |
| MU3001 | 30DP1 | 1 | 0.36 | 0.00 |
| **MU3001** | | | **2.88** | **0.00** |
| **SF340** | | | | |
| SF340 | 12AP1 | 0 | 3.06 | 0.00 |
| SF340 | 30AP1 | 0 | 1.02 | 0.00 |
| SF340 | 12DP1 | 1 | 3.06 | 0.00 |
| SF340 | 30DP1 | 1 | 1.02 | 0.00 |
| **SF340** | | | **8.15** | **0.00** |
| **Grand Total:** | | | **70.35** | **0.00** |

| ACODE | FLIGHTPATH | Range | DayTimeEvents | NightTimeEvents |
|---|---|---|---|---|
| **717** | | | | |
| 717 | 12AP1 | 0 | 0.13 | 0.00 |
| 717 | 30AP1 | 0 | 0.04 | 0.00 |
| 717 | 12DP1 | 1 | 0.13 | 0.00 |
| 717 | 30DP1 | 1 | 0.04 | 0.00 |
| **717** | | | **0.34** | **0.00** |
| **737500** | | | | |
| 737500 | 12AP1 | 0 | 0.13 | 0.00 |
| 737500 | 30AP1 | 0 | 0.04 | 0.00 |
| 737500 | 12DP1 | 1 | 0.13 | 0.00 |
| 737500 | 30DP1 | 1 | 0.04 | 0.00 |
| **737500** | | | **0.34** | **0.00** |
| **A319** | | | | |
| A319 | 12AP1 | 0 | 0.66 | 0.00 |
| A319 | 30AP1 | 0 | 0.22 | 0.00 |
| A319 | 12DP1 | 1 | 0.66 | 0.00 |
| A319 | 30DP1 | 1 | 0.22 | 0.00 |
| **A319** | | | **1.76** | **0.00** |
| **BAE146** | | | | |
| BAE146 | 12AP1 | 0 | 0.13 | 0.00 |
| BAE146 | 30AP1 | 0 | 0.04 | 0.00 |
| BAE146 | 12DP1 | 1 | 0.13 | 0.00 |
| BAE146 | 30DP1 | 1 | 0.04 | 0.00 |
| **BAE146** | | | **0.34** | **0.00** |
| **BEC58P** | | | | |
| BEC58P | 12AP1 | 0 | 11.57 | 0.00 |
| BEC58P | 30AP1 | 0 | 3.86 | 0.00 |
| BEC58P | 12DP1 | 1 | 11.57 | 0.00 |
| BEC58P | 30DP1 | 1 | 3.86 | 0.00 |
| **BEC58P** | | | **30.86** | **0.00** |
| **CIT3** | | | | |
| CIT3 | 12AP1 | 0 | 0.40 | 0.00 |
| CIT3 | 30AP1 | 0 | 0.13 | 0.00 |
| CIT3 | 12DP1 | 1 | 0.40 | 0.00 |
| CIT3 | 30DP1 | 1 | 0.13 | 0.00 |
| **CIT3** | | | **1.06** | **0.00** |
| **CL601** | | | | |
| CL601 | 12AP1 | 0 | 5.25 | 0.00 |
| CL601 | 30AP1 | 0 | 1.75 | 0.00 |
| CL601 | 12DP1 | 1 | 5.25 | 0.00 |
| CL601 | 30DP1 | 1 | 1.75 | 0.00 |
| **CL601** | | | **14.00** | **0.00** |

| ACODE | FLIGHTPATH | Range | DayTimeEvents | NightTimeEvents |
|---|---|---|---|---|
| **CNA441** | | | | |
| CNA441 | 12AP1 | 0 | 1.33 | 0.00 |
| CNA441 | 30AP1 | 0 | 0.44 | 0.00 |
| CNA441 | 12DP1 | 1 | 1.33 | 0.00 |
| CNA441 | 30DP1 | 1 | 0.44 | 0.00 |
| **CNA441** | | | **3.54** | **0.00** |
| **DHC6** | | | | |
| DHC6 | 12AP1 | 0 | 0.93 | 0.00 |
| DHC6 | 30AP1 | 0 | 0.31 | 0.00 |
| DHC6 | 12DP1 | 1 | 0.93 | 0.00 |
| DHC6 | 30DP1 | 1 | 0.31 | 0.00 |
| **DHC6** | | | **2.48** | **0.00** |
| **DHC830** | | | | |
| DHC830 | 12AP1 | 0 | 3.66 | 0.00 |
| DHC830 | 30AP1 | 0 | 1.22 | 0.00 |
| DHC830 | 12DP1 | 1 | 3.66 | 0.00 |
| DHC830 | 30DP1 | 1 | 1.22 | 0.00 |
| **DHC830** | | | **9.76** | **0.00** |
| **GASEPF** | | | | |
| GASEPF | 12AP1 | 0 | 6.58 | 0.00 |
| GASEPF | 30AP1 | 0 | 2.19 | 0.00 |
| GASEPF | 12DP1 | 1 | 6.58 | 0.00 |
| GASEPF | 30DP1 | 1 | 2.19 | 0.00 |
| **GASEPF** | | | **17.54** | **0.00** |
| **GASEPV** | | | | |
| GASEPV | 12AP1 | 0 | 1.00 | 0.00 |
| GASEPV | 30AP1 | 0 | 0.33 | 0.00 |
| GASEPV | 12DP1 | 1 | 1.00 | 0.00 |
| GASEPV | 30DP1 | 1 | 0.33 | 0.00 |
| **GASEPV** | | | **2.66** | **0.00** |
| **GIV** | | | | |
| GIV | 12AP1 | 0 | 0.53 | 0.00 |
| GIV | 30AP1 | 0 | 0.18 | 0.00 |
| GIV | 12DP1 | 1 | 0.53 | 0.00 |
| GIV | 30DP1 | 1 | 0.18 | 0.00 |
| **GIV** | | | **1.42** | **0.00** |
| **LEAR35** | | | | |
| LEAR35 | 12AP1 | 0 | 0.60 | 0.00 |
| LEAR35 | 30AP1 | 0 | 0.20 | 0.00 |
| LEAR35 | 12DP1 | 1 | 0.60 | 0.00 |
| LEAR35 | 30DP1 | 1 | 0.20 | 0.00 |
| **LEAR35** | | | **1.60** | **0.00** |

| ACODE | FLIGHTPATH | Range | DayTimeEvents | NightTimeEvents |
|---|---|---|---|---|
| **MU3001** | | | | |
| MU3001 | 12AP1 | 0 | 1.60 | 0.00 |
| MU3001 | 30AP1 | 0 | 0.53 | 0.00 |
| MU3001 | 12DP1 | 1 | 1.60 | 0.00 |
| MU3001 | 30DP1 | 1 | 0.53 | 0.00 |
| **MU3001** | | | **4.26** | **0.00** |
| **SF340** | | | | |
| SF340 | 12AP1 | 0 | 4.52 | 0.00 |
| SF340 | 30AP1 | 0 | 1.51 | 0.00 |
| SF340 | 12DP1 | 1 | 4.52 | 0.00 |
| SF340 | 30DP1 | 1 | 1.51 | 0.00 |
| **SF340** | | | **12.06** | **0.00** |
| **Grand Total:** | | | **104.02** | **0.00** |

| ACODE | FLIGHTPATH | Range | DayTimeEvents | NightTimeEvents |
|---|---|---|---|---|
| **717** | | | | |
| 717 | 12AP1 | 0 | 0.12 | 0.01 |
| 717 | 30AP1 | 0 | 0.04 | 0.00 |
| 717 | 12DP1 | 1 | 0.12 | 0.01 |
| 717 | 30DP1 | 1 | 0.04 | 0.00 |
| **717** | | | **0.32** | **0.02** |
| **737500** | | | | |
| 737500 | 12AP1 | 0 | 0.12 | 0.01 |
| 737500 | 30AP1 | 0 | 0.04 | 0.00 |
| 737500 | 12DP1 | 1 | 0.12 | 0.01 |
| 737500 | 30DP1 | 1 | 0.04 | 0.00 |
| **737500** | | | **0.32** | **0.02** |
| **A319** | | | | |
| A319 | 12AP1 | 0 | 0.63 | 0.03 |
| A319 | 30AP1 | 0 | 0.21 | 0.01 |
| A319 | 12DP1 | 1 | 0.63 | 0.03 |
| A319 | 30DP1 | 1 | 0.21 | 0.01 |
| **A319** | | | **1.67** | **0.09** |
| **BAE146** | | | | |
| BAE146 | 12AP1 | 0 | 0.12 | 0.01 |
| BAE146 | 30AP1 | 0 | 0.04 | 0.00 |
| BAE146 | 12DP1 | 1 | 0.12 | 0.01 |
| BAE146 | 30DP1 | 1 | 0.04 | 0.00 |
| **BAE146** | | | **0.32** | **0.02** |
| **BEC58P** | | | | |
| BEC58P | 12AP1 | 0 | 10.99 | 0.58 |
| BEC58P | 30AP1 | 0 | 3.67 | 0.19 |
| BEC58P | 12DP1 | 1 | 10.99 | 0.58 |
| BEC58P | 30DP1 | 1 | 3.67 | 0.19 |
| **BEC58P** | | | **29.32** | **1.54** |
| **CIT3** | | | | |
| CIT3 | 12AP1 | 0 | 0.38 | 0.02 |
| CIT3 | 30AP1 | 0 | 0.12 | 0.01 |
| CIT3 | 12DP1 | 1 | 0.38 | 0.02 |
| CIT3 | 30DP1 | 1 | 0.12 | 0.01 |
| **CIT3** | | | **1.01** | **0.05** |
| **CL601** | | | | |
| CL601 | 12AP1 | 0 | 4.99 | 0.26 |
| CL601 | 30AP1 | 0 | 1.66 | 0.09 |
| CL601 | 12DP1 | 1 | 4.99 | 0.26 |
| CL601 | 30DP1 | 1 | 1.66 | 0.09 |
| **CL601** | | | **13.30** | **0.70** |

| ACODE | FLIGHTPATH | Range | DayTimeEvents | NightTimeEvents |
|---|---|---|---|---|
| **CNA441** | | | | |
| CNA441 | 12AP1 | 0 | 1.26 | 0.07 |
| CNA441 | 30AP1 | 0 | 0.42 | 0.02 |
| CNA441 | 12DP1 | 1 | 1.26 | 0.07 |
| CNA441 | 30DP1 | 1 | 0.42 | 0.02 |
| **CNA441** | | | **3.36** | **0.18** |
| **DHC6** | | | | |
| DHC6 | 12AP1 | 0 | 0.88 | 0.05 |
| DHC6 | 30AP1 | 0 | 0.29 | 0.02 |
| DHC6 | 12DP1 | 1 | 0.88 | 0.05 |
| DHC6 | 30DP1 | 1 | 0.29 | 0.02 |
| **DHC6** | | | **2.36** | **0.12** |
| **DHC830** | | | | |
| DHC830 | 12AP1 | 0 | 3.48 | 0.18 |
| DHC830 | 30AP1 | 0 | 1.16 | 0.06 |
| DHC830 | 12DP1 | 1 | 3.48 | 0.18 |
| DHC830 | 30DP1 | 1 | 1.16 | 0.06 |
| **DHC830** | | | **9.27** | **0.49** |
| **GASEPF** | | | | |
| GASEPF | 12AP1 | 0 | 6.25 | 0.33 |
| GASEPF | 30AP1 | 0 | 2.08 | 0.11 |
| GASEPF | 12DP1 | 1 | 6.25 | 0.33 |
| GASEPF | 30DP1 | 1 | 2.08 | 0.11 |
| **GASEPF** | | | **16.66** | **0.88** |
| **GASEPV** | | | | |
| GASEPV | 12AP1 | 0 | 0.95 | 0.05 |
| GASEPV | 30AP1 | 0 | 0.31 | 0.02 |
| GASEPV | 12DP1 | 1 | 0.95 | 0.05 |
| GASEPV | 30DP1 | 1 | 0.31 | 0.02 |
| **GASEPV** | | | **2.53** | **0.13** |
| **GIV** | | | | |
| GIV | 12AP1 | 0 | 0.50 | 0.03 |
| GIV | 30AP1 | 0 | 0.17 | 0.01 |
| GIV | 12DP1 | 1 | 0.50 | 0.03 |
| GIV | 30DP1 | 1 | 0.17 | 0.01 |
| **GIV** | | | **1.35** | **0.07** |
| **LEAR35** | | | | |
| LEAR35 | 12AP1 | 0 | 0.57 | 0.03 |
| LEAR35 | 30AP1 | 0 | 0.19 | 0.01 |
| LEAR35 | 12DP1 | 1 | 0.57 | 0.03 |
| LEAR35 | 30DP1 | 1 | 0.19 | 0.01 |
| **LEAR35** | | | **1.52** | **0.08** |

| ACODE | FLIGHTPATH | Range | DayTimeEvents | NightTimeEvents |
|---|---|---|---|---|
| **MU3001** | | | | |
| MU3001 | 12AP1 | 0 | 1.52 | 0.08 |
| MU3001 | 30AP1 | 0 | 0.50 | 0.03 |
| MU3001 | 12DP1 | 1 | 1.52 | 0.08 |
| MU3001 | 30DP1 | 1 | 0.50 | 0.03 |
| **MU3001** | | | **4.05** | **0.21** |
| **SF340** | | | | |
| SF340 | 12AP1 | 0 | 4.29 | 0.23 |
| SF340 | 30AP1 | 0 | 1.43 | 0.08 |
| SF340 | 12DP1 | 1 | 4.29 | 0.23 |
| SF340 | 30DP1 | 1 | 1.43 | 0.08 |
| **SF340** | | | **11.46** | **0.60** |
| **Grand Total:** | | | **98.82** | **5.20** |

# Nef-Calc

## MYEF - Airport Movements - 2015

| FLIGHTPATH | Aircraft Code | DayTime Events | NightTime Events |
|---|---|---|---|
| **12AP1** | | | |
| 12AP1 | GASEPF | 4.45 | 0.00 |
| 12AP1 | GASEPV | 0.67 | 0.00 |
| 12AP1 | BEC58P | 7.82 | 0.00 |
| 12AP1 | CNA441 | 0.90 | 0.00 |
| 12AP1 | DHC6 | 0.63 | 0.00 |
| 12AP1 | SF340 | 3.06 | 0.00 |
| 12AP1 | DHC830 | 2.47 | 0.00 |
| 12AP1 | BAE146 | 0.09 | 0.00 |
| 12AP1 | MU3001 | 1.08 | 0.00 |
| 12AP1 | CL601 | 3.55 | 0.00 |
| 12AP1 | LEAR35 | 0.40 | 0.00 |
| 12AP1 | GIV | 0.36 | 0.00 |
| 12AP1 | CIT3 | 0.27 | 0.00 |
| 12AP1 | 717 | 0.09 | 0.00 |
| 12AP1 | A319 | 0.45 | 0.00 |
| 12AP1 | 737500 | 0.09 | 0.00 |
| **12AP1** | | **26.38** | **0.00** |
| **12DP1** | | | |
| 12DP1 | GASEPF | 4.45 | 0.00 |
| 12DP1 | GASEPV | 0.67 | 0.00 |
| 12DP1 | BEC58P | 7.82 | 0.00 |
| 12DP1 | CNA441 | 0.90 | 0.00 |
| 12DP1 | DHC6 | 0.63 | 0.00 |
| 12DP1 | SF340 | 3.06 | 0.00 |
| 12DP1 | DHC830 | 2.47 | 0.00 |
| 12DP1 | BAE146 | 0.09 | 0.00 |
| 12DP1 | MU3001 | 1.08 | 0.00 |
| 12DP1 | CL601 | 3.55 | 0.00 |
| 12DP1 | LEAR35 | 0.40 | 0.00 |
| 12DP1 | GIV | 0.36 | 0.00 |
| 12DP1 | CIT3 | 0.27 | 0.00 |
| 12DP1 | 717 | 0.09 | 0.00 |
| 12DP1 | A319 | 0.45 | 0.00 |
| 12DP1 | 737500 | 0.09 | 0.00 |
| **12DP1** | | **26.38** | **0.00** |
| **30AP1** | | | |
| 30AP1 | GASEPF | 1.48 | 0.00 |
| 30AP1 | GASEPV | 0.22 | 0.00 |
| 30AP1 | BEC58P | 2.61 | 0.00 |
| 30AP1 | CNA441 | 0.30 | 0.00 |
| 30AP1 | DHC6 | 0.21 | 0.00 |
| 30AP1 | SF340 | 1.02 | 0.00 |
| 30AP1 | DHC830 | 0.82 | 0.00 |
| 30AP1 | BAE146 | 0.03 | 0.00 |
| 30AP1 | MU3001 | 0.36 | 0.00 |
| 30AP1 | CL601 | 1.18 | 0.00 |
| 30AP1 | LEAR35 | 0.13 | 0.00 |
| 30AP1 | GIV | 0.12 | 0.00 |
| 30AP1 | CIT3 | 0.09 | 0.00 |

# Nef-Calc

## MYEF - Airport Movements - 2015

| FLIGHTPATH | Aircraft Code | DayTime Events | NightTime Events |
|---|---|---|---|
| 30AP1 | 717 | 0.03 | 0.00 |
| 30AP1 | A319 | 0.15 | 0.00 |
| 30AP1 | 737500 | 0.03 | 0.00 |
| **30AP1** | | **8.79** | **0.00** |
| **30DP1** | | | |
| 30DP1 | GASEPF | 1.48 | 0.00 |
| 30DP1 | GASEPV | 0.22 | 0.00 |
| 30DP1 | BEC58P | 2.61 | 0.00 |
| 30DP1 | CNA441 | 0.30 | 0.00 |
| 30DP1 | DHC6 | 0.21 | 0.00 |
| 30DP1 | SF340 | 1.02 | 0.00 |
| 30DP1 | DHC830 | 0.82 | 0.00 |
| 30DP1 | BAE146 | 0.03 | 0.00 |
| 30DP1 | MU3001 | 0.36 | 0.00 |
| 30DP1 | CL601 | 1.18 | 0.00 |
| 30DP1 | LEAR35 | 0.13 | 0.00 |
| 30DP1 | GIV | 0.12 | 0.00 |
| 30DP1 | CIT3 | 0.09 | 0.00 |
| 30DP1 | 717 | 0.03 | 0.00 |
| 30DP1 | A319 | 0.15 | 0.00 |
| 30DP1 | 737500 | 0.03 | 0.00 |
| **30DP1** | | **8.79** | **0.00** |
| **Grand Total:** | | **70.35** | **0.00** |

# Nef-Calc

## MYEF - Airport Movements - 2035

| FLIGHTPATH | Aircraft Code | DayTime Events | NightTime Events |
|---|---|---|---|
| **12AP1** | | | |
| 12AP1 | GASEPF | 6.58 | 0.00 |
| 12AP1 | GASEPV | 1.00 | 0.00 |
| 12AP1 | BEC58P | 11.57 | 0.00 |
| 12AP1 | CNA441 | 1.33 | 0.00 |
| 12AP1 | DHC6 | 0.93 | 0.00 |
| 12AP1 | SF340 | 4.52 | 0.00 |
| 12AP1 | DHC830 | 3.66 | 0.00 |
| 12AP1 | BAE146 | 0.13 | 0.00 |
| 12AP1 | MU3001 | 1.60 | 0.00 |
| 12AP1 | CL601 | 5.25 | 0.00 |
| 12AP1 | LEAR35 | 0.60 | 0.00 |
| 12AP1 | GIV | 0.53 | 0.00 |
| 12AP1 | CIT3 | 0.40 | 0.00 |
| 12AP1 | 717 | 0.13 | 0.00 |
| 12AP1 | A319 | 0.66 | 0.00 |
| 12AP1 | 737500 | 0.13 | 0.00 |
| **12AP1** | | **39.02** | **0.00** |
| **12DP1** | | | |
| 12DP1 | GASEPF | 6.58 | 0.00 |
| 12DP1 | GASEPV | 1.00 | 0.00 |
| 12DP1 | BEC58P | 11.57 | 0.00 |
| 12DP1 | CNA441 | 1.33 | 0.00 |
| 12DP1 | DHC6 | 0.93 | 0.00 |
| 12DP1 | SF340 | 4.52 | 0.00 |
| 12DP1 | DHC830 | 3.66 | 0.00 |
| 12DP1 | BAE146 | 0.13 | 0.00 |
| 12DP1 | MU3001 | 1.60 | 0.00 |
| 12DP1 | CL601 | 5.25 | 0.00 |
| 12DP1 | LEAR35 | 0.60 | 0.00 |
| 12DP1 | GIV | 0.53 | 0.00 |
| 12DP1 | CIT3 | 0.40 | 0.00 |
| 12DP1 | 717 | 0.13 | 0.00 |
| 12DP1 | A319 | 0.66 | 0.00 |
| 12DP1 | 737500 | 0.13 | 0.00 |
| **12DP1** | | **39.02** | **0.00** |
| **30AP1** | | | |
| 30AP1 | GASEPF | 2.19 | 0.00 |
| 30AP1 | GASEPV | 0.33 | 0.00 |
| 30AP1 | BEC58P | 3.86 | 0.00 |
| 30AP1 | CNA441 | 0.44 | 0.00 |
| 30AP1 | DHC6 | 0.31 | 0.00 |
| 30AP1 | SF340 | 1.51 | 0.00 |
| 30AP1 | DHC830 | 1.22 | 0.00 |
| 30AP1 | BAE146 | 0.04 | 0.00 |
| 30AP1 | MU3001 | 0.53 | 0.00 |
| 30AP1 | CL601 | 1.75 | 0.00 |
| 30AP1 | LEAR35 | 0.20 | 0.00 |
| 30AP1 | GIV | 0.18 | 0.00 |
| 30AP1 | CIT3 | 0.13 | 0.00 |

# Nef-Calc

## MYEF - Airport Movements - 2035

| FLIGHTPATH | Aircraft Code | DayTime Events | NightTime Events |
|---|---|---|---|
| 30AP1 | 717 | 0.04 | 0.00 |
| 30AP1 | A319 | 0.22 | 0.00 |
| 30AP1 | 737500 | 0.04 | 0.00 |
| **30AP1** | | **12.99** | **0.00** |
| **30DP1** | | | |
| 30DP1 | GASEPF | 2.19 | 0.00 |
| 30DP1 | GASEPV | 0.33 | 0.00 |
| 30DP1 | BEC58P | 3.86 | 0.00 |
| 30DP1 | CNA441 | 0.44 | 0.00 |
| 30DP1 | DHC6 | 0.31 | 0.00 |
| 30DP1 | SF340 | 1.51 | 0.00 |
| 30DP1 | DHC830 | 1.22 | 0.00 |
| 30DP1 | BAE146 | 0.04 | 0.00 |
| 30DP1 | MU3001 | 0.53 | 0.00 |
| 30DP1 | CL601 | 1.75 | 0.00 |
| 30DP1 | LEAR35 | 0.20 | 0.00 |
| 30DP1 | GIV | 0.18 | 0.00 |
| 30DP1 | CIT3 | 0.13 | 0.00 |
| 30DP1 | 717 | 0.04 | 0.00 |
| 30DP1 | A319 | 0.22 | 0.00 |
| 30DP1 | 737500 | 0.04 | 0.00 |
| **30DP1** | | **12.99** | **0.00** |
| **Grand Total:** | | **104.02** | **0.00** |

# Nef-Calc

## MYEF - Airport Movements - 2035

| FLIGHTPATH | Aircraft Code | DayTime Events | NightTime Events |
|---|---|---|---|
| **12AP1** | | | |
| 12AP1 | GASEPF | 6.25 | 0.33 |
| 12AP1 | GASEPV | 0.95 | 0.05 |
| 12AP1 | BEC58P | 10.99 | 0.58 |
| 12AP1 | CNA441 | 1.26 | 0.07 |
| 12AP1 | DHC6 | 0.88 | 0.05 |
| 12AP1 | SF340 | 4.29 | 0.23 |
| 12AP1 | DHC830 | 3.48 | 0.18 |
| 12AP1 | BAE146 | 0.12 | 0.01 |
| 12AP1 | MU3001 | 1.52 | 0.08 |
| 12AP1 | CL601 | 4.99 | 0.26 |
| 12AP1 | LEAR35 | 0.57 | 0.03 |
| 12AP1 | GIV | 0.50 | 0.03 |
| 12AP1 | CIT3 | 0.38 | 0.02 |
| 12AP1 | 717 | 0.12 | 0.01 |
| 12AP1 | A319 | 0.63 | 0.03 |
| 12AP1 | 737500 | 0.12 | 0.01 |
| **12AP1** | | **37.07** | **1.95** |
| **12DP1** | | | |
| 12DP1 | GASEPF | 6.25 | 0.33 |
| 12DP1 | GASEPV | 0.95 | 0.05 |
| 12DP1 | BEC58P | 10.99 | 0.58 |
| 12DP1 | CNA441 | 1.26 | 0.07 |
| 12DP1 | DHC6 | 0.88 | 0.05 |
| 12DP1 | SF340 | 4.29 | 0.23 |
| 12DP1 | DHC830 | 3.48 | 0.18 |
| 12DP1 | BAE146 | 0.12 | 0.01 |
| 12DP1 | MU3001 | 1.52 | 0.08 |
| 12DP1 | CL601 | 4.99 | 0.26 |
| 12DP1 | LEAR35 | 0.57 | 0.03 |
| 12DP1 | GIV | 0.50 | 0.03 |
| 12DP1 | CIT3 | 0.38 | 0.02 |
| 12DP1 | 717 | 0.12 | 0.01 |
| 12DP1 | A319 | 0.63 | 0.03 |
| 12DP1 | 737500 | 0.12 | 0.01 |
| **12DP1** | | **37.07** | **1.95** |
| **30AP1** | | | |
| 30AP1 | GASEPF | 2.08 | 0.11 |
| 30AP1 | GASEPV | 0.31 | 0.02 |
| 30AP1 | BEC58P | 3.67 | 0.19 |
| 30AP1 | CNA441 | 0.42 | 0.02 |
| 30AP1 | DHC6 | 0.29 | 0.02 |
| 30AP1 | SF340 | 1.43 | 0.08 |
| 30AP1 | DHC830 | 1.16 | 0.06 |
| 30AP1 | BAE146 | 0.04 | 0.00 |
| 30AP1 | MU3001 | 0.50 | 0.03 |
| 30AP1 | CL601 | 1.66 | 0.09 |
| 30AP1 | LEAR35 | 0.19 | 0.01 |
| 30AP1 | GIV | 0.17 | 0.01 |
| 30AP1 | CIT3 | 0.12 | 0.01 |

# Nef-Calc

## MYEF - Airport Movements - 2035

| FLIGHTPATH | Aircraft Code | DayTime Events | NightTime Events |
|---|---|---|---|
| 30AP1 | 717 | 0.04 | 0.00 |
| 30AP1 | A319 | 0.21 | 0.01 |
| 30AP1 | 737500 | 0.04 | 0.00 |
| **30AP1** | | **12.34** | **0.65** |
| **30DP1** | | | |
| 30DP1 | GASEPF | 2.08 | 0.11 |
| 30DP1 | GASEPV | 0.31 | 0.02 |
| 30DP1 | BEC58P | 3.67 | 0.19 |
| 30DP1 | CNA441 | 0.42 | 0.02 |
| 30DP1 | DHC6 | 0.29 | 0.02 |
| 30DP1 | SF340 | 1.43 | 0.08 |
| 30DP1 | DHC830 | 1.16 | 0.06 |
| 30DP1 | BAE146 | 0.04 | 0.00 |
| 30DP1 | MU3001 | 0.50 | 0.03 |
| 30DP1 | CL601 | 1.66 | 0.09 |
| 30DP1 | LEAR35 | 0.19 | 0.01 |
| 30DP1 | GIV | 0.17 | 0.01 |
| 30DP1 | CIT3 | 0.12 | 0.01 |
| 30DP1 | 717 | 0.04 | 0.00 |
| 30DP1 | A319 | 0.21 | 0.01 |
| 30DP1 | 737500 | 0.04 | 0.00 |
| **30DP1** | | **12.34** | **0.65** |
| **Grand Total:** | | **98.82** | **5.20** |

# APPENDIX B – Noise Exposure Forecast Maps

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AREAS ENCOMPASSED BY CONTOURS

| CONTOUR | TOTAL AREA (AC) |
|---|---|
| NEF 25 | 170.5 |
| NEF 30 | 67.5 |
| NEF 35 | 48.7 |

client

Bahamas Civil Aviation Department

consultants

Stantec Aviotec



notes

1. Aerial image copyright Microsoft Corporation. The image is not corrected for planimetric accuracy.
2. Aircraft movement data used to generate contours were provided by the Airport for a portion of 2014. The runway and flight assignments were based on stakeholder consultations and the Bahamas Aeronautical Information Publication.
3. All runway approaches were assumed to be flown at a 3.0 degree glide slope for all aircraft.
4. NEF contours were computed using Transport Canada's NEFCAL_2_0_6 software.

project title

EXUMA INTERNATIONAL AIRPORT MASTER PLAN

exhibit title

2015 NOISE EXPOSURE FORECAST MAPPING

scale

1 mm = 20 m.
1 inch = 1640 feet

0 250 500 750 meters

0 500 1250 1875 2500 feet

| date | revision | project no. | exhibit |
|---|---|---|---|
| 30 NOVEMBER 2015 | 2 | AP1418-3 | B-1 |


AREAS ENCOMPASSED BY CONTOURS

| CONTOUR | TOTAL AREA (AC) |
|---|---|
| NEF 25 | 231.0 |
| NEF 30 | 94.4 |
| NEF 35 | 64.2 |

client

Bahamas Civil Aviation Department

consultants

Stantec Aviotec

notes
1. Aerial image copyright Microsoft Corporation. The image is not corrected for planimetric accuracy.
2. Aircraft movement data used to generate contours were provided by the Airport for a portion of 2014. The runway and flight assignments were based on stakeholder consultations and the Bahamas Aeronautical Information Publication.
3. All runway approaches were assumed to be flown at a 3.0 degree glide slope for all aircraft.
4. NEF contours were computed using Transport Canada's NEFCAL_2_0_6 software.

project title

EXUMA INTERNATIONAL AIRPORT
MASTER PLAN

exhibit title

2035 NOISE EXPOSURE FORECAST MAPPING

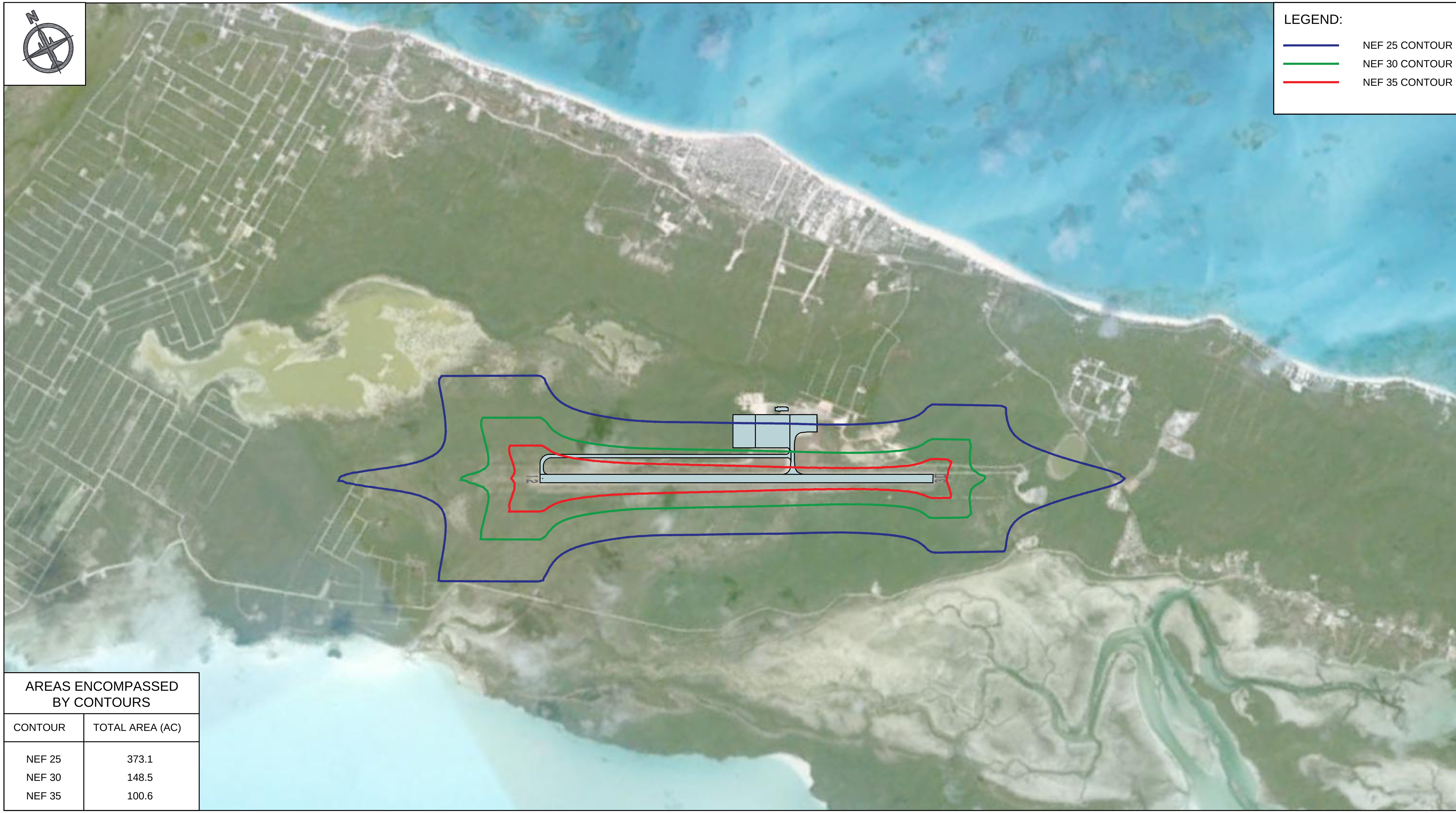
scale

1 mm = 20 m.
1 inch = 1640 feet

0 250 500 750 meters

0 500 1250 1875 2500 feet

| date | revision | project no. | exhibit |
|---|---|---|---|
| 30 NOVEMBER 2015 | 2 | AP1418-3 | B-2 |




AREAS ENCOMPASSED BY CONTOURS

| CONTOUR | TOTAL AREA (AC) |
|---|---|
| NEF 25 | 373.1 |
| NEF 30 | 148.5 |
| NEF 35 | 100.6 |

client

Bahamas Civil Aviation Department

consultants

Stantec Aviotec



notes

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2. Aircraft movement data used to generate contours were provided by the Airport for a portion of 2014. The runway and flight assignments were based on stakeholder consultations and the Bahamas Aeronautical Information Publication.
3. All runway approaches were assumed to be flown at a 3.0 degree glide slope for all aircraft.
4. NEF contours were computed using Transport Canada's NEFCAL_2_0_6 software.

project title

EXUMA INTERNATIONAL AIRPORT MASTER PLAN

exhibit title

2035 NOISE EXPOSURE FORECAST MAPPING WITH 5% NIGHTTIME MOVEMENTS

scale

1 mm = 20 m.
1 inch = 1640 feet

0 250 500 750 meters
0 500 1250 1875 2500 feet

| date | revision | project no. | exhibit |
|---|---|---|---|
| 30 NOVEMBER 2015 | 2 | AP1418-3 | B-3 |


AREAS ENCOMPASSED BY CONTOURS

| CONTOUR | TOTAL AREA (AC) |
|---|---|
| NEF 25 | 376.6 |
| NEF 30 | 155.9 |
| NEF 35 | 103.8 |

client

Bahamas Civil Aviation Department

consultants

Stantec Aviotec



notes

1. Aerial image copyright Microsoft Corporation. The image is not corrected for planimetric accuracy.
2. Aircraft movement data used to generate contours were provided by the Airport for a portion of 2014. The runway and flight assignments were based on stakeholder consultations and the Bahamas Aeronautical Information Publication.
3. All runway approaches were assumed to be flown at a 3.0 degree glide slope for all aircraft.
4. NEF contours were computed using Transport Canada's NEFCAL_2_0_6 software.

project title

EXUMA INTERNATIONAL AIRPORT
MASTER PLAN

exhibit title

2035 NOISE EXPOSURE FORECAST MAPPING
WITH 1000 FEET RUNWAY EXTENSION

scale

1 mm = 20 m.
1 inch = 1640 feet

0 250 500 750 meters

0 500 1250 1875 2500 feet

| date | revision | project no. | exhibit |
|---|---|---|---|
| 30 NOVEMBER 2015 | 2 | AP1418-3 | B-4 |

Project Management
Feasibility Studies
Master & Facility Planning
Operational Analysis
Concept & Detail Designs

IT Assessment & Planning
Network Infrastructure
WIFI/Wireless Infrastructure
Common-Use Systems
Revenue/Mgmt. Systems

Terminal Security Consulting
Security Systems Design
Special Terminal Systems
Baggage Handling Systems
Cargo & Hold Bag Screening

Terminal Gate Planning
Airside Design &Modelling
Aircraft Servicing Design
Aviation Fuelling Design
Apron & GSE Marking

Procurement & Tendering
Project Implementation
Systems Integration Services
Testing & Commissioning
Operational Readiness

Aviotec

Canadian Office
5925 Airport Road, Suite 200
Mississauga Ontario
Canada L4V 1W1
Phone: +1.905.918.0888
Fax: +1.905.605.0422
E-mail: info@aviotec-group.com