



ICAO

ENVIRONMENT

Scoping Report on Review of Measures to Better Understand Encroachment around Airports

Deliverable of ICAO Committee on Aviation Environmental Protection (CAEP)

2022

Notes

This state of play report is produced by ICAO Committee on Aviation Environmental Protection (CAEP) Working Group 2 on Airport and Operations during the CAEP/12 cycle. Following the review by subsidiary bodies, the ICAO Council approved the technical recommendation made by CAEP and approved the publication of this report during the 226th Session, which took place from 24 May to 23 June 2022.

Disclaimer

The information contained in this state of play report is for general information purposes only. States and stakeholders should review the information contained in the report based on national regulations, procedures and requirements. ICAO shall not be responsible whatsoever for any cost or liabilities incurred as a result of its use.

TABLE OF CONTENTS

1. INTRODUCTION & SUMMARY	1
2. DESCRIPTION OF ENCROACHMENT	3
3. LITERATURE REVIEW	4
3.1 ICAO Documents	4
3.2 Non-ICAO Guidance Documents	15
3.3 Case Studies.....	19
4. SUMMARY OF DOCUMENTS.....	34
4.1 Good Practices.....	34
4.2 Measurement methodologies.....	35
4.3 Common challenges	36
5. RECOMMENDATIONS.....	39
6. REFERENCE DOCUMENTS.....	41
ICAO Documents in Literature Review	41
Non-ICAO Documents in Literature Review	41
Case Study Supporting Documents.....	41
Appendix: Templates for State Submissions.....	42

1. INTRODUCTION & SUMMARY

Encroachment into high aircraft noise areas around airports and planning for land-use compatibility in the vicinity of airports are becoming more important issues that should be addressed in the aviation community. The aviation industry, with increasing development at existing airports, as well as the construction of new airports, is having to contend with the ever-expanding residential and commercial development of surrounding land. Although technological advancements have greatly reduced the noise produced by aircraft, development moving closer and closer to airports negates these advances and means that concerns and complaints about aircraft noise around airports continue to arise. While there are steps that can be taken to reduce or manage incompatible land uses near airports, it is not realistic to expect to completely eliminate encroachment, and thus it is essential for airports to proactively address the issue as best as possible and also attempt to mitigate the negative impacts where possible.

CAEP Working Group 2 - Airports and Operations, was tasked with collecting good practices to address the challenges related to population encroachment into the noise contours at airports. The collection was to include a literature review and analysis of ICAO Documents, and at CAEP Steering Group meeting in 2020, the collection and assessment of non-ICAO documents was also approved as part of the work.

From the review of received documents, some common challenges for airports relating to the issue of encroachment were identified. They include challenges accessing data and information to track levels of encroachment, maintaining positive dialogue and negotiations between the airport and municipality, competing economic interests and competing planning priorities between the airport and the municipalities, as well as addressing conflicts with the interests of residents and property owners in the vicinity of airports.

An analysis of the ICAO documents as well as the documents received from States has generated the following recommendations, with the understanding that local issues and nuances at individual airports may present challenges with implementation, for addressing encroachment into the noise contours at airports.

- It is important to maintain dialogue with communities and local governments or other stakeholders, including educating or informing on the issues of encroachment and its impacts;
- Airports and the relevant authorities should work together to ensure correct application of land-use planning techniques in development of airports;

- Airports should strive to have a comprehensive noise management plan or strategy;
- New guidelines or requirements developed by the relevant authorities should be based on technically robust and up-to-date scientific evidence and coordinated with relevant stakeholders;
- Additional development of procedures and metrics considering local issues may facilitate the measurement of encroachment; and
- Having a single authority to enforce the continuity of noise zoning regulations across several local government areas within the airport noise contours may alleviate the problem of multi-jurisdictional interests.
-

This report contains the collected materials and references, providing an overview of some of the challenges being encountered and of good practices related to encroachment at airports, and expands on these recommendations and collected methods to address encroachment.

2. DESCRIPTION OF ENCROACHMENT

While ICAO's Balanced Approach to Aircraft Noise Management identifies compatible land use planning as one of key components to an effective noise management strategy, the development of land near and in high aircraft noise areas around airports for non-compatible uses has been and continues to be a major challenge that airports are facing. Competing priorities of local governments, limited means for airport operators to influence local planning decisions, and lack of enforceable measures due to inconsistent approaches between different levels of government present challenges for airports when trying to ensure that only compatible land uses are approved near airports.

In the Airport Planning Manual - Part 2 (ICAO Doc 9184), it is stated that aircraft noise can have a significant impact on local communities and is therefore a major factor influencing land-use planning in the vicinity of airports. The goal is to minimize the population affected by aircraft noise by introducing compatible land-use zoning around airports. Compatible land-use planning is also a vital instrument in ensuring that the gains achieved by the reduced noise of the latest generation of aircraft and improved operational measures are not offset by further residential development and encroachment around airports.

3. LITERATURE REVIEW

ICAO Docs 9184, 9829, 9911, and 10031 and ICAO Circular 351 were reviewed and analyzed by the Task Group. As Doc 9184 (Airport Planning Manual – Part 2) and Doc 9829 (Guidance on the Balanced Approach to Aircraft Noise Management) were the most relevant to this review, summary information is included below for those two documents. ICAO Doc 9911, Recommended Method for Computing Noise Contours Around Airports, provides valuable and comprehensive information for calculating noise contours at airports, although the specific computation methods fall outside of the scope of this report.

A review of non-ICAO documents was also approved for this task. Members and Observers of Working Group 2 were sent a request to submit or connect with contacts to provide non-ICAO guidance documents and case studies, which have also been reviewed for the report. Templates, attached in the Appendix, were provided by the Task Group, which respondents completed with information from the documents or examples they submitted. Those submissions are included in Sections 3.2 and 3.3. The Task Group received two completed templates for non-ICAO guidance documents, and five completed templates for case studies.

3.1 ICAO Documents

- *3.1.1.*

Document title & date of publication	<i>ICAO Doc 9184: Airport Planning Manual, Part II – Land Use and Environmental Management</i> <i>Fourth Edition, 2018</i>
Overview and Purpose of the Document	<p><i>The purpose of the Airport Planning Manual (APM) is to provide effective practices at an airport to reduce the potential environmental effects caused by the airport and its operations. Part 2 of this manual (APM Part 2) is focused on the land use and environmental management on and around an airport. The scope of APM Part 2 does not include information about reducing the impacts of aircraft in-flight but only on impacts from ground sources.</i></p> <p><i>As guidance on proper airport and land-use compatibility planning, APM Part 2 presents a variety of possible land uses with a broad appreciation of their relative sensitivity to the operational safety of aircraft and airport operations, local</i></p>

	<p><i>third party risk and aircraft noise exposure, and describes their compatibility with aircraft noise and airport operations.</i></p>
<p>Methodology Used</p>	<p><i>The document was originally based on conclusions of the Special Meeting on Aircraft Noise in the Vicinity of Aerodromes held in 1969 and on the current practices of several States. It incorporates guidance material on airport environmental aspects as recommended by the Eighth Air Navigation Conference held in 1974.</i></p> <p><i>Since these issues have evolved considerably in recent years, it was necessary to update the information included in previous editions of the manual. This publication reflects updates from the Committee on Aviation Environmental Protection (CAEP) that were first presented to CAEP/4 in 1998. Further updates have since been added and this final version of the manual was approved at the CAEP/10 meeting in February 2016.</i></p> <p><i>It is intended that the manual be kept up to date. Future editions will be improved based on the results of the work of ICAO and of comments and suggestions received from the users of this manual. Readers are therefore invited to give their views, comments and suggestions on this edition. These should be directed to the Secretary General of ICAO.</i></p>
<p>Guidance or Requirements on Zoning Regulations and/or Land Use Planning</p>	<p><i>There are many techniques for regulating development or bringing about conversion or modification of existing land-uses to achieve greater compatibility between the airport and its environs. Some of these may be controls, such as zoning or building and housing codes; other methods influence development through acquisition or taxation. The desired goal is for effective land-use planning based on objective criteria to minimize the amount of noise-sensitive development close to airports, while allowing for other productive uses of the land. (7.1.2)</i></p> <p>.</p> <p><i>6.3.1 In general, the planning noise contours can be used to define noise zones around the airport. The structure of noise zones should be inherently related to the particular situation where they are applied. In many jurisdictions, two zones (e.g. medium and high noise zones) are used, but in some cases</i></p>

more zones, either with a finer gradation or a greater noise range (e.g. medium to very high) may be used.

6.3.2 Land-use rules are then adopted and enforced based on the noise level in each zone. Some examples are provided below and in Appendix 3.

— In a high-noise zone, new noise-sensitive developments, such as residences, hospitals and schools might be prohibited. Those which already exist might be subject to sound insulation and ventilation retrofits.

— In a medium-noise zone, new developments might be allowed but subject to maximum density limits or specific sound insulation and ventilation requirements.

These zones or land-use rules may be subdivided into various noise exposure levels for appropriate land-use planning and other measures by the national or local authorities. Such measures should be strictly enforced to prevent any noise sensitive development. Outside these noise zones, the level of aircraft noise is deemed to be compatible with residential activity and land-use restrictions are generally not required.

6.3.3 The values of the noise exposure indices, corresponding to the noise zones adopted for land-use planning, should form a logical progression. States use different noise descriptors and noise-exposure calculation methods to determine the noise levels for different land uses.

Ideally, land-use decisions around airports would try to find a compatible balance between the interests in the land and the aeronautical use of the airport. For this reason, the authorities, local or central, have an important part to play in ensuring that aircraft noise exposure is taken into account when planning land use in the vicinity of airports and that the ensuing plans are implemented.

Overall, land-use management measures can be categorized as:

	<p><i>a) planning instruments, including comprehensive planning, noise zoning, subdivision regulations, transfer of development rights, and easement acquisition.</i></p> <p><i>b) mitigating instruments, including building codes, noise insulation programmes, land acquisition and relocation, transaction assistance, real estate disclosure, and noise barriers.</i></p> <p><i>c) financial instruments, including capital improvements, tax incentives and noise-related airport charges.</i></p> <p><i>In an ideal scenario, noise zoning regulations are established and known by all relevant authorities and stakeholders. The noise contours produced by the airport authority should be based upon on maximum airport capacity and the worst possible noise case scenarios and provided to a single high-level government authority to administer and oversee.</i></p>
<p>Good Practices for Noise Monitoring (systems, frequency, etc.)</p>	<p><i>Of the airport examples discussed in APM Part 2, most have some form of noise monitoring system in place, though specifics vary greatly between locations. For example, in Australia, Noise and Flight Path Monitoring System (NFPMS) collects noise and flight path data at Brisbane, Cairns, Canberra, Gold Coast, Sydney, and Melbourne, Essendon, Adelaide and Perth airports. This system operates 24-hours-a-day, seven-days-a-week, collecting data from every aircraft operating to and from the airport. NFPMS uses monitors located within local communities and is the world’s largest, most geographically-spread system of its type.</i></p> <p><i>Noise monitoring is not undertaken to determine compliance with aircraft noise regulations — there are no regulations which specify a maximum allowed level of aircraft noise. Rather it is undertaken to provide the basis for regular reviews of aircraft operators and noise abatement procedures at airports.</i></p> <p><i>In addition to the NFPMS, temporary noise monitors can be implemented for short periods (normally four weeks) to obtain data from locations that do not require permanent noise monitoring or where a permanent monitor cannot be installed. Temporary noise monitors have been deployed at more than 50 locations over the past three years.</i></p>

	<p><i>APM Part 2 does not provide overall guidance on noise monitoring, as this is discussed in ICAO's Annex 16, Volume I.</i></p>
<p>Guidance on Measuring Encroachment (metrics, methods, etc.)</p>	<p><i>Limited guidance provided. In order to assess certain risks (such as exposure to aircraft accidents), specific methodologies can be developed by States and used to define a dedicated zoning policy, in a similar approach as the zoning policy related to noise exposure.</i></p>
<p>What have been the results of implementation of these practices (if known)? What specific challenges have been encountered?</p>	<p><i>Local land development decisions are often made based on considerations which may ignore both the need to minimize the impact of aviation noise on the community and the importance of protecting the airport from encroachment by incompatible development. The most common issues are the return that the owners or developers want from their commercial properties, the local government's interest in increasing the tax base, and the interest of the owners and residents in maintaining or improving the value of their homes. For the airport environs, the cumulative total of such local decisions can seriously degrade a balanced, comprehensive planning approach and development policy. The desired goal is for effective land-use planning based on objective criteria, to minimize the amount of noise-sensitive development close to airports, while allowing for other productive uses of the land.</i></p> <p><i>Land acquisition and relocation have been widely used in the United States by airport operators as the ultimate solution to land-use compatibility in certain areas with significant noise exposure.</i></p>
<p>Recommendations/Predicted future challenges</p>	<p><i>In many instances where there are multiple local government authorities responsible for development approvals, these local jurisdictions with zoning power (cities, towns or larger administrative units) may often have differing or conflicting policies that have little continuity between authorities. They may also not be aligned to the noise zoning regulations and the maximum theoretical noise contours that have been produced (contours should be based on maximum airport capacity). Having a single authority to enforce the continuity of noise zoning regulations across several local government</i></p>

	<p><i>areas within the airport noise contours can alleviate the problem of multi-jurisdictional interests.</i></p> <p><i>With a view to promoting a uniform method of assessing noise around airports, ICAO recommends the use of the methodology contained in Recommended Method for Computing Noise Contours around Airports (Circular 205).</i></p> <p><i>There are substantial benefits to be gained from the correct application of land-use planning techniques in the development of airports. Land-use planning benefits may take time to be fully realized and should be implemented as soon as noise problems are foreseen. Efforts to correct situations detrimental to proper land-use around airports should however not be ignored simply because of the lead time for such measures to be effective. This is particularly true in the application of land-use planning to existing airports where it is recognized that the ability to make immediate land-use changes is limited, but where it is also important to prevent further expansion of incompatible land uses.</i></p>
--	--

■ 3.1.2.

Document title & date of publication	<p><i>ICAO Doc 9829 : Guidance on the Balanced Approach to Aircraft Noise Management</i></p> <p><i>Second Edition, 2008</i></p>
Overview and Purpose of the Document	<p><i>The main overarching ICAO policy on aircraft noise is the Balanced Approach to Aircraft Noise management adopted by the ICAO Assembly in its 33rd Session (2011) and reaffirmed in all the subsequent Assembly Sessions (reference A39-I, Appendix C). Detailed guidance on the application of the Balanced Approach is provided in the ICAO Doc. 9829, Guidance on the Balanced Approach to Aircraft Noise Management.</i></p> <p><i>The four main elements of the balanced Approach to Noise Management are as follows:</i></p>

	<p>1) <i>Reduction of Noise at Source (Technology Standards);</i></p> <p>2) <i>Land use Planning and Management;</i></p> <p>3) <i>Noise Abatement Operational Procedures; and,</i></p> <p>4) <i>Operating Restrictions.</i></p>
<p>Methodology Used</p>	<p><i>At the 37th Session of the ICAO Assembly in September/October 2010, all participating Contracting States adopted Resolution A37-18, which expressed the unanimous consensus of the worldwide aviation community on both aircraft noise and gaseous emissions.</i></p> <p><i>1.1.2 Appendices C, D, E, F and G to Resolution A37-18 cover the issue of aircraft noise in general, while Appendices C, E and F, in particular, contain the principal elements and the basic components of a process for implementing the concept of the “Balanced Approach” to manage aircraft noise at international airports.</i></p> <p><i>This document is guidance provided by ICAO on the “Balanced Approach”.</i></p>
<p>Guidance or Requirements on Zoning Regulations and/or Land Use Planning</p>	<p><i>Because in many instances the implementation of compatible land-use measures and the realization of the resulting benefits may be long-range, effective land-use measures should be identified early in order to have the most significant and lasting benefits over the long term.</i></p> <p><i>It is recognized that in some situations such as at locations lacking available land, the opportunity to incorporate some or all of the following principles may not be available. However, as stated by the ICAO Assembly, ICAO Contracting States are urged, where the opportunity still exists, to minimize aircraft noise problems through preventive measures such as:</i></p> <ul style="list-style-type: none"> <i>• locating new airports in an appropriate place, such as away from noise-sensitive areas;</i> <i>• taking the appropriate measures so that land-use planning is taken fully into account at the initial stage of any new airport or of development at an existing airport;</i>

- *defining and updating zones around airports associated with different noise levels taking into account population levels and growth as well as forecasts of traffic growth and establishing criteria for the appropriate use of such land, taking account of ICAO guidance;*

- *enacting legislation, establishing guidance or using other appropriate means to achieve compliance with those land-use criteria; and*

- *ensuring that reader-friendly information on aircraft operations and their environmental effects are available to communities near airports.*

- *Land-use management can be applied differently (in several zones), allowing for urbanization control or management to be less restricted the farther away it takes place from the airport. This can be illustrated by the following criteria for the possible various zones surrounding the airport:*

- - *All housing is forbidden — occurs very often within the actual airport perimeter and in areas of highest noise exposure.*

- - *New housing is forbidden — no additional housing is allowed in this area.*

- - *Limited and regulated housing growth — all new housing is regulated and required to be soundproofed, and all existing housing, prior to regulations, has benefited or will benefit from financial aid for soundproofing as defined within the noise mitigation programme.*

- - *Regulated housing growth — all new housing is regulated and soundproofed, but all existing housing, prior to regulations, does not benefit from financial aid for soundproofing as defined within the noise mitigation programme.*

- *Unregulated housing growth — outside these areas, housing is no longer constrained for aircraft noise reasons.*

Under the Balanced Approach, an operating restriction is defined as “any noise-related action that limits or reduces an aircraft’s access to an airport.” Operating restrictions can

	<p><i>improve the noise climate by limiting or prohibiting movements of the noisiest aircraft at an airport, enabling the airport to contain or shrink the noise contours around the airport. This should not be used as a first resort.</i></p>
<p>Good Practices for Noise Monitoring (systems, frequency, etc.)</p>	<p><i>Guidance from ICAO is not covered in this document.</i></p> <p><i>Some of the included case studies provide details on their noise monitoring procedures.</i></p> <p><i>Amsterdam Schiphol Airport:</i> <i>Noise monitoring and enforcement. The total noise budget and the distribution of aircraft noise in the airport environs are strictly enforced by an independent government agency. The noise exposure is permanently measured in more than 30 measurement points in the built-up areas around the airport.</i></p> <p><i>Exceeding a level at one or more measurement points has to be compensated by means of mitigation measures that prevent further infringement of the noise level (such as change in runway use and/or routes, closure of runways or reduction in traffic).</i></p> <p><i>Auckland International Airport:</i> <i>Noise monitoring: AIAL must monitor noise to ensure that the maximum level of noise allowed in each aircraft noise area is not exceeded. AIA monitors noise from aircraft operations using the ANOMS noise monitoring system. There are three fixed noise monitors and one portable monitor in the community close to the boundary of the high aircraft noise area. Restrictions on noise levels mean that outside the high aircraft noise area, noise must not exceed Ldn 65 dBA on a 365-day rolling average and outside the moderate aircraft noise area must not exceed Ldn 60 dBA on a 365-day rolling average.</i></p> <p><i>AIA also monitors noise from engine testing. This must not exceed a 7-day rolling average of Ldn 55 dBA and a LAm_{ax} 75 dBA between 2200 to 0700 hours at any dwelling which is in the main residential zone or which is outside the airport designated area and outside the aircraft noise areas.</i></p> <p><i>Narita International Airport:</i> <i>Noise monitoring:</i></p>

	<p>— <i>Year-round monitoring.</i> Aircraft noise is reported 365 days a year with 17 permanent stations positioned around Runway A and 16 stations around Runway B.</p> <p>— <i>Short-term monitoring.</i> Short-term monitoring is carried out continuously at 58 locations in the noise impact zones around the airport for one week both in winter and summer. These noise impact zones were defined in accordance with the specifications of the national Noise Prevention Law. In locations where more stringent monitoring is required, additional monitoring is carried out.</p> <p>Zurich Airport: Noise monitoring: Nine permanent noise monitoring terminals are operated in the vicinity of the airport.</p> <p>The results are evaluated each month in a noise bulletin that is available to municipal authorities, politicians and other interested parties via the Internet.</p>
<p>Guidance on Measuring Encroachment (metrics, methods, etc.)</p>	<p><i>In order to better evaluate the appropriateness of measures to prevent additional encroachment of incompatible land use around airports, it is suggested to calculate the degree and rate of encroachment and also the effectiveness of land-use planning and management measures adopted over time. Assessment of the rate of encroachment aims to safeguard improvements in the noise climate achieved at airports.</i></p> <p><i>An important step in land-use planning and management is to have a methodology to evaluate the effectiveness of the land-use planning and management measures adopted. In this context, it may be appropriate to develop an encroachment analysis for each specific international airport. An encroachment analysis is an evaluation over a time frame, usually ten to twenty years, of the percentage of change in population/households within the airport noise-regulated area where land-use planning is applicable as defined by the authority.</i></p> <p><i>Appendix 1 describes the findings of a limited number of States relative to assessments of population growth and encroachment around airports. It indicates that encroachment has occurred and points to how the problem might be described and assessed in a systematic way. Assessing and quantifying encroachment requires that an</i></p>

	<p><i>airport maintain historical population and housing information. The information in Appendix 1 illustrates possible means of quantifying encroachment, given the appropriate historical data.</i></p> <p><i>Brazil, Japan, the United Kingdom and the United States provided examples that track population/housing growth over time. Brazil and Japan presented their information as tracked against a formal noise zone as described in Doc 9184. The United Kingdom and the United States presented population changes over time as tracked against changing contours over time, which in general were receding.</i></p> <p><i>These studies also tracked population and housing trends separately. In some instances, population had gone down, yet the number of housing units had increased. This may be the result of a declining density per household.</i></p> <p><i>However, the financial obligation on aviation will most likely involve the insulation or purchase of housing units. For this reason, it may be better to define encroachment by tracking the housing counts.</i></p> <p><i>Appendix 2 provides guidance for ICAO Contracting States on developing a methodology regarding the rate of encroachment at international airports, to evaluate not only the level of encroachment at these airports, but also the effectiveness of the land-use planning and management measures adopted.</i></p>
<p>What have been the results of implementation of these practices (if known)? What specific challenges have been encountered?</p>	
<p>Recommendations/Predicted future challenges</p>	<p><i>The ICAO Assembly recognized in particular that States have legal obligations, laws, existing arrangements and established policies that may govern the management of noise problems at their airports and could affect the implementation of local noise-related operating restrictions. The Assembly also observed that at many airports land-use planning and management and noise abatement operational procedures are</i></p>

	<i>already being used and other noise mitigation measures are in place, although urban encroachment continues in certain areas.</i>
--	---

3.2 Non-ICAO Guidance Documents

- *3.2.1.*

Document title & date of publication	<i>Regulamento Brasileiro da Aviação Civil – RBAC nº 161 – Emenda nº 03 – Planos de Zoneamento de Ruído de Aeródromos – PZR</i> https://www.anac.gov.br/assuntos/legislacao/legislacao-1/rbha-e-rbac/rbac/rbac-161/@@display-file/arquivo_norma/RBAC161EMD01.pdf
State/Country	<i>Brazil</i>
Overview and Purpose of the Document	<i>The regulation establishes, for aerodrome operators, the requirements for design and implementation of the Noise Zoning Plan - PZR and defines technical criteria applicable in the analysis of issues related to aeronautical noise in civil aviation.</i>
Methodology Used	<i>PZR is composed by the noise contours limits and by a table with compatible and incompatible land uses for the areas bounded by these curves.</i> <i>The noise contours limits are calculated for the actual movement, and for the aerodrome final occupation movement. They are drawn superimposed and analyzed with table.</i> <i>The regulation establishes the PBZR – Basic Noise Zoning Plan, and the PEZR – Specific Noise Zoning Plan, based on the number of aircraft movement annually.</i> <i>PEZR – above 7.000 aircrafts annual movements</i> <i>PBZR – subdivided into 4 classes based on the annual movement.</i>
Guidance or Requirements on Zoning Regulations and/or Land Use Planning	<i>The document establishes a table for PBZR and another for PEZR with the proposed restrictions for land use, for the noise levels of 65 dB, 75 dB, and above 75 dB, to be considered for urban planning.</i>

Good Practices for Noise Monitoring (systems, frequency, etc.)	<i>The PZR must be updated whenever there is a change in any operational procedure or in the physical characteristics of the aerodrome. It is recommended that the plan should be done together with the land user manager, to enable the incorporation of the municipal law.</i>
Guidance on Measuring Encroachment (metrics, methods, etc.)	<i>Encroachment is not being measured yet. In fact, every airport that has a PEZR must provide a communication channel specifically for airport noise disturbance.</i>
What have been the results of implementation of these practices (if known)? What specific challenges have been encountered?	<i>Designing the PZR gives a good sense of what area should be preserved to avoid encroachment. However, the incorporation of the PZR in the municipal law is a challenge, together with the surveillance.</i>
Recommendations/Predicted future challenges	<i>A future challenge is to allow different land usages inside the PZR limits, ensuring the compatibility with the airport operation.</i>

■ 3.2.2.

Document title & date of publication	<i><u>Land Use Compatibility and Airports, A Guide for Effective Land Use Planning – Prepared by the Compatible Land Use Planning Task Force (1998)</u></i>
State/Country	<i>United States</i>
Overview and Purpose of the Document	<i>Resource guide to assist local governments and airports in identifying and implementing appropriate compatible land use tools. The guide identifies the importance of airport land use compatibility planning, summarizes the issues involved in achieving compatibility, presents a variety of methods which have been used to attain land use compatibility, and describes the responsibilities involved in implementing land use compatibility measures.</i>
Methodology Used	<i>Task Force that prepared report consisted of representatives from airport planning staffs, airport planning consultants, city/county planning departments, state aviation departments,</i>

	<p><i>and the FAA Southern Region Environmental Program Manager. Below is an outline of the document:</i></p> <ul style="list-style-type: none"> <i>I. Introduction</i> <i>II. Roles and Responsibilities</i> <i>III. Legislation and Regulations Relating to Aircraft Noise and Compatible Land Use Planning</i> <i>IV. Funding Sources</i> <i>V. Airport and Local Land Use Planning Process</i> <i>VI. Coordination and Implementation of Airport and Local Land Use Planning</i> <i>VII. Compatible Land Use Tools and Their Potential Applications</i> <i>VIII. Negotiation/Mediation</i> <i>IX. Public Education and Awareness Programs</i> <i>X. Conclusion</i>
<p>Guidance or Requirements on Zoning Regulations and/or Land Use Planning</p>	<p><i>To address the issues of aircraft noise and land use compatibility, legislation and regulation in the US has focused on:</i></p> <ul style="list-style-type: none"> <i>1. Providing assistance to airport operators to prepare and carry out noise-compatibility programs.</i> <i>2. Providing funding for noise compatibility planning and projects.</i> <i>3. Requiring airport operators to ensure that actions are taken to establish and maintain compatible land uses around airports.</i> <i>4. Establishing a National Noise Policy that phases out noisier (Stage 1, 2, and 3) aircraft while phasing in quieter aircraft according to a specified time frame.</i> <i>5. Establishing a commitment by the federal government to fully consider the environmental effects (including noise) of a proposed action such as a new runway or a major runway extension.</i> <i>6. Establishing mitigation measures, which minimize impacts to water, wetlands, and endangered species and protect the historical and cultural environment.</i> <p><i>Land use planning and regulatory tools available to local government organizations include Comprehensive Plans,</i></p>

	<p><i>Zoning Regulations, Subdivision Regulation, Building/Housing Codes, Capital Improvement Programming, Official Map Regulations, Infrastructure Extensions, Growth Policies, Transferable Development Rights / Purchase of Development Rights, and State Airport Zoning Commission Regulations, among others.</i></p> <p><i>Communication and cooperation directed toward the establishment of common goals is essential, e.g., in the development of Airport Master Plans.</i></p>
<p>Good Practices for Noise Monitoring (systems, frequency, etc.)</p>	<p><i>Not covered.</i></p>
<p>Guidance on Measuring Encroachment (metrics, methods, etc.)</p>	<p><i>Not covered.</i></p>
<p>What have been the results of implementation of these practices (if known)? What specific challenges have been encountered?</p>	<p><i>The FAA promotes an understanding of land use compatibility planning issues around airports and provides programs and sources of support to minimize noise impacts. However, state and local governments are responsible for land use planning, zoning and regulation. Interest in tax revenues from development can at times supersede best land use planning practices.</i></p> <p><i>That said, many of the tools described in the report have been heavily utilized to help mitigate noise impacts. For example, since 1983, more than 275 airports in the United States have taken advantage of the FAA’s voluntary Part 150 Noise Compatibility Planning Program.</i></p>
<p>Recommendations/Predicted future challenges</p>	<p><i>The guide contains many detailed recommendations towards ensuring compatible land uses around airports (and the associated risk of encroachment). One broad conclusion is that dialogue is the common ingredient necessary to achieve compatible land use. Without dialogue, there can be no consensus, no plan, and no success.</i></p>

3.3 Case Studies

- 3.3.1.

Airport(s)/Location/ Organization	Airport: <i>Vancouver International Airport (YVR)</i> Location: <i>City of Richmond, Province of British Columbia</i> Organization: <i>Vancouver Airport Authority</i>
State/Country	<i>Canada</i>
Stakeholders involved (please insert an ‘X’ beside all that apply)	<input checked="" type="checkbox"/> Government <input checked="" type="checkbox"/> Federal <input checked="" type="checkbox"/> Local <input type="checkbox"/> Air Navigation Service Providers <input type="checkbox"/> Air Operators <input type="checkbox"/> Manufacturers <input checked="" type="checkbox"/> Community <input type="checkbox"/> Other (please specify):
What challenges are being faced as a result of encroachment?	<i>Despite the Airport Authority’s efforts to reduce the number of people affected by aircraft noise, the City of Richmond continues to permit residential developments and densify in areas exposed to high levels of aircraft noise. From national census data, it is estimated that the population in the City of Richmond living within the Noise Exposure Forecast (NEF) 30 contour has increased by over 70% during a twenty-year period between 1996 and 2016. Additional planned developments currently under consideration by the City of Richmond will result in more people living within the NEF 30 contour in coming years.</i>
What are the factors leading to encroachment at this location?	<i>While there are many factors influencing development and encroachment around the airport, the following factors were identified as possible key contributors:</i> <ul style="list-style-type: none"> ▪ <i>Development opportunities provided to the region following the Vancouver 2010 Winter Olympics;</i>

	<ul style="list-style-type: none"> ▪ <i>The location of the Canada Line (rapid transit line) that runs through the areas of the City of Richmond located within the NEF 30 contour, and the City’s supporting policies to densify residential developments around the Canada Line stations to enhance accessibility and ridership on public transit;</i> ▪ <i>Limited amount of development land within the City due to Agriculture Land Reserve designations;</i> ▪ <i>Underlying City Official Community Plans and policies that continue to support non-compatible land uses in the high noise areas.</i>
<p>How is encroachment being measured?</p> <ul style="list-style-type: none"> - Please provide metrics, indicators, or methods used in measurement 	<p><i>To understand the level of encroachment, a population count analysis was completed using census data collected by Statistics Canada. This data is collected every five years, and the analysis looked at a twenty-year period between the years 1996 and 2016. The study concluded that the population within the NEF 30 long-term planning contour has increased by over 70% between 1996 and 2016, despite discouragement by the Airport Authority and reference to the Transport Canada land use guidelines (TP1247 – Land Use in the Vicinity of Aerodromes) that recommends against residential developments in areas exposed to NEF 30 or greater.</i></p>
<p>Is there a noise management program in place?</p> <p>Please provide details on:</p> <ul style="list-style-type: none"> - Noise monitoring (is noise monitoring required, what system is used, frequency of monitoring, etc.) - Noise modelling (is modelling required, what system is used for modelling, how are contours determined, time range for forecasts, etc.) 	<p><i>The Airport Authority has a comprehensive noise management program to minimize impacts of noise from airport and aircraft operations. This includes noise abatement procedures, noise monitoring, maintaining a noise management committee, reporting, and responding to community concerns.</i></p> <p><u>Noise Monitoring:</u></p> <p><i>As part of the airport’s Ground Lease with the Federal Government, the Airport Authority is responsible for noise management activities, including maintaining a noise monitoring and flight tracking system.</i></p>

	<p><i>The Airport Authority uses the Aircraft Noise and Operations Monitoring System (ANOMS) provided by Envirosuite (formerly EMS Bruel and Kjaer), and has twenty permanent and one portable noise monitoring terminals connected to the system. Radar data provided by NAV CANADA is integrated into the system. The ANOMS is used to quantify aircraft noise levels in community, identify and report on trends, ensure compliance with the Noise Abatement Procedures, and to investigate and respond to community concerns.</i></p> <p><u><i>Noise Modelling:</i></u></p> <p><i>Vancouver Airport Authority uses the Transport Canada Noise Exposure Forecast (NEF), prescribed as the official metric for airport noise assessment in Canada, to create long term noise planning contours for the airport. These contours are provided to the municipalities to assist them with compatible land use planning decisions and development of policies.</i></p> <p><i>The current long-term planning contour was published in 1994 and represents a future “near capacity” operating scenario for the airport. This contour was provided to the City of Richmond and was used as a basis for the development of the City’s aircraft noise policies.</i></p>
<p>Are there other types of measures being used to address encroachment?</p>	<p><i>In 1994, the City of Richmond and the Airport Authority signed an Accord outlining an agreement to consult with each other on the Airport Land Use Plan and the City’s zoning and Official Community Plan Bylaws. The Airport Authority actively provides comments discouraging residential developments in areas within the NEF 30 contour consistent with the Transport Canada guidelines; however, there is no obligation for the City to incorporate these comments into their plans.</i></p>
<p>List any specific tools used in addressing or managing encroachment</p>	<ul style="list-style-type: none"> <i>• Using the long-term noise planning contour representing a “near capacity” operating scenario as a basis for discussions with the City of Richmond.</i>

	<ul style="list-style-type: none"> • Referencing the Transport Canada land use guidelines. • During ongoing discussions with the City of Richmond, using the results of the population analysis to reinforce the quantifiable level of encroachment. • The City of Richmond’s Aircraft Noise Sensitive Development bylaw, created in 2004, does identify areas where residential development is prohibited. The Airport Authority must remain vigilant and proactive to ensure these areas are not released for residential development by the City due to pressure from land developers.
<p>Plans and/or recommendations for future practices</p>	<ul style="list-style-type: none"> • Monitor ongoing and planned developments, and better track planning parameters used to represent the population density of a development (e.g. Floor Area Ratio, Building Coverage Ratio, etc.) and find a means to collect and monitor this information. • Remain engaged and participate in discussions related to regional transit and any planned expansion of the Canada Line. • Continue analysis of future census data to track the level of encroachment.
<p>Accompanying Documents, if available (please attach a copy of the document to your email and list here, or provide a web address where the document can be accessed)</p>	<p><i>Analysis: Residential Encroachment Around Vancouver International Airport</i></p>

■ 3.3.2

<p>Airport(s)/Location/ Organization</p>	<p><i>Toronto Pearson Airport (YYZ)</i></p> <p><i>Vancouver International Airport (YVR)</i></p> <p><i>Winnipeg Richardson International Airport (YWG)</i></p> <p><i>Montreal Trudeau International Airport (YUL)</i></p> <p><i>Calgary International Airport (YYC)</i></p>
---	--

	<i>Regina International Airport (YQR)</i>
State/Country	Canada
Stakeholders involved (please insert an ‘X’ beside all that apply)	<input checked="" type="checkbox"/> Government <input checked="" type="checkbox"/> Federal <input checked="" type="checkbox"/> Local <input type="checkbox"/> Air Navigation Service Providers <input type="checkbox"/> Air Operators <input type="checkbox"/> Manufacturers <input checked="" type="checkbox"/> Community <input type="checkbox"/> Other (please specify):
What challenges are being faced as a result of encroachment?	<i>Land use planning around an airport directly impacts the sustainability of both the community and the airport. Incompatible land uses and encroachment, therefore, can pose challenges to maintaining safe 24-hour operations and future expansions and growth to support local and regional economic development and jobs. It also undermines gains achieved through other noise control measures including noise reduction at source, operating restrictions, and noise abatement procedures, and can result in an increase in noise complaints.</i>
What are the factors leading to encroachment at this location?	<p><i>While land use planning practices around airports vary across Canada, the following factors were identified by the airports listed above as possible contributing factors:</i></p> <ul style="list-style-type: none"> ▪ <i>Insufficient scientific rigor and evidence to support land use compatibility guidelines contained in TP1247 – Land Use in the Vicinity of Aerodromes</i> ▪ <i>Airports have little or no control over land use planning as the responsibility is delegated to the municipalities.</i>

	<ul style="list-style-type: none"> ▪ <i>Decrease in the Noise Exposure Forecast (NEF) footprint with the newer aircraft and air navigation technology</i> ▪ <i>Development and political pressure to develop within the high noise areas</i> ▪ <i>City's plan for growth and creation of new subdivisions in previously undeveloped lands near the airport</i> ▪ <i>In most Provinces, there is no regulatory requirement for alignment between the City's planning and development policies and Transport Canada's land use guidelines</i>
<p>How is encroachment being measured?</p> <ul style="list-style-type: none"> - Please provide metrics, indicators, or methods used in measurement 	<ul style="list-style-type: none"> ▪ <i>Development of new subdivisions in the vicinity of the airport</i> ▪ <i>Increase in new development surrounding the airport property and a correlation with an increase in noise inquiries from these areas</i> ▪ <i>Municipal land use and development plans which support densification and population growth in the areas located within the NEF 30 contour</i> ▪ <i>Exemptions to the protection area, allowing developments inconsistent with Transport Canada guidelines</i>
<p>Is there a noise management program in place?</p> <p>Please provide details on:</p> <ul style="list-style-type: none"> - Noise monitoring (is noise monitoring required, what system is used, frequency of monitoring, etc.) - Noise modelling (is modelling required, what system is used for modelling, how are contours determined, time range for forecasts, etc.) 	<p><i>Each airport has a noise management program that is unique and specific to their local environment. The four largest airports (YYZ, YVR, YYC, and YUL) all have noise management programs as well as aircraft noise and flight tracking systems.</i></p> <p><i>The NEF is the official metric for noise assessment in Canada. All airports, with the exception of Montreal Trudeau Airport, have created long-term planning NEF contours to assist local municipalities with land use planning decisions. Montreal Trudeau Airport creates the NEF contour annually as a key performance indicator in reduction of the aircraft noise footprint.</i></p>
<p>Are there other types of measures being used to address encroachment?</p>	<p><i>The airports are currently using the following measures to address encroachment:</i></p>

	<ul style="list-style-type: none"> ▪ Working with municipalities and providing input and comments to limit and mitigate sensitive land use developments around the airports ▪ Partnership with a local university on noise annoyance research ▪ Educating local authorities, landowners, developers, and communities about airport activities and noise related issues
<p>List any specific tools used in addressing or managing encroachment</p>	<p>All airports except YUL use a long-term planning NEF contour to assist municipalities with land use planning decisions around the airport.</p> <p>The airports have also worked with their provincial and/or municipal governments to support and encourage the use of NEF and its guidelines in the municipal land use planning. While the municipalities around these airports have incorporated the NEF contour and the supporting guidelines into their official plans and bylaws, airports continue to see inconsistency and incompatible developments as there is no regulated framework except in the Province of Alberta.</p> <p>The Alberta government enacted the Airport Vicinity Protection Area (AVPA) in 1979 based on the long-term NEF contour to manage developments close to YYC. The AVPA is an enforceable regulation and applies to all municipalities within the AVPA.</p>
<p>Plans and/or recommendations for future practices</p>	<p>As Transport Canada plans to review the NEF metric, the airports will support this work and provide input where required. Airports have provided the following input:</p> <ul style="list-style-type: none"> ▪ Airports recommend that Transport Canada engage at the provincial and municipal levels. ▪ Guidelines contained in TP1247 should be supported by scientific evidence and facts to help prohibit incompatible land uses. ▪ If Transport Canada is to adopt a new metric for land use planning, it should provide the similar level of protection as the current long-term planning NEF contours.
<p>Accompanying Documents, if available (please attach a copy of the document to your email and list</p>	<p><i>Land Use Planning at Airports in Canada</i></p>

here, or provide a web address where the document can be accessed)	
--	--

▪ 3.3.3

Airport(s)/Location/ Organization	<i>Delhi Airport/India/DIAL</i>
State/Country	<i>New Delhi/India</i>
Stakeholders involved (please insert an 'X' beside all that apply)	<input type="checkbox"/> Ministry of Environment, Forest & Climate Change <input checked="" type="checkbox"/> Air Navigation Service Providers <input checked="" type="checkbox"/> Airport Operator <input checked="" type="checkbox"/> Development Authorities <input checked="" type="checkbox"/> Airport Authority of India
What challenges are being faced as a result of encroachment?	<ul style="list-style-type: none"> - <i>There is no encroachment area defined so far around airport.</i> - <i>Airport started during 1962, during that time it was fully in isolation, however, over the years the community started settling around the airport.</i> - <i>We are in the process of defining the airport noise zone.</i>
What are the factors leading to encroachment at this location?	<ul style="list-style-type: none"> - <i>Attractive offers like connectivity, land values & employments etc.</i>
How is encroachment being measured? - Please provide metrics, indicators, or methods used in measurement	<ul style="list-style-type: none"> - <i>A noise study is conducted every five years wherein population residing in each contours are identified. This help to track the encroachments in noise contours</i> - <i>Indicator: Population/KM² in 5dBA contour line gap</i> - <i>E.g.:</i> <ul style="list-style-type: none"> ○ <i>Population/KM² in 60dBA to 65 dBA contour</i> ○ <i>Population/KM² in 55dBA to 60 dBA contour</i>

<p>Is there a noise management program in place?</p> <p>Please provide details on:</p> <ul style="list-style-type: none"> - Noise monitoring (is noise monitoring required, what system is used, frequency of monitoring, etc.) - Noise modelling (is modelling required, what system is used for modelling, how are contours determined, time range for forecasts, etc.) 	<ul style="list-style-type: none"> - <i>At Delhi Airport, several noise mitigation program is in place which is in line with ICAO balanced approach –</i> <p><i>Noise Mitigation Measures adopted at Delhi Airport –</i></p> <ul style="list-style-type: none"> ○ <i>Promote latest fleets</i> ○ <i>Runway Use Plan – Mixed Mode Operations</i> ○ <i>Low power/Low drag approach</i> ○ <i>Continuous Descent Approach</i> ○ <i>Restriction on Ground Run-up</i> ○ <i>Promote usage of FEGP</i> ○ <i>Restricted use of reverse thrust</i> ○ <i>Restriction on operation of Chapter 2 aircraft</i> ○ <i>Noise Barrier for Runway near resident area</i> ○ <i>Aircraft Noise Monitoring</i> ○ <i>Airport Noise Mapping</i> ○ <i>Aircraft Noise Redressal Cell</i> <ul style="list-style-type: none"> - <i>At Delhi Airport, we have 5 permanent noise monitoring terminal and 1 mobile noise monitoring terminal. Each runway funnel has one noise monitoring terminal.</i> - <i>The noise measurement is carried out 24*7. At India, we measure noise in following metrics – Lden (where day is 0600-1800, evening 1800-2200, and night 2200-0600), Lday, Levening, Lnight, LDE (where day is 0600-1800 and evening 1800-2200 with no penalty), Leq-24h, DNL (where day is 0600-2200 and night 2200-0600), and LMax.</i> - <i>Delhi Airport carries out noise modelling frequently. As per regulator requirement noise modelling is to be carried out once in five years.</i>

	<ul style="list-style-type: none"> ○ <i>Noise modeling is done using INM 7.0c. Next modeling will be done using AEDT software.</i> ○ <i>Noise modelling is done in three phases – Noise mapping, Validation and Noise Management Action Plan</i> ○ <i>Noise Mapping is enclosed as DGCA CAR</i> ○ <i>Noise Modelling forecast is done as per the airport master plan. For Delhi Airport, noise contour forecast has been done till year 2034 as per Delhi Airport master plan.</i>
<p>Are there other types of measures being used to address encroachment?</p>	<ul style="list-style-type: none"> - <i>We are mapping the noise contour and addressing the complaints.</i>
<p>List any specific tools used in addressing or managing encroachment</p>	<ul style="list-style-type: none"> - <i>Encroachment is something which airports may not have direct control but can only influence stakeholders for improvements.</i> - <i>As a mitigation strategy, the airport noise zone notification specifies the following below mentioned requirement. This help the airport operator to protect airport from future community demands like insulations as they are willingly shifting to noise zone. Also, it is a proactive measure wherein the noise insulation requirements are considered beforehand by developers.</i> <ul style="list-style-type: none"> ○ <i>Development Authorities / Regional Planning Department shall specify provisions for inclusion of sound resistance in new buildings, facilities and projects of residential, institutional, hospital and commercial facilities in the design, construction and materials selections for improving indoor environment under existing building codes and bye laws for any building constructions coming under airport noise zones.</i> - <i>Any development at 20 km radius from Airport ARP, requires the developer to obtain no</i>

	<i>objection certification from airport. One of the conditions in NOC is “The applicant will not complain/claim compensation against aircraft noise, vibrations, damages etc. caused by aircraft operations at or in the vicinity of the airport.”</i>
Plans and/or recommendations for future practices	<p><i>Recommendation:</i></p> <ul style="list-style-type: none"> - <i>State Development Authority and City Master Plan should understand about the airport and airport developments and its community impacts.</i> - <i>All development contracts should include an undertaking from buyers on acceptance of aircraft noise presence at the area</i> - <i>Airports shall not be liable for any compensation for encroachments</i>
Accompanying Documents, if available (please attach a copy of the document to your email and list here, or provide a web address where the document can be accessed)	<ul style="list-style-type: none"> - <i>DGCA Civil Aviation requirement – Relevant pages related to Noise Mapping requirements</i> - <i>Airport Noise Zone Notification in India</i> - <i>Delhi Airport Noise Mitigation Measure Document</i>

■ 3.3.4.

Airport(s)/Location/ Organization	<i>Suvarnabhumi Airport</i>
State/Country	<i>Samut Prakarn province, Thailand</i>
Stakeholders involved (please insert an ‘X’ beside all that apply)	<input checked="" type="checkbox"/> Government <input checked="" type="checkbox"/> Federal <input checked="" type="checkbox"/> Local <input checked="" type="checkbox"/> Air Navigation Service Providers <input checked="" type="checkbox"/> Air Operators <input type="checkbox"/> Manufacturers <input checked="" type="checkbox"/> Community <input type="checkbox"/> Other (please specify):

<p>What challenges are being faced as a result of encroachment?</p>	<ul style="list-style-type: none"> - <i>Encroachment, after the airport had finished its construction phase or expansion phase, has brought conflicts between the airport operator and people in surrounding communities. As a result, future airport expansion/development projects often receive an objection. The delay of such projects leads to insufficient capacity to serve passengers and flights in the future, causing the operation that is over the airport's capacity. This could further cause low level of service and reduce passengers' satisfaction.</i> - <i>Suvarnabhumi Airport has adopted a noise compensation program for residents and sensitive areas within the forecast noise contour. AOT purchases residents in the area with NEF>40 as they receive high level of noise impact and are considered as incompatible with airport operation. For those with medium level of noise impact or those in the area with NEF 30-40, AOT pays for sound insulation. However, people who live outside the contour also request for compensation.</i>
<p>What are the factors leading to encroachment at this location?</p>	<ul style="list-style-type: none"> - <i>The area is being utilized more industrially and commercially, especially for businesses relating to aviation industry. Moreover, facilities and utilities system have been improved greatly e.g. transportation as well as water and electricity supplies. All these have attracted people to live near the airport for work, transportation, and the conveniences.</i> - <i>Lack of stringent enforcement for the types of land use that are compatible with airport operation.</i>
<p>How is encroachment being measured?</p> <ul style="list-style-type: none"> - Please provide metrics, indicators, or methods used in measurement 	<p><i>The changes in the types and the ratio of land use within the forecast noise contour between different years.</i></p>
<p>Is there a noise management program in place?</p>	<ul style="list-style-type: none"> - <i>Currently, Suvarnabhumi Airport has Airport Noise and Operation Monitoring Stations (ANOMS). There are 19 stations in total, both inside the airport and around the airport's vicinity. There will be 6 and 5</i>

<p>Please provide details on:</p> <ul style="list-style-type: none"> - Noise monitoring (is noise monitoring required, what system is used, frequency of monitoring, etc.) - Noise modelling (is modelling required, what system is used for modelling, how are contours determined, time range for forecasts, etc.) 	<p><i>more stations for the construction of the 3rd and the 4th runway, respectively.</i></p> <ul style="list-style-type: none"> - <i>Suvarnabhumi Airport had generated a noise contour by forecasting the worst-case scenario. Also, actual noise contour is also monitored annually to make a comparison with the forecast noise contour.</i> - <i>Aviation Environmental Design tool (AEDT), developed by FAA, and has been used to generate noise contours. Forecast noise contour had been modelled with the worst-case scenario. The actual noise contour has been modelled with the actual flights annually. The NEF contour is divided into the area with high level of impact (NEF>40) and the area with medium level of impact (NEF 30-40).</i>
<p>Are there other types of measures being used to address encroachment?</p>	<p><i>None</i></p>
<p>List any specific tools used in addressing or managing encroachment</p>	<ul style="list-style-type: none"> - <i>Satellite map</i> - <i>GIS software</i> - <i>Aerial photograph</i> - <i>Land use planning</i> - <i>Noise contour to be distributed to administrative office to aid in construction permit.</i>
<p>Plans and/or recommendations for future practices</p>	<ul style="list-style-type: none"> - <i>Generate the noise contour with the worst-case scenario to inform people deciding to move into the area.</i> - <i>Install ANOMS within noise contour and the nearby areas to monitor noise impact.</i>
<p>Accompanying Documents, if available (please attach a copy of the document to your email and list here, or provide a web address where the document can be accessed)</p>	

▪ 3.3.5.

Airport(s)/Location/ Organization	<i>Don Mueang International Airport</i>
State/Country	<i>Bangkok province, Thailand</i>
Stakeholders involved (please insert an 'X' beside all that apply)	<input checked="" type="checkbox"/> Government <input checked="" type="checkbox"/> Federal <input checked="" type="checkbox"/> Local <input type="checkbox"/> Air Navigation Service Providers <input checked="" type="checkbox"/> Air Operators <input type="checkbox"/> Manufacturers <input checked="" type="checkbox"/> Community <input type="checkbox"/> Other (please specify):
What challenges are being faced as a result of encroachment?	<i>Don Mueang International Airport (DMK) has been operated for 107 years. People living in the area can accept occurring impacts. Therefore, DMK does not receive any complaints from people in surrounding communities. Meanwhile, they support DMK's development to modernize the airport for the more convenience and the higher passengers' capacity.</i>
What are the factors leading to encroachment at this location?	<p>- The area is being utilized more industrially and commercially, especially for businesses relating to aviation industry. Moreover, facilities and utilities system have been improved greatly e.g. transportation as well as water and electricity supplies. All these have attracted people to live near the airport for work, transportation, and the conveniences.</p> <p>- Lack of stringent enforcement for the types of land use that are compatible with airport operation.</p>
How is encroachment being measured? - Please provide metrics, indicators, or methods used in measurement	<i>The changes in the types and the ratio of land use within the forecast noise contour between different years.</i>

<p>Is there a noise management program in place?</p> <p>Please provide details on:</p> <ul style="list-style-type: none"> - Noise monitoring (is noise monitoring required, what system is used, frequency of monitoring, etc.) - Noise modelling (is modelling required, what system is used for modelling, how are contours determined, time range for forecasts, etc.) 	<p><i>Monitoring: - DMK monitors aircraft noise twice a year, 7 days consecutively each time. Airport Noise and Operation Monitoring Stations (ANOMS) will be installed in the future to monitor aircraft noise.</i></p> <p><i>Modelling: - Aviation Environmental Design tool (AEDT), developed by FAA, has been used to generate noise contours. Forecast noise contour had been modelled with the worst-case scenario. The actual noise contour has been modelled with the actual flights annually. The NEF contour is divided into the area with high level of impact (NEF>40) and the area with medium level of impact (NEF 30-40).</i></p>
<p>Are there other types of measures being used to address encroachment?</p>	<p><i>None</i></p>
<p>List any specific tools used in addressing or managing encroachment</p>	<ul style="list-style-type: none"> - <i>Satellite map</i> - <i>GIS software</i> - <i>Aerial photograph</i> - <i>Land use planning</i> - <i>Noise contour to be distributed to administrative office to aid in construction permit.</i>
<p>Plans and/or recommendations for future practices</p>	<ul style="list-style-type: none"> - <i>Generate the noise contour with the worst-case scenario to inform people deciding to move into the area.</i> - <i>Install ANOMS within noise contour and the nearby areas to monitor noise impact.</i>
<p>Accompanying Documents, if available (please attach a copy of the document to your email and list here, or provide a web address where the document can be accessed)</p>	

4. SUMMARY OF DOCUMENTS

4.1 Good Practices

The guidance and case studies above show a number of common practices used in noise planning that can help minimize encroachment issues. While programs and processes are different from State to State, they all highlight the importance of 1) planning for noise, 2) use of community engagement among a broad range of stakeholders, and 3) tools and practices to analyze and manage the process.

A focus on planning is important to most airport growth, and this is true for encroachment issues as well. The creation of long term noise planning contours and supporting compatible land use guidance material are critical to airports and can help limit problems with encroachment by identifying high noise areas and providing advice to local cities on which land uses should be permitted based on noise exposure. With a good noise study, the airport will have the information it needs to identify areas of most concern and manage encroachment issues as best as they can. This is seen in the case of the US and the description of maintaining compatible land uses around airports, as well as the Brazil example which describes updating plans and noise exposure maps when there is a change in any operational procedure or in the physical characteristics of the aerodrome. The examples also show that plans and maps should consider the broadest area of noise possible, not just a narrowly defined noise footprint. While aircraft have gotten quieter this may not always be the case in the future, and there may be a need to keep encroachment at a certain distance. These areas can be developed but it is best if the land uses are not noise sensitive, such as light industry.

The State examples also show that community outreach and good communications are important to successfully manage and mitigate potential encroachment. The topic involves numerous interest groups within a community. Part of planning and developing a noise map should include dialogue with a wide range of stakeholders across the aviation and local community. Measures to manage encroachment usually involve trade-offs. The community will appreciate the circumstances and the outcome better if they have been involved in discussions and understand the trade-offs associated with land use planning.

Finally, there are many tools and actions available to assist ongoing noise management and encroachment issues. The Canadian example discussed closely monitoring development applications and city plans to acquire data on what is actually happening in the community. The US example discusses possible zoning restrictions that allow only compatible land use. These can be combined with other noise mitigation procedures to reduce impacts to manageable levels. There are also various publicly-available resources which exist to assist with noise interventions. For example, the Aviation Noise Impact Management through novel Approaches (ANIMA) Project

(<https://anima-project.eu>) is a research project which has resulted in an online platform that may be used by stakeholders to address issues relating to aircraft noise. The ANIMA noise platform contains information on aviation noise and annoyance, research data, and numerous case studies of noise interventions employed at European airports.

4.2 Measurement methodologies

Measuring encroachment efficiently and sustainably at airports remains a challenging endeavor for many aviation authorities and airports. ICAO Doc 9829, Guidance on the Balanced Approach to Aircraft Noise, describes an analysis of encroachment as the percentage of change in population/households within the airport noise-regulated area where land-use planning is applicable as defined by the authority. Assessing and quantifying encroachment requires that an airport maintain historical population and housing information.

It is suggested that the degree and rate of encroachment and also the effectiveness of land-use planning and management measures adopted over time be calculated. In this context, it may be appropriate to develop an encroachment analysis for each specific international airport. An encroachment analysis is an evaluation over a time frame, usually ten to twenty years, of the percentage of change in population/households within the airport noise-regulated area where land-use planning is applicable as defined by the authority. Assessment of the rate of encroachment aims to safeguard improvements in the noise climate achieved at airports. More details on developing a methodology to evaluate the rate of encroachment is available in Appendix 2 of ICAO Doc. 9829.

Vancouver International Airport in Canada has performed an analysis of encroachment around the airport using population census data, which is collected nationally every five years. A population count analysis was completed to determine the change in population living within the airport's long term noise planning contour over a 20-year period. The Indira Gandhi International Airport (Delhi Airport) in India conducts a noise study every five years wherein population residing in each of the contours is identified, to help track the encroachments in noise contours. The indicator they use to measure is population/KM² in each 5dBA contour line gap (e.g., Population/km² residing in the 60dBA to 65 dBA contour). Some other metrics that maybe be used to assess encroachment include development of new subdivisions in the vicinity of the airport, increases in new development surrounding the airport property and a correlation with an increase in noise inquiries from these areas, and exemptions to the protection area, allowing developments inconsistent with local guidelines.

For methodologies on creating noise contours, guidance exists in ICAO Doc 9911. There is an ISO Standard for noise monitoring activities around airports. ISO 20906:2009 "Acoustics - Unattended

monitoring of aircraft sound in the vicinity of airports” provides requirements and specifications for the application and operation of noise monitoring systems and instruments.

There are many commercially-available Noise and Operations Monitoring Systems (NOMS) offered by various providers. As each airport’s situation is unique, it is best to consider an individual airport’s needs and the features that are offered by each provider if and when selecting a system. These systems can allow an airport to analyze trends in aircraft noise and provide data which can aid in addressing concerns from the community.

4.3 Common challenges

This section outlines common challenges related to the issue of encroachment. The table below identifies common challenges that were identified through the literature review or experiences provided by Task Group members, along with some examples that highlight the challenges.

Common Challenges	Examples of Challenges
A. Access to data and information to track level of encroachment	<ul style="list-style-type: none"> • The availability of population data may make it difficult to track level of encroachment (e.g. census data is often not available every year). • Information on proposed residential developments provided by the municipalities is often difficult to track and airport staff may be challenged to interpret this information.
B. Maintaining positive dialogue and negotiations between the airport and municipality	<ul style="list-style-type: none"> • Changes in elected municipal officials can lead to changes in planning and development priorities, which in turn may impact long term compatible land use plans and commitments negotiated with the airport. • Municipalities may not be fully aware of the impacts of aircraft noise and of the desirability of land use controls requiring the airport to provide education and awareness of the issues. • Land use planning is often one issue among many between the airport and municipalities, which may make it a challenge to maintain a positive dialogue as other non-related factors could potentially influence the tone of discussions.
C. Delegation of planning authority	<ul style="list-style-type: none"> • Planning is often delegated to the local municipal level. • While federal governments often provide recommendation and guidance to encourage and assist with land use planning around airports, there is often no legal requirement or obligation for the municipal government to follow or incorporate these into their policies and plans.

	<ul style="list-style-type: none"> • When airport noise planning contours extend over multiple cities, there may be challenges implementing a coordinated land use planning strategy and there is a greater chance that some of the cities will not implement desired control measures.
D. Competing economic interests	<ul style="list-style-type: none"> • Interest in tax revenues from development could potentially supersede best land use planning practices. • Development is market driven and there are many complex regional factors that municipal staff and elected officials must consider in their planning decisions. • Development fees and community amenities provided by property developer is direct and tangible to the municipality, whereas the broader economic benefits provided by an airport may be difficult to visualize.
E. Competing planning priorities between the airport and the municipalities	<ul style="list-style-type: none"> • Municipalities may over-rely on measures to mitigate noise impacts to approve and promote non-compatible developments (e.g. sound insulation, covenants, disclosure, etc.) in high noise areas, instead of avoiding or prohibiting non-compatible developments outright. • Municipalities may give lower priority and consideration to aircraft noise impacts compared to the economic advantages of developing more residential land or the need for additional housing stock within a community. • Zoning changes from residential to industrial or commercial may not make economic sense to the municipality if there is little demand for these types of uses or if there is an oversupply; therefore, a zoning change may be viewed as limiting development opportunities and diminishing the opportunities for tax revenues or development fees.
F. Interests of residents and property owners	<ul style="list-style-type: none"> • In some cases, residents and property owners may oppose proposed rezoning from residential to commercial/industrial uses arguing threats to private property rights or perceived economic loss due to a reduction in property values. • Conversely, proposed rezoning from single family or low density residential uses to high density residential uses may be supported by residents and property owners due to the perceived higher property values associated with high density residential land use designations.

Incompatible land uses can pose challenges to maintaining safe 24-hour operations and can lead to legal challenges or political pressures to change the nature of the airport’s operations. Airports may also often encounter significant public resistance to planned infrastructure expansion of facilities or services due to the presence of non-compatible developments that has occurred in

proximity to the airport lands. However, in many cases, airports have little or no control over the land use planning or decisions made regarding development in surrounding areas.

Respondents to the Task Group questionnaire indicated that land use planning controls are often delegated to the municipal/city level, and federal governments provide airport noise zoning and supporting national land use planning guidelines. These guidelines include recommendations for compatible and non-compatible land uses within a defined airport noise contour.

The application of these guidelines often brings out challenges due to competing planning priorities between the municipality and airport. Because residential development is often viewed as a main priority for local governments, it can be difficult to achieve a balance when the airport expresses opposition to non-compatible developments in high noise areas or other similar encroachment concerns.

While federal land use planning guidelines may be directly incorporated into local laws or planning policies and plans, true enforcement is often not possible due to the legal and regulatory structure that delegates responsibilities between the various levels of government.

Whereas federal governments do maintain a level of control over certain types of non-compatible developments, such as those related to building heights or wildlife attractants that have a direct impact on aviation, this level of control does not often extend to non-compatible developments related to noise.

Municipalities, provinces or states within a country can also experience a lack of agreement between their various regulations and guidelines regarding planning and development.

5. RECOMMENDATIONS

As indicated in some of the documents, the ideal scenario would not encourage or allow further noise sensitive developments to occur within the encroachment or noise exposure areas around an airport. Since in reality this is not always possible, there are certain measures that can be taken to either discourage encroachment or to mitigate its effects on both the communities and the airports. Given that regulations, guidelines, jurisdictional authorities, and planning issues are often local and unique to each airport, these recommendations may not be applicable or possible in every situation.

Maintaining a dialogue with stakeholders

As is identified in several of the documents reviewed, maintaining dialogue with communities and local governments helps to build the relationship of the airport with these partners and can assist in resolving or avoiding disputes related to encroachment. This also allows an avenue for education of various stakeholders on the effects of encroachment. This can sometimes help to dissuade development in incompatible areas. It is important to be proactive using a well-planned strategic approach to address encroachment. This includes continuing engagement in the long term, not just when a planning application is in process. Every effort should be made to have as inclusive and collaborative a process as possible, informing and seeking input from as many stakeholders as is feasible. Communication and cooperation directed toward the establishment of common goals is essential, for example, in the development of Airport Master Plans and City Area Plans. It is also important to educate or inform various levels of government of the issues of encroachment and the impacts it can have on communities when they are developing future planning strategies, as well as ensure airports seek to understand planning objectives and drivers for development in their local Cities and actively participate and provide input when City Area Plans are developed.

Application of compatible land-use planning

There are substantial benefits to be gained from the correct application of land-use planning techniques in the development of airports. As with open dialogue, land-use planning benefits may take time to be fully realized and should be implemented as soon as noise problems are foreseen. Efforts to correct situations detrimental to proper land-use around airports should however not be ignored simply because of the lead time for such measures to be effective. This is particularly true in the application of land-use planning to existing airports where it is recognized that the ability to make immediate land-use changes is limited, but where it is also important to prevent further expansion of incompatible land uses. (ICAO Doc. 9184)

Noise management plans

Although it will not stop encroachment from occurring, having a comprehensive noise management plan or strategy for the airport will help to mitigate the negative impacts that can occur from encroachment. This will also demonstrate the airport operator's commitment to managing the impacts of noise and can be used to facilitate dialogues with local municipalities to encourage compatible land uses in high aircraft noise areas to ensure noise mitigation benefits are not lost due to encroachment.

Noise management plans should also include long term noise planning contours to assist city planners in identifying high aircraft noise areas around the airport. Ideally, these planning contours should be based on a future state of operations, both in terms of forecasted aircraft operations as well as planned airport infrastructure (e.g. new runways), to ensure land use planning decisions are compatible with growth plans for the airport.

Science-backed guidelines

When new guidelines or requirements are developed by the relevant authorities, they should be based on technically robust and up-to-date scientific evidence in order to reduce or prohibit incompatible land uses around airports. Additional development of procedures and metrics considering local issues may facilitate the measurement of encroachment and responses to it. Since the issues relating to aircraft noise can vary greatly depending on situation and location, development or assessment of appropriateness of various metrics should occur at a more local level.

Continuity in enforcement

It is common that there are multiple local government authorities responsible for development approvals, and local jurisdictions with zoning power (cities, towns, or larger administrative units) may often have differing policies between authorities. They may also not be aligned to the noise zoning regulations and the maximum theoretical noise contours that have been produced (contours should be based on maximum airport capacity). Having a single authority to provide oversight and enforce the continuity of noise zoning regulations across several local government areas within the airport noise contours may alleviate the problem of multi-jurisdictional interests.

6. REFERENCE DOCUMENTS

ICAO Documents in Literature Review

- ICAO Doc. 9184 – Airport Planning Manual, Part 2, Land Use Planning and Environmental Management, Fourth Edition - 2018
- ICAO Doc. 9829 – Guidance on the Balanced Approach to Aircraft Noise Management – 2014
- ICAO Doc. 9911 - Recommended Method for Computing Noise Contours Around Airports, Second Edition – 2018
- ICAO Doc. 10031- Guidance on Environmental Assessment of Proposed Air Traffic Management Operational Changes, First Edition – 2014
- ICAO Circular 351 - Community Engagement for Aviation Environmental Management – 2017

Non-ICAO Documents in Literature Review

- [Land Use Compatibility and Airports, A Guide for Effective Land Use Planning](#) – Prepared by the Compatible Land Use Planning Task Force (1998)
- [RBAC no 161 – Emenda no 02 – Planos de Zoneamento de Ruído de Aeródromos – PZR - Regulamento Brasileiro da Aviação Civil \(2020\)](#)

Case Study Supporting Documents

- Gazette of India : Ministry of Environment, Forest and Climate Change Notification, New Delhi, 18th June, 2018 - Airport Noise Zone Notification in India
- Aircraft Noise Abatement Action Plan – Delhi Airport (2020)
- Analysis: Residential Encroachment Around Vancouver International Airport – Prepared by Vancouver International Airport (2020)
- Land Use Planning at Airports in Canada – Prepared by the Canadian Airports Council (2020)

Appendix: Templates for State Submissions

Template for Submission of Non-ICAO Guidance Document Summary

Document title & date of publication	
Overview and Purpose of the Document	
Methodology Used	
Guidance or Requirements on Zoning Regulations and/or Land Use Planning	
Good Practices for Noise Monitoring (systems, frequency, etc.)	
Guidance on Measuring Encroachment (metrics, methods, etc.)	
What have been the results of implementation of these practices (if known)? What specific challenges have been encountered?	
Recommendations/Predicted future challenges	

Template for Submission of Case Studies on Encroachment into Noise Contours

Airport(s)/Location/ Organization	
State/Country	
Stakeholders involved (please insert an 'X' beside all that apply)	<input type="checkbox"/> Government <input type="checkbox"/> Federal <input type="checkbox"/> Local <input type="checkbox"/> Air Navigation Service Providers <input type="checkbox"/> Air Operators <input type="checkbox"/> Manufacturers <input type="checkbox"/> Community <input type="checkbox"/> Other (please specify):
What challenges are being faced as a result of encroachment?	
What are the factors leading to encroachment at this location?	
How is encroachment being measured? - Please provide metrics, indicators, or methods used in measurement	
Is there a noise management program in place? Please provide details on: - Noise monitoring (is noise monitoring required, what system is used, frequency of monitoring, etc.) - Noise modelling (is modelling required, what system is used for modelling,	

how are contours determined, time range for forecasts, etc.)	
Are there other types of measures being used to address encroachment?	
List any specific tools used in addressing or managing encroachment	
Plans and/or recommendations for future practices	
Accompanying Documents, if available (please attach a copy of the document to your email and list here, or provide a web address where the document can be accessed)	

— END —

